Ruirside Developments Ltd.

42A Parkgate Street

Detailed Site Assessment

265381-00_Hickeys-DSA_2019-12-05

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1 Introduction

1.1 Project Contractual Basis

Arup were appointed by Ruirside Developments Ltd. to prepare a detailed assessment of the potential for land contamination at the Hickeys site located on Parkgate Street.

This assessment comprises an appendix to the Environmental Impact Assessment Report that supports the planning application for the Hickeys Parkgate Street Project.

1.2 Project Objectives

This report presents a Detailed Site Assessment (DSA) of the current land contamination risks and the potential land contamination risks associated with the use of the site following the proposed development.

The DSA includes findings of a detailed intrusive site investigation and subsequent monitoring of groundwater and ground gases. The report discusses the potential land contamination risks associated with the proposed use for the site. It has taken account of the site specific Preliminary Site Assessment (PSA) [1] previously prepared for the site.

Potential contamination risks associated with the demolition of the existing buildings are not covered by this PSA. These are covered by the construction strategy and Construction Environmental Management Plan (CEMP) which are appended to the Environmental Impact Assessment Report.

1.3 Scope of Work

The scope of works includes:

- Review and interpretation of the results of the site investigation carried out in March and May 2019 and subsequent monitoring of groundwater, surface water and ground gases.
- Review the Source-Pathway-Receptor (SPR) linkages on site for the current situation and the proposed development.
- Undertake a Generic Quantitative Risk Assessment of any Source-Pathway-Receptor (SPR) linkages, where such linkages exist; and
- Assess the impact of the proposed development on any land contamination present.

1.4 Proposed End Use of the Site

Ruirside Developments Limited seeks Permission, at a site (c.0.73ha), at 42A Parkgate Street, Dublin 8, for a ‘Build-to-Rent’ strategic housing development of mixed-use residential and commercial development. This comprises of a number of residential units (including ‘shared living’ units) and associated residential amenity facilities, office space, retail space, café/ restaurant space, all accommodated in 4no. blocks ranging in height from 6 to 27 storeys.

Further works which are relevant to this assessment include:

- Conservation, repair and adaptation of protected structures (including (a) stone wall; (b) turret and (c) square tower, all on the riverfront side, and (d) entrance stone arch on the Parkgate Street frontage) and some other existing structures of heritage interest on site, in part or in full.
- Demolition of existing Parkgate House, large warehouse and miscellaneous structures.
- Construction of 1-level basement to accommodate c.50 private car parking spaces, c.40no. car club parking spaces and 650no. bicycle parking spaces.
- Landscape design to include new public plaza and pedestrian connections from Parkgate Street to proposed new ‘river walk’, behind the existing heritage structures to be retained. Also, communal residential courtyard between Blocks B1, B2 and B3, and external rooftop terraces at Levels 06, 07, 08 and 09.

1.5 Guidance

At present, there is no statutory nor regulatory guidance on the assessment of land contamination in Ireland, except where the site is operated under an EPA regulated licence [3] e.g. Industrial Emission Licence (IEL) or Integrated Pollution Control (IPC) permit. This 2013 EPA [3] guidance document presents a summary of the processes to be followed and clearly sets out the documents to be prepared at each stage. The 2013 EPA guidance follows a similar international guidance on the assessment of land contamination (CLR11). In the absence of a directly relevant guidance the 2013 EPA guidance has been followed.

This Geo-environmental and Geotechnical Interpretive Report has been prepared in general accordance with the EPA Detailed Site Assessment (DSA) template within the EPA’s guidance document on management of contaminated land [3].

2 Previous Ground Investigations

2.1 Introduction

The GSI online databases, Goldmine and the Geotechnical Data Viewer were checked for historical site investigations within or in proximity to the site. The following sections outline the historic investigations identified and a brief summary of their findings.

2.2 Site Investigations Ltd. (1973) Site Investigation

A site investigation (SI) was carried out in November 1973 by Site Investigations Ltd. for Joseph McCullough & Associates at Parkgate Street (GSI Report No. 760).

The investigation consisted of 3 No. shell and auger boreholes (BHs 1 to 3) and was undertaken in November 1973.

The boreholes were located to the west and northwest of the existing building near the site boundary.

The logs reveal made ground to be present beneath the site in thicknesses ranging from 2.4 to 4.3m overlying natural ground consisting of a mixture of silts and gravels to a depth of 6.7 to 7.9mBGL before encountering possible bedrock. Thicknesses of made ground and depths to bedrock appear to increase from north to south, towards the River Liffey.

2.3 Caltex Site Investigation – Report ID 256

3 No. boreholes were dug adjacent to the site (GSI Report No. 256) along the Parkgate Street side of the existing TII building.

The company name is recorded as Caltex which may be related to the Maxol garage that was located approximately where these boreholes were dug.

The records do not show who the carried out the drilling or the technique used, maximum depths recorded were recorded as being between 2.74 to 7.01mbgl.

The logs reveal made ground to be present beneath the site in thicknesses ranging from 2.1 to 4.3m overlying natural ground consisting of a mixture of sands and gravels to a depth of 5.6 to 6.1mBGL before encountering what was described as Black Boulder Clay.

2.4 Arup Consulting Engineers (2003) Geotechnical and Environmental Assessment Report

Arup Consulting Engineers (now Arup), prepared a geotechnical and environmental assessment report in 2003 for No. 43 Parkgate Street.

The ground investigation works were carried out by IGSL Limited (IGSL) in December 2002 under the direction of representatives from Arup. The GI consisted of 8 No. shell and auger boreholes (No. 1 to 7, and 8B) and 16 No. window samples (No. 1 to 8, 9B and 10 to 16). Refer to **Appendix A** of the PSA.

During the GI works, environmental soil sampling was carried out. Analyses were carried out for the purposes of soil disposal. However, these tests were carried out before Waste Acceptance Criteria set out in the Council Decision (2003/33/EC) of the Landfill Directive was finalised. The Council Decision (2003/33/EC) specifies a sample preparation of leachates as according to the CEN method. The method used during the 2002 SI was that of the NRA method. While the correct sample preparation was not carried out for waste characterisation, the results serve to indicate the potential chemicals of concern on site.

The following organic contaminants were observed to be present in the soils:

- Mineral Oil – Associated with diesel, turpentine, and fuel oil;
- Polycyclic Aromatic Hydrocarbons (PAHs) – Formed through the incomplete combustion of fossil fuels, typically found in ash and clinker. Also, a component of petrol.

Furthermore, the following heavy metals were detected within the soils associated with the lead works and potentially the print works. The following metals were noted to be present in the made ground:

- Arsenic;
- Chromium;
- Copper;
- Lead; and
- Zinc.

Concentrations of these metals were found to exceed the Dutch Intervention Values (DIV). The DIV values were used in Holland as Generic Assessment Criteria for sites and represented concentrations above which there would be an unacceptable risk to human health and the environment, assuming a final use of residential and including for potential plant uptake. DIV exceedances of arsenic and chromium were isolated to one sample respectively. Elevations of copper was noted in 3 No. samples which exceeded the DIV threshold (190mg/kg Cu) while 6 No. samples contained concentrations of lead that exceeded the DIV threshold (530mg/kg Pb). These exceedances were located within the top 2-3m (0-3mbgl) across the site, refer to **Table 1** below.

Table 1: Samples Exceeding the Dutch Intervention Values for Soil

Metals	DIV (soil) mg/kg	No. Exceedances	No. of DIV exceedances for Soil
Arsenic	76	1	WS12 0.5mbgl-1.0mbgl, 126.0mg/kg
Chromium III/VI	180/78	1	WS15 0.5-1.0mbgl, 848mg/kg (Total Cr)
Copper	190	3	WS4 1.5-2.0mbgl, 191mg/kg WS11 0.5-1.0mbgl, 403mg/kg

Metals	DIV (soil) mg/kg	No. Exceedances	No. of DIV exceedances for Soil
			WS15 0.5-1.0mbgl, 299mg/kg
Lead	530 mg/kg	6	WS2 0.5-1.0mbgl, 946mg/kg WS3 0.5mbgl, 1031mg/kg WS4 1.5-2.0mbgl, 552mg/kg WS11 0.5-1.0mbgl, 625mg/kg WS12 0.5-1.0mbgl, 981mg/kg WS15 0.5mbgl-1.0mbgl, 710mg/kg
Total No. Exceedances		11	

One groundwater sample was taken from a borehole adjacent to the River Liffey quay wall in south-western corner of the site (BH1 at 3.5mbgl). The water sample was analysed using gas chromatography and showed to contain hydrocarbons (188.3mg/l) for petrol rage organics (>C_{10}). The laboratory analysis identified the hydrocarbons as 'possible gasoline residues'.

As mentioned in **Section 4.2 and Section 4.3**, three rounds of ground gas and water level monitoring was carried out in 2003 (25 February and 3 & 15 March 2003).

Carbon dioxide was detected at a number of locations (maximum concentration of 2.3% CO_2) and methane was detected at one location only (WS5 3.3-3.9% CH_4) over the three rounds of monitoring. The previous report assessed the concentrations against CIRIA 149, however methodology this is now obsolete.

The water level monitoring results are discussed in **Section 4.2**.

3 Ground Investigation 2019

3.1 Rationale and Strategy

As mentioned in Section 2.5, a GI was carried out at Hickeys from March to May 2019. The GI was carried out as the preliminary site assessment (PSA) identified a number of where there is insufficient information to carry out a robust assessment with the information available during the preparation of the PSA. The PSA identified a number of features with potential for causing contamination on site and the potential pollutant linkages identified in the conceptual site model (CSM).

3.2 Intrusive Investigation

Ground Investigations Ireland Ltd. (GII), under the instruction of Arup, carried out the GI between March and May 2019. The GII Ground Investigation Report (2019) is presented in **Appendix A**.

The following intrusive works relevant to the DSA were carried out:

- 18 No. window sample boreholes to recover soil samples;

- 4 No. cable percussion boreholes to a maximum depth of 7.6mbgl;
- 4 No. rotary core follow-on boreholes to a maximum of 15.60mbl;
- 4 No. rotary core follow-on boreholes to a maximum depth of 17.0mbgl;
- Installation of 10 No. groundwater monitoring wells;
- Installation of 3 no. gas monitoring caps;
- Geophysical survey; and
- Geotechnical and environmental laboratory testing.

3.2.1 Window Samples

As listed above, 18 No. window sample boreholes were carried out and soil samples were recovered for environmental and geotechnical soil testing.

Window sampling was carried out across the site including within the warehouse building. The locations of the window samples are show in the GII (2019) report.

The logs from the window sampling is presented in Appendix 4 of the GII report, shown in Appendix A of this report.

Samples were chosen for environmental testing based on information recorded on the logs by the site engineer and taking into account the site history.

3.2.2 Boreholes

As listed above, a total of 12 No. boreholes were dug on site:

- 4 No. cable percussion boreholes to a maximum depth of 7.6mBGL;
- 8 No. rotary core follow-on boreholes to a maximum of 17.0mBGL.

The boreholes were carried out to establish the nature, thickness and depth of the overburden and bedrock.

The rotary boreholes were located within the footprint of the warehouse building. Due to access restraints, cable percuissive boreholes could not be carried out within the footprint of the warehouse and as such were progressed at external locations close to the existing buildings.

The locations of the boreholes are shown in the GII (2019) report. The logs are presented in Appendix 4 of the GII report, shown in Appendix A of this report.

3.2.3 Soil Sampling

To give a robust understanding of the nature of contamination within the made ground and natural soils in vertical and lateral extent, environmental samples were taken from both boreholes and window samples. At boreholes, bulk distributed samples were taken from made ground and granular soil at 1m intervals to 8mbgl. In window samples, a small distributed sample was taken from the made ground and natural material at 1m intervals commencing at 0.5mbgl to a 4mbgl or until practical refusal.

Samples were collected in dedicated soil pots and jars as specified and supplied by the analytical laboratory. Samples were taken in accordance with methods specified and referenced in the Investigation of potentially contaminated sites - Code of practice (BS 10175:2011+A1:2013).

Representative geotechnical samples of the soils were also collected in dedicated sample pots and bulk bags.

3.2.4 Monitoring Installations

Monitoring installations were installed at boreholes across the site to record the groundwater levels and gas emissions from the made ground. Given the proximity of the site to the river Liffey estuary this information will be used to establish the tidal influence of the estuary and the flow of ground water in the site. Overall the following monitoring installations were constructed:

- Installation of 10 No. groundwater monitoring wells
- Installation of 3 no. gas monitoring caps

3.2.5 Groundwater Monitoring

Following the completion of the ground investigation, monitoring was carried out comprising one round of manual groundwater level and groundwater quality sampling in all installed monitoring well boreholes. All wells were developed using a plastic bailer, with at least three times the volume of the water within the well was extracted from each location. The groundwater monitoring results are presented in Appendix 7 of the GII report in Appendix A of this report.

Where possible, groundwater monitoring was carried out on a number of historic boreholes where they could be located or where it was feasible. These boreholes had been established during the GI carried out in 2002 (Arup Report, 2003), refer to Section 2.3. The locations of the historic boreholes are shown in Figure 2, Volume I of the IGSL GI factual report that formed part of the Arup geotechnical and geo-environmental assessment report issued in 2003, refer to Appendix A of the PSA report.

Water samples were collected from BH101, BH103, BH104, BH106 and BH107 using low-flow sampling techniques in accordance with “Water quality - Sampling. Guidance on sampling of groundwater” (BS ISO 5667-11:2009) [6].

The sample containers used were provided by the laboratory.

A number of field analytical tests were carried out including pH, Electrical Conductivity (EC), Dissolved Oxygen (DO) and Redox. The results of the field monitoring are presented in Appendix B of the ground investigation report (Appendix A). These were measured using a YSI Pro Plus Quatro multiparameter meter and a Eijkelkamp 12Vdc peristaltic pump.

Samples were only collected once the consecutive pH, EC and DO readings were observed within 10% of each other. After sampling, the samples were stored in cool boxes with ice packs before being sent to the laboratory.

3.2.6 Ground Gas Monitoring

Three rounds of ground gas monitoring were carried out on 3 No. boreholes (WS110, WS114, WS117) on the 3rd, 30th May and 13th June 2019. The gas monitoring results are presented in Appendix 7 of the GII report in Appendix A of this report.

3.2.7 Laboratory Analysis

All soil and water samples taken on site were kept cool on site until they were transported by courier the laboratory in the UK (Exova Jones). Samples were scheduled for analysis as instructed by Arup engineers based on information collated during the PSA and the logs recorded during the GI.

4 Results and Discussion of Ground Investigation

4.1 Site Geology

The site geology consists generally of made ground overlying a layer of clay with occasional shell fragments, which overlies sand and gravel. Limestone bedrock is present underneath the natural soils. A summary of the strata proven at the site is summarised in Table 2. This information is compiled from the borehole and window sample logs from the site investigation as presented in Appendices 4 and 5 of the site investigation report produced by Ground Investigations Ireland presented in Appendix A of this DSA. The strata proven is consistent with the regional geology and generally consistent with findings from previous site investigations for the site presented in the PSA.

Table 2: Site geology

Lithology	Description	Depth (mbgl)	Thickness (m)
Made ground	**Hardcore** Concrete and Tarmacadam	0 – 1.3	0.04 – 1.3
	Clay/ Gravel Brown to dark brown slightly sandy clay and gravel with cobbles and anthropogenic materials (including, but not limited to slag, redbrick, mortar, charcoal). Gravel is angular to subrounded, fine to coarse.	0 – 5.0	1.4 – 5.0
Clay	Soft, light brown to brown, slightly sandy silty clay with occasional shell fragments	1.9 – 6.20	0.3 – 1.40
Sand and gravel	Loose to very dense grey to brown slightly clayey gravelly fine to coarse sand and gravel with occasional cobbles. Gravel is subangular to subrounded.	2.6 – 8.50	1.2 - 3.8
Weathered Bedrock	Angular cobbles of weak, thinly laminated dark grey to black Mudstone and Limestone	6.4 – 8.6	0.2 - 1.5
Limestone Bedrock	Weak to very strong dark grey fine grained limestone with bands of mudstone (?) and calcite veining	6.7 – 17.0 (proven)	8.7 (proven

4.1.1 Made Ground

The made ground is present in all boreholes and window samples on the site. A generally thin layer of concrete or tarmacadam overlies the clay and gravel made ground layers.

The thickness of the made ground varies between 1.4m in WS113 to 5.0m in BH104 and typically contains slag, red brick fragments, mortar and charcoal.

4.1.2 Natural Strata

A clay layer with occasional shell fragments is present across the site and is likely to be alluvium deposits from the River Liffey floodplain before the site was reclaimed in the early 1800's.

Layers of sand and gravel underlying the clay layer were also present throughout the site and are likely to be river or estuarine deposits in the area of the River Liffey channel.

A layer of angular cobbles of limestone were then encountered, described by the drillers as weathered bedrock followed by weak to very strong dark grey fine-grained limestone with bands of mudstone and calcite veining, proven to 17.0mBGL.

4.2 Site Hydrogeology

During the site investigation, only the natural sand and gravel was found to be water bearing. No groundwater was encountered in the made ground. Groundwater monitoring installations were installed in all boreholes, with response zones in the following locations:

- BH101, BH103, BH106 in the natural clay and/ or gravel;
- BH102, BH104, BH105 in the limestone bedrock;
- BH107 in the natural gravel and the limestone bedrock.

Water levels in the boreholes and historic boreholes (BH101, BH103, BH104, BH105, BH106, BH107, BH01, BH02, BH05, BH06, WS06, WS12 and WS13) were manually recorded on four occasions in May and June 2019 while the site investigation works were ongoing. Water levels were not recorded in BH102 as it was not completed or was not accessible during this time.

Water levels in the boreholes were electronically recorded over a four-week period between 14th August and 12th September 2019 using transducers in BH101, BH102, BH103 and BH106. A summary of this data is presented in Table 3 and Figure 1 below.

The groundwater level in both the natural sand and gravel aquifer and in the limestone bedrock aquifer varied with the tide during the monitoring period.

BH106 in the south-centre of the site had the maximum variation in groundwater level as it was closest to the River Liffey and so was impacted by the tidal variation most. Groundwater levels in BH103, located in the north-centre of the site and furthest away from the river, varied the least but was still influenced slightly by tidal variation.

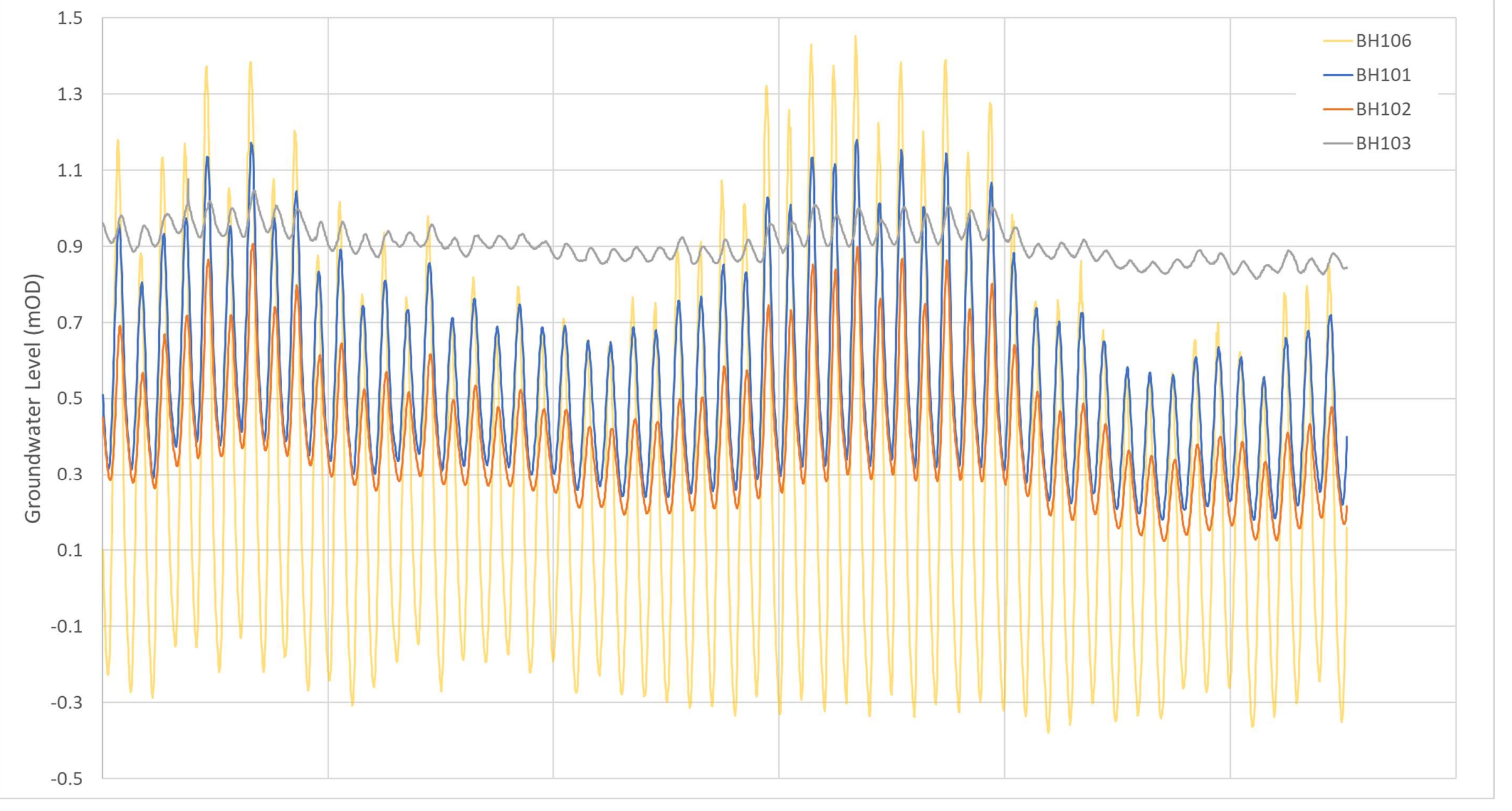
Based on this data, groundwater flow across the site is in a north-west to south-east direction toward the river during low tide and in a south-east to north-west direction at high tide.

Table 3: Summary of monitored groundwater levels

Location ID	**Aquifer Type**	**Groundwater Level Maximum (mOD)**	**Groundwater Level Minimum (mOD)**
BH101	Sand and gravel	1.18	0.18
BH102	Limestone bedrock	0.91	0.12
BH103	Sand and gravel	1.08	0.82
BH106	Sand and gravel	1.45	-0.38

The data from the transducers and manual readings are presented in Appendix A.

Figure 1: Groundwater Transducer Data - 14/08/2019 to 12/09/2019



4.3 Gas Monitoring

Gas monitoring installations were installed in three window samples – WS110, WS114 and WS1117. The response zone was installed in the made ground and the natural clay.

Gas monitoring was carried out on three occasions during the site investigation works in May 2019 and on one occasion in June 2019 in tandem with the groundwater monitoring.

4.4 Laboratory Testing Results

4.4.1 Soil Analysis

Soil samples were collected from the window samples and boreholes during the site investigation period and are presented in Appendix A. A summary of the soil sample results are as follows:

4.4.2 Water Quality

Water quality samples were taken from the boreholes on one occasion during the groundwater monitoring rounds and are presented in Appendix A.

4.4.3 Ground Gas

Gas monitoring results taken from the window samples are presented in Appendix A. A summary of the results are as follows:

4.5 Conceptual Site Model

An initial conceptual model was presented in the PSA which raised several site uncertainties, some of which have been addressed through the DSA.

Below is a summary of the CSM in which the site has been subdivided into sources, pathways and receptors and key source pathway receptor (SPR) linkages are highlighted.

4.5.1 Sources

The PSA highlighted the following potential sources:

- Made-ground of unknown origin;
- Above ground storage tanks;
- Underground storage tanks;
- Historical contamination from former Maxol station (adjoining the site);
- Asbestos containing materials in the soil.

4.5.2 Pathways

The principal pathways highlighted in the PSA were:

- Direct exposure of contamination in the made ground (ingestion, inhalation and dermal contact);
- Percolation of recharge through the unsaturated made ground to the groundwater in the made ground;
- Percolation of liquid contaminants through the made ground to the gravel layer;
- Percolation of liquid contaminants through the made ground and gravel layer to the underlying bedrock;
- Groundwater flow through the made ground and quay wall;
- Groundwater flow through the gravel layer and the quay wall; and
- Movement of ground gas through the unsaturated made ground.

4.5.3 Potential Receptors

The principal receptors highlighted in the PSA are:

- Demolition and construction workers;

- Site users (current and future including employees, residents, etc.);
- Groundwater;
- Groundwater in the gravel layer;
- River Liffey;
- Irish Sea.

4.5.4 Source Pathway Receptor (SPR) Linkages

Considering the CSM outlined above, the following plausible SPR linkages are highlighted in Table 4 for the current and proposed development of the site.

Table 4 -Identified Source-Pathway-Receptors

Source	Pathway	Receptor
Made-ground of unknown origin;	Direct exposure of contamination in the made ground (ingestion, inhalation and dermal contact);	Demolition and construction workers;
	Percolation of recharge through the unsaturated made ground to the groundwater in the made ground;	Groundwater;
	Percolation of liquid contaminants through the made ground to the gravel layer;	Groundwater in the gravel layer;
	Percolation of liquid contaminants through the made ground and gravel layer to the underlying bedrock;	Groundwater;
	Groundwater flow through the made ground and quay wall;	River Liffey;
		Irish Sea.
	Movement of ground gas through the unsaturated made ground.	Site users (current and future including employees, residents, etc.);
		Demolition and construction workers;
Above ground storage tanks;	Percolation of liquid contaminants through the made ground to the gravel layer;	Groundwater in the gravel layer;
	Percolation of liquid contaminants through the made ground and gravel layer to the underlying bedrock;	Groundwater;
Underground storage tanks;	Percolation of liquid contaminants through the made ground to the gravel layer;	Groundwater in the gravel layer;
	Percolation of liquid contaminants through the made ground and gravel layer to the underlying bedrock;	Groundwater;
Historical contamination from former Maxol station (adjoining the site);	Direct exposure of contamination in the made ground (ingestion, inhalation and dermal contact);	Demolition and construction workers;
		Site users (current and future including employees, residents, etc.);

Source	Pathway	Receptor
	Percolation of liquid contaminants through the made ground to the gravel layer;	Groundwater;
	Percolation of liquid contaminants through the made ground and gravel layer to the underlying bedrock;	Groundwater in the gravel layer;
	Movement of ground gas through the unsaturated made ground.	Site users (current and future including employees, residents, etc.);
		Demolition and construction workers;
Asbestos containing materials in the soil.	Direct exposure of contamination in the made ground (ingestion, inhalation and dermal contact);	Demolition and construction workers;
		Site users (current and future including employees, residents, etc.);

Considering the receptors highlighted above, human health criteria for the soils and environmental quality standards for the groundwater are considered as part of a generic quantitative risk assessment (GQRA). The GQRA has been carried out for the contaminants identified in Section 4.4.

5 Generic Quantitative Risk assessment (GQRA)

5.1 Generic Assessment Criteria (GACs)

5.1.1 Soil

There are no Irish soil quality standards for assessing risk of contaminated soils to site users. EPA guidance states that:

"EPA recommends the use of GAC, based on the UKEA Contaminated Land Exposure Assessment (CLEA) model, either produced by the UKEA itself (known as Soil Guideline Values/SGVs) or values generated using the CLEA model by reputable third-party organisations such as Land Quality Management (LQM) or Contaminated Land: Applications in Real Environments (CL:AIRE). Where GAC have not been published or if practitioners don't use human health GAC publications, values should be generated by appropriately qualified and experienced professionals using the CLEA model to ensure consistency with the EPA approach"

Consistent with the EPA guidance limits this GQRA refers to C4SL's (Category 4 Screening Levels) derived using CLEA and as an output from the UK Department for Environment, Food and Rural Affairs (DEFRA) research project SP1010 and which incorporate feedback from the project's Steering Group and the wider contaminated land community [15]. The project's Steering Group included individuals from the following organisations:

- Department for Environment, Food and Rural Affairs (Defra)
- Department for Communities and Local Government (DCLG)
- Welsh Government (WG)
- Environment Agency (EA)
- Natural Resources Wales (NRW)
- Public Health England (PHE, formerly the Health Protection Agency)
- Food Standards Agency (FSA) and
- Homes and Communities Agency (HCA)

Where no C4SL is available, the LQM's S4UL's (suitable for use limits) have been derived using the CLEA model by a group of contaminated land consultants and members of academia [16]. These have been endorsed in the UK by the Chartered Institute of Environmental Health (CIEH). The S4UL's are relatively conservative and do not take account of individual exposure pathways at each site or the local soil type.

Where no S4UL is available, Generic Assessment Criteria developed by Arup using the CLEA model have been used.

Where, no C4SL, S4UL or Arup standards are available, values from the other countries surrogates comprising similar compounds have been used. These have not been derived using the CLEA model but are considered to be conservative and comprise a suitable standard for this preliminary assessment.

In the GQRA the soil assessment criteria are collectively referred to as GAC.

Although all standards used in this assessment were not specifically derived for Irish soil, the large factor of safety built into the CLEA model makes them a suitable conservative assessment criteria in the absence of Irish soil standards. They are also commonly used in Northern Ireland.

The GAC's are available for a range of different land uses. These have been reviewed and compared to the site uses proposed for the Parkgate Street site.

The proposed development at No. 42A Parkgate Street will be a mixed-use development with both commercial and residential units. For this reason, the environmental soil testing results were screened against two sets of GAC thresholds modelled for Commercial and Residential (without home-grown produce) site uses respectively.

Section 4.3.4 of the CLEA Software Handbook[1] (V1.05) describes the assumptions made by the CLEA model on the receptor behaviour under the standard commercial land use:

"*The standard commercial land use described in the CLEA software assumes a typical commercial or light industrial property; it does not apply to heavy industrial workers and facilities, nor to work that is predominantly undertaken outside such as construction work or landscape maintenance. Soil and soil-derived dust ingestion rates, proportion of time spent inside and outside, number of hours on site and proportion of time spent in active and passive respiration are defined for the patterns of an office or warehouse worker undertaking relatively light work indoors with standard hour days and short outside breaks.*

[…]

Children are not the critical receptor for long-term risks for the commercial land use scenario, as they are not typical regular users of the land."

Under the commercial land use, the default critical receptor in the CLEA model is an adult male and female over the age of 17 years. The Commercial GAC values are derived from the CLEA modelling this scenario.

In the residential land use scenario (without homegrown produce), the CLEA model uses receptor data for those persons aged 1-18 years of age as the default critical receptors and therefore the GAC thresholds derived are typically lower as it assumes a more vulnerable default site user who is exposed to the soil, for example, residents using green spaces and in contact with the soil but without consumption of produce grown in the soil.

[1] Environment Agency (2010) CLEA Software (Version 1.05) Handbook. Accessible at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/455747/LIT_10167.pdf

The soil organic matter (SOM) for the site was set at 2.5% as this was shown to be most representative of the material on site.

5.1.1.1 Asbestos

Currently, there are no Irish or UK GAC for asbestos. Based on current understanding there is no 'zero risk level' for asbestos [9], hence any measurable amount can pose a risk to a receptor. In this assessment it has been assumed that if the laboratory limit of detection is not exceeded, no asbestos is present in the sample.

However, even if asbestos was not observed in the tested sample, there still remains the possibility that it could be present in concentrations less than the laboratory detection limit. Hence soils with recorded concentrations of asbestos below the detection limit could still present a risk.

5.1.2 Groundwater

The EQSs are prepared by the European Union to assess the quality of water within the member states of the Union [10][11][12]. They are not statutory requirements for land owners, but exceedances of the standards are considered to comprise pollution as they could affect the quality status of the water body.

Where no surface water EQS are available, in order of preference, groundwater quality standards [12] and then older EPA interim guideline values (IGV) [13] have been used to provide a qualitative assessment levels. An exceedance of a groundwater standard or IGI value does not necessarily denote that the water quality is unacceptable but highlights that the concentration could be unacceptable and requires additional consideration.

If water quality beneath the site is seen to exceed the EQS value, this could be either due to an on-site contamination source or an off-site source.

5.2 Results of GQRA

5.2.1 Soils

Under the commercial land-use scenario, the following samples exceeded the GAC thresholds, refer to Table 5.

Table 5 - Samples exceeding GAC threshold for Commercial land use.

Contaminant	**GAC Threshold**	**No. Exceedances**	**Sample ID and Depth (mbgl)**	**Sample Result**
Lead	2300 mg/kg	1	WS105A at 0.5mbgl	4755mg/kg
Dibenzo[ah] anthracene	3.55 mg/kg	1	WS106 at 0.5mbgl	4.81mg/kg
Total No. of Exceedances		2		

Under the residential (without home grown produce) land use scenario, a total of No. 15 samples exceeded the GAC thresholds, refer to Table 6 below. The locations of the window samples and boreholes from where the samples were taken, are show in the GII (2019) report, shown in Appendix A of this report.

Table 6 - Samples exceeding GAC threshold for residential (without home grown produce) land use scenario.

Contaminant	GAC Threshold	No. Exceedances	Sample ID and Depth (mbgl)	Sample Result
Arsenic	2 mg/kg	1	BH101 at 1.0 mbgl	43.1 mg/kg
Lead	310 mg/kg	8	WS106 at 0.5 mbgl	366 mg/kg
			WS106 at 1.0 mbgl	414 mg/kg
			WS114 at 1.5 mbgl	385 mg/kg
			WS103 at 2.6 mbgl	521 mg/kg
			WS101 at 1.0 mbgl	312 mg/kg
			WS105A at 0.5 mbgl	4755 mg/kg
			TP102 at 1.0 mbgl	692 mg/kg
			WS110 at 0.9 mbgl	2229 mg/kg
Benzo[a] anthracene	14 mg/kg	1	WS106 at 0.5 mbgl	19.01 mg/kg
Benzo[a] pyrene	3 mg/kg	2	WS106 at 0. 5 mbgl	17.27 mg/kg
			WS105A at 1.3 mbgl	8.97 mg/kg
Dibenzo[ah] anthracene	0.32 mg/kg	3	WS106 at 0.5 mbgl	4.81 mg/kg
			WS106 at 1.0 mbgl	0.64 mg/kg
			WS105A at 1.3 mbgl	1.46 mg/kg
Total No. of Exceedances		15		

Based on the results of the soil testing, except for lead and Dibenzo[ah] anthracene on one occasion, the determinands are below the (commercial) GAC limit.

It is likely the lead is resultant from the previous uses on site such as the printworks and metalworks. Dibenzo[ah] anthracene is a PolyAromatic Hudrocarbon (PAH) and these are typically associated with the partial combustion of fossil fuels. While the description of the made ground at 0.5mBGL mentions only mortar and redbrick fragments, from 1.4mBGL down there is mention of the presence of slag. This slag may have been present in the upper sample and was not observed.

While the exceedances for the Residential (without home grown produce) were more extensive, this should be recognised as a more conservative screening value than the Commercial GACs.

The majority of the exceedances (eight from fifteen in total) against the residential GACs were for Lead, which as stated above can be linked back to the previous uses of the site. The next most common exceedances were for PAH's (Benzo [a] anthracene, Benzo [a] Pyrene and Dibenzo [ah] anthracene) (six from fifteen in total). Typically PAH's are linked to partial combustion of fossil fuels and given the descriptions of made ground across the site made reference to slag, ash and charcoal, this is not unexpected.

The final exceedance was for arsenic which was located in one sample and may be associated with the slag which was noted in the made ground descriptions from the sample.

It should be noted that the exceedances in relation to the commercial GACs are both located in WS105A and WS106 at a depth of 0.5mBGL. These are both located in the courtyard area adjacent to the site boundary with the TII Building.

One sample which had lead concentrations in excess of the residential GAC was recovered from (2.6mBGL / +1.09mOD). This sample would be situated 1.6m beneath the top of the proposed slab and as such would pose a negligible risk to any receptors on the site. The remaining samples, WS110, 0.9mBGL / +3.35mOD and WS114, 1.5mBGL / +2.75mOD, will both be situated beneath the ground floor of the other buildings on site which appear to have ground floor levels of +5.2 to +5.5mOD meaning at least 2.45m of cover between those soils and any potential receptors.

5.2.2 Groundwater Quality

A summary of the results are presented in Table 7 - Groundwater GAC Exceedances**Error! Reference source not found.**.

The majority of GAC exceedances are observed in BH101, located in the south-west of the site and in the area of the old generator room, boiler house No. 2 and the old chimney and downgradient of underground storage tanks 1 and 2.

Table 7 - Groundwater GAC Exceedances

Test	Units	LOD*	GAC	BH101	BH103	BH104	BH106	BH107	Number of Exceedences	Max	Median	Min
Dissolved Arsenic	ug/l	<0.9	7.5	<LOD	10.6	<LOD	<LOD	<LOD	1	10.60	10.60	10.60
Dissolved Barium	ug/l	<1.8	100	155.1	66.6	11.4	17.5	42.5	1	155.10	42.50	11.40
Total Dissolved Iron	ug/l	<4.7	200	1840	1335	17.1	4.7	160.6	2	1840.00	160.60	4.70
Dissolved Magnesium	mg/l	<0.1	50	188.2	14.1	4.3	28.9	26.1	1	188.20	26.10	4.30
Dissolved Manganese	ug/l	<1.5	50	1637	617.3	24.5	635.7	322.5	4	1637.00	617.30	24.50
Dissolved Potassium	mg/l	<0.1	5	54.3	14.1	2.6	17.7	16.9	4	54.30	16.90	2.60
Dissolved Sodium	mg/l	<0.1	150	1518	24.6	17.2	110.6	53.2	1	1518.00	53.20	17.20
Sulphate as SO_4	mg/l	<0.5	187.5	363.5	21.5	44	97.5	133.4	1	363.50	97.50	21.50
Chloride	mg/l	<0.3	187.5	2668.9	31.7	31.7	159.7	43.6	1	2668.90	43.60	31.70
Ammoniacal Nitrogen as N	mg/l	<0.03	0.175	0.24	6.88	0.03	0.58	0.29	4	6.88	0.29	0.03
Electrical Conductivity @25C	uS/cm	<2	1875	8635	735	330	1210	898	1	8635.00	898.00	330.00
Total Dissolved Solids	mg/l	<35	1000	5008	448	213	678	584	1	5008.00	584.00	213.00

*LOD = Limit of Detection

Orange shaded cells indicate an exceedance.

6 Soil Management Options

The most cost effective and environmentally sustainable solution for the management of excavation spoil on site is for reuse in landscape features or as fill, where appropriate. The options for soils disposal include:

1. Reuse on the source site
2. Reuse on another development site (carried out under an Article 27 determination);
3. Recovery and use in a permitted waste recovery facility; and
4. Disposal to Licensed Landfill/Disposal Facility.

6.1 Reuse on Site

The engineering design of the proposed structure requires the raising of site levels to approximately +5.5mOD beneath parts of the site, namely the areas where the current factory building is located, beneath proposed Blocks A and B1.

The undercroft is being constructed along the western margin of the site beneath Block B2 and this will be excavated down to a provide a finished slab level of +2.6mOD.

Existing levels across the site vary from +5.29mOD to the north to +3.8mOD to the south close to the quay wall for the River Liffey. The floor slab in the existing warehouse is at approximately +4.3mOD.

This would suggest that there is an excavation of approximately 2.7 to 1.2m required for the construction of the undercroft and filling from a minimum of 1.2m for the slab level for Block A and Block B1.

Where the excavated material from the undercroft can be shown to not contain elements which potentially pose a risk to site occupants or the proposed structures on site, the material may be reused. Given the current design of the proposed buildings includes for suspended slabs sited on pile caps it would be proposed to use site won materials which do not contain asbestos or exhibit any exceedances of the GACs which fulfil the Class 1 / Class 2 General fill Specification from Series 600 of the TII Specification for Roadworks. This material could then be used around the pile caps which shall be constructed for the slab beneath Blocks A and B1.

6.2 Reuse on another site

Under Article 27 the excavated materials are deemed to be a ‘by-product’ of a ‘process’, which have a lawful and beneficial re-use at a separate location that requires such materials. Excavated materials that can meet these requirements are natural soil and rock and engineered materials that meet technical specifications and create no environmental risk to the receiving environment. Where feasible the Article 27 approach provides a cost-effective solution, which does not require any waste licencing or permitting, just an EPA determination of the material as a by-product.

As the materials to be excavated from the subject site are predominantly made-ground, determination as a by-product is considered unlikely. In addition, the determination requires confirmation of a lawful re-use, which means the receiving site has to have appropriate planning permission to receive such materials and have the capacity at the time of excavation. In light of these constraints we consider this option to be unlikely and have not considered it further.

6.3 Recovery

Recovery and use in a permitted waste recovery facility is based on complying with the prevailing limits for soil recovery as set for each facility. These are typically lower than the acceptance criteria set for inert licenced landfills.

Given that the majority of the soils to be excavated during the construction of the undercroft are classified as requiring disposal to non-hazardous or hazardous licenced landfill, recovery is not considered as a likely option for these soils.

Some of the soils from elsewhere classified as potentially suitable for an inert licenced landfill could be sent to a recovery facility should they meet the site-specific standards and particular requirements of the facilities permit, e.g. a site may not be permitted to take made ground.

6.4 Disposal to a Licenced Landfill

Disposal of the materials to licenced facilities is considered the most likely option based on the assessment undertaken on the data available to date. The costs of disposal are based on the classification of the materials requiring disposal, falling into one of the following categories. These are listed in order of increasing costs:

- Suitable for disposal to an Inert Licenced Landfill;
- Suitable for disposal to a Non-Hazardous Licenced Landfill;
- Suitable for disposal to a Non-Hazardous Licenced Landfill, but containing <0.1% Asbestos;
- Suitable for Disposal to a Hazardous Licenced Landfill;
- Suitable for Disposal to a Hazardous Licenced Landfill but containing <0.1% Asbestos;
- Soils requiring export for specialist disposal or incineration.

6.4.1 Waste Classification Criteria

The soils within the assumed excavation areas have been classified in respect of their waste classification. The waste assessment criteria that have been used were derived from:

- Waste Assessment Criteria as presented in Annex II to Directive 1999/31/EC;

- Environmental Protection Agency's 2015 report entitled Waste Classification List of Waste and Determining if Waste is Hazardous or Non-Hazardous; and
- Joint agency document entitled Waste Classification guidance on the classification and assessment of waste (1st Edition, Version 1.1 dated May 2018) referred to as WM3.

The WM3 document is applied through the HazWasteOnline tool which has been used to carry out part of this assessment.

It should be noted that the assessment criteria used to categorize the soils are based on Irish and European standard criteria.

Specific landfills were not consulted in relation to their acceptance criteria, which would be required in further stages of assessment to provide actual alternatives.

The criteria outlined in the Landfill Directive represents the minimum limits for acceptance of materials. The operators of landfills may use their own discretion to set their own limits for materials.

The soils categorized largely includes made ground (historic fill and recent made ground). It is not likely that any consideration was given to potential contamination at the time of deposition of these materials. It is likely, therefore, that there is a high level of heterogeneity within the made ground. Considering this heterogeneity, it should be noted that proportionally the soil sample analysed and categorized represents a very small quantity of the total volume of soil and therefore are only representative of a discrete location.

As a consequence of the nature of the material and notwithstanding the results of our classification for each cell there remains a risk that the classification is not representative of the bulk of soils in each cell. Allowance should be made for encountering hotspots of contamination within the site.

6.5 Method

In order to quantify the volume of soil with differing waste classification the site was sub-divided into cells based on the position of ground investigation locations and the sampling frequency. Samples collected from boreholes in each cell were used to attribute a waste classification to each cell.

This exercise was repeated for 1m lifts from ground level across the site (4.5mOD to 3.5mOD, 3.5mOD to 2.5mOD and 2.5mOD to 1.5mOD). This was based on the assumed depth of dig to 2.6mOD to facilitate the construction of the undercroft.

Where no soil samples were collected from a cell the waste classification is based on the nearest confirmed classification with the same depth within similar soil types.

These breakdowns do not account for any potential hotspots located across the site which were not identified during the ground investigations.

Additional costs may be associated with the disposal and/or treatment of contaminated groundwater arising from dewatering operations across the site.

Materials with a high proportion of waste may require some limited screening prior to disposal. The selective excavation and handling of materials according to their waste classification also poses challenges in terms of site logistics and programming. Earthworks contracts may indeed choose to apply a much simpler and conservative classification to each site that allows them to excavate and deposit in the one location.

7 Likely Remediation Strategy

This section presents options for remediation strategy for the proposed works. The options are considered illustrative and are all subject to the final design of the buildings. These will be finalised during the planning process and detailed design of the site. An options appraisal has not been undertaken as the mitigation measures are intrinsic to the development design or relate to site management as described below.

7.1 Excavated Materials Management

To facilitate the controlled excavation of these soils, the site was divided into 20m by 20m grids labelled A to D from North to South, and numbered 1 to 4 going from West to East. Therefore on this basis we have assigned a category for disposal to each of these cells based on the results of the chemical testing.

However, firstly we must consider the results of the various screening exercises applied to the tested soils in turn.

7.1.1 GACs

Based on the screening carried out on the soils, a number of locations were identified where the soils contained parameters which exceeded the GACs for Residential Land Use (without Plant Uptake). These were as presented in Table 8 and are reproduced below.

Table 8 - GAC Exceedances

Contaminant	GAC Threshold	No. Exceedances	Sample ID and Depth (mbgl)	Sample Result
Arsenic	2 mg/kg	1	BH01 at 1.0 mbgl	43.1 mg/kg
Lead	310 mg/kg	8	WS106 at 0.5 mbgl	366 mg/kg
			WS106 at 1.0 mbgl	414 mg/kg
			WS114 at 1.5 mbgl	385 mg/kg
			WS103 at 2.6 mbgl	521 mg/kg
			WS101 at 1.0 mbgl	312 mg/kg
			WS105A at 0.5 mbgl	4755 mg/kg
			TP102 at 1.0 mbgl	692 mg/kg
			WS110 at 0.9 mbgl	2229 mg/kg
Benzo[a] anthracene	14 mg/kg	1	WS106 at 0.5 mbgl	19.01 mg/kg
Benzo[a] pyrene	3 mg/kg	2	WS106 at 0. 5 mbgl	17.27 mg/kg
			WS105A at 1.3 mbgl	8.97 mg/kg
	0.32 mg/kg	3	WS106 at 0.5 mbgl	4.81 mg/kg

Contaminant	GAC Threshold	No. Exceedances	Sample ID and Depth (mbgl)	Sample Result
Dibenzo[ah] anthracene			WS106 at 1.0 mbgl	0.64 mg/kg
			WS105A at 1.3 mbgl	1.46 mg/kg
Total No. of Exceedances		15		

Based on this table and Figure 1 (Location of GAC exceedances) it can be seen that the majority of the exceedances (13 of 15) occur within the second lift on site, (3.5mOD to 2.5mOD).

Materials arising from grids which are shown to contain exceedances of the GACs are not suitable for reuse on site and as such will require categorisation and disposal off-site.

7.1.2 Asbestos

Excavated soils which were noted to contain low levels of asbestos (<0.1%) will require disposal off site.

In one case four of the asbestos detects all occurred in close proximity, at TP102, BH101, WS101 and WS103, all within the 3.5-2.5mOD lift.

Three of the remaining detects were located in the top lift (4.5-3.5mOD) at locations WS108 (+3.78mOD), WS114 (+3.78mOD) and WS117 (+3.78mOD).

The final detect was located in WS115 at 1.78mOD, within the 2.5-1.5mOD lift. These soils are located beneath the footprint of Block A and Block B1 and as such the levels in this area will be built up to 5.5mOD.

7.1.3 Disposal Categories

Materials requiring Disposal need to be classified according to the following:

- Waste Assessment Criteria as presented in Annex II to Directive 1999/31/EC;
- Environmental Protection Agency's 2015 report entitled Waste Classification List of Waste and Determining if Waste is Hazardous or Non-Hazardous; and
- Joint agency document entitled Waste Classification guidance on the classification and assessment of waste (1st Edition, Version 1.1 dated May 2018) referred to as WM3.

Based on the findings of these assessments the soils were divided into the following categories:

- Suitable for disposal to an Inert Licenced Landfill
- Suitable for disposal to a Non-hazardous Licenced Landfill

- Suitable for disposal to a Non-hazardous Licenced Landfill which can also accept asbestos
- Suitable for disposal to a Hazardous Licenced Landfill
- Suitable for disposal to a Hazardous Licenced Landfill which can also accept asbestos
- Requires Specialist Disposal and/or Ex-Situ Treatment

A number of figures were prepared which detailed the disposal categories for the soils which would apply, should they be sent off-site for disposal as a waste.

Note that the site was divided into a number of grids for the purpose of this exercise. These grids could be further subdivided and additional testing could be carried out if required to further define the extent of the contaminated soils.

However, provision should always be included for the management of unidentified hotspots across the dig, given the variable nature of the made ground across the site.

The categories proposed above are based on current legislation and requirements. Additional Criteria or alternative limits may apply to some specific landfills based upon their licence.

Table 9 - Disposal Category Breakdown

Lift	**GL - 3.5**	**3.5-2.5**	**2.5-1.5**	**Overall %**
Classification	%			
Inert Licenced Landfill	0%	21%	26%	16%
Non Hazardous Licenced Landfill	50%	32%	63%	48%
Non Hazardous Licenced Landfill with Asbestos	17%	5%	11%	11%
Hazardous Licenced Landfill	8%	32%	0%	13%
Hazardous Licenced Landfill with Asbestos	17%	10%	0%	9%
Specialist disposal or Ex-Situ Treatment	8%	0%	0%	3%

7.2 Gas Protection Measures

Three rounds of ground gas monitoring were carried out on 3 No. boreholes (WS110, WS114, WS117) on the 3rd, 30th May and 13th June 2019.

Results are presented in Table 10.

Table 10 - Ground gas monitoring

Sample ID	Date	Barometric Pressure	Methane	CO_2	CO	H_2S	O_2	Flow Rate	Comment
		mbar	%	%	ppm	ppm	%	l/s	
WS110	03/05/2019	-	0	2.5	1	1	17.5		

Sample ID	Date	Barometric Pressure	Methane	CO_2	CO	H_2S	O_2	Flow Rate	Comment
		mbar	%	%	ppm	ppm	%	l/s	
	30/05/2019		0	2.8	2	3	15.6		
	13/06/2019	1008	0	6.7			6.9	0.2	
	03/05/2019	-	0.1	3	1	1	18.2		
	30/05/2019		-	-	-	-	-		
WS114	13/06/2019	1008	0	5	-	-	17.7	0.01	
	03/05/2019		1.4	4.3	1	1	12.7		
	30/05/2019		0.1	3.9	2	3	13		
WS117	13/06/2019		-	-	-	-	-	-	Concreted Over

Based on the limited data available, and considering no identifiable sources were observed during the ground investigation, a characteristic Gas screening Value of 0.0134L/h was calculated. Noting that the flow rates, where recorded were low and the concentrations of methane and carbon dioxide were typically below 1% and 5% respectively the site would be described as a low risk site with a Characteristic Gas Situation (CS) of 1.

The proposed property would be classed as a Type B property according to BS8485:2015:+A1:2019. A type B property is described as follows:

> *private or commercial property with central building management control of any alterations to the building or its uses but limited or no central building management control of the maintenance of the building, including the gas protection measures. Multiple occupancy. Small to medium size rooms with passive ventilation of rooms and other internal spaces throughout ground floor and basement areas. May be conventional building or civil engineering construction. Examples include managed apartments, multiple occupancy offices, some retail premises and parts of some public buildings (such as schools, hospitals, leisure centres) and parts of hotels.*

A Type B building with CS1 would therefore have a Gas Protection Score of 0.

A gas protection score is usually achieved through using a combination of the following three methods with particular scores related to different approaches to these measures:

- Floor slab, basement slab or basement slab and walls
- Ventilation measures

- Gas resistant membrane.

The tables 5, 6 and 7 from BS8485:2015+A1:2019 outline the scoring for the different types of slab, ventilation measures and membranes available to the designer.

8 Summary and Conclusions

Some soils have been shown to reflect the industrial history of the site and contain the following elevated parameters:

- Arsenic
- Lead
- Benzo[a] anthracene
- Benzo[a] pyrene
- Dibenzo[ah] anthracene

Arsenic and lead are metals and the remaining three compounds (Benzo[a] anthracene, Benzo[a] pyrene and Dibenzo[ah] anthracene) are PolyAromatic Hydrocarbons.

In addition, low levels of asbestos contamination were observed in the soils.

Ground gas was not noted in concentrations or at flow rates so as to pose a potential risk.

The following parameters were noted to exceed the GACS for Groundwater:

- Arsenic
- Barium
- Iron
- Magnesium
- Manganese
- Potassium
- Sodium
- SO4
- Chloride
- Ammoniacal Nitrogen as N
- Electrical Conductivity @25C
- Total Dissolved Solids

The majority of these exceedances were noted in BH101 which is to the south of the site, near the quay wall. The borehole is also located next to the generator building and down gradient from the UST (underground storage tanks) identified on site. No hydrocarbons were detected and it should be noted that some of the exceedances could be linked to the tidal behaviour of the waters in the River Liffey.

Exceedances in Arsenic, Iron, Manganese, Potassium and Ammoniacal Nitrogen were noted in BH103 which was located at the northern (upgradient) boundary of the site. Manganese, Potassium and Ammoniacal Nitrogen were also picked up in BH106 and BH107.

Based on the above we do not observe any major impacts to the River Liffey. The detected exceedances in BH101, likely have originated from the waters within the River Liffey.

9 Recommendations

The soil samples recovered during the Ground Investigation were tested against a suite of parameters which included the contaminants highlighted in the PSA as Potential Contaminants of Concern. These results were screened with a view to assessing the possibility of retaining these materials on site and reusing them as fill materials beneath the development where there is an expected materials deficit. By demonstrating there is no associated risk with the soils currently beneath the site, we can retain on site suitable materials and limit the costly and unnecessary disposal of materials suitable for reuse.

Two main questions dictate whether any excavated material can be reused on site:

- Does the material pose a risk to the surrounding environment or future site users; and
- Will the material have acceptable geotechnical qualities to be suitable for use as fill material beneath the proposed development?

The environmental question was assessed by screening the soil results against the Arup derived Generic Assessment Criteria (GACs).The GACs are values which have been calculated for typical soils in certain proposed end uses to determine the concentration above which there would be an unacceptable risk to human health or the environment. The samples recovered during the ground investigation were screened against the GACs for a residential end use without plant uptake. In addition, the samples were screened for the presence of asbestos fibres. There is no calculated GAC for Asbestos.

Asbestos fibres were detected at concentrations at <0.1% in a number of locations across the site (8/73). Exceedances of the GACS were detected in 10/73 samples, with 3 samples containing exceedances of both the GACS and containing Asbestos <0.1%.

Therefore, soils showing exceedances of the GACs and/or containing Asbestos are automatically ruled out for reuse and will require disposal offsite. Locations which did not have any evidence of parameters elevated above the GACs or containing asbestos would be suitable for retention and reuse on site as long as the proposed end use did not change.

The remaining surplus soils would require disposal according to their classification based on:

- Waste Assessment Criteria as presented in Annex II to Directive 1999/31/EC;
- Environmental Protection Agency's 2015 report entitled Waste Classification List of Waste and Determining if Waste is Hazardous or Non-Hazardous; and
- Joint agency document entitled Waste Classification guidance on the classification and assessment of waste (1st Edition, Version 1.1 dated May 2018) referred to as WM3.

10 References

Environment Agency (2010) CLEA Software (Version 1.05) Handbook. Accessible at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/455747/LIT_10167.pdf

Appendix A

GII Factual Report

A1