33/41 WICKLOW STREET

Geotechnical and Geoenvironmental Interpretative Report

for

Buildwell Homes Ltd

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Project no. 7588

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Geotechnical & Geo-environmental Interpretative Report

33/41 WICKLOW STREET

Client:
BUILDWELL HOMES LTD

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PURPOSE OF THE REPORT

Ramboll UK was instructed by Buildwell Homes Ltd to design, procure and undertake a ground investigation for the proposed development of the 33 /41 Wicklow Street site in central London.

This Geotechnical and Geo-environmental Interpretative Report is required to satisfy the requirements of the planning process, identify and quantify ground based geotechnical and geo-environmental hazards and risks that could affect the re-development of the site and to propose concept foundation solutions for substructure design.

The report also provides a strategy for addressing and managing the identified risks through design and the site redevelopment process.

SITE INFORMATION

APPROX. GRID REFERENCE 530675,182840 **APPROX. AREA** 310m^2

CURRENT SITE DESCRIPTION

The site is currently vacant, unoccupied and covered in hard standing. Around the site periphery, there is vegetation such as brambles and bushes with discarded refuse and materials in the north-western corner.

Site surroundings are predominantly residential and industrial developments. A railway line runs along its western boundary.

The following key parameters were identified from the site investigation which relate to the geometry of the Network Rail asset beneath the site.

Geometry of the Network Rail Clerkenwell No.3 Tunnel

Depth to tunnel crown (mbgl)	1.25
Depth to eastern tunnel shoulder (mbgl)	2.38
Approximate tunnel diameter (m)	9.00

SITE HISTORY

The site is understood to be formed over an existing railway tunnel dating from at least 1871. The site was initially vacant land and then occupied by residential properties between 1896 and the 1970s. A former engineering works was historically located to the north of the site and various industrial activities have taken place in the vicinity of the site in the course of its history. The site is likely to be underlain by a significant depth of Made Ground fill which was formed over the existing railway tunnels to achieve the current site levels. The most recent use of the site has been as a car park.

PROPOSED DEVELOPMENT

The proposed scheme comprises the construction of a new residential structure with a lightweight bubble deck raft foundation.

SCOPE OF THE INVESTIGATION

A combined geotechnical and geo-environmental ground investigation, designed by Ramboll was undertaken at the site between the 20th July 2011 and 29th July 2011.

The scope of works completed included 4No. observation pits to a maximum depth of 4mbgl, one window sample to a maximum depth of 8mbgl with a ground gas monitoring installation, associated in situ and laboratory geotechnical and geo-environmental testing. A total of 6No. monitoring rounds for ground gas and groundwater levels were undertaken on the 12th August 2011, 9th September 2011, 16th September 2011, 6th October 2011, 14th October 2011 and 25th October 2011.

GEOLOGY

The geology was identified to consist of Made Ground (1.2 - 4.0m in thickness) over London Clay (thickness unproven).

HYDROLOGY	There are no surface water bodies within the site boundary or in the vicinity of the site.
HYDROGEOLOGY	There are no shallow groundwater bodies underlying the site. Perched water in the granular lenses in the Made Ground may be encountered on site.
GROUND CONTAMINATION RISK ASSESSMENTS	
HUMAN HEALTH	The majority of the reported determinand concentrations (particularly lead and benzo (a) pyrene) in samples of Made Ground and underlying strata were below their respective Generic Assessment Criteria (GAC) screening values. Due to the nature of the proposed development comprising predominantly hard standing with limited landscaping, the risk to future site users has been assessed as LOW. Risk to construction workers during site redevelopment has been assessed as LOW/MODERATE due to the direct contact pathway being active during construction. However, the risks can be mitigated to LOW through the implementation of best practice measures during site works by the Contractor. The Contractor will be responsible for site health and safety and will manage the risk through control of suitable Health and Safety measures including provision of PPE, education of the workforce and inductions for all site staff and visitors.
CONTROLLED WATERS	Risk to Controlled Waters has been assessed as LOW due to the absence of sensitive receptors in the vicinity of the site and relevant pollutant linkages.
GROUND GASES	Based on best practice guidance including CIRIA C665, the Wicklow Street site has been classified as a Characteristic Situation 1 site (very low risk site). No special ground gas protection measures are required for the proposed development.
MATERIAL CLASSIFICATION	The generic qualitative assessment undertaken on the Made Ground data from the Wicklow Street site showed that the Made Ground contained contaminants (particularly lead) at concentrations likely to pose environmental receptors. The waste classification analysis showed that the Made Ground is likely to classify as hazardous waste. Based on the reported concentrations and the risk assessments it is considered that: • The existing Made Ground soils could be reused on site on site under hard standing areas. However, it cannot be reused in soft landscape areas due to potential risk to sensitive end users and human health • Excess material being removed from site for disposal will classified as hazardous waste. It will be subject to duty of care and current waste management regulations. Depending on the receiving facility, further testing, e.g. Waste Assessment Criteria (WAC) testing may be required. The earthworks contractor should establish the suitability of the material for disposal to the proposed disposal facility.
CONCLUSIONS AND RECOMMENDATIONS	
GEOTECHNICAL CONSIDERATIONS	Due to the close proximity of the asset it is envisaged that a lightweight raft foundation scheme will be required to evenly distribute the superstructure load. Due to the heterogeneous nature of the Made Ground, it is envisage that a layer of engineering fill will be required and will act as the founding material. As part of detailed design, the interaction of the foundation, soil and the assets will be analysed.

GEO-ENVIRONMENTAL CONSIDERATIONS	A comprehensive site investigation and ground contamination risk assessment has been undertaken at the Wicklow Street site and the majority of ground contamination has been assessed as LOW and LOW/MODERATE. Residual risks to Construction workers can be minimised by the implementation of best practice measures during the site works by the contractor. Risk to construction works can be managed by the implementation of an Environmental Management Plan (EMP) which will include addressing previously unidentified contamination during the site works.

1 INTRODUCTION

1.1 Brief

Ramboll were instructed by Buildwell Homes Ltd to undertake an intrusive geotechnical and geoenvironmental assessment at 33-41 Wicklow Street, London.

The Ground Investigation was carried out between 20th and 29th July 2011 by Concept Site Investigation and comprised 1No. driver tube sampler, 4No. hand excavated observation pits, groundwater, gas and tunnel monitoring, together with associated laboratory testing.

1.2 Proposed Development

The proposed scheme comprises the construction of a new steel frame residential structure. Due to the proximity of the Network Rail assets to existing ground level, a shallow foundation scheme is required.

Based on Ramboll's design experience working above sensitive masonry tunnels, a lightweight bubble deck raft is recommended. The foundation scheme will be finalised during detailed design where the impact of the development on the assets will be quantified.

1.3 Purpose of Report

This aim of this report is to provide details both on the ground conditions on site and present information on the geometry of the underlying Network Rail tunnel and its interaction with the LUL retaining wall by interpreting information from the Site Investigation report (Concept Site Investigations, 2011). This information will be used to facilitate the design of the proposed substructure.

The report also includes an assessment of the ground contamination risks at the site as well as a ground contamination risk assessment undertaken using data from the 2011 investigation.

1.4 Constraints and Limitations

This interpretative report should be read in conjunction with the Site Investigation Report for Wicklow St, London WC1X 9JX prepared by Concept Site Investigation (Concept Site Investigation, 2011).

This report has been prepared for the exclusive use of Buildwell Homes Ltd for the purpose of assisting them in evaluating the site in the context of the proposed development. This report should not be used in whole or in part by any third parties without the express permission of Ramboll in writing.

Ramboll has endeavoured to assess all information provided to them during this appraisal. The report summarises information from a number of external sources and cannot offer any guarantees or warranties for the completeness or accuracy of information relied upon. The proposed geotechnical design options and recommendations summarised in this report relate to details of the proposed development at the time of its preparation. Any substantial changes to the proposed design may require a reassessment of the implications of the risks identified and a review of the geotechnical design options.

This report has been undertaken with the assumption that the site will be developed for residential end use, in accordance with the proposed design scheme. The conclusions resulting from this study are not necessarily indicative of future conditions or operating practices at or adjacent to the site.

Ramboll does not accept responsibility for the design of any elements that have incorporated assumptions stated within this report where the responsibility of the design of such elements lies with a third party.

2 SITE SETTING

2.1 Site Location and Description

The site is located on the southern side of Wicklow Street, in the Kings Cross area of London (see Figure 2.1). The site is centred at National Grid reference 530675, 182840 and covers an approximate area of 310m^2.

The site is currently fenced off, undeveloped and covered in hardstanding. Around the site periphery, there is vegetation such as brambles and bushes with discarded refuse and materials in the north-western corner.

2.2 Site Boundaries and Surroundings

The site is underlain by Network Rail's Clerkenwell No.3 Tunnel, part of the Midlands City Line, which runs in a northwest-southeast direction from the King's Cross Portal to the Farringdon Portal.

The site is in a predominately residential area, bounded to the north by a currently undeveloped site which is used for car parking and residential property including a relatively new 6 storey masonry residential block and Victorian era 3 storey brick houses.

To the south of the site, there are residential properties which face onto Swinton Street, two of which are located above the Clerkenwell Tunnel.

To the west of the site is a London Underground (LUL) retaining wall (asset no. W334), which separates the site from the LUL tracks for the Circle, Hammersmith and City and Metropolitan lines. The site is bounded to the east by a wall separating it from pedestrian access to nearby properties.

2.3 Site History

The site history is presented in detail in the Desk Study and Stage 1 Risk Assessment report (Ref 101187) prepared by MRH Geotechnical dated May 2010.

The site is understood to be formed over an existing railway tunnel dating from at least 1871. The site was initially vacant land and then occupied by residential properties between 1896 and the 1970s. A former engineering works was historically located to the north of the site and various industrial activities have taken place in the vicinity of the site in the course of its history. The site is likely to be underlain by a significant depth of Made Ground fill which was formed over the existing railway tunnels to achieve the current site levels.

Prior to the construction of the Clerkenwell Tunnel between 1863 and 1867 and up until 1896, the site remained undeveloped and unoccupied. Based on historical maps from 1896 to their demolition between 1966 and 1973, there were 4 terraced structures on site. Since the demolition of these structures the site has remained undeveloped and unoccupied.

The main site constraints to the site include a Network Rail Tunnel running across the centre of the site at shallow depth and a London Underground Railway track running along the eastern boundary of the site.

2.4 Environmental Setting

The environmental setting of the site is summarised below:

- The site does not lie within a Source Protection Zone for groundwater abstraction;
- There are no abstraction licenses within 500m of the site; and
- There are no surface water bodies in the immediate vicinity of the site

2.5 Pollutant Linkages

A Phase 1 Risk Assessment, based on the source - pathway - receptor and pollutant linkage methodology and the environmental setting of the site has been undertaken in 2010 by MRH Geotechnical.

Given the nature of the site, the ground overlying the railway tunnels is likely to be Victorian fill of various compositions used to achieve the current levels on site following construction of the tunnels. As such this material may contain contamination from the sourced materials in the fill. This potential contamination may present a risk to the construction workers, water supplies installed for the proposed development and the future occupants of the site in any areas of soft landscaping.

Fill materials over the existing tunnels have the potential to generate ground gases if they contain organic materials. Ground gas has the potential to migrate into the proposed development, accumulate in confined spaces and present a risk of asphyxiation or explosion.

Risk to Controlled Waters has been assessed as Low due to the absence of any receptors (surface water, groundwater) in the vicinity of the site.

3 GROUND INVESTIGATION

3.1 Introduction

A combined geotechnical and geo-environmental ground investigation, designed by Ramboll was undertaken at the site between the 20th July 2011 and 29th July 2011.

Objectives of the ground investigation related to substructure design included:

- Obtaining information for the detailed design and construction of the foundations for the proposed development; and
- Determining the geometry of the Clerkenwell No.3 tunnel and its interaction with the LUL retaining wall.

Objectives of the ground investigation related to the ground contamination assessment included:

- Obtaining data to refine the pollutant linkages and propose a strategy for the management of any ground contamination risks identified in order to facilitate the safe development of the site.
- Obtaining data to undertake Preliminary Waste Classification analysis for materials likely to be disposed of to a licensed treatment or disposal facility during the site works.

Concept Site Investigation were appointed by Ramboll on behalf of Buildwell Homes Ltd to carry out the site investigation works. Ramboll provided part time inspection of the works and contract administration.

3.2 Fieldwork

The Ground Investigation was undertaken in general accordance with:

- The Code of Practice for Ground Investigation – BS 5930. (1999)
- Methods of test for Soils for Civil Engineering Purposes – BS1377 (1990)

The fieldwork was undertaken in July 2011. The exploratory holes were carried out by Concept Site Investigations under the permanent supervision of their own Site Engineer. The exploratory holes were logged and sampled for geotechnical and contamination testing by Concept Site Investigation.

The Ground Investigation comprised the following items of fieldwork:

- One window sample (WS01) to a maximum depth of 8mbgl with a 50mm gas monitoring installation. The installation was screened in the Made Ground stratum; and
- 4No. Observations pit (OP01 to OP04-5) to a maximum depth of 4mbgl.

A summary of the exploratory holes installed and the purpose of each installation is presented in Table 3.1 below and the as-dug locations of the exploratory holes are shown in Figure 3.1 (Concept Site Investigation, 2011).

Table 3.1 Summary of the Exploratory Holes for Ground and Substructure Investigation

Hole Number	Type	Scheduled depth	Remarks
WS01	WS	8m	To determine the nature and extent of the Made Ground. To obtain samples from the Made Ground deposits for geotechnical and chemical testing. Install a ground gas monitoring installation for ground gas monitoring.
OP01	OP	2.5m	Investigate location and geometry of key features on the Clerkenwell No.3 tunnel and its interaction with the LUL retaining wall, Asset W334. Installation of tunnel monitoring points in pits OP03 and OP04-05. To obtain samples for laboratory analyses and chemical testing.
OP02	OP	2.5m	
OP03	OP	1.2m	
OP04-05	OP	4m	

Note: WS - Window Sample, OP - observation pit.

Window sample WS01 was hand excavated to a depth of 1.20m, prior to being drilled to a depth of 8.0m using a "Geo" drive-tube sampling rig. The observation pits were hand dug to varying depths. Pits OP01 and OP02 were terminated at 2.50m, OP03 at 1.20m and pit OPO4-05 was terminated at 4.0m.

It was intended that trial pits OP01 and OP02 be excavated to provide information about the interaction between the Clerkenwell tunnel and the LUL retaining wall, but the base of the pits were located above where the tunnel abuts the nearby retaining wall. In these pits, only the boundary brick masonry wall for the site and its associated concrete footings were found (see Figures 3.2 and 3.3).

Exploratory hole OP03 was excavated to confirm the location and geometry of the tunnel crown and OP04-05 was excavated to confirm the location and geometry of the tunnel crown and shoulders.

3.3 Factual Reporting

The Site Investigation Report for 33-41 Wicklow Street, London (Concept Site Investigation, 2011) was prepared by Concept Site Investigation on completion of the site works and testing. The report contains logs of all exploratory holes, results of the laboratory testing and sketches showing the geometry of the tunnels and the boundary brick wall on site based on what was encountered in the observation pits.

3.4 Clerkenwell No.3 Tunnel Location and Description

The Clerkenwell No.3 Tunnel is a brick tunnel with an exterior bitumen lining. The tunnel runs in a northwest to southeast direction beneath the site and its crown is located at 1.25mbgl (+13.27mOD), based on observations from pits OPO3 and OP04-05 as presented in Figures 3.4 and 3.5 (Concept Site Investigation, 2011).

The tunnel is assumed arch shaped with a diameter of approximately 9m. The eastern shoulder is formed of a horizontal lip which is approximately 1m wide and

2.38m below ground level (+12.21mOD). The geometry of the western section of the tunnel and the depth to tunnel invert were not proven in the Site Investigation.

The interpretation of the tunnel geometry based on the observations in pits OP01, OP02, OP03 and OP04-05 is shown in Figure 3.6.

3.5 Sampling and In-situ Testing

27no. Bulk, 12no. disturbed and 30 no. environmental samples were recovered from the exploratory holes for description and laboratory testing. Hand shear vane and pocket penetrometer tests were carried out in cohesive material where encountered in the trial pits.

Due to the nature of the works and the ground conditions, it was not possible to extract undisturbed samples for testing.

3.6 Laboratory Testing

The samples collected from the exploratory holes were scheduled by Ramboll for geotechnical and chemical testing. The following tests were scheduled:

- Moisture Content and Atterberg Limit
- Particle Density
- Particle Size Distribution
- Electrochemical tests
- Contamination and organic testing of soil samples

A selected number of soil samples were analysed for a range of potential contaminants. A total of 8No soil samples tested for a range of potential contaminants including metals, TPH and PAHs. All samples were screened for potential asbestos containing materials (ACMs). All soil samples were obtained and dispatched to a UKAS and MCerts laboratory under a chain of custody. The chemical results are included in Appendix B.

4 GROUND CONDITIONS ENCOUNTERED

4.1 Introduction

The exploratory holes revealed Made Ground overlying London Clay. The natural deposits were only encountered in WS01.

A summary of the strata encountered during the Ground Investigation is presented in Table 4.1 below.

Table 4.1: Summary of geology encountered during Ground Investigation

Stratum	Level of Top of Stratum (mOD)	Thickness (m)
MADE GROUND	+14.52 to +14.75	1.2 to 4
LONDON CLAY*	+11.38	Not proven

* Only encountered in borehole WS01

The following sections provide descriptions derived from the laboratory testing conducted during the Site Investigation.

4.2 Made Ground

Made Ground was encountered in all of the exploratory holes on site, with the thickness varying from 1.2 m (OP03) to 4 m (OP04-05). The description of this stratum varies from dark grey clayey sand to dark brown very silty, very sandy fine to coarse gravel, brown slightly sandy gravelly clay, gravelly sand and a mixture of concrete, brickwork, clinker, ceramic, tiles, metal and coarse flint.

The depth of the base of Made Ground was proven to 2.7mbgl in WS01 which is located in the north east section of the site. OP04-05 demonstrated that Made Ground was present to the full depth of the tunnel as is described as multicoloured sandy, slightly clayey to brown slightly sandy gravel with concrete, brickwork clinker, ceramic and tiles, becoming brown sandy gravelly clay with occasional cobbles.

4.2.1 Classification

12no. Particle size distribution tests were carried out in the Made Ground. A summary of the cohesive and granular content of each exploratory hole is presented in Table 4.2

In WS01, OP01 and OP03 there was high granular content, greater than 63%; whilst in pits 0P02 and 0P04-05, which are located in the southern section of the site, the granular content varied greatly. The particle size distribution tests show that in the south of the site the Made Ground has a high clay and silt content in the top (OP02) and middle of the stratum (OP02 and OP04-05).

Table 4.2 Summary of Particle Size Distribution tests

Exploratory Hole	Clay and silt content (%)	Sand, gravel and cobble content (%)
WS01	17 - 22	78- 83
OP01	31 - 36	64 - 69
OP02	29 - 87	13 - 71
OP03	26 - 29	71 - 74
OP04-05	22 - 79	21 - 78

12 no. Moisture content and 4 no. Atterberg limit tests were also carried out in the Made Ground. As shown in Table 4.3, the material tested in all the holes had a relatively low moisture content ranging from 18%- 33%. The lowest moisture content was encountered in the middle of the stratum in pit OPO2, whilst the highest was encountered again in OP02 and in pit OP04-05.

The Liquid Limit of the material ranged from 53%-73%, with a plasticity index ranging from 28-45% indicating that the Made Ground is a high plasticity soil.

Table 4.3 Summary of Moisture Content and Atterberg Limit Tests

Exploratory Hole	Moisture Content (%)	Liquid Limit (%)	Plasticity Index (%)
WS01	23 - 26	53	34
OP01	19	-	-
OP02	18 – 33	56 – 73	32 - 45
OP03	22 - 25	-	-
OP04-05	27 – 33	53	28

The only form of groundwater encountered on site was seepage at 7.20mbgl (+7.38mOD) in WS01 and it is therefore assumed the site is high above the water table.

4.3 London Clay

The top of the London Clay was encountered at 3.20 mbgl (+11.38 mOD) in WS01. The material was described as brown mottled grey sandy clay become grey at depth. WS01 only penetrated approximately 5m into the London Clay; therefore the thickness of this stratum cannot be verified.

4.4 Chemical Ground Conditions

Chemical analyses of the underlying soils were undertaken to establish the ground aggressiveness. Sulfate, pH and chloride tests were carried out on soil samples.

4.4.1 Ground Aggressivity Testing

10no. Sulfate, pH and chloride tests were carried out on soil samples. Sulfate values from the 2:1 soil water extract ranged from 76 mg/l to 186mg/l and pH values varied from 8.1 – 8.7. Chloride values from a 2:1 soil water extract ranged from 5mg/l to 16mg/l.

Based on these results, the site has a design sulfate class DS-1 and an aggressive chemical environment for concrete (ACEC) class of AC-1.

4.5 Ground Contamination Testing

All chemical testing was undertaken by ChemTest, a UCAS and MCerts laboratory. A general testing suite was used for all samples including metals and semi metals (arsenic, cadmium, hexavalent chromium, copper, lead, mercury, nickel, selenium and zinc), water soluble boron, sulphide, sulphate, total sulphur, pH, total petroleum hydrocarbons (TPH), speciated poly aromatic hydrocarbons (PAH) for all samples analysed. A speciated TPH - CWG aliphatic/aromatic carbon fractions was analysed in one of the samples. All samples were screened for potential asbestos containing materials (ACMs).

In total 8No soil samples were analysed from the trial pits and boreholes. The samples analysed where obtained from a depth range of 0.3 - 2.0mbgl and included the following:

- OPO1(0.3mbgl),OPO2(0.3mbgl),OPO3(0.3mbgl),OPO4(0.5mbgl), WS01 (0.5mbgl); and
- OPO1 (2mbgl), OPO2 (1.5mbgl) and WS01 (1.0mbgl).

Leachate testing was not undertaken as there are no active pollutant linkages related to Controlled Waters from the site.

4.6 Ground Gas and Groundwater level monitoring

A total of 6No. monitoring visits were undertaken between August 2011 and October 2011 in the existing monitoring installation on the site. Due to the site constraints and the presence of an underground tunnel across the majority of the site, only 1No monitoring well (WS1) could be installed during ground investigation. The monitoring visits were undertaken on the 12th August 2011, 9th September 2011, 16th September 2011, 6th October 2011, 14th October 2011 and 25th October 2011. Typically, ground gas monitoring dates were selected, as far as reasonably practicable, to coincide with periods of falling atmospheric pressure, as determined from the MET Office (www.meto.gov.uk) website.

A summary of the data from the ground gas monitoring visits is presented in Table 4.2. The ground gas monitoring results are presented in Appendix B.

Table 4.4: Summary of the ground gas monitoring at Wicklow Street

BH ID	No of visits	Water Depth (min/ max)	Gas Flow [3]	CH_4[8]	CO_2[1]	O_2[2]	H_2S
		mAOD	l/h	% v/v	%v/v	% v/v	ppm
WS01	6	DRY[4]	BDL	BDL	0.2	19.8	BDL

[1] The concentrations noted are the maximum concentrations encountered in each stratum during the course of the monitoring visits (unless otherwise stated)/ [2]Minimum concentrations / [3] The maximum flow rate from within the borehole, not from within the soil /[4]BDL is Below Detection Limit – gas flow (0.1L/h) [4]Groundwater[other than a column of ~10 -15cm] was not encountered in the monitoring installation during all the monitoring visits.

Methane (CH_4) concentrations ranged from below detection limit (<0.1%v/v) during all monitoring visits.

Carbon Dioxide (CO_2) concentrations were typically below detection limits during all but one visit on the 14th October 2011 when a maximum concentration of 0.2%v/v was recorded.

The lowest oxygen (O_2) concentration of 20.0%v/v was recorded during the monitoring visit undertaken o the 14th October 2011. This was also associated with the highest CO_2 concentration of 0.2%v/v recorded on the site.

Gas flow rates were typically ranged from below detection limits (0.1L/h).

5 GROUND CONTAMINATION ASSESSMENT

5.1 Introduction

Environmental risks are assessed within the risk management framework established in Part IIA of the Environmental Protection Act (EPA) 1990 (HMSO, 1990), which provides a statutory definition of contaminated land. To fall within this definition it is necessary that, as a result of the condition of the land, substances may be present on or under the land such that:

(a) Significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) Pollution of controlled waters is being, or is likely to be, caused.

Risk from contamination is assessed by consideration of possible linkages between contaminant sources and potential receptors which could be harmed or polluted.

The key aspect of the framework is the development of a Conceptual Site Model (CSM) which illustrates the spatial interaction between the potential sources and receptors on site.

For a risk of pollution or environmental harm to occur as a result of ground contamination, all of the following elements must be present:

- A source, i.e., a substance that is capable of causing pollution or harm;
- A receptor, i.e., something which could be adversely affected by the contaminant; and
- A pathway, i.e., a route by which the contaminant can reach the receptor.

If one of these elements is absent there can be no significant risk. If all are present then the degree of the risk is a function of the magnitude and mobility of the source, the sensitivity of the receptor and the nature of the migration pathway.

A plethora of guidance exist in the UK industry assisting both Local Authorities and practitioners in assessing the degree to which land is contaminated and deciding whether such land is contaminated within the context of the Environmental Protection Act (EPA) 1990 (HMSO, 1990). The overall approach is detailed in Contaminated Land Report (CLR) 11 (DEFRA and Environment Agency, 2003). Risk to Controlled Waters is assessed in accordance with Environment Agency (EA) guidance (Carey et al., 2000; Carey et al., 2006).

In order to assess the significance of the chemical concentrations recorded, generic assessment criteria must be selected based on the critical receptors identified at the site. Receptors are considered in relation to human health receptors (e.g., site users) and environmental receptors (e.g., groundwater and surface water).

Potential risks to human health from soil impacts are considered using the measured soil concentrations. Potential risks to environmental receptors and any drinking water abstractions are considered using soil leachate and groundwater concentrations as indicative of the component of soil contamination that may enter the aqueous phase. On the Wicklow Street site, the risks to Controlled Waters have been assessed as Low due to the absence of pollutant linkages. As such they are not discussed further in the report.

The full list of receptors considered under the EPA 1990 is reproduced in Appendix C.

The risk management approach adopted in this report includes the following:

- An initial screening of the chemical data used in the assessment of risk to human health and controlled waters;
- A refinement of the preliminary CSM identifying relevant pollutant linkages;
- Estimation of risk associated with the pollutant linkages; and

- Development of a risk management strategy where significant risk is identified.

5.2 Human Health Assessment

5.2.1 Methodology

The contaminated land assessment regime in the UK is currently going through a period of review. Existing statutory and non-statutory guidance documents and research publications are available which can be used for assessing risks to Human Health and Controlled Waters from the development of land.

Current UK guidance is provided in Environment Agency Science Reports and an updated Contaminated Land Exposure Assessment (CLEA) framework (Environment Agency, 2009a, b, c, d, e, f, g, h, i, j, k, l and m). This framework sets out three standard land uses for which generic assessment criteria are derived for individual contaminants: residential, allotments and commercial/industrial.

It is proposed to redevelop the Wicklow Street site into residential development consisting of a block of flats. The human health risk assessment has been conservatively undertaken in accordance with a residential without plant uptake land use scenario in accordance with current UK guidance.

The Generic Assessment Criteria (GAC) adopted for assessment of soils in relation to Human Health for this site are based on published Soil Guideline Values for those compounds for which published criteria are available. In the absence of Soil Guideline Values, LQM/CIEH 2009 Generic Assessment Criteria and Ramboll in-house screening criteria (derived using CLEA v1.06 in accordance with published guidance) were used.

Soil Guideline Values for organic compounds are published for different soil organic matter (SOM) content of 1.0%, 2.5% and 6.0%. The GAC values adopted for screening are based on the measured % SOM estimated from the measured fraction organic carbon (foc) as obtained from the analytical chemical results.

The GAC used in this assessment and their origin are presented in Appendix D. For determinands with no GAC screening values, detection limits from a UKAS/MCERTs laboratory were used for the assessment.

5.2.2 Soil Screening Analysis and Contaminant Distribution Assessment

The method of this generic assessment adheres to the guidance as set out in CLR 11 (DEFRA and EA, 2004). Laboratory chemical results are included in Appendix B.

Chemical analysis data screening tables are presented in Appendix E. The concentrations reported above the GAC screening value are highlighted in red.

No ACMs were reported in the Made Ground soil samples screened for asbestos containing materials.

Measured concentrations of contaminants in the Made Ground above the relevant GAC are summarised in Table 5.1.

Table 5.1: Summary of soil contaminant concentrations in Made Ground above GAC

Determinand Group	Specific Determinand	GAC (mg/kg)	No of samples analysed	No of reported concentrations above GAC	Maximum (mg/kg)
Metals	Arsenic	35	8	1	48
	Lead	450	8	7	3300
Polycyclic Aromatic Hydrocarbons	Benzo (a) pyrene	1	8	1	1.6
	Benzo (b) fluoranthene	7.4	8	1	7.7

A discussion of the lateral and vertical distribution of the potential contaminants with reported excedences above their respective GAC is presented in Table 5.2.

Table 5.2: Contaminant distribution Assessment

Determinand Group	Specific Determinand	Contaminant Distribution Assessment
Metals	Arsenic	Of the 8No samples analysed, one sample, OPO1(0.3mbgl) a concentration of 48mg/kg which was marginally above the GAC of 35mg/kg. All other samples analysed reported arsenic concentrations in the range11 - 32mg/kg
	Lead	Of the 8No samples analysed, a total of 7No reported excedences of the lead GAC of 450mg/kg. The highest excedences were reported in samples WS01 (1mbgl), OP01(0.3mbgl), OPO4(0.5mbgl) at respective concentrations of 3300mg/kg, 2700mg/kg and 1700mg/kg. All other reported excedences were marginally above the GAC of 450mg/kg in the concentration range of 610 - 1000mg/kg No outliers have been detected in the data set. A statistical analyses of the results was undertaken and it reported a U95 of 2501.74mg/kg which exceeds the GAC of 450mg/kg
Polycyclic Aromatic Hydrocarbons	Benzo (a) pyrene	Of the 8No samples analysed, 3No samples, namely OPO1(0.3mbgl), WS1(0.5mbgl) and WS1(1mbgl) reported concentrations above the benzo (a) pyrene GAC of 1mg/kg at respective concentrations of 1.6mg/kg, 1.6mg/kg and 7.5mg/kg. Excedences at shallow depths (<0.5mbgl) were only marginally above the GAC of 1mg/kg
	Benzo (b) fluoranthene	Of the 8No samples analysed, only one sample WS1(1mbgl) reported a concentration of 7.7mg/kg which was marginally greater than the GAC of 7.4mg/kg.

As a summary, the following potential sources of contamination were reported:

- Potential site wide impact of lead in the Made Ground;
- Isolated potential impact of benzo (a) pyrene at location WS1(1mbgl)

5.3 Material Classification

In order to assess the suitability of materials for reuse on site, the reported chemical concentrations of potential contaminants have been compared to GAC. GACs are set for soils to be protective of human health and for leachates and groundwaters to identify potential risks to environmental receptors. Dependent on the proposed end use of the materials, concentrations below the GAC are not considered likely to pose any significant risks to the specific receptors.

The GAC for soils and human health have been selected based on current UK guidance and comprise published Soil Guideline Values (SGV) where available, or

GACs published by LQM/CIEH (Nathanial et al., 2009) for a typical residential without plant uptake land use scenario.

A summary of the chemical properties of the Made Ground identified on the site is shown in Table 5.3.

Table 5.3: Chemical properties of the Made Ground at the Wicklow Street site

Material Type	Chemical Characteristics
Made Ground	There are significant depth of Made Ground overlying the Network Rail Tunnel running through the Wicklow Street site The majority of potential contaminants reported concentrations below their respective GAC. However, a potential site wide impact of lead was reported with a total of 7No out of 8No samples reporting concentrations above their respective GAC No ACMs were reported from all Made Ground soil samples screened for potential ACMs

5.4 Waste Classification Analysis of the Made Ground

The assessment of any contaminated soils to determine any hazardous properties and its classification in terms of hazardous waste is based on List of Waste Regulations (LoWR) (HMSO, 2005a) and the Hazardous Waste Regulations (HWR) (HMSO, 2005b). These waste regulations provide a mechanism for determining the classification of waste as hazardous or non-hazardous.

The waste classification analysis of the Made Ground soils likely to be excavated during earthworks during the Wicklow Street construction works has been undertaken in accordance with Environment Agency guidance (Environment Agency, 2003a,b) and guidance from the Health and Safety Commission (HSC, 2005). The assessment has also been undertaken in line with the Industry Code of Practice (CoP), The Definition of Waste: Development Industry Code of Practice (CL:AIRE, 2011).

A summary of the waste classification analysis of the material types, based on the data presented in Appendix B is presented in Table 5.4.

Table 5.4: Waste Classification analysis of soil materials at the Wicklow Street site

Material[b]	EWC Code[a]	Worst Case Waste Classification	Determinands above Hazardous Waste Thresholds
Made Ground	17 05 03	Hazardous	Lead

[a]European Waste Catalogue (EWC). EWC Code 17 05 03 is described as soil and stone not containing dangerous substances (17 05 03*)

[b]The conservative approach used in the assessment involved using the detection limits as the worst case concentrations in the samples tested.

The generic qualitative assessment undertaken on the Made Ground data from the Wicklow Street site showed that the Made Ground contained potential contaminants at concentrations likely to pose a significant risk to human health or environmental receptors. The main potential contaminant of concern was lead. The waste classification analysis showed that the existing Made Ground on site contained materials with hazardous properties.

Based on the reported concentrations, the risk assessments and the preliminary waste classification analyses undertaken, it is considered that:

- The Made Ground within the Wicklow street site is not suitable for reuse in areas of soft landscaping. However, it could be reused under hard standing, provided it is geotechnically suitable.
- Excess material being removed from site for disposal is likely to be classified as hazardous waste. It will be subject to duty of care and current waste management regulations. Depending on the receiving facility, further testing, e.g. Waste Assessment Criteria (WAC) testing may be required. The earthworks contractor should establish the suitability of the material for disposal to the proposed disposal facility.

5.5 Ground Gas Risk Assessment

The gas regime at the site has been characterised in accordance with best practice methodology using the guidelines in the *CIRIA C665* report titled '*Assessing risks posed by hazardous ground gases to buildings'* (*Wilson* et al, 2007).

The guidance outlines the method of classifying the risk posed by a gas regime using a combination of the flow and recorded concentrations of methane and carbon dioxide to generate a Gas Screening Value (GSV). The worst case GSV is then used to define the gas regime (Characteristic Situation) of the site.

Characteristic Situations refer to which gas protective measures are required so as to ensure that the risks posed by the presence of methane and carbon dioxide increase the redundancy within the protection system to ensure that the building is never exposed to unacceptable risk (Wilson et al, 2007).

The guidance specifies the types of gas protection measures which would be required for each characteristic situation so as to ensure that the risks posed by the presence of methane and carbon dioxide are reduced to an acceptable level.

5.5.1 Risk Assessment

The typical worst case ground gas regime, as recorded during monitoring visits, within the Wicklow Street development site have been discussed previously in Section 4.6. In accordance with the CIRIA C665 guidance (Wilson et al., 2007), all concentrations and flow rates recorded below instrument detection limit (BDL) were conservatively assumed to be at the concentration of the instrument detection limit. The worst case concentrations were selected based on a combination of the gas flow rate, methane and carbon dioxide concentrations from each of the monitoring rounds. Where the recorded data was below the instrument detection limit, the detection limit was used for the risk assessment. The detection limit for CH_4, CO_2 and gas flow rate was respectively 0.1%v/v, 0.1%v/v and 0.1l/h.

A summary of the ground gas risk assessment for the Sovereign Harbour site is presented in Table 5.5.

Table 5.5: Ground Gas Risk Assessment for Wicklow Street

BHID	Max flow rate(l/h)	CH_4 (%v/v)	GSV CH_4 (l/h)	CO2 (%v/v)	GSV CO_2 (l/h)	Characteristic Situation
WS01	0.1	0.1	0.001	0.2	0.002	1

A total of 6No. ground gas monitoring visits have been undertaken at the proposed Wicklow Street development site. The ground gas monitoring visits were undertaken where possible during periods of falling atmospheric pressures as recommended in the CIRIA C665 guidance (Wilson et al, 2007).

The ground gas risk assessment defines the site as predominantly Characteristic Situation 1 site (very low risk site), suggesting that no special ground gas protective measures are required for the proposed development.

5.6 Risk Estimation

5.6.1 Introduction

This qualitative risk assessment has been undertaken in accordance with CIRIA C552: *Contaminated Land Risk Assessment, A Guide to Good Practice* (Rudland et al., 2001). The CIRIA C552 risk categories and the assessment methodology are detailed in Appendix F.

Potential pollutant linkages are identified using the source-pathway-receptor framework detailed in Section 5.1. An assessment of the potential significance of each linkage is then made by consideration of the likely magnitude and mobility of the source, the sensitivity of the receptor and nature of the migration/exposure pathways.

An assessment of the likelihood of the risk being realised and the magnitude of potential risk is undertaken to give an estimation of the significance of each potential pollutant linkage identified. The assessment is undertaken based on the end use proposed.

The information presented in the previous sections of this report have been collated and evaluated to refine the Conceptual Site Model (CSM) for the site. The refined CSM of the site is presented in Figure 5.1.

5.7 Sources

The identified contaminant impacts within the Wicklow Street site are typically associated with the Made Ground stratum. The potentially significant sources identified during the ground investigation and contamination assessment are summarised in Table 5.6.

Table 5.6: Potential contamination hazards within the Wicklow Street site

Source	Main potential contaminants	Description/properties
Made Ground (site wide)	lead	Potential site wide impact of lead in the Made Ground. Elevated concentrations of lead above GAC were reported in the majority of the samples analysed.
Made Ground (localised)	benzo (a) pyrene	Isolated potential impact of benzo (a) pyrene at location WS1(1mbgl) where an excedence at a concentration of 7.5mg/kg relative to a GAC of 1mg/kg was reported. Two other samples reported marginal excedences at concentrations of 1.6mg/kg.
Made Ground (site wide)	organic and inorganic contaminants	In addition, to the identified sources of potential contaminants, there is uncertainty in relation of areas not investigated. Potentially impacted materials could be identified during site works

5.8 Receptors

The site specific receptors that could potentially be affected by the contamination hazards identified in the previous sections are summarised in Table 5.7.

Table 5.7: Potential receptors identified

Category	Receptor	Properties
Humans	Future site users	Potential exposure and contact with contamination to future site users within landscaped areas.
	Construction workers[1]	Potential exposure and contact with contamination to construction workers during construction activities such as reworking of made ground, excavations etc.
Property	Materials and site structures	Foundations and services beneath the ground may be damaged by potentially aggressive compounds present in soils and groundwater.

Category	Receptor	Properties
		However, due to the absence of elevated concentrations of contaminants and elevated soil pH this receptor is not considered to be sensitive. It is not considered further in this report.

5.9 Potential Pathways

In order for contaminants to reach potential receptors, there has to be a viable pathway between the contaminant source and receptor. The main potential pathways that may affect the migration of contaminants within the proposed development site is related to direct contact through dust, solid and liquid phase

5.10 Qualitative Risk Assessment

Potential pollutant linkages are identified using the source-pathway-receptor framework detailed above. An assessment of the potential significance of each linkage is then made by consideration of the likely magnitude and mobility of the source, the sensitivity of the receptor and nature of the migration/exposure pathways.

This qualitative risk assessment has been undertaken in accordance with CIRIA C552: *Contaminated Land Risk Assessment, A Guide to Good Practice* (Rudland et al., 2001). The CIRIA C552 risk categories and the assessment methodology are detailed in Appendix F

An assessment of the likelihood of the risk being realised and the magnitude of potential risk is presented below to give an estimation of the significance of each potential pollutant linkage identified. The assessment is undertaken based on the end use proposed.

An assessment of the plausible pollutant linkages is presented in below in Table 5.8

Table 5.8: Possible linkages between sources and receptors during enabling and construction

Hazard/Pollutant	Pathways	Receptors	Potential Severity	Probability of Risk	Level of Risk
Lead in Made Ground (site wide)	Direct Contact	Future site users	Medium	Unlikely	Low
		Site operatives and construction workers[a]	Medium	Low likelihood	Low-Moderate[a]
Made Ground (localised benzo (a) pyrene)	Direct Contact	Future site users	Medium	Unlikely	Low
		Site operatives and construction workers[a]	Medium	Low likelihood	Low-Moderate[a]
Unknown contaminants (due to uncertainty) in Made Ground	Direct Contact	Future site users	Medium	Unlikely	Low
		Site operatives and construction workers[a]	Medium	Low likelihood	Low-Moderate[a]

[a] The risk to construction workers and site operatives assumes that the contractor will deal with all risk to construction workers, based on the hazards identified within this report and revised according to ground conditions encountered during any on-site activities. The Contractor will be responsible for site health and safety and will manage the risk through control of suitable Health and Safety measures including provision of PPE, education of the workforce and inductions for all site staff and visitors

Risk to future site users has been assessed as Low because the majority of the development will comprise of hard standing and the pathway of direct contact would be absent. As such there will be no active pollutant linkage when the new development is occupied.

Risk to construction workers and site operatives have been assessed as Low - Moderate due to the fact that they will have direct contact with the existing Made Ground soils during the site enabling and construction works. However, the risk can be mitigated to Low through the implementation of best practice measures during site works by the contractors. The Contractor will be responsible for site health and safety and will manage the risk through control of suitable Health and Safety measures including provision of PPE, education of the workforce and inductions for all site staff and visitors.

In order to minimise risk to human health during construction and construction activities giving rise to contamination, a number of best practice risk management measures should be implemented during the construction phase of the proposed development on the Wicklow Street site. These are discussed further in subsequent chapters.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

This report presented and discussed the ground based geotechnical and geo-environmental risks as well as a number of concept foundation solutions for substructure design and a ground contamination risk assessment based on the pollutant linkage methodology in accordance with UK guidance.

The main geotechnical and geo-environmental conclusions from the information presented in this report are outlined below.

6.1.1 Geo-environmental conclusions

A summary of the ground risk assessments is presented below:

- Risk to Controlled Waters has been assessed as LOW due to the absence of sensitive Controlled Water receptors in the vicinity of the site.
- Human health risks to future site users have been assessed as LOW as the majority of the site will be under hard standing; and
- Human health risks to construction workers as been assessed as LOW/MODERATE due to the fact that construction workers are likely to be in contact with potentially contaminated material during site works, particularly Made Ground soils with elevated lead concentrations above the GAC of 450mg/kg. However, the risks can be mitigated to LOW through the implementation of best practice measures during site works by the contractors. The Contractor will be responsible for site health and safety and will manage the risk through control of suitable Health and Safety measures including provision of PPE, education of the workforce and inductions for all site staff and visitors.
- Risks to future site users due to ground gas have been assessed as LOW due to the absence of ground gas generation sources underlying the site. Based on the ground gas monitoring and risk assessment undertaken, the site has been classified as a Characteristic Situation 1 site. No special ground gas protection measures are required for the proposed development.
- Existing Made Ground soils are not considered to be suitable for reuse in soft landscape areas (e.g. raised planter beds) due to the presence of elevated lead. Preliminary waste classification analyses shows that the Made Ground is likely to be classified as Hazardous Wastes for disposal purposes. Any material taken off site to a disposal or treatment facility will be subject to the requirements of the receiving facility. Additional testing such as Waste Acceptance Criteria (WAC) testing may be required by the receiving facility.

6.2 Recommendations

This section outlines a number of recommendations for managing both the geotechnical and geo-environmental ground based risks identified in this report.

Since it has been previously specified by Network Rail that no piling will be allowed within 5m of the tunnel, a shallow foundation solution has been adopted. A stiff raft foundation scheme is considered most appropriate as this will allow loads to be spread effectively across the site, thereby limiting concentrated stresses imposed on the tunnel; and will allow differential settlements to be controlled.

A lightweight bubble deck raft solution will minimise the weight of the raft. This uses lightweight concrete and spherical plastic void formers to reduce the volume of concrete required, thereby minimising the stresses imposed on the tunnel.

Ramboll have successfully used a bubble deck raft solution at Camden Road, London which located directly above three Network Rail brick arches.

For the Made Ground, based on Ramboll's experience in working in similar ground conditions, the following design parameters are recommended for the purpose of design.

Table 6.1: Design Parameters for Made Ground

	Unit Weight, γ (kN/m^3)	Angle of friction, φ' (°)	Stiffness, E' (kN/m^2)
Made Ground	19	30	15,000

As part of detailed design, the interaction of the raft, soil and the London Underground Lines and Network Rail infrastructure will be analysed.

6.2.1 Geo-environmental considerations

Based on the ground investigation completed and the risk assessment undertaken for the proposed development site, it is considered that no special remedial measures are required for the proposed development on the Wicklow Street site. However, best practice measures to minimise potential contamination from construction activities should be adopted by the Contractor undertaking the development of the site. These are detailed in Table 6.2.

Table 6.2: Outline measures to be implemented on site to minimise ground contamination risks

Category of mitigation	Description of Mitigation Measures
Protective Measures during Construction	Risk to construction workers should be dealt with by the Contractor based on the identified hazards. These should also be revised based on the ground conditions encountered during on site activities The Contractor will be responsible for site health and safety and will manage the risk through control of suitable Health and Safety measures including provision of PPE, education of the workforce and inductions for all site staff and visitors. The proposed development is subject to CDM Regulations
Environmental Management	An Environmental Management Plan (EMP) should prepared and implemented by the contractor to prevent construction work and future operations from giving rise to land contamination. The EMP should include some of the following protective measures during construction: • Care should be taken when undertaking ground works; • If any unknown contamination is detected and report any signs of contamination to the project Environmental Consultant so that appropriate material characterisation and risk assessments can be undertaken; • Storage of materials (including oils and fuels for plant and machinery) in accordance with EA Pollution Prevention Guidelines; • Obtaining appropriate permits from the Environment Agency and the local utility provider to allow for dewatering during construction. Due to the nature and size of the development a Site Waste Management Plan (SWMP) will be required for the proposed development. The SWMP is aimed at ensuring efficient and correct handling and disposal of waste. The following general advice is made: • Any potentially contaminated material identified during the works should be transferred to a bunded waste storage area, scheduled for testing by the Engineer, and should be secured until receipt of laboratory test results and treated in accordance with advice from the Engineer;

Category of mitigation	Description of Mitigation Measures
	• All excavated material scheduled for off-site disposal will represent controlled waste and thus will have to be handled in accordance with the appropriate Waste Management and Duty of Care Regulations; and • Existing Made Ground soils can be reused as engineering fill, particularly under hardstanding areas. The geotechnical suitability of the materials should be assessed separately. • Existing Made Ground soils are not suitable to be reuse in soft landscape areas (e.g. raise planter beds) due to the presence of elevated lead concentrations
Previously Unidentified Contamination	The Contractor should report any areas of contamination identified during construction to the Environmental Consultant. If no further source of contamination are identified, then no further action will be required Any material excavated and to be disposed off site should be carried out in accordance with waste management 'duty of care' regulations

Should all the risk mitigation measures outlined above be implemented, the risks associated with ground contamination at the site are likely to be low, the proposed development works will not give rise to additional ground contamination risks and the site would be suitable for the proposed development.

7 REFERENCES

Concept Site Investigation (2011). *Site Investigation Report 33-41 Wicklow Street,London, WC1X 9JX*

Department of the Environment (1991). *Waste Management Paper 27*.

Environment Agency (2007). *Soil Guideline Values*.

Land Quality Management/Chartered Institute of Environmental Health (2007). *Generic Assessment Criteria*.

Ramboll (2010). Network Rail Form A 33-41 Wicklow Street

FIGURES

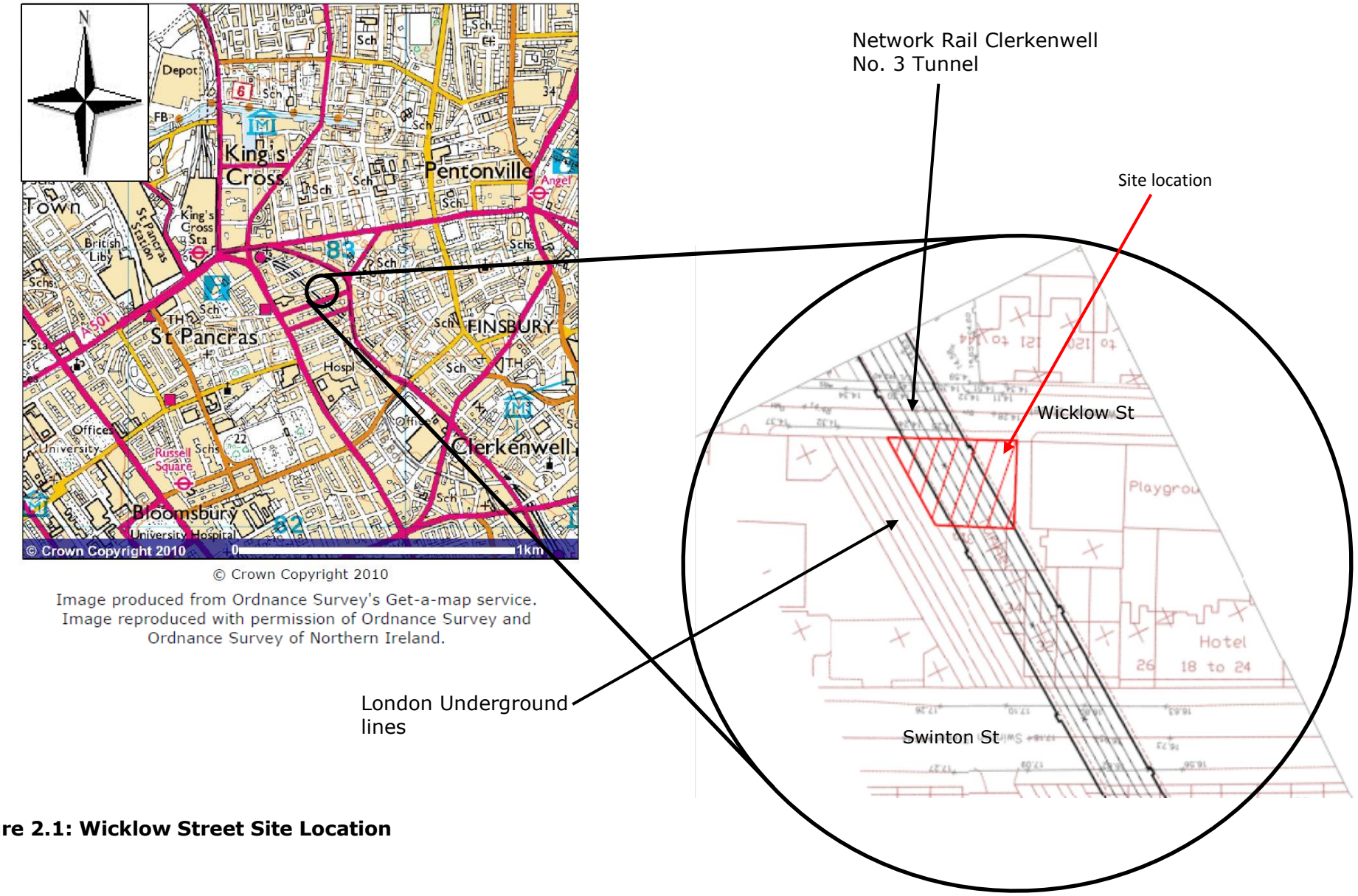

Figure 2.1: Wicklow Street Site Location

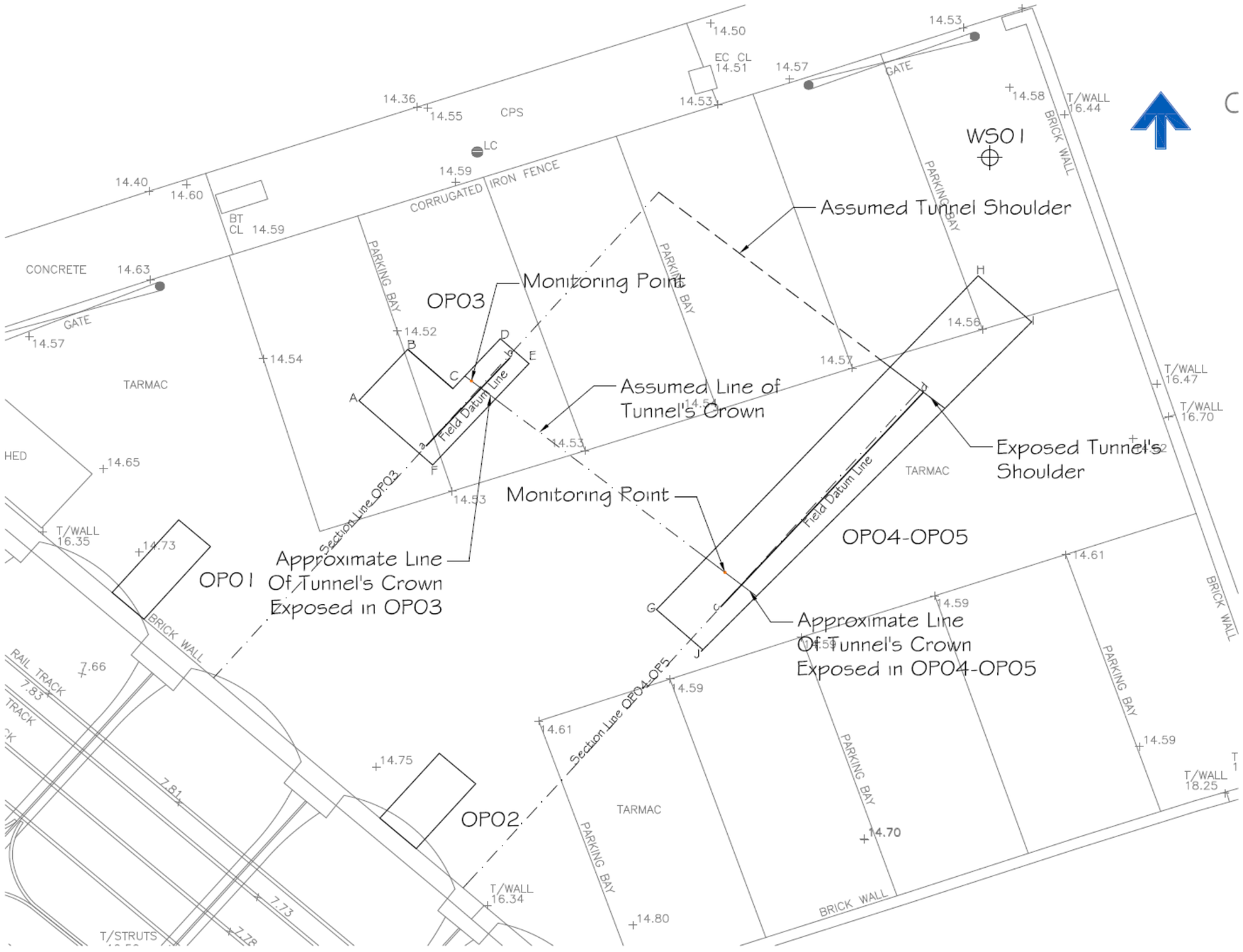

Figure 3.1: Exploratory Hole Location Plan (Concept Site Investigations, 2011)

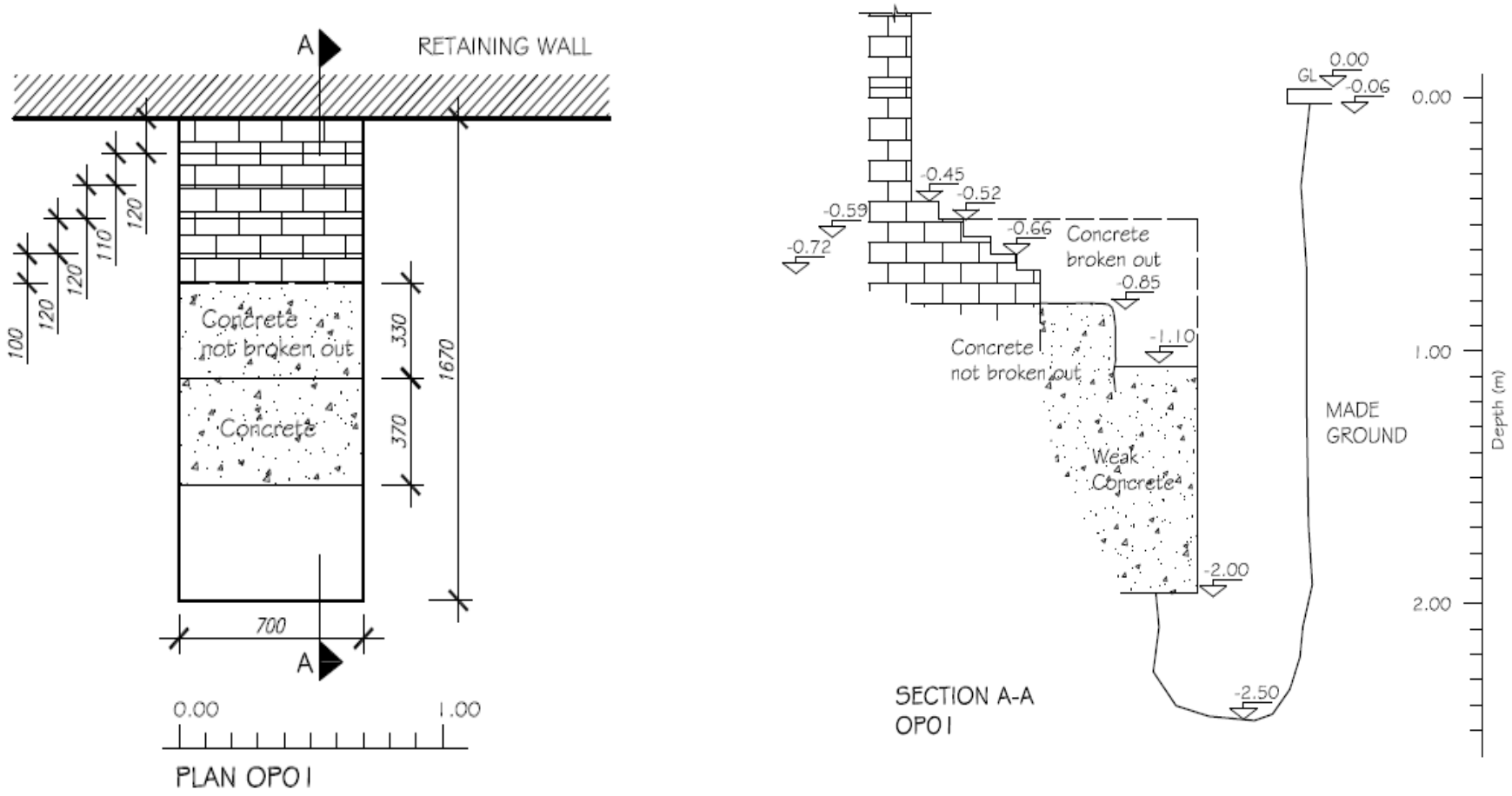

Figure 3.2: Plan and section through trial pit OP01 (Concept Site Investigations, 2011)

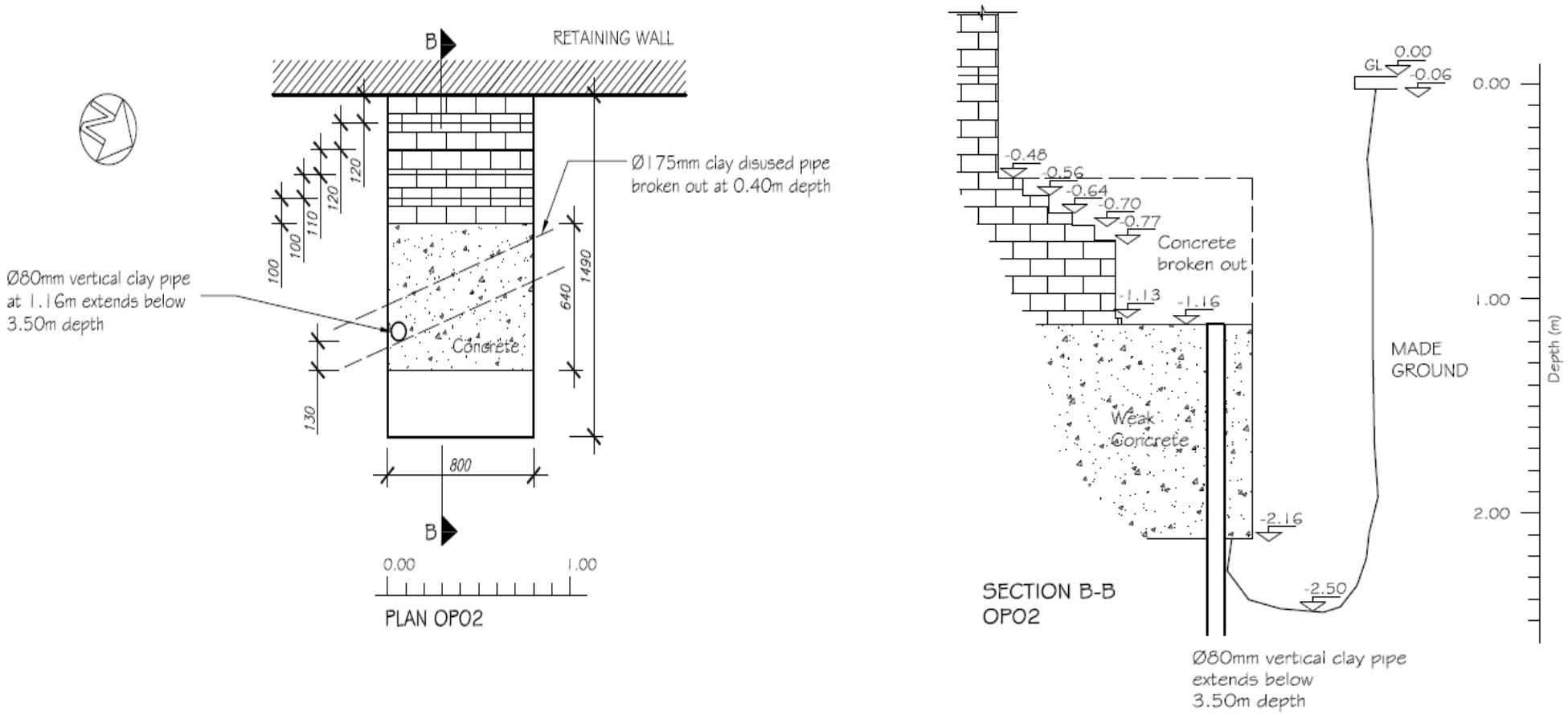

Figure 3.3: Plan and section through trial pit OP02 (Concept Site Investigations, 2011) - Not to Scale

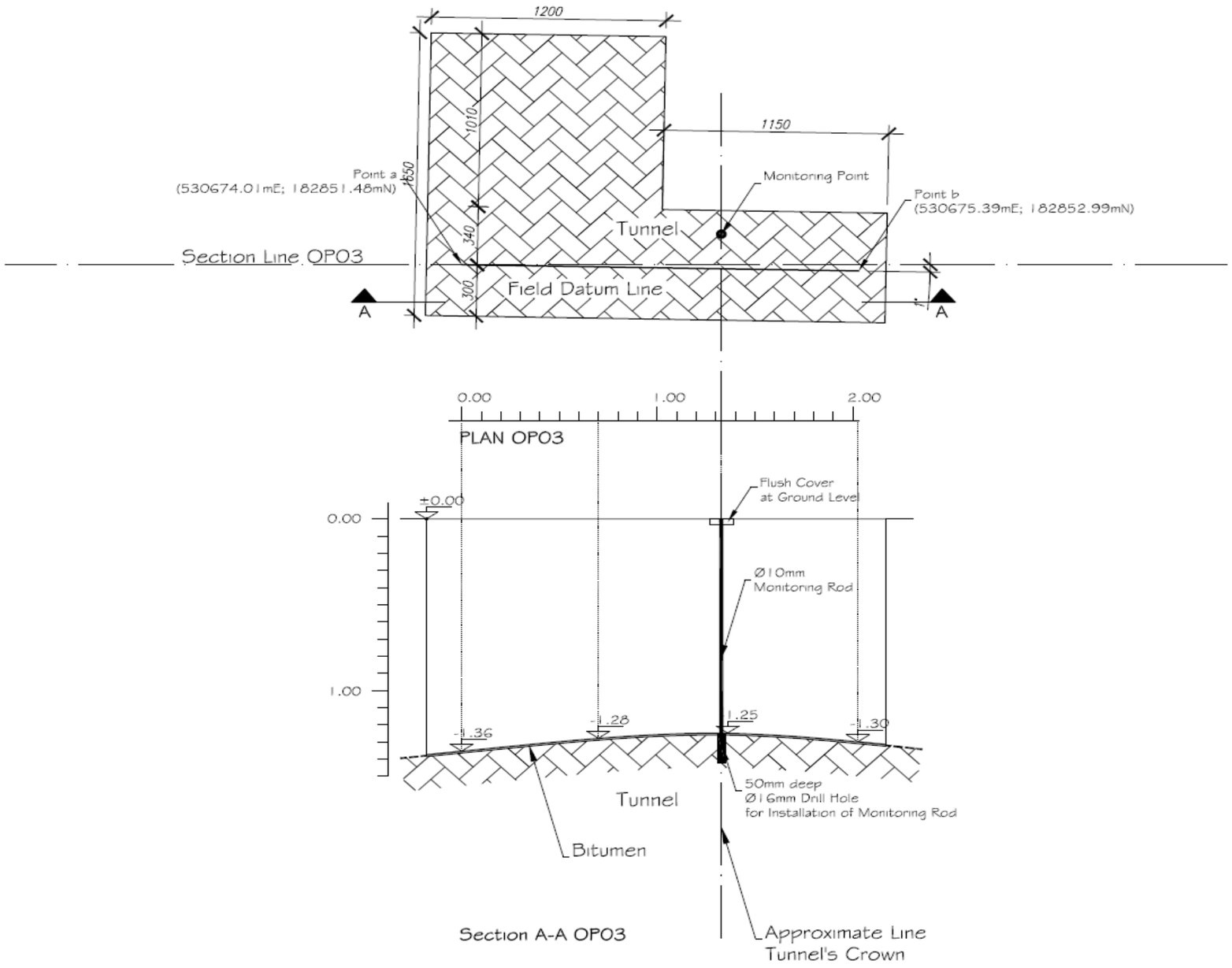

Figure 3.4: Plan and section through trial pit OP03 (Concept Site Investigations 2011) – Not to scale

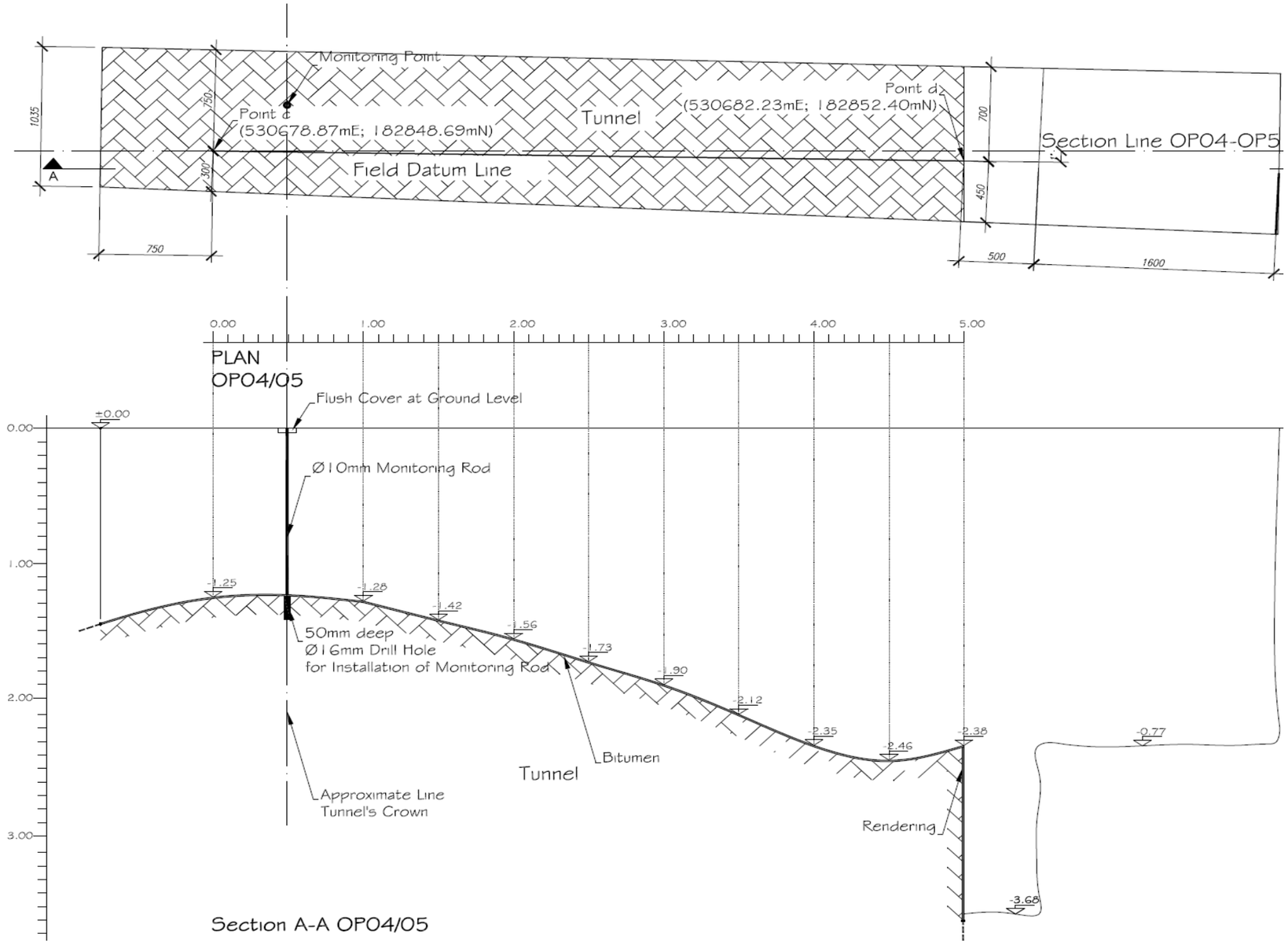

Figure 3.5: Plan and section through trial pit OP04-05 (Concept Site Investigations 2011) – Not to scale

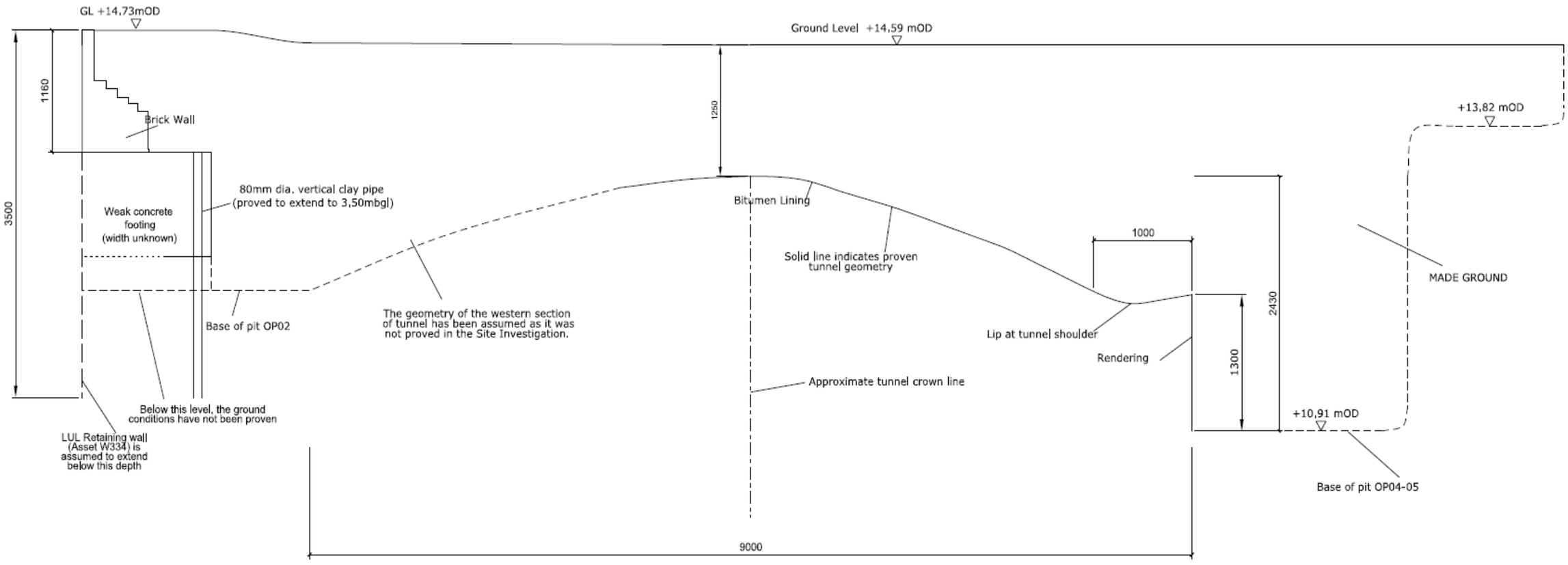

Figure 3.6: Geometry of the Network Rail Clerkenwell No.3 tunnel (based on Drawings 112341/03 and 112341/04, Concept Site Investigations 2011)- Not to scale

SOURCES
Made Ground (heterogeneous)

RECEPTORS
Humans (construction workers and future site users

PATHWAYS
Direct contact - dust, inhalation

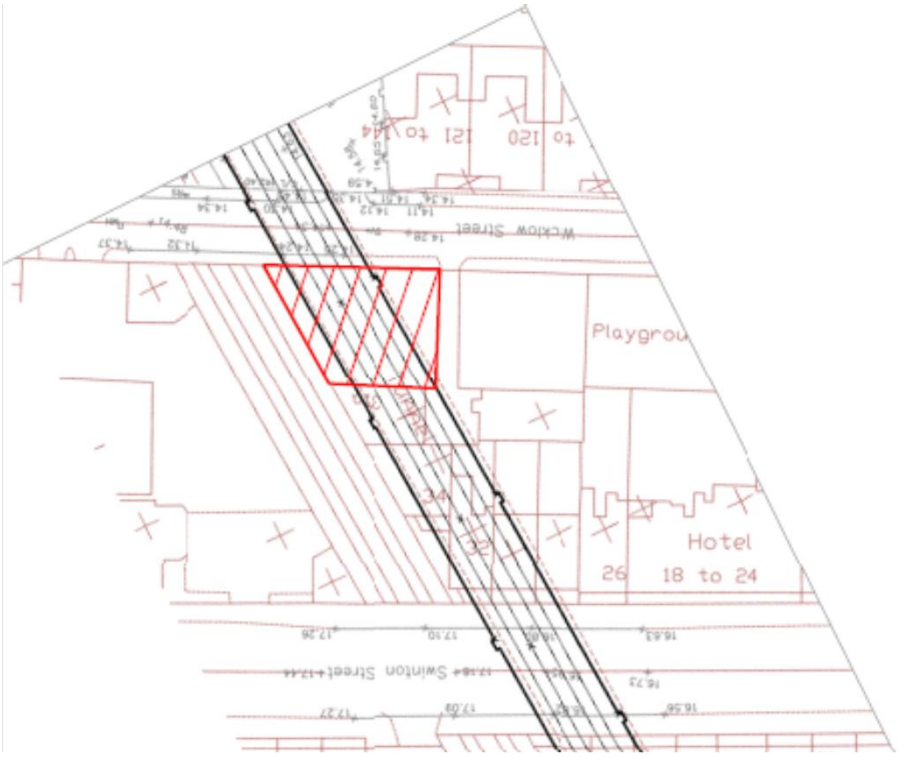

Figure 5.1: Revised Conceptual Site Model

APPENDIX A: GROUND INVESTIGATION FACTUAL REPORT (CONCEPT SITE INVESTIGATIONS, 2011)

APPENDIX B: GROUND GAS MONITORING DATA & GROUND CONTAMINATION RESULTS FROM CHEMTEST

APPENDIX C: ENVIRONMENTAL RECEPTORS

Table B1: Pollution to controlled waters.

'Section 78A(9) of the EPA 1990 defines the pollution of controlled waters as: "the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter".' (A35)

'Before determining that pollution of controlled water is being, or is likely to be, caused, the local authority should be satisfied that a substance is continuing to enter controlled waters or is likely to enter controlled waters. The local authority should regard something as being "likely" to be caused when the local authority judge it more likely than not to occur.' (A36)

'Land should **not** be designated as contaminated land where:

(a) a substance is already present in controlled waters;

(b) entry into controlled waters of that substance from land has ceased; and

(c) it is not likely that further entry will take place.' (A37)

'Substances should be regarded as having entered controlled waters where:

(a) they are dissolved or suspended in those waters; or

(b) if they are immiscible with water, they have direct contact with those waters on or beneath the surface of the water.' (A38)

The term 'continuing to enter' should be taken to mean any entry additional to any which has already occurred. (A39)

Reproduced from DETR (2000) Contaminated Land: Implementation of Part IIA of the Environmental Protection Act 1990. Circular 2/2000. and Scottish Executive Rural Affairs Department (2000) Circular 1/2000. Environmental Protection Act 1990: Part IIA – Contaminated Land.

Table B2: Significant harm to various receptors.

Type of receptor	Description of harm to that type of receptor that is to be regarded as significant harm
Human beings	Death, disease, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. For these purposes, disease is to be taken to mean an unhealthy condition of the body or a part of it and can include, for example, cancer, liver dysfunction or extensive skin ailments. Mental dysfunction is included only insofar as it is attributable to the effects of a pollutant on the body of the person concerned. In the Guidance, this description of significant harm is referred to as a 'human health effect'.
Any ecological system, or living organism forming part of such a system, within a location which is: an area notified as an area of special scientific interest under section 28 of the Wildlife and Countryside Act 1981. any land declared a national nature reserve under section 35 of that Act any area designated as a marine nature reserve under section 36 of that Act an area of special protection of birds, established under section 3 of that Act any European Site within the meaning of regulation 10 of the Conservation (Natural Habitats etc) Regulations 1994 (i.e. Special Areas of Conservation and Special Protection Areas) any candidate Special Areas of Conservation or potential Special Protection Areas given equivalent protection any habitat or site afforded policy protection under paragraph 13 of Planning Policy Statement 9 (PPS9) on	For any protected location: Harm which results in an irreversible adverse change, or in some other substantial adverse change, in the functioning of the ecological system within any substantial part of that location; or Harm which affects any species of special interest within that location and which endangers the long-term maintenance of the population of that species at that location. In addition, in the case of a protected location which is a European Site (or a candidate Special Area of Conservation or a potential Special Protection Area), harm which is incompatible with the favourable conservation status of natural habitats at that location or species typically found there. In determining what constitutes such harm, the local authority should have regard to the advice of English Nature and to the requirements of the Conservation (Natural Habitats etc) Regulations 1994. In Planning Policy Guidance this description of significant harm is referred to as an 'ecological system effect'.

Type of receptor	Description of harm to that type of receptor that is to be regarded as significant harm
nature conservation (i.e. candidate Special Areas of Conservation, potential Special protection Areas and listed Ramsar sites); or any nature reserve established under Section 21 of the National Parks and Access to the Countryside Act 1949.	
Property in the form of: crops, including timber produce grown domestically, or on allotments, for consumption livestock other owned or domesticated animals; wild animals which are the subject of shooting or fishing rights.	For crops, a substantial diminution in yield or other substantial loss in their value, resulting from death, disease or other physical damage. For domestic pets, death, serious disease or serious physical damage. For other property in this category, a substantial loss in its value resulting from death, disease or other serious physical damage. The local authority should regard a substantial loss in value as occurring only when a substantial proportion of the animals or crops are dead or otherwise no longer fit for their intended purpose. Food should be regarded as being no longer fit for purpose when it fails to comply with the provisions of the Food Safety Act 1990. Where a diminution in yield or loss in value is caused by a pollutant linkage, a 20% diminution or loss should be regarded as a benchmark for what constitutes a substantial diminution or loss. In Planning Policy Guidance this description of significant harm is referred to as an 'animal or crop effect'.
Property in the form of buildings. For this purpose 'building' means any structure or erection and any part of a building, including any part below ground level, but does not include plant or machinery comprised in a building.	Structural failure, substantial damage or substantial interference with any right of occupation. For this purpose, the local authority should regard substantial damage or substantial interference as occurring when any part of the building ceases to be capable of being used for the purpose for which it is or was intended. Additionally, in the case of a scheduled Ancient Monument, substantial damage should be regarded as occurring when the damage significantly impairs the historic, architectural, traditional, artistic or archaeological interest by reason of which the monument was scheduled in the Guidance this description of significant harm is referred to as a 'building effect'.

Reproduced from DETR (2000) Contaminated Land: Implementation of Part IIA of the Environmental Protection Act 1990. Circular 2/2000. and Scottish Executive Rural Affairs Department (2000) Circular 1/2000. Environmental Protection Act 1990: Part IIA – Contaminated Land.

APPENDIX D: RAMBOLL UK GAC USED FOR THE SCREENING ASSESSMENTS

APPENDIX E: GROUND CONTAMINATION ASSESSMENT - SCREENING SHEETS

Wicklow Street Soil Screening sheets

APPENDIX F: QUALITATIVE RISK ASSESSMENT METHODOLOGY

The qualitative risk assessment in this report is undertaken in accordance with CIRIA C552: *Contaminated Land Risk Assessment, A Guide to Good Practice* (Rudland et al., 2001). The CIRIA C552 risk categories are detailed in Appendix D

Potential pollutant linkages are identified using the source-pathway-receptor framework. An assessment of the potential significance of each linkage is then made by consideration of the likely magnitude and mobility of the source, the sensitivity of the receptor and nature of the migration/exposure pathways.

The CIRIA C552 risk categories are given in Table D1, Table D2 and Table D3.

Table D1: Definition of Magnitude of Consequence

Category	Definition
Severe	Acute risks to human health, catastrophic damage to buildings/property, major pollution of controlled waters
Medium	Chronic risks to human health, pollution of sensitive controlled waters, significant effects on sensitive ecosystems or species, significant damage to buildings or structures
Mild	Pollution of non-sensitive waters, minor damage to buildings or structures
Minor	Requirement for protective equipment during site works to mitigate health effects, damage to non-sensitive ecosystems or species

Table D2: Definition of Probability of Exposure

Category	Definition
High Likelihood	Pollutant linkage may be present, and risk is almost certain to occur in the long term, or there is evidence of harm to the receptor
Likely	Pollutant linkage may be present, and it is probable that the risk will occur over the long term
Low Likelihood	Pollutant linkage may be present, and there is a possibility of the risk occurring, although there is no certainty that it will do so
Unlikely	Pollutant linkage may be present, but the circumstances under which harm would occur are improbable

Table D3: Risk Assessment Matrix

		Potential Severity			
		Severe	**Medium**	**Mild**	**Minor**
Probability of Risk	**High Likelihood**	Very high	High	Moderate	Low/Moderate
	Likely	High	Moderate	Low/Moderate	Low
	Low Likelihood	Moderate	Low/Moderate	Low	Very low
	Unlikely	Low/Moderate	Low	Very low	Very low

A description of these risk classifications and likely action required are given in CIRIA 552 as follows:

Very high risk - High probability that severe harm could arise to a designated receptor from an identified hazard ***or*** there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in substantial liability. Urgent investigation and remediation are likely to be required.

High risk - Harm is likely to arise to a designated receptor from an identified hazard. This risk, if realised, is likely to result in substantial liability. Urgent investigation is required and remedial works may be necessary in the short term and are likely over the long term.

Moderate risk - It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation is normally required to clarify risks and to determine potential liability. Some remedial works may be required in the long term.

Low risk - It is possible that harm could arise to a designated receptor from an identified hazard but it is likely that this harm, if realised, would at worst normally be mild.

Very low risk - It is a low possibility that harm could arise to a designated receptor. In the event of such harm being realised it is not likely to be severe.