Earthworks & Remediation Plan

Building P1

King's Cross Central
General Partner Ltd

September 2012

King's Cross

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PURPOSE OF THE REPORT

This Earthworks and Remediation Plan (ERP) describes the ground conditions and remediation proposals for Plot P1 of the King's Cross Central (KXC) development. It provides details of the proposed earthworks for the KXC P1 development and associated landscaping.

This ERP has been prepared as part of the Reserved Matters submission to address Condition 18 of the KXC outline planning permission dated 22 December 2006 (ref. 2004/2307/P) (the "Outline Planning Permission") which states:

'Applications for approval of Reserved Matters shall be accompanied by an Earthworks and Remediation Plan to deliver appropriate site levels and ground conditions for that part of the development. All works shall be carried out in accordance with the Earthworks and Remediation Plan as approved'.

SITE INFORMATION

APPROX. GRID REFERENCE	529928, 183748	**APPROX. AREA (ha)**	~0.40ha

EXISTING INFORMATION

A number of reports commissioned by Kings Cross Central General Partner Limited detailing information for the various KXC development plots and the entire KXC site have been reviewed as part of the preparation of this report. These reports include the Kings Cross Central Environmental Statement (2004 and 2005 Supplement) (the ES), information from a site specific investigation undertaken at the P1 site between May/June 2012 and a number of ground contamination interpretative reports for sites adjacent to the P1 site.

CURRENT SITE DESCRIPTION

Plot P1 forms part of the KXC site, comprising 67 acres of development land to the north of Kings Cross Station, London.

The KXC P1 site is currently used as a Bam Nuttal site compound the storage of a wide range of construction and associated materials including concrete, sand bags, LPG gas cylinders, metal, and plastic and storage containers. To the east of the site is a dedicated fuel storage area which is bunded and separated from the rest of the site by a fence. Localised areas of fuel spillages have been observed in the area. The Western Goods Shed building is located on the south eastern part of the site.

The KXC P1 site is relatively flat. Existing site levels range from +25.27m AOD in the west to +26.94m AOD in the east.

PROPOSED DEVELOPMENT

The redevelopment proposals for Plot P1 are for a mixed use development comprising open market and 'key worker' affordable residential apartments, a co-located primary school and school for the hearing impaired, community meeting facilities, a commercial unit and a basement for car parking and plant. The development will also incorporate podium level landscaped areas and a playground at street level for the schools. A new area of public realm is proposed between Building P1 and Plot P2, referred to as Holder Street, to provide vehicular access to the basement, drop-off and servicing for the schools and pedestrian access to the school and affordable housing entrances.

The proposed finished floor level (FFF) at ground floor is generally set at +25.2m AOD across the majority of the ground floor. In the northern part of the site the finished floor levels (FFL) vary from +25.44m AOD in the affordable residential entrance to +26.25m AOD at the entrance to the community facilities. The proposed ground floor plan is shown in Appendix A. The basement level is set at 21.94m AOD as shown in Figure 1.4 in Appendix

	A. The external levels are set at +26.50m AOD at the north west corner of P1 on Canal Reach, +25.7m AOD to the north east corner of the building on Handyside Street, +25.0m AOD at the southern end of the pedestrianized area of Canal Reach and +24.5m AOD to the south east of the site on Holder Street.
SITE HISTORY	Between 1746 and 1834, Plot P1 was undeveloped and comprised open fields. The first indication of the site's use as railway lands appears on the 1862 map and continue until around 1994. During the period between 1968 and the early 1990s, historic maps show a significant contraction of the goods and railway infrastructure, with the gradual reduction in depot/storage facilities and other railway infrastructure (e.g. tracks and sidings). By the early 1990s, most of the wider KXC site (including Plot P1) had been cleared and remained relatively undeveloped until implementation of the KXC development in 2008. A small part of the existing Western Goods Shed is located on the south eastern corner of the P1 site. The area around Plot P1 has historically included a mixture of railway tracks, sidings and ancillary buildings as well as residential developments to the south of the Regent's Canal. The existing site conditions are described in Section 1.2. Potentially contaminative land uses on the site have been associated with the use of the site and its immediate surrounds as railway land with associated infrastructure including railway tracks, depots and railway sidings. These historic land uses can lead to localised impacts of organic and inorganic contamination and this has been investigated on the site.
ENVIRONMENTAL SETTING	
GEOLOGY	The underlying geology at the site comprises of Made Ground (variable composition and between 2.5 – 4.0m in thickness), London Clay (30.5 – 36.55m in thickness), Lambeth Group Clays (16m in thickness), Thanet Sands (proven to 7.6m in thickness) and Upper Chalk (unproven thickness).
HYDROLOGY	There are no surface water features located on the site. The nearest surface water feature is the Regent's Canal which is located at ~80m to the south of the site.
HYDROGEOLOGY	The hydrogeology of the site consists of perched water in granular lenses in the Made Ground and groundwater in the Thanet Sands and Upper Chalk Stratum. The aquifers are separated from the Made Ground by a significant depth of relatively impermeable London Clay and Lambeth Group Clays. Pore water was recorded in the London Clay stratum at depths of between 11.40 – 18.81m AOD. The London Clay stratum is classified by the Environment Agency as a Non Aquifer. Groundwater in the Thanet Sands and Upper Chalk Aquifers (Principal Aquifers) were not identified as part of the ground investigations.
PRELIMINARY GROUND CONTAMINATION RISK ASSESSMENTS	
HUMAN HEALTH	The majority of the contaminants identified in the Made Ground and underlying strata were below their respective Generic Assessment Criteria (GAC) screening values. Marginally elevated concentrations of arsenic , lead and benzo (a) pyrene have been identified. These substances could potentially pose a risk to human health. Asbestos free fibres in the form of chrysotile was reported in one of the samples analysed as a concentration below the hazardous waste threshold of 0.01mg/kg. Due to the nature of the proposed development comprising predominantly hard standing with areas of soft landscaping in the form of raised planted beds with imported top soil, the risks to future site users has been assessed as

	LOW. The risks to construction workers has been assessed as LOW/MODERATE. However, the risks can be mitigated to LOW through the implementation of best practice measures during site works. This will include suitable health and safety measures such as the use of appropriate PPE and education of the workforce.
CONTROLLED WATERS	Leachate data from the soils on site indicate that the majority of the potential contaminants are below GAC. Due to the presence of significant depths of London Clay and Lambeth Group Clays (>40m) underlying the site, the groundwater in the Thanet Sands and Upper Chalk are not considered as sensitive receptors. Though 2No large piles will terminate in the Thanet Sands, the piles will be formed using bentonite and will be encased through the Made Ground. As such there is no pathway for contaminant migration into the underlying aquifers. Risks to Controlled Waters (groundwater and surface waters) have been assessed as LOW.
GROUND GASES	Based on best practice guidance including CIRIA C665, the proposed KXC Plot P1 site has been classified as a Characteristic Situation 1 site. A Characteristic Situation 1 site is a site with very low ground gas generation potential. The risk from ground gases has been assessed as LOW. As such specific ground gas protection measures are not required as part of the new development.
REMEDIAL STRATEGY	Earthworks proposed for the development include the removal and stockpiling or disposal of surface finish materials, excavations for substructure and basement construction and landscaping to achieve formation levels in the landscaped areas. It is proposed to re-use as much material as practicable in the KXC development. Due to the presence of ash, clinker and benzo (a) pyrene in the Made Ground, the existing Made Ground cannot be reused in soft landscape areas. However, Made Ground materials could be reused under hard standing areas, provided they are geotechnically suitable. Where site won materials cannot be reused in landscape areas, they will be taken off site under appropriate duty of care and waste management legislation. Any site remediation required for identified or previously unidentified contamination at the P1 site would be implemented in accordance with the principles of the King's Cross Central site wide remediation strategy as set out in the ES, Vol 4 Part 16 (Paragraph 16.6.7 to 16.6.9).
CONCLUSIONS	This ERP presents a strategy for managing ground contamination during the site enabling and construction works for P1 in order to deliver appropriate site levels and ground conditions and minimise any risks to human health and environmental receptors. The strategy presented in this ERP is in line with the King's Cross Central Environmental Statement and other ERPs submitted and approved by the London Borough of Camden in respect to reserved matters submissions for Plots R2, R4, R5North, the Eastern Goods Yard and T6.

1 INTRODUCTION

1.1 Scope and objectives

At the request of Kings Cross Central General Partner Limited (KCCGPL), Ramboll UK have been instructed to provide an Earthworks and Remediation Plan (ERP) to support a Reserved Matters Submission for Plot P1 (and associated landscaping) of the Kings Cross Central (KXC) development. The indicative location of Plot P1 is shown in Figure 1.1 and in the context of the wider KXC illustrative masterplan in Figure 1.2.

The purpose of this document is to address Condition 18 of the KXC outline planning permission dated 22 December 2004 (ref. 2004/2307/P) (the Outline Planning Permission) which states:

'Applications for approval of Reserved Matters shall be accompanied by an Earthworks and Remediation Plan to deliver appropriate site levels and ground conditions for that part of the development. All works shall be carried out in accordance with the Earthworks and Remediation Plan as approved'.

This document addresses the ground conditions and remediation strategy for the whole of Plot P1 and a small amount of landscaping principally between Plots P1 and P2.

This ERP should be read in the context of the following documents which were submitted in support of the original KXC outline planning application or the current Reserved Matters submission for Plot P1:

- Kings Cross Central Environmental Statement (ES) Volume 4: Part 16 Soils and Contamination Specialist Report, Arup, May 2004;
- Kings Cross Central ES Volume 5: Supplement, Arup, September 2005;
- Kings Cross Revised Code of Construction Practice (CoCP), RPS, September 2005; and
- Urban Design Report and submitted landscape, infrastructure and architectural drawings for the Building P1 and associated landscaping.

A site specific ground investigation has been undertaken on Plot P1. This ERP has been informed by existing information for the site and its vicinity and the results of this site investigation.

This ERP also refers to the ground conditions recorded on adjacent sites, notably T1 which lies to the west of Plot P1. A number of historic site investigations carried out across the KXC site between 1992 and 1997 have also been reviewed. These documents are useful in providing a picture of ground conditions around the site which can be used to suggest likely conditions within Plot P1.

A list of previous reports used in the preparation of this ERP are presented in Table 1.1.

Table 1.1: List of available information

Report Title	Author	Date
Contract "L" Phase 3 Ground Investigation Geotechnical Factual Report on Site Investigation [1]	Foundation and Exploration Services	1995
Kings Cross Central ES Volume 2: Part 9 Cultural Heritage and Townscape Specialist Report. Appendix 9B.	International Heritage Conservation and Management (IHCM), RPS and Arup	May 2004
Desk study for potential historic ordnance contamination. Kings Cross Central - Risk Zoning & Mitigation. Volume 3. A report prepared by RPS for Argent	RPS	June 2007
Ground Contamination Interpretative Report for Kings Cross T1 Building. A report prepared by Ramboll Whitbybird for Argent Kings Cross Ltd. Ref 4970.E.AGCIR.1A.	Ramboll Whitbybird	August 2008
Earthworks and Remediation Plan, Kings Cross Building T1. A report prepared by Ramboll Whitbybird for Argent. Ref 4970.E.ERP.1B.	Ramboll Whitbybird	June 2008
Addendum to the Ground Contamination Interpretative Report for Kings Cross Building T1. A report prepared by Ramboll Whitbybird for Argent Kings Cross Ltd. Ref 4970.E.GCIR.1C.	Ramboll Whitbybird	March 2009
Earthworks and Remediation Plan for Building R4.	WSP	January 2010
Generic Quantitative (Environmental) Risk Assessment R4, Kings Cross, London.	WSP	June 2010
Kings Cross T6 Ground Contamination Interpretative Report.	Ramboll	July 2010
Earthworks and Remediation Plan, Kings Cross Central Building T6. Ref 6955.E.ERP.8A.	Ramboll	August 2010
Kings Cross R5 Ground Contamination Interpretative Report. A report prepared by Ramboll for Kings Cross Central Partner Ltd. Ref 7665.E.GCIR.2A	Ramboll	September 2010
Earthworks and Remediation Plan for Building R5N. A report prepared by Ramboll for Kings Cross Central Partner Ltd. Ref 7965.E.ERP.5A	Ramboll	January 2011
Geotechnical & Geoenvironmental Desktop Site Appraisal for Kings Cross Plot P1. A report prepared by Ramboll for Kings Cross Central Partner Ltd. Ref 6727.E.DSA.1E	Ramboll	December 2011

[1] As detailed in Volume 4 Part 16 (paragraph 16.1, 16.4.7 and Figure 16.1) a large number of investigations related to the CTRL works were undertaken within the KXC site. As shown in Figure 16.1, the Foundation and Exploration Services investigation extended across several parcels of land (including parts of the KXC P1 site) with the Kings Cross area.

1.2 Site Details

Site Address : Kings Cross Central, London, N1

National Grid Reference : TQ928 748 (529928, 183748)

Size : 0.13ha

Plot P1 is located in the north west of the KXC development site, as shown in Figures 1.1 and 1.2.

The majority of the site is currently used as a Bam Nuttal site compound for the storage of a wide range of construction and associated materials including concrete, sand bags, LPG gas cylinders, metal, and plastic and storage containers. To the east of the site is a dedicated bunded fuel storage area. Localised areas of fuel spillages have been observed in the area. Parts of the Western Goods Shed are located in the south eastern part of the site. This building is due to be demolished pursuant to Conservation Area Consent 2004/2321/C.

Site surroundings include other development plots which form part of the wider KXC development site. In particular, Plot T1 lies immediately west of P1, separated by a new area of public realm, known as Canal Reach (formerly Canal Street). Building T1 and the section of Canal Reach between T1 and P1 has already received Reserved Matters approval (ref: 2009/0415/P) and construction of the Energy Centre which forms part of that building is now substantially complete, with commissioning of plant underway.

1.3 Existing Site Levels

Plot P1 is relatively flat. Existing site levels range from +25.27m AOD in the west to +26.94m AOD in the east. The existing site levels are shown on Drawing 6727/G/100 in Appendix B.

1.4 Proposed P1 Development and Site Levels

The redevelopment proposals for Plot P1 are for a mixed use development comprising open market and 'key worker' affordable residential apartments, a co-located primary school and school for the hearing impaired, community meeting facilities, a commercial unit and a basement for car parking and plant. The development will also incorporate podium level landscaped areas and a playground at street level for the schools. A new area of public realm is proposed between Building P1 and Plot P2, referred to as Holder Street, to provide vehicular access to the basement, drop-off and servicing for the schools and pedestrian access to the school and affordable housing entrances.

The proposed finished floor level (FFF) at ground floor is generally set at +25.2m AOD across the majority of the ground floor. In the northern part of the site the finished floor level (FFL) varies from +25.44m AOD in the affordable residential entrance to +26.25m AOD at the entrance to the community facilities. The proposed ground floor plan is shown in Figure 1.3 of Appendix A. The basement level is set at 21.94m AOD as shown in Figure 1.4 in Appendix A.

The external levels are set at +26.50m AOD at the north west corner of P1 on Canal Reach, +25.7m AOD to the north east corner of the building on Handyside Street, +25.0m AOD at the southern end of the pedestrianized area of Canal Reach, and +24.5m AOD to the south east of the site on Holder Street. The external levels are shown on the ground floor plan in Figure 1.3, Appendix A.

2 SITE CHARACTERISATION

2.1 Site History

The site history has been reviewed by inspecting historical and current plans dating from 1746 – 2011, including those which formed part of the KXC Cultural Heritage and Townscape Specialist Report in the original KXC ES (IHCM et al., 2004). These plans are provided for reference in Appendix C with the approximate location of Plot P1 highlighted in red. Other historical maps related to the site have been obtained from the Ground Sure environmental search reports. These are reproduced in Appendix C.

A detailed history of the site and its immediate surroundings is presented in Table 2.1 below. Potentially contaminative activities are shown in bold.

Table 2.1: Summary of the P1 site history

Source	Scale	P1 Site	Surroundings
Rocque's Map 1746	1: 75	The site is undeveloped and comprises large open fields.	Site surroundings are largely open undeveloped fields. A small settlement, Pancras Wells is shown to the south of the site.
Tomson's Map 1801	1: 75	No significant changes on the site.	Significant developments (residential) to the south and west of the site. Much of the area to the north and east of the site is still undeveloped fields.
Greenwood's Map 1827	1: 75	No significant changes on the site since 1801.	No significant changes to the immediate vicinity of the site. Extensive development has continued to take place to the south and west of the site. A **tank farm** associated with the Imperial **Gas Works** is shown ~300m south of the site.
Bartlett's Map 1834	1: 75	No significant changes on the site since 1827.	Development has continued to take place to the south and west of the site.
Standford's Map 1862	1: 75	The site is occupied by a number of buildings and railway infrastructure relating to the wider King's Cross Goods Yard and Coal Depot.	There has been significant development in the immediate area around the site, in particular, the development and construction of King's Cross Station and the development of the land behind with Goods depots and associated railway infrastructure.
1056 Scale Town Plan 1871	1: 1 056	The site is occupied by a number of structures associated with the use of the wider area as **railways, sidings and goods depot.**	A number of buildings associated with the use of the wider area as **railway land** are visible including a **locomotive cleaning shed and locomotive and carriage repair sheds and a store house** to the north, several **store houses** to the west, **offices and weighting machines** to the south. The wider area is predominantly occupied by **railway tracks.** A **goods depot** is visible further to the east of the site.
County Series 1875 - 1877	1: 1 250	No significant changes on the site since 1871.	No significant changes to the area around the site. The **goods depot, coal depots, engine sheds and railway tracks** remain visible further north and west of the site.
County Series 1896	1: 1 250	No significant changes on the site since 1877.	No significant changes to area around the site.
County	1: 1 250	No significant changes	No significant changes to the area around the

Source	Scale	P1 Site	Surroundings
Series 1916		on the site since 1896.	site.
National Grid 1951-1952	1: 1 250	No significant changes on the site since 1916.	No significant changes to the area around the site. The majority of the buildings in the vicinity of the site are now labelled as **goods depots** and **engine sheds.**
National Grid 1968 - 1971	1: 1 250	No significant changes on the site since 1952.	The majority of the **railway infrastructure** (i.e. **railway buildings, sidings and tracks**) have been removed. A **freight line terminal** is visible further to the east of the site. An **electrical substation** is shown to the west of the site.
National Grid 1982 - 1983	1: 1 250	No significant changes on the site since 1971.	The clearance of the surrounding buildings has extended further north, west and south. The **freight terminal** now occupies the entire northern boundary of the site. The **electrical substation** remains to the west of the site.
National Grid 1986 - 1991	1: 1 250	No significant changes on the site since 1983.	No significant changes to the site since 1983.
National Grid 1991 - 1993	1: 1 250	No significant changes on the site since 1991.	No significant changes to the site since 1991.
National Grid 1993 - 1994	1: 1 250	No significant changes on the site since 1993.	No significant changes to the site since 1993.
Mastermap 2011	1: 2,500	The site has been cleared of all buildings and structures.	Save for some heritage buildings around the Eastern Goods Yard, the majority of the site has been cleared as part of the wider King's Cross Central development.

In summary, between 1746 and 1834, Plot P1 was undeveloped and comprised open fields. The first indication of the site's use as railway lands appear on the 1862 map and continue until around 1994. During the period between 1968 and the early 1990s, historic maps show a significant contraction of the goods and railway infrastructure, with the gradual reduction in depot/storage facilities and other railway infrastructure (e.g. tracks and sidings). By the early 1990s, most of the wider KXC site (including Plot P1) had been cleared and remained relatively undeveloped until implementation of the KXC development in 2008.

A small part of the existing Western Goods Shed is located on the south eastern corner of the P1 site. The area around Plot P1 has historically included a mixture of railway tracks, sidings and ancillary buildings as well as residential developments to the south of the Regent's Canal. The existing site conditions are described in Section 1.2.

Potentially contaminative land uses on the site have been associated with the use of the site and its immediate surrounds as railway land with associated infrastructure including railway tracks, depots and railway sidings. These historic land uses can lead to localised impacts of organic and inorganic contamination. The ground contamination sources specific to the P1 site, based on recent ground investigation data are discussed in detail in Section 3.6.

2.2 Unexploded Bomb Risk

In 2007, Argent commissioned RPS Planning and Development to undertake an Unexploded Ordnance (UXO) Survey of the wider Kings Cross Central area in order to discharge Condition 68 of the Outline Planning Permission.

Based on Volume 3 of the Kings Cross Central Risk Zoning and Mitigation UXO Report (RPS, 2007), the KXC P1 site is located in a low to moderate risk area in relation to UXO risks. Section 4.1 of the report outlines the recommended mitigation measures required for low to moderate risk areas and these related to different types of works on site .e.g. site enabling works, shallow excavations, deep excavations and boreholes and piled foundation related activities. The mitigation measures include:

- the requirement to ensure all site personal attend an Explosive Ordnance Site Safety Awareness Briefing for site activities not involving intrusive works; or
- the requirement to have an Explosive Safety Engineer on call for all site activities involving intrusive works.

2.3 Published Geology

British Geological Map Sheet No 256, North London, Map Scale 1: 50 000 Solid and Drift edition (BGS, 1994) indicates that the site is underlain by a sequence of London Clay, Lambeth Group, Thanet Sands and Upper Chalk. However, due to the historical development of the site, shallow Made Ground deposits are likely to be present above the London Clay. This reflects the expected stratigraphy detailed in paragraph 16.4.12 of the ES (Arup, 2004), which accompanied the KXC outline planning application.

2.4 Published Hydrogeology

Published hydrogeology indicates that the hydrogeological regime underlying the site comprises perched water in the Made Ground and groundwater in the underlying Thanet Sands and Upper Chalk formations. The quantity of perched water in the Made Ground may increase after periods of heavy rainfall.

The Environment Agency Groundwater Vulnerability Map Sheet 40, Thames Estuary, scale 1: 10 000, classifies the Lambeth Group and Thanet Sands as Secondary Aquifers. The Chalk Aquifer is classified as a Principal Aquifer. The London Clay is a non aquifer (unproductive stratum) of low permeability and offers protection to the underlying groundwater in the Thanet Sands and Upper Chalk which are likely to be in hydraulic continuity.

2.5 Environmental Setting

A summary of the environmental setting of the site is presented in Table 2.2 below.

Table 2.2: Summary of Environmental Setting Data

Parameters	Description
Surface Water	There are no natural surface water features within the site boundary. The closest surface water is the Regent's Canal located ~ 80m to the south of the site. The Western Goods Shed is located on the south eastern corner of the P1 site. The building was built between 1897 -1899 and was used to house goods traffic for the historic railways on the site. The Canal Inlet into the building which is located along the Regent's Canal does not extent as far as the P1 site which is located further north. There are no surface water abstraction licenses within the site boundary.
Source Protection Zones	There are no Source Protection Zones within the site boundary or within 1000m of the site.
Groundwater Abstraction Licences	There are no groundwater abstraction licenses within the site boundary. The closest groundwater abstraction boreholes are located ~264m to the north of the site (outside the KXC development area) for general use by the Concrete Batching Plant. There are no potable water abstraction licenses within 1000m of the site.

2.6 Previous Earthworks and Remediation Plans

As discussed in Section 1.1, other ERPs have been submitted to, and approved by the London Borough of Camden as part of reserved matters or other planning submissions for other plots within the northern part of the KXC development site, including T1, T6, R2, R4, R5 and the Eastern Goods Yard. Of these, T1 is located the closest to Plot P1, lying immediately to the west of the site boundary. These documents have been used for reference in the production of this ERP to assess the impact of surrounding historical land uses (which were generally the same as Plot P1) and potential contamination in the vicinity of the site.

Table 2.3 summarises the sources of contamination identified in the above plans. The relative locations of each parcel of land and their proximity to Plot P1 can be seen on Figure 1.2.

Table 2.3: Summary of identified contamination within the KXC site

Earthworks and Remediation Plan[e]	Contamination Sources Identified
T1 [a, g, h]	• Side wide impacts of hydrocarbons and polycyclic aromatic hydrocarbons (PAHs) were identified in the Made Ground. In the southern half of the site, adjacent to Plot P1, significantly elevated diesel range hydrocarbon impacts were identified in the Made Ground at depths of between 1.3 - 3.2mbgl and were considered to have been associated with the former fuel depot at the site. Risk to Human Health were assessed as Low/Moderate; • Elevated concentrations of ground gases were reported in the southern part of the site and the site was classified as a Characteristic Situation 2 site (low risk) in accordance with CIRIA C665 guidance. This suggested that the requirements for ground gas protection measures subject to the proposed earthworks being completed, including the removal of the hydrocarbon impacted material which was attributed as the source of the ground gases. The majority of the Made Ground at the site was removed as part of the basement excavation and no special ground gas protective measures were required for the scheme. • The risk to Controlled Waters [mainly the Regent's Canal] were assessed as Moderate due to the presence of hydrocarbon contamination in the Made Ground and the presence of historic services on the site which could create preferential pathways to the Canal.
T6[b]	• The Made Ground was identified as a potential source of contamination. Marginal excedences of benzo (a) pyrene, anthracene, fluoranthene, napthalene as well as arsenic and total petroleum hydrocarbons ((TPHs) were noted during the Site Investigation; • The site was characterised as a Characteristic Situation 1 site, suggesting that no ground gas protection measures were required as part of the Building T6 development; and • Risk to controlled waters was assessed as Low.
Eastern Goods Yard [C]	• Potential sources of contamination comprise Made Ground associated with the backfilled granary basin walls and tunnels and the railway and canal interchange which included the transportation of coal; • Historical land raise formed by material contamination ash, clinker and slag; • Historical coal residues and fuel spillage in the Made Ground are possible; • Elevated concentrations of Lead and Asbestos were recorded in the site investigation testing compared to commercial human health screening values; and • No special ground gas precautions were recommended. Sites were no ground gas protection measures are recommended are typically low risk or Characteristic Situation 1 sites as per CIRIA C665 guidance.
R2[d]	• Potential sources of contamination comprise Made Ground and railway tracks; • Visual contamination of ash and tarmac was observed during the site investigation; and • An elevated concentration of Benzo(a)pyrene was recorded when compared to commercial human health screening values.

Earthworks and Remediation Plan[e]	Contamination Sources Identified
R5 [e]	• The shallow Made Ground was identified as a potential source of contamination. Marginal exceedences of benzo (a) pyrene were reported in one of the Made Ground soil samples. Exceedences of VOC species at concentrations marginally above the GACs [detection limits] were also reported in the Made Ground samples analysed. • Plot R5 was assessed as a Characteristic Situation 1 site, suggesting that no ground gas protection measures were required as part of the new development; and • Risk to controlled waters were assessed as Low.
R4[f]	• A review of the Generic Quantitative Risk Assessment for Building R4 prepared by WSP in June 2010, based on site specific data, showed the following: ○ Exceedences of benzo (a) pyrene in the Made Ground ○ The site was characterised as a Characteristic Situation 1 site, suggesting no special ground gas protection measures were required as part of the new development.

[a] Earthworks and Remediation Plan, Kings Cross Building T. A report prepared by Ramboll Whitbybird for Argent. Ref 4970.E.ERP.1B, dated June 2008.
[b]Earthworks and Remediation Plan. Kings Cross Central Building T6, ref 6955.E.ERP.8A dated August 2010 produced by Ramboll.
[c]Earthworks and Remediation Report, the Eastern Goods Yard, ref: 67940-13 dated September 2007, produced by Ove Arup & Partners Ltd.
[d]Earthworks and Remediation Plan, Development of Building R2, Kings Cross Central, ref: 110733, dated 2008 produced by TPS.
[e]Earthworks and Remediation Plan Building R5. Ref 7665.E.ERP.2A.R5N. dated January 2011, produced by Ramboll.
[f]Earthworks and Remediation Plan Building R4 dated January 2010, produced by WSP UK.
[g] Ground Contamination Interpretative Report for Kings Cross T1 Building. A report prepared by Ramboll Whitbybird for Argent Kings Cross Ltd. Ref 4970.E.AGCIR.1A.
[h]Addendum to the Ground Contamination Interpretative Report. A report prepared by Ramboll Whitbybird for Argent Kings Cross Ltd. Ref 4970.E.GCIR.1C.

3 GROUND AND GROUNDWATER CONDITIONS

3.1 Historic Site Investigation Data

As stated in Sections 1.1 and 2.5, a number of previous ERPs and historic site investigations have been reviewed to inform our understanding of the site conditions within Plot P1. Plans showing the location of historic boreholes and trial pits adjacent to the P1 site as well as geological cross sections are shown in Drawings 6727/YE/002 and 6727/YE/003 in Appendix B.

A review of historic ground investigations which informed the preparation of the KXC ES (Arup, 2004; 2005) indicates that only one trial pit (TP3804) has been taken within Plot P1. As detailed in Volume 4 Part 16 (paragraph 16.1, 16.4.7 and Figure 16.1) a large number of investigations related to the CTRL works were undertaken within the KXC site. As shown in Figure 16.1, the Foundation and Exploration Services investigation extended across several parcels of land (including parts of the KXC P1 site) with the Kings Cross area. The closest area to the P1 site with significant ground investigation data is the T1 site which is located to the west of Plot P1. Drawings 6727/YE/002 and 6727/YE/003 show the location of T1 relative to P1, as well as the location of the historic ground investigation locations in the vicinity of the site.

The KXC T1 ground investigation, undertaken by Soil Mechanics on behalf of Ramboll in 2008 comprised a total of 43No. Soil samples, 12No. leachate samples and 5No. water samples were analysed based on the preliminary conceptual site model and the information identified during the site works. Evidence of visual and olfactory signs of hydrocarbon contamination, PAH contamination and diesel impacted Made Ground was recorded in the southern part of the T1 site. This is thought to be due to the location of a diesel depot in the 1960s in the southern half of the site. Risks to human health were assessed as moderate. Leachable contaminants (hydrocarbons) were also reported in the soils and elevated contaminants were reported in the perched groundwater. This is thought to be due to the historic presence of the diesel depot in the southern half of the site. The risks to Controlled Waters (specifically the Regent's Canal) were assessed to be moderate. In 2009, further investigations were undertaken by Soil Mechanics on behalf of Ramboll within Plot T1 to further delineate the extent of the hydrocarbon contamination in the southern part of the site and prepare a risk management strategy for addressing any identified risks. Due to the high clay content of the Made Ground and the presence of underlying London Clay at shallow depths across the site, it is anticipated that the identified hydrocarbon impacted soils are likely to be localised within the KXC T1 site and would not have impacted the KXC P1 site.

As discussed in Section 1.2, the first phase of the T1 development consisting of the Energy Centre has now been completed. Site works for the phase II area of the KXC T1 site have not yet started. However, in March 2012, an excavation was undertaken to achieve the reduced ground floor level for the new development on the southern half of Plot T1. It is expected that the identified hydrocarbon contamination and impacted soils within the T1 site have been completely removed as part of the excavation works for the proposed foundations and residual impacts of the hydrocarbon contamination on the P1 site are likely to be minimal.

3.2 KXC P1 Site Specific Ground Investigation

A multidisciplinary (geo-environmental, geotechnical and archaeological) investigation was undertaken at the site between May and June 2012. The ground investigation scope specific to the assessments presented in this ERP were discussed and agreed with the Contaminated Land Officer of the London Borough of Camden in

November 2012. A copy of the CLO correspondence dated 29/11/2012 is provided in Appendix D.

The Geoenvironmental scope of works completed included 4No cable percussive boreholes to a maximum depth of 63.50mbgl with ground gas and groundwater monitoring installations and 24No trial pits to a maximum depth of 4.7mbgl. The fieldwork was undertaken between the 1st of May 2012 and the 6th June 2012. Ground gas and groundwater level monitoring was undertaken between the 8th June 2012 and the 27th June 2012.

Selected soil samples were analysed for a range of total and leachable potential contaminants. The information was used undertake a site specific risk assessment and to develop an appropriate ground contamination risk management strategy for the site.

The ground contamination risk assessment report for the KXC P1 site is included in Appendix E.

3.3 Geology

Ground conditions below the site have been interpreted from ground investigation information contained in Table 16.1 of the ES, previous phases of ground investigation in the vicinity of the site and site specific information obtained from the investigation completed at the site between May and June 2012.

The ground conditions identified at the site are summarised in Table 3.1 below.

Table 3.1: Summary of the anticipated geology at the KXC P1 site

Stratum	Level of Top of Stratum (m AOD)	Thickness (m)	Description and Comments
Made Ground	+23.68 - +26.32	0.498 – 4.0	Loose to medium dense slightly sandy gravelly CLAY. Gravel is angular to rounded find to coarse brick, wood, tarmac, glass, concrete, ash metal, ceramic tile and tarmac. A significant number of underground obstructions including redundant services, drainage pipes and old concrete based slabs were identified in the stratum. This material may effectively represent the extent to which the site has been locally raised since the end of the use of the site as railway land with associated infrastructure.
	+21.88 - +24.93	0.55 – 1.20	This varies from reddish brown sandy GRAVEL of crushed brick to loose to medium dense slightly gravelly very clayey SAND. Gravel is angular to sub rounded of flint, tarmac, granite cobbles, lean mix concrete, ash and clinker. Underground obstructions encountered in this layer included railway tracks/sleepers, railway tracks, concrete with rebar, The material typically occurs at depths of >1.5mbgl. This material may effectively represent the Made Ground below the historic ground level at the time the site was used as railway land.
	+21.38 - +24.02	0.25 – 1.15	Soft greenish grey black slightly gravelly CLAY. Gravel is sub rounded to round fine and medium flint, brick, ceramic and glass with an organic odour.
London Clay	+19.81 - +23.62	30.5 – 36.55	Firm yellowish brown and light brown randomly fissured CLAY with frequent grey partings and occasional pockets of selenite crystals The London Clay Stratum was established in all the boreholes and in the in the majority of the trial pits.
Lambeth Group CLAY	-10.69 - -15.65	Unproven - 16	Stiff greyish brown and grey CLAY. The Lambeth Group was established in 3 of the 4 boreholes completed at the site.
Thanet Sands	Unproven - -29.72	Unproven – 7.6	Grey gravelly fine and medium SAND. Gravel is rounded fine to medium black flint
Upper Chalk	Unproven - -37.52	Unproven	Recovered as structureless CHALK composed of compact, cream, slightly gravelly SILT. Occasional angular fine flint fragments.

Geological cross sections based on the exploratory hole logs adjacent to the KXC P1 site are shown in Drawings 6727/YE/002 and 6727/YE/003 in Appendix B. Geological sections based on the information obtained from the recent May/June 2012 investigation are included in the Ground Contamination Interpretative Report included in Appendix E.

3.4 Groundwater

As part of the ground investigations and follow on groundwater monitoring undertaken at the P1 site between May/June 2012, the following was identified:

- Perched water was identified in the Made Ground. The water was generally associated with redundant infrastructure on site particularly services such as clay or plastic pipes. Made Ground is a Non Aquifer;

- Pore water was recorded in the London Clay stratum at depths of between 11.40 – 18.81m AOD. The London Clay stratum is classified by the Environment Agency as a Non Aquifer.

Ground water is anticipated at depth in the Thanet Sands and Chalk Aquifers which are classified as Principal Aquifers.

3.5 Ground Gases

A total of 4No ground gas monitoring visits were undertaken at the P1 site as part of the 2012 SI. The monitoring visits were undertaken on the 8/06/2012, 13/06/2012, 20/06/2012 and 27/06/2012.

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.met.gov.uk) website. A summary of the data from the ground gas monitoring visits is presented in Table 3.2.

Table 3.2: Summary of ground gas monitoring data at the KXC Plot P1

BH ID	No of visits	Water Depth (min/ max)	Gas Flow [3]	CH_4 [1]	CO_2 [1]	O_2 [2]	H_2S
		mAOD	l/h	% v/v	%v/v	% v/v	ppm
BH1	4	DRY	0.2	BDL[4]	BDL	20.5	BDL
BH2	4	DRY	0.8	BDL	BDL	18.4	BDL
BH3	4	DRY	1.5	BDL	BDL	0.6	BDL
BH4	4	DRY	4	BDL	0.4	19.7	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)

3.6 Ground Contamination

Due to the historic development of the site, there is the potential to encounter ground contamination at the site. A site specific investigation was undertaken at the site between May/June 2012. The generic screening assessment and contaminant distribution assessment undertaken as part of the 2012 ground investigation identified some contamination localised in the Made Ground. This included the following:

- Localised marginal impacts of arsenic in Made Ground in the north eastern part of the site; and
- Random impacts of benzo (a) pyrene across the site due to the presence of ash and clinker in the Made Ground across the site; and
- Asbestos in Made Ground. This was identified in one of the samples analysed and it was characterised as a chrysotile based free fibre.

Based on the 2012, ground investigation, the identified sources of ground contamination are summarised in Table 3.3.

Table 3.3: Potential contamination hazards identified within the P1 site

Source	Main potential contaminants	Description/properties
Made Ground	Benzo (a) pyrene, TPH, arsenic, lead, arsenic and copper, asbestos	Marginal excedences of arsenic and benzo (a) pyrene in the soil samples.Samples with reported marginal excedences of arsenic are located in the north eastern corner of the site. Samples with reported excedences of benzo (a) pyrene are randomly distributed across the site and there are no defined clusters of the contaminant across the site. Made Ground across the site was found to contain ash, clinker, tarmac .One sample reported the presence of chrysotile free fibres. Localised impacts of leachable lead and copper in the centre of the site .The samples with reported excedences above GAC are located in the area where the proposed basement would be located.
Underground structures	Organic (e.g. TPH) and inorganic contaminants	A number of historic structures including concrete slabs and historic formation levels were identified in the trial pits during the investigation. Potential contaminants could be associated with these structures including organic and inorganic contaminants.

4 EARTHWORKS

4.1 Proposed Earthworks and Volumes

The proposed earthworks volumes for Plot P1 relate to the submitted proposals for the development on Plot P1, set out in Section 1.4 of this document. The P1 development would include a basement across the majority of the site to accommodate plant and car parking.

As noted in Section 1.3, the current site levels on Plot P1 vary from +25.27m AOD in the west to +26.94m AOD in the east.

The proposed finished floor level (FFF) at ground floor is generally set at +25.2m AOD across the majority of the ground floor. In the northern part of the site the finished floor levels (FFL) vary from +25.44m AOD in the affordable residential entrance to +26.25m AOD at the entrance to the community facilities. The proposed ground floor plan is shown in Figure 1.3 of Appendix A. The basement level is set at 21.94m AOD as shown in Figure 1.4 in Appendix A.

The external levels are set at +26.50m AOD at the north west corner of P1 on Canal Reach, +25.7m AOD to the north east corner of the building on Handyside Street, +25.0m AOD at the southern end of the pedestrianized area of Canal Reach and +24.5m AOD to the south east of the site on Holder Street. The external levels are shown on the ground floor plan in Figure 1.3, Appendix A.

The required earthworks for the Building P1 development (and associated landscaping) are as follows:

- Removal and stockpiling/disposal of existing surface finish materials;
- Basement excavation across the majority of the P1 building footprint;
- Piles to be installed under the building footprint and under the base of temporary tower crane;
- Minor works associated with earth movements to achieve final site levels in the landscape areas;
- Excavation for the proposed P1 building to the underside of the ground/basement slabs; and
- Installation of service ducts.

An assessment of the volumes of materials that will be excavated during the ground works for the P1 development is detailed in Table 4.1 below. The volumes have been estimated from the existing and proposed site levels detailed above and are based on the stated assumptions in notes a to d.

Table 4.1: Estimated Earthwork Volumes for KXC P1 site.

Total Excavated Volume [a/c/d]		22,625 m^3
	Excavated Made Ground Materials [b,d]	16,141m^3
	Excavated London Clay Materials [b]	6,484 m^3

[a]Total volume estimated from the number of proposed number of piles (387no) across the entire building footprint as follows, 387no 750mm diameter and 25m long piles within the building footprint, 150no 750mm diameter and 25m long piles within the retaining wall across the perimeter of the site.

[b]Total volumes of excavated Made Ground and London Clay are based on the anticipated stratigraphy (Made Ground, London Clay]. The estimated volumes of London Clay includes estimated London Clay from the basement excavations and London Clay from the pile arisings.

[c]Volumes quoted are only estimates based on the existing information.

[d]Due to the presence of a basement across the majority of the site, separate earthworks figures have not been estimated for the excavations to the underside of the ground slab

[d]The estimate volume of Made Ground includes the Made Ground excavated in the public realm areas. The volume of Made Ground to be excavated in the public realm areas is estimated to be about 1581m^3

4.2 Material Suitability and Reuse Options

As noted in Section 3.3, Made Ground and London Clay are expected to comprise the bulk of the excavated materials and arisings from the P1 development. A number of underground obstructions including existing pavements and roads have been identified on the P1 site. These include a concrete surface, redundant services, historic railway tracks, unknown sub base and unknown foundations.

It is proposed to re-use as much material as practicable within the KXC development. This will be subject to appropriate chemical and geotechnical suitability criteria. During the earthworks, the concrete pavings, underground obstructions and any asphalt layers encountered can be excavated, crushed and processed for reuse on the wider KXC site as fill material including reuse as a piling mat material. However, due to the presence of benzo (a) pyrene at elevated levels above their Generic Assessment Criteria (GAC), the existing Made Ground soils on the P1 site are unsuitable to be reused in areas of soft landscaping due to the potential exposure pathways that could be present in soft landscape areas. Where site won materials cannot be reused in landscape areas, the will be taken off site under current duty of care and waste management regulations.

Where areas of soft landscaping are proposed, chemically suitable topsoil and sub sub soil materials will be imported as required. All imported material for use in soft landscape areas will require validation testing to confirm its suitability.

4.3 Unsuitable Materials

Materials which do not have the appropriate geotechnical properties in accordance with the Highways Agency Specification for Highway Works based on the proposed end use will be deemed unsuitable. This could include the following materials:

- Soft cohesive material, not suitable as fill under new pavement or hard landscape areas;
- Contaminated material; or,
- Made Ground with unsuitable engineering properties (e.g. high fines content, high moisture content, significant quantities of organic matter); or
- Other material designated as unsuitable due to lack of compliance with particular engineering fill parameters, and as determined in the Specification for Highway Works.

Any excavated material that is unsuitable for use in the development will be removed from the site to a suitably licensed waste treatment or disposal facility.

All unsuitable excavated material will require information that is appropriate to the receiving waste facility. This may include:

- Material description;
- Standard Chemical Testing; and
- Waste Acceptance Criteria (WAC) Testing as appropriate.

All material disposed off-site will be accompanied by the appropriate duty of care documents in accordance with current waste management regulations.

4.4 Stockpiling and Handling

4.4.1 Stockpiling for Re-use Onsite

As outlined in Section 4.2 excavated suitable material will be allocated for either direct placement as fill, crushing and re-use as appropriate, or where surplus to requirements, removed from the P1 site.

Any material to be reused on site will be temporarily stockpiled within the KXC development area (based on material type), prior to removal from site under appropriate duty of care and waste management regulations.

4.4.2 Contaminated Material

Any excavated materials identified as contaminated will be moved to designated areas and temporarily stockpiled on plastic sheeting or hard standing areas where appropriate. Measures (e.g. use of dust suppression methods, containment, bunding) shall be taken to restrict dust and surface water run-off from the temporary stockpiling in order to reduce the potential for contaminant migration.

4.4.3 Treatment of Contaminated Material

Any excavated material that is unsuitable for use in the development will be removed from the site to a suitably licensed waste facility under duty of care regulations. If required, the pre-treatment of soils prior to transfer to a licensed facility or soil recycling site or re-use elsewhere will be undertaken where practicable. Treatment may be carried out within the wider KXC or where this is not possible, at an off-site treatment facility.

4.5 Method and Sequencing of Works

4.5.1 General

The sequence of excavating and relocating material for reuse will be coordinated to ensure that the following objectives are met:

- Transportation and double handing is kept to a minimum; and,
- A designated area is provided for stockpiling material for use during and after the works.

The anticipated sequencing would be as follows:

- Removal of all Bam Nuttall equipment on the site with their associated infrastructure;
- Breaking out and removal of any existing hardstanding, pavements and foundations within the P1 site and landscaping area. These will be either

stockpiled in a designated area and crushed/processed for future placement on site or removed for disposal off site;

- Any remediation would be undertaken as required. This is discussed further in Section 6.
- Excavation of the foundations and any unsuitable materials present beneath the slab level. Any material that is required for re-use will be placed in the designated temporary stockpile and the remainder will be disposed off-site under current duty of care and waste management regulations.

4.5.2 Drainage of Excavated Areas

As part of the ground investigations undertaken at the site in May/June 2012, significant quantities of perched water were not encountered within the Made Ground on the P1 site. It is however, considered where perched water is identified, particularly after periods of heavy rainfall, it is likely to be localised in the granular lenses with the Made Ground. Pore water has been identified in the London Clay at depth as discussed in Section 3.4.

Groundwater encountered in excavations will be managed during construction works by the contractor. Excavations will be kept free of standing water in order to minimise the Health and Safety risk and minimise access difficulties. Pumping from sumps should maintain an adequately dry working area.

5 GROUND CONTAMINATION RISK ASSESSMENT

5.1 Environmental Risk Assessment

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 water 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 contaminated land risk management 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.

In accordance with the UK approach to contaminated land assessment and paragraph 16.6.9 of the KXC ES, the potential human health and environmental risks after development have been considered in the context of a Source-Pathway-Receptor (SPR) model. This characterises the potential sources of contamination and their potential pathways to the key receptors during the construction and operation phases of Building P1 and its associated landscaping. The SPR model is then used to identify plausible pollutant linkages (PPLs) which in turn inform the requirements of the remediation strategy.

5.1.1 Potential Sources

Potential sources of contamination based on land use, historic site investigation data as well as information obtained from the recent 2012 site investigation have been identified in Section 3.1. The potential sources of ground contamination as is relevant to the P1 site are summarised in Table 3.2 in Section 3.6.

5.1.2 Potential Receptors

The P1 site-specific receptors that could potentially be affected by the contamination hazards detailed in Section 3.6 are presented in Table 5.1.

Table 5.1: Potential receptors identified

Category	Receptor	Properties
Humans	Future site users (visitors, workers, site maintenance staff)	Potential contact with contaminated soils in soft landscaped areas; potential for accumulation of ground gas within buildings and resulting health effects.
	Construction workers	Reworking of any contaminant impacted materials in Made Ground or natural strata during construction works can expose workers to contamination.
Property	Materials and site structures	Foundations and services may be damaged by potentially aggressive compounds present in soils. Potential for ground gas ingress into buildings.
Neighbouring property	Other KXC development plots - both commercial and residential	The KXC development includes a mixture of residential and commercial developments in the vicinity of Plot P1. Potentially aggressive compounds present in soils; potential for offsite migration of ground gases.
Controlled Waters	Surface Water of the Regent's Canal	There are no surface water features located on the site. The nearest surface water feature is the Regent's Canal which is located ~80m to the south/south-east of the site and could be a sensitive receptor if preferential flow paths are present in granular lenses in the Made Ground.
	Groundwater in the Thanet Sands and Upper Chalk Aquifer	Perched water may be encountered in the granular lenses in the Made Ground. The Made Ground is separated from the underlying Thanet Sands and Chalk Aquifer significant depths (>40m) of London Clay and Lambeth Group Clay strata which are relatively impermeable. The proposed development will include piles that would extend into the Thanet Sands and Chalk Aquifer.
Wildlife	Flora and Fauna	No significant plant or animal receptors have been identified on the site. This potential receptor is therefore not considered further in this report.

5.1.3 Potential Pathways

In order for contaminants to reach potential receptors, there has to be a viable pathway for the contaminant. Potential pathways that may affect the migration of contaminants within Plot P1 are listed in Table 5.2.

Table 5.2: Potential Pathways

Pathway	Medium	Properties
Direct contact	Dust, solid and liquid phase	There may be direct contact with potentially contaminated Made Ground across the site. There is a possibility of dust fumes being produced during earth works in the construction phase. Dermal contact/ingestion of potentially contaminated soils during construction or operational phase of site.
Migration of ground gas	Gaseous flow	Made Ground is known to be heterogeneous in composition. Migration through granular material in Made Ground and alongside buried utility pipes/cables or along preferential flow paths. Based on the 2012 ground investigation data and the ground gas risk assessment undertaken in accordance with best practice guidance, CIRIA C665, the P1 site has been classified as a Characteristic Situation 1 site – a very low risk site with a low ground gas generation potential. As such this potential pathway is not considered to be active on the P1 site and is not considered further in this report.
Leaching through Made Ground	Unsaturated flow	Potential for leaching and migration of potential contaminants along preferential flow paths in the Made Ground due to its heterogeneity. There may be preferential flow pathways through granular lenses to the Regent's Canal in the west of the site.
Foundations (e.g. proposed piles) and underground infrastructure	Preferential flow	Piling could create preferential flow paths for the vertical migration of potential contaminants to the underlying groundwater in the Thanet Sands and Upper Chalk Aquifer. The underlying groundwater is separated from potentially contaminated Made Ground by significant depths of relatively impermeable London Clay and Lambeth Group Clays.
Overland flow, surface run off	Preferential flow	Potential migration of contamination with overland flow and run off from excavations or water during periods of rain fall. The increased infiltration could result in the mobility of contaminants through granular lenses in the Made Ground towards the Regent's Canal to the west of the site.

5.1.4 Plausible Pollutant Linkages

A number of pollutant linkages based on the anticipated sources, receptors and pathways in Sections 4.1.1, 4.1.2 and 4.1.3 have been identified and a qualitative risk assessment undertaken. The risk assessment and risk ratings for each potential pollutant linkage is presented in Table 5.3.

Table 5.3: Pollutant linkages for the KXC P1 site

Hazard/ Pollutant	*Pathways*	*Receptor*	*Potential Severity*	*Probability of Risk*	*Risk Rating*	*Justification of the Risk Rating*
Made Ground (railway infrastructure, underground obstructions, redundant infrastructure associated with coal storage)	Ingestion, dermal contact, inhalation	Future site users	Medium	Unlikely	Low	All the potential historic and existing sources of ground contamination are associated with the Made Ground on site. Marginal excedences of contaminants such as arsenic and benzo (a) pyrene have been reported in the Made Ground. The proposed development would predominantly consist of hard standing areas and as such the direct contact pathway would be absent. Based on the absence of a pollutant linkage, the risk to future site users has been assessed as Low due to the absence of a pollutant linkage.
		Construction workers	Medium	Low Likelihood	Low/ Moderate[a]	The risk to Construction Workers have been assessed as Low/Moderate due to the likelihood of construction workers coming into direct contact with soils impacted in benzo (a) pyrene. The risks can be mitigated to Low through the implementation of best practice measures during site works to minimise the direct contact pathway.
	Direct contact	Materials and site structures	Mild	Low Likelihood	Low	The risks are considered low because the development will include concrete materials designed to the appropriate sulphate and pH classification for the site.
	Leaching, migration	Regent's Canal	Mild	Low Likelihood	Low	The Regent's Canal is located at ~80m to the west of the site. The site is underlain by relatively impermeable London Clay. The Made Ground is likely to be predominantly clay based material such that preferential flow pathways through the granular lenses in the Made Ground would be reduced. Additionally, the use of hard standing surfaces across the proposed development will significantly reduce infiltration and migration through the existing Made Ground. The majority of the site would be occupied by a basement which will involve the excavation and removal of the localised leachable materials. In the absence of any material which is likely to leach, there are no pollutant linkages and the risks have been assessed as Low. The residual risks to Controlled Waters have thus been assessed as Low due to the absence of a viable pollutant linkage during occupation.
		Thanet Sands and Upper Chalk Aquifer	Medium	Unlikely	Low	The localised areas with leachable contaminants are in the areas where the proposed basement would be dug out. The site is underlain by over 40m of London Clay and Lambeth Group clays which are relatively impermeable. The proposed development would be based on a piled foundation solution with maximum pile lengths of up to 55m in length which will extend into the Thanet Sands Stratum. Though the 2No large piles will terminate in the Thanet Sands, the piles will be formed using bentonite and will be encased through the Made Ground. As such is there is no pathway for contaminant migration into the underlying aquifers. As such the residual risks to groundwater are considered to be Low.

[a] *In the absence of mitigation measures being adopted during construction works, the risks to construction workers and site operatives is classified as Moderate due to the direct contact pathway being active during site works. However, it is considered 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. Should the contractor ensure that direct contact between potentially contaminated Made Ground and construction staff or site visitors is avoided; the risks during construction works would be Low.*

5.2 Summary of Human Health Risks

Based on the existing information, including the 2012 SI data, the risks posed to human health during operation have been estimated as Low because the majority of the new development will consist of hardstanding areas and the direct contact pathway will be absent. Furthermore, any potential contamination identified during the site works would be removed as part the site redevelopment in accordance with the remedial strategy set out in the ES, Vol 4 Part 16 (Paragraph 16.6.7 to 16.6.9). Should any remediation be implemented during site redevelopment, the direct contact pathway during site occupation would be absent and the risk would be low.

The risks to construction workers have been estimated as Low/Moderate due to the likelihood of the direct contact pathway between potentially contaminated Made Ground and construction workers being active during construction works. However, the risks to construction workers can be mitigated to Low through the implementation of best practice measures during site works.

5.3 Property

There is a potential for building materials, services and building structures contact with potentially impacted soils. This will be prevented by placing all structures and services in clean, inert soils. The pathway of direct contact between potentially impacted soils and these building elements will be removed following implementation of these measures.

5.4 Summary of Controlled Waters Risks

Based on existing information, including the 2012 SI data, the risk posed to Controlled Waters receptors, specifically the underlying Thanet Sands and Upper Chalk aquifer have been assessed as Low due to the significant (>40m) of London Clay separating the Made Ground and the underlying Thanet Sands and Chalk Aquifers. The risk to the surface water of the Regent's Canal has been assessed as LOW due to the absence of significantly elevated leachable contaminants above their respective Generic Assessment Criteria (GAC).

5.5 Ground Gas Risk Assessment

Based on the 2012 SI data and best practice guidance including CIRIA C665, the proposed KXC Plot P1 site has been classified as a Characteristic Situation 1 site. A Characteristic Situation 1 site is a site with very low ground gas generation potential. The risk from ground gases has been assessed as LOW.

As such specific ground gas protection measures are not required as part of the new development.

6 REMEDIATION STRATEGY

6.1 Remediation Strategy

The site-wide remediation strategy for the KXC development is described within Volume 4 Part 16 of the ES (paragraphs 16.6.7 to 16.6.9). Paragraph 16.6.8 of the ES addresses the sub-areas which include the site (i.e. Areas 3 and 4) and recommends the following remediation measures, where applicable:

- Removal of contamination hotspots from in-filled canal basins (areas 3 and 4);
- Use of capillary break layer in soft landscaping (areas 3 and 4);
- Inert backfill for services trenches (areas 3 and 4);
- Cement stabilisation of coal-rich material (areas 3 and 4);
- Removal, for off-site disposal, of liquid tars and sludges from gasholder slumps (area 4); and
- Excavate and treat on site material with high hydrocarbon/PAH content using bioremediation including perched water (area 4).

As part of the scheme development and assessment of site specific information, a remediation strategy for Plot P1 has been developed and is described below.

As noted previously and based on the ground investigation data from the 2012 investigation at the P1 site, it is considered that there is a low potential for significant or widespread ground contamination at the site, although localised ground contamination may be present. On the basis of the findings presented in this ERP, no specific remediation (treatment) measures are expected.

6.2 Risk management during site enabling and construction works

Notwithstanding the historic and recent ground investigation data and assessments undertaken at the KXC P1 site, there remains a potential for unidentified contamination to be encountered during excavation works due to the former historical uses of the site. Therefore, a contamination watching brief will be maintained through the excavation works for unsuitable or unexpected conditions and to ensure the various recommendations provided are implemented and recorded. If previously unidentified areas of potential contamination (such as hydrocarbon impacted soils) are encountered during enabling earthworks at the site, they will be dealt with in line with paragraph 16.6.9 of the ES. Soil will either be sampled in-situ in the ground (and left undisturbed while the samples are tested and the results interpreted) or be excavated and stockpiled separately in an appropriate manner (i.e. bunded and covered in stockpiles etc). The CLO will be informed if significant unexpected contamination is encountered.

If required, validation testing will be undertaken following remediation of any identified hotspots in line with Section 16.9 of the ES.

Any tanks or similar features encountered during the earthworks will be decommissioned in line with the Environment Agency guidance in PPF27[1]. Soil

[1] Environment Agency, Installation, decommissioning and removal of underground storage tanks, PPG27

samples will be taken from below the position of the tank location following its removal to check for subsurface contamination. If soil or groundwater contamination is identified it will be selectively excavated for disposal offsite. Alternatively, additional investigations including a risk assessment will be carried out to determine the need for remediation.

A specialist asbestos contractor will be consulted and advise on works if asbestos containing materials are encountered. Work specifically involving asbestos materials and asbestos air monitoring will be undertaken under the supervision of appropriate experienced personnel.

7 REFERENCES

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WSP (2010) Generic Quantitative (Environmental) Risk Assessment R4, Kings Cross, London. June 2010.

APPENDICES

APPENDIX A: FIGURES

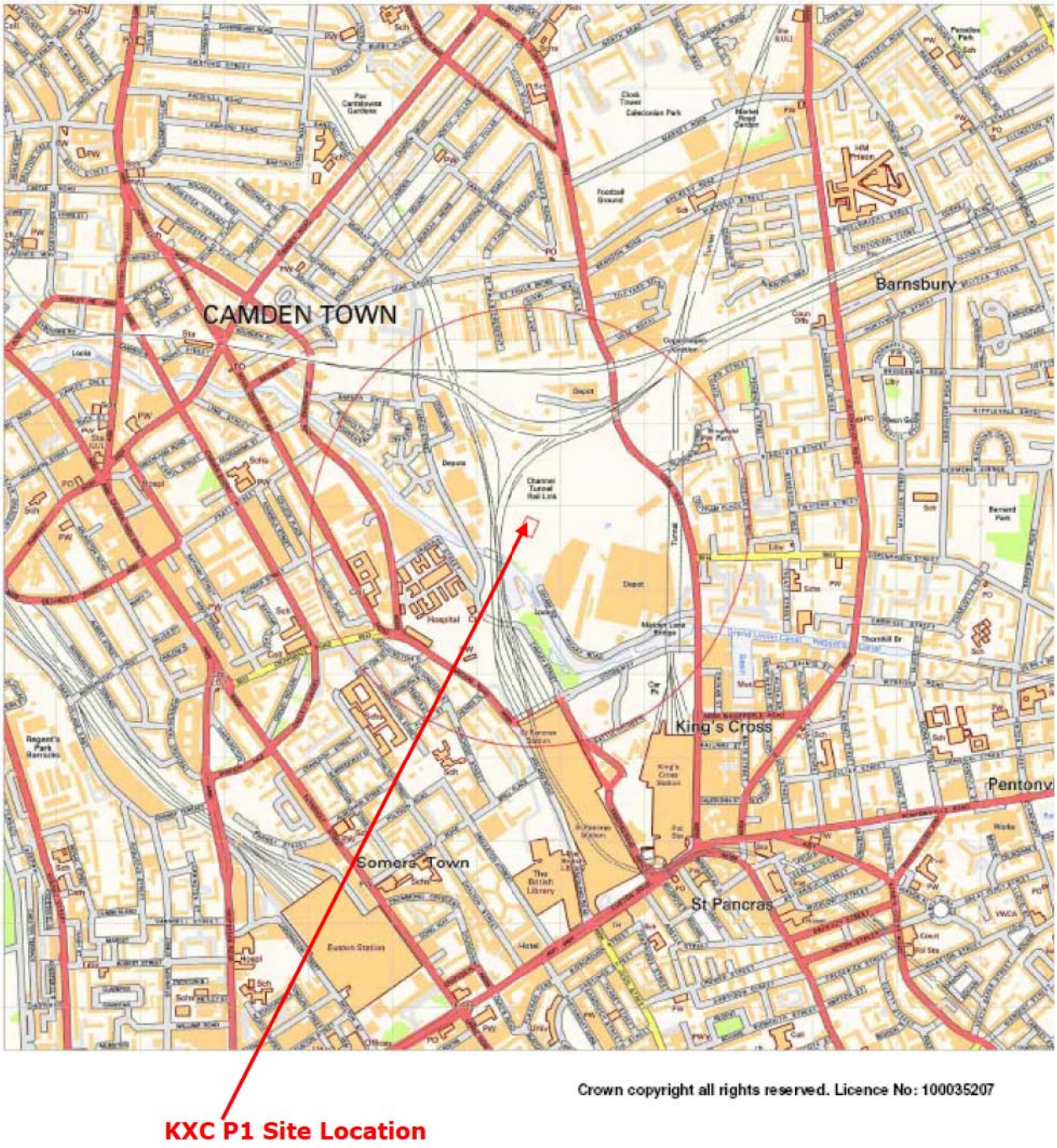


FIGURE 1.1: SITE LOCATION PLAN

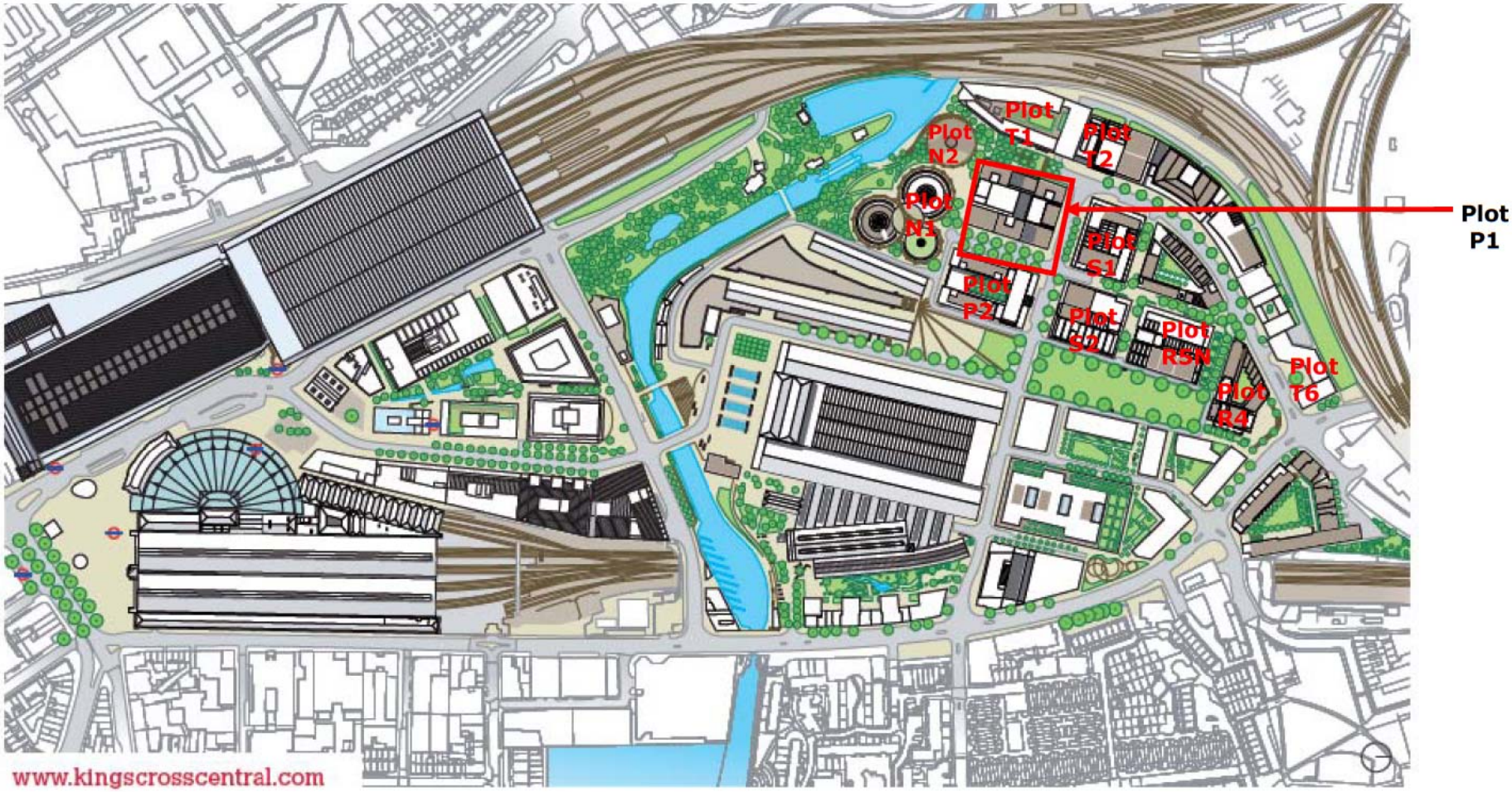


FIGURE 1.2: KINGS CROSS ILLUSTRATIVE MASTER PLAN WITH THE P1 SITE IN THE NORTH WESTERN SECTION OF THE KXC SITE

FIGURE 1.3: KXC P1 GROUND FLOOR PLAN SET AT +25.20M AOD ON AVERAGE

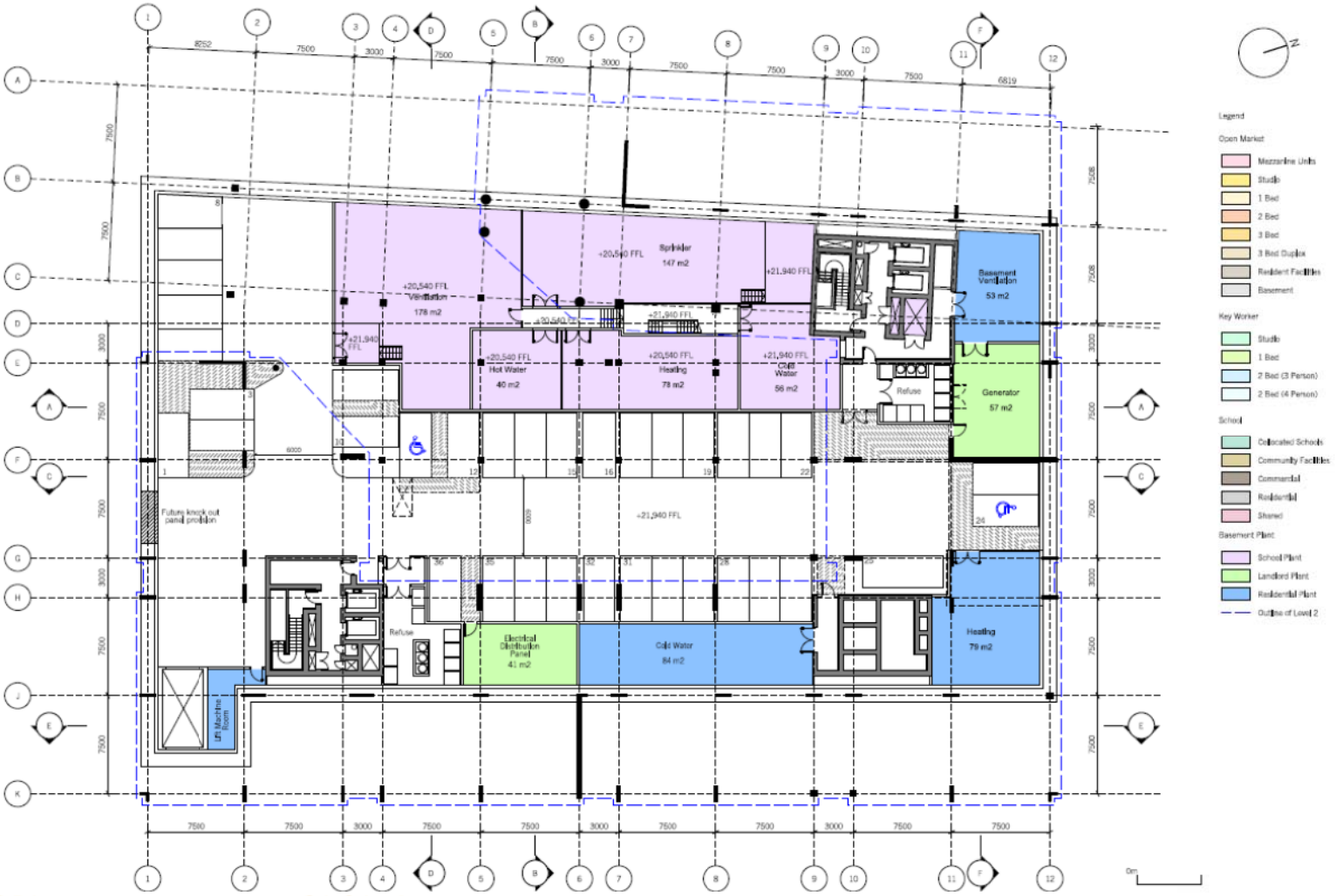


FIGURE 1.4: KXC P1 BASEMENT PLAN SET AT +21.94M AOD ON AVERAGE

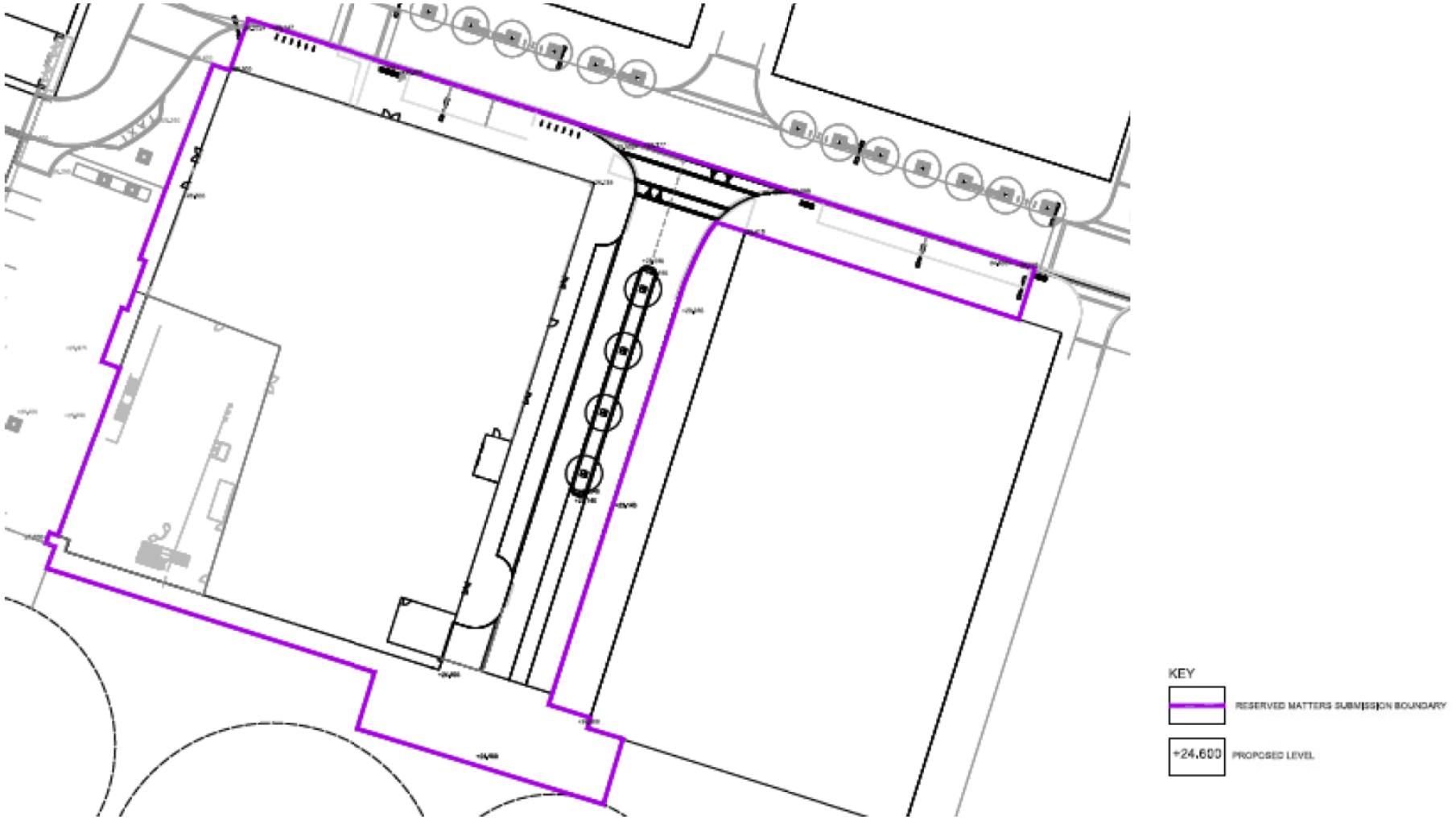


FIGURE 1.5: KXC P1 EXTERNAL LANDSCAPE AREAS AND SITE LEVELS

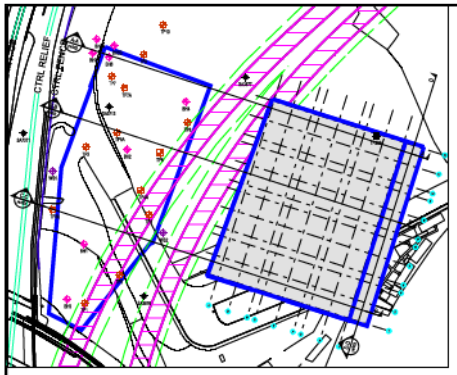
APPENDIX B: DRAWINGS

DRAWING 6727/YE/002: GEOLOGICAL CROSS SECTION BASED ON HISTORIC INVESTIGATIONS IN THE VICINITY OF THE KXC P1 SITE

DRAWING 6727/YE/003: GEOLOGICAL CROSS SECTION BASED ON HISTORIC INVESTIGATIONS IN THE VICINITY OF THE KXC P1 SITE

DRAWING 6272/YE/005: PRELIMINARY CONCEPTUAL SITE MODEL FOR THE KXC P1 SITE

DRAWING 6727/CG/002: KXC P1 CONSTRAINTS PLAN - THAMES LINK TUNNELS



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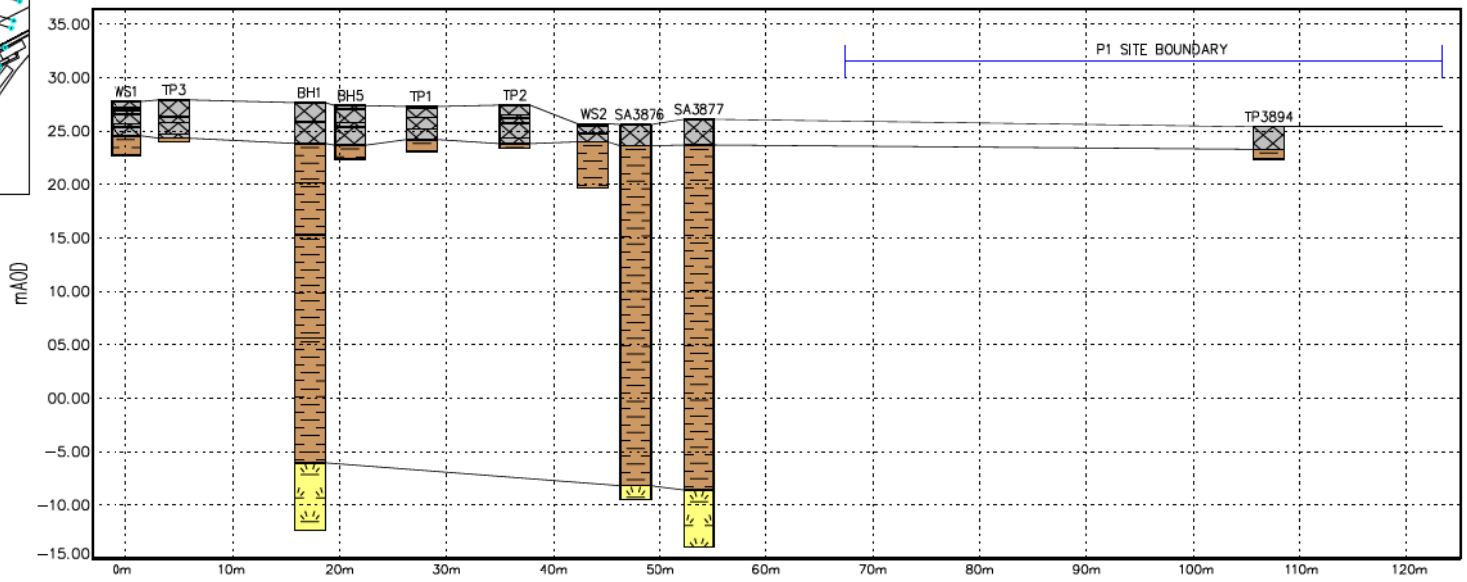

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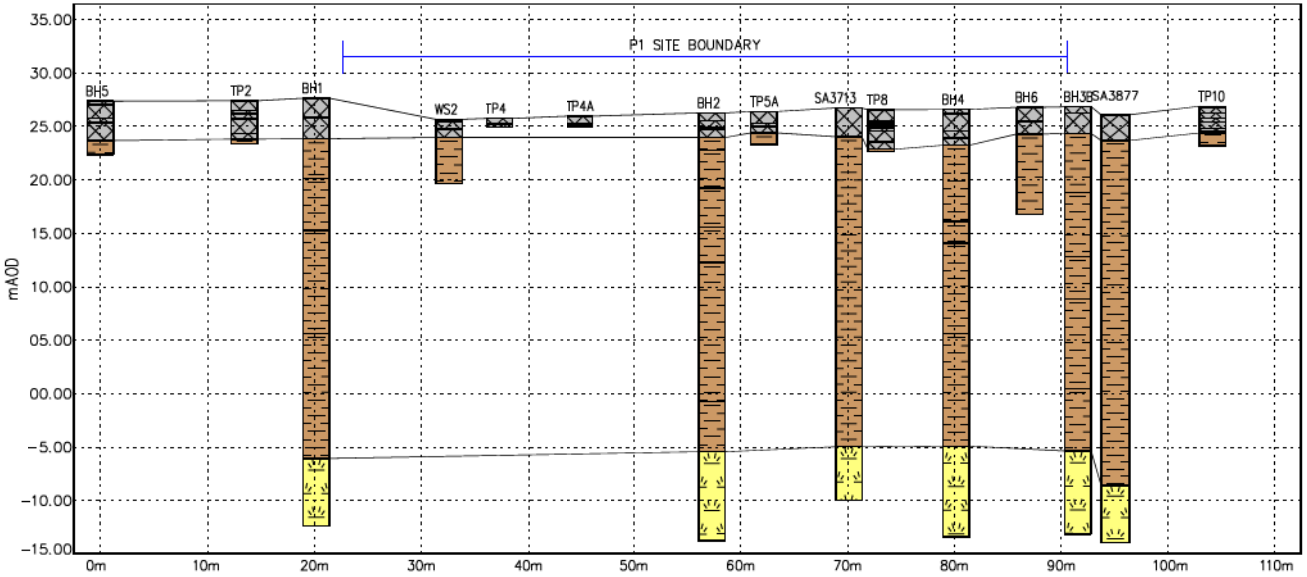

Notes

1. DO NOT SCALE FROM THIS DRAWING
2. ALL DIMENSIONS ARE IN MILLIMETRES U.N.O.
3. ALL HEIGHTS ARE IN METRES ABOVE ORDNANCE DATUM U.N.O.
4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS

P1 SITE BOUNDARY

MADE GROUND

LONDON CLAY

LAMBETH GROUP

Rev	Description	Date	By	Chk	App
P1	INFORMATION	26/10/2011	Rmax	OF	SC

INFORMATION

KINGS CROSS BUILDING P1

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GEOLOGICAL SECTION C & D

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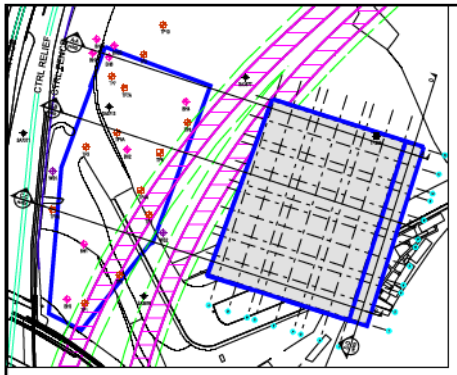
NTS @ A3	OCT 2011	Rmax	OF

Drawing No. 6727/YE/003 Rev: I01



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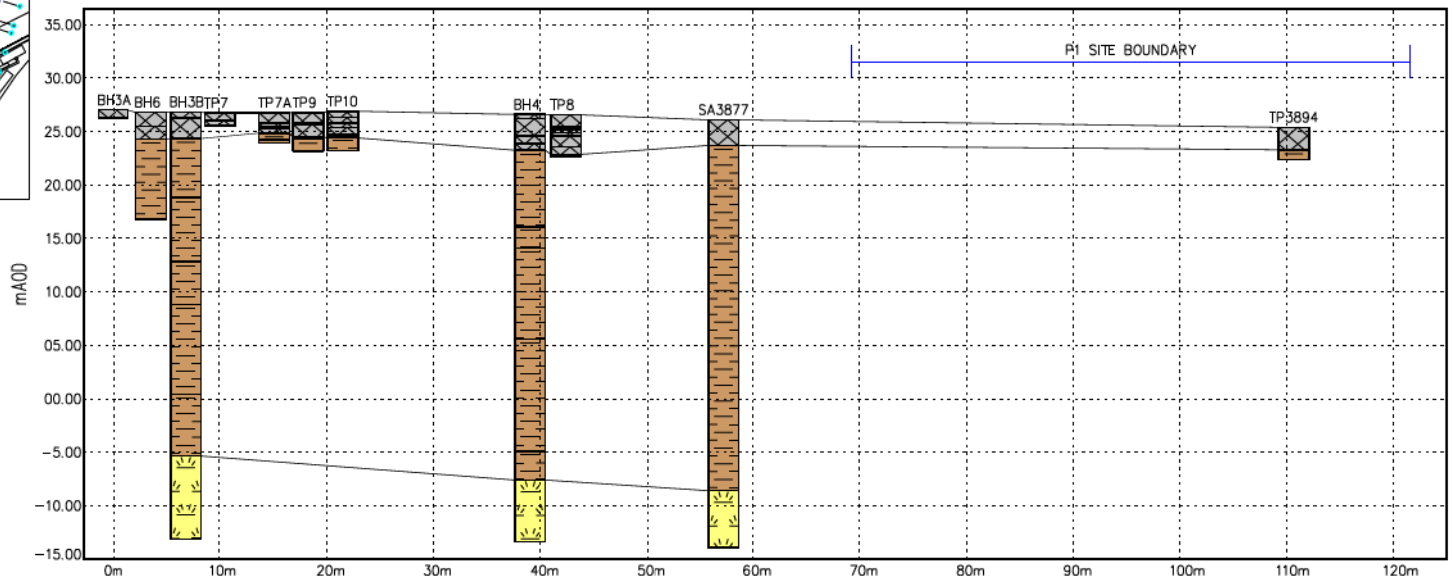

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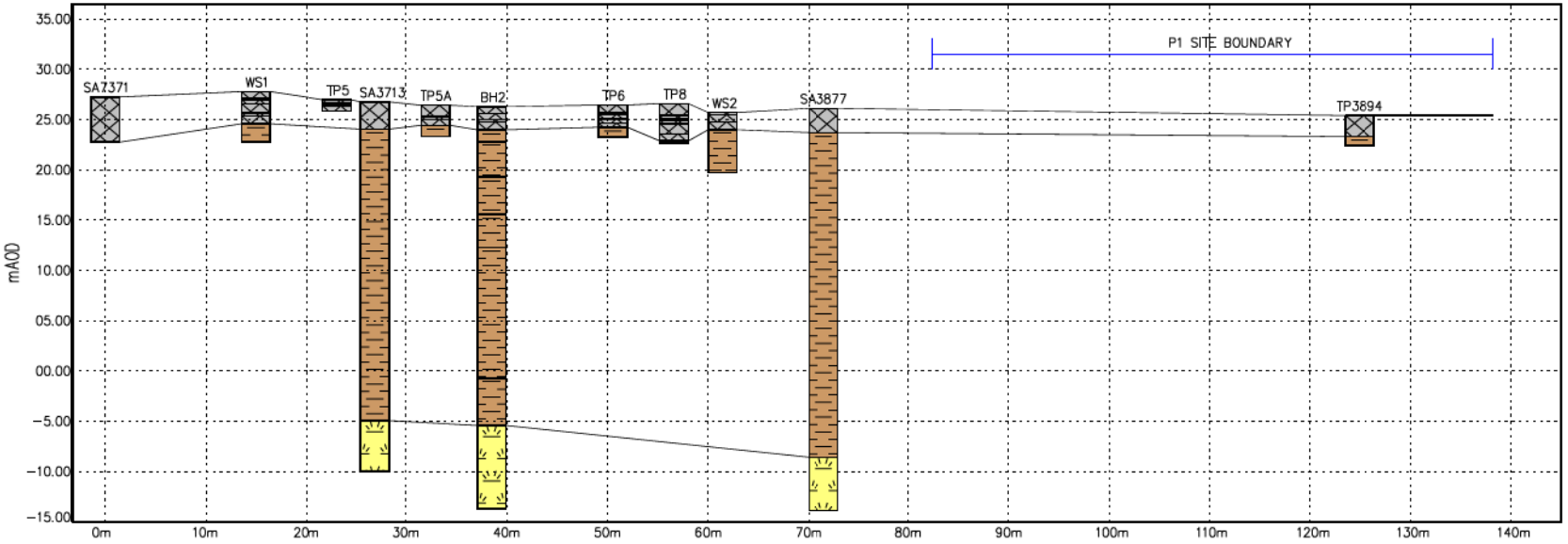

Notes

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P1 SITE BOUNDARY

MADE GROUND

LONDON CLAY

LAMBETH GROUP

Rev	Description	Date	By	Chk	App
I01	INFORMATION	28/10/2011	Rmax	OF	SC

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GEOLOGICAL SECTION A & B

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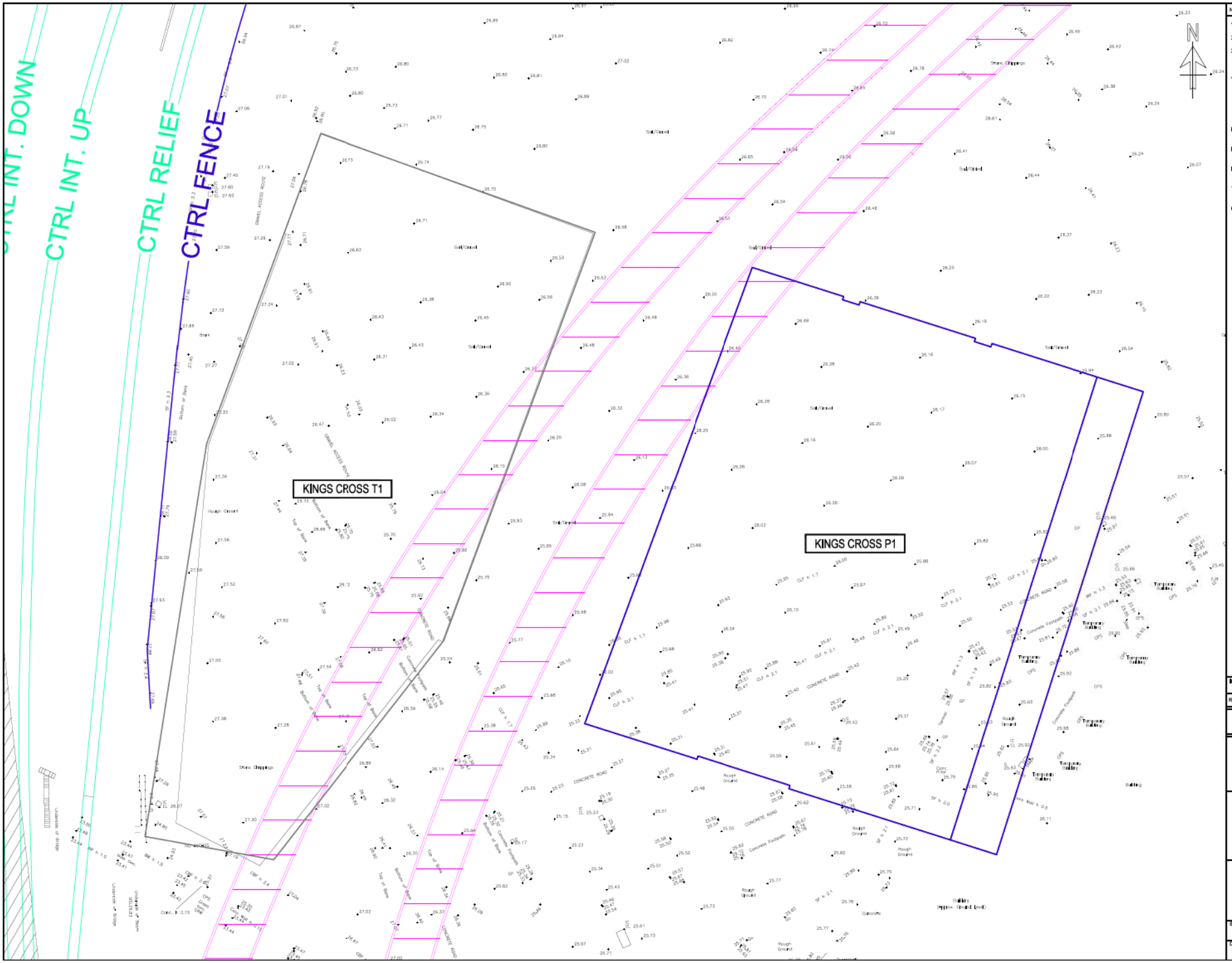
Drawing No. 6727/YE/002 Rev: I01



Notes

1. DO NOT SCALE FROM THIS DRAWING.
2. ALL DIMENSIONS ARE IN METRES (U.N.O.
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
4. THIS DRAWING PROVIDES AN INDICATIVE DISTRIBUTION OF DIESEL IMPACTED MADE GROUND BASED ON EXPLORATORY INVESTIGATIONS TO DATE.

KEY:

PHASE 1 SITE BOUNDARY

PHASE 2 SITE BOUNDARY

THAMESLINK 2000 TUNNEL

CTRL RAIL LINES

Rev	Description	Date	By	Chk	App
I01	ISSUE FOR INFORMATION	18.05.2012	MES	OF	

INFORMATION

KINGS CROSS BUILDING P1

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EXISTING SITE LEVELS

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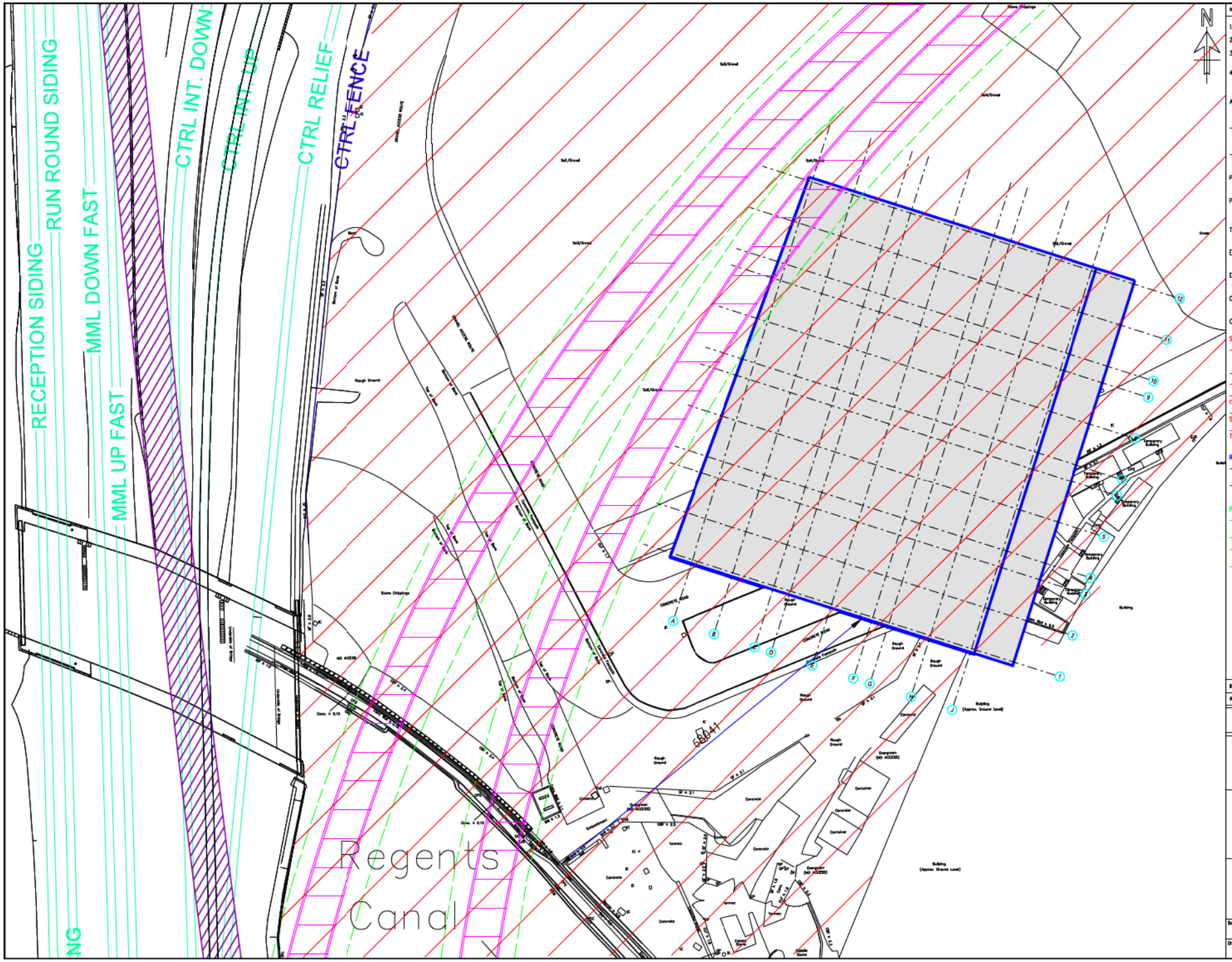
Drawing No.: 6727/G/100 Rev: I01



Notes

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4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS

ADDITIONAL CONSTRAINTS:-

-PREVIOUSLY UNIDENTIFIED CONTAMINATION

-UNDERGROUND OBSTRUCTIONS ASSOCIATED WITH THE HISTORIC USE OF THE SITE

P1 SITE BOUNDARY

PROPOSED P1 DEVELOPMENT

THAMESLINK 2000 TUNNELS

EXISTING THAMESLINK 2000 TUNNEL

EXCLUSION ZONE

CTRL RAIL LINES

CTRL FENCE

SOURCES:-

-HISTORICAL LAND USE - COAL STORAGE DEPOT, RAILWAY SIDING AND ASSOCIATED ANCILLARY BUILDINGS

-MADE GROUND ACROSS THE SITE

-GROUND GASES FROM THE MADE GROUND

-UNDERGROUND OBSTRUCTIONS AND STRUCTURES (SITE WIDE)

-ELECTRICAL SUBSTATION (~100M WEST OF THE SITE)

-CONCRETE BATCHING PLANT (~100M NORTH OF THE SITE)

RECEPTORS:-

-HUMANS - FUTURE SITE USERS AND CONSTRUCTION WORKERS PROPERTY

-CONTROLLED WATERS - SURFACE WATER OF THE UNION CANAL

PATHWAYS:-

-DIRECT CONTACT THROUGH DUST, SOLID AND LIQUID PHASES

-MIGRATION OF GROUND GASES

-LEACHING AND LATERAL MIGRATION THROUGH GRANULAR LOSSES IN MADE GROUND

-OVERLAND FLOW AND SURFACE RUN OFF

Rev	Description	Date	By	Chk	App
P1	INFORMATION	28/10/2011	Rmax	OF	SC

INFORMATION

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CONCEPTUAL SITE MODEL

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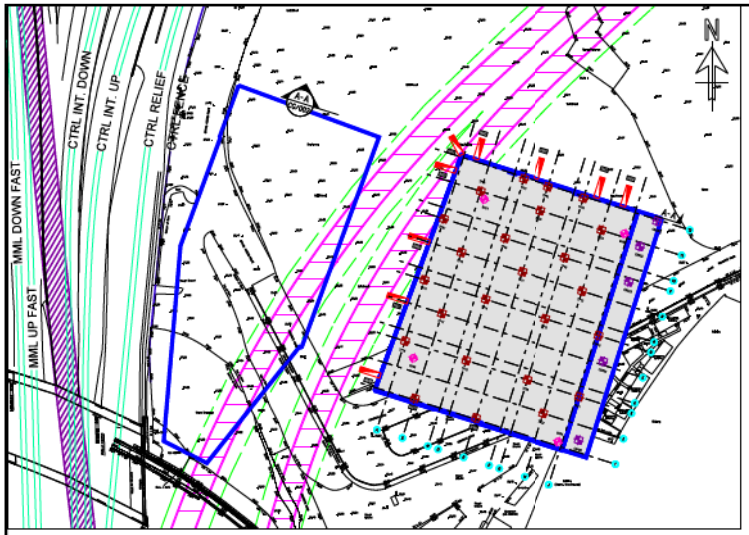
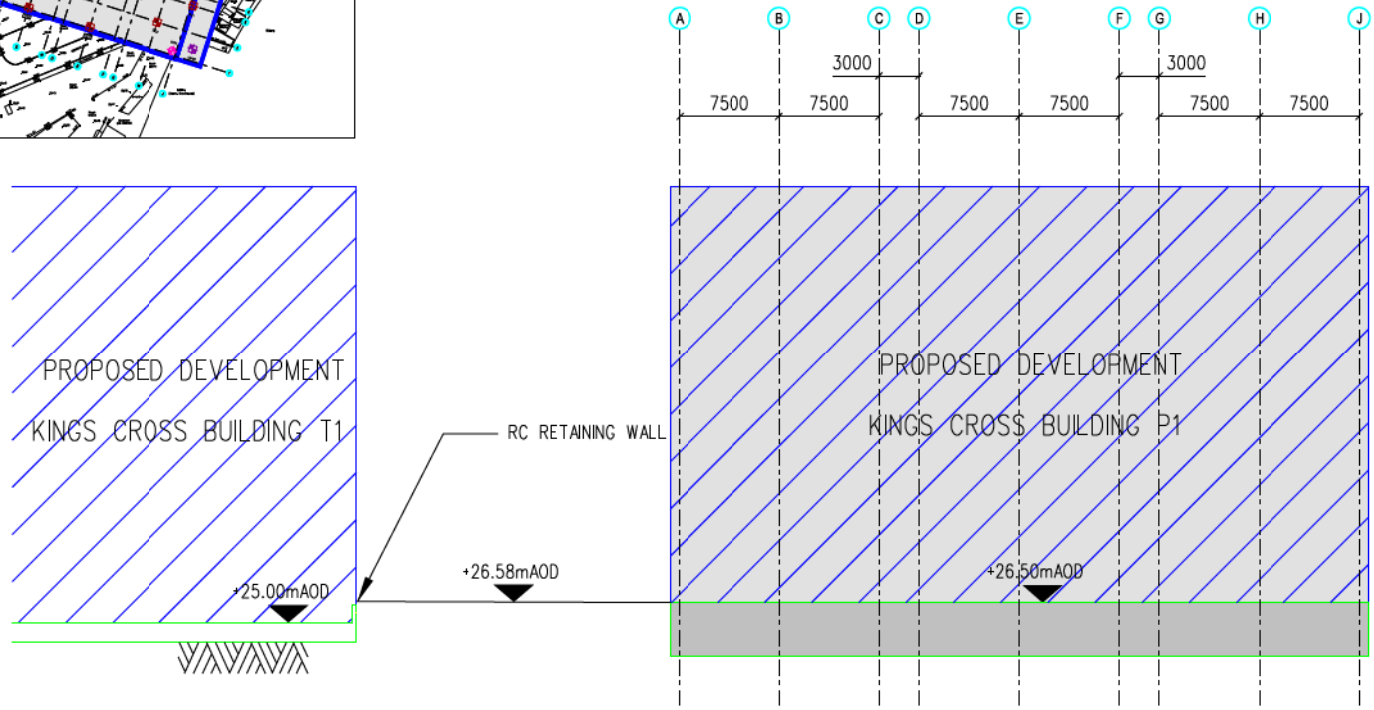
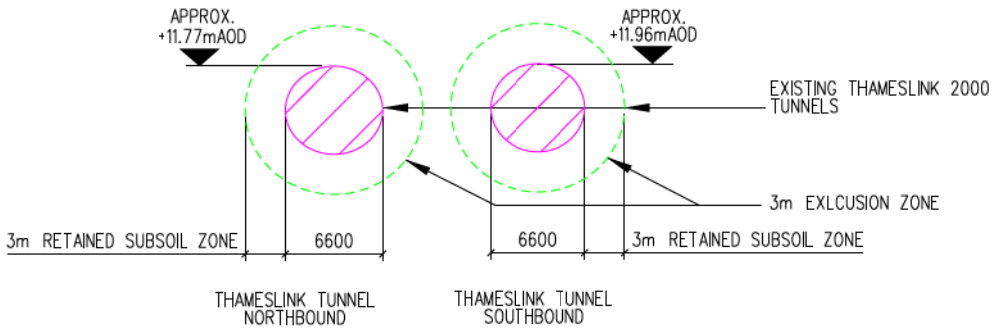
NTS @ A3	OCT 2011	Rmax	OF

Drawing No.: 6727/YE/005 Rev: I01







SECTION A-A
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CG002

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4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS
5. THIS DRAWING HAS BEEN PRODUCED BASED ON INFORMATION FROM THE FOLLOWING
6. TRACK SUPPORT ZONE TAKEN FROM CHANNEL TUNNEL RAIL LINK TECHNICAL MANUAL VOLUME 5, FIGURE 2
7. DETAIL OF HS1 FENCE TBC DURING PROPOSED SITE INVESTIGATION
8. EXCAVATION OUTSIDE THE HS1 TRACK SUPPORT ZONE DO NOT REQUIRE SOIL INVESTIGATION, SPEED RESTRICTION OR A SUBMISSION TO THE NR(CTRL) TRACK AND CIVIL ENGINEERING (REF. CHANNEL TUNNEL RAIL LINK TECHNICAL MANUAL VOLUME 5, PAGE 13)
9. TRACK SUPPORT ZONE 2 TAKEN FROM HS1 GUIDANCE TO OUTSIDE PARTIES (C/05/OP/32/3002) DATE 26th FEBUARY 2010

DRAWINGS:-
103-DBC-00100-10361-01
RLE, Rail Link Engineering (22/03/04)
103-DBC-00100-10360-01
RLE, Rail Link Engineering (22/03/04)
24308/05/500/07
PBA, Peter Brett Associates LLP

PROPOSED P1 DEVELOPMENT
PROPOSED T1 DEVELOPMENT
THAMESLINK 2000 TUNNELS
EXISTING THAMESLINK 2000 TUNNEL
EXCLUSION ZONE
CTRL RAIL LINES
CTRL FENCE
BOREHOLES
TRIAL PITS
TRIAL PITS WITH CBR'S
OBSERVATION TRENCH

Rev	Description	Date	By	App
I02	INFORMATION	22/04/2012	Rmax	TH
			CC	
I01	INFORMATION	13/10/2011	Rmax	TH
			CC	

INFORMATION

KINGS CROSS T1

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CONSTRAINTS SECTIONS FOR BUILDING P1

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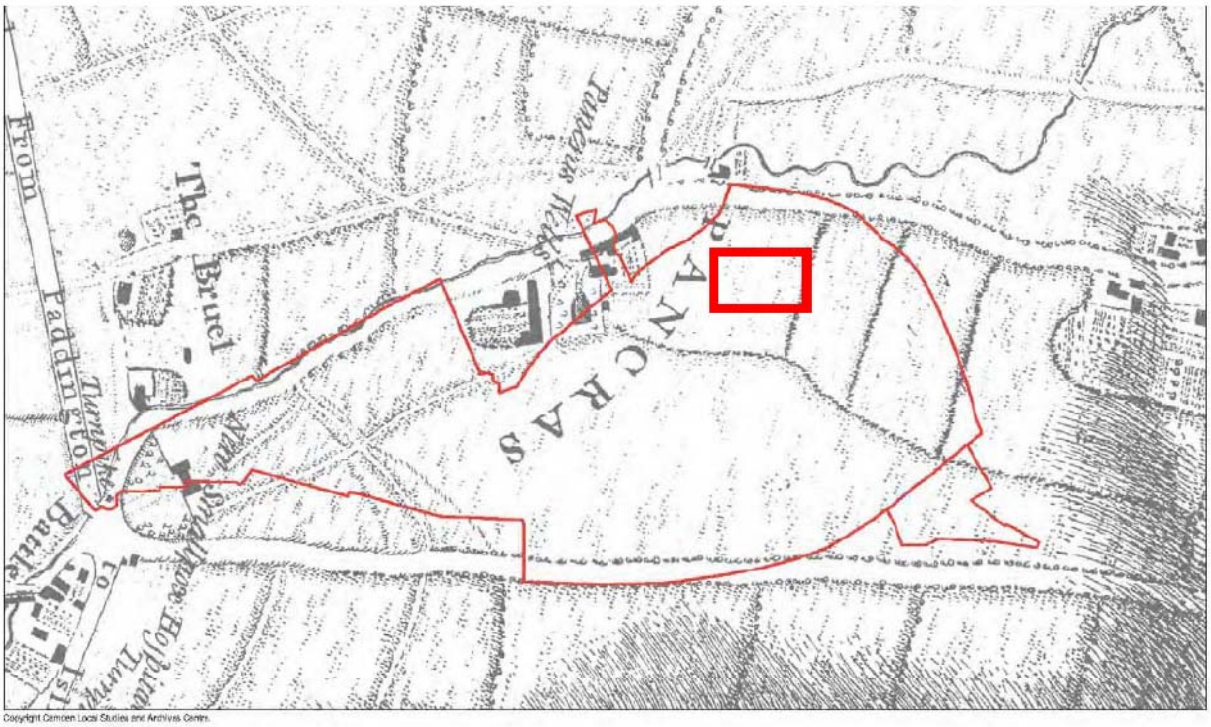
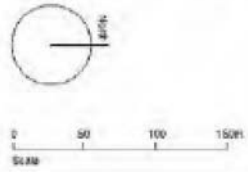
RTD @ A3	OCT 11	Rmax	CC

Drawing No. 6727/CG/002 Rev. I02

APPENDIX C:HISTORICAL MAPS

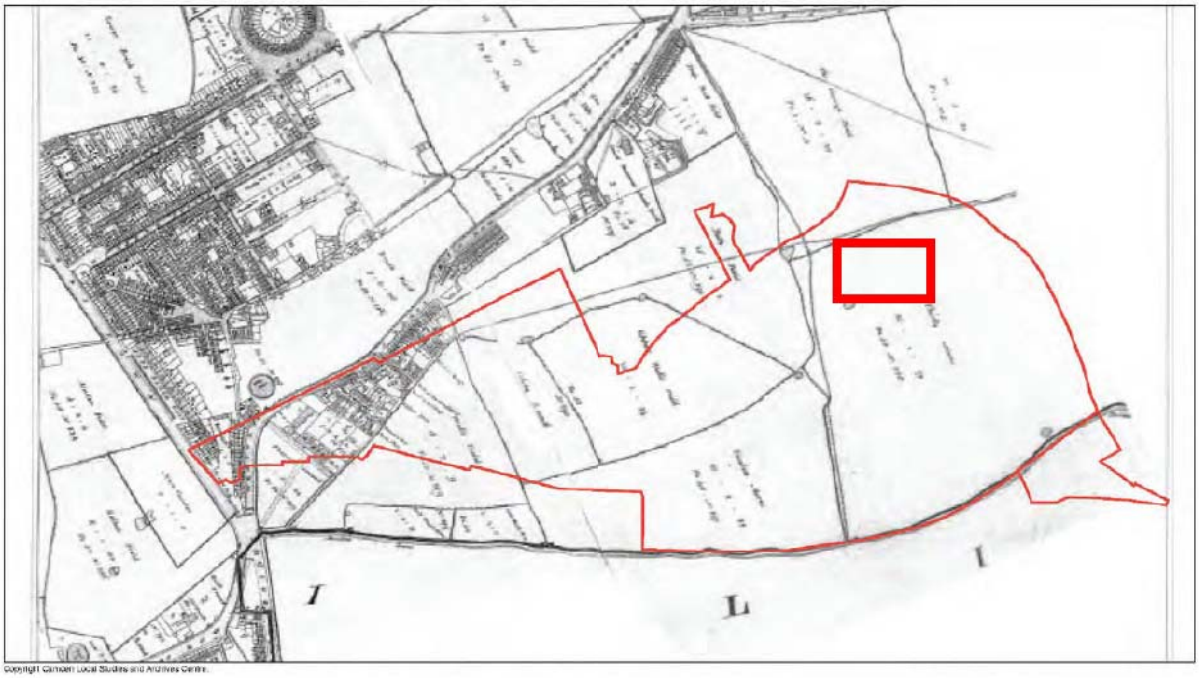
HISTORIC PLANS PRE-DATING THOSE IN THE GROUNDSURE REPORTS ARE REPRODUCED BELOW.

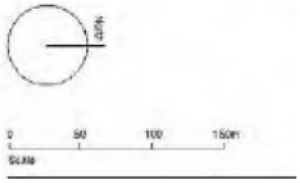




Historic Maps
1746 - Rocque

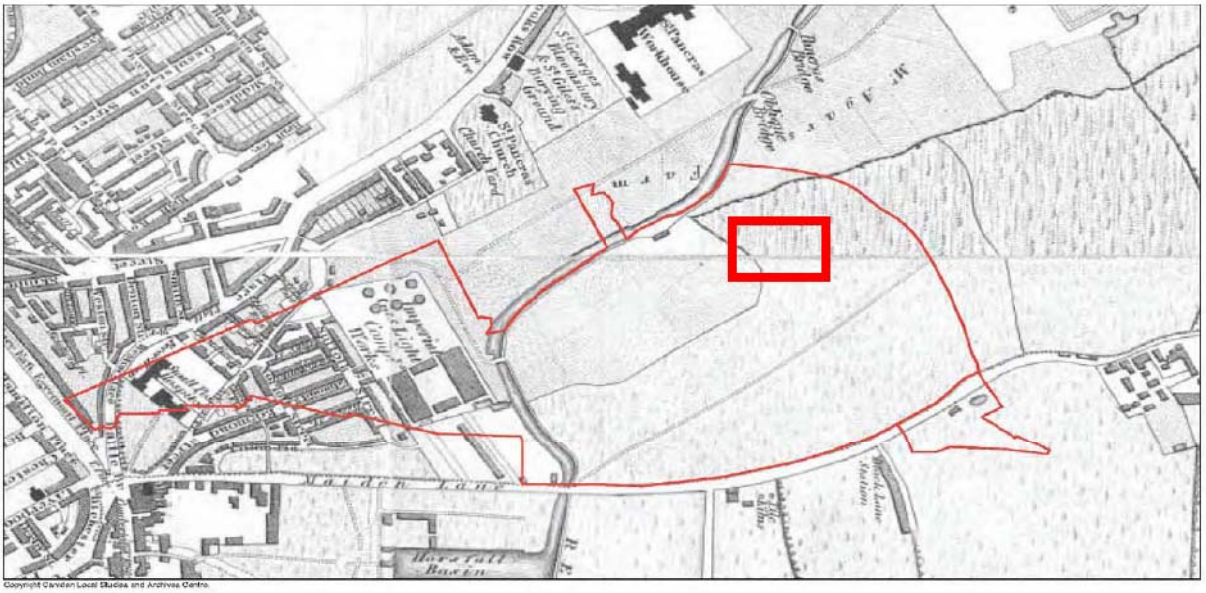
Location of the P1

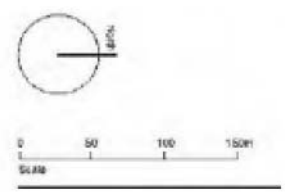




Historic Maps
1801 - Tomson

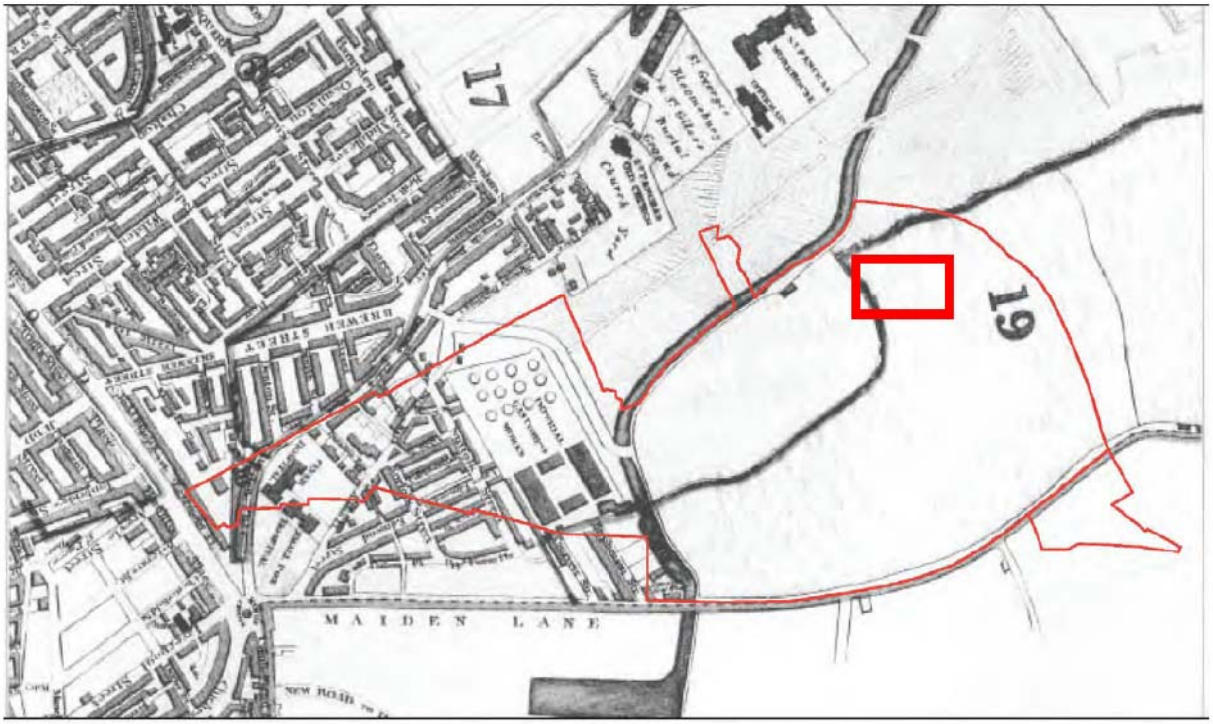
Location of the P1





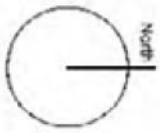
Historic Maps
1827 -

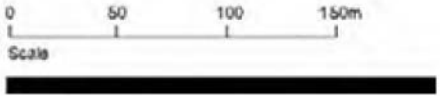
Location of the P1



Historic Maps
1834 - Bartlett

Location of the P1





Location of the P1

Historic Maps
1862 - Standford