

Earthworks and Remediation Plan

Building S4

King's Cross Central
General Partner Ltd

December 2020

**KINGS
CROSS**

Intended for

King's Cross Central Limited Partnership

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KING'S CROSS BUILDING S4 EARTHWORKS AND REMEDIATION PLAN

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Revision **Draft for Planning Pre-ground Investigation**
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EXECUTIVE SUMMARY

PURPOSE OF THE REPORT	Ramboll have been appointed by King’s Cross Central Limited Partnership to provide geo-environmental services to support the development of Building S4 at King’s Cross.		
	This report comprises a draft Earthworks and Remediation Plan prior to the Ground Investigation being undertaken. This report will be updated with site specific information following issue of the Ground Investigation Report in accordance with the requirements of Planning Condition 18 of planning permission application reference 2004/2307/P, 2004.		
APPROXIMATE GRID REFERENCE	530080, 183810	APPROXIMATE AREA (ha)	0.3
SITE DESCRIPTION	The site, Plot S4, is currently predominantly covered by portacabins, which are serving as the main offices for the wider KXC development. To the north of the site lies Plot S5 and to the west lies Plot S3, both of which are being redeveloped. To the east lies Lewis Cubitt Park. To the south lies the recently developed Plot S2. The Thameslink Canal tunnels run directly beneath Plot S3, running close to the west of the Plot S4. The Camden Sewer runs adjacent and underneath the eastern portion of the site.		
SITE HISTORY	Between 1746 and 1834, the site comprised large open fields. The first indication of the site’s use as railway land appears on the 1862 map with this use continuing relatively unchanged until around 1994. A roundhouse engine shed has been present nearby from 1860 to 1932. During the period between 1968 and the early 1990s, historical maps show a significant contraction of the goods and railway infrastructure with the gradual reduction in goods buildings and the closure of ancillary buildings, and the site was labelled to be in use as a freightliner terminal. By the early 1990s, the majority of the wider KXC site (including Plot S4) had been cleared and remained relatively undeveloped until implementation of the KXC development in 2008.		
PROPOSED DEVELOPMENT	Building S4 is a mixed tenure residential development of up to 14 storeys over basement level fronting Cubitt Park, within Development Zone S to the north of the King’s Cross Central development site. The building comprises an L-shaped block, housing two buildings of social rented and market housing respectively, sharing a party wall above a ground floor of retail, residential lobbies, amenity space and entrances to both tenures fronting both Cubitt Park to the east and Chilton Court to the west.		
GROUND INVESTIGATION	A ground investigation is due to be undertaken on 7 December 2020.		
CONTAMINATION FINDINGS	To be confirmed once the ground investigation is complete.		
GROUND GAS	To be confirmed once the ground investigation is complete.		
PRELIMINARY WASTE ASSESSMENT	To be confirmed once the ground investigation is complete.		
EARTHWORKS			
EARTHWORKS REQUIREMENTS	To be confirmed once the ground investigation is complete.		
PRELIMINARY REMEDIATION STRATEGY			
PRELIMINARY REMEDIATION STRATEGY	To be confirmed once the ground investigation is complete.		

1. INTRODUCTION

1.1 Brief

Ramboll UK Limited have been instructed to provide an Earthworks and Remediation Plan (ERP) to support a Reserved Matters Submission for Building S4 of the King's Cross Central (KXC) development.

The King's Cross Central Redevelopment site was granted Outline Planning Permission in 2004 under application reference 2004/2307/P. Land Contamination matters are dealt with under Condition 18 which states that *"relevant applications for approval of the 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"*.

The purpose of this draft ERP is to provide information pertaining to the ground conditions and prevailing geo-environmental setting at the site in the context of the development proposal. In addition, this document highlights the potential contamination risks present at the site and provides a strategy for addressing the identified risks as part of the earthworks and construction phases of the development.

1.2 Pertinent Reports

This ERP should be read in the context of the following overarching documents which were submitted in support of the original KXC outline planning application and/or the current Reserved Matters submission for KXC Building S4.

- King's Cross Central Environmental Statement (ES) Volume 4: Part 16 Soils and Contamination Specialist Report, Arup, May 2004;
- King's Cross Central ES Volume 5: Supplement, Arup, September 2005; and,
- King's Cross Revised Code of Construction Practice (CoCP), RPS, September 2005.

In July 2020, Ramboll completed a combined Geo-environmental and Geotechnical Desk Study (DBA) for Plot S4. Following the recommendation for site-specific exploratory works, a Ground Investigation will be undertaken by Concept Engineering Consultants Ltd in December 2020, as per Ramboll's specification and under the technical supervision of Ramboll engineers.

Salient reports used in the preparation of this ERP have been presented as Table 1:1 below.

Table 1:1: List of Salient Reports

Report Title	Author	Date
King's Cross Project Contract 4 for Borehole Investigations at King's Cross	Soil Mechanics	July 1993
Contract L Phase 3 Ground Investigations King's Cross / St Pancras Geotechnical Report	Foundation and Exploration Services	February 1996
Contract 2 for Phase 4 Ground Investigations in Project Area 100	Soil Mechanics	October 1997
King's Cross Central Redevelopment Plot S4 Geoenvironmental and Geotechnical Desk Study	Ramboll UK Limited	July 2020
King's Cross Building Plot S4 Factual Ground Investigation Report	Concept Engineering Consultants Ltd	TBC
King's Cross Plot S4 Geoenvironmental and Geotechnical Interpretive Report	Ramboll UK Limited	TBC

2. SITE CHARACTERISATION

2.1 Site Description

The site is located within the London Borough of Camden and makes up part of the King's Cross Central (KXC) Development as shown on the site location plan below and included in figures included as Appendix 1. The site has an approximate National Grid Reference 530080, 183810, and is circa 0.3 hectares in size.

The site is roughly L-shaped and is bound by Plot S5 to the north; Lewis Cubitt Park to the east; Plot S2 to the south; Plot S1 to the southwest; and Plot S3 to the west. The Thameslink Canal tunnels run directly beneath the adjacent Plot S3 running from northwest corner to the southwest. The Camden Sewer runs adjacent and underneath the eastern portion of the site.

At the time of the site walkover the site was occupied by temporary office space utilised by Argent and other contractors, in the southern extent of the site; and a storage yard and access route in the northern extent of the site. The storage yard comprises concrete hardstanding and is utilised for the storage of materials in the construction of the nearby plots. An access road is located at the southern end of the storage yard and crosscuts the site from east to west, providing an access route from the adjacent Plot S3 to the storage yard and temporary office space.

The topography of the site is generally flat and of a higher topography than the surrounding sites. The site levels on this plot were reportedly raised using building rubble and resurfaced with Tarmac in around June 2014 by Carillion, for the use of the plot as a temporary lorry holding area and storage area to serve the development of plots to the south (particularly the B Plots).

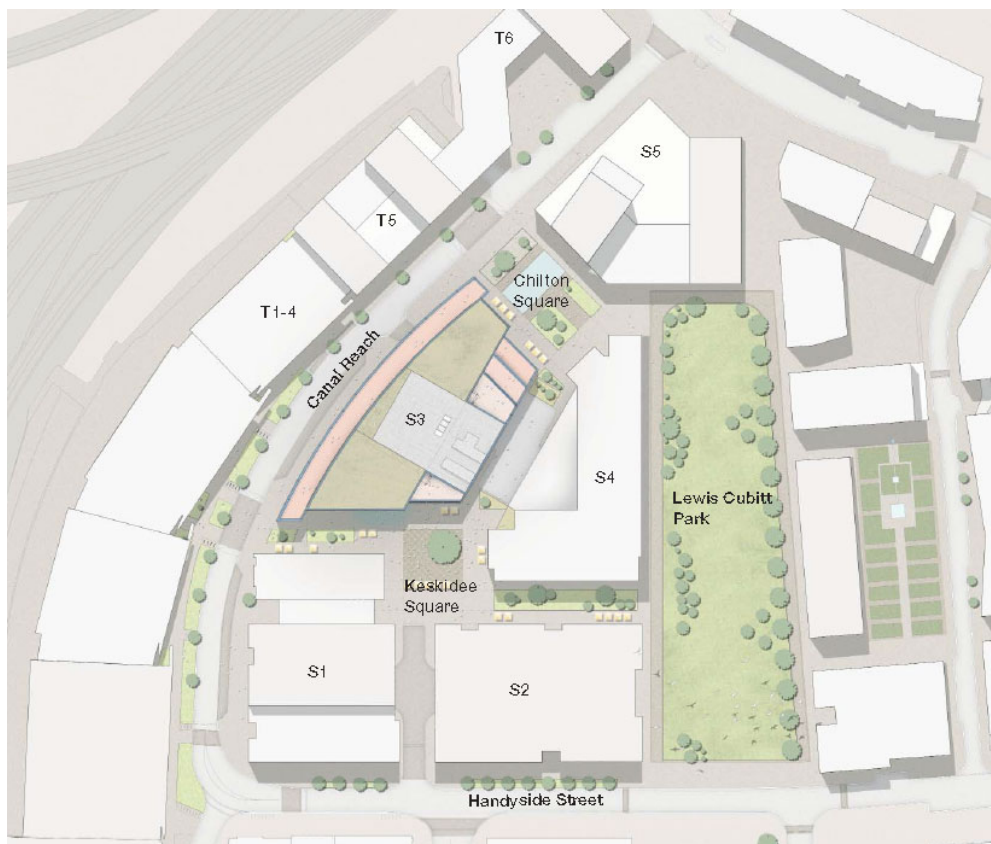


Figure 1: Site Location Plan

2.2 Site Surrounds

The surrounding land comprises:

- **North:** Plot S5 was formerly used for storage, containing portacabins and the Skip Garden (a sustainable, urban, community garden with a café at ground floor level). In November 2020, Laing O'Rourke are currently undertaking the earthworks on this plot. This will be updated at following the ground investigation on Plot S4.
- **East:** Lewis Cubitt Park (public open space).
- **South:** Plot S2 which has been constructed as an office building, with commercial space and retail units at the ground floor.
- **Southwest:** Plot S1 is currently being developed into an office building, piling and basement excavations have been completed at this plot and the building is currently under construction.
- **West:** Plot S3 was formerly covered in asphalt hardstanding and utilised as a lorry loading and unloading area for deliveries relating to the construction of the nearby plots. In November 2020, BAM are currently undertaking the earthworks on this plot. This will be updated at following the ground investigation on Plot S4.

2.3 Proposed Development

Building S4 is a mixed tenure residential development of up to 14 storeys over basement level fronting Cubitt Park, within Development Zone S to the north of the King's Cross Central development site. The building comprises an L-shaped block, housing two buildings of social rented and market housing respectively, sharing a party wall above a ground floor of retail, residential lobbies, amenity space and entrances to both tenures fronting both Cubitt Park to the east and Chilton Court to the west.

2.4 Site History

A summary of the history of the site and its immediate surroundings is presented in Table 2:1. Potentially contaminative activities are shown in bold.

Table 2:1: Site History

Time	Site	Surrounding
Pre-1871	Rocque's Map of London shows the area of the site as undeveloped and covered by open fields. No significant deviations from this are shown on Tomson's Map (1801), Greenwood's Map (1827) or Bartlett's Map (1834). By Stanford's Map of 1862 the site is occupied by a number of structures including parts of a goods depot .	On Rocque's map the surrounding area is undeveloped with a small settlement, Pancras Wells shown to the north of the site. Tomson's Map of 1801 shows significant development in the vicinity of the site. On Greenwood's map of 1827 extensive development has taken place to the north and west of the site. A tank farm associated with a gas works is shown approximately 500 m to the south. Continued development has occurred on Bartlett's Map of 1834. On Stanford's map of 1862 there have been significant developments within the immediate vicinity of the site with the redevelopment of the area as railway land with associated rail tracks and ancillary buildings.
1871 to 1901	The site is mapped as part of a ' Goods Depot '. Several railway lines associated with the Great Northern Railway dissects the site. Part of a roundhouse carriage shed (later relabelled as an engine shed) is situated in the north corner of the site.	There are no significant changes in the surrounding area over this period of time, however the surrounding area contains a number of significant features including (but not limited to): • A railway turntable is located approximately 60 m northwest of the site. • A Locomotive cleaning shed is located approximately 70 m to the northwest.

Time	Site	Surrounding
		- A coal depot with associated railway lines and engineers' workshop are located approximately 100 m and 200 m north of the site respectively. - A railway line is located approximately 155 m to the west of the site, running north to south out of St Pancras Railway Station which is located approximately 750 m to the south of the site. - A good's shed, labelled to be operated by Midlands Railway, is located approximately 250 m southwest of the site and contains associated railway lines King's Cross Station is located approximately 620 m southeast of the site. - Rows of streets of terraced houses are shown from approximately 200 m to the east of the site.
1931 to 1971	By 1946 the engine/carriage shed is no longer present and is instead occupied by further railway sidings. A number of works buildings on the site are also shown to have been demolished during the period of the late 1940s and early 1950s. A coal hopper is shown in the northwest corner of the site.	The removal of onsite railway sidings in 1968 coincides with the removal of goods depot, Engine sheds and workshops on the land within the radius of 100 m from the site. In the immediate surrounds the coal depot located to the north of the site was no longer labelled and was noted to be a goods shed with associated railway lines. By the late 1940s, St Pancras Hospital is labelled as a hospital for Tropical Diseases, approximately 300 m to the southwest of the site, in the area of the previous burial grounds. Continued residential development of streets and terraced houses is apparent to the east of the site.
1971 to 1976	No changes occurred on site and it is mapped as an undeveloped plot of land labelled as freightliner terminal .	By the early 1970s some previous terraced streets situated approximately 500 m to the northeast of the site are no longer shown and had been replaced by several industrial buildings labelled as a sand and gravel depot, warehouses, garages and Beaconsfield buildings.
1976 to 1989	The number of railway sidings present on site has reduced once more, and all goods shed and building structures are no longer shown. The remainder of the site is undeveloped.	The area to the north of the site was noted to be in use as King's Cross Freight and Freightliner Terminal by 1988, associated features of the terminal included a tank and conveyer located approximately 180 m northwest. No other significant changes occurred to the surrounding area.
1989 to 2010	By 1993 the railway line located on the southern site boundary had been removed; and by 1999 the site is no longer mapped as 'Goods Depot'. By 2006 the Channel Tunnel Rail Link was noted to be under construction on the site.	Some railway sidings/lines situated immediately to the north of the site are shown to have been removed. Between 1999 and 2006 complete removal of the railway sidings has occurred in the surrounds to the north and south of the site, and the Channel Tunnel Rail link is labelled as under construction.

Time	Site	Surrounding
2010 to 2020	By 2010 all railway sidings and lines have been removed from site, along with the small square building which was situated in the west of the site. The Channel Tunnel Rail Link is first noted on site in the 2010 map. In the last few years Plot S4 comprises of temporary Portacabins which are served as the main offices for the KXC contractors working on site.	Since 2010, the King's Cross Central Redevelopment has entailed several plots surrounding Plot S4 to have been developed. Plot S1, to the northwest and west is currently surrounded by temporary, wooden, hoarding fencing, with vehicular access from the north via Canal Reach, Plot S2 to the south is constructed as an office building, Plot S1 to the southwest is currently being developed into an office building, Plot S5 to the north used for storage, containing portacabins and the Skip Garden. In the area to the immediate east of the site Lewis Cubitt Park has been constructed including an artificial pond used for recreational purposes.

2.5 Potential Contamination

With reference to the Department of the Environment Industrial Profile for Railway Engineering Works, DoE, typical contaminants of concern associated with former railway land-uses include:

- fuels, oils and hydraulic lubricants as a result of past spills;
- heavy metals such as mercury associated with old relay switches;
- solvents associated with maintenance activities (degreasing and thinning);
- creosotes used to preserve timber-based infrastructure;
- polychlorinated biphenols associated with electrical infrastructure (substations and transformers);
- herbicides / pesticides associated with vegetation control; and,
- asbestos containing material (ACM) used in locomotive lagging, rail stock breaks and insulation and building infrastructure (cabling, ducts).

The site has been occupied by a variety of railway infrastructure including goods and coal depots, locomotive cleaning sheds and carriage sheds, tracks and works. Therefore, any potential contaminants of concern associated with the historical railway land use could potentially be site wide.

The presence of a significant thickness of Made Ground does present a potential source of hazardous ground gas including elevated concentrations of Methane (CH₄) and or Carbon Dioxide (CO₂).

2.6 Unexploded Ordnance

RPS Explosives Engineering Team has carried out a separate desktop study which specifically considers the potential presence of historical Unexploded Ordnance (UXO) at the KXC regeneration area. Within this report, two High-Explosive bombs are recorded to have landed on the site between 1940 and 1941 on bombsight.org.

In order to mitigate the risk of UXO, it is recommended that a UXO management plan is in place prior to commencing intrusive works and that all site personnel attend an Explosive Ordnance Site Safety and Awareness Briefing. Furthermore, an Explosives Safety Engineer should be on call during all excavations, progression of boreholes and the construction of piles.

Contractors risk assessments and method statements (RAMS) covering all groundwork should take into consideration the information presented within RPS's UXO Risk Assessment.

3. GROUND CONDITIONS

3.1 Introduction

A combined geo-environmental and geotechnical ground investigation is due to be undertaken in December 2020, by Concept Site Investigations Limited (Concept) under the appointment of Galldris Construction Ltd and the technical guidance and supervision of Ramboll.

The geo-environmental findings of the site investigation will be provided in detail within the Geoenvironmental and Geotechnical Interpretive Report (GIR) in 2021 and will be summarised for the purpose of this document within the following section.

3.2 Exploratory Works

The scope of the ground investigation was specified by Ramboll as part of the King's Cross Central Redevelopment, Plot S4 Contracts Documents for Ground Investigation, dated September 2020.

The Ground Investigation has now been instructed and Argent have appointed Concept to undertake the works, via Galldris, the Principal Contractor, starting on 7 December 2020.

3.3 Geology

A summary of the anticipated geology based on data from surrounding plots is provided in Table 3.1. The detail and depths of the geology will need to be updated in 2021 following the Ground Investigation.

Table 3.1: Summary of Expected Ground Conditions

Stratum	Stratigraphy (period)	Level of Top of Stratum (mOD)	Expected Thickness (m)	Typical Description	Hydrogeological Classification
Made Ground	Post-Quaternary	+27.90 to +20.92	1.20 to 5.00	Variable fill material including clayey gravelly fill material containing ash, clinker, slag, glass, brick, concrete, flint, charcoal, decomposing wood and other man-made materials.	Unclassified
London Clay (Weathered)	Palaeogene	+25.40 to +20.60	4.00 to 8.40	Soft to stiff brown/grey/orange mottled bluish grey slightly micaceous silty CLAY with occasional dark grey staining.	Unproductive Strata
London Clay (Unweathered)	Palaeogene	+24.90 to -10.96	20.00 to 31.00	Firm becoming stiff grey fissured CLAY with occasional thin partings of light grey fine sandy silt. Fissures are likely to be closely spaced. Occasional selenite crystals and mudstone cobbles were recorded within T5 and T6 Plots.	Unproductive Strata
Lambeth Group	Palaeogene	-4.90 to -28.40	14.00 to 26.10	Very stiff multi-coloured CLAY, locally silty laminations, with	Secondary A Aquifer

Stratum	Stratigraphy (period)	Level of Top of Stratum (mOD)	Expected Thickness (m)	Typical Description	Hydrogeological Classification
				occasional fine to medium gravel sized shell fragments. Likely to have occasional closely spaced smooth randomly orientated fissures.	
Thanet Sand	Palaeogene	-29.25 to -36.30	0.15 to 7.30	Medium dense to very dense dark grey fine to medium SAND with medium dense sub-angular to rounded medium flint gravel.	Principal Aquifer
Upper Chalk	Cretaceous	-34.90 to -36.55	Unproven	Structureless CHALK composed of compact, cream, slightly gravelly SILT.	Principal Aquifer

3.4 Hydrogeology

Under the Water Framework Directive, the Environment Agency (EA) classified geological stratum to reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) but also their role in supporting surface water flows and wetland ecosystems. The Aquifer classifications for the underlying stratum have been summarised as Table 3:1.

Table 3:1: Environment Agency Aquifer Classification

Stratum	Environment Agency Aquifer Classification	Environment Agency Aquifer Description
Made Ground	Unclassified	None
The London Clay Formation	Unproductive Stratum	Low permeability that have negligible significance for water supply or river base flow
Lambeth Group	Secondary A Aquifer	Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
Upper Chalk Formation	Principal Aquifer	Highly permeable layers capable of supporting significant water storage. Able to support large water abstractions.

According to the Environment Agency the Made Ground and superficial deposits are not classified; the London Clay is an unproductive stratum; the Lambeth Group is classified as a Secondary A Aquifer; and the Thanet Sands and Upper Chalk are classified as Principal Aquifers and are considered to be in hydraulic connectivity.

The site is not located within a Groundwater Source Protection Zone (GSPZ); with the nearest being an Outer Catchment Zone situated approximately 500 m to the east of the site. The nearest Groundwater Abstraction Licences are situated approximately 280 m to the northwest of the site, within a borehole at the King's Cross Concrete Plant and is non-potable. There are no groundwater abstractions for public water supply located within 2 km of the site.

Groundwater monitoring was undertaken throughout the majority of all the previous ground investigations surrounding the site. Perched groundwater within the Made Ground may be contained within the granular bands that exist in this stratum.

Small quantities of perched groundwater within granular lenses in the Made Ground were recorded at Plots P1, T1, T2, S5 and S3 at an average elevation of approximately +23.4 mOD to +25.0 mOD, respectively. It is considered that until site specific information is available, it can be assumed that similar levels and amounts of perched water will be present at Plot S4.

In BH CP-03 from the plot S3 (which is approximately 50 m from the boundary line of the proposed plot), the perched groundwater was recorded at the level -15.52 mOD i.e. 42.6 mbgl in the layer of Thanet sand. This may result in the bore instability in case of piled foundations where length of pile is greater than 40 m. Mitigation measures shall be included within the pile foundation construction methodology if the pile length exceeds 40 m.

Perched groundwater within the Made Ground and permeability of the underlying cohesive deposits have not been significant enough on adjacent plots to impact on the viability of contiguous piled walls or the stability of battered excavations.

In general, groundwater levels were observed to vary in depth from as shallow +28.2 mOD to as deep as +10.0 mOD within the London Clay. It should be noted that across all plots that have undergone development, any quantities of groundwater that were found within the Made Ground were limited and to date no evidence of an upper aquifer has been recorded across the wider King's Cross Central Site.

Groundwater levels on the site will vary seasonally. The piezometric level readings of the London Clay during previous investigations indicate that the pore water pressure is approximately hydrostatic. It is a necessity that standpipes be installed during the ground investigation for the plot of S4, in order to fully establish the groundwater flow regime that is specific to this site.

3.5 Hydrology

There are no surface water features on-site. The nearest surface water body is the Regent's Canal, part of the wider Grand Union Canal network and located approximately 220 m southwest of the site at its closest point. The River Quality Record for the GUC is Chemical Grade B and Biological Grade O.

The GUC is a hydraulically isolated water body flowing east. The canal is contained within the combination of canal wall and clay liner construction. The nearest surface water abstraction is located 354 m southwest of the site at Camley Street Nature Park. The water is used for make-up or top up water for ponds on site, however, no details of annual abstraction rates are available.

Historically, throughout the development of central London, the majority of natural tributaries to the River Thames have been culverted, dried up or in-filled. Records obtained from 'lost rivers' (Barton, 1992) indicates that the nearest of these (The Fleet) is located approximately 500 m to the west of the site and flows southwards into the River Thames following an approximate route of the Grand Union Canal.

3.6 Ground Gases

A ground gas monitoring program comprising six return visits following the ground investigation will be undertaken over a three-month period to comply with CIRIA C665. The Characteristic Situation will then be calculated, and confirmation of any gas protection measures required within the proposed building will be provided.

The ground gas monitoring period is due to commence in January 2021 and will therefore be complete late March / early April 2021.

3.7 Evidence of Ground Contamination

Evidence of ground contamination will be comprehensively discussed in detail as part of the GIR (Ramboll, 2021). The following Section will provide a summary of the findings.

Due to this ERP being issued prior to the plot specific ground investigation being undertaken, a summary of the contamination encountered on the surrounding plots has been provided for information only. Due to the nature of contamination in the ground, that encountered on surrounding plots will not necessarily reflect what is encountered on Plot S4 during the Ground Investigation and subsequent earthworks.

3.7.1 Soils

On Plot S3 and S5 adjacent to the west and north of the site, visual evidence of contamination included anthropogenic inclusions of brick, concrete, coal, ash, slag, plastic, asphalt, pottery fragments, wood, Terram membrane and clinker within the Made Ground deposits.

Asbestos was found during the Plot S3 and S5 GI. Subsequent quantitative asbestos analysis found samples to contain concentrations <0.001% w/w.

Areas of hydrocarbon contamination were identified during the S3 and S5 ground investigations. Hot spots of hydrocarbon contamination and also creosote railway sleepers have been removed during the earthworks on both plots in recent weeks.

The contamination present at Plot S4 is likely to be similar to that of the above but cannot be guaranteed and a detailed description will be provided following the Ground Investigation.

3.7.2 Groundwaters

Perched Groundwater

Elevated sulphate, vanadium and cyanide were detected in the groundwater samples on the adjacent Plot S3. Elevated sulphate was also recorded on Plot S5.

The contamination in groundwater beneath Plot S4 will be confirmed following the ground investigation and subsequent monitoring in early 2021.

Principal Aquifer Groundwater

On Plot S3 to the West of the Site, one deep groundwater sample was submitted for chemical analysis on 18 September 2019, following the completion of the second phase of exploratory works. Elevated concentrations of sulphate were detected within the sample at a concentration of 2,200 mg/l, above the GAC for controlled waters of 400 mg/l. This was considered to be representative of background water quality within the Lambeth Group.

Groundwater samples from the S4 Ground Investigation will be taken in early 2021 to assess the Principal Aquifer groundwater beneath the Site.

3.8 Preliminary Waste Classification

3.8.1 Results

To be confirmed following ground investigation.

3.8.2 Interpretation

To be confirmed following ground investigation.

4. EARTHWORKS STRATEGY

4.1 Anticipated Construction Activities

The anticipated construction activities likely to be undertaken as part of the proposed development have been summarised (in sequence) below (where all levels are to an accuracy of +/-500 mm):

- i. Reduced dig across the extent of the site to 24.5 mOD from an existing ground level of 26.0 mOD to;
- ii. Installation of the piling mat;
- iii. Installation of piles from piling mat level. Combination of discrete and contiguous piles below S4 footprint;
- iv. Excavation of piling mat and soils down to slab formation level of 24.5 mOD;
- v. Local deeper excavations for pile caps and drainage;
- vi. Excavate single storey basement to a general level of 18.4 mOD.
- vii. Excavate local deepening's for lift pit and core pile caps to 17.1 mOD.
- viii. Construction of basement pile caps;
- ix. Construction of suspended basement slab and suspended ground floor slab;
- x. Erection of superstructure primary frame and infrastructure connections.

4.2 Estimated Volumes

To be confirmed following the ground investigation.

4.3 Estimated Lorry Movements

In the absence of any data from the ground investigation at the Plot S4 Site, conservative estimated volumes of material requiring excavation and importation have been estimated based on that of information from the neighbouring Plots of S3 and S5.

It is estimated that the lorry movement are unlikely to exceed 1500.

4.3.1 Export

It is estimated that the lorry movement are unlikely to exceed 1200 exported loads.

4.3.2 Import

It is estimated that the lorry movement are unlikely to exceed 300 imported loads.

4.4 Suitability of Materials

4.4.1 Introduction

For the purposes of this document, suitable material is defined as 'material that, by its chemical and physical composition, is suitable for use as part of the proposed development'.

Conversely, unsuitable material is defined as 'material that, by its chemical and physical composition, is only suitable for off-site disposal either to landfill or treatment facility and cannot be incorporated into the proposed development'.

4.4.2 Soft Landscaping Material

Soft landscaped areas (including on the roof) have been included as part of the proposed design.

Based on the ground encountered on the surrounding plots, it is unlikely that site won soils would be considered suitable for use within the proposed soft landscaping on the roof area.

It should therefore be assumed at this stage that imported topsoil will be required for all soft landscaped areas, including the roof.

4.4.3 Engineering Fill (below roads and hardstanding)

In the context of this subsection entitled 'suitability of materials' engineering fill is defined as the site-won material that is suitable as fill to structures for applications within carriageways, pedestrian pavements and hard-landscaped areas and not imported fill.

To be confirmed following ground investigation.

4.4.4 Unsuitable Materials

To be confirmed following the ground investigation.

4.4.5 Treatment and Re-use

To be confirmed following the ground investigation.

4.5 Material Handling

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

The anticipated material sequencing would be as follows:

- i. Cut to formation level, bulk of arisings generated;
- ii. Importation of pile matt: direct placement assumed; material not stockpiled;
- iii. Pile foundation arisings generated;
- iv. Importation of concrete for piles, pile caps and suspended slab (direct pour);
- v. Localised excavations for spur drainage trenches, arisings generated; and,
- vi. Importation of engineering fill for infrastructure: both direct placement and temporary stockpiling anticipated.

4.5.2 Stockpiling and Re-use On-site

Excavated materials shall be adequately segregated in accordance with material type (Made Ground and London Clay) and temporarily stockpiled for classification.

Surplus and/or unsuitable materials will be removed from site as generated following classification to negate the requirement for more onerous stockpile management measures such as surface

water run-off mitigation measures. However; the requirements for additional mitigation will be continuously assessed throughout the course of the construction program.

In the absence of any detailed material management plan, it is anticipated that the stockpiling of material on-site will be restricted by access requirements and therefore arrangements may need to be made for temporary stockpiling of material on vacant plots of the wider KXC development.

4.5.3 Contaminated Material

Where suspected impacted material is encountered, material will be segregated and placed upon impermeable polythene sheeting or hardstanding for subsequent classification prior to disposal.

Mitigation measures including the use of dust suppression methods and containment via bunding shall be implemented to restrict dust entrainment and surface water run-off from the temporary stockpile in order to reduce the potential for contaminant migration.

4.5.4 Drainage of Excavated Areas

It is considered likely that perched water within the Made Ground and London Clay will be encountered as part of the earthworks.

Where encountered, a localised sump and pump methodology will be adopted on-site. Discharge will either be used for dust suppression techniques on-site, assuming no evidence of impact is observed, or discharge to the KXC site-wide drainage network, specifically the combined sewer system.

Prior to the commencement of earthworks on-site, discharge consent will be sought by the contractor from the operator.

Where practicable, excavations and superficial soils will be kept free of standing water in order to minimise any potential risks associated with access and or ground stability.

5. GROUND CONTAMINATION ASSESSMENT

5.1 Introduction

The following Section summarises the source, pathway, receptor (S-P-R) model generated as part of the Plot S4 DBA (Ramboll, July 2020) and will be refined as part of the GIR following the plot specific ground investigation in 2021.

5.2 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:

- Significant harm is being caused or there is a significant possibility of such harm being caused; or,
- 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.

5.3 Preliminary Conceptual Site Model

The preliminary conceptual site model for Plot S4 was developed as part of the Plot S4 DBA (Ramboll, July 2020). A summary of the qualitative risk assessment has been presented in Section 6.

Potential Sources

On-site:

- Historical use of the site comprising railway land, a roundhouse, goods sheds, coal sheds and locomotive cleaning depots.
- The Camden Sewer runs adjacent and underneath the eastern portion of the site which is now abandoned and grouted at both the ends and poses a risk of associated residual contamination.
- Historical potential sources of contamination sources include Made Ground associated with the construction and development of surrounding areas. The site may contain imported made ground/fill from off-site.

- Degradation of volatile organic materials within the Made may produce hazardous ground gases.
- Due to the historical use of the site it is likely that a number of underground structures and obstructions could be identified within the Made Ground.

Off-site:

- Historically the surrounds have been in industrial use since the 1800s including the presence of storage tanks, concrete batching plants, electricity substation, coal sheds and railway land use within close proximity to the site.

Potential Pathways

If contamination is encountered, to reach the receptor there has to be a viable pathway for the contaminant. The site-specific pathways identified are summarised in Table 5:1.

Table 5:1: Potential Pathways

Receptor	Pathway	Comments
Human Health	Direct contact with contaminated soils and inhalation and ingestion of dusts.	Future site users have the potential to come into direct contact with contaminated soils and inhale and ingest dusts in soft landscaped areas. Construction workers have the potential to come in direct contact with asbestos in soils during site enabling works and construction activities.
	Inhalation of vapours and ground gases.	Future site users, adjacent site users and construction workers have the potential to be affected by concentrations of hazardous ground gases (carbon dioxide and methane) and depleted oxygen levels.
Controlled Waters	Leaching and vertical migration of soil impacts to the Grand Union Canal, Secondary A Aquifer (Lambeth Group) and Principal Aquifer (Thanet Sands, Upper Chalk).	Leachable contaminants have the potential to impact controlled waters via vertical and lateral migration within the Made Ground due to its heterogeneity. However, this will be very limited following redevelopment with hardstanding and/or buildings covering the majority of the site. Piles may extend into the deeper aquifers and offer a preferential pathway for leachable contaminants.
Buildings and Structures	Damage to building materials or services through direct contact with contaminants or through contaminant migration.	Hydrocarbons, sulphates and other contaminants which may be present in the soil and have the potential to affect subsurface construction materials, in particular water supply pipes and buried concrete. Hazardous ground gases may also have the potential to migrate and build up in buildings and confined spaces.
Flora	Direct contact with impacted soils and root uptake.	This will be very limited following development as hardstanding is proposed across the majority of the site with areas of soft landscaping constructed largely at podium level.

Potential Receptors

The site-specific receptors that could potentially be affected by the contamination hazards are summarised in Table 5:2.

Table 5:2: Potential Receptors

Feature	Location	Rationale	Receptor Present?
Humans	On-site	The proposed development comprises a mixed residential and commercial development. Receptors include future commercial and residential site users and construction workers. Construction workers may come into contact with potentially contaminated ground during earthworks.	Yes
	Off-site	The site is located within a mixed commercial and residential setting.	Yes
Controlled Waters	On-site	Groundwater is anticipated to be perched within the Made Ground deposits and present in the underlying Secondary A (Lambeth Group) and Principal Aquifers (Thanet Sand and Upper Chalk formation). The presence of a considerable thickness of unproductive London Clay formation (>30 m) will act as a barrier to migration of contaminants (if present) to deeper aquifers. In addition, the site is not located within a groundwater Source Protection Zone and there are no groundwater abstractions for public water supply located within 1 km of the site. There are no surface water receptors located on site.	No
	Off-site	Groundwater flow pathways are expected to be present within the Made Ground and perched groundwater on site may have the ability to migrate horizontally off-site. Groundwater within the deeper Secondary A and Principal Aquifers is expected to be in continuity with the wider deeper aquifers. The nearest surface water course is the Grand Union Canal located approximately 250 m southwest of the site.	Yes
Built Environment	On-site	The site is proposed to be developed into a mixed commercial and residential development with water supply pipes.	Yes
Ecological Receptors	On-site	Potential for flora to be installed in areas of proposed soft landscaping and the brown/green roof areas.	Yes
	Off-site	A Local Nature Reserve is located 295 m southwest relating to Camley Street Nature Park. This receptor is not considered vulnerable given the distance.	No

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.

Table 5:3 forms an assessment of the significance of potential pollutant linkages associated with the site.

Table 5:3: Results of the Preliminary Contaminated Land Risk Assessment

Source	Potential Contaminants of Concern	Pathway	Receptor	Potential Severity	Probability	Level of Risk	Justification (Comment on Source)
On-site							
Made Ground	Heavy metals, semi metals, inorganics, sulphates, petroleum hydrocarbons, PAHs, tars, lubricants, volatile organic compounds (VOCs), semi volatile organic compounds (SVOCs), herbicides, polychlorinated biphenyls (PCBs) and asbestos.	Direct contact, inhalation, ingestion of soil, dust and vapour	Future site users	Medium	Low	Low	There is limited potential for future site users to come into contact with contaminated soils as the majority of areas of soft landscaping are proposed to be formed at podium level following removal of the principal source, the Made Ground.
		Direct contact, inhalation and ingestion of soil, dust and vapour	Construction workers	Medium	Likely	Moderate ^a	Potential for exposure during excavation / earthworks as construction and maintenance workers are likely to be in contact with Made Ground. The on-site substation may be a source of PCBs. Best practice measures during site works should be implemented by the contractor. The contractor will be responsible for site health and safety and will manage risks through the control of suitable Health and Safety measures including provision of PPE, education of the workforce and inductions for all site staff and visitors.
		Soil and dust ingestion and inhalation	Adjacent site users	Medium	Unlikely	Moderate ^a	Potential for dust generation during construction and maintenance works will only occur over a limited period of time. Good construction practice is likely to inhibit the potential for generation.
		Leaching and seepage followed by vertical and lateral migration	Secondary A Aquifer (Lambeth Group) and Principal Aquifer (Thanet Sands and Upper Chalk)	Medium	Low	Moderate / Low	There is the potential for contaminants in the Made Ground to migrate vertically via preferential pathways offered by the foundations and impact the Secondary A Aquifer and Principal Aquifer.
			Grand Union Canal	Mild	Unlikely	Very Low	While there is potential for leaching and migration via preferential pathways in any in granular lenses in the Made Ground, the majority of the source of contamination (Made Ground) is likely to be removed as part of the earthworks.
		Direct contact	Future Potable water supply lines	Medium	Low	Moderate / Low	Organic contaminants have the potential to permeate into water supply lines.

Source	Potential Contaminants of Concern	Pathway	Receptor	Potential Severity	Probability	Level of Risk	Justification (Comment on Source)
			Sub-surface construction materials	Medium	Low	Moderate / Low	Ground chemistry and its aggressivity to buried structural materials have not been characterised. Sulphate bearing minerals have the potential to deteriorate concrete strength.
		Direct contact with impacted soils and root uptake	Flora	Mild	Unlikely	Very Low	While phytotoxic contaminants may be present in the soils underlying the site the majority of soft landscaped areas will be formed at podium level with soils demonstrated to be suitable for use as a growing medium.
	Asbestos	Direct contact, inhalation, ingestion of dust and fibres	Future site users	Severe	Low	Moderate	There is limited potential for future site users to come into contact with asbestos in contaminated soils as the majority of areas of soft landscaping are proposed to be formed at podium level following removal of the principal source, the Made Ground.
			Construction workers	Severe	Likely	High ^a	Potential for exposure during excavation / earthworks as construction and maintenance workers are likely to be in contact with Made Ground. 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 risks through the control of suitable Health and Safety measures including provision of PPE, education of the workforce and inductions for all site staff and visitors.
			Adjacent site users	Severe	Unlikely	Moderate / Low	Potential for dust generation during construction and maintenance works will only occur over a limited period of time. Good construction practice is likely to inhibit the potential for generation.
	Ground Gas	Inhalation and accumulation of ground gas in confined areas via vertical/lateral migration.	Future site users	Medium	Low	Moderate/ Low	Receptors have the potential to be affected by elevated concentrations of volatile vapours associated with any hydrocarbon contamination and hazardous ground gases (carbon dioxide and methane) and depleted oxygen levels that are associated with organic materials present in Made Ground beneath the site.
			Construction Workers	Medium	Low	Moderate/ Low	
			Adjacent site users	Medium	Low	Moderate/ Low	
			Property	Medium	Low	Moderate/ Low	

Source	Potential Contaminants of Concern	Pathway	Receptor	Potential Severity	Probability	Level of Risk	Justification (Comment on Source)
Underground Obstructions	Unknown inorganic and organic contaminants	Direct contact, inhalation, ingestion of soil, dust and vapour	Future site users	Medium	Unlikely	Low	There is limited potential for future site users to come into contact with contamination associated with underground obstructions as these will be removed during construction works. The Camden Sewer has the potential for associated historical contamination to be present.
		Direct contact, inhalation and ingestion of soil, dust and vapour	Construction workers	Medium	Likely	Moderate ^a	Potential for exposure during excavation / earthworks as construction and maintenance workers are likely to be in contact with Made Ground. Best practice measures during site works should be implemented by the contractor. The contractor will be responsible for site health and safety and will manage risks through the control of suitable Health and Safety measures including provision of PPE, education of the workforce and inductions for all site staff and visitors.
		Soil and dust ingestion and inhalation	Adjacent site users	Medium	Unlikely	Low ^a	Potential for dust generation during obstruction removal but will only occur over a limited period of time. Good construction practice is likely to inhibit the potential for generation.
		Leaching and seepage followed by vertical and lateral migration	Secondary A Aquifer (Lambeth Group) and Principal Aquifer (Thanet Sands and Upper Chalk)	Medium	Low	Moderate / Low	There is the potential for contaminants in the Made Ground to migrate vertically via preferential pathways offered by the foundations and impact the Secondary A Aquifer and Principal Aquifer.
			Grand Union Canal	Mild	Unlikely	Very Low	While there is potential for leaching and migration via preferential pathways in granular lenses in the Made Ground, the majority of the source of contamination (Made Ground) is likely to be removed as part of earthworks.
On-site							
Historical and current potential contaminative land uses include storage tanks, concrete	Heavy metals, semi metals, inorganics, sulphates, petroleum hydrocarbons, PAHs, tars, lubricants,	Leaching and seepage followed by vertical and lateral migration	Secondary A Aquifer (Lambeth Group) and Principal Aquifer (Thanet Sands and Upper Chalk)	Medium	Unlikely	Low	There is the potential for off-site contaminants to migrate on-site via perched water or granular lenses within the Made Ground. Leachable contaminants could then migrate vertically via preferential pathways offered by the foundations and impact the Secondary A Aquifer and Principal Aquifer.

Source	Potential Contaminants of Concern	Pathway	Receptor	Potential Severity	Probability	Level of Risk	Justification (Comment on Source)
batching plants, electricity substations, coal sheds and railway land uses	volatile organic compounds (VOCs), semi volatile organic compounds (SVOCs), herbicides, polychlorinated biphenyls (PCBs) and asbestos.						
Ground Gas	Carbon dioxide, methane, volatile vapours and depleted oxygen	Inhalation / accumulation of ground gas in confined areas via vertical/lateral migration.	Future site users	Medium	Unlikely	Low	The degradation of off-site organic materials and presence of hydrocarbon contaminant can give rise to volatile vapours, hazardous ground gases (carbon dioxide and methane) and depleted oxygen concentrations which have the potential to migrate and impact on-site receptors.
			Construction Workers	Medium	Unlikely	Low	
			Property	Mild	Unlikely	Very Low	

^a The risks to construction workers and adjacent site users will be reduced to Low on the assumption that the contractor will deal with all risks 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 managing site environmental and health and safety procedures including provision of PPE, education of the workforce and inductions for all site staff and visitors.

6. REMEDIATION STRATEGY

6.1 Introduction

In accordance with the King's Cross Central Environmental Statement, Part 16, Arup May 2004, during the construction phases, mitigation measures to prevent the risk of harm to human health and risk of pollution to controlled waters will be implemented as detailed within the ES and CoCP.

In accordance with Part 16.4.16, the subject site falls within the Area 4 defined as Railway Lands.

The following Section outlines the ground contamination risk assessment for the subject site Building S4 and the remediation strategy to be adopted based on available site-specific data.

6.2 Conceptual Site Model

The revised CSM will be provided following the ground investigation.

6.3 Site Specific Remediation Strategy

To be confirmed following ground investigation.

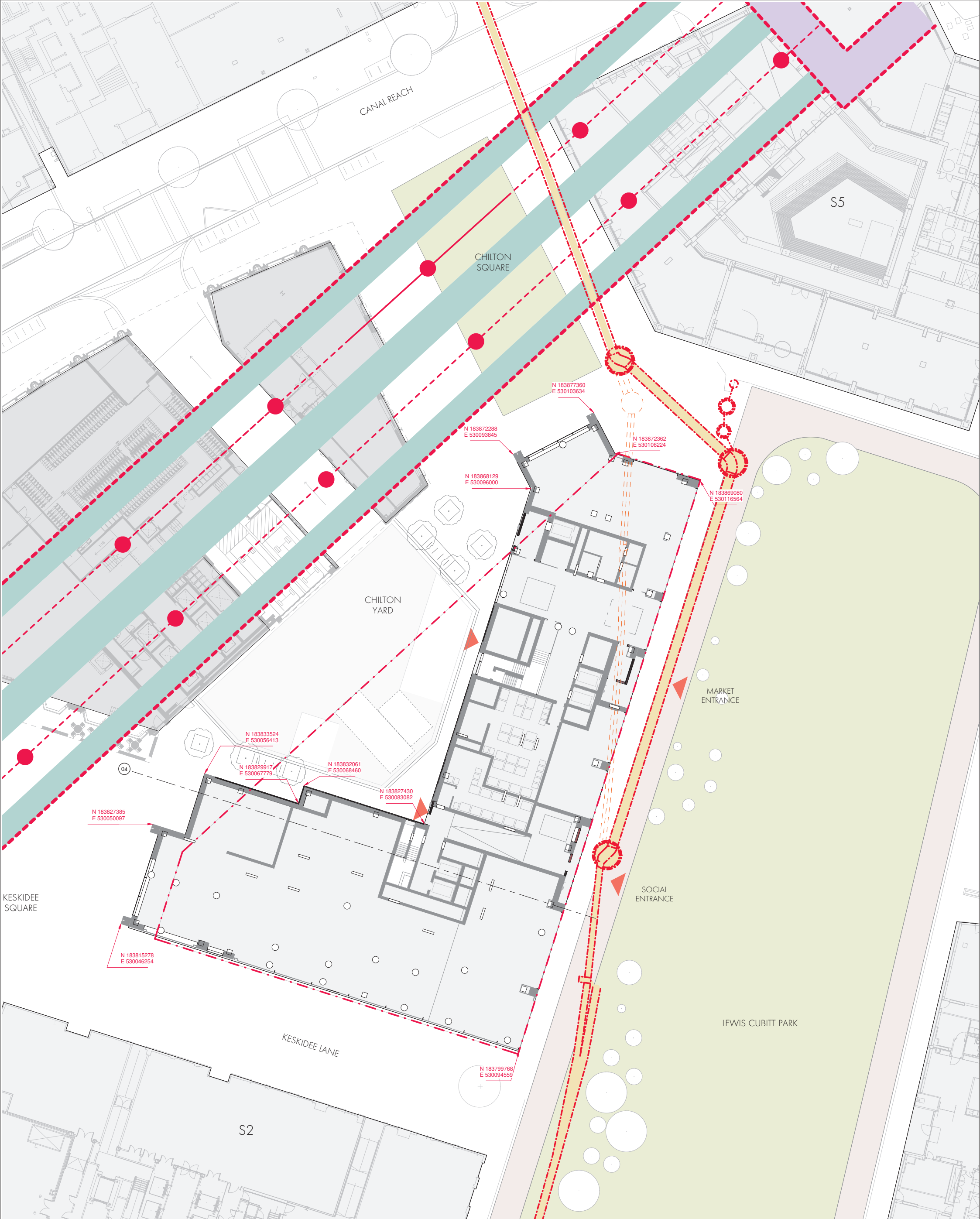
6.4 Unforeseen Contamination

To be confirmed following ground investigation.

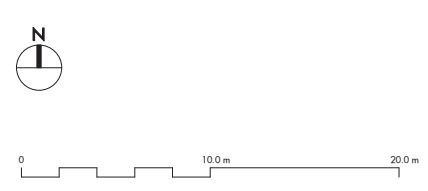
6.5 Best Practice Risk Management Measures

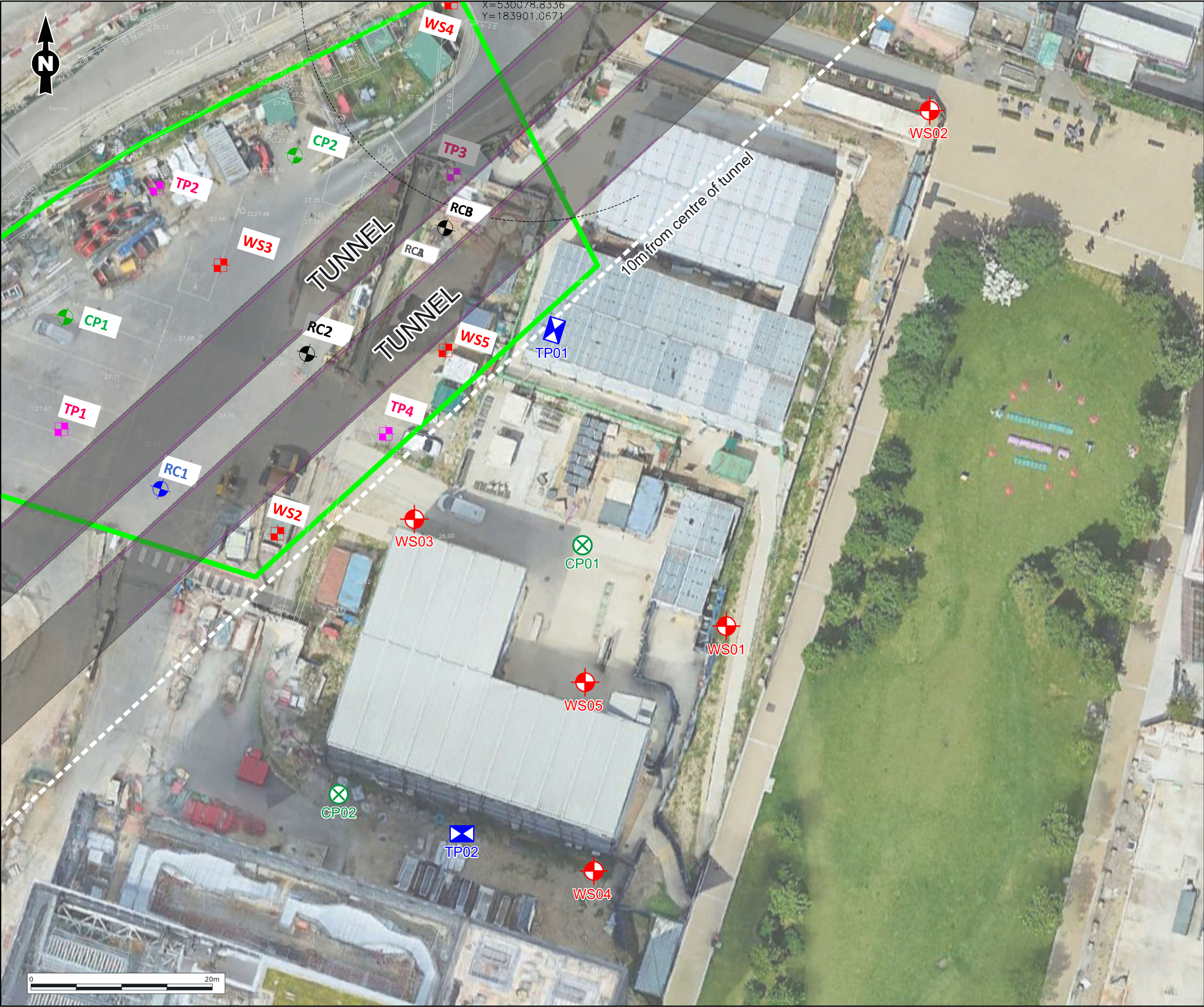
Best practice risk management measures should be adopted as part of the construction phases of works. The best practice risk management measures to be adopted will be tabulated and presented in the final issue of this ERP.

APPENDIX 1
FIGURES / DRAWINGS



- Site Boundary
- Existing Sewer Alignment
- Realigned Sewer Exclusion Zone
- Thameslink Tunnels
- Thameslink Tunnel Centreline
- 5m Tunnel Exclusion Zone





Legend

Site Boundary

Window Sample

Deep Borehole

Trial Pit

Targeting former sewer ~3.5 m bgl.

Coverage for former railway use and roundhouse.

Sufficient coverage beneath proposed building footprint for ground gas risk assessment.

Deep BH installations to attain groundwater sample from underlying aquifer.

ROTARY CORED BOREHOLE

CABLE PERCUSSIVE BOREHOLE COMPLETED

TERMONATED DUE TO CABLE OBSTRUCTION

CABLE PERCUSSIVE BOREHOLE TO BELOW TUNNEL INVERT WITH ROTARY FOLLOW-ON

TRIAL PIT

DYNAMIC SAMPLER

Figure Title

Proposed Borehole Locations

Project Name

KXS4 Stage 3

Project Number

NA

Figure No.

1

Date

November 2020

Prepared By

BVK

Scale

Refer to scale bar

Issue

6

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