4.1.3 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 the R5 site are listed in Table 4.3.

Table 4.3: 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. Ground gas concentrations (CO_2 and CH_4) were typically below detection limits and the site has been characterised as a Characteristic Situation 1 site in accordance with CIRIA C665 guidance. A Characteristic Situation 1 site is a low risk site. As such this pathway is not considered to be active on the R5 site. It is not considered further.
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. Soil leachate data is not available for the R5 site. However, Controlled Water receptors including the Regent's Canal and the underlying groundwater in the Thanet Sands and Upper Chalk formation are not considered to be sensitive in the context of the R5 site. As such this potential pathway is not considered to be active on the R5 site. It is not considered further.
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 Chalk. The proposed piles for the Building R5 are anticipated to terminate in the London Clay formations. As such the piles will not breach the impermeable strata that isolate any contamination in the Made Ground from the primary aquifer in the Chalk. This pollutant linkage is therefore not considered active at this site. The pathway is not considered further in this report.
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 in the Made Ground. However, the Controlled Water receptors are not considered to be active on the R5 site and as such, the pathway is not considered further.

4.1.4 Plausible Pollutant Linkages

A number of pollutant linkages based on the identified sources, receptors and pathways presented 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 justification for the risk rating is presented in Table 4.4. A revised conceptual site model for the site is shown in Drawing 7665/YE/002 in Appendix B.

Table 4.4: Possible linkages between sources and receptors during enabling and construction

Hazard/ Pollutant	Pathways	Receptor	Potential Severity	Probability of Risk	Level of Risk	Justification
Made Ground (benzo (a) pyrene and volatile PAHs)	Soil ingestion, inhalation of soil/dust, inhalation of volatised compounds, dermal absorption	Site operatives and construction workers[a]	Medium	Low Likelihood	Low/Moderate	Risk has been assessed as Low/Moderate because construction workers may come into contact with Made Ground containing benzo (a) pyrene concentrations marginally above GAC during site enabling and construction works. The risk can be mitigated by the contractors implementing best practice measures during site works.
		Future Site Users	Medium	Unlikely	Low	The majority of the new development will consist of hard standing areas and direct contact for future site users with existing Made Ground soils is unlikely, hence a risk rating of Low. The inhalation pathway is also considered to be inactive for this site. All imported soils used for soft landscaping will require verification testing.
Underground structures	Soil ingestion, inhalation of soil/dust, inhalation of volatised compounds, dermal absorption	Site operatives and construction workers[a]	Medium	Low Likelihood	Low/Moderate	Risk has been assessed as Low/Moderate because construction workers may come into contact with Made Ground containing benzo (a) pyrene concentrations marginally above GAC, particularly during site enabling and construction works. The risk can be mitigated by the contractors implementing best practice measures during site works.
		Future Site Users	Medium	Unlikely	Low	The development will consist of hard standing areas and direct contact for future site users with existing Made Ground soils is unlikely, hence a risk rating of Low.

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

4.2 Ground Gas Risk Assessment

A total of 5No ground gas monitoring visits have been completed at the R5 site by Bam Ritchies between March - May 2010.

Ground gas concentrations (CO_2 and CH_4) were typically below detection limits.

A ground gas risk assessment undertaken on Plot R5 in accordance with CIRIA C665 guidance characterises it as a Characteristic Situation 1 site. A Characteristic Situation 1 site is considered a low risk site in terms of ground gas generation potential. No special ground gas protection measures are therefore required for Plot R5.

5 EARTHWORKS

5.1 Proposed Earthworks and Volumes

The following earthworks volumes relate to the submitted proposals for Phase I of the development of Plot R5, specifically R5 North. Details of the earthworks relating to the South Block will be provided as part of the separate reserved matters submission for R5 South.

The current site levels on the R5 site vary from 25.55m AOD to +25.73m AOD from west to east.

As shown on Figure 1.3 and discussed in Section 1.4, the proposed FFLs of the R5 North development will range from +25.40m AOD in the West Block to 27.35m AOD in the North Block. The site levels in the courtyard range from +25.40m AOD in the west to +26.50m AOD in the south-east.

The proposed levels of the public realm areas are shown in Figure 1.4. These range from +24.6m AOD to +27.9m AOD on York Way (alongside the North Block) and +25.7m AOD to 27.5m AOD on the western footpath along East Street. The levels along the carriageway of East Street and the eastern footpath remain the same as those approved under the R4 submission. Similarly, the levels approved previously for the East Lane courtyard garden are broadly maintained for the revised scheme, increasing from +25.97m AOD to +28.12m AOD west to east.

R5 North does not include a basement.

The required earthworks for R5 North are as follows;

- Removal and stockpiling/disposal of existing surface finish materials;
- Excavation for the proposed R5 North buildings to the underside of the ground slabs;
- Piles to be installed under the building footprints and under the base of temporary tower crane; and
- Minor works associated with earth movements to achieve final site levels in the landscape areas.

An assessment of the volumes of materials that will be excavated during the ground works for R5 North is detailed in Table 5.1. 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 5.1: Estimated Earthwork Volumes for R5 North

Total Excavated Volume (North, West and East Blocks and associated landscaping = R5 North) [a/c/d]		2335 m^3
Comprising of:	Excavation to underside of ground slab.	1167 m^3
	Excavation for piling under building footprint	1168 m^3
	Excavated Made Ground Materials [b]	149 m^3
	Excavated London Clay Materials [b]	1640 m^3

[a]Total volume estimated from the number of proposed piles on the North Block (99no), West Block (71no) and East Block (16no), maximum pile length (24m), pile diameter (750mm). The figures are specific to the North, West and East Blocks only. The South Block which will form part of the Phase II development has not been included in the calculations.

[b]Total volumes of excavated Made Ground and London Clay are based on the site's stratigraphy and the length of proposed piles.

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

[d]Earthworks figures for the East Lane courtyard garden and the majority of East Street have already been provided as part of the earlier approved proposals for Building R4. To avoid double counting, the figures above do not include the East Street carriageway and eastern footpath, which remain unchanged under the current proposals. Further, the figures also exclude the revised proposals for the East Lane courtyard garden which are not considered to materially alter the earthworks figures quoted in the R4 submission.

5.2 Material Suitability

Made Ground and London Clay are expected to comprise the bulk of the excavated material for R5 North.

It is proposed to re-use as much material as practicable within the KXC development. Elevated concentrations of benzo (a) pyrene were reported in the Made Ground. Based on the risk assessment set out in Section 4, the materials are considered to be chemically suitable for reuse under hard standing.

Should previously unidentified contamination be identified, validation testing and appropriate risk assessments will be undertaken to determine suitability for reuse in hard standing areas.

5.2.1 Treatment and reuse of Existing Pavement Material

No existing pavement material has been identified on the R5 site. However, if any hard pavement surface comprising concrete and asphalt is identified during the earthworks then these can be excavated, crushed and processed for re-use on the wider KXC site.

5.2.2 Soft Landscaping Material

Existing Made Ground soils on the R5 site are unsuitable to be reused in areas of soft landscaping due to the potential exposure of future site users to Made Ground containing benzo (a) pyrene at concentrations above GAC screening values.

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.

5.2.3 Engineering Fill Material (below roads and hardstanding)

Engineering fill materials is defined as material that is suitable as fill to structures or for applications within carriageways, pedestrian pavements and hard landscape areas.

Based on the risk assessment undertaken following the 2010 SI, the existing materials are considered to be chemically suitable for reuse under hard standing.

5.3 Unsuitable Materials

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

The 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); and,
- Other material designated as unsuitable due to lack of compliance with particular engineering fill parameters, and as determined in the Specification for Highway Works.

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.

5.4 Stockpiling and Handling

5.4.1 Stockpiling for Re-use Onsite

As outlined in Section 5.3 excavated suitable material will be allocated for either direct placement as fill, crushing and re-use as appropriate, or where surplus to requirement, removed from the R5 site (Figure 1.2).

Any material to be reused on site will be temporarily stockpiled on Plot S5 to the north of the R5 site (Figure 1.2).

5.4.2 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.

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.

5.5 Method and Sequencing of Works

5.5.1 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:

- Breaking out and removal of any existing hardstanding, pavements and foundations, if identified at the R5 site. These will be either stockpiled in the designated area (Plot S5 on Figure 1.2) and crushed/processed for future placement on site or removed directly 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.

A site specific ground contamination risk assessment was undertaken following the 2010 SI and is discussed in Section 4. The Ground Contamination Interpretative Report for the R5 site is included in Appendix E.

5.5.2 Drainage of Excavated Areas

Limited groundwater was encountered in the Made Ground during the 2010 SI for Plot R5. It is possible that further perched water may be encountered within granular lenses in the Made Ground during periods of heavy rainfall. Pore water was encountered in the London Clay stratum.

Groundwater encountered in excavations will be managed during construction works. 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.

6 REMEDIATION STRATEGY

6.1 Introduction

The ground contamination risk assessment for the R5 site based on the pollutant linkage methodology has been presented in Section 4. The earthworks proposals for R5 North which are detailed in Section 5 were informed by the chemical quality of existing materials as detailed in Section 4.

A summary of the ground contamination risk assessment including earthworks proposals for the R5 North development are detailed below:

- Risk to Controlled Waters (surface water of the Regent's Canal and groundwater in the Thanet Sands and Chalk Aquifer) has been assessed as LOW due to the distance of the Regent's Canal from the site and the significant depths of London Clay and Lambeth Group clays separating the underlying aquifers from the Made Ground stratum. Additionally, the foundation solution (piles) of the new development will only extend into the London Clay and/or Lambeth Group clay strata.
- Based on the ground gas monitoring data, risk to future site users from ground gases has been assessed as LOW;
- Human health risks to future site users have been assessed as LOW as the majority of the site will be under hard standing; and
- Human health risks to construction workers has been assessed as LOW/MODERATE due to the potential for contact with Made Ground within which marginal excedences of benzo (a) pyrene has been reported. However, the risks can be mitigated to LOW through the implementation of best practice measures during site works by the contractors. The Contractor will be responsible for site health and safety and will manage the risk through control of suitable Health and Safety measures including provision of PPE, education of the workforce and inductions for all site staff and visitors.
- Some underground obstructions were identified during the site works. Further obstructions could be identified during site works and these could be associated with ground contamination, however, based on the historic and existing land uses at the site, this is considered unlikely. Any identified contamination could create an active pollutant linkage to construction workers which could be mitigated during site works as above.
- Due to the presence of benzo (a) pyrene above GAC screening values in the Made Ground, existing Made Ground soils are not considered to be suitable for use in soft landscape areas, where the direct exposure pathway to future site users could be active. However, the existing Made Ground soils are considered to be suitable for reuse in hard standing areas.

Based on the 2010 SI data and ground contamination risk assessment set out in Section 4, it is considered that special remedial measures are not required for the development of Plot R5.

6.2 Remedial Options for Unforeseen Contamination

A comprehensive site investigation and ground contamination risk assessment has already been undertaken at the R5 site, as detailed in Sections 3 and 4 of this ERP.

It is not anticipated that significant unforeseen contamination will be encountered on the site. However, in the unlikely event that previously unidentified contamination is

encountered at the site during construction works, the following approach will be implemented:

- Any remediation will be carried out in accordance with the principles of the site wide remediation strategy as set out in the KXC ES, Vol 4 Part 16 (Paragraph 16.6.7 to 16.6.9);
- A contamination watching brief will be maintained during the construction phases and any contaminated materials identified during earthworks will be segregated and dealt with in line with paragraph 16.6.9 of the KXC ES. This states that if unforeseen contamination is identified during the course of the works, the construction manager would instruct specific investigations, advise the Local Authority and liaise on the remediation methodology as appropriate. Also, as stated in the ES (Section 16.9), the results of the validation testing will form the basis of a Remediation Plan/Report for each plot/phase.

7 REFERENCES

Arup (2004) King's Cross Central Environmental Statement (ES) Volume 4: Part 16 Soils and Contamination Specialist Report, May 2004

Arup (2004) King's Cross Central Environmental Statement (ES) Volume 4: Part 16 Soils and Contamination Specialist Report. May 2004

Arup (2004) King's Cross Central Environmental Statement (ES) Volume 4: Part 16 Soils and Contamination Specialist Report. May 2004

Arup (2005) King's Cross Central ES Volume 5: Supplement. September 2005

British Geological Survey Map 1: 50 000 Map England and Wales Sheet 256 North London (BGS, 1994);

Foundation and Exploration Services (1995) Contract "L" Phase 3 Ground Investigation Geotechnical Factual Report on Site Investigation.

International Heritage Conservation and Management (IHCM), RPS and Arup (2004) King's Cross Central ES Volume 2: Part 9 Cultural Heritage and Townscape Specialist Report. Appendix 9B. May 2004

International Heritage Conservation and Management (IHCM), RPS and Arup (2004) King's Cross Central ES Volume 2: Part 9 Cultural Heritage and Townscape Specialist Report. Appendix 9B..May 2004

National Rivers Authority (1995). Policy and Practice for the Protection of Groundwater. Groundwater Vulnerability Map Sheet 40 (Thames Estuary) 1: 10 000 Map Series.

Ramboll (2010) Ground Contamination Interpretative Report T6. Ref 6955.E.GCIR.1C. A report prepared for Urbanest by Ramboll UK. August 2010

Ramboll (2010) Ground Contamination Interpretative Report R5. Ref 7665.E.GCIR.2A. A report prepared for Kings Cross Central General Partner Limited by Ramboll UK. September 2010

Soil Mechanics (1993) Contract 3 for Borehole Investigations at Kings Cross.

Soil Mechanics(1997) Contract 2 for Phase 4 Ground Investigations in Project Area 100.

WSP UK (2010) Kings Cross Central Earthworks & Remediation Plan Building R4, January 2010

WSP UK (2010a) Generic Quantitative (Environmental) Risk Assessment
R4, Kings Cross, London. A report prepared for Carillion. June 2010

APPENDICES

APPENDIX A: FIGURES

Figure 1.1. Aerial Photograph of Site

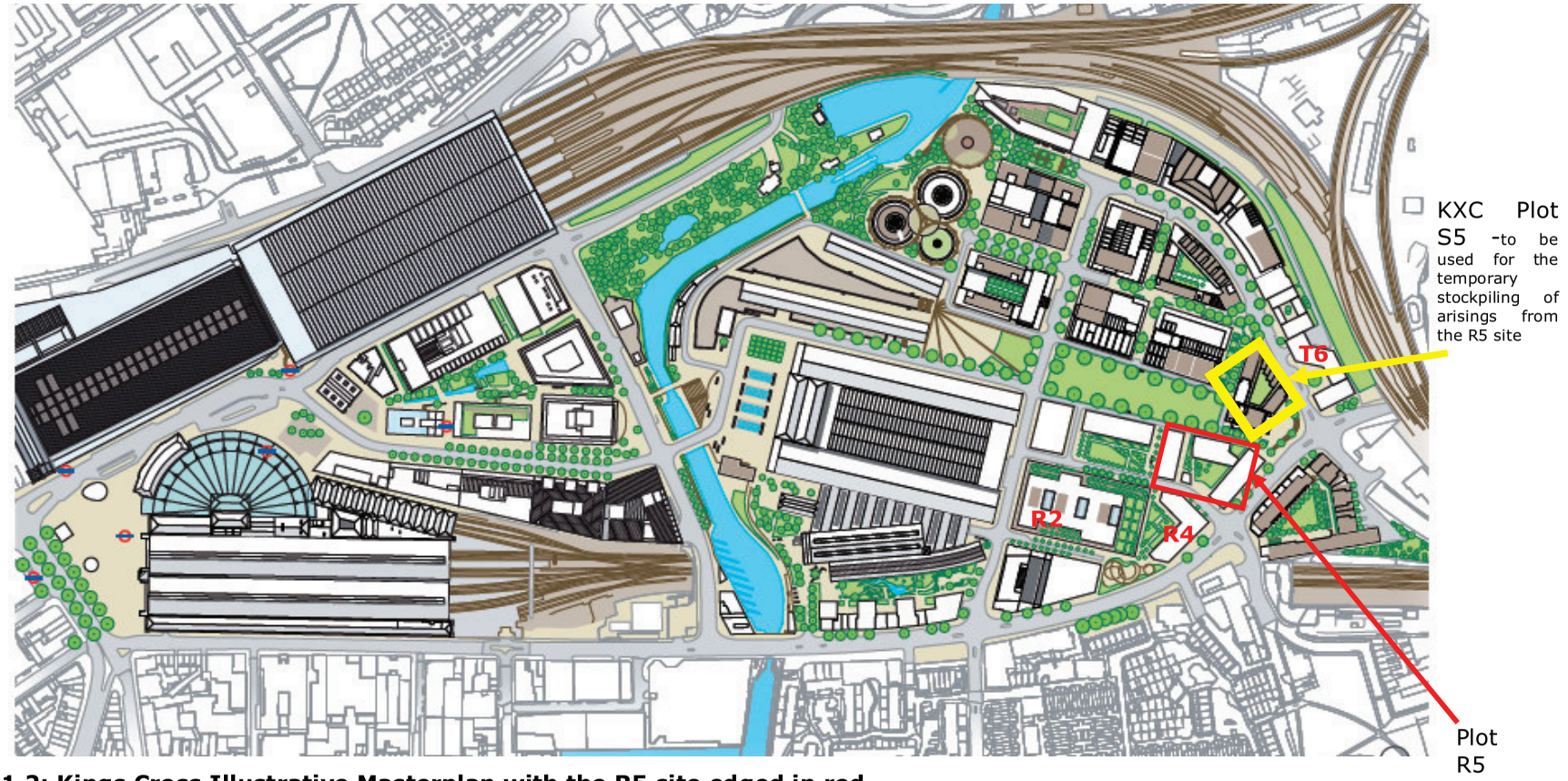


Figure 1.2: Kings Cross Illustrative Masterplan with the R5 site edged in red

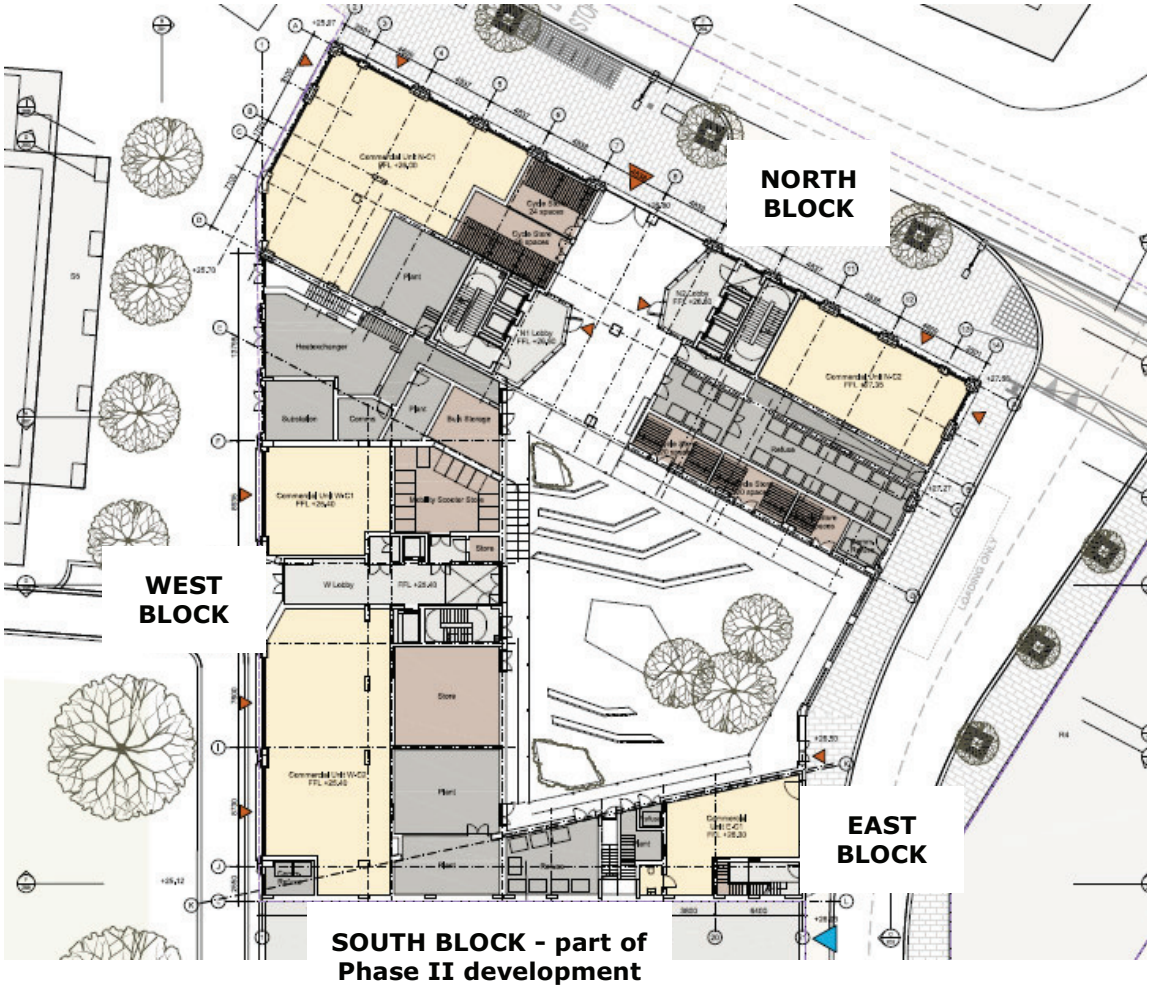


Figure 1.3: Ground Floor Plan of R5 North

THE NORTH, WEST AND EAST BLOCKS FORM PART OF THE "R5 NORTH" SUBMISSION. THE SOUTHERN BLOCK WILL BE DEVELOPMENT AS PART OF THE PHASE II WORKS

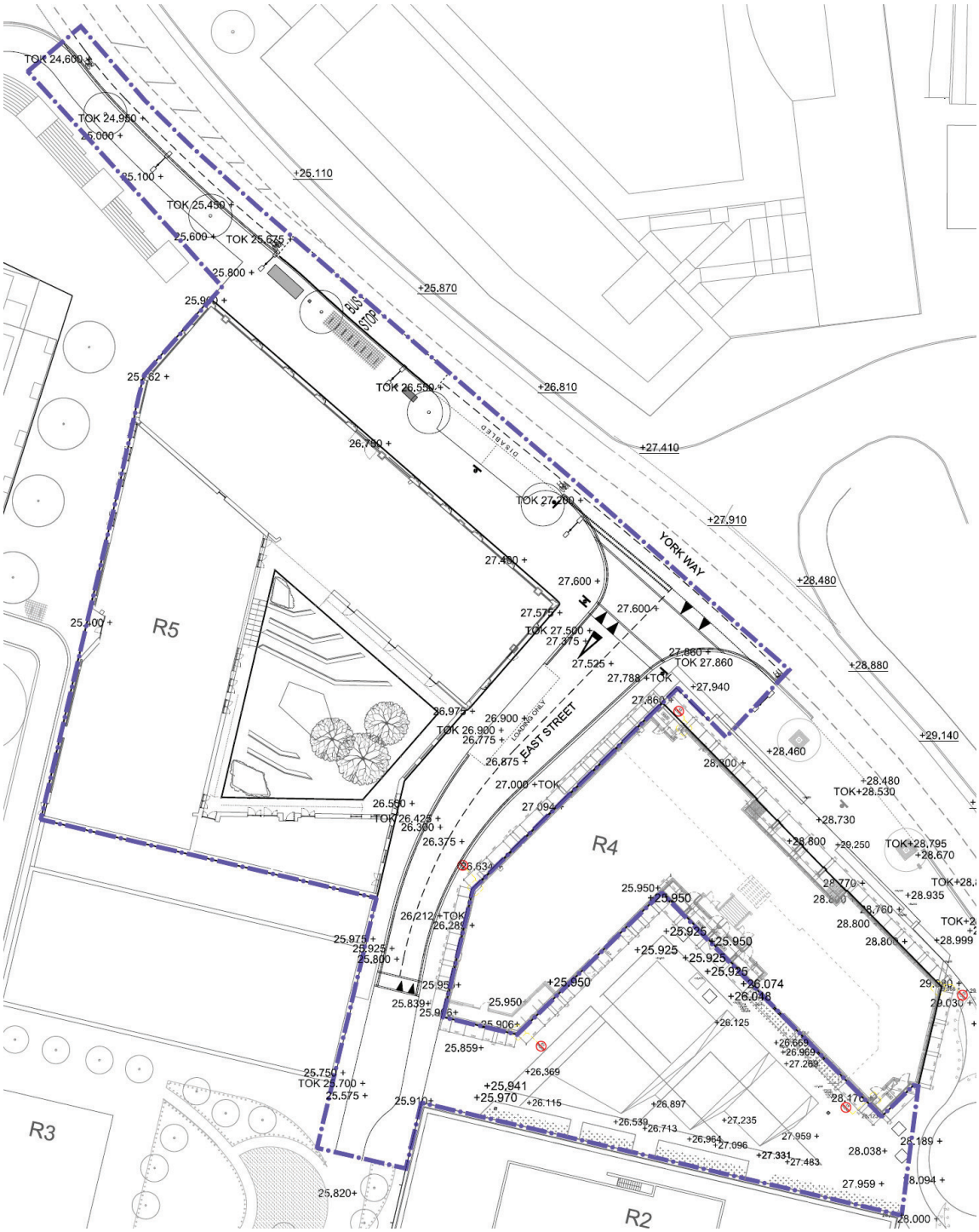


Figure 1.4: KXC R5 North External Landscape Areas and Site Levels

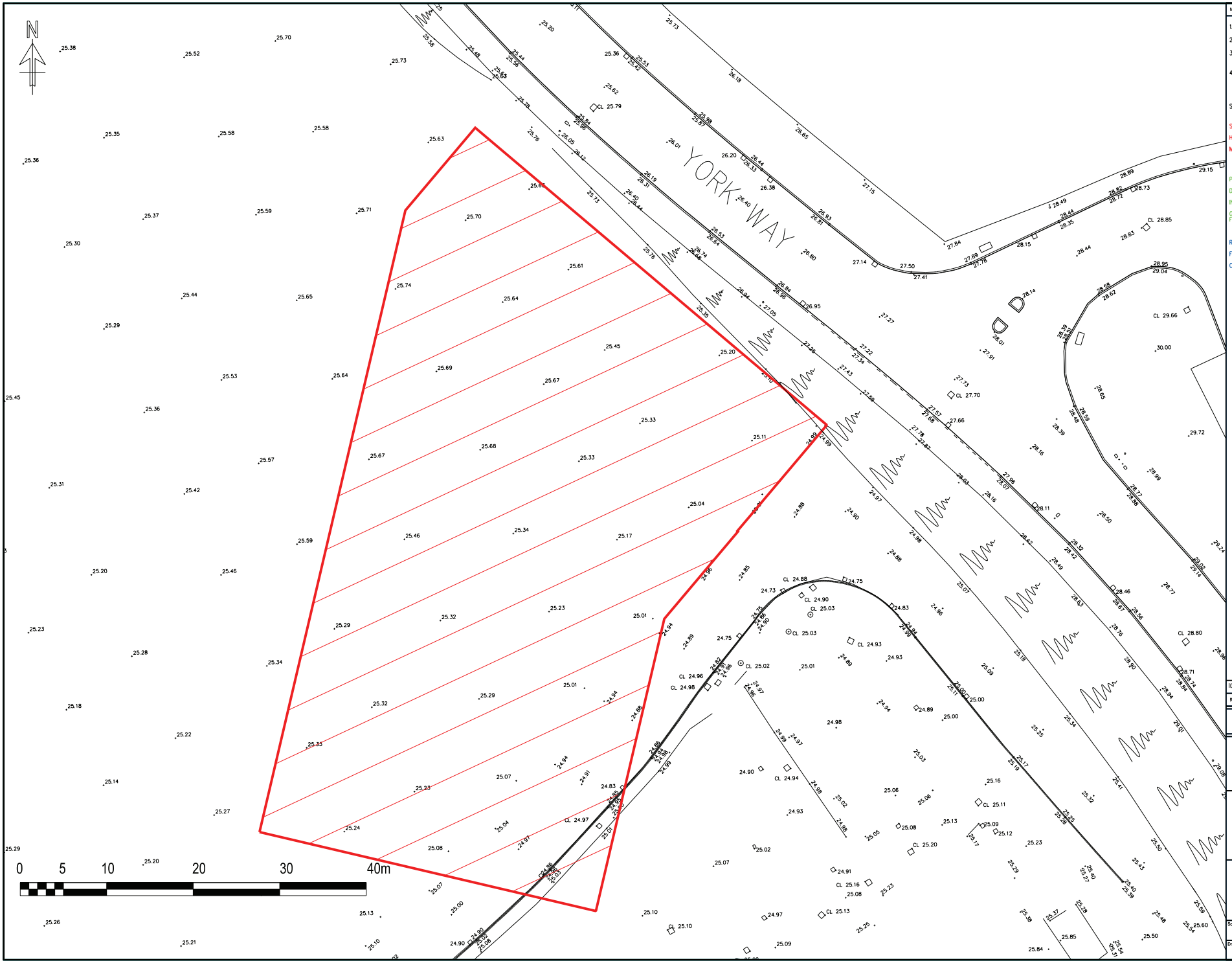
APPENDIX B: DRAWINGS

DRAWING 7665/CG/002: EXPLORATORY HOLE LOCATION PLAN

DRAWING 7665/CG/003: GEOLOGICAL CROSS THROUGH THE R5 SITE

DRAWING 7665/YE/101: PRELIMINARY CONCEPTUAL SITE MODEL

DRAWING 7665/YE/102: REFINED CONCEPTUAL SITE MODEL



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

SITE BOUNDARY

SOURCES:-
HISTORIC RAILWAY LINES & SIDINGS
MADE GROUND

PATHWAYS:-
DIRECT CONTACT
INGESTION INHALATION
GROUND GAS MIGRATION THOUGH PREFENTIAL FLOW PATHS

RECEPTORS:-
FUTURE SITE USERS
CONSTRUCTION WORKERS

Rev.	Description	Date	By	Chk	App
I01	INFORMATION	31.08.2010	Rmax	OF	SC

INFORMATION

KINGS CROSS R5

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PRELIMINARY CONCEPTUAL SITE MODEL

Scale:	Date:	Drawn:	Checked:
NTS @ A3	AUG 10	Rmax	OF

Drawing No.: 7665/YE/001 Rev. I01