Heathrow Airport Limited

Heathrow's North-West Runway

Geo-Environmental Assessment

16 June 2014

AMEC Environment & Infrastructure UK Limited

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Non-Technical Summary

Heathrow Airport Limited (HAL) is proposing to expand the existing Heathrow Airport site to the north-west. The proposed development includes construction of a third runway, taxiways, stands, several new airport buildings, ancillary buildings and car parks. The proposed development area is large and the current land use across the area can be summarised as:

- Industrial/ commercial estates, office buildings, agricultural land, recreational areas, car parks, hotels, an active landfill, gravel pits, residential areas, a major road (M25), petrol stations, an energy from waste plant, a British Pipeline Association (BPA) site and potentially a pipeline, a biodiversity site and surface water features; lakes and six water courses.

The ground conditions are considered to be similar across the development area in terms of solid geology with slight variations in the superficial geology. The general anticipated ground conditions comprise the following:

- Worked ground/ made ground/ Topsoil underlain by;
- Alluvium (where present), a Secondary aquifer, underlain by;
- Langley Silt Member (where present) underlain by;
- River Terrace Deposits (RTD) (where present), a Principal aquifer, underlain by;
- London Clay Formation.

As the development will be undertaken on mainly brownfield land the development will result in an improvement to high-value commercial land.

The main potential sources of contamination at the site are 2 currently active landfills and 16 historical landfills (some of which are partly within the site) which are present as a result of historical sand and gravel quarrying. Given the number of landfills, the type of waste present and uncertainty over the landfill construction, there is a high likelihood that the Principal aquifer in the RTD, where present following quarrying, has been impacted by contaminants leaching from these landfills. There is also a possibility that surface water features have been impacted given their proximity to the landfills in some areas of the site.

In the current condition, prior to mitigation measures, there are anticipated to be low risks to current site users (those spending a considerable proportion of their time on-site, residents and workers) and low risks to off-site residents.

During the construction phase, risks to construction and maintenance workers are considered to be low based on the assumption that, as is standard practice, the workers will be wearing suitable Personal Protective Equipment (PPE),

adopt best-practice site hygiene procedures and comply with site health, safety and environmental management plans.

There is the potential for spills and leaks from equipment and storage areas during the construction and operation phase of the development. In order to ensure low risks from spills and leaks to environmental receptors, including ground and surface water, a Site Environmental Management Plan should be in place including details of emergency procedures to deal with incidents or unexpected contamination.

During the operational phase it is assumed that mitigation measures will have been included in the construction process to reduce risks to human health and environmental receptors. Risks may include presence of ground gas, contaminated soils and groundwater and the potential creation of preferential pathways during construction works.

Outline recommendations for mitigation measures have been included in **Section 5** of this report. These recommendations should be reviewed following completion of finalised development proposals, confirmation of foundation design, location of landscaped areas, river diversions and flood storage areas.

Abbreviations

AOD	Above Ordnance Datum
BGS	British Geological Survey
BPA	British Pipeline Association
CSM	Conceptual Site Model
DONR	Duke of Northumberland's River
EA	Environment Agency
HAL	Heathrow Airport Limited
NVZ	Nitrate Vulnerable Zone
PPE	Personal Protective Equipment
RTD	River Terrace Deposits
SPZ	Source Protection Zone
UXO	Unexploded Ordnance

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1. Introduction

1.1 Background

This Geo-Environment Desk Study has been prepared by Mott MacDonald on behalf of AMEC Environment & Infrastructure for Heathrow Airport Limited (HAL). To meet the growing need for additional air capacity, HAL has proposed an extension to the existing Heathrow Airport1 (**Figure 1, Appendix A**). The proposed development would include:

- A 3,500 m runway to the north-west of the existing Airport;
- Two new terminal buildings;
- Aircraft movement areas and taxiways;
- Various aircraft stands (pier serviced stands and remote stands);
- Car parking; and
- Ancillary uses.

Further details of the development can be found in HAL's submission to the Airports Commission[1].

This report provides the technical assessment and details underlying the Contaminated Land Strategy presented in Volume 1 of HAL's submission to the Airports Commission[1]. The assessment of potential effects with and without mitigation was undertaken in accordance with the Commission's Sustainability Appraisal Framework (SAF) as described below[2]. **Sections 2 and 3** of this report describe the geo-environmental setting of the proposed site and provide background on historical land use and associated potential land contamination, respectively. The results of the Phase 1 Contaminated Land Risk Assessment are described in **Section 4**. Measures to manage and minimise identified risks during construction and operation are proposed in **Section 5**. Conclusions and recommendations are summarised in **Section 6** of this report.

1.2 Airports Commission's Requirements

The Airports Commission requires scheme promoters to undertake a desk-based ground conditions assessment. This assessment should include consideration of existing and previous uses of the proposed site to determine what physical constraints exist or are likely to exist in relation to proposed or potential future engineering works and the associated costs of overcoming these constraints.

[1] Heathrow (2014) Taking Britain further – Heathrow's plan for connecting the UK to growth.

[2] Airports Commission (2014) Appraisal Framework. April 2014. Available at www.gov.uk/government/uploads/system/uploads/attachment_data/file/300223/airports-commission-appraisal-framework.pdf

Specific to this Strategy, promoters should establish the situation in relation to:

- Ground contamination - including requirements and options for eliminating any potential for significant environmental harm, and rendering land safe and fit for intended use (including protecting controlled waters); and
- Specialist engineering works - which may be necessary due to the quality of the ground surface, such as working on land in low-lying or water-logged areas.

1.3 Heathrow's Objectives

The objectives of this study are to review existing information relating to the site and to identify potential current in-ground constraints for the proposed development, in order to ensure that correct mitigation measures can be built into the scheme. By using the information that is already available, it is intended to make a preliminary assessment to highlight potential land quality issues that will need to be taken into account in the design, construction and operation of the proposed development. The study aims to demonstrate that:

- Risk to human health is managed during construction and operation;
- Risk to sensitive environmental resources is managed during construction and operation; and
- Potential waste reduction and material management options is considered, with the aim of reducing the amount of waste that has to be taken off-site for disposal.

2. Baseline

2.1 Methodology

This study comprises a review of readily available geological, environmental and historical information; a site reconnaissance visit; a preliminary environmental risk assessment prepared in accordance with current government and industry guidance; and the provision of a report summarising the desk study findings.

The information for this study has been taken from a number of sources including:

- Published geological and hydrogeological maps;
- Envirocheck reports supplied by Landmark Information Group;
- The Environment Agency (EA) website;
- British Geological Survey (BGS) boreholes in the area; and
- Site reconnaissance visit.

2.2 Site Description

For the purpose of this report the site has been divided into three zones (displayed in **Figure 2.1**). This has been decided based on the proposed land use and locations: Zone 1; runway, Zone 2; airport buildings, ancillary buildings and car park, and Zone 3; airport buildings, ancillary space and car park. These zones exclude the area of land for the enhanced Colne Valley Park as these works do not require intrusive investigations and there is flexibility in locating any infrastructure that does (i.e. to avoid any contaminated land).

2.2.1 Zone 1

Zone 1 extends from the village of Sipson in the east to the fringes of the village of Colnbrook in the west. It has an area of 185 hectares. Land use comprises industrial and commercial estates, office buildings, agricultural land, an active landfill, residential areas, a major road (M25), a petrol station, an energy from waste plant and surface water features including lakes and three rivers.

2.2.2 Zone 2

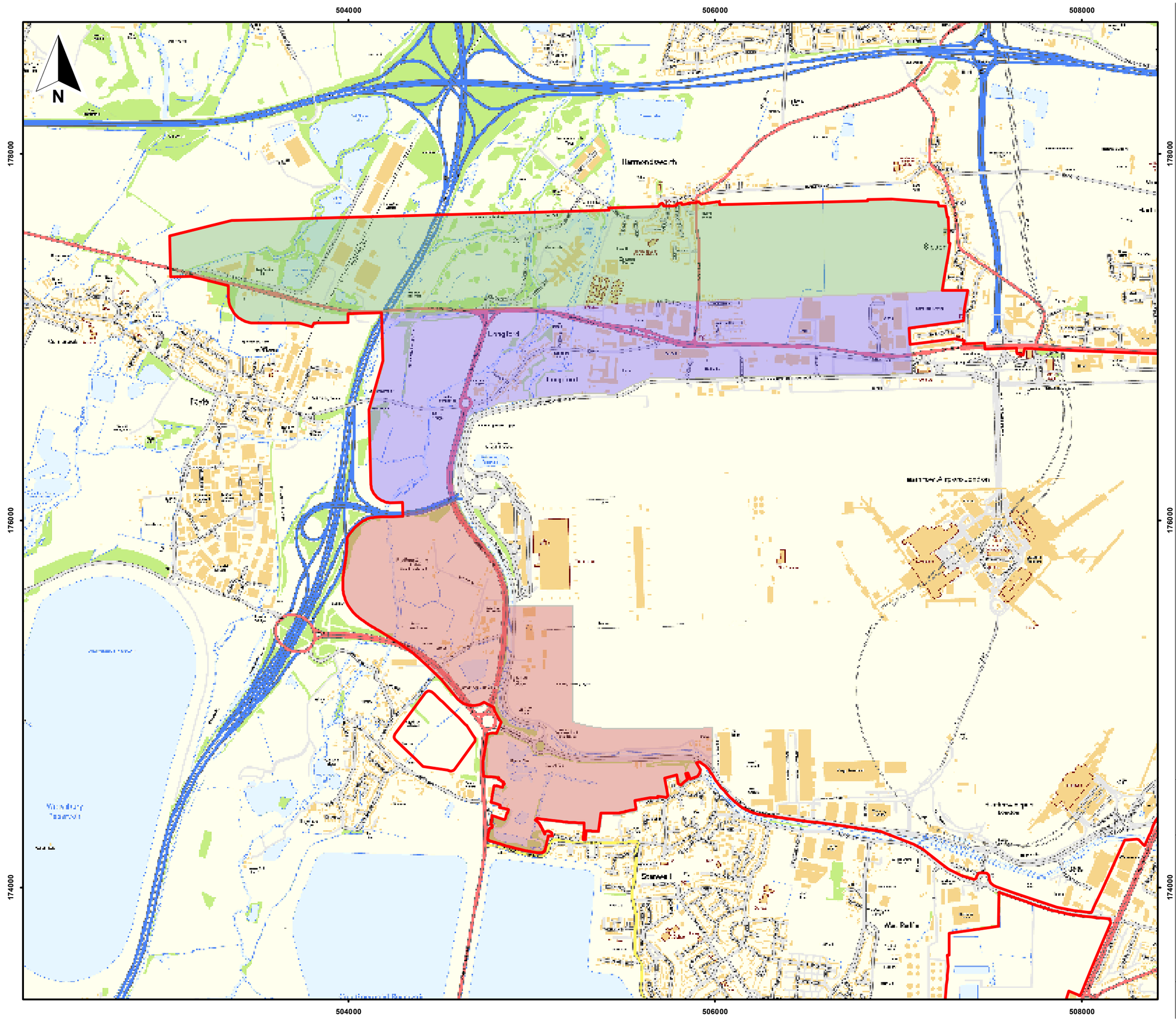
The eastern boundary of Zone 2 is also the village of Sipson and its western boundary is the M25. It has an area of 187 hectares. Land uses within Zone 2 include a recreation ground, a business park, several industrial estates (warehouses), several large car parks, a petrol station, a hotel, a conference centre, the village of Longford (with residential two storey properties), agricultural land, a British Pipeline Association (BPA) site and potentially a pipeline, a biodiversity site and three rivers.

2.2.3 Zone 3

Zone 3 extends from its western boundary, the M25, to the fringes of the settlement of Stanwell. Zone 3 has an area of 154 hectares. Land uses within Zone 3 include airport land, a balancing pond, a gravel pit and associated works, agricultural land, a fuel depot, a petrol station and several small lakes.

2.2.4 Topography

The site elevation varies between 21 m and 28 m Above Ordnance Datum (AOD). The site is flat within the east of Zone 1, with ground becoming more uneven towards the west relating to in-filled ground and the M25. Topography is also variable in Zone 2 due to in-filled ground. The topography within Zone 3 is flatter, ranging from 20.0 to 22.5 m (AOD).



Legend

Masterplan Site Boundary

Zones

Zone Number

- Zone 1
- Zone 2
- Zone 3

0 250 500 1,000 Metres

Scale: 20,000 @ A3

Project Path

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Geo-Environmental Desk Study

Figure 2.1

Geo-environmental study area with zones

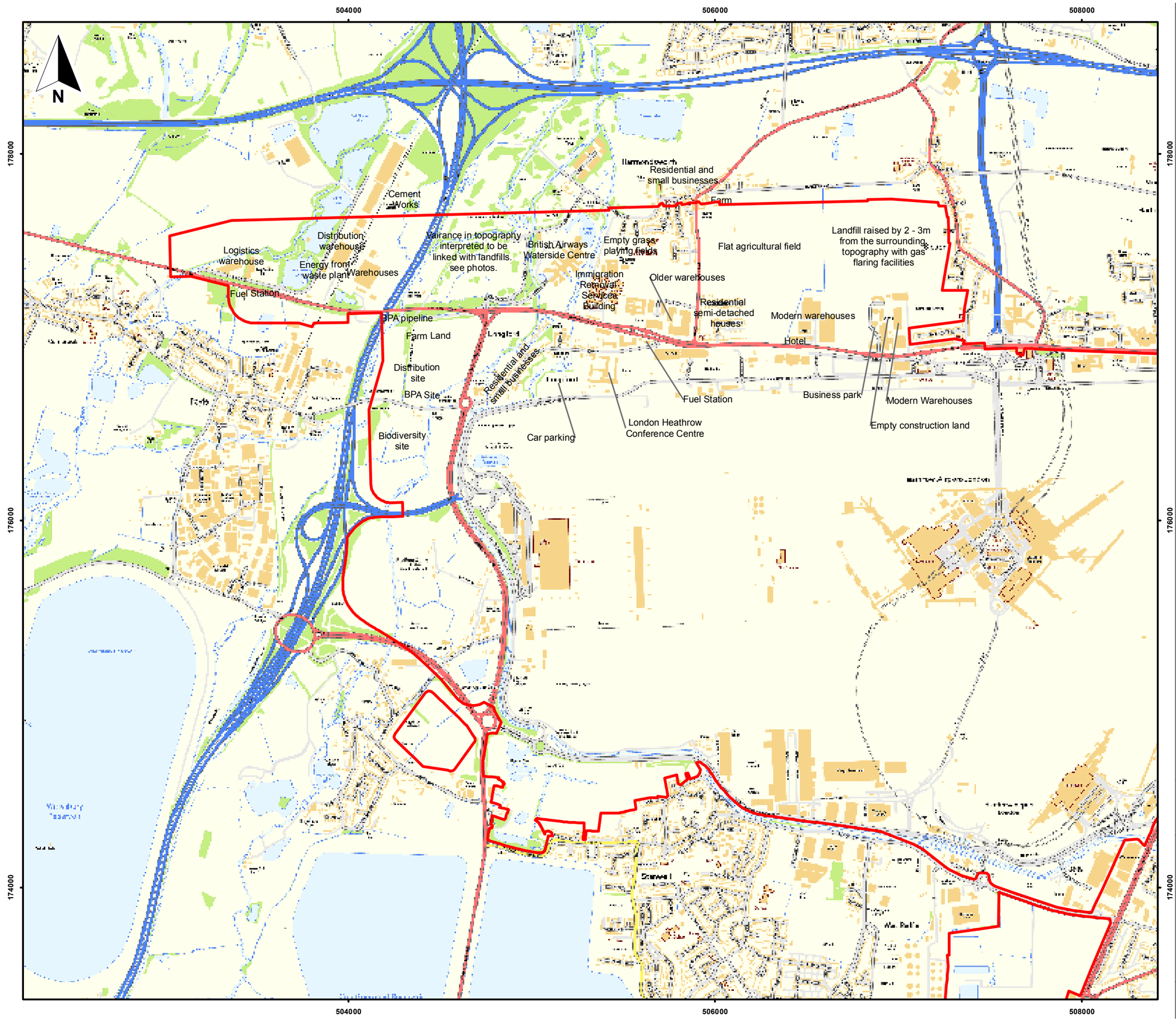
03/04/14
Lee Cutting/George Newman

Mott MacDonald

2.3 Site Walkover

A site walkover survey was carried out by the project team on 18 March 2014 and observations made during this investigation can be found in **Figure 2.2** below. Site photographs are included within **Appendix B**.

A site walkover of Zone 3 was not undertaken as it's largely within the existing boundary of Heathrow.



Legend

Masterplan Site Boundary

0 250 500 1,000 Metres

Scale: 20,000 @ A3

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Figure 2.2

Site visit observations

03/04/14
Lee Cutting/George Newman

Mott MacDonald

2.4 Geology

Table 2.1 summarises the anticipated geology beneath Zone 1 and Zone 2, based upon the published geology maps, borehole data from BGS website and Envirocheck Reports[3]. Several areas of artificial ground (in-filled ground, made ground and worked ground) are recorded on site. The worked ground is associated with historical quarrying and landfills; these are summarised in **Section 3**.

Table 2.1 Summary of the Anticipated Geological Profile within Zone 1 and Zone 2.

Strata	Typical Description	Approx. Depth to top of Strata (m bgl)	Approx. Thickness (m)
Superficial Geology			
Topsoil (where present)	Topsoil	0	0 to 0.5
Worked ground – infilled ground – made ground (where present)	Landfill materials (Inert, industrial, commercial, household, special, liquids/sludges, construction, demolition and dredging)	0.5	1.0 to 8.0
Alluvium (where present) – West of the Duke of Northumberland's River	Clay, silt, sand and gravel	0.15	0.5
Langley Silt Member (where present) – East of the Duke of Northumberland's River	Clay and silt	0.5	1.0 to 2.0
River Terrace Deposits (where present)*	Sand and Gravel with occasional lenses of clay	1.5	0.5 -5
Bedrock Geology			
London Clay Formation	Clay, silt and sand	5.0 to 10.0	Up to 60

*River Terrace Deposits are a mixture of Shepperton Gravel Member and Taplow Gravel Formation which were not differentiated in the BGS boreholes; therefore the BGS map has been used to interpret which of the two is present nearest the surface.

Table 2.2 summarises the anticipated geology within Zone 3.

[3] Landmark (2014) Envirocheck Reports prepared for Mott MacDonald covering the area of Heathrow Airport Ref 53927727_1-1, Ref 53926386_1_1, Ref 53929599_1_1 and Ref 54486344_1_1

Table 2.2 Summary of the Anticipated Geological Profile within Zone 3.

Strata	Typical Description	Approx. Depth to top of Strata (m bgl)	Approx. Thickness (m)
Superficial Geology			
Topsoil (where present)	Topsoil	0	0 to 0.5
Worked ground – infilled ground – made ground (where present)	Landfill materials (Inert, industrial, commercial, household, special, liquids/sludges, construction, demolition and dredging)	0.5	1.0 to 8.0
Alluvium (where present) – West of the Colne River	Clay, Silt, Sand and Gravel	0.15	0.5
River Terrace Deposits (where present)*	Sand and Gravel with occasional lenses of clay	1.5	0.5 -5
Bedrock Geology			
London Clay Formation	Clay, Silt and Sand	5.0 to 10.0	Up to 60

*The River Terrace Deposits are a combination of the Shepperton Gravel Member and Taplow Gravel Formation which were not differentiated in the BGS boreholes; therefore the BGS map has been used to interpret which of the two is present nearest the surface.

Due to the presence of sand and gravel quarrying and subsequent landfilling at the site, the Alluvium and River Terrace Deposits may be present across the entirety of the site.

2.5 Hydrogeology

A review of the local hydrogeology, based on the EA website and the Groundwater Vulnerability Map[3] of the area, has identified the following hydrogeological features.

Table 2.3 Summary of aquifer classifications beneath the site

Strata	Aquifer Classification
Superficial Geology	
Worked ground – infilled ground (where present)	Unproductive Strata (potential presence of perched water)
Alluvium (where present)	Secondary A aquifer
Langley Silt Member (where present)	Unproductive Strata
River Terrace Deposits (where present)*	Principal aquifer
Bedrock Geology	
London Clay Formation	Unproductive Strata

*River Terrace Deposits are a mixture of Shepperton Gravel Member and Taplow Gravel Formation which were not differentiated in the BGS boreholes; therefore the BGS map has been used to interpret which of the two is present nearest the surface.

Data from the EA website[4] indicates that there are no Groundwater Source Protection Zones (SPZs) within the proposed development site. However there is a SPZ1 approximately 100 m to the north west of the site (north west of Orlitts Lake).

The Envirocheck reports[3] indicate that the groundwater vulnerability is intermediate to high due to highly permeable soils.

There are 10 licensed groundwater abstractions recorded at the site (**Table 2.4**).

Table 2.4 Record of Groundwater Abstractions

Abstraction	Type	Use	Location
28/39/36/0058	Groundwater	Process Water	Northrop Road (within site boundary) Gravel aquifer
TH/039/0028/007	Groundwater	Evaporative Cooling, toilet flushing and irrigation	Heathrow Airport (within site boundary) Chalk aquifer
28/39/36/0023	Groundwater	Spray Irrigation, General Farming & Domestic	Home Farm (within site boundary). Gravel aquifer
28/39/31/0144	Groundwater	Spray Irrigation	Mayfield Farm. Within site boundary. Gravel aquifer
28/39/28/0586	Surface water	Supply To A Leat For Throughflow	Stanwell Moor
28/39/28/0301	Surface water	Spray Irrigation	Multiple points: Colne Brook downstream of development, and west of Horton Brook
28/39/28/0520	Surface water	Make-Up Or Top Up Water	Colne Brook downstream of development
28/39/28/0576	Groundwater	Iver South Sewage Treatment	Northwest of site. Chalk aquifer
TH/39/0031/001	Groundwater	(Heathrow Airport)	South of Airport. Gravel aquifer
28/39/31/0185	Groundwater	(Heathrow Airport)	South of Airport. Gravel aquifer

Source: Environment Agency

The regional groundwater flow direction in the River Terrace Deposits is interpreted to be south, towards the River Thames. However, local flow direction across the site may vary due to historical construction.

2.6 Hydrology and Drainage

Four rivers intersect all three zones at the site, all in the western half, flowing from north to south. The most westerly river is the Colne Brook, which bisects the western fringe of the site around Orlitts lake. The next feature is the Wraysbury River which follows the course of the M25 crossing the motorway from east to west in the south western corner of the site. The third water feature is the River Colne. There is a bifurcation to the north of the site between the boundary and the M4, the river then flows 300 m east of the Wraysbury River. The final feature is the Duke of Northumberland's River (DONR) which is a bifurcation of the River Colne. This river flows past the western extremities of Harmondsworth and is then diverted round the western boundary of Heathrow airport. All

[4] Environment Agency (2014) What's in my Backyard - Information in the area of Heathrow. http://environment-agency.gov.uk

four rivers have moderate ecological quality[4]. The River Colne fails on current chemical quality as does the Wraysbury River. According to the EA website the DONR and the Colne Brook do not require assessment[4]. Finally, the Port Land Brook (small brook joining the Colne and DONR) has a Good current chemical quality. All six watercourses hydromorphological status is heavily Modified[4].

There are a number of ponds and lakes, including Orlitts Lake and Colnbrook West in Zone 1. In Zone 3 there are several unnamed ponds associated with in-filled gravel pits.

The development proposals include diversion or culverting of the rivers that intersect the site. Plans for river alterations can be found in **Appendix A, Figure A3**.

There are six active discharge licenses within the site boundary. With one sewage discharge and four trade discharges. Four of the discharges are to rivers/ streams in the area, one is to a county ditch and another to land. Historically there have been a further 20 discharge licences within the site boundary which have been revoked. The location of discharge consents can be found in **Appendix A, Figure A6**.

There have been 11 pollution incidents to controlled water within the site boundary. Five were considered to be significant. The pollutants recorded as being involved are oils, chemicals, inert materials/ waste and miscellaneous pollutants. All incidents are shown in **Figure 2.3**.

2.7 Flooding

The EA[4] website states that at the current time all three zones are partially affected by either a Flood Zone 3 (land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year) or Flood Zone 2 (land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year).

Zone 1 is currently shown as not being at risk from flooding east of the DONR.

Zone 2 is currently shown as having areas in the east categorised as Flood Zone 2 and 3. Areas in the south west of the zone are shown to be benefiting from flood defences.

The south-eastern half of Zone 3 is currently shown as not being at risk from flooding, whereas the north western half is shown as a Flood Zone 2.

2.8 Soils Classification

The MAGIC website[5] indicates that the majority of the soils within the all three Zones are described as freely draining slightly acid loamy soils. The soils in the western half of the three zones are locally described as loamy and clayey floodplain soils with naturally high groundwater.

Based on the MAGIC maps the majority of the proposed development site is designated as non-agricultural land. However there is an area within the south east of Zone 2 and the north east of Zone 3 which is designated Grade 3 agricultural land. There is also an area in the east of Zone 1 which is designated Grade 1 and Grade 2 agricultural land. Development will result in a permanent loss of these resources.

2.9 Sensitive Land Uses

The Envirocheck Report[3] and the MAGIC website[5] indicate that the majority of all three zones are within an adopted greenbelt.

The entire site with the exception of the far western part of Zone 1 and the south eastern half of Zone 3 is located within a Nitrate Vulnerable Zone (NVZ) for surface water[4].

2.10 Land Based Geo-Environmental Risks

The Landmark Envirocheck Report, the EA website and site observations have been used to compile the locations of the following geo-environmental risks associated with the proposed development site:

- Industrial Pollution;
- Radioactive substances;
- Registered Waste Treatment or Disposal Sites; and
- Mining, Landfill and Quarrying.

These have been summarised in **Figure 2.3**.

The Envirocheck reports[3] and the EA website[4] have identified two active landfills and 16 historical landfills within the footprint of the site as detailed in **Figure 2.3** and **Figure A5, Appendix A**. A number of other landfills are also present in the area surrounding the site.

[5] MAGIC (2014) http://magic.gov.uk

504000
506000
508000
178000
176000
174000
N

Legend

Masterplan Site Boundary

Historical Contamination

Hotspot Contamination

- Pollution incident to controlled waters
- Registered waste treatment site
- Historical Mining Site (BGS)
- Industrial Waste Pollution
- Radioactive Pollution Incident
- Registered Radioactive Substance
- Significant Pollution Incident
- Fuel Station

Landfills

Landfill Type; Waste Type

- Active;Household, Commercial, Industrial
- Active;Inert
- Historical;Household, Commercial, Industrial
- Historical;Industrial
- Historical;Inert
- Historical;Inert, Commercial & Household
- Historical;Inert, Industrial, Commercial & Liquids/Sludge
- Historical;Inert, Industrial, Commercial, Household & Liquid
- Historical;Inert, Industrial, Commercial, Household, Special
- Historical;Other
- Historical;Unknown

0 250 500 1,000 Metres

Scale: 20,000 @ A3

Project Path

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Figure 2.3

Geo-environmental site risk map

Based on Environment Agency and Landmark (2014) data plus site observations.

03/04/14
Lee Cutting/George Newman

Mott MacDonald

2.11 Unexploded Ordnance (UXO)

Review of the Zetica Regional Unexploded Bomb Risk Map (**Appendix G**) for West London has shown that the Heathrow area is considered at low to moderate risk from Unexploded Ordnance (UXO). Zetica have reported that the surrounding towns of Hayes, Harlington and Feltham recorded between 189 and 231 high explosive bombs, two parachute bombs and between eight and 24 incendiary bombs. Therefore further assessment is likely to be required.

2.12 Radon

The Envirocheck Report[3] indicates that there is a very low risk to the site from presence of radon as less than 1% of homes are above the action level. No radon protective measures are necessary in the construction of new dwellings or extensions.

2.13 Historical Land Use and Potential Land Contamination

2.13.1 Records from Historical Maps

A series of historical maps[3] of the site have been examined in order to understand the history of the area and identify potential historical contamination sources. Potential contamination sources within each zone are summarised in **Appendix C, Figures C1 – C5**. These maps only show information from the Envirocheck Report[3] and may therefore differ from **Figure 2.3** which also summarises EA data and site observations.

2.13.2 Historical Sources of Contamination

Zone 1

The main potentially contaminating historical land uses identified in the east of Zone 1 include an active landfill, a fire engine house and a road research laboratory (now the Waterside BA central office).

Those identified in the western half of the zone include several landfills (see **Figure 2.3**), gravel pits, sand and ballast works, an energy from waste plant, a disused railway, a fuel station and several large distribution warehouses. See **Appendix C** for further details.

Zone 2

The main potentially contaminating historical land uses identified in Zone 2 are similar to that of Zone 1. In the eastern half of the site the sources identified were a number of warehouses ranging in age and use (mainly distribution), pitting and construction works, two gravel pits and a fuel station.

In the western half of the site, seven landfills were identified (see **Figure 2.3**) and a BPA fuel pipeline site. See **Appendix C** for further details.

Zone 3

The main potentially contaminating historical land uses identified in the north half of the site include three gravel pits, a gravel works (servicing the gravel pits), further works (type unknown), several piggeries and another pit of unknown origin (assumed to be another gravel pit).

In the southern half of the site the potential historical sources identified were several gravel pits and associated works, a fuel station, a fuel depot, several warehouses (use unknown) and large drains associated with one of the warehouses. See **Appendix C** for further details.

3. Assessment of effects

3.1 Phase 1 Contaminated Land Risk Assessment

The primary regulatory regime, under which contaminated land in the UK is managed, is Part II A of the Environmental Protection Act (EPA), 1990, although numerous other subsidiary Regulations are also relevant. This report adopts a strategy for the assessment of potential land contamination based on current guidance documents related to Part II A of the EPA. Particular reference is made to CIRIA Report C552[6] and to the Model Procedures for the Management of Land Contamination (CLR11)[7].

Following the procedures in CLR11, a key element of the Preliminary Risk Assessment is the development of a conceptual model which may be refined or revised as more information and understanding is obtained through the risk assessment process. The conceptual model is described in terms of the contaminant Sources, transport Pathways and possible Receptors that may be present, and the potential 'Pollutant Linkages' between them, as defined in the relevant legislation and guidance. These activities are described in CIRIA C552 as "hazard identification".

3.2 Conceptual Model

Based upon the Sources, Pathways and Receptors (defined in **Appendix E**), conceptual models have been derived for the zones displaying the potential pollutant linkages in the following section.

Schematic representations of these conceptual models are presented below.

The locations of the contamination sources identified are shown in **Figures 2.2 and 2.3**.

A risk estimation and evaluation for the three zones was carried out using the methodology displayed in **Appendix E** and the results displayed in **Appendix F**. A summary of the main potential risks is included below.

3.2.1 Zone 1

The conceptual site models (CSM) for Zone 1 are displayed below. The first CSM identifies potential pollutant linkages currently and during construction, the second CSM identifies potential pollutant linkages during the operational phase of the development.

[6] Construction Industry Research and Information Association (2001) Contaminated Land Risk Assessment – A Guide to Good Practice. CIRIA Report C552

[7] Department for Environment Food and Rural Affairs (Defra) / Environment Agency (2004) Model Procedures for the Management of Land Contamination – Contaminated Land Report 11

Sources:

Current:

S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater,
S2: Made ground related to the construction of any existing buildings
S3: Current industrial estate,
S4: Railway,
S5: Off-site landfills
S6: Presence of roads and associated spills/ leaks from vehicles

Construction Phase:

S7: Potential contamination during construction including spills and leaks from vehicles and storage areas. Potential dust and odour from excavation and construction works.

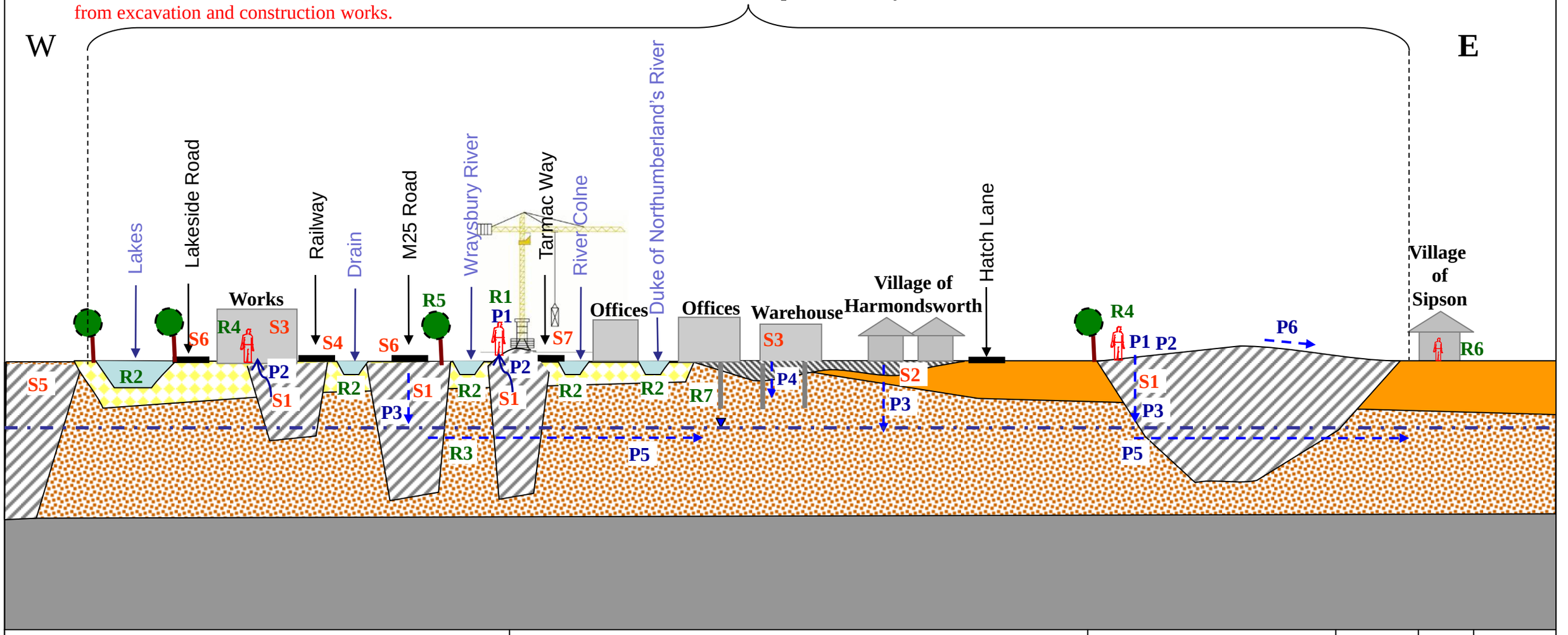
Pathways:

P1: Direct Contact with contaminated soils,
P2: Airborne routes (inhalation of gases, vapours and dust),
P3: Vertical leaching through permeable sub-strata,
P4: Transport through man made pathways (drainage, service conduits, piled foundations),
P5: Horizontal and vertical migration through groundwater,
P6: Surface run-off.

Receptors:

R1: Construction and maintenance workers
R2: Surface water bodies (River and Lakes)
R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.
R4: Site users
R5: Vegetation, planting and landscaping
R6: Off-site residents
R7: Structural and infrastructure materials

Zone 1 – Extent of Proposed Runway



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Client: LHR Airport Ltd

Project: Heathrow Expansion

Key

- Made ground
- Landfill
- Alluvium
- Langley Silt Member
- River Terrace Deposits
- London Clay
- Indicative groundwater level

NOT TO SCALE

Drawn	PLG	01.04.14
Checked	JS	02.04.14
334594/EVT/EES/01/CSM01.ppt	Approved	JD	04.04.14

Title

Figure 3.1: Current and Construction Conceptual Model – Zone 1

Sources:

Operational

S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater,
S2: Made ground related to construction,
S4: Railway,
S5: Off-site landfills.
S10: Potential contamination during operation of the proposed runway including spills, leaks and de-icing activities.

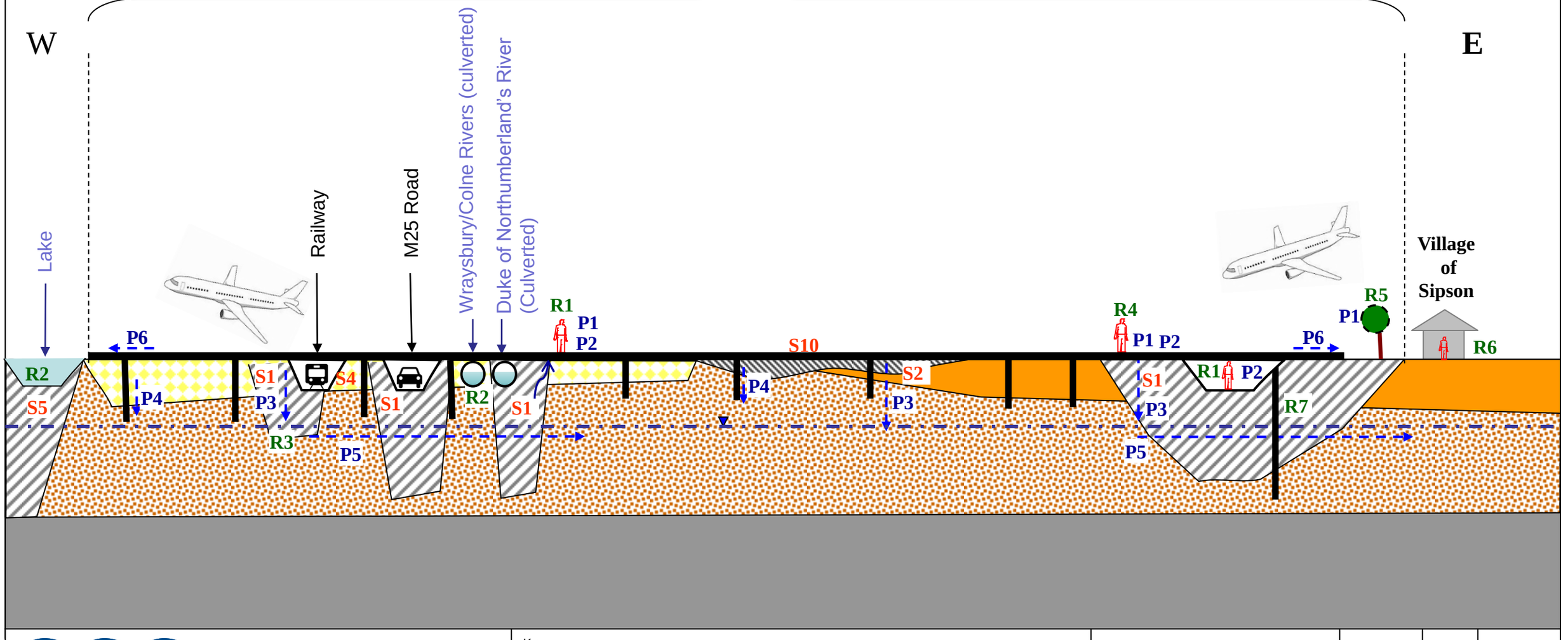
Pathways:

P1: Direct Contact with contaminated soils,
P2: Airborne routes (inhalation of gases, vapours and dust)
P3: Vertical leaching through permeable sub-strata
P4: Transport through man made pathways (drainage, service conduits, piled foundations)
P5: Horizontal and vertical migration through groundwater
P6: Surface Run-off

Receptors:

R1: Construction and maintenance workers
R2: Surface water bodies (River and Lakes)
R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.
R4: Site users
R5: Vegetation, planting and landscaping
R6: Off-site residents
R7: Structural and infrastructure materials

Zone 1 – Extent of Proposed Runway



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United Kingdom

Key

- Made ground
- Landfill
- Alluvium
- Langley Silt Member
- River Terrace Deposits
- London Clay
- Indicative groundwater level

NOT TO SCALE	Drawn	PLG	01.04.14
	Checked	JS	02.04.14
334594/EVT/EES/01/CSM01.ppt	Approved	JD	04.04.14

Client: LHR Airport Ltd

Project: Heathrow Expansion

Title

Figure 3.2: Operational Conceptual Model – Zone 1

Summary of Zone 1 Preliminary Phase I Risk Assessment

Human Health Risks

The risks posed to site users and off-site residents are currently considered to be low. The main potential risks relate to presence of landfills beneath the site and either direct contact or ground gas migration pathways. Current risks are assessed as low as the majority of landfilled areas are open ground and used for recreation. Other sources are unlikely to present a risk to human health.

During the construction phase, construction workers are likely to come into direct contact with contaminated made ground, particularly in areas of landfill and areas of excavation, tunnelling and levelling. However risks to construction and maintenance workers have been assessed as low, assuming that appropriate Personal Protective Equipment (PPE) will be used during intrusive works, monitoring of dust and vapour will be completed during the works and good hygiene will be used as appropriate. Risk to off-site residents is considered to be moderate, given the scale of the development and the disturbance of landfill materials associated, it is likely that dusts and odours may be produced. This will be managed during construction through adherence to a comprehensive Construction Environmental Management Plan.

Site users are not considered in the construction stage with regards to direct contact as it is assumed that the site access will be restricted to construction workers.

A low risk to human health during the operational phase will be associated with any underground structures e.g. tunnels and potential presence of ground gas based on the assumption that appropriate ground gas mitigation measures and ventilation if required will be installed during construction.

Environmental Risks

Currently it is considered that there is a high risk to the Principal aquifer within the RTD and Secondary aquifer in the Alluvium, associated with presence of historical landfills and transport via vertical leaching and/ or horizontal migration through groundwater. The construction of the landfills is unknown and it is likely that the RTD and Alluvium have been removed in these areas, therefore the risk is to groundwater beneath adjacent land. There is considered to be a low risk to surface water bodies, from migration of groundwater, however it is likely that some of the lakes and reservoirs are lined in this area. Other risks posed to surface water bodies are considered to be low. Risk to vegetation, planting and landscaping is considered to be low, with many of the landfills already vegetated with no obvious negative effects noted during the site walkover.

Risks during construction are assessed as moderate to low and mainly relate to creation of pathways due to potential piling and drainage, and potential spills and leaks from equipment. It is considered that these risks can be managed and mitigated by ensuring good construction practice through use of a Construction Environmental Management Plan.

During operation due to the site use as a runway, spills, leaks and de-icing are likely to pose the greatest risk of contamination. However, recycling of de-icer materials will be undertaken as part of plans to more effectively

manage de-icer use on the airport. Risk to surface water bodies can be mitigated by use of appropriate drainage[8]. Rivers will have been either culverted or diverted off site.

Structure and Infrastructure Materials

Risks posed to structure and infrastructure materials are moderate at all stages due to potential contamination within the made ground beneath the site. It is assumed that the construction and operational stages will introduce mitigation measures and appropriate design to reduce the risk posed to materials.

For more information on proposed mitigation measures resulting from the risk assessment please see **Chapter 5**.

3.2.2 Zone 2

The CSM for Zone 2 are displayed below. The first CSM identifies potential pollutant linkages currently and during construction, the second CSM identifies potential pollutant linkages during the operational phase of the development.

[8] AMEC (2014) Sustainable Drainage Assessment

Sources:

Current

S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater
S2: Made ground related to the construction of existing buildings
S8: Fuel station, potential underground fuel tanks
S9: Oil / gas Pipeline
S3: Commercial/industrial use
S6: Presence of existing roads and associated spills/ leaks from vehicles

Construction Phase:

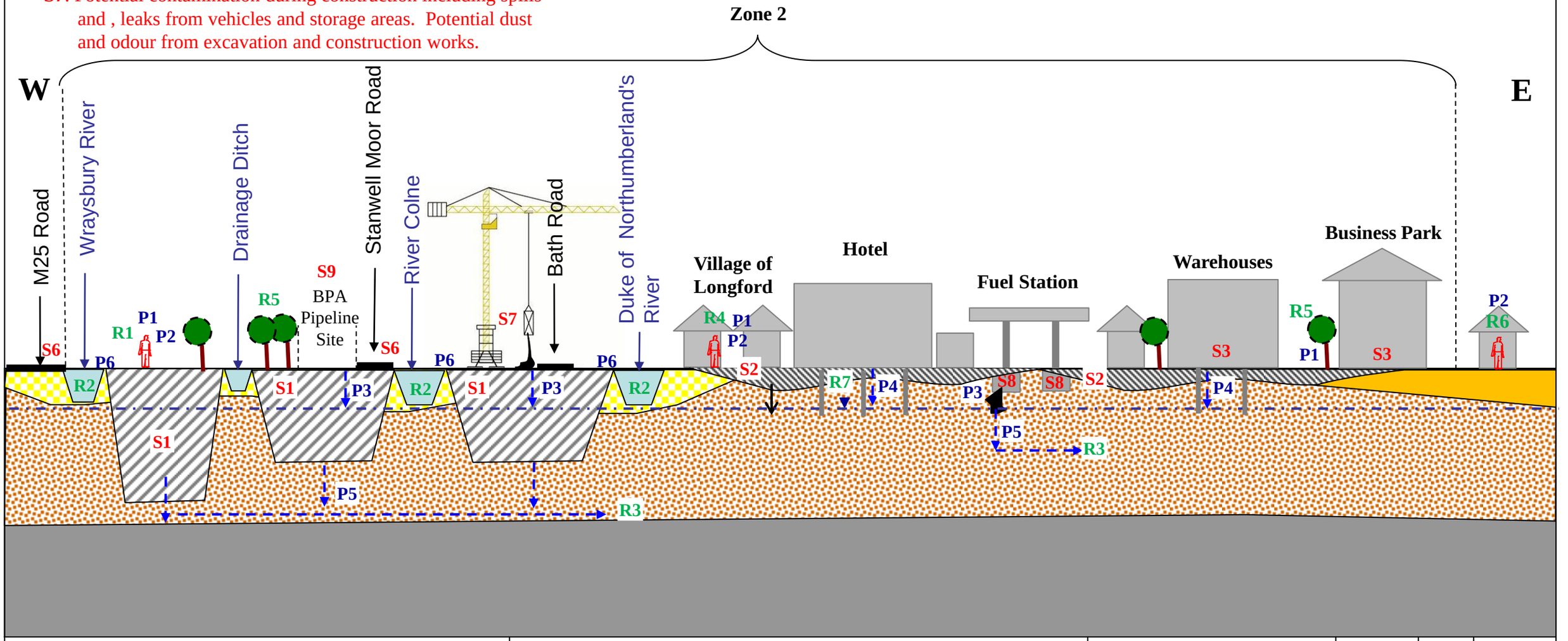
S7: Potential contamination during construction including spills and , leaks from vehicles and storage areas. Potential dust and odour from excavation and construction works.

Pathways:

P1: Direct Contact with contaminated soils,
P2: Airborne routes (inhalation of gases, vapours and dust)
P3: Vertical leaching through permeable sub-strata
P4: Transport through man made pathways (drainage, service conduits, piled foundations)
P5: Horizontal and vertical migration through groundwater
P6: Surface run-off

Receptors:

R1: Construction and maintenance workers
R2: Surface water bodies (Rivers and Lakes)
R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.
R4: Site users
R5: Vegetation, planting and landscaping
R6: Off-site residents
R7: Structural and infrastructure materials



Key

- Landfill
- Alluvium
- Langley Silt Member
- River Terrace Deposits
- London Clay
- Indicative groundwater level

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Client: LHR Airport Ltd

Project: Heathrow Expansion

NOT TO SCALE

Drawn	GN	31.04.14
Checked	JS	01.04.14
334594/EVT/EES/01/CSM02.ppt	Approved	JD	04.04.14

Title

Figure 3.3: Current and Construction Conceptual Model – Zone 2

Sources:

Operational

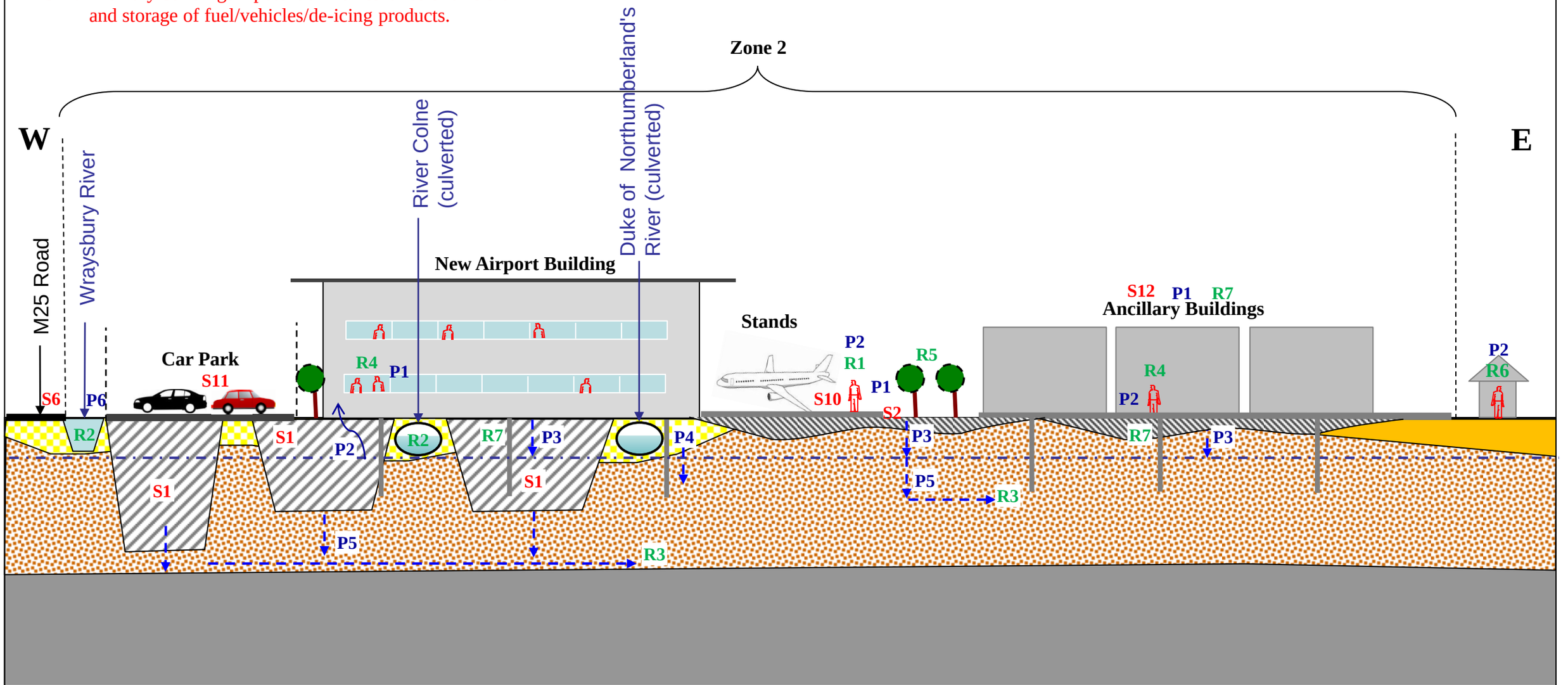
S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater,
S2: Made ground related to construction
S6: Presence of existing roads and associated spills/ leaks from vehicles
S10: Airport activities including airport stands, fuelling, loading, de-icing.
S11: Car park – spills and leaks from vehicles.
S12: Ancillary buildings – potential maintenance of aircraft and storage of fuel/vehicles/de-icing products.

Pathways:

P1: Direct Contact with contaminated soils,
P2: Airborne routes (inhalation of gases, vapours and dust)
P3: Vertical leaching through permeable sub-strata
P4: Transport through man made pathways (drainage, service conduits, piled foundations)
P5: Horizontal and vertical migration through groundwater
P6: Surface run-off

Receptors:

R1: Construction and maintenance workers
R2: Surface water bodies (River and Lakes)
R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.
R4: Site users
R5: Vegetation, planting and landscaping
R6: Off-site residents
R7: Structural and infrastructure materials



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Title

Figure 3.4: Operational Conceptual Model – Zone 2

Summary of Zone 2 Preliminary Phase I Risk Assessment

Human Health Risks

Risks present in the current stage remain the same as for Zone 1.

Construction phase risks are greater for Zone 2, given that proposed site use includes several new buildings, including a new large terminal building.

Operational risks to end users mainly relate to migration of ground gas from the on-site landfills and potential accumulation within the buildings and any confined spaces such as tunnels, infrastructure and underground structures. Mitigation measures will be implemented at design and construction stages which may include ground gas protection measures and ventilation.

Environmental Risks

Risks posed to environmental receptors in Zone 2 are assumed to be the same as Zone 1 in all three phases, with the following exceptions: Zone 2 has a higher development density than Zone 1 and may include larger excavation works including foundations and tunnelling. Mitigation relating to piling and drainage will be required to protect groundwater resources. There is a higher likelihood of spills related to aircraft at stands when fuelling and de-icing or in aircraft maintenance buildings, if present. Recycling of de-icer materials will be undertaken as part of plans to more effectively manage de-icer use on the airport and will reduce this risk.

Structure and Infrastructure Materials

Risks to materials are the same as Zone 1. However, as there are more structures proposed for Zone 2 there is a greater chance that these structures could come into contact with contamination. These risks will be mitigated through ground investigation and design.

3.2.3 Zone 3

The CSM for Zone 3 are displayed below. The first CSM identifies potential pollutant linkages currently and during construction, the second CSM identifies potential pollutant linkages during the operational phase of the development.

Sources:

S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater,
S2: Made ground related to the construction of existing buildings
S3: Industrial estate
S13: Quarry
S5: Off-site landfills

Construction Phase:

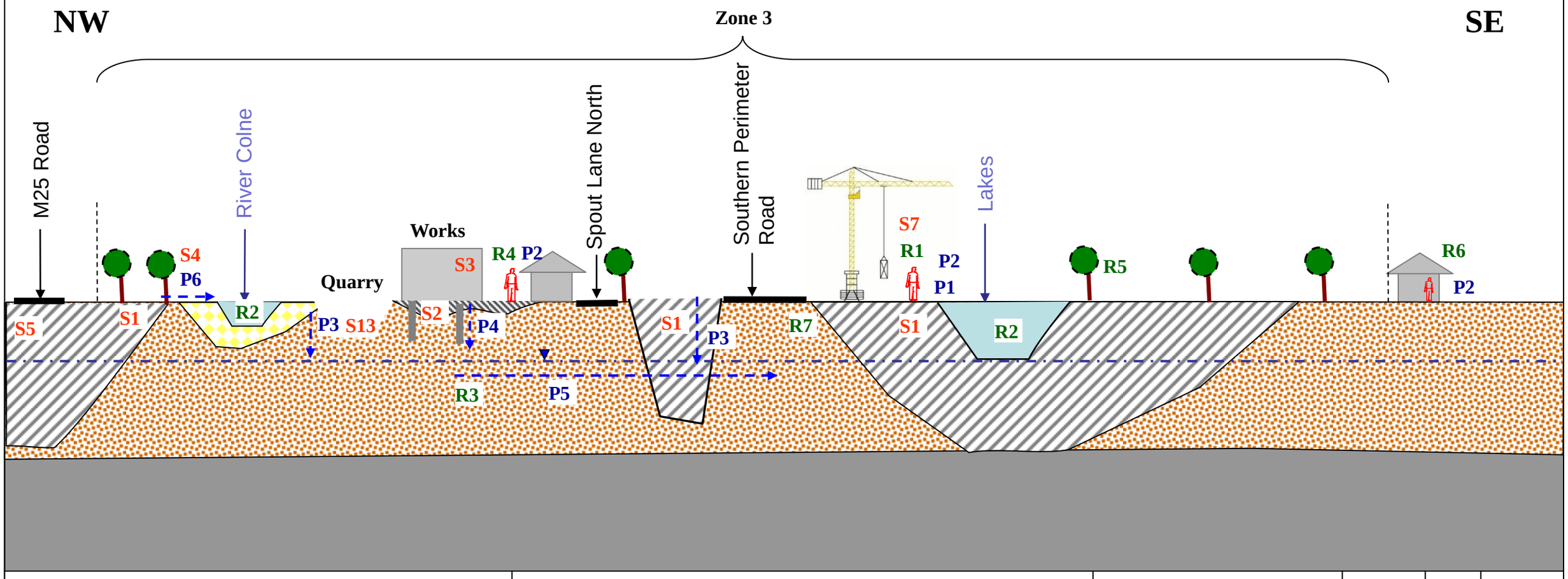
S7: Potential contamination during construction including spills and , leaks from vehicles and storage areas. Potential dust and odour from excavation and construction work.

Pathways:

P1: Direct Contact with contaminated soils
P2: Airborne routes (inhalation of gases, vapours and dust)
P3: Vertical leaching through permeable sub-strata
P4: Transport through man made pathways (drainage, service conduits, piled foundations)
P5: Horizontal and vertical migration through groundwater
P6: Surface Run-off

Receptors:

R1: Construction and maintenance workers
R2: Surface water bodies (rivers and lakes)
R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.
R4: Site users
R5: Vegetation, planting and landscaping
R6: Off-site residents
R7: Structural and infrastructure materials



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Client: LHR Airport Ltd

Project: Heathrow Expansion

Title

Figure 3.5: Current and Construction Conceptual Model– Zone 3

Sources:

Operational

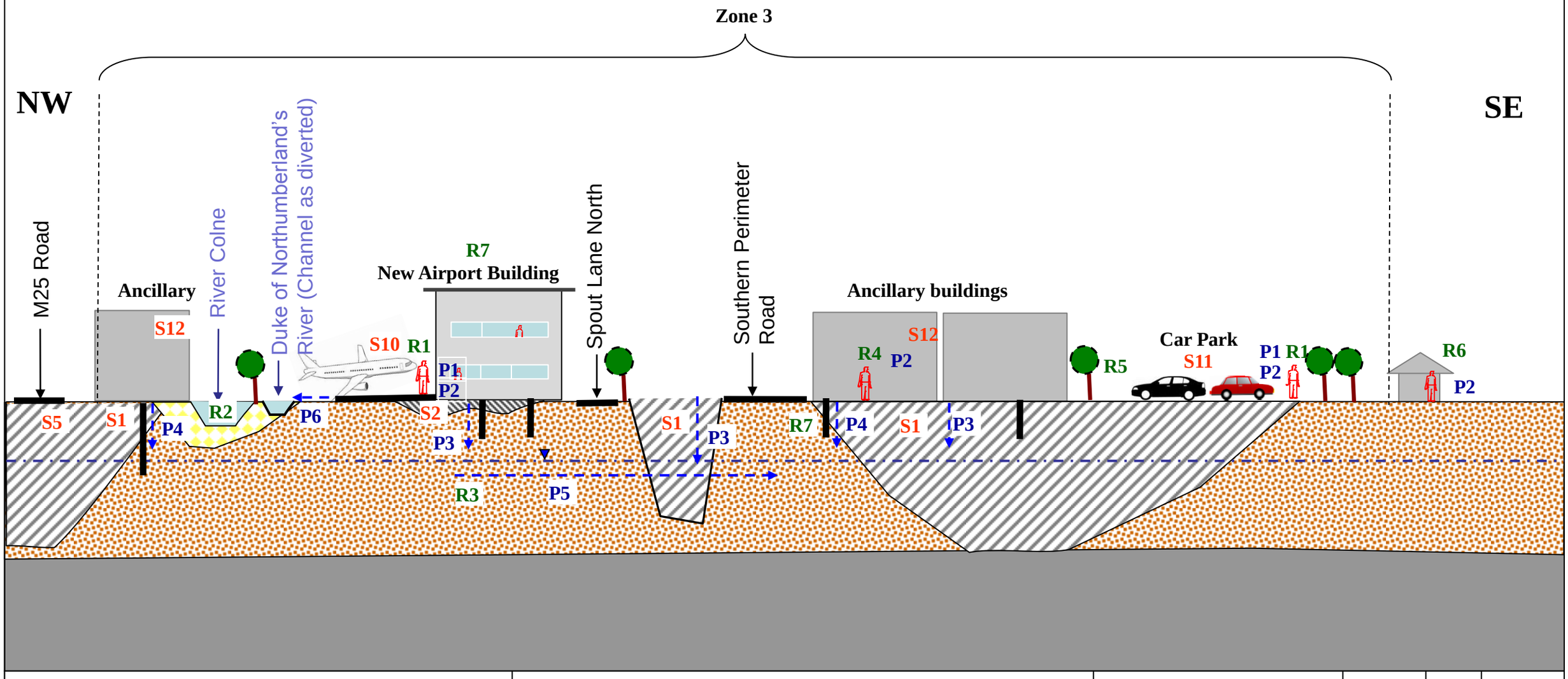
S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater,
S2: Made ground related to construction,
S5: Off-site landfills,
S10: Airport activities including airport stands, fuelling, loading, de-icing.
S12:Ancillary buildings – potential storage of fuel/vehicles/de-icing products,
S11: Car park – spills and leaks from vehicles.

Pathways:

P1: Direct Contact with contaminated soils,
P2: Airborne routes (inhalation of gases, vapours and dust)
P3: Vertical leaching through permeable sub-strata,
P4: Transport through man made pathways (drainage, service conduits, piled foundations),
P5: Horizontal and vertical migration through groundwater,
P6: Surface run-off

Receptors:

R1: Construction and maintenance workers
R2: Surface water bodies (Rivers and Lakes)
R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.
R4: Site users
R5: Vegetation, planting and landscaping
R6: Off-site residents
R7: Structural and infrastructure materials



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334594/EVT/EES/01/CSM03.ppt	Approved	JD	04.04.14

Title

Figure 3.6: Operational Conceptual Model – Zone 3

Summary of Zone 3 Preliminary Phase I Risk Assessment

Human Health Risks

Risks present in the current and construction stage remain the same as for Zone 1 and 2.

Operational phase risks are similar to Zone 2, given that proposed site use includes several new buildings, presenting the potential for ground gas risk, this will be mitigated through appropriate design and ventilation if required.

Environmental Risks

Risks posed to environmental receptors in Zone 3 are assumed to be from de-icing, spills from any aircraft maintenance buildings (if present), fuel spills from the fuel depot. However, recycling of de-icer materials will be undertaken as part of plans to more effectively manage de-icer use on the airport.

Structure and Infrastructure Materials

Risks to materials are the same as Zone 2.

4. Mitigation Strategy

In order to manage and minimise the risks identified in **Section 3**, mitigation measures can be applied to the construction and operational phases of the development. It is assumed that the mitigation will be undertaken through design rather than remediation of contaminated land due to the extensive area of landfill present and associated treatment and disposal costs. The recommended mitigation measures are presented in the table below and should be confirmed following completion of finalised development proposals, confirmation of foundation design, location of landscaped areas, river diversions and flood storage areas.

Table 4.1 Mitigation Measures

Mitigation	Objectives	Zone requiring mitigation	Additional Information Required to inform mitigation
Gas protection measures for buildings and confined spaces (if constructed over former landfills/ ground gas sources)	Protection of the site end-site users from ground gas sources	Zone 2 and 3 due to location of buildings. Zone 1 if underground tunnels/ structures/ infrastructure are required.	Geo-environmental ground investigation including comprehensive ground gas monitoring is required to identify the ground gas regime in areas of proposed development and to appropriately design the gas protection measures. Finalised development proposals will also be needed to design the ground investigation.
Materials re-use (and appropriate Permitting)	Re-use of materials on site (where possible) and reduction of material sent to landfill.	All zones particularly in areas of levelling, excavation, tunnelling.	Comprehensive geo-environmental ground investigation is required to identify the quality of the materials present below the footprint of the site and especially the material potentially to be excavated during the construction works. Consultation with the regulators will be necessary for the preparation of permit application. Permitting will require substantial time inputs for undertaking discussions with regulators and preparation of permit applications. Materials re-use may not be possible in areas of contaminated made ground but pre-treatment and segregation could reduce volume for landfill.
Foundation Works Risk Assessment	Avoid/ reduce environmental impacts to groundwater and human health from deep foundation works. Obtain approval for the works from the EA.	All areas where piled foundations are required.	Geo-environmental and geotechnical ground investigation is required to obtain a better understanding of the geology underneath the site and the quality of the soils and groundwater. Discussions with the geotechnical team will be required to assess the requirement (or not) for piled foundation solutions for the buildings/ runway/ infrastructure.
Engineered drainage with spill capture.	Manage spills and drainage during operational processes.	All zones.	To be undertaken during the detailed design phase by drainage specialists.

Table 4.1 (continued) Mitigation Measures

Mitigation	Objectives	Zone requiring mitigation	Additional Information Required to inform mitigation
Infiltration drainage (for unimpacted surface and roof runoff only) only through unworked ground with no significant contamination	Manage unimpacted surface and roof runoff	Mainly Zone 2 and 3, just runway in Zone 2.	Undertake soakaway testing as part of a larger geotechnical and geo-environmental ground investigation. Obtain regulatory approval.
Use correct materials in the construction of any potable water pipes and other structures.	Avoid contamination of potable water and degradation of construction materials.	All zones	Geo-environmental ground investigation information needed to assess soil and groundwater quality and therefore appropriate construction materials.
Ensure appropriate H&S measures during construction. Including but not limited to use of appropriate Personal Protective Equipment, Respiratory Protective Equipment, confined spaces working, good site hygiene etc)	Reduce risks to construction workers from contact with contaminated soils and groundwater, dust and gas/ vapours.	All zones	Geo-environmental ground investigation information needed to be obtained to inform the level of PPE required. Monitoring may be required during construction works (dust and vapours)
Construction Environmental Management Plan (including but not limited to dust suppression, odour management, environmental monitoring, storage of materials, management of surface water and runoff etc).	Reduce risks to human health (on and off-site residents/ users) and the environment during the construction phase.	All zones	Monitoring at the site boundaries may be required to assess and manage risks to off-site residents.
Undertake environmental monitoring during the construction phase.	Monitor risks to environmental and human health receptors during construction.	All zones	Groundwater, surface water and ground gas data will be required to set a baseline, followed by regular monitoring during construction and for several months following completion. The scope and frequency of the monitoring will require agreement of the EA.
Manage waste appropriately during construction	Waste will be produced during construction from excavation of tunnels, foundations, levelling of areas and river diversions. Waste disposal quantities and costs will be informed by the geotechnical and surface water teams and potentially the contractors during site works. This is likely to represent a considerable cost.	All zones	A number of initial assumptions have been made to inform preliminary costings. However ground investigation data will identify the quality of the materials and the potential waste disposal category.
Environmental Management Plan for Operational Phase (including spill procedures/ capture, fuel storage, contained de-icing, drainage)	Limit environmental impact during the operational phase	All zones	The operator will complete this based upon their proposed use of each area of the site.
Undertake environmental monitoring during the operation phase.	Monitor environmental risk during operational phase	All zones	Methods of monitoring to be included in the Environmental management plan put together by the operator.
Complete a materials management plan for the site works which would include procedures for sustainable use of soils on site where possible. Compensation may be required for the loss of grade 1 or 2 agricultural soils.	Mitigate the loss of valuable agricultural soils (category 3b, 2 and 1) beneath the footprint of the proposed link road	All zones	Finalised development plans.

5. Conclusions

The main potential sources of contamination at the site are the 13 historical and two current landfills on site. Given the number of landfills, the type of waste present and uncertainty over the landfill construction, it is likely that that the Principal aquifer in the RTD has historically been impacted by leaching contaminants from these landfills. There is also a possibility that surface water features have been impacted given their proximity to the landfills in some areas of the three zones. The landfill sites may also be a source of ground gas, dependent upon the waste composition, which could pose a risk to both construction workers and site end users in areas of enclosed buildings or confined spaces (tunnels, underground structures etc.).

In the current condition, prior to mitigation measures, there are anticipated to be moderate to low risks to current site users (those spending a considerable proportion of their time on site, residents and workers) and low risks to off-site residents.

During the construction phase, risks to construction and maintenance workers are considered to be low based on the assumption that, as is standard practice, the workers will be wearing suitable PPE, adopt best-practice site hygiene procedures and comply with site health, safety and environmental management plans. On site monitoring may also be required to manage the risks to human health including dust from construction and excavation and ground gas and vapour monitoring due to presence of landfills. There is the potential for unexpected contamination to be present at the site, and consideration should be given to this risk in completion of a Construction Environmental Management Plan. As the development will be undertaken on mainly brownfield land the development will result in an improvement to high-value commercial land.

The main risks to environmental receptors during the construction phase of the proposed development relate to spills and leaks from equipment and plant. During operation, the main environmental risks relate to spills, leaks and de-icing operations. If these risks are mitigated by use of a Site Environmental Management Plan including emergency response procedures, appropriate drainage and environmental monitoring, the risk is considered to be low.

Risks to human health during the operational phase assume that appropriate design, including ground gas protection measures and ventilation, are incorporated during construction. The main environmental risk is from de-icing of the runway and stands and from potential leaks and spills. Recycling of de-icer materials will be undertaken as part of plans to more effectively manage de-icer use on the airport. Generally lower risks have been identified during the operational phase due to re-development of brownfield land.

Recommendations for mitigation measures have been included in **Section 4** of this report. These recommendations should be reviewed following completion of finalised development proposals, confirmation of foundation design, location of landscaping, river diversions and flood storage areas.

Appendix A
Figures and Drawings

504000
506000
508000
510000

178000
176000
174000
172000

N

Legend

Masterplan Site Boundary

0 250 500 1,000 1,500 Metres

Scale: 20,000 @ A3

Project Path

Heathrow
Making every journey better

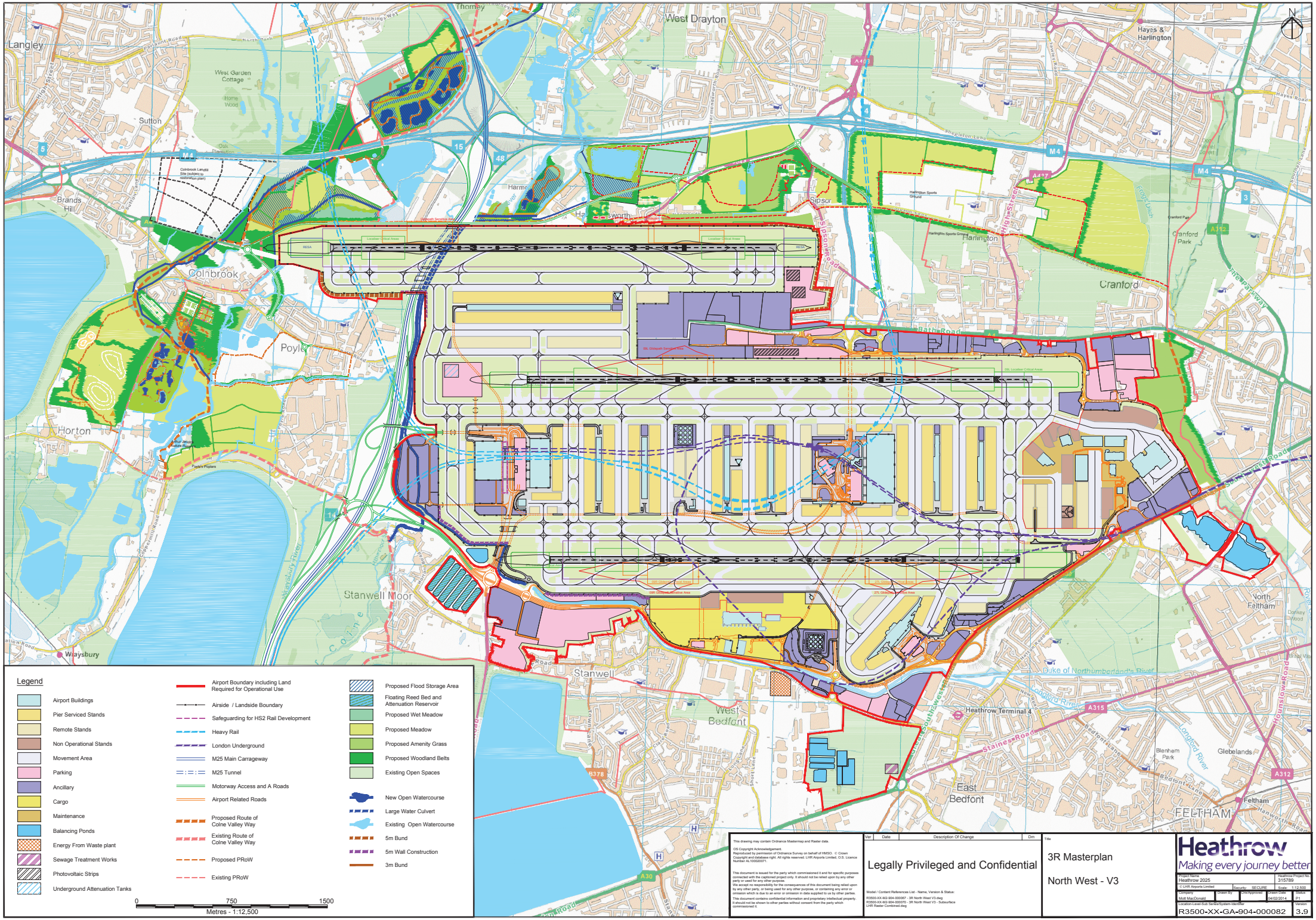
Geo-Environmental Desk Study

Appendix A1

Existing Site Map

03/04/14
Lee Cutting/George Newman

Mott MacDonald



Ver	Date	Description Of Change	Dm

Legally Privileged and Confidential

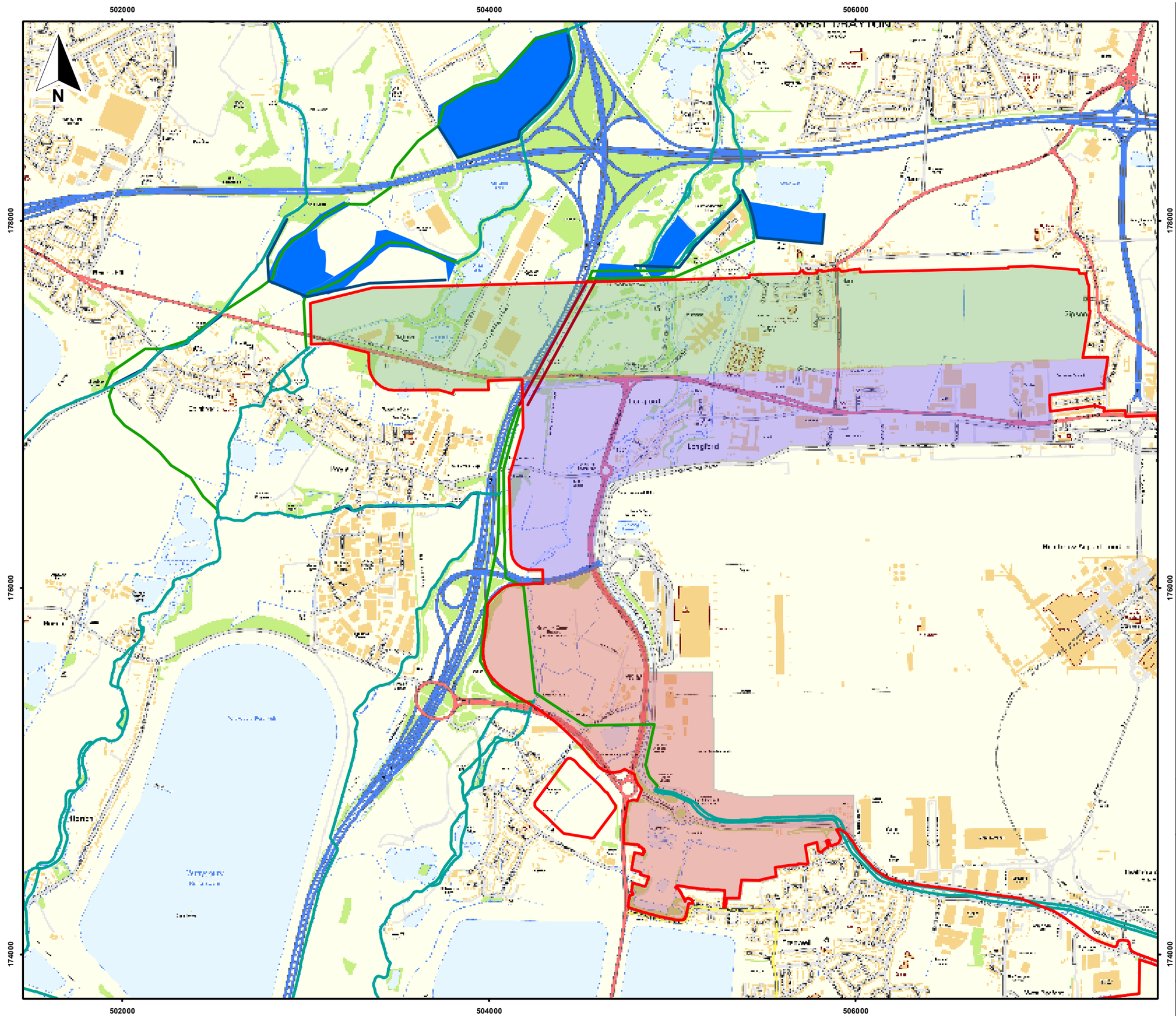
Model / Content References List - Name, Version & Status:
R3500-XX-M2-904-000067 - 3R North West V3.dwg
R3500-XX-M2-904-000070 - 3R North West V3 - Subsurface LHR Raster Combined.dwg

Title: 3R Masterplan

North West - V3

Heathrow
Making every journey better

Project Name: Heathrow 2025			Heathrow Project No: 315789
© LHR Airports Limited		Security: SECURE	Scale: 1:12,500
Company: Matt MacDonald	Drawn By	Chk/Approved	Drawn Date: 04/02/2014
			Status: P1
Location Level Sub Series/System Identifier: R3500-XX-GA-904-000082			Version: 3.9



Legend

- Masterplan Site Boundary
- Flood bund lines
- Existing rivers
- Culvert
- Channels
- Channel modification
- Flood storage areas

Zones

Zone Number

- Zone 1
- Zone 2
- Zone 3

0 250 500 1,000 Metres

Scale: 20,000 @ A3

Project Path

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Geo-Environmental Desk Study

Appendix A3

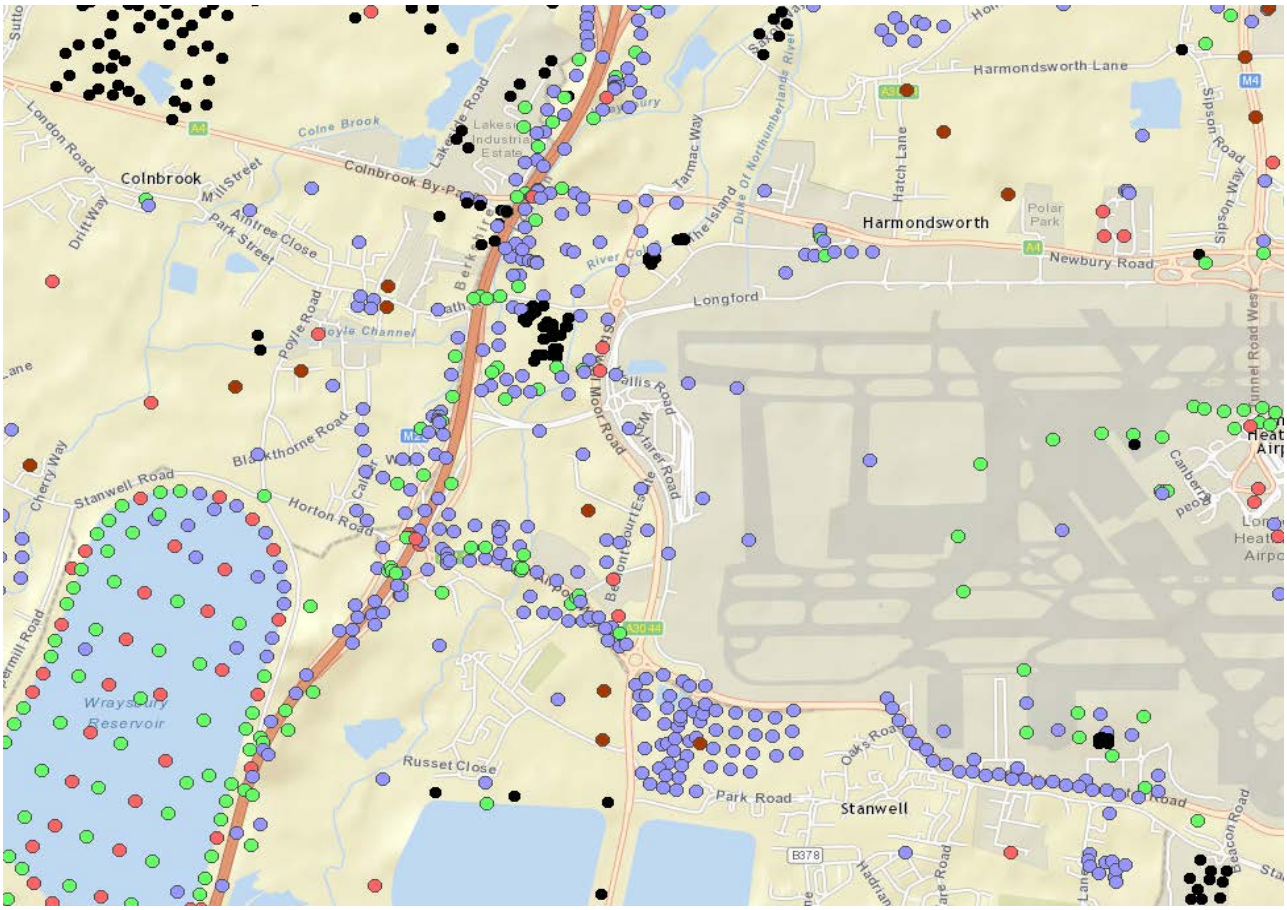
Proposed Watercourse Alterations

03/04/14
Lee Cutting/George Newman

Mott MacDonald

Figure A4 BGS Borehole Logs Locations and Scans

Borehole scans in the area of Heathrow



Key:

- = 0 – 10m
- = 10 – 30m
- = 30+m
- Confidential
- Unknown

Source: BGS Geology Viewer 2014[9]

[9] British Geological Survey (2014) Borehole Scans in the area of Heathrow
http://mapapps.bgs.ac.uk/geologyofbritain/home.html?mode=boreholes

2.

269/25

TQ07/99

A-C

(b) Drift	...	...	10	10
LC) RB) Ck)	...	...	c.277	c. 287
? UGS) G	...	...	c.784	c.1071
LGS	...	...	c.120	c.1191
ORS	...	...	c. 14	c.1205
	...	...	c. 3	1208

Drift 10'

L.C & R.B. c 277'

CK & ?U.G.S. c. 784'

Gault c.120'

L.G.S. c.14'

O.R.S. c.3'

Surface Soil	10	0	10	0
London Clay	220	0	230	0
Thanet Sand	57	0	287	0
Chalk and Flint	373	0	660	0
Marl	411	0	1071	0
Gault	120	0	1191	0
Lower Greensand	14	0	1205	0
Red clay & sandstone	3	0	1208	0

(c)

Drift 24½	Brown Clay	4	-	4	-
	Gravel and Clay	1	-	5	-
	Coarse Sand and Gravel	13	6	18	6
	Clay and Gravel	6	-	24	6
LC 170½	Blue Clay and Clay Stones	146	6	171	-
	Sandy Clay	24	-	195	-
	Mottled Clay	27	-	222	-
	Sandy Clay	6	-	228	-
	Sand	7	-	235	-
RB 78	Sand and Clay in bands	5	-	240	-
	Clay with sandy bands	12	-	252	-
	Mottled Clay with sandy streaks	15	-	267	-
	Conglomerate	6	-	273	-
UCh 327	Chalk and Flints	261	-	534	-
	Hard Grey Chalk	6	-	540	-
	Hard putty Chalk	60	-	600	-

TQ07 NE 67

Contract : IMMIGRATION DETENTION CENTRE
Client : J.A.FAIRHEAD
Coordinates : TQ 0530 7720
Dates : 20/02/91

Job Number : G/0753
Trial Pit No.: 1
Location : HARMONDSWORTH

Dimensions : 2.3 x 0.6m
Ground Level :

Red. Level	Description	Depth m.	Samples Taken	In-Situ Tests	Legend	Diagram
	Turf underlain by Topsoil - Soft to firm, dark brown, silty CLAY with occasional gravel	0.00				
		(0.35)				
	MADE GROUND - Black sandy gravel pavement course underlain by rubble fill comprising bricks & boulder-sized concrete blocks	0.35				
		(0.45)				
	Firm, orange-brown, friable, silty CLAY with occasional fine gravel & rare rootlets	0.80				
		(0.30)				
	Soft, brown, friable, very silty CLAY with occasional fine gravel grading into :-	1.10				
		(0.70)				
	Soft, mottled grey/orange-brown, fissured, very silty CLAY with some fine to coarse (becoming coarser with depth) gravel. Becoming very soft towards base	1.80				
		(1.00)				
	Dense, reddish-brown, slightly clayey, sandy, fine to coarse, subangular to subrounded GRAVEL (Taplow Gravel)	2.80				
		(0.40)				
	End Of Trial Pit	3.20				

Key:

Sample Types:
U Undisturbed
D Disturbed
B Bulk Disturbed
W Water
P Piston
J Jar
T Thin Wall
✱ No Recovery

In-Situ Tests:
SPT SPT Value
CPT CPT Value
pp Pocket Penetrometer
m/c Moisture Content %

General Remarks :
Water seepage at 3.0m rising to 2.6m after 3 hours. Pit remained vertical & stable except slight caving in the gravels below water level. Density of gravels assessed from excavation workrate.

Equipment and Methods:
JCB 3c Excavator

Scale : 5m/sheet
Sheet No. 1 Of 1.
Depth 0 to 5 metres.

Engineer : N.J.CRAWFORD
Appendix : 1
Figure No. : 1

REF: 8839

DATE: April 1988

RIG: Shell & Auger

DIAM: 150 mm

BOREHOLE LOG

TQ07NE 88

No. 10

070-775

LOCATION: HOLLOWAY LANE

GROUND LEVEL:

DESCRIPTION OF STRATA	CHANGE OF STRATA			SAMPLES			WATER LEVEL		S.P.T / C.P.T / N-VAL
	LEGEND	DEPTH (m)	REDUCED LEVEL	REF:	DEPTH (m)	TYPE	Struck (m)	Standing (m)	
TOPSOIL			0.3						
Firm brown CLAY		1.0		1	1.0	B			
		2.0	2.1	2	2.0	B			
SAND & GRAVEL		3.0		3	3.0	B			
		4.0		4	4.0	B			
		5.0		5	5.0	B	4.9		
		6.0		6	6.0	B			
		7.0		7	7.0	B			
		8.0	7.9						
Firm brown laminated CLAY		9.0	9.4						
Firm blue laminated CLAY		10.0							
		11.0	11.0	8	11.0	B			

D. K. SYMES ASSOCIATES

Mineral Planning & Development Consultants

44 NORTH BAR, BANBURY, OXON OX16 0TH

0295 - 61542/3

Norwest Holst Soil Engineering Ltd.

Trial Pit No. **724**

Contract No. F9046 (PART 1)
Location HEATHROW S A S
Client HEATHROW AIRPORT LTD.
Excavation Plant JCB 3CX
Dimensions (l x b x h) 2.00 x 1.00 x 2.20m

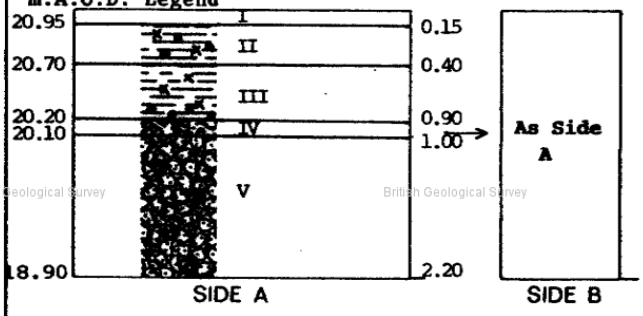
TRIAL PIT LOG

Sheet 1 of 1

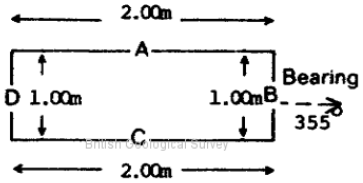
TQ07NW 164

Co-ords E504432 N176192
Ground Level 21.10 m.A.O.D.
Date 13/4/91

ELEVATIONS:—



PLAN (Not to scale)



SAMPLES

No. & Type	Depth m.
D	0.50
D	1.00
B	1.00
D	1.50
D	2.00
B	2.00

MEXIPROBE at 0.50m
CBR readings at 75mm penetration

Position	1	2	3	4	5
→	0.1	0.2	0.1	0.1	0.2
	0.3	0.3	0.3	0.3	0.3
	0.5	0.5	0.4	0.3	0.5
	0.8	0.6	0.5	1.0	0.7
	4.5G	1.0G	5.5G	6.5G	2.0
	>15G	>15G	5.5G	>15G	10G
			5.5G		>15G
			>15G		

As Side A

SIDE C

As Side A

SIDE D

G = Reading affected by gravel.

No.	Depth m.	STRATA DESCRIPTION	Cv kN/m²
I	0.00–0.15	Soft brown friable sandy clay TOPSOIL with many roots and rootlets and rare fine to coarse subangular to rounded flint gravel.	HAND VANE at
II	0.15–0.40	Soft brown mottled orange friable silty CLAY with some root penetration and rare fine to coarse subangular to rounded flint gravel. (ALLUVIUM)	
III	0.40–0.90	Soft light grey brown with indistinct orange brown laminations very silty CLAY with occasional gastropod shells and with occasional root penetration to 0.80m ...below 0.80m with occasional to some fine to coarse subangular to rounded flint gravel. (ALLUVIUM)	at 0.50m 10 18 16 15
IV	0.90–1.00	Loose grey brown slightly clayey silty SAND and fine to medium subangular to subrounded flint GRAVEL. (TERRACE GRAVEL)	19 17
V	1.00–2.20	Loose brownish slightly clayey sandy fine to coarse subangular to subrounded flint GRAVEL with occasional flint cobbles. Pit terminated at 2.20m due to very slow penetration. (TERRACE GRAVEL) Backfilled on completion.	16 17 20

NOTES Cv · Approximate value of undrained shear strength from hand vane
Groundwater: Strike at 0.90m. Rising to 0.90m immediately
Pumping: None
Supports/Stability: None / Collapsing in strata IV & V continuously all sides.

TQ 07 NE/308 0556 7697

Sampling

Depth	Type	Casing	Shift	N/(Cu)
0.00			13/10	
0.40-0.80	B			
1.20-1.55	CB	1.15		49/ 225
2.70-3.05	CB	2.70		50/ 190
3.60	W			
4.20-4.65	CB	4.10		55
5.10-5.55	SD	5.00		23
6.10-6.55	U	5.60		(119)
6.60	D			
7.10-7.55	SD	5.60		19
8.10-8.55	U	5.60		(191)
8.60	D			
9.10-9.55	SD	5.60		21

Strata

Description	Depth	Level
	G.L.	24.30
MADE GROUND: Firm mid to dark brown silty sandy CLAY with some to much brick, concrete and flint gravel and occasional cobble sized fragments of concrete.	0.85	23.45
Very dense mid orange brown clayey fine to mainly coarse SAND and fine to coarse sub-angular to rounded flint GRAVEL. Sand and gravel proportions variable. (Terrace Gravels)		
At depth - with some pockets of orange brown clay.		
Firm to stiff highly fissured mid brown and orange brown mottled silty to very silty CLAY. Structure disturbed. (London Clay)	5.00	19.30
Very stiff very closely fissured dark grey very silty CLAY with some black silt pockets and partings of mid grey silt. Indistinctly laminated in partings. (London Clay)	5.40	18.90
At top of stratum as gravel sized lithorelics in a clay matrix.		
At 8.60m - occasional claystone fragments and with fine pyrite crystals on partings.		

Legend

Drilling

Type	From	To	Size	Fluid
Cable Tool	0.00	15.00	0.15	

Groundwater

Co-ordinates:

Ground Level: 24.30m AOD

Struck	Behaviour	Sealed	Date	Hole	Cased	Water
	Groundwater encountered at 3.60m					

Remarks Water added to assist boring in gravels.
Borehole backfilled on completion.

Borehole Record

Exploration Associates

Project
Bath Road, Longford, Middlesex
Wood and Company

Contract M9067

Borehole 1 (1 of 2)

Soil Mechanics

BOREHOLE No. H020

Sheet 1 of 4

Equipment & Methods	Location No. 7600	TQ 07 NE 1335
Hand dug inspection pit to 1.20m then cable tool boring in 150mm diameter to 30.50m.	Location HEATHROW ACCESS ROAD	
Carried out for: Heathrow Airport Limited	Ground Level: 26.19 m A.O.D.	Coordinates: 507594 E, 177382 N
		Date: 02.11.89 to 07.11.89

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records
TOPSOIL (Driller's description)	26.19		(0.20)					
	25.99		0.20					
Soft to firm brown very silty CLAY with rarely fine to medium sand. (SUBSOIL)			(1.10)					
	24.89		1.30	1.20 – 1.45	U	1		60 blows
				1.50	D	2		
				1.50 – 2.00	B	3	C N=30	8,10,8,7,7,8
Dense light brown/brown angular to rounded fine to medium flint GRAVEL with much coarse flint gravel and some becoming, with depth, a little fine to coarse sand. (RIVER TERRACE DEPOSITS)			(2.70)	2.50 – 3.00	B	4	C N=42	6,8,11,10,10,11
				3.50 – 4.00	B	5	C N=46	5,4,8,10,14,14
Medium dense light brown/brown fine to coarse SAND with a little angular to subrounded fine to medium flint gravel. (RIVER TERRACE DEPOSITS)	22.19		4.00					
			(0.70)					
	21.49		4.70	4.50 – 5.00	B	6	C N=14	5,6,5,3,3,3
Firm brown CLAY. (WEATHERED LONDON CLAY)			(0.30)					
	21.19		5.00					
Stiff grey brown CLAY with extremely closely spaced subhorizontal to subvertical rough irregular generally planar gleyed fissures with occasional subhorizontal layers of dark grey green silt. rare pyritised nodule (LONDON CLAY)			(10.20)	6.70 – 7.15	U	7		40 blows
				7.20	D	8		
				8.70 – 9.15	D	9	S N=27	2,3,5,6,8,8

Remarks

Logged by: AWSF

Scale: 1:50

Fig. 50

Notes:

Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics 10.01.90/09.59 (Ver 4.1.1)

All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Soil Mechanics

BOREHOLE No. H002

Sheet 1 of 4

Equipment & Methods Cable tool boring in 150mm diameter from ground level to 25.00m	Location No. 7600 Location HEATHROW ACCESS ROAD TQ07NE/336
Carried out for Heathrow Airport Limited	Ground Level 28.08 m A.O.D. Coordinates 507388 E 178090 N Date 28.11.89 to 29.11.89

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records
TOPSOIL (Driller's description)	28.08		(0.40)					
	27.68		0.40					
Very stiff brown and orange brown very silty CLAY. (ALLUVIAL CLAY)			(1.30)	1.00 – 1.45	U	1		45 blows
				1.50	D	2		
	26.38		1.70					
Dense brown, grey brown and black angular to subrounded fine to coarse flint GRAVEL (in places predominantly coarse) with some fine to coarse sand, becoming with some fine to medium and much coarse sand. (RIVER TERRACE DEPOSITS)			(3.30)	2.00 – 2.50	B	3	C N=46	6,9,10,10,12,14
				3.00 – 3.50	B	4	C N=36	5,6,8,8,9,11
				4.00 – 4.50	B	5	C N=39	6,7,8,10,11,10
	23.08		5.00					
Medium dense brown, grey brown and black angular to subrounded fine to coarse (predominantly coarse) flint GRAVEL with much becoming a little fine to coarse sand. (RIVER TERRACE DEPOSITS)			(2.50)	5.00 – 5.50	B	6	C N=24	3,4,5,6,6,7
				6.00 – 6.50	B	7	C N=19	3,4,3,5,5,6
				7.00 – 7.50	B	8	C N=18	2,3,4,4,5,5
	20.58		7.50					
Medium dense brown,grey brown and black angular to subrounded fine to coarse becoming predominantly medium to coarse flint GRAVEL with much coarse sand and some fine to medium sand. (RIVER TERRACE DEPOSITS)			(2.30)	8.00 – 8.50	B	9	C N=14	3,2,3,3,3,5
				9.00 – 9.50	B	10	C N=10	4,3,2,2,3,3
	18.28		9.80					
Firm brown CLAY (WEATHERED LONDON CLAY)	18.08		10.00	9.80 – 10.25	U	11		

Remarks

1. Falling head test performed in the gravel.

Logged by NWSF

Scale 1:50

Fig. 49

Notes:

Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Norwest Holst Soil Engineering Ltd.

Borehole No. 820

BOREHOLE LOG

Contract No. F9046 (PART 1)
Location HEATHROW SURFACE ACCESS STUDIES
Client HEATHROW AIRPORT LIMITED
Method of Boring CABLE PERCUSSION
Diameter of Borehole 150mm

TQ07NW 236

Sheet 2 of 2
Co-ords. E504203 N177579
Ground Level 24.40 m.A.O.D.
Date 2 - 3/3/91

Description of Strata	Legend	Depth Below G.L.(m)	O.D. Level (m)	Casing Depth at Sampling	Sampling and Coring	"N"/ R.Q.D.%	Daily Progress
Stiff grey brown very closely fissured indistinctly laminated silty CLAY. (LONDON CLAY)					10.00-10.45 s 10.50-11.00	"21"	
					11.00-11.45	(110)	
					11.65 11.20-12.00		
Borehole complete at 12.00m.		12.00	12.40				3/3/91

Type of Sample

Is	S.P.T.	■	Undisturbed
Ic	C.P.T.	x	Vane
0	Jar	△	Water
●	Bulk	▮	Piezometer

Remarks (Observations of Ground Water etc.) (-) U100 blows

Chiselling: 1.00 - 1.30m (0:50 hr)
1.70 - 2.00m (0:30 hr)
6.50 - 7.00m (1:20 hr)
7.20 - 7.40m (0:30 hr)
7.70 - 8.00m (1:15 hr)

Borehole backfilled on completion.

Water levels are subject to seasonal or tidal variations and should not be taken as constant

Norwest Holst Soil Engineering Ltd.

Borehole No. 829

Contract No. F9048 (PART 1) - BOREHOLE LOG

Location. HEATHROW SURFACE ACCESS STUDIES

Client. HEATHROW AIRPORT LIMITED

Method of Boring. CABLE PERCUSSION

Diameter of Borehole. 150mm

TQ07NW 243

Sheet 1 of 3

Co-ords. E504380 N177628

Ground Level 22.50 m.A.O.D.

Date 12 - 14/3/91

Description of Strata	Legend	Depth Below G.L.(m)	O.D. Level (m)	Casing Depth at Sampling	Sampling and Coring	"N"/ R.Q.D.%	Daily Progress
Compacted mixed soils and clays. (Drillers Description)							
Soft-firm orange brown soil plastic and rags. (Drillers Description) (LANDFILL)		0.60	21.90				
MADE GROUND: Dark grey / black clayey ash and sand with some fine to medium angular to rounded assorted gravel with occasional brick fragments, glass, polythene and plastic. (LANDFILL)		1.00	21.50		1.00 1.00-1.45	(16)	
MADE GROUND: Black clayey ash and sand with some cobbles of concrete and occasional fine angular flint gravel, wood, metal, glass and polythene. (<5% degradable material) (LANDFILL)		1.30	21.20		1.65 1.70-2.00 1.70(12/3/91)		
MADE GROUND: Soft grey brown silty clay with some concrete, brick and slag / ash and occasional fine angular flint gravel. (LANDFILL)		2.00	20.50		2.00-2.45 s	"11"	
MADE GROUND: Cobbles of concrete and some cloth in matrix of very soft grey silty sandy clay with occasional polythene and newspaper. (10-15% degradable material) (LANDFILL)		3.00	19.50		3.00 3.00-3.45 3.00-3.50 N.R.	(100)	
MADE GROUND(?): Grey sand and fine to medium angular flint gravel with occasional flint cobbles wood, plastic and pockets of very soft light brown silty clay. (<5% degradable material) (LANDFILL)		3.50	19.00		3.50-4.00		
Medium dense brown SAND and fine to coarse angular flint GRAVEL. (TERRACE GRAVEL) ...4.00-4.45 with pockets of very soft grey brown silty clay.		4.00	18.50		4.00-4.45 s	"25"	
					5.00 5.00-5.15 s N.R.	63*for 150mm	
Stiff brown fissured indistinctly laminated silty CLAY. (LONDON CLAY)		5.90	16.60		5.60-6.05 s 6.20-6.60	"19"	
Firm grey brown fissured indistinctly laminated silty CLAY. (LONDON CLAY)		6.60	15.90	6.50 12/3 7.00 13/3 14/3	6.60-7.05 7.25 7.50 7.60-8.05	(74) (83)	
...below 8.60m stiff					8.25 8.25-8.60 8.60-9.05 9.25 9.30-9.60	(84)	12/3 13/3

Type of Sample

Is	S.P.T.	■	Undisturbed
Ic	C.P.T.	x	Vane
0	Jar	△	Water
●	Bulk	▮	Piezometer

Remarks (Observations of Ground Water etc.) (-) U100 blows * Seating blows only

Chiselling obstructions from 3.00-3.50m, for 1 hr 10 mins
14.70-14.90m, for 50 mins

Groundwater: 12/3/91: Strike at 3.00m, rising to 1.70m in 5 mins, no further rise, casing at 3.00m
pm WL, dry (moist), casing at 6.50m
13/3/91:am WL, dry, casing at 6.50m
seepage at 14.80m, no rise, casing at 7.00m
pm WL, dry, casing at 7.00m
14/3/91:am WL, dry, casing at 7.00m

Falling Head Permeability Test undertaken at 3.50m. $k = 3.40 \times 10^{-7}$ m/sec

Piezometer installed at 2.50m as shown (14/3/91)

Water levels are subject to seasonal or tidal variations and should not be taken as constant

Soil Mechanics

BOREHOLE No. H022

Sheet 1 of 3

TQ07NW /406

Equipment & Methods	Location No. 7600	
Cable tool boring in 150mm diameter from ground level to 10.50m.	Location: HEATHROW ACCESS ROAD	
Carried out for	**Ground Level**	**Coordinates** / **Date**
Heathrow Airport Limited	22.58 m A.O.D.	504190 E, 176710 N / 21.11.89

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records
TOPSOIL (Driller's description)	22.58		(0.20)					
	22.38		0.20					
				1.00 – 1.45	D	1	S N=14	3,1,4,3,4,3
				1.00 – 1.50	B	2		
Firm grey brown/black very silty CLAY with a little becoming rare angular to subrounded fine to coarse flint gravel and some to much fine to coarse sand size ash, some becoming rare medium sand to coarse gravel size brick and concrete fragments with some fragments of paper, wood and plastic. Strong oily smell. (FILL)				2.00 – 2.45	D	3	S N=6	4,2,3,1,1,1
				2.00 – 2.50	B	4		
			(4.40)					
				3.00 – 3.45	D	5	S N=6	1,1,2,1,2,1
				3.00 – 3.50	B	6		
				3.10	W	15		
				4.00 – 4.50	B	7	S N=3	–,1,–,1,1,1
	17.98		4.60					
Medium dense brown and black clayey and silty fine to coarse SAND with much angular to subangular fine to medium occasionally coarse flint gravel and some coarse sand to medium gravel size brick and ash fragments. (FILL)				5.00 – 5.50	B	8	S N=14	6,1,3,5,2,4
			(1.20)					
	16.78		5.80					
Loose brown fine to coarse SAND and angular to subrounded fine to medium flint GRAVEL with some coarse flint gravel. (RIVER TERRACE DEPOSITS)				6.00 – 7.00	B	9	S N=9	3,2,2,2,3,2
			(0.90)					
	15.88		6.70					
Stiff becoming from 9.00m very stiff grey brown CLAY with extremely to very closely spaced subhorizontal to subvertical rough irregular generally planar occasionally undulose and smooth regular planar gleyed fissures with rare subhorizontal layers of dark grey green silt. (LONDON CLAY)				7.00 – 7.45	U	10		10 blows
				7.50	D	11		
			(3.80)					
				9.00 – 9.45	D	12	S N=18	1,2,4,4,5,5

Remarks

1. Falling head test performed in fill material.

Logged by: AWSF

Scale: 1:50

Fig. 25

Notes:

Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics 10.01.90/09.33 (Ver 4.1.4)

All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Soil Mechanics

BOREHOLE No. H049

Sheet 1 of 2

Equipment & Methods Cable tool boring in 150mm diameter from ground level to 10.50m.	**Location No.** 7600 **Location** HEATHROW ACCESS ROAD TQ07NW	409
Carried out for Heathrow Airport Limited	**Ground Level** 23.01 m A.O.D.	**Coordinates** 504266 E 177034 N	**Date** 22.11.89

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records
TOPSOIL (Driller's description)	23.01		(0.30)					
	22.71		0.30					
Loose black and grey brown silty fine to coarse SAND with a little angular to subrounded fine to medium flint gravel and rare coarse sand size brick fragments, cloth and metal. (FILL)			(1.70)	1.00 – 1.45	D	1	S N=8	6,4,3,2,1,2
				1.00 – 1.50	B	2		
	21.01		2.00	2.00 – 2.45	D	3	S N=10	2,2,3,1,3,3
				2.00 – 2.50	B	4		
Firm grey brown and black in places dark grey green CLAY with a little fine to medium rarely coarse sand and a little to some subangular to subrounded fine to coarse flint gravel with occasional coarse sand to coarse gravel size brick fragments. (FILL)			(3.00)	3.00 – 3.50	B	5	S N=5	–,1,1,1,2,1
				4.00 – 4.45	D	6	S N=9	1,2,1,2,3,3
				4.00 – 4.50	B	7		
				4.10	W	9		
	18.01		5.00					
Medium dense white, grey and black angular to subrounded fine to coarse flint GRAVEL with some fine to coarse sand. (RIVER TERRACE DEPOSITS)		o·o·o ·o·o· o·o·o ·o·o· o·o·o	(1.00)	5.00 – 5.50	B	8	C N=19	3,4,5,5,3,6
	17.01		6.00					
rare shell fragments				6.00 – 6.45	U	10		45 blows
				6.50	D	11		
Stiff grey brown CLAY with extremely to very closely spaced subhorizontal to subvertical rough irregular generally planar occasionally undulose slightly gleyed fissures with occasional subhorizontal partings of dark grey green silt. (LONDON CLAY)			(4.50)	8.00 – 8.45	D	12	S N=18	2,2,3,5,5,5

Remarks

1. Falling head test performed in the gravel.

Logged by: NWF

Scale: 1:50

Fig. 28

Notes:

Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 10.01.90/09.34 (Ver 4.1.4)

Soil Mechanics

BOREHOLE No. H012

Sheet 4 of 5

Equipment & Methods

As sheet 1

Location No. 7600

TQ 07 NW 1412

Location

HEATHROW ACCESS ROAD

Carried out for

Heathrow Airport Limited

Ground Level | Coordinates | Date

As sheet 1

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records
LONDON CLAY (As sheet 3) — locally extremely closely fissured			(11.90 pen)	30.00 – 30.45	D	26	S N=39	7,7,8,9,11,11
BOREHOLE ENDS AT 30.50 m.	-4.66		30.50					

Water Level Observations During Boring

Date	Time	Depth of Hole (m)	Depth of Casing (m)	Depth to Water (m)	Remarks
1989					
16.11	–	3.40	3.00	3.40	Water struck
16.11	–	3.40	3.00	3.00	After 20 mins
16.11	–	6.30	6.30	DRY	Water sealed off
16.11	–	13.50	6.30	DRY	End of shift
17.11	–	13.50	6.30	DRY	Start of shift
17.11	–	30.50	6.30	DRY	End of borehole

Remarks

2. Standpipe installed upon completion.

Logged by MHF

Scale 1:50

Fig. 3.1

Notes:

Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 10.01.90/09.36 (Ver 4.1.4)

A5 Landfill Information tables

Table A.1 Historical landfill sites in the proposed development area

Landfill Site	Location	Zone	Licence Status	Dates of operation	Type of waste
FS Sipson	West of Sipson	1	IPPC	N/A	Household, Commercial & Industrial
Harmondsworth	South of Harmondsworth Lane	1	IPPC	Potentially Still active	Household, Commercial & Industrial
South Moor Lane	North of Accommodation Lane	1	Closed	31 December 1963 – N/A	Industrial
Accommodation Lane	East of River Colne	1	Closure	N/A	Other wastes (Construction, Demolition, Dredgings)
Colnbrook By-Pass, Hillingdon	West of Tarmac Way	1	Closure	N/A	Other wastes (Construction, Demolition, Dredgings)
British Airways Area 4 Prospect Park Landfill	West of River Wraysbury	1	Modified	N/A	Other wastes (Construction, Demolition, Dredgings)
Willow Piggeries	East of M25 and North of A4	1	Closed	31 December 1940 – 31 December 1981	N/A
Home Farm	West of M25	1	Closed (leachate control)	31 December 1963 – N/A	Inert, industrial, commercial, household, special, liquids/sludges
Colnbrook By Pass No.1	West of M25 and north of Colnbrook By-pass	2	Closed	31 December 1965 – 31 March 1993	Inert and industrial
Tanhouse Farm No.1	West of the lakes	1	Closed	31 December 1964 – 08 April 1991	Inert, industrial, commercial and liquids/sludges
Tanhouse Farm No. 2	North of Colnbrook By-pass	1	Closed	31 December 1976 – 31 December 1991	Inert, industrial, commercial and liquids/sludges
Tanhouse Farm, Colnbrook	North of Lakeside road	1	Closure	N/A	Households, commercial and industrial
Procea Products	North of Lakeside road	1	Closed	N/A	N/A
Accomodation Lane East No.3	South of Colnbrook By-Pass and east of Stanwell Moor Road	1	Closed	31 December 1972 – 31 December 1973	Inert
Accomodation Lane East No.2	South of Colnbrook By-Pass and west of Stanwell Moor Road	1	Closed	31 December 1973 – 31 December 1982	N/A
Accomodation Lane East No.1	South of Colnbrook By-Pass and north of Bath Road	2	Closed	31 December 1973 – 31 December 1982	N/A
Accomodation Lane West	South of Colnbrook By-Pass and east of M25	2	Closed	31 December 1960 – 31 December 1970	Commercial and household
South of Old Bath Road No.1	South of Bath Road and East of M25	2	Closed	31 December 1953 – 31 December 1971	Inert, industrial, commercial and household
South of Old Bath Road No.2	West of River Colne and north of M25	2	Closed	N/A – 31 December 1960	N/A

Table A.2 (Continued) Historical landfill sites in the proposed development area

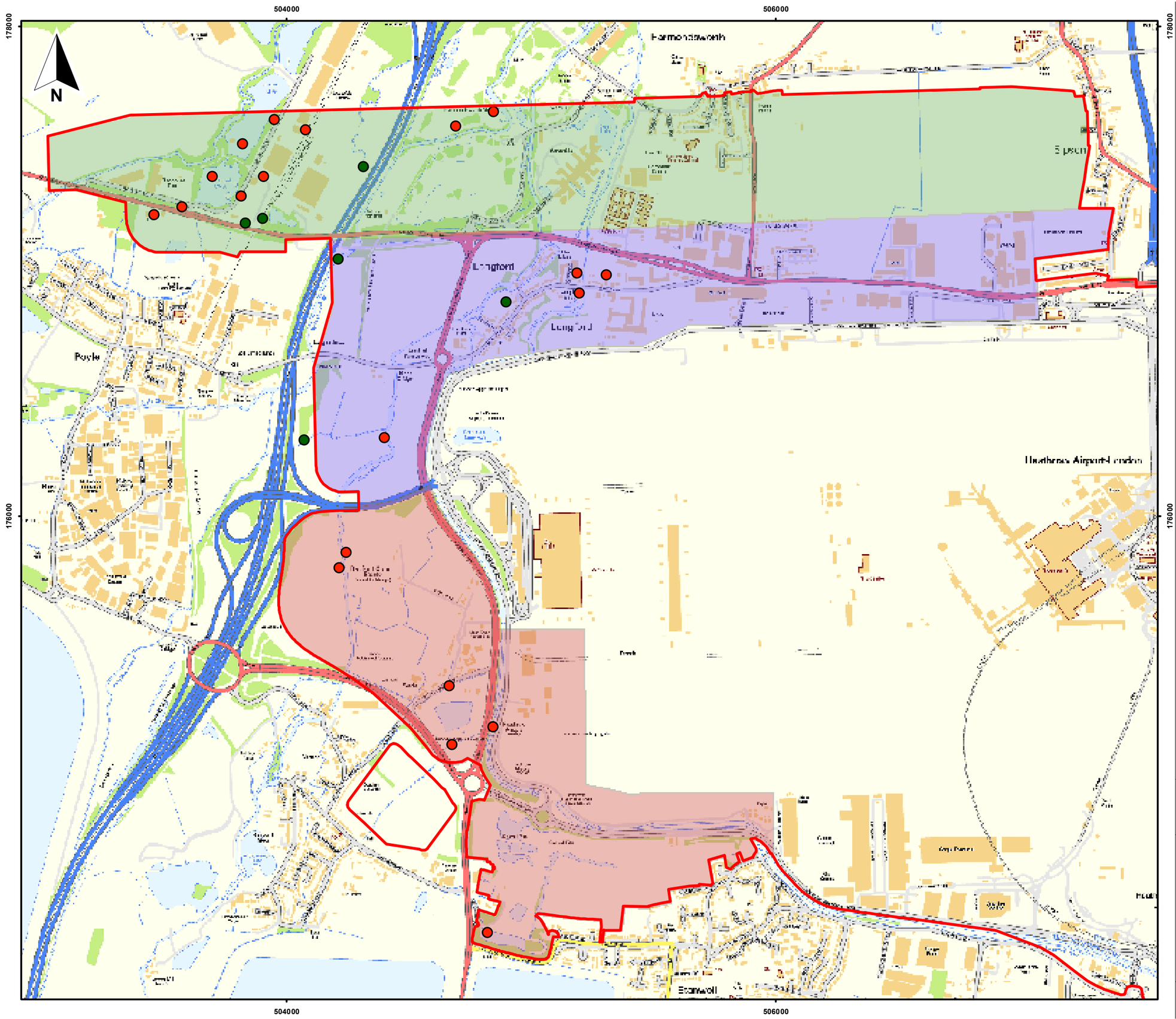
Landfill Site	Location	Zone	Licence Status	Dates of operation	Type of waste
FS Sipson	West of Sipson	1	IPPC	N/A	Household, Commercial & Industrial
Horton Road	East of M25 and west of River Colne	2/3	Closed	02 May 1950 – 31 December 1984	N/A
Spout Arch	South of Spout Lane North and West of Stanweel Moor Road	3	Closed	31 December 1968 – 31 December 1970	N/A
Stanwell Moor Road West	East of Airport way and West of Stanwell Moor Road	3	Closed	31 December 1970 – 07 August 1986	Inert
Stanwell No.2	South of Southern Perimeter Road and east of Stanwell Moor Road	3	Closed	31 December 1974 – 25 June 1985	Inert, commercial and household
Stanwell I I I Landfill	South of Southern Perimeter Road and North of Park Road	3	Transferred	N/A	Inert

Source: EA / Envirocheck Reports

Table A.3 Historical landfill sites within 50m of the proposed development area

Landfill Site	Location	Licence Status	Dates of operation	Type of waste
Egglesey Farm Area C	West of M25 and South of Colnbrook By-Pass	Modified	N/A	Household, Commercial & Industrial
Horton Road	West of M25 and west of North of Horton Road	Closed	31 December 1963 – 31 December 1977	Inert, industrial, commercial and liquids/sludges
Spout Lane Tip	South of Airport way and West of Stanwell Moor Road	Closed	N/A	N/A
Sutton Lane, Colnbrook	North Colnbrook By-Pass and South of M4	IPPC	N/A	Household, Commercial & Industrial
Sutton Lane No.2	North Colnbrook By-Pass and East Sutton Lane	Closed	31 December 1965 – 31 December 1980	Inert and Industrial

Source: EA/ Envirocheck Reports



Legend

Masterplan Site Boundary

Discharge Licenses

Active or Revoked

- Revoked
- Active

Zones

Zone Number

- Zone 1
- Zone 2
- Zone 3

0 250 500 Metres

Scale: 15,000 @ A3

Project Path

Heathrow
Making every journey better

Geo-Environmental Desk Study

Appendix A6

Map of discharge consents

03/04/14
Lee Cutting/George Newman

Mott MacDonald

Appendix B
Site Walkover Photos

Figure B.1 Flat agricultural field

Figure B.2 Warehouses on Skyport Drive

Figure B.3 Houses on Zealand Avenue

Figure B.4 Shell fuel station on the A4

Figure B.5 Houses on Pinglestone Clos

Figure B.6 Office building in commercial estate off Bath Road (A4)

Figure B.7 Construction site in commercial estate

Figure B.8 Warehouses off Bath Road (A4)

Figure B.9 Agricultural field west of the Village of Sipson

Figure B.10 Gas flare for landfill west of Sipson

Figure B.11 Recreational field in Harmondsworth

Figure B.12 Gas flare in car park for Harmondsworth Moor

Figure B.13 Bridge over the River Colne

Figure B.14 Harmondsworth Moor, facing south.

Figure B.15View from Harmondsworth Moor facing SE

Figure B.16 View of Harmondsworth Moor facing east

Figure B.17 High Street of Longford

Figure B.18 Landifll between Bath Road, A4 and M25

Figure B.19 Distribution car park on Bath Road near M25

Figure B.20 Agricultural land south of Colnbrook Bypass (A4)

Figure B.21 BPA fuel line

Figure B.22 River Colne next to M25

Figure B.23 BPA fuel line site

Figure B.24 Biodiversity site

Figure B.25 Ditch running next to Biodiversity site

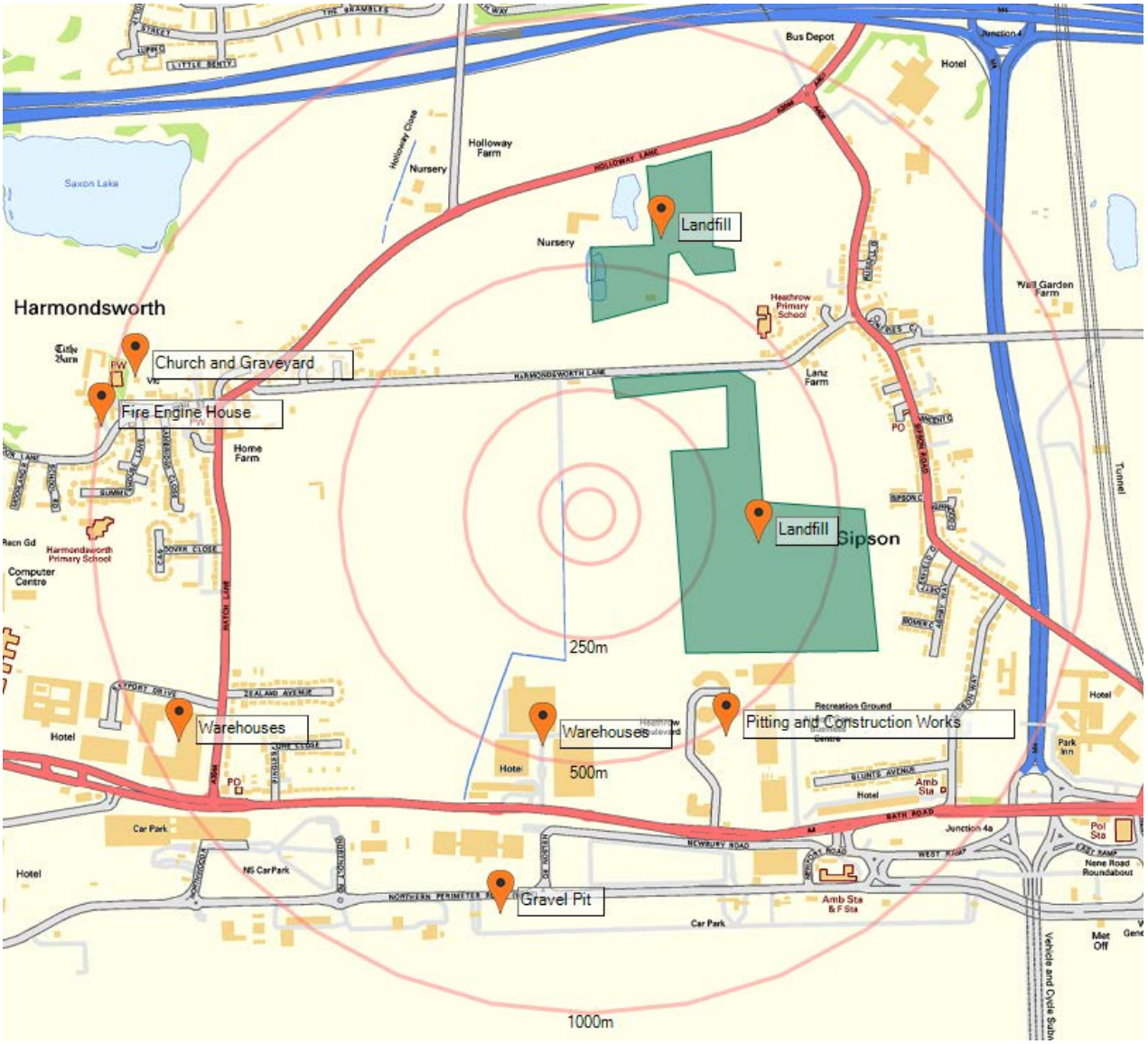
Figure B.26 Warehouse on Lakeside Road

Figure B.27 Colnbrook West Lake

Figure B.28 Energy from waste plan on Lakeside Road

Appendix C
Historical Contamination Maps

Figure C.1 Zone 1 and 2 east historical contamination identified from Envirocheck Report[3]



Source: Landmark 2014[3]

Table C.1 Zone 1 and 2 east historical contamination identified from Envirocheck Report[3]

Feature	First appearance	Present to	Grid ref (easting)	Grid ref (northing)	Notes
Gravel Pit	1897	1935	506459	176740	
Church and Graveyard	1868	2014	505729	177816	
Fire Engine House	1900	1938	505661	177718	
Pitting and Construction Works	1935	1960	506912	177096	
Warehouses	1948	2014	505816	177085	
Warehouses	1975	2014	506546	177077	
Landfill	1963	1994	506782	178091	Inert, Industrial, Commercial and Household Waste
Landfill	2006	2014	506978	177483	Household, Commercial & Industrial Waste Landfill

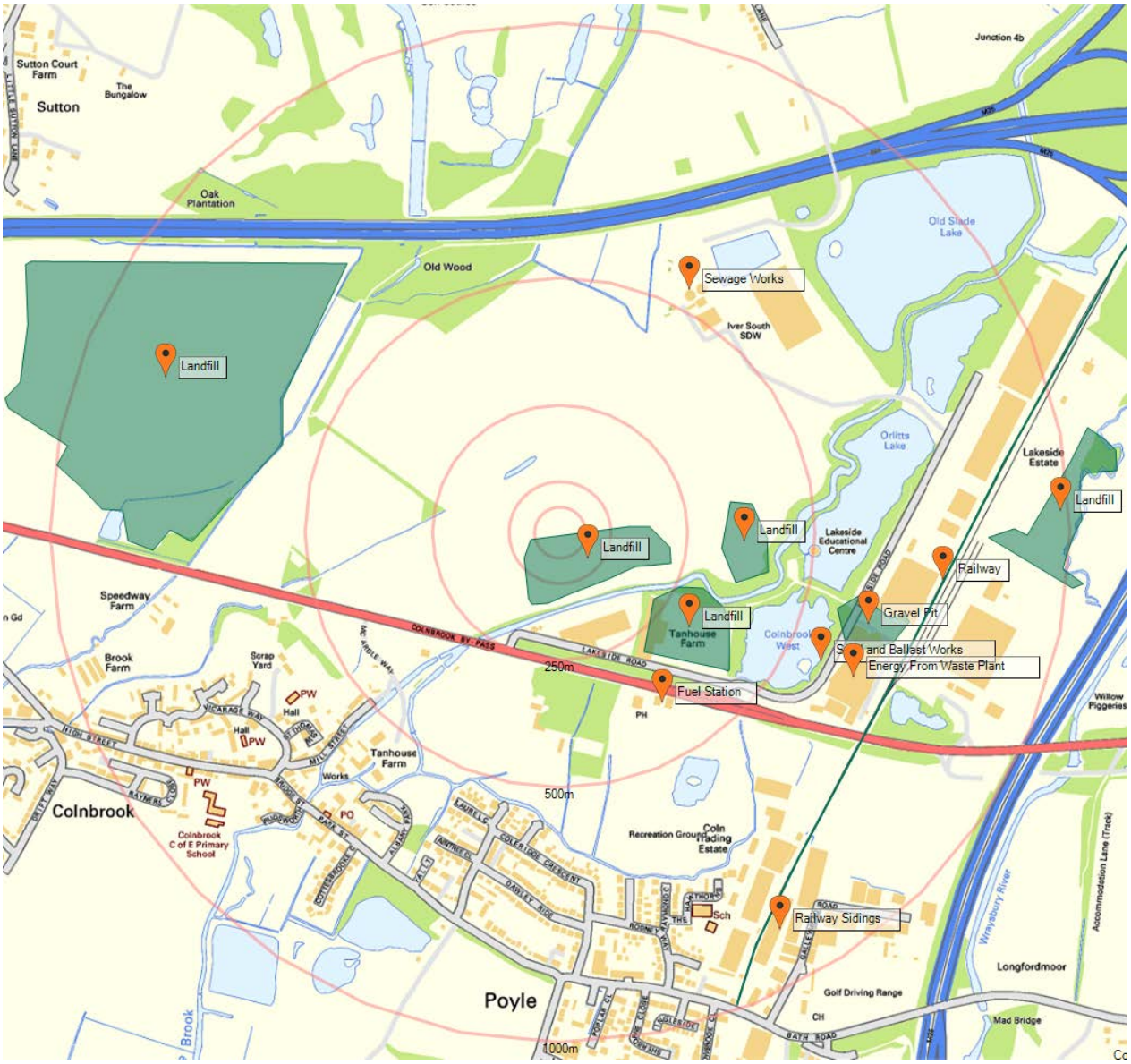
Figure C.2 Zone 1 and 2 Central, Historical Contamination identified from Envirocheck Report[3]

Source: Landmark 2014[3]

Table C.2 Zone 1 and 2 Central Historical Contamination identified from Envirocheck Report[3]

Feature	First appearance	Present to	Grid ref (easting)	Grid ref (northing)	Notes
Gravel Pit	1868	1900	505585	176897	
Church & Graveyard	1868	2014	505734	177797	
Fire Engine House	1900	1938	505628	177712	
Road Research Laboratory	1935	1970	505401	177210	
Gravel Pit	1935	1960	504453	17729	
Warehouses	1948	2014	505816	177069	
Landfill	1972	1982	504804	176985	Inert Waste
Landfill	1972	1982	504577	176922	Inert Waste
Landfill	1960	1970	504384	176877	Commercial and Household Waste. Previous gravel works.
Landfill	1960	Unknown	504969	177835	Industrial Waste
Fuel Station	1989	2014	505628	176988	

Figure C.3 Zone 1 West Historical Contamination identified from Envirocheck Report[3]



Source: Landmark 2014[3]

Table C.3 Zone 1 west historical contamination identified from Envirocheck Report[3]

Feature	First appearance	Present to	Grid ref (easting)	Grid ref (northing)	Notes
Fuel Station	1989	2014	503480	177233	
Gravel Pit	1926		503885	177388	
Railway Sidings	1897	1989	503711	176788	
Sewage Works	1932	2014	503533	178043	
Sand and Ballast Works	1935	1966	503792	177315	
Landfill	1964	1991	503335	177517	Inert, Industrial, Commercial and Liquids/Sludge Waste
Landfill	1964	1991	503643	177550	Inert, Industrial, Commercial and Liquids/Sludge Waste
Landfill	1964	1991	503534	177382	Inert, Industrial, Commercial and Liquids/Sludge Waste
Landfill	2006	2014	502507	177873	Household, Commercial & Industrial Waste Landfill
Energy From Waste Plant	2010	2014	503855	177283	
Landfill	2006	2014	504263	177610	Other Wastes
Railway	1897	1989	503627	176644	Still present in 2014 as a disused railway

Figure C.4 Zone 2 west historical contamination identified from Envirocheck Report[3]

Source: Landmark 2014[3]

Table C.4 Zone 2 west historical contamination identified from Envirocheck Report[3]

Feature	First appearance	Present to	Grid ref (easting)	Grid ref (northing)	Notes
Baptist Church	1868		504764	176702	Graveyard maybe
Railway Sidings	1897		503695	176756	Goods Shed
Railway	1868	2014	503606	175986	
Railway Sidings	1932		503855	177273	
Sand and Ballast Pit	1932		503902	177336	
Gravel Pit	1935		504445	177292	
Landfill	1950	1984	504219	176249	Waste Unknown
Landfill	1953	1971	504153	176444	Inert, Commercial, Industrial and Household Waste
Landfill	1960	1970	504193	176929	Commercial and Household
Landfill	1960	1982	504357	176933	Commercial and Household
Landfill	1972	1982	504580	176927	Inert Waste
Landfill	1973	1982	504400	176798	Unknown Waste
Landfill	1972	1982	504806	176987	Inert Waste
Oil/Gas Fuel Pipeline Station	1970	2014	504381	176641	
STW Sludge Beds	1970	2006	504887	175986	
Landfill	1965	1993	504137	177273	Previously Gravel Works
Sludge Beds	1970	2006	504714	176360	
Landfill	2006	2014	503692	176190	Household, Commercial and Industrial Waste
Landfill	2007	2014	504215	177559	Other Waste

Figure C.5 Zone 3 Historical Contamination identified from Envirocheck Report[3]

Source: Landmark 2014[3]

Table C.5 Zone 3 Historical Contamination identified from Envirocheck Report[3]

Feature	First appearance	Present to	Grid ref (easting)	Grid ref (northing)	Notes
Fuel Depot	1970	2014	505943	174803	
Gravel Pit	1970	2014	504611	174874	A lake by 1985
Gravel Pit	1970	2014	504601	174704	Lake by 1985
Works	1970	2014	504773	174591	Warehouse by 1986
Warehouse	1970	1989	505757	174561	
Drains	1970	2014	504828	174483	
Gravel Pit	1986	2014	504917	174696	Lake by 2006
Works	1975	2014	504492	175315	
Gravel Works	1970	1989	504506	174712	
Gravel Pit	1986	2014	505168	174642	Lake by 2006
Gravel Pit	1970	1989	503701	175622	
Gravel Pit	1970	1989	504086	175544	
Gravel Works	1970	1989	503834	175490	
Fuel Station	1986	2014	505578	174669	
Gravel Pit	2006	2014	504359	175446	
Pit	2006	2014	504703	175208	
Gravel Pit	2007	2014	505030	174457	
Gravel Pit	2007	2014	505208	174445	
Piggery	1986	2006	504592	175758	
Piggery	1986	2006	504709	175686	
Piggery	1986	2006	504357	175851	

Appendix D
Contaminated Land Risk Methodology

The following Contaminated Land Risk Assessment methodology is based on CIRIA C5526, in order to quantify potential risk via risk estimation and risk evaluation, which can be adopted at the Phase I stage. This will then determine an overall risk category which can be used to identify likely actions. This methodology uses qualitative descriptors and therefore is a qualitative approach.

The methodology requires the classification of:

- The magnitude of the consequence (severity) of a risk occurring, and
- The magnitude of the probability (likelihood) of a risk occurring.

The potential consequences of contamination risks occurring at this site are classified in accordance with the following table, which is adapted from the CIRIA guidance.

Table D.1 Classification of Consequence

Classification	Definition of Consequence
Severe	Short-term (acute) risks to human health. Short-term risk of pollution of sensitive water resource or ecosystem. Catastrophic damage to crops/buildings/property/infrastructure, including off-site soils.
Medium	Medium/long-term (chronic) risks to human health. Medium/long-term risk of pollution of sensitive water resource or ecosystem. Significant damage to crops/buildings/property/infrastructure (on or off-site). Contamination of off-site soils.
Mild	Easily preventable, permanent health effects on humans. Pollution of non-sensitive water resources. Localised damage to crops/buildings/property/infrastructure (on or off-site).
Minor	Easily preventable, non-permanent health effects on humans, or no effects. Minor, low-level and localised contamination of on-site soils. Easily repairable damage to crops/buildings/property/infrastructure.

The probability of contamination risks occurring at this site will be classified in accordance with **Table C.2**, Classification of probability, which is also adapted from the CIRIA guidance. Note that for each category, it is assumed that a pollution linkage exists. Where a pollution linkage does not exist, the likelihood is zero, as is the risk.

Table D.2 Classification of Probability

Classification	Definition of Probability
High Likelihood	Circumstances are such that an event appears very likely in the short-term or almost inevitable in the long-term; or there is already evidence that such an event has occurred.
Likely	Circumstances are such that such an event is not inevitable, but is possible in the short-term and is likely over the long-term.
Low Likelihood	Circumstances are such that it is by no means certain that an event would occur even over a longer period, and it is less likely in the short-term.
Unlikely	Circumstances are such that it is improbable that an event would occur even in the very long-term.

For each possible pollution linkage (source-pathway-receptor) identified, the potential risk can be evaluated, as presented in **Section 6**. Based upon this, CIRIA C552 presents definitions of the risk categories, together with the investigatory and remedial actions that are likely to be necessary in each case, as in **Table C.3**. These risk categories apply to each pollutant linkage, not simply to each hazard or receptor.

Table D.3 Definition of Risk Categories and Likely Actions Required

Risk Category	Definition and Likely Actions required
Very high	Severe harm to a defined receptor is very likely, or has already occurred. The risk is likely to result in a substantial liability. Urgent investigation (if not already undertaken) is likely to be required. Urgent remediation is likely to be required.
High	Harm to a defined receptor is likely. The risk, if realised, may result in a substantial liability. Urgent investigation (if not already undertaken) is likely to be required. Remediation is likely to be required in the long term, possibly sooner.
Moderate	Harm to a defined receptor is possible, but severe harm is unlikely. Investigation is likely to be required to clarify the level of potential liability and risk. Some remediation may be required in the longer term.
Low	Harm to a defined receptor is possible, but is likely to be mild at worst. Liabilities could theoretically arise, but are unlikely. Further investigation is not required at this stage. Remediation is unlikely to be required.
Very low	Harm to a defined receptor is unlikely, and would be minor at worst. No liabilities are likely to arise. Further investigation is not required at this stage. Remediation is very unlikely to be required.

Appendix E
Development of Conceptual Model - Hazard Identification

For the proposed development, as mentioned in **Section 2.1** the site has been divided into the three Zones (**Section 2, Figure 2.1**), a conceptual model has been developed for each zone. The following sources, pathways and receptors have been identified. The conceptual site models are illustrated in **Appendix A** and are discussed below.

Sources of Contamination

Zone 1

Current

S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater,

S2: Made ground related to the construction of existing buildings,

S3: Current industrial estate,

S4: Railway,

S5: Off-site landfills.

S6: Presence of roads and associated spills/ leaks from vehicles

Construction Phase

S7: Potential contamination during construction including spills and leaks from vehicles and storage areas. Potential dust and odour from excavation and construction works.

Operational

S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater,

S2: Made ground related to construction,

S4: Railway,

S5: Off-site landfills,

S8: Potential contamination during operation of the proposed runway including spills, leaks and de-icing activities.

Zone 2

Current

S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater,

S2: Made ground related to the construction of existing buildings,

S8: Fuel station, potential underground fuel tanks,

S9: Oil/ gas Pipeline,

S3: Commercial/ industrial use,

S6: Presence of existing roads and associated spills/ leaks from vehicles.

Construction Phase

S7: Potential contamination during construction including spills and leaks from vehicles and storage areas. Potential dust and odour from excavation and construction works

Operational

S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater,

S2: Made ground related to construction,

S6: Presence of existing roads and associated spills/ leaks from vehicles

S10: Airport activities including airport stands, fuelling, loading, de-icing.

S9: Car park – spills and leaks from vehicles.

S11: Car park – spills and leaks from vehicles

S12: Ancillary buildings – potential maintenance of aircraft and storage of fuel/ vehicles/ de-icing products.

Zone 3

Current

S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater,

S2: Made ground related to historical construction,

S3: Industrial estate,

S13: Quarry,

S5: Off-site landfills.

Construction Phase

S7: Potential contamination during construction including spills and leaks from vehicles and storage areas. Potential dust and odour from excavation and construction works.

Operational

S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater,

S2: Made ground related to construction,

S5: Off-site landfills.

S10: Airport activities including airport stands, fuelling, loading, de-icing.

S12: Ancillary buildings – potential storage of fuel/vehicles/de-icing products

S11: Car park – spills and leaks from vehicles.

Potential Contamination Transport Pathways

P1: Direct Contact with contaminated soils

P2: Airborne routes (inhalation of gases, vapours and dust)

P3: Vertical leaching through permeable sub-strata

P4: Transport through man-made pathways (drainage, service conduits, piled foundations)

P5: Horizontal and vertical migration through groundwater

P6: Surface Run-off

Potential Contamination Receptors

Current, Construction and Operational Phases:

R1: Construction and maintenance workers

R2: Surface water bodies (Rivers and Lakes)

R3: Principal aquifer within RTD and Secondary aquifer in the Alluvium.

R4: Site users

R5: Vegetation, planting and landscaping

R6: Off-site residents

R7: Structural and infrastructure materials

Appendix F
Risk Estimation and Evaluation

Risk Estimation & Risk Evaluation

The term risk is widely used in different contexts and circumstances, often with differing definitions. In UK Government publications about the environment, the standard definition is that "Risk is a combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence"[7].

Following the development of the conceptual model and the identification and assessment of potential pollutant linkages, a preliminary assessment can be made of risk estimation and risk evaluation, as discussed in CLR11 and CIRIA C552, to determine whether an unacceptable contamination risk is likely to exist.

CLR11 defines risk estimation as predicting the magnitude (or consequence) and probability of the risk occurring that may arise as a result of that hazard. This is also identified in CIRIA C552 in which the risk assessment methodology uses qualitative descriptors of consequence, probability and thus risk. These descriptors are adopted for the purposes of this risk assessment. A description of the risk assessment methodology adopted is given in **Appendix C**.

Overall contamination risk = Probability of event occurring x Consequence of event occurring

This relationship can be represented in a matrix (**Table F.1**), which is adapted from the CIRIA guidance.

Table F.1 Preliminary Contamination Risk Assessment Matrix

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High likelihood	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate risk	Low risk
	Low likelihood	Moderate risk	Moderate risk	Low risk	Very low risk
	Unlikely	Low risk	Low risk	Very low risk	Very low risk

The following preliminary qualitative risk evaluation can therefore be made for each significant pollutant linkage at this site, based upon the defined conceptual model and the risk estimation process discussed above. Risk Evaluation Tables.

Table F.2 Summary of Contamination Risks Evaluation in Zone 1

Source	Pathways	Receptor	Consequence	Probability	Risk
Current Use					
S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater, S2: Made ground related to the construction of existing buildings, S3: Current industrial estate, S4: Railway, S5: Off-site landfills S6: Presence of roads and associated spills/ leaks from vehicles	P1: Direct Contact with contaminated soils	R4: Site users	Mild[5]	Low Likelihood	Low
		R5: Vegetation, planting and landscaping	Minor	Likely	Low
		R7: Structural and infrastructure materials	Medium	Likely	Moderate
	P2: Airborne routes (inhalation of gases, vapours and dust)	R4: Site users	Mild[5]	Low Likelihood	Low
		R6: Off-site residents	Medium	Unlikely	Low
	P3: Vertical leaching through permeable sub-strata	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
	P4: Transport through man-made pathways (drainage, service conduits, piled foundations)	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	Likely[3]	Moderate
		R2: Surface water bodies (rivers and lakes)	Mild	Low likelihood	Low
	P5: Horizontal and vertical migration through groundwater	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
		R2: Surface water bodies (rivers and lakes)	Mild	Likely	Moderate
	P6: Surface Run-off	R2: Surface water bodies (rivers and lakes)	Mild	Low Likelihood	Low

Table F.3 (Continued) Summary of Contamination Risks Evaluation in Zone 1

Source	Pathways	Receptor	Consequence	Probability	Risk
Construction Phase					
S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater,	P1: Direct Contact with contaminated soils	R1: Construction and maintenance workers	Mild	Low Likelihood	Low[1]
		R5: Vegetation, planting and landscaping	Minor	Likely	Low
		R7: Structural and infrastructure materials	Mild	Likely	Moderate
S2: Made ground related to the construction of existing buildings,	P2: Airborne routes (inhalation of gases, vapours and dust)	R1: Construction and maintenance workers	Mild	Low Likelihood	Low[1]
		R6: Off-site residents	Mild	Low Likelihood	Low[6]
S3: Current industrial estate,	P3: Vertical leaching through permeable sub-strata	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
S4: Railway,	P4: Transport through man made pathways (drainage, service conduits, piled foundations)	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	Low likelihood	Moderate
S5: Off-site landfills		R2: Surface water bodies (rivers and lakes)	Mild	Low likelihood	Low
S6: Presence of roads and associated spills/ leaks from vehicles	P5: Horizontal and vertical migration through groundwater	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
S7: Potential contamination during construction including spills and leaks from vehicles and storage areas. Potential dust and odour from excavation and construction works.		R2: Surface water bodies (rivers and lakes)	Mild	Likely	Moderate
	P6: Surface Run-off	R2: Surface water bodies (rivers and lakes)	Mild	Low likelihood	Low

Table F.4 (Continued) Summary of Contamination Risks Evaluation in Zone 1

Source	Pathways	Receptor	Consequence	Probability	Risk
Operational Phase					
S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater, S2: Made ground related to construction, S4: Railway, S5: Off-site landfills S10: Potential contamination during operation of the proposed runway including spills, leaks and de-icing activities	P1: Direct Contact with contaminated soils	R1: Construction and maintenance workers	Mild	Low Likelihood	Low[1]
		R5: Vegetation, planting and landscaping	Minor	Likely	Low
		R7: Structural and infrastructure materials	Mild	Likely	Moderate
	P2: Airborne routes (inhalation of gases, vapours and dust)	R1: Construction and maintenance workers	Mild	Low Likelihood	Low[1]
		R4: Site users	Mild	Low Likelihood	Low
		R6: Off-site residents	Mild	Low Likelihood	Low[6]
	P3: Vertical leaching through permeable sub-strata	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	Low likelihood[2]	Moderate
	P4: Transport through man made pathways (drainage, service conduits, piled foundations)	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	Low likelihood	Moderate
		R2: Surface water bodies (rivers and lakes)	Mild	Low likelihood[3]	Low
	P5: Horizontal and vertical migration through groundwater	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
		R2: Surface water bodies (rivers and lakes)	Mild	Low likelihood[3]	Low
	P6: Surface Run-off	R2: Surface water bodies (rivers and lakes)	Mild	Low likelihood[2]	Low

1 The risk for the future construction and maintenance workers is considered low with the assumption that appropriate PPE will be used during intrusive works and monitoring (dust and vapour) and good hygiene will be used during the site works as appropriate.
2 The probability is assessed as low during the operation phase considering that appropriate drainage will be installed on site.
3 Assumes piling will be required.
4 For Spills during the construction and operation phase the probability of spilled contaminants interacting and contaminating the surrounding environment is assessed as low based on the assumption that, as is standard practice, there will be a Site Environmental Management Plan in place for such incidents.
5 Mild consequence level based on assumed low exposure time for site users e.g. dog walkers.
6 The risk level is based on the assumption that gas mitigation through monitoring and design will be carried out.

Table F.5 Zone 2 Preliminary Contamination Risk Evaluation

Source	Pathways	Receptor	Consequence	Probability	Risk
Current Use					
S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater, S2: Made ground related to the construction of existing buildings S8: Fuel station, potential underground fuel tanks S9: Oil / gas Pipeline S3: Commercial /industrial use S6: Presence of existing routes and associated spills/ leaks from vehicles	P1: Direct Contact with contaminated soils	R4: Site users	Mild[4]	Low Likelihood	Low
		R5: Vegetation, planting and landscaping	Minor	Likely	Low
		R7: Structural and infrastructure materials	Mild	Likely	Moderate
	P2: Airborne routes (inhalation of gases, vapours and dust)	R4: Site users	Mild[4]	Likely	Low
		R6: Off-site residents	Medium	Unlikely	Low
	P3: Vertical leaching through permeable sub-strata	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
	P4: Transport through man made pathways (drainage, service conduits, piled foundations)	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
		R2: Surface water bodies (Rivers and Lakes)	Mild	Likely	Moderate
	P5: Horizontal and vertical migration through groundwater	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
		R2: Surface water bodies (Rivers and Lakes)	Mild	Likely	Moderate
	P6: Surface run-off	R2: Surface water bodies (Rivers and Lakes)	Mild	Low likelihood	Low

Table F.6 (Continued) Zone 2 Preliminary Contamination Risk Evaluation

Source	Pathways	Receptor	Consequence	Probability	Risk
Construction Phase					
S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater,	P1: Direct Contact with contaminated soils	R1: Construction and maintenance workers	Mild	Low Likelihood[1]	Low
		R5: Vegetation, planting and landscaping	Minor	Likely	Low
		R7: Structural and infrastructure materials	Mild	Likely	Moderate
S2: Made ground related to the construction of existing buildings	P2: Airborne routes (inhalation of gases, vapours and dust)	R1: Construction and maintenance workers	Mild	Low Likelihood[1]	Low
S8: Fuel station, potential underground fuel tanks		R6: Off-site residents	Mild	Low Likelihood	Low[3]
S9: Oil / gas Pipeline	P3: Vertical leaching through permeable sub-strata	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
S3: Commercial /industrial use					
S6: Presence of existing roads and associated spills/ leaks from vehicles	P4: Transport through man-made pathways (drainage, service conduits, piled foundations)	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
		R2: Surface water bodies (rivers and lakes)	Mild	Likely	Moderate
S7: Potential contamination during construction including spills and , leaks from vehicles and storage areas. Potential dust and odour from excavation and construction works[2]	P5: Horizontal and vertical migration through groundwater	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
		R2: Surface water bodies (rivers and lakes)	Mild	Likely	Moderate
	P6: Surface run-off	R2: Surface water bodies (rivers and lakes)	Mild	Low Likelihood	Low

Table F.7 (Continued) Zone 2 Preliminary Contamination Risk Evaluation

Source	Pathways	Receptor	Consequence	Probability	Risk
Operational Phase					
S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater, S2: Made ground related to construction	P1: Direct Contact with contaminated soils	R1: Construction and maintenance workers	Mild	Low Likelihood[1]	Low
		R5: Vegetation, planting and landscaping	Minor	Likely	Low
		R7: Structural and infrastructure materials	Mild	Likely	Moderate
	P2: Airborne routes (inhalation of gases, vapours and dust)	R1: Construction and maintenance workers	Mild	Low Likelihood[1]	Low
		R6: Off-site residents	Mild	Low Likelihood	Low[3]
		R4: Site users	Mild	Low Likelihood[3]	Low[3]
S6: Presence of existing roads and associated spills/ leaks from vehicles	P3: Vertical leaching through permeable sub-strata	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	Low Likelihood	Moderate
S10: Airport activities including airport stands, fuelling, loading, de-icing. S11: Car park – spills and leaks from vehicles.	P4: Transport through man-made pathways (drainage, service conduits, piled foundations)	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	Low Likelihood	Moderate
		R2: Surface water bodies (rivers and lakes)	Mild	Low	Low
		R4: Site users	Medium	Low Likelihood[3]	Moderate
S12: Ancillary buildings – potential maintenance of aircraft and storage of fuel/vehicles/de-icing products.	P5: Horizontal and vertical migration through groundwater	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
		R2: Surface water bodies (rivers and lakes)	Mild	Likely	Moderate
	P6: Surface run-off	R2: Surface water bodies (rivers and lakes)	Mild	Likely	Moderate

1 For construction/maintenance workers and site workers, the probability of contact with contaminants is assessed as low based on the assumption that, as is standard practice, the workers will be wearing suitable Personal Protective Equipment (PPE), complete monitoring for dust and vapours (where applicable), adopt good site hygiene procedures and comply with site Health and Safety and Environmental Management Plans.
2 For Spills during the construction and operation phase the probability of spilled contaminants interacting and contaminating the surrounding environment is assessed as low based on the assumption that, as is standard practice, there will be a Site Environmental Management Plan in place for such incidents.
3 It is assumed that appropriate measures to mitigate contamination and ground gas through monitoring and design will be carried out.
4 Mild consequence level based on assumed low exposure time of site users e.g. dog walkers

Table F.8 Summary of Contamination Risks Evaluation in Zone 3

Source	Pathways	Receptor	Consequence	Probability	Risk
Current Use					
S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater, S2: Made ground related to the construction of existing buildings, S3: Industrial estate, S13: Quarry, S5: Off-site landfills	P1: Direct Contact with contaminated soils	R4: Site users	Mild	Low Likelihood	Low
		R5: Vegetation, planting and landscaping	Minor	Likely	Low
		R7: Structural and infrastructure materials	Mild	Likely	Moderate
	P2: Airborne routes (inhalation of gases, vapours and dust)	R4: Site users	Mild	Low likelihood	Low
		R6: Off-site residents	Medium	Unlikely	Low
	P3: Vertical leaching through permeable sub-strata	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High likelihood	High
	P4: Transport through man-made pathways (drainage, service conduits, piled foundations)	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	Low likelihood	Moderate
		R2: Surface water bodies (rivers and lakes)	Mild	Low likelihood	Moderate
	P5: Horizontal and vertical migration through groundwater	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High likelihood	High
		R2: Surface water bodies (rivers and lakes)	Mild	Likely	Moderate
	P6: Surface Run-off	R2: Surface water bodies (rivers and lakes)	Mild	Low likelihood	Low

Table F.9 (Continued) Summary of Contamination Risks Evaluation in Zone 3

Source	Pathways	Receptor	Consequence	Probability	Risk
Construction Phase					
S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater, S2: Made ground related to the construction of existing buildings, S3: Industrial estate, S13: Quarry, S5: Off-site landfills S7: Potential contamination during construction including spills and , leaks from vehicles and storage areas. Potential dust and odour from excavation and construction work.	P1: Direct Contact with contaminated soils	R1: Construction and maintenance workers	Mild	Low Likelihood	Low
		R5: Vegetation, planting and landscaping	Minor	Likely	Low
		R7: Structural and infrastructure materials	Mild	Likely	Moderate
	P2: Airborne routes (inhalation of gases, vapours and dust)	R1: Construction and maintenance workers	Mild	Low Likelihood	Low[1]
		R6: Off-site residents	Mild	Low Likelihood	Low
	P3: Vertical leaching through permeable sub-strata	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
	P4: Transport through man made pathways (drainage, service conduits, piled foundations)	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	Low likelihood	Moderate
		R2: Surface water bodies (rivers and lakes)	Mild	Low likelihood	Moderate
	P5: Horizontal and vertical migration through groundwater	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
		R2: Surface water bodies (rivers and lakes)	Mild	Likely	Moderate
	P6: Surface run-off	R2: Surface water bodies (rivers and lakes)	Mild	Low likelihood	Low

Table F.10 (Continued) Summary of Contamination Risks Evaluation in Zone 3

Source	Pathways	Receptor	Consequence	Probability	Risk
Operational Phase					
S1: On-site landfills potential for presence of ground gas, contaminated made ground and perched groundwater, S2: Made ground related to construction, S5: Off-site landfills S10: Airport activities including airport stands, fuelling, loading, de-icing. S12: Ancillary buildings – potential storage of fuel/vehicles/de-icing products, S11: Car park – spills and leaks from vehicles. .	P1: Direct Contact with contaminated soils	R1: Construction and maintenance workers	Mild	Low Likelihood	Low[1]
		R5: Vegetation, planting and landscaping	Minor	Likely	Low
		R7: Structural and infrastructure materials	Mild	Likely	Moderate
	P2: Airborne routes (inhalation of gases, vapours and dust)	R4: Site users	Mild	Low Likelihood	Low[5]
		R1: Construction and maintenance workers	Mild	Low Likelihood	Low[1]
		R6: Off-site residents	Mild	Low Likelihood	Low[5]
		R4: Site users	Mild	Low Likelihood	Low[5]
	P3: Vertical leaching through permeable sub-strata	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	Low likelihood[2]	Moderate
	P4: Transport through man made pathways (drainage, service conduits, piled foundations)	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	Low likelihood	Moderate
		R2: Surface water bodies (rivers and lakes)	Mild	Low likely[3]	Low
	P5: Horizontal and vertical migration through groundwater	R3: Principal aquifer within RTD and Secondary aquifer in the alluvium.	Medium	High Likelihood	High
		R2: Surface water bodies (river and lakes)	Mild	Likely	Moderate
	P6: Surface Run-off	R2: Surface water bodies (rivers and lakes)	Mild	Low likelihood[2]	Low

1 The risk for the future construction and maintenance workers is considered very low with the assumption that appropriate PPE will be worn, monitoring will be completed for vapours and dust, if required, and good hygiene will be used during the site works.
2 The probability is assessed as low during the operation phase considering that appropriate drainage will be installed on site.
3 Assumes piling will be required.
4 For Spills during the construction and operation phase the probability of spilled contaminants interacting and contaminating the surrounding environment is assessed as low based on the assumption that, as is standard practice, there will be a Site Environmental Management Plan in place for such incidents.
5 It is assumed that appropriate measures to mitigate contamination and ground gas through monitoring and design will be implemented.

Appendix G
UXO Map

REGIONAL UNEXPLODED BOMB RISK

LONDON – West

NUMBER OF BOMBS PER BOROUGH

Borough	High Explosive	Parachute mines	Incendiary*
Acton	328	3	39
Brentford & Chiswick	338	2	68
Ealing	621	8	52
Feltham	231	2	24
Hayes & Harlington	189	2	8
Heston & Isleworth	344	4	39
Ruislip & Northwood	228	4	21
Southall	123	1	3
Wembley	493	4	32
Willensden	618	11	30
Yiewsley & West Drayton	114	0	17

London and its approaches are renowned for the heavy bombing inflicted on them during WWII. This is reflected in the number of UXB found since the war and so it is accepted that a significant risk from UXB exists across the London area. On average, less than 10% of high explosive and 50% of incendiary bombs failed to explode. This map shows the relative increase in this risk based on bombing densities.

*Larger incendiary devices only. This figure does not include the numerous smaller incendiary devices (eg. 1kg devices).

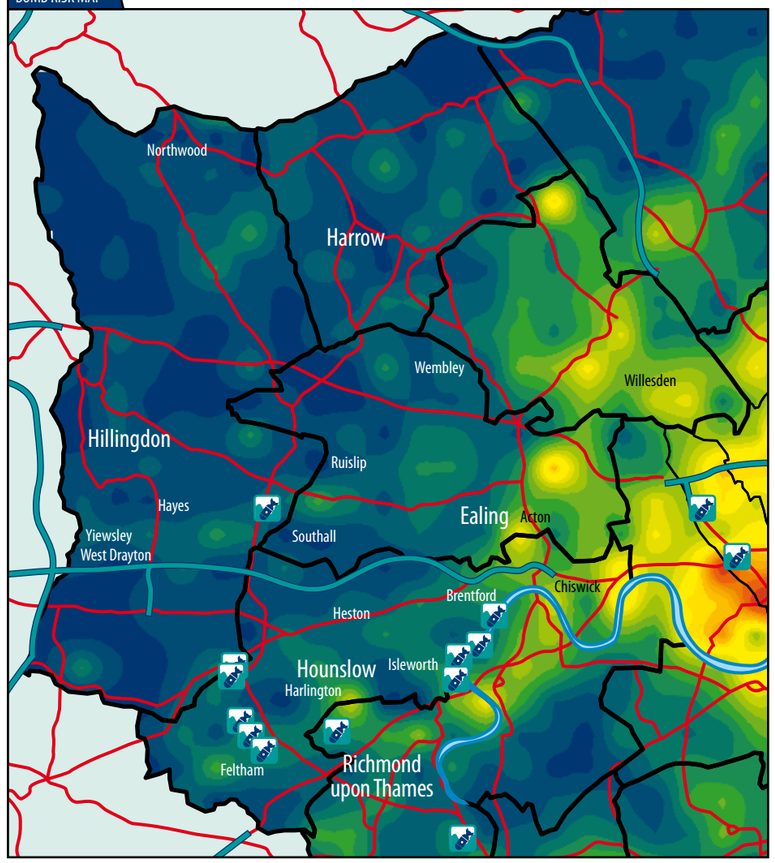
The information in this UXB risk map is derived from a number of sources and should be read in conjunction with the 'Users' Guide' attached. The often inaccessible nature and changing ground conditions in estuaries and riverbeds (eg. movement of silt that may contain ordnance) means that historical bombing records of these areas may be poor or inaccurate, and further assessment of the bomb risk may be required as part of a site specific study. Zetica cannot guarantee the accuracy or completeness of the information or data.

BOMB RISK

KEYPOINTS

Abandoned bombs

BOMB RISK MAP



UXB hazard map

This map can be used as part of a preliminary risk assessment in line with CIRIA guidance (C681).

A FOUR-STEP PROCESS

- Risk assessment and method statement from a qualified explosive ordnance clearance (EOC) operative.
- Surface geophysical survey to allow shallow groundwork.
- MAGCONE detects UXBs and obstructions on piling layout to the no-risk depth.
- Detected UXBs can be dealt with by our EOC engineers and a Clearance Certificate issued for the site.

zetica

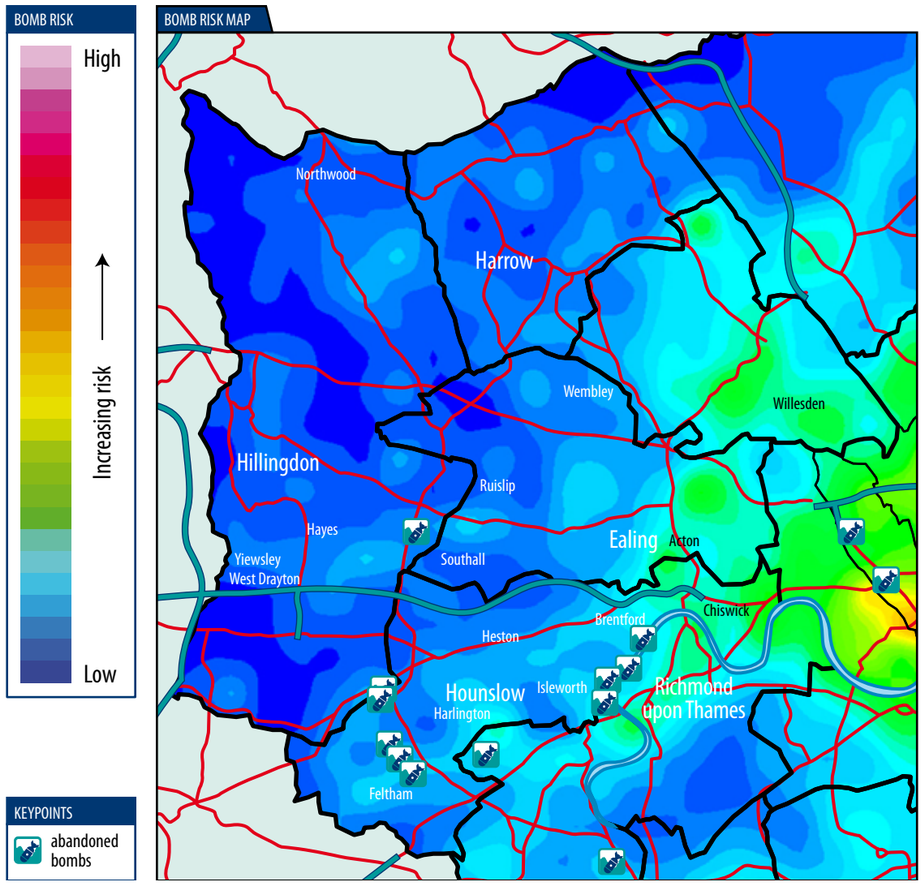
For more details on this and related services, telephone: +44 (0) 1993 886682 or visit our website: www.zetica.com

RISK MITIGATION AND INVESTIGATION

LONDON – West

Risk mitigation map

This map is based on Zetica's bomb risk map and can be used as a guide to the relative risk of intrusive activities such as piling, drilling or deep bulk excavation, and the likelihood that some form of risk mitigation may be recommended. However, this map is a guide only and, in practice, a detailed desk study may conclude that extensive risk mitigation is not required even in a high risk area.



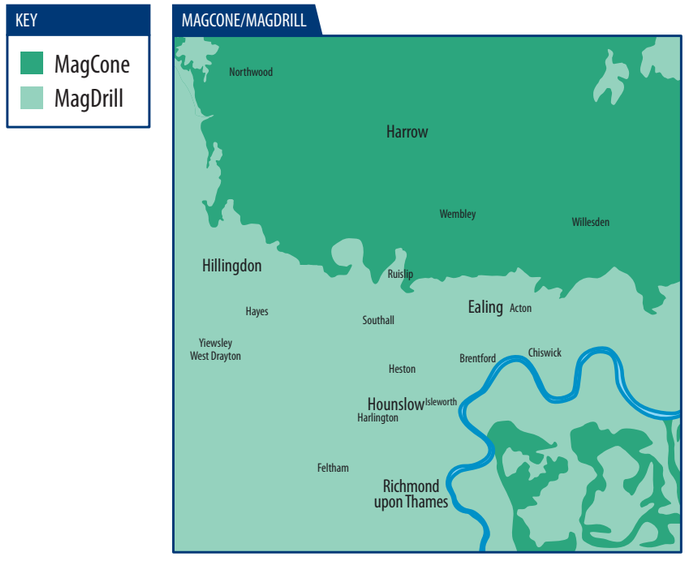
Investigation options

The unexploded bomb (UXB) risk for intrusive site works, such as drilling or piling that usually extend to depths greater than can be mapped from surface, can be effectively managed by clearing borehole or pile locations using MagCone or MagDrill techniques.

For the London area, the geology is extremely complex with a complicated succession that includes several units that are unsuitable for MagCone techniques. To give a first order approximation as to which technique might be appropriate for a site, a simplified map has been produced.

This map has been compiled from the BGS Solid and Drift map sheets 256, 257, 270 and 271. The complex geology has been reduced to three areas coloured grey, green and pink. Areas that involve units that are probably only suitable for MagDrill, which include gravels, are shown in pink. Areas that involve units probably suitable for MagCone, such as London Clay or alluvium, are coloured green. Where chalk crops out at surface or there is negligible soil cover over chalk, it is shown in grey.

This map is for indicative purposes only and specific site geology needs to be taken in to account, especially close to the boundaries shown on the map.



MagCone/MagDrill map

This map compilation provides a guide to appropriate intrusive UXB detection methods. The map is based on British Geological Survey maps at 1:50,000 scale. Soft, compressible alluvial materials can typically be investigated using MagCone (CPT-based) methods whereas sands and dense gravels from River Terrace deposits are typically investigated using MagDrill (drilling-based) methods.

The use of an inappropriate method could result in insufficient depth of detection or a less cost effective technique being used.

BOMB MAP USERS' GUIDE

Sources of information and explanation of bomb risk

Why?

Unexploded bombs (UXB) still present a risk to construction projects long after the end of the Second World War (WWII). UXBs often entered the ground unnoticed at high velocity and penetrated to a depth of several metres. Here they remain – vulnerable to disturbances from construction work. Beyond the depth of shallow excavation work, the greatest risk is to piling, drilling and probing crews. A piling rig could repeatedly hit a UXBs with considerable force before the crew realises an obstruction has been impacted. It could then be up to 72 hours before the detonator activates.

Who?

The responsibility for avoiding UXB risk usually lies with construction companies or house builders particularly those who are redeveloping urban sites. In addition, project engineering or environmental consultants are expected to advise their clients of a site's history. Other interested parties include those organisations whose employees are physically at most risk from intrusive works, normally piling companies, drillers or probing operators.

How?

UXB risk should be assessed for every site, but especially those in known heavily bombed areas or those situated near war-time strategic installations that were priority targets for enemy aircraft, for example, airfields. Zetica's regional bomb risk map is therefore a first point of reference from which the relative, potential abundance of UXBs can be judged. Consultants then advise their clients that an ordnance-risk desk study is required, which they may obtain from external sources. Construction companies or house builders who assess their own risk could choose to come direct to Zetica.

When?

Do not wait for the piling or drilling company to be on site before thinking about UXB risk – it will inevitably cause delays and higher costs. Request the regional bomb risk map from Zetica as soon as a site is being considered, and then use it to help you or your clients to decide if an ordnance-risk desk study is required.

Where?

Maps can be obtained for any county in England, Scotland, Wales or Northern Ireland – or for any London borough. They can help determine the areas that were most heavily bombed – but no part of the country should be considered 100% safe from UXB risk. Even remote rural areas can have a high risk if, for example, they were locations for decoy airfields or beacons that were lit to fool enemy pilots into thinking they had located a burning city that had been successfully hit by others in the raid.

How to use this regional map of London

This map is designed to give you an indication of the potential risk from UXBs in your area. If you are conducting work that involves excavation, piling or other disturbance of the ground, then you should use the map to identify the category of risk for your site.

The risk boundaries are a guide, compiled from data based on the political areas for which records are held; being just outside a high-risk area does not mean there is no UXB risk. You should use the map to assist in your decision of whether to investigate the UXB risk further.

Information on the regional risk remaining from UXBs in the UK

Zetica has built the largest UXB database of its kind in the UK. It includes a unique digital library of bomb census data, and maps showing key strategic points and bombing densities from the First and Second World Wars. The main sources of information include records from central government (Public Records Office), the Ministry of Defence, and the German Luftwaffe.

Using information from this database, Zetica has published maps of UXB risk on a regional, county and borough scale. The maps indicate relative degrees of UXB risk based on available records for bombing densities and known targeted areas for regions within the UK. The risk is broken down into individual boroughs, towns or cities. The data are based on the historical boroughs and are then overlaid onto the modern map. It is important to note that more-detailed research may be required for individual sites, particularly where proximity to a potential WWII target means the local risk may be higher.

Relative UXB risk across London

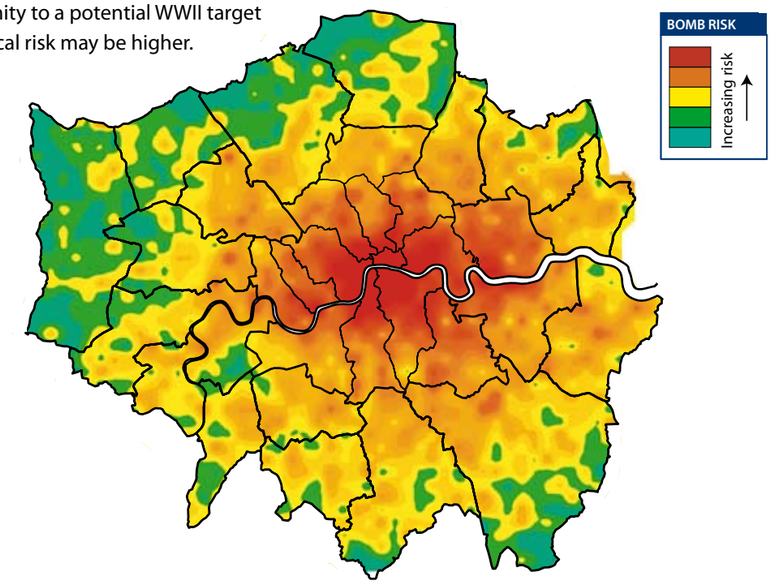
The relative risk for the London area is established by plotting the recorded bombing densities. These are represented as counts of high explosive bombs in km^2 area.

The areas coloured green represent a record of less than 10 bombs per km^2. Compared to other areas of the UK, this still represents a signficant risk.

However, this is much lower than parts of Central London, where the red colouration indicates in excess of 150 bombs falling per km^2, representing a very significant UXB risk.

Other WWII targets

Other regions with the risk of UXBs are key strategic points as defined by the government during WWII as representing potential enemy targets. Where these exist outside areas mapped as high, moderate or low risk, a site-specific assessment of the UXB risk may be required.



What to do if…

…you have a site that has a potential UXB risk

In the absence of current legislation requiring you to address the risk from UXBs, your responsibilities under health and safety legislation and regulations such as construction design and management require that you address all identified risks. The first stage is to request further advice from a professional adviser such as Zetica, or to gain more site-specific information by commissioning an ordnance-risk desk study. Then a strategy to deal with the risk can be established that is tailored to your proposed work.

…you find a suspect item or require advice

If during site works you find a suspect (ordnance-related) item, it is very important that you do not touch or move it (even if it has already been moved by an excavator). If it is clearly ordnance related, then dial 999 and ask for the police. Ensure that the area around the item is kept as clear as possible without placing yourself at risk. If you are unsure and do not wish to cause undue alarm, or you just require some advice, then you can call Zetica. We have experienced qualified UXB specialists on hand who can offer support and advice during any site works.

More-detailed procedures should be established in advance if you are in an area where the risk of finding a UXB is shown to be significant (moderate to high).

Site-specific desktop studies

Zetica is able to provide high-quality, site-specific UXB risk information for any residential, industrial or commercial property in the UK. These desktop studies provide details of the bombing density within an area and for the site itself, in order to indicate the risks of UXBs still being present. A risk assessment is provided to facilitate informed decision making on whether any further risk mitigation measures are required.