



ENVIRONMENTAL
CONSULTING

**Phase II-III
Geo-Environmental Site Assessment
Wessex Yard
8 New Lane
Havant
PO9 2JJ**

Prepared for

**PMC
106 Queens Road
Portsmouth
Hampshire
PO2 7NE**

**Omnia ref: A10708/1.1
November 2016**

Quality Assurance

Remarks	Draft	
Date	November 2016	
Prepared by	Kate Duggan	
Signature		
Checked by	Dr. Adrian King	
Signature		
Authorised by	Tim Mitchell	
Signature		
Project number	A10708/1.1	

www.omnia-consulting.co.uk

Omnia Environmental Consulting Ltd.
10 Manor Court, Barnes Wallis Road, Segnesworth, Fareham, PO15 5TH
Tel: 0149 808 808

Executive Summary	
Site Address	Wessex Yard, 8 New Lane, Havant Hampshire PO9 2JJ
National Grid Reference	472139, 106616
Site Area	0.328 hectares
Current Site Use	The site is located immediately west of 8 New Lane, Havant, and comprises an irregular shaped parcel of land. At the time of the site walkover the site was an irregular parcel of land which was divided into two part. The southern section occupied by A1 Recovery, a vehicle recovery and repair company, the northern section was utilised as a scaffolding firm.
Site History	The DTS did not locate any plans from either the Hampshire Records Office or the National Gas Archives which indicated the historical layout of the former Gasworks site. However, information was obtained from the Contaminated Land Officer (CLO) which summarised information held on the Local Authority GIS system indicated that three gasometers had been located on site between c.1879 and c.1933 but did not provide details about other historical structures located on site. Information was also provided on the presence of a neighbouring infilled pit to the east, as set out on Figure 4. The pit is noted to extend to the eastern site boundary and to be infilled with an 'Unknown Waste Type'.
Environmental Setting	Environment Agency groundwater data and information provided within a statutory response from Portsmouth Water indicates that the site is located within a groundwater Source Protection Zone 1c (SPZ 1c) associated with the Bedhampton Springs In the case of the subject site the SPZ1c applies to the Chalk aquifer which is located at depth beneath a confining layer comprising the London Clay Formation and the Lambeth Group. The site is located 403m north of the SPZ1 attributed to unconfined Chalk strata. No groundwater abstraction licenses or public water supplies were identified within a 1km radius of the site, the closest being Bedhampton Ps Spring No.2 located 1091m west of the site.
Geology, Hydrology & Hydrogeology	<u>Geology</u> Made Ground was encountered within all exploratory locations. The unit generally comprised a dark brown, gravelly CLAY, comprising sub angular to sub rounded, fine to coarse flint and anthropogenic material including, brick, concrete and asphalt. Made Ground ranged from 0.80m to 5.00m in thickness, but generally ranged from 0.80m to 1.50m across the majority of the site. Locations within close proximity to, and within the historic gasometers and historic tanks WS106 and WS107, encountered a greater thickness of Made Ground ranging from 3.70m bgl to 5.00m bgl in thickness. Soils attributed to the River Terrace Deposits Member were encountered directly beneath Made Ground within all exploratory locations with the exception of BH102A, WS104, WS106 and WS107. The unit was found to comprise two distinct lithologies, the first comprising a soft to firm, brownish gravelly CLAY, with slight variations in the percentage of gravel. The gravel comprising of angular to sub rounded, fine to coarse flint. The second lithology comprised a loose, brownish yellow clayey fine to coarse grained SAND with a maximum proven thickness of 3.40m encountered within location WS101. Soils attributed to the London Clay were encountered directly beneath Made Ground or River Terrace Deposits. The unit was uniform in nature across the site, comprising a stiff grey CLAY

	Soil attributed to the Bognor Sand Member of the London Clay Formation were encountered beneath the typical London Clay. The unit was variable across the site but generally comprised a dense to very dense, greenish grey gravelly, silty fine to medium grained SAND containing gravel of sub-angular, coarse and frequently cobble sized weakly cemented SANDSTONE. <u>Hydrogeology</u> Groundwater was encountered at depths varying between 1.00 to 2.60m bgl at locations TP101, WS101 and WS106 – WS108. Given the absence of water strikes at the majority of shallow locations, and the variability in the depth to groundwater strikes, it is considered that the shallow water strikes represent locally perched water within the Made Ground. Therefore indicating that water within the Made Ground is laterally discontinuous and does not represent a continuous water body. It is considered that true groundwater was encountered within sandy and gravelly horizons within the London Clay Formation at depths ranging from 7.60 – 10.50m bgl. The presence of cohesive strata attributed to the London Clay Formation is considered to act as an aquitard with natural groundwater being at least semi-confined, as demonstrated by the recorded difference between the groundwater strikes and resting water level. The hydraulic gradient across the site has been calculated to reduce to the south west, evident of a south westerly flow direction.
Revised Conceptual Site Model	
The Revised Conceptual Site Model identified potentially active pollution linkages within the near surface in relation to the migration of vapours into buildings. The site has been classified as Characteristic Situation 2 due to the presence of elevated ground gas. This assessment is based on all areas of external areas being capped by hardstanding, however should the proposed layout vary, and soft landscaping be proposed the risk assessment and Conceptual Site Model should be revisited.	
Recommendations	
To mitigate the risks associated with vapour migration into buildings, vapour resistant membranes should be installed within all buildings. Contact should be made with the membrane provider in order to adopt a suitable membrane specification. Ground gas protection measures compliant with a Characteristic Situation 2 assessment should be adopted for the site. These should comprise a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be installed in line with guidance in BRE Report 414, and ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours. Gas and vapour membranes should be validated by a suitably qualified Engineer to confirm compliance with BRE414 and best practice. Upon completion of the inspection a validation report should be prepared for submission to the Local Authority. It is recommended that a Piling Risk Assessment is prepared to assess the potential risk to controlled waters during the piling process. Consideration should be given to the potential for mobilisation of near surface contaminants into the underlying aquifer through potential bridging of the underlying aquitard (London Clay). Depending on pile depth consideration should also be given for the potential for turbidity on the aquifer.	

If during the development stage any evidence of contamination is identified, works should be halted and contact made with a suitably qualified Environmental Consultant. As determined appropriate by the Consultant, further investigation and sampling may be required to determine the appropriate actions. Upon completion contact should be made with the regulator to achieve sign off of the works.

Table of Contents

Quality Assurance	ii
Executive Summary	iii
Table of Contents	vi
1.0 INTRODUCTION	1
1.1 Background	1
1.2 Proposed Development	1
1.3 Objectives	1
1.4 Sources of Information	1
1.5 Risk Classification	2
1.6 Limitations	2
1.7 Confidentiality	2
2.0 SITE SETTING	3
2.1 Site Details	3
2.2 Current Site Use	3
2.3 Surrounding Area	4
3.0 ENVIRONMENTAL SETTING	5
3.1 Geology & Hydrogeology	5
3.2 Hydrology	5
3.3 Geotechnical Data	5
3.4 Mining & Ground Workings	6
3.5 Radon Risk Potential	6
3.6 Industrial Land Uses	6
3.7 Sensitive Land Uses	6
4.0 PREVIOUS INVESTIGATIONS	7
4.1 Phase I Desk Top Study Former Town Gas Works, 8 New Lane, Havant, Hampshire, PO9	7
4.1.1 On-Site Historical Development	7
4.1.2 Conclusions from the Desk Study	8
4.2 Phase II Ground Investigation Report at Former Wessex Site, 8 New Lane, Havant	8
4.2.1 Findings of the Ground Investigation Report	9
4.2.2 Conclusions and Recommendations of the Ground Investigation Report	9
5.0 SITE INVESTIGATION	10
5.1 General	10
5.2 Laboratory Analysis	11
5.3 Gas and Groundwater Monitoring	11
6.0 GROUND AND GROUNDWATER CONDITIONS	12
6.1 Ground Conditions	12
6.1.1 Made Ground	12
6.1.2 Superficial Deposits	12
6.1.2 Bedrock	13
6.2 Laboratory Classification	13
6.2.1 Particle Size Distribution Tests	13
6.2.2 Soil Classification Tests	14
6.2.3 pH and Sulphate	14
6.3 In-Situ Testing	15
6.3.1 Standard Penetration Tests (SPT)	15

6.4	Groundwater Conditions	17
6.5	Side Stability and Ease of Excavation	17
6.6	Ground Gas	17
7.0	TIER 1 QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT	20
7.1	Human Health Risk Assessment	20
7.2	Controlled Waters	25
7.2.1	Perched Waters	27
7.2.3	Groundwater	27
7.3	Ground Gas	28
8.0	REVISED CONCEPTUAL SITE MODEL	30
9.0	CONCLUSIONS & RECOMMENDATIONS	31

APPENDICES

Appendix I	Limitations
Appendix II	Glossary
Appendix III	Drawings
	Figure 1 – Site Location Plan
	Figure 2 – Proposed Development
	Figure 3 – Intrusive Hole Locations
	Figure 4 - GIS and OS mapping detailing neighbouring Gas Works Pit.
Appendix IV	Exploratory Hole Logs
Appendix V	Chemical Analysis Results
Appendix VI	Origin of GAC Values
Appendix VII	Geotechnical Analysis Results

1.0 INTRODUCTION

1.1 Background

Omnia Environmental Consulting (OEC) have been commissioned by PMC Ltd to undertake a Phase II to III Geo-environmental Site Assessment at the site of a proposed residential development at Wessex Yard, 8 New Lane, Havant, PO9 2JH. A site location map is presented as Figure 1.0 in Appendix III.

The site has previously been subject to a Phase 1 Desk Top Study entitled 'Phase I Desk Top Study Site at Former Town Gas Works, 8 New Lane, Havant Hampshire report reference (15214/DS) by Soils Limited and dated October 2015. This report identified a number of potentially active pollution linkages, which were considered to have the potential to present a significant risk to human health. The site was then subjected to a Phase II-III ground investigation undertaken by Soils Ltd and reported in the entitled Phase II Ground Investigation Report at Former Wessex Site, 8 New Lane, Havant report reference (15295/GIR) dated January 2016. The Phase II report concluded that a supplementary site investigation was required to further characterise the site. The previous Desk Top Study and Ground Investigation are discussed in Section 4.

The outline proposed site layout is presented as Figure 2 (Appendix III).

1.2 Proposed Development

It is understood that the proposed development will comprise the construction of three (3no.) apartment blocks fronting onto New Lane to the west and Eastern Road to the north. The apartments are understood to range from three (3no.) to four (4no.) storeys in height and comprise a total of thirty-nine (39no.) one (1no.) and two (2no.) bedroom apartments with associated parking and areas of soft landscaping areas to the rear of the apartment blocks.

1.3 Objectives

The objectives of the Phase II-III Geo-Environmental Site Assessment are to:

- Undertake a review of previous Phase I and Phase II investigation reports pertaining to the site;
- Undertake an assessment of the near surface through intrusive site investigation;
- Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors; and,
- Provide a factual and interpretative report relating to the site and provide recommendations on any potential development issues with particular consideration of Residential, Construction Worker and Environmental receptors.

1.4 Sources of Information

Background information was sought from the following sources:

- Soils Limited Report 15214/DS – 'Phase I Desk Top Study at Former Town Gas Works, 8 New Lane, Havant Hampshire, PO9 2JJ. Dated October 2015
- Soils Limited Report 15295/GIR – Phase II Ground Investigation Report at Former Wessex Site, 8

New Lane, Havant. Dated January 2016

- Environment Agency Groundwater Vulnerability Map (www.environment-agency.gov.uk/wiyby); and,
- British Geological Survey Map Sheet 316, Fareham, Solid & Drift Edition at a scale of 1:50,000.

1.5 Risk Classification

OEC Ltd has utilised the available data to classify the site on the basis of its likely contaminated land liability and potential for geotechnical constraints in relation to the property development. The risk classification definitions are summarised below:

Risk	Definition
Low	There are unlikely to be significant contaminated land liabilities/geotechnical constraints associated with the property.
Low-Moderate	There are unlikely to be significant contaminated land liabilities/geotechnical constraints associated with the property with regard to the proposed use. However, minor issues may require further consideration in the event of a future redevelopment of the site etc.
Moderate	Some potential contaminated land liabilities/geotechnical constraints are likely to affect the property as a result of historical and/or current activities. The risks identified are unlikely to pose an immediate significant issue but the purchaser/developer may wish to make further enquiries of the vendor or undertake further environmental improvements. Redevelopment of the site will likely require further site investigation.
Moderate-High	Some potentially significant contaminated land liabilities/geotechnical constraints have been identified at the property that requires further assessment including intrusive ground investigations.
High	Significant potential contaminated land liabilities/geotechnical constraints have been identified at the property. Further assessment including intrusive ground investigation will be required to determine to level of risk and associated liability.

1.6 Limitations

The limitations of this report are presented in Appendix I.

1.7 Confidentiality

OEC has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from OEC; a charge may be levied against such approval.

2.0 SITE SETTING

2.1 Site Details

Site Address	Wessex Yard, 8 New Lane, Havant, Hampshire PO9 2JH
National Grid Reference	472139, 106616
Area	~0.33Ha

All acronyms used within this report are defined in the Glossary presented in Appendix II

A site location map is presented as Figure 1 (Appendix III).

2.2 Current Site Use

Site Description

The site at Wessex Yard, was situated immediately south east of the junction of New Lane and Eastern Road, and was accessed via an access route off New Lane. At the time of the site walkover the site comprised an irregular parcel of land which was divided into two parts. The southern section, comprising the majority of the site, was occupied by A1 Recovery, a vehicle recovery and repair company, the northern section was occupied by Total Scaffolding Supplies.

Site access was via the south western corner of the site with the access route passing between two buildings, one located either side. The southern building comprised a two storey commercial unit, rectangular in shape, aligned approximately east to west and utilised as offices for both the A1 Recovery and Practical Van Hire. An approximately triangular area of concrete hardstanding was located to the west of the building and abutting New Lane, with this area being utilised for car parking at the time of the site walkover. The building to the north of the access route was the larger of the two buildings located on site and comprised a whitewashed two storey building with a gable roof which formed a reversed 'L' shape adjacent to the western site boundary. The building appeared to have been extended to the east with a more modern brick built extension with a flat roof. At the time of the site walkover, the entire building appeared to have had several different uses including vehicle repair unit, which utilised the majority of the ground floor, tyre storage and welfare facilities. The first floor was in use as office space with additional welfare facilities.

The eastern part of the site comprised an open yard comprising hardstanding in differing states of repair. At the time of the site walkover this area was used as a storage area for recovery vehicles and crash damaged vehicles awaiting collection or repair.

Located just to north east of the main building and immediately south of the boundary with the scaffolding yard occupying the northern area of the site were two rectangular metal Above Ground Storage Tanks (ASTs) comprising a smaller tank atop a larger tank. Adjacent to the rectangular ASTs was an IBC measuring ~1.00m(l) x 1.00m(w) x 1.00m(h) (~1,000 litres) which appeared to be utilised for the storage of waste fuel storage tank. A yellow spill tray was located beneath the IBC to mitigate against leaks.

To the south west of the above storage tanks and located on the north gable end of the building was a roller shutter door which permitted access to the workshop area of the building. Adjacent to the

left (east) of the roller shutter door was a dark grey/black rectangular tank understood to have been used for the storage of oil. To the north of the roller shutter door was a wash down area, with surface drainage which is understood to have been connected to an interceptor system.

The northern area of the site was utilised as a storage area for scaffolding equipment including differing lengths of scaffolding bars, couplings and associated equipment. A portacabin, which served as an office was located in the northeast area of the site adjacent to the northern site boundary. Access to the northern area of the site was via a second site entrance in the northeast corner of the site and was accessed from Eastern Road. The whole of the northern area was covered by concrete hardstanding which was observed to be in good condition, with the exception of a small rectangular area approximately 1.50m wide by 2.00m in length which comprised soft standing at the time of the site walkover and is understood to have been previously broken out and backfilled as part of a former site investigation.

2.3 Surrounding Area

The surrounding land uses are summarised below:

Direction	Land Use
North	Cemetery (north) and residential with private gardens (north west)
East	Commercial properties and electricity substation associated with the railway.
South	Commercial building and railway line.
West	Residential with private gardens with commercial units beyond.

3.0 ENVIRONMENTAL SETTING

3.1 Geology & Hydrogeology

The British Geological Survey (BGS) map for the site (Sheet 316, Fareham, Solid and Drift Edition at a scale of 1:50,000) indicates that the site is underlain by the following geological sequence:

Geological Unit	Classification	Description	Aquifer Classification
Superficial	River Terrace Deposits (undifferentiated)	Sand, silt and clay	Secondary (A) Aquifer
Bedrock	London Clay Formation (Northern Half)	Clay, silt and sand	Unproductive Strata
	Bognor Sand Member (Southern Half)	Sand	Secondary (A) Aquifer

Environment Agency groundwater data and information provided within a statutory response from Portsmouth Water indicates that the site is located within a groundwater Source Protection Zone 1c (SPZ 1c) associated with the Bedhampton Springs. SPZ 1c is a relatively new definition which is applied to aquifers which were previously considered to be protected from contamination by low permeability overlying geology, but which could be affected by deep subsurface activities such as piling.

In the case of the subject site the SPZ1c applies to the Chalk aquifer which is located at depth beneath a confining layer comprising the London Clay Formation and the Lambeth Group. The site is located 403m north of the SPZ1 attributed to unconfined Chalk strata. No groundwater abstraction licenses or public water supplies were identified within a 1km radius of the site, the closest being Bedhampton Ps Spring No.2 located 1091m west of the site.

It is anticipated that shallow groundwater, if present, will follow the local topography and flow in a southerly to south-westerly direction towards Portsmouth Harbour.

3.2 Hydrology

One (1no.) surface watercourse was identified within 250m from the site, comprising an unnamed tertiary river and a culvert located approximately 190m west of the site.

The site is not located within a currently defined flood risk zone, and is situated within an area with limited potential for groundwater (clearwater) flooding.

3.3 Geotechnical Data

Geotechnical Data presented within the Previous Desk Study Report identifies the following ground conditions:

Hazard	Designation
Shrink-Swell Clay	Low
Landslides	Very Low

Ground Dissolution	No Hazard
Compressible Ground	No Hazard
Collapsible Deposits	Low
Running Sand	Low

3.4 Mining & Ground Workings

The site is not located within an area that is affected by coal mining and therefore no Coal Authority Mining Report was obtaining for the purposes of this report.

The previous Desk Study did not identify any non-coal mining areas within 50m of the site and the site is not within 250m of a brine affected area

3.5 Radon Risk Potential

The previous Desk Study Report indicates that the site is within an area where less than 1% of properties are above the action level. At this level BRE publication BR211 indicates that no radon protective measures are necessary in the construction of new extensions or dwellings.

3.6 Industrial Land Uses

The previous Desk Study report indicates that there are six (6no.) industrial land uses within 100m of the site, with three (3no.) located on site and one (1no.) adjacent. The on-site industrial land uses are attributed to garage services with tanks, builder's merchants and a car breakdown and recovery service. The previous Desk Study identified a licenced waste management facility and a registered waste transfer site as potential on site contamination source. However, the report does not specify to which industrial site use these were attributed to. The one (1no.) off-site entry within 100m of the site is attributed to railway line located 14m south of the site.

3.7 Sensitive Land Uses

The previous Desk Study states the site is located within a currently defined Nitrate Vulnerable Zone (NVZ). There are no other sensitive land uses within 250m of the site.

4.0 PREVIOUS INVESTIGATIONS

The site has been subject to at least three phases of previous site investigation. A Phase I Desk Top Study (DTS) and separate Phase II Ground Investigation Report (GIR) produced by Soils Limited were provided to OEC for review, with the findings of both reports summarised in the following section. The Phase I DTS undertaken by Soils Limited indicates that monitoring installations were present on-site at the time of the initial site walkover, indicating an earlier phase of investigation, but no records of this investigation have been reviewed.

4.1 Phase I Desk Top Study Former Town Gas Works, 8 New Lane, Havant, Hampshire, PO9 2JJ (ref: 15214/DS) – October 2015

An initial Phase I Desk Top Study (DTS) was produced by Soils Limited entitled 'Phase I Desk Study Site at Former Town Gas Works, 8 New Lane, Havant, Hampshire' (ref: 15214/DS) and dated October 2015. Data from this report have been used and referenced within this section to provide information of potential sources of contaminants identified.

4.1.1 On-Site Historical Development

The Phase I DTS identified a number of potential sources of contamination which are listed in Table 4.1 below.

Table 4.1 Summary of Potential Contaminant Sources

Potential Source	Potential Contaminants	Potential Impact
On Site		
Gas Works	Metals (As, Cd, Pb, Hg, Se, Ni), Asbestos, Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH) and ammoniacal liquors	Human Health Controlled Waters Future Site Users
Gas works/pit (Historic)	Metals (As, Cd, Pb, Hg, Se, Ni), Asbestos, Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH) and ammoniacal liquors	Human Health Controlled Waters Future Site Users
Garage services	Metals (As, Cd, Pb, Hg, Se, Ni), Asbestos, Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH) Volatile Organic Compounds (VOC)	Human Health Controlled Waters Future Site Users
Above ground Storage Tanks (AST)	Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH)	Human Health Controlled Waters
Licensed Waste Management Facilities	Metals (As, Cd, Pb, Hg, Se, Ni), Asbestos, Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH)	Human Health Controlled Waters
Made Ground	Metals (As, Cd, Pb, Hg, Se, Ni), Asbestos, Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH)	Human Health
Off Site		
Historic infilled ground associated with historic gas works (4m east)	Metals (As, Cd, Pb, Hg, Se, Ni), Asbestos, Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH) Ground gas	Future Site Users
Railway Line (14m South)	Metals (As, Cd, Pb, Hg, Se, Ni), Asbestos,	Future Site Users

	Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH).	
--	---	--

All acronyms used within this report are defined in the Glossary presented in Appendix II.

4.1.2.1 Historical Gasworks Layout

The DTS did not locate any plans from either the Hampshire Records Office or the National Gas Archives which indicated the historical layout of the former Gasworks site. However, information was obtained from the Contaminated Land Officer (CLO) which summarised information held on the Local Authority GIS system. This information indicated that three gasometers had been located on site between c.1879 and c.1933 but did not provide details about other historical structures located on site.

However, information from the Local Authority did indicate ASTs with distribution points as well as a UST, all of which relate to more recent land use as a Depot.

4.1.2.2 Adjacent Infilled Pit

The DTS identified a large gravel pit associated to the development of the Gas Works, with the GIS Entry naming the entry as Gas Works/Pit, and being noted to extend directly to the eastern site boundary. Records indicate that the pit is noted to be infilled with an 'unknown waste type'. The gas work pit is identified on historical mapping from 1867 with the pit being backfilled with unknown waste type c.1953.

The GIS print out and OS mapping review are presented as Figure 4.

4.1.2 Conclusions from the Desk Study

The conclusions and recommendations of the DTS were as follows:

- The risk of impact to identified receptors for the identified potential sources was generally considered to be moderate to high. A number of potentially active pollution linkages were identified and a full intrusive investigation was advised.
- A discovery strategy and appropriate PPE were also recommended during the redevelopment of the site to address any other contamination that may be identified during the works.
- The report also stated that a geotechnical investigation may be required in order to further assess the underlying ground conditions for any future redevelopment on-site.

4.2 Phase II Ground Investigation Report at Former Wessex Site, 8 New Lane, Havant (ref: 15295/GIR) – January 2016

A Phase II Ground Investigation was undertaken by Soils Limited during November 2015 and comprised the advancement of nine (9no.) windowless sampler probeholes, ten (10no.) super heavy dynamic probe locations, groundwater monitoring of six (6no.) monitoring installations and associated chemical laboratory testing.

4.2.1 Findings of the Ground Investigation Report

The ground investigation encountered Made Ground up to 3.00m thick, immediately underlain by River Terrace Deposits proven to a maximum depth of 5.00m bgl. The Bognor Sand Formation, indicated by geological mapping was not encountered on site. Groundwater strikes were encountered at depths ranging from 2.00 – 4.00m bgl.

The Tier I human health risk assessment identified elevated concentrations of heavy metals (As & Pb), PAHs (Napthalene, Phenanthrene, Fluoranthene, Benzo(a)Anthracene, Chrysene, Benzo(b)Fluoranthene, Benzo(a)Pyrene, Indeno(1,2,3-cd)Pyrene and Dibenzo(a,h)Anthracene), TPH (C₈-C₃₅), Benzene and Xylenes which were considered to pose a significant risk to human health based on a residential end use without homegrown produce.

Groundwater samples indicated elevated concentrations of TPH Aromatic C₂₁-C₃₅ but no details were provided regarding sample depth, borehole response zones or the adopted sampling method.

4.2.2 Conclusions and Recommendations of the Ground Investigation Report

The report drew the following conclusions:

- The ground investigation identified elevated concentrations of lead and PAHs which were considered to pose a risk to human health and controlled waters; and,
- Elevated concentrations of hydrocarbons were identified in groundwater samples taken from the northeast and southwest of the site.

The report recommended that a further phase of investigation was undertaken to investigate the following:

- Investigate previously inaccessible areas of the site such as under building footprints and locate buried features such as tar wells;
- Investigate and sample near surface soil samples in areas of proposed soft landscaping and communal open space;
- Investigate and sample the contents of the former gas holders and other storage tanks on site. Characterised material used to backfill the gas holders for offsite disposal;
- If required cable percussive holes to install additional groundwater monitoring wells and characterised ground conditions for foundation design;
- Undertake a full Groundwater Risk Assessment to determine risk to groundwater;
- Undertake additional soil gas monitoring over falling and rising atmospheric pressures to confirm the gas characteristic situation for the site (to include PID monitoring to assess potential vapour risk to end-users); and,
- Based on the findings of the further intrusive investigation, the production of a remediation strategy if necessary for soils and groundwater.

5.0 SITE INVESTIGATION

5.1 General

A ground investigation was designed based on the findings of the 'Phase I Desk Study Site at Former Town Gas Works, 8 New Lane, Havant, Hampshire' and the initial 'Phase II Ground Investigation Report at Former Wessex Site, 8 New Lane, Havant', the proposed site layout as shown in Figure 2 (Appendix III). In addition, the investigation has been used to collect limited geotechnical information to assist in the design and construction of the proposed developments.

Exploratory fieldwork was conducted over the course of four (4no.) days commencing on the 12th and finishing on the 15th July 2016 and comprised the following:

Table 5.1 Summary of Fieldwork

Potential Source/Rationale	Location Hole	Type	Maximum Depth (m bgl)	Monitoring Well Response Zone (m bgl)
General spread across the site for assessment of potential contamination. Assessment of geotechnical settings. Groundwater monitoring.	BH101- BH103	Cable Percussive Borehole	14.00	8.00 - 11.00 (BH101) 7.00 - 11.00 (BH102A) 6.50 - 10.50 (BH103)
Targeting historic gasometer locations on site and to assess the potential contamination contained therein	TP101- TP102	Trial Pit Excavation	1.60	N/A
General spread across the site for assessment of potential contamination. Assessment of geotechnical settings.	WS101- WS102	Window Sample Probehole	5.00	N/A
Targeting historic gas works for potential contamination. Assessment of geotechnical settings. Ground gas monitoring Within close proximity of historic gas	WS103- WS104	Window Sample Probehole	5.00	0.50 - 2.50 (WS103) 0.50 - 3.50 (WS104)
Targeting garage for potential contamination. Assessment of geotechnical setting.	WS105	Window Sample Probehole	4.00	N/A
Targeting historic gasometer for potential contamination. Assessment of geotechnical setting	WS106- WS107	Window Sample Probehole	3.70	N/A
General spread across the site for assessment of potential contamination. Assessment of geotechnical settings. Ground gas monitoring.	WS108	Window Sample Probehole	5.00	1.00 - 2.50
General spread across the site for assessment of potential contamination. Assessment of geotechnical settings.	WS109 WS109A	Window Sample Probehole	5.00	N/A
General spread across the site for assessment of potential contamination. Assessment of geotechnical settings. Ground gas monitoring.	WS110	Window Sample Probehole	3.00	0.50 - 2.50

The exploratory hole locations are illustrated in Figure 3.0 (Appendix III). The ground conditions encountered are indicated on the exploratory hole logs, which are provided in Appendix V.

5.2 Laboratory Analysis

Selected soil samples were submitted for a range of chemical analysis including, metals, pH, water-soluble sulphate (2:1 extract), total cyanide, phenols, speciated Polycyclic Aromatic Hydrocarbons (PAHs), asbestos fibres in soil and banded Total Petroleum Hydrocarbons (TPH). Groundwater samples were submitted for a range of chemical analysis including metals, PAHs, TPH-CWG, BTEX, phenols & cresols, sulphate, pH and total cyanide.

Jones Environmental Laboratory of Deeside undertook the analytical work in accordance with UKAS accreditation where applicable and the testing results are included in Appendix VI and discussed in Section 7.

5.3 Gas and Groundwater Monitoring

Following the intrusive phase of site works, a total of six rounds of ground gas and groundwater monitoring was undertaken between the 22rd July and 19th August 2015.

Concentrations of methane (CH₄), carbon dioxide (CO₂) and Oxygen (O₂) were measured using an infra-red gas analyser (GA5000), calibrated to a reference standard (before and after each survey) and gas flow rates were measured using an internal flow pod. Gas measurements were recorded until gas concentrations stabilised for three consecutive readings, with a minimum duration of ninety seconds, at each location, at which point the maximum concentration of CH₄ and CO₂ together with the lowest concentration of O₂ were recorded.

Groundwater monitoring was undertaken using an electronic dip tape to record the depth to groundwater. Ground gas and groundwater results are presented in Section 6 and discussed in Section 7.

6.0 GROUND AND GROUNDWATER CONDITIONS

6.1 Ground Conditions

The ground investigation generally confirms the published geology and identifies the strata set out in Table 6.1 below:

Table 6.1 Summary of Strata

Strata		Typical Description	Min Depth to Top of Strata (m)	Max Depth to Top of Strata (m)	Max Thickness (m)
Made Ground		Dark brown, gravelly CLAY. Gravel is sub angular to sub rounded, fine to medium flint, brick concrete asphalt and wood.	GL	GL	5.00
River Terrace Deposits		Soft to firm, brown gravelly CLAY. Gravel is angular to sub rounded fine to coarse flint	0.50	1.50	1.50
		Loose, yellowish brown fine to medium SAND.	1.40	3.00	3.40
London Clay Formation	London Clay Formation	Firm to stiff grey CLAY	4.50	5.10	5.00
	Bognor Sand Member	Dense to very dense, greenish grey slightly silty SAND Partially cemented	7.6	11.00	6.4 proven (Base Not Encountered)

6.1.1 Made Ground

Made Ground was encountered within all exploratory locations. The unit generally comprised a dark brown, gravelly CLAY, comprising sub angular to sub rounded, fine to coarse flint and anthropogenic material including, brick, concrete and asphalt. Made Ground ranged from 0.80m to 5.00m in thickness, but generally ranged from 0.80m to 1.50m across the majority of the site. Locations within close proximity to, and within the historic gasometers and historic tanks WS106 and WS107, encountered a greater thickness of Made Ground ranging from 3.70m bgl to 5.00m bgl in thickness. A strong hydrocarbon odour was present within BH103, TP101-TP102, WS104, WS106 and WS107

6.1.2 Superficial Deposits

6.1.2.1 River Terrace Deposits

Soils attributed to the River Terrace Deposits Member were encountered directly beneath Made Ground within all exploratory locations with the exception of BH102A, WS104, WS106 and WS107, where a greater thickness of Made Ground was identified. The unit was found to comprise two distinct lithologies, the first comprising a soft to firm, brownish gravelly CLAY, with slight variations in the percentage of gravel. The gravel comprising of angular to sub rounded, fine to coarse flint, with a

maximum thickness of 1.50m being proven within window sample probehole (WS110). The second lithology comprised a loose, brownish yellow clayey fine to coarse grained SAND with a maximum proven thickness of 3.40m encountered within location WS101.

6.1.2 Bedrock

The London Clay Formation encountered during the site investigation was found to comprise two distinct lithologies, the first comprising cohesive strata of “Typical” London Clay with the second lithology comprising sands and sandstone attributed to the Bognor Sand Member of the London Clay Formation.

In order to avoid confusion, the cohesive strata are referred to simply as “London Clay” rather than London Clay Formation, with granular strata attributed to the Bognor Sand Member. The base of the London Clay Formation was not proven within any intrusive locations.

6.1.3.1 London Clay

Soils attributed to the London Clay were encountered directly beneath Made Ground or River Terrace Deposits with the top of the unit encountered at depths ranging from of 4.80m bgl to 5.10m bgl across the site. The unit was uniform in nature across the site, comprising a stiff grey CLAY.

The base of this unit was marked by a stiff, grey, gravelly CLAY with the gravel component comprising sub-rounded to well-rounded black flint. The gravelly CLAY unit was encountered at depths ranging from 7.10m bgl to 10.00m bgl with a maximum thickness of 1.00m encountered within BH101.

6.1.3.2 Bognor Sand Member

Soil attributed to the Bognor Sand Member of the London Clay Formation were encountered beneath the typical London Clay at depths ranging from 7.60m bgl to 11.00m bgl across the site. The unit was variable across the site but generally comprised a dense to very dense, greenish grey gravelly, silty fine to medium grained SAND containing gravel of sub-angular, coarse and frequently cobble sized weakly cemented SANDSTONE.

6.2 Laboratory Classification

6.2.1 Particle Size Distribution Tests

Three (3 no.) soil samples were submitted to the laboratory for Particle Size Distribution testing, the results are presented below in Table 6.2. The tests are generally consistent with the field descriptions. Geotechnical test results are presented within Appendix VII.

Table 6.2 Summary of Particle Size Distribution Tests

Location	Depth	Lab Description	Granulometric Composition (%)				
			Clay	Silt	Sand	Gravel	Cobbles
BH101	3.00	Yellowish brown clayey silty sandy GRAVEL	7	11	27	55	0
BH101	11.00	Grey sandy, GRAVEL	1	0	3	96	0
BH103	14.00	Greyish brown, clayey silty SAND	5	16	79	0	0

6.2.2 Soil Classification Tests

Soil classification testing, including Atterberg limits and moisture content are summarised in Table 6.3 below. Testing shows the clays to primarily comprise high to very high plasticity clays with a medium to high volume change potential.

Table 6.3 Summary of Soil Plasticity

Location	Depth (m)	Natural Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	Percentage passing 425µm sieve (%)	Modified Plasticity Index	Remarks
BH101	9.00	27	28	72	44	100	44	Very High Plasticity
BH102A	6.00	26	26	65	39	100	39	High Plasticity

6.2.3 pH and Sulphate

Chemical analyses for pH and soluble sulphate content are presented in Appendix VI and Appendix VIII and are summarised in Table 6.4 overleaf.

Due to the size of the dataset, site characteristic pH and SO₄ values were calculated as an average of the highest 20% of soluble sulphate and lowest 20% of pH values in line with guidance set out in BRE Special Digest 1 – Concrete in Aggressive Ground.

Utilising this approach, the soils at the site have been classified as Design Sulphate Class DS-2, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-2. However, this concrete characteristic site value represents a worst case scenario and does not represent the site as a whole.

The chemical testing results indicate a difference in soluble sulphate (SO₄) within soil samples at intrusive locations WS109A and BH101 where soluble sulphate results range from 511-1526(mg/l) identified within the north western section of the site. Due to this variability the site has been grouped into two location profiles, the first section identified as Zone A where high soluble sulphate concentrations have been identified which will be classified as DS-2, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-2. Zone B, which comprises the majority of the site, has been classified as DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1 in accordance with BRE Special Digest 1 (2005).

The zonation of the concrete classification have been identified within Figure 4.0

Table 6.4 Summary of pH and Sulphate Data

Location	Depth (m bgl)	SO ₄ in 2:1 water / soil (mg/l)	pH Value	Concrete Classification
BH101	3.00	1400	7.7	DS-2 AC2
BH101	9.00	400	8.5	DS-1 AC1
BH101	11.00	511	8.5	DS-2 AC2
BH102A	2.50	21.4	8.8	DS-1 AC1
BH102A	6.00	450	8.4	DS-1 AC1
BH103	1.50	120	7.6	DS-1 AC1
BH103	8.00	119	8.7	DS-1 AC1
WS103	2.70	10.8	7.7	DS-1 AC1
WS104	4.70	117	9.7	DS-1 AC1
WS105	3.70	172	8.5	DS-1 AC1
WS108	4.50	190	8.3	DS-1 AC1
WS109A	1.50	1526	7.3	DS-2 AC2
WS110	3.00	150	8.6	DS-1 AC1

6.3 In-Situ Testing

6.3.1 Standard Penetration Tests (SPT)

In-situ testing was undertaken within the underlying soils through Standard Penetration Tests. The results of these in-situ tests are presented in Table 6.5 below.

Table 6.5 Summary of SPT values

Location	Start Depth (m bgl)	Strata Type	CPT/SPT "N" Value	Terzaghi & Peck Approximate Undrained Shear Strength (kN/m ²)**	BS5930 Soil Strength (Cohesive)	BS5930 Soil Density (Granular)
BH101	1.20	Cohesive	37	167	Very High	-
	2.00	Cohesive	18	81	High	-
	3.00	Granular	15	-	-	Medium Dense
	4.00	Granular	11	-	-	Medium Dense
	6.50	Cohesive	15	68	Medium	-
	9.50	Cohesive	24	108	High	-
	11.00	Granular	50	-	-	-
BH102A	1.20	Cohesive	4	18	Very Low	-
	2.00	Granular	6	-	-	Very Loose
	3.00	Granular	2	-	-	Very Loose
	4.00	Cohesive	17	77	High	-
	5.00	Cohesive	13	59	Medium	-
	8.00	Cohesive	19	86	High	-
	9.00	Cohesive	50	225	Very High	-
BH103	11.00	Granular	50	-	-	Very Dense
	1.20	Cohesive	37	167	Very High	-
	2.00	Granular	22	-	-	Medium Dense
	3.00	Granular	10	-	-	Medium Dense

	6.50	Cohesive	16	77	High	-
	8.00	Granular	50	-	-	Very Dense
	9.50	Granular	50	-	-	Very Dense
	12.50	Granular	50	-	-	Very Dense
	14.00	Granular	50	-	-	Very Dense
WS101	1.20	Cohesive	24	108	High	-
	2.00	Granular	9	-	-	Loose
	3.00	Granular	13	-	-	Medium Dense
	4.00	Granular	23	-	-	Medium Dense
	5.00	Cohesive	13	59	Medium	-
WS103	1.20	Cohesive	18	81	High	-
	2.00	Cohesive	34	-	-	Medium Dense
WS104	1.20	Cohesive	1	5	Extremely Low	-
	2.00	Granular	0	0	Extremely Low	-
	3.00	Granular	21	-	-	Medium Dense
	4.00	Cohesive	22	-	-	Medium Dense
	5.00	Cohesive	12	54	Medium	-
WS105	1.20	Cohesive	17	77	High	-
	2.00	Cohesive	6	27	Low	-
	3.00	Granular	7	-	-	Loose
	4.00	Granular	22	-	-	Medium Dense
WS106	1.20	Granular	22	-	-	Medium Dense
	2.00	Granular	4	45	Medium	-
	3.00	Granular	13	59	Medium	-
WS107	1.20	Cohesive	4	18	Very Low	-
	2.00	Granular	1	-	-	Very Loose
	3.00	Cohesive	10	45	Medium	-
	4.00	Cohesive	>50	225	Very High	-
WS108	1.20	Cohesive	25	113	High	-
	2.00	Granular	18	-	-	Medium Dense
	3.00	Granular	8	-	-	Loose
	4.00	Granular	9	-	-	Loose
	5.00	Cohesive	13	59	Medium	-
WS109A	1.20	Cohesive	16	72	Medium	-
	2.00	Cohesive	15	68	Medium	-
	3.00	Granular	8	-	-	Loose
	4.00	Granular	17			Medium Dense
	5.00	Granular	21			Medium Dense
WS110	1.20	Cohesive	25	113	High	-
	2.00	Granular	17	-	-	Medium Dense
	3.00	Granular	12	-	-	Medium Dense

6.4 Groundwater Conditions

Groundwater was encountered within eight (8no.) of thirteen (13no.) intrusive locations during site works. The depth to groundwater strikes was found to be variable across the site with the water strike details summarised in Table 6.6 below

Table 6.6 Groundwater Observations

Location	Depth to Strike (m bgl)	Type	Geology
BH101	10.50	Strike	Natural
BH102A	9.40	Strike	Natural
BH103	7.60	Strike	Natural
TP101	1.50	Seepage	Made Ground
WS101	1.10	Strike	Made Ground
WS106	1.00	Strike	Made Ground
WS107	1.00	Strike	Made Ground
WS108	2.60	Strike	Made Ground

Groundwater was encountered at depths varying between 1.00 to 2.60m bgl at locations TP101, WS101 and WS106 – WS108. Given the absence of water strikes at the majority of shallow locations, and the variability in the depth to groundwater strikes, it is considered that the shallow water strikes represent locally perched water within the Made Ground. Therefore indicating that water within the Made Ground is laterally discontinuous and does not represent a continuous water body.

It is considered that true groundwater was encountered within sandy and gravelly horizons within the London Clay Formation at depths ranging from 7.60 – 10.50m bgl. The presence of cohesive strata attributed to the London Clay Formation is considered to act as an aquitard with natural groundwater being at least semi-confined, as demonstrated by the recorded difference between the groundwater strikes and resting water level.

The hydraulic gradient across the site has been calculated to reduce to the south west, evident of a south westerly flow direction, as set out on Figure 3.

6.5 Side Stability and Ease of Excavation

No collapses were encountered during the site works.

6.6 Ground Gas

The results of ground gas and groundwater monitoring are presented in Table 6.7 overleaf:

Table 6.7 Summary of Ground Gas and Groundwater Monitoring Results

Well	Date	CH ₄ Peak %v/v	CH ₄ Steady %v/v	CH ₄ GSV l/hr	CO ₂ Peak %v/v	CO ₂ Steady %v/v	CO ₂ GSV l/hr	O ₂ %v/v	Atmos (mb)	Atmos. Dynamic	Flow (l/hr)	Depth to Base (mbgl)	Depth to Water (mbgl)
WS103	22/07/2016	<0.1	<0.1	<0.0001	5.0	5.0	0.0050	15.5	1017	Falling	0.1	2.54	N/A
	29/07/2016	<0.1	<0.1	<0.0001	0.9	0.9	0.0009	19.4	1010	Falling	0.1		N/A
	05/08/2016	<0.1	<0.1	<0.0001	0.5	0.5	0.0005	21.4	1018	Rising	<0.1		N/A
	19/08/2016	<0.1	<0.1	<0.0001	6.0	6.0	0.0060	16.7	1005	Falling	0.1		N/A
	25/08/2016	<0.1	<0.1	<0.0001	4.1	4.1	0.0041	17.1	1012	Falling	<0.1		N/A
	04/09/2016	<0.1	<0.1	0.0003	6.0	6.0	0.018	13.90	1014	Steady	0.3		N/A
WS104	22/07/2016	<0.1	<0.1	<0.0001	1.9	1.9	0.0019	15.1	1016	Falling	<0.1	3.42	1.10
	27/07/2016	5.7	5.5	0.0055	6.1	6.1	0.0061	0.1	1010	Falling	0.1		1.40
	05/08/2016	<0.1	<0.1	<0.0001	5.3	5.0	0.0053	10.8	1018	Rising	<0.1		1.10
	19/08/2016	6.8	6.8	0.0068	5.0	5.0	0.0050	9.8	1004	Falling	<0.1		1.18
	25/08/2016	<0.1	<0.1	0.0001	5.5	2.9	0.0029	7.7	1013	Falling	<0.1		1.10
	04/09/2016	0.20	0.10	0.0006	0.50	0.20	0.0015	21.10	1014	Steady	0.30		1.03
WS108	22/07/2016	<0.1	<0.1	0.0001	4.7	4.7	0.0047	15.6	1016	Falling	<0.1	2.59	N/A
	29/07/2016	<0.1	<0.1	0.0001	4.2	4.2	0.0042	16.2	1009	Falling	0.1		2.52
	05/08/2016	<0.1	<0.1	0.0001	2.4	2.4	0.0024	16.7	1018	Rising	<0.1		2.33
	19/08/2016	<0.1	<0.1	0.0001	5.7	5.7	0.0057	15.6	1004	Falling	<0.1		2.52
	25/08/2016	<0.1	<0.1	0.0001	4.2	4.2	0.0042	15.8	1012	Falling	<0.1		N/A
	04/09/2016	<0.1	<0.1	0.0004	4.10	4.10	0.0164	17.30	1014	Steady	0.40		N/A

Well	Date	CH ₄ Peak %v/v	CH ₄ Steady %v/v	CH ₄ GSV l/hr	CO ₂ Peak %v/v	CO ₂ Steady %v/v	CO ₂ GSV l/hr	O ₂ %v/v	Atmos (mb)	Atmos. Dynamic	Flow (l/hr)	Depth to Base (mbgl)	Depth to Water (mbgl)
WS110	22/07/2016	<0.1	<0.1	0.0001	2.5	2.5	0.0025	17.8	1017	Falling	<0.1	2.28	N/A
	29/07/2019	<0.1	<0.1	0.0001	0.9	0.9	0.0009	19.7	1011	Falling	<0.1		N/A
	05/08/2016	<0.1	<0.1	0.0001	2.1	2.1	0.0021	18.0	1019	Rising	<0.1		N/A
	19/08/2016	<0.1	<0.1	0.0001	3.4	3.4	0.0034	16.6	1005	Falling	<0.1		N/A
	29/08/2016	<0.1	<0.1	0.0001	3.0	3.0	0.0030	16.8	1012	Falling	<0.1		N/A
	04/09/2016	<0.1	<0.1	0.0005	4.20	4.20	0.0021	14.80	1014	Steady	0.5	N/A	N/A

7.0 TIER 1 QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT

OEC has undertaken a Tier 1 qualitative risk assessment to determine if any potential contaminants within the underlying soils pose an unacceptable level of risk to the identified receptors.

7.1 Human Health Risk Assessment

At a Tier 1 stage the long term (chronic) human health toxicity of the soil has been assessed by comparing the on-site concentrations of organic and inorganic compounds with reference values published by the EA (Contaminated Land Exposure Assessment (CLEA) Soil Guideline Values (SGV)) and where absent, Generic Assessment Criteria (GACs) published by LQM/CIEH Suitable for Use Levels (S4UL) 2015. Based on the proposed residential end use with soft landscaping areas across the site, OEC has adopted screening values for a residential end use without homegrown produce. The origin of the GAC values are presented within Appendix VII.

In order to adopt a conservative approach, the Tier 1 human health risk assessment includes data obtained by the ground investigation undertaken by Soils Limited, in addition to the chemical results obtained from the current site investigation.

The results of this comparison have been summarised within Table 7.1.

Table 7.1 Summary of Inorganic and Hydrocarbon Toxicity Assessment for a Residential End Use without home grown produce

Determinand	Units	GAC	n	MC	Loc. of Exc	Pathway	Assessment
Inorganics							
Arsenic	mg/kg	40	28	109.2	WS108 @ 4.50m bgl WS109A @ 0.60 m bgl WS109A @1.50m bgl WS3 @ 0.50	1	Further Assessment Required
Beryllium	mg/kg	1.7	28	1.8	BH102 @ 6.50m bgl	1	Further Assessment Required
Boron	mg/kg	11000	28	4.7	N/A	1	No Further Action
Cadmium	mg/kg	85	28	2.6	N/A	1	No Further Action
Chromium (III)	mg/kg	910	28	127.7	N/A	1	No Further Action
Chromium (VI)	mg/kg	6	28	<2	N/A	1	No Further Action
Copper	mg/kg	7100	28	235	N/A	1	No Further Action
Lead	mg/kg	310	28	7225	WS106 @ 3.00m bgl TP101 INSIDE @ 1.60m bgl WS3 @ 0.50m bgl WS6 @ 0.80m bgl WS4 @ 2.40m bgl	1	Further Assessment Required
Mercury	mg/kg	56	28	14	N/A	2	No Further Action
Nickel	mg/kg	180	28	41.6	N/A	1	No Further

							Action
Selenium	mg/kg	430	28	1	N/A	1	No Further Action
Vanadium	mg/kg	1200	28	76	N/A	1	No Further Action
Zinc	mg/kg	40000	28	1291	N/A	1	No Further Action
Asbestos	Mass %	N.D ^(iv)	28	<0.001	WS106 @ 3.00m bgl	2	Further Assessment Required
PAH							
Phenol	mg/kg	750	28	316	N/A	2	No Further Action
Cyanide	mg/kg	791	28	2502.6	WS109A @ 0.60m bgl	2	Further Assessment Required
Naphthalene	mg/kg	2.3	28	6270	WS105 @ 0.30m bgl, WS109A @ 0.60m bgl WS1 @ 4.80m bgl WS3 @ 0.50m bgl	2	Further Assessment Required
Acenaphthylene	mg/kg	2900	28	614	N/A	3	No Further Action
Acenaphthene	mg/kg	3000	28	116	N/A	1	No Further Action
Fluorene	mg/kg	2800	28	642	N/A	1	No Further Action
Phenanthrene	mg/kg	1300	28	2570	WS1 @ 4.80m bgl	3	No Further Action
Anthracene	mg/kg	3100	28	334	N/A	3	No Further Action
Fluoranthene	mg/kg	1500	28	1550	WS1 @ 4.80	3	No Further Action
Pyrene	mg/kg	3700	28	812	N/A	3	No Further Action
Benzo(a)Anthracene	mg/kg	11	28	502	WS105 @ 0.3m bgl WS109A @ 0.60m bgl WS3 @ 0.50m bgl WS1 @ 4.80m bgl	3	Further Assessment Required
Chrysene	mg/kg	30	28	306	WS105 @ 0.3m bgl WS109A @ 0.60m bgl WS1 @ 4.80m bgl	3	Further Assessment Required
Benzo(b/k)Fluoranthene ⁽ⁱ⁾	mg/kg	110	28	632	WS105 @ 0.3m bgl WS109A @ 0.60m bgl WS1 @ 4.80m bgl	3	Further Assessment Required
Benzo(a)Pyrene	mg/kg	3.2	28	368	WS104 @ 4.70m bgl WS105 @ 0.3m bgl WS106 @ 3.00m bgl WS109A @ 0.60m bgl WS3 @ 0.50m bgl WS1 @ 4.80m bgl	3	Further Assessment Required
Indeno(123-cd)Pyrene	mg/kg	45	28	211	WS105 @ 0.3m bgl WS109A @ 0.60m bgl WS1 @ 4.80m bgl	3	Further Assessment Required
Dibenzo(a,h)Anthracene	mg/kg	0.31	28	40.3	WS104 @ 4.70m bgl WS105 @ 0.3m bgl WS106 @ 3.00m bgl WS109A @ 0.60m bgl WS3 @ 0.50m bgl WS1 @ 4.80m bgl	3	Further Assessment Required
Benzo(ghi)Perylene	mg/kg	360	28	142	N/A	3	No Further

							Action
TPH (Banded)							
TPH C ₅ -C ₆ (aliphatic)	mg/kg	42	19	<1	N/A	2	No Further Action
TPH C ₆ -C ₈ (aliphatic)	mg/kg	100	19	0.204	N/A	2	No Further Action
TPH C ₈ -C ₁₀ (aliphatic)*	mg/kg	27	19	244	WS106 @ 3.00m bgl WS109A @ 0.60m bgl	2	Further Assessment Required
TPH C ₁₀ -C ₁₂ (aromatic)*	mg/kg	130	19	79	N/A	1	No Further Action
TPH C ₁₂ -C ₁₆ (aromatic)*	mg/kg	1100	19	305	N/A	1	No Further Action
TPH C ₁₆ -C ₂₁ (aromatic)*	mg/kg	1900	19	1546	N/A	1	No Further Action
TPH C ₂₁ -C ₄₀ (aromatic)*	mg/kg	1900	19	5810	WS105 @ 0.30m bgl WS109A @ 0.60m bgl	1	Further Assessment Required
TPH Aliphatic							
TPH C ₅ -C ₆ (aliphatic)	mg/kg	42	10	1.5	N/A	2	No Further Action
TPH C ₆ -C ₈ (aliphatic)	mg/kg	100	10	5.64	N/A	2	No Further Action
TPH C ₈ -C ₁₀ (aliphatic)	mg/kg	27	10	<2	N/A	2	No Further Action
TPH C ₁₀ -C ₁₂ (aliphatic)	mg/kg	130	10	<2	N/A	1	No Further Action
TPH C ₁₂ -C ₁₆ (aliphatic)	mg/kg	1100	10	<3	N/A	1	No Further Action
TPH C ₁₆ -C ₃₅ (aliphatic)	mg/kg	65000	10	<10	N/A	1	No Further Action
TPH Aromatic							
TPH C ₅ -C ₇ (aromatic)	mg/kg	370	10	621	WS1 @ 4.80m bgl	2	Further Assessment Required
TPH C ₇ -C ₈ (aromatic)	mg/kg	860	10	603	N/A	2	Further Assessment Required
TPH C ₈ -C ₁₀ (aromatic)	mg/kg	47	10	904	WS1 @ 4.80m bgl	2	Further Assessment Required
TPH C ₁₀ -C ₁₂ (aromatic)	mg/kg	250	10	9540	WS1 @ 4.80m bgl	1	Further Assessment Required
TPH C ₁₂ -C ₁₆ (aromatic)	mg/kg	1800	10	5667	WS1 @ 4.80m bgl	1	Further Assessment Required
TPH C ₁₆ -C ₂₁ (aromatic)	mg/kg	1900	10	7293	WS1 @ 4.80m bgl	1	Further Assessment Required
TPH C ₂₁ -C ₃₅ (aromatic)	mg/kg	1900	10	7418	WS1 @ 4.80m bgl	1	Further Assessment Required

Notes

Main Exposure Pathways: 1 = Soil Ingestion, 2 = Vapour Inhalation (indoor), 3 = Dermal Contact & Ingestion, 4 = Dust Inhalation.

Abbreviations: GAC = General Assessment Criteria, n = number of samples, MC = Maximum Concentration; Loc of Ex = Location of Exceedance.

* The Tier 1 GAC for the hydrocarbon fraction is derived from the CIEH/S4UL assessment for petroleum hydrocarbons Criteria

Working Group (CWG) for both aliphatic and aromatic compounds. OEC has utilised the lowest of the aliphatic and aromatic chain lengths in order to adopt a conservative approach, which is considered satisfactory for the protection of human health.
(i) Benzo (b) Fluoranthene (2.6mg/kg) Benzo (k) Fluoranthene (77mg/kg)

Referring to Table 7.1, the results of this direct comparison indicate that the adopted Tier 1 Screening values for a residential end use without home grown produce have been exceeded for the following determinants:

- Arsenic;
- Beryllium;
- Lead;
- Cyanide;
- Naphthalene;
- Benzo(a)Anthracene;
- Chrysene;
- Benzo(b/k)Fluoranthene;
- Benzo(a)Pyrene;
- Indeno(123-cd)Pyrene;
- Dibenzo(a,h)Anthracene;
- TPH C₈-C₁₀ (aliphatic);
- TPH C₂₁-C₄₀ (aromatic); and,
- Asbestos Fibres.

Metals

Minor exceedences of Arsenic were identified within locations WS108 (4.50m bgl) and WS109A (0.60m bgl) with the highest concentration recorded at location WS109A at a depth of 1.50m bgl.

Elevated concentrations of Lead were identified within locations TP101 (inside) at a depth of 1.60m bgl and WS107 (4.00m bgl), these positions were located in close proximity to the historic gasometer, with TP101 (Inside) located within the boundary of the gasometer structure. Lead concentrations recorded across the site were generally compliant with the Tier I screening value of (300mg/kg) with elevated concentrations exceeding this being restricted to two (2no.) locations (WS106 & TP101 (Inside)) which were both located within the boundary of the northernmost gasometer structure indicated on historic mapping. Observations made on site indicated that soil arisings from within the gasometer structure showed visual and olfactory signs of impact, whereas soils from immediately outside of the gasometer wall showed no visual or olfactory signs of impact, indicating that the gasometer structure is acting as a barrier between internal and external soils.

Given the age of the gasometer structure (c.1897-1932), it is considered that the high concentrations of lead recorded within WS106 & TP101 (Inside) could be attributed to lead paint which would have been applied to the inside of the gasometer structure.

A review of the proposed site layout indicates that all historic gasometer structures are located beneath an area of proposed hardstanding comprising car parking, and areas of raised planting.

Given that the main exposure pathway for heavy metals is via soil ingestion, it is considered that the presence of hardstanding and the proposed building footprint will sever the exposure pathway

rendering the pollution linkage inactive. It is therefore considered unlikely that elevated concentrations of lead and arsenic within the vicinity of locations WS108, WS109A, WS107, TP101 and WS107 pose a significant risk to human health.

Cyanide

Elevated concentrations of cyanide which exceeded the Tier 1 screening criteria were identified within location WS109A (0.60m bgl). Given that the main exposure pathway for cyanide is via inhalation, it is considered that elevated concentrations of cyanide in near surface soils in the vicinity of location WS109A have the potential to pose a significant risk to human health.

Asbestos Fibres

Laboratory analysis identified the presence of Chrysotile fibre bundles in a single soil sample from location WS106 at a depth of 3.00m bgl, with asbestos quantification reporting fibre concentrations of below the laboratory limit of quantification (<0.001%).

It is considered that the presence of asbestos fibres within near surface soils have the potential to pose a significant risk to constructions workers at this location. However, OEC consider that these risks will be mitigated due to the management of construction workers exposure through the use of suitable PPE and hygienic working practices as required in under HSE/CDM regulations.

When considering the risks posed to future site users, it is considered that given that the main exposure pathway is via fibre inhalation that both the sample depth and location beneath an area of hard standing will act to sever the exposure pathway, rendering the pollution linkage inactive.

Polycyclic Aromatic Hydrocarbons (PAH)

Elevated concentrations of Naphthalene, Benzo(a)Anthracene, Chrysene, Benzo(b/k)Fluoranthene, Benzo(a)Pyrene, Indeno(123-cd)Pyrene were identified within intrusive locations WS104 (4.70m bgl), WS105 (0.30m bgl), WS106 (3.00m bgl), and WS109A (0.60m bgl) with the highest concentrations recorded in WS105 (0.30m bgl) and WS109A (0.60m bgl).

The main exposure pathway for PAHs is via dermal contact and ingestion, except for naphthalene which is via vapour inhalation. Locations WS105 and WS109A are located beneath proposed building footprints and it is considered that the presence of the building footprint will act to will sever the exposure pathway for dermal contact and soil ingestion. However, it is considered that the exposure pathway for vapour inhalation will remain active and therefore has the potential to pose a significant risk to future site users.

Total Petroleum Hydrocarbons (TPH)

Elevated concentrations of Total Petroleum Hydrocarbons (TPH) C₈-C₁₀ and C₂₁-C₄₀ were identified within intrusive locations WS105 (0.30m bgl), WS106 (3.00m bgl), WS109 (0.60m bgl), and WS109A (0.60m bgl). Intrusive location WS106 is within an area of proposed car parking, the presence of hard standing will sever the exposure pathway rendering the pollution linkage inactive. However, position WS109 is located within the proposed building footprint. The exposure pathway for TPH C₈-C₁₀ is vapour inhalation therefore it is considered that mitigation measures will need to be implemented within the building footprint in the form of a hydrocarbon resistant membrane to sever the exposure

pathway.

Elevated concentrations of Total Petroleum Hydrocarbons of TPH C₂₁-C₄₀ were identified within intrusive locations WS105 at a depth of 0.30m bgl and within WS109 at a depth of 0.60m bgl. Both positions are located in an area of proposed building footprint. The exposure pathway for TPH C₂₁-C₄₀ is soil ingestion, it is therefore considered that the presence of hardstanding will severing the exposure pathway rendering it inactive. It is therefore considered is unlikely that elevated concentrations of TPH will pose a significant risk to human health.

7.2 Controlled Waters

OEC has undertaken a Tier 1 qualitative risk assessment to determine whether any potential contaminants within the underlying groundwater pose an unacceptable level of risk to the identified receptor.

For the purpose of the Tier 1 assessment all laboratory data has been compared directly to the UK Drinking Water Standards (UKDWS), due to the presence of a Secondary (A) Aquifer beneath the site. In cases where a determinant does not have a UK DWS screening value, the measured concentrations have been also been compared to the Freshwater EQS or World Health Organisation Drinking Water Standard (WHO DWS) screening values in order to adopt a conservative approach.

The groundwater results from the initial site visit have not been included in this assessment as these were considered unrepresentative. The bailer method by which these water samples were obtained is not deemed characteristic when a high suspended solid percentage is present within the sample, as this can skew the results to reflect the suspended solid content rather than reflective of the dissolved phase determinants in the underlying aquifer. The return monitoring visit utilised a peristaltic pump and YSI data logger in line with the low-low (mircopurging) methodology of water collection as preferred by the Environment Agency. This technique allows for a sample to be collected directly from formation water without overt agitation of the water column present within the monitoring pipe.

Table 7.2 Tier 1 Risk Assessment for Controlled Waters

Determinand	Units	UK Drinking Water Threshold	WHO DWS	FW EQS	n	MC	No of Ex	Loc of Ex	Assessment
Inorganics									
Arsenic	µg/l	10.0	-	50	4	29.6	-	BH101 (Groundwater) BH102A (Groundwater) WS104 (Perched)	Further Assessment Required
Cadmium	µg/l	5.0	-	2000	4	<0.5	-	-	No Further Assessment
Chromium	µg/l	50.0	-	5	4	62.7	-	BH102A (Groundwater)	Further Assessment Required
Lead	µg/l	10.0	-	7.2	4	95	1	BH102A (Groundwater)	Further Assessment Required
Mercury	µg/l	1.0	-	1	4	<1	-	-	No Further Assessment

Nickel	µg/l	20.0	-	20	4	138	-	BH102A (Groundwater)	Further Assessment Required
Selenium	µg/l	10.0	-	20	4	<3	-	-	No Further Assessment
Copper	µg/l	2000.0	-	1	4	157	-	-	No Further Assessment
Zinc	µg/l	-	-	50	4	335	-	BH102A (Groundwater)	Further Assessment Required
PAH									
Cyanide	µg/l	50.0	7.0	50	4	570	-	BH103 (Groundwater) WS104 (Perched water)	Further Assessment Required
Naphthalene	µg/l	-	-	2.4	4	1.6	-	-	No Further Assessment
Anthracene	µg/l	-	-	0.1	4	0.44	0.75	WS104 (Perched Water)	Further Assessment Required
Fluoranthene	µg/l	-	-	0.1	4	1.36	3	WS104 (Perched Water)	Further Assessment Required
Benzo(a)Pyrene	µg/l	-	0.7	0.05	4	0.02	-	-	No Further Assessment
Indeno(123-cd)Pyrene	µg/l	-	-	0.2	4	<0.01	-	-	No Further Assessment
Benzo(ghi)Perylene	µg/l	-	-	0.2	4	<0.01	-	-	No Further Assessment
PAHs (sum of 4) ^(*)	µg/l	0.1	-	-	4	0.04	-	-	No Further Assessment
TPH Aliphatics									
TPH C ⁸ -C ¹⁰	µg/l	-	15,000	20	4	<5	-	-	No Further Assessment
TPH C ¹⁰ -C ¹²	µg/l	-	15,000	-	4	<5	-	-	No Further Assessment
TPH C ¹² -C ¹⁶	µg/l	-	300	-	4	<10	-	-	No Further Assessment
TPH C ¹⁶ -C ²¹	µg/l	-	300	-	4	<10	-	-	No Further Assessment
TPH C ²¹ -C ³⁵	µg/l	-	300	-	4	<10	2	-	No Further Assessment
TPH Aromatics									
TPH C ⁸ -C ¹⁰	µg/l	-	-	20	4	<5	-	-	No Further Assessment
TPH C ¹⁰ -C ¹²	µg/l	-	100	-	4	58	-	-	No Further Assessment
TPH C ¹² -C ¹⁶	µg/l	-	100	-	4	60	-	-	No Further Assessment
TPH C ¹⁶ -C ²¹	µg/l	-	90	-	4	10	-	-	No Further Assessment
TPH C ²¹ -C ³⁵	µg/l	-	90	-	4	<10	2	-	No Further Assessment

With reference to Table 7.2, it can be seen that the adopted screening values have been exceeded for the following determinands:

- Metals (Arsenic, Chromium, Lead, Nickel & Zinc);
- Cyanide; and,
- PAHs (Anthracene & Fluoranthene);

Groundwater beneath the site has been characterised as perched isolated horizons in the near surface made ground, and absent where locations have been advanced into natural strata. Groundwater was not identified as a continuous piezometric surface until deep cable percussive boreholes were advanced beyond a confining clay horizon, and encountered as a strike at a depth of 7.60-11.00m bgl. As such the risk assessment below has made the distinction between the two separate waterbodies.

7.2.1 Perched Waters

Elevated concentrations of PAH were identified within the perched water taken from location WS104. Dissolved Anthracene concentrations shows an exceedance of the Freshwater EQS with a maximum concentration of 0.97µg/l, and an exceedance of Fluoranthene with a maximum concentration of 1.36µg/l. The screening value for both Anthracene and Fluoranthene are compared to a Freshwater EQS of 0.1µg/l.

Water found at this location is considered to be perched as shallow groundwater was localised within areas of thick Made Ground across identified within positions WS104, WS106 and WS107, as detailed in Section 6.4. It is therefore considered that the elevated concentrations of Anthracene and Fluoranthene do not have the potential to present a significant risk to off site receptors as the identified water is isolated within the made ground.

In addition to this concentration of Anthracene and Fluoranthene were not present above the Laboratory Limit of Detection (LOD) within the underlying deep groundwater. This demonstrates that migration to the underlying deeper groundwater is not taking place, and as such no linkage is present between the waterbodies.

7.2.3 Groundwater

Elevated concentrations of the heavy metals of arsenic, chromium, lead, nickel and zinc were found to exceed the UK DWS in groundwater samples from location BH102A, with a single exceedance recorded in BH103 for cyanide.

Consideration has given to the likelihood that determinants originate from the subject site as follows:

Review of the borehole logs BH101-BH103 show a thickness of stiff London Clay in the range of 4.00-6.00m which confines the underlying groundwater, encountered as a strike between 7.60-11.00m bgl. It is considered that the London Clay present between near surface geology and groundwater acts as an impermeable barrier which would act to prevent the migration of contaminants to groundwater, as demonstrated in the case of the concentrations identified within the near surface perched water above.

Is therefore considered that the identified exceedances are not coupled to the historic processes undertaken on site, and are rather attributed to an off-site source. As set out in Section 4.1.2.2 an

infilled pit is present on the neighbouring site to the east. Review of groundwater flow direction, as set out in Section 6.4 indicates a south westerly flow direction across the site. BH102a is located close to the eastern site boundary and given the flow direction would support the theory that concentrations are originating on the neighbouring site. Furthermore the absence of these concentration down gradient in BH103 indicated that the determinants have a limited mobility.

Therefore, given the above it is considered that the site itself does not have the potential to present a significant risk to controlled waters, and the identified concentrations are characteristic of the background quality of the underlying groundwater.

7.3 Ground Gas

The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in CIRIA Report C665 (*Assessing risks posed by hazardous ground gases to buildings*, 2007). However, it is recommended that the full ground gas assessment and any recommended protection measures are agreed with the local authority prior to the adoption of any protection measures on-site. Furthermore, the installation of any gas protection measures should be validated by a suitably qualified engineer.

The results of the ground gas monitoring and calculated Gas Screening Values are presented in Table 6.7.

Six (6no.) consecutive groundwater and ground gas monitoring visits were undertaken within WS101, WS103, WS104, WS108 and WS110, during which concentrations of methane of 6.8% v/v were recorded. Carbon dioxide concentrations were encountered to a maximum of 6.1% v/v.

In accordance with the methodology outlined within CIRIA publication C665, OEC have utilised the results of the ground gas monitoring surveys to calculate a tentative Gas Screening Value (GSV). The maximum GSV calculated for methane was 0.0055l/hr whilst the maximum GSV for carbon dioxide was 0.018l/hr.

The GSV has been compared to the criteria outlined within CIRIA C665 to determine the level of risk to the proposed development and to ensure that the appropriate remedial options are incorporated into any future building design.

It is understood that the proposed development will comprise the construction of three (3no.) three (3no.) storey apartment block of thirty-nine (39no.) one (1no.) to two (2no.) bedroom apartments with associated parking and soft landscaping areas in the form of public open space.

Guidance for a Situation A development set out in CIRIA C665 states that the maximum GSV for both methane and carbon dioxide is <0.07l/hr for a CS-1 classification, with maximum permissible concentrations of 1% v/v (CH₄) and/or 5% v/v (CO₂). Given the identified maximum CH₄ concentration of 6.8 and CO₂ concentration of 6.1%, it is recommended that a Characteristic Situation 2 assessment is adopted for the development.

Characteristic Situation 2 assessment indicates a low to intermediate gas regime which will require low level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be installed in line with guidance in BRE Report 414, and ventilation of the sub-floor void should facilitate

a minimum of one complete volume change per 24 hours.

8.0 REVISED CONCEPTUAL SITE MODEL

Following the completion of the Tier 1 risk assessment, a revised conceptual site model has been prepared for the site and is shown in Table 8.0.

Source	Exposure Pathway	Potential Receptor	Probability of Exposure	Discussion of Pollutant Linkage
Human Health				
Elevated concentrations of cyanide, PAH and TPH in near surface.	Migration of vapour into buildings and confined spaces	Future site users	Likely	Elevated concentrations have been identified within the Made Ground at intrusive locations WS105 and WS109A, within areas of proposed building footprint. The exposure pathway for these determinants is vapour inhalation, therefore it is likely that elevated concentrations of cyanide, PAH and TPH will pose a significant risk to human health and mitigation systems in the form of a vapour resistant membrane within buildings will need to be placed.
Ground Gas (CH ₄) and (CO ₂)	Migration of ground gas into buildings and confined spaces	Future site users	Likely	Peak concentrations of CH ₄ of 6.8% v/v and CO ₂ of 6.1% to v/v indicate that an Characteristic Situation 2 assessment is appropriate for the site.

This assessment is based on all areas of external areas being capped by hardstanding, however should the proposed layout vary, and soft landscaping be proposed the risk assessment and Conceptual Site Model should be revisited.

9.0 CONCLUSIONS & RECOMMENDATIONS

Revised Conceptual Site Model

The Revised Conceptual Site Model identified potentially active pollution linkages within the near surface in relation to the migration of vapours into buildings. The site has been classified as Characteristic Situation 2 due to the presence of elevated ground gas.

This assessment is based on all areas of external areas being capped by hardstanding, however should the proposed layout vary, and soft landscaping be proposed the risk assessment and Conceptual Site Model should be revisited.

Recommendations

To mitigate the risks associated with vapour migration into buildings, vapour resistant membranes should be installed within all buildings. Contact should be made with the membrane provider in order to adopt a suitable membrane specification.

Ground gas protection measures compliant with a Characteristic Situation 2 assessment should be adopted for the site. These should comprise a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be installed in line with guidance in BRE Report 414, and ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.

Gas and vapour membranes should be validated by a suitably qualified Engineer to confirm compliance with BRE414 and best practice. Upon completion of the inspection a validation report should be prepared for submission to the Local Authority.

It is recommended that a Piling Risk Assessment is prepared to assess the potential risk to controlled waters during the piling process. Consideration should be given to the potential for mobilisation of near surface contaminants into the underlying aquifer through potential bridging of the underlying aquitard (London Clay). Depending on pile depth consideration should also be given for the potential for turbidity on the aquifer.

If during the development stage any evidence of contamination is identified, works should be halted and contact made with a suitably qualified Environmental Consultant. As determined appropriate by the Consultant, further investigation and sampling may be required to determine the appropriate actions. Upon completion contact should be made with the regulator to achieve sign off of the works.

APPENDIX I
LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between OE Ltd and the Client as indicated in Section 1.2.
 2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information it has been assumed it is correct. No attempt has been made to verify the information.
 3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination, which are enforced, by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.
 4. During the site walkover reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not been made known or accessible.
 5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.
 6. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.
 7. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials this is for indicative purposes only and do not constitute or replace full and proper surveys.
 8. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.
 9. OE cannot be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by OE is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by OE in this connection without their explicit written agreement there to by OE.
 10. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.
-

APPENDIX II

GLOSSARY

AST	ABOVE GROUND STORAGE TANK
BGS	BRITISH GEOLOGICAL SURVEY
BSI	BRITISH STANDARDS INSTITUTE
BTEX	BENZENE, TOLUENE, ETHYLBENZENE, XYLENES
CIEH	CHARTERED INSTITUTE OF ENVIRONMENTAL HEALTH
CIRIA	CONSTRUCTION INDUSTRY RESEARCH ASSOCIATION
CLEA	CONTAMINATED LAND EXPOSURE ASSESSMENT
CSM	CONCEPTUAL SITE MODEL
DNAPL	DENSE NON-AQUEOUS PHASE LIQUID (CHLORINATED SOLVENTS, PCB)
DWS	DRINKING WATER STANDARD
EA	ENVIRONMENT AGENCY
EQS	ENVIRONMENTAL QUALITY STANDARD
GAC	GENERAL ASSESSMENT CRITERIA
GL	GROUND LEVEL
GSV	GAS SCREENING VALUE
HCV	HEALTH CRITERIA VALUE
ICSM	INITIAL CONCEPTUAL SITE MODEL
LNAPL	LIGHT NON-AQUEOUS PHASE LIQUID (PETROL, DIESEL, KEROSENE)
ND	NOT DETECTED
LMRL	LOWER METHOD REPORTING LIMIT
NR	NOT RECORDED
PAH	POLY AROMATIC HYDROCARBON
PCB	POLY-CHLORINATED BIPHENYL
PID	PHOTO IONISATION DETECTOR
QA	QUALITY ASSURANCE
SGV	SOIL GUIDELINE VALUE
SPH	SEPARATE PHASE HYDROCARBON
SP.TPH (CWG)	TOTAL PETROLEUM HYDROCARBON (CRITERIA WORKING GROUP)
SPT	STANDARD PENETRATION TEST
SVOC	SEMI VOLATILE ORGANIC COMPOUND
UST	UNDERGROUND STORAGE TANK
VCCS	VIBRO CONCRETE COLUMNS
VOC	VOLATILE ORGANIC COMPOUND
WTE	WATER TABLE ELEVATION
UNITS	
M	METRES
KM	KILOMETRES
%	PERCENT
%V/V	PERCENT VOLUME IN AIR
MB	MILLI BARS (ATMOSPHERIC PRESSURE)
L/HR	LITRES PER HOUR
µG/L	MICROGRAMS PER LITRE (PARTS PER BILLION)
PPB	PARTS PER BILLION
MG/KG	MILLIGRAMS PER KILOGRAM (PARTS PER MILLION)
PPM	PARTS PER MILLION
MG/M ³	MILLIGRAM PER METRE CUBED
M BGL	METRES BELOW GROUND LEVEL

M BCL	METRE BELOW COVER LEVEL
MAOD	METRES ABOVE ORDNANCE DATUM (SEA LEVEL)
KN/M ²	KILO NEWTONS PER METRE SQUARED
μM	MICRO METRE
