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ST BARNABAS HOSPICE
COLUMBIA DRIVE
WORTHING
WEST SUSSEX

FACTUAL AND INTERPRETATIVE REPORT ON THE GROUND INVESTIGATION

Report No. LW21058 March 2010

Report prepared for the benefit of:

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PHASE 1 CONTAMINATION ASSESSMENT (DESK STUDY)	
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FACTUAL AND INTERPRETATIVE REPORT ON THE GROUND INVESTIGATION

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1. INTRODUCTION

It is proposed to redevelop the existing St Barnabas Hospice Site at Columbia Drive, Worthing, West Sussex for the construction of a number of two storey residential units with associated gardens, soft landscaping areas and car parking.

Ashdown Site Investigation Limited was commissioned to carry out a combined geotechnical and contamination risk assessment of the Site by Mr C Wiggins of:

Wilmington Homes Limited
Thatcher's
The Thatchway
Angmering
West Sussex
BN16 4HJ

The instruction to proceed was received by email dated 17th February 2010. The report is prepared for the benefit of the developer Wilmington Homes Ltd, the housing association Worthing Homes Ltd and the contractor William Blunt Building Contractors Ltd.

The purpose of the works was to:

i. assess the expected geology and hydrogeology underlying the Site;
ii. establish the development history and most recent Site use;
iii. identify potential sources of on-site and off-site contamination;
iv. establish the potential for on-site migration of contamination from off-site sources;
v. identify sensitive receptors that may be at risk from any contamination migrating from the Site and develop a preliminary conceptual model;
vi. assess ground and near surface groundwater conditions prevailing at the Site;
vii. investigate the form and type of existing foundation footings;
viii. provide information to assist others in undertaking the design of foundations and ground floors;
ix. test for the presence of potentially hazardous contamination and gas in the ground;
x. provide a quantitative contamination risk assessment; and
xi. provide a quantitative site specific conceptual model.

The analysis and discussions contained in this report are based on the ground conditions encountered during an earlier intrusive investigation, together with the findings from a programme of laboratory analyses, both undertaken in May 2006 (originally reported in Ashdown Site Investigation Ltd Report Ref: LW17096, dated June 2006), a walkover survey undertaken in February 2010 and reference to historical Ordnance Survey maps and published geological and environmental information from various sources. The latter have been obtained from interrogation of database information compiled by Groundsure Limited. The possibility of a variation in ground and groundwater conditions away from the

positions investigated should not be overlooked. Groundwater conditions can vary both seasonally and due to other effects.

Copies of the historical maps and geo-environmental data referred to in this report are included in a separate bound volume, entitled Geo-Environmental Data and Historical Maps (Ashdown Site Investigation Limited, Report Number LW21058/map, dated February 2010).

It is noted that the investigation was undertaken and the report prepared specifically for the Client's project and the recommendations given may not be appropriate to alternative schemes. The copyright for the report and licence for use shall remain vested in Ashdown Site Investigation Limited (the Company) who disclaim all responsibility or liability (whether at common law or under the express or implied terms of the Contract between the Company and the Client) for any loss or damage of whatever nature in the event that this report is relied on by a third party, or is issued in circumstances or for projects for which it was not originally commissioned, or where the exploratory hole records and test results contained therein are interpreted by anyone other than the Company.

The general methodology adopted for the investigation of the Site follows the guidance published within:

- BS10175:2001 Investigation of Potentially Contaminated Sites - Code of Practice;
- BS5930:1999: Code of Practice for Site Investigations;
- CLR11 - Model Procedures for the Management of Land Contamination;
- PPS23 Planning and Pollution Control;
- Environment Agency Research and Development Publication 20, 1999 "Methodology for the Derivation of Remedial Targets for Soil and Groundwater to protect water resources".

The risk assessment presented in this report follows 'source-pathway-receptor' techniques for the determination of whether a site is contaminated, which are standard practice in the UK, being intrinsic to the Contaminated Land (England) Regulations 2000 - Part 2A of the Environmental Protection Act 1990.

The report considers end users as the most sensitive human health receptors. If significant risks to construction workers are identified by the preliminary assessment attention is drawn to this. No assessment of risk from acute exposure has been undertaken in this connection.

This report is not intended to be either an ecological or archaeological assessment. An appropriate specialist should be consulted about any concerns that may arise in this regard.

2. PHASE 1 CONTAMINATION ASSESSMENT (DESK STUDY)

2.1 Site Location and Walkover Survey

The Site comprises an irregular shaped plot of land located to the north of Columbia Drive, Worthing, West Sussex, and is centred on the approximate Ordnance Survey national grid reference TQ 1159 0459. A site location plan and site plan are presented as Figure 1 and Figure 2 respectively.

At the time of the walkover survey the Site was occupied by an operational hospice. The irregular shaped brick built building was predominantly single storey, with a first floor present on the north western wing. A gas powered boiler room was located approximately centrally within the structure.

Access to the Site was via a tarmacadam surfaced driveway from Columbia Drive to the south, towards visitor and staff car parks located on the western and northern parts of the Site. A brick built annex, concrete garage, 'portacabin', greenhouse and two timber sheds were present on the north eastern part of the Site, together with a paved area.

The area to the south east and south of the building was in use as green areas, with raised beds, a rockery and areas of lawn and seating present. A small electrical substation was present on the south eastern boundary, within a fenced off area. A large green emergency generator was present immediately to the west of the substation on a concrete plinth (understood to contain a fuel tank).

Mature and immature trees were located close to all boundaries of the Site. Trees were also present within the car parking area in the western part of the Site and the garden areas to the south and south east of the building.

2.1.1 Potential Contamination Sources Identified by Walkover Survey

The walkover survey identified the following potential sources of contamination:

On Site

- Potential PCB contamination from electrical sub station on Site.
- Potential petroleum hydrocarbon contamination from emergency generator.
- Potential localised petroleum hydrocarbon contamination from on site car parking.

No significant sources of off Site contamination have been identified by the Walkover Survey.

2.2 Geological data review

2.2.1 *Expected Geology*

The stratigraphic succession that may be anticipated on-site is presented in the following table. In preparing the table reference has been made to the British Geological Survey 1:50,000 series scale map Sheet 318, the British Geological Survey lexicon of named rock units and the maps included within Appendix A (Section 1) of the accompanying Geo-Environmental Data and Historical Maps Volume.

Table 1. Anticipated Geological Strata

Type	Stratum	Age
Superficial Deposits	Brickearth	Quaternary
Bedrock Geology	Lambeth Group	Paleocene

Brickearth

The Brickearth in this area comprises brown sandy (fine) silt or clay largely originating from the solution weathering of the previously existing chalk. The material will have been reworked by water flow to produce some lateral variability in the grain size of the soil. The Brickearth can be expected to contain a variable content of flint. It may be regarded as normally or very lightly overconsolidated.

Lambeth Group

The Lambeth Group (formerly named the Woolwich and Reading Beds) are a complex of sedimentary deposits comprising sand, silt and gravel with laterally variable clay and sand. In the lower parts of the succession the clay and sand become inter-laminated.

2.2.2 *Ground Stability & Geological Features*

A review of the data presented within the Geo-Environmental Data and Historical Maps Volume report has been undertaken. The following summarises the data and the assessment of potential risk that the ground hazard/feature may pose to the Site. Ashdown Site Investigation Ltd (ASI Ltd) has commented, where appropriate, on the potential risk to the Site from the ground hazard/feature reported by the Groundsure data.

Table 2. Ground Workings, Mining, Extraction & Natural Cavities

Section	Remarks	ASI Ltd Assessment
Ground workings	A brickworks is identified 144m to the north of the Site.	In view of the distance from the Site and the expected underlying geology this is not considered to pose a significant risk to the Site (See also Section 2.5.1).

The groundsure data indicates the absence of any significant landslips or faults within 500m of the Site.

The Site is in an area where between 1% and 3% of properties are above the action level requiring protective measures in respect of Radon Gas. However, no radon protective measures are reported by the BGS to be necessary in the construction of new dwellings. It is recommended that discussions with building control are undertaken in connection with any requirements they may have.

No significant risk to the Site associated with ground workings, mining, natural cavities or other extraction activities is reported.

The maximum hazard rating of natural subsidence within the study Site boundary (including a 50m buffer zone) is **Low**. This hazard rating is based on the interrogation of the six British Geological Survey (BGS) natural ground stability datasets (GeoSure).

There is considered to only be either a low or negligible risk of volume change susceptible clays, landslides, ground dissolution, compressible deposits, collapsible deposits or running sand deposits at the Site although the reader is referred to the site specific geotechnical assessment discussed in Section 4 of this report.

2.2.3 *Potential Contamination Sources identified by Geological Data Review*

No significant sources of contamination were identified either on or off site by the geological data review.

2.3 Environmental Data Review

Records of potentially contaminative activities, authorisations, pollution incidents and land uses recorded by the regulatory authorities and compiled by Groundsure in their EnviroInsight Report have been reviewed. Data are supplied by the British Geological Survey (BGS), Environment Agency, Health Protection Agency, The Coal Authority and Local Authorities.

Locations of registered potentially hazardous industrial or other land uses, records of pollution incidents affecting controlled water, water abstraction licenses and waste water discharge licenses are shown on the maps presented in the accompanying Geo-Environmental Data and Historical Maps Volume report.

The information and potential risks to or from the various sources is assessed below.

Table 3. Authorisation, Incidents and Registers

Section	Remarks	ASI Ltd Assessment
Records of Licensed Discharge Consents	A single entry lies within 250m and refers to the discharge of miscellaneous surface water 215m to the north of the Site.	In view of the distance from the Site this is not considered to pose a significant risk.

Table 4. Current Land Uses

Section	Remarks	ASI Ltd Assessment
Current Industrial Data	An electrical sub station and the St Barnabas Hospice are listed on the Site. The closest off Site entry lies 108m to the north east and refers to an electrical sub station.	There is a potential risk of PCB contamination from the on site sub station. In view of the distance, the off site entries are not considered to pose a significant risk. The Hospice building is not considered to pose a significant risk.

No landfills, waste sites or other potentially contaminative land uses likely to impact the site have been identified. No recorded environmentally sensitive sites have been identified in the vicinity of the Site.

2.3.1 *Potential Contamination Sources Identified by Environmental Data Review*

The following potential sources of significant contamination have been identified by the Environmental Data Review.

On Site

- Potential PCB contamination from electrical sub station.

No significant sources of off Site contamination have been identified by the Environmental Data review.

2.4 Hydrogeology and Hydrology

2.4.1 *Groundwater Vulnerability & Soil Classification*

The vulnerability of groundwater to contamination can be judged by an assessment of the underlying geology, as summarised in the following table.

Table 5. Groundwater Vulnerability

Soil Type	Geological Class	Vulnerability/ Leaching Potential	ASI Ltd Assessment
Lambeth Group	Minor Aquifer	High*	The Lambeth group comprises a generally sandy formation with inter laminated layers of clay in the deeper parts. Groundwater flow would be expected to be dominated by pore water flow within the sand layers. Clay layers may be expected to provide more significant attenuation of mobile contaminants.

* The Environment Agency has applied a default High classification. This classification is assumed where there is insufficient data within urban areas to determine an appropriate leaching potential.

2.4.2 *Abstractions Licences*

No abstraction licences are indicated within 1km of the Site.

2.4.3 *Potable Water Abstraction Licenses and Source Protection Zones (SPZs)*

No potable water abstraction licenses are indicated within 2km of the Site.

The Site does not lie within an Environment Agency Source Protection Zone with regard to the protection of the quality of groundwater that is abstracted for potable supply.

2.4.4 *Surface Water*

The data indicates that there are no surface water features, main rivers, or Environment Agency information on river quality within 250m of the Site.

2.4.5 *Flooding*

The boundary of an Environment Agency Zone 2 floodplain lies 125m to the west of the Site. There are no flood defences, areas benefiting from flood defences or areas used for flood storage within 250m of the Site.

The British Geological Survey reports a negligible susceptibility to groundwater flooding within 50m of the Site. The BGS consider the confidence rating of their data in this area to be moderate to high.

2.5 Site History

Historical Ordnance Survey maps covering the area of the Site have been reviewed. It is noted that each map presents information applicable at the time of the survey (or revision date) and is subject to surveying and cartographic errors and/or advances. Revisions to maps are made at irregular intervals and it is possible that significant developments may have taken place on or within the vicinity of the Site that have not been revealed by the maps.

In the following table 'In Vicinity of Site' generally considers features of relevance within approximately 250m of the Site boundary, but may also include more distant features if considered to be pertinent to the assessment of the development history.

At the time of the earliest historical map referenced in 1875 the Site comprised part of an open field. The surrounding area was used for farmland. A small stream aligned north east to south west is indicated approximately 30m to the north west of the Site.

Significant changes depicted on the maps are identified in the following table.

Table 6. Summary of Significant Historical Maps

Map Details	On-site	In Vicinity of Site	Significant Potential Contamination Sources
1896 1:10,560		A brickworks is shown ~260m to the north east.	
1909 1:10,560		A rectangular building is shown ~230m to the north east as part of the brickworks, two kilns are shown ~260m to the north east. The boundary of the brickworks site lies ~150m to the north east.	
1912 1:2,50		Houses are shown over the eastern part of the brick works.	
1932 1:2,500	The Site now comprises part of several small holdings	The brickworks to the north east are no longer shown.	

Map Details	On-site	In Vicinity of Site	Significant Potential Contamination Sources
1971 1:2,500		The area of the former brickworks has been extensively redeveloped for housing. Residential development is also shown to the east of the Site.	
1978 1:10,000	A cross shaped building is now shown on the footprint of the existing hospice labelled as St Barnabas Nursing Home. An electrical sub station is shown on the south eastern boundary.	The surrounding area has been developed for housing.	Potential for PCB contamination from electrical sub station.
1994 1:1,250	The nursing home has been extended to the east.		

2.5.1 *Potential Contamination Sources identified by Historical Map Review*

The following potential sources of contamination have been identified from the historical map review:

On Site

- Potential PCB contamination form electrical sub station.

No significant sources of off site contamination have been identified by the historical map review.

Although a former brickworks has been identified to the north east no significant excavation was recorded within around 200m of the Site on the historical maps. Nor has the former brickworks been recorded as a landfill by any of the data sets. In view of the above, the distance from the Site and the expected geology underlying the area of the Site, the brickworks is not considered to pose a significant risk.

2.6 Preliminary Contamination Risk Assessment

2.6.1 Basis of Preliminary Contamination Risk Assessment

An appropriate preliminary risk assessment of a site in terms of contamination status considers the potential sources of contamination, the potential receptors and how the sources and receptors may be linked (the pathways).

Potentially significant (unacceptable) risk due to contamination will only be considered to exist where a reasonable 'pollutant linkage', (a pathway from source to receptor) can be identified. A site is considered suitable for use where no significant pollutant linkages are present.

This preliminary risk assessment takes into account the proposals for the Site, key features noted from the walkover survey, information from the database search and any potential risks identified from the review of historical Ordnance Survey maps and other data.

The assessment is based on the proposed development for a number of two storey residential units with associated private gardens and areas of soft landscaping. Should the proposed end use be altered, a revised risk assessment may be required.

2.6.2 Preliminary Risk Assessment for Human Health

2.6.2.1 Potential Contamination Sources

The following potential sources of contamination that may pose a risk to end users have been identified by the desk study:

1) Potential PCB contamination from electrical sub station.
2) Potential petroleum hydrocarbon contamination from emergency generator.
3) Potential localised petroleum hydrocarbon contamination from car parking.

2.6.2.2 Potential Pathways

The following potential pathways have been identified by the desk study:

a) Dermal contact with soil (Indoor & Outdoor);
b) Direct soil and dust ingestion;
c) Consumption of homegrown produce, including soils attached to homegrown produce;
d) Inhalation of indoor and outdoor soil dust;
e) Inhalation of soil vapours;

2.6.2.3 *Preliminary Assessment of Risk to Human Health*

A number of potential sources of contamination have been identified at the Site. There is considered to be the potential for these sources to pose a significant risk to the end users of the Site by the pathways listed above.

2.6.2.4 *Conceptual Model*

A preliminary human health risk assessment conceptual model is presented in the following table of this report and is presented diagrammatically as Figure 4.

Table 7. Preliminary Human Health (End Users) Conceptual Model – Potential Pollutant Linkages and Initial Assessment of Risk

Contaminant Source	Potential Pathway(s)	Initial Assessment of Risk to Human Health
Potential PCB contamination from electrical sub station.	Dermal contact with soil (Indoor & Outdoor), Direct soil and dust ingestion, Consumption of homegrown produce, including soils attached to homegrown produce, Inhalation of indoor and outdoor soil dust.	Low
Potential petroleum hydrocarbon contamination from emergency generator.	Dermal contact with soil (Indoor & Outdoor), Direct soil and dust ingestion, Consumption of homegrown produce, including soils attached to homegrown produce, Inhalation of indoor and outdoor soil dust, Inhalation of soil vapours.	Low
Potential petroleum hydrocarbon contamination from car parking.	Dermal contact with soil (Indoor & Outdoor), Direct soil and dust ingestion, Consumption of homegrown produce, including soils attached to homegrown produce, Inhalation of indoor and outdoor soil dust, Inhalation of soil vapours.	Low

2.6.3 *Preliminary Risk Assessment for Controlled Water*

2.6.3.1 *Potential Contamination Sources*

The following potential sources of contamination that could affect controlled waters have been identified by the risk assessment:

1) Potential PCB contamination from electrical sub station.
2) Potential petroleum hydrocarbon contamination from emergency generator.
3) Potential localised petroleum hydrocarbon contamination from car parking.

2.6.3.2 *Preliminary Assessment of Risk to Controlled water*

The Site is expected to be underlain by superficial deposits of Brickearth which in turn are expected to be underlain by the Lambeth Group. The Lambeth Group is classified as a minor aquifer of high vulnerability; the high vulnerability classification being assigned in the absence of detailed data being available within the surrounding urban area. The Site does not lie within an Environment Agency Source Protection Zone with regard to the extraction of water for potable supply.

It is considered that the potentially localised petroleum hydrocarbon contamination from car parking does not represent an ongoing source of contamination. In view of the likely clayey nature of the geology below the Site any localised contamination in this area is unlikely to pose a significant risk to controlled waters below the Site.

However, the presence of an oil tank attached to the emergency generator located in the south east of the Site may pose a significant, albeit low, risk to controlled waters.

The presence of an electrical sub station may pose a risk of PCB contamination to controlled waters. In view of the size of the sub station and the nature of the underlying geology this risk is considered to be low.

2.6.3.3 *Conceptual Model*

A preliminary controlled water risk assessment conceptual model is presented in the following table of this report and is presented diagrammatically as Figure 4.

Table 8. Preliminary Controlled Water Conceptual Model – Potential Pollutant Linkages and Initial Assessment of Risk

Contaminant Source	Potential Pathway(s)	Initial Assessment of Risk to Controlled Water
Potential PCB contamination from electrical sub station.	Groundwater Flow	Low
Potential petroleum hydrocarbon contamination from emergency generator.	Groundwater Flow	Low

3.1.3 Methodology

3.1.3.1 Window Sampler Boreholes

Eight boreholes (designated WS1 to WS8) were excavated by window sampler techniques to depths of between 3.00m and 5.0m below ground level.

The window sampler rig comprises a series of 1.0m long hollow steel tubes, ranging in diameter from 35mm to 100mm, driven into the ground by means of a track-mounted drop weight. The sampler is extracted from the ground using a hydraulically operated jack. The enclosed sample is then examined and sampled via a slotted opening (window) in the side of the tube.

3.1.3.2 Hand Dug Foundation Inspection Pits

Six trial pits (designated TP1 to TP6) were excavated using hand tools to depths of between 0.95m and 1.2m below ground level, principally to investigate the form and depth of the existing foundations.

3.1.4 Sampling

Disturbed samples of soil were taken at the depths shown in the exploratory hole records and collected in either plastic bags, plastic tubs or amber jars fitted with gas tight lids. On collection, amber jars were stored in cool boxes with cooling blocks to maintain temperatures below 4°C and transferred to refrigerators upon return to the office until forwarded to the external accredited laboratory.

3.1.5 In Situ Testing

The depths of in situ testing, together with the results, are summarised on the borehole logs in Appendix A. Notes providing additional information on the tests that were performed are also included in the appendix.

Undrained Shear Strength

Undrained shear strength determinations were made in situ within the cohesive soils using a Geonor hand shear vane as part of the investigation.

Additionally undrained shear strength determinations were made within samples of the cohesive soils held in the window sampler tubes using a hand penetrometer. Although samples taken by the window sampling technique cannot be regarded as undisturbed for testing, penetrometer testing can provide a useful indication of the strength of the material.

3.1.6 *Installations*

Gas and groundwater monitoring standpipes were installed to depths of between 3.15m and 5.00m within boreholes WS1, WS2, WS3, WS7 and WS8.

Each standpipe comprises 19mm diameter slotted tube surrounded by pea gravel. The top 1.00m length of each tube is formed from plain pipe, sealed into the borehole with bentonite clay. All installations are completed with a gas tap and protected by a lockable steel cover, concreted into place flush with the ground surface. Descriptions of the installations are shown in the exploratory hole records given in Appendix A.

The standpipe installations were monitored on the 4th March 2010. No significantly elevated levels of carbon dioxide (maximum 2.2% by volume), and no methane or carbon monoxide were recorded; neither was any gas flow recorded.

3.2 Laboratory testing

Results from the laboratory tests are provided in Appendix B.

3.2.1 Geotechnical Testing

Geotechnical testing was undertaken by Ashdown Site Investigation Ltd in accordance with the methods given in BS1377:1990 Parts 1 to 8 'Methods of test for soils for civil engineering purposes'.

Notes to assist with the interpretation of the tests are contained within Appendix B.

The following tests were carried out:

Table 10. Geotechnical testing

Type of test	No. of samples tested
Moisture Content	25
Atterberg Limits	16

3.2.2 Chemical Testing

Chemical testing of selected samples was scheduled by Ashdown Site Investigation Ltd, and was undertaken by a laboratory with recognised (UKAS and MCERTS) accreditation for quality control.

The type and number of tests undertaken are detailed in the following table. The rationale for testing is discussed further in Section 5.

Table 11. Chemical testing

Determinand	No. of soil samples tested
Arsenic	9
Cadmium	9
Chromium	9
Lead	9
Mercury	9
Nickel	9
Selenium	9
Copper	9
Zinc	9
Hexavalent Chromium	9
Total Cyanide	9

Determinand	No. of soil samples tested
Free Cyanide	9
Complex Cyanide	9
Sulphide	9
Elemental Sulphur	9
Thiocyanide	9
Total Monohydric Phenols	9
Vanadium	9
pH	16
Organic Content	9
Speciated PAHs	9
Total Polychlorinated Biphenyls (PCB)	6
Speciated Petroleum Hydrocarbons	9
Water Soluble Sulphate	16

3.3 Ground Conditions

3.3.1 Stratigraphy

3.3.1.1 Surface Covering

A topsoil layer some 0.10m thick was recorded at boreholes WS1 to WS7 and trial pits TP3, TP4 and TP6.

Borehole WS8 was excavated through a tarmacadam surface some 0.15m thick.

Trial pits TP2 and TP5 recorded a pea gravel surface cover some 100mm and 150mm in thickness, respectively.

Concrete paving over a concrete blinding layer some 0.30m thick was recorded at trial pit TP1.

3.3.1.2 Made Ground

Underlying the surface cover, made ground comprising brown silty clay and sand with variable amounts of flint, brick, ash and concrete was found to depths of between 0.35m and 0.60m below ground level in boreholes WS2, WS3 and WS8; and trial pit TP5 only.

Fragments of polystyrene were noted in trial pit TP5 within the made ground soils.

Made ground was not recorded at the remaining exploratory hole positions.

3.3.1.3 Brickearth

Beneath the latter materials, undisturbed pale grey and orange brown firm to stiff silty clay with a variable quantity of gravel of flint and chalk with subordinate horizons of clayey gravel and sand was recorded to the full depth of the investigation.

These soils are considered to be representative of the Brickearth indicated to be present on the published geology map.

3.3.2 Stability and Groundwater Conditions

Whilst the trial pits remained stable, instability was generally recorded within the undisturbed soils in the boreholes.

A groundwater seepage was noted within the undisturbed Brickearth soils in borehole WS8, at 4.00m below ground level.

2.6.3.3 *Conceptual Model*

A preliminary controlled water risk assessment conceptual model is presented in the following table of this report and is presented diagrammatically as Figure 4.

Table 8. Preliminary Controlled Water Conceptual Model – Potential Pollutant Linkages and Initial Assessment of Risk

Contaminant Source	Potential Pathway(s)	Initial Assessment of Risk to Controlled Water
Potential PCB contamination from electrical sub station.	Groundwater Flow	Low
Potential petroleum hydrocarbon contamination from emergency generator.	Groundwater Flow	Low

3. FACTUAL REPORT

3.1 Ground investigation

3.1.1 Introduction

The ground investigation comprised the excavation of a series of window sampler boreholes and hand dug trial pits. The fieldwork was carried out on 8th and 9th May 2006. The exploratory hole locations are shown on the Site Plan (Figure 1).

Descriptions of the strata encountered and comments on groundwater conditions are shown in the exploratory hole records given in Appendix A. Notes to assist in the interpretation of the records are also contained in the appendix. It should be noted that the exploratory hole logs are taken from the original factual report produced by Ashdown Site Investigation Ltd, Report Ref: LW17096, dated July 2006.

3.1.2 Investigation and Sampling Strategy

The investigation comprised a mixture of targeted sampling in areas identified as posing or being subject to potentially significant risks by a phase 1 contamination assessment, together with non targeted sampling over other areas to provide spatial coverage. The following table provides a summary of the rationale behind the positioning of the exploratory holes for contamination assessment purposes.

The pattern and density of sampling adopted is considered adequate for a quantitative assessment of the extent of contamination at the Site. The results from the ground investigation, together with the desk study work, provide information allowing preparation of a quantitative risk assessment.

Table 9. Sampling Location Rationale

Exploratory Hole	Reason for positioning
Boreholes WS3, WS4 and WS5	Located adjacent to electrical sub station
Boreholes WS3 and WS4	Located adjacent to emergency generator
Borehole WS1, WS2 and WS6 to WS8	Non-targeted contamination sampling for spatial coverage.

Standing water levels of between 1.95m and 5.00m were recorded within boreholes WS1 to WS3, WS5 and WS7 on completion.

It is noted that water levels are unlikely to have equalised during the period of the intrusive investigation.

Depths to groundwater of 1.2m and 2.1m were recorded at the positions of WS1 and WS7 respectively during the monitoring undertaken on the 4th March 2010. The standpipe within borehole WS3 was recorded to be obstructed at a depth of 1.1m (and was recorded to be dry at that depth).

3.3.3 Existing Foundations

The foundation details exposed in the trial pits are shown in Figure 3 of this report.

The foundations generally appeared to comprise mass concrete strip foundations bearing at depths of between 0.90m and 1.20m below ground level. The depth of foundation was not proven in trial pit TP5, where it extended below a depth of 1.20m.

The footings were generally recorded to extend between 30mm and 90mm from the face of the wall although within trial pit TP2, the footing was noted to extend some 350mm from the wall. No projection was recorded in trial pit TP3.

All of the footings were founded into the firm to stiff Brickearth deposits.

4. GEOTECHNICAL ASSESSMENT

The geotechnical assessment has been prepared in connection with the development proposals shown on the Site Layout Plan prepared by Martin Critchell Architects (Reference 09.013/12, dated April 2009).

In summary this drawing indicates the proposed development to comprise demolition of the existing structure, and the construction of new flats and houses together with associated roads and car parking areas.

At the time of writing, no details were available concerning the loads likely to be applied to the foundations.

4.1 Foundations

4.1.1 Soil Shrinkage/Heave Potential

The fine grained Brickearth deposits have been classified as clays of low to high plasticity and with modified plasticity indices in the range of 5% to 41% the soils may exhibit a negligible to high volume change potential. It is noted that the majority of samples tested posses modified plasticity indices indicative of a medium volume change potential.

It is recommended that precautions against shrinkage and heave for any foundation system constructed within the cohesive Brickearth deposits should assume a medium volume change potential as a minimum and take into account current guidance such as that given by the National House Builders Council (NHBC).

Whilst this report has been prepared to provide advice to assist designers in undertaking detailed design, the report itself does not represent a detailed design statement. All detailed foundation design including assessment of minimum founding depths for spread foundations, requirements for sleeving or reinforcing of piled foundations and requirements for placement of void formers must take into account the volume change potential of the soil and the presence of trees (previous, present and proposed).

A tree survey was beyond the scope of the present investigation. However attention is drawn to the presence of mature and immature trees close to the boundaries of the Site, within a planted area at the location of the western car park and within the gardens to the south of the existing hospice building. It is strongly recommended that a full arboricultural survey of the Site be undertaken prior to finalising foundation depths for any proposed structures.

4.1.2 Spread Foundations

Any made ground should be regarded as potentially variable in nature and state of compaction and, as such, unsuitable as a founding medium for shallow footings.

New footings should be constructed below the made ground and any soils disturbed by the construction or removal of any previously existing foundations and services.

For design purposes, a net allowable bearing capacity of 100kN/m^2 may be assumed for the construction of spread (pad or strip) foundations up to 1m across bearing within the minimum firm Brickearth clay soils. The quoted bearing capacity is expected to limit settlement to less than 25mm. Subject to any precautions required to protect against the effects of soil shrinkage or heave, a minimum depth to formation of 0.9m should be adopted.

Attention is drawn to the presence of coarse soils encountered at approximately 2m depth within boreholes WS5 to WS7. Given the potential for mixed soil conditions to be present beneath footings, it is recommended that they be suitably reinforced both top and bottom to minimise the potential for cracking to occur due to differential settlement or alternatively further investigation should be undertaken to evaluate the presence, or otherwise, of uniform ground conditions within 1.5m depth beneath proposed footings.

4.2 Groundwater

Standing water levels were recorded between approximately 2m and 5m depth across the site at the time of the investigation. Groundwater depths of 1.2m and 2.1m were recorded at the positions of WS1 and WS7 respectively during the monitoring undertaken on the 4th March 2010. The potential for ephemeral bodies of perched groundwater at various levels within both the made ground and natural soils should not be overlooked.

Where encountered, ingress of perched water above the groundwater table is expected to be adequately managed by pumping from sumps. It is recommended that where deep excavations are required further trial pitting and pumping from proposed formation depths be undertaken in advance to more fully establish likely stability of excavations and requirements for pumping at this site.

4.3 Stability of Excavations

All excavations through made ground soils or granular Brickearth deposits must be assumed to be subject to short term instability. Excavations wholly within undisturbed natural clay soils may be assumed to be stable in the short term. Where stable excavations are required in made ground or granular natural soils or in any case where medium or long term stability is required, excavations should be suitably supported or side slopes battered back to a safe angle of repose.

Construction of stable excavations below the water table in granular soils may be problematic. As discussed above it is recommended that additional trial pitting be undertaken prior to fully establish requirements for stable excavations at this Site.

Where personnel access is required to any excavation its stability should be assessed by a suitably qualified and experienced responsible person. For general

guidance it is recommended that personnel access to unsupported excavations greater than 1.2m depth should be prohibited.

4.4 Aggressivity to Concrete

In consideration of the soils encountered beneath the site and its historical usage it is considered 'natural ground conditions' may be assumed for the purposes of assessing the aggressivity of the chemical environment for concrete classification (ACEC class). Given the noted occurrence of groundwater seepages, 'mobile groundwater' conditions should be assumed.

Chemical analysis of the soil indicates a sulphate content falling into Design Sulfate Class DS-1 of Table C1 of the Building Research Establishment Special Digest No 1 "Concrete in aggressive ground", 2005. The results of the pH tests indicate that the underlying soils are neutral to slightly alkaline.

In accordance with the BRE digest, a DS-1 Design Sulfate Class and an AC-1 ACEC classification may be assumed as a minimum for the design of concrete in contact with the ground at the site.

4.5 Ground Floors

In view of the variable thickness of made ground, the presence of soils of predominantly medium volume change potential and given that significant disturbance to the near surface soils will occur during demolition and removal of the existing structures on Site, it is recommended that ground floors be suspended for all sensitive structures.

It is recommended that ground bearing floor slabs could be employed for non sensitive areas such as cycle sheds and bin stores. Differential movement between the floor slab and structural walls and across the floor slab itself should be anticipated. It is therefore recommended that ground bearing floors should be fully debonded from structural load bearing walls and suitably reinforced top and bottom to enable spanning of soft spots. Formations should be adequately proof rolled and any excessively soft materials excavated and replaced with a suitable engineered fill. The detailing of any services through or under ground bearing floors should incorporate flexible connections and where appropriate enhanced falls.

5. PHASE 2 CONTAMINATION ASSESSMENT

5.1 Basis of Risk Assessment

Laboratory testing was undertaken to evaluate the levels of the following contaminants within the soils: Polychlorinated biphenyls (PCB) and Petroleum Hydrocarbons. In addition to this, samples from across the Site were also tested for the following commonly occurring significant contaminants for the assessment of risk to human health: arsenic; cadmium; chromium; lead (including lead compounds); mercury; nickel; selenium, cyanide, sulphide, thiocyante, monohydric phenols and polycyclic aromatic hydrocarbons (PAH). The polycyclic aromatic hydrocarbons were speciated into the sixteen individual compounds specified by the United States Environmental Protection Agency (USEPA). In consideration of the potential sources of contamination identified by the phase 1 contamination assessment the contaminants tested for are considered suitable to enable a quantitative assessment of risk to be undertaken.

Soils

The results from the majority of the analyses can be assessed by way of careful consideration of the proposed end use as well as physical features of the soil type and wider environment as part of a quantitative 'Contaminated Land Exposure Assessment' or 'CLEA model' assessment.

Quantitative risk assessment using the CLEA model is the method preferred by the regulatory authorities in the UK to assist in determining the contamination status of soils in terms of risk to human health.

5.2 Analysis of Contamination Test Results

Results from the chemical (contamination) testing are summarised in Appendix B.

A quantitative assessment of the results of this investigation has been undertaken comparing soil contaminant concentrations on Site against Soil Screening Values generated by Ashdown Site Investigation Ltd using the CLEA Model, published by the Environment Agency. For further information on the derivation of these values see the notes in Appendix C. The chemical data used within the CLEA model is also summarised within Appendix C. The data was obtained from various sources including guidance documents published by the Environment Agency and other statutory bodies.

In view of the proposed development, the soil screening values used in this assessment have been calculated using the default "Residential" land use as set out in Science Report SC050021/SR3, January 2009. The critical receptor for this land use is considered to be a young female child resident on Site from birth to age 6. Exposure routes that are considered include the potential for direct ingestion of the soil with the pathways associated with ingestion of site grown vegetables and ingestion of soil attached to vegetables, the outdoor and indoor ingestion of dust and the potential inhalation of dust and vapours.

Statistical Analysis

Statistical analysis of the data set has been undertaken in line with guidance set out in 'Comparing Soil Contamination Data with a Critical Concentration' report, published by the CIEH/ CL:AIRE (May 2008). The report replaces the (now withdrawn) guidance set out in CLR7.

The CIEH/CL:AIRE guidance provides a framework for assessing measured contaminant concentrations on a Site against user defined critical concentrations – or indicators of risk.

Under a planning scenario, the null hypothesis tested is whether the true population mean is greater than a "critical concentration". The critical concentration used within this assessment is the relevant screening value for the proposed end use.

The null hypothesis can be rejected if it can be shown (with a sufficient degree of confidence) that the true population mean lies below the critical concentration. The confidence level recommended within the guidance is 95% i.e. the statistical evidence must show that there is 95% likelihood that the true population mean lies below the critical concentration. In this instance the Site is considered suitable for the proposed use.

Where there is insufficient evidence to reject the null hypothesis, further risk assessment and/or remediation may be necessary.

Guidance on comparing soil contamination data with a critical concentration are provided in Appendix C. The summary sheets from the statistical analysis are also presented in Appendix C.

As with any statistical assessment, the number of samples considered will impact confidence in the data set, the results presented and any conclusions made. This assessment was based on a total of 5 soil samples collected from the shallow made ground and undisturbed soils recovered from depths of less than 400mm at locations provided on Figure 2. In general the soils within the data set are considered to have a pH of 8 and an organic content of 1%.

5.2.1 *Metal and Semi-Metal Contamination*

The following table summarises the calculated soil screening values along with sample means and 95th percentile upper confidence limits. Discussion of the data is presented beneath the table.

Table 12. Soil Screening Values and Upper Confidence Limits for Zootoxic Metal and Semi-Metal Contaminants

Contaminant	Soil Screening Value (mg/kg)	Sample Mean (mg/kg)	95% Upper Confidence Limit (mg/kg)	Can H_o be rejected	Evidence against H_o (%)
Arsenic	32	6.81	7.71	Yes	100
Cadmium	10	0.25	0.25	Yes	100
Chromium III	3000	23.16	35.84	Yes	100
Lead	226	92.18	356.75	**No**	**83**
Mercury	170	0.54	1.80	Yes	100
Nickel	130	16.27	20.43	Yes	100
Selenium	350	0.39	0.99	Yes	100
Chromium VI	4.3	1.00	1.00	Yes	100

The statistical analysis indicates that a slightly elevated level of lead is present within the shallow soils. Inspection of the results shows that only a single elevated concentration of lead was present in the sample taken from borehole WS8 at 0.3m depth, within the sub base materials below the car parking area.

A further four samples of the undisturbed soils taken from depths below 1m were also tested and did not record any significantly elevated concentrations of the metals tested for.

In addition to the metals discussed above, samples were also tested for the presence of cyanide, sulphate and thiocyante. No significantly elevated concentrations of these contaminants were recorded within either the shallow soils or the deeper undisturbed samples taken.

5.2.2 *Organic Contamination*

5.2.2.1 *Polycyclic Aromatic Hydrocarbons (PAHs)*

Polycyclic Aromatic Hydrocarbons (PAHs) are a group of chemicals that contain two or more benzene rings fused together. The samples tested generally recorded low concentrations of total PAHs (<5.4mg/kg) with the exception of the sample of sub base material tested from borehole WS8 (0.3m) which recorded a concentration of 145mg/kg.

Individual PAH compounds exhibit a range of physical properties and human toxicities and therefore, where they are present, a risk assessment cannot effectively be made against the total PAH concentration.

To allow an assessment to be made, the PAH concentrations within the soil samples were speciated to give concentrations of 16 individual PAHs defined by the United States Environmental Protection Agency (USEPA).

Benzo(a)pyrene and Naphthalene

Benzo(a)pyrene is recognised as a significant carcinogen and is normally considered to be the primary driver for remediation where PAH contamination is identified. It is typically a product of partly combusted fuel (soot/ exhaust residue) and it is also common in tarmacadam road pavement, coal tar, coal ash and clinker. Where it is not associated with fuel spills and, where found associated with ashy soils or tarmacadam, for example, it may not be especially volatile. As such whilst PAH in soil can be hazardous by inhalation, this is usually as dust and particles in smoke, rather than as vapours. It tends to bind readily to soils and therefore will not easily leach to groundwater, thus minimising the risk of its migration through the ground.

Naphthalene is most commonly associated with the distillation of coal tar and as such is often associated with the presence of clinker and tarmacadam road pavement. Naphthalene is the lightest PAH and consequently has a higher volatility than others. It is less tightly bound to soils than benzo(a)pyrene and therefore exhibits greater mobility.

The following table summarises the calculated soil screening values along with sample means and 95th percentile upper confidence limits. Discussion of the data is presented beneath the table.

Table 13. Soil Screening Values and Upper Confidence Limits for naphthalene and benzo(a)pyrene

Contaminant	Soil Screening Value (mg/kg)	Sample Mean (mg/kg)	95% Upper Confidence Limit (mg/kg)	Can H_o be rejected	Evidence against H_o (%)
Naphthalene*	0.6	0.25	0.25	Yes	100
Benzo(a)pyrene*	0.8	1.57	7.06	**No**	**0**

* Based on a SOM concentration of 1%

The statistical analysis of the results indicates that elevated concentrations of benzo(a)pyrene are present within the shallow soils. However, this again is due to a single elevated concentration recorded within the sample taken from borehole WS8 at 0.3m depth. All of the other shallow samples tested recorded concentrations of benzo(a)pyrene at or below the detection limit of 0.5mg/kg, indicating that benzo(a)pyrene is not endemic to the Site as a whole but rather is localised to the base materials in the area of borehole WS8.

None of the deeper samples of undisturbed soils tested recorded significantly elevated concentrations of PAH.

5.2.2.2 *Petroleum Hydrocarbons*

Petroleum hydrocarbons encompass a large number of individual chemical compounds found within substances such as petrol, diesel, lubricating oil, waxes and tar based substances. Consequently they are associated with a wide range of

land uses and encountered on a large number of sites investigated, from fuel filling stations and car maintenance garages to more innocuous land uses such as domestic garages and car parking areas.

Petroleum hydrocarbons can be split into aromatic (containing benzene rings) and aliphatic fractions. Once split into aromatic and aliphatic fractions it is necessary for assessment purposes to further speciate into fractions according to the equivalent carbon number and similarities in fate and transport properties.

Nine samples form varying depths were tested for the presence of petroleum hydrocarbons.

None of the samples taken from boreholes WS3, WS4 or WS5, located in the vicinity of the oil tank associated with the emergency generator, recorded any detectable concentrations of petroleum hydrocarbons.

The samples taken from WS2 in the southern part of the Site also recorded no detectable concentrations of petroleum hydrocarbons.

The sample taken from WS8 at 0.3m depth recorded a total concentration of 304mg/kg of petroleum hydrocarbons. Speciation shows that these were almost entirely comprised of the heavier EC_{16}-EC_{40} range, suggesting the most likely source to be either from an oil leak, or to represent an old spillage of fuel that has weathered.

Soil screening values for equivalent carbon fractions of petroleum hydrocarbons have been calculated as a joint project between LQM and CIEH and published in 'The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment' 2nd Edition, 2009." The screening values have been developed for the standard "Residential" land use as set out in Science Report SC050021/SR3, January 2009.

The following table lists the screening values for equivalent carbon weight fractions calculated for 1% organic content.

Table 14. Soil Screening Values for petroleum hydrocarbons calculated by LQM/CIEH.

Petroleum Hydrocarbon Fraction	Screening Value (mg/kg)
Aliphatic EC 5-6	30
Aliphatic EC >6-8	73
Aliphatic EC >8-10	19
Aliphatic EC >10-12	93
Aliphatic EC >12-16	740
Aliphatic EC >16-35	45000
Aliphatic EC >35-44	45000
Aromatic EC 5-7	65
Aromatic EC >7-8	120
Aromatic EC >8-10	27
Aromatic EC >10-12	69

Petroleum Hydrocarbon Fraction	Screening Value (mg/kg)
Aromatic EC >12-16	140
Aromatic EC >16-21	250
Aromatic EC >21-35	890

None of the concentrations of the individual fractions recorded within the sample from borehole WS8 exceed the relevant screening values for residential use.

5.2.2.3 Polychlorinated Biphenyls (PCB)

PCBs are a family of chemicals that were used in electrical components, such as transformers, switchgear and capacitors, because of their good electrical insulation properties, fire resistance and chemical stability. They were found to affect the immune system and to cause cancer and liver damage. In Britain their use declined rapidly in the 1970s. As a result of their toxicity and persistence in the environment they have been banned internationally since 1986. It should be assumed that any transformer or capacitor made before 1976 contains PCBs and that PCBs may still be present in components manufactured between 1976 and 1986.

A total of six samples, taken from boreholes WS3, WS4 and WS5 locatd in close proximity to the substation on Site, were tested for the presence of PCBs. None of the samples recorded concentrations above the detection limit for the test.

5.3 Quantitative Contamination Risk Assessment

5.3.1 *Quantitative Contamination Risk Assessment for Human Health*

A quantitative conceptual model of the risk to human health has been prepared based upon the following information.

5.3.1.1 *Identified Sources*

Elevated concentrations of lead and benzo(a)pyrene have been recorded within a sample taken from borehole WS8 at 0.3m depth. It is noted that this sample was removed from the pavement base materials. At the concentrations recorded the contaminants recorded in the base materials in this area of the Site may pose a risk to end users if it remains within garden or soft landscaping areas.

5.3.1.2 *Potential Sources*

Only one borehole was undertaken below the car parking areas at the Site. Some slightly elevated concentrations of petroleum hydrocarbons were recorded immediately below the surface. Although the concentrations recorded are not considered to pose a significant risk to end users there remains a potential risk, albeit very low, that other localised areas of petroleum hydrocarbon contamination may be present below other car parking areas.

5.3.1.3 *Pathways*

Pathways by which potentially contaminated soils could reasonably be expected to come into contact with potential receptors are:

a) Dermal contact with soil (Indoor & Outdoor);
b) Direct soil and dust ingestion;
c) Consumption of homegrown produce, including soils attached to homegrown produce;
d) Inhalation of indoor and outdoor soil dust;
e) Inhalation of soil vapours.

5.3.1.4 *Assessment of Risk to Human Health*

The elevated concentrations of benzo(a)pyrene and lead were recorded within the pavement base materials located immediately below the surfacing of the area of car parking. Slightly elevated concentrations of petroleum hydrocarbons, although at levels not considered to pose a significant risk to end users, were also recorded within this sample. The risk to end users is considered likely to be localised to the made ground soils below the car park.

There remains a low potential risk that other localised areas of petroleum hydrocarbon contamination may exist below other car parking areas. Attention is drawn to the Discovery Strategy in Section 5.5.

5.3.1.5 *Conceptual Model*

A quantitative human health risk assessment conceptual model is presented in the following table. The model has been constructed based on the proposed development of the Site for houses with private gardens and areas of public soft landscaping.

A diagrammatic representation of the quantitative contamination risk assessment conceptual model is presented as Figure 5.

Table 15. Quantitative Human Health Conceptual Model - Pollutant Linkages and Assessment of Risk

Contaminant Source	Potential Pathway(s)	Assessment of Risk to Human Health
Elevated concentrations of lead and benzo(a)pyrene below the car parking area in the northern part of the Site.	Dermal contact with soil (Indoor & Outdoor), Consumption of homegrown produce, including soils attached to homegrown produce, Direct soil and dust ingestion, Inhalation of indoor and outdoor soil dust.	Low
Potential for localised petroleum hydrocarbon contamination below car parking areas.	Dermal contact with soil (Indoor & Outdoor), Consumption of homegrown produce, including soils attached to homegrown produce, Direct soil and dust ingestion, Inhalation of indoor and outdoor soil dust, Inhalation of soil vapours.	Low

5.3.2 *Quantitative Contamination Risk Assessment for Controlled Water*

5.3.2.1 *Identified Sources*

Slightly elevated concentrations of petroleum hydrocarbons were recorded in borehole WS8.

5.3.2.2 *Assessment of Risk to Controlled water*

Although slightly elevated concentrations of petroleum hydrocarbons were recorded in one sample from borehole WS8, these were present in heavy carbon fractions. Due to the nature of these chemicals they exhibit extremely low solubility and mobility within the soils.

In addition to this the Brickearth deposits were recorded to comprise silty clay soils to depths in excess of 5.0m below ground level. These soils will not allow significant downward movement of groundwater and the high fines content will significantly retard the movement of any shallow contamination.

As such the Site is not considered to pose a significant risk to controlled waters.

5.3.2.3 Conceptual Model

A quantitative controlled water risk assessment conceptual model is presented in the following table.

A diagrammatic representation of the quantitative contamination risk assessment conceptual model, identifying no risk to controlled waters, is presented as Figure 5.

Table 16. Quantitative Controlled Water Conceptual Model - Pollutant Linkages and Assessment of Risk

Contaminant Source	Potential Pathway(s)	Assessment of Risk to Controlled water
No significant sources identified.	None identified	No significant pollutant linkage identified.

5.4 Risks to Other Potential Receptors

Although not statutory drivers for remedial works, the potential contamination sources identified at the Site by this investigation may present risks to other potential on-site receptors such as construction workers and services. This is discussed briefly below. Where the contamination source identified at the Site poses no specific risk to on-site receptors general guidance has been given with regards to potential contamination sources not recorded by the investigation.

5.4.1 Construction Workers

It is considered that as a minimum and in accordance with industry best practise all ground-workers should be issued with the appropriate PPE and should be instructed in safe working methods. As a precaution instructions should also be given in the recognition of potentially hazardous materials, including oily and odorous soil and water and discoloured or fibrous substances. Any oil-like substances contacting the skin must be washed off immediately using an appropriate cleanser. Operatives should be warned to avoid contact between hands and mouth before washing. The consumption of food and smoking must be confined to designated clean areas. Suitable welfare (washing) facilities should be provided.

5.4.2 Services

The risk of damage to services from the levels of petroleum hydrocarbon and PAH contamination identified is considered to be low. It is considered that the service provider's requirements represent the most informed decision when it comes to the protection of their services. It is recommended that the developer should contact all service providers with regard to specific precautions they may require.

5.4.3 Planting

The elements boron, copper and zinc are considered to be essentially non-toxic to humans and as such have not been incorporated into published guidance relating to the CLEA Model. Together with nickel, they do however have the potential to impair the growth of plants and to adversely affect aquatic life.

None of samples recorded significantly elevated concentrations of these elements. The nature of some of the made ground identified at the Site would not be considered suitable as a growing medium. Made ground may become dusty where it is exposed and may not readily support the growth of plants. A horticulturist should be consulted with regard to any specific planting schemes.

5.5 Discovery Strategy

A slightly elevated concentration of petroleum hydrocarbons was recorded within a sample from borehole WS8 at 0.3m depth. This was located within the car parking area in the north of the Site. It is recommended that once hard surfacing and associated base materials have been stripped, formations below car parking areas on the Site should be inspected by an appropriate person to confirm the materials exposed are similar to (no worse than) those recorded by the investigation. Should areas of stained or odorous material be identified additional testing should be undertaken and an appropriate risk assessment carried out to ensure that no significant risk to end users or controlled waters exists.

It is also recommended that the stripped formation below the existing hospice building in the centre of the Site is inspected following its demolition. Any suspected contamination should be tested and an appropriate risk assessment undertaken.

The oil tank and emergency generator should be appropriately decommissioned and removed from the Site. Additional testing for petroleum hydrocarbons should be undertaken below the footprint of the tank to confirm the absence of significant contamination.

In addition, should materials not previously identified or suspected of being 'contaminants' be encountered during the course of the works advice should be sought immediately on their identification and how they should be treated.

If necessary the newly identified contaminants will be subject to a revised risk assessment and remediation strategy.

5.6 Handling and Disposal of Waste and Quality of Imported Materials

5.6.1 Waste Management

Soils and other materials taken for disposal should be handled, transferred and disposed of as controlled waste in accordance with the requirements of the Waste Management, Duty of Care Regulations. Copies of waste transfer notes detailing the site address, the waste type, details of the haulage contractor and full details of the disposal site must be kept.

The Site Waste Management Plans Regulations, 2008, require a site waste management plan to be prepared and implemented by clients and principal contractors for all construction projects with an estimated cost greater than £300,000 excluding VAT. The plans must record details of the construction project, estimates of the types and quantities of waste that will be produced, and confirmation of the actual waste types generated and how they have been managed. More detailed reporting requirements apply to projects exceeding £500,000.

5.6.2 Quality of Imported Soils

Full details of the source of any imported soils should be documented (including topsoil). Any material from a potentially contaminated (e.g. industrial) site should be rejected. It is recommended that chemical (contamination) testing results are obtained and supplied for comment prior to accepting the soils on Site. As a minimum the contaminants tested for should include arsenic, cadmium, chromium, lead, mercury, nickel, selenium and the polycyclic aromatic hydrocarbon benzo(a)pyrene. The material should be free from petroleum hydrocarbons, and contain no significant quantity of putrescible material (incl. wood or paper). Materials must comply with current CLEA guidance for the proposed end use of the Site.

It is stressed that the quality of any materials imported onto the Site is critical to the successful completion of any remediation works.

6. CONCLUSIONS

The following conclusions present a summary of the main findings of the investigation. However, no reliance should be placed on any point of the conclusions until the whole of the report has been read as other sections of the report may put into context the information contained herein.

6.1 Geotechnical Assessment

- The ground investigation confirmed the underlying soils to comprise a shallow and variable thickness of made ground, overlying generally firm to stiff Brickearth deposits.
- Standing water levels were recorded between approximately 2m and 5m depth across the site at the time of the intrusive investigation. Recent monitoring of the standpipes installed at the Site has recorded groundwater at approximately 1m to 2m below ground level.
- All excavations through made ground soils or granular Brickearth deposits must be assumed to be subject to short term instability. Excavations wholly within undisturbed natural clay soils may be assumed to be stable in the short term.
- Where encountered, ingress of perched water above the groundwater table is expected to be adequately managed by pumping from sumps. It is recommended that where deep excavations are required further trial pitting and pumping from proposed formation depths be undertaken in advance of construction to more fully establish likely stability of excavations and requirements for pumping at this site.
- It is recommended that precautions against shrinkage and heave for any foundation system constructed within the cohesive Brickearth deposits should assume a medium volume change potential as a minimum and take into account current guidance such as that given by the National House Builders Council (NHBC).
- A net allowable bearing capacity of 100kN/m^2 may be assumed for the construction of spread (pad or strip) foundations up to 1m across bearing within the minimum firm Brickearth clay soils.
- A DS-1 Design Sulfate Class and an AC-1 ACEC classification may be assumed as a minimum for the design of concrete in contact with the ground at the site.
- It is recommended that ground floors be suspended for all sensitive structures. Ground bearing floor slabs could be employed for non sensitive areas such as cycle sheds and bin stores.

6.2 Contamination Status Assessment

- The Site is currently occupied by a hospice and associated car parking.
- The Site does not lie within an Environment Agency Source Protection Zone with regard to the protection of the quality of groundwater that is abstracted for potable supply.
- The Site comprised open land at the time of the earliest historical map referenced in 1875. The hospice was constructed circa 1978.
- Testing of the soils below the Site has identified elevated concentrations of lead and benzo(a)pyrene within the pavement base materials below the car park in the northern part of the Site.
- Some localised remedial works are considered to be required within the car park area to protect the future site occupants where direct contact with any made ground soils can be expected i.e. areas of domestic garden and soft landscaping.
- A discovery strategy with regard to potential petroleum hydrocarbon contamination below car parking areas is discussed in Section 5.5.
- Quantitative conceptual models have been prepared of the complete pollutant linkages that have been identified in relation to human health and controlled waters. These are presented in Tables 15 and 16. A diagrammatic conceptual model is presented as Figure 5.
- It is advised that the local authority has ultimate jurisdiction over contamination assessment, and, as such, they must be involved in discussions relating to the scope of the investigation works undertaken and the conclusions drawn, along with any specific proposals for remedial action.

Ashdown Site Investigation Limited
March 2010

APPENDIX A

Exploratory Hole Notes

In Situ Testing Notes

Exploratory Hole Records

Summary of Gas Analyses and Water Depths

NOTES FOR THE INTERPRETATION OF EXPLORATORY HOLE RECORDS

1 Symbols and abbreviations

Samples

U 'Undisturbed' Sample: - also known as 'U100' or 'U4' - 100mm diameter by 450mm long. The number of blows to drive in the sampling tube is shown after the test index letter in the SPT column.
Uo Sample not obtained.
U* Full penetration of sample not obtained.
U** Full penetration obtained but limited sample recovered.
Pi Piston Sample: 'Undisturbed' sample 100mm diameter by 600mm long.
D Disturbed Sample.
R Root Sample.
B Bulk Disturbed Sample.
W Water Sample.
J Jar Sample (sample taken in amber glass jar fitted with gas tight lid)
T Tub Sample
E Environmental Sample, comprising a plastic tub, amber jar and glass vial

In situ Testing

S Standard penetration test (SPT): In the borehole record the depth of the test is that at the start of the normal 450mm penetration, the number of blows to achieve the standard penetration of 300mm (the "N" value) is shown after the test index letter, but the seating blows through the initial 150mm penetration are not reported unless the full penetration of 450mm cannot be achieved. In the latter case, the symbols below are added to the test index letter:-
S* Seating blows only
S** Blow count includes seating blows
S++ No penetration
So 'Split spoon' SPT sampler sank under its own weight.
The test is usually completed when the number of blows reaches 50. The depths of both the top and bottom of the test drive are shown in the sample column on the Borehole Record. If a sample is not recovered in the sampler, a disturbed sample is taken on completion of the test drive. Both are given the same depth as the top of the SPT test drive.

C Standard Penetration Test (SPT) conducted usually in coarse granular soils or weak rocks using the same procedure as for the SPT but with a 50mm diameter, 60° apex solid cone fitted in place of the sampler. Variations in test results are indicated by the same symbols as for the SPT (above). Where a bulk disturbed sample is taken, it is given the same depth as the top of the SPT.

V Vane Test: Undrained shear strength (cohesion) (kN/m^2) shown within the SPT column.
V* Shear strength >130kPa

H Hand penetrometer Test: Undrained shear strength (cohesion) (kN/m^2) shown within the SPT column.
H* Shear strength >225kPa

M Mackintosh Probe Penetration Test: Number of blows for 300mm penetration shown under SPT column. A very approximately correlation with the SPT "N" value can be obtained by dividing the number of blows by 10. The results should however be used with caution.

P Perth Penetrometer Test: See Insitu Testing Notes in Appendix C for full description. Number of blows for 300mm penetration shown under SPT column. In sand the number of blows is approximately equivalent to the SPT "N" value.

2 Soil Description

Description and classification of soils has been carried out using as a general basis the British Standard Code of Practice for Site Investigation (BS5930: 1999).

When composite soils have been described, the following terms are used to indicate the various proportions of the subsidiary constituents present (refer to **Note*** below):

with a trace/ occasional	up to 10% (approximately)
with a little	10% to 25% (approximately)
with some	25% to 35% (approximately)
with many/ much	35% to 50% (approximately)
and	approximately 50%

Cohesive Soils

The consistency of clay given in the Report is based on both visual inspection of the samples and results of in situ and/or laboratory strength tests when carried out.

The classification of consistency is made on the following basis:

Consistency of Clay	**Undrained Shear Strength (cohesion)**
Very soft	Less than 20 kN/m^2
Soft	20 to 40 kN/m^2
Soft to Firm	40 to 50 kN/m^2
Firm	50 to 75 kN/m^2
Firm to Stiff	75 to 100 kN/m^2
Stiff	100 to 150 kN/m^2
Very Stiff (hard)	Greater than 150 kN/m^2

Note*: All soils possessing cohesion and plasticity will be described as CLAY.

It is recognised that any granular soil that has in excess of approximately 35% fines (clay and silt) can often be expected to behave as a cohesive soil despite the dominance of silt, sand and/or gravel particles within the soil mass.

To reflect this, it is the soil type that dominates the behaviour of the soil mass that appears on the exploratory hole records.

Granular Soils

The relative densities of granular soils (sand and gravel) given in the report are based on field estimations and the results of the Standard Penetration Test (SPT) and equivalent correlation from other testing. The classification in terms of "N" Values is as follows:

SPT "N" Value	**Relative Density**
0 - 4	Very loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
Greater than 50	Very dense

Chalk

Chalk description generally follows the guidance on chalk classification offered by the Construction Industry Research and Information Association (CIRIA) Project Report 11, 'Foundations in Chalk'. This is based on assessment of chalk density, discontinuity spacing and aperture, and the proportion of intact chalk to silt of chalk (putty chalk). An assessment of the chalk as a structured or structureless material will be made where possible.

IN-SITU TESTING NOTES

Standard Penetration Testing
Standard penetration testing (SPT) is carried out within a cased cable percussion borehole. The test is performed using a either a split spoon (barrel) sampler in sandy deposits, or, in coarse granular soils or weak rocks, using a 50mm diameter, 60° apex solid cone fitted in place of the sampler.

The sampler is driven into the deposits at the base of the borehole by means of a 65kg hammer falling freely through 760mm.

In the borehole record the depth of the test is that at the start of the normal 450mm penetration, the number of blows to achieve the standard penetration of 300mm (the "N" value) is shown after the test index letter, but the seating blows through the initial 150mm penetration are not reported unless the full penetration of 450mm cannot be achieved.

(BS 5930:1999 Code of Practice for Site Investigations)

Dynamic Probe Testing
The DPH (heavy) dynamic probing rig drives a 32mm diameter rod with a $15cm^2$ area, 90° end cone into the ground by means of a 50kg hammer which falls freely through a distance of 0.5m. The number of blows per 100mm penetration (N_{100}) is recorded.

The DPSH (super heavy) dynamic probing rig drives a 35mm diameter rod with a $20cm^2$ area, 90° end cone into the ground by means of a 63.5kg hammer that falls freely through a distance of 0.75m. The number of blows per 100mm penetration (N_{100}) is recorded. The results can provide a useful indication of the relative strength of the material. (British Standard Methods of test for Soils for civil engineering purposes BS1377: Part 9: 1990, Test 3.2).

A tentative correlation with the Standard Penetration Test (SPT) N value can be made summing three consecutive the N_{100} blow counts.

Perth Penetrometer Test
In this test a hardened stainless steel rod is driven into the deposit by a 9.5kg sliding hammer falling freely through 600mm. After an initial penetration of 150mm the number of blows required to drive the rod a further 300mm is recorded. In sand the Perth blow count gives a close correlation to the "N-value" that could be expected from a standard penetration test (SPT) made in similar materials. The results are less reliable in coarser grained materials but can give an indication of their engineering properties.

Undrained Shear Strength
Undrained shear strength determinations are made in situ within the cohesive soils using a Geonor hand shear vane or (usually in the case of window sampler boreholes) a hand penetrometer. The test records the undrained shear strength (cohesion) in kN/m^2. The shear vane records a maximum shear strength of 130 kN/m^2 and the hand penetrometer records a maximum shear strength of 250 kN/m^2. (BS 5930:1999 Code of Practice for Site Investigations)

California Bearing Ratio Test
In this test a hand held Farnell cone penetrometer apparatus is pushed into the deposits for the estimation of the California bearing ratio of the subgrade (for use in pavement design). The test equipment is design for the estimation of the bearing ratio of fine grained soils (clay and silt) only and is unsuitable for use in coarse grained soils and rock. (BS 5930:1999 Code of Practice for Site Investigations)

Gas Survey
The gas spike survey consists of driving a 30mm diameter steel spike 1.0m into the ground, removing the spike and inserting a probe into the hole so formed. Where possible the gap around the probe is sealed against air ingress by heeling-in the soft surface materials. Readings for the proportion of O_2, CO_2 and CH_4 (methane) are taken using an infra red gas analyser. The spike survey is a prospecting tool used primarily to test for the presence of gas and should be not used to prove the absence of gas.

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:- **St Barnabas Hospice, Worthing**

Start date	08/05/2006	End date	08/05/2006
Easting		Northing	
Ground level	11.10	Page	1 of 1

Standpipe Installation	Samples & Testing: Type	Depths: From	Depths: To	Vane/ Pen Test N Value	Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
	D	0.05				(0.10) 0.10	11.00	Topsoil. Firm to stiff brown silty CLAY with a trace of fine gravel of chalk and flint (Brickearth).
	D	0.50						
	V	0.50		98				
	D	1.00						becoming firm with a little coarse sand and fine gravel of flint and chalk below 1.00m depth.
	V	1.00		103				
	D	1.50				(2.90)		
	H	1.50		53				
	D	2.00						becoming very silty below 1.90m depth. with some gravel of flint and chalk below 2.0m depth.
	D	2.50						
	H	2.50		67				
	V *	2.90						
	D	3.00				3.00	8.10	Stiff pale grey and orange brown mottled silty slightly sandy CLAY (Brickearth).
	D	3.50				(1.00)		
	H	3.50		100				
						4.00	7.10	Medium dense orange brown and grey slightly clayey medium SAND with a trace of fine to medium gravel of flint (Brickearth).
	D	4.50				(1.00)		
						5.00	6.10	

Remarks

Borehole remained stable.

Standing water level 1.95m depth after 10 minutes of completion of borehole.

Gas and groundwater standpipe installed to 5.00m depth; 4.00m slotted pipe with pea gravel surround between 5.00m and 1.00m depth; plain pipe with bentonite clay seal between 1.00m depth and ground level; gas tap and security cover concreted flush with ground surface.

V* = Cu >130kPa.

Method	Window Sampler
Borehole Dia. (mm)	various
Casing Dia. (mm)	
Made by:	PC
Job No. : **LW17096**	**Borehole No.** **WS1**

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:- **St Barnabas Hospice, Worthing**

Start date	09/05/2006	End date	09/05/2006
Easting		Northing	
Ground level	12.10	Page	1 of 1

Standpipe Installation	Samples & Testing: Type	Depths: From	Depths: To	Vane/ Pen Test N Value	Strata: Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
	T	0.05				(0.10)	12.00	Topsoil.
	T	0.20				0.10 (0.20)		MADE GROUND: Brown silty clay with occasional cobbles of brick and a trace of fine to medium gravel of ash. (compact)
						0.30 (0.30)	11.80	MADE GROUND: Pale grey clayey fine sand (compact)
	T	0.50				0.60	11.50	Firm orange brown silty CLAY with a trace of fine to medium gravel of flint (Brickearth).
	D	1.00						
	T	1.00				(1.40)		
	D	1.50						
	H	1.50		57				
	D	2.00				2.00	10.10	Firm pale grey and orange brown mottled slightly silty CLAY with some fine gravel of flint and chalk. (Brickearth)
	H	2.50		70		(1.00)		
	D	2.60						with much fine gravel of flint and chalk below 2.90m depth.
						3.00	9.10	Firm to stiff pale brown and orange brown silty CLAY with much fine gravel and coarse sand of chalk and flint. (Brickearth)
	D	3.50						
	H	3.80		90		(1.60)		
	D	4.50				4.60	7.50	Stiff orange brown very silty slightly sandy CLAY with occasional fine gravel of flint (Brickearth).
						(0.40)		
	V *	5.00				5.00	7.10	

Remarks

Borehole collapsed to 4.00m depth.

Standing water level 2.87m depth after 10 minutes of completion of borehole.

Gas and groundwater standpipe installed to 4.00m depth; 3.00m slotted pipe with pea gravel surround between 4.00m and 1.00m depth; 1.00m plain pipe with bentonite clay seal between 1.00m depth and ground level; gas tap and security cover concreted flush with ground surface.

V* = Cu >130kPa.

Method	Window Sampler
Borehole Dia. (mm)	various
Casing Dia. (mm)	
Made by:	PC
Job No. : **LW17096**	**Borehole No.** **WS2**

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:- St Barnabas Hospice, Worthing	Start date	09/05/2006	End date	09/05/2006
	Easting		Northing	
	Ground level	12.10	Page	1 of 1

Standpipe Installation	Samples & Testing: Type	Depths: From	Depths: To	Vane/ Pen Test N Value	Strata: Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
	J	0.05				(0.10) 0.10	12.00	Topsoil. MADE GROUND: Brown clay with some medium to coarse angular gravel of concrete and brick. (compact)
	J	0.30				(0.40) 0.50	11.60	Firm to stiff orange brown silty CLAY with a trace of fine to medium gravel of flint. (Brickearth)
	J	1.00				(1.20)		
	H	1.30		57				
	J	1.30				1.70	10.40	Firm to stiff pale grey and orange brown mottled slightly silty CLAY. (Brickearth)
	D	1.80						
	H	1.80		73				with a trace of medium gravel of flint below 2.0m depth.
	V *	2.00				(1.20)		with a little fine gravel/coarse sand of flint and chalk below 2.30m depth.
	D	2.50						
	H	2.50		90				
	D	3.00				2.90	9.20	Firm to stiff pale grey and orange brown mottled slightly silty CLAY with much coarse sand/fine gravel of flint and chalk (Brickearth).
	D	3.50						
	V	4.00		113		(2.10)		becoming stiff below 4.00m depth.
	D	4.50						
	V *	5.00				5.00	7.10	

Remarks

Borehole collapsed to 3.15m depth.

Standing water level 2.95m depth on completion of borehole.

Gas and groundwater standpipe installed to 3.15m depth; 2.15m slotted pipe with pea gravel surround between 3.15m and 1.00m depth; 1.00m plain pipe with bentonite clay seal between 1.00m depth and ground level; gas tap and security cover concreted flush with ground surface.

V* = Cu >130kPa.

Method	Window Sampler
Borehole Dia. (mm)	various
Casing Dia. (mm)	
Made by:	PC
Job No. :	**Borehole No.**
LW17096	**WS3**

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:- St Barnabas Hospice, Worthing	Start date	09/05/2006	End date	09/05/2006
	Easting		Northing	
	Ground level	12.20	Page	1 of 1

Standpipe Installation	Samples & Testing: Type	Depths: From	Depths: To	Vane/ Pen Test N Value	Strata: Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
	J	0.10				(0.12) 0.12	12.08	Topsoil Firm to stiff brown silty CLAY with a trace of fine gravel of flint. (Brickearth)
	J	0.40						becoming orange brown below 0.50m depth. with some iron staining below 0.60m depth.
	J	1.00				(1.73)		
	J	1.30						
	H	1.50		77				
	D	1.80				1.85	10.35	Firm to stiff pale grey and orange brown mottled silty slightly sandy CLAY with much fine gravel and coarse sand of flint, chalk and occasional small pockets of coarse sand (Brickearth).
	D	2.40				(1.15)		
	D	3.00				3.00	9.20	

Remarks

Borehole collapsed to 2.55m depth.

Borehole remained dry.

Borehole decommissioned with bentonite clay between 2.55m depth and ground level.

V* = Cu >130kPa.

Method	Window Sampler
Borehole Dia. (mm)	various
Casing Dia. (mm)	
Made by:	PC
Job No. :	**Borehole No.**
LW17096	**WS4**

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:-	St Barnabas Hospice, Worthing	Start date	09/05/2006	End date	09/05/2006
		Easting		Northing	
		Ground level	12.00	Page	1 of 1

Standpipe Installation	Samples & Testing: Type	Depths: From	Depths: To	Vane/ Pen Test N Value	Strata: Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
	J	0.05				(0.10) 0.10	11.90	Topsoil. Firm brown very silty CLAY with a trace of fine to medium gravel of flint. (Brickearth)
	J	0.30						
	J	1.00				(1.90)		
	H	1.20		60				
	J	1.50						
	H	1.70		97				becoming firm to stiff below 1.70m depth.
	D	2.00				2.00	10.00	Firm/medium dense pale brown very silty CLAY and fine to coarse GRAVEL of chalk and flint. (Brickearth)
	D	2.50				(1.30)		
	D	3.00						
	D	3.50				3.30	8.70	Firm orange brown silty CLAY with some fine to medium angular gravel of flint and chalk (Brickearth).
	H	3.50		63		(0.50)		
	D	4.00				3.80	8.20	Stiff brown and pale grey mottled CLAY with occasional pockets of grey sand (Brickearth).
	V *	4.00						
	D	4.50				(1.20)		
	H	4.50		107				
	V *	5.00				5.00	7.00	with a little medium gravel of flint at base.

Remarks

Borehole collapsed to 4.20m depth.

Standing water level 3.60m depth after 5 minutes of completion of borehole.

Borehole decommissioned with bentonite clay between 4.20m depth and ground level.

V* = Cu >130kPa.

Method	Window Sampler
Borehole Dia. (mm)	various
Casing Dia. (mm)	
Made by:	PC
Job No. :	**Borehole No.**
LW17096	**WS5**

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:- **St Barnabas Hospice, Worthing**

Start date	08/05/2006	End date	08/05/2006
Easting		Northing	
Ground level	12.10	Page	1 of 1

Standpipe Installation	Samples & Testing: Type	Depths: From	Depths: To	Vane/ Pen Test N Value	Strata: Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
	D	0.05				(0.10) 0.10	12.00	Topsoil with a trace medium to coarse gravel of concrete.
	D	0.50						Stiff brown silty CLAY with a trace of medium to coarse angular gravel of flint (Brickearth).
	D	1.00				(1.80)		becoming pale brown/orange brown below 1.00m depth.
	V *	1.00						with some black fine gravel of ironstone below 1.20m depth.
	D	1.50						
	H	1.50		103				
	D	2.00				1.90	10.20	Medium dense pale brown very silty very clayey very sandy fine to medium GRAVEL of chalk and flint (Brickearth).
	D	2.50				(1.10)		
	D	3.00				3.00	9.10	

Remarks

Borehole remained dry and stable.

Borehole decommissioned with bentonite clay between 3.00m depth and ground level.

V* = Cu >130kPa.

Method	Window Sampler
Borehole Dia. (mm)	various
Casing Dia. (mm)	
Made by:	PC
Job No. :	**Borehole No.**
LW17096	**WS6**

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:- **St Barnabas Hospice, Worthing**

Start date	08/05/2006	End date	08/05/2006
Easting		Northing	
Ground level	11.80	Page	1 of 1

Standpipe Installation	Samples & Testing: Type	Depths: From	Depths: To	Vane/ Pen Test N Value	Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
	D	0.05				(0.10) 0.10	11.70	Topsoil Firm orange brown silty CLAY with a trace of fine gravel of flint. (Brickearth)
	D	0.50						
	D	1.00						
	V *	1.00				(2.20)		
	D	1.50						
	H	1.50		103				
	D	2.00						with some fine rootlets to 2.0m depth.
	V *	2.00						
						2.30	9.50	Medium dense pale brown silty clayey SAND with much coarse sand of chalk and medium to coarse gravel of flint. (Brickearth)
	D	2.50				(0.30)		
						2.60	9.20	Firm brown slightly silty CLAY with a little coarse sand of weak white chalk (Brickearth).
	D	3.00				(0.70)		
	V	3.00		73				
						3.30	8.50	Stiff brown and pale grey mottled CLAY (Brickearth).
	D	3.50						
	H	3.50		113				
	V *	4.00						becoming sandy below 3.9m depth.
						(1.70)		
	D	4.50						
	H	4.50		110				
						5.00	6.80	

Remarks

Borehole remained stable.

Standing water level 5.00m depth on completion of borehole.

Gas and groundwater standpipe installed to 5.00m depth; 4.00m slotted pipe with pea gravel surround between 5.00m and 1.00m depth; plain pipe with bentonite clay seal between 1.00m depth and ground level; gas tap and security cover concreted flush with ground surface.

V* = Cu >130kPa.

Method	Window Sampler
Borehole Dia. (mm)	various
Casing Dia. (mm)	
Made by:	PC
Job No. :	**Borehole No.**
LW17096	**WS7**

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:- St Barnabas Hospice, Worthing	Start date	08/05/2006	End date	08/05/2006
	Easting		Northing	
	Ground level	11.40	Page	1 of 1

Standpipe Installation	Samples & Testing: Type	Depths: From	Depths: To	Vane/ Pen Test N Value	Strata: Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
						(0.15) 0.15	11.25	Tarmacadam. MADE GROUND: Red brown medium to coarse sand with much fine to coarse gravel of brick. (loose)
	T	0.30				(0.25) 0.40	11.00	Firm to stiff green grey very silty CLAY. (Brickearth) becoming orange brown with occasional fine gravel of flint below 0.50m depth.
	D	0.50						
	D	1.00				(1.80)		
	D	1.50						
	H	1.50		97				with occasional thin bands of fine gravel/coarse sand of chalk below 1.90m depth.
	D	2.00				2.20	9.20	Firm to stiff pale brown CLAY with a little coarse sand/fine gravel of flint (Brickearth).
	D	2.50						
	H	2.50		87				
	D	3.00						
	D	3.50						becoming firm below 3.50m depth.
	H	3.50		57		(2.80)		
	V	4.00		63				
	D	4.50						
						5.00	6.40	

Remarks

Borehole collapsed to 4.80m depth.

Slight groundwater seepage below 4.00m depth.

Gas and groundwater standpipe installed to 4.80m depth; 3.80m slotted pipe with pea gravel surround between 4.80m and 1.00m depth; 1.00m plain pipe with bentonite clay seal between 1.00m depth and ground level; gas tap and security cover concreted flush with ground surface.

V* = Cu >130kPa.

Method	Window Sampler
Borehole Dia. (mm)	various
Casing Dia. (mm)	
Made by:	PC
Job No. :	**Borehole No.**
LW17096	**WS8**

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:- **St Barnabas Hospice, Worthing**

Date Trial Pit Excavated	08/05/2006		
Easting		Northing	
Ground level	11.50	Page	1 of 1

Installation Details	Samples & Testing: Type	Depths: From	Depths: To	Vane Cu/ Pen Test N Value	Strata: Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
						(0.30)		Concrete paving (50mm) over, Weak concrete.
	T	0.20				0.30	11.20	
								Stiff grey slightly sandy silty CLAY (Brickearth).
	T	0.40						
	V	0.50		130		(0.50)		
						0.80	10.70	
								Stiff orange brown slightly sandy silty CLAY (Brickearth).
	V	1.00		110		(0.40)		
	D	1.20				1.20	10.30	
								End of Trial Pit

Remarks

Trial pit remained dry and stable.

Method	Hand Dug
Pit Length (m)	
Pit Width (m)	
Made by:	PC
Job No. : **LW17096**	**Trial Pit No.** **TP1**

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:- St Barnabas Hospice, Worthing	Date Trial Pit Excavated	08/05/2006		
	Easting		Northing	
	Ground level	11.70	Page	1 of 1

Installation Details	Samples & Testing: Type	Depths: From	Depths: To	Vane Cu/ Pen Test N Value	Strata: Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
						(0.10) 0.10	11.60	Pea gravel.
	D V	0.50 0.50		100		(1.10)		Stiff orange silty CLAY with a trace of fine to medium gravel of flint (Brickearth).
	V	1.00		122				
	D	1.20				1.20	10.50	End of Trial Pit

Remarks

Trial pit remained dry and stable.

Method	Hand Dug
Pit Length (m)	
Pit Width (m)	
Made by:	PC
Job No. : LW17096	**Trial Pit No.** TP2

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:- St Barnabas Hospice, Worthing	Date Trial Pit Excavated	08/05/2006		
	Easting		Northing	
	Ground level	11.50	Page	1 of 1

Installation Details	Samples & Testing: Type	Depths: From	Depths: To	Vane Cu/ Pen Test N Value	Strata: Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
	D	0.05				(0.10) 0.10	11.40	Topsoil.
	D V	0.50 0.50		92		(0.90)		Firm to stiff orange brown silty CLAY with a trace of fine gravel of flint. (Brickearth) becoming stiff towards base.
	D V *	1.00 1.00				1.00	10.50	End of Trial Pit

Remarks

Trial pit remained dry and stable.

V* = Cu >130kPa.

Method	Hand Dug
Pit Length (m)	
Pit Width (m)	
Made by:	PC
Job No. : LW17096	**Trial Pit No.** TP3

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:- **St Barnabas Hospice, Worthing**

Date Trial Pit Excavated	09/05/2006		
Easting		Northing	
Ground level	11.50	Page	1 of 1

Installation Details	Samples & Testing: Type	Depths: From	Depths: To	Vane Cu/ Pen Test N Value	Strata: Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
	D	0.05				(0.10) 0.10	11.40	Topsoil.
	D	0.30						Stiff orange brown silty CLAY with a trace of medium angular gravel of flint (Brickearth).
	V	0.50		130		(0.85)		
	D V *	0.95 0.95				0.95	10.55	End of Trial Pit

Remarks

Trial pit remained dry and stable.

V* = Cu >130kPa.

Method	Hand Dug
Pit Length (m)	
Pit Width (m)	
Made by:	PC
Job No. : **LW17096**	**Trial Pit No.** **TP4**

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:- St Barnabas Hospice, Worthing	Date Trial Pit Excavated	09/05/2006		
	Easting		Northing	
	Ground level	11.80	Page	1 of 1

Installation Details	Samples & Testing: Type	Depths: From	Depths: To	Vane Cu/ Pen Test N Value	Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
						(0.15)		Pea gravel.
						0.15	11.65	
	D	0.20				(0.20)		MADE GROUND: Brown silty sandy clay with occasional fragments of polystyrene and fine gravel of brick. (compact)
						0.35	11.45	
	D	0.50						Firm to stiff brown silty CLAY. (Brickearth)
	V	0.50		87		(0.85)		
								becoming stiff towards base.
	D	1.20				1.20	10.60	
	V *	1.20						End of Trial Pit

Remarks

Trial pit remained dry and stable.

V* = Cu >130kPa.

Method	Hand Dug
Pit Length (m)	
Pit Width (m)	
Made by:	PC
Job No. :	**Trial Pit No.**
LW17096	**TP5**

ASHDOWN SITE INVESTIGATION LTD

SITE NAME:- **St Barnabas Hospice, Worthing**

Date Trial Pit Excavated	09/05/2006		
Easting		Northing	
Ground level	11.60	Page	1 of 1

Installation Details	Samples & Testing: Type	Depths: From	Depths: To	Vane Cu/ Pen Test N Value	Strata: Legend	Depth (Thickness)	Reduced Level	Strata Descriptions
	D	0.05				(0.10) 0.10	11.50	Topsoil.
	D	0.30						Firm to stiff orange brown silty CLAY with a little fine to medium gravel of flint. (Brickearth)
	V	0.50		67		(0.90)		becoming stiff towards base.
	D V*	1.00 1.00				1.00	10.60	End of Trial Pit

Remarks

Trial pit remained dry and stable.

V* = Cu >130kPa.

Method	Hand Dug
Pit Length (m)	
Pit Width (m)	
Made by:	PC
Job No. : **LW17096**	**Trial Pit No.** **TP6**

ASHDOWN SITE INVESTIGATION LIMITED

Site: St Barnabas Hospice, Columbia Drive, Worthing

Report No.: LW21058
Sheet No.: 1 of 1

SUMMARY OF GAS ANALYSES AND WATER DEPTHS

WS1

Date	Methane (%)		Carbon Dioxide (%)		Oxygen (%)		Carbon monoxide	Hydrogen Sulphide	Gas Pressure	Emission Rate	Standing Water Depth	Atmospheric Pressure (mb)	
	Peak	Static	Peak	Static	Min.	Static	(ppm)	(ppm)	(mb)	(l/hr)	(m bgl)	On-site	Trend
04/03/10	0.0	0.0	1.5	1.5	13.0	13.0	1	0	0	0	1.20	1022	Rising

WS2

Date	Methane (%)		Carbon Dioxide (%)		Oxygen (%)		Carbon monoxide	Hydrogen Sulphide	Gas Pressure	Emission Rate	Standing Water Depth	Atmospheric Pressure (mb)	
	Peak	Static	Peak	Static	Min.	Static	(ppm)	(ppm)	(mb)	(l/hr)	(m bgl)	On-site	Trend
04/03/10	*	*	*	*	*	*	*	*	*	*	*	*	*

* Standpipe covered.

WS3

Date	Methane (%)		Carbon Dioxide (%)		Oxygen (%)		Carbon monoxide	Hydrogen Sulphide	Gas Pressure	Emission Rate	Standing Water Depth	Atmospheric Pressure (mb)	
	Peak	Static	Peak	Static	Min.	Static	(ppm)	(ppm)	(mb)	(l/hr)	(m bgl)	On-site	Trend
04/03/10	#	#	#	#	#	#	#	#	#	#	#	#	#

Standpipe unserviceable.

WS7

Date	Methane (%)		Carbon Dioxide (%)		Oxygen (%)		Carbon monoxide	Hydrogen Sulphide	Gas Pressure	Emission Rate	Standing Water Depth	Atmospheric Pressure (mb)	
	Peak	Static	Peak	Static	Min.	Static	(ppm)	(ppm)	(mb)	(l/hr)	(m bgl)	On-site	Trend
04/03/10	0.0	0.0	2.2	2.2	9.2	9.2	0	0	0	0	2.10	1022	Rising

WS8

Date	Methane (%)		Carbon Dioxide (%)		Oxygen (%)		Carbon monoxide	Hydrogen Sulphide	Gas Pressure	Emission Rate	Standing Water Depth	Atmospheric Pressure (mb)	
	Peak	Static	Peak	Static	Min.	Static	(ppm)	(ppm)	(mb)	(l/hr)	(m bgl)	On-site	Trend
04/03/10	#	#	#	#	#	#	#	#	#	#	#	#	#

Standpipe unserviceable.

Remarks: Readings taken using an infra red gas analyser.
Emission rate measured using a flow pod attached to infra red gas analyser.

Weather Conditions:

04/03/10 – Clear

APPENDIX B

Geotechnical Laboratory Testing Notes

Laboratory Test Results

i) Geotechnical Testing

ii) Contamination Testing

GEOTECHNICAL LABORATORY TESTING NOTES

Index Tests
Index (Atterberg Limit) tests are undertaken on samples of fine grained soils provide the primary information for the classification of cohesive soils.

Fine grained soil is tested to determine its liquid and plastic limits, which are moisture contents that define boundaries between material consistency states. These tests are used to evaluate indices used for soil identification and to help determine the shrinkage and swelling characteristics of the soil under conditions of changing moisture content.

The tests are carried out in accordance with BS1377: Part 2: 1990 Classification tests.

Particle Size Distribution Tests
Sieve analyses are carried out soil samples to establish their particle size distribution that can assist in the assessment of the permeability and classification of granular soils.

The tests are carried out in accordance with BS1377: Part 2: 1990 Classification tests.

Natural Moisture/ Saturated Moisture Content Determination of Chalk
The results of natural moisture or saturated moisture content tests of disturbed samples of chalk are used to assist in the classification of the chalk to determine key geotechnical parameters of strength, density and crushing properties.

The tests are carried out in accordance with BS1377: Part 2: 1990 Classification tests.

Soil Suction Testing
Soil suction tests are undertaken for the determination of the state of desiccation in clay soils.

The testing is carried out in accordance with the Building Research Establishment Information Paper IP4/93, dated February 1993.

Triaxial Compression Tests
Undrained triaxial compression tests are carried out on undisturbed samples of cohesive soil in order to assist in the determination of the undrained shear strength of the soil. The results of moisture content and density determinations are also included.

The tests are carried out in accordance with BS1377: Part 7: 1990 Shear strength tests (total stress).

Shear Vane and Hand Penetrometer Testing
Undisturbed samples are tested in the laboratory using a Geonor Hand Shear Vane for the determination of their undrained shear strength.

The vane tests are carried out in general accordance with BS1377: Part 7: 1990 Shear strength tests (total stress).

GEOTECHNICAL LABORATORY TESTING NOTES

One Dimensional Consolidation Tests
One-dimensional consolidation tests are performed on undisturbed soil samples to ascertain their settlement characteristics.

The tests are carried out in accordance with BS1377: Part 5: 1990 Compressibility, Permeability and Durability tests.

Dry Density / Moisture Content Relationship (Compaction) Testing
Compaction testing for the determination of the dry density / moisture content relationship is carried out on using either a 2.5kg, 4.5kg hammer or a vibrating hammer.

The tests are carried out in accordance with the British Standard BS1377: Part 4: 1990 Compaction-related tests.

California Bearing Ratio
The soil is usually compacted at the as dug "natural" moisture content and often at moisture contents around the natural moisture content.

The California bearing ratio is determined in accordance with the British Standard BS1377: Part 4: 1990 Compaction related tests.

Chemical Testing
Soil samples are tested for their concentration of water soluble sulphate and pH for use in concrete mix design.

Water samples are tested for total sulphate concentration and pH value.

Where a water soluble sulphate content in soils or a total sulphate content in groundwater exceeds 3000mg/l SO_4 the magnesium sulphate content of the samples is required to be determined (BRE Special Digest 1:2005).

ASHDOWN SITE INVESTIGATION LTD

Site: St. Barnabas Hospice, Columbia Drive, Worthing, West Sussex
Report No.: LW17096
Sheet No.: 1 of 2

SOIL CLASSIFICATION SUMMARY

BH/TP No.	Depth *m*	Moist. Cont. %	Atterberg Limits LL %	PL %	PI %	% Passing 425 *μm* sieve	Class'n	Visual Description of Sample
WS1	1.00	26	49	21	28	100	CI	Brown sandy CLAY.
	2.00	21						
	3.50	26	43	19	24	95	CI	Pale brown CLAY with lenses of pale grey silty sand and gravel of flint.
WS2	1.00	22	43	19	24	100	CI	Brown silty CLAY.
	2.50	26	42	21	21	98	CI	Brown and grey–brown CLAY with gravel of chalk.
	3.50	24					N	GRAVEL of chalk with brown silty clay.
WS3	2.50	23	53	20	33	90	CH	Pale brown CLAY with gravel of chalk.
	3.00	25	26	19	7	60	CL	Grey-brown CLAY with gravel of chalk and flint.
	3.50	21						
WS4	1.30	22						
	2.40	23						
	3.00	22						

Remarks:

ASHDOWN SITE INVESTIGATION LTD

Site: St. Barnabas Hospice, Columbia Drive, Worthing, West Sussex. Report No.: LW17096
Sheet No.: 2 of 2

SOIL CLASSIFICATION SUMMARY

BH/TP No.	Depth *m*	Moist. Cont. %	Atterberg Limits LL %	PL %	PI %	% Passing 425 *μm* sieve	Class'n	Visual Description of Sample
WS5	2.00	21	41	20	21	95	CI	Brown and grey – brown slightly silty CLAY with gravel of flint.
	2.50	15						
	3.00	17					N	GRAVEL of chalk.
	3.50	22						
WS6	1.00	24	43	20	23	100	CI	Brown silty CLAY.
	2.00	15					N	GRAVEL of chalk and flint in a matrix of brown silty clay.
	2.50	15					N	GRAVEL of chalk.
	3.00	13					N	GRAVEL of chalk.
WS7	1.00	25	54	22	32	100	CH	Brown silty CLAY.
	1.50	23						
	2.50	17						
	3.50	32	67	25	42	98	CH	Brown, orange-brown and grey-brown CLAY with gravel of flint.
WS8	1.50	21	34	20	14	97	CL	Brown silty CLAY with gravel of flint.

Remarks:

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UKAS TESTING 2683

ANALYTICAL REPORT No. AR3692

Location: St Barnabus Hospice, Worthing

Your Ref No: LW17098

Reporting Date: 22/05/2006

F.A.O. David Harris

Ashdown Site Investigation Limited

The Old Dairy, Swanborough Farm

Swanborough, Lewes, East Sussex, BN7 9PF

Soils	Top/Bot Depth (m)	Lab No.	2M2	2M3	3M3	3M4	4M4	4M5	5M5	5M6
Arsenic*	(Mg/Kg)	n/t	7.4	7.4	8.3	7.9	8.9	9.8	9.8	10.1
Cadmium*	(Mg/Kg)	n/t	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium*	(Mg/Kg)	n/t	12	12	13	11	10	9.2	8.4	8.5
Lead*	(Mg/Kg)	n/t	82	36	18	13	8.2	6.4	5.6	5.6
Mercury*	(Mg/Kg)	n/t	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nickel*	(Mg/Kg)	n/t	12	8.2	8.1	6.2	5.2	4.5	4.2	4.3
Copper*	(Mg/Kg)	n/t	10	7.2	6.4	5.2	<5	<5	<5	<5
Zinc*	(Mg/Kg)	n/t	71	36	29	23	16	13	12	12
Selenium	(Mg/Kg)	n/t	6.0	<5	<5	<5	<5	<5	<5	<5
Hexavalent Chromium	(Mg/Kg)	n/t	14	05	24	23	20	18	17	17
Vanadium*	(Mg/Kg)	n/t	7.5	7.8	8.3	7.8	8.9	8.9	8.9	8.9
pH Value*	(Value)	n/t	7.9	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Water Soluble Sulphate	(g/l 2:1 SO4)	n/t	<0.5	0.08	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Cyanide*	(Mg/Kg)	n/t	<5	<5	<5	<5	<5	<5	<5	<5
Free Cyanide	(Mg/Kg)	n/t	<5	<5	<5	<5	<5	<5	<5	<5
Complex Cyanide	(Mg/Kg)	n/t	<5	<5	<5	<5	<5	<5	<5	<5
Sulphide	(Mg/Kg)	n/t	<5	<5	<5	<5	<5	<5	<5	<5
Elemental Sulphur*	(Mg/Kg)	n/t	<5	<5	<5	<5	<5	<5	<5	<5
Thiocyanate	(Mg/Kg)	n/t	<5	<5	<5	<5	<5	<5	<5	<5
Total Monohydric Phenols*	(Mg/Kg)	n/t	<5	<5	<5	<5	<5	<5	<5	<5
Total PCB	(Mg/Kg)	n/t	<5	<5	<5	<5	<5	<5	<5	<5

(1) = labelled 1:2.5D
* = UKAS accredited
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ANALYTICAL REPORT No. AR3692

Location: St Barnabus Hospice, Worthing

Your Ref No: LW17D9E

Reporting Date: 22/05/2006

F.A.O. David Harris
Ashdown Site Investigation Limited
The Old Dairy, Swanborough Farm
Swanborough, Lewes, East Sussex, BN7 9PF

Soils	TP/BH Depth (m) Our ref	WS5 2.00 12158	WS6 2.50 12157	WS6 3.00 12158	WS7 1.50 12159	WS8 0.30 12160	WS8 1.50 12161
Arsenic*	(mg/kg)	n/t	n/t	n/t	n/t	7.9	n/t
Cadmium*	(mg/kg)	n/t	n/t	n/t	n/t	<0.5	n/t
Chromium*	(mg/kg)	n/t	n/t	n/t	n/t	12	n/t
Lead*	(mg/kg)	n/t	n/t	n/t	n/t	395	n/t
Mercury*	(mg/kg)	n/t	n/t	n/t	n/t	1.7	n/t
Nickel*	(mg/kg)	n/t	n/t	n/t	n/t	10	n/t
Copper*	(mg/kg)	n/t	n/t	n/t	n/t	14	n/t
Zinc*	(mg/kg)	n/t	n/t	n/t	n/t	132	n/t
Selenium	(mg/kg)	n/t	n/t	n/t	n/t	<0.5	n/t
Hexavalent Chromium	(mg/kg)	n/t	n/t	n/t	n/t	<2	n/t
Vanadium*	(mg/kg)	n/t	n/t	n/t	n/t	24	n/t
pH Value*	(Value)	7.9	8.6	8.5	8.1	8.4	8.4
Water Soluble Sulphate	(g/l 2os SO4)	n/t	<0.05	<0.05	<0.05	0.12	<0.05
Total Cyanide*	(mg/kg)	n/t	n/t	n/t	n/t	<1	n/t
Free Cyanide	(mg/kg)	n/t	n/t	n/t	n/t	<1	n/t
Complex Cyanide	(mg/kg)	n/t	n/t	n/t	n/t	3.5	n/t
Sulphide	(mg/kg)	n/t	n/t	n/t	n/t	<10	n/t
Elemental Sulphur*	(mg/kg)	n/t	n/t	n/t	n/t	<2	n/t
Thiocyanate	(mg/kg)	n/t	n/t	n/t	n/t	7.5	n/t
Total Monohydric Phenols*	(mg/kg)	n/t	n/t	n/t	n/t	n/t	n/t

* = UKAS accredited

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ANALYTICAL REPORT No. AR3692

Location: St Barnabus Hospice, Worthing

Your Job No: LW17096

Reporting Date: 22/05/2006

F.A.O. David Harris
Ashdown Site Investigation Limited
The Old Dairy, Swanborough Farm
Swanborough, Lewes, East Sussex, BN17 9PF

Soils	TP/BH	WS2	WS3	WS4	WS5	WS8
	Depth(m)	0.20	0.20	0.40	0.60	0.60
	Our ref	12748	12750	12752	12754	12756
Naphthalene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthylene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Phenanthrene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Anthracene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Pyrene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Benz(a)anthracene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Chrysene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(b)fluoranthene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(k)fluoranthene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(123-cd)pyrene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenz(ah)anthracene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(ghi)perylene*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Total PAH*	(mg/kg)	<0.5	<0.5	<0.5	<0.5	14.3

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ANALYTICAL REPORT No. AR3692

Location: St Barnabus Hospice, Worthing

F.A.O. David Harris
Ashdown Site Investigation Limited
The Old Dairy, Swanborough Farm
Swanborough, Lewes, East Sussex, BN7 9PF

Your Job No: LWA7098

Reporting Date: 22/05/2008

Petroleum Hydrocarbon analysis-soils

	TP/BH	WS2	WS2	WS3	WS3	WS4	WS4	WS5	WS5	WS8	WS8
	Depth(m)	0.20	1.30 (1)	0.20	1.00	0.40	1.30	0.30	1.20	0.30	0.60
	Our ref	12149	12127	12128	12127	12127	12127	12127	12128	12127	12127
Aromatic											
$>C_8-C_{10}$	(MgKg)	<	<	<	<	<	<	<	<	<	<
$>C_{10}-C_{12}$	(MgKg)	<	<	<	<	<	<	<	<	<	<
$>C_{12}-C_{16}$	(MgKg)	<	<	<	<	<	<	<	<	<	<
$>C_{16}-C_{21}$	(MgKg)	<	<	<	<	<	<	<	<	<	<
$>C_{21}-C_{35}$	(MgKg)	<	<	<	<	<	<	<	<	<	<
$>C_{35}-C_{44}$	(MgKg)	<	<	<	<	<	<	<	<	<	<
Aliphatic											
$>C_8-C_{10}$	(MgKg)	<	<	<	<	<	<	<	<	<	<
$>C_{10}-C_{12}$	(MgKg)	<	<	<	<	<	<	<	<	<	<
$>C_{12}-C_{16}$	(MgKg)	<	<	<	<	<	<	<	<	<	<
$>C_{16}-C_{21}$	(MgKg)	<	<	<	<	<	<	<	<	<	<
$>C_{21}-C_{35}$	(MgKg)	<	<	<	<	<	<	<	<	<	<
$>C_{35}-C_{44}$	(MgKg)	<	<	<	<	<	<	<	<	<	<
Total Petroleum Hydrocarbons	(MgKg)	<	<	<	<	<	<	<	<	<	304

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ANALYTICAL REPORT No. AR3998

Location: St Bamabus Hospice, Worthing

Your Ref No: LW17056

Reporting Date: 09/06/06

F.A.O. David Harris
Ashdown Site Investigation Limited
The Old Dairy, Swanborough Farm
Swanborough, Lewes, East Sussex, BN7 3PF

Soils	TP/BH Depth (m)	Our Ref	Organic Content*	(mg/kg)	1.5	0.5	0.9	1.0	1.7	0.3	1.5	0.7	1.5
			WS2	0.20	1.30 (1)	WS3	0.20	WS3	0.40	WS4	1.30	WS5	WS8
			17149	12127		12120	12121	12122		12123		12125	12126

(1) = Isplotted 1.5O
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APPENDIX C

Notes on CLEA

Statistical Assessment Notes – Comparing Contamination Data with Critical Concentration

CLEA Model Chemical Data Inputs

Statistical Analysis Summary Sheets

ASHDOWN SITE INVESTIGATION LIMITED

Notes on the Contaminated Land Exposure Assessment & Calculation of Soil Screening Values

Assessing risk to human health using the CLEA Model

Background to the CLEA Model

The Environment Agency and DEFRA published the Contaminated Land Exposure Assessment (CLEA) model in 2002. The methodology for the generation of assessment criteria was set out within Contaminated Land Reports (CLR) 7 to 10.

Toxicological data reports (TOX documents) for 23 individual contaminants were also published between 2002 and 2004 for use within the CLEA model.

Following the release of the TOX documents the Environment Agency published a series of Soil Guideline Values (SGVs) for the contaminants arsenic, cadmium, chromium, lead, mercury, nickel, selenium, phenol, toluene and ethylbenzene. SGVs are generic assessment criteria developed for three land uses, the assumptions for each land use were included within the CLR reports.

The generic land uses considered were:

- Residential (with and without plant uptake/vegetable growing)
- Allotments
- Commercial and Industrial

The SGVs can be used as preliminary screening values for sites which fit with the conceptual model (assumptions) of the generic land uses.

The CLEA UK version of the model was released in 2005. This model could be used to generate more detailed and site specific assessment criteria. The CLEA UK model could also be used to generate generic assessment criteria for sites which lie outside of the generic land uses.

Current Guidance

In August 2008 the CLR 7 to 10 documents were officially 'withdrawn' by the Environment Agency along with published SGV reports.

Three new guidance documents were released, replacing the withdrawn CLR7-CLR10 documents, these were:

"*Guidance on Comparing Soil Contamination Data with a Critical Concentration*", CIEH/CL:AIRE (May 2008) – replacing CLR7;
"Human health toxicological assessment of contaminants in soil (Science Report SC050021/SR2)" Environment Agency, August 2008 – replacing CLR9; and,
"Updated technical background to the CLEA model (Science Report SC050021/SR3)" , Environment Agency, August 2008 - replacing CLR10

A revised version of the CLEA UK software model (ver 1.04) was also released in conjunction with the revised guidance. The latest version of the model uses purely deterministic calculations to derive assessment criteria.

The Environment Agency website (www.environment-agency.go.uk) presents the latest guidance. They advise that the current schedule of work includes the review, revision if necessary and re-issue of the TOX reports previously published. As each new TOX report is published, the previous one will be withdrawn.

In the absence of official government figures for some of the contaminants Ashdown Site Investigation Ltd have used the CLEA model to generate Soil Screening Values (SSVs) for a number of the priority contaminants. Where possible the chemical data used to generate these figures has

been taken from reports published by the Environment Agency, where no data exists, reference has been made to other published data.

Discussion on Adjustment of Background Daily Intake of Contaminants for Child Targets

As exposure to soils is unlikely to be the sole means through which people may be exposed to a contaminant a background exposure or Mean Daily Intake (MDI) is calculated for each contaminant. Adjustment factors for the MDI are included within Science Report SC050021/SR2 in order to take into consideration the different bodyweights and respiration rates for different age classes.

The starting principle for deriving SSVs is that they are set so that the Average Daily Exposure (ADE) from soils plus the MDI equals the Tolerable Daily Intake (TDI) for that contaminant.

Where the MDI is equal to 50% or greater than TDI then exposure from soils is to be allowed to contribute up to 50% of the TDI when deriving SSVs. When calculating an SSV, this portion of the TDI is referred to as the Tolerable Daily Soil Intake (TDSI).

ASHDOWN SITE INVESTIGATION LIMITED

Notes on the "Guidance on Comparing Soil Contamination Data with a Critical Concentration" (CIEH & CL: AIRE, May 2008)

The Chartered Institute of Environmental Health & CL:AIRE, have published updated guidance on the statistical assessment of contaminated land data, "*Guidance on Comparing Soil Contamination Data with a Critical Concentration" (May 2008).* This is an update to previous guidance published within Contaminated Land Report CLR7 (Defra, 2002).

The CIEH/CL:AIRE guidance forms part of a package of proposed improved UK guidance highlighted in the Defra discussion paper, "*Assessing risks from land contamination –a proportionate approach. Soil guideline values: The Way Forward (CLAN 06/2006)". This discussion paper discussed* the role and use of SGVs for managing the risks associated with soil contamination.

The guidance states that its overall aim is to "increase understanding amongst stakeholders of the role that statistics can play in quantifying the uncertainty attached to estimates of the mean concentration of contaminants in soil, thereby creating a more informed basis for regulatory decision-making".

The initial question, on which the guidance is based, is whether the Site under consideration is to be assessed under the Planning System or under Part 2A of the Environmental Protection Act 1990. The key questions asked when considering contaminant concentrations vary depending on the scenario under consideration. The key questions will generally be:

- **Planning Scenario** – "can we confidently say that the level of contamination on this land is low relative to some appropriate measure of risk?" or "that the level of contamination is lower than the critical concentration" (alternative hypothesis).

- **Part 2A Scenario** – "can we confidently say that the level of contamination on this land is high relative to some appropriate measure of risk?" or "that the level of contamination is higher than the critical concentration" (alternative hypothesis).

Within the guidance, to 'answer' the relevant question above, a null hypothesis has been outlined for each scenario, which, if rejected with a high degree of confidence, means that the alternative hypothesis can be accepted. The null hypothesis for a planning scenario is that the soils contain levels of contamination above the critical concentration (i.e. the soils are assumed to be unsuitable for use until proven otherwise). Under the Part 2A scenario, the null hypothesis is that the soils contain levels of contamination below the critical concentration (i.e. the land is assumed not to fall within Part 2A legislation until proved otherwise).

For the planning scenario the null hypothesis may be rejected if it is considered that the 95th percentile of the normally distributed population as a whole lies below the critical concentration i.e. there is a 95% probability that your true population mean lies below the critical concentration. A lower probability of the true mean lying below the critical concentration may be used, but deviation from the standard 95% requires justification.

For the Part 2A scenario the null hypothesis may be rejected if it can be shown that the lower 95th percentile lies above the critical concentration. If the lower 95th percentile lies below the critical concentration but the true population mean lies above the critical concentration further assessment should be undertaken before the Site can be classified under Part 2A.

Guidance on the treatment of outliers (results that are not representative of a sample population), is also provided in the report. The guidance confirms that outliers should only be excluded from the dataset where they are either demonstrably the result of an error that can be identified and explained, or clearly indicate that more than one soil population exists within the dataset.

Where an individual result is recognised as a 'statistical outlier' or 'contamination hot-spot' within the data set (and where the critical concentration for that contaminant is exceeded), remediation work and or further investigation may be required.

CLEA Model Chemical Data Inputs

Chemical	agvT Isomer	Oral HCV						Inhalation HCV					
		agvT	$_{T}$Veb WB ^{T}gk gh	Notes	ainsoxo Isio rtiw sregmoC	Isemb rtiw sregmoC ainsoxo	notsiteni rtiw sregmoC ainsoxo	agvT	$_{T}$Veb WB ^{T}gk gh	Notes	ainsoxo Isio rtiw sregmoC	Isemb rtiw sregmoC ainsoxo	notsiteni rtiw sregmoC ainsoxo
Arsenic	inorganic	ID	0.3	Environment Agency, 2009. Soil Guidance Values for arsenic in soil.	Yes	Yes	No	ID	0.022	Environment Agency, 2009. Soil Guidance Values for arsenic in soil.	No	No	Yes
Cadmium	inorganic	TDI	0.36	Environment Agency, 2009. Soil Guidance Values for cadmium in soil.	Yes	Yes	No	TDI	0.014	Environment Agency, 2009. Soil Guidance Values for cadmium in soil.	No	No	Yes
Chromium (III)	inorganic	TDI	180	LQM/CIEH GAC 2nd Edition (2009)	Yes	Yes	No	TDI	0.1	LQM/CIEH GAC 2nd Edition (2009)	No	No	Yes
Chromium (VI)	inorganic	TDI	4	LQM/CIEH GAC 2nd Edition (2009)	Yes	Yes	No	ID	0.0001	LQM/CIEH GAC 2nd Edition (2009)	No	No	Yes
Lead	inorganic	TDI	3.57	JECFA 2000. Safety Evaluation of Certain Food Additives and Contaminants	Yes	Yes	No	TDI	0.071	EPACIS, 1998. Lead: Department of the Environment. Toxicity and Exposure. Report No. PN 1525/4/11 IRSN 01/152/4/11	No	No	Yes
Mercury (inorganic)	inorganic	TDI	2	Environment Agency, 2009. Soil Guidance Values for mercury in soil.	Yes	No	No	TDI	0.08	Environment Agency, 2009. Soil Guidance Values for mercury in soil.	No	No	Yes
Nickel	inorganic	TDI	12	Environment Agency, 2009. Soil Guidance Values for nickel in soil.	Yes	Yes	Yes	TDI	0.008	Environment Agency, 2009. Soil Guidance Values for nickel in soil.	No	No	Yes
Selenium	inorganic	TDI	86.4	Environment Agency, 2009. Soil Guidance Values for selenium in soil.	Yes	Yes	Yes	NR	0	No Inhalation HCV	No	No	No
Benzo(a)pyrene	organic	ID	0.02	Environment Agency, 2002. Contaminants in soil. Collation of toxicological data and intake values for humans - Report(s)/pyrene. TOX 2	Yes	Yes	Yes	ID	0.00001	Environment Agency, 2002. Contaminants in soil. Collation of toxicological data and intake values for humans - Report(s)/pyrene. TOX 20	No	No	Yes
Naphthalene	organic	TDI	20	Environment Agency, 2003. Contaminants in soil. Collation of toxicological data and intake values for humans - naphthalene. TOX 20	Yes	Yes	Yes	TDI	0.88	Environment Agency, 2003. Contaminants in soil. Collation of toxicological data and intake values for humans - naphthalene. TOX 20	Yes	No	Yes

Chemical	aqyT lsimsrl	JA notsterini bns lsrs snidmo	Oral MDI for Adults		Initiation MDI for adults		Air-water partition coefficient in air		Diffusion coefficient in air	
			Notes	$F_{veb\ bH}$	Notes	$F_{mc\ ^2m}$	assiun)M2E ts potsiucs (potsts To potassem) sstoN	$F_{e\ ^2m}$	assiun)M2E ts potsiucs (potsts To potassem) sstoN	
Arsenic	Inorganic	No	Index dose used	NR	Index dose used	NR	Inorganic Chemical	NR	Inorganic Chemical	
Cadmium	Inorganic	Yes	Environment Agency, 2008. Soil Guidance Values for cadmium in soil.	0.02	Environment Agency, 2008. Soil Guidance Values for cadmium in soil.	NR	Inorganic Chemical	NR	Inorganic Chemical	
Chromium (III)	Inorganic	Yes	LQM/CIEH GAC 2nd Edition (2009)	0.27	LQM/CIEH GAC 2nd Edition (2009)	NR	0	NR	0	
Chromium (VI)	Inorganic	Yes	LQM/CIEH GAC 2nd Edition (2009)	NR	LQM/CIEH GAC 2nd Edition (2009)	NR	0	NR	0	
Lead	Inorganic	Yes	Environment Agency, 2002. Contaminants in soil: Collation of toxicological data and intake values for humans - rept. TOX 8	2	Department of the Environment, Transport and the Regions. Air Quality Information Archive. http://www.aeat.co.uk/netcen/airqual/publications/pdfs/	NR	Inorganic Chemical	NR	Inorganic Chemical	
Mercury (Inorganic)	Inorganic	Yes	Environment Agency, 2008. Soil Guidance Values for mercury in soil	0	Environment Agency, 2008. Soil Guidance Values for mercury in soil	NR	Inorganic Chemical	NR	Inorganic Chemical	
Nickel	Inorganic	No	Environment Agency, 2008. Soil Guidance Values for nickel in soil	0.08	Environment Agency, 2008. Soil Guidance Values for nickel in soil	NR	Inorganic Chemical	NR	Inorganic Chemical	
Selenium	Inorganic	NR	Environment Agency, 2008. Soil Guidance Values for selenium in soil	0.08	Index dose used	NR	Inorganic Chemical	NR	Inorganic Chemical	
Benzo(a)pyrene	Organic	Yes	Index dose used	NR	TOX20	2.8	Environment Agency, 2003. Contaminants in soil: Collation of toxicological data and intake values for humans - rept. TOX 20	0.000008	Environment Agency, 2008. Science Report - SC050021/SR7	0.000004
Naphthalene	Organic	Yes	NR	7	NR	0.00823	NR	0.000008	Environment Agency, 2008. Science Report - SC050021/SR7	0.000004

Chemical	Chem Type	Diffusion coefficient in water		Relative molecular mass	Vapour pressure		Water solubility		Organic carbon - water partition coefficient (K_{oc})	
		D_{ia} ($cm^2 s^{-1}$)	Reference	M_r (g mol^{-1})	p^*	Reference	S_w (g m^{-3})	Reference	K_{oc} ($m^3 kg^{-1}$)	Reference
Arsenic	Inorganic	NR	Inorganic Chemical to be calculated (tests)	NR	NR	Inorganic Chemical to be calculated (tests)	+2E6000	Environment Agency, 2009. Soil Guidance Values for arsenic in soil.	NR	Inorganic Chemical
Cadmium	Inorganic	NR	Inorganic Chemical to be calculated (tests)	NR	NR	Inorganic Chemical to be calculated (tests)	18000000	Environment Agency, 2009. Soil Guidance Values for cadmium in soil.	NR	Inorganic Chemical
Chromium (III)	Inorganic	NR	Inorganic Chemical to be calculated (tests)	0	NR	Inorganic Chemical to be calculated (tests)	8E6000	LCMMCIEH GAC 2nd Edition (2009)	NR	LCMMCIEH GAC 2nd Edition (2009)
Chromium (VI)	Inorganic	NR	Inorganic Chemical to be calculated (tests)	0	NR	Inorganic Chemical to be calculated (tests)	2E6000	LCMMCIEH GAC 2nd Edition (2009)	NR	LCMMCIEH GAC 2nd Edition (2009)
Lead	Inorganic	NR	Inorganic Chemical to be calculated (tests)	0	NR	Inorganic Chemical to be calculated (tests)	10000	Environment Agency, 2009. Soil Guidance Values for mercury in soil.	NR	Inorganic Chemical
Mercury (Inorganic)	Inorganic	NR	Inorganic Chemical to be calculated (tests)	NR	NR	Inorganic Chemical to be calculated (tests)	7400	Environment Agency, 2009. Soil Guidance Values for nickel in soil.	NR	Inorganic Chemical
Nickel	Inorganic	NR	Inorganic Chemical to be calculated (tests)	NR	NR	Inorganic Chemical to be calculated (tests)	25000000	Environment Agency, 2009. Soil Guidance Values for selenium in soil.	NR	Inorganic Chemical
Selenium	Inorganic	NR	Inorganic Chemical to be calculated (tests)	NR	NR	Inorganic Chemical to be calculated (tests)	217000	Environment Agency, 2009. Soil Guidance Values for selenium in soil.	NR	Inorganic Chemical
Benzo(a)pyrene	Organic	3.87E-10	Environment Agency, 2008. Science Report - SC050021/R1	252.31	7.5E-11	Environment Agency, 2008. Science Report - SC050021/R7	0.0038	Environment Agency, 2008. Science Report - SC050021/R7	2.8E+11	Environment Agency, 2008. Science Report - SC050021/R7
Naphthalene	Organic	8.1E-10	Environment Agency, 2008. Science Report - SC050021/R7	128.17	10.000002	Environment Agency, 2008. Science Report - SC050021/R7	18	Environment Agency, 2008. Science Report - SC050021/R7	2.8E+11	Environment Agency, 2008. Science Report - SC050021/R7

Chemical	qryChemical	Octanol - water partition coefficient (K_{ow})	Soil-water partition coefficient (K_d)	Dermal absorption fraction	Soil-plant availability correction	Root - shoot correction factor	Root - root store correction factor	Root - tuber correction factor	Root - fruit correction factor	Soil-to-plant concentration factor (green vegetables)	
		(tblChemical) pcOctanol	r_g cm							lios WD r_g gm tavo (etsed WA to WD) tinia r_g gm	
Arsenic	inorganic	inorganic Chemical	500	0.03	0.8	0.5	0.5	0.5	0.5	0.00043	numeric
Cadmium	inorganic	inorganic Chemical	100	0.001	s	0.5	0.5	0.5	0.5	0.052	numeric
Chromium (III)	inorganic	LCMMCIEH GAC 2nd Edition (2009)	4800	0	s	0.5	0.5	0.5	0.5	0.00023	numeric
Chromium (VI)	inorganic	LCMMCIEH GAC 2nd Edition (2009)	18	0	s	0.5	0.5	0.5	0.5	0.00023	numeric
Lead	inorganic	inorganic Chemical	38000	0	s	0.5	0.5	0.5	0.5	0	model
Mercury (inorganic)	inorganic	inorganic Chemical	500	0	s	0.5	0.5	0.5	0.5	0.0058	numeric
Nickel	inorganic	inorganic Chemical	500	0	s	0.5	0.5	0.5	0.5	0.0058	numeric
Selenium	inorganic	inorganic Chemical	50	0	50	0.5	0.5	0.5	0.5	0.0108	numeric
Benzo(a)pyrene	organic	Environment Agency, 2008. Science Report - SC050021/SR3	0	0	s	NR	NR	NR	NR	0	model
Naphthalene	organic	Environment Agency, 2008. Science Report - SC050021/SR3	NR	NR	s	NR	NR	NR	NR	0	model

Chemical	Soil-plant concentration factor (green vegetables)		Soil-to-plant concentration factor (root vegetables)		Soil-to-plant concentration factor (tuber vegetables)		Soil-to-plant concentration factor (fruit vegetables)		Soil-to-plant concentration factor (cereals)		Soil-to-plant concentration factor (pulses)	
	lios WD r_g gm tavo (etsed WA to WD) tinia r_g gm	qryT	lios WD r_g gm tavo (etsed WA to WD) tinia r_g gm	qryT	lios WD r_g gm tavo (etsed WA to WD) tinia r_g gm	qryT	lios WD r_g gm tavo (etsed WA to WD) tinia r_g gm	qryT	lios WD r_g gm tavo (etsed WA to WD) tinia r_g gm	qryT	lios WD r_g gm tavo (etsed WA to WD) tinia r_g gm	qryT
Arsenic	0.00043	numeric	0.00043	numeric	0.00043	numeric	0.00043	numeric	0.00043	numeric	0.00043	numeric
Cadmium	0.052	numeric	0.052	numeric	0.052	numeric	0.052	numeric	0.052	numeric	0.052	numeric
Chromium (III)	0.00023	numeric	0.00023	numeric	0.00023	numeric	0.00023	numeric	0.00023	numeric	0.00023	numeric
Chromium (VI)	0.00023	numeric	0.00023	numeric	0.00023	numeric	0.00023	numeric	0.00023	numeric	0.00023	numeric
Lead	0	model	0	model	0	model	0	model	0	model	0	model
Mercury (inorganic)	0.0058	numeric	0.0058	numeric	0.0058	numeric	0.0058	numeric	0.0058	numeric	0.0058	numeric
Nickel	0.0058	numeric	0.0058	numeric	0.0058	numeric	0.0058	numeric	0.0058	numeric	0.0058	numeric
Selenium	0.0108	numeric	0.0108	numeric	0.0108	numeric	0.0108	numeric	0.0108	numeric	0.0108	numeric
Benzo(a)pyrene	0	model	0	model	0	model	0	model	0	model	0	model
Naphthalene	0	model	0	model	0	model	0	model	0	model	0	model

Environment Agency, 2008. Science Report - SC050021/SR3

Inorganic Chemical	qty Chemical	Soil-to-plant concentration factor (root vegetables)			Soil-to-plant concentration factor (herbaceous fruit)			Soil-to-plant concentration factor (shrub fruit)			Soil-to-plant concentration factor (tree fruit)			F_g g)	Soil-to-plant concentration factor (assimilation) to account for soil surface dust-to-soil correction factor (DWQ)
		WT to WD) Insig F_g gm /ssed	qty T	solon	WT to WD) Insig F_g gm /ssed	qty T	solon	WT to WD) Insig F_g gm /ssed	qty T	solon	WT to WD) Insig F_g gm /ssed	qty T	solon		
Arsenic	inorganic	0.0004	numeric W	Environment Agency, Values for arsenic in soil, 2008, Soil Guidance	0.00023	numeric W	Environment Agency, Values for arsenic in soil, 2008, Soil Guidance	0.0011	numeric W	Environment Agency, Values for arsenic in soil, 2008, Soil Guidance	0.0011	numeric W	Environment Agency, Values for arsenic in soil, 2008, Soil Guidance	0.5	1
Cadmium	inorganic	0.028	numeric W	Environment Agency, Values for cadmium in soil, 2008, Soil Guidance	0.021	numeric W	Environment Agency, Values for cadmium in soil, 2008, Soil Guidance	0.0014	numeric W	Environment Agency, Values for cadmium in soil, 2008, Soil Guidance	0.0014	numeric W	Environment Agency, Values for cadmium in soil, 2008, Soil Guidance	0.5	1
Chromium (III)	inorganic	0.00023	numeric W	LCM/CIEH GAC 2nd Edition (2009)	0.00023	numeric W	LCM/CIEH GAC 2nd Edition (2009)	0.00023	numeric W	LCM/CIEH GAC 2nd Edition (2009)	0.00023	numeric W	LCM/CIEH GAC 2nd Edition (2009)	0.5	1
Chromium (VI)	inorganic	0.0001	numeric W	LCM/CIEH GAC 2nd Edition (2009)	0.00021	numeric W	LCM/CIEH GAC 2nd Edition (2009)	0.08	numeric W	LCM/CIEH GAC 2nd Edition (2009)	0.08	numeric W	LCM/CIEH GAC 2nd Edition (2009)	0.5	1
Lead	inorganic	0	model	CLEA to estimate	0	model	CLEA to estimate	0	model	CLEA to estimate	0	model	CLEA to estimate	0.5	1
Mercury (inorganic)	inorganic	0.0089	numeric W	Environment Agency, Values for mercury in soil, 2008, Soil Guidance	0.0043	numeric W	Environment Agency, Values for mercury in soil, 2008, Soil Guidance	0.001	numeric W	Environment Agency, Values for mercury in soil, 2008, Soil Guidance	0.0011	numeric W	Environment Agency, Values for mercury in soil, 2008, Soil Guidance	0.5	1
Nickel	inorganic	4.3E-10	numeric W	Environment Agency, Values for nickel in soil, 2008, Soil Guidance	0.0018	numeric W	Environment Agency, Values for nickel in soil, 2008, Soil Guidance	0.0025	numeric W	Environment Agency, Values for nickel in soil, 2008, Soil Guidance	0.0034	numeric W	Environment Agency, Values for nickel in soil, 2008, Soil Guidance	0.5	1
Selenium	inorganic	0.00264	numeric W	Environment Agency, Values for selenium in soil, 2008, Soil Guidance	0.00083	numeric W	Environment Agency, Values for selenium in soil, 2008, Soil Guidance	0.003	numeric W	Environment Agency, Values for selenium in soil, 2008, Soil Guidance	0.0023	numeric W	Environment Agency, Values for selenium in soil, 2008, Soil Guidance	0.5	1
Benzo(a)pyrene	organic	0	model	CLEA to estimate	0	model	CLEA to estimate	0	model	CLEA to estimate	0	model	CLEA to estimate	0.5	1

Statistical Analysis Summary Sheets

Test Results

ClientClient ref.: Site ref.: LWZ1058 Date: 25-Feb-2010

Project ref.: St Bamabus Hospice Data description: User details: AB

Dataset: Arsenic (mg/kg)

Sample mean, $\bar{x}$ (mg/kg)	8.8058
Sample standard deviation, s	0.9434
Sample size, n	5
Critical concentration, Cc (mg/kg)	32

Use Normal distribution to test if

Outliers & non-detects

	NO
Outliers present?	
Significance level	5%
Outliers removed?	0
Non-detects	0

Normality test

Significance level: 5%

Normal distribution

Use: One-sample t-test

Test scenario:

Planning: Is true mean lower than critical concentration ($\mu < Cc$)?

Null hypothesis: The true mean concentration is equal to or greater than the critical concentration: $\mu \geq Cc$

Alternative hypothesis: The true mean concentration is less than the critical concentration: $\mu < Cc$

Evidence against Null hypothesis: 100%

Base decision on: evidence level

Evidence level required: 95%

Balance of probability? N/A

Reject Null Hypothesis? Yes

$\mu < Cc$ (re this dataset)

Back to data | Back to summary | Go to outlier test | Go to normality test

Test Results

Client/client ref:
Site ref: LWZ1058
Date: 25-Feb-2010
Project ref: St Bamabus Hospice Data description:
User details: AB

Dataset:	Cadmium (mg/kg)
Sample mean, $\bar{x}$ (mg/kg)	0.25
Sample standard deviation, s	0
Sample size, n	5
Critical concentration, Cc (mg/kg)	10

Outliers & non-detects

Use Normal distribution to test it

Outliers present?	NO
Significance level	5%
Outliers removed?	0
Non-detects	5

Normality test

Significance level: 5%

Single value distribution

Use: Anderson-Darling

Test scenario: Planning: Is true mean lower than critical concentration (μ < Cc)?

Null hypothesis: The true mean concentration is equal to or greater than the critical concentration: μ ≥ Cc

Alternative hypothesis: The true mean concentration is less than the critical concentration: μ < Cc

Evidence against Null hypothesis: 100%

Base decision on: evidence level

Evidence level required: 95%

Balance of probability? N/A

Reject Null Hypothesis? Yes

μ < Cc (re this dataset)

Proposed null hypothesis
size x alt no navig
notifyingcouncil sfd spacxcs

Sample mean 0.25 mg/kg
Sample Std Dev 0.25 mg/kg
Critical concentration 10. mg/kg

Concentration (mg/kg)

Back to data | Back to summary | Go to outlier test | Go to normality test

Test Results

Client/client ref: Site ref: LWZ1058 Date: 25-Feb-2010

Project ref: St Bramabus Hospice Data description: User details: AB

Dataset:	Chromium (mg/kg)
Sample mean, $\bar{x}$ (mg/kg)	23.183
Sample standard deviation, s	6.5051
Sample size, n	5
Critical concentration, Cc (mg/kg)	3000

Outliers & non-detects

Outliers present?	No
Significance level	5%
Outliers removed?	0
Non-detects	0

Use Normal distribution to test for outliers

Normality test

Significance level: 5%

Non-normal distribution

Use: Auto: Chebychev

Test scenario: Planning: Is true mean lower than critical concentration (μ < Cc)?

Null hypothesis: The true mean concentration is equal to or greater than the critical concentration: μ ≥ Cc

Alternative hypothesis: The true mean concentration is less than the critical concentration: μ < Cc

Evidence against Null hypothesis: 100%

Base decision on: evidence level

Evidence level required: 95%

Balance of probability? N/A

Reject Null Hypothesis? Yes

μ < Cc (re this dataset)

Back to data | Back to summary | Go to outlier test | Go to normality test

Test Results

Client/client ref.: Site ref.: LW21058 Date: 25-Feb-2010

Project ref.: St Bramabus Hospice Data description: User details: AB

Dataset:	Lead (mg/kg)
Sample mean, $\bar{x}$ (mg/kg)	92.177
Sample standard deviation, s	135.72
Sample size, n	6
Critical concentration, Cc (mg/kg)	228

Normality test

Significance level: 5%

Non-normal distribution

Use: Anderson-Darling

Outliers & non-detects

Outliers present?	YES
Significance level	5%
Outliers removed?	0
Non-detects	0

Use Normal distribution to test for outliers

Test scenario: Planning: Is true mean lower than critical concentration ($\mu < Cc$)?

Null hypothesis: The true mean concentration is equal to or greater than the critical concentration: $\mu \geq Cc$

Alternative hypothesis: The true mean concentration is less than the critical concentration: $\mu < Cc$

Evidence against Null hypothesis: 83%

Base decision on: evidence level

Evidence level required: 95%

Balance of probability? N/A

Reject Null Hypothesis? No

Not enough evidence

Back to data | Back to summary | Go to outlier test | Go to normality test

Test Results

Client/client ref:
Project ref: St Bamabus Hospice Data description:
Site ref: LW21058
Date: 25-Feb-2010
User details: AB

Dataset:	Mercury (mg/kg)
Sample mean, $\bar{x}$ (mg/kg)	0.339
Sample standard deviation, s	0.6463
Sample size, n	5
Critical concentration, Cc (mg/kg)	170

Outliers & non-detects

Outliers present?	YES
Significance level	5%
Outliers removed?	0
Non-detects	4

Use Normal distribution to test if

Test scenario: Planning: is true mean critical concentration (μ < Cc)?

Null hypothesis: The true mean concentration is equal to or greater than the critical concentration: μ ≥ Cc

Alternative hypothesis: The true mean concentration is less than the critical concentration: μ < Cc

Evidence against Null hypothesis: 100%

Base decision on: evidence level

Evidence level required: 95%

Balance of probability? NA

Reject Null Hypothesis? Yes

μ < Cc (re this dataset)

Normality test

Significance level: 5%

Non-normal distribution

Use: Anderson-Darling

Back to data | Back to summary | Go to outlier test | Go to normality test

Test Results

Client/client ref.: Site ref.: LW21058 Date: 25-Feb-2010

Project ref.: St Barnabus Hospice Data description: User details: AB

Dataset:	Nickel (mg/kg)
Sample mean, $\bar{x}$ (mg/kg)	16.272
Sample standard deviation, s	4.3858
Sample size, n	5
Critical concentration, Cc (mg/kg)	130

Outliers & non-detects

	No
Outliers present?	5%
Significance level	0
Outliers removed?	0
Non-detects	

Use Normal distribution to test if

Test scenario: Planning: Is true mean lower than critical concentration ($\mu < Cc$)?

Null hypothesis: The true mean concentration is equal to or greater than the critical concentration: $\mu \geq Cc$

Alternative hypothesis: The true mean concentration is less than the critical concentration: $\mu < Cc$

Evidence against Null hypothesis: 100%

Base decision on: evidence level

Evidence level required: 95%

Balance of probability? N/A

Reject Null Hypothesis? Yes

$\mu < Cc$ (re this dataset)

Normality test

Significance level: 5%

Normal distribution

Use: Auto: One-sample t-test

Back to data | Back to summary | Go to outlier test | Go to normality test

Test Results

Client/client ref: Site ref: LW21058 Date: 25-Feb-2010

Project ref: St Barnabus Hospice Data description: User details: AB

Dataset:	Selenium (mg/kg)
Sample mean, $\bar{x}$ (mg/kg)	0.3872
Sample standard deviation, s	0.3088
Sample size, n	5
Critical concentration, Cc (mg/kg)	350

Normality test

Significance level:	5%
Non-normal distribution	
Use:	Anderson-Darling

Outliers & non-detects

Outliers present?	Yes
Significance level	5%
Outliers removed?	0
Non-detects	4

Use Normal distribution to test for outliers

Test scenario:

Planning: Is true mean lower than critical concentration ($\mu < Cc$)?

Null hypothesis:	The true mean concentration is equal to or greater than the critical concentration: $\mu \geq Cc$
Alternative hypothesis:	The true mean concentration is less than the critical concentration: $\mu < Cc$

Evidence against Null hypothesis: 100%

Base decision on:	evidence level
Evidence level required:	95%
Balance of probability?	N/A
Reject Null Hypothesis?	Yes

$\mu < Cc$ (re this dataset)

Back to data | Back to summary | Go to outlier test | Go to normality test

Test Results

ClientUpdate ref: Site ref: LW21058 Date: 25-Feb-2010

Project ref: St Barnabus Hospice Data description: User details: AB

Dataset:	Chromium VI (mg/kg)
Sample mean, $\bar{x}$ (mg/kg)	1
Sample standard deviation, s	0
Sample size, n	5
Critical concentration, Cc (mg/kg)	4.3

Normality test

Significance level: 5%

Single value distribution

Use: Chebychev

Outliers & non-detects

Outliers present?	NO
Significance level	5%
Outliers removed?	0
Non-detects	5

Use Normal distribution to test if

Test scenario: planning: is true mean critical concentration (μ > Cc)?

Null hypothesis: The true mean concentration is equal to or greater than the critical concentration: μ ≥ Cc

Alternative hypothesis: The true mean concentration is less than the critical concentration: μ < Cc

Evidence against Null hypothesis: 100%

Base decision on: evidence level

Evidence level required: 95%

Balance of probability? N/A

Reject Null Hypothesis? Yes

μ > Cc (re this dataset)

Back to data | Back to summary | Go to outlier test | Go to normality test

Test Results

ClientAdvisor ref: | Site ref.: LW21058 | Date: 25-Feb-2010

Project ref.: St Bamabus Hospice Data description: | User details: AB

Dataset:	Naphthalene (mg/kg)
Sample mean, $\bar{x}$ (mg/kg)	0.25
Sample standard deviation, s	0
Sample size, n	5
Critical concentration, Cc (mg/kg)	0.6

Outliers & non-detects

	NO	
Outliers present?		
Significance level	5%	
Outliers removed?	0	
Non-detects	5	

Use Normal distribution to test for outliers

Normality test

Significance level: 5%

Single value distribution

Use: Anderson-Darling

Test scenario: Planning: Is true mean critical concentration (μ > Cc)?

Null hypothesis: The true mean concentration is equal to or greater than the critical concentration: μ ≥ Cc

Alternative hypothesis: The true mean concentration is less than the critical concentration: μ < Cc

Evidence against Null hypothesis: 100%

Base decision on: evidence level

Evidence level required: 95%

Balance of probability? N/A

Reject Null Hypothesis? Yes

μ < Cc (re this dataset)

Back to data | Back to summary | Go to outlier test | Go to normality test

Test Results

Client/client ref.: Site ref.: LW21058 Date: 25-Feb-2010

Project ref.: St Bamabus Hospice Data description: User details: AB

Dataset:	Bq/kg (mg/kg)
Sample mean, $\bar{x}$ (mg/kg)	1.27
Sample standard deviation, s	2.8139
Sample size, n	5
Critical concentration, Cc (mg/kg)	0.8

Normality test

Significance level: 5%

Non-normal distribution

Use: Anderson-Darling

Outliers & non-detects

Outliers present?	YES
Significance level	5%
Outliers removed?	0
Non-detects	3

Use Normal distribution to test for outliers

Test scenario: Planning: Is true mean lower than critical concentration ($\mu < Cc$)?

Null hypothesis: The true mean concentration is equal to or greater than the critical concentration: $\mu \geq Cc$

Alternative hypothesis: The true mean concentration is less than the critical concentration: $\mu < Cc$

Evidence against Null hypothesis: evidence level: 0%

Base decision on: Evidence level required: 95%

Balance of probability? N/A

Reject Null Hypothesis? No

$\mu \geq Cc$

Back to data | Back to summary | Go to outlier test | Go to normality test

FIGURES

Figure 1	Site Location Plan
Figure 2	Site Plan
Figure 3	Foundation Inspection Pits
Figure 4	Preliminary Conceptual Model
Figure 5	Quantitative Conceptual Model

SITE: St Barnabas Hospice, Columbia Drive, Worthing

Site Location Plan

Not To Scale

Figure 1

LW21058

INVESTIGATION
ASHDOWN SITE

SIR John,	
DRAWING BY	
TM/3702B	2
DRAWING NO.	SCALE 1:500

Whitgift, West Surrey.
Collingtree Park
St Barnabas Hospice

AV	June 2006	
DRAWN BY	DATE	SCALE

ASHDOWN SITE INVESTIGATION LIMITED

Ashdown Site Investigation Limited
Head Office
Unit 2
The Bell Business Park
Smarden
Kent
TN27 8QD

Tel: 01233 770741 Fax: 01233 770622
Email: mail@ashdownsite.co.uk
Website: www.ashdownsite.co.uk

Conforming design
Planning Issue

8501EW1	3
Project No.	Issue No.

Proposed Residential Development
at Bellurgan
Louth

JV	30/06/2021
Drawn by	Date
Issue	1:50

Ashdown Site Investigations Limited
Unit 8 Bay 1
Enterprise Park
Clonshaugh
Dublin 17
Tel: 01 533 6588
Fax: 01 533 6589
Email: info@ashdownsi.com
Web: www.ashdownsi.com

Sources

1. Potential PCB contamination from electrical sub station.
2. Potential petroleum hydrocarbon contamination from emergency generator.
3. Potential localised petroleum hydrocarbon contamination from car parking.

Pathways

a. Dermal contact with soil (Indoor & Outdoor);
b. Direct soil and dust ingestion;
c. Consumption of homegrown produce; including soils attached to homegrown produce;
d. Inhalation of indoor and outdoor soil dust;
e. Inhalation of soil vapours;
f. Groundwater flow.

Receptors

I. Human Health
II. Groundwater

SITE: St Barnabas Hospice, Columbia Drive, Worthing	Preliminary Conceptual Model. Not To Scale		Figure 4 LW21058

Sources

1. Elevated concentrations of lead and benzo(a)pyrene below the car parking area in the northern part of the Site.
2. Potential for localised petroleum hydrocarbon contamination below car parking areas.

Pathways

a. Dermal contact with soil (Indoor & Outdoor);
b. Direct soil and dust ingestion;
c. Consumption of homegrown produce, including soils attached to homegrown produce;
d. Inhalation of indoor and outdoor soil dust;
e. Inhalation of soil vapours.

Receptors

I. Human Health
II. Groundwater – no sourcepathway/receptor linkage

SITE: St Barnabas Hospice, Columbia Drive, Worthing	Quantitative Conceptual Model. Not To Scale	Figure 5 LW21058

ELLIS KNOWLES INVESTIGATION