ASHDOWN SITE INVESTIGATION
L•I•M•I•T•E•D

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Cimbrone Developments Ltd
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New Malden
Greater London
KT3 3NE

Dear Sir/Madam,

Beech Hill Stores, Eddeys Lane, Headley Down, Bordon GU35 8HU
Investigation Proposal

Introduction

Ashdown Site Investigation Ltd. has been commissioned to prepare an investigation proposal in relation to the proposed redevelopment of the site known as "Beech Hill Stores, Eddeys Lane, Headley Down, Bordon". A site location plan is included as Appendix A.

We understand that the development proposals for the site comprise the demolition of the buildings around the north and west of the site, and the construction of six detached houses with associated gardens.

It is understood that planning conditions in relation to contaminated land have been imposed for the development[1]. This site investigation proposal is intended to support the discharge of Condition 5 a).

The proposal has been prepared in line with current guidance[2,3,4,5].

Phase 1 Land Quality Assessment

GeoSmart Information Ltd. has undertaken a Phase 1 Contaminated Land Assessment for the site[6].

A copy of the preliminary conceptual model for the site, as presented within the report, is included as Appendix B.

The risk assessment has identified several potential sources of contamination, both on and off-site.

The on-site potential sources identified comprise historical use of the site as a laundry, coal yard and commercial premises.

The off-site potential sources identified comprise a garage/filling station 80m to the north west and a historical landfill site 195m to the north west.

[1] East Hampshire District Council, Planning Application Ref: 58616
[2] Environment Agency, Land contamination risk assessment, published 8th October 2020.
[3] BS10175:2011+A2:2017, Investigation of potentially contaminated sites. Code of practice. December 2017.
[4] BS 5930:2015+A1:2020, Code of practice for ground investigation. May 2020.
[5] Contaminated Land Risk Assessment: A guide to good practice, CIRIA C552, 2001.
[6] EnviroSmart Plus, Report Ref: 74457R1, February 2021.

The report recommended that a "proportionate programme of site investigation and monitoring works be undertaken in order to establish the presence or absence of contamination and to enable a quantitative assessment of the association environmental risks."

It also recommended that the potential for asbestos materials within the existing buildings on the site should be investigated prior to demolition works. Such a survey would be outside of the scope of the proposed ground investigation works discussed in this document.

Proposed Intrusive Works

The objectives of the proposed investigation are to:

- Obtain data on the nature and extent of contamination, the geology and hydrogeology at the site;
- Provide data on the potential risks identified in the preliminary conceptual model and to undertake a quantitative risk assessment; and
- Provide data to enable the selection and design of remedial works (if required) to be undertaken.

It is proposed to drill 6 no. dynamic sampler boreholes to depths of up to 2.0m below ground level, along with shallow hand dug pits (up to 0.5m deep) at a further two locations.

Gas monitoring standpipes will be installed within 3 of the dynamic sampler boreholes.

In the event that any visual or olfactory evidence of suspected petroleum hydrocarbon or volatile contamination (i.e. stained or odorous soils) is encountered during the investigation then boreholes will extended, where possible, to try and progress below the base of any such impacted soils.

Investigation Locations

As the distribution of contamination from the potential source identified is unknown, a systematic sampling strategy is proposed across currently accessible areas of the site i.e. outside the extent of the existing buildings. The boreholes and shallow pits have been proposed in a herringbone layout within a regular grid.

Given the relatively small size of the site (total site area c. 50m by c. 50m), the spacing of the exploratory holes (~15m-25m centres) falls within the density of testing considered sufficient for a detailed investigation, as specified within Section 7.7.2.3.3 of BS101075:2011+A2:2017.

It is noted that, as with any ground investigation, and in accordance with the guidance presented in BS10175, depending on the findings of the current proposed works it may be necessary to recommend further works.

Soil Sampling and Testing

Samples of each soil strata encountered within the boreholes/pits will be obtained at regular intervals to provide a large range of samples that can be to be selected for laboratory testing. Should made ground be encountered at borehole locations, then the investigation will ensure that samples of made ground are obtained from within the top 1m, which is considered to be the depth where future end users of the site could reasonably come into contact with the soils and soil derived dust.

Deeper samples of any made ground encountered will also be obtained, along with regular samples of any undisturbed soils into which the investigation progresses.

Samples from within the top metre will be tested for concentrations of heavy metals and polycyclic aromatic hydrocarbon (PAH) compounds. Samples will also be screened for the presence of asbestos materials.

Any soils showing evidence of suspected petroleum hydrocarbon contamination i.e. stained or odorous soils will also be sampled and tested for concentrations of petroleum hydrocarbons (with the results speciated into 5 equivalent carbon weight fractions between C8 and C35) and volatile organic compounds. Where possible, samples from below any impacted areas will also be collected and tested.

If no visual or olfactory evidence of contamination is encountered during the investigation, then the likelihood of petroleum hydrocarbons or volatile contaminants being present at sufficient concentrations as to pose an unacceptable risk to end users would be considered to be very low to negligible. In this situation, selected shallow samples from across the site will be tested for concentrations of petroleum hydrocarbons and volatile organic compounds to confirm the absence of significant contamination.

The laboratory testing will be carried out by an accredited laboratory.

Generic Assessment Criteria

The results of the laboratory testing will be compared to generic assessment criteria. The most sensitive receptor identified by the conceptual model is considered to be a proposed end user of the site following its development.

As such, the generic assessment criteria ("soil screening values") to be used in the assessment will comprise the 'Suitable For Use Levels' (S4UL)[7] or, in lieu of an S4UL being developed for lead, the Category 4 Screening Level (C4SL)[8] for the generic "Residential" land use[9].

[7] Nathanail, C.P, et al., The LQM/CIEH S4ULs for Human Health Risk Assessment, 2015, Land Quality Press, Nottingham. Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3071.
[8] SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Final Project Report, published by DEFRA, 2014.
[9] As defined within Science Report SC050021/SR3, January 2009, with the amendments discussed in the LQM/CIEH report.

The critical receptor for the "Residential" 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, the outdoor and indoor ingestion of dust, the potential inhalation of dust and vapours, ingestion of site grown vegetables and ingestion of soil attached to vegetables.

Where published S4UL do not exist for volatile organic compounds, reference may be made to other screening values, such as the EIC GAC.

Gas Standpipes and Monitoring

Three main pieces of guidance[10,11,12] are available relating to carrying out an assessment of the risk posed by ground gases. The British Standard refers readers to the CIRIA document for guidance on how to conduct the risk assessment.

The potential gas source identified is a historical landfill site located some 190m to the north west. Given the large distance from the source and the likely presence of clayey soils within the underlying Lambeth Group, the likelihood of significant gas migration to the assessment site is considered to be very low.

It is proposed to install three standpipes in boreholes WS01, WS02 and WS05. The proposed standpipes are all located as close to the northern and western boundaries as possible.

If made ground is found to be present to shallow (less than 1m) depths, then the standpipes will be installed with the response zone sealed within the undisturbed soils below any made ground. If greater depths (>1m) of made ground are encountered, then the response zone may be sealed within the made ground to assess the potential for gas migration through such soils.

Monitoring of the standpipes will be undertaken using a GFM435 and MiniRae 3000.

The GFM435 will give flow rates and concentrations of bulk gases (methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide). The weather conditions and the local air pressure trends should be recorded at the time of each visit.

The MiniRAE 3000 is calibrated for isobutylene. Whilst a correction factor can be applied to the PID reading for a known VOC, the proposed use of the PID in the monitoring period currently proposed is to provide a qualitative assessment of the risk of soil vapours being present, alongside the visual inspection of soils within the boreholes and the results of laboratory testing.

Whilst noting Table 5.5a and Table 5.5b of CIRIA C665, it is initially proposed to undertake three monitoring visits undertaken at approximately weekly intervals, beginning around one week following installation of the standpipes.

[10] Assessing risks posed by hazardous ground gases to buildings, CIRIA C665, 2007.
[11] BS8485:2015+A1:2019 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings, January 2019.
[12] BS8576:2013 Guidance on investigation for ground gas – Permanent gases and Volatile Organic Compounds (VOCs), April 2013.

CIRIA C665 states that "**focusing on a minimum number and period of readings can be misleading and the key should be that the monitoring period for a specific site covers the "worst case" scenario.** Such a "worst case" scenario will occur during falling atmospheric pressure and, in particular weather conditions such as rainfall, frost and dry weather… It should be noted that most rapid falls in atmospheric pressure occur when the pressure was initially high, for example 1010 or 1020mb." (emphasis as per original).

It acknowledges that the monitoring period used for any given site represents a balance between the cost of additional monitoring and the confidence in the results, and a judgement on whether additional monitoring would change the scope of the assessment. The guidance states that the investigations should provide data sufficient as to allow predictions of worst case conditions.

BS8576 provides a broadly similar commentary and states:

"Monitoring should be sufficient to allow prediction of worst case conditions. Justification should be provided for the monitoring period and frequency that is adopted. This should be based on the preliminary conceptual model. Factors that should be taken into account in the decision process include periods of rising, falling and stable barometric pressure and the need to be able to predict the nature and timing of worst case conditions."

However, in relation to worst case conditions it states that:

"Gas monitoring does not necessarily need to be carried out under worst case conditions. **It does not necessarily need to be at low or falling atmospheric pressure, but rather should be continued until it is unlikely that additional data will change the interpretation of the data**, the outcome of the risk assessment and proposed remedial actions. This requires continued assessment of data as the monitoring progresses. One of the main considerations is to assess whether gas flow rates or concentrations could possibly increase and thereby affect the risk assessment and hence the choice of protective measures." (emphasis added).

In view of the above, it is emphasised that depending on the findings of the initial period of monitoring, it may be necessary to recommend further monitoring to refine any uncertainties within the data. Appendix F of BS8576 provides guidance on assessment whether sufficient gas monitoring has been collected.

Potential Risks to Controlled Waters

The preliminary conceptual model identifies the risk to controlled waters beneath the site as "moderate/low".

It is not currently proposed to carry out any groundwater sampling and testing. Initially, the results of the laboratory testing on the shallow soils will be used to provide a qualitative assessment of the level of potential risk posed to the underlying aquifer.

Should the results of the soil testing indicate any locally gross contamination which may pose a risk to controlled waters, then the risk assessment may recommend further works, such as the installation of further standpipes to

intersect the groundwater at the site, followed by groundwater sampling and associated laboratory testing.

Quantitative Ground Contamination Risk Assessment

Following completion of the intrusive investigation and gas monitoring period, a quantitative ground contamination risk assessment report will be prepared. The report will include a description of the works carried out, exploratory hole records, test results and a summary of the ground and groundwater conditions.

The quantitative ground contamination risk assessment will include analysis of the laboratory test results and comparison with the SSV specified.

The ground gas monitoring data will be assessed in accordance with Table F.1 of Appendix F of BS8576 to make a decision as to whether sufficient monitoring data has been collected or whether further monitoring is required. Should this assessment conclude that sufficient data has been obtained, worst case gas screening values will be calculated and compared to the published values in CIRIA C665.

The report will refine the preliminary conceptual model and present a quantitative conceptual model.

The report may also recommend any further works that may be required to address any uncertainties within the quantitative conceptual model, should this be necessary.

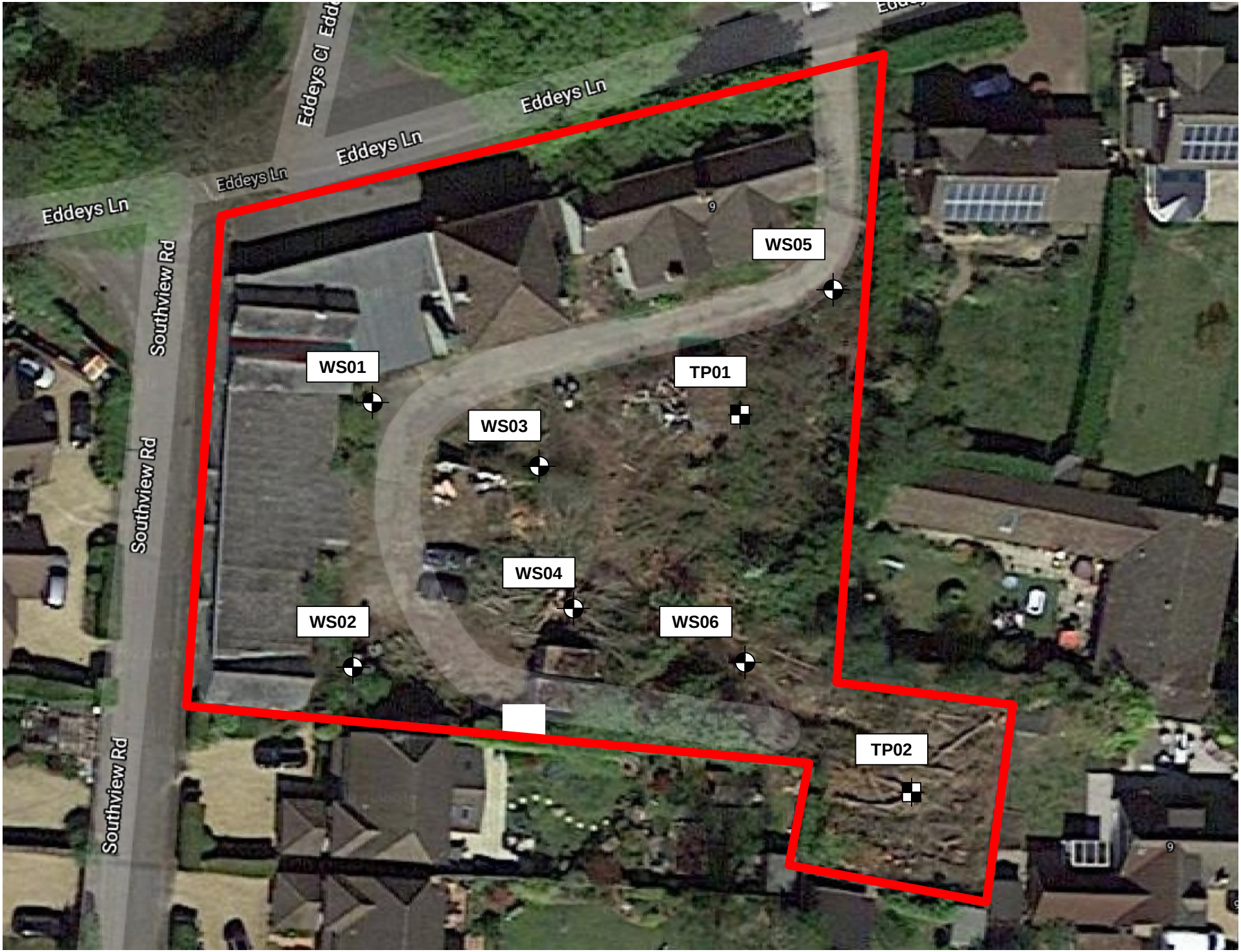
Local Authority Approval

It is recommended that this investigational proposal is submitted to the Local Authority in relation to Condition 5 a) of the planning permission, for their approval prior to undertaking any intrusive investigation works at the site.

Yours sincerely

Stuart Card
Ashdown Site Investigation Limited

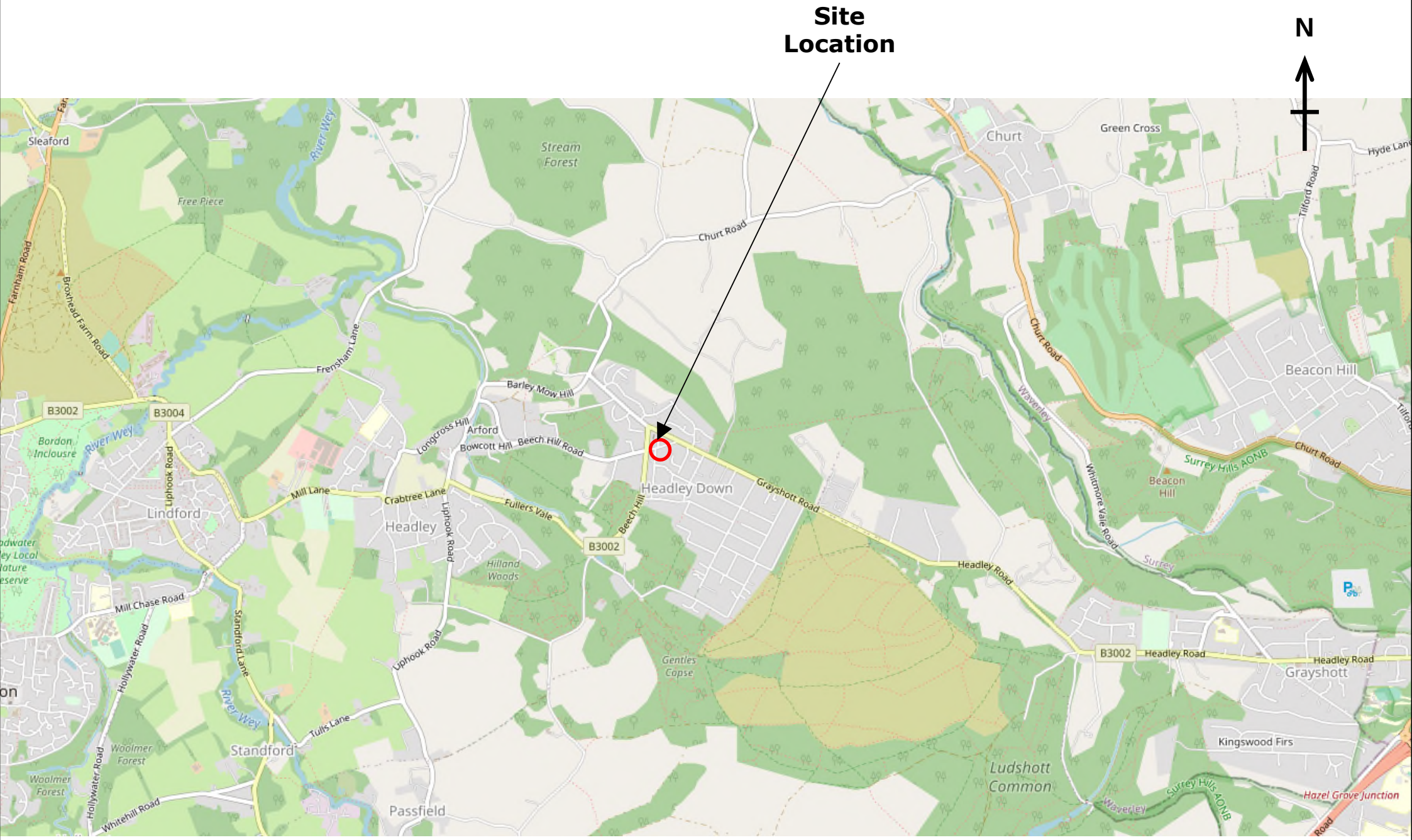
Figures



ASHDOWN SITE INVESTIGATION LIMITED	**Site Plan**	**Site Name**	**Figure No.**	**Project Reference**
		Beech Hill Stores, Eddeys lane, Headley Down, Bordon	1	P15095

Appendix A

Site Location Plan



ASHDOWN SITE INVESTIGATION LIMITED	Site Location Plan	Site Name	Appendix	Project Reference
		Beech Hill Stores, Eddeys lane, Headley Down, Bordon	A	P15095

Appendix B

Preliminary Conceptual Model

2.5 Preliminary Risk Assessment

Nr	Sources	Pathways	TYPE	Receptors	Consequence	Probability	Risk classification	Comments
On-Site sources - Laundry, Coal Yard and Commercial (Retail including post office)								
1	Potential for **inorganic** and low volatility organic contaminants to be present within the subsurface **soils**	Dermal contact, ingestion & inhalation of soils & soil dust	HH	Future Site occupants	**MEDIUM**	**LOW LIKELIHOOD**	**MODERATE/LOW RISK**	Given the historical use of the Site as a laundry and coal yard, there is potential for residual contaminants associated with these land uses which could impact future Site users, particularly in garden areas.
2		Consumption of home grown produce	HH		**MEDIUM**	**LOW LIKELIHOOD**	**MODERATE/LOW RISK**	
3		Ingress into water supply pipework and subsequent water ingestion	HH		**MEDIUM**	**LOW LIKELIHOOD**	**MODERATE/LOW RISK**	
4		Building materials in direct contact with aggressive ground	PROP	Future Site buildings	**MILD**	**UNLIKELY**	**VERY LOW RISK**	Aggressive ground conditions are not anticipated to be present.
5		Dissolution into pore water/shallow groundwater and subsequent migration	CW	Hythe Formation (a Principal Aquifer)	**MEDIUM**	**LOW LIKELIHOOD**	**MODERATE/LOW RISK**	There is potential that contaminants associated with the historical uses of the Site could impact underlying groundwater.
6		Dissolution into pore water/shallow groundwater and subsequent lateral migration	CW	Drain (c. 170 m east)	**MILD**	**UNLIKELY**	**VERY LOW RISK**	The risk classification reflects the reasonable distance to the nearest surface water feature.
7		Dissolution into aqueous phase and preferential migration via drainage structures	CW		**MILD**	**UNLIKELY**	**VERY LOW RISK**	

2.5 Preliminary Risk Assessment

Nr	Sources	Pathways	TYPE	Receptors	Consequence	Probability	Risk classification	Comments
8	Potential for **volatile organic** contaminants to be present within the subsurface **soils**	Dermal contact, ingestion & inhalation of soils & soil dust	HH	Future Site occupants	**MEDIUM**	**LOW LIKELIHOOD**	**MODERATE/LOW RISK**	Given the historical use of the Site as a laundry and coal yard, there is potential for residual contaminants associated with these land uses which could impact future Site users, particularly in garden areas.
9		Consumption of home grown produce	HH		**MEDIUM**	**LOW LIKELIHOOD**	**MODERATE/LOW RISK**	
10		Ingress into water supply pipework and subsequent water ingestion	HH		**MEDIUM**	**LOW LIKELIHOOD**	**MODERATE/LOW RISK**	
11		Migration of vapours to surface; inhalation indoors	HH		**MEDIUM**	**UNLIKELY**	**LOW RISK**	It is understood there is no bulk fuel storage currently present on-Site. It is possible that given the former uses of the Site, that bulk fuel storage may have been present, however, it is plausible that the source mass associated with any volatile contaminants that were originally present on-Site may have been significantly reduced due to the effects of volatilisation and degradation over time.
12		Migration of vapours to surface; inhalation outdoors	HH		**MEDIUM**	**UNLIKELY**	**LOW RISK**	
13		Building materials in direct contact with aggressive ground	PROP	Future Site buildings	**MILD**	**LOW LIKELIHOOD**	**LOW RISK**	Aggressive ground conditions are not anticipated to be present.
14		Dissolution into pore water/shallow groundwater and subsequent migration	CW	Hythe Formation (a Principal Aquifer)	**MEDIUM**	**LOW LIKELIHOOD**	**MODERATE/LOW RISK**	There is potential that contaminants associated with the historical uses of the Site could impact underlying groundwater.
15		Dissolution into pore water/shallow groundwater and subsequent migration	CW	Drain (c. 170 m east)	**MEDIUM**	**UNLIKELY**	**LOW RISK**	The risk classification reflects the reasonable distance to the nearest surface water feature.
16		Dissolution into aqueous phase and preferential migration via drainage structures	CW		**MEDIUM**	**UNLIKELY**	**LOW RISK**	

2.5 Preliminary Risk Assessment

Nr	Sources	Pathways	TYPE	Receptors	Consequence	Probability	Risk classification	Comments
17	Potential for **asbestos** containing materials within the subsurface **soils**	Liberation of sub surface ACMs and inhalation of asbestos fibres	HH	Future Site occupants	**MEDIUM**	**LOW LIKELIHOOD**	**MODERATE/LOW RISK**	Given the age of the existing building structures asbestos-containing material may be present within the building fabric and surrounding subsoils.
18	Potential for **dissolved phase** contaminants to be present within **shallow groundwater**	Lateral and vertical groundwater movement via natural or artificial flow paths	CW	Hythe Formation (a Principal Aquifer)	**MEDIUM**	**LOW LIKELIHOOD**	**MODERATE/LOW RISK**	There is potential that contaminants associated with the historical uses of the Site could impact underlying groundwater.
19		Lateral and vertical groundwater movement via natural or artificial flow paths	CW	Drain (c. 170 m east)	**MEDIUM**	**UNLIKELY**	**LOW RISK**	The risk classification reflects the reasonable distance to the nearest surface water feature.
20	Potential for elevated **methane** to be present within the sub-surface **soils**	Lateral and vertical migration into on-Site buildings; potential to cause an explosion	HH	On-Site properties and their occupants	**SEVERE**	**UNLIKELY**	**MODERATE/LOW RISK**	Based on the prevailing conceptual understanding an appreciable gas source is considered unlikely. The risk classification is a reflection of the severity of consequences rather than the likelihood of occurrence.
21		Lateral migration towards off-Site buildings; potential to cause an explosion	HH	Off-Site properties and their occupants	**SEVERE**	**UNLIKELY**	**MODERATE/LOW RISK**	
22	Potential for elevated **carbon dioxide** to be present within the subsurface **soils**	Lateral and vertical migration into on-Site buildings; potential to cause asphyxiation	HH	Occupants of on-Site buildings	**SEVERE**	**UNLIKELY**	**MODERATE/LOW RISK**	
23		Lateral migration towards off-Site buildings; potential to cause asphyxiation	HH	Occupants of off-Site buildings	**SEVERE**	**UNLIKELY**	**MODERATE/LOW RISK**	
24	Potential for **radon** within the subsurface	Lateral migration towards on-Site buildings; potential to cause long term health effects	HH	Occupants of on-Site buildings	**MEDIUM**	**UNLIKELY**	**LOW RISK**	The Site lies in an area where <1% of homes are at or above the UK radon action level (200 Bq/m3).
						OVERALL RISK RATING	**MODERATE/LOW RISK**	

2.5 Preliminary Risk Assessment

Nr	Sources	Pathways	TYPE	Receptors	Consequence	Probability	Risk classification	Comments
Off-Site sources - Garage c. 80 m north west (1970 - present)								
25	Potential for both inorganic and volatile organic contaminants to be present within the subsurface soils	Dermal contact, ingestion & inhalation of soils & soil dust	HH	Future Site occupants	**MEDIUM**	**UNLIKELY**	**LOW RISK**	Given the proximity of the garage to the Site, there is potential that this land use could impact the Site. However, given the topography of the surrounding area (see mapping in section 3.6), with parts of the Site located at higher elevation, it is considered unlikely that any contaminants associated with the garage would preferably migrate towards the Site.
26		Consumption of home grown produce	HH		**MEDIUM**	**UNLIKELY**	**LOW RISK**	
27		Ingress into water supply pipework and subsequent water ingestion	HH		**MEDIUM**	**UNLIKELY**	**LOW RISK**	
28		Migration of vapours to surface; inhalation indoors	HH		**MEDIUM**	**UNLIKELY**	**LOW RISK**	
29		Migration of vapours to surface; inhalation outdoors	HH		**MEDIUM**	**UNLIKELY**	**LOW RISK**	
30		Dissolution into pore water/shallow groundwater and subsequent migration	CW	Hythe Formation (a Principal Aquifer)	**MEDIUM**	**UNLIKELY**	**LOW RISK**	

2.5 Preliminary Risk Assessment

Nr	Sources	Pathways	TYPE	Receptors	Consequence	Probability	Risk classification	Comments
Off-Site sources - Errie Tip is located c. 195 m north west of the Site; the landfill received commercial and household waste between 1961 and 1973.								
31	Potential for elevated **methane** to be present within the sub-surface **soils**	Lateral and vertical migration into on-Site buildings; potential to cause an explosion	HH	On-Site properties and their occupants	**SEVERE**	**UNLIKELY**	**MODERATE/LOW RISK**	Given there is a landfill recorded in close proximity to the Site, there is the potential for gas generation which could impact the Site. However, there are a number of factors which significantly reduce the likelihood of landfill gas affecting the proposed development including: - The age of the waste. Infilling ceased in ~ 1973 making the material in the ground approximately 48 years old. Typically a landfill will achieve its peak gas generation potential within around 30 years following deposition, as such even if large quantities of putrescible material had been deposited the rate of gas generation will now be in decline. - The date of infilling. Given that the waste was deposited before introduction of the Control of Pollution Act 1974 it is very unlikely that there will be any engineered capping layer over the waste, as such any gas generated will preferentially vent vertically to atmosphere rather than laterally through the superficial geology towards the Site. The risk classification is based upon the consequence as opposed to the likelihood of occurrence.
32	Potential for elevated **carbon dioxide** to be present within the subsurface **soils**	Lateral and vertical migration into on-Site buildings; potential to cause asphyxiation	HH	Occupants of on-Site buildings	**SEVERE**	**UNLIKELY**	**MODERATE/LOW RISK**	

2.5 Preliminary Risk Assessment

Nr	Sources	Pathways	TYPE	Receptors	Consequence	Probability	Risk classification	Comments
Off-Site sources - Electricity Sub Station c. 120 m north east (1970 - present) c. 165 m west (1970 - present) and c. 245 m north west (1970 - 1988).								
33	Potential contaminant: polychlorinated biphenyls (PCBs)	Dermal contact, ingestion & inhalation of soils & soil dust	HH	Future Site occupants	**MEDIUM**	**UNLIKELY**	**LOW RISK**	Given the location of the sub station and the relatively low mobility of PCB contaminants, it is unlikely that future Site occupants would be impacted.
34		Consumption of home grown produce	HH		**MEDIUM**	**UNLIKELY**	**LOW RISK**	
35		Ingress into water supply pipework and subsequent water ingestion	HH		**MEDIUM**	**UNLIKELY**	**LOW RISK**	
36		Migration of vapours to surface; inhalation indoors	HH		**MEDIUM**	**UNLIKELY**	**LOW RISK**	
37		Migration of vapours to surface; inhalation outdoors	HH		**MEDIUM**	**UNLIKELY**	**LOW RISK**	
38		Dissolution into pore water/shallow groundwater and subsequent migration	CW	Hythe Formation (a Principal Aquifer)	**MEDIUM**	**UNLIKELY**	**LOW RISK**	Although permeable deposits exist, PCBs are not readily soluble.
						OVERALL RISK RATING	**MODERATE/LOW RISK**	