Depth	Thickness	Soil Type	Description
			chalk. **CIRIA Grades Dm & Dc** **(Lewes Nodular Chalk)**
0.5m/5m to 20m+	15m+	Chalk	Possibly extremely weak to weak CHALK, with rare small to large flints, recovered as gravelly silt putty chalk with orange brown staining within the boreholes. **(Lewes Nodular Chalk)**

14 Groundwater Strikes

No groundwater was struck within the exploratory holes during this investigation.

E FIELD TESTING AND SAMPLING

The following in-situ tests and sampling methods were employed. Descriptions are given in Appendix B together with the test results.

- Standard Penetration Test
- Hand Penetrometer (Unconfined Compressive Strength)
- Perth Penetrometer
- BRE 365 Soakage Test
- Constant Head Soakage Test

F GEOTECHNICAL LABORATORY TESTS

The following tests were carried out on selected samples. Test method references and results are given in Appendix C.

- Moisture Content
- 4 Point Plasticity Index
- Saturation Moisture Content
- Sulphate and pH content of soils

G DISCUSSION OF GEOTECHNICAL TEST RESULTS AND RECOMMENDATIONS

15 Soil Classification and Properties

Soil Type	Depth	Compressibility	VCP	Permeability	Frost Susceptible	CBR	Remarks
Topsoil	GL to 0.2/0.9m	N/A	N/A	Variable	Yes	N/A	Not suitable for foundations
Clay	0.2m to 2.8m	Moderate to High	Medium	Low	Yes	Fair	
Chalk	0.2m /2.8m to 20m+	Negligible	Negligible	Variable	Yes	Good	

16 Swelling and Shrinkage

Atterberg Limit tests were carried out on eleven samples of cohesive soils. Based on modified values taking into account the coarse soil fraction, four of the plasticity tests classified the clays as of NHBC Low Volume Change Potential (VCP), with one sample classified as NHBC Medium VCP. One sample was classified as NHBC High VCP. On balance it is considered NHBC Medium could be considered an appropriate preliminary site wide classification for those areas where clay soils overly chalk. Further testing will be required to better assess this and 'zoning' of the site may be required.

It is anticipated that significant foundation deepening due to trees will not be required due to the general absence of vegetation on site. Some proposed plots close to boundary hedges and trees may however require some deepening. Such deepening will only be required where cohesive soils are found to overlie the chalk. Where chalk is not overlain by superficial cohesive soils, no deepening will be required due to the non-shrinkability of the chalk strata.

NHBC Chapter 4.2 Foundation Depth Chart for MEDIUM Volume Change Potential Soils										
Water Demand	Tree Type (common examples)	Distance over Height Ratio (D/H)								
		0.0	0.1	0.2	0.3	0.4	0.5	0.6	1.0	1.25
		Foundation Depth (m)								
High	Broad Leaf (Elm, Eucalyptus, Hawthorn, Oak, Poplar, Willow or unknown species)	*	*	*	2.5	2.35	2.2	2.0	1.3	0.9
	Coniferous (Cypress)	*	*	2.3	1.95	1.6	1.25	0.95	0.9	0.9
Moderate	Broad Leaf (Ash, Beech, Fruit,	2.0	1.85	1.7	1.6	1.4	1.3	1.15	0.9	0.9

	Chestnut, Lime, Maple, Sycamore, Plane)									
	Coniferous (Cedar, Pine, Spruce, Douglas Fir, Wellingtonia, & Yew)	2.0	1.7	1.4	1.05	0.9	0.9	0.9	0.9	0.9
Low	Broad Leaf (Birch, Hazel, Holly, Magnolia, Elder)	1.5	1.4	1.25	1.15	1.0	0.9	0.9	0.9	0.9

*Trench fill foundations deeper than 2.5m will only be acceptable if they are designed by an engineer (see NHBC Technical Requirement R5) taking into account all potential movement on the foundations and substrate (further details are given in NHBC Chapter 4.2, section D7).

Where trees have been or are to be removed from within 2m of the face of the proposed foundation and where the height on removal is less than 50% of the mature height given in NHBC Chapter 4.2 then distance (D) can be assumed to be 2m. This is to cater for the occurrence of 'saplings'.

Minimum foundation depths of 0.9m bgl apply outside the zone of influence of new planting. Where new planting is proposed foundation depths should be calculated in accordance with NHBC Chapter 4.2, section D6.

Where areas of woodland coincide with clay soils, and where that woodland is to be removed, significant desiccation of soils and subsequent heave should be expected, and these areas should be assumed to require a piled foundation solution.

17 Lateral Pressures & Heave

Where foundations are more than 1.5m deep, and are within the zone of influence of existing or removed trees, then precautions will also need to be taken against the effects of lateral swelling of soils beneath building units due to removal of trees, or cutting tree roots. The NHBC requirements for the relief of lateral pressure are set out in Chapter 4.2 of the NHBC Standards, and to which the reader is referred to. The basic requirement is that compressible material or void former should be installed on the inner face of external foundation walls. With pier and beam foundations additional voids are required below ring beams.

In all cases where deep foundations are adopted, special precautions may be required to prevent damage to roots of retained trees. Where significant desiccation due to vegetation can be expected, piled foundations may be required.

18 Groundwater Levels

No groundwater was encountered during this investigation. It should be noted that the addition of water during soakage testing, particularly within the cable percussive boreholes, may have masked any groundwater strikes.

However, based on a borehole record for a disused well servicing the former 'Maunders House' on-site and records for boreholes within Capstone Pumping Station, adjacent to the site, groundwater is anticipated to be at significant depth. The disused well was noted on the borehole record to be 289ft (90m) deep, whilst boreholes within the pumping station were recorded as 150ft (47m) deep. These boreholes are likely to have been sunk for the abstraction of groundwater. Based on the respective elevations of these boreholes, the groundwater table beneath the site is anticipated to be at around sea level.

Groundwater levels vary considerably from season to season and year to year, often rising close to the ground surface in wet or winter weather, and falling in periods of drought. Long-term monitoring from boreholes or standpipes is required to assess the ground water regime and this was not possible during the course of this site investigation.

19 Soakaways

The hierarchy of surface water disposal as per the sustainable Urban Drainage Systems Manual (C753) and Building Regulations (Part H) is, in order of preference:-

1) Infiltration

2) Watercourse or river

3) Sewer

7 No. BRE 365 soakage tests and 10 No. Constant Head soakage tests were carried out across the site to test the effectiveness of both shallow and deep infiltration as a means of water disposal.

In accordance with the client's specification of works, soakage testing was carried out within the exploratory trial pits and cable percussive boreholes, as detailed below:

BRE365 Soakage Tests

The BRE Digest 365 paper on soakaway design allows for the design of trench soakaways as well as traditional square and circular soakaways.

The test to measure the soil infiltration rate is carried out in pits which are excavated to the full depth of the proposed soakaway. The trial pits are filled and allowed to drain to empty or near empty, three times, on the same day or on consecutive days.

The pit is considered full when the water level is the same as the proposed inlet invert. The time for the water level to fall from ¾ full to ¼ full is obtained and the soil infiltration rate is obtained from the following formula:

$$f = \frac{V_{p75-25}}{a_{p50} \, x \, t_{p75-25}}$$

Where: f = soil infiltration rate (in this case expressed in $l/m^2/minute$)

V_{p75-25} = the effective storage volume of water in the trial pit between 75% and 25% effective depth;

a_{p50} = the internal surface area of the trial pit up to 50% effective depth and excluding the base area;

t_{p75-25} = the time for the water level to fall from 75% to 25% effective depth.

For this site, the BRE 365 soakage tests were carried out in trial pits excavated by a tracked excavator to determine if shallow infiltration is a viable method of surface water disposal. The depth range of soakage testing was specified by the client. The full results of the BRE365 soakage tests are appended, however, the soakage rates from each trial hole are summarised in the table below.

Results of BRE 365 Soakage tests				
Pit	**Depth (m)**	**f l/m²/min**	**BRE Units (m/sec)**	**Comments**
TP1	1.9	0.152	2.54×10^{-6}	Three fillings carried out. Test No. 3 did not fall to 25% max water depth.
TP2	1.8	22.47	3.75×10^{-4}	Three fillings carried out.
TP3	1.8	4.75	7.92×10^{-5}	Three fillings carried out.
TP4	1.8	4.56	7.60×10^{-5}	Three fillings carried out.
TP5	2.1	0.165	2.75×10^{-6}	One filling carried out. Test did not fall to 25% max water depth.
TP6	2.1	0.065	1.08×10^{-6}	Two fillings carried out. Test No.1 and 2 did not fall to 25% max water depth.
TP7	1.8	2.84	4.73×10^{-5}	Three fillings carried out.

The results indicate that the use of shallow soakaways could be effective in areas of the site where discharge is directly into chalk strata. Soakage testing carried out where discharge was into the overlying superficial deposits encountered in some locations indicates poor rates of soakage within these soils. Shallow soakaways are not considered viable in these areas.

Saturation moisture content tests were carried out on three samples of chalk obtained from trial pits across the site (TP2@1.4m, TP4@1.7m, TP7@1.6m). The Dry Density of these samples were recorded in the range 1.53Mg/m³ and 1.69Mg/m³.

With reference to CIRIA C574, the calculated dry density of these samples indicates the chalk is of medium density. CIRIA C574 states, "where the chalk is of medium density (or higher), the closest part of the soakaway should be at least 5 m away from any foundations".

Constant Head Soakage Test

10 No. Constant Head soakage tests were carried out within the cable percussive boreholes (2 tests per borehole) as requested by the client. Tests were carried out at variable depths to obtain information on the variation of potential soakage rates with depth. During each test a head of water was maintained at around 2mbgl.

The full results of the Constant Head soakage tests are again appended, however, the soakage rates from each borehole are summarised in the table below.

Results of Constant Head Soakage tests		
Borehole	**Test Depth (m)**	**Approximate Soakage Rate (l/min)**
BH1	10	100
	15	250
BH2	8	200
	13	500
BH3	15	300
	20	600
BH4	12	50
	17	150
BH5	10	50
	15	100

The results of the constant head tests indicate fair to good soakage potential within the chalk at depth. Generally a poorer rate of soakage was obtained where discharge was at shallower depths.

The Environment Agency will need to be consulted at an early stage on whether conventional shallow discharge or borehole soakaways may be acceptable on the subject site given the sites location within Source Protection Zones 1 & 2 and the presence of potable groundwater abstraction wells adjacent to the site and nearby. It is likely that shallow discharge will be the preferred option and that interceptors will be required for ponding areas. Off-site discharge may be required.

The Environment Agency stipulates that an unsaturated zone of at least 8m must be in place between the bottom of the soakaway and the underlying water table. Based on the anticipated depth to groundwater, the size of the unsaturated zone is unlikely to restrict the use of borehole soakaways on this site. It should however be noted that groundwater levels are likely to rise over the winter months and periods of wetter weather.

20 Sulphates and Acidity

The recorded pH values are in the range 7.7 to 8.6. The recorded soluble sulphate concentrations are in the range 8 mg/l to 96 mg/l.

The Design Sulphate Class is DS-1. Groundwater should be assumed to be immobile based on the anticipated depth to groundwater. The ACEC site classification is AC-1s.

21 Bearing Capacity & Foundations

Based on the soils encountered during this investigation, an allowable bearing capacity of 120kPa is available for normal strip or trench fill foundations set upon the firm to stiff clays or medium dense chalk strata. Where foundations are set within the clay soils, foundations will require deepening in accordance with NHBC Chapter 4.2 for Medium VCP soils. Allowances should be made for nominal mesh reinforcement to help cater for potential differential movement between soil types.

22 Solution Feature Risk

No solution features were encountered within the Chalk during this site investigation. However, a careful watch should be kept during construction and if any unexpected features or soft spots are encountered they should be inspected by an Engineering Geologist to determine the precautions required.

The inclusion of reinforcement in foundations reduces the risk of settlement due to solution features.

23 Floor Slabs

Suspended floor slabs should be utilised in accordance with NHBC Chapter 4.2 due to the presence of NHBC Medium VCP soils. Ground bearing floor slabs may be appropriate where foundations are emplaced directly on chalk strata.

24 Settlement

Settlement for traditional spread load foundations are expected to be within tolerable limits based on the above recommendations.

25 Excavations and Trenching

Statutory support will be required in all excavations where personnel must work.

26 Slopes & Retaining Walls

Slope angles across the site were varied, with localised areas of steeply sloping ground visually estimated as being up to around 10 degrees. Cohesive soils generally found at the crest and base of slopes across the site were not noted to contain shear surfaces that may indicate that residual shear strengths are in control of slope stability at the site. Areas of steeply sloping ground were not found to be overlain by cohesive soils during this investigation. In addition, groundwater was not found to be present within 3m of ground level. Based on available borehole records, groundwater is anticipated to be at significant depth.

For these reasons slope instability is not expected to be a problem at the site unless significant retaining walls are proposed (in excess of 1.0m), in which case, the requirement for stability analysis should be assessed.

The following suggested design parameters could be assumed at this stage for any retaining walls that may be required.

Soil Type: Clay-with-Flints

Parameters	Range	Suggested Design Value
Plasticity Index	12-63	25
Effective Angle of Friction, φ' (degrees)	Not Tested	24
Effective Long-Term Cohesion (kN/m²)	-	0
Bulk Density (Mg/m³)	Not Tested	1.9
Undrained Shear Strength	150-270	60

Soil Type: Chalk Head

Parameters	Range	Suggested Design Value
Plasticity Index	11-22	20
Effective Angle of Friction, φ' (degrees)	Not Tested	24
Effective Long-Term Cohesion (kN/m²)	-	0
Bulk Density (Mg/m³)	Not Tested	1.9
Undrained Shear Strength	140-210	60

Soil Type: Upper Chalk

Parameters	Range	Suggested Design Value
Bulk Density (Mg/m^3)	1.94-2.06	2.0
Intact Dry Density (Mg/m^3)	1.53-1.69	1.55

27 Road Construction

At this stage a site wide preliminary CBR value of about 3% is considered achievable based on the physical characteristics of the clay soils after Table 13/2, HA44/91 (1995)[6]. In-situ and laboratory testing once a proposed development layout plan is known may allow for the revision of this preliminary design value.

General

The most important element of any road construction is drainage and attention must be given not only to the drainage of the subsoil, but to the various layers of construction. To this end the formation should be shaped to a camber or crossfall to allow water movement out of the sub-base. Silty soils soften extremely quickly if allowed to become wet or if they are excavated below the water table and this softening can give rise to a very substantial increase in costs.

Sub-base and coarse capping materials tend to segregate during placing operations, particularly when end tipped. On soft clay subgrades this can lead to punching and softening of the formation. The use of a layer of sand or geofabric will minimise the problem.

Because of the variability of shallow soils the formation should be proof rolled, and any soft spots found should be excavated and replaced with compacted granular material. The surface of the formation should then be compacted, prior to laying the road sub base. Details of surface tolerances and formation compaction are given in the DOT Specification for Highway Works (1991 amended Aug 1993), Clause 616.

It should be noted that if concrete is to be used in construction, sulphate tests should be carried out.

Construction traffic should be kept off formations and it is often advisable to leave a protective layer of soil above formation level until the last moment before placing the sub-base.

[6] The Highways Agency, Earthworks- Design & Preparation of Contract Documents, Volume 4 Section 1 Part 1 HA 44/91 (1995).

H LAND QUALITY

28 Analytical Framework

There is no single methodology that covers all the various aspects of the assessment of potentially contaminated land and groundwater. Therefore, the analytical framework adopted for this investigation is made up of a number of procedures, which are outlined below. All of these are based on a Risk Assessment methodology centred on the identification and analysis of Source – Pathway – Receptor linkages.

The CLEA model[7] provides a methodology for quantitative assessment of the long term risks posed to human health by exposure to contaminated soils. Toxicological data is used to calculate a Soil Guideline Value (SGV) for an individual contaminant, based on the proposed site use; these represent minimal risk concentrations and may be used as screening values.

In the absence of any published SGVs for certain substances, Southern Testing have derived or adopted Tier 1 screening values for initial assessment of the soil, based on available current UK guidance including the LQM/CIEH[8] S4UL's and CL:AIRE[9] generic assessment criteria. In addition, in March 2014, DEFRA[10] published the results of a research programme to develop screening values to assist decision making under Part 2A of the Environmental Protection Act. Category 4 screening levels were published for 6 substances, with reference to human health risk only. This guidance includes revisions of the CLEA exposure parameters, presenting parameters for public open space land use scenarios, and also of the toxicological approach. The screening levels represent a low risk scenario, based on a 'Low Level of Toxicological Concern' rather than the 'Minimal Risk' of CLEA, and the analytical results of this investigation may be considered relative to these levels.

The values used are valid at the time of writing but may be subject to change and any such changes will have implications for the assessments based upon them. Their validity should be confirmed at the time of site development.

Site-specific assessments are undertaken wherever possible and/or applicable.

CLEA requires a statistical treatment of the test results to take into account the normal variations in concentration of potential contaminants in the soil and allow comparisons to be made with published guidance.

Ground gases are assessed in accordance with the guidance given in CIRIA report C665.

---

[7] Environment Agency Publication SC050021/SR3 'Updated technical background to the CLEA Model' (2009).
[8] The LQM/CIEH S4ULs for Human Health Risk Assessment. (2014).
[9] The EIC/AGS/CL:AIRE Soil Generic Assessment Criteria for Human Health Risk Assessment (2009).
[10] SP1010 Development of Category 4 Screening Levels foe Assessment of Land Affected by Contamination. DEFRA (2014).

29 Site Investigation – Soil

29.1 Sampling Regime

The number of sample locations was limited and were intended to provide general coverage across the site. The sampling locations were specified by the client.

29.2 Testing

The potential for contamination by agricultural activities and made ground associated with former buildings was identified in the preliminary conceptual model and observations made on site and, therefore, the following tests were selected.

Test Suite	Number of Samples	Soil Tested
STL Key Contaminant Suite	6 1	Topsoil Natural
Asbestos Identification	6 1	Topsoil Natural
STL Pesticide Suite	2	Topsoil

The test results are presented in full in Appendix D. A summary and discussion of the significance of the results and identified contamination sources is given below.

29.3 Test Results and Identified Contamination Sources

29.3.1 General Contaminants

The results of the key contaminant tests have been analysed in accordance with the CLEA methodology. The samples have been grouped into two populations comprising Topsoil and Subsoil. For each parameter in each population the sample mean is calculated and compared to a Tier 1 screening value. If the sample mean exceeds the screening value, the soil may be regarded as contaminated and further assessment may be required. If neither the sample mean nor any single value exceeds the screening value, the soil may be regarded as not contaminated, though further confirmatory assessment may be required. Where any single parameter value exceeds the screening value but the sample mean does not, further statistical analysis may be applied to that parameter if the available data is suitable. Such analysis would include an assessment of the Normality of the distribution of the data, consideration of the presence of outliers, and the calculation of a UCL estimate of the mean.

Summary data is presented in the tables below and the laboratory analysis is included in Appendix D. The screening values and source notes are presented in Table 1 "Tier 1 Screening Values" at the front of Appendix D.

Soil Type: Topsoil

Contaminants	Units	No of Samples Tested	Range	Sample Mean	Residential with Homegrown Produce Consumption Tier 1 Screening Value
Arsenic (As)	mg/kg	6	6.2 – 15	11.2	37
Cadmium (Cd)	mg/kg	6	0.6 – 1.0	0.8	11
Total Chromium (Cr)	mg/kg	6	16 - 50	30.3	910
Hexavalent Chromium (CrVI)	mg/kg	6	<4.0	<4.0	6
Lead (Pb)	mg/kg	6	50 - 190	121	200
Mercury (Hg)	mg/kg	6	<0.3 – 0.8	<0.5	7.6-11
Selenium (Se)	mg/kg	6	<1.0	<1.0	250
Nickel (Ni)	mg/kg	6	16 - 33	24	130
Copper (Cu)	mg/kg	6	23 – 190	69	2,400
Zinc (Zn)	mg/kg	6	46 - 120	92	3,700
Phenol	mg/kg	6	<1.0	<1.0	120-380
Benzo[a]pyrene	mg/kg	6	0.27 – 4.9	2.32	1.7-2.4
Naphthalene	mg/kg	6	<0.05	<0.05	2.3-13
Total Cyanide (CN)	mg/kg	6	<1.0	<1.0	/
Acidity (pH value)	Units	6	7.7 – 8.1	8	/
Soil Organic Matter	%	6	2.6 – 5.3	4.2	/

The results of testing on six samples of topsoil were compared to the current Tier 1 Screening values for residential with homegrown produce consumption, the strictest generic soil screening values.

With the exception of elevated Benzo[a]pyrene within three samples, no other exceedances were recorded within the topsoil samples analysed.

Significantly elevated Benzo[a]pyrene concentrations of 4.4 mg/kg and 4.9 mg/kg and a slightly elevated concentration of 2.5 mg/kg were recorded within BH3@0.1m, WLS1@0.15m and TP1@0.1m respectively. Notwithstanding the above, the mean Benzo[a]pyrene concentration within the topsoil across the site is slightly less than the normal range of upper soil screening values of 1.7-2.4 mg/l, based on soil organic matter.

Soil Type: Natural

Contaminants	Units	No of Samples Tested	Range	Sample Mean	Residential with Homegrown Produce Consumption Tier 1 Screening Value
Arsenic (As)	mg/kg	1	8.9	8.9	37
Cadmium (Cd)	mg/kg	1	0.8	0.8	11
Total Chromium (Cr)	mg/kg	1	23	23	910
Hexavalent Chromium (CrVI)	mg/kg	1	<4.0	<4.0	6
Lead (Pb)	mg/kg	1	50	50	200
Mercury (Hg)	mg/kg	1	<0.3	<0.3	7.6-11
Selenium (Se)	mg/kg	1	<1.0	<1.0	250
Nickel (Ni)	mg/kg	1	26	26	130
Copper (Cu)	mg/kg	1	23	23	2,400
Zinc (Zn)	mg/kg	1	48	48	3,700
Phenol	mg/kg	1	<1.0	<1.0	120-380
Benzo[a]pyrene	mg/kg	1	<0.05	<0.05	1.7-2.4
Naphthalene	mg/kg	1	<0.05	<0.05	2.3-13
Total Cyanide (CN)	mg/kg	1	<1	<1	/
Acidity (pH value)	Units	1	8.3	8.3	/
Soil Organic Matter	%	1	1.6	1.6	/

The results of testing on a single sample of natural soil was also compared to the current Tier 1 Screening values for residential with homegrown produce consumption, the strictest generic soil screening values. The sample was found to be free from significant contamination with respect to the parameters determined.

29.3.2 Asbestos

No asbestos containing materials were detected in the samples analysed and none were observed in the exploratory holes. However, it should be noted that the exploratory holes are of small diameter and the samples obtained may not reflect the full composition of the soils on the site. Therefore, there is always the potential for pockets of asbestos or for asbestos containing materials to be present, which have not been detected in the sampling.

29.3.3 Organic Contaminants

Two samples taken from TP4@0.2m and TP6@0.2m were tested for the presence of pesticides and herbicides. No presence of pesticides or herbicides were detected within these samples.

30 Site Investigation – Waters

A source of on-site contamination in the form of agricultural activities associated with current land uses was identified in the preliminary Conceptual Site Model (CSM). Although elevated concentrations of some contaminants were recorded within topsoil in some locations, given the significant anticipated depth to the groundwater table, any risk to groundwater is considered negligible. Groundwater sampling and analysis was therefore not considered necessary.

31 Site Investigation – Gas

31.1 Gas Sources

The desk study identified a potential land gas source in the form of an adjacent former landfill site.

This type of source is characterised as being of Moderate generation potential, after Wilson and Haines (2005)[11].

The elevation of the site above that of the former landfill may provide a plausible pathway for the migration of land gases from this source.

31.2 Sampling Strategy

The number and spacing of the gas monitoring wells were specified by the client and were based on a targeted investigation of the potential migration pathways for the identified off-site former landfill source.

31.3 Monitoring Programme

A programme of land gas monitoring was outside the scope of this investigation. The sensitivity of the proposed development is rated as Moderate and, therefore, twelve gas readings should be carried out over a period of six months (CIRIA C665, Table 5.5).

32 Summary of Identified Contamination

- Elevated concentrations of Benzo[a]pyrene in three out of six samples of topsoil (BH3@0.1m, WLS1@0.15m and TP1@0.1m).

This investigation was of limited scope considering the scale of the site and further investigation will be required. There remains a risk that further potential sources of on-site contamination may be encountered in areas of the site not targeted during the ground investigation.

There exists the potential for contamination in the form of land gas. A programme of land gas monitoring will be required.

[11] Wilson, S and Haines, S. 2005. Site investigation and monitoring for ground gas assessment – back to basics. Land Contamination & Reclamation 13, 3, 211-222.

33 Risk Evaluation

The object of the risk evaluation is to assess the pollution linkages for specific contaminant groups considered in the conceptual model, identify any unacceptable risks and, therefore establish whether there is a need for further investigation and/or remedial action.

The risks are considered in the context of the specific development proposals for the site and, therefore, the conclusions may not be appropriate for alternative schemes.

33.1 Benzo[a]pyrene

The elevated Benzo[a]pyrene concentrations recorded within topsoil suggest this material may not be suitable for reuse on site.

Further sampling and testing of this material is recommended to determine whether these concentrations represent hotspots of contamination or are indicative of the concentrations across the site, and whether this material may be considered suitable for reuse.

33.2 Revised Conceptual Model

The preliminary site model has been refined in light of the findings of this investigation and is summarised below.

Metals	*Polyaromatic Hydrocarbons*	*Organic Compounds*	*Landfill Gas*	*Asbestos*	PATHWAYS	RECEPTORS
N	P	N	N	N	Ingestion and inhalation of contaminated soil and dust	Human Health
N	P	N	n/a	N	Dermal contact with contaminated soil and dust	
N	N	N	P	N	Inhalation of vapours or gases	
N	P	N	n/a	N	Uptake into edible fruit and vegetables	
N	N	N	n/a	N	Surface water run-off into surface water features	Water Environment
N	N	N	n/a	N	Migration through ground into surface water or groundwater	
N	N	N	n/a	N	Off-site migration of contaminated groundwater	
N	P	N	n/a	N	Vegetation on site growing in contaminated soil	Flora and Fauna
N	N	N	n/a	N	Aquatic life in affected waters	
N	P	N	n/a	N	Contact with contaminated soil	Building materials/ buried services
N	N	N	P	n/a	Fire or explosion	

Key:

Y Pollutant linkage likely

N Pollutant linkage not likely

P Pollutant linkage possible

n/a Pathway not applicable to contaminant

33.3 Relevant Pollutant Linkages

Relevant Pollutant Linkages for which remedial action may or will be required have been identified in the revised conceptual model, as follows.

Contaminant/Source	Pathways	Receptors
Benzo[a]pyrene in Topsoil	Soil/dust Dermal exposure Soil/dust Ingestion/inhalation Plant uptake Direct contact	Future residents
Land Gas	Vapour Inhalation	Future residents

34 Discussion and Conclusions

At this stage no proposed development layout has been supplied, however it is understood that the intended development is residential, with private garden areas.

This limited contamination investigation has indicated topsoil soils on site contain concentrations of Benzo[a]pyrene that exceed the screening value for the residential with homegrown produce consumption land use scenario. On the basis of testing to date, these soils would not be considered suitable for reuse on site. It is recommended that extensive further sampling and testing is carried out to identify and delineate the extent of any contamination within soils across the site.

Should no further testing be carried out, an allowance would need to be made for the removal of the existing topsoil and replacement with certified imported soils in proposed private garden areas and areas of communal landscaping.

The potential for the site to be impacted by land gas from an adjacent former landfill source was identified in the Conceptual Site Model and from observations made on site. A programme of land gas monitoring should be carried out to identify the risk from land gases and to determine any requirement for the incorporation of land gas protective measures in the development.

As with any site, areas of contamination not identified during site investigation works may come to light in the course of redevelopment. Accordingly, a discovery strategy must be in place during the redevelopment to ensure that any hitherto unknown contamination is identified and dealt with in an appropriate manner. Depending on the nature of any such contamination, it may prove necessary to reassess the remedial strategy for the site.

A formal remediation strategy and verification plan should be agreed with the regulatory authorities prior to commencement of any remedial works.

35 General Guidance

Allowance should be made for experienced verification of any remedial works.

It may be that specific local requirements apply to this site, of which we are not aware at this time.

In general terms, the workforce and general public should be protected from contact with contaminated material. There is a range of relevant documents published by the Health and Safety Executive, and organisations such as CIRIA, and the BRE.

Some soils will require removal from site and disposal to suitably licensed landfills. Different guidelines and charges will apply to different waste classification. As waste producers, the Developer holds responsibilities under the various governing regulations. The chemical analyses appended to this report should be forwarded to tip operators for their own assessment, to confirm classification of the soils for offsite disposal, and whether they can accept the material. Waste Acceptance Criteria (WAC) testing may be requested for confirmation of the material's classification.

All hazardous and non-hazardous soils leaving site will need to be pre-treated. Waste minimisation by selective excavation is a recognised form of pre-treatment.

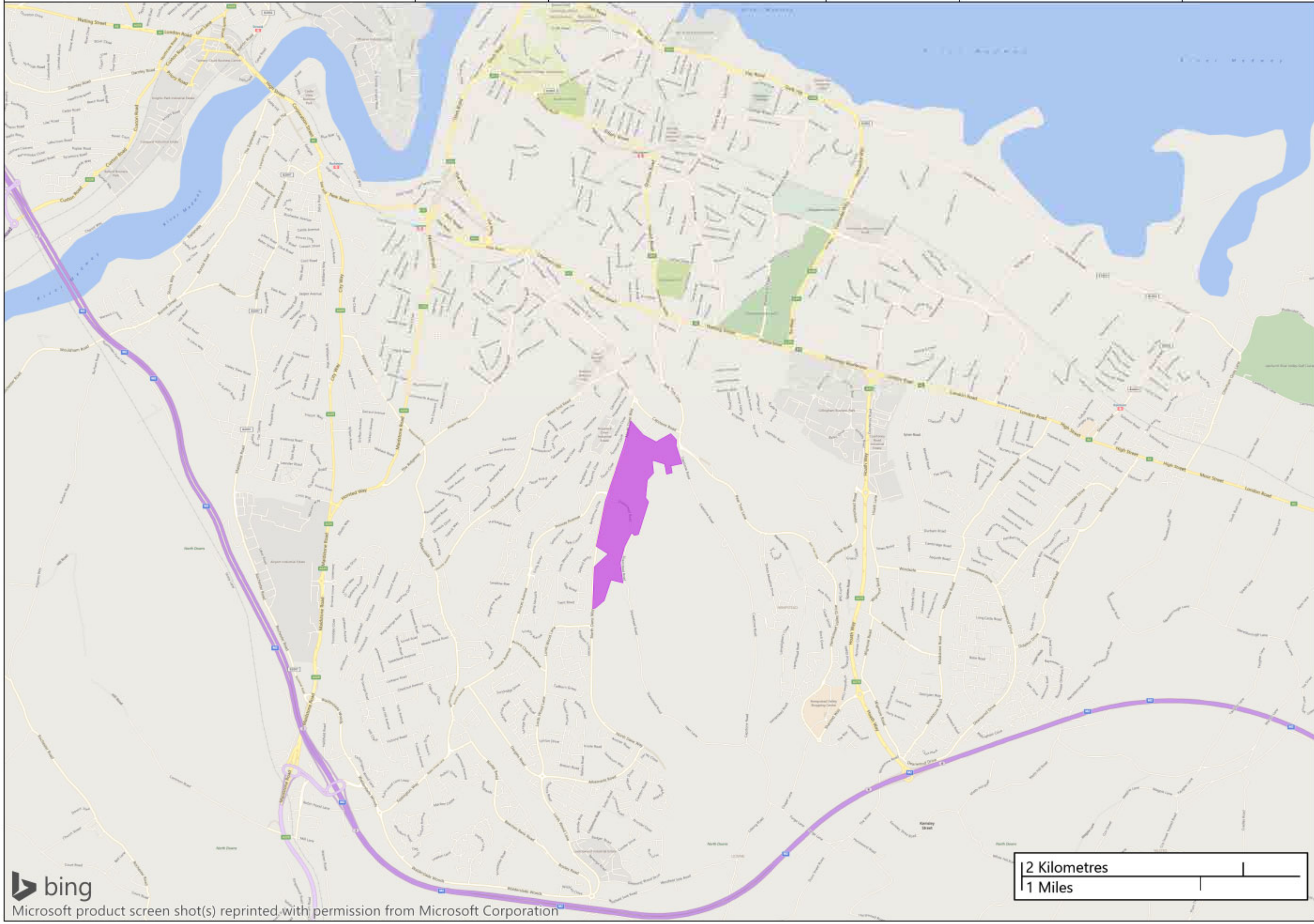
Many water supply companies now require higher specification pipe on contaminated sites, even following remediation.

APPENDIX A

Site Plans and Exploratory Hole Logs

Southern Testing ST Consult

Project Name:	Land off Shawstead Road	Project ID:	J13752	Site Plan Figure 1
Location:	Hale, Kent	Engineer:	JMW	
Client:	KD Attwood & Partners	Scale:	1:50000	

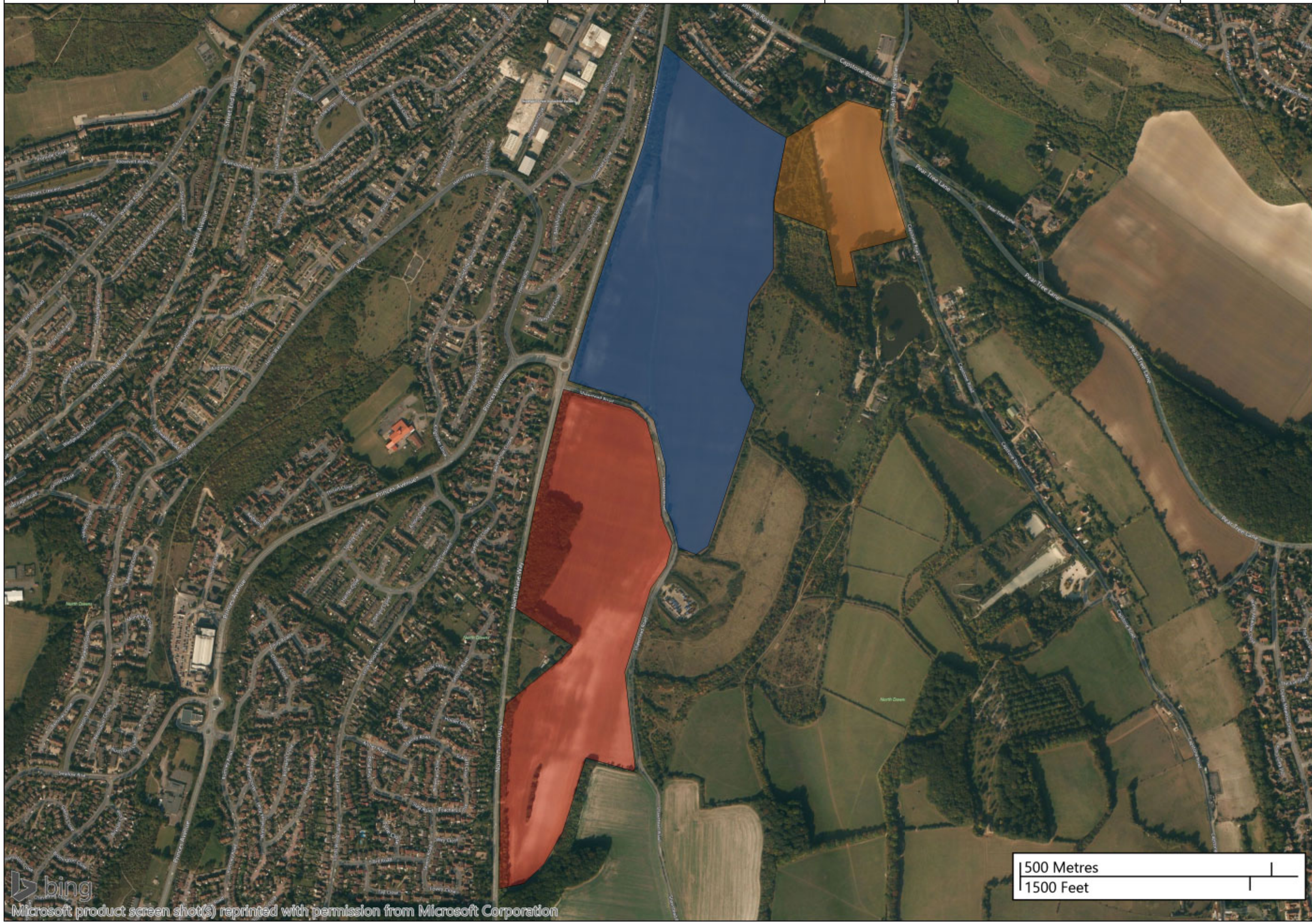


Legend Key

Project Bounds - Project Bounds

Southern Testing ST Consult

Project Name:	Land off Shawstead Road	**Project ID:**	J13752	Site Plan Figure 2
Location:	Hale, Kent	**Engineer:**	JMW	
Client:	KD Attwood & Partners	**Scale:**	1:11000	



Legend Key

- Central Field - Boundary
- Southern Field - Boundary
- North Eastern Field and Woodland - Boundary