

soiltechnics

environmental and geotechnical consultants

Proposed industrial development
Harts Farm Way
Havant

Ground Investigation Report

Cedar Barn, White Lodge, Walgrave, Northamptonshire NN6 9PY

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**Proposed industrial development
off
Harts Farm Way
Hampshire
PO9 1JU**

GROUND INVESTIGATION REPORT

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Aerial photograph of site



Additional proposed area
for ground investigations-
09/09/2016

Report status and format

Report section	Principal coverage	Report status	
		Revision	Comments
1	Executive summary		
2	Introduction		
3	Desk study information and site observations		
4	Fieldwork		
5	Ground conditions encountered		
6	Laboratory testing		
7	Engineering assessment		
8	Chemical contamination		
9	Gaseous contamination		
10	Effects of ground conditions on building materials		
11	Classification of waste soils under the Waste Acceptance Criteria		
12	Further investigations		

List of drawings

Drawing	Principal coverage	Status	
		Revision	Comments
01	Site location plan		
02	Plan showing existing site features and location of exploratory points		To be updated following completion of topographical survey
03	Plan showing site development proposals and location of exploratory points		
04	Plot summarising results of pocket penetrometer determinations		
05	Section showing construction of standpipes installed in boreholes DTS02, DTS03, DTS07 and DTS08.		

List of appendices

Appendix	Content
A	Definitions of geotechnical terms used in this report
B	Definitions of geo-environmental terms used in this report
C	Trial pit records
D	Borehole records (driven tube sampler)
E	Plots summarising results of in-situ dynamic probing determinations
F	Copies of laboratory test result certificates – classification testing
G	Copies of laboratory test result certificates – concentrations of chemical contaminants
H	Analysis and summary of test data in relation to concentrations of chemical contaminants
I	Conceptual models for chemical contamination
J	Record of in-situ gas monitoring results
K	Landfill waste acceptance criteria – primary classification
L	Landfill waste acceptance criteria – secondary classification
M	Landfill waste acceptance criteria – basic categorisation schedules
N	Copies of Statutory Undertakers replies
O	Copy of correspondence received from the Local Authority Building Control and/or Environmental Health Officers
P	Copy of desk study information produced by Envirocheck
Q	Unexploded Ordnance Desk Study report

1 Executive summary

1.1 General

- 1.1.1 We recommend the following executive summary is not read in isolation to the main report which follows.

1.2 Site description, history and development proposals

- 1.2.1 The site is located within a commercial / business area towards the south-west of Havant. At the time of our investigation, the site comprised a disused open land with certain areas covered in concrete and hardstandings. In addition, Brockhampton stream was observed running alongside the southern boundary of the site into a general eastern to western direction.
- 1.2.2 A review of historical maps indicates the site remained mainly undeveloped until circa 1970s when the site is first time recorded as a council Depot. This former use of the site is recorded until 2000s after which the site has not records of usage.
- 1.2.3 We understand the scheme will comprise the construction of a new concrete hardstanding, light weight Tempa store, portacabins-type offices and external racking.

1.3 Ground conditions encountered

- 1.3.1 The exploratory excavations encountered Made Ground overlying Alluvium.
- 1.3.2 Based on groundwater observations in exploratory excavations, we consider it is unlikely that groundwater will be encountered in excavations extending to depths of up to 1.9m.

1.4 Foundation solution

- 1.4.1 The Alluvium are in our opinion capable of supporting the proposed buildings in spread type foundations with founding levels being located at the top of Alluvium deposits.
- 1.4.2 Proposed access road and associated hardstanding areas will be located at or about existing ground levels with formation located on Made Ground soils. A CBR design value of 3% has been derived from near surface soil conditions.

1.5 Chemical and gaseous contamination

- 1.5.1 In general the site is does not pose a risk to end users of the site or water receptors, however levels of lead and chromium in soil in trial pit TP06 and copper and zinc in groundwater (DTS07) were measured above their respective guideline values. Should these areas be covered in buildings or hardstanding then no further action is required. However, if the surface is unbound then remediation in the form of a capping layer is likely.
- 1.5.2 Based on gas monitoring completed to date the development does not require gas protective measures.
- 1.5.3 Barrier pipes for potable water may be required.

1.6 Landfill classification

- 1.6.1 Comparison of test data with landfill waste acceptance criteria indicates that Made Ground soils can be classified as **Stable non-reactive hazardous waste in non-hazardous landfill** for off-site disposal for landfill.
- 1.6.2 It is possible that these soils can be zoned by extra testing, thus potentially reducing the quantity of hazardous waste by re-classifying it as non-hazardous.
- 1.6.3 Alluvium can be classified as **inert waste** based on soils being of natural origin and unlikely to be affected by artificial contamination.

2 Introduction

2.1	Objectives
2.2	Client instructions and confidentiality
2.3	Site location and scheme proposals
2.4	Report format and investigation standards
2.5	Status of this report
2.6	Report distribution

2.1 Objectives

- 2.1.1 This report describes a ground investigation carried out for a proposed industrial development off Harts Farm Way, Havant, Hampshire, PO9 1JU.
- 2.1.2 The objective of the ground investigation was to establish ground conditions at the site, sufficient to identify possible foundation solutions for the development and provide parameters necessary for the design and construction of foundations.
- 2.1.3 The investigation included an evaluation of potential chemical and gaseous contamination of the site leading to the production of a risk assessment in relation to contamination.
- 2.1.4 The investigation is to determine the value or liabilities of the land / property but also to support a future planning application for the site by satisfying National Planning Policies Framework sections 120 and 121.
- 2.1.5 Our brief also included investigations and testing to allow classification of soils at the site to be disposed of to landfill.

2.2 Client instructions and confidentiality

- 2.2.1 The investigation was carried out in September 2016 and reported in November 2016 acting on instructions received from our client Travis Perkins plc.
- 2.2.2 This report has been prepared for the sole benefit of our above named instructing client, but this report, and its contents, remains the property of Soiltechnics Limited until payment in full of our invoices in connection with production of this report.
- 2.2.3 Our original investigation proposals were outlined in our letter to Travis Perkins plc on 26th August 2016. The investigation generally followed our original investigation proposals.
- 2.2.4 Based on information provided our initial investigations, and Envirocheck, focused on land due east of the current site, denoted on Drawing 01. We understand the reason for the change of site was it was deemed too small and "Plot 4" was preferable, the boundary of which is defined on Drawing 02.

- 2.2.5 Although this report includes elements of investigation beyond the extent of the proposed site boundaries, our assessment in this report focuses on “Plot 4”, only.

2.3 Site location and scheme proposals

- 2.3.1 The National Grid reference for the site is 470794, 105937. A plan showing the location of the site is presented on Drawing 02.
- 2.3.2 We understand the scheme will comprise the construction of a new concrete hardstanding, light weight Tempa store, portacabins-type offices and external racking.

2.4 Report format and investigation standards

- 2.4.1 Sections 2 to 6 of this report describe the factual aspects of the investigation with Section 7 presenting an engineering assessment of the investigatory data. Section 8 provides a risk assessment of chemical contamination based on readily available historic records, inspection of the soils and laboratory testing. Section 9 provides a similar risk assessment in relation to gaseous contamination with Section 10, a risk assessment relating to construction materials likely to be in contact with the ground. Section 11 provides a classification of waste soils for off-site disposal under the waste acceptance criteria.
- 2.4.2 This investigation integrates both contamination and geotechnical aspects. The investigation was carried out generally, and where practical following the recommendations of BS EN 1997:2 2007 ‘Eurocode 7 – Geotechnical Design – Part 2: Ground Investigation and Testing’. The investigation process also followed the principles of BS10175: 2011 ‘Investigation of potentially Contaminated Sites – Code of Practice’. In view of the client’s requirement for rapid implementation of the investigation, the following elements, defined in BS10175, have been completed and incorporated in this report.
- a) Phase I Preliminary investigation (desk study and site reconnaissance)
 - b) Phase II Exploratory and main (intrusive) investigations
- 2.4.3 The extent and result of the preliminary investigation (desk study) is reported in Section 3. Fieldwork combined the exploratory investigation and main investigation stages into one phase with the extent of these works described in Sections 4 and 6 of this report. Any supplementary investigations deemed necessary are identified in Section 12. Section 13 provides information on any remedial strategy and specification if required.

2.5 Status of this report

2.5.1 This report is final based on our current instructions.

2.5.2 This investigation has been carried out and reported based on our understanding of best practice. Improved practices, technology, new information and changes in legislation may necessitate an alteration to the report in whole or part after publication. Hence, should the development commence after expiry of one year from the publication date of this report then we would recommend the report be referred back to Soiltechnics for reassessment. Equally, if the nature of the development changes, Soiltechnics should be advised and a reassessment carried out if considered appropriate.

2.6 Report distribution

2.6.1 This report has been prepared to assist in the design and planning process of the development and normally will require distribution to the following parties, although this list may not be exhaustive:

Table summarising parties likely to require information contained in this report

Party	Reason
Client	For information / reference and cost planning
Developer / Contractor / project manager	To ensure procedures are implemented, programmed and costed
Planning department	Potentially to discharge planning conditions
Environment Agency	If ground controlled waters are affected and obtain approvals to any remediation strategies
Independent inspectors such as Building Control	To ensure procedures are implemented and compliance with building regulations
Project design team	To progress the design
Principal Designer (PD)	To advise in construction risk identification and management under the Construction (design and management) regulations
Waste recycling operators	For recycling or reducing hazardous properties (if and where appropriate)

Table 2.6.1

3 Desk study information and site observations

3.1	General
3.2	Description of the site
3.3	Injurious and invasive weeds and asbestos
3.4	History of the site
3.5	Geology and geohydrology of the area
3.6	Landfill, waste transfer stations and infilled ground
3.7	Radon
3.8	Flood risk
3.9	Enquiries with statutory undertakers
3.10	Enquiries with Local Authority Building Control and Environmental Health Officers
3.11	Unexploded ordnance risk

3.1 General

3.1.1 We have carried out a desk study which was limited to a review of readily available information including:

- a) Review of published Ordnance Survey maps dating back to 1867 at various published scales
- b) Inspection of geological maps produced by the British Geological Survey together with relevant geological memoirs
- c) Consultation with Statutory Undertakers
- d) Site reconnaissance
- e) Other relevant published documents

3.1.2 We have obtained old Ordnance Survey maps using the Envirocheck database system. In addition to retrieval of historical and current Ordnance Survey data, Envirocheck provide information compiled from outside agencies including: -

- Ordnance Survey
- Environment Agency
- Scottish Environment Protection Agency
- The Coal Authority
- British Geological Survey
- Centre for Ecology and Hydrology
- Countryside Council for Wales
- Scottish Natural Heritage
- Natural England
- Health Protection Agency

3.1.3 The study did not extend to research of meteorological information or consultation with other interested parties such as English Heritage (ancient monuments), Ordnance Survey (survey control points), Planning Authorities or Archaeological Units.

3.1.4 We have received copy of a recently undertaken desk study carried out by Groundsure which information has been partially utilise in order to present a more exhaustive coverage. It should be noted that the area under consideration within desk study carried out by Groundsure refers to the area of interest named as "Plot 4" as well as immediately adjacent areas to the east.

3.1.5 A copy of records produced by Envirocheck is presented in Appendix P. Envirocheck produce a wealth of factual database information. Although we can provide a discussion on each of the database topics, this would produce a very lengthy document, but some of these discussions would not be relevant to the aims of this report. As a consequence we have extracted some of the relevant topics and discussed them in this section of the report.

3.1.6 The data presented in the following report sections has primarily been extracted from the Envirocheck report.

3.2 Description of the site

3.2.1 The site is located within a predominantly light industrial and commercial area situated approximately 1.2km to the south west of Havant town centre. At the time of our investigations, the site comprised an open square-shaped area of circa 7,900m². The closest water features comprise Brockhampton stream flowing along the southern site boundary and a rectangular-shaped pond some 160m off the eastern site boundary, which flows to the stream. We understand that the channel of the stream, off the eastern site boundary, was straightened in part and is now culverted under an access road (refer Drawing 02).

3.2.2 Local topography to the site is relatively flat with a minor fall towards the coastline located 550m to the south and south-west of the site.

3.2.3 The site was, at the time of our investigations, unused however historical maps record it as being occupied by a Council Depot and recycling centre. Former buildings have been demolished; however areas of open surfacing are present in locations of former buildings. A partially demolished concrete wall was observed within the western quadrant of the site.

3.2.4 Vegetation on site consisted of trees of different deciduous species located defining the eastern and northern boundaries to a maximum height of 16m with western boundary comprising a row of conifers to a maximum height of 12m. Shrubs and tall grasses (between 0.5m to 2m) were observed covering most of the south-eastern and north-western quadrants.

3.2.5 The site is bounded to the north by A27 road, with warehouses and small commercial units to the east and with Broadmarsh highways depot to the west. Southern boundary was defined by the presence of Brockhampton stream beyond with an open area (southern half of the former depot) and new layout road observed.

3.2.6 A number of photographs reiterating the above are presented below.



Photograph 1

Looking north-east at
the eastern area
adjacent to "Plot 4".



Photograph 2

Looking west, with
"Plot 4" in the
background.



Photograph 3

Looking north, overhead
electricity poles in
background.



Photograph 4

Looking east, across "Plot 4", cylindrical concrete feature in foreground.



Photograph 5

Looking east, along the southern site boundary, showing the newly diverted Brockhampton stream covered in vegetation.



Photograph 6

The site looking north-east, across "Plot 4"

3.2.7

A plan showing observed site features and location of exploratory points is presented on Drawing 02.

3.3 Injurious and invasive weeds and asbestos

3.3.1 Injurious and invasive weeds

3.3.1.1 The following weeds are controlled under the Weeds Act 1959:

- Common Ragwort,
- Spear Thistle,
- Creeping or Field Thistle,
- Broad leaved Dock
- Curled Dock

3.3.1.2 Whilst it is not an offence to have the above weeds growing on your land, you must:

- Stop them spreading to agricultural land, particularly grazing areas or land used for forage, like silage and hay
- Choose the most appropriate control method for the your site
- Not plant them in the wild

3.3.1.3 Should you allow the spread of these weeds to another parties land, Natural England could serve you with an Enforcement Notice. You can also be prosecuted if you allow animals to suffer by eating these weeds.

3.3.1.4 In addition to the above, you must not plant in the wild or cause certain invasive and non-native plants to grow in the wild as outlined in the Wildlife and Countryside act 1981. It is an offence under section 14(2) of the act to '*plant or otherwise cause to grow in the wild*' any plants listed in schedule 9, part II. This can include moving contaminated soil or plant cuttings. The offence carries a fine or custodial sentence of up to 2 years. The most commonly found invasive, non-native plants include:

- Japanese knotweed
- Giant hogweed
- Himalayan balsam
- Rhododendron ponticum
- New Zealand pigmyweed

3.3.1.5 You are not legally obliged to remove these plants or to control them. However, if you allow Japanese knotweed to spread to another parties land, you could be prosecuted for causing a private nuisance.

3.3.1.6 The presence of such weeds on site may have considerable effects on the cost / timescale in developing the site. Japanese knotweed can cause significant damage to buildings, roads and pavements following development, if untreated prior to development.

3.3.1.7 Our investigations exclude surveys to identify the presence of injurious and invasive weeds. We did not observe any obvious evidence the above species, however, we recommend specialists in the identification and procedures to deal with injurious and invasive weeds are appointed prior to commencement of any works on site.

3.3.2 Asbestos

3.3.2.1 Our investigations exclude surveys to identify the presence or indeed absence of asbestos on site. It should be noted however, that where intrusive investigations were undertaken we did not observe any obvious evidence of potential asbestos containing materials. This information does not constitute a site specific risk assessment and we recommend specialists in the identification and control / disposal of asbestos are appointed prior to commencement of any works on site or, if appropriate, purchase of the site.

3.3.2.2 The presence of asbestos on site may have considerable effects on the cost / timescale in developing the site. There is good guidance in relation to Asbestos available on the Health and Safety Executive (HSE) web site.

3.4 History of the site

3.4.1 An attempt to trace the history of the site has been carried out by obtaining copies of old Ordnance Survey maps provided by Envirocheck. As previously stressed, due to the change in site boundary, the history of the site summarised on the following table refers to Plot 4 and not the demarked boundary on the Envirocheck drawings which refers to the eastern neighbouring site:-

Summary description of site history from Ordnance Survey maps		
Date	Onsite	Offsite
1867 - 1870	Site is recorded undeveloped. Water channel flowing in a south west direction recorded within the southern site boundary, with several trees lining the side of the water channel.	Brockhampton Stream approximately 150m to the east and running afterwards alongside southern site boundary. Broad Water 60m east. Harts Farm recorded 30m south-east. Land situated 200m south recorded as "liable to flooding at Spring Tides" (West Marsh). Tannery 350m north east. Portsmouth Water Works situated 400m north-east. Factory 600m north east. South Coast Railway trending north east – south west 500m north west. Parchment factory 750m north east.
1897-1898	No significant change	Watercress beds recorded 100m to the east of the site. 250m south recorded as "highest point to which tides flow". 220m north west recorded as "highest point to which ordinary tides flow". Brockhampton Nurseries present 275m north of site. "Leather works" recorded 600m north east. "Water Works" recorded 450m to the north-east of the site.
1909 - 1910	No significant change.	Sewage works recorded 600m east.
1932-1933	As above	No significant change.
1938 - 1942	As above	As above

Summary description of site history from Ordnance Survey maps		
Date	Onsite	Offsite
1962-1966	As above	"Works" recorded 380m to the south-west of site and 450m to the north west and north-east. Major residential developments to the north 300m and beyond. A27 recorded immediately adjacent to the north of the site. Normal tidal limit recorded 0m south of site
1972 - 1975	Council depot recorded on site including buildings and access roads	Engine Works and Sheet Metal Works recorded 275m to the east of the site Harts Farm Cottages farm recorded 100m to the south-east. "Sewage works" recorded 350m to the south of the site. "Works" recorded 300m and 500m to the east.
1990 - 1993	Electricity line recorded crossing the site into a general north-east to south-west direction. Site recorded as Harts Farm Depot	"Industrial estate" recorded 50m to the north of the site. Developments 100m south. Industrial estate 150m – 200m north west. Incinerator recorded 80m to the west. "Works" recorded 310m to south west.
2000	No significant change.	"Sewage works" to the south have been extended. "Works" 220m to the east. "Industrial estate" now recorded 350m to the south-east. Disused tanks recorded 400m west on the site previously occupied by sewage works.
2006	No significant change.	No significant change.
2016	Depot no longer present. However, the footprint of former buildings still recorded on site. Brockhampton stream has been straightened and now lies just off the southern site boundary.	Recycling Centre recorded 150m – 200m west.

Table 3.4.1

3.5 Geology and geohydrology of the area

3.5.1 Geology of the area

- 3.5.1.1 Envirocheck reproduce geological map extracts taken from the British Geological Survey (BGS) digital geological map of Great Britain at 1:50,000 scale (ref Appendix P). A summary of the recorded geological information for the site is presented in Table 3.5.1 below:-

Summary of Geology and likely aquifer containing strata					
Strata	Bedrock or superficial	Approximate thickness	Typical soil type	Likely permeability	Aquifer designation
Alluvium	Superficial	2m – 5m	Clay, silt, sand and gravel	Permeable	Secondary A Aquifer (r)
Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation (Undifferentiated)	Bedrock	>35m	Chalk	High permeability	Principal Aquifer (r)

Table 3.5.1

- (r) recorded aquifer designation
- (a) assumed aquifer designation

3.5.1.2 Superficial deposits are the youngest geological deposits formed during the Quaternary, which extends back about 2.6 million years. They rest on older deposits or rocks referred to as bedrock. Soil types and assessments of permeability are based on geological memoirs, in combination with our experience of investigations in these soil types.

3.5.1.3 Principal aquifers are defined as deposits exhibiting high permeability capable of high levels of groundwater storage. Such deposits are able to support water supply and river base flows on a strategic scale.

3.5.1.4 Secondary A aquifers are predominantly permeable layers capable of supporting water supplies at a local rather than strategic scale. In some cases, Secondary A aquifers can form an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

3.5.2 Water abstractions

3.5.2.1 Nine active groundwater points are located within 2000m of the site. The closest groundwater abstraction point lies 379m to the north-west, upstream of the site, with water abstracted as a direct potable water supply.

3.5.2.2 The site is not located within a zone protecting a potable water supply abstracting from a principal aquifer (i.e. a source protection zone). It should be noted however that an inner protection zone is located approximately 120m to the north of the site. An inner protection zone is defined as the 50 day travel time from any point below the water table to the source.

3.5.3 Coal mining and brine extraction

3.5.3.1 The site is not recorded to be within an area affected by past or present coal mining, or minerals worked in association with coal or brine extraction (within the Cheshire Brine Compensation District).

3.5.4 Shallow mining and natural subsidence hazards

3.5.4.1 The British Geological Survey present hazard ratings for shallow mining and natural subsidence hazards. The site, specifically "Plot4" has the following ratings;

Table summarising mining and subsidence hazards

Hazard	Rating
Mining hazard in non-coal mining areas	No hazard
Potential for collapsible ground stability hazard	Low
Potential for compressible ground stability hazard	Moderate
Potential for ground dissolution stability hazard	Very low
Potential for landslide ground stability hazard	Low
Potential for running sand ground stability hazard	Low
Potential for shrinking or swelling clay ground stability hazard	Very low

Table 3.5.4

3.5.4.1 In addition to the above hazard ratings, a report completed by Ove Arup and Partners in December 1991, commissioned by the Department of the Environment (DoE) indicates where mining should be borne in mind when considered planning and development of land. The site is **not** recorded as lying in an area of conclusive rock mining as indicated by the report.

3.5.5 Borehole records

3.5.5.1 The British Geological Survey (BGS) retain records of boreholes formed from ground investigations carried out on a nationwide basis. The location of boreholes with records held by the BGS is recorded on the borehole map contained in Appendix P. We do not normally obtain copies of these records but can do on further instructions. There is normally a charge made by the BGS for retrieving and copying these records.

3.6 Landfill, waste transfer stations and infilled ground

3.6.1 A number of landfill sites are recorded in the area. In addition, old Ordnance Survey maps indicate some localised quarrying activities which have apparently been backfilled. The following table summarises these landfill and waste transfer stations sites:

Summary of Landfill sites						
Landfill/waste transfer station name	Source of information	Type	Location (m)	Waste authorised	Licence status	
Portsmouth Water Plc	Envirocheck	Registered	360m N	Inert	Unknown	
Southmoore Lane	Envirocheck	Recorded	270m SW	Household, Acid, Commercial	Closed	
Broadmarsh Site	Envirocheck	Recorded	270m SW	Unknown	Unknown	
Hampshire C.C.	Envirocheck	Registered	520m SW	Civic Amenity/Refuse Amenity Waste, Concrete Waste, Construction And Demolition Wastes, Excavated Natural Materials, Hardcore And Rubble, Household, Crude Waste, Incinerator Residues Silt and Dredgings	Unknown	
Harts Farm Way	Envirocheck	Historical	300m SW	Household	Ceased	
Land South of Budds Farm Sewage Works	Envirocheck	Historical	430m SW	Household	Ceased	

Table 3.6.1

- 3.6.2 Other waste sites including waste treatment, transfer or disposal sites have been as well recorded in close proximity to the site, the following table summarises these locations;

Summary of other waste sites					
Landfill/waste transfer station name	Source of information	Type	Location (m)	Waste authorised	Licence status
Havant incinerator and waste transfer station	Envirocheck	Historical	Recorded adjacent to western site boundary	Household, commercial and industrial	Surrendered
Havant Household waste and metal recycling centre (Veolia environmental services)	Envirocheck	Historical	50m-SW	Household, commercial and industrial	Unknown
Conroys Recycling Ltd.	Envirocheck	Active	120m-SW	Physical treatment facility	Issued

Table 3.6.2

- 3.6.3 In addition, apparent quarrying and infilled ground is recorded within 1km of the site. The following table summarises these locations:

Summary of infilled ground				
BGS Mineral Site name	Type	Location	Commodity/ origin of backfilling	Licence status
Potentially infilled land	Non water	824 NE	Unknown	N/A
Potentially infilled land	Water	14 E	Unknown	N/A
Bedhampton Wharf	Wharf	392 SW	Marine Sand & Gravel	Active
Havant Park Brick Field	Opencast	876 NE	Common Clay & Shale	Ceased

Table 3.6.3

- 3.6.4 In addition, it should be noted that the course of Brockhampton stream has been recently altered as it is presented in Drawing 02. We have considered this as infilled land which extents alongside the southern boundary of the site.

3.7 Radon

- 3.7.1 Envirocheck use the British Geological Survey database to review reported radon levels in the area in which the site is located to establish recommended radon protection levels for new dwellings. The database records the site as being located where **basic** protection is recommended.
- 3.7.2 The Building Research Establishment publication applies to all new buildings, conversions and refurbishments whether they be for domestic or non-domestic use. For non-domestic buildings, the guidance supplements the requirements for radon protection at work specified in the Ionising Radiations Regulations 1999, legislation made under the Health and Safety at Work Act administered by the Health and Safety Executive (HSE). Further information is contained in the HSE/BRE guide “Radon in the Workplace”.

- 3.7.3 It is noteworthy that the BRE and BGS / HPA information is based on statistical analysis of measurements made in dwellings in combination with geological units, which are known to emit radon. Therefore there is a risk for actual radon levels at the site to exceed the levels assessed by the BGS / HPA / BRE. Currently, the only true method of checking actual radon levels is by measurement within a building on the site over a period of several months. It should be noted that it is not currently a requirement of the Building Regulations to test new buildings for radon, however the BRE recommends testing on completion or occupation of all new buildings (domestic and non-domestic), extensions and conversions. Should you wish to undertake radon monitoring following completion of the development, we can provide proposals.

3.8 Flood risk

- 3.8.1 The site is not located within a fluvial or tidal flood plain. The area is located within a medium risk area of surface water flooding.
- 3.8.2 In addition to the above, the site is at risk of flooding from groundwater to below ground structures.
- 3.8.3 It should be noted that this information does not constitute a site specific Flood Risk Assessment (FRA), and a full FRA may be required for the development to support a planning application or satisfy planning conditions.

3.9 Enquiries with statutory undertakers

- 3.9.1 We have contacted the following Statutory Undertakers (SUs) to obtain copies of their records in order to avoid damaging their apparatus during our fieldwork activities: -
- a) BT Openreach Ltd
 - b) Scotia Gas Network
 - c) Portsmouth Water
 - d) Southern Water
 - e) SSE
 - f) Linesearch
 - g) Virgin Media
- 3.9.2 Copies of responses received prior to publication of this report are presented in Appendix N. These records have been obtained solely for the purposes described above. Some of these records have been obtained from the Internet and from our database without contacting the statutory undertaker direct. Occasionally, SU information is recorded on drawings larger than A3, and thus cannot be easily presented in this report. In such cases we will copy the correspondence but not incorporate the drawing in this report, and maintain the records on our office file.
- 3.9.3 In addition, we have visited the Linesearch web site (www.linesearch.org) which provides a report on national grid networks (National Gas and Electricity Transmission Networks). Again a copy of their report is presented in Appendix N.

3.9.4 Normally Statutory Undertakers drawings record the approximate location of their services. We recommend further on site investigations be undertaken to confirm the position of the apparatus and thus establish the effect on the proposed development and the necessity or otherwise for the permanent or temporary diversion of the service to allow the construction of the development to safely and successfully proceed.

3.9.5 It should be noted that a triple syphon sewer underlies the centre of the site running into a general north-south direction. SSE underground cables (3 x 33kV) trend approximately north – south across the centre of the site from overhead poles recorded within the northern boundary. We are not aware that the supply to such services was capped offsite and as such they should be treated as live until further information indicates otherwise.

3.9.6 It should be noted that statutory undertakers' records normally exclude private services.

3.10 Enquiries with local authority building control and environmental health officers

3.10.1 We have contacted Local Authority Building Control, at this stage we are still awaiting for a response.

3.10.2 We have contacted Local Authority Environmental Health Officers with a copy of the correspondence presented in Appendix O.

3.11 Unexploded Ordnance (UXO)

3.11.1 As part of our fieldwork activities we obtained an Unexploded Ordnance Desk Study report (presented in Appendix P) from MACC international www.macc-eod.com. The risk was such that a UXO officer attended our investigations on site checking for metallic objects in advance of our drilling operations. MACC report that the area surrounding the site suffered bombing during WWII. It is also a credible possibility that live ammunition may have been buried on multiple sites in Havant. The preliminary UXO risk is considered to be MEDIUM within the site boundary.

4 Fieldwork

4.1	General
4.2	Site restrictions
4.3	Exploratory trial pits
4.4	Driven tube sampling
4.5	Dynamic probing
4.6	Measurement of landfill type gases in gas monitoring standpipes
4.7	Sampling strategies

4.1 General

4.1.1 Fieldwork activities were carried out between 15th and 16th September 2016 and comprised of the following activities:-

- Excavation of nine exploratory trial pits
- Excavation of eight exploratory boreholes formed using driven tube sampling equipment
- Dynamic probing testing in five locations

4.1.2 The above mentioned exploratory locations were undertaken in the "Plot 4" area as well as adjacent areas to the east. The distribution of the exploratory points is presented in the following table;

Table location of exploratory points			
Exploratory point	Date of excavation	Western area- "Plot 4"	Eastern area
TP01	16/09/16	✓	
TP02			
TP03			
TP04			
TP05			
TP06			
TP07			
DTS05			
DTS06	15/09/16		
DTS07			
DTS08			
TP08			✓
TP09			
DTS01			
DTS02			
DTS03			
DTS04			

Table 4.1.2

- 4.1.3 The position of exploratory points relative to site development proposals is presented on Drawing 03. The position of exploratory points shown on these plans is approximate only and confirmation of these positions is subject to dimensional surveys, which is considered outside our brief. It should be noted that although some of the investigatory points are outside of the development area we have presented all data from the wider site.
- 4.1.4 The extent of fieldwork activities and position of exploratory points were determined by Soiltechnics in agreement with Travis Perkins plc.
- 4.1.5 Exploratory points were positioned to avoid known locations of underground services, to avoid possible location of proposed foundations but were also positioned to provide a reasonable coverage of the site. Prior to commencement of exploratory excavations an electronic cable locating tool was used to scan the area of the excavation. If we received a response to this equipment, then the excavation would be relocated.
- 4.1.6 All soils exposed in excavations were described in accordance with BS EN ISO 14688 '*Identification and Classification of soil*'.

4.2 Site restrictions

- 4.2.1 Care was taken to avoid buried services such as main sewers and electricity cables predominantly located to the east of the area denominated as "Plot 4".

4.3 Exploratory trial pits

- 4.3.1 Surface concrete/bituminous bound materials were initially broken out using hydraulic breaking equipment fixed to the rubber tyred excavator. Once broken, excavation continued using normal excavation techniques.
- 4.3.2 Trial pits TP01 to TP09 were excavated to a maximum depth of 3.5m. The excavations were backfilled with excavated material compacted using the back of the excavator bucket. Whilst we attempted to reinstate the excavation to its original condition the soils could not be fully compacted into the trial pit and thus the soils were left proud of the ground surrounding the pit to allow for short-term settlement of the backfill. A Geotechnical Engineer supervised the excavations.
- 4.3.3 Sampling and logging was carried out as trial pit excavations proceeded but were not entered at depths exceeding 1.2m, or where trial pit sides were deemed unstable. The density of granular soils encountered in excavations was gauged by the ease of excavation.

- 4.3.4 Soil samples for subsequent laboratory determination of concentration of chemical contaminants were taken from the sides of trial pits using clean stainless steel equipment and stored in new plastic containers, which were labelled and sealed. Samples from below access depth into trial pits were taken as a sub sample from soil contained in the excavator bucket, discarding any soil, which may have been in contact with the bucket. If as a consequence of visual or olfactory evidence, a sample was suspected to be contaminated by organic material, the sample was stored in an amber glass jar with a PTFE sealing washer.
- 4.3.5 Soil samples for subsequent classification laboratory testing were taken from the side of trial pits or from bulk samples taken from the excavator bucket. The sample was placed in a plastic bag and subsequently sealed and labelled. Samples for moisture content determination were placed in sealable tubs and appropriately labelled.
- 4.3.6 Sample sizes were appropriate for the laboratory test being considered.
- 4.3.7 A pocket penetrometer was used in the fine soils encountered. This tool is deemed to measure the apparent ultimate bearing capacity of the soil under test. The pocket penetrometer is calibrated in kg/cm². The reading can be approximately converted to equivalent undrained shear strength by multiplying the results by a factor of 50. Pocket penetrometer testing was carried out in the sides of trial pits when access could be safely achieved otherwise testing was carried out on excavated intact clods. The results are reported in columns to the right of trial pit results. The pocket penetrometer is not covered by British Standards. This tool has the advantage that it can be used to determine the approximate in-situ undrained shear strength of stony cohesive soils.
- 4.3.8 A summary of pocket penetrometer results obtained from the fine soils encountered in exploratory excavations are presented in graphical format on Drawing 04.
- 4.3.9 Trial pit records are presented in Appendix C.

4.4 Driven tube sampling

- 4.4.1 Boreholes DTS01 to DTS08 were formed using driven tube sampling equipment. Driven tube sampling comprises driving 1m long steel sample tubes which are screw coupled together or coupled to extension rods and fitted with a screw on cutting edge. The sample tubes are of various diameters, generally commencing with 100mm and reducing, with depth, to 50mm and include a disposable plastic liner which is changed between sampling locations to limit the risk of cross contamination. On completion of excavation the liner containing the sample is cut open and the soil sample logged by a geo-environmental engineer.
- 4.4.2 Samples for determination concentration of chemical contaminants are taken from samples obtained in the disposable tubes as sub-samples using stainless steel sampling equipment.

- 4.4.3 In some locations, surface concrete was either broken out or cored prior to excavation of the borehole. The concrete surface was reinstated on completion.
- 4.4.4 A pocket penetrometer was used in the fine soils retrieved from the borehole. This tool is deemed to measure the apparent ultimate bearing capacity of the soil under test. The pocket penetrometer is calibrated in kg/cm². The reading can be approximately converted to an equivalent undrained shear strength by multiplying the results by a factor of 50. The results are reported on borehole records. The pocket penetrometer is not covered by British Standards.
- 4.4.5 A summary of pocket penetrometer results obtained from the fine soils retrieved from the boreholes are presented in graphical format on Drawing 04.
- 4.4.6 Combined gas and groundwater monitoring standpipes were installed in DTS02, DTS03, DTS07 and DTS08. The standpipes were installed following the recommendations of BS EN ISO 22475-1:2006 '*Geotechnical Investigation and Testing – Sampling methods and groundwater measurements – Part 1: Technical Principles for execution*' and BS8576:2013 '*Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)*'. Details of the standpipe installation are recorded on Drawing 05.
- 4.4.7 Water levels in the standpipes have been measured during a return visit to the site. The water level was measured using a measuring tape calibrated in 1mm intervals with an electronic end piece, which emits an alarm sound in contact with water. Water levels are measured from ground levels at the borehole position.
- 4.4.8 Records of boreholes formed using driven tube sampling techniques are presented in Appendix D.

4.5 Dynamic probing

- 4.5.1 Dynamic probing (DP) testing was carried out in five locations. Dynamic probing consists of driving a 50mm diameter, 90° cone into the ground, via an anvil and extension rods with successive blows of a freefall hammer. The number of blows required to drive the cone each successive 100mm (N₁₀) is recorded.
- 4.5.2 Dynamic probing was carried out following BS EN ISO 22476-2:2005 and the apparatus used was categorised as 'Super heavy' (DPSH-B) in accordance with the standard.
- 4.5.3 Dynamic probing data is presented in graphical format on Appendix E.

4.6 Measurement of landfill type gases in gas monitoring standpipes

- 4.6.1 The concentrations of landfill type gases collected within gas monitoring standpipes installed in boreholes DTS02, DTS03, DTS07 and DTS08 was measured using a portable infra-red gas analyser (model GA5000, manufactured by Geotechnical Instruments). Initially the gas analyser was connected to the gas valve on the top of the standpipe to allow the flow rate to be measured. Essentially this is a measurement of gas pressure produced in the standpipe, which is compared with atmospheric pressure at the time of measurement to produce an equivalent gas 'flow' in l/hr. The equipment used is capable of measuring to an accuracy of 0.1l/hr; below this the gas analyser records zero flow. Following BS8485:2015 '*Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*' (clause 6.3.4), we assume flows of 0.1l/hr when the gas analyser reads zero, thus producing a pessimistic gas flow rate in our assessment of ground gases.
- 4.6.2 Following measurement of 'flow' the gas analyser pumps gases contained in the standpipe through the analyser. Initial readings of gas concentrations are noted manually, followed by subsequent recordings at regular time periods until 'steady state' concentrations are achieved. The analyser records 'peak' and 'steady' concentrations of the following gases:
- Methane (CH₄)
 - Carbon dioxide (CO₂)
 - Oxygen (O₂)
- 4.6.3 The ambient atmospheric temperature and barometric pressure was also recorded at the site.
- 4.6.4 Methane in concentrations of between 5 to 15% in air is potentially explosive. The 5% methane concentration in air is defined as the Lower Explosive Limited (LEL). The gas analyser measures a percentage of the LEL. For example, 10% LEL equates to 10% of 5%, i.e. 0.5% methane concentration in air.
- 4.6.5 Records of gas monitoring data are presented in Appendix J.

4.7 Sampling strategies

4.7.1 Geotechnical

4.7.1.1 In general we adopted a judgemental sampling strategy in relation to geotechnical aspects of the investigation. The location and frequency of sampling was carried out in consideration of the following:-

- i) Topography
- ii) Geology (including Made Ground)
- iii) Nature of development proposals

4.7.2 Environmental

4.7.2.1 Details of sampling with respect to contamination issues are described in Section 8.

4.7.3 Sample retention

4.7.3.1 Samples are stored for a period of one month following issue of this report unless otherwise required.

5 Ground conditions encountered

5.1	Soils
5.2	Groundwater
5.3	Evidence of contamination
5.4	Obstructions and instability

5.1 Soils

- 5.1.1 The exploratory excavations encountered a similar profile of soils considered to be Made Ground overlying Alluvium.
- 5.1.2 Made Ground was encountered in all locations and observed between depths of 0.75m to 2.0m and comprised a chaotic mixture of fine, coarse and chalk soils.
- 5.1.3 The coarse Made Ground soils comprised brown to dark brown and orange brown slightly clayey to clayey sand and gravel with occasional cobbles of brick and concrete and occasional boulders of concrete. Gravel consisted of flint, limestone, fragments of brick, concrete, occasional bituminous coated material, rare plastic, timber and metal.
- 5.1.4 The fine Made Ground soils comprised firm to stiff medium to high strength brown, dark brown and orange brown sandy gravelly to very gravelly clay. Gravels consisted of flint occasional limestone, chalk, and fragments of brick, concrete rare metal, timber and plastic. Occasional rootlets and roots (up to 50mm in diameter) and generally were observed throughout.
- 5.1.5 Made Ground deposits observed in exploratory locations TP01, TP05, TP02 and DTS06, DTS07 and DTS08 comprised a layer of chalk at depths in a range of 0.3m to 1.5m. The Chalky Made Ground deposits comprised medium strong white slightly sandy gravel and cobbles of angular chalk.
- 5.1.6 Alluvial deposits were encountered in all exploratory locations at depths below 1.4m Alluvial deposits comprised loose to dense light cream and orange brown slightly clayey slightly sandy gravel with local boulder-sized lenses of sandy gravelly clay observed at depths below 2m. Gravel consisted of fine to coarse angular to rounded flint and extended beyond the termination depths of the boreholes and trial pits.

5.1.7 The following table summarises the geology encountered;

Table summarising soil types				
Strata	Depth to top (m)	Depth to bottom (m)	Thickness (m)	Summary description
Made Ground	0.0m	1.3-2.0	1.3-2.0	Mixture of fine, coarse and chalky soils comprising anthropogenic fragments
Alluvium	1.3-2.0	Beyond depth of termination	N/A	Light cream clayey sandy gravels and cobbles of flint

Table 5.1.7

5.2 Groundwater

5.2.1 Groundwater inflows were observed in many of the exploratory excavations. A summary of our observations is tabulated below:

Table summarising groundwater observations			
Exploratory point	Date of observation	Depth (m) below ground levels	Observations
TP01	16/09/16	2.15	Groundwater inflows from 2.15m. Groundwater level at 2.3 on completion
TP02	16/09/16	1.9	Groundwater inflows from 1.9m. Groundwater level at 1.9 on completion
TP03	16/09/16	2.15	Groundwater inflows from 2.15m. Groundwater level at 2.25m on completion
TP04	16/09/16	2.0	Groundwater inflows from 2.0m. Groundwater level at 2.8m on completion
TP05	16/09/16	2.3	Groundwater inflows from 2.3m promoting collapse of trial pit from 1.8m
TP06	16/09/16	2.0	Groundwater seepages from 2.0m promoting collapse of trial pit.
TP07	16/09/16	2.15	Groundwater inflows from 2.15m. Groundwater level at 2.2m on completion promoting collapse from this depth.
TP08*	15/09/16	1.4	Groundwater inflows from 1.4m. Groundwater level at 2.0m on completion, collapse of trial pit from 1.8m
TP09*	15/09/16	1.1	Groundwater inflows from 1.1m. Groundwater level at 2.1m 5 minutes after completion, collapse of trial pit from 1.5m
DTS01*	15/09/16	1.25	Groundwater strike at 1.25m.
DTS02*	15/09/16	0.95	Groundwater strike at 0.95m
	30/09/16	1.93	Monitoring observation
	10/10/16	2.05	Monitoring observation
	28/10/16	1.56	Monitoring observation
DTS03*	15/09/16	1.25	Groundwater measured at 1.25m
	30/09/16	1.88	Monitoring observation
	10/10/16	1.98	Monitoring observation
	28/10/16	1.34	Monitoring observation
DTS04*	15/09/16	1.54	Groundwater strike at 1.54m remained stable on completion
DTS05	16/09/16	1.5	Groundwater strike at 1.5m, remained stable 5 minutes after completion
DTS06	16/09/16	1.8	Groundwater strike at 1.8m

Table summarising groundwater observations			
Exploratory point	Date of observation	Depth (m) below ground levels	Observations
DTS07	16/09/16	1.7	Groundwater strike at 1.75m
	30/09/16	1.05	Monitoring observation
	10/10/16	1.08	Monitoring observation
	28/10/16	2.65	Monitoring observation
DTS08	16/09/16	-	No groundwater observed on completion
	30/09/16	1.08	Monitoring observation
	10/10/16	0.73	Monitoring observation
	28/10/16	2.94	Monitoring observation

Table 5.2.1

*Exploratory locations undertaken outside the proposed site boundaries

- 5.2.2 It should be noted that water levels will vary depending generally on recent weather conditions and only long term monitoring of levels in standpipes will provide a measure of seasonal variations in groundwater levels.

5.3 Evidence of contamination

- 5.3.1 During the excavation of our exploratory points, evidence of potential contamination was identified; however, specific contaminant observations are presented below;

Table summarising contamination observations			
Exploratory point	Depth of contamination	Strata	Description
TP01	0.45-0.50	Made Ground	Greyish blue coloured sand and gravel soils which exposed a slight hydrocarbon contamination odour

Table 5.3.1

5.4 Obstructions and instability

- 5.4.1 No in-ground obstructions were identified during our site investigations. Generally trial pit excavations were terminated prematurely when excavations extended beyond the level of groundwater as it promoted the collapse of the pit. Where driven tube samplers encountered groundwater levels, the use of casing allowed drilling to achieve depths below groundwater table.

6 Laboratory testing

6.1	Classification testing
6.2	Chemical testing

6.1 Classification testing

6.1.1 Laboratory testing was carried out on samples retrieved from exploratory points within the denominated as “Plot 4” area. The method of testing is recorded on the laboratory test certificate. The following table summarises the classification testing scheduled;

Table summarising classification testing			
Exploratory point	Depth (m)	Soil type	Testing scheduled
TP01	1.0	Made Ground	Liquid limit/plasticity limit and plasticity index/ moisture content
TP02	2.0	Alluvium	Particle size distribution (by wet sieving)
TP04	1.5	Made Ground	Liquid limit/plasticity limit and plasticity index/ moisture content
TP05	2.5	Alluvium	Particle size distribution (by wet sieving)
TP06	0.7	Made Ground	Liquid limit/plasticity limit and plasticity index/ moisture content
DTS06	1.5	Made Ground	Liquid limit/plasticity limit and plasticity index/ moisture content
DTS07	1.1	Made Ground	Liquid limit/plasticity limit and plasticity index/ moisture content

Table 6.1.1

6.1.2 Laboratory test certificates are presented in Appendix F.

6.2 Chemical testing

6.2.1 Again, laboratory testing was carried out on samples retrieved from exploratory points within the denominated as “Plot 4” area. Chemical testing was carried out based on ground conditions and with reference to the contamination Initial Conceptual Model as presented in Section 8. The testing suites and parameters are presented in Appendix B. The following table summarises the chemical testing scheduled;

Table summarising chemical testing			
Exploratory point	Depth (m)	Medium/soil type	Testing scheduled (Refer to Appendix B for details).
TP01	0.2	Made Ground	Suite 1/Suite 2/ Suite 7/ Asbestos ID
TP01	0.5	Made Ground	Suite 7
TP02	0.2	Made Ground	Suite 1/ Asbestos ID
TP02	0.6	Made Ground	Suite 1
TP02	2.0	Made Ground	Suite 8
TP03	0.3	Made Ground	Suite 1/ Suite 2/ Asbestos
TP04	0.6	Made Ground	Suite 1/ Suite 2/ Asbestos
TP06	0.3	Made Ground	Suite 1/ Asbestos

Table summarising chemical testing			
Exploratory point	Depth (m)	Medium/soil type	Testing scheduled (Refer to Appendix B for details).
DTS07	0.6	Made Ground	Suite 8
DTS07	1.5	Made Ground	Suite 8
DTS08	0.1	Made Ground	Suite 1/ Asbestos
Composite	-	Made Ground	Waste Acceptance Criteria
Table 6.2.1			

- 6.2.2 Laboratory testing was carried out by an independent specialist testing house, which operates a quality assurance scheme. Copies of laboratory test result certificates are presented in Appendix G.

7 Engineering assessment

7.1	General description of the development
7.2	Building foundation design and construction
7.3	Influence of trees and other major vegetation
7.4	Service trench excavations
7.5	Infiltration potential
7.6	Pavement foundations

7.1 General description of the development

- 7.1.1 The following assessments are made on the investigatory data presented in the preceding sections of this report and are made with reference to specific nature of the development. Should scheme proposals change then it may be necessary to review the investigation and report.
- 7.1.2 We understand the scheme will comprise the construction of a new concrete hardstanding, light weight Tempa store, portacabins-type office and external racking. We understand that the store and office buildings often use the slab as a foundation. Given the depth of Made Ground and the potentially high settlement under concentrated sustained loads resulting in deflection of the slab, we recommend that independent foundations are introduced for the structures.
- 7.1.3 It should be noted that, with reference to Section 11 the Made Ground soils have been classified as **stable non-reactive hazardous waste in non-hazardous landfill**, however, this classification has the potential to be reduced subject to zoning.

7.2 Building foundation, design and construction

- 7.2.1 Definitions of geotechnical terms used in the following paragraphs are provided in Appendix A.
- 7.2.2 The exploratory locations encountered a profile of soils considered to be Made ground overlying Alluvium. Made Ground deposits was observed as fine, coarse and chalky soils extending between 1.3m to 2m. Alluvium deposits were encountered as loose to medium dense sandy gravel with local lenses of gravelly clay at depths of below 1.4m. Groundwater inflows were observed at depths of below 1.5m, but standing around 1m on return monitoring.
- 7.2.3 In our opinion the naturally deposited Alluvium will adequately support the proposed buildings proposed buildings on spread type foundations. We recommend foundations extend to a minimum depth of 1.3m below existing or proposed ground levels whichever gives the deeper founding level. In all cases, we recommend foundation excavations fully penetrate any Made Ground deposits and extend into the Alluvium by a minimum of 0.3m into the naturally deposited soils, subject to an overall minimum foundation depth of 1.3m. It is possible that shallower foundations could be adopted, bearing on to Made Ground soils, however such foundations are likely to be subject to significant total and differential settlement. It should be noted

that there are a number of trees and major vegetation on the site which will require foundation depths exceeding the minimum depth defined above. Further guidance on this is provided in the following report paragraphs.

- 7.2.4 The majority of the near surface Alluvium deposits exhibit a degree of plasticity and potentially adopting a conservative approach, our assessment of bearing values is based on the assumption that the soils exhibit cohesion. Calculations based on a conservative undrained shear strength of say 60kN/m² (medium strength) category) below proposed founding levels indicate following bearing values for pad type foundations;

Table of bearing values for fine soils			
Plan size of pad (m)	Ultimate bearing value kN/m ²	Presumed bearing value kN/m ²	Allowable bearing pressure kN/m ²
1 x 1	610	220	75 (150)
1.5 x 1.5	570	205	50 (100)
2 x 2	550	200	35 (75)
Table 7.2.4			

- 7.2.5 The above values are based on a total settlement of 25mm. However, if higher loads are required and a settlement of 50mm can be accommodated then the values in red can be adopted.

- 7.2.7 Based on observations in exploratory excavations, it is likely that excavations to founding levels will encounter both cohesive and granular soils. Whilst these soils will ultimately generate similar amounts of total settlement under applied foundation loads, the rate at which settlement will be achieved will differ. Granular soils will produce settlements almost immediately loads are applied with cohesive soils generating settlement sometime after completion of construction. In the event that a soft area is located in the course of foundation excavations then we recommend excavations continue to locate stiffer/denser soils.

- 7.2.8 Assuming a spacing of say 6m between frame / pad centres and a total settlement of 25mm, the angle of distortion in the building frame would be 10/6000 = 1/600 which is within normally acceptable limits. For 50mm total settlement, this may increase to approximately 1/200.

- 7.2.9 It is likely settlement will be fully achieved within say 25 years of construction.

7.2.10 Trench Stability

- 7.2.10.1 Based on groundwater observations in exploratory excavations, it is likely that groundwater will be encountered in excavations extending beyond 1.9m, with groundwater inflows promoting collapse of trench sides and the construction of a successful spread type foundation difficult. In addition to this, should excavations be left open then based on return visits to monitor groundwater within boreholes, water could stand at some 1m below ground level. We recommend, therefore, that as soon as trench excavations are opened foundation concrete be poured as quickly as practically possible.

7.3 Influence of trees and other major vegetation

7.3.1 Soil classification and new foundation design

- 7.3.1.1 The results of plastic and liquid limit determinations performed on near surface samples of the Made Ground and Alluvium indicate the deposits vary between non-shrinkable to medium volume change potential when classified in accordance with National House Building Council (NHBC) Standards, Chapter 4.2. Adopting a worst case medium volume change then foundations taken down onto a depth of 0.9m will penetrate the zone of shrinkage and swelling caused by seasonal wetting and drying. Trees and other major vegetation extend this zone and will require deeper foundations. A good guide to this subject is provided in NHBC Standards, Chapter 4.2.

7.3.2 Tree species identification

- 7.3.2.1 There are a number of trees and other major vegetation at the site. We recommend a qualified Arboriculturist (listed in the Arboricultural Association Directory of Consultants – www.trees.org.uk) be appointed to determine the location, height (and mature height) and water demand of all trees/major hedgerows at the site, information, which will be necessary to design foundations in accordance with NHBC Standards, Chapter 4.2.

7.4 Service Trench Excavations

- 7.4.1 Generally, the sides of trench excavations will remain stable in the short term. As described in Section 7.2.10 above, groundwater will likely be encountered from 1.9m, with water standing around 1m based on return monitoring visits. Groundwater inflows will promote progressive instability in trench sides requiring continuous trench sheet piling to maintain an open excavation. We anticipate water will be controlled with nominal pumping techniques.
- 7.4.2 We recommend any trench excavation requiring human entry is shored as necessary to conform with current best practice, and accepted by the Health and safety Executive (HSE) and in particular, following guidance provided in the HSE publication 'Health and safety in construction (HSG 150)' (www.hse.gov.uk).

7.5 Infiltration Potential

7.5.1 Requirements for use of infiltration systems

- 7.5.1.1 It is a requirement under H3 (3) of the current building regulations to discharge stormwater collected by a development to soakaways as a priority (as opposed to water courses and sewers).

7.5.2 Contamination considerations

- 7.5.2.1 With reference to Environment Agency (EA) publication '*Groundwater protection: Policy and practice (GP3) Section G*, 2012, outside of SPZ1, the EA will support sustainable drainage systems for new discharges to ground. This is subject to an appropriate risk assessment to demonstrate that ground conditions are suitable and infiltration systems do not present an unacceptable risk of promoting mobilisation of contaminants or creating new pathways for contaminant migration.

7.5.3 Assessment following fieldwork investigations

- 7.5.3.1 Although, it is possible that the predominantly granular deposits of the Alluvium could dispose of stormwater using infiltration systems, laboratory testing undertaken on two groundwater samples indicates presence of contaminants above their respective guideline values. While the respective leachate testing did not show presence of contaminants which could potentially be derived from leachable concentrations within the Made ground deposits. Considering a worst-case scenario in which soakaways will discharge rainwater through Made Ground, this would promote leaching of chemical contaminants in the soil sufficient to cause concern. On this basis, the use of soakways systems would be only recommended if design allows for discharge within the naturally deposits Alluvium avoiding any discharge within the Made Ground deposits.
- 7.5.3.2 Whilst groundwater was recorded to be standing at a depth as shallow as 1m, it is possible that permeable paving could be used, with any chamber sealed through Made Ground. In addition, Brockhampton Stream flows along the southern boundary of the site, it may be possible to discharge rainwater into the stream. This may be preferential to percolating through a permeable paving.
- 7.5.3.3 If either of these solutions are sought, advice and permission from the Environmental Agency will be required.

7.6 Pavement Foundations

- 7.6.1 It is anticipated that the proposed access road and associated hardstanding areas will be located at or about existing ground levels with formation located on Made Ground soils.
- 7.6.2 Equilibrium CBR (California Bearing Ratio) values (with reference to Transport and Road Research Laboratory (TRRL) Report LR1132 '*Structural design of Bituminous Roads*') are derived from knowledge of soil classification data (plasticity index for soils exhibiting cohesion (clay type) and particle size distribution for granular soils), the location of the water table pavement thickness, and weather conditions at the time of construction. It is anticipated that excavations to formation levels will encounter a mixture of both granular and cohesive soils. Granular soils will provide numerically high CBR values, but cohesive soils will typically provide significantly lower values. Assuming an average plasticity index of 30 for cohesive soils, a low water table, a 'thin' pavement the following equilibrium CBR values are derived for varying construction conditions.

Equilibrium CBR values for differing construction conditions

Poor	Average	Good
CBR = 3%	CBR = 4%	CBR = 4%

Table 7.6.2

- 7.6.3 We recommend these CBR values be utilised for design purposes and reassessed immediately prior to construction. The Made Ground deposits soils are considered frost susceptible and this may override the CBR criteria for pavement foundation design purposes. It should also be noted that the thickness of the pavement foundation also relates to the amount and loading from construction traffic, which is discussed in detail in the Transport and Road Research Laboratory (TRRL) Report LR1132 '*Structural design of Bituminous Roads*'.
- 7.6.4 It is possible to derive the 'in-situ' CBR value at formation from undrained shear strength data by applying a conversion factor of 23 (refer TRRL laboratory report LR889). Thus, adopting pessimistic undrained shear strength of say 70kN/m² at formation level (based on in-situ shear strength measurements) then an equivalent CBR value can be obtained i.e.
- $$\text{In-situ CBR} = \text{undrained shear strength} \times \frac{1}{23} = 3\%$$
- 7.6.5 The 'in-situ' CBR derived above, is susceptible to change dependent upon weather conditions during construction. The equilibrium CBR value derived in paragraph 7.6.3 above is an estimate of the CBR value, which will predominate during the life of the pavement. We recommend the insitu CBR of 3% derived from shear strength data be utilised for design purposes and reassessed during construction.
- 7.6.6 It should be noted that a gravelly cobbly chalk deposit (Made Ground) was encountered within the near surface soils, which in its current state was observed as reasonably competent, however softening due to surface weathering of this deposit may provide lower CBR values that have been calculated above.
- 7.6.7 The fact that the clay subgrade soils are likely to be deemed frost susceptible will probably be the overriding criteria for pavement foundation design purposes. It should also be noted that the thickness of the pavement foundation also relates to the amount and loading from construction traffic, which is discussed in detail in the Transport and Road Research Laboratory (TRRL) Report LR1132 '*Structural design of Bituminous Roads*'.
- 7.6.8 Made Ground deposits at the site exhibit a degree of variation in compactness. Some long-term settlement of hardstandings will occur due to consolidation of the Made Ground deposits and from applied loads, particularly uniformly distributed loads. It is difficult to accurately predict levels of settlement, as potentially applied loading patterns are not known.

- 7.6.9 Once formation levels have been established it is recommended that the formation be trimmed and rolled following current requirements of the Highways Agency Specification for Highways Works (clause 616) (refer www.dft.gov.uk/ha/standards/mchw/vol1). Such a process will identify any soft areas, which we recommend be either excavated out and backfilled with a suitable well compacted material similar to those exposed in the sides of the resulting excavation, or large cobbles of a good quality stone rolled into the formation to stabilise the 'soft' area.
- 7.6.10 The silty nature of the Made Ground will render them moisture susceptible with small increases in moisture content giving rise to a rapid loss of support to construction plant. We therefore recommend, as soon as formation is trimmed and rolled, that sub-base is laid in order to avoid deterioration of the subgrade in wet or frosty conditions.

8 Chemical contamination

8.1	Contaminated land, regulations and liabilities
8.2	Objectives and procedures
8.3	Development characterisation and identified receptors
8.4	Identification of pathways
8.5	Assessment of sources of contamination
8.6	Initial conceptual model
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8.1 Contaminated land, regulation and liabilities

8.1.1 Statute

8.1.1.1 Part IIA of the Environment Protection Act 1990 became statute in April 2000. The principal feature of this legislation is that the hazards associated with contaminated land should be evaluated in the context of a site-specific risk based framework. More specifically contaminated land is defined as:

“any land which appears to the local authority in whose area it is situated to be in such a condition, by reasons of substances in, on or under the land, that:

- a) Significant harm is being caused or there is a significant possibility of such harm being caused; or*
- b) Pollution of controlled waters is being or is likely to be caused”.*

8.1.1.2 Central to the investigation of contaminated land and the assessment of risks posed by this land is that:

- i) There must be contaminants(s) at concentrations capable of causing health effects (*Sources*).
- ii) There must be a human or environmental receptor present, or one which makes use of the site periodically (*Receptor*); and
- iii) There must be an exposure pathway by which the receptor comes into contact with the environmental contaminant (*Pathway*).

8.1.1.3 In most cases the Act is regulated by Borough or District Councils and their role is as follows:

- i) Inspect their area to identify contaminated land
- ii) Establish responsibilities for remediation of the land
- iii) See that appropriate remediation takes place through agreement with those responsible, or if not possible:
 - by serving a remediation notice, or
 - in certain cases carrying out the works themselves, or
 - in certain cases by other powers
- iv) keep a public register detailing the regulatory action which they have taken

8.1.1.4 For “special” sites the Environment Agency will take over from the Council as regulator. Special sites typically include:-

- Contaminated land which affects controlled water and their quality
- Oil refineries
- Nuclear sites
- Waste management sites

8.1.2 Liabilities under the Act

8.1.2.1 Liability for remediation of contaminated land would be assigned to persons, organisations or businesses if they caused, or knowingly permitted contamination, or if they own or occupy contaminated land in a case where no polluter can be found.

8.1.3 Relevance to predevelopment conditions

8.1.3.1 For current use, Part IIA of the Environmental Protection Act 1990 provides the regulatory regime. The presence of harmful chemicals could provide a ‘source’ in a ‘pollutant linkage’ allowing the regulator (local authority or Environment Agency) to determine if there is a significant possibility of harm being caused to humans, buildings or the environment. Under such circumstances the regulator would determine the land as ‘contaminated’ under the provision of the Act requiring the remediation process to be implemented.

8.1.4 Relevance to planned development

8.1.4.1 The developer is responsible for determining whether land is suitable for a particular development or can be made so by remedial action. In particular, the developer should carry out an adequate investigation to inform a risk assessment to determine:

- a) Whether the land in question is already affected by contamination through source – pathway – receptor pollutant linkages and how those linkages are represented in a conceptual model

- b) Whether the development proposed will create new linkages e.g. new pathways by which existing contaminants might reach existing or proposed receptors and whether it will introduce new vulnerable receptors, and
- c) What action is needed to break those linkages and avoid new ones, deal with any unacceptable risks and enable safe development and future occupancy of the site and neighbouring land?

8.1.4.2 Building control bodies enforce compliance with the Building Regulations. Practical guidance is provided in Approved documents, one of which is Part C, '*Site preparation and resistance to contaminants and moisture*' which seeks to protect the health, safety and welfare of people in and around buildings, and includes requirements for protection against harm from chemical contaminants.

8.1.5 Pollution of controlled waters

8.1.5.1 Part IIA of the Environment Protection Act 1990, defines pollution of controlled waters as

'The entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter'

8.1.5.2 Paragraphs A36 and A39 of statutory guidance (DETR 2000) further define the basis on which land may be determined to be contaminated land on the basis of pollution of controlled waters.

'Before determining that pollution of controlled waters is being, or likely to be, caused, the Local Authority should be satisfied that a substance is continuing to enter controlled waters, or is likely to enter controlled waters. For this purpose, the local authority should regard something as being likely when they judge it more likely than not to occur'

'Land should not be designated as contaminated land where:

- a) A substance is already present in controlled waters:*
- b) Entry into controlled waters of that substance from the land has ceased, and*
- c) It is not likely that further entry will take place.*

Substances should be regarded as having entered controlled waters where:

- a) They are dissolved or suspended in those waters; or*
- b) If they are immiscible with water, they have direct contact with those waters, or beneath the surface of the waters'*

8.1.5.3 Controlled waters are defined in statute to be:

'territorial waters which extend seawards for 3 miles, coastal waters, inland freshwaters, that is to say, the waters in any relevant lake or pond or of so much of any relevant river or watercourse as is above the freshwater limit, and groundwaters, that is to say, any waters contained in underground strata.'

8.1.6 Further information

8.1.6.1 The above provides a brief outline as regards current statute and planning controls. Further information can be obtained from the Department for the Environment, Food and Rural Affairs (DEFRA) and their Web site www.defra.gov.uk.

8.2 Objectives and procedures

8.2.1 Objectives

8.2.1.1 This report section discusses investigations carried out with respect to chemical contamination issues relating to the site. The investigations were carried out to determine if there are any liabilities with respect to Part IIA of the Environment Protection Act. As stated in Section 2.4.2, the investigation process followed the principles of BS10175: 2011 *'Investigation of potentially contaminated sites – Code of Practice'*, with the investigation combining a desk study (preliminary investigation) together with the exploratory and main investigations (refer BS10175: 2011 for an explanation).

8.2.1.2 This section of the report produces *'Conceptual models'* based on investigatory data obtained to date. The conceptual model is constructed by identification of *contaminants* and establishment of feasible *pathways* and *receptors*. The conceptual model allows a *risk assessment* to be derived. Depending upon the outcome of the risk assessment it may be necessary to carry out remediation and/or further investigations with a view to eliminating, reducing or refining the risk of harm being caused to identified receptors. If appropriate, our report will provide recommendations in this respect.

8.2.1.3 Clearly we must consider the current pre-development condition, establishing risks which may require action to render the site safe to all relevant (current) receptors meeting the requirements of current legislation (Part IIA of the Environmental Protection Act 1990).

8.2.1.4 Definition of terms used in the preceding paragraph and subsequent parts of this section of the report are presented in Appendix B.

8.2.2 Procedure to assess risks of chemical contamination

8.2.2.1 For the purposes of presenting this section of this report, we have adopted the following sequence in assessing risks associated with chemical contamination.

Table outlining sequence to assess risk associated with chemical contamination		
Conceptual model element	Contributory information	Outcome
Receptor	Development categorisation	Identification of receptors at risk of being harmed Method of analysing test data Criteria for risk assessment modelling
Pathways	Geology and ground conditions Development proposals	Identification of critical pathways from source to receptor
Source	Previous site history Desk study information Site reconnaissance Fieldwork observations	Testing regime Identification of a chemical source Analysis of test data and other evidence

Table 8.2.2

8.2.2.2 We have adopted, in general, the procedures described in CIRIA C552 '*Contaminated land risk assessment - a guide to good practice*' in deriving a risk assessment. Initially we have carried out a 'phase 1 assessment' based on desk study information and site reconnaissance, to produce an initial conceptual model and thus a preliminary risk assessment. This model / assessment is then used to target fieldwork activities and laboratory testing, with the results of this part of the investigation used to allow a phase 2 assessment to be produced by updating the conceptual model and refining the risk assessment.

8.3 Development characterisation and identified receptors

8.3.1 Site characterisation

8.3.1.1 The nature of the site has a significant influence the likely exposure pathways between potentially contaminated soils and potential receptors. The following table summarises elements which characterise the site based on site observations and desk study information.

Summary of site characteristics		
Element	Source / criteria	Characteristic
Current land use	Observations	Site currently comprised of an unoccupied area formerly used as a depot.
Future land use	Advice	Commercial activities.
Site history	Desk study	Site is recorded as an undeveloped land until 1970s when is recorded as a depot.
Geology	Desk study / Site investigation	Made Ground overlying Alluvium.
Ground water	Aquifer potential	Secondary A aquifer within Alluvium. Underlying Chalk deposits comprise a Principal aquifer.
	Abstractions	Nine active groundwater points are located within 2000m of the site. The closest groundwater abstraction point lies 379m to the north-west, upstream of the site, with water abstracted as a direct potable water supply.

Summary of site characteristics

Element	Source / criteria	Characteristic
	Source protection zone	Site not within source protection zone.
Surface waters	Location	Brockhampton stream located along the southern site boundary and a pond is recorded some 160m to the east.
	Abstractions	There are no active surface water abstractions located within 2000m of the site.

Table 8.3.1

8.3.2 Identified receptors

8.3.2.1 The principal receptors subject to harm caused by any contamination of the proposed development site are as follows.

Principle Receptor	Detail
Humans	Users of the current site
	End user of the developed site
	Construction operatives and other site investigators
Vegetation	Plants and trees, both before and after development
Controlled waters	Surface waters (Rivers, streams, ponds and above ground reservoirs)
	Ground waters (used for abstraction or feeding rivers / streams etc)
Building materials	Materials in contact with the ground

Table 8.3.2

This section of the report assesses those receptors listed above. Section 10 provides a risk assessment in relation to building materials.

8.3.3 Human receptors

8.3.3.1 The Contaminated Land Exposure Assessment (CLEA) model can be used to derive guideline values, against which land quality data can be compared to allow an assessment of the likely impacts of soil contamination on humans. The parameters used within the model can be chosen to allow guideline values to be derived for a variety of land uses and exposure pathways. For example, a construction worker is likely to be exposed in different ways and for different durations than an adult in a residential setting.

8.3.3.2 The site is not currently in use and therefore we have not considered current site users further. Following completion of the proposed commercial development, the critical future site user (receptor) is considered to be an adult. This criterion has been used in the conceptual model for the future site use. Our assessment also considers construction operatives as adult receptors.

8.3.4 Vegetation receptors

8.3.4.1 Soil contaminants can have an adverse effect on plants if they are present at sufficient concentrations. The effects of phytotoxic contaminations include growth inhibition, interference with natural processes within the plant and nutrient deficiencies.

8.3.4.2 Vegetation is currently present along the site boundaries and is likely to remain following completion of the redevelopment. On this basis vegetation is considered to be a potentially viable receptor.

8.3.4 Water receptors

8.3.4.1 The site lies in an area designated as a Secondary A aquifer probably contained in the Alluvium deposits, in addition Chalk deposits (Principal Aquifer) are recorded at depth. On this basis, groundwater is considered a potentially viable receptor.

8.3.4.2 Brockhampton stream was observed located running alongside the southern boundary of site and therefore surface water are also considered as a potentially viable receptor.

8.3.5 Summary of identified receptors

8.3.5.1 Based on the above assessments, the following table summarises identified and critical receptors.

Table summarising identified (viable) receptors				
Principle Receptor	Detail	Viable and critical receptors		
		Viability and justification		Critical receptor
Humans	Users of the current site	No	Site not in use	N/A
	End user of the developed site	Yes	Commercial use	Adult
	Construction operatives and other site investigators	Yes		Adult
Vegetation	Current site	Yes	Trees around boundary	Vegetation
	Developed site	Yes	Trees likely to remain	Vegetation
Controlled waters	Surface waters (Rivers, streams, ponds and above ground reservoirs)	Yes	Brockhampton stream flowing alongside southern boundary	Surface waters
	Ground waters (used for abstraction or feeding rivers / streams etc.)	Yes	Site over Secondary A aquifer and Principal aquifer at depth	Groundwater
Building materials	Materials in contact with the ground	Yes	Assessed in report section 10	Building materials

Table 8.3.5

8.4 Identification of pathways

8.4.1 Pathways to human receptors

- 8.4.1.1 Guidance published by the Environment Agency in Science Report SC050021/SR3 'Updated technical background to the CLEA model' provides a detailed assessment of pathways and assessment and human exposure rates to source contaminants. In summary, there are three principal pathway groups for a human receptor:

Table summarising likely pathways

Principal pathways	Detail
Ingestion through the mouth	Ingestion of air-borne dusts
	Ingestion of soil
	Ingestion of soil attached to vegetables
	Ingestion of home grown vegetables
Inhalation through the nose and mouth.	Inhalation of air-borne dusts
	Inhalation of vapours
Absorption through the skin.	Dermal contact with dust
	Dermal contact with soil

Table 8.4.1.1

- 8.4.1.2 The site is currently surfaced by gravels and some hardstanding from a former building, as such all pathways are considered to be present with the exception of pathways associated with the consumption of vegetables. Development proposals are for new buildings and associated yard, which is also likely to be gravelled in part. As such, the same pathways from potentially contaminated soils to future human receptors will remain the same albeit a low likelihood of exposure.

- 8.4.1.3 All of the above pathways are considered potentially viable for any future construction operatives with the exception of those associated with the consumption of vegetables.

- 8.4.1.4 A summary of our pathway assessment is presented in Section 8.4.4.

8.4.2 Pathways to vegetation

- 8.4.2.1 Guidance published by the Environment Agency in Science Report SC050021/SR (Evaluation of models for predicting plant uptake of chemicals from soil) provides a detailed assessment of plant uptake pathways. In summary, plants are exposed to contaminants in soils by the following pathways:

- Passive and active uptake by roots.
- Gaseous and particulate deposition to above ground shoots.
- Direct contact between soils and plant tissue.

- 8.4.2.2 All of the above routes of exposure are considered to be present for vegetation.

8.4.3 Pathways to controlled waters

8.4.3.1 A number of pathways exist for the transport of soil contamination to controlled waters. A summary of these pathways is presented below:

- Percolation of water through contaminated soils.
- Near-surface water run-off through contaminated soils.
- Saturation of contaminated soils by flood waters.

8.4.3.2 Based on exploratory investigations the soils exhibit permeability, as such contaminants could feasibly migrate through the soil into the groundwater. On this basis, percolation of water through contaminated soil is considered a potentially viable pathway. Following development, buildings and hardstanding will restrict this pathway, however we understand that it is possible that the development will not be fully drained and therefore percolation is considered to be a viable pathway for the purposes of this assessment.

8.4.3.3 Conversely, near surface water run-off through contaminated soils is unlikely due to the permeability.

8.4.3.4 The site is not located within an area at risk of fluvial or tidal flood risk and saturation of contaminated soils by flood waters is therefore considered unlikely.

8.4.4 Summary of identified likely pathways

8.4.4.1 Based on the above assessments, the following table summarises likely pathways of potential chemical contaminants at the site to identified receptors.

Table of likely pathways		
Receptor group	Critical receptor	Pathway
End users	Adult	Inhalation of vapours
Construction operatives	Adult	Ingestion of air-borne dusts
		Ingestion of soil
		Inhalation of air-borne dusts
		Inhalation of vapours
		Dermal contact with dust
		Dermal contact with soil
Vegetation		Root uptake, deposition to shoots and foliage contact
Controlled waters	Groundwater	Percolation of water through contaminated soils
Table 8.4.4		

8.5 Assessment of sources of chemical contamination

8.5.1 Introduction

8.5.1.1 Initially, potential sources of contamination are assessed using the following elements of the investigation process.

- History of the site
- Desk study information
- Site reconnaissance
- Geology
- Fieldwork

These elements will dictate a relevant soil/water testing regime to quantify possible risks of any identified contaminative sources which may harm identified receptors.

8.5.2 Source assessment – History of the site

8.5.2.1 The history of the site and its immediate surroundings based on published Ordnance Survey maps is described in Section 3.

8.5.2.2 Based on published historical maps, the site is recorded as a former metal recycling / council depot with wash-down facility, although not within the industrial profiles published by the EA we have considered that common occurring inorganic and organic contaminants and hydrocarbons are likely associated with this former use.

8.5.3 Source assessment – Desk study information

8.5.3.1 Envirocheck presents a detailed database of environmental information in relation to the site including;

- Pollution incidents
- Landfill sites
- Trading activities

8.5.3.2 Based on the Envirocheck data (refer Appendix P) trading activities are recorded in close proximity to the site which could generate a source of contamination. The following tables summarises records provided by Envirocheck.

Table summarising sources derived from recorded adjacent industrial activities			
Activity	Location	Probability of source affecting the site	Possible contaminants associated
Council depot and metal recycling	On site	Likely	Metals, PAHs, TPHs
MOT Garage	19m-E	Low likelihood	Metals, PAHs, TPHs
Sheet Metal works	19m-E	Low likelihood	Metals, PAHs
Metal finishers	20/22/36m-E	Low likelihood	Metals, PAHs
Boat builders and repairers	36m SE	Low likelihood	Metals, PAHs, TPHs
Havant incinerator	170m SW	Low likelihood	Metals, PAHs

Table 8.5.3.2

- 8.5.3.3 With reference to Section 3.6 there are a number of landfill transfer and management waste sites, which are also recorded as former uses of adjacent sites, we are of the opinion that based on records potential contaminants associated with those uses have been already considered from on-site former site uses.
- 8.5.3.4 The site has no record of pollution events.
- 8.5.3.5 The site was recorded as a registered waste transfer site. Records suggest no known restriction on source of waste including Ferrous/Non-Ferrous Cans, Glass, Paper/Cardboard Waste, Plastics, with an input of materials being small (Equal to or greater than 10,000 and less than 25,000 tonnes per year). Such contaminants are presented in the Table 8.5.3.2 above and are a potential source of chemical contamination.
- 8.5.4 Source assessment – Site reconnaissance**
- 8.5.4.1 A full description of the site and observed adjacent land uses is provided in Section 3 of this report. A plan summarising observations made on site during our site reconnaissance visit is presented on Drawing 02.
- 8.5.4.2 We did not observe any obvious evidence of any current or recent activities on site or adjacent sites, which provide a potential source of chemical contamination.
- 8.5.5 Source assessment – Geology**
- 8.5.5.1 The geological map of the area indicates the topography local to the site is formed in deposits of Alluvium. Typically, and in our experience, these deposits do not exhibit any abnormal concentrations of naturally occurring chemical contaminants.
- 8.5.6 Source assessment – Fieldwork observations**
- 8.5.6.1 All the exploratory excavations exposed Made Ground soils, which contained anthropogenic materials, which could potentially be a source of contamination.
- 8.5.6.2 In addition, during excavation of trial pit TP01 we noted evidence of hydrocarbon impacted soils, samples of which were issued for laboratory analysis.

8.5.7 Source assessment – Summary

8.5.7.1 Based on the paragraphs above, we have identified the following potential sources of contamination:

Table summarising results of source assessment				
Source	Origin of information	Possible contaminant	Probability of risk occurring	Likely extent of contamination
On site				
Council depot and metal recycling	Historic maps	Metals, PAHs, TPH and asbestos	Likely	Potentially site wide
Made Ground	Fieldwork observations	Metals, PAHs and asbestos	Likely	Potentially site wide
Suspected former wash down area	Desk study/Site investigations	TPH	Low-likelihood	Local to TP01
Adjacent sites				
Former commercial activities	Desk study information	Metals ,PAHs, TPH	Low-likelihood	Limited to site boundaries
Table 8.5.7.1				

8.6 Initial Conceptual Model

8.6.1 Based on our assessment of potential contaminative sources, identified receptors and viable pathways to receptors described in preceding paragraphs, we have produced an initial conceptual model in the form of a table which is presented in Appendix I.

8.6.2 Based on the conceptual model there are risks which exceed the low category which in our opinion are unacceptable, and require either remedial action or further investigation by laboratory testing of soil / water samples to refine the risk assessment.

8.7 Laboratory testing

8.7.1 Testing regime – Human receptors

8.7.1.1 Based on our source assessment (and our initial conceptual model) there are potential sources of chemical contamination at the site and on adjacent sites therefore laboratory testing is considered necessary.

8.7.1.2 Seven samples were submitted for measurement of organic and inorganic contaminants and determination of the presence/absence of asbestos in six locations. In addition, one sample taken from trial pit TP01 and submitted for determination of concentration of total petroleum hydrocarbon (TPH) and BTEX contamination.

8.7.2 Testing regime – Water receptors

8.7.2.1 In order to produce a qualitative assessment, we have also selected three leachate and two groundwater samples for measurement of the concentrations of commonly occurring inorganic and organic contaminants, where they are considered a risk to water resources. Based on our conceptual model, it is considered unlikely that naturally deposited soils at the site have been affected by artificial contamination thus we have selected Made Ground soils only.

8.7.2.2 As none of the soils or groundwater at the site exhibited any olfactory evidence of fuel/oil contamination we have not scheduled testing for measurement of leachable total petroleum hydrocarbons (TPH).

8.7.3 Testing regime – Vegetation

8.7.3.1 As described in 8.7.1 above we have scheduled testing for a suite of inorganic and organic contaminants. With reference to 'BPG Note 5 - Best Practice Guidance for Land Regeneration' testing will include copper and zinc.

8.7.4 Scheduled Testing

8.7.4.1 The following table summarises the chemical testing scheduled as well as a rationale for the testing;

Table summarising scheduled testing					
Exploratory point	Depth (m)	Strata/ medium	Targeted sampling?	Scheduled testing	Rationale
TP01	0.2	Made Ground	N	Suites 1, 2 & 7 / Asbestos ID	General site coverage
TP01	0.5	Made Ground	Y	Suite 7	Hydrocarbon impacted soils
TP02	0.2	Made Ground	N	Suite 1/ Asbestos ID	General site coverage
TP02	0.6	Made Ground	N	Suite 1	General site coverage
TP03	0.3	Made Ground	N	Suites 1 & 2/ Asbestos ID	General site coverage
TP04	0.6	Made Ground	N	Suites 1 & 2/ Asbestos ID	General site coverage
TP06	0.3	Made Ground	N	Suite1/ Asbestos ID	General site coverage
DTS08	0.1	Made Ground	N	Suite1/ Asbestos ID	General site coverage
DTS07	1.05	Groundwater	N	Suite 3	General site coverage
DTS08	0.69	Groundwater	N	Suite 3	General site coverage

Table 8.7.4.1

Refer to Appendix B for testing suite descriptions

8.7.4.2 Obviously, additional testing (quantity and types) would allow a more accurate risk assessment to be made. The results of laboratory determination of concentration of chemical contaminants are presented in Appendix G.

8.7.5 Criteria for assessment of test data – Human receptors

- 8.7.5.1 Assessment of laboratory test data has been carried out with reference to current nationally recognised documents listed in the final page of Appendix B. Due to changes in guidance on contaminated land, items 6-8 and item 10 in the document listing above have been withdrawn. In the absence of alternative guidance however we have used these documents. Where new guidance is available, this has been followed in preference to superseded guidance.
- 8.7.5.2 The Land Quality Management (LQM) and the Chartered Institute of Environmental Health (CIEH) have derived Suitable for Use Levels (S4ULs) which are presented in *'The LQM/CIEH S4ULs for Human Health Risk Assessment'* (2015). S4ULs have been used as a screening tool to assess the risks posed to the health of humans from exposure to soil contamination in relation to appropriate land uses. Where published S4ULs are not available, we have adopted C4SLs (Category 4 Screening Levels) produced by DEFRA or SGVs (Soil Guideline Values) as appropriate. In the absence of any of these criteria we have adopted Soil Screening Values (SSV) derived by Soiltechnics and by Atkins (SSV^{ATK}). The CLEA model used to derive SSVs has been used with toxicology data presented by the EA, LQM/CIEH and Atkins (in that order of preference). SSVs produced by Atkins are presented on their ATRISK^{SOIL} website.
- 8.7.5.3 S4ULs, C4SLs, SGVs, SSVs and SSV^{ATK}s represent 'intervention values'; indications to an assessor that soil concentrations above these levels might present an unacceptable risk to the health of site users. These guideline values have been produced using conceptual exposure models, which use assumptions and are applied to differing end uses of land. If the values are exceeded, it does not necessarily imply there is an actual risk to health and site-specific circumstances should be taken into account. Conversely, where a critical pathway or chemical form of the contaminant has not been evaluated, a risk may be present even if the adopted guideline value has not been exceeded.
- 8.7.5.4 For evaluation of test data in relation to polycyclic aromatic hydrocarbon (PAH), phenols and total petroleum hydrocarbon (TPH) contamination, we have compared measured concentrations with corresponding S4ULs. The S4UL fractions are dependent on the Soil Organic Matter (SOM) content of the soils. We have adopted the relevant guideline values based on SOM testing.
- 8.7.5.5 We have followed procedures outlined by the CIEH to compare measured concentrations of metals and PAH contaminants against guideline values. TPH contamination results are compared directly with the relevant guideline values. The guidance presents an approach to data analysis and includes the examination of data for potential outliers, assessment of the normality of the test data and the calculation of a 95% Upper Confidence Limit (UCL). The UCL provides an estimate of the population mean, based on test data, with a 95% confidence that the actual mean does not exceed this value. The UCL is compared to the guideline value for the site.
- 8.7.5.6 We have adopted an industrial/commercial land use for proposed end users of the site. In the absence of guidelines we have also adopted industrial guideline values for assessment of construction operatives.

8.7.6 Criteria for assessment of test data – Vegetation

8.7.6.1 Guidance published by Forest Research in “*BPG Note 5 - Best Practice Guidance for Land Regeneration*” suggests that a residential without plant uptake or industrial/commercial CLEA model should be adopted for this receptor although specific guideline values are provided for copper and zinc at 130mg/kg and 300mg/kg respectively. As a practice we have adopted the industrial / commercial CLEA model for assessment of test data for vegetation.

8.7.6.2 It is difficult to quantify the phytotoxicity of a contaminant as large variations exist between plant tolerances, soil effects and synergistic/antagonistic reactions between chemicals. Due to the complexities of the effects of soil contamination on different plant species, we recommend that the test results presented in this report are passed to a landscape architect for the selection of suitable planting.

8.7.7 Criteria for assessment of test data – Controlled waters

8.7.7.1 For interpretation of test data in relation to water receptors we have directly compared measured values with the Environmental Quality Standards (EQS) and UK Drinking Water Standards (UKDWS). In the absence of EQS or UKDWS we have adopted World Health Organisation Drinking Water Guidelines (WHODWG)

8.7.7.2 EQS values are published by the Environment Agency in their publication, “*Environment Agency technical advice to third parties on Pollution of Controlled Waters for Part 11A of the Environmental Protection Act 1990*”. EQS values for most inorganic contaminants in freshwater are dictated by the hardness of the receiving watercourse. The hardness of water is a measure of the concentration of calcium carbonate in the water. Although we have not sampled water from nearby watercourses, we have visited Southern Water website which indicates the water hardness in the local area is above 250mg/l.

8.7.7.3 Using this information for List II substances (DOE Circular 7/89) we have compared the measured values with the EQS values relative to the hardness of the receiving watercourse assuming a worst case scenario of the watercourse supporting ‘sensitive’ aquatic life.

8.7.7.4 UKDWS are presented in the Water Supply (Water Quality) Regulations.

8.7.7.5 Following our receptor assessment (outlined in Section 8.3.5 above), we have adopted EQS values in preference to alternative guidelines where possible.

8.7.8 Evaluation of test data – Human receptors

8.7.8.1 Tables summarising and analysing test data are presented in Appendix H. The following table summarises the outcome of the analyses.

Table Summarising assessment of test data for Human receptors					
Analysis tables	Receptor group	Critical receptor	CLEA model	Inorganic contaminants	Organic contaminants
1 and 2	Future site users and construction operatives	Adult	Industrial / commercial	Refer to Section 8.7.8.2	No exceedances
Table 8.7.8.1					

8.7.8.2 With reference to table 1 in Appendix H, analysis of chemical test data with respect to critical (adult) receptors for future site uses, indicates chromium (III) and lead have been measured above their respective guideline values. These elevated values were identified in a distinct Made Ground type observed within TP06 around 0.3m depth and thus has been separated from the rest of the data set.

8.7.8.3 The elevated concentration of chromium (III) was measured at 61mg/kg compared to a S4UL of 33mg/kg and lead was measured at 2300mg/kg compared to the guideline value (C4UL) of 1100mg/kg. It should be noted that provision of hardstanding or buildings will sever the pathway between source and end users, however a capping layer is required if the surface is unbound.

8.7.8.4 With reference to table 6 none of the measured concentrations of TPH or BTEX exceed the relevant guideline outlined in Section 8.7.2.

8.7.8.5 In addition to the above, no asbestos was detected in any of the samples.

8.7.9 Evaluation of test data – Vegetation

8.7.9.1 Comparison of test data with guideline values is presented on Tables 2 and 3 in Appendix H. None of the measured concentrations exceed the adopted guideline values with the exception of a number of elevated contaminants measured in TP06 at 0.3m. However, this is in isolation and we are of the opinion that measured concentrations site wide are unlikely to exhibit significant contamination with respect to vegetation.

8.7.9.2 It is difficult to quantify the phytotoxicity of a contaminant as large variations exist between plant tolerances, soil effects and synergistic/antagonistic reactions between chemicals. Due to the complexities of the effects of soil contamination on different plant species, we recommend that the test results presented in this report are passed to a landscape architect for the selection of suitable planting.

8.7.10 Evaluation of test data – Controlled waters

8.7.10.1 Inorganic contaminants

8.7.10.1.1 With reference to table 4 in Appendix H, none of the measured concentrations of leachable inorganic contaminants exceed the relevant guideline outlined in Section 8.7.7. However, with reference to table 5, elevated concentrations of copper and zinc were measured in a groundwater sample taken from DTS07.

8.7.10.1.2 Concentration of copper was measured at 35µg/l against a guideline value of 28µg/l with concentration of zinc measured at 160µg/l against a guideline value of 125µg/l.

8.7.10.2 Organic contaminants (polycyclic aromatic hydrocarbons)

8.7.10.2.1 For the analysis of PAH contamination, the sum of the following contaminants has been compared to a UKDWS.

- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(ghi)perylene
- Indeno(1,2,3-cd)pyrene

8.7.10.2.2 The summed concentration of the PAH 'suite' do not exceed the UKDWS. In addition the leachable and dissolved concentrations of benzo(a)pyrene and naphthalene, do not exceed their respective guideline values.

8.7.10.3 Total petroleum hydrocarbons (TPHs)

8.7.10.3.1 From the exploratory investigations and groundwater samples taken we did not observe any potentially hydrocarbon impacted waters by olfactory or visual methods. However, during development, should it become evident that greater concentration of hydrocarbons is observed then we would be happy to re-attend site to assess the degree of impacted ground.

8.7.10.4 Summary

8.7.10.4.1 Elevated concentration of copper and zinc within groundwater was recorded within the single tested sample which could potentially pose a risk to water receptors.

8.8 Updated conceptual model

8.8.1 Having now completed analysis of laboratory testing, we can now update our conceptual model which is presented in Appendix I.

8.8.2 Based on the conceptual model there are risks which exceed the low category, which in our opinion are unacceptable and require further consideration.

8.9 Remedial recommendations and further investigations

8.9.1 Based on the above, concentrations of chromium (III) and lead local to trial pit TP06 pose a risk to future end users and copper and zinc potentially pose a risk to groundwater receptors. In areas of unbound surfaces, providing a sufficient thickness of material is introduced, risks to end users will be minimised. In our opinion, a minimum of 300mm of compacted material will be sufficient to act as a cover system. Elsewhere, buildings/hardstandings will sever the pathway to end users and to water receptors and therefore no further actions are required.

8.9.2 However should infiltration systems be installed then it is recommended infiltration systems are sealed through the Made Ground to minimise the potential for any contamination mobilisation. All discharges to groundwater are subject to compliance with the Water Framework Directive (2000/60/EC) and Groundwater Daughter Directive (2006/118/EC).

8.10 Risk assessment summary and recommendations

8.10.1 Based on our assessments described above, we can provide the following summary and recommendations for each identified receptor.

8.10.2 End users

8.10.2.1 We are of the opinion that the site represents a low risk of causing harm to the health of future end users of the developed site, based on current development proposals providing sufficient thickness of materials are introduced in areas of unbound surfacing.

8.10.3 Construction operatives and other site investigators

8.10.3.1 The risk of damage to health of construction operatives and other site investigators is, in our opinion, **low/moderate**. As a precautionary approach, however, we recommend adequate hygiene precautions are adopted on site. Such precautions would be:-

- Wearing protective clothing particularly gloves to minimise ingestion from soil contaminated hands.
- Avoiding dust by dampening the soils during the works.
- Wearing masks if processing produce dust.

8.10.3.2 Guidance on safe working practices can be obtained from the following documents

- The Health and Safety Executive Publication *"Protection of Workers and the General Public during the Development of Contaminated Land"* (HMSO) and
- *"A Guide to Safer Working on Contaminated Sites"* (CIRIA Report 132).

8.10.3.3 In addition, reference should be made to the Health and Safety Executive. In all cases work shall be undertaken following the requirements of the Health and Safety at Work Act 1974 and regulations made under the Act including the COSHH regulations.

8.10.3.4 If during the course of excavations hydrocarbon type odours become evident we recommend works are halted, and the air quality measured to determine if the excavation can be safely entered. If the air quality is unacceptable then appropriate personal protective equipment, will be required for human entry into the excavation. If elevated concentrations of airborne hydrocarbons / vapours are detected on site, we recommend Soiltechnics are advised to determine an appropriate course of action with respect to building construction.

8.10.4 Controlled waters

8.10.4.1 Buildings and hardstanding will effectively sever the pathway between potentially contaminated soils and groundwater thus we are of the opinion that the site represents a **low** risk of causing harm to Controlled Waters of the developed site, based on current development proposals.

8.10.5 Vegetation

8.10.5.1 We recommend that the test results presented in this report are passed to a landscape architect for the selection of suitable planting.

8.11 Statement with respect to National Planning Policy Framework

8.11.1 Based on investigations completed to date with respect to chemical contamination, we are of the opinion the proposed development will be safe and suitable for use for the purpose for which it is intended (without the need for any remedial action) thus meeting the requirements of the National Planning Policy Framework section 121, and compliant with the Building Regulations Part C, *'Site preparation and resistance to contaminants and moisture'*

8.12 On Site Monitoring

8.12.1 We have attempted to identify the potential for chemical contamination on the site, however, areas, which have not been investigated at this stage, may exhibit higher levels of contamination. If such areas are exposed at any time during construction we will be pleased to re-attend site to assess what action is required to allow the development of safely proceed.

9 Gaseous contamination

9.1	Legislative framework
9.2	General
9.3	Assessment of source of gases
9.4	Gas migration
9.5	Conceptual model
9.6	Development categorisation
9.7	Monitoring observations
9.8	Classification of site characteristic gas situation
9.9	Assessment of gas protective measures
9.10	Statement with respect to National Planning Policy Framework

9.1 Legislative framework

- 9.1.1 There is currently a complex mix of documentation relating to legislative and regulatory procedures on the issue of contamination and it is not considered a purpose of this report to discuss the detail of these regulations. Essentially, Government Policy is based on '*suitable for use approach*', which is relevant to both the current and proposed future use of land. For current use Part IIA of the Environmental Protection Act 1990 provides the regulatory regime (see Section 8.1 above). The presence of harmful soil gases could provide a 'source' in a 'pollutant linkage' allowing the regulator (Local Authority) to determine if there is a significant possibility of harm being caused to humans, buildings or the environment. Under such circumstances the regulator would determine the land as 'contaminated' under the provision of the Act requiring the remediation process to be implemented with the Environment Agency responsible for enforcement.
- 9.1.2 The Town and Country Planning (General Development Procedure) Order 1995, requires the planning authority to consult with the Environment Agency before granting planning permission for development on land within 250 metres of land which is being used for deposit of waste, (or has been at any time in the last 30 years) or has been notified to the planning authority for the purposes of that provision.
- 9.1.3 Building control bodies enforce compliance with the Building Regulations. Practical guidance is provided in Approved documents, one of which is Part C, '*Site preparation and resistance to contaminants and moisture*' which seeks to protect the health, safety and welfare of people in and around buildings and includes requirements for protection against harm from soil gas.

9.2 General

9.2.1 The following assessment relates to the potential for, and the effects of, gases generated by biodegradable matter. A separate, but related class of problem involves migration of vapour phase of hydrocarbons resulting from spillages of petroleum and solvents, but this is addressed under organic contamination in Section 8. The potential for the development to be affected by radon gas is considered in Section 3 above. The principal ground gases are carbon dioxide (CO₂) and methane (CH₄). The following table provides a summary of the effects of these gases when mixed with air.

Significant gas concentrations in air		
Gas	Concentration by volume	Consequence
Methane	0.25%	Ventilation required in confined spaces
	5 - 15%	Potentially explosive when mixed with air
	30%	Asphyxiation
	75%	Death after 10 minutes
Carbon Dioxide	0.5%	8 hour long term exposure limit (LTEL) (HSE workplace limit)
	1.5%	15 min short term exposure limit (STEL) (HSE workplace limit)
	>3%	Breathing difficulties
	6 – 11%	Visual distortion, headaches, loss of consciousness, possible death
	>22%	Death likely to occur

Table 9.2.1

9.2.2 Following the current Building Regulations Approved Document C1, Section 2 'Resistance to Contaminants' (2004 incorporating 2010 and 2013 amendments) a risk assessment approach is required in relation to gaseous contamination based on the source-pathway-receptor conceptual model procedure. We have adopted procedures described in the following reference documents for investigation and assessments of risk of the development being affected by landfill type gases (permanent gases) and if appropriate the identification of mitigation measures.

- BS10175:2011 'Investigation of potentially contaminated sites- Code of Practice'
- BS8576:2013 'Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)'
- BS8485:2015 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'
- CIRIA Report C665 'Assessing risks posed by hazardous ground gases to buildings' (2007)
- CL:AIRE Research Bulletin RB17 'A pragmatic approach to ground gas risk assessment' (November 2012)

Whilst we have followed the guidance and recommendations of BS8576, we have used BS8485:2015 to derive recommendations for protective works.

9.2.3 An assessment of the risk of the site being affected by ground gases is based on the following aspects:

- a) Source of the gas
- b) Investigation information
- c) Migration feasibility
- d) Sensitivity of the development and its location relative to the source

9.3 Assessment of source of gases

9.3.1 General sources

9.3.1.1 The following table summarises the common sources of ground gases and parameters affecting the generation of ground gases:

Source and control of gases	
Type	Parameters affecting the rate of gassing
Landfills	Portion of biodegradable material, rate reduces with time
Mineworkings	Flooding reduces rate of gassing
Dock silt	Portion of organic matter
Carbonate deposits	Ground / rainwater (acidic) reacts with some carbonates to produce carbon dioxide.
Made Ground	Thickness of Made Ground and proportion of degradable organic matter
Naturally deposited soils/rocks	Portion of organic matter

Table 9.3.1

The rate of decomposition in gas production is also related to atmospheric conditions, pH, temperature, and water content / infiltration.

9.3.1.2 As the site is not within a dockland environment or an area affected by mineworkings, and near surface soils do not exhibit high carbonate content, then potential gas sources are limited to landfills and/or soils with a high proportion of organic matter.

9.3.2 Landfill and infilled ground sources

9.3.2.1 Waste Management Paper 27 (1991) produced by the Department of the Environment '*Control of Landfill Gases*' contains the recommendation to avoid building within 50m of a landfill site actively producing large quantities of landfill type gases and to carry out site investigations within a zone 250m beyond the boundary of a landfill site. No distinction is made between sites of differing ground conditions, but the paper does not advocate the site is safe beyond the 250m zone, dependant, of course, upon the type of landfill and potential for migration of landfill gases.

9.3.2.2 Envirocheck reports a number of landfill and quarrying sites located within 1000m distance from the site. Records indicate the authorised waste to be other than inert materials or the information is not provided with regards to the infilled material and therefore we consider that potential sources of ground gases posing a risk for site users have been identified and further assessments are required.

9.3.3 Soil conditions

9.3.3.1 The exploratory excavations, exposed Made Ground soils which presented moderately elevated content of organic matter (ranging from 0.47% to 7.4%) in some locations. It should be noted however that these soils were encountered at shallow levels and did not extend beyond 0.6m.

9.3.3.2 Based on laboratory analysis, at deeper levels Made Ground exposed significantly reduced levels of organic matter and therefore we are of the opinion that the risk of ground gases generation from this potential source is low.

9.3.3.3 However, based on historical mapping the course of Brockhampton stream encroached onto the southern part of the site, but has since been infilled and straightened with its new course immediately adjacent to the south of the site. The former stream may have just been infilled, the potential for sediments to remain. As such there is a potential for the infill materials and remaining sediments to be a source of landfill type gases, albeit a potential low risk. This low risk is, in part, supported by observations made from trial pits TP03 and TP07 were undertaken close/on to the former stream channel, where there were no obvious signs that the soils exhibited excessive amounts of organic material.

9.3.4 Source assessment summary

9.3.4.1 The following table summarises the possibility of a source of landfill type gases.

Source assessment summary		
Potential source origin	Viability of source	Evidence
Landfills/Restored quarries/ stream backfilling	Possible	Desk study information Restored opencast quarry 14m and 384m from site and stream course backfilling, source of backfill not known.
Mineworkings	Unlikely	Desk Study information Geological conditions not amenable
Dock silt	Unlikely	Site remote from dockland environment
Carbonate deposits	Low likelihood	Underlying Chalk deposits recorded on site
Made Ground	Unlikely	Made Ground with high quantities of organic matter only located at shallow levels
Soils / rocks	Low likelihood	Soils exposed in exploratory excavations do not exhibit high concentrations of organic matter, but may do locally
Table 9.3.4		

- 9.3.4.2 Based on the above it there is a possibility of a source of potential landfill gases which may affect the subject site. On this basis, it is considered necessary to consider possible pathways for migration of ground gases from this potential source to the site.

9.4 Gas migration

- 9.4.1 Exploratory excavations encountered a reasonably consistent deposit of Alluvium deposits to depths of in excess of 3.5m, which in our opinion are relatively permeable and would provide little resistance to both lateral and vertical migration of landfill type gases. In addition, based on published geological records the Alluvium deposits extend from the subject site to the former quarry which was probably excavated for the exploitation of sands and gravels. On this it is considered possible that the potential source of landfill type gases (identified in Section 9.3 above) would feasibly migrate to the subject site.

9.5 Conceptual model

- 9.5.1 Based on the above, there is a potential source of landfill type gases, and a feasible migration pathway to the site via potentially permeable Alluvium Deposits. Our conceptual model is tabled below. On this evidence we are of the opinion that the site is at risk of being affected by ground gases (carbon dioxide / methane) sufficient to potentially cause harm to human end users of the site, construction operatives or indeed buildings. On this basis, we have installed monitoring standpipes in boreholes, and implemented a monitoring regime, generally following procedures described in BS8576:2013 to quantify the risk and, if appropriate, identify mitigation measures.

Conceptual model		
Potential source origin	Potential pathway	Receptors at risk
Landfills recorded from 270m from site – source of includes Household and commercial Organic material within former stream channel	Via sands and gravels	End users Construction operatives Buildings
Table 9.5.1		

9.6 Development categorisation

- 9.6.1 With reference to BS8485:2015 (table 3), the proposed building type would be classified as 'Type C- Commercial/public' and 'Type D – commercial/industrial'.

9.7 Monitoring observations

- 9.7.1 Four standpipes have been installed at the site in accordance with BS9576:2013, Section 9 (refer Drawing 05). Following BS8576:2013 (Figure 6) and CIRIA Report C665 (Tables 5.5a and 5.5b) we have provisionally assessed the site as low risk of generation potential of source ideally requiring six monitoring visits over a two month period. This initial assessment will be reviewed pending the results of three return visits.
- 9.7.2 We have returned to site for three of the proposed monitoring visits to obtain measurements of landfill type gases at atmospheric conditions in the range of 1014 to 1035mb and temperatures in the range of 13°C to 18°C. Essentially concentrations of methane were not detected above flow detection limit and concentrations of carbon dioxide measured in the range of 0.3 to 5.2%. If flows were detected during our monitoring visits then these are recorded, but where no flow is detected then we have assumed flow at the detection limit of the monitoring equipment at 0.1l/s.
- 9.7.3 Gas monitoring results are summarised in Appendix I.

9.8 Classification of site characteristic gas situation

- 9.8.1 Using test data and with reference to Table 2 of BS8485:2015, the site would be classified as characteristic gas situation one.
- 9.8.2 Clearly further monitoring will increase the accuracy of this risk assessment, however in our opinion we have followed current best practice with respect to investigations completed to date, the monitoring regime and analysis of data, and again in our opinion, the data categories used in the analysis is considered to be *'representative and comprehensive'* as defined in section 6.3.7 of BS8485:2015.
- 9.8.3 In addition we have assessed the sufficiency of data in accordance with annex F of BS8576:2013. The following table summarises our assessment.

Action	Result
From current results (concentration, flow rates and pressure) estimate likely risk associated with ground gas (note steady state flow results are to be used, not peak values that only last a few seconds on opening the gas tap)	Current estimate of risk GSV = gas concentration x borehole flow rate. CSV = $5.2/100 \times 0.1 = 0.0052\text{l/hr}$ Characteristic situation CS2 (Due to CO ₂ concentration above > 5%) (maximum limit is 0.7l/hr)
What increase in gas concentration is required to increase the estimated risk and level of gas protection to be provided?	Estimate increase in gas concentration Keeping the flow rate constant, the gas concentration would need to exceed 100% to move into the next band. This is not feasible.
What increase in flow rate is required to increase the estimated risk and level of gas protection to be provided?	Estimate increase in flow rate: Keeping the concentration constant, the flow rate would need to exceed 13.46l/hr to move into the next risk band, ie to needs to increase 134.6 times. From current data and knowledge of the gas source and generation potential, this is not considered feasible.

Action	Result
Is the increase in gas concentration feasible given the known source of the gas?	No It is not possible for the methane concentration to exceed 100%
Is the increase in flow rate feasible when compared to gas generation and migration model results, the collected gas monitoring data and the conceptual site model?	No Future gas generation exceeding the above calculated values is unlikely to occur
Decide whether further monitoring is required.	Based on the above analysis, further gas monitoring is not required.
Table 9.8.3	

9.9 Gas protective measures – new buildings

- 9.9.1 Based on monitoring, development categorisation (section 9.6 above), and the site characteristic gas situation (section 9.8 above) and with reference to Table 4 of BS8485:2015, the development does not require any gas protective measures.

9.10 Statement with respect to National Planning Policy Framework

- 9.10.1 Based on investigations completed to date with respect to gaseous contamination, we are of the opinion the proposed development will be safe and suitable for use for the purpose for which it is intended (without the need for any remedial action) thus meeting the requirements of the National Planning Policy Framework section 121, and compliant with the Building Regulations Part C, *'Site preparation and resistance to contaminants and moisture'*.

10 Effects of ground conditions on building materials

10.1	General
10.2	Reference documents
10.3	Concrete – general mechanisms of attack
10.4	Concrete – sulphate attack
10.5	Plastic pipes

10.1 General

10.1.1 Building materials are often subjected to aggressive environments which cause them to undergo chemical or physical changes. These changes may result in loss of strength or other properties that may put at risk their structure integrity or ability to perform to design requirements. Aggressive conditions include:-

- Severe climates
- Coastal conditions
- Polluted atmospheres
- Aggressive ground conditions

This report section only considers aggressive ground conditions, with other items considered outside our brief and scope of investigations.

10.1.2 In aggressive ground conditions, the potential for contaminant attack depends on the following:-

- The presence of water as a carrier of chemical contaminants, (except free phase organic contamination)
- The availability of the contaminant in terms of solubility, concentration and replenishment rate
- Contact between the contaminant and the building material
- The nature of the building materials and its capability of being attacked by contaminants

In general the thicker the building material the less likelihood there is for contaminant attack to cause damage to the integrity of the structure.

10.2 Reference documents

10.2.1 In production of the following report paragraphs we have made reference to these documents:

- *'Concrete in aggressive ground'* Special Digest 1: 2005 (Building Research Establishment)
- *'Guidance for the selection of Water supply pipes to be used in Brownfield sites'*

10.3 Concrete - General mechanisms of attack

10.3.1 There are a number of mechanisms by which contaminants attack concrete including the following:-

- Hydrolysis of the hardened concrete.
- Degradation as a result of exchange reactions between calcium in calcium hydroxide (free lime hydrate) and ions in aggressive solutions.
- Expansive reactions as a result of chemical reaction or salt crystallisation.

10.4 Concrete - Sulphate attack

10.4.1 Hazard

10.4.1.1 Sulphate attack on concrete is characterised by expansion, leading to loss of strength, cracking, spalling and eventual disintegration. There are three principal forms of sulphate attack, as follows:-

- Formation of gypsum through reaction of calcium hydroxide and sulphate ions.
- Ettringite formation through reaction of tricalcium aluminate and sulphite ions.
- Thaumasite formation as a result of reactions between calcium silicate hydrates, carbonate ions (from aggregates) and sulphate ions

10.4.2 Assessment

10.4.2.1 The hazard of sulphide attack is addressed by reference to procedures described in Building Research Establishment (BRE) Special Digest 1: 2005 *'Concrete in Aggressive Ground'* to establish a design sulphate class (DS) and the *'aggressive Chemical Environment for Concrete'* (ACEC). These procedures have been followed during our investigation and are described in the following paragraphs.

10.4.3 Desk Study Information

- 10.4.3.1 The first step in the procedure is to consider specific elements of the desk study. These are tabulated below.

Summary of desk study information			
Element	Interrogation	Outcome	SD1: 2005 reference
Geology	Likelihood of soils containing pyrites	Unlikely	Box C6
Past industrial uses	Brownfield site?	Yes	C2.1.2
Table 10.4			

- 10.4.3.2 A brownfield site is defined in SD1: 2005 as a site, or part of a site which has been subject to industrial development, storage of chemicals (including for agricultural use) or deposition of waste, and which may contain aggressive chemicals in residual surface materials, or in ground penetrated by leachates. Where the history of the site is not known, it should be treated as brownfield until there is evidence to classify it as natural.

- 10.4.3.3 Based on the above it is necessary to follow the procedures described in figure C6 (*'locations on brownfield sites except where soils may contain pyrite'*).

10.4.4 Assessment of Design Sulphate Class

- 10.4.4.1 The sulphate concentration in a 2:1 water/soil extract was measured in two samples of Made Ground, one sample of Alluvium and one sample of groundwater. The highest test result has been used as the characteristic value (refer to table 10.4.7). The measured values are not considered to be significantly variable.

- 10.4.4.2 The concentration of sulphate was measured at less than 3000mg/l and thus the concentration of magnesium was not measured.

10.4.5 Assessment of groundwater mobility

- 10.4.5.1 With reference to SD1: 2005, Section C3.2, we are of the opinion that ground and site characteristics suggest 'mobile groundwater' conditions.

10.4.6 Assessment of pH

- 10.4.6.1 Following SD1: 2005, Section C5.1.1 (step 4) only a 'small number' of samples have been tested and thus the characteristic value for pH within Made Ground and Alluvium equates to the lowest measured values of 8.4 and 8.3 respectively.

- 10.4.6.2 None of the measured pH values were below 5.5, thus the concentration of chlorides and nitrates was not measured.

10.4.7 Assessment of aggressive chemical environment for concrete (ACEC)

10.4.7.1 Based on the design sulphate class, characteristic value of pH and assessment of groundwater mobility, and with reference to table C2 of SDI: 2005, the ACEC class for each soil type is presented in Table 10.4.7.1 below.

Summary of concrete classification						
Soil type	No. of samples	Characteristic pH	Groundwater mobility	Characteristic sulphate (mg/l)	DS class	ACEC class
Made ground (coarse soils)	1	8.4	Mobile	190	DS-1	AC-1
Made ground (fine soils)	1	8.9	Mobile	49	DS-1	AC-1
Alluvium	1	8.3	Mobile	19	DS-1	AC-1
Groundwater samples	1	8.3	N/A	14	DS-1	AC-1
Table 10.4.7.1						

10.5 Plastic Pipes

10.5.1 Hazards

10.5.1.1 Plastic pipes are predominantly manufactured from PVC and PE but other materials can be used. In general they perform well but it is known that chemical attack and permeation of contaminants through the pipes can result from use in contaminated land. A published review on plastic pipes reports the following:-

- Polyethylene (PE) - good resistance to solvents, acids and alkalis
- Poly vinyl chloride (PVC) - most common form of pipe. Good general resistance to chemical attack but can be attacked by solvents such as ketones, chlorinated hydrocarbons and aromatic polypropylene (PP) - chemically resistant to acids, alkalis and organic solvents but not recommended for use with storing oxidising acids, chlorinated hydrocarbons and aromatics.
- Poly vinylidene fluoride (PVDF) - inert to most solvents, acids and alkalis as well as chlorine, bromide and other halogens
- Polytetrafluoroethylene (PTFE) - one of the most inert thermoplastics available. PTFE has good chemical resistance to solvents, acids and alkalis

10.5.2 Assessment

10.5.2.1 A survey carried out by the Water Research Centre (WRc) on reported incidents of permeation (more than 25), only two involved PVC with these incidents relating to spillages of fuel.

10.5.2.2 The UK Water Industry research (UKWIR) have published a document entitled '*Guidance for the selection of Water supply pipes to be used in Brownfield sites*'. The publication defines brownfield sites as

'Land or premises that have been used or developed. They may also be vacant, or derelict. However they are not necessarily contaminated'

10.5.2.3 Whilst we have not carried out a full investigation set out in guidance in the UKWIR document, the subject site does exhibit a degree of localised hydrocarbon (PAH) contamination. The UKWIR document advises a trigger concentration of 0.125mg/kg for their 'extended VOC (Volatile Organic Carbons) suite' which includes the PAH suite which we have results for. The measured concentration of individual contaminants forming part of the PAH suite exceeds the trigger value of 0.125mg/kg and therefore barrier pipe may be required. We recommend Portsmouth Water however is consulted on this to gain their opinion and requirements.

11 Classification of waste soils under the Waste Acceptance Criteria

11.1	The Landfill Directive
11.2	Classification of soil types
11.3	Waste Acceptance Criteria (WAC)
11.4	Primary Classification
11.5	Secondary Classification
11.6	Naturally deposited soils not affected by artificial contaminants
11.7	Basic Categorisation
11.8	Treatment of waste
11.9	Reuse of soils - Materials Management Plans

11.1 The Landfill Directive

11.1.1 The Landfill Directive represents an important change in the way we dispose of waste. It encourages waste minimisation by promoting increased levels of recycling and recovery. The Landfill Directive became law in 1999 and transcribed into the Landfill (England and Wales) Regulations which came into force in 2002. These Regulations were amended in 2005 by introducing criteria to classify soils for disposal to landfill. It is the duty of the waste producer (the client) to classify the soils for this purpose.

11.2 Classification of soil types

11.2.1 Our investigations consider two soil types which may be generated as wastes as part of construction operations, potentially contaminated soil and uncontaminated soil. A full hazard assessment and subsequent testing for waste acceptance criteria is undertaken on soils which are not considered to be naturally deposited or are likely to be affected by artificial contamination. For soils that are unlikely to be affected by artificial contamination (such as natural soils), specific testing in relation to the classification process is not necessary.

11.3 Waste acceptance criteria (WAC)

11.3.1 The Environment Agency publication, *'Framework for the classification of contaminated soils as hazardous wastes'* (July 2004), provides an appropriate procedure for establishing if the soils are hazardous or non-hazardous and applies to soils that are identified as potentially contaminated. Uncontaminated, natural soils are considered separately (see Section 11.6).

11.3.2 Primary classification

11.3.2.1 The first stage is classifying a potentially 'contaminated' soil for disposal to landfill is to establish its chemical status by first identifying potential sources/types of chemical contamination (desk study) followed by intrusive site investigations to obtain samples for undefined testing of soil samples to measure concentrations of chemical contaminants. Such data provides information to partly complete the basic characteristic checklist.

11.3.2.2 Laboratory test data is then compared with the Environment Agency publication '*hazardous waste – Interpretation of the definition and classification of hazardous waste (second edition, version 2.1)*'. Where the waste is suspected to contain oil, we have referred to the Environment Agency draft consultation paper '*How to Find Out if Waste Oil and Wastes that Contain Oil are Hazardous*' (Draft Version 2.5 – October 2006). With reference to these documents a hazard assessment has been carried out to enable categorisation of the material as hazardous or non-hazardous and to subsequently establish the European Waste Catalogue (EWC) code (ref Section 11.3.4 below).

11.3.3 Secondary classification

11.3.3.1 If the soil is deemed hazardous then measurement of organic contaminants and leachable inorganic contaminants is necessary for comparison with values listed in the Environment Agency publication '*Guidance on sampling and testing of wastes to meet landfill waste acceptance procedures*' (April 2005) Table 5.1. Similarly should the soil be deemed as non-hazardous then such testing may also be undertaken to determine if it is potentially inert. This document also provides guidance on sampling materials and frequency as well as test procedures and quality assurance of testing.

11.3.3.2 The above procedures are described with respect to the subject site in the following sections Section 11.4 (primary) and 11.5 (secondary), leading to basic characterisation of soils for disposal. Subject to the results of the categorisation and anticipated development methodology, consideration should be given by the developer to reduce volumes of disposal or treatment to allow reclassification.

11.3.4 European waste catalogue (EWC) coding

11.3.4.1 The EWC 2002 is a catalogue of all wastes, grouped according to generic industry, process or waste type. It is divided into twenty main chapters, each with a two digit code between 01 and 20. Following the EWC, in our opinion, soils considered as part of this investigation would be categorised within 'Group 17' of the EWC catalogue, which comprises 'Construction and Demolition Wastes (including excavated soils from contaminated sites)'.

11.3.4.2 The Catalogue further categorises the waste, such that soils considered as part of this investigation would be classified as either 17 05 04 defined as '*soil and stones (other than those mentioned in 17 05 03)*'; or 17 05 03* defined as soil or stones containing dangerous substances (where hazardous wastes are described by entries followed by an asterisk).

11.4 Primary classification

11.4.1 Soil types

- 11.4.1.1 Based on soils exposed in exploratory excavations, in combination with anticipated construction works, we assume soils requiring off-site disposal will comprise Made Ground and Alluvium.

11.4.2 Classification as hazardous or non-hazardous waste

- 11.4.2.1 The Environment Agency publication '*Framework for the classification of contaminated soils as hazardous wastes*' (July 2004) provides the following procedure for establishing if the soils are hazardous or non-hazardous. The first stage in classifying a potentially 'contaminated' soil for disposal is to establish its chemical status by first identifying potential sources/types of chemical contamination (desk study) followed by intrusive site investigations to obtain samples for laboratory testing of soil samples to measure concentrations of chemical contaminants.
- 11.4.2.2 An assessment of potential source of contamination is presented in Section 8 of this report. Laboratory testing has been set as deemed appropriate to our source assessment.
- 11.4.2.3 We have carried out an analysis of test data for each chemical contaminant considered in this investigation. A conservative approach has been adopted for the analysis whereby the maximum test value for each contaminant has been adopted as a preliminary screening process to determine if the soils are hazardous or non-hazardous. Should the analysis indicate potentially hazardous properties then a process of zoning by further analysing the site history, geological conditions and analytical data may be undertaken.
- 11.4.2.4 Laboratory test data measures the concentration of anions, which are unlikely to exist in the pure metallic form in the soil, but probably exist as a compound. Following guidance provided in the Environment Agency Technical Guidance WM3 '*Guidance on the classification and assessment of waste*' (2015), we have reviewed a variety of compounds for each of the metallic and semi metallic elements we have tested.
- 11.4.2.5 To determine the hazardous waste properties for each element, we have reviewed chemical compounds listed in Table 3.2 of Annex VI of the European Regulation (1272/2008) for Classification, Labelling and Packaging (CLP) of chemicals which has now superseded the Approved Supply List (Published by the Health and Safety Executive) for the classification of hazardous chemicals in the UK. In order to provide a 'worst case' scenario, initially we adopt the most severe hazardous properties (risk phrases) associated with the various compounds for each element under review. If measured concentrations produce a hazardous outcome then the element or elements are reassessed on a site specific basis. For review of organic contamination, we have directly adopted the threshold concentrations for the appropriate organic compounds listed in Table 3.2.

- 11.4.2.6 The compound or compounds adopted for each element is used to convert the measured metallic concentration to the substance concentration using their respective molecular weights. This derived conversion factor is then used in the threshold concentration spreadsheet (refer paragraph 11.4.2.8 below).
- 11.4.2.7 Our assessment of each of the chemical substances is maintained on our files and is available for confidential review/audit by the Environment Agency.
- 11.4.2.8 A spreadsheet detailing the hazard assessment following the procedures described in *'framework for the classification of contaminated soils as hazardous wastes'* is presented in Appendix J.
- 11.4.2.9 The spreadsheet indicates the soils are **hazardous**, based on HP7, HP11 and HP14. It is likely that this is a consequence of elevated copper, lead and zinc in measured on a soil sample from trial pit TP06 at 0.3m, which was noted as different to other Made Ground types. In addition Total Petroleum Hydrocarbons measured at 2562mg/kg in TP01 at 0.5m, which makes this soil hazardous.
- 11.4.2.10 It is possible that these soils can be zoned by extra testing, thus potentially reducing the quantity of hazardous waste by re-classifying it as non-hazardous.

11.5 Secondary assessment

- 11.5.1 Following *'Guidance on sampling and testing of wastes to meet landfill waste acceptance procedures'* produced by the Environment Agency (Version 1, April 2005) we have scheduled testing of **one** sample to measure the parameters listed in table 5.1 (landfill waste acceptance criteria) included in the above publication. A copy of the test result certificate is presented in Appendix F. The source of the composite sample is detailed below:

Composition of soil samples for classification testing

Strata	Source	Soil Type
Made Ground	DTS05@ 0.5 DTS06@ 0.1 DTS07@ 0.6-0.9 DTS08@ 0.1m	Mixture of fine grained and coarse grained soils including dark brown to brown and white mottled orange, white and dark grey sandy gravelly clay and sandy gravel. With gravels of flint, chalk, timber, brick, concrete, rare pottery, metal plastic, limestone and bituminous coated material.

Table 11.5.1

- 11.5.2 The sample was deemed representative of Made Ground soils as described in Section 5. The sample was formed by combining individual samples taken from exploratory excavations within the Made Ground. The combined sample was then quartered in the laboratory to produce a representative sample for subsequent testing.
- 11.5.3 Laboratory test data has been compared with the landfill waste acceptable criteria (table 5.1) to allow the secondary assessment to be completed. A copy of table 5.1 is presented in Appendix K with test result data added for ease of comparison.

- 11.5.4 Comparison of test data with landfill waste acceptance criteria indicates that Made Ground soils are suitable for disposal as **stable non-reactive hazardous waste in non-hazardous landfill**.

11.6 Naturally deposited soils not affected by artificial contaminants

- 11.6.1 With reference to the European Waste Catalogue and table 5.1 of the Environment Agency publication '*a better place – guidance for waste destined for disposal in landfills – version 2 June 2006*', naturally occurring soils not likely to be affected by contamination can be classified as inert waste, with a EWC code of 17 05 04. Should any of the naturally deposited soils be suspected to contain contamination (by virtue of visual or olfactory evidence) upon excavation, then such soils should be stockpiled appropriately and additional testing carried out as considered necessary. Based on evidence obtained during our investigations, we are of the opinion that the Alluvium at the site are not likely to be affected by chemical contamination and thus can be classified as **inert waste**.

11.7 Basic categorisation

- 11.7.1 Based on the preceding assessment, we have produced **two** basic categorisation schedules relating to the Made Ground and Alluvium, which are presented in Appendix L. This schedule should be provided together with a copy of this report to an appropriately licensed landfill facility to demonstrate the material can be deposited at this facility.
- 11.7.2 We understand that some landfill sites have licences which have restrictions on concentrations of chemical contaminants and thus we recommend this report is provided to the selected landfill facility to confirm (or otherwise) it can accept the waste. Please be aware that landfill sites are obligated to undertake in house quality assurance tests and thus may require further WAC testing for any soils encountered as part of this investigation. There is no obligation on any landfill operator to accept waste if they choose not to and waste operators may require additional testing of untested waste soils prior to acceptance at landfill in accordance with the landfill regulations.

11.8 Treatment of waste

- 11.8.1 Treatment of wastes is now a requirement of the landfill directive applied by the Landfill (England and Wales) Regulations 2002. Landfill cannot accept untreated waste (be it hazardous or non-hazardous), thus waste producers have the choice of treating it themselves on site or treating it elsewhere prior to disposal to landfill. The regulations require:

'10 – (1) The operator of a landfill shall ensure that the landfill is only used for landfilling waste which is subject to prior treatment unless:

a) It is inert waste for which treatment is not technically feasible; or

b) It is waste other than inert waste and treatment would not reduce its quantity or the hazards which it poses to human health or the environment.'

11.8.2 Regulation 2 defines treatment as: *'physical, thermal, chemical or biological processes (including sorting) that change the characteristics of waste in order to reduce its volume or hazardous nature, facilitate its handling or enhance recovery.'*

11.8.3 A treatment option must comply with the definition of treatment. This involves a 'three point test' against which treatment is assessed i.e.

1. It must be a physical, thermal, chemical or biological process including sorting
2. It must change the characteristics of the waste: and
3. It must do so in order to:
 - a) Reduce its volume: or
 - b) Reduce its hazardous nature: or
 - c) Facilitate its handling: or
 - d) Enhance its recovery.

11.8.4 Treatment of inert wastes

11.8.4.1 Inert waste does not need to be treated if it is not technically feasible however treatment should reduce the amount of waste which goes to landfill and enhance its recovery (by re-use or recycling). Inert wastes are often suitable for recycling, for example as an aggregate or an engineering fill material. A fact sheet on treatment of inert wastes is available on the following website www.environment-agency.gov.uk

11.8.4.2 Clearly, excavations in the River Terrace Deposits will generate inert wastes which could be reused on site or off site for bulk filling, subject of course to maintenance of an acceptable water content and provided that it is fit for its intended purpose.

11.8.5 Treatment of non-hazardous waste

11.8.5.1 Guidance and indeed examples of treatment is provided in the Environment Agency publication *'Treatment of non-hazardous wastes for landfill- your waste – your responsibility,'* again available on the EA website.

11.8.6 Landfill operators

11.8.6.1 It is a requirement of the landfill operator to check if the waste soils taken to the facility have been treated.

11.9 Reuse of Soils - Materials Management Plans

- 11.9.1 Where soils are to be moved and reused onsite, or are to be imported to the site, a Waste Exemption or an Environmental Permit is required.
- 11.9.2 An alternative is the use of a Materials Management Plan (MMP) to determine where soils are and are not considered to be a waste. By following '*The Definition of Waste: Development Industry Code of Practice*' published by CL:AIRE (produced in 2008 and revised in March 2011), soils that are suitable for reuse without the need for remediation (either chemical or geotechnical) and have a certainty of use, are not considered to be waste and therefore do not fall under waste regulations. In addition, following this guidance may present an opportunity to transfer suitable material between sites, without the need for Waste Exemptions or Environmental Permits.
- 11.9.3 MMPs offering numerous benefits, including maximising the use of soils onsite, minimising soils going to landfill and reducing costs and time involved in liaising with waste regulators.
- 11.9.4 We can provide further advice on this and provide fees for producing a Materials Management Plan on further instructions.

12 Further investigations

12.1 Further investigations

- 12.1 Based on laboratory results the Made Ground soils at this site have been classified as ***Stable non-reactive hazardous waste in non-hazardous landfill***. However, we consider there is a possibility that further investigations within the Made Ground soils with additional laboratory testing (say a further 15 chemical tests for just copper, lead and zinc in areas located in close proximity to TP06, plus delineating the extent of TPH impacted soils in areas adjacent to TP01) may allow the X50 to be utilised for the Primary Assessment. This has the potential to reduce the waste classification to non-hazardous, which has the potential to reduce to costs of removing soils from site.
- 12.2 We would be please to carry out any required investigations on further instructions.