

HUMBERSIDE MATERIALS LABORATORY LIMITED

Atherton Way

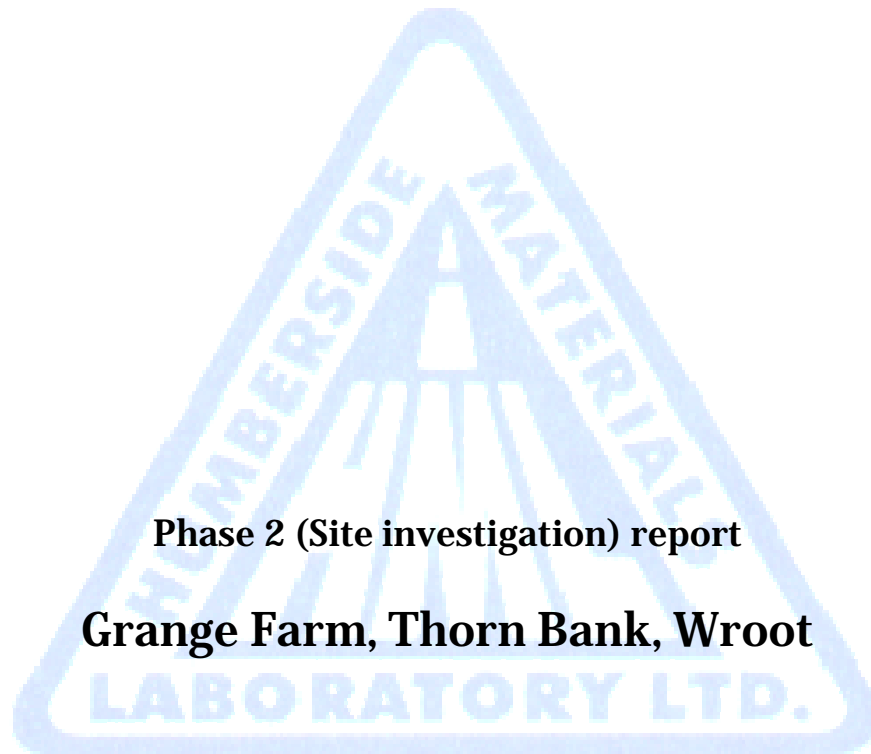
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Phase 2 (Site investigation) report

Grange Farm, Thorn Bank, Wroot

LABORATORY LTD.

Client: Howard J Wroot

Date: June 2018

Report number: 0700/4507/P/P2

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1 Introduction

The client, Mr Wroot, engaged Humberside Materials Laboratory Limited (HML) to undertake a geo-environmental investigation for a proposed development on land at or adjacent to the property at Grange Farm, Thorn Bank, Wroot, North Lincolnshire. The land is hereinafter described as *the site*.

1.1 Aims

The aim of the investigation is to assess relevant geo-environmental aspects of the site in relation to the proposed development works. This includes an evaluation of encountered ground conditions and geotechnical and contamination issues.

1.2 Scope

The scope of the investigation includes:

- Review of available desk-top information
- Intrusive site investigation with windowless sampler boreholes
- Assessment of contamination test results
- Evaluation of geotechnical engineering issues

1.3 Conditions and Limitations

This report is produced solely for the above client(s) and should only be copied in full. When transmitted electronically, the definitive copy of the report is held by Humberside Materials Laboratory Ltd.

This report is prepared on the assumption that all facts have been disclosed.

The comments given in this report and the opinions expressed assume that conditions do not vary beyond the range revealed by this study and the information provided in the production of this report is complete and reliable.

2 Review of desk study information

2.1 Sources of information

The main source of desk study information used is the HML desk study report (HML reference: 0700/4507/P) for the same site, dated March 2018. The desk study report contains various sources of information, including a Landmark Envirocheck report with historical maps.

2.2 Site description and location

2.2.1 Location and size

The site is part of Grange Farm, which is situated off Thorn Bank, to the southeast of the village of Wroot in North Lincolnshire. The site is centred around national grid reference (NGR) 471950 401810.

The site occupies a roughly rectangular-shaped tract of land and is about 32m wide by about 47m long. The total area is about 0.13 hectares.

The proposed site access is via an existing culvert/bridge over South Thorn Bank Drain from Thorn Bank road.

A site location plan is included in Appendix A.

2.2.2 Site features

The site comprises the western end of the farmyard for Grange Farm. The site is essentially an open space with no buildings or other man-made features. The ground surface is mainly bare earth with some patchy gravel hardstanding.

The site appears to have been in general use as a farm produce storage area. At the time of the walkover survey it was being used to store straw bales and there was a stockpile of carrots present.

There is an overhead electricity pole situated close to or within the north corner of the site. This supports three electricity cables that run just inside the site's west boundary.

Views of the site are presented in Appendix A.

2.2.3 Site topography

The site is generally level. The ground level is inferred to be about 0m AOD across the site.

2.2.4 Surrounding land use

The site is within a relatively remote rural area. The site is generally bound by the following:

- **South:** Hedgerow with agricultural land beyond
- **West:** A row of poplar trees with agricultural land beyond
- **East:** Farm yard, which contains a farmhouse and outbuildings
- **North:** South Thorn Bank Drain (land drain) with Thorn Road, North Thorn Bank Drain and open fields beyond.

2.2.5 Local topography

The local topography beyond the site is relatively flat.

2.2.6 Visible evidence of contamination

There is no evidence of any significant contamination at the site. No staining or sheen was noted that might indicate a spillage (e.g. of oil). No unusual odours were identified.

No evidence has been found on-site of fuel/oil /chemical storage at or adjacent to the site. No indications of any above or below ground tanks, drums or liquid containers have been observed.

2.2.7 Proposed development

It is proposed to develop the site by constructing a single low rise property within the site.

Much of the site is expected to contain private gardens. It is assumed that the residential gardens may be used to cultivate homegrown produce for human consumption.

Plans of the proposed works are available from the client.

2.3 Site History

The site has been part of the farmyard to Grange Farm for over 100 years. The site is shown to have been part of the farm since the earliest inspected map, dated 1885.

The site has been undeveloped apart from the northeast corner of the site. This corner of the site is shown to be occupied by part of a collection of farm building in maps dated from 1885 until 2000. However, in maps dated 2006 and more recently, these buildings are no longer shown and the site is empty.

The most recently demolished building in the north east corner of the site is understood to have been used as accommodation for farm workers. Since its removal, occupancy of the site was from a static caravan situated on the farm.

2.4 Geology and hydrogeology

Based on the reviewed desk top information, the anticipated ground conditions are as shown below (in Table 1).

Table 1: Anticipated geology (subject to confirmation)		
<i>Strata</i>	<i>Possible description</i>	<i>Possible depth to base of stratum (m bgl)</i>
Topsoil / hardstanding	Organic soil / compacted gravel	0.1 to 0.5
Made ground	GRAVEL of brick, concrete, tile and timber	0.1 to 1.0
Sutton Sand Formation	Loose silty fine SAND	1.0 to 7.0
Peat	Highly organic CLAY or (fibrous / amorphous) PEAT	Not known
Weathered Sherwood Sandstone	Pinkish red or buff-grey medium-to coarse-grained sand	Not known
Sherwood Sandstone (formerly Bunter Sandstone)	Pinkish red or buff-grey, medium-to coarse-grained (pebbly) friable sandstone	Not known

According to the Coal Authority, the site is not in an area which may be affected by coal mining. Therefore, a coal mining report is not required.

The depth to the groundwater table is unknown.

The anticipated geology is comprised predominantly of silty sands. Therefore, the ground conditions could be of medium permeability. The soils are classed as being of high leaching potential.

The underlying bedrock is a principal aquifer. The site is within a Source Protection Zone (III).

A land drain (South Thorn Bank Drain) about 10m to the north of the site runs east-west along the south side of Thorn Bank. It contained water at the time of the walkover survey, with a water level at circa 2m below adjacent ground levels.

2.5 Waste-related data

There are no reported (*BGS recorded, Historical, Registered or Local authority-recorded*) *landfill sites* near to the site. There are none within 1km.

There are no reported *licensed waste management facilities* near to the site. There are none within 1km.

There is no identified *potentially infilled land* near to the site. The nearest such land is about 775m to the northwest of the site.

There are no reported *waste transfer sites* or *registered waste treatment or disposal sites* near to the site. There are none within 1km.

2.6 Radon

With respect to *Radon potential*, the site is in a Lower probability area with less than 1% of homes above the action level. No radon protection measures are therefore necessary for new developments.

2.7 Industrial land use

The site appears to have been used for agricultural storage for possibly more than 100 years. It is part of Grange Farm's farmyard.

2.8 Contamination assessment

The HML Phase 1 report identified potential contamination linkages associated with ash from burning (e.g. coal combustion) and from asbestos in the near surface ground. The possible contaminants of concern were PAHs, metals and asbestos. The preliminary risks associated with these linkages were assessed to be very low to medium.

3 Site Investigation Works

3.1 Fieldwork

All intrusive SI works took place on Thursday 3rd May 2018.

Three windowless sampler boreholes (BH1, BH2 & BH3) were carried out to explore the ground conditions around the site. One-metre-long samples of the ground material were progressively extracted in plastic tubes. The sample tubes were sealed and returned to the HML laboratory where they were promptly logged and sampled by an engineer.

In-situ testing included SPTs (i.e. standard penetration tests) in BH1 and BH2. These were carried out at metre intervals. The test conditions were such that uncorrected N values should be nearly identical to corrected N_{60} values (e.g. using Bowles, 1996).

The positions of all exploratory holes were established relative to existing site features and using GPS locating equipment. The depths to sub-strata and groundwater were measured from ground level.

The procedures adopted for this site investigation are based on BS 5930 (2015) – Code of Practice for Site Investigations. The soils and rocks encountered have been described with reference to BS5930 (2015), BS EN ISO 14688-1 (2002) and BS EN ISO 14689-1 (2003).

Approximate locations of all site works are shown in the exploratory hole location plan (in Appendix A).

3.2 Laboratory Testing

Geochemical testing was undertaken by Chemtech, a UKAS and MCERTS accredited laboratory. The scope of geochemical testing comprised:

- 3 number tests to identify the presence of asbestos
- 3 number tests on a suite of metals/metalloids
- 1 number test for sulphate and pH (and magnesium and chloride)
- 3 number tests on a suite of speciated PAHs

No testing for TPH (or MTBE/BTEX) was carried out. This was because no visual or olfactory evidence was found of fuel/oil-related contaminants or the potential storage of fuel/oil.

Results for all the testing undertaken are included later in this report (in Appendix C).

4 Encountered Ground Conditions

4.1 Sequence of sub-strata

The encountered ground conditions, as shown in the logs (in Appendix B) for the three boreholes (BH1 to BH3), were generally as expected and agreed with the anticipated site geology. A summary is shown below (in Table 2).

Table 2: Summary of encountered ground conditions (during site works)				
<i>Stratum</i>	<i>General description</i>	<i>Locations encountered</i>	<i>Depth to base of stratum (m bgl)</i>	
			<i>Min.</i>	<i>Max.</i>
TOPSOIL	Dark brown silty SAND with occasional rootlets and rare fine gravel brick fragments	All three BHs	0.24	0.4
SUTTON SAND FORMATION	Grey or brown slightly silty fine to medium SAND (with occasional gravel)	All three boreholes	>3.5	>3.5
Notes: BHs all collapsed in at about 2.4m-2.5m bgl, after withdrawal of steel tubing				

The ground conditions were found to be relatively uniform. Similar ground conditions were found in all three boreholes.

4.2 Topsoil

A thin layer of topsoil appears to be present across most of the site. It was found in all three boreholes to depths ranging between 0.24m (BH3) and 0.4m (BH2) bgl.

The topsoil was revealed as a dark brown silty SAND with occasional rootlets. Rare fine-gravel-sized brick fragments were recorded in BH3, but this could easily have migrated down from the surface and no other indication of made ground was noted.

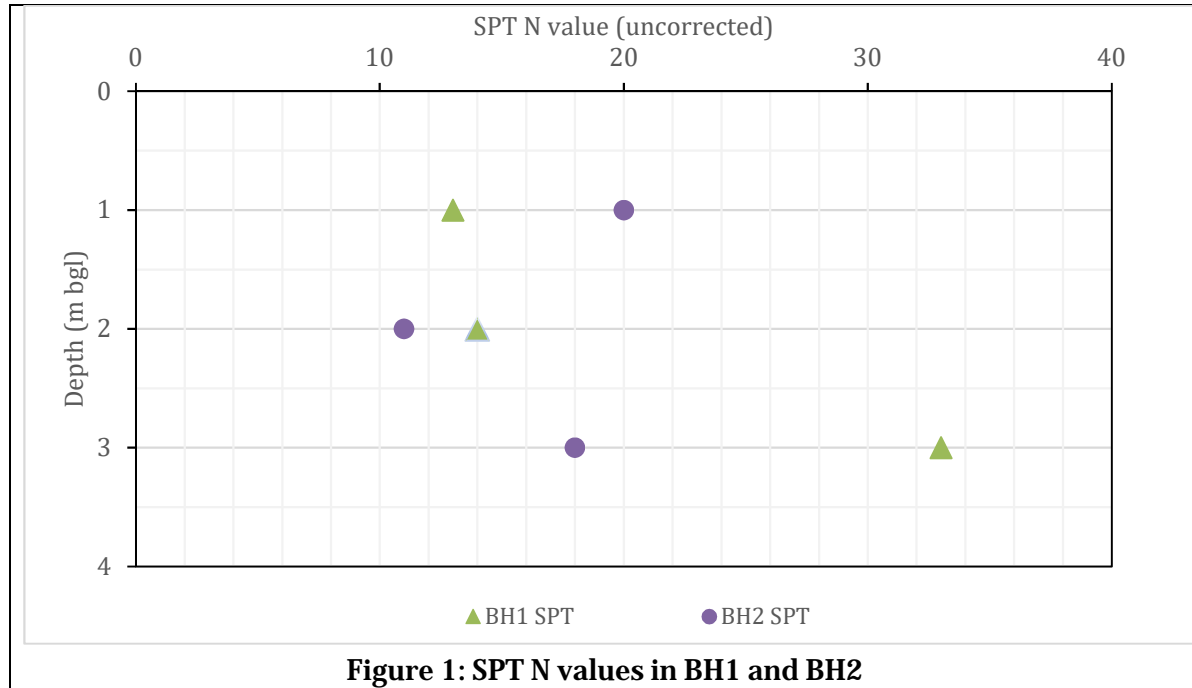
No olfactory or visual evidence of contamination was noted, including TPH contamination. No hydrocarbon odour or staining was reported. No indication of potential fuel storage (e.g. below ground tanks) was identified. Therefore, no TPH testing was scheduled.

4.3 Sutton Sand (Formation)

The Sutton Sand Formation was revealed across the site. It was encountered down to the full depth of exploration (3.5m bgl) in all three boreholes.

The Sutton Sand was revealed consistently as a (slightly silty) fine to medium SAND. The colour varied between (light) brown and (light) grey, generally becoming browner with depth.

The relative density of the Sutton Sand was found to be medium dense. The results of SPTs (from 1.0m to 3.45m bgl) revealed uncorrected N values ranging from 11 to 33 blows, as shown below (in Figure 1). The SPT N values generally remained relatively consistent with depth. At shallow depths (<1.0m bgl), the sand could be loose to medium dense.



Based on the SPT results and the log descriptions, at depths of at least 1.0m bgl, the Sutton Sand is expected to have an angle of friction of between 30 and 36 degrees. The density index is likely to range from 35% to 65%.

4.4 Groundwater observations

Groundwater was observed during the drilling of each of the three boreholes (BH1, BH2 & BH3). Groundwater strikes were recorded at depths of between 2.4m and 2.5m bgl. No groundwater was observed at shallower depths. Therefore, the groundwater table is anticipated at a depth of about 2.4m-2.5m bgl, although this might vary with (seasonal) weather changes.

4.5 Geochemical properties

The results of geochemical testing are presented later (in Appendix C). An assessment of the results is provided later (in following sections of this report).

5 Analysis of contamination data

5.1 Assessment criteria

Based on the anticipated development proposals for the site, the contaminated land assessment scenarios considered is *residential with homegrown produce land use* (i.e. residential with plant uptake).

The assessment criteria (in mg/kg) for soil, as presented later (in Appendix D) have been taken from the *generic assessment criteria* (GAC) published in the *Land Quality Management Ltd/Chartered Institute of Environmental Health suitable for use levels* (LQM/CIEH S4ULs) report (LQM/CIEH, 2015). The exception to this is the GAC for lead which is taken from the provisional Category 4 Screening Level (C4SL) data published in a report by Defra (2014). It is further acknowledged that lead is a non-threshold chemical and so should be *as low as reasonably practicable* (ALARP).

5.2 Soil contamination

Three samples of shallow soil (one sample from each hole: BH1, BH2 & BH3) were tested for soil contamination, which included (1) a suite of metals and metalloids (2) a suite of speciated PAHs and (3) the presence of asbestos fibres. The samples were taken from depths of between 0.1m and 0.3m bgl. Therefore, the sampled soil was predominantly of topsoil.

5.2.1 Metals and metalloids

There were no clear exceedances of any GAC for metals. The measured concentrations of total chromium (of 36mg/kg – 50mg/kg) were above the GAC for Chromium VI (at 9mg/kg) but it is considered implausible that the percentage of chromium VI could be as high as 18% of total chromium in such a site, with no history of major industry nearby. The measured concentration of lead ranged from 20 to 28mg/kg, which is far below the GAC (of 82-210mg/kg) and easily below the upper limit of the estimated rural background concentration of <100mg/kg.

5.2.2 Polycyclic aromatic hydrocarbons (PAHs)

There were no exceedances in any of the species of PAH tested. Nearly all the tested species of PAHs were detected as present in each of the three borehole samples, but the measured concentrations were all far below the relevant GAC. Benzo(a)pyrene concentrations of 0.39mg/kg to 0.52mg/kg were detected, which are well below the GAC of 2.2mg/kg and below the surrogate marker threshold value of 0.79mg/kg.

5.2.3 *Asbestos*

No asbestos was detected in any of the three samples tested.

5.3 **Aggressivity of ground to buried concrete**

The results of sulphate (SO₄) and pH tests as well as magnesium, chloride, nitrate and nitrite analyses (included in Appendix C) provide information relevant to the durability of buried concrete within the ground conditions at the site. These results can be used to design buried concrete, for example, in accordance with BRE Special Digest 1 (BRE, 2005).

The results revealed a low quantity of water-soluble sulphate of 12mg/l, and a total sulphate of 0.0322% in a sample of the Sutton Sand (from BH1 at 0.3m-1.0m bgl). A pH level of 7.6 was reported. Therefore, the classification for buried concrete should be DS-1 and AC-1s, based on BRE (2005).

5.4 **Summary**

- No elevated levels of PAHs have been identified, although concentrations of nearly all species have been detected as present.
- No elevated levels of metal or metalloid GAC have been identified, including lead and arsenic.
- No asbestos has been detected in any of the three near surface samples tested.
- The classification for buried concrete should be DS-1 and AC-1s, based on BRE guidance (BRE, 2005) and the results of tests on a sample of the Sutton Sand.

6 Revised Contamination Assessment

6.1 Revised conceptual site model (CSM)

Based on the initial CSM and preliminary RA from the Phase 1 report, and analysis of the contamination test data, a revised CSM has been developed, as shown below (in Table 3). This presents potential relevant contamination linkages, which are those linkages that might possibly pose more than a *low* or *very low* risk to receptors.

Table 3: Revised Conceptual Site Model				
Source, S		Pathway, P		Receptor, R
Source type/area	Contaminant	Route	Sub-route	
none	none	Ingestion	Soils	Workers, future occupants
			Indoor dust	
		Outdoor dust	Workers, future occupants	
		Root uptake		
		In water supply	Workers, future occupants	
		Absorption		Dermal contact
Inhalation	Workers, future occupants	Indoor dust	Workers, future occupants	
		Outdoor dust		
Leachate migration	Surface water, bedrock aquifer, ecology, adjacent site users	Vertically in unsaturated zone	Building materials & services	
		Laterally in saturated zone		
Along services	Future occupants, building materials			
Gas migration		Through pores and fissures		
Along services	Future occupants, building materials,			
Aggressive attack		Permeation of material		
		Chemical reaction		
Not applicable:				
Item		Rationale		
S: asbestos (e.g. from previously removed structures)		No asbestos identified in near surface soil samples		
S: PAHs and metals (from combustion products, e.g. ash)		No elevated levels of metals or PAHs detected. No ash noted in borehole logs.		

Accordingly, the revised risk assessment yields no significant contamination risks as the conceptual site model has not identified any potentially significant contamination linkages at the site. Therefore, no remediation works are anticipated.

Nevertheless, any unforeseen contamination encountered during the development of the site should be reported to the local authority. Work should be halted in any area of the revealed potential contamination and the contamination investigated/assessed to the satisfaction of the local authority.

7 Engineering Issues

7.1 Foundations

The Sutton Sand Formation revealed on site should provide a suitable bearing stratum for proposed low-rise buildings. This stratum has been proven by three boreholes (BH1 – BH3) to a depth of (at least) 3.5m bgl.

Traditional shallow foundations (i.e. strip or pad footings) at formation depths of 0.45m to 1.0m bgl in loose to medium dense sand of the Sutton Sand Formation should be able to provide an allowable bearing pressure of at least 50kPa. At depths of 1.0m to 1.5m bgl, in the medium dense sand, allowable bearing pressures of at least 150kPa should be available.

The anticipated presence of peat at depth below the site (possibly as shallow as 3.5m bgl) means that wide footings (e.g. greater than 750mm) and raft solutions might not be suitable at the site. Such footings have a larger zone of influence and could cause consolidation of the suspected underlying peat. Similarly, deeper foundation solutions (e.g. piling or deep trench fill) might also be inappropriate.

All foundations should be designed by a competent engineer with consideration to all factors and the information within this report.

7.2 Buried concrete

As discussed, the results of pH and sulphate tests on sample of the Sutton Sand (from BH1 at 0.3m-1.0m bgl) indicate the classification for buried concrete should be DS-1 and AC-1s, based on BRE (2005).

7.3 Excavations and groundwater control

Conventional earth moving plant should be able to readily excavate the ground material on site. Shallow excavations (down to depths of about 1.2m bgl) could retain steep sides. However, appropriate shoring/battering should be used where appropriate (e.g. as per Irvine and Smith, 1992).

The results of borehole drilling indicate the groundwater table is likely to be about 2.4m-2.5m bgl, although this could vary with seasonal changes. Therefore, shallow excavations could remain relatively dry.

7.4 Radon

With respect to *radon potential*, the site is in a lower probability area with less than 1% of homes above the action level. No radon protection measures are therefore necessary for new homes.

7.5 Gas protection measures

No significant sources of hazardous ground gas such as nearby landfills or former mine workings have been identified near the site. Nevertheless, the site appears to be adjacent to and probably overlies a broad deposit of peat, which has the potential to produce some methane and carbon dioxide, albeit in limited quantities.

RB17, The Pragmatic Approach to Ground Gas Assessment by CL:AIRE, (Card et al., 2012) indicates that a CIRIA C665 (Wilson et al., 2007) classification of CS2 (i.e. Characteristic Situation 2) is appropriate where natural sources such as peat and alluvium are present. CS2 gas protection measures can be provided in several ways, for example, a gas resistant membrane can be combined with basic underfloor ventilation, as detailed in BS8485 (2015) and CIRIA C665.

8 Summary and Conclusions

8.1 Ground conditions

The borehole logs (in Appendix B) indicate the following general sequence of sub-strata at the site (in descending order).

- TOPSOIL: Dark brown silty SAND with occasional rootlets (and occasional fine-gravel-sized brick fragments). *[to depths of 0.24-0.4m bgl]*
- SUTTON SAND FORMATION: Medium dense (light) grey or (light) brown (slightly) silty fine to medium SAND. *[to depths of >3.5m bgl]*

8.2 Geotechnical properties

The anticipated geotechnical properties of the sand of the Sutton Sand Formation are summarised below (in Table 4). These are based on engineering evaluations and estimations and the results of testing, as described previously.

Depth (m bgl)	SPTs	Relative density	Density index (%)	Drained / Effective friction angle (°)
<1.0	-	(Loose or medium dense)*	(15 – 65)*	(28 – 36)*
1.0 – 3.5	11 – 33	Medium dense	35 – 65	30 – 36

* estimated possible values only, not based on test results

8.3 Foundations

The Sutton Sand Formation revealed on site should provide a suitable bearing stratum for proposed low-rise buildings. Traditional shallow foundations (i.e. strip or pad footings) at formation depths of 0.45m to 1.0m bgl in loose to medium dense sand should be able to provide an allowable bearing pressure of at least 50kPa. At depths of 1.0m to 1.5m bgl, in the medium dense sand, allowable bearing pressures of at least 150kPa should be available.

The anticipated presence of peat at depth below the site (possibly as shallow as 3.5m bgl) means that wide footings (e.g. greater than 750mm) such as rafts and deeper foundations (e.g. piling or deep trench fill) might not be suitable at the site.

All foundations should be designed by a competent engineer with consideration to all factors and the information within this report.

8.4 Excavations and groundwater

Groundwater strikes were recorded in BH1 – BH3 at depths of between 2.4m and 2.5m bgl. No groundwater was observed at shallower depths, so shallow excavations (e.g. to 1.5m bgl) could remain dry.

8.5 Gas protection measures

RB17, The Pragmatic Approach to Ground Gas Assessment by CL:AIRE, (Card et al., 2012) indicates that a CIRIA C665 (Wilson et al., 2007) classification of CS2 (i.e. Characteristic Situation 2) is appropriate due to the presence of deep peat deposits. CS2 protection measures can be provided by combining a gas resistant membrane with basic underfloor ventilation, as detailed in BS8485 (2015).

8.6 Radon

With respect to *radon potential*, the site is in a lower probability area with less than 1% of homes above the action level. No radon protection measures are therefore necessary for new homes.

8.7 Buried concrete

The classification for buried concrete should be DS-1 and AC-1s, based on BRE guidance (BRE, 2005) and the results of tests.

8.8 Contamination test data

No elevated levels of PAHs have been identified, although concentrations of nearly all tested species have been detected.

No elevated levels of metals or metalloids have been identified, including lead and arsenic.

No asbestos has been detected in the three near surface samples tested.

8.9 Contamination risk assessment

The revised conceptual site model and risk assessment yield no potentially significant contamination linkages at the site. Therefore, no remediation works are anticipated.

Nevertheless, any unforeseen contamination encountered during the development of the site should be reported to the local authority. Work should be halted in any area of

the revealed potential contamination and the contamination investigated/assessed to the satisfaction of the local authority.

R M Lester MEng MSc

M J Green IEng FIHIE

9 References

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Appendix A



Site location



Aerial view of site (north is up page)



SITE PLAN - BOREHOLE / TRIAL PIT LOCATIONS



Humberside Materials Laboratory Ltd
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CLIENT :- H J Wroot

SITE :- Grange Farm, Wroot



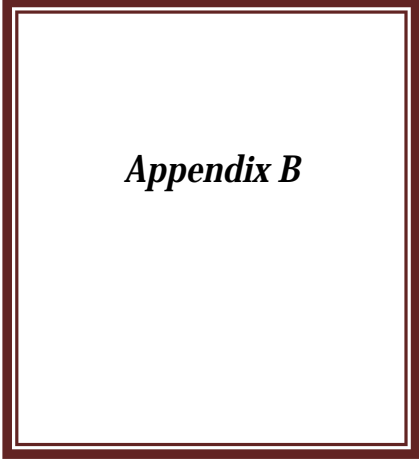
The site entrance seen from Thorn Bank road (view towards southeast)



The site (view towards southeast)



The site (view towards southeast)



Appendix B



HUMBERSIDE MATERIALS LABATORY Ltd.

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BOREHOLE LOG

**Borehole
No
BH3**

Client :- H J Wroot
Site :- Grange Farm, Wroot
Project No :- 4507

Location :- see site plan
Date :- 03-May-18

Coordinates E: 471961 N: 401814
Elevation :-
Excavated by :- Dando Terrier
Drilled by :- DD & SP

Depth (m)	Lithology / Description / Depth (m)	Elevation	Thickness (m)	Samples	Water level & well	SPT		SHDCP		Notes
						0	10	20	30	
0	Dark brown silty SAND with occasional rootlets and rare fine-gravel of brick fragments. (TOPSOIL)	0	0.24	1 D						
0.2										
0.4	Grey slightly silty fine to medium SAND. Becoming brown mottled grey at 0.33m bgl. Becoming brown at 0.9m bgl. (SUTTON SAND FORMATION)	0.4		2 D						
0.6										
0.8										
1.0	SUTTON SAND FORMATION	1.0		3 D						
1.2										
1.4										
1.6										
1.8										
2.0										
2.2										
2.4										
2.6										
2.8										
3.0	3.5	3.0								
3.2										
3.4		3.4								
3.6										
3.8										
4.0										

Sample Key
B Bulk
D Disturbed
W Water
SS Split spoon
U undisturbed
DCP SHDCP
HV Hand Vane

Notes :- Borehole collapsed in to 2.5m bgl after removal of steel tubing

Depth drilled :-3.5
Casing depth :-

File Ref :- 700/ 4507
Logged by :- D Driver



HUMBERSIDE MATERIALS LABATORY Ltd.

Atherton Way, Brigg
North Lincs DN20 8AR
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BOREHOLE LOG

**Borehole
No
BH2**

Client :- H J Wroot
Site :- Grange Farm, Wroot
Project No :- 4507

Location :- see site plan
Date :- 03-May-18

Coordinates E: 471951 N: 401806
Elevation :-
Excavated by :- Dando Terrier
Drilled by :- DD & SP

Depth (m)	Lithology / Description / Depth (m)	Elevation	Thickness (m)	Samples	Water level & well	SPT		SH DCP		Notes	
						0	10	20	30		40
0	Dark brown silty SAND with occasional rootlets. (TOPSOIL)	0									
0.2		0.2		1 D							
0.4		0.4									
0.6	Medium dense light grey slightly silty fine to medium SAND. Becoming greyish brown at 0.65m bgl. Becoming brown at 1.0m bgl. (SUTTON SAND FORMATION)	0.6		2 D							
0.8		0.8									
1.0		1.0					20				SPT at 1.0m: 3,4,5,5,5,5
1.2		1.2									
1.4		1.4		3 D							
1.6		1.6									
1.8		1.8									
2.0	Medium dense brown silty fine SAND. (SUTTON SAND FORMATION)	2.0					11				SPT at 2.0m: 3,3,3,2,3,3
2.2		2.2									
2.4		2.4									
2.6		2.6									
2.8		2.8									
3.0		3.0					18				SPT at 3.0m: 3,3,3,3,6,6
3.2		3.2									
3.4		3.4									
3.6		3.6									
3.8		3.8									

Sample Key
B Bulk
D Disturbed
W Water
SS Split spoon
U undisturbed
DCP SHDCP
HV Hand Vane

Notes :- Borehole collapsed in to 2.4m bgl after removal of steel tubing

Depth drilled :-3.5
Casing depth :-

File Ref :- 700/ 4507
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BOREHOLE LOG

**Borehole
No
BH1**

Client :- H J Wroot
Site :- Grange Farm, Wroot
Project No :- 4507

Location :- see site plan
Date :- 03-May-18

Coordinates E: 471947 N: 401819
Elevation :-
Excavated by :- Dando Terrier
Drilled by :- DD & SP

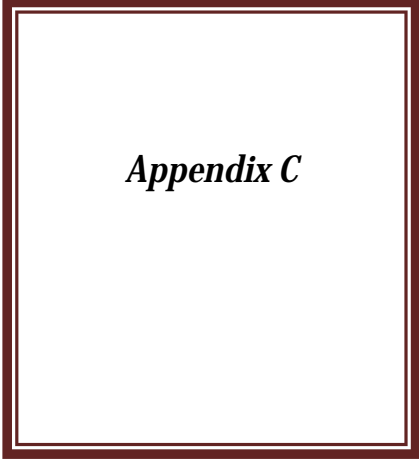
Depth (m)	Lithology / Description / Depth (m)	Elevation	Thickness (m)	Samples	Water level & well	SPT		SH DCP		Notes	
						0	10	20	30		40
0	Dark brown silty SAND with occasional rootlets. (TOPSOIL)	0									
0.2		0.25		1 D							
0.4	Light greyish brown slightly silty fine to medium SAND. (SUTTON SAND FORMATION) Medium dense light brown fine to medium SAND. (SUTTON SAND FORMATION)	0.38									
0.6		0.6		2 D							
0.8		0.8									
1.0		1.0					13				SPT at 1.0m: 2,3,3,4,3,3
1.2		1.2									
1.4		1.4		3 D							
1.6		1.6									
1.8		1.8									
2.0		2.0					14				SPT at 2.0m: 4,3,3,3,4,4
2.2		2.2									
2.4		2.4			strike						
2.6		2.6									
2.8		2.8									
3.0		3.0					33				SPT at 3.0m: 6,7,8,7,9,9
3.2		3.2									
3.4		3.4									
3.5		3.5									
3.6		3.6									
3.8		3.8									

Sample Key
B Bulk
D Disturbed
W Water
SS Split spoon
U undisturbed
DCP SHDCP
HV Hand Vane

Notes :- Borehole collapsed in to 2.4m bgl after removal of steel tubing

Depth drilled :-3.5
Casing depth :-

File Ref :- 700/ 4507
Logged by :- D Driver



Appendix C



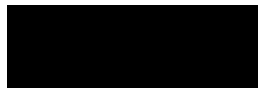
ANALYTICAL TEST REPORT

Contract no: 71662
Contract name: Wroot Grange Farm, Wroot
Client reference: 0700/4507/P
Clients name: Humberside Materials Laboratory
Clients address: Atherton Way
Brigg
North Lincolnshire
DN20 8AR
Samples received: 08 May 2018
Analysis started: 08 May 2018
Analysis completed: 15 May 2018
Report issued: 15 May 2018

Notes: Opinions and interpretations expressed herein are outside the UKAS accreditation scope. Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling. Methods, procedures and performance data are available on request. Results reported herein relate only to the material supplied to the laboratory. This report shall not be reproduced except in full, without prior written approval. Samples will be disposed of 6 weeks from initial receipt unless otherwise instructed.

Key: U UKAS accredited test
M MCERTS & UKAS accredited test
\$ Test carried out by an approved subcontractor
I/S Insufficient sample to carry out test
N/S Sample not suitable for testing

Approved by:



Dave Bowerbank
Customer Services Co-ordinator

Chemtech Environmental Limited

SAMPLE INFORMATION

MCERTS (Soils):

Soil descriptions are only intended to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions. MCERTS accreditation applies for sand, clay and loam/topsoil, or combinations of these whether these are derived from naturally occurring soils or from made ground, as long as these materials constitute the major part of the sample. Other materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

All results are reported on a dry basis. Samples dried at no more than 30°C in a drying cabinet.
Analytical results are inclusive of stones.

Lab ref	Sample id	Depth (m)	Sample description	Material removed	% Removed	% Moisture
71662-1	B/48589 BH1-1	0.10-0.30	Sand	-	-	15.2
71662-2	B/48590 BH2-1	0.10-0.30	Sand	-	-	19.9
71662-3	B/48591 BH3-1	0.10-0.30	Sand	-	-	14.0
71662-4	B/48592 BH1-2	0.30-1.00	Sand	-	-	4.7

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SOILS

Lab number			71662-1	71662-2	71662-3	71662-4
Sample id			B/48589	B/48590	B/48591	B/48592
Depth (m)			BH1-1	BH2-1	BH3-1	BH1-2
Date sampled			0.10-0.30	0.10-0.30	0.10-0.30	0.30-1.00
			03/05/2018	03/05/2018	03/05/2018	03/05/2018
Test	Method	Units				
Arsenic (total)	CE127 ^M	mg/kg As	7.1	5.8	5.8	-
Cadmium (total)	CE127 ^M	mg/kg Cd	<0.2	<0.2	<0.2	-
Chromium (total)	CE127 ^M	mg/kg Cr	47	36	50	-
Copper (total)	CE127 ^M	mg/kg Cu	9.7	7.0	9.0	-
Lead (total)	CE127 ^M	mg/kg Pb	22	20	28	-
Mercury (total)	CE127 ^M	mg/kg Hg	<0.5	<0.5	<0.5	-
Nickel (total)	CE127 ^M	mg/kg Ni	5.7	3.7	3.9	-
Selenium (total)	CE127 ^M	mg/kg Se	0.3	<0.3	0.3	-
Vanadium (total)	CE127 ^M	mg/kg V	13	7.5	9.3	-
Zinc (total)	CE127 ^M	mg/kg Zn	38	36	36	-
pH	CE004 ^M	units	-	-	-	7.6
Magnesium (2:1 water soluble)	CE061	mg/l Mg	-	-	-	2.3
Chloride (2:1 water soluble)	CE049 ^U	mg/l Cl	-	-	-	15
Nitrate (2:1 water soluble)	CE049 ^U	mg/l NO ₃	-	-	-	6.7
Nitrite (2:1 water soluble)	CE049	mg/l NO ₂	-	-	-	<1
Sulphate (2:1 water soluble)	CE061 ^M	mg/l SO ₄	-	-	-	12
Sulphate (total)	CE062 ^M	mg/kg SO ₄	-	-	-	185
Sulphur (total)	CE127	mg/kg S	-	-	-	<100
PAH						
Naphthalene	CE087 ^M	mg/kg	0.06	0.04	0.04	-
Acenaphthylene	CE087 ^M	mg/kg	<0.01	<0.01	<0.01	-
Acenaphthene	CE087 ^M	mg/kg	0.09	0.04	0.05	-
Fluorene	CE087 ^U	mg/kg	0.07	0.04	0.03	-
Phenanthrene	CE087 ^M	mg/kg	0.82	0.42	0.54	-
Anthracene	CE087 ^U	mg/kg	0.30	0.19	0.19	-
Fluoranthene	CE087 ^M	mg/kg	1.20	0.61	0.83	-
Pyrene	CE087 ^M	mg/kg	1.09	0.58	0.75	-
Benzo(a)anthracene	CE087 ^U	mg/kg	0.58	0.30	0.40	-
Chrysene	CE087 ^M	mg/kg	0.55	0.30	0.38	-
Benzo(b)fluoranthene	CE087 ^M	mg/kg	0.63	0.38	0.45	-
Benzo(k)fluoranthene	CE087 ^M	mg/kg	0.31	0.15	0.17	-
Benzo(a)pyrene	CE087 ^U	mg/kg	0.52	0.28	0.39	-
Indeno(123cd)pyrene	CE087 ^M	mg/kg	0.32	0.16	0.22	-
Dibenz(ah)anthracene	CE087 ^M	mg/kg	0.09	<0.02	<0.02	-
Benzo(ghi)perylene	CE087 ^M	mg/kg	0.35	0.19	0.25	-
PAH (total of USEPA 16)	CE087	mg/kg	6.97	3.71	4.69	-
Subcontracted analysis						
Asbestos (qualitative)	\$	-	NAD	NAD	NAD	-

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METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE127	Arsenic (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg As
CE127	Cadmium (total)	Aqua regia digest, ICP-MS	Dry	M	0.2	mg/kg Cd
CE127	Chromium (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Cr
CE127	Copper (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Cu
CE127	Lead (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Pb
CE127	Mercury (total)	Aqua regia digest, ICP-MS	Dry	M	0.5	mg/kg Hg
CE127	Nickel (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Ni
CE127	Selenium (total)	Aqua regia digest, ICP-MS	Dry	M	0.3	mg/kg Se
CE127	Vanadium (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg V
CE127	Zinc (total)	Aqua regia digest, ICP-MS	Dry	M	5	mg/kg Zn
CE004	pH	Based on BS 1377, pH Meter	Wet	M	-	units
CE061	Magnesium (2:1 water soluble)	Aqueous extraction, ICP-OES	Dry		1	mg/l Mg
CE049	Chloride (2:1 water soluble)	Aqueous extraction, IC-COND	Dry	U	1	mg/l Cl
CE049	Nitrate (2:1 water soluble)	Aqueous extraction, IC-COND	Dry	U	1	mg/l NO ₃
CE049	Nitrite (2:1 water soluble)	Aqueous extraction, IC-COND	Dry		1	mg/l NO ₂
CE049	Sulphate (2:1 water soluble)	Aqueous extraction, IC-COND	Dry	U	10	mg/l SO ₄
CE062	Sulphate (total)	Acid extraction, ICP-OES	Dry	M	100	mg/kg SO ₄
CE127	Sulphur (total)	Acid extraction, ICP-MS	Dry		100	mg/kg S
CE087	Naphthalene	Solvent extraction, GC-MS	Wet	M	0.01	mg/kg
CE087	Acenaphthylene	Solvent extraction, GC-MS	Wet	M	0.01	mg/kg
CE087	Acenaphthene	Solvent extraction, GC-MS	Wet	M	0.01	mg/kg
CE087	Fluorene	Solvent extraction, GC-MS	Wet	U	0.01	mg/kg
CE087	Phenanthrene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Anthracene	Solvent extraction, GC-MS	Wet	U	0.02	mg/kg
CE087	Fluoranthene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Pyrene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Benzo(a)anthracene	Solvent extraction, GC-MS	Wet	U	0.02	mg/kg
CE087	Chrysene	Solvent extraction, GC-MS	Wet	M	0.01	mg/kg
CE087	Benzo(b)fluoranthene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Benzo(k)fluoranthene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Benzo(a)pyrene	Solvent extraction, GC-MS	Wet	U	0.02	mg/kg
CE087	Indeno(123cd)pyrene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Dibenz(ah)anthracene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Benzo(ghi)perylene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	PAH (total of USEPA 16)	Solvent extraction, GC-MS	Wet		0.27	mg/kg
\$	Asbestos (qualitative)	HSG 248, Microscopy	Dry	U	-	-

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DEVIATING SAMPLE INFORMATION

Comments

Sample deviation is determined in accordance with the UKAS note "Guidance on Deviating Samples" and based on reference standards and laboratory trials.

For samples identified as deviating, test result(s) may be compromised and may not be representative of the sample at the time of sampling.

Chemtech Environmental Ltd cannot be held responsible for the integrity of sample(s) received if Chemtech Environmental Ltd did not undertake the sampling. Such samples may be deviating.

Key

N	No (not deviating sample)
Y	Yes (deviating sample)
NSD	Sampling date not provided
NST	Sampling time not provided (waters only)
EHT	Sample exceeded holding time(s)
IC	Sample not received in appropriate containers
HP	Headspace present in sample container
NCF	Sample not chemically fixed (where appropriate)
IT	Sample not cooled
OR	Other (specify)

Lab ref	Sample id	Depth (m)	Deviating	Tests (Reason for deviation)
71662-1	B/48589 BH1- 1	0.10-0.30	N	
71662-2	B/48590 BH2- 1	0.10-0.30	N	
71662-3	B/48591 BH3- 1	0.10-0.30	N	
71662-4	B/48592 BH1- 2	0.30-1.00	N	

Appendix D

Generic Assessment Criteria (GAC)

Soil contamination

Table: Generic assessment criteria for metals			
Element	Residential <i>with</i> homegrown produce land-use* (mg/kg)	Residential <i>without</i> homegrown produce land-use* (mg/kg)	Commercial
Arsenic	37	40	640
Cadmium	11	85	190
Chromium III	910	910	8600
Chromium VI	6	6	33
Copper	2400	7100	68000
Lead	82-210	130 - 330	1100 - 6000
Mercury element	1.2	1.2	58 (25.8)
Mercury inorganic	40	56	1100
Mercury methyl	11	15	320
Nickel	130	180	980
Selenium	250	430	12000
Vanadium	410	1200	9000
Zinc	3700	40000	730000
* from LQM/CIEH (2015) except lead			
** from Defra (2014)			
() solubility or vapour saturation limits			

Table: Soil GACs for PAH									
Element	Residential with homegrown produce land-use			Residential without homegrown produce land-use			Commercial		
	SOM			SOM			SOM		
	1%	2.5%	6%	1%	2.5%	6%	1%	2.5%	6%
Acenaphthene	210	510	1100	3000 (57)	4000 (141)	6000 (336)	84000 (57)	97000 (141)	100000
Acenaphthylene	170	420	920	2900 (86.1)	4600 (212)	6000 (336)	83000 (86.1)	97000 (212)	100000
Anthracene	2400	5400	11000	31000 (1.17)	35000	37000	520000	540000	540000
Benzo(a)anthracene	7.2	11	13	11	14	15	170	170	180
Benzo(a)pyrene	2.2	2.7	3	3.2	3.2	3.2	35	35	36
Benzo(b)fluoranthene	2.6	3.3	3.7	3.9	4	4	44	44	45
Benzo(k)fluoranthene	77	93	100	110	110	110	1200	1200	1200
Benzo(ghi)perylene	320	340	350	360	360	360	3900	4000	4000
Chrysene	15	22	27	30	31	32	350	350	350
Dibenzo(ah)anthracene	0.24	0.28	0.3	0.31	0.32	0.32	3.5	3.6	3.6
Fluoranthene	280	560	890	1500	1600	1600	23000	23000	23000
Fluorene	170	400	860	2800 (30.9)	3800 (76.5)	4500 (183)	63000 (30.9)	68000	71000
Indeno(123-cd) pyrene	27	36	41	45	46	46	500	510	510
Naphthalene	2.3	5.6	13	2.3	5.6	13	190 (76.4)	460 (183)	1100 (432)
Phenanthrene	95	220	440	1300 (36.0)	1500	1500	22000	22000	23000
Pyrene	620	1200	2000	3700	3800	3800	54000	54000	54000
BaP as Surrogate marker	0.79	0.98	1.1	1.2	1.2	1.2	15	15	15

Table: Soil GACs for TPH									
Element	Residential with homegrown produce land-use			Residential without homegrown produce land-use			Commercial		
	SOM			SOM			SOM		
	1%	2.5%	6%	1%	2.5%	6%	1%	2.5%	6%
Aliphatic EC5-6	42	78	160	42	78	168	3200 (304)	5900 (558)	12000 (1150)
Aliphatic >EC6-8	100	230	530	100	230	530	7800 (144)	17000 (322)	40000 (736)
Aliphatic >EC8-10	27	65	150	27	65	150	2000 (78)	4800 (190)	11000 (451)
Aliphatic >EC10-12	130(48)	330 (118)	760 (283)	130 (48)	330 (118)	770 (283)	9700 (48)	23000 (118)	47000 (283)
Aliphatic >EC12-16	1100(24)	2400 (59)	4300 (142)	1100 (24)	2400 (59)	4400 (142)	59000 (24)	82000 (59)	90000 (142)
Aliphatic >EC16-35	65000(8.5)	92000 (21)	110000	65000 (8.48)	92000 (21)	110000	160000 0	170000 0	180000 0
Aliphatic >EC35-44	65000(8.5)	92000 (21)	110000	65000 (8.48)	92000 (21)	110000			
Aromatic EC5-7	70	140	300	370	690	1400	26000 (1220)	46000 (2260)	86000 (4710)
Aromatic >EC7-8	130	290	660	860	1800	3900	56000 (869)	110000 (1920)	180000 (4360)
Aromatic >EC8-10	34	83	190	47	110	270	3500 (613)	8100 (1500)	17000 (3580)
Aromatic >EC10-12	74	180	380	250	590	1200	16000 (364)	28000 (899)	34000 (2150)
Aromatic >EC12-16	140	330	660	1800	2300	2500	36000 (169)	37000	38000
Aromatic >EC16-21	260	540	930	1900	1900	1900	28000	28000	28000
Aromatic >EC21-35	1100	1500	1700	1900	1900	1900	28000	28000	28000
Aromatic >EC35-44	1100	1500	1700	1900	1900	1900	28000	28000	28000

Table: GAC for petroleum hydrocarbons in soil			
PH	Residential without homegrown produce land-use (mg/kg)		
	SOM of 1%	SOM of 2.5%	SOM of 6%
Benzene	0.38	0.7	1.4
Toluene	880	1900	3900
Ethylbenzene	83	190	440
o-xylene	88	210	480
m-xylene	82	190	450
p-xylene	79	180	430
phenol	760 (31000)	1500 (35000)	3200 (37000)