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Sanctuary Group

Althorne Way, Canewdon

Phase II Geo-environmental Assessment Report

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Document Control Sheet

Revision No	Date	Status	Changes	Author	Approved
0	10 October 2012	Final	-	SMC	DJG
1	04 January 2013	Final	Reference to Plot 3 removed. Land Remediation Relief section amended.	SMC	DJG

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Executive Summary

Details	Summary of Main Text
Introduction	This report has been prepared on the instructions of the Sanctuary Group which proposes to develop the site for residential end use. It presents the results of a preliminary contamination assessment for the development.
Site description	The site currently comprises an open area used for car parking, with an electricity sub-station in the southwest and a row of lock-up garages along the eastern boundary.
Environmental Setting	Beneath a thin layer of concrete made ground, strata comprising River Terrace Deposits described as clayey sand and gravel and sandy gravelly clay, are shown overlying London Clay formation described as silty clay. The River Terrace strata are classified by the Environment Agency as a Secondary A aquifer the London Clay as unproductive strata. The site is not within a groundwater source protection zone. The closest surface water feature is a stream (a tributary of the River Crouch) approximately 110m to the northeast. Controlled water receptors are therefore considered to be moderately sensitive to potential contamination. The site is surrounded by housing to the south, east and west and a school to the north.
Ground Conditions Encountered	Made Ground (maximum proven depth 0.10m bgl) River Terrace Deposits (maximum proven depth 2.30m bgl) London Clay (maximum proven depth)
Groundwater	Not encountered during the investigation.
Geotechnical	
Existing Construction	There is existing development on the site comprising a row of 'lock-up' garages along the eastern side. Any buried old construction encountered should be fully penetrated by all new foundations and broken well away from any new construction.
Excavations	Excavation to likely required depths generally should be readily achievable with standard excavation plant. Heavy duty excavation plant/breaking equipment may be required to excavate any remaining buried construction.
Foundations	Deep trench fill Raft foundations (if high water demand trees removed) Piled foundations (if high water demand trees removed) Heave precautions are required to allow for the effects of trees
Ground Floors	Suspended over a void where within the influencing distance of trees.
Design CBR	10% on natural coarse soils.
Soakaways	Soakaway drainage is considered unsuitable for this site.

Details	Summary of Main Text
Contamination	
Conceptual site model	No contamination SPR linkages were identified by the assessment
Risk Assessment	There is no significant risk to human health. There is no significant risk to groundwater. There is no significant risk to water supply pipes. There is no significant risk to the environment.
Remediation	No remedial measures are considered necessary
Land Remediation Relief	Potentially qualifying expenditure has not been identified associated with this project.
Additional Investigation	
Additional Investigation	An asbestos survey is required prior to demolition of the on site structures. Deep boreholes will be required to inform the design if piled foundations are to be adopted.

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1 Introduction

1.1 General

This report has been prepared by MLM Consulting Limited (MLMCL) on the instructions of Sanctuary Group (Client), which is proposing to develop the site for residential end use.

1.2 Terms of Reference

The terms of reference for the work were set out in the MLM proposal DMB/731776/002FP/SMC dated 9 August 2012.

1.3 Technical Approach

The geo-environmental and geotechnical work undertaken by MLM follows the Association of Geotechnical and Geoenvironmental Specialists (AGS) *Good Practice Guidelines for Site Investigations.*

The process of contamination assessment adopted in this report generally follows the model procedures for the management of contaminated land described in the Environment Agency Contaminated Land Report 11. It also takes into account the guidance issued in the National Planning Policy Framework (NPPF) and NHBC Standards Chapter 4.1 *Land quality: Managing ground conditions*.

The format of the report is in general accordance with the reporting requirements of BS5930:1999+A2:2010.

1.4 Proposed Development

It is understood that the proposed development will comprise new housing with associated infrastructure

Details of the proposed layout are shown on MEPK Architects' drawing 1173/P-03, dated March 2012

2. The Site

2.1 Location and Description

The site is located approximately 100m to the north-east of the centre of Canewdon village, Essex, approximately 4km to the northeast of the centre of Rochford. It is approximately square in shape and covers an area of approximately 0.08 hectares. It is bounded to the north by a playing field, to the south and east by existing housing and to the west by Gay's Lane, with further housing beyond.

The site is currently in use as a car park, with row of garages along the eastern boundary and an electricity sub-station in the south-west corner; the western quarter of the site is covered with trees.

The National Grid Reference for the approximate centre of the site is 590170, 194650.

A location plan of the site is presented as Figure 1.

2.2 Geology

The geological map of the area shows the site to be underlain by River Terrace deposits of recent age, overlying London Clay Formation of Eocene age.

2.3 Hydrogeology

According to the Environment Agency (EA) website the River Terrace deposits are classified as a Secondary (A) aquifer and the underlying London Clay as unproductive strata.

Secondary A aquifers are defined by the EA as *permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.*

Unproductive Strata are defined by the EA as *rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.*

The site is not within a groundwater Source Protection Zone (SPZ).

There are no abstractions from groundwater within 500m of the site.

2.4 Hydrology

There are no water features on the site. The closest surface water feature is a stream (a tributary of the River Crouch) approximately 110m to the northeast

The site is not in an area shown as likely to be affected by flooding.

There are no abstractions from surface waters within 500m of the site.

3. Previous Assessment

3.1 General

A Phase I Contamination Assessment has been carried out by MLM. The findings of this assessment are presented in its *Althorne Way, Canewdon – Preliminary Contamination Assessment Report* dated September 2012 (Ref. DMB/731776/R2) and summarised below.

3.2 Summary of Findings

The site is underlain by River Terrace deposits classified as a Secondary (A) aquifer overlying London Clay classified as unproductive strata.

The site is in an area where less than 1% of homes have recorded radon concentrations in excess of the 'action' level.

The site is not within a groundwater Source Protection Zone (SPZ) and there are no abstractions from groundwater within 500m of the site.

From 1874 to 1961, the site is shown as part of a large open field, with Canewdon village to the south and Gay's Lane on its western border. From 1971 to the present day the site is shown to be developed as it is today, with houses to the east, west and south and a playing field to the north.

There are no Contaminated Land Register entries (under Part 11A of the EPA 1990), Pollution Prevention and Control Entries or contemporary trade directory entries with potentially contaminated land uses landfill sites or waste management recorded within 250m of the site.

Identified potential contamination sources include made ground from site development, the garages (including current and historical storage) and the electricity sub-station.

The assessment has identified potentially complete SPR-linkages which present risks to future site users, construction workers, water supply pipes, adjacent site users and future planting. The risks range from low to moderate; moderate or high risks generally require further investigation and remedial/preventative measures.

3.3 Tree Survey

A tree survey has also been undertaken by Phelps Associates. The findings of this assessment are presented in its Arboricultrual Tree report dated 4 March 2012 (ref. PA.S702).

4. Geo-environmental Investigation

4.1 Site Work

Site work was carried out on 30 August 2012 and included cable percussion boreholes

4.2 Exploratory Holes

The exploratory holes were set out by an MLM engineer based on the findings of the desk study and site walkover in locations to maximise the available data, whilst operating within the constraints of the site.

Exploratory holes were put down at the site as listed in Table 4.1 below.

Table 4.1 – Summary Schedule of Exploratory Holes

Type	Ref.	Depth Range (m bgl)
Cable percussion boreholes	BH1 and BH2	5.0

Boreholes 1 and 2 were put down in the area of the proposed Plot 1 and the existing garages/proposed Plot 2 respectively

The locations of all the exploratory holes are presented on drawing 731776/02.

All boreholes were logged by a geo-environmental engineer in general accordance with BS5930:1999 (incorporating Amendment 2:2010).

The exploratory hole logs are presented in Appendix A.

Features, structures or certain ground conditions may be present between exploratory hole locations, which are different to those encountered during the investigation but which may impact upon construction.

4.3 In Situ Testing

Standard penetration tests (SPTs) were undertaken at regular intervals in the cable percussion/windowless sampler boreholes.

In situ test types and depths are recorded on the relevant exploratory hole records.

4.4 Sampling

Geotechnical undisturbed samples were recovered from the cable percussion boreholes in aluminium tubes (U100s).

Disturbed samples were recovered from all exploratory holes: in bulk bags and/or tubs depending on the soil types and proposed laboratory testing.

Contamination samples were recovered in tubs or glass jars, depending on the proposed laboratory analysis.

Sample types and depths are recorded on the relevant exploratory hole records.

4.5 Laboratory Analysis

4.5.1 Geotechnical Testing

The following laboratory tests were scheduled on soil samples recovered from the exploratory holes:

Table 4.2 Summary Schedule of Geotechnical Testing

Test	No.
Natural moisture content	4
Atterberg limits	4

Geotechnical testing was undertaken by a UKAS-accredited laboratory to BS1377 and the results are presented in Appendix B.

4.5.2 Contamination Analysis

The following laboratory analysis was scheduled on soil samples recovered from the exploratory holes:

Table 4.3 Summary Schedule of Contamination Analysis - Soil

Test	No.
Metals (As, Cd, Cr, Cu, Ni, Zn, Pb, Hg, Se)	5
PAH (speciated USEPA 16)	5
Water soluble sulphate	5
pH value	5

Contamination analysis was undertaken by a UKAS-accredited laboratory and the results are presented in Appendix C

5 Ground and Groundwater Conditions

5.1 General

The following includes interpretation of the field data and laboratory test results taking into account the ground and groundwater conditions encountered, drilling and sampling methods, transport, handling and specimen preparation.

The following general strata sequence was encountered across the site. Interpolation between exploratory hole positions has been undertaken based on visual observations and laboratory testing.

Table 5.1 Generalised Strata Sequence

Stratum	Depth range (m bgl)		Proven Thickness range (m)
	Top	Base	
Made Ground	GL	0.06-1.00	0.06-1.00
River Terrace Deposits	0.06-1.00	0.80-2.30	0.74-2.20
London Clay	0.80-2.30	>5.00*	2.70-4.20

* Base of stratum not proven in all holes

The findings of the site investigations generally match the published geology for the area.

5.2 Made Ground and Surfacing

Made ground was present in both boreholes and comprised concrete surfacing

5.3 River Terrace Deposits

Underlying the made ground orange brown clayey to very clayey sand and gravel was encountered, underlain in borehole BH2 by orange brown and grey brown sandy slightly gravelly clay. These deposits are assessed to be River Terrace Deposits.

5.4 London Clay formation

Underlying the River Terrace Deposits grey silty clay was encountered to the full depth of investigation. These deposits are assessed to be the London Clay Formation.

5.5 Groundwater Conditions

Groundwater seepages were not encountered during the investigation.

5.6 Contamination Observations

No visual or olfactory evidence of contamination was noted at the site. However investigation below the garages was not possible and there is a risk (albeit a small one) that contamination from materials stored in the garages may have entered the soils in the area

5.7 Underground Obstructions

There is existing development on the site comprising a row of 'lock-up' garages along the eastern side. It is possible that below ground construction (e.g. foundations) from these structures will remain following their demolition.

6 Material Properties

6.1 General

The following presents a summary of the properties of the soils encountered, based on field observations, in situ field testing and laboratory test results.

For the purposes of property designation, soils are divided into fine soils (clays and silts) and coarse soils (sands and gravels).

Soil plasticity class for fine soils is based on the classification system of BS5930, adopting modified plasticity index values (based on percentage passing 425μm sieve).

Volume change potential of fine soils on change of moisture content has been assessed using guidance provided in NHBC Standards/BRE Digest 240 - Part 1.

Equivalent approximate undrained shear strengths (c_u) and equivalent approximate coefficients of volume compressibility (m_v) have been calculated from recorded SPT N values, adopting f_1 and f_2 values respectively (based on CIRIA 143) appropriate to the recorded plasticity.

6.2 River Terrace Deposits

Natural moisture content of 25% is recorded in the fine fraction of these materials, together with a plasticity index of 39%. On this basis, these soils are classified as of high plasticity (CH soils) and of high swelling/shrinkage potential on change of moisture content.

An In situ SPT N value of 10 has been recorded within the fine fraction of these materials. An approximate undrained shear strength of 45kN/m^2 has been derived based on this result adopting an f_1 value of 4.5 based on a recorded plasticity of 39%), as shown on Figure 2.

An approximate coefficient of volume compressibility (m_v) of 0.12m^2/MN has been derived from the in situ SPT test within the fine fraction of these materials adopting an f_2 value of 0.45 (based on the 'average' plasticity) as shown on Figure 3.

6.3 London Clay Formation

Recorded natural moisture contents in the fine fraction of these materials range from 27% to 30% and plasticity indices from 42% to 48%. On this basis these soils are classified as of high and very high plasticity (CH and CV soils) and of high swelling/shrinkage potential on change of moisture content.

In situ SPT values within the fine fraction of these materials range from 10 to 19. Approximate undrained shear strengths based on these results range from 45kN/m2 to 85kN/m^2, adopting an f_1 value of 4.5 (based on an 'average' plasticity of 43%) as shown on Figure 2.

Approximate coefficients of volume compressibility (m_v)derived from the in situ SPT testing within the fine fraction of these materials range from 0.12m^2/MN to 0.22m^2/MN adopting an f_2 value of 0.45 (based on the 'average' plasticity) as shown on Figure 3.

7 Geotechnical Assessment

7.1 General

This geotechnical assessment is based on the parameters determined from the field work and laboratory analysis as described in section 6. It presents a geotechnical assessment of possible foundation solutions and infrastructure design; it does not constitute a detailed design report for the proposed development.

The merits of the available options discussed should be reviewed by the foundation/structural engineers.

The proposed development is understood to comprise three houses in two blocks with associated car parking and landscaping/gardens.

It is anticipated that finished ground levels will be at, or close to, existing ground levels. Should this not be the case then this assessment may need to be reviewed.

7.2 Existing Buried Construction

There are existing buildings on the western site of the site and it is possible that existing buried construction including foundations and/or services will be encountered below the site.

All foundations should be carried down to fully penetrate any existing construction, which should be broken well away from any new construction.

Any soil disturbed by excavation of foundations or services should also be fully penetrated by new foundations.

7.3 Excavations

Excavation to anticipated founding depths should be readily achievable using standard excavation plant. However, excavation through any buried construction may require heavy-duty excavation plant.

Random and sudden falls should be expected from the faces of near vertically sided excavations put down at the site. This situation is likely to be prevalent in the natural coarse soils and is likely to be exacerbated by water inflows. Temporary trench support, or battering of excavation sides, is likely to be required for all excavations that are to be left open for any length of time, and will definitely be required where man entry is required.

Particular attention should be paid to excavation at, or close to, site boundaries and adjoining existing roads and structures, where collapse of excavation faces could have a disproportionate effect.

A risk assessment of the stability of any open excavation should be undertaken by a competent person and appropriate measures adopted to ensure safe working practise in and around open excavations. Further guidance on responsibilities and requirements for working near, and in, excavations can be obtained from the Construction Design and Management Regulations (2007).

Groundwater was not encountered within likely excavation depths and based on site observations, it is considered that sump pumping is likely to be sufficient to deal with anticipated flows. It should be recognised that groundwater levels will fluctuate seasonally and the timing of construction may dictate the extent of groundwater control required.

Any water pumped from excavations is likely to need to be passed via settlement tanks before being discharged to the sewer; discharge consents will also be required.

7.4 Foundations

The appropriate foundation solution adopted for the site will depend not only on ground conditions, but also on structural loading, load distribution and the limiting criteria for movement or settlement of the buildings, which may have high specification finishes and unevenly distributed loadings so that settlement, and particularly differential settlement, will need to be maintained within tight tolerances.

A willow tree and an elm tree (both high water demand species) are identified in the group of trees on the western edge of the site by an arboricultural survey undertaken at the site; although the exact locations of these trees were not accurately plotted as they were designated as part of a group of trees of mixed species, recommended for removal. However, the architects' plan shows the majority of this is group of trees is now to be retained (where possible) and the effect of this (assuming the willow and/or elm are retained and grow to full mature height) is that Plot 1 will have to be piled and the foundations of Plot 2 deepened to allow for the effects of these trees on the highly shrinkable clay. As a result, minimum founding depths (for Plot 2) are likely to range from 1.5m bgl to 2.35m bgl, stepping up away from the area of tree influence as appropriate.

As an alternative, it is noted in the arboricultural survey that the high water demand trees are currently only a maximum height of 10m. if these trees were removed prior to development, it should be possible to construct all plots on trench fill foundations with minimum founding depths ranging from 1.25m bgl to 2.50m bgl, stepping up away from the area of tree influence as appropriate or raft foundations on a layer of granular fill of between 0.75m and 1.25m thick (see below)

Care should be taken to ensure the verticality of deep, narrow foundations to prevent eccentric loading.

7.4.1 Strip/Trench Fill Foundations

Traditional trench fill foundations are considered suitable for Plot 2 of the proposed development (or for all plots if the high water demand trees are removed) and based on the design soil parameters provided in earlier sections of this report, as a guide, an allowable net bearing capacity of 120kN/m^2 should be available for a 0.6m wide trench fill foundation bearing on the natural fine soils.

This value should result in total settlements of not more than 20mm, keeping differential settlements within acceptable limits.

7.4.2 Piled Foundations

As noted above, unless the high water demand trees noted within the site are removed, their influence (based on the requirements of NHBC Chapter 4.2) will exceed 2.5m (for the foundations of Plot 1), which is generally taken as the deepest practicable depth of excavation for trench fill foundations. Under these circumstances piled foundations would be recommended for this plot.

Driven piles, bored piles with the use of casing or CFA piles should be suitable for this site. However, the choice of piling system and detailed design of piles are beyond the scope of this report and should be undertaken the specialist piling contractor taking into account the following considerations.

- Piles should extend a minimum of five pile diameters into the bearing stratum to fully mobilise end-bearing resistance

It is considered that the building will be brickwork/blockwork and on this basis a reinforced ground beams constructed at depths of not less than 1.0m bgl should be constructed between piles/pile caps.

7.4.3 Raft Foundations

A second alternative, should the high water demand trees be removed, would be to construct one or both of the buildings on a raft foundation. Should this approach be adopted a thickness of granular fill equal to not less than half the required founding depth as determined from NHBC Standards (with a maximum permissible depth of 1.25m bgl), will be required. An allowable net bearing capacity of 100kN/m^2 should be available, assuming the granular fill is placed and compacted in accordance with a suitable specification such as the Specification for Highway Works.

The granular fill should extend to a distance outside the footprint of the plot at least equal to the depth of excavation.

7.5 Ground Floor Slabs

All buildings at the site are likely to be within the influencing distance of trees and ground floors will need to be suspended over a suitable void in accordance with the requirement of NHBC Standards.

If a raft foundation is adopted the ground floor slab will be integral with the raft.

If buried construction is to remain below new ground floor slabs (for example in the area of Plot 2) it should be broken away from the slab to avoid interaction (i.e. to prevent the slab 'breaking its back' over the existing construction).

7.6 Tree Influence

As noted above, all foundations and ground floors should be constructed in accordance with requirements of NHBC Standards, in relation to tree influence

A number of trees are to be removed and their roots should be grubbed out and foundations extended to below the zone of disturbance created by this activity.

Both buildings are to be constructed within the influencing distance of trees, and heave protection will be required on the uppermost sections of piles (if constructed), or piles over-bored to allow for the uplift effects of clay heave, and on the underside of any ground beams.

Consideration should be given to the possible effect of direct root action on foundations or services, and to the continued stability of existing trees, where buildings are constructed very close to existing trees that are to remain.

7.7 Pavement Construction

Following site preparation/re-grading the sub-grade will comprise natural coarse River Terrace Deposits. Based on Table 5.1 of the Highways Agency Interim Advice Note 73/06, an overall design CBR value of 10% is recommended

It is recommended that the above design CBR values be confirmed by in situ testing.

7.8 Below Ground Concrete Design

Based on the results of the pH and water soluble sulphate determinations on soil samples and in accordance with the categorisation system of BRE Special Digest 1, the soils below the site fall within Design Sulphate Class DS-1 with a corresponding ACEC Class of AC-1.

7.9 Soakaway Potential

The soils below the site are predominantly cohesive and where coarse soils are noted they are described as clayey to very clayey. On this basis it is considered that soakaway drainage will be impracticable for this site and an alternative method of drainage should be adopted.

7.10 Reuse of Materials

The concrete surfacing should be suitable for crushing, grading and re-use as fill at the site.

Excavated natural fine soils are considered suitable for re-use as fill at the site but as they will be liable to long term consolidation settlement their use should be limited to areas where long-term settlements would not be an issue.

Excavated natural coarse soils are considered unsuitable for re-use as structural fill at the site due to their high clay content, but could be used for non structural filling below buildings or hardstanding as adequate compaction can be applied to minimise long term settlements.

8 Assessment of Soil Chemistry Data

8.1 Approach

This section presents a generic quantitative risk assessment (GQRA) of potential soil contamination. GQRA involves a comparison of chemical laboratory results to generic assessment criteria (GAC) that are considered appropriate and relevant to the context of the site. The purpose of the GQRA is to identify potential sources of contamination for further evaluation in the Contaminated Land Risk Assessment section of the report. GAC used in human health risk assessments have been adopted from the following guidance:

- Soil guideline values (SGV) derived using the Contaminated Land Exposure Assessment (CLEA) model and published on the Environment Agency website. Currently these GAC are for arsenic, cadmium, mercury, nickel, selenium, BTEX compounds and phenols. The new SGVs do not differentiate between *'with'* and *'without'* plant uptake. For the purpose of the GQRA the term SGV is taken to mean GAC
- GAC published jointly by LQM and the Chartered Institute of Environmental Health. Currently these are for TPH aromatic/aliphatic, polyaromatic hydrocarbons, chlorophenols, chlorinated solvents and certain metals. GAC for TPH and PAH compounds are soil organic matter dependent (where SOM was not determined a value of 1% is assumed)
- GAC published jointly by the Environmental Industries Commission, Association of Geotechnical and Geoenvironmental Specialists (AGS) and Contaminated Land: Applications in Real Environments for a range of volatile organic compounds and certain metals (EIC/AGS/CL:AIRE 2009)

A full list of GAC used in the assessment is included in Appendix D.

Risks to water supply pipes have been assessed using guidance published by UKWIR. The guidance provides threshold concentrations above which organic compounds can permeate water supply pipes, impact on their construction and cause a water quality issue for consumers. Previous guidance from WRAS has been withdrawn but may still be in use by certain water supply companies. For the purposes of this assessment it is assumed that polyethylene water supply pipework will be adopted. Should an alternative material (such as PVC) be adopted different (lower) TVs will apply.

Potential risks to plant life, such as for proposed landscaping, are assessed through BS3882:2007. This standard sets out the threshold values in soil above which phytotoxic effects can occur from the metals copper, nickel and zinc.

Appropriately sensitive testing methods have been adopted throughout and on this basis, where contaminants are recorded at less than detection limits, they are considered to be 'not present'.

8.2 Risks to Human Health

The development proposals are for housing. For the purpose of human health risk assessment, the closest designated site end use to this is residential land use, which has been adopted for this assessment.

A soil organic matter SOM content of 1% has been assumed for the purposes of this assessment.

None of the contaminant concentrations are recorded above their respective GAC and therefore further assessment of these contaminants in relation to human health risks is considered unnecessary.

8.3 Risks to Water Supply

Samples of made ground (through which any new sewerage and water supply pipes are likely to pass) were analysed for the organic substances listed by UKWIR guidance.

Recorded concentrations of organic contaminants are below the relevant threshold values (TVs).

It should be noted that the TVs are for use by designers in the selection of appropriate pipe materials. Exceedance of a TV indicates only that there could be a 'water quality issue'. TVs are generally protective of taste and odour quality of water in plastic water pipes and only TVs for benzene and MTBE are protective of human health.

8.4 Risks to Plant Life

Samples of made ground were analysed for the potentially phytotoxic metal compounds listed in BS3882:2007. Recorded concentrations of copper, nickel and zinc are all below the relevant guideline values.

9 Assessment of Groundwater Data

9.1 General

Groundwater was not encountered during the investigation/post field work monitoring.

9.2 Risks to the Groundwater

Soil leachate/groundwater testing was not considered necessary because of the low contamination concentrations in the soil and the fact that, following development, most of the site will be covered in impermeable surfacing and buildings, the risk to the groundwater is considered minimal

10 Contaminated Land Risk Assessment and Conceptual Site Model

10.1 General Approach

The assessment of risk from contamination follows the source-pathway-receptor approach. If one of these three elements is absent it is considered that there is no risk of harm. If, however, there is considered to be a linkage between source and receptor then a risk-based approach is used to assess the significance or impact of the potential SPR-linkage.

Source - Contamination that has the potential to impact on human health and/or the environment. Identification of sources of contamination will normally involve generic quantitative risk assessment (GQRA), which compares test results with current guidelines. GQRA was undertaken in the preceding sections of the report.

Pathway - The route by which a receptor may come into contact with the source.

Receptor - Receptors are typically humans or the environment (e.g. water resources) that could be affected by contamination.

Risks are defined as the likelihood of an event occurring combined with the magnitude of the consequence of that event occurring. This is explained further and definitions provided in Appendix E.

10.2 Identified Contamination Sources

Based on the GQRA presented in the previous sections, no source of contamination that could impact on receptors have been identified and therefore no further assessment is considered necessary.

11 Remediation and Risk Management

11.1 General

This assessment has no identified potential hazards at the site with possible SPR-linkages, which could represent potentially unacceptable risks to human health, the groundwater and future plant growth.

On this basis, no soil remedial measures are required

11.2 Groundwater Remediation

Groundwater remediation is considered unnecessary.

11.3 Off Site Disposal

If material is to be removed from the site the laboratory test results in Appendix C should be presented to the proposed receiving landfill site, prior to export, to confirm that they are suitably licensed to accept them. Some additional testing may be necessary for the receiving landfill to confirm its acceptability to receive the waste.

It is anticipated that the natural excavated soils will be classified as inert for off-site disposal purposes

11.4 Remediation Documentation

Based on the findings and recommendations of this report, remediation will not be required and as such a remediation strategy document will not be required as part of any planning submission.

11.5 Construction Health and Safety

It is recommended that construction workers at the site adopt appropriate personal hygiene precautions at the site and use personal protective equipment as required, particularly provision of washing facilities, wearing of gloves and avoidance of hand to mouth contact (e.g. eating or smoking), especially when dealing with made ground.

Handling of soil and water should be minimised and dust suppression measures should be implemented, particularly during any excavation through the made ground. Soils should be dampened during excavation and handling to limit dust, and lorries suitably sheeted. Surface run-off from vehicle washing, dust suppression or storms, during construction, should be controlled to prevent entry into watercourses and off-site drainage systems.

Gas and vapour monitoring should be carried out before man entry into deep excavations or confined spaces.

These precautions are considered to be industry standard when developing sites of this nature, and reference can be made to the HSE document HSG66 *Protection of workers and the general public during development of contaminated land* for further information.

12 Conclusions and Recommendations

12.1 Conclusions

The site is underlain by a thin layer of concrete surfacing over River Terrace deposits, which in turn overlie soils identified as London Clay Formation. Existing construction including foundations and/or services may be present following demolition of the existing garages at the site.

Deep trench fill and piled foundations (unless high water demand trees are removed) are considered suitable for the proposed development.

There is likely to be inadequate infiltration capacity for soakaway drainage.

Crushed graded concrete and excavated natural soils should be suitable for re-use at the site. Excavated soils disposed of off-site are likely to be classified as inert.

There is no significant contamination of the soils below the site

There is no significant risk of contamination being leached from the soils at the

12.2 Recommendations

The natural fine soils should be suitable as a founding stratum for Plot 3 (or for all plots if high water demand trees are removed) and an allowable net bearing capacity of 120kN/m^2 should be available for a trench fill foundation 0.6m. This value should result in settlements of not more than 20mm and 25mm respectively, keeping differential settlements within acceptable limits.

The natural find soils should be suitable as founding strata for raft foundations for al plots (if high water demand trees are removed) and an allowable net bearing capacity of 100kN/m^2 should be available for a trench fill foundation 0.6m wide. This value should result in settlements of not more than 20mm, keeping differential settlements within acceptable limits.

If the high water demand trees are to remain, Plots1/2 should be provided with a piled foundation.

Existing buried construction should be fully penetrated by, and broken away from new foundations.

Deepening of foundations/slip coatings on piles (in accordance with the guidelines of NHBC Standards/BRE298) is/are recommended to allow for clay swelling/shrinkage effects due to trees at the site (whether to remain or be removed). Heave protection is likely to be required where foundations are within the influencing distance of trees.

Ground floors need to be suspended over a void due to the influence of trees. Buried construction should be broken away from the slab to avoid interaction.

Where a raft foundation is adopted, the ground floor will be integral with the raft.

Following the surfacing strip an overall design CBR of 10% should be available on the made ground following treatment/natural fine soils/natural coarse soils, following proof rolling of the formation.

The soils at the site fall within Design Sulphate Class DS-1 with a corresponding ACEC Class of AC-1.

12.2.1 Further Investigation

A Demolition and Refurbishment asbestos survey is required (by law) prior to the onset of demolition of the existing structures on the site.

Additional investigation by deep borehole may be required by the piling contractor to confirm soil parameters for pile design.

13 Land Remediation Relief

13.1 Outline

Land Remediation Relief (LRR) is a 150% credit on corporation tax claimable by certain corporate bodies (excluding public bodies) against qualifying expenditure when undertaking investigation and remediation of potentially contaminated or derelict (not in productive use (i.e. being used for a particular purpose) since pre-1998) sites. It is to be reviewed and may be cancelled as part of the government's spending cuts, but at the time of writing this report it is in place and can be claimed for qualifying expenditure.

13.2 Qualifying Expenditure

The following table lists those items that might be expected to be considered as qualifying expenditure under the LRR scheme, with an explanation of which (if any) may qualify on this site.

Table 13.1 Potentially Qualifying Expenditure

Expenditure	Qualifying	Reasoning
Ground investigation*	No	No significant contamination risks identified.
Contamination laboratory analysis	No	No significant contamination risks identified.
Contamination assessment and reporting**	No	No significant contamination risks identified.
Remediation Method Statement	No	Remediation is not required.
Remediation (soil)	No	Remediation is not required.
Remediation (groundwater)	No	Remediation is not required.
Remediation (gas)	No	Remediation/protective measures are not required.
Demolition works***	No	The land is currently, or has until recently been, in a 'productive state' i.e. being used.

* A proportion of the ground investigation fieldwork (attributable to contamination investigation)

** All contamination assessment work (except the desk study) and the proportion of the report related to contamination should qualify

*** Applicable if the land was in a 'non-productive state' when acquired, or has been in a non-productive state since before 1st April 1998 and cannot be brought into a productive state without undertaking the proposed demolition works. Applies only to removal of redundant foundations, services and certain below ground structures

The identification of asbestos containing materials (ACMs) in the buildings on this site is outside the scope of this report. However, should a subsequent asbestos survey identify ACMs requiring removal, both the survey and the removal works should count as qualifying expenditure.

The identification of Japanese Knotweed is outside the scope of this report. However, should this plant be noted on site, the cost of in situ treatment (but not of excavation and removal to landfill) is qualifying expenditure.

14 References

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34. National House Building Council (2007) *Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present.*

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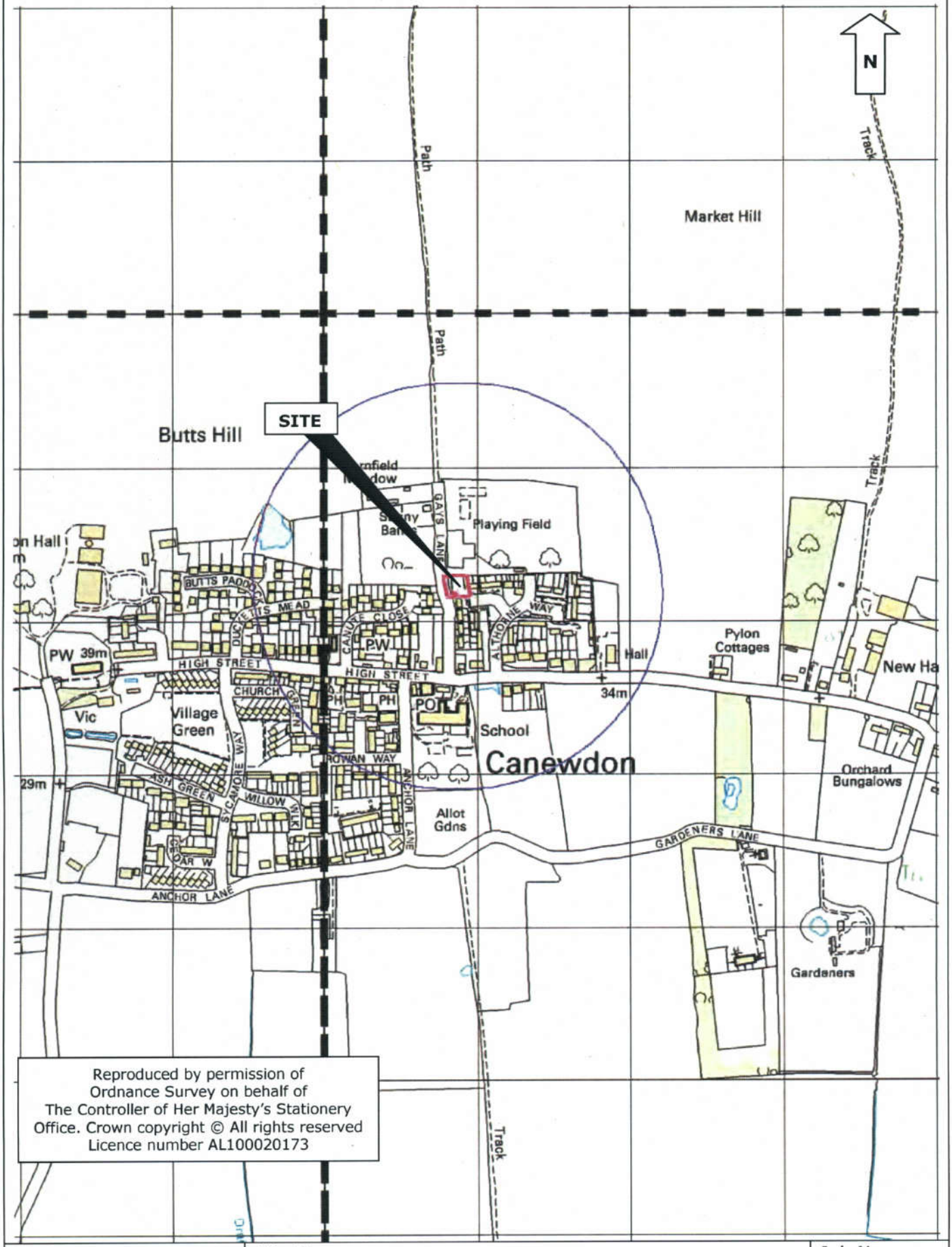
Figures



MLM www.mlm.uk.com	Site Name **Site Location Plan**	Job No. 731776 Figure No. **1**

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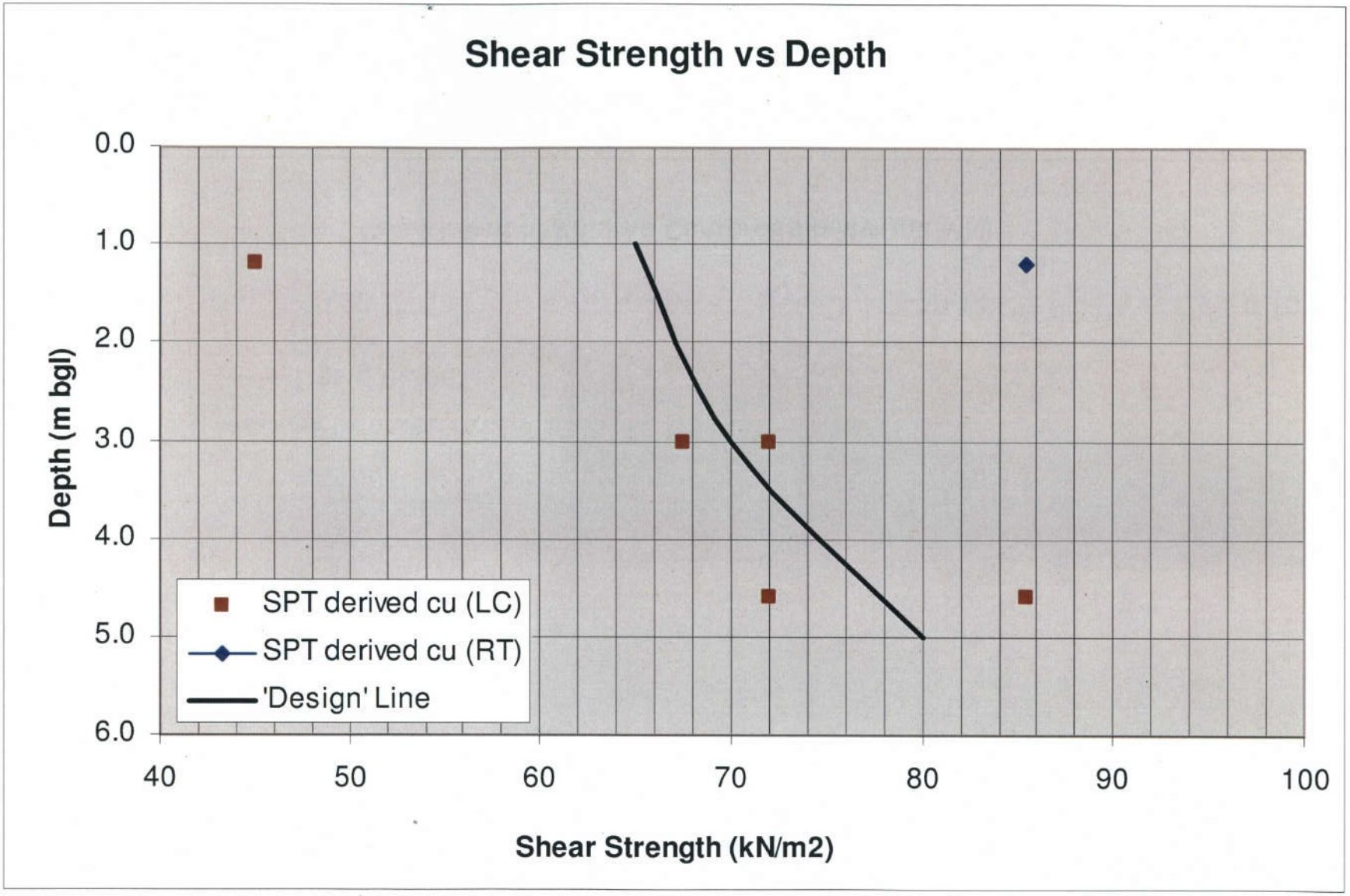
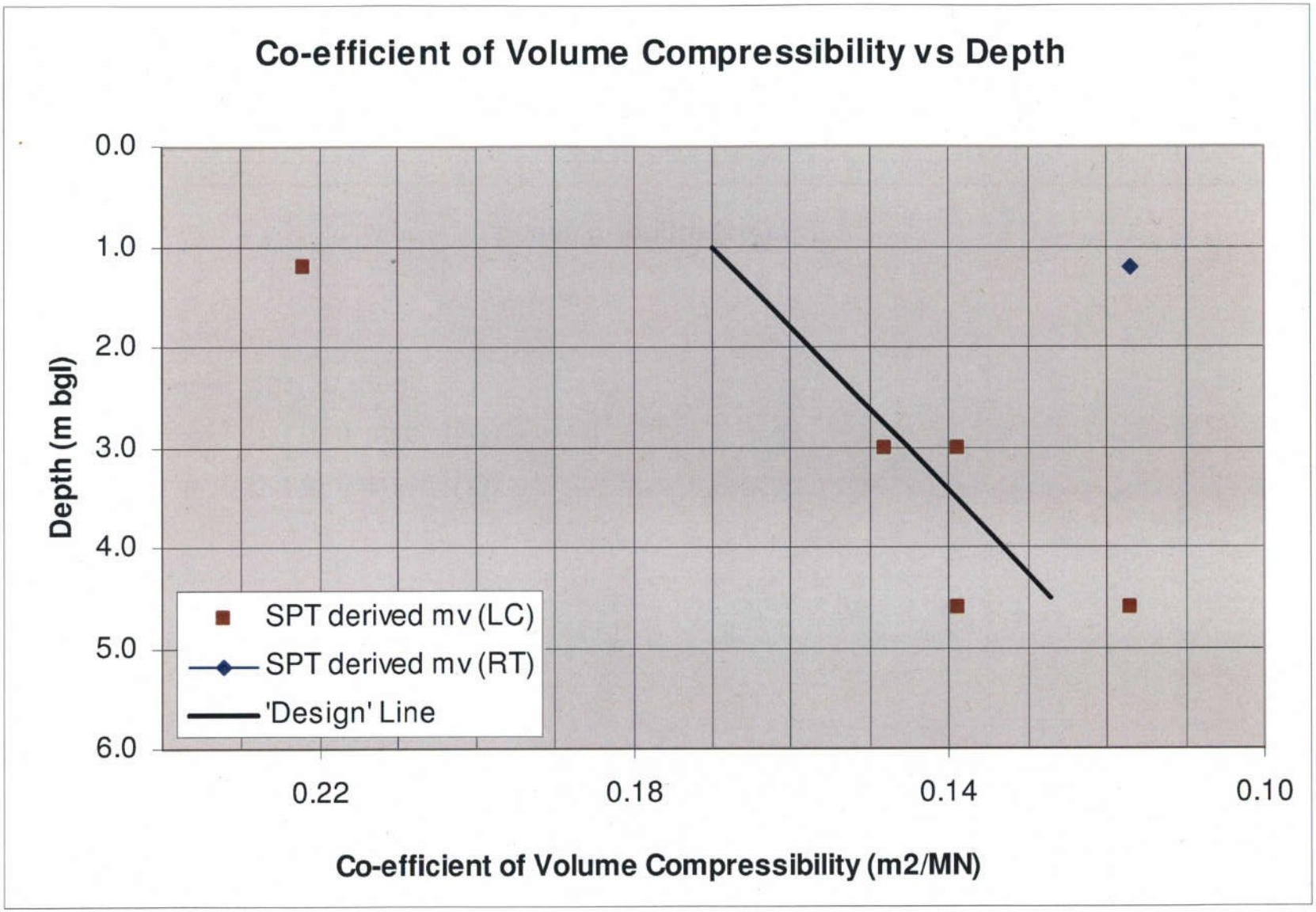


MLM www.mlm.uk.com	Site name **Althorne Way, Canewdon**	Job No. 731776 Figure No. **2**



MLM www.mlm.uk.com	Site name **Althorne Way, Canewdon**	Job No. 731776 Figure No. **3**

Drawing

770776/002 - Exploratory Hole Location Plan

NOTES

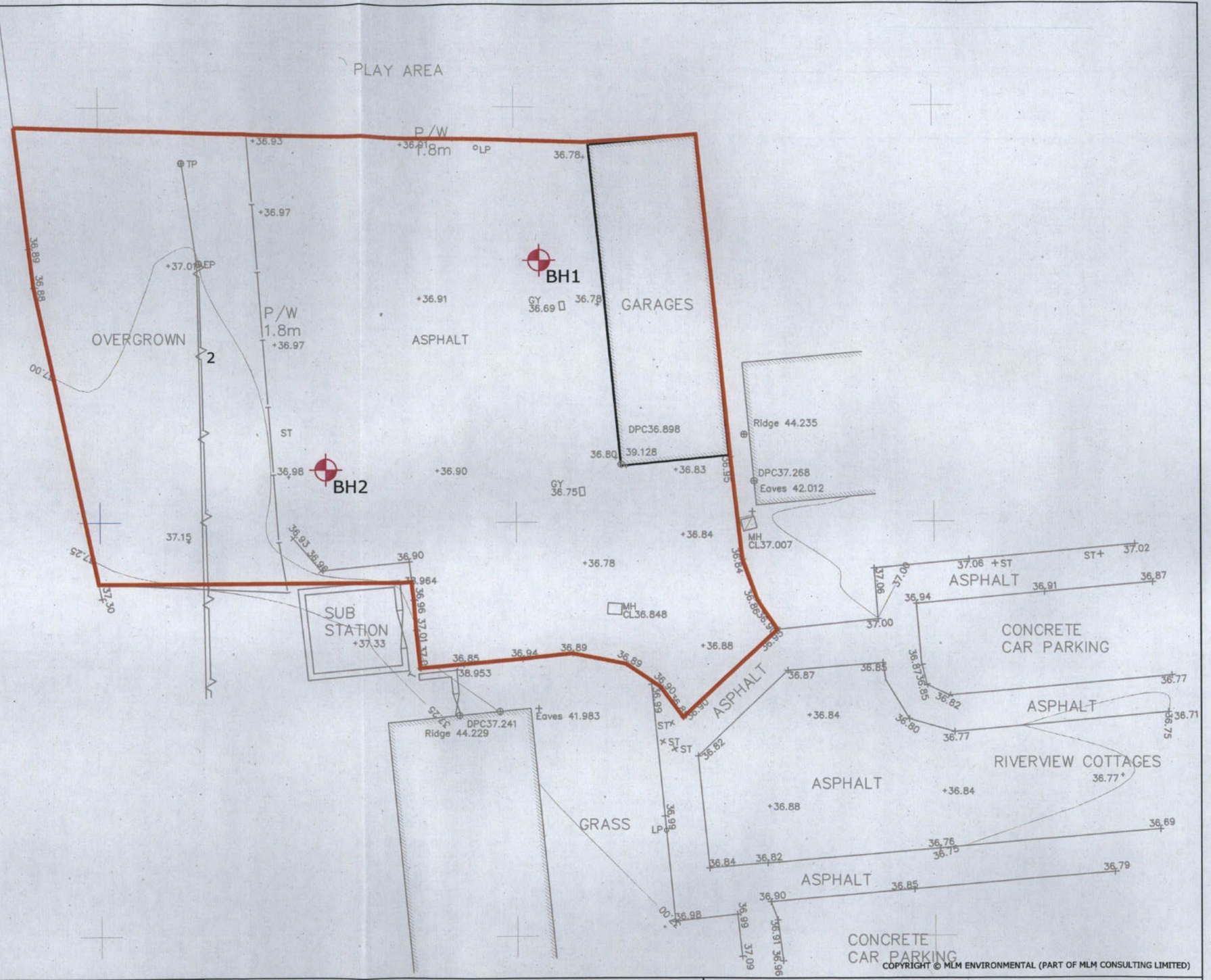
1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS, ARCHITECTS AND SPECIALISTS DRAWINGS AND THE SPECIFICATION.

2. DO NOT SCALE FROM THIS DRAWING MANUALLY OR ELECTRONICALLY. WRITTEN PERMISSION MUST BE OBTAINED FROM MLM PRIOR TO SCALING ELECTRONICALLY OR USING THIS ELECTRONIC FILE.

LEGEND :

SITE BOUNDARY

BH1 BOREHOLE LOCATION



Rev	Date	Description	Made	Ckd
.	.	.	.	.

MLM
Multidisciplinary Consulting
Building 7200, IQ Cambridge, Cambridge, CB25 9TL
Tel: 01223 815600 Fax: 01223 815630
Website: www.mlm.uk.com

Drawing Status: FINAL ISSUE

Client: SANCTUARY HOUSING

Project: LAND AT ALTHORNE WAY

Drg Title: EXPLORATORY HOLE LOCATION PLAN

Drawn/Design	Checked	Approved	Date
PW	SMC	SMC	JAN 2013

Scales: 1:200 @ A3

Drg No.: 731776/002

Rev: .

Appendices

Appendix A:	Exploratory Hole Logs
Appendix B:	Geotechnical Test Results
Appendix C:	Results of Chemical Analysis
Appendix D:	Generic Assessment Criteria
Appendix E:	Defining Risk

Appendix A

Exploratory Hole Logs

Project:	Land at Althorne Way	EXPLORATORY HOLE REFERENCE:	**BH1**
Location:	Canewden	Drilling Method:	Cable Percussion
Project ID:	731776	Start of Drilling:	30/08/2012
Client:	Sanctuary Housings	Completion:	30/08/2012
Project Engineer:	H. Carter	Ground Level: (mAOD)	-
Logged by:	H. Carter	Coordinates:	-

BH1

IN SITU TESTS/SAMPLING				STRATA								
Depth (m)	Sample Ref.	SPT Results (Type)	Shear Strength (kPa)	Level (mAOD)	Depth (m)	Legend	Description of Strata	Thickness (m)	Installation Details	Chiselling Depth (m)	Chiselling Time (mins)	Water (m)
					0.10		Concrete.	0.10				Dry
0.20	D1						Orange-brown clayey to very clayey SAND and fine to coarse angular to rounded chert GRAVEL. (River Terrace Deposits)	0.70				
0.40	D2				0.5							
					0.80		Firm becoming stiff brown and grey mottled CLAY. (London Clay Formation)					
0.90	D3				1.0							
1.20	D4	(S) N=10 (1,-/2,2,3,3)										
					1.5							
2.00	U1				2.0			2.50				
2.45	D5				2.5							
3.00	D6	(S) N=15 (1,-/2,4,4,5)			3.0							
					3.30		Stiff brown silty CLAY. (London Clay Formation)					
					3.5							
4.00	U2				4.0			1.70				
4.45	D7				4.5							
4.60	D8	(S) N=16 (4,-/3,3,5,5)										
							End of Borehole at 5.00 m					

Notes:
Casing Depth (m bgl):
Well Diameter (mm):

Remarks:
1. Groundwater not encountered during the investigation.
2. Borehole backfilled with arisings.

Legend:

▽	Water Strike
▼	Water Standing
S	Standard Penetration Test - Split Spoon Method
C	Standard Penetration Test - Solid Cone Method
N=17	SPT "N" Value with number of blows per 75mm in brackets
D	Small Disturbed Sample
E	Environmental Sample
U	Undisturbed Sample
B	Bulk Sample
J	Jar Sample
W	Water Sample

Well Installation/Backfill Legend:

Backfill Details: Concrete, Bentonite, Filter Gravel, Arisings Backfill

Pipe Details: Plain Pipe, Slotted Pipe, Piezometer Tip

Project:	Land at Althorne Way
Location:	Canewden
Project ID:	731776
Client:	Sanctuary Housings
Project Engineer:	H. Carter
Logged by:	H. Carter

EXPLORATORY HOLE REFERENCE: **BH2**

Drilling Method:	Cable Percussion
Start of Drilling:	30/08/2012
Completion:	30/08/2012
Ground Level: (mAOD)	-
Coordinates:	-

BH2

IN SITU TESTS/SAMPLING				STRATA									
Depth (m)	Sample Ref.	SPT Results (Type)	Shear Strength (kPa)	Level (mAOD)	Depth (m)	Legend	Description of Strata	Thickness (m)	Installation Details	Chiselling Depth (m)	Chiselling Time (mins)	Water (m)
					0.06		Concrete.	0.06				Dry
0.30	D1				0.40		Orange-brown clayey to very clayey SAND and fine to coarse angular to rounded chert GRAVEL. (River Terrace Deposits)	0.34				
0.70	D2				0.5		Firm orange-brown and grey-brown mottled sandy slightly gravelly CLAY. Gravel is fine to coarse angular to rounded chert. (River Terrace Deposits)					
1.20	D3	(S) N=19 (5,-/3,5,5,6)			1.0							
1.60	D7				1.5			1.90				
2.10	U1				2.0							
2.40	D4				2.30		Stiff brown mottled occasionally silty CLAY. (London Clay Formation)					
3.00	D5	(S) N=16 (4,-/3,3,5,5)			2.5							
4.00	U2				3.0			2.70				
4.45	D6				3.5							
4.60		(S) N=19 (4,-/3,4,5,7)			4.0							
					4.5		*End of Borehole at 5.00 m*					

Notes:
Casing Depth (m bgl):
Well Diameter (mm):

Remarks:
1. Groundwater not encountered during the investigation.
2. Borehole backfilled with arisings.

Legend:

▽	Water Strike
▼	Water Standing
S	Standard Penetration Test - Split Spoon Method
C	Standard Penetration Test - Solid Cone Method
N=17	SPT "N" Value with number of blows per 75mm in brackets
D	Small Disturbed Sample
E	Environmental Sample
U	Undisturbed Sample
B	Bulk Sample
J	Jar Sample
W	Water Sample

Well Installation/Backfill Legend:

Backfill Details: Concrete, Bentonite, Filter Gravel, Arisings Backfill

Pipe Details: Plain Pipe, Slotted Pipe, Piezometer Tip

Appendix B

Geotechnical Test Results

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : 13/09/12 PAGE 1 of 8 Pages

Contract: Canewden

Serial No.: S25844

UKAS TESTING 0998

CLIENT:

MLM ENVIRONMENTAL LIMITED
7200 Cambridge Research Park
Cambridge
CB5 9TL

Soil Property Testing

18 Halcyon Court, St Margarets Way,
Stukeley Meadows, Huntingdon,
Cambs. PE29 6DG.

Telephone (01480) 455579 Fax (01480) 453619
Email SPTownend@btclick.com

SAMPLES SUBMITTED BY:

MLM

APPROVED SIGNATORIES:

☐ S.P.TOWNEND FGS
Technical Director

☐ W.JOHNSTONE
Deputy Technical/Quality Manager

☑ J.C.GARNER B.Eng (Hons.) FGS
Quality Manager

SAMPLES LABELLED:

CANEWDEN

DATE RECEIVED: 31/08/12

SAMPLES TESTED BETWEEN 31/08/12 and 13/09/12

REMARKS: For the attention of Mr S Cook
Your ref 731776

NOTES:

1. All remaining samples or remnants from this contract will be disposed of after 21 days from today, unless we are notified to the contrary.
2. (a) UKAS - United Kingdom Accreditation Service.
   (b) Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.
3. Tests marked "NOT UKAS ACCREDITED" in this test report are not included in the UKAS Accreditation Schedule for this testing laboratory.
4. This test report may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 2 of 8

Contract: Canewden

Serial No.: S25844

SCHEDULE OF LABORATORY TESTS

Bh./ Tp No.	Sample Ref	Depth (from)	1:Moisture Content Determination	4:Liquid/Plastic limit 1 point	Remarks
BH1	D3	1.30	*	*	
	D4	2.40	*	*	
BH2	U1	2.00	*	*	
	U2	4.00	*	*	
-	-	-	4	4	<— Total Number of Tests ——

Scheduled by: MLM ENVIRONMENTAL LIMITED

Target Date: 13/09/12

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 3 of 8

Contract
Canewden

Serial No.
S25844

UKAS TESTING
0998

SUMMARY OF MOISTURE CONTENT, LIQUID LIMIT, PLASTIC LIMIT, PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)	SAMPLE PREPARATION				Description	CLASS
								Method S/N	Ret'd 0.425mm (%)	Corr'd M/C <0.425mm	Curing Time (hrs.)		
BH1	1.20 -1.65	D4	30	74	26	48	0.08	N	0(A)		144	Firm brown CLAY with occasional grey and yellowish brown mottling	CV
BH1	2.45	D5	27	66	24	42	0:07	N	0(A)		119	Stiff brown CLAY with occasional yellowish brown and grey mottling	CH
BH2	2.10	U1	25	62	23	39	0.05	N	0(A)		118	Stiff dark yellowish brown CLAY	CH
BH2	4.00	U2	27	68	24	44	0.07	N	0(A)		166	Stiff dark yellowish brown CLAY	CH

METHOD OF PREPARATION : BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2 S = Wet Sieved Specimen
N = prepared from Natural

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter. A = Assumed, M = Measured

COMMENTS :

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

TEST REPORT.

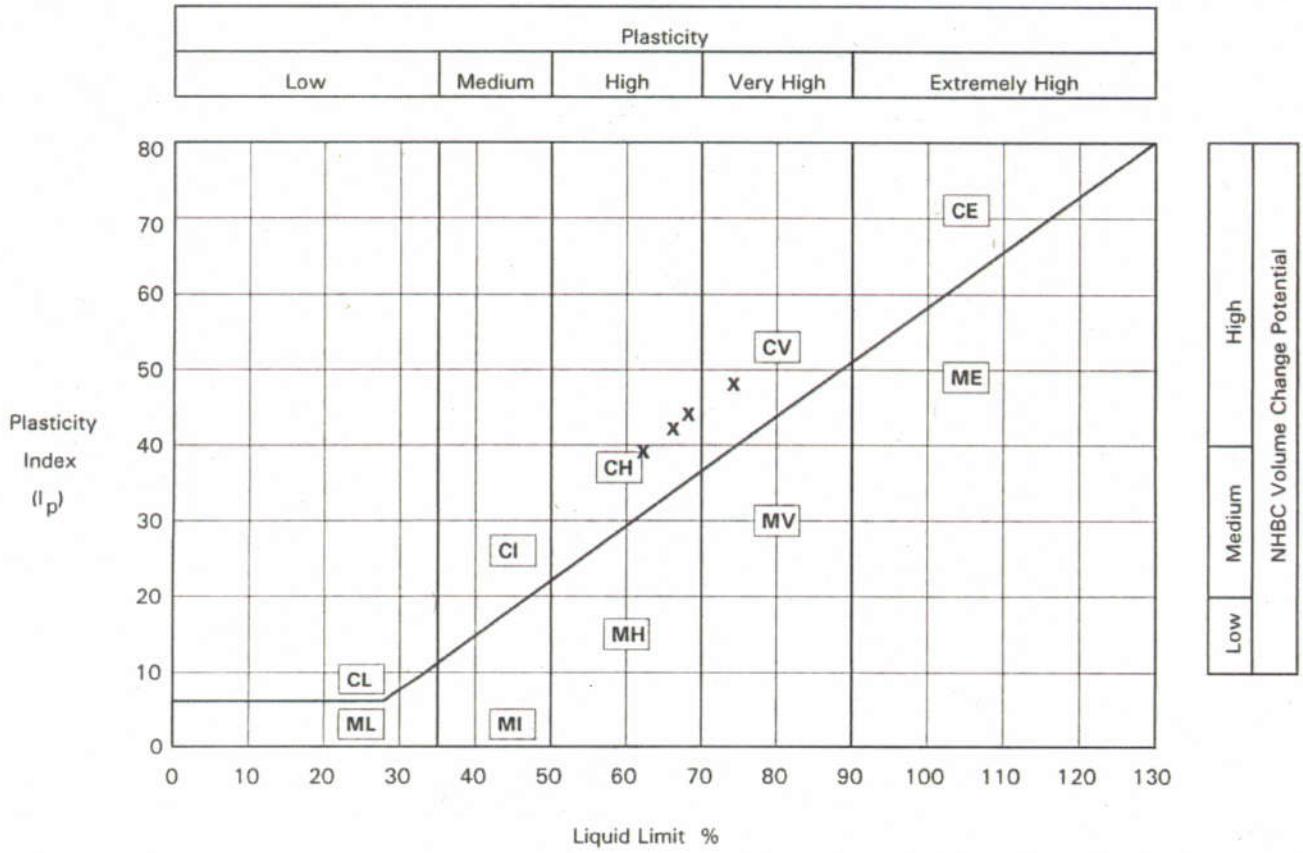
ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 4 of 8

Contract: Canewden

Serial No.: S25844

PLOT OF PLASTICITY INDEX AGAINST LIQUID LIMIT USING CASAGRANDE CLASSIFICATION CHART



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index PLASTICITY CHART BS5930:1999:Figure 18

TEST REPORT.

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Contract: Canewden

Serial No.: S25844

UKAS TESTING 0998

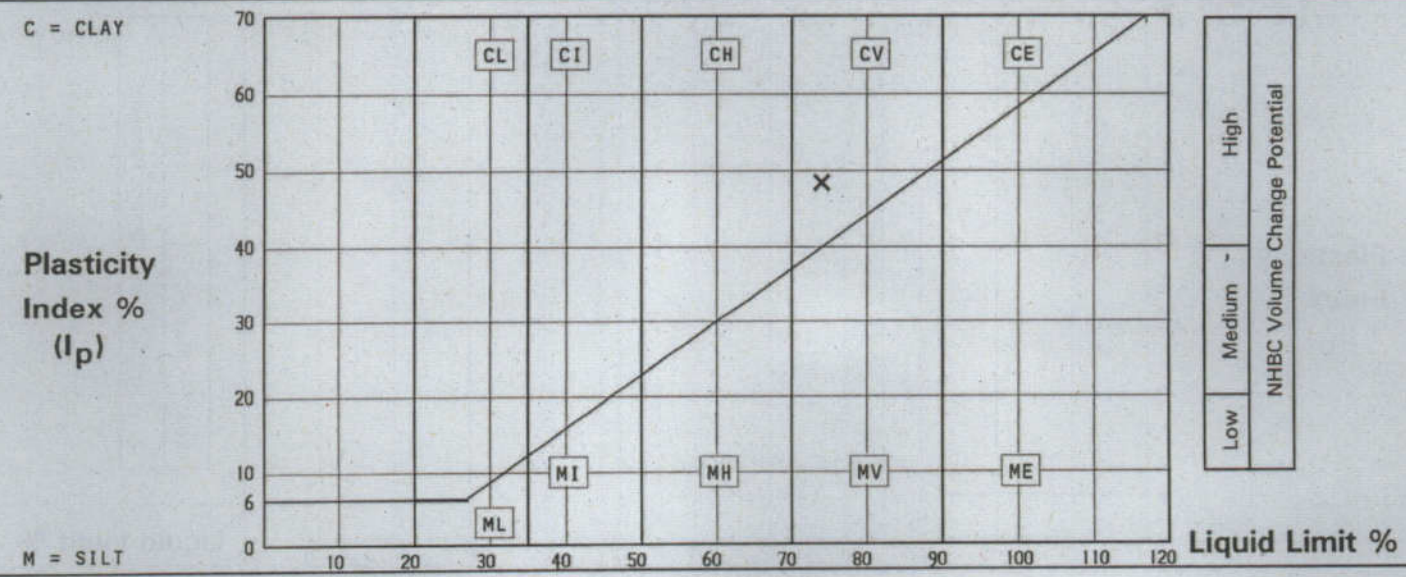
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
BH1	1.20 -1.65	D4	30	Firm brown CLAY with occasional grey and yellowish brown mottling	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve (Assumed)	0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	144 Hours

Liquid Limit	74 %
Plastic Limit	26 %
Plasticity Index	48 %
Liquidity Index	0.08
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 6 of 8

Contract: Canewden

Serial No.: S25844

UKAS TESTING 0998

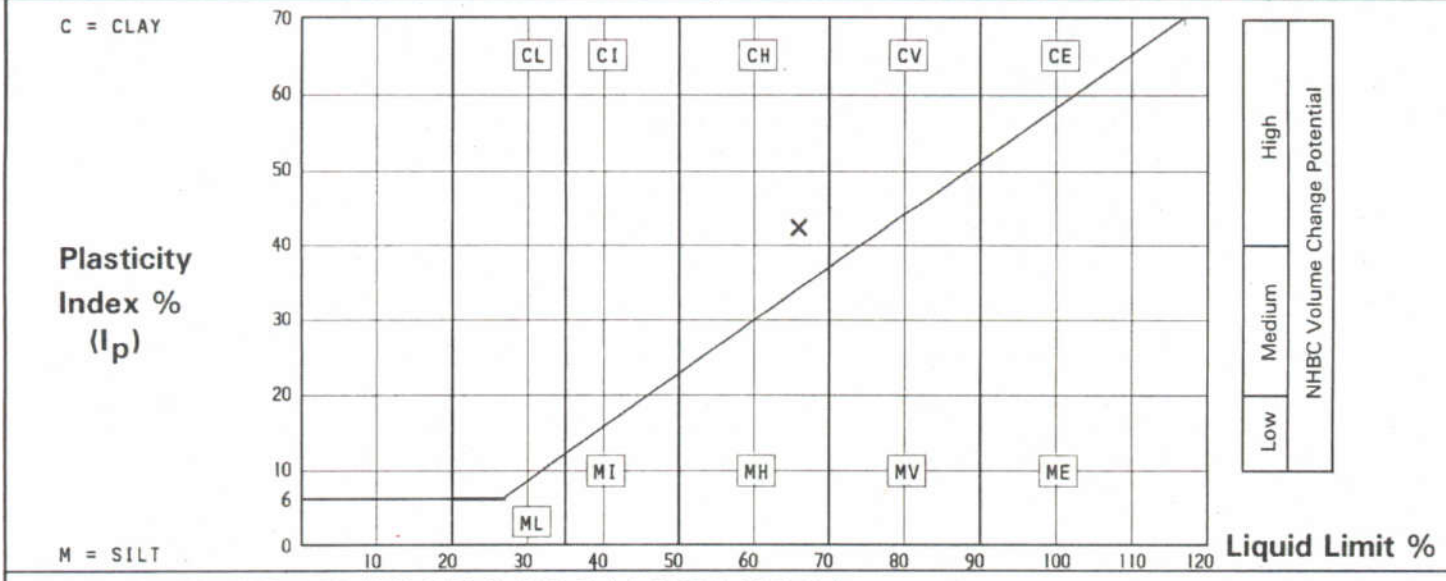
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
BH1	2.45	D5	27	Stiff brown CLAY with occasional yellowish brown and grey mottling	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve (Assumed)	0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	119 Hours

Liquid Limit	66 %
Plastic Limit	24 %
Plasticity Index	42 %
Liquidity Index	0.07
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 7 of 8

Contract: Canewden

Serial No.: S25844

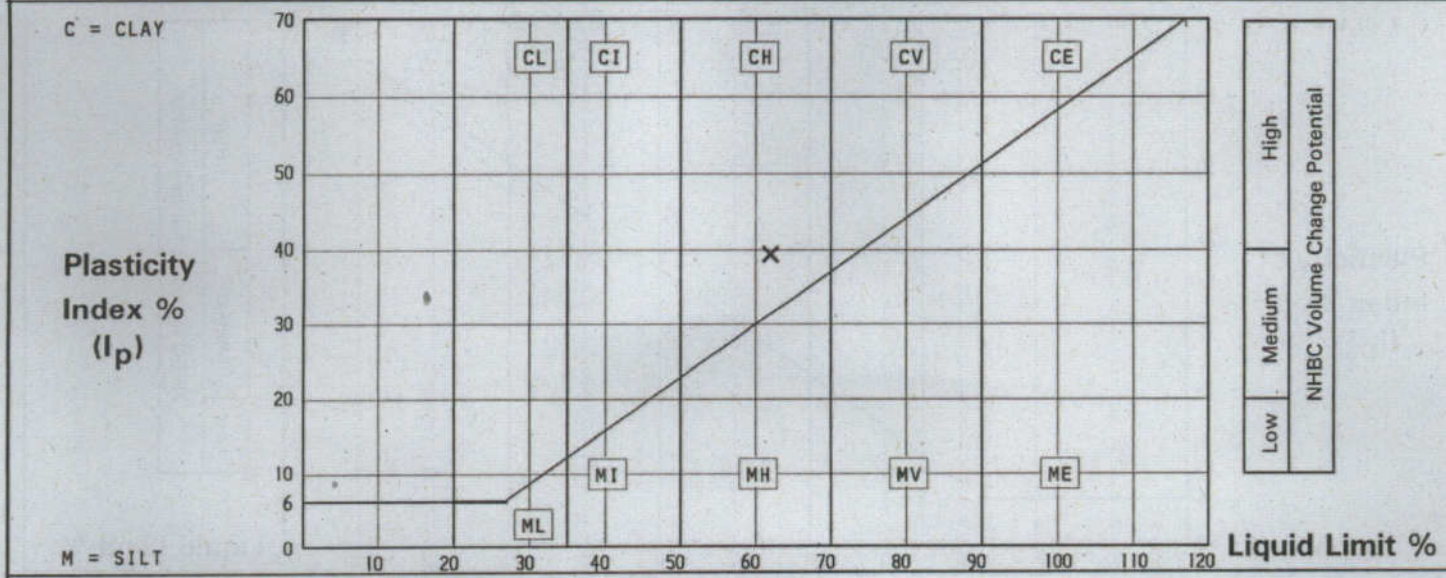
UKAS TESTING 0998

DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
BH2	2.10	U1	25	Stiff dark yellowish brown CLAY	

PREPARATION

Method of Preparation	Specimen from Natural Soil	Liquid Limit	62 %
Sample retained 0.425 sieve	(Assumed) 0 %	Plastic Limit	23 %
Corrected moisture content for material passing 0.425mm	%	Plasticity Index	39 %
Curing Time	118 Hours	Liquidity Index	0.05
		Clay Content	Not analysed. %
		Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 8 of 8

Contract: Canewden

Serial No.: S25844

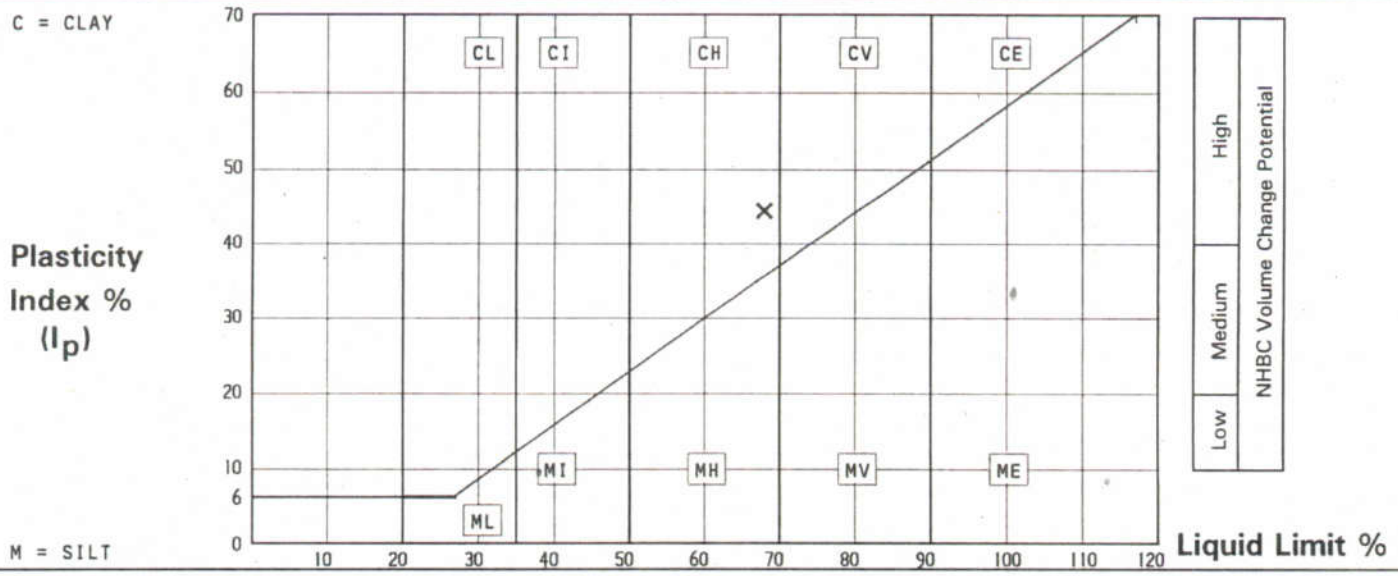
UKAS TESTING 0998

DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
BH2	4.00	U2	27	Stiff dark yellowish brown CLAY	

PREPARATION

Method of Preparation	Specimen from Natural Soil	Liquid Limit	68 %
Sample retained 0.425 sieve	(Assumed) 0 %	Plastic Limit	24 %
Corrected moisture content for material passing 0.425mm	%	Plasticity Index	44 %
Curing Time	166 Hours	Liquidity Index	0.07
		Clay Content	Not analysed. %
		Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

Appendix C

Results of Chemical Analysis

MLM
Building 7200
IQ Cambridge
Cambridge
CB25 9TL

FAO Simon Cook

LABORATORY TEST REPORT

Results of analysis of 5 samples received 6 September 2012

Canewden - 731776

Chemtest
The right chemistry to deliver results

Report Date
14 September 2012

Login Batch No					212343				
Chemtest LIMS ID					AH70537	AH70538	AH70539	AH70540	AH70541
Sample ID					BH1	BH1	BH1	BH2	BH2
Sample No					D1	D2	D3	D1	D2
Sampling Date					Not Provided	Not Provided	Not Provided	Not Provided	Not Provided
Depth					0.1m	0.4m	0.9m	0.3m	0.7m
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓	*					
2010	pH			M			8.9		7.9
2120	Sulfate (2:1 water soluble) as SO4	14808798	g l-1	M			0.03		<0.01
2450	Arsenic	7440382	mg kg-1	M	24	32	15	16	11
	Cadmium	7440439	mg kg-1	M	<0.10	<0.10	<0.10	<0.10	<0.10
	Chromium	7440473	mg kg-1	M	22	45	83	55	28
	Copper	7440508	mg kg-1	M	31	31	44	29	16
	Mercury	7439976	mg kg-1	M	<0.10	<0.10	<0.10	<0.10	<0.10
	Nickel	7440020	mg kg-1	M	18	38	49	33	18
	Lead	7439921	mg kg-1	M	6.5	14	17	13	8.0
	Selenium	7782492	mg kg-1	M	<0.20	<0.20	<0.20	<0.20	<0.20
	Zinc	7440666	mg kg-1	M	17	44	67	40	11
2700	Naphthalene	91203	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Acenaphthylene	208968	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Acenaphthene	83329	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Fluorene	86737	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Phenanthrene	85018	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Anthracene	120127	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Fluoranthene	206440	mg kg-1	M	< 0.1	< 0.1	0.19	< 0.1	< 0.1
	Pyrene	129000	mg kg-1	M	< 0.1	< 0.1	0.16	< 0.1	< 0.1
	Benzo[a]anthracene	56553	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Chrysene	218019	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Benzo[b]fluoranthene	205992	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Benzo[k]fluoranthene	207089	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

All tests undertaken between 06/09/2012 and 14/09/2012

* Accreditation status

This report should be interpreted in conjuction with the notes on the accompanying cover page.

MLM
Building 7200
IQ Cambridge
Cambridge
CB25 9TL

FAO Simon Cook

LABORATORY TEST REPORT

Results of analysis of 5 samples received 6 September 2012

Canewden - 731776

Chemtest
The right chemistry to deliver results

Report Date
14 September 2012

					212343				
					AH70537	AH70538	AH70539	AH70540	AH70541
					BH1	BH1	BH1	BH2	BH2
					D1	D2	D3	D1	D2
					Not Provided	Not Provided	Not Provided	Not Provided	Not Provided
					0.1m	0.4m	0.9m	0.3m	0.7m
					SOIL	*SOIL*	*SOIL*	*SOIL*	*SOIL*
2700	Benzo[a]pyrene	50328	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Dibenzo[a,h]anthracene	53703	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Indeno[1,2,3-cd]pyrene	193395	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Benzo[g,h,i]perylene	191242	mg kg-1	M	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Total (of 16) PAHs		mg kg-1	M	< 2	< 2	< 2	< 2	< 2

All tests undertaken between 06/09/2012 and 14/09/2012

* Accreditation status

This report should be interpreted in conjuction with the notes on the accompanying cover page.

Appendix D

Generic Assessment Criteria

Assessment Criteria – Human Health (soil)

Substance	Criteria Source	Residential			Industrial and Commercial		
Metals							
Arsenic	SGV 05.09	32			640		
Cadmium	SGV 07.09	10			230		
Chromium, III (total)	LQM/CIEH	3000			3.04 E+04		
Chromium, IV	LQM/CIEH	4.3			35		
Copper	LQM/CIEH	2330			7.17 E+04		
Lead	SGV 10	450			750		
Mercury	SGV 03.09	170			3600		
Nickel	SGV 03.09	130			1800		
Selenium	SGV 03.09	350			1.3 E+04		
Zinc	LQM/CIEH	3750			6.65 E+05		
Other Metals							
Antimony	EIC/AGS/CL:AIRE	550			7500		
Barium	EIC/AGS/CL:AIRE	1300			2.20 E+04		
Beryllium	LQM/CIEH	12			1950		
Boron	LQM/CIEH	291			1.92 E+05		
Molybdenum	EIC/AGS/CL:AIRE	670			1.70 E+04		
Vanadium	LQM/CIEH	140			4250		
TPHCWG carbon banding							
	Soil Organic Matter	1%	2.5%	6%	1%	2.5%	6%
aliphatic EC>5-6	LQM/CIEH	30	55	110	3400	6200	1.3E+4
aliphatic EC>6-8	LQM/CIEH	73	160	370	8300	1.8E+4	4.2E+4
aliphatic EC>8-10	LQM/CIEH	19	46	110	2100	5100	1.2E+4
aliphatic EC>10-12	LQM/CIEH	93	230	540	1.0E+4	2.4E+4	4.9E+4
aliphatic EC>12-16	LQM/CIEH	740	1700	3000	6.1E+4	8.3E+4	9.1E+4
aliphatic EC>16-35	LQM/CIEH	4.5E+4	6.4E+4	7.6E+4	1.6E+6	1.8E+6	1.8E+6
aromatic EC>5-7 (benzene)	LQM/CIEH	65	130	280	2.8E+4	4.9E+4	9.0E+4
aromatic EC>7-8 (toluene)	LQM/CIEH	120	270	611	5.9E+4	1.1E+5	1.9E+5
aromatic EC>8-10	LQM/CIEH	27	65	151	3700	8600	1.8E+4
aromatic EC>10-12	LQM/CIEH	69	160	346	1.7E+4	2.9E+4	3.45E+4
aromatic EC>12-16	LQM/CIEH	140	310	593	3.6E+4	3.7E+4	3.78E+4
aromatic EC>16-21	LQM/CIEH	250	480	770	2.8E+4	2.8E+4	2.8E+4
aromatic EC>21- 35	LQM/CIEH	890	1100	1230	2.8E+4	2.8E+4	2.8E+4
PAH Compounds							
	Soil Organic Matter	1%	2.5%	6%	1%	2.5%	6%
Acenaphthene	LQM/CIEH 2009	210	480	1000	8.5E+4	9.8E+4	1.0E+5
Acenaphthylene	LQM/CIEH 2009	170	400	850	8.4E+4	9.7E+4	1.0E+5
Anthracene	LQM/CIEH 2009	2300	4900	9200	5.3E+5	5.4E+5	5.4E+5
Benzo[a]anthracene	LQM/CIEH 2009	3.1	4.7	5.9	90	95	97
Benzo[a]pyrene	LQM/CIEH 2009	0.83	0.94	1		14	
Benzo[b]fluoranthene	LQM/CIEH 2009	5.6	6.5	7		100	
Benzo[ghi]perylene	LQM/CIEH 2009	44	46	47	650	660	660
Benzo[k] fluoranthene	LQM/CIEH 2009	8.5	9.6	10		140	
Chrysene	LQM/CIEH 2009	6	8	9.3		140	
Dibenzo[ah]anthracene	LQM/CIEH 2009	0.76	0.86	0.9		13	
Fluoranthene	LQM/CIEH 2009	260	460	670		2.3E+4	
Fluorene	LQM/CIEH 2009	160	380	780	6.4E+4	6.9E+4	7.1E+4
Indeno[123-cd]pyrene	LQM/CIEH 2009	3.2	3.9	4.2	60	61	62
Naphthalene	LQM/CIEH 2009	1.5	3.7	8.7	200	480	1100
Phenanthrene	LQM/CIEH 2009	92	200	380	2.2E+4	2.2E+4	2.3E+4
Pyrene	LQM/CIEH 2009	560	1000	1600		5.4E+4	
BTEX Compounds							
Benzene	SGV 03.09	0.33			95		
Toluene	SGV 03.09	610			4,400		
Ethylbenzene	SGV 03.09	350			2,800		
o-Xylene	SGV 03.09	250			2,600		
m-Xylene	SGV 03.09	240			3,500		
p-Xylene	SGV 03.09	230			3,200		
Other Compounds							
Cyanide, total	Dutch IV	50			50		
Phenol, total	SGV 06.09	420			3200		

Notes:

1. GAC based on sandy loam soil with SOM 6% (except TPH and PAH compounds)
2. All units mg kg^{-1}
3. Where GAC for TPH are exceeded, consider calculating SSAC to determine if risk is from ingestion (for which capping may be required) or from inhalation (for which vapour protection may be required)
4. GAC for TPH may be used as v-GAC for organic vapour assessment

Assessment Criteria – Controlled Waters

	EQS (µg l^{-1})			UK DWS (µg l^{-1})		EQS (µg l^{-1})	UK DWS (µg l^{-1})
List 1 dangerous substances							
	Fresh	Estuary	Marine				
Mercury	1	0.5	0.3	1	Endrin	0.005	0.1
Cadmium	5	5	2.5	5	Total 'Drins	0.03	-
Hexachlorocyclohexane	0.1	0.02	0.02	-	Hexachlorobenzene	0.03	-
Carbon tetrachloride	12			-	Hexachlorobutadiene	0.1	-
Total DDT	0.025			0.5	Chloroform	12	-
pp DDT	0.01			-	1,2-dichloroethane	10	-
Pentachlorophenol	2			0.1	Trichlorethylene	10	-
Dieldrin	0.01			0.03	Perchlorethylene	10	-
Isodrin	0.005			0.1	Trichlorobenzene	0.4	-
Aldrin	0.01			0.03			

List 2 dangerous substances				
1,1,1-Trichloroethane	100	-	Fenitrothion	0.01	0.1
1,1,2-Trichloroethane	400	-	Flucofuron	1	0.1
2,4-D (ester)	1	-	Iron	1000	200
2,4-D (non-ester)	40	-	Linuron	2	0.1
2,4-Dichlorophenol	20	-	Malathion	0.01	0.1
2-Chlorophenol	50	-	Mecoprop	20	0.1
4-Chloro-3-methyl-phenol	40	-	Mevinphos	0.02	0.1
Arsenic	50	10	Naphthalene (use for PAH)	10	0.1
Atrazine & Simazine	2	0.1	Omethoate	0.01	0.1
Azinphos-methyl	0.01	0.1	PCSDs	0.05	0.1
Bentazone	500	0.1	Permethrin	0.01	0.1
Benzene (use for TPH)	30	1	pH	6 - 9	6.5 - 10
Biphenyl	25	-	Sulcofuron	25	0.1
Boron	2000	1	Toluene	50	0.1
Chloronitrotoluenes	10	-	Triazaphos	0.005	0.1
Cyfluthrin	0.001	0.1	Tributyltin	0.02	0.1
Demeton	0.5	0.1	Trifluralin	0.1	0.1
Dichlorvos	0.001	0.1	Triphenyltin	0.02	0.1
Dimethoate	1	0.1	Xylene (m and p, o)	30	-
Endosulphan	0.003	0.1			

List 2 dangerous substances (hardness related)							
Hardness (mg l^{-1} $CaCO_3$)	0-50	>50 -100	>100 -150	>150 -200	>200 -250	>250	
Suitable for all fish							
Copper	1	6	10	10	10	28	2000
Nickel	50	100	150	150	200	200	20
Vanadium	20	20	20	20	60	60	-
Suitable for salmonid (game) fish							
Chromium	5	10	20	20	50	50	50
Lead	4	10	10	20	20	20	25
Zinc	8	50	75	75	75	125	-
Suitable for Cyprinid (coarse) fish							
Chromium	150	175	200	200	250	250	50
Lead	20	125	125	250	250	250	25
Zinc	75	175	250	250	250	500	-

Other Compounds			
Acrylamide	0.1	Tetrachloroethene and Trichloroethene	10
Antimony	5	Trihalomethanes (ii)	100
Benzo(a)pyrene	0.01	Vinyl chloride	0.5
Bromate	10	Aluminium	200
Cyanide	50	Iron	200
1, 2-dichloroethane	3	Manganese	50
Epichlorohydrin	0.1	Sodium	200
Fluoride	1.5	Tetrachloromethane	3
Heptachlor	0.03	Ammonium	0.5 mg l^{-1}
Heptachlor epoxide (iii)	0.03	Nitrate	50 mg l^{-1}
Other pesticides	0.1	Nitrite	0.5 mg l^{-1}
Pesticides (total)	0.5	Chloride	250 mg l^{-1}
Polycyclic aromatic hydrocarbons (i)	0.1	Sulphate	250 mg l^{-1}
Selenium	10	TPH (1989 Regs)	10

Notes:

i. Specified compounds are benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]-perylene, indeno[1,2,3-c,d]pyrene.
ii. Specified compounds are chloroform, bromoform, dibromochloromethane, bromodichloro-methane.

Unless stated otherwise all units µg l^{-1}

Assessment Criteria – Water Supply Pipework

Substance [1]	WRAS (withdrawn)	Anglian Water	UK WIR	
			PE	PVC
Organic compounds				
TPH	50	50 – 1000 [2]	-	
TPH >C5-C10	-	-	2	1.4
TPH >C11-C20	-	-	10 [3]	NL
TPH >C21-C40	-	-	500 [3]	NL
Extended VOC suite	-	-	0.5 [3]	0.125 [3]
Extended SVOC suite	-	-	2 [3]	1.4 [3]
BTEX + MTBE	-	-	0.1	0.03
Chlorinated hydrocarbons				
Dichloromethane	-	1	-	-
1,2-dichloroethane	-	0.2	-	-
1,1,1-trichloroethane	-	8	-	-
1,2-dichloropropane	-	0.1	-	-
Tetrachloromethane	-	0.15	-	-
Trichloroethene	-	1.5	-	-
Tetrachloroethene	-	0.5	-	-
Vinyl chloride	-	0.1	-	-
Methyl bromide	-	10	-	-
Total	-	7	-	-
Aromatic hydrocarbons				
Benzene	-	0.5	0.1	0.03
Ethylbenzene	-	0.5	0.1	0.03
Trimethyl benzene	-	0.1	-	-
Propylbenzene	-	2	-	-
Toluene	-	0.25	0.1	0.03
Xylenes	-	0.5	0.1	0.03
Phenol	5	1	2 [3]	0.4 [3]
Cresol	-	1	2 [3]	0.04 [3]
Total	-	7	-	-
Chlorinated phenols				
Chlorophenols	-	0.5	-	-
Dichlorophenols	-	0.5	-	-
Trichlorophenols	-	0.5	-	-
2,4,6-trichlorophenol	-	0.5	-	-
Pentachlorophenol	-	0.5	-	-
Total	-	1	2 [3]	0.04 [3]
Chlorinated aromatic hydrocarbons				
Chlorobenzene	-	0.5	-	-
Dichlorobenzene	-	0.5	-	-
Trichlorobenzene	-	0.5	-	-
Pentachlorobenzene	-	0.5	-	-
Total	-	1	-	-
Polyaromatic hydrocarbons				
Naphthalene	-	5	-	-
Anthracene	-	10	-	-
Phenanthrene	-	10	-	-
Fluoranthene	-	10	-	-
Pyrene	-	10	-	-
Benzo[a]pyrene	-	1	-	-
Total	50	20	2	1.4
Other organic compounds				
Tetrahydrafurane	-	4	-	-
Styrene	-	5	-	-
Pyridine	-	2	-	-
Ethers	-	-	0.5	1
Nitrobenzene	-	-	0.5 [3]	0.4 [3]
Ketones	-	-	0.5 [3]	0.02 [3]
Aldehydes	-	-	0.5	0.02
Amines	-	-	Detected	NL

Notes:

1. All units mg kg^{-1} in soil.
2. The threshold for TPH is 1000mg kg^{-1} provided no other organic compounds are present. If the TPH level exceeds 50mg kg^{-1} then the sum of TPH plus other organic compounds must not be greater than the upper threshold. If the other compounds are not tested for then the threshold for TPH must be set at the lower threshold.
3. All UKWIR TV's (except BTEX and MTBE) are based on taste and odour detection threshold.
4. PE – polyethylene; PVC – polyvinyl chloride

Appendix E

Defining Risk

Risk Assessment

The environmental risks identified for each pollutant linkage shown in the Conceptual Model and Risk Assessment (section 4) has been derived using a matrix based on the model provided in CIRIA C552 Contaminated Land Risk Assessment, A guide to Good Practice, which considers both the magnitude of consequence and the likelihood of occurrence.

The overall risk is determined by using a worst case scenario matrix as follows.

		Likelihood of Occurrence				
		Almost Certain	**Likely**	**Possible**	**Unlikely**	**Very Unlikely**
Potential Magnitude of Consequence	**Severe**	Very High	High	Moderate	Low	Low
	Moderate	High	Moderate	Moderate	Low	Very Low
	Mild	Moderate	Moderate	Low	Very Low	Very Low
	Negligible	Low	Low	Very Low	Very Low	Very Low

Input for the matrix above is based on the following scenarios for the potential magnitude of the consequence and the likely occurrence of the event.

Potential Magnitude of the Consequence

Severe	• Permanent damage to buildings and structure • Long term irreversible damage to human health • Acute contamination of groundwater and/or surface water
Moderate	• Major (but reversible) damage to buildings and structures. • Long term (but curable) effects on human health • Heavy contamination of groundwater and /or surface water
Mild	• Minor reversible damage to building and structure • Short term effects on human health. • Minor contamination of groundwater and/or surface water
Negligible	• Very little or no damage to buildings and structures. • Very minor, short term or no effects on human health. • Very little or no contamination of groundwater and/or surface water

Likelihood of Occurrence

Almost Certain	• There is a clear pollutant linkage and circumstances are such that an event will inevitably occur or there is already evidence of harm to receptors
Likely	• There is a pollutant linkage and circumstances are such that an event is likely to occur in either the long or short term
Possible	• There is a pollutant linkage and circumstances are possible under which the event could occur in the short term but more likely in the long term
Unlikely	• There is a pollutant linkage and circumstances are possible under which the event could occur. It is however, unlikely in long term and even less so in the short term
Very Unlikely	• There is a pollutant linage however circumstances are such that it is unlikely that an event would ever occur