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PHASE I - III GEO-ENVIRONMENTAL SITE INVESTIGATION

Chartwell Road, Lancing Business Park
Lancing
West Sussex

REC REFERENCE: 20839P1R0

REPORT PREPARED FOR: GRALAW LTD AND BV 3663

JANUARY 2015



QUALITY ASSURANCE

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EXECUTIVE SUMMARY	
Site Address	Former Graham Wood Structural site, Chartwell Road, Lancing Business Park, Lancing, BN15 8TY
Grid Reference	E517608, N103936
Site Area	1.69ha
Current Site Use	The subject site comprised two (2 no.) stores with travelling cranes located within the southern area, whilst the northern area comprised a two-storey office building and a works unit to the east of the office. The majority of the site was covered with high grade concrete or a gravel and aggregate top surface.
Environmental Setting	The site is underlain by a Secondary (A) Aquifer (moderate risk receptor). The site is not located within an Environment Agency designated Source Protection Zone (SPZ). There are no groundwater abstractions within 1.0km of the site boundary. The site is not within an area that is at risk from flooding.
Site History	Historical maps indicate that the site was largely undeveloped up until 1932, when the site was occupied by a number of railway sidings, tanks and buildings associated with such industry. The site then formed part of the current industrial estate in 1970-71, with the site within its current configuration from 1972-76.
Landfill Sites & Ground Gases	A historical landfill was located 362m south-west of the subject site and is understood to have held inert, industrial, commercial and household waste. The landfill had a licence from 1976 but there are no other details to when operations ceased.
Geology, Hydrology & Hydrogeology	**Superficial Deposits** – Brickearth (Sand, Silts and Clays) **Bedrock** – Lambeth Group (Clay, Silt and Sand) **Groundwater** – Secondary (B) Aquifer - Brickearth and Secondary (A) Aquifer – Lambeth Group There are no surface water courses within 250m of the subject site.
Intrusive Ground Investigation	
Ground Conditions	**Made Ground** Made Ground was encountered within all intrusive locations to a maximum depth of 1.80m bgl (WS104). The unit comprised a variable mix of fine and coarse grained soils with an occasional clay chalk fill. The unit comprised variable amounts of minor constituents such as brick, concrete, porcelain, flint, chalk, plastic, ash, charcoal, aggregate, black organic matter, rusted metal, wound metal cable and metal rings. **Superficial Deposits** **Brickearth** Brickearth was noted to be highly variable with both fine and coarse grained soils recorded at varying depths across the site. The fine grained soils predominately comprised very soft to soft brown –grey silty CLAY whilst the coarse grained soils were encountered either as a clayey SAND or clayey sandy GRAVEL. Brickearth was recorded to a maximum depth of 3.00m bgl within WS104. **Raised Beach Deposits** The unit initially comprised a soft to firm brown-orange gravelly CLAY with gravel of flint and chert, thereafter the unit was typically encountered as a brown-orange to dark yellow slightly clayey SAND and GRAVEL. The Raised Beach Deposits were encountered to a maximum depth of 3.00m bgl (WS106), all be it the base was not

encountered.

Bedrock

Lambeth Group

The unit was typically encountered as dark yellow to orange fine to medium SAND with variable amounts of gravel, clay and silt. The Lambeth Group was encountered to a maximum depth of 4.00m bgl (WS101, WS103 and WS104) with the base of the unit not encountered.

Groundwater was encountered within the bedrock of the Lambeth Group at depths ranging from 3.00m bgl to 3.50m bgl.

Geotechnical Assessment

Units 2-6- western area of the site

It is estimated that an allowable bearing capacity in the range of **77 to 115 kPa** is achievable for conventional circular or square foundations with a width of 1.00m and factor of safety of 3, limiting total settlement to less than 25mm. **(Unit 2 to 6 - western area of the site)**. Should higher bearing capacities be required, consideration should be given, or a piled solution.

Warehouse and office- eastern area of the site

It is estimated that an allowable bearing capacity of **100 kPa to >200 kPa** for conventional foundations with a width less than 1.00m, limiting total settlement to less than 25mm. **(Warehouse and office – eastern area of the site)**.

North-western area
It is recommended that either a piled foundation solution, or a raft foundation explored for the proposed building within the north-western area.

It is considered that subsurface concrete can be designed in accordance with Design Sulphate Class DS-2, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-2 in accordance with the recommendations provided in BRE Special Digest 1 (2005).

It is considered that an approximate permeability of 3.46×10^{-6} to 2.19×10^{-6} m/s is indicative of the site for the coarse grained soils of Raised Beach Deposits and Brickearth, which typifies soils of a moderate permeability and as such are likely to have significant soakage potential.

It is considered that a CBR of 7% is achievable for the subject site. Any value greater than 7% is considered to account for the variability of made ground.

Developed Conceptual Site Model (CSM)

The Tier I Human Health Risk has not identified any concentrations of constituents of concern that exceed the Tier I screening values (commercial) for the protection of human health.

The subject site is not considered to present a significant risk to controlled waters.

The ground gas assessment indicates a moderate risk to future site users and is classified as Characteristic Situation 2, and as such gas protection measures are required for the subject site. This assessment is based on three (3 no.) initial visits and therefore based on industry guidance further visits (a total of 6) should be undertaken pre adoption, subject to agreement with the Local Authority.

Recommendations

It is recommended that one or two of the following gas protection measures should be incorporated into any new structures:

- Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft) with at least 1200g DMP;
- Installation of a suitable sub floor void former or coarse sub-base matrix capable of achieving complete volume change in 24hr period;
- Independent validation to confirm appropriate installation of membrane; and,
- All joints and service penetrations to the taped and sealed.

If any unexpected contamination is encountered during the construction phase, it is recommended that works are stopped in the affected area and that contact is made with a suitably qualified geo-environmental consultant.

If consideration is given to a stiffened edge raft foundation, it is recommended that plate load testing is undertaken to determine settlement and to aid in the raft design. If a piled design is considered, it is recommended that a deep borehole is undertaken circa 15.00m bgl to accurately determine strata changes and undertake in-situ tests to depth.

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1.0 INTRODUCTION

1.1 Background

Resource and Environmental Consultants (REC) Ltd have been commissioned by KMG Partnership on behalf of Grawlaw Ltd and BV 3663 to undertake a Phase I to III Intrusive Investigation at Former Graham Wood Structural Ltd site, Chartwell Road, Lancing Business Park, Lancing, BN15 8TY.

1.2 Proposed Development

We understand that the proposed development is to demolish the current vacant industrial estate on site and re-develop into two (2 no.) industrial plots. The plot on the western side of the site is to comprise of six (6 no.) industrial units (between 371 m^2 to 496 m^2) with associated car parking and a total area of 0.65 ha. The plot on the eastern side of the site is to consist of a depot with loading docks, lorry parking bays and car parking spaces, a total area of 1.05 ha. At the time of writing the proposed loadings of the development are not known.

1.3 Objectives

The objectives of the geo-environmental investigation are to:

- Review historical plans, geology, hydrogeology, site sensitivity, flood-plain issues, mining records and any local authority information available in order to complete a Desk Study in line with Environment Agency (EA) document Model Procedures for the Management of Contaminated Land (Contaminated Land Report 11 (CLR11));
- Undertake a preliminary stage of sampling and analysis to provide an overview of environmental issues identified;
- Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors;
- Assess the geotechnical information and provide preliminary recommendations in relation to foundations, pavement construction and floor slabs;
- Provide an assessment of the soakage of the underlying soils to assist in the design of infiltration based SuDS.
- Provide recommendations regarding future works required.

1.4 Limitations

The limitations of this report are presented in Appendix I.

1.5 Confidentiality

REC has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from REC; a charge may be levied against such approval.

2.0 SITE SETTING

2.1 Site Details

Site Address	Former Graham Wood Structural Ltd site, Chartwell Road, Lancing Business Park, Lancing, BN15 8TY
National Grid Reference	E517608, N103936
Site Area	1.69ha

All acronyms used within this report are defined in the Glossary presented in Appendix II.

A site location map is presented in Appendix III.

2.2 Current Site Use

Site Description

The subject site was accessed on the 01st December 2104, on the north-western corner of the site from Chartwell Road. The subject site comprised two (2 no.) stores with travelling cranes located within the southern area, whilst the northern area comprised a two-storey office building and a works unit to the east of the office. The majority of the site was covered with high grade concrete or a gravel and aggregate top surface.

At the time of the walkover it was evident, the site had been disused for a period of time with overgrown vegetation.

In front of the works building, there were several compressed gas containers present. To the rear of the most southern store appeared to be a large chemical store.

Hazardous Materials Storage

A metal storage tank which was diesel filled was noted within the front of the most northern store building. The tank (~1.50(l) x ~0.50m (w) x ~1.00m (h)) appeared not to have leaked and was double skinned. The tank appeared to be portable via pallet truck due to metal bars present underneath the tank.

Seven (7 no.) industrial bulk containers (IBCs) were located on the eastern area of the site behind the two stores. The containers were filled with red liquid which on the container appeared to identify the liquid as a waste solvent. The containers had been welded shut and appeared not to have leaked at the time of the walkover.

Polychlorinated Biphenyls (PCBs)

No equipment that may potentially contain PCBs was observed at the site.

Waste Storage

No potentially hazardous waste streams are generated at the property, however on the eastern area of the site behind the works and store there were a number of materials and waste dumped. The waste predominately comprised scaffolding boards and poles, with others being miscellaneous

items.

Asbestos Containing Material (ACM)

Corrugated cement asbestos sheeting was noted to be present on the outside of the works and store building. REC also recommends that the contractor working on the scheme satisfy themselves that ACMs are not present in other areas of the site prior to undertaking any demolition works

Drainage Issues

A formal drainage survey has not been completed however foul sewers were noted across the site to link into Chartwell Road.

2.3 Surrounding Area

The surrounding land uses are summarised below:

Direction	Land Use
North	Industrial Units
East	Industrial Units
South	Industrial Units
West	Scrapyard, Waste Transfer Station

3.0 SITE HISTORY

3.1 On-Site Historical Development

A review of historical mapping pertinent to the site is summarised in Table 3.1 below. In addition, a selection of historical maps are presented within Appendix IV.

Table 3.1 Summary of Potentially Contaminative Historical Land Uses

Map Edition	Historical Land Use
1873(1:2,500)	The site occupies two fields pertaining to the off-site property "New Barn". The majority of the site is within the eastern field, with the south-western corner in the other field with a track running through it.
1912 (1:2,500)	A rail line apparently a sidings is present on the eastern boundary of the site, otherwise no significant change in land use.
1932 (1:2,500)	A number of railway sidings are now situated across the site from east to west and the areas forms an entry point to the Southern Railway carriage works to the south. Two small buildings are present on the eastern area of the site and are assumed to be associated with railway works.
1943 (1:2,500)	Two tanks present on site, one in south-eastern area the other within the south-western area of the site. However no details of what the tank holds are given.
1951 (1:1,250)	The eastern area of the site occupied by a number of buildings associated with the railway carriage works. Eastern tank no longer present on site.
1970-71 (1:1,250)	The subject site is now Churchill Industrial Estate, the majority of the site is cleared but two buildings are present within the eastern area of the site.
1972-76 (1:2,000)	The site is within its current configuration, all be it the southernmost store and travelling crane is not evident.
1979-84 (1:2,000)	The southernmost store and travelling crane is present.
1991-94 (1:2,000)	No significant change in land use.
2014 (1:10,000)	No significant change in land use.

3.2 Off-Site Historical Development

A review of potentially contaminative uses identified on historical Ordnance Survey maps within a 250m radius of the site is summarised below in Table 3.2.

Table 3.2 Summary of Potentially Contaminative Off-Site Historical Land Uses

Surrounding Feature	Distance	Dates	Direction
Tank	~50m	pre 1873-pre 1912	South
Railway Line	~200m	pre 1873 to present	North
Railway/Carriage Works	~20m	1912 to pre 1970-71	East

Surrounding Feature	Distance	Dates	Direction
Extension of Railway/Carriage Works	Adjacent	1932 to pre 1970-71	South
Tanks 6 more Tanks	~250m ~50-250m	1932 to pre 1970-71 1943 to 1970-71	South North, East and South
Electrical substation	Immediately	1970-71 to 1994*	South
Printing works	~10m	1970-71 to 1994*	South
Numerous Factories	~50m-200m	1970-71 to 1994*	N,E,S,W
Timber works	~100m	1970-71 to 1994*	South-west
Engineering works	~200m	1970-71 to 1994*	South-west

Notes - * Based on mapping scale ceasing at 1994

3.3 Planning History

REC has undertaken a review of on-line planning records held by Adur and Worthing Council and no environmentally pertinent information has been obtained.

4.0 ENVIRONMENTAL SETTING

4.1 Geology & Hydrogeology

The British Geological Survey (BGS) map for the site, (Sheet 318, 1:50,000, Brighton and Worthing, Solid & Drift edition) indicates that the site is underlain by the following geological sequence:

Geological Unit	Classification	Description	Aquifer Classification
Brickearth	Superficial Deposits	Sand, Silt and Clay	Secondary (B) Aquifer
Lambeth Group	Bedrock	Clay, Silt and Sand	Secondary (A) Aquifer

The Groundsure report indicates there are no groundwater abstractions within 1.0km radius of the site. The site is not located with an Environment Agency designated Groundwater Source Protection Zone (SPZ)

Based on the local topography and location of surface watercourses it is considered likely that shallow groundwater, if present, will flow in a southern direction toward the sea.

4.2 Geotechnical Data

Geotechnical Data presented within the Groundsure report identifies the following ground conditions:

Hazard	Designation
Shrink-Swell Clay	Low.
Landslides	Negligible.
Ground Dissolution	Negligible.
Compressible Ground	Negligible.
Collapsible Deposits	Low.
Running Sand	Low.

4.3 Historic Ground Workings

A number of historic ground workings have been undertaken within 250m of the subject site, with two unspecified pits opened up north-east and north-west of the site. A former refuse heap 99m north-west of the site is detailed within the Groundsure report.

According to the Groundsure report a number of historical railway features are present, these are probably pertaining to the former use as carriage works. The database indicates, that a number of railway sidings may still be present on site.

4.4 Hydrology

There are no surface water courses within 250m of the subject site.

4.5 Radon Risk Potential

The Groundsure Report indicates the site is situated in an area where between 1% and 3% of homes are above the Action Level and that the BGS reports that full radon protective measures are not necessary in the construction of new dwellings or extensions.

4.6 Industrial Land Uses

The site is situated within an industrial area and there are eighty-five (85 no.) industrial land uses within 250m of the subject site. Four of the industrial uses relate to the on-site travelling cranes and former operations at the site. There are two (2 no.) electrical substations adjacent to the site, 5m south and 7m north-east of the site.

4.7 Sensitive Land Uses

No environmentally sensitive land uses have been identified within close proximity to the subject site.

4.8 Site Sensitivity Assessment

The site is considered to be located within a low to moderate sensitivity setting due to the following reasons:

- Bedrock is designated as a Secondary (A) Aquifer;
- The underlying geology comprising low permeability strata with Secondary (A) and (B) Aquifers; and,
- There are no surface watercourses within influencing distance of the site.

5.0 CONSULTATIONS

5.1 Local Authority Contaminated Land Officer

The Contaminated Land Officer at Adur and Worthing Council was contacted regarding any specific reports of pollution or nuisance at the subject site. A response is currently awaited and will be reported as soon as available.

5.2 Landfill Sites and Waste Treatment Sites

A historical landfill was located 362m south-west of the site, which held inert, industrial, commercial and household waste. The landfill held a licence from 1976, with no details of when the licence was relinquished. The subject site used to be a licensed waste site which is classed a specialist waste transfer station.

5.3 Regulatory Database

The following information has been obtained from a commercially available environmental database. The summary table only includes records not otherwise detailed in the report. A full copy of the database report is provided on the CD at the rear of this report.

Table 5.1 Summary of Groundsure Data

	0-249m	250-500m	Details
Contaminated Land Register Entries and Notices	0	0	N/A
Authorised industrial processes (IPC/IPPC/LAPPC).	14	2	On site – permits for coating and enamelling with no enforcements notified.
Fuel Stations Entries	0	0	N/A
Licensed radioactive substances	0	0	N/A
Enforcements, prohibitions or prosecutions	0	0	N/A
Discharge Consents	10	8	Closest 91m north-west, a packaging factory discharge to surface water, which was revoked in 1997.
Pollution Incidents	8	12	Closest 12m west, causing minor impact to land from inert materials and waste.
Consents issued under the Planning (Hazardous Substances) Act 1990	0	0	N/A
Control of Major Accident Hazard (COMAH) sites	0	0	N/A

6.0 INITIAL CONCEPTUAL SITE MODEL (CSM)

6.1 Initial CSM

In accordance with Environment Agency, CLR 11 (2004) and BSI 10175 (Code of Practice for Investigation of Potentially Contaminated Land), REC Ltd have developed an initial CSM to identify potential contamination sources, migration pathways and receptors within the study area.

6.2 Contaminant Sources

On-site Potential Sources

- Historic Made Ground associated with current and historical development including:
- Historic railway sidings; and,
- Historic Tanks on-site.

Off-site Potential Sources

Potentially historical contaminative land uses within 250m of the subject site including:

- Railway Sidings, Tanks, Works and Factories;
- Two (2 no.) electrical substations (5m south and 7m south east); and,
- Historical landfill (362m south-west)

6.3 Potential Pathways

- Ingestion of contaminated soil;
- Dermal contact;
- Inhalation of fibres, vapours and dust; and;
- Lateral and vertical migration.

6.4 Potential Receptors

- Future site users;
- Secondary (A) Aquifer; and,
- Secondary (B) Aquifer.

Construction workers are not considered to be a plausible receptor as exposure will be managed through the use of appropriate PPE and hygienic working practices as required under HSE / CDM regulations. Furthermore, the length of any exposure is likely to be for a short duration.

An Initial Conceptual Site Model has been prepared for the site and is presented within Table 6.1.

Table 6.1 Initial Conceptual Site Model

Source	Contaminant	Potential Migration pathways	Potential Receptors	Likelihood of Occurrence On site	Magnitude of Occurrence	Overall Risk Rating	Active/Inactive
On site							
Historic Made Ground associated with development including railway sidings and historic uses within 250m of the subject site	Metals (As, Cd, Cr, Pb, Hg, Se, Ni) Polycyclic Aromatic Hydrocarbons (PAH) Asbestos fibres in Soil Ground Gas (CO_2 and CH_4) Total Petroleum Hydrocarbons (TPH)	Ingestion of contaminated soils Dermal contact with contaminated soils Ingestion of contaminated soils Dermal contact with contaminated soils Inhalation of fibres Migration into Buildings Inhalation of Vapours Vertical Migration	Future Site Users Secondary (A) and (B) Aquifer	Likely Unlikely	Medium Medium	Moderate Moderate	**Active** – Further Investigation **Active** – Further Investigation **Active** – Further Investigation **Active** – Further Investigation **Active** – Further Investigation **Active** – Further Investigation
Off Site							
Potentially Historical contaminative land uses within 250m of the subject site	Total Petroleum Hydrocarbons (TPH) and Volatile Organic Compounds Ground Gas (CO_2 and CH_4) Historical Landfill (382m south-west)	Lateral migration onto site via preferential pathway Migration of vapours into buildings Lateral migration onto site via preferential pathway Migration of ground gas into buildings Lateral migration onto site via preferential pathway contact and ingestion of contaminated soils	Future Site Users Future Site Users Future Site Users	Likely Likely Unlikely	Medium Medium Medium	Moderate Moderate Moderate	**Active** – Further Investigation **Active** – Further Investigation **Inactive** - PCB's have a limited mobility and any contamination is likely to be localised immediately around the substation. It is therefore considered unlikely that lateral migration to the subject site would occur.

7.0 SITE INVESTIGATION

7.1 Site Investigation

7.1.1 General

A ground investigation has been designed based on the findings of the desk study with exploratory holes advanced to target specific potential contaminant sources set out in Table 6.1. In addition, exploratory holes have also been advanced to provide information on baseline conditions across the site, in view of the proposed development. The investigation has also been used to collect geotechnical information to assist in the design and construction of the development.

Exploratory fieldwork was completed on the 01st and 02nd December 2014. The works are summarised in Table 7.1.

Table 7.1 Summary of Fieldwork

Potential Source/Rationale	Location Hole	Type	Maximum Depth (m bgl)	Monitoring Wells Response Zone (m bgl)
Provide baseline geotechnical conditions across the site and confirm the findings of the initial conceptual site model	WS101	Window Sample	4.00	1.00-4.00
	WS102		3.00	N/A
	WS103		4.00	N/A
	WS104		4.00	1.00-3.00
	WS105		3.00	N/A
	WS106		3.00	1.00-3.00
Provide anticipated soakaway conditions	TP101	Machine Excavated Trial Pit	2.00	N/A
	TP102a		2.20	
Identify existing foundation conditions at the site and provide baseline geotechnical conditions	TP102b		1.30	
	TP103		1.60	
	TP104		0.70	
	TP105		1.30	
	TP106		1.70	
Provide baseline geotechnical conditions across the site and confirm the findings of the initial conceptual site model	TP107		2.00	
Provide anticipated soakaway conditions	TP108		2.00	

Notes
m bgl – metres below ground level.

The window sample holes and trial pits were designed to provide geotechnical information, and to retrieve environmental samples for chemical testing in order to confirm the findings of the Initial Conceptual Site Model (ICSM). The trial pits were designed to identify existing foundation conditions at the site and provide anticipated infiltration conditions.

The sampling locations are illustrated in Figure 2 and Figure 3 (Appendix III).

The ground conditions encountered and details of monitoring well response zones are indicated on the logs which are provided in Appendix VI.

All samples were collected using appropriate PPE and sampling equipment that was cleaned at each sampling location. A detailed copy of REC Ltd sampling methodology, QA procedures and laboratory chain of custody forms can be provided upon request.

7.2 In-Situ Testing

7.2.1 In-Situ Standard Penetration Testing (SPT)

In-situ geotechnical testing was conducted using the Standard Penetration Test (SPT) and where the ground is granular, a 60° cone (SPT(C)) was used instead of the sampling tube. The results are shown in the borehole logs in Appendix VI and presented in Table 8.3 and discussed in Section 8 and 10.

7.2.2 Hand Shear Vanes

In-situ geotechnical testing was carried out by hand shear vane tests in the fine grained soils. The tests were undertaken using 33mm and 19mm shear vane paddle. The results of the in-situ testing are presented within exploratory hole logs in Appendix VI and presented in Table 8.3.

7.2.3 In-Situ California Bearing Ratio (CBR)

In-situ CBR tests were undertaken at selected locations using a TRL probe, with locations presented in Figure 3 (Appendix III). Tests were undertaken at depths of ground level and 1m below ground level in order to intersect the likely pavement sub formation level. The results are presented in Table 8.8 and testing certificates are presented in Appendix X.

7.3 Laboratory Analysis

7.3.1 Soil Chemical Analysis

Selected soil samples were submitted for a range of chemical analysis comprising, metals, pH, total sulphate, water soluble sulphate (2:1 extract), sulphide, cyanide, phenols, total and speciated poly-aromatic hydrocarbons (PAHs), asbestos, and speciated petroleum hydrocarbon (TPH).

Chemical analysis was undertaken on deeper soil samples included pH and sulphate (2:1 extraction) analysis to aid concrete design. The results of these tests are included within the soil chemical test data in Appendix VII and discussed in Sections 8 and 10.

Scientific Analysis Laboratories (SAL) Ltd of Braintree undertook the analytical work and the testing results are included in Appendix VII and discussed in Section 9.0.

7.3.2 Geotechnical Laboratory Analysis

Selected soil samples were submitted to Professional Soil Laboratories (PSL) Ltd of Doncaster, where the following geotechnical tests were undertaken:

- Atterburg Limits Determinations;
- Particle Size Distribution Tests; and,
- Re-compacted California Bearing Ratio (CBR) determinations.

Laboratory analysis sheets are included in Appendix IX and are summarised in Section 8.0.

7.4 Gas and Groundwater Monitoring

Following the intrusive phase of site works, gas and groundwater monitoring was undertaken from the 10th December 2014 to 22nd December 2014, on three (3 no.) occasions.

Concentrations of methane (CH_4), carbon dioxide (CO_2) and Oxygen (O_2) were measured using an infra-red gas analyser (GFM435), calibrated to a reference standard (before and after each survey) and gas flow rates were measured using an internal flow pod. Gas measurements were recorded for a minimum of ninety seconds at each location, at which point the maximum concentration of CH_4 and CO_2 together with the lowest concentration of O_2 were recorded.

Groundwater monitoring was undertaken using an electronic dip meter to record the depth to groundwater. Ground gas and groundwater results are presented in Section 8 and discussed in Section 9.

8.0 GROUND AND GROUNDWATER CONDITIONS

8.1 Ground Conditions

8.1.1 Summary of Ground Conditions

The ground investigation generally confirms the published geology; however the geology was increasingly variable across the subject site. The identified strata are set out in Table 8.1 below:

Table 8.1 Summary of Strata

Strata	Min Depth to Top of Strata (m bgl)	Max Depth to Top of Strata (mbgl)	Max Thickness (m)
Made Ground	0.00	0.00	1.80 (WS104)
Superficial Deposits (Brickearth)	0.40 (WS101)	1.80 (WS104)	1.20 (WS104)
Superficial Deposits (Raised Beach Deposits)	0.60 (WS105)	1.00 (TP106)	>2.30 (WS106) Base not encountered
Lambeth Group (Bedrock)	0.60 (TP103)	3.00 (WS104)	>2.50 (WS103) Base not encountered.

8.1.2 Made Ground

Made Ground was encountered within all intrusive locations to a maximum depth of 1.80m bgl (WS104). The unit comprised a variable mix of fine and coarse grained soils with an occasional clay chalk fill. The unit comprised variable amounts of minor constituents such as brick, concrete, porcelain, flint, chalk, plastic, ash, charcoal, aggregate, black organic matter, rusted metal, wound metal cable and metal rings.

8.1.3 Superficial Deposits

Brickearth

The superficial deposits of Brickearth were only encountered within the western and central area of the site, in front of the warehouse and store. Brickearth was noted to be highly variable with both fine and coarse grained soils recorded at varying depths across the site. The fine grained soils predominately comprised very soft to soft brown –grey silty CLAY whilst the coarse grained soils were encountered either as a clayey SAND or clayey sandy GRAVEL. Brickearth was recorded to a maximum depth of 3.00m bgl within WS104.

Raised Beach Deposits

Raised beach deposits rather than Brickearth were encountered in a number of locations to the rear of the current warehouse on the eastern area of the site. A boundary change is estimated to be located within area of TP105 with deposits prominent from this point eastwards. The unit initially comprised a soft to firm brown-orange gravelly CLAY with gravel of flint and chert, thereafter the unit was typically encountered as a brown-orange to dark yellow slightly clayey SAND and GRAVEL. The Raised Beach Deposits were encountered to a maximum depth of 3.00m bgl (WS106), all be it the base was not encountered.

8.1.4 Bedrock

Lambeth Group

The bedrock of the Lambeth Group was only encountered within the western area of the site, predominately a depths of 1.50m bgl to 3.00m bgl, however the bedrock was encountered at a shallow depth of 0.60m bgl (TP103) within the southern central area of the site. The unit was typically encountered as dark yellow to orange fine to medium SAND with variable amounts of gravel, clay and silt. The Lambeth Group was encountered to a maximum depth of 4.00m bgl (WS101,WS103 and WS104) with the base of the unit not encountered.

8.1.5 Existing Foundation Conditions

Five (5 no.) trial pits were advanced to expose and identify the existing foundation conditions for the buildings present on the site. The foundation pit drawings are presented in Appendix III, Figure 4 and summary of the conditions are presented in Table 8.2 below.

Table 8.2 Summary of Existing Foundation Conditions

Location	Building/Direction	Top of Foundation Depth (mm bgl)	Toe of Foundation Depth (mm bgl)	Distance Stepped Out (mm)	Strata
TP102	Travelling crane – metal column/South-west	140	1300	1300	sandy GRAVEL (BE)
TP103	Warehouse/ Southern corner	800	Not proven – at termination of 1600mm	600	SAND (LG)
TP104	Metal column inside warehouse/south	700	Not proven at 700mm	>600	MG
TP105	Front Corner of warehouse/north	650	1300	650	gravelly CLAY (RBD)
TP106	Back corner of warehouse/north-east	1000	1500	1500	slightly clayey gravelly SAND (RBD)

Notes – MG (Made Ground), BE (Brickearth), RBD (Raised Beach Deposits) and LG (Lambeth Group).

8.1.6 In-Situ Testing

Undrained shear strength values of the fine grained soils were determined using in-situ hand shear vane testing, and SPT N values using the theoretical relationship of N value x 4.5. The relative densities of the coarse grained soils were derived from the Standard Penetration Tests. The results of these in-situ tests are presented in Table 8.3 below.

Table 8.3 Summary of Standard Penetration Tests and Hand Shear Vane Test

Location	Depth (m bgl)	Strata	SPT "N" Value	Soil strength (BS5930)	Direct shear vane reading (kN/m^2)	Approximate Undrained Shear Strength (N x 4.5 kN/m^2)	Relative Density
WS101	1.20-1.65	BE (CLAY)	6	Low strength	-	27	N/A
	1.50	BE (CLAY)	-	Low strength	30	-	
	1.80	BE (CLAY)	-	Very Low strength	12	-	
	2.00-2.45	LG (SAND/CLAY)	4	N/A	N/A	N/A	Loose
	3.00-3.45	LG (SAND)	2*				Loose
	4.00-4.45		15*				Medium Dense
WS102	1.20-1.65	BE (CLAY)	5	Low strength	-	23	N/A
	2.00-2.45	LG (SAND)	10	N/A	N/A	N/A	Medium Dense
	3.00-3.45		12*				
WS103	1.20-1.65	BE (SAND)	10	N/A	N/A	N/A	Medium Dense
	2.00-2.45	LG (SAND)	13				
	3.00-3.45		7*				Loose
	4.00-4.45		4*				
WS104	1.20-1.65	MG	4	Very Low Strength	-	18	N/A
	2.00-2.45	BE (CLAY)	4		-	18	
	2.50		-	Low strength	20	-	
	2.80		-	Low strength	20	-	
	3.00-3.45	LG (CLAY)	8	Low strength	-	36	
	4.00-4.45	LG (SAND)	20*	N/A	N/A	N/A	Medium Dense
WS105	1.20-1.65	RBD (SAND and GRAVEL)	21	N/A	N/A	N/A	Medium Dense
	2.00-2.45	RBD(SAND)	41				Dense
	3.00-3.45		18				Medium Dense
WS106	1.20-1.65	RBD (SAND and GRAVEL)	35	N/A	N/A	N/A	Dense
	2.00-2.45		42				Dense
	3.00-3.45		16				Medium Dense
TP101	1.80	BE (CLAY)	-	Medium strength	45	-	N/A
TP102	1.60	BE (CLAY)	-	Low strength	30	-	N/A
TP105	1.00	BE (CLAY)	-	Medium strength	45	-	N/A
TP107	1.00	RBD (CLAY)	-	Medium strength	48	-	N/A

Notes – MG (Made Ground), BE (Brickearth), RBD (Raised Beach Deposits) and LG (Lambeth Group). * N value halved due to presence of groundwater.

8.1.7 Side Stability and Ease of Excavation

Generally the majority of the trial pits remained stable during excavation and easily excavated to target depth, however both TP101 and TP102 collapsed during the infiltration tests. TP102 had a substantial collapse during the test and was unstable, leading to the termination of the test.

8.1.8 Particle Size Distribution Tests

Two (2 no.) soil samples were submitted to the laboratory for particle size distribution testing, the results are presented below in Table 8.4. The tests are generally consistent with the on-field descriptions.

Table 8.4 Summary of Particle Size Distribution Tests

Location	Depth	Lab Description	Granulometric Composition			
			Clay/Silt	Sand	Gravel	Cobbles
TP102	1.20-1.50	Brown sandy silty clayey GRAVEL	16	12	72	0
TP108	1.00-1.50	Brown sandy clayey GRAVEL	8	11	81	0

8.1.9 Soil Infiltration

In-situ soil infiltration tests were undertaken within three of the trial pits (TP101, TP102 and TP018). The infiltration test within TP102 was located 2.00m east of foundation pit 102. No groundwater was encountered within trial pits prior to the commencement of the tests. The results are presented in Table 8.5, with testing sheets presented in Appendix XI.

Table 8.5 Soil Infiltration Results

Location	Depth (m)	Material	Test No.	Soil Infiltration Rate (m/s)
TP101	1.11-1.58*	Brown slightly sandy gravelly CLAY	1	N/A(3.97×10^{-4})*
TP102	1.08-2.15	Brown sandy silty clayey GRAVEL underlain by silty CLAY	1	3.46×10^{-6}
TP108	1.06-1.98	Brown sandy clayey GRAVEL	1	2.19×10^{-6}

Notes - * Trial pit collapsed from 2.00m bgl to 1.58m bgl voiding test.

The application of soakaway drainage will ultimately be dependent on the specific requirements of the development. All soakaways should be designed in accordance with BRE Special Digest 365 – *Soakaway Design*.

8.1.10 Soil Plasticity

The Atterberg Limits determinations, summarised in Table 8.6 below, show the clay to be of low to intermediate plasticity, with a low volume change potential.

Table 8.6 Summary of Plasticity Index Test Results

Location	Depth (m)	Natural Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	Percentage passing 425µm sieve (%)	Modified Plasticity Index	Volume Change Potential
WS101	1.20	23	21	38	17	100	Moderate	Low
WS104	1.80	24	20	35	15	100	Moderate	Low
WS106	1.00	19	19	33	14	83	Low	Low

8.1.11 California Bearing Ratio

The California Bearing Ratio (CBR) for the soils were measured using in situ tests and also laboratory testing. The results are summarised in Table 8.7.

In situ tests were undertaken using a TRL probe. The result sheets are included in Appendix X and the locations are shown on Figure 2 and 3. CBR results have been averaged from the blow counts across the strata tested and any abnormally high blow counts ignored as these are likely to be from larger granular material and so represent anomalies.

Laboratory CBR tests were undertaken on large disturbed samples re-compacted at natural moisture content using a 2.5kg rammer. The CBR result is the average of the tests on the top and bottom of the sample.

Table 8.7 Summary of CBR Testing

Location	Depth (m)	Strata	In Situ or Lab Test	CBR (%)
TP102	0.30	Made Ground: Grey slightly clayey very sandy GRAVEL	Lab Test	92
TP107	0.20-0.60	Made Ground: Grey slightly clayey very sandy GRAVEL	Lab Test	100
DCP101	0.40-0.79	Inferred Made Ground	In-situ	13
DCP102	0.0-0.10	Inferred Made Ground	In-situ	100
DCP103	0.30-0.80	Inferred Made Ground	In-situ	7
DCP104	0.0-0.3	Inferred Made Ground	In-situ	99
DCP105	0.40-0.60	Inferred Made Ground	In-situ	21
DCP106	0.0-0.12	Inferred Made Ground	In-situ	88

8.1.13 pH and Sulphate

Chemical analyses for pH and soluble sulphate content contained in Appendix VII (summarised below in Table 8.8), shows that the soils at the site generally meet Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1 in accordance with BRE Special Digest 1 (2005), however TP107 at 0.50m bgl is classed as DS-2, AC-2.

Table 8.8 Summary of pH and Sulphate Data

Location	Depth (m)	SO_4 in 2:1 water / soil (g/l)	pH Value	Concrete Classification
WS101	0.30	0.25	8.0	DS-1, AC-1
WS103	0.30	0.03	8.3	DS-1, AC-1
WS104	0.60	0.04	8.9	DS-1, AC-1
WS106	0.80	0.02	7.9	DS-1, AC-1
TP101	0.90	0.03	8.0	DS-1, AC-1
TP107	0.50	0.51	8.4	DS-2, AC-2
WS101	2.50	0.08	7.7	DS-1, AC-1
WS102	1.60	0.04	8.0	DS-1, AC-1
WS104	3.20	0.02	8.0	DS-1, AC-1
WS106	1.50	0.01	7.4	DS-1, AC-1

8.2 Groundwater Conditions

Groundwater strikes were encountered as seepages in a number of locations. The depth of the seepages are shown on the exploratory hole records and summarised in Table 8.9 below:

Table 8.9 Summary Groundwater Strikes

Location	Depth to strike (m)	Depth to standing water (m)	Notes
WS101	3.00	-	within the SAND unit
WS102	3.00	-	within the SAND unit
WS103	3.00	-	within the SAND unit
WS104	3.50	-	within the SAND unit

8.3 Ground Gas

The results of the ground gas and groundwater monitoring are presented in Table 8.10 overleaf.

Table 8.10 Summary of ground gas and groundwater monitoring results

Well	Date	Initial CH_4 % v/v	Peak CH_4 % v/v	1hr CH_4 x CO_2	Initial CO_2 % v/v	Peak CO_2 % v/v	1hr CO_2 x CO_2	O_2 % v/v	Atmos. (hPa)	Dynamic	Flow (l/hr)	Response zone (bgl) (m)	Depth to Base (bgl) (m)	Depth to Water (bgl) (m)
WS1S	25/01/12	<0.1	<0.1	<0.0001	0.5	2.9	0.0432	18.4	1018	Falling	1.2	1.00-2.00	2.08	1.70
	18/01/12	<0.1	<0.1	<0.0001	0.3	2.2	0.0200	18.2	1021	Rising	<0.1	1.00-2.00	2.83	1.63
	10/01/12	<0.1	<0.1	<0.0001	0.1	3.2	0.0320	18.0	1013	Falling	<0.1	1.00-2.00	2.18	DRY
WS1M	25/01/12	<0.1	<0.1	<0.0001	0.1	0.9	0.0090	18.6	1018	Falling	<0.1	1.00-3.00	3.05	DRY
	18/01/12	<0.1	<0.1	<0.0001	0.1	1.1	0.0110	18.6	1021	Rising	<0.1	1.00-3.00	3.05	DRY
	10/01/12	<0.1	<0.1	<0.0001	0.1	1.9	0.0190	18.4	1013	Falling	<0.1	1.00-3.00	3.05	DRY
WS1W	25/01/12	<0.1	<0.1	<0.0001	0.1	12.5	0.125	17.1	1018	Falling	0.4	1.00-3.00	3.50	0.90
	18/01/12	<0.1	<0.1	<0.0001	0.1	1.9	0.0190	<0.1	1021	Rising	<0.1	1.00-3.00	3.09	0.52
	10/01/12	<0.1	<0.1	<0.0001	0.1	0.3	0.0103	1.2	1013	Falling	<0.1	1.00-3.00	2.25	0.82

9.0 TIER 1 QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT

REC has undertaken a Tier 1 qualitative risk assessment to determine if any potential contaminants within the underlying soils and groundwater pose an unacceptable level of risk to the identified receptors.

9.1 Human Health Risk Assessment

At a Tier 1 stage the long term (chronic) human health toxicity of the soil has been assessed by comparing the on-site concentrations of organic and inorganic compounds with reference values published by the EA (Contaminated Land Exposure Assessment (CLEA) Soil Guideline Values (SGV)) and where absent, Generic Assessment Criteria (GACs) published by LQM/CIEH (2nd edition).

The results of this comparison have been summarised within Table 9.1 (overleaf).

Table 9.1 Summary of Inorganic and Hydrocarbon Toxicity Assessment for a Commercial End Use

Determinand	Units	GAC	C4SL	n	MC	Loc. of Ex	Pathway	Assessment
Inorganics								
Arsenic	mg/kg	640[i]	640	6	32	N/A	1	No Further Action
Cadmium	mg/kg	230[ii]	410	6	2.1	N/A	1	No Further Action
Chromium (VI)	mg/kg	35[ii]	49	6	<1	N/A	1	No Further Action
Lead	mg/kg	-	2330	6	1600	N/A	1	No Further Action
Mercury	mg/kg	410[i]	-	6	<1.0	N/A	2	No Further Action
Nickel	mg/kg	1800[i]	-	6	49	N/A	1	No Further Action
Selenium	mg/kg	13000[i]	-	6	<3	N/A	1	No Further Action
Copper	mg/kg	71700[ii]	-	6	280	N/A	1	No Further Action
Zinc	mg/kg	665000[ii]	-	6	4200	N/A	1	No Further Action
Cyanide - Total	mg/kg	16200[iii]	-	6	<1	N/A	1	No Further Action
Asbestos	-	N.D[iv]	-	6	N.D	N/A	5	No Further Action
Organics								
Phenols - Total.	mg/kg	1100000[ii]	-	6	1.5	N/A	1	No Further Action
Naphthalene	mg/kg	200[ii]	-	6	0.6	N/A	2	No Further Action
Acenaphthylene	mg/kg	84000[ii]	-	6	<0.1	N/A	3	No Further Action
Acenaphthene	mg/kg	84000[ii]	-	6	<0.1	N/A	1	No Further Action
Fluorene	mg/kg	64000[ii]	-	6	<0.1	N/A	1	No Further Action
Phenanthrene	mg/kg	22000[ii]	-	6	1.0	N/A	3	No Further Action
Anthracene	mg/kg	530000[ii]	-	6	0.2	N/A	3	No Further Action
Fluoranthene	mg/kg	23000[ii]	-	6	1.7	N/A	3	No Further Action
Pyrene	mg/kg	54000[ii]	-	6	1.6	N/A	3	No Further Action
Benzo(a)Anthracene	mg/kg	90[ii]	-	6	0.8	N/A	3	No Further Action
Chrysene	mg/kg	140[ii]	-	6	0.9	N/A	3	No Further Action
Benzo(b/k)Fluoranthene	mg/kg	100[ii]	-	6	1.4	N/A	3	No Further Action
Benzo(a)Pyrene	mg/kg	14[ii]	76	6	0.6	N/A	3	No Further Action
Indeno(123-cd)Pyrene	mg/kg	60[ii]	-	6	0.3	N/A	3	No Further Action
Dibenzo(a,h)Anthracene	mg/kg	13[ii]	-	6	0.1	N/A	3	No Further Action
Benzo(ghi)Perylene	mg/kg	650		6	0.2	N/A	3	No Further Action
TPH C_5-C_6 (aliphatic)*	mg/kg	3400[ii]	-	6	<0.10	N/A	2	No Further Action
TPH C_6-C_8 (aliphatic)*	mg/kg	8300[ii]	-	6	<0.10	N/A	2	No Further Action
TPH C_8-C_{10} (aliphatic)*	mg/kg	2100[ii]	-	6	<0.10	N/A	2	No Further Action
TPH C_{10}-C_{12} (aromatic)*	mg/kg	17000[ii]	-	6	10	N/A	2	No Further Action
TPH C_{12}-C_{16} (aromatic)*	mg/kg	36000[ii]	-	6	26	N/A	1	No Further Action
TPH C_{16}-C_{21} (aromatic)*	mg/kg	28000[ii]	-	6	260	N/A	1	No Further Action
TPH C_{21}-C_{35} (aromatic)*	mg/kg	28000[ii]	-	6	230	N/A	1	No Further Action

Notes
Pathway: 1 = Soil Ingestion, 2 = Vapour Inhalation (indoor), 3 = Dermal Contact & Ingestion, 4 = Dust Inhalation 5 = Consumption of home-grown produce and attached soils

Abbreviations:
GAC = General Assessment Criteria, C4SL = Category 4 Screening Level,
n = number of samples, MC = Maximum Concentration; Loc of Ex = Location of Exceedance.

GAC Tier 1 Origin
(i) 2009 Soil Guideline Value (SGV);
(ii) LQM/CIEH Generic Assessment Criteria for 1% Soil Organic Matter (SOM);
(iii) CLEA 1.06 Derived Value;
(iv) N.D = Not Detected

Referring to Table 9.1, the results of this direct comparison indicates that the soil samples submitted to the laboratory does not exceed any of the screening criteria for a commercial end use.

Asbestos was not identified in any of the soil samples submitted for screening analysis.

9.2 Controlled Waters

The subject site is underlain by a Secondary (B) Aquifer within the superficial deposits of Brickearth and Secondary (A) Aquifer within the bedrock of the Lambeth Group. According to GroundSure data there are no groundwater abstractions within 1.00km of the subject site. It is considered that the subject site is unlikely to pose a significant risk to controlled waters based on groundwater only being encountered within Secondary (A) Aquifer at 3.00m to 3.50m bgl within the Lambeth Group. No groundwater was encountered with the predominately fine grained Brickearth deposits directly below the made ground at the site, therefore itis considered unlikely that mobilisation of potential contaminants is likely to occur into the Secondary (A) Aquifer. This is further supported by the absence of significantly elevated concentration in the near surface.

9.3 Ground Gas

The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in CIRIA Report 665 (*Assessing risks posed by hazardous ground gases to buildings*, 2007). However, it is recommended that the full ground gas assessment and recommended protection measures are agreed with the local authority prior to their adoption on-site. Furthermore, all protection measures adopted should be validated by a suitably qualified engineer.

The Phase I report and subsequent ground investigation has identified the following potential sources of ground gas:

- Historic Made Ground associated with current and historical development; and,
- Historical landfill (362m south-west).

During the monitoring visit completed to date, no significantly elevated concentrations of methane were recorded within all monitoring installations (<0.1%v/v), however elevated levels of carbon dioxide (up to 12.5% v/v) was recorded in WS101 with flow rates of than 0.4 l/hr. All of the monitoring visits was undertaken during periods of rising and falling atmospheric pressure dynamic.

In accordance with the methodology outlined with the CIRIA publication C665, REC have utilised the results of the ground gas monitoring surveys to calculate a tentative Gas Screening Value (GSV). The maximum GSV calculated for methane was <0.0001 l/hr (All monitoring locations) and for carbon dioxide was 0.05 l/hr (WS101).

The GSV has been compared to the criteria outlined with CIRIA C665 to determine the level of risk to the proposed development and to ensure the appropriate remedial options are incorporated into any future building design in this area.

CIRIA C665 states that the maximum GSV for carbon dioxide and methane is <0.07 l/hr for Characteristic Situation 1 and although the GSVs for this site fall into this bracket carbon dioxide levels have been recorded in excess of 12%. As a precaution it is therefore recommended that characteristic situation 2 is used.
This suggests that one or two of the following measures should be incorporated into any new structures:

a. Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft) with at least 1200g DMP;

b. Installation of a suitable sub floor void former or coarse sub-base matrix capable of achieving complete volume change in 24hr period;

c. Independent validation to confirm appropriate installation of membrane; and,

All joints and service penetrations to the taped and sealed. This assessment is based on three (3 no.) monitoring visits.

Industry best practice requires six gas monitoring visits when a source of ground gas, or gas concentrations have been identified. As such it is recommended that prior to adoption further gas monitoring is undertaken.

9.4 Revised Conceptual Model

The assessment and conceptual model has not identified any potentially significant pollutant linkages based on a commercial redevelopment of the site. It is therefore concluded that the site is suitable for redevelopment without the requirement for significant remedial action.

10.0 GEOTECHNICAL ASSESSMENT

10.1 Proposed Development

We understand the proposed development is to demolish the current vacant industrial estate on site and re-develop into two (2 no.) industrial plots. The plot on the western side of the site is to comprise of six (6 no.) industrial units (between 371 m^2 to 496 m^2) with associated car parking and a total area of 0.65 ha. The plot on the eastern side of the site is to consist of a depot with loading docks, lorry parking bays and car parking spaces, a total area of 1.05 ha. At the time of writing the proposed loadings of the development are not known.

10.2 Summary of Ground Conditions

In summary the ground conditions consisted of made ground predominately to a maximum depth of circa 1.00m bgl, overlying Brickearth to a depth of 3.00m bgl (western area of the site) or Raised Beach Deposits to a depth of 3.00m bgl (eastern area of the site), underlying the Lambeth Group to 4.00m bgl (base not encountered).

Groundwater was encountered within the Lambeth Group at 3.00m bgl to 3.50m bgl.

10.3 Foundation Conditions and Bearing Capacity

It is considered that the Made Ground not suitable for a founding material due to the inherent variability of the material.

Due to the subject site having highly variable underlying ground conditions with both fine and coarse grained soils encountered, the proposed development has been split into three sections to aid foundation conditions and design. The three sections are:

- Unit 1 (north-western area of the site);
- Unit 2 to 6 (south-western to western area of the site); and,
- The new warehouse and office (eastern area of the site).

10.3.1 Unit 1 Foundation Conditions

Within the proposed area of Unit 1, made ground was encountered to a maximum depth of 1.80m bgl. Within this area very soft low strength fine grained soils were encountered to a depth of 3.90m bgl. It is therefore considered that conventional shallow foundations not be suitable within this area.

It is recommended that either a piled foundation solution or a raft foundation be explored for the proposed building within this north-western area. The raft foundation would spread the load over the underlying variable soils and minimise differential settlement.

The use of ground improvement techniques such as vibro granular columns will allow shallow foundations to be utilised with the Made Ground. The vibro granular columns should provide a bearing capacity of around 150kN/m^2 but will also remove variability within the underlying soils. However elevated carbon dioxide has been identified on site and as such the granular columns providing a pathway for the elevated ground gas

If consideration is given to a stiffened edge raft foundation, it is recommended that plate load testing is undertaken to determine settlement and the modulus of subgrade reaction.

If a piled design is considered, it is recommended that a deep borehole is undertaken circa 15.00m bgl to accurately determine strata changes and undertake deep in-situ tests.

10.3.2 Unit 2 to 6 Foundation Conditions

Within the area of the Unit 2 to 6 on the western area of the site, Made Ground was encountered to a maximum depth of 1.10m bgl (WS102). At a depth of 1.50m bgl to 1.70m bgl, the fine grained soils had undrained shear strengths ranging from 30 kN/m^2 to 45 kN/m^2, indicating low to medium strength fine grained soils of Brickearth. Utilising the above depths and shear strengths, it is estimated that an allowable bearing capacity in the range of **77 to 115 kPa** be achievable for conventional circular or square foundations with a width of 1.00m and factor of safety of 3, limiting total settlement to less than 25mm.

If higher bearing capacities area required, consideration should be given to the use of piled foundations. Pile design should be undertaken by a specialist contractor in order to reduce the factor of safety based on their extensive pile testing data and the anticipated ground conditions. The specialist contractor will also be able to advise on whether it will be necessary to sleeve the pile through the Made Ground in order to negate against negative skin friction within the soft cohesive soils.

Consideration should be given to mature conifers on southern boundary of the site in relation to foundation conditions.

10.3.2 Warehouse and Office

Within the area of the proposed warehouse the underlying soils predominately comprised medium dense coarse grained soils. At a depth of 1.20m bgl SPT N values of the coarse grained soils ranged from 10 (WS103) to 35 (WS106). Utilising the N values, it is estimated that an allowable bearing capacity of **100 kPa to >200 kPa** for conventional foundations with a width less than 1.00m, limiting total settlement to less than 25mm.

10.4 Ground Floor Slabs

A reinforced suspended floor slab has been considered which would address potential condensation issues and assist in the mitigation of potential gas ingress issues. However due to the span issues a reinforced ground bearing floor slab would likely be a more suitable option. Atterberg determination listed in Table 8.6 has identified the underlying cohesive soils to be of low plasticity and therefore subjected to a low volume change potential.

It is therefore recommended that that in situ plate load tests are undertaken on the underlying Made Ground to assess settlement of the formation within the footprints of the proposed structure and enable re-enforcement design by the structural engineer.

Should a reinforced ground bearing floor slab be proposed for the scheme, it is recommended that it is formed on a significant thickness of engineered fill (such as Type 1) in order to limit settlement effects.

10.5 Pavement and Road Construction

An assessment of the likely California Bearing Ratio (CBR) for the Made Ground has been assessed based on the laboratory and in-situ tests. The CBR results were typically variable with results in the range of 7-21% and 71-100%.

It is considered that the higher end CBR values are more likely to be reflective of the variability of the gravel content within the made ground. As such, it is considered that a CBR of 7% be achievable for the subject site and any value greater than 7%, accounts for the variability of Made Ground.

10.6 Drainage

The presence of substantial depths of Made Ground across the site may result in settlement. It is therefore recommended that drain runs are designed using steeper gradients and flexible joints to allow for some differential settlement.

The soil infiltration test within TP101 was void on the basis of the trial pit collapsing substantially during the test. It is therefore considered that an approximate permeability of 3.46×10^{-6} to 2.19×10^{-6} m/s is indicative of the site for the coarse grained soils of Raised Beach Deposits and Brickearth, which typifies soils of a moderate permeability and as such are likely to have a moderate soakage potential. Given the variability of soils across the site, it is recommended that the soils be inspected prior to adoption of soakaways, as fine grained soils encountered within areas of the site soakaways are likely to be restricted to the eastern sector of the site within the coarse grained soils.

10.7 Concrete Durability

It is considered that subsurface concrete can be designed in accordance with Design Sulphate Class DS-2, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-2 in accordance with the recommendations provided in BRE Special Digest 1 (2005).

10.8 Excavations

Site observations indicated that excavations should be feasible in the near surface with normal plant, however obstructions were identified in the near surface including former foundations and former floor slabs. It is anticipated that any obstructions will be grubbed out during the reduced level dig for the sub structure works. It should also be noted that a number of collapses occurred during the excavation of trial pits across the site.

Due to the variability of the Made Ground it is considered that all excavations are supported or battered back in accordance with guidance contained in CIRIA RR97.

10.9 Construction Activity and Inspection

The following activities and inspections should be incorporated in to the site works:

- Due to the variability of the soils at the site it is recommended that sufficient allowance is made for the inspection of formation and sub formations to foundations and pavement construction;
- Excavations where access is required should be subject to a risk assessment from a competent person and where appropriate mitigation measures such as benching back the sides or use of support systems in accordance with CIRIA R97 utilised;
- Where access to confined spaces is required appropriate mitigation measures should be addressed within the Construction Stage Health and Safety Plan. Particular account should be

taken of the gas results;

- The presence of potential contamination and mitigation measures should be addressed as part of the Construction Stage Health and Safety Plan and should include measures to design out the risks, reduce their impact and finally the use of Personnel Protective Equipment (PPE).

END OF REPORT

APPENDIX I

LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between REC Ltd and the Client as indicated in Section 1.2.

2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information it has been assumed it is correct. No attempt has been made to verify the information.

3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.

4. During the site walkover reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not be made known or accessible.

5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.

6. In addition to the above REC Ltd note that when investigating, or developing, potentially contaminated land it is important to recognise that sub-surface conditions may vary spatially and also with time. The absence of certain ground, ground gas, and contamination or groundwater conditions at the positions tested is not a guarantee that such conditions do not exist anywhere across the site. Due to the presence of existing buildings and structures access could not be obtained to all areas. Additional contamination may be identified following the removal of the buildings or hard standing.

7. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.

8. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials this is for indicative purposes only and do not constitute or replace full and proper surveys.

9. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.

10. This report presents an interpretation of the geotechnical information established by excavation, observation and testing. Whilst every effort is made in interpretative reporting to assess the soil conditions over the Site it should be noted that natural strata vary from point to point and that man made deposits are subject to an even greater diversity. Groundwater conditions are dependent on seasonal and other factors. Consequently there may be conditions present not revealed by this investigation.

11. REC can not be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by REC is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by REC in this connection without their explicit written agreement there to by REC.

12. Rather, this investigation has been undertaken to provide a preliminary characterisation of the existing sub-surface geotechnical characteristics and make up and the findings of this study are our best interpretation of the data collected, within the scope of work and agreed budget. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.

13. This investigation has been undertaken to reasonably characterise existing sub-surface conditions and the findings of this study are our best interpretation of the data collected, within the scope of work and agreed budget. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.

APPENDIX II

GLOSSARY

TERMS

AST	Above Ground Storage Tank
BGS	British Geological Survey
BSI	British Standards Institute
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CIEH	Chartered Institute of Environmental Health
CIRIA	Construction Industry Research Association
CLEA	Contaminated Land Exposure Assessment
CSM	Conceptual Site Model
DNAPL	Dense Non-Aqueous Phase Liquid (chlorinated solvents, PCB)
DWS	Drinking Water Standard
EA	Environment Agency
EQS	Environmental Quality Standard
GAC	General Assessment Criteria
GL	Ground Level
GSV	Gas Screening Value
HCV	Health Criteria Value
ICSM	Initial Conceptual Site Model
LNAPL	Light Non-Aqueous Phase Liquid (petrol, diesel, kerosene)
ND	Not Detected
LMRL	Lower Method Reporting Limit
NR	Not Recorded
PAH	Poly Aromatic Hydrocarbon
PCB	Poly-Chlorinated Biphenyl
PID	Photo Ionisation Detector
QA	Quality Assurance
SGV	Soil Guideline Value
SPH	Separate Phase Hydrocarbon
Sp.TPH (CWG)	Total Petroleum Hydrocarbon (Criteria Working Group)
SPT	Standard Penetration Test
SVOC	Semi Volatile Organic Compound
UST	Underground Storage Tank
VCCs	Vibro Concrete Columns
VOC	Volatile Organic Compound
WTE	Water Table Elevation

UNITS

m	Metres
km	Kilometres
%	Percent
%v/v	Percent volume in air
mb	Milli Bars (atmospheric pressure)
l/hr	Litres per hour
µg/l	Micrograms per Litre (parts per billion)
ppb	Parts Per Billion
mg/kg	Milligrams per kilogram (parts per million)
ppm	Parts Per Million
mg/m^3	Milligram per metre cubed
m bgl	Metres Below Ground Level
m bcl	Metre Below Cover Level

mAOD	Metres Above Ordnance Datum (sea level)
kN/m^2	Kilo Newtons per metre squared
µm	Micro metre

APPENDIX III

FIGURES

Figure 1 - Site location Map

Drawing Title:	
Job No: 26839	Date: 15-10-19
Drawn by: W.Sutherland	Approved by: T.Mitchell
Scale: NTS	Size: A4

Client: Charlwell Road, Lancing Business Park

Job Title: Charlwell Road, Lancing Business Park

Drawing No: 26839

Revision:

Resource and Environment Consultants Ltd

REC

Environment House, Sheperds Close, Shoreham-by-Sea, West Sussex, BN43 5AD
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KEY
Approximate Window Sample Location
WS101
Probable Location
Approximate Trial Pit Location
TP101
Approximate Dynamic Cone Penetrometer Test Location
DCP101
Outline of new building
Outline of new building
Outline of new building
Existing Clubhouse
Existing Clubhouse
Existing Clubhouse

Figure 3 - Proposed Development Layout Locations with Investigation Points
Drawing Title:
Job No: 3363
Drawn by: T.Mitchell
Approved by: M.Roberts
Status: FINAL
Scale: NTS
Date: 09-11-21
Client:
Project:
Site:
Charlesworth Road, Charlesworth Business Park
Environmental Consultants Ltd
Resource and Environmental Consultants Ltd
Environment House, Sapphire East, 550 Streetsbrook Road, Solihull, B91 1QT
Tel: 0121 705 2838 Fax: 0121 711 7830
Website: www.recltd.com
KEY
Approximate Window Sample Location
WS101
Approximate Trial Pit Location
TP101
Approximate Dynamic Cone Penetrometer Test Location
DCP101
Trial Pit
Window Sample
Dynamic Cone Penetrometer Test
Proposed Site Boundary
Proposed Building
Existing Building
Existing Site Boundary
Proposed Hardstanding
Proposed Soft Landscaping
Existing Hardstanding
Existing Soft Landscaping
Proposed Site Access
Existing Site Access
Proposed Site Entrance
Existing Site Entrance
Proposed Site Exit
Existing Site Exit
Proposed Site Entrance/Exit
Existing Site Entrance/Exit
Proposed Site Access Road
Existing Site Access Road
Proposed Site Boundary
Existing Site Boundary
Proposed Building
Existing Building
Proposed Hardstanding
Existing Hardstanding
Proposed Soft Landscaping

Plot 1

Plot 2

Plot 3

Job Title: Charlwell Road, Lanoing Business Park	Client: KMG Partnership	Job No: 20839	Drawn by: W.Sperdin	Approved by: T.Mitchell	Scale: NTS
					Notes:
Drawing Title: Figure 4 - Foundations Plots 1, 2 and 3 (TP102 and TP103)					

KEC Resource & Environmental Consultants Ltd
Business Centre, Sedgewick Road, Environmental House, Sedgewick Road
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Registered Office: Environmental House, Segensworth North, Fareham, Hants. PO15 5RR
Tel: 01329 847 452 Fax: 01329 847 453
Website: www.kecltd.co.uk

Project: Langley Business Park, Chartwell Road, Langley

Client: KMC Partnership

Job No: 2808 36 | Status: INT | Approved by: T.Mitchell | Date: 25-11-22 | Issue: | Scale: | Drawing Title: Figure 4 - Site Investigation Plan (TP104 and TP105)

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Tel: 01329 847 783
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Job Title: Charlwell Road Business Park Lancing

Client: KMS partnership

Scale: NTS
Job No: 28029
Drawn by: W.Sharpe
Approved by: T.Mitchell
21-11-14

Drawing Title: Figure 4 - Foundations pit TP106

APPENDIX IV

PHOTOGRAPHS



PLATE 1 – TP101 (02/12/2014)



PLATE 2 – NORTH-WESTERN AREA OF THE SITE WITH OFFICE BUILDING (02/12/2014)



PLATE 3 – FORMER GRAHAM WOOD WAREHOUSE (FACING EAST – 02/12/2014)



PLATE 4 – AREA OF TRAVELLING CRANES AND AST (FACING SOUTH 02/12/2014)



PLATE 5 – DOUBLE BUNDED AST LOCATED IN FRONT OF SOUTHERN WAREHOUSE (02/12/2014)



PLATE 6 – TP102 FOUNDATION PIT (02/12/2014)



PLATE 7 - TP102 SOAKAWAY (02/12/2014)



PLATE 8 – TP103 FOUNDATION PIT (FACING EAST 02/12/2014)



PLATE 9 – TP106 FOUNDATION PIT (02/12/2014)



PLATE 10 – TP105 FOUNDATION PIT (02/12/2014)



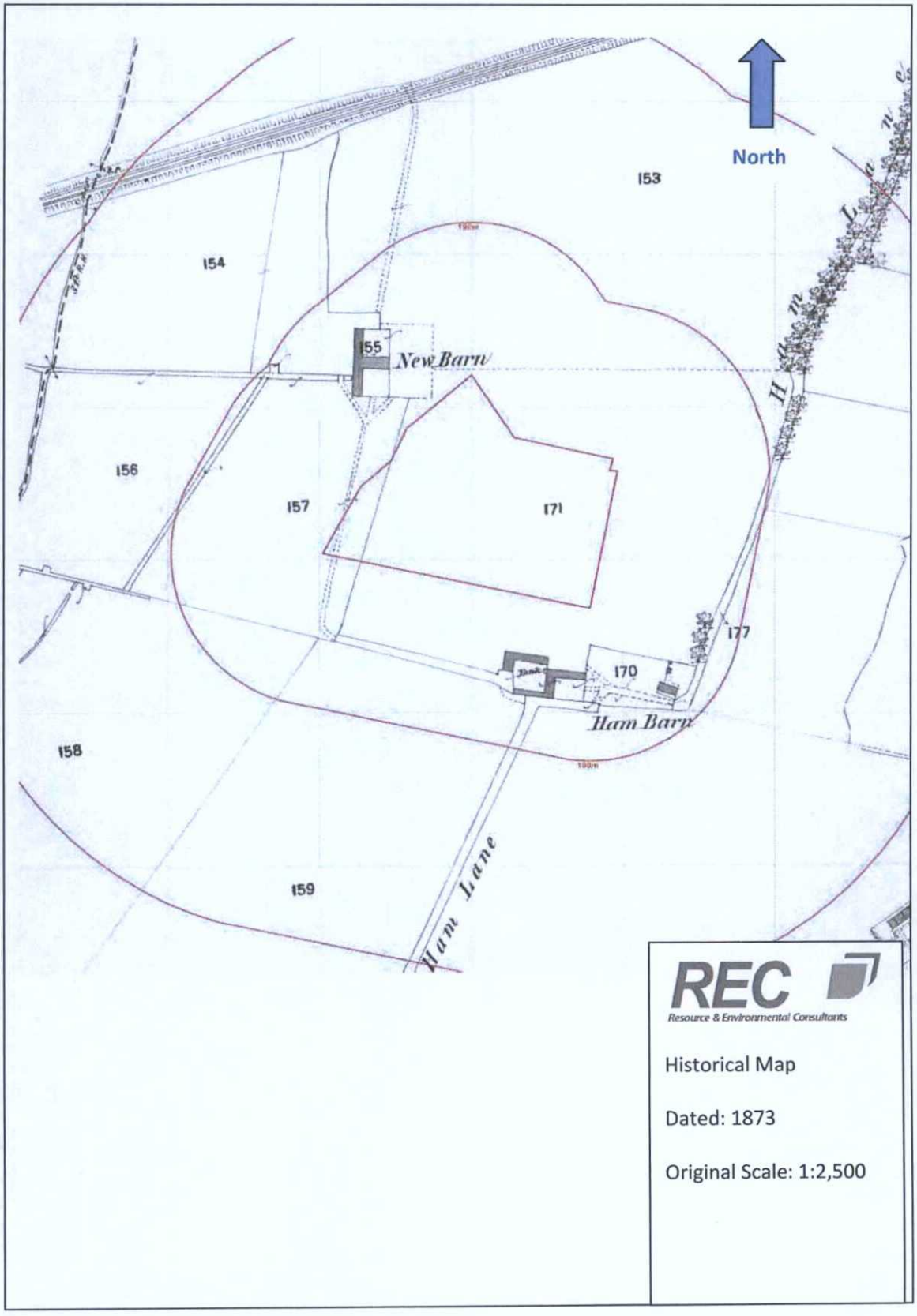
PLATE 11 – TP106 FOUNDATION PIT (02/12/2014)

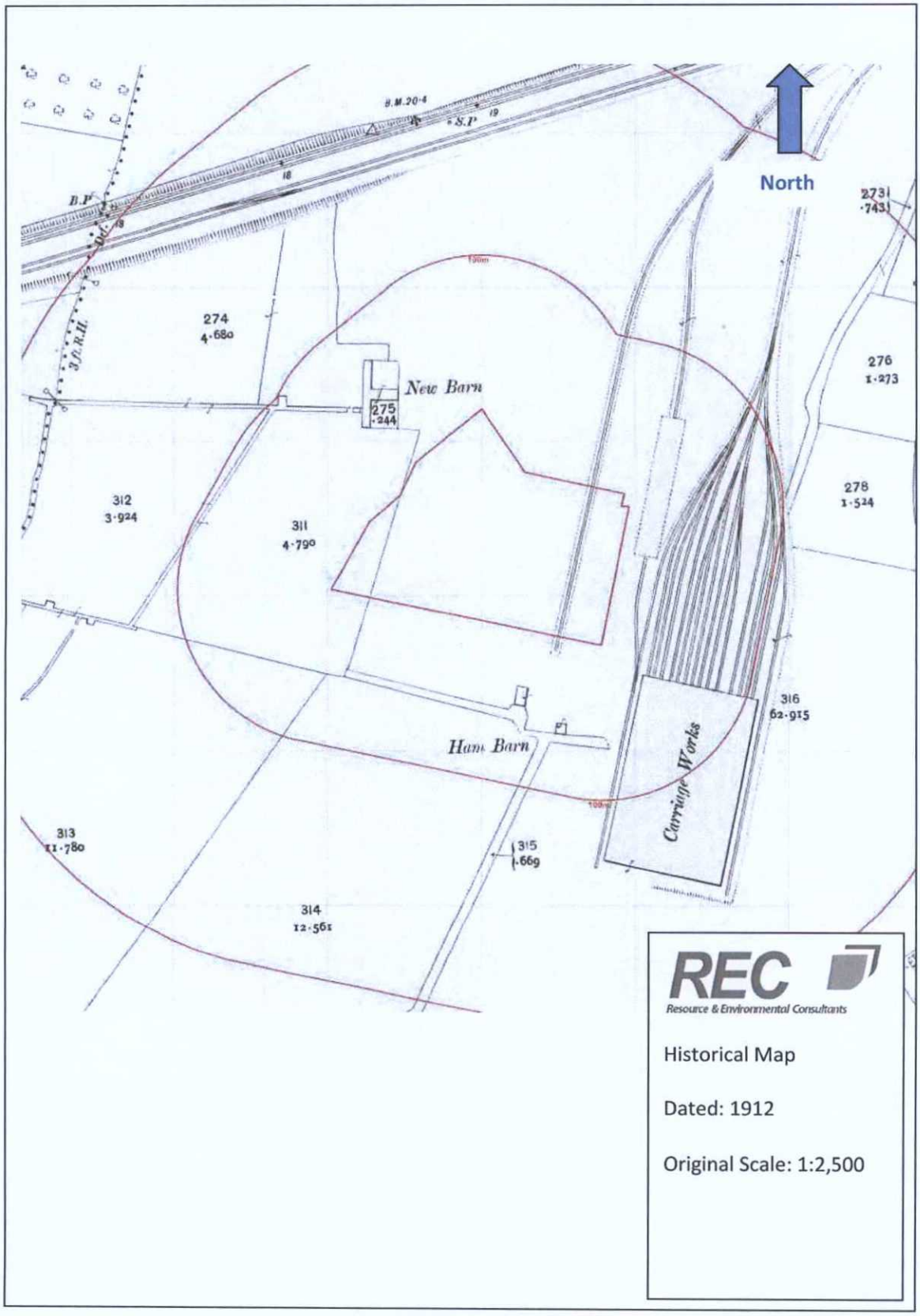


PLATE 12 – NUMBER OF INDUSTRIAL BULK CONTAINERS ON EASTERN AREA OF SITE ADJACENT TO WS106 (FACING EAST 02/12/2014)

APPENDIX V

HISTORICAL MAPS


North
153
154
155
New Barn
156
157
171
177
170
Ham Barn
158
159
Ham Lane
REC
Resource & Environmental Consultants
Historical Map
Dated: 1873
Original Scale: 1:2,500

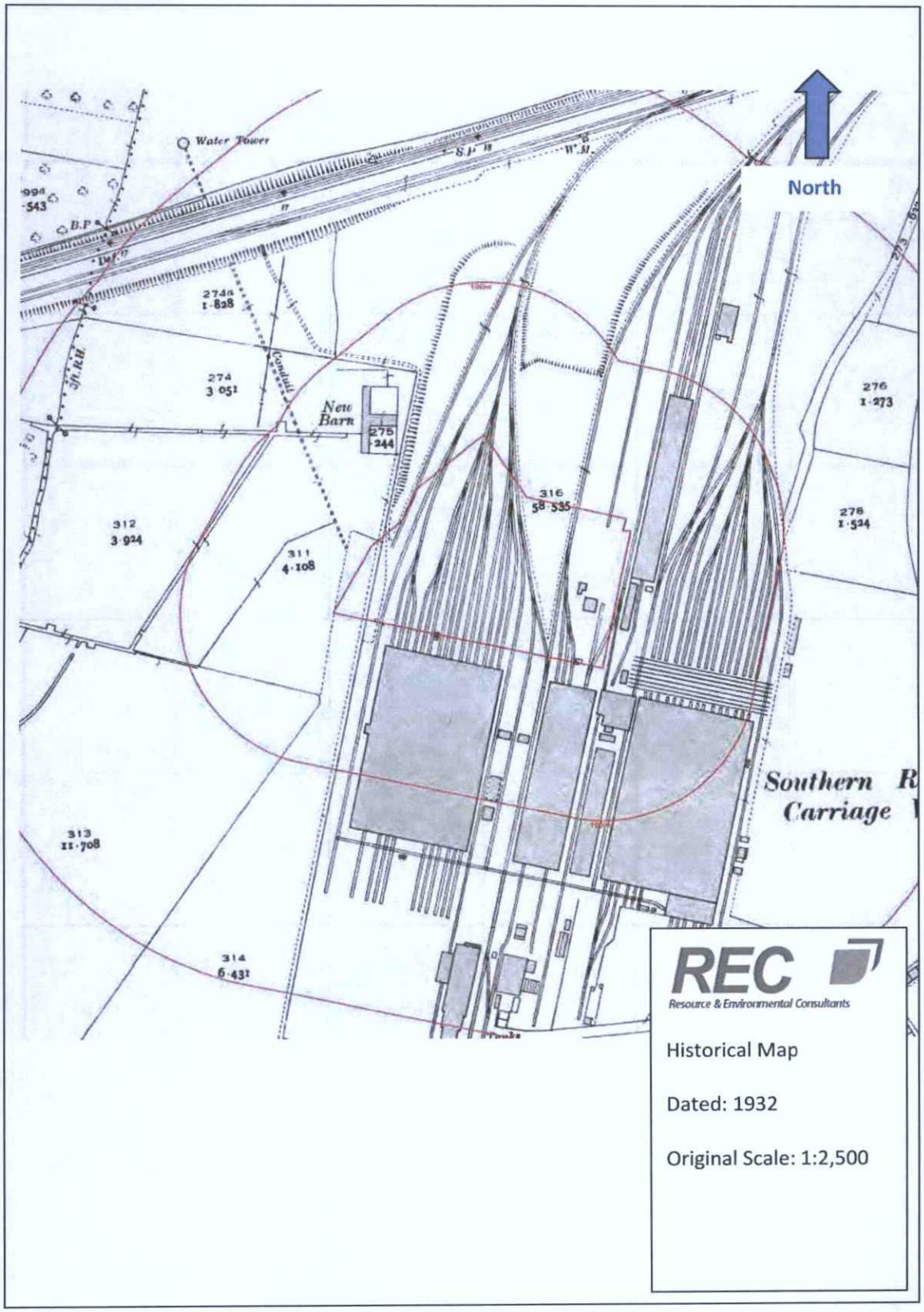


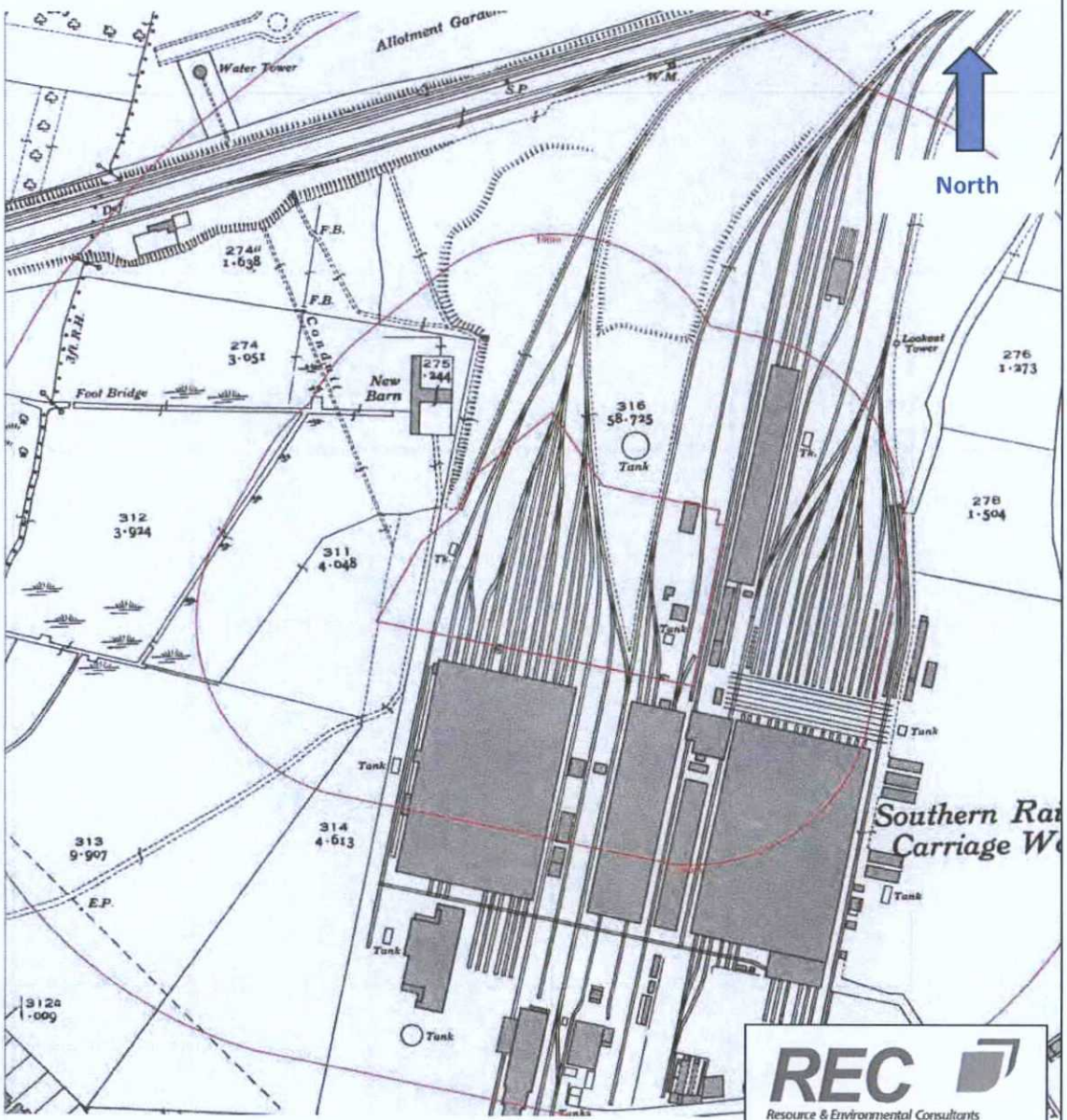
REC
Resource & Environmental Consultants

Historical Map

Dated: 1912

Original Scale: 1:2,500


North
Water Tower
New Barn
Southern R
Carriage
REC
Resource & Environmental Consultants
Historical Map
Dated: 1932
Original Scale: 1:2,500

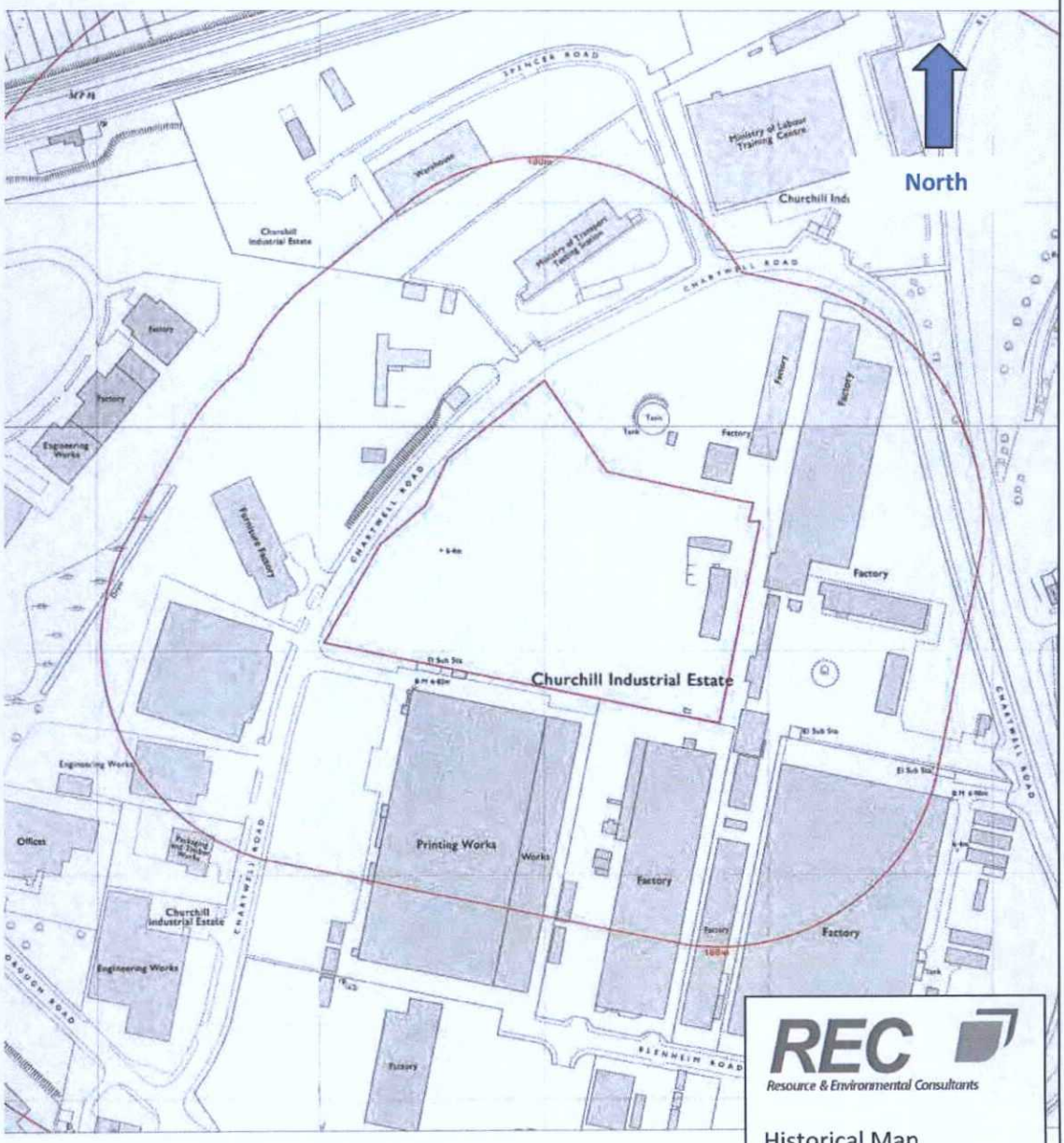


REC
Resource & Environmental Consultants

Historical Map

Dated: 1943

Original Scale: 1:2,500

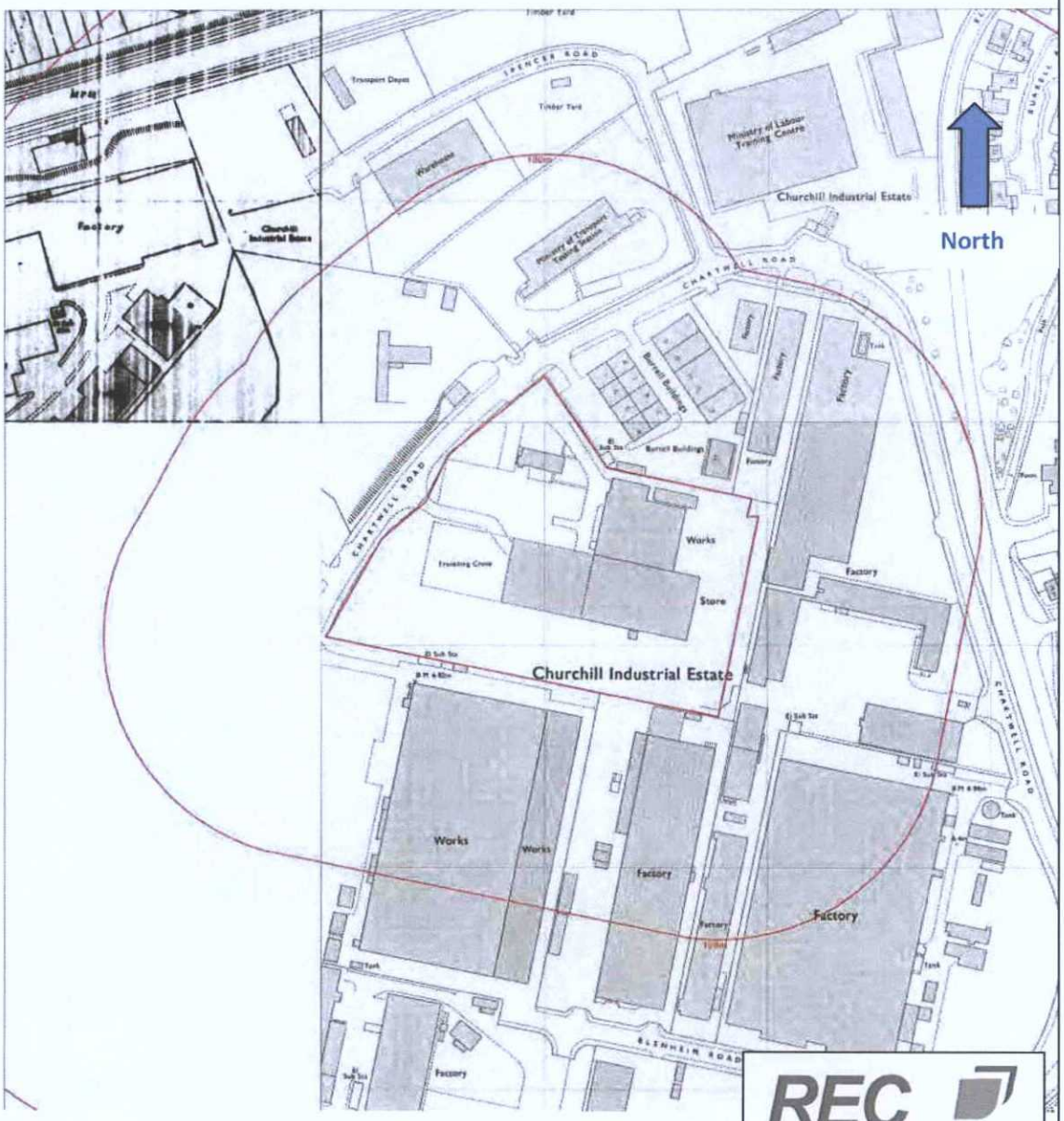


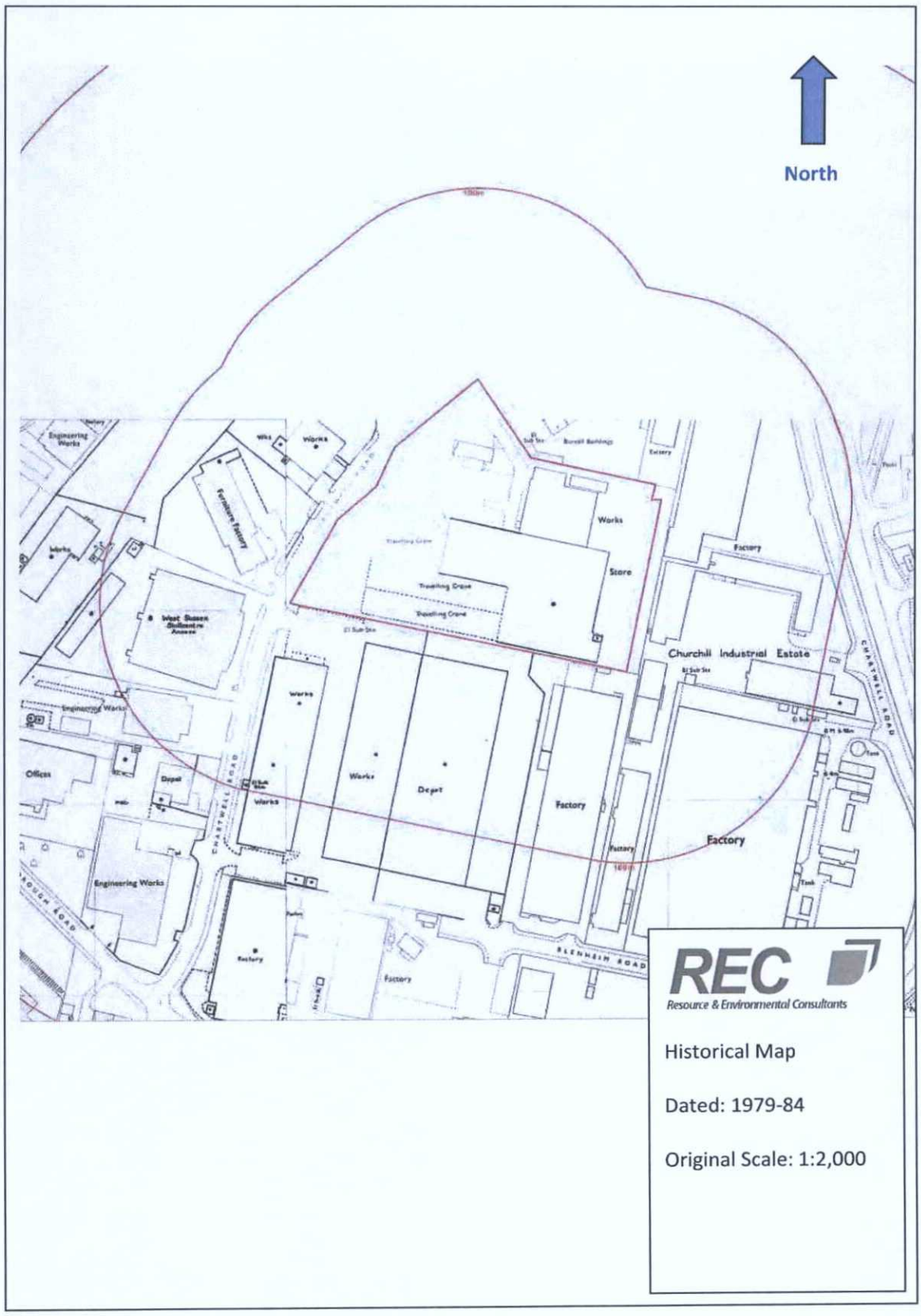
REC Resource & Environmental Consultants

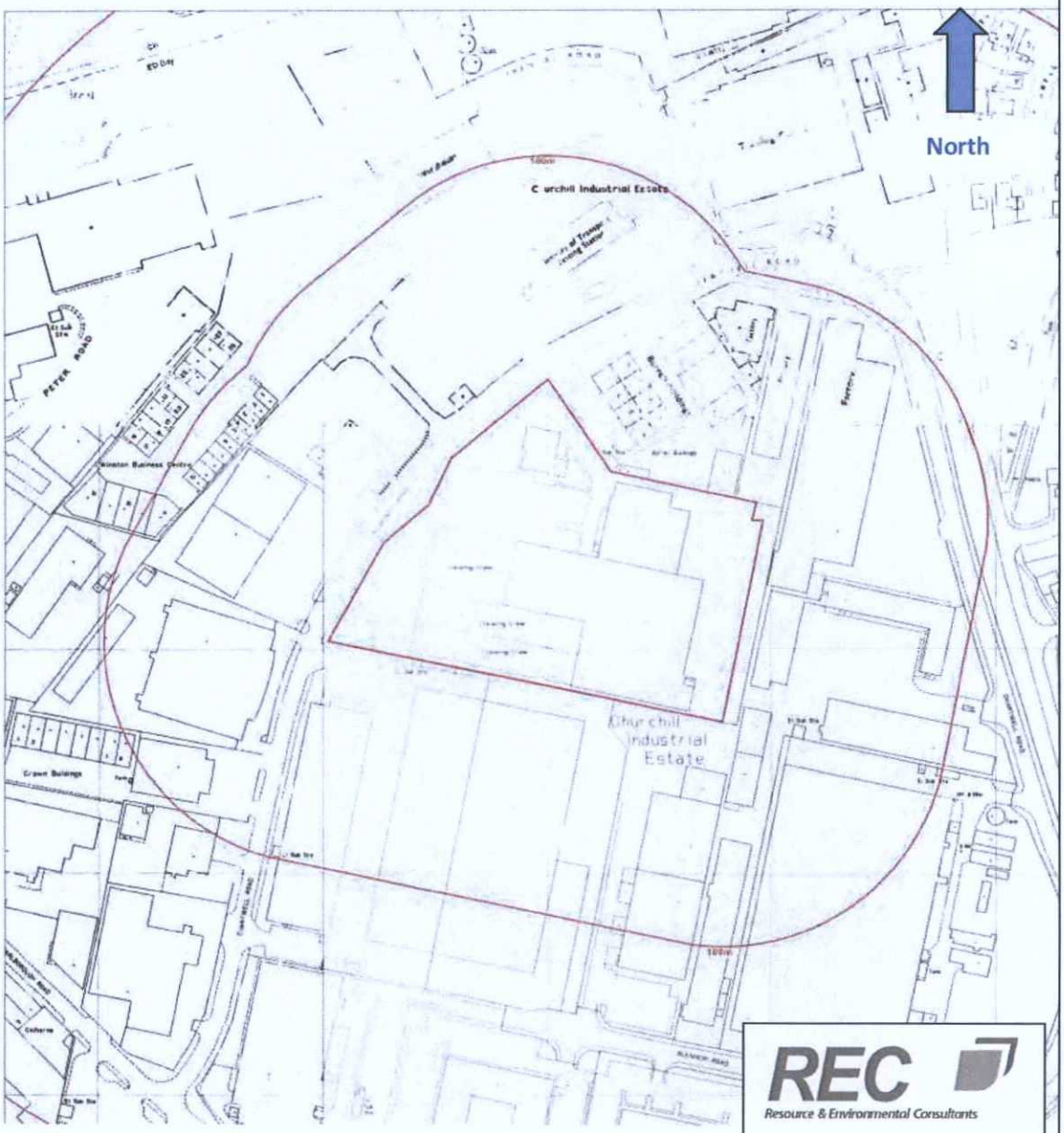
Historical Map

Dated: 1970-71

Original Scale: 1: 1,250


North
Churchill Industrial Estate
Churchill Industrial Estate
Works
Store
Works
Works
Factory
Factory
Factory


North
Works
Store
Travelling Crane
Travelling Crane
Factory
Churchill Industrial Estate
Works
Depot
Factory
Factory
Offices
Depot
Engineering Works
Factory
CHARTWELL ROAD
BLENHEIM ROAD
REC
Resource & Environmental Consultants
Historical Map
Dated: 1979-84
Original Scale: 1:2,000



REC Resource & Environmental Consultants

Historical Map

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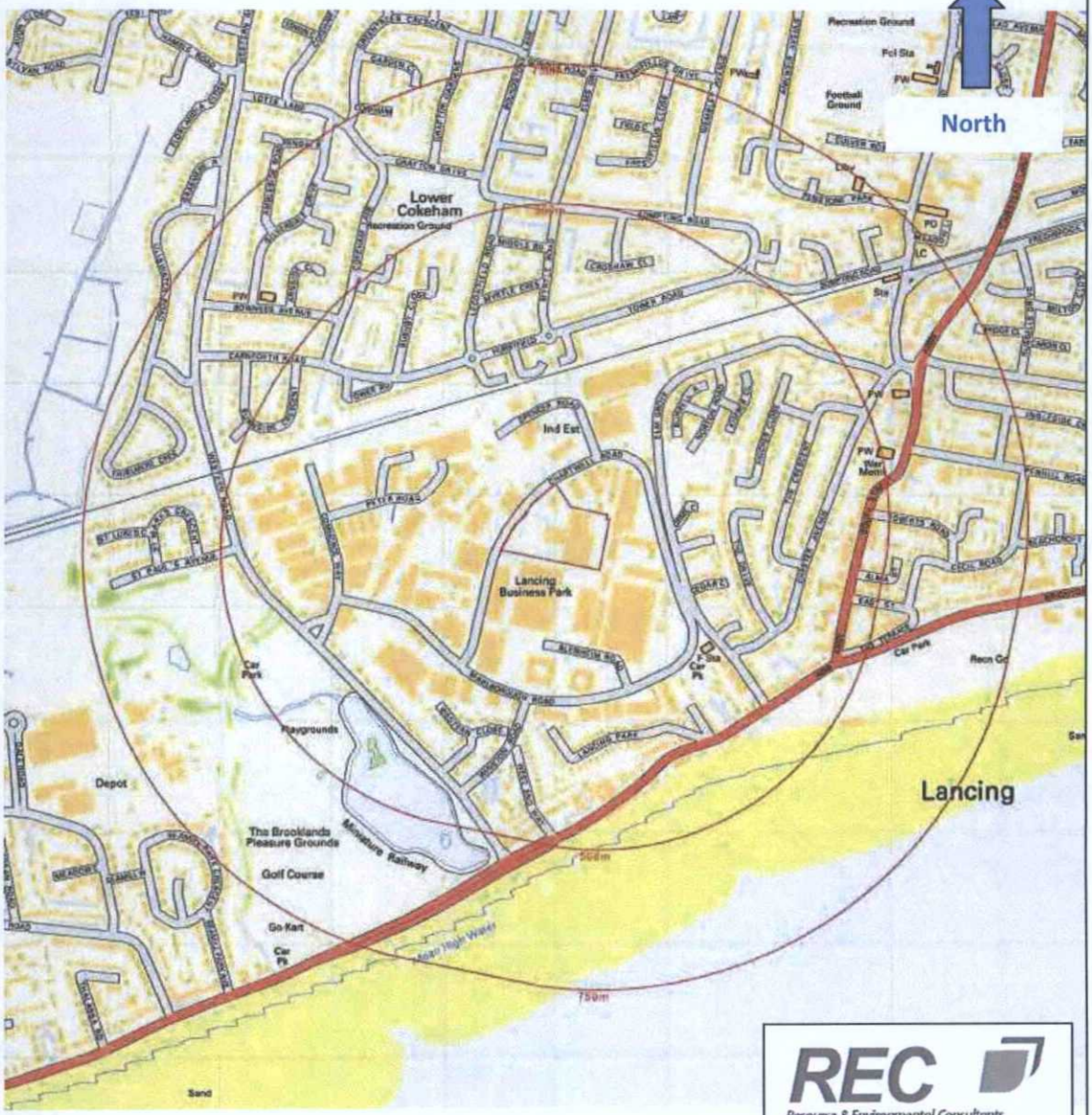

REC
Resource & Environmental Consultants

Historical Map

Dated: 2014

Original Scale: 1:10,000

APPENDIX VI

REC EXPLORATORY LOGS

Trial Pit Log

Trialpit No **TP101** Sheet 1 of 1

Project Name:	Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: - Level:
Location:	Lancing, West Sussex	Dimensions (m): 1.80 × 0.70	Date 02/12/2014
Client:	Gralaw Ltd and BV 3663	Depth 2.00	Scale 1:20 Logged P.Sullivan

Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
Depth	Type	Results				
0.20	B					Dark grey-brown gravelly SAND. Gravel is angular to subangular fine to cobble size flint, brick, concrete and porcelain. Sand is medium to coarse. (MADE GROUND)
0.20	ES		0.30			
0.50	ES					White clay CHALK fill. (MADE GROUND)
0.90	ES		0.70			Soft brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel of angular to rounded fine to cobble size flint. (BRICKEARTH)
1.30	B					
		HVP=45	1.70			Soft medium strength brown slightly gravelly sandy CLAY. Sand is fine to medium. Gravel of subangular to rounded fine to coarse flint. (BRICKEARTH)
2.00	B		2.00			End of pit at 2.00 m

Remarks: No groundwater was encountered.

Stability: Unstable - collapsed to 1.58m bgl.

Trial Pit Log

Trialpit No **TP102**

Sheet 1 of 1

Project Name:	Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: - Level:
Location:	Lancing, West Sussex	Dimensions (m): Depth 2.20	1.70 × 0.70
Client:	Gralaw Ltd and BV 3663		

Date 02/12/2014

Scale 1:20

Logged P.Sullivan

Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
Depth	Type	Results				
0.30	B					Brown gravelly SAND. Sand is medium to coarse. Gravel is angular to sub-angular fine to cobble size flint, brick, concrete, plastic, ash and charcoal. (MADE GROUND)
0.30	ES		0.40			
0.50	ES		0.50			Black sandy GRAVEL. Sand is coarse. Gravel of angular fine to coarse ash and charcoal. (MADE GROUND)
						Firm brownish-grey slightly gravelly CLAY. Gravel is angular to sub-angular fine to coarse flint and chalk. (MADE GROUND)
0.90	ES		0.90			Brown slightly clayey sandy GRAVEL. Sand is medium to coarse. Gravel is angular to subangular fine to cobble size flint. (BRICKEARTH)
		HVP=30	1.50			Soft low strength grey silty CLAY. (BRICKEARTH)
			2.20			End of pit at 2.20 m

1 2 3 4

Remarks: No groundwater was encountered.

Stability: Unstable - multiple collapses during infiltration test.

Trial Pit Log

Trialpit No **TP103** Sheet 1 of 1

Project Name: Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: - Level:	Date 02/12/2014
Location: Lancing, West Sussex		Dimensions (m): 1.70 × 0.70, Depth 1.60	Scale 1:20
Client: Gralaw Ltd and BV 3663			Logged W.Spraggs

Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
Depth	Type	Results				
						Grey light reddish-orange sandy GRAVEL. Sand is fine to coarse. Gravel of angular to rounded fine to coarse brick, aggregate and occasional cobble size brick and concrete. (MADE GROUND)
			0.30			Soft black slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel of angular fine to coarse ash and aggregate. (MADE GROUND)
			0.50			White clay CHALK fill. (MADE GROUND)
			0.60			Yellowish-orange fine to coarse SAND. (LAMBETH GROUP)
			1.60			End of pit at 1.60 m

1 2 3 4

Remarks: No groundwater was encountered.

Stability: Stable

Trial Pit Log

REC

Trialpit No **TP104**

Sheet 1 of 1

Project Name:	Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: - Level:	Date 02/12/2014
Location:	Lancing, West Sussex	Dimensions (m): Depth 0.70	1.10 × 0.60	Scale 1:20
Client:	Gralaw Ltd and BV 3663			Logged W.Spraggs

Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
Depth	Type	Results				
						Concrete. (MADE GROUND)
			0.20			Yellow to white fine to coarse SAND with occasional chalk fragments and fine ash . Concrete foundation at 0.70m bgl. (MADE GROUND)
			0.70			End of pit at 0.70 m

Remarks: No groundwater was encountered.

Stability: Stable

Trial Pit Log

Trialpit No **TP105** Sheet 1 of 1

Project Name:	Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: - Level:	Date 02/12/2014
Location:	Lancing, West Sussex	Dimensions (m): Depth 1.30	1.30 / 1.00	Scale 1:20
Client:	Gralaw Ltd and BV 3663			Logged W.Spraggs

Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
Depth	Type	Results				
						Concrete. (MADE GROUND)
			0.20			
			0.30			Yellow-grey gravelly SAND. Sand is fine to coarse. Gravel is angular to subangular fine to coarse brick, concrete and flint. (MADE GROUND)
						Soft grey to black gravelly CLAY. Gravel of angular fine to coarse flint, concrete, clinker, brick, chalk fragments and black organic matter. (MADE GROUND)
			0.70			Soft to firm medium strength brown gravelly CLAY. Gravel of angular to rounded medium to coarse flint and chert. (RAISED BEACH DEPOSITS)
		HVP=45				
			1.30			End of pit at 1.30 m

1 2 3 4

Remarks: No groundwater was encountered.

Stability: Stable

Trial Pit Log

Trialpit No **TP106**

Sheet 1 of 1

Project Name:	Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: - Level:	Date 02/12/2014
Location:	Lancing, West Sussex	Dimensions (m): 2.70 × 0.60, Depth 1.70		Scale 1:20
Client:	Gralaw Ltd and BV 3663			Logged W.Spraggs

Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
Depth	Type	Results				
			0.10			Concrete. (MADE GROUND)
						Soft black slightly silty sandy gravelly CLAY. Sand is fine to coarse. Gravel of angular to rounded fine to coarse flint, ash, clinker, concrete, brick and rusted metal. (MADE GROUND)
			1.00			Brown-orange slightly clayey gravelly SAND. Sand is fine to coarse. Gravel of angular to rounded, fine to coarse flint and chert. (RAISED BEACH DEPOSITS)
			1.70			End of pit at 1.70 m

1 2 3 4

Remarks: No groundwater was encountered.

Stability: Stable

Trial Pit Log

Trialpit No **TP107** Sheet 1 of 1

Project Name: Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: - Level:	Date 02/12/2014
Location: Lancing, West Sussex		Dimensions (m): 1.70 × 0.60 Depth 2.00	Scale 1:20
Client: Gralaw Ltd and BV 3663			Logged W.Spraggs

Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
Depth	Type	Results				
			0.10			Grey sandy GRAVEL of aggregate material. Sand is coarse. (MADE GROUND)
						Red COBBLES of brick and concrete. (MADE GROUND)
0.20 - 0.60	B		0.20			Black slightly clayey gravelly SAND. Sand is fine to coarse. Gravel of angular to rounded fine to coarse ash, clinker, brick, wound cable, concrete, metal rods, cobble size brick, clinker and metal rings. (MADE GROUND)
0.50	ES					
			0.70			
0.80	ES					Firm medium strength brown-orange gravelly CLAY. Gravel of angular to rounded fine to coarse flint and chert. (RAISED BEACH DEPOSITS)
0.90	D	HVP=48				
1.20 - 1.50	B		1.20			Brown-orange slightly clayey sandy GRAVEL. Sand is fine to coarse. Gravel of angular to rounded fine to coarse flint and chert. (RAISED BEACH DEPOSITS)
			2.00			End of pit at 2.00 m

1 2 3 4

Remarks: No groundwater was encountered.

Stability: Stable

Trial Pit Log

Trialpit No **TP108** Sheet 1 of 1

Project Name: Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: - Level:	Date 02/12/2014
Location: Lancing, West Sussex		Dimensions (m): 1.70 × 0.60 Depth 2.00	Scale 1:20
Client: Gralaw Ltd and BV 3663			Logged W.Spraggs

Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
Depth	Type	Results				
			0.05			Grass cover. (MADE GROUND)
0.20	ES					Black slightly clayey gravelly SAND. Sand is fine to coarse. Gravel of angular to rounded fine to coarse ash, flint and concrete. (MADE GROUND)
0.30 - 0.60	B		0.30			Soft brown slightly silty gravelly CLAY. Gravel of angular to rounded fine to coarse flint, clinker, chalk and brick fragments. (MADE GROUND)
0.60	ES		0.70			Brown-orange slightly clayey sandy GRAVEL. Sand is fine to coarse. Gravel of angular to well-rounded fine to coarse flint and chert. (RAISED BEACH DEPOSITS)
1.00 - 1.50	B					
			2.00			End of pit at 2.00 m

Remarks: No groundwater was encountered.

Stability: Stable

Borehole Log

REC Resource & Environmental Consultants Ltd

Borehole No. **WS101** Sheet 1 of 1

Project Name:	Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: -	Hole Type WS
Location:	Lancing, West Sussex		Level:	Scale 1:25
Client:	Gralaw Ltd and BV 3663		Dates: 01/12/2014 - 01/12/2014	Logged By W.Spraggs

Back fill / Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.10			Black light brown slightly clayey gravelly SAND. Sand is fine to coarse. Gravel of angular to sub-rounded fine to coarse brick, concrete and flint. (MADE GROUND)
		0.30	ES					
					0.40			Black fine to coarse SAND of ash with occasional fine brick and chalk fragments. (MADE GROUND)
		0.60	ES					Soft dark brownish black slightly silty slightly gravelly sandy CLAY. Sand is fine to medium. Gravel of angular fine to coarse, brick, flint, chalk, ash and black organic matter. (MADE GROUND)
					0.70			
		1.00	ES		1.00			Soft dark grey slightly sandy silty CLAY with rare fine brick fragments. Sand is fine. (MADE GROUND)
		1.20		N=6 (1,1/1,2,1,2)	1.20			Soft low strength dark grey slightly sandy silty CLAY. Sand is fine. (BRICKEARTH)
		1.20	D					
				HVP=30				
		1.60	D					
					1.70			Soft very low strength dark grey sandy very silty CLAY. Sand is fine. (BRICKEARTH)
				HVP=12				
					1.90			Very soft dark yellow silty very sandy CLAY with occasional angular fine flint and chert. Sand is fine. (LAMBETH GROUP)
		2.00		N=4 (3,2/1,1,1,1)	2.00			
					2.00			Loose dark yellow slightly clayey silty gravelly SAND. Sand is fine to medium. Gravel of angular to sub-rounded fine to coarse flint and chert. (LAMBETH GROUP)
					2.30			
		2.50	D					Soft dark yellow slightly silty slightly sandy gravelly CLAY. Gravel of angular to sub-rounded fine to coarse flint and chert. Sand is fine to medium, (LAMBETH GROUP)
	▼							*...becoming very sandy.*
		3.00		N=4 (1,1/1,1,1,1)	3.00			Loose dark yellow silty SAND with occasional angular fine to coarse flint and chert. Sand is fine to medium. Medium dense at 4.00m bgl. (LAMBETH GROUP)
					3.00			
		3.50	D					
		4.00		N=30 (2,5/5,6,9,10)	4.00			End of borehole at 4.00 m
					4.00			

Remarks
Groundwater was encountered at 3.00m bgl.

Borehole Log

REC Resource & Environmental Consultants Ltd

Borehole No. **WS102** Sheet 1 of 1

Project Name:	Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: -	Hole Type WS
Location:	Lancing, West Sussex		Level:	Scale 1:25
Client:	Gralaw Ltd and BV 3663		Dates: 01/12/2014 - 01/12/2014	Logged By W.Spraggs

Back fill / Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.31			Concrete. (MADE GROUND)
		0.40	ES		0.50			Black slightly silty clayey sandy GRAVEL. Sand is fine to coarse. Gravel of angular to sub-rounded fine to coarse brick, concrete, flint and ash with occasional cobble size brick. (MADE GROUND)
		0.70	ES					White clay CHALK fill. (MADE GROUND)
					1.10			
		1.20	D		1.20			Loose dark brown slightly clayey sandy GRAVEL. Sand is fine to coarse. Gravel of angular to rounded fine to coarse flint and chert. (BRICKEARTH)
		1.20		N=5 (1,3/2,1,1,1)	1.30			Very soft dark brown silty CLAY with occasional chert fragments. (BRICKEARTH)
		1.60	D					
					1.70			Very soft dark brown silty sandy CLAY with occasional flint and chert. Sand is fine to coarse. (BRICKEARTH)
		2.00		N=10 (1,1/2,2,3,3)	2.00			Medium dense dark yellow silty clayey very gravelly SAND. Sand is fine to coarse. Gravel of angular to rounded fine to coarse flint and chert. (LAMBETH GROUP)
					2.00			
		2.50	D					
	▼	3.00		N=25 (2,5/7,6,5,7)	3.00			End of borehole at 3.00 m
					3.00			

1 2 3 4 5

Remarks
Groundwater was encountered at 3.00m bgl.

REC Resource & Environmental Consultants Ltd

Borehole Log

Borehole No. **WS103** Sheet 1 of 1

Project Name:	Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: -	Hole Type WS
Location:	Lancing, West Sussex		Level:	Scale 1:25
Client:	Gralaw Ltd and BV 3663		Dates: 01/12/2014 - 01/12/2014	Logged By W.Spraggs

Back fill / Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.20			Concrete. (MADE GROUND)
		0.30	ES		0.40			Soft brown-black slightly silty sandy gravelly CLAY. Sand is fine to coarse. Gravel of angular to rounded fine to coarse flint, brick, concrete and black organic matter. (MADE GROUND)
		0.60	ES		0.80			Soft brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel of angular to rounded fine to coarse flint and chert fragments. (BRICKEARTH)
		1.00	D					Medium dense brown slightly clayey silty SAND. Sand is fine to medium. (RIVER TERRRACE DEPOSITS)
		1.20		N=10 (1,1/2,1,2,5)	1.20			*...occasional bands of angular to rounded fine to coarse flint and chert.*
		1.50	D		1.50			Medium dense dark orange-yellow slightly gravelly SAND. Sand is fine to coarse. Gravel of angular to rounded fine to coarse flint. (LAMBETH GROUP)
		2.00		N=13 (4,5/3,3,3,4)	2.00			
		2.70	D		2.70			Medium dense dark yellow fine to medium SAND. (LAMBETH GROUP)
	▼	3.00		N=14 (4,5/4,4,3,3)	3.00			*...No recovery within window sample liner.*
		4.00		N=8 (5,4/2,1,1,4)	4.00			End of borehole at 4.00 m
					4.00			

Remarks
Groundwater was encountered at 3.00m bgl.

Borehole Log

REC Resource & Environmental Consultants Ltd

Borehole No. **WS104** Sheet 1 of 1

Project Name:	Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: -	Hole Type WS
Location:	Lancing, West Sussex		Level:	Scale 1:25
Client:	Gralaw Ltd and BV 3663		Dates: 01/12/2014 - 01/12/2014	Logged By W.Spraggs

Back fill / Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.20			Grass cover - Dark yellow brown slightly silty gravelly SAND. Sand is fine to coarse. Gravel of angular fine to coarse brick flint, brick, black organic matter and ash. (MADE GROUND)
		0.30	ES		0.40			Black gravelly SAND. Sand is fine to coarse. Gravel of angular fine to coarse ash and clinker. (MADE GROUND)
		0.60	ES					White clay CHALK fill. (MADE GROUND)
		1.20		N=4 (1,1/1,1,1,1)	1.20			
		1.20	D					
					1.60			Very soft brown silty CLAY with occasional fine rootlets and black organic matter. (MADE GROUND)
		1.80	D		1.80			Very soft brown silty CLAY. (BRICKEARTH)
		2.00		N=4 (1,1/1,1,1,1)	2.00			
		2.50	D	HVP=20				
				HVP=20				
		3.00		N=8 (1,2/2,2,2,2)	3.00			
		3.20	D		3.00			Soft to firm dark yellow slightly silty sandy CLAY with occasional fine to coarse flint and chert. Sand is fine to medium. (LAMBETH GROUP)
					3.90			
		4.00		N=40 (3,6/9,10,10,11)	4.00			Dense dark yellow slightly silty slightly clayey SAND with occasional fine to coarse flint and chert. Sand is fine to medium. (LAMBETH GROUP)
					4.00			End of borehole at 4.00 m

Remarks

Groundwater was encountered at 3.50m bgl.

REC Resource & Environmental Consultants Ltd

Borehole Log

Borehole No. **WS105** Sheet 1 of 1

Project Name:	Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: -	Hole Type WS
Location:	Lancing, West Sussex		Level:	Scale 1:25
Client:	Gralaw Ltd and BV 3663		Dates: 01/12/2014 - 01/12/2014	Logged By W.Spraggs

Back fill / Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.05			Grass cover - Type I aggregate. (MADE GROUND)
					0.15			Red GRAVEL of angular to sub-angular coarse brick. (MADE GROUND)
					0.30			Soft brown gravelly CLAY. Gravel of angular fine to coarse flint and chert. (MADE GROUND)
		0.40	ES					
					0.60			Black gravelly SAND. Sand is fine to coarse ash. Gravel of angular fine to coarse ash, flint, brick, clinker and chert. (MADE GROUND)
		0.70	ES					
								Soft brown-orange CLAY. (RAISED BEACH DEPOSITS)
		1.20		N=21 (2,2/3,4,6,8)	1.20			
					1.20			Dark brown coarse SAND with flint and chert. (RAISED BEACH DEPOSITS)
					1.25			Medium dense dark yellow brown slightly clayey SAND and GRAVEL. Sand is fine to coarse. Gravel of angular to rounded fine to coarse flint and chert. (RAISED BEACH DEPOSITS)
		1.50	D					
		2.00		N=41 (5,8/9,9,11,12)	2.00			
					2.20			Dense dark yellow fine to coarse SAND with occasional angular to rounded fine to coarse flint and chert. (LAMBETH GROUP)
		2.30	D					
		3.00		N=18 (4,4/4,4,5,5)	3.00			End of borehole at 3.00 m
					3.00			

1 2 3 4 5

Remarks
No groundwater was encountered.

Borehole Log

Borehole No. **WS106** Sheet 1 of 1

Project Name:	Chartwell Road, Lancing Business Park	Project No. 20839	Co-ords: -	Hole Type WS
Location:	Lancing, West Sussex		Level:	Scale 1:25
Client:	Gralaw Ltd and BV 3663		Dates: 01/12/2014 - 01/12/2014	Logged By W.Spraggs

Back fill / Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.05			Grass cover - Type I aggregate. (MADE GROUND)
					0.15			Red GRAVEL of angular to sub-angular coarse brick. (MADE GROUND)
					0.30			Soft brown gravelly CLAY. Gravel of angular fine to coarse flint and chert. (MADE GROUND)
		0.40	ES					Black gravelly SAND. Sand is fine to coarse ash. Gravel of angular fine to coarse ash, flint, brick, clinker and chert. (MADE GROUND)
					0.70			Soft brown-orange gravelly CLAY. Gravel of angular to rounded fine to coarse flint, occasional cobble size of flint. (RAISED BEACH DEPOSITS)
		0.80	ES					
		1.00	D					
		1.20		N=35 (5,8/9,10,7,9)	1.20			
					1.20			Medium dense dark yellow clayey SAND and GRAVEL. Sand is fine to coarse. Gravel of angular to rounded fine to coarse flint and chert. Dense at 2.00m bgl. (RAISED BEACH DEPOSITS)
		1.50	D					
		2.00		N=42 (5,10/10,12,10,10)	2.00			
		2.50	D					
		3.00		N=16 (5,5/5,4,3,4)	3.00			
					3.00			End of borehole at 3.00 m

1 2 3 4 5

Remarks
No groundwater was encountered.

APPENDIX VII CHEMICAL TESTING RESULTS

APPENDIX VII

CHEMICAL TESTING RESULTS

SAL
a CONCEPT LIFE SCIENCES company

Scientific Analysis Laboratories is a limited company registered in England and Wales (No 2514788) whose address is at Hadfield House, Hadfield Street, Manchester M16 9FE

Scientific Analysis Laboratories Ltd

Certificate of Analysis

3 Crittall Drive
Springwood Industrial Estate
Braintree
Essex
CM7 2RT
Tel : 01376 560120
Fax : 01376 552923

Report Number: 441171-1

Date of Report: 10-Dec-2014

Customer: Resource Environmental Consultants Ltd
Environment House
Segensworth Business Centre
Segensworth Road (West)
Fareham
PO15 5RQ

Customer Contact: Mr Tim Mitchell

Customer Job Reference: 20839
Customer Purchase Order: 20839/14/SO263
Customer Site Reference: Chartwell Road, Lancing Business Park
Date Job Received at SAL: 04-Dec-2014
Date Analysis Started: 05-Dec-2014
Date Analysis Completed: 10-Dec-2014

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with QP22

UKAS TESTING
1650

Report checked and authorised by :
Simi Okanlami
Project Manager

Issued by :
Simi Okanlami
Project Manager

[redacted]

SAL Reference: 441171
Project Site: Chartwell Road, Lancing Business Park
Customer Reference: 20839

Soil Analysed as Soil
REC002 (SE)

				SAL Reference	441171 001	441171 002	441171 003	441171 004	441171 005	441171 006
				Customer Sample Reference	WS101 ES1 @ 0.30m	WS103 ES1 @ 0.30m	WS104 ES2 @ 0.60m	WS106 ES2 @ 0.80m	TP101 ES3 @ 0.90m	TP107 ES1 @ 0.50m
				Date Sampled	01-DEC-2014	01-DEC-2014	01-DEC-2014	01-DEC-2014	01-DEC-2014	01-DEC-2014
Determinand	Method	Test Sample	LOD	Units						
Arsenic	T257	A40	2.0	mg/kg	32	13	4.8	11	15	19
Cadmium	T257	A40	0.1	mg/kg	0.5	2.1	0.5	0.1	0.1	2.1
Chromium	T257	A40	0.5	mg/kg	26	24	4.9	34	20	67
Copper	T257	A40	2	mg/kg	110	280	38	270	16	230
Lead	T257	A40	2	mg/kg	250	470	180	56	22	1600
Mercury	T245	A40	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Nickel	T257	A40	0.5	mg/kg	41	49	7.4	19	16	37
Selenium	T257	A40	3	mg/kg	<3	<3	<3	<3	<3	<3
Zinc	T257	A40	2	mg/kg	970	1800	130	540	64	4200
Asbestos ID	T27	A40			Asbestos not detected	Asbestos not detected	Asbestos not detected	Asbestos not detected	Asbestos not detected	Asbestos not detected
Chromium VI	T82	A40	1	mg/kg	<1	<1	<1	<1	<1	<1
pH	T7	A40			8.0	8.3	8.9	7.9	8.0	8.4
SO4(Total)	T102	A40	0.01	%	0.28	0.08	0.06	0.02	0.02	0.35
(Water Soluble) SO4-- expressed as SO4	T242	A40	0.01	g/l	0.25	0.03	0.04	0.02	0.03	0.51
Cyanide(Total)	T4	AR	1	mg/kg	<1	<1	<1	<1	<1	<1
Phenols(Mono)	T221	AR	1.0	mg/kg	<1.0	1.5	<1.0	<1.0	<1.0	1.3

SAL Reference: 441171
Project Site: Chartwell Road, Lancing Business Park
Customer Reference: 20839

Soil Analysed as Soil
Suite C

				SAL Reference	441171 001	441171 002	441171 003	441171 004	441171 005	441171 006
				Customer Sample Reference	WS101 ES1 @ 0.30m	WS103 ES1 @ 0.30m	WS104 ES2 @ 0.60m	WS106 ES2 @ 0.80m	TP101 ES3 @ 0.90m	TP107 ES1 @ 0.50m
				Date Sampled	01-DEC-2014	01-DEC-2014	01-DEC-2014	01-DEC-2014	01-DEC-2014	01-DEC-2014
Determinand	Method	Test Sample	LOD	Units						
TPH (C5-C6)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
TPH (C6-C8)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
TPH (C8-C10)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
TPH (C10-C12)	T219	AR	2	mg/kg	10	<2	<2	<2	<2	<2
TPH (C12-C16)	T219	AR	2	mg/kg	26	<2	<2	<2	<2	23
TPH (C16-C21)	T219	AR	2	mg/kg	58	8	11	<2	<2	260
TPH (C21-C35)	T219	AR	2	mg/kg	86	68	90	<2	<2	230

SAL Reference: 441171
Project Site: Chartwell Road, Lancing Business Park
Customer Reference: 20839

Soil Analysed as Soil
Total and Speciated USEPA16 PAH (SE)

					SAL Reference	441171 001	441171 002	441171 003	441171 004	441171 005	441171 006
					Customer Sample Reference	WS101 ES1 @ 0.30m	WS103 ES1 @ 0.30m	WS104 ES2 @ 0.60m	WS106 ES2 @ 0.80m	TP101 ES3 @ 0.90m	TP107 ES1 @ 0.50m
					Date Sampled	01-DEC-2014	01-DEC-2014	01-DEC-2014	01-DEC-2014	01-DEC-2014	01-DEC-2014
Determinand	Method	Test Sample	LOD	Units							
Naphthalene	T16	AR	0.1	mg/kg		0.6	<0.1	<0.1	<0.1	<0.1	0.1
Acenaphthylene	T16	AR	0.1	mg/kg		(9) <2.0	<0.1	<0.1	<0.1	<0.1	(9) <2.0
Acenaphthene	T16	AR	0.1	mg/kg		(9) <2.0	<0.1	<0.1	<0.1	<0.1	(9) <2.0
Fluorene	T16	AR	0.1	mg/kg		(9) <2.0	<0.1	<0.1	<0.1	<0.1	(9) <2.0
Phenanthrene	T16	AR	0.1	mg/kg		0.6	0.2	0.5	<0.1	<0.1	1.0
Anthracene	T16	AR	0.1	mg/kg		0.2	<0.1	0.1	<0.1	<0.1	0.2
Fluoranthene	T16	AR	0.1	mg/kg		0.4	0.3	1.3	<0.1	<0.1	1.7
Pyrene	T16	AR	0.1	mg/kg		0.5	0.3	1.2	<0.1	<0.1	1.6
Benzo(a)Anthracene	T16	AR	0.1	mg/kg		0.3	0.1	0.6	<0.1	<0.1	0.8
Chrysene	T16	AR	0.1	mg/kg		0.4	0.2	0.6	<0.1	<0.1	0.9
Benzo(b/k)Fluoranthene	T16	AR	0.1	mg/kg		0.4	0.2	1.0	<0.1	<0.1	1.4
Benzo(a)Pyrene	T16	AR	0.1	mg/kg		0.2	<0.1	0.6	<0.1	<0.1	0.5
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg		(9) <2.0	<0.1	0.2	<0.1	<0.1	0.3
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg		(9) <2.0	<0.1	0.1	<0.1	<0.1	0.1
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg		(9) <2.0	<0.1	0.2	<0.1	<0.1	0.2
PAH(total)	T16	AR	0.1	mg/kg		3.7	1.1	6.4	<0.1	<0.1	8.8

SAL Reference: 441171
Project Site: Chartwell Road, Lancing Business Park
Customer Reference: 20839

Soil Analysed as Soil
Miscellaneous

					SAL Reference	441171 007	441171 008	441171 009	441171 010
					Customer Sample Reference	WS101 D3 @ 2.50m	WS102 D3 @ 1.60m	WS104 D4 @ 3.20m	WS106 D2 @ 1.50m
					Date Sampled	01-DEC-2014	01-DEC-2014	01-DEC-2014	01-DEC-2014
Determinand	Method	Test Sample	LOD	Units					
(Water Soluble) SO4-- expressed as SO4	T242	A40	0.01	g/l		0.08	0.04	0.02	0.01
pH	T7	A40				7.7	8.0	8.0	7.4

Index to symbols used in 441171-1

Value	Description
A40	Assisted dried < 40C
AR	As Received
9	LOD raised due to dilution of sample
S	Analysis was subcontracted
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Method Index

Value	Description
T245	ICP/OES(Aqua Regia Extraction)
T16	GC/MS
T82	ICP/OES (Sim)
T221	Colorimetry (CE)
T4	Colorimetry
T27	PLM
T7	Probe
T257	ICP/OES (SIM) (Aqua Regia Extraction)
T102	ICP/OES (HCl extract)
T54	GC/MS (Headspace)
T242	2:1 Extraction/ICP/OES (TRL 447 T1)
T219	GC/FID (SE)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Arsenic	T257	A40	2.0	mg/kg	U	001-006
Cadmium	T257	A40	0.1	mg/kg	U	001-006
Chromium	T257	A40	0.5	mg/kg	U	001-006
Copper	T257	A40	2	mg/kg	U	001-006
Lead	T257	A40	2	mg/kg	U	001-006
Mercury	T245	A40	1.0	mg/kg	U	001-006
Nickel	T257	A40	0.5	mg/kg	U	001-006
Selenium	T257	A40	3	mg/kg	U	001-006
Zinc	T257	A40	2	mg/kg	U	001-006
Asbestos ID	T27	A40			SU	001-006
Chromium VI	T82	A40	1	mg/kg	N	001-006
pH	T7	A40			U	001-010
SO4(Total)	T102	A40	0.01	%	U	001-006
(Water Soluble) SO4-- expressed as SO4	T242	A40	0.01	g/l	U	001-010
Cyanide(Total)	T4	AR	1	mg/kg	U	001-006
Phenols(Mono)	T221	AR	1.0	mg/kg	U	001-006
TPH (C5-C6)	T54	AR	0.10	mg/kg	N	001-006
TPH (C6-C8)	T54	AR	0.10	mg/kg	N	001-006
TPH (C8-C10)	T54	AR	0.10	mg/kg	N	001-006
TPH (C10-C12)	T219	AR	2	mg/kg	U	001-006
TPH (C12-C16)	T219	AR	2	mg/kg	U	001-006
TPH (C16-C21)	T219	AR	2	mg/kg	U	001-006
TPH (C21-C35)	T219	AR	2	mg/kg	U	001-006
Naphthalene	T16	AR	0.1	mg/kg	U	001-006
Acenaphthylene	T16	AR	0.1	mg/kg	U	001-006
Acenaphthene	T16	AR	0.1	mg/kg	U	001-006
Fluorene	T16	AR	0.1	mg/kg	U	001-006
Phenanthrene	T16	AR	0.1	mg/kg	U	001-006
Anthracene	T16	AR	0.1	mg/kg	U	001-006
Fluoranthene	T16	AR	0.1	mg/kg	N	001-006
Pyrene	T16	AR	0.1	mg/kg	N	001-006
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	U	001-006
Chrysene	T16	AR	0.1	mg/kg	U	001-006
Benzo(b/k)Fluoranthene	T16	AR	0.1	mg/kg	U	001-006
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	U	001-006
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	U	001-006
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	U	001-006
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	U	001-006
PAH(total)	T16	AR	0.1	mg/kg	U	001-006

APPENDIX VIII ORIGIN OF TIER I VALUES

APPENDIX VIII

ORIGIN OF TIER I VALUES

ORIGIN OF REC TIER I VALUES

Constituent	Origin of Risk Assessment Value
Arsenic	2009 SGV
Cadmium	LQM CIEH 2nd Edition 2009
Chromium	LQM CIEH 2nd Edition 2009
Lead	Residential Half 2003 EA SGV based on planned target blood lead level reduction to 5µg/l.
	Commercial Calculated using commercial exposure equation within lead SGV 2003 with revised input data from HPA and taking proposed blood lead levels into account.
Mercury	2009 SGV
Nickel	2009 SGV
Selenium	Soil guideline value, DEFRA/Environment Agency
Copper	LQM CIEH 2nd Edition 2009
Zinc	LQM CIEH 2nd Edition 2009
Cyanide - Total	CLEA 1.06 Derived Value
Phenols - Total.	LQM CIEH 2nd Edition 2009 – 1% SOM
Naphthalene	General Assessment Criteria (GAC) developed by CIEH / LQM the using CLEA 1-06 with supporting data from SR3, SR7 and existing Tox report where applicable. 1% SOM
Acenaphthylene	
Acenaphthene	
Fluorene	
Phenanthrene	
Anthracene	
Fluoranthene	
Pyrene	
Benzo(a)Anthracene[	
Chrysene	
Benzo(b/k)Fluoranthene [iii]	
Benzo(a)Pyrene	
Indeno(123-cd)Pyrene	
Dibenzo(a,h)Anthracene	
Benzo(ghi)Perylene	
TPH C_5-C_6 (aliphatic)	
TPH C_6-C_8 (aliphatic)	
TPH C_8-C_{10} (aliphatic)	
TPH C_{10}-C_{12} (aliphatic)	
TPH C_{12}-C_{16} (aromatic)	
TPH C_{16}-C_{21} (aromatic)	
TPH C_{21}-C_{35} (aromatic)	

APPENDIX IX

GEOTECHNICAL TESTING RESULTS

PSL
Professional Soils Laboratory

LABORATORY REPORT

UKAS TESTING
4043

Contract Number: PSL14/6391

Client's Reference: Report Date: 23 December 2014

Client Name: REC Fareham
Environment House
Segensworth Business Centre
Segensworth Road West
Fareham
PO15 5RQ

For the attention of: Will Spraggs

Contract Title: Chartwell Road, Lancing Business Park

Date Received: 4/12/2014
Date Commenced: 4/12/2014
Date Completed: 23/12/2014

Notes: **Observations and Interpretations are outside the UKAS Accreditation**

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson
(Director)

A Watkins
(Director)

M Beastall
(Laboratory Manager)

[redacted]

D Lambe
(Senior Technician)

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SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Depth m	Description of Sample
TP102	1	B	0.30	MADE GROUND grey very sandy slightly clayey gravel.
TP102	2	B		Brown sandy clayey silty GRAVEL.
TP107	1	B	0.20-0.60	MADE GROUND grey very sandy slightly clayey gravel.
TP108	2	B	1.00-1.50	Brown sandy clayey GRAVEL.
WS101	1	D	1.20	Brown sandy very silty CLAY.
WS104	2	D	1.80	Brown sandy very silty CLAY.
WS106	1	D	1.00	Brown gravelly sandy very silty CLAY.

PSL
Professional Soils Laboratory

Compiled by	Date	Checked by	Date	Approved by	Date
[redacted]	23/12/14	[redacted]	23/12/14	[redacted]	23/12/14

CHARTWELL ROAD, LANCING BUSINESS PARK.

Contract No: PSL14/6391

Client Ref: 20839

SUMMARY OF SOIL CLASSIFICATION TESTS

(B.S. 1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Depth m	Moisture Content % Clause 3.2	Bulk Density Mg/m^3 Clause 7.2	Dry Density Mg/m^3 Clause 7.2	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4.4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	% Passing .425mm	Remarks
WS101	1	D	1.20	23				38	21	17	100	Intermediate plasticity CI.
WS104	2	D	1.80	24				35	20	15	100	Intermediate plasticity CI.
WS106	1	D	1.00	19				33	19	14	83	Low plasticity CL.

SYMBOLS : NP : Non Plastic

* : Liquid Limit and Plastic Limit Wet Sieved.

PSL
Professional Soils Laboratory

Compiled by	Date	Checked by	Date	Approved by	Date
[redacted]	23/12/14	[redacted]	23/12/14	[redacted]	23/12/14

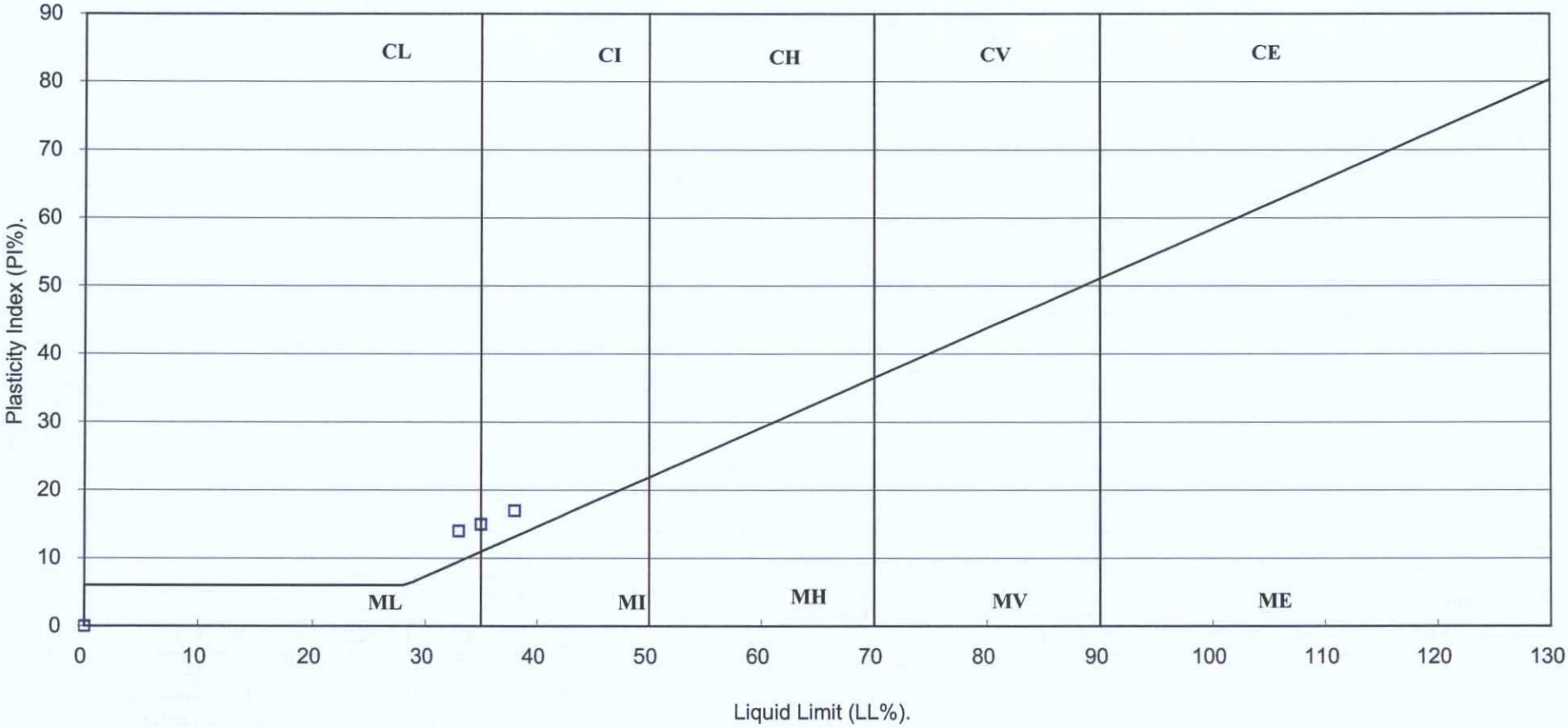
CHARTWELL ROAD, LANCING BUSINESS PARK.

Contract No: PSL14/6391

Client Ref: 20839

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(B.S.5930 : 1999)



	Compiled by	Date	Checked by	Date	Approved by	Date
PSL Professional Soils Laboratory	[redacted]	23/12/14	[redacted]	23/12/14	[redacted]	23/12/14
	CHARTWELL ROAD, LANCING BUSINESS PARK.				Contract No:	PSL14/6391
					Client Ref:	20839

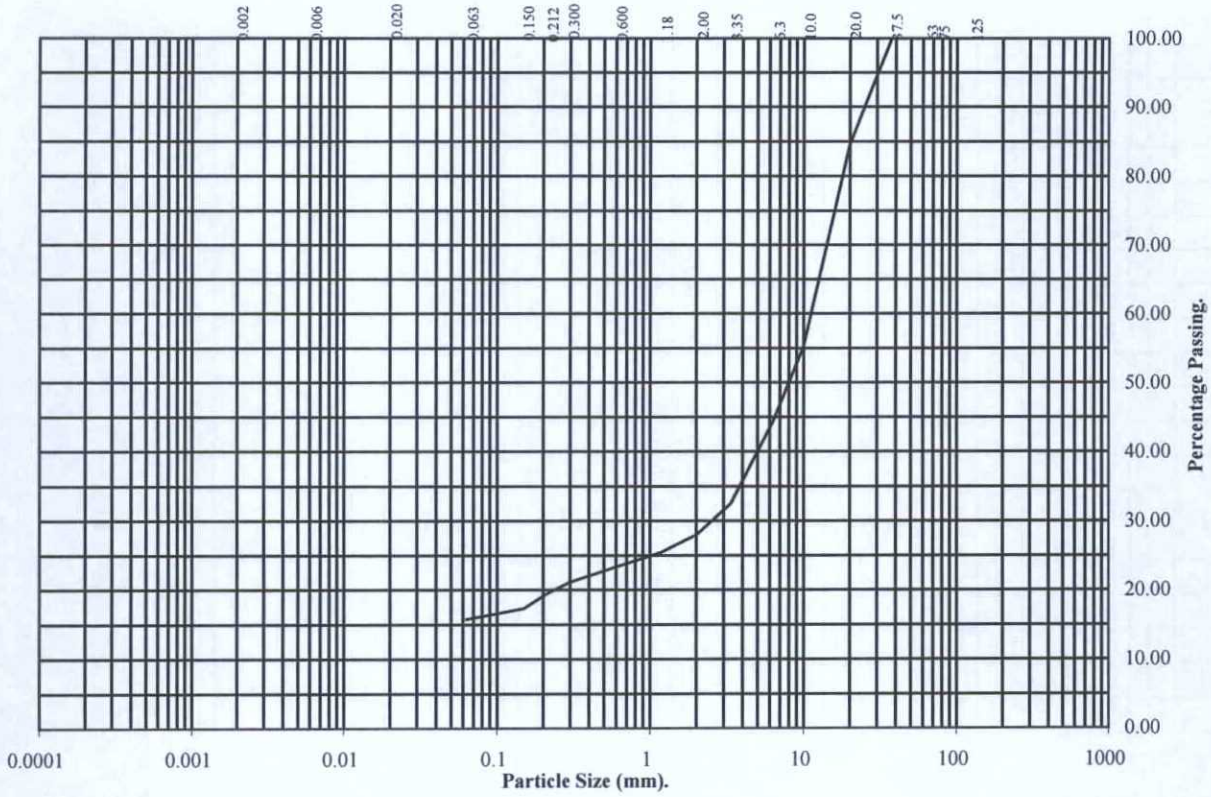
Particle Size Distribution Test

BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: TP102 **Depth (m):**

Sample Number: 2 **Sample Type:** B



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	85
10	55
6.3	44
3.35	33
2	28
1.18	25
0.6	23
0.3	21
0.212	20
0.15	17
0.063	16

Soil Fraction	Total Percentage
Cobbles	0
Gravel	72
Sand	12
Silt / Clay	16

Remarks:
See summary of soil descriptions.

Checked By	Date	Approved By	Date
[redacted]	23/12/14	[redacted]	23/12/14

PSL Professional Soils Laboratory	**CHARTWELL ROAD, LANCING BUSINESS PARK.**	**Contract No.: PSL14/6391**

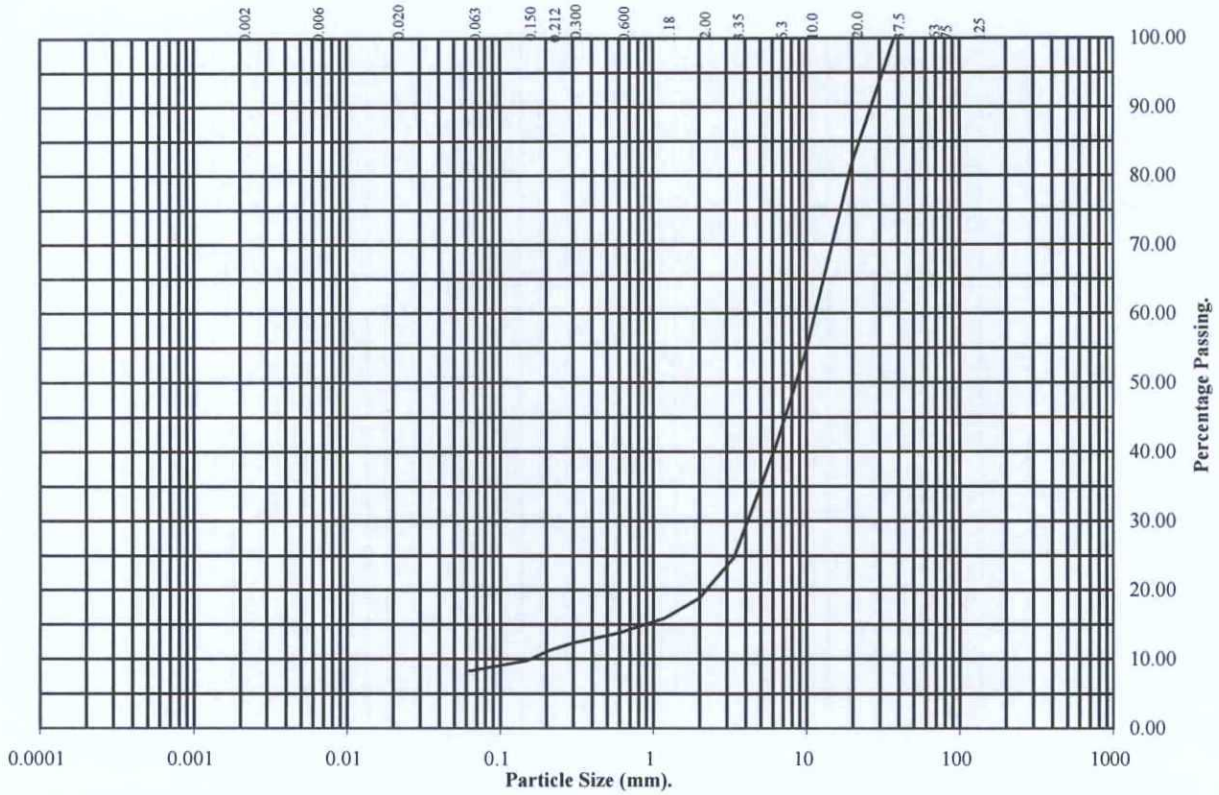
Particle Size Distribution Test

BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: TP108 **Depth (m):** 1.00-1.50

Sample Number: 2 **Sample Type:** B



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	82
10	55
6.3	41
3.35	25
2	19
1.18	16
0.6	14
0.3	12
0.212	11
0.15	10
0.063	8

Soil Fraction	Total Percentage
Cobbles	0
Gravel	81
Sand	11
Silt / Clay	8

Remarks:
See summary of soil descriptions.

Checked By	Date	Approved By	Date
[redacted]	23/12/14	[redacted]	23/12/14

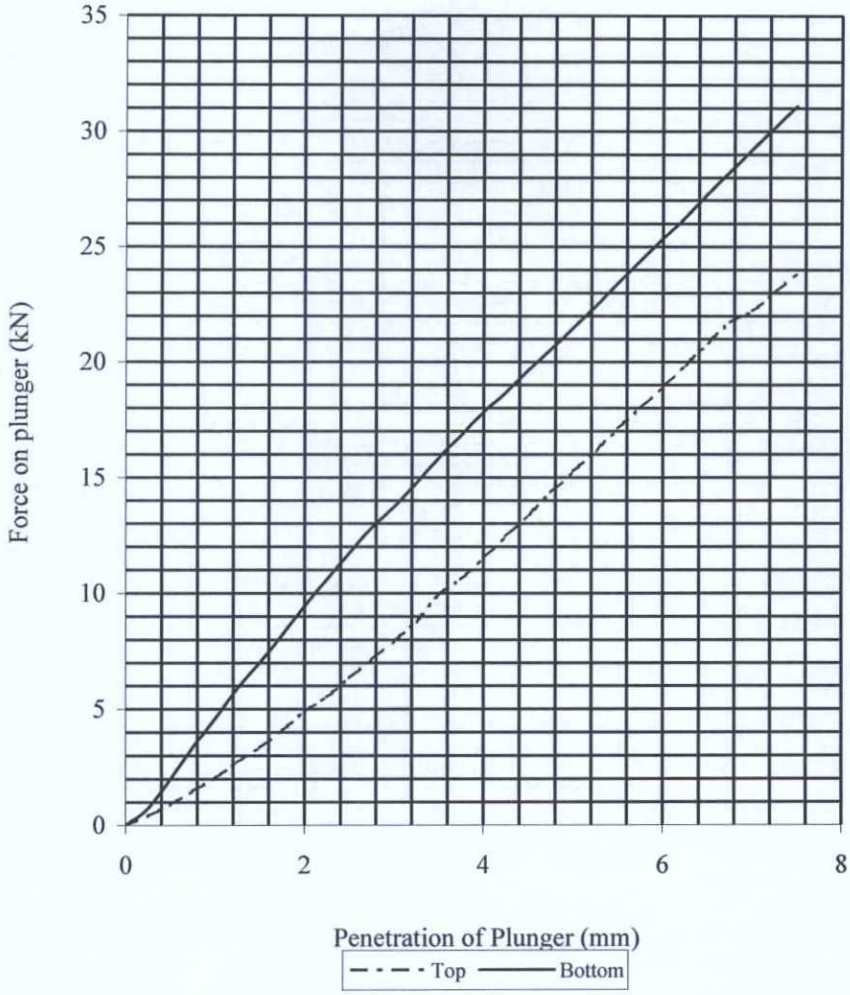
PSL Professional Soils Laboratory	**CHARTWELL ROAD, LANCING BUSINESS PARK.**	**Contract No.: PSL14/6391**

California Bearing Ratio Test.

BS 1377 : Part 4 : 1990

Hole Number: TP102 **Depth (m):** 0.30

Sample Number: 1 **Sample Type:** B



Initial Sample Conditions		Test Conditions		Method of compaction		2.5Kg Rammer	
Moisture Content:	15	Surcharge Kg:	4.20	Final Moisture Content %		C.B.R. Value %	
Bulk Density Mg/m3:	1.94	Soaking Time hrs	0	Sample Top	15	Sample Top	76.5
Dry Density Mg/m3:	1.69	Swelling mm:	0	Sample Bottom	15	Sample Bottom	107.5
Percentage retained on 20mm BS test sieve:	31	Remarks:	See Summary of Soil Description.				

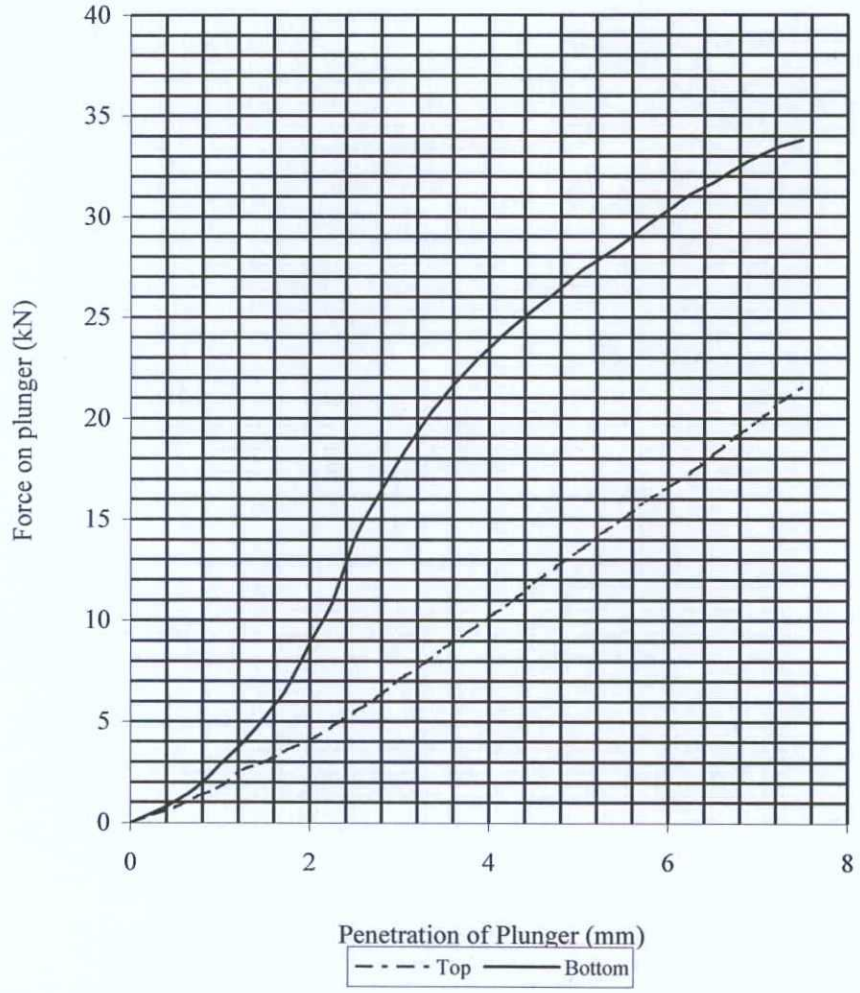
Checked by	Date	Approved By	Date
[redacted]	23/12/14	[redacted]	23/12/14

PSL Professional Soils Laboratory	CHARTWELL ROAD, LANCING BUSINESS PARK.	Contract No. PSL14/6391

California Bearing Ratio Test.

BS 1377 : Part 4 : 1990

Hole Number:	**TP107**	**Depth (m):**	**0.20-0.60**
Sample Number:	**1**	**Sample Type:**	**B**



Initial Sample Conditions		Test Conditions		Method of compaction		2.5Kg Rammer	
Moisture Content:	15	Surcharge Kg:	4.20	Final Moisture Content %		C.B.R. Value %	
Bulk Density Mg/m3:	2.00	Soaking Time hrs	0	Sample Top	15	Sample Top	67.2
Dry Density Mg/m3:	1.74	Swelling mm:	0	Sample Bottom	15	Sample Bottom	136.0
Percentage retained on 20mm BS test sieve:	27	Remarks:	See Summary of Soil Description.				

Checked by	Date	Approved By	Date
[redacted]	23/12/14	[redacted]	23/12/14

PSL Professional Soils Laboratory	**CHARTWELL ROAD, LANCING BUSINESS PARK.**	**Contract No. PSL14/6391**

APPENDIX X IN-SITU CBR TESTING RESULTS

APPENDIX X

IN-SITU CBR TESTING RESULTS

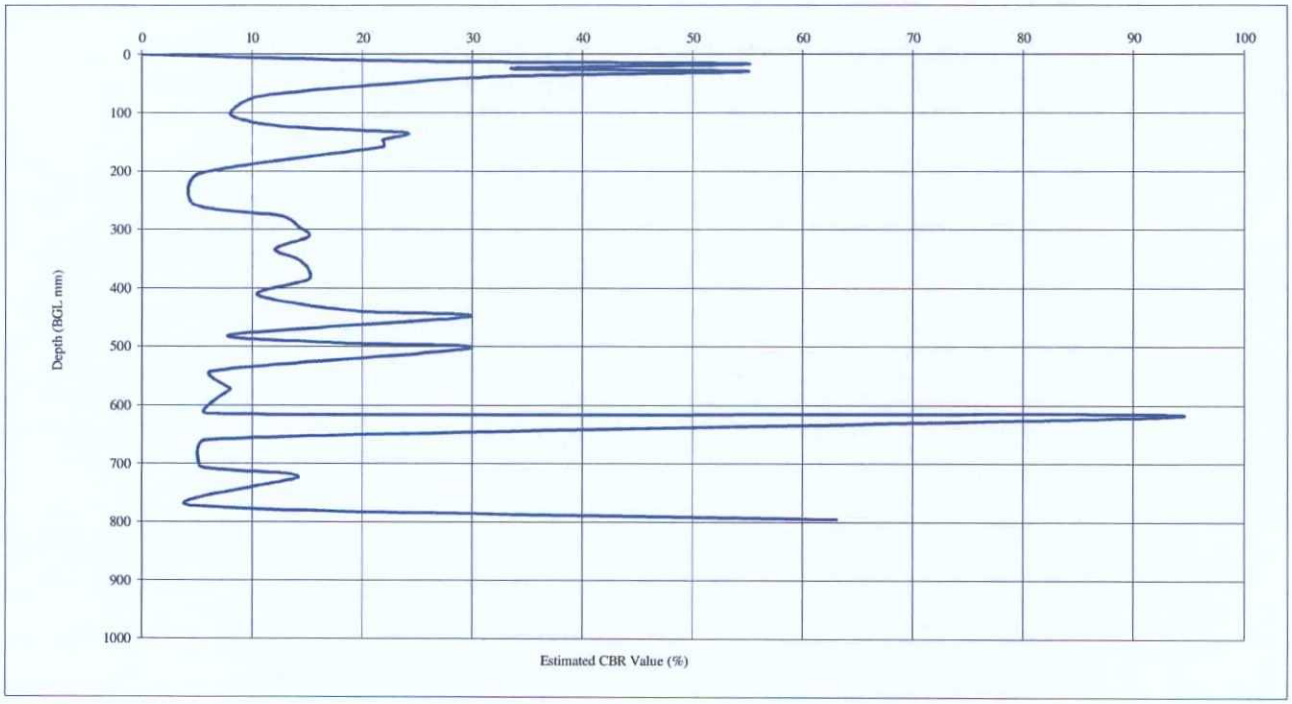
REC Geo-Environmental

Determination of Dynamic Cone Penetrometer - Estimated CBR Value (%)

In Accordance with TRL Report PR/INT/277/04

Site Name	Chartwell Road, Lancing	**Test Date:**	10/12/2014
Site Ref	20839	**Test Location:**	DCP101
Test No.:	1	**Easting:**	0
Initial Depth (mm BGL):	0	**Northing:**	0
Final Depth (mm BGL):	795		

Estimated California Bearing Ratio Graph



Start Depth (mm) BGL	Finish Depth (mm) BGL	No. of Blows	Blows Per Layer	DCP mm/Blows	Ave Estimated Layer (CBR %)
0	400	21	21	19.05	13.40
400	795	41	20	19.75	12.90

Average estimated CBR value of 13% between 0.40 - 0.79m bgl

Comments

Site Engineer:	Checked By:	Date:	Approved By:	Date:
P.Sullivan	A.King	12/12/2014	A.King	12/12/2014

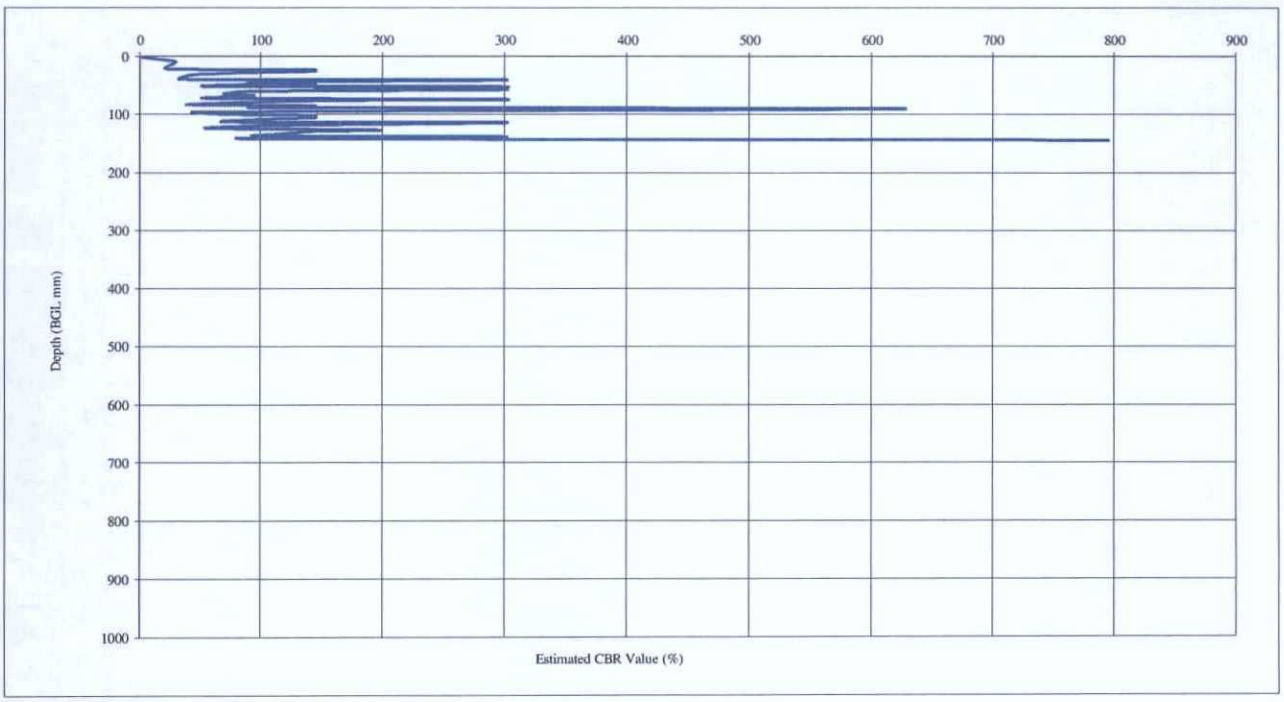
REC Geo-Environmental

Determination of Dynamic Cone Penetrometer - Estimated CBR Value (%)

In Accordance with TRL Report PR/INT/277/04

Site Name	Chartwell Road, Lancing	**Test Date:**	10/12/2014
Site Ref	20839	**Test Location:**	DCP102
Test No.:	2	**Easting:**	0
Initial Depth (mm BGL):	0	**Northing:**	0
Final Depth (mm BGL):	144		

Estimated California Bearing Ratio Graph



Start Depth (mm) BGL	Finish Depth (mm) BGL	No. of Blows	Blows Per Layer	DCP mm/Blows	Ave Estimated Layer (CBR %)
0	144	54	54	2.67	107.09

Average estimated CBR value of 100% between GL - 0.14m bgl

Comments

Site Engineer:	Checked By:	Date:	Approved By:	Date:
P.Sullivan	A.King	12/12/2014	A.King	12/12/2014

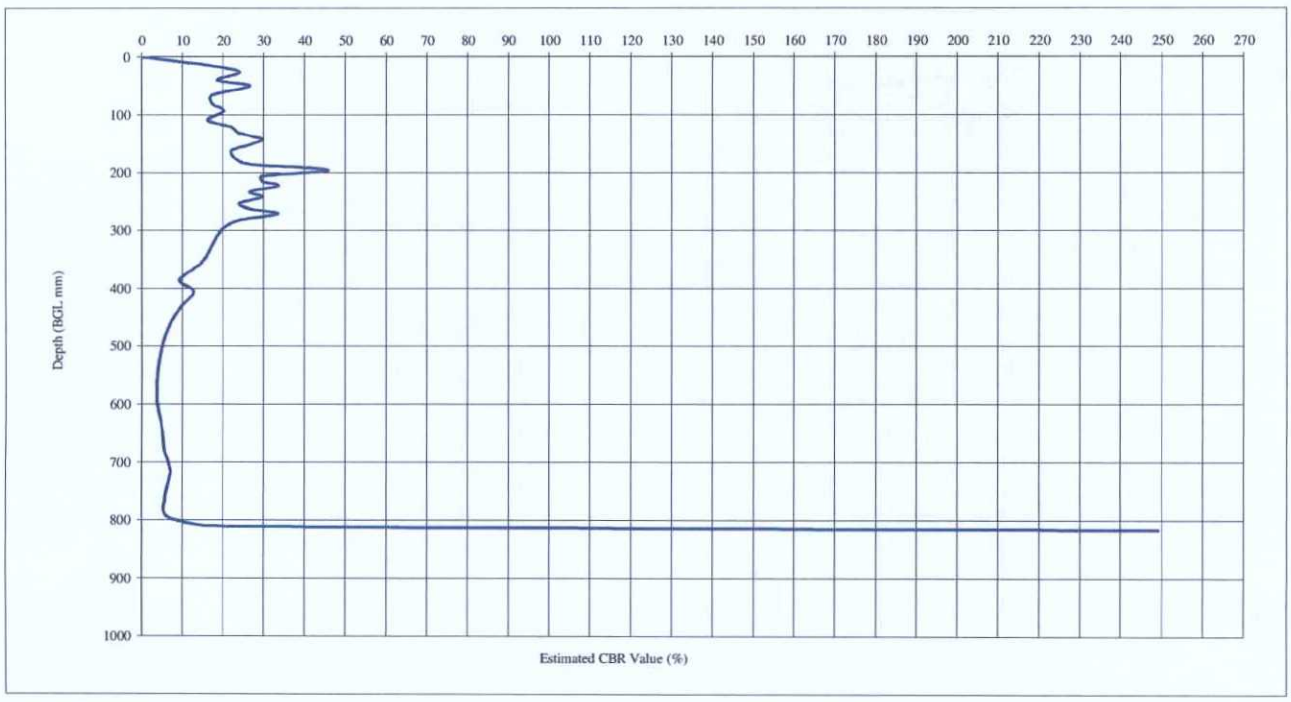
REC Geo-Environmental

Determination of Dynamic Cone Penetrometer - Estimated CBR Value (%)

In Accordance with TRL Report PR/INT/277/04

Site Name	Chartwell Road, Lancing	**Test Date:**	10/12/2014
Site Ref	20839	**Test Location:**	DCP103
Test No.:	1	**Easting:**	0
Initial Depth (mm BGL):	0	**Northing:**	0
Final Depth (mm BGL):	816		

Estimated California Bearing Ratio Graph



Start Depth (mm) BGL	Finish Depth (mm) BGL	No. of Blows	Blows Per Layer	DCP mm/Blows	Ave Estimated Layer (CBR %)
0	300	27	27	11.11	23.69
300	800	42	15	33.33	7.42

Average estimated CBR value of 7.4% between 0.30 - 0.80m bgl

Comments

Site Engineer:	Checked By:	Date:	Approved By:	Date:
P.Sullivan	A.King	12/12/2014	A.King	12/12/2014

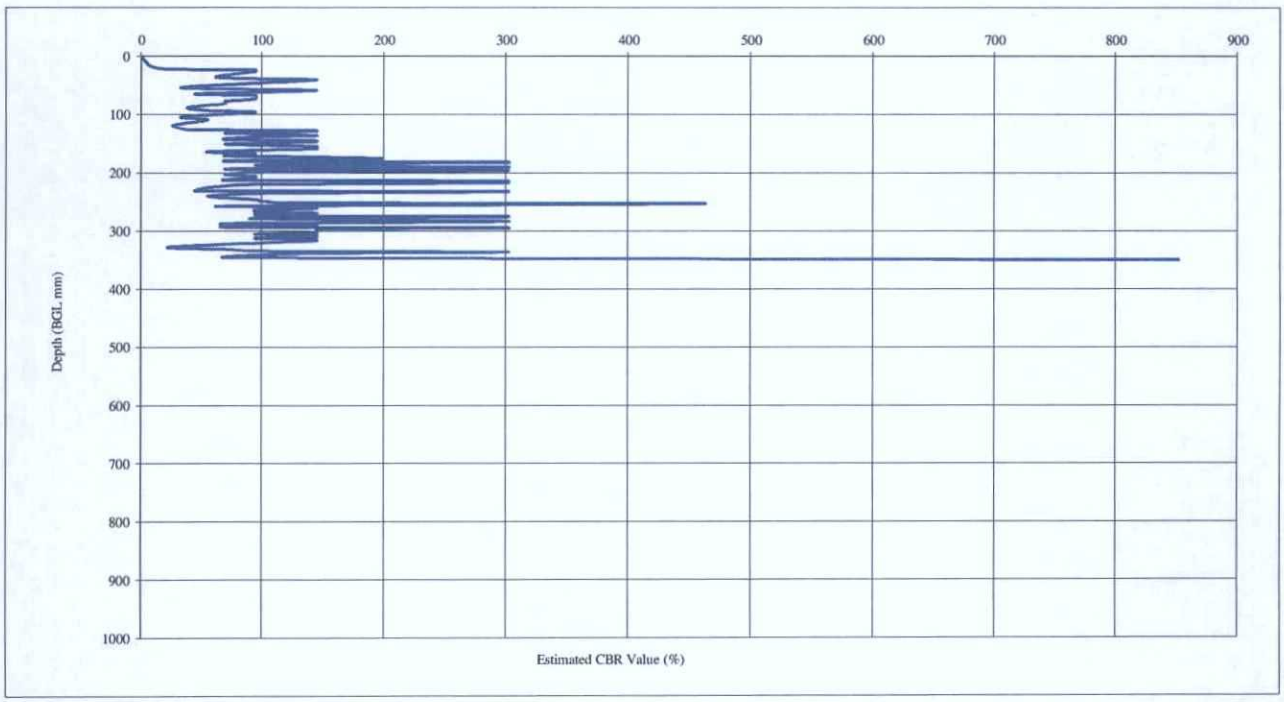
REC Geo-Environmental

Determination of Dynamic Cone Penetrometer - Estimated CBR Value (%)

In Accordance with TRL Report PR/INT/277/04

Site Name	Chartwell Road, Lancing	**Test Date:**	10/12/2014
Site Ref	20839	**Test Location:**	DCP104
Test No.:	1	**Easting:**	0
Initial Depth (mm BGL):	0	**Northing:**	0
Final Depth (mm BGL):	350		

Estimated California Bearing Ratio Graph



Start Depth (mm) BGL	Finish Depth (mm) BGL	No. of Blows	Blows Per Layer	DCP mm/Blows	Ave Estimated Layer (CBR %)
0	350	122	122	2.87	99.13

Average estimated CBR value of 99.1% between GL - 0.35m bgl

Comments

Site Engineer:	Checked By:	Date:	Approved By:	Date:
P.Sullivan	A.King	12/12/2014	A.King	12/12/2014

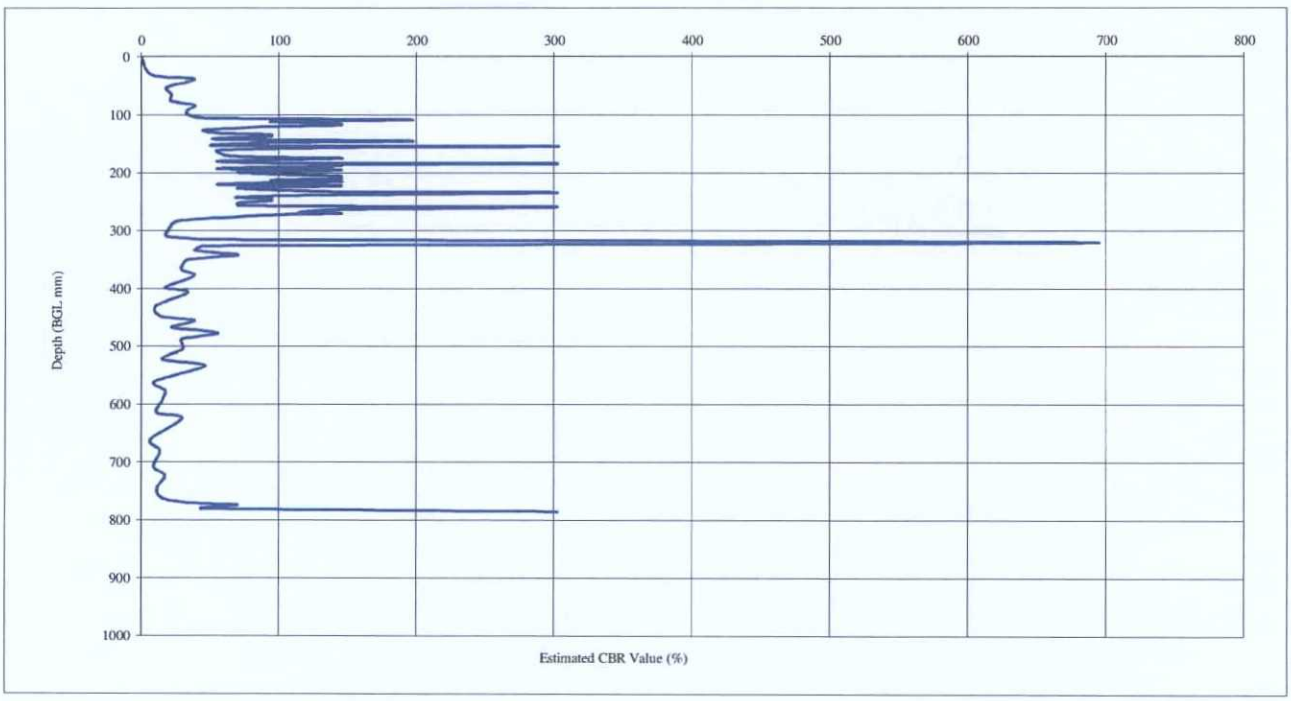
REC Geo-Environmental

Determination of Dynamic Cone Penetrometer - Estimated CBR Value (%)

In Accordance with TRL Report PR/INT/277/04

Site Name	Chartwell Road, Lancing	**Test Date:**	10/12/2014
Site Ref	20839	**Test Location:**	DCP105
Test No.:	1	**Easting:**	0
Initial Depth (mm BGL):	0	**Northing:**	0
Final Depth (mm BGL):	785		

Estimated California Bearing Ratio Graph



Start Depth (mm) BGL	Finish Depth (mm) BGL	No. of Blows	Blows Per Layer	DCP mm/Blows	Ave Estimated Layer (CBR %)
0	400	94	94	4.26	65.35
400	600	110	16	12.50	20.92
600	785	126	110	1.68	174.32

Average estimated CBR value of 20.9% between 0.40 - 0.60m bgl

Comments

Site Engineer:	Checked By:	Date:	Approved By:	Date:
P.Sullivan	A.King	12/12/2014	A.King	12/12/2014

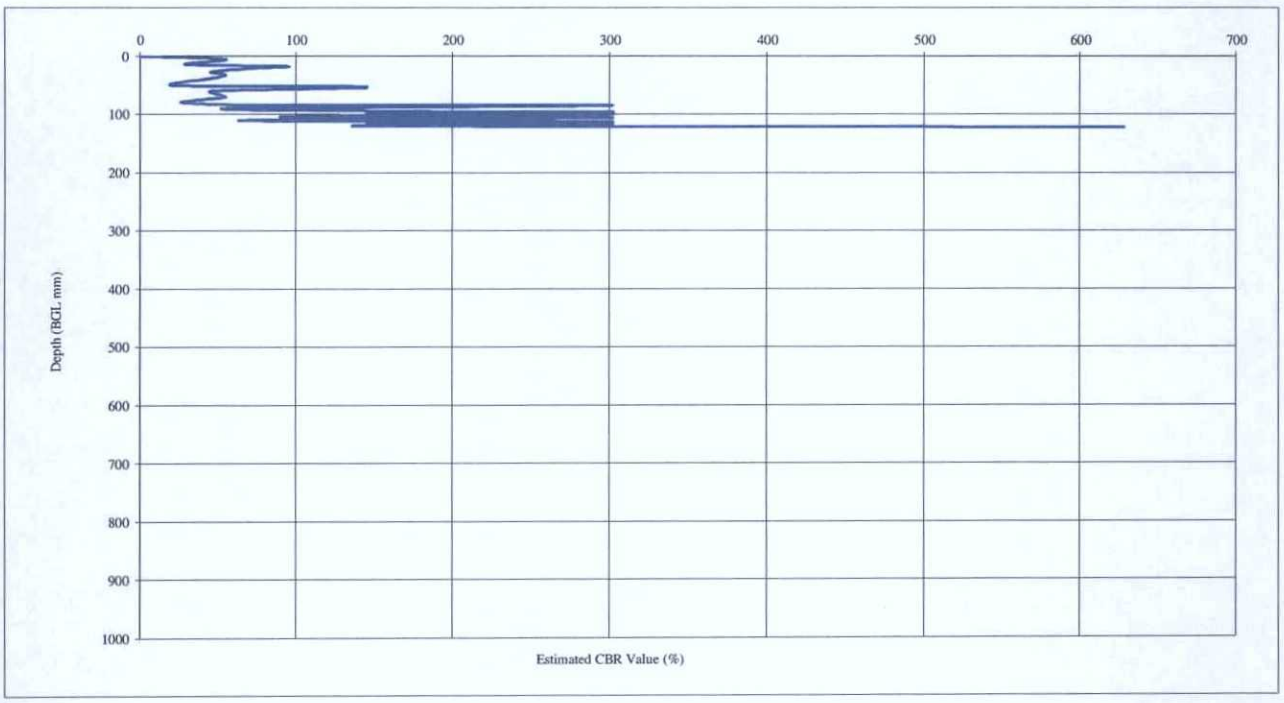
REC Geo-Environmental

Determination of Dynamic Cone Penetrometer - Estimated CBR Value (%)

In Accordance with TRL Report PR/INT/277/04

Site Name	Chartwell Road, Lancing	**Test Date:**	10/12/2014
Site Ref	20839	**Test Location:**	DCP106
Test No.:	1	**Easting:**	0
Initial Depth (mm BGL):	0	**Northing:**	0
Final Depth (mm BGL):	122		

Estimated California Bearing Ratio Graph



Start Depth (mm) BGL	Finish Depth (mm) BGL	No. of Blows	Blows Per Layer	DCP mm/Blows	Ave Estimated Layer (CBR %)
0	122	38	38	3.21	88.01

Average estimated CBR value of 88% between 0.0 - 0.10m bgl

Comments

Site Engineer:	Checked By:	Date:	Approved By:	Date:
P.Sullivan	A.King	12/12/2014	A.King	12/12/2014

APPENDIX XI

SOIL INFILTRATION TESTING RESULTS

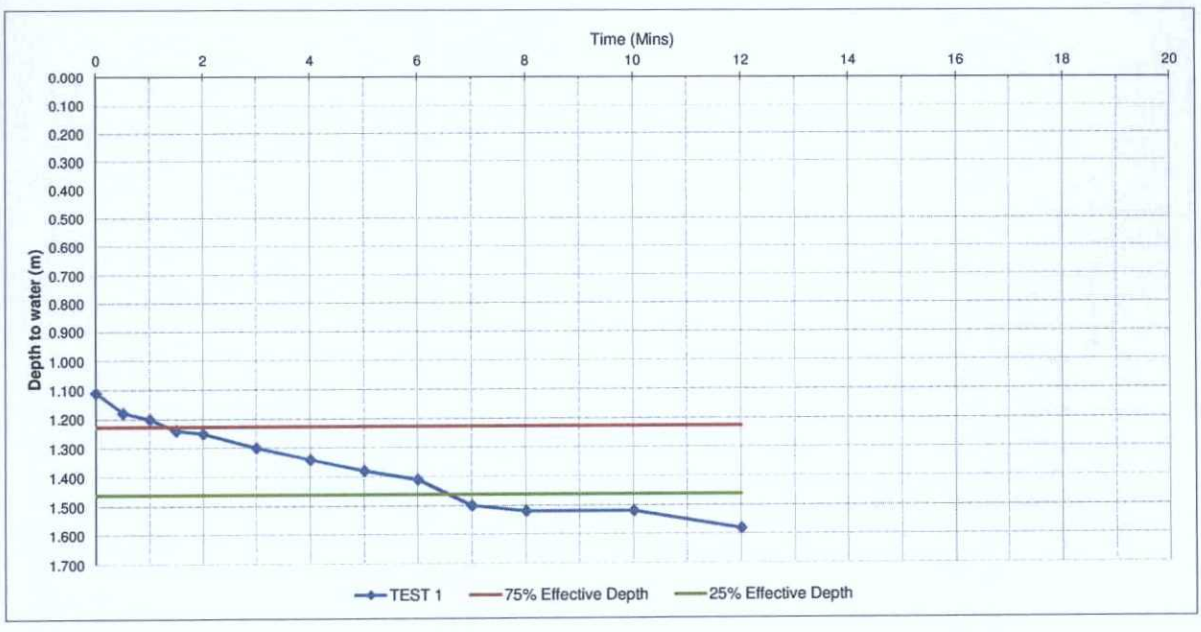
REC
Resource & Environmental Consultants Ltd

Site	**Chartwell Road, Lancing Business Park**	Trial Pit Number	TP101
Job Number	**20839**	Length.....	1.80 m
Date of Test	**02nd December 2014**	Width.....	0.70 m
		Depth.....	1.58 m
		Groundwater Level.....	m

Remarks	TEST 1		TEST 2		TEST 3	
	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
	0	1.110				
	0.5	1.180				
	1	1.200				
	1.5	1.240				
	2	1.250				
	3	1.300				
	4	1.340				
	5	1.380				
	6	1.410				
	7	1.500				
	8	1.520				
	10	1.520				
	12	1.580				
Hole collapsed from 2.10m bgl to 1.58m bgl during test.						

Effective Storage Depth	m	0.47		
75% Effective Storage Depth	m	0.35		
(i.e. depth below GL)	m	1.23		
25% Effective Storage Depth	m	0.12		
(i.e. depth below GL)	m	1.46		
Effective Storage Depth 75%-25%	m	0.24		
Time to fall to 75% effective depth	mins	1.50		
Time to fall to 25% effective depth	mins	6.60		
V (75%-25%)	m3	0.30		
a (50%)	m2	2.44		
t (75%-25%)	mins	5.10		
SOIL INFILTRATION RATE	m/s	**3.97E-04**		

DESIGN SOIL INFILTRATION RATE, f	**3.97E-04**



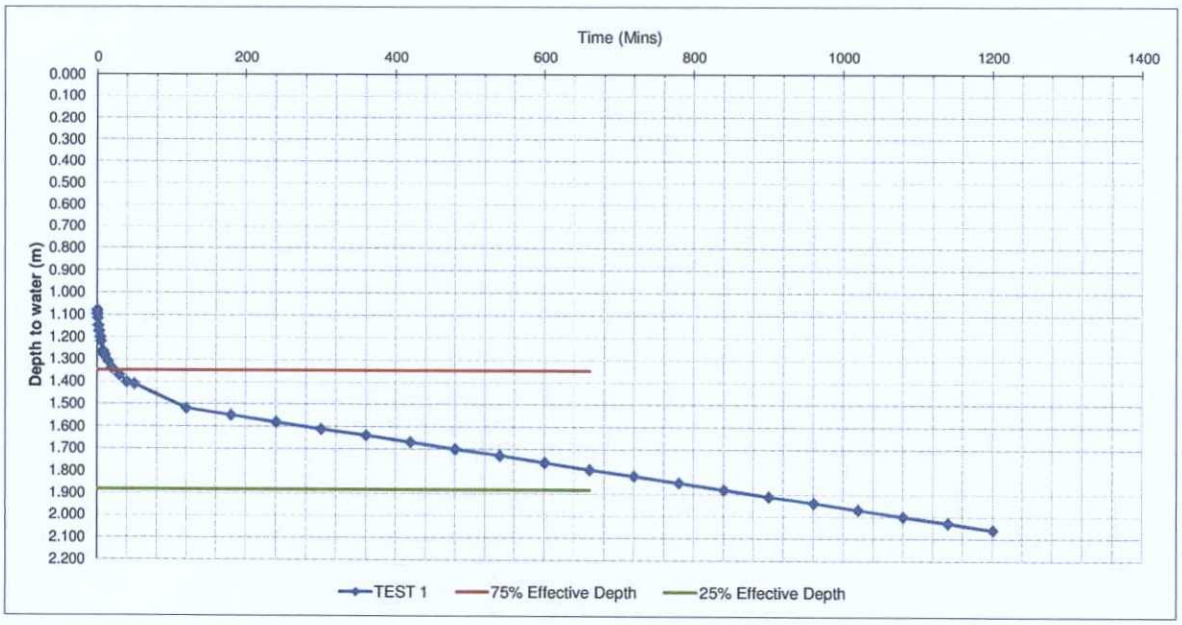
REC
Resource & Environmental Consultants Ltd

Site	Chartwell Road, Lancing Business Pa	Trial Pit Number	TP102	
Job Number	20839	Length.....	1.70	m
Date of Test	02nd December 2014	Width.....	0.70	m
		Depth.....	2.15	m
		Groundwater Level.....		m

Remarks	TEST 1		TEST 1 (continued)		TEST 3	
	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
	0	1.080	780	1.850		
	0.5	1.095	840	1.880		
	1	1.115	900	1.910		
	2	1.150	960	1.940		
	3	1.175	1020	1.970		
	4	1.200	1080	2.000		
	5	1.220	1140	2.030		
	7	1.265	1200	2.060		
	8	1.265	1260	2.090		
	9	1.280	1320	2.120		
	10	1.280	1380	2.150		
	15	1.310				
Data extrapolated from 180 mins to reach 25%.	20	1.340				
	30	1.370				
	40	1.400				
	50	1.410				
	120	1.520				
	180	1.550				
	240	1.580				
	300	1.610				
	360	1.640				
	420	1.670				
	480	1.700				
	540	1.730				
	600	1.760				
	660	1.790				
	720	1.820				

Effective Storage Depth	m	1.07
75% Effective Storage Depth	m	0.80
(i.e. depth below GL)	m	1.35
25% Effective Storage Depth	m	0.27
(i.e. depth below GL)	m	1.88
Effective Storage Depth 75%-25%	m	0.54
Time to fall to 75% effective depth	mins	25.00
Time to fall to 25% effective depth	mins	840.00
V (75%-25%)	m3	0.64
a (50%)	m2	3.76
t (75%-25%)	mins	815.00
SOIL INFILTRATION RATE	m/s	**3.46E-06**

DESIGN SOIL INFILTRATION RATE, f	**3.46E-06**



REC
Resource & Environmental Consultants Ltd

Site	Chartwell Road, Lancing Business Park	Trial Pit Number	TP108	
Job Number	20839	Length.....	1.70	m
Date of Test	02nd December 2014	Width.....	0.60	m
		Depth.....	1.98	m
		Groundwater Level.....		m

Remarks	TEST 1		TEST 2		TEST 3	
	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
	0	1.060				
	0.5	1.100				
	1	1.140				
	2	1.180				
	3	1.230				
	4	1.230				
	5	1.240				
	8	1.280				
	9	1.295				
	10	1.300				
	15	1.310				
	20	1.320				
	30	1.360				
	40	1.380				
	60	1.400				
	120	1.420				
	180	1.440				
	240	1.460				
Data extrapolated from 240 mins to reach 75%.	300	1.480				
	360	1.500				
	420	1.520				
	480	1.540				
	540	1.560				
	600	1.580				
	660	1.600				
	720	1.620				
	780	1.640				
	840	1.660				
	900	1.680				
	960	1.700				
	1020	1.720				
	1080	1.740				
	1140	1.760				
	1200	1.780				
	1260	1.800				
	1320	1.820				
	1380	1.840				

Effective Storage Depth	m	0.92		
75% Effective Storage Depth	m	0.69		
(i.e. depth below GL)	m	1.29		
25% Effective Storage Depth	m	0.23		
(i.e. depth below GL)	m	1.75		
Effective Storage Depth 75%-25%	m	0.46		
Time to fall to 75% effective depth	mins	9.00		
Time to fall to 25% effective depth	mins	1150.00		
V (75%-25%)	m3	0.47		
a (50%)	m2	3.14		
t (75%-25%)	mins	1141.00		
SOIL INFILTRATION RATE	m/s	**2.19E-06**		

DESIGN SOIL INFILTRATION RATE, f	**2.19E-06**

