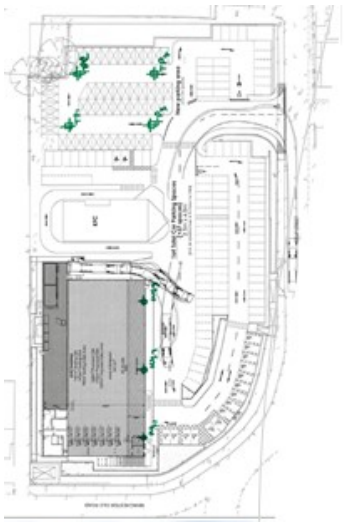









EARTH ENVIRONMENTAL
& GEOTECHNICAL

GeoEnvironmental Investigation

ALDI Kemp Street

Middleton

January 2019

On behalf of

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PHASE II GEOENVIRONMENTAL INVESTIGATION

ALDI KEMP STREET

MIDDLETON

Report Ref: A2823/19/B.0

JANUARY 2019

Prepared on Behalf of:

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PHASE II GEOENVIRONMENTAL INVESTIGATION

ALDI KEMP STREET, MIDDLETON

Report Reference: A2823/19

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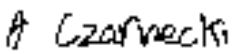
Written by: **Jessica Sheridan**
Senior Consultant



Approved by:

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Managing Director

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1.0 INTRODUCTION

1.1 Background

A Geo-Environmental Site Investigation has been commissioned by SWF Consulting Ltd (SWF) on behalf of ALDI Food Stores Ltd (the Client) to examine ground conditions and retrieve soil samples for chemical and geotechnical testing, for a proposed extension of the existing food-store on Kemp Street, Middleton.

1.2 Previous Investigations

Shepherd Gilmour Environmental (SGE) Ltd GeoEnvironmental Desk Study and Ground Investigation, Reference: P0492 CK (ME968), Dated May 2007

SGE were commissioned by Kirkland Developments Ltd to prepare a desk study and carry out an intrusive ground investigation for the site. The proposed development involved the demolition of existing structures and redevelopment of the site with a number of commercial buildings with associated hardstanding.

The desk study highlighted that historically, the site was occupied predominantly by Parkfield Mills (later Parkfield Works). Tanks and reservoirs were present on-site from the mid-1950s until the 1980s, and an electricity substation was located in the southern part of the site from the early 1980s. The contemporary trade directory also indicated a scrap metal merchants was once present on the site, together with a joiners, glassworks and garage.

Neighbouring land uses were previously predominantly industrial and included various works (soap, dye, finishing, bleach etc). In more recent years the area appeared to become a mixture of residential and commercial.

The following potential sources of contamination were considered:

- Made Ground i.e. potentially contaminated waste material associated with the infilling on former reservoirs
- Fuel storage tanks and chemical storage

A site investigation was subsequently carried out and comprised:

- 14 no. window sampler borehole to depths of between 2.00m bgl and 4.00m bgl
- 3 no. cable percussion boreholes to depths of between 15.50m bgl and 22.80m bgl
- 1 no. hand dug trial pit to a depth of 0.50m bgl
- Installation of 6 no. gas and groundwater monitoring installations and subsequent monitoring.

Ground conditions across the site generally comprised made ground to a maximum depth of 3.50m bgl, overlying interbedded brown clays and gravelly sands. Rockhead (red sandstone) was encountered at 22.40m bgl. Brick, ash and clinker were observed in the made ground during the fieldwork.

20 no. soil samples underwent chemical analysis and were screened for a range of analytes.

Three samples (WS9 at 0.50m, WS14 at 1.00m and HP1 at 0.50m) contained concentrations of lead in exceedance of soil guideline values for industrial/commercial end use (at the time of testing).

Soil leachate analysis was also carried out to assess the risk to controlled waters. Concentrations of arsenic in 3 no. locations and phenols in 5 no. locations were considered to pose a risk.

Soils were classified as a combination of hazardous and non-hazardous for off-site disposal.

The risk to end users from potential soil contamination on the site was concluded to be **LOW** based on the proposed industrial/commercial end use and the site being predominantly covered by hardstanding.

Conventional foundations were not considered suitable for the proposed development due to the presence of deep made ground and potential for large total and differential settlement. Ground improvement (vibro-displacement) or piled foundations were recommended.

1.3 Terms of Reference

Earth Environmental and Geotechnical Ltd (EEG) was commissioned by the Client to undertake a Geo-Environmental Investigation of the site in accordance with a proposal A2823 dated 7th November 2018.

The objectives of this investigation are as follows:

- *Assess the presence and likely extent of any potential environmental hazards (soil contamination) associated within the areas of the site investigated.*
- *Assess the ground conditions for design of foundations.*
- *Classify soils for off-site disposal purposes.*

1.4 Limitations of the Study

The report is written in the context of an agreed scope of work and budget and should not be used in a different context. New information, improved practices or changes in legislation may require a reinterpretation of the report in whole or in part. EEG reserve the right to amend either conclusions or recommendations in light of any further information that may become available. The report is provided for the sole use by the client and is confidential to them.

Recommendations within this report are also based on exploratory records and examination of samples and, where applicable, laboratory tests. No liability can be accepted for conditions not revealed by the boreholes and trial pits particularly at intervening locations. Whilst every effort is made to ensure accuracy of data supplied, all opinions expressed as to the spatial distribution of strata between sampling locations is for guidance only and no responsibility is accepted as to its accuracy.

2.0 SITE LOCATION & DESCRIPTION

The site is approximately rectangular with maximum dimensions of 130m NW-SE by 70m SW-NE, with an approximate area of 1.0ha.

Access to the site is gained from the northeast corner, from Kemp Street which forms the eastern boundary. The site itself is currently occupied by a single storey ALDI food store in the southwest and a fast food outlet in the central western area. The buildings appear to be of fairly recent construction (presumed 2010s) and in good state of repair. Associated car parking laid with asphalt occupies the eastern half of the site. Several drainage covers are visible in the external car park area, together with other services including gas, electricity and BT. An electricity substation is located immediately off-site, adjacent the southwest corner of the site.

A vacant plot of land is present in the northwestern site corner, and is separated from the active part of the site by low wooden barrier fencing. This part of the site is also laid with asphalt; however, it appears to be in poor condition with frequent cracks penetrated by brambles and vegetation.

The topography of the site appears to be generally flat and level, however, the land to the north sits at an elevation approximately 4.0m to 5.0m higher. The difference in elevation is accommodated by a retaining wall along the northern site boundary. The land to the south (Manchester Old Road) is at an elevation approximately 2.0m to 3.0m lower, this elevation change is also accommodated with a retaining wall.

The site is situated within suburban setting amongst residential and commercial/retail developments.

A location plan is shown in Figure 1, below, together with a site features plan as Figure 2, overleaf.

Figure 1 Site Location Plan

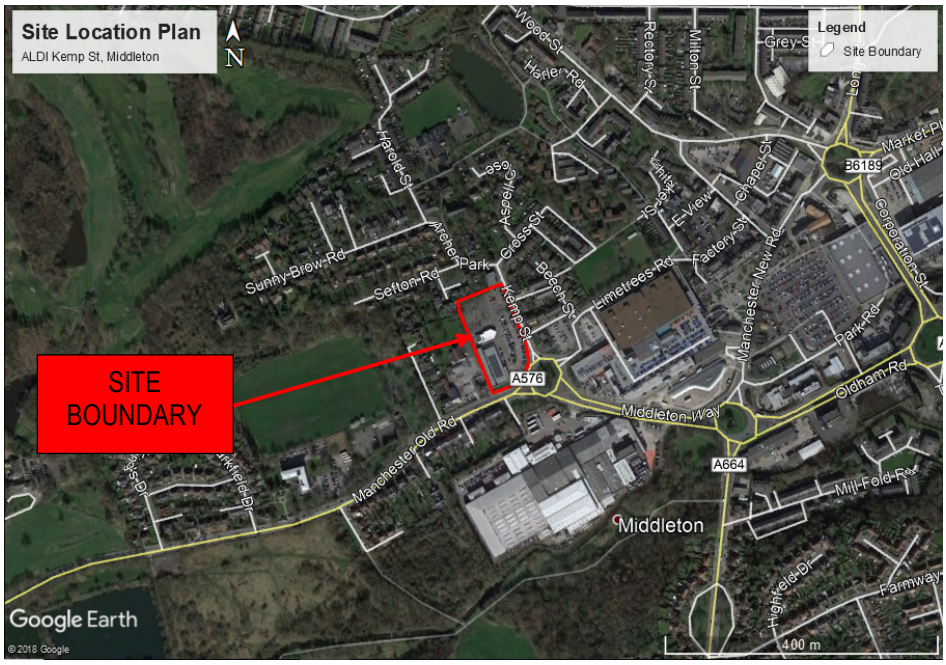
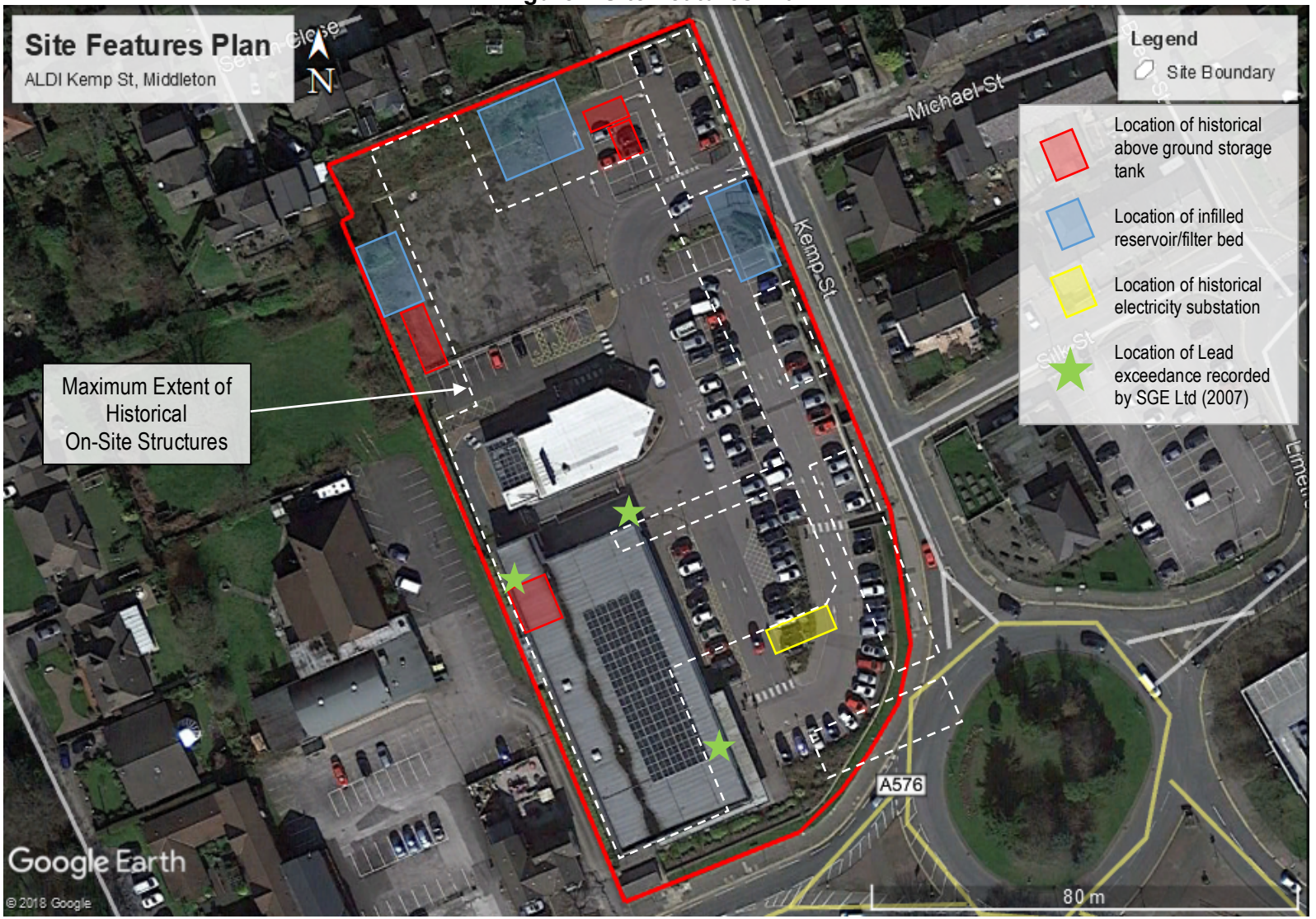


Figure 2 Site Features Plan



Site photographs are presented in Figures 3 to 7 below.

Figure 3 Existing ALDI food store frontage, looking SW



Figure 4 View across vacant plot of land in the NW of the site, looking W



Figure 5 Overview of site from Kemp St, looking SW



Figure 6 Typical Soil Profile in Trial Pits



Figure 7 Typical Soil Profile in Boreholes

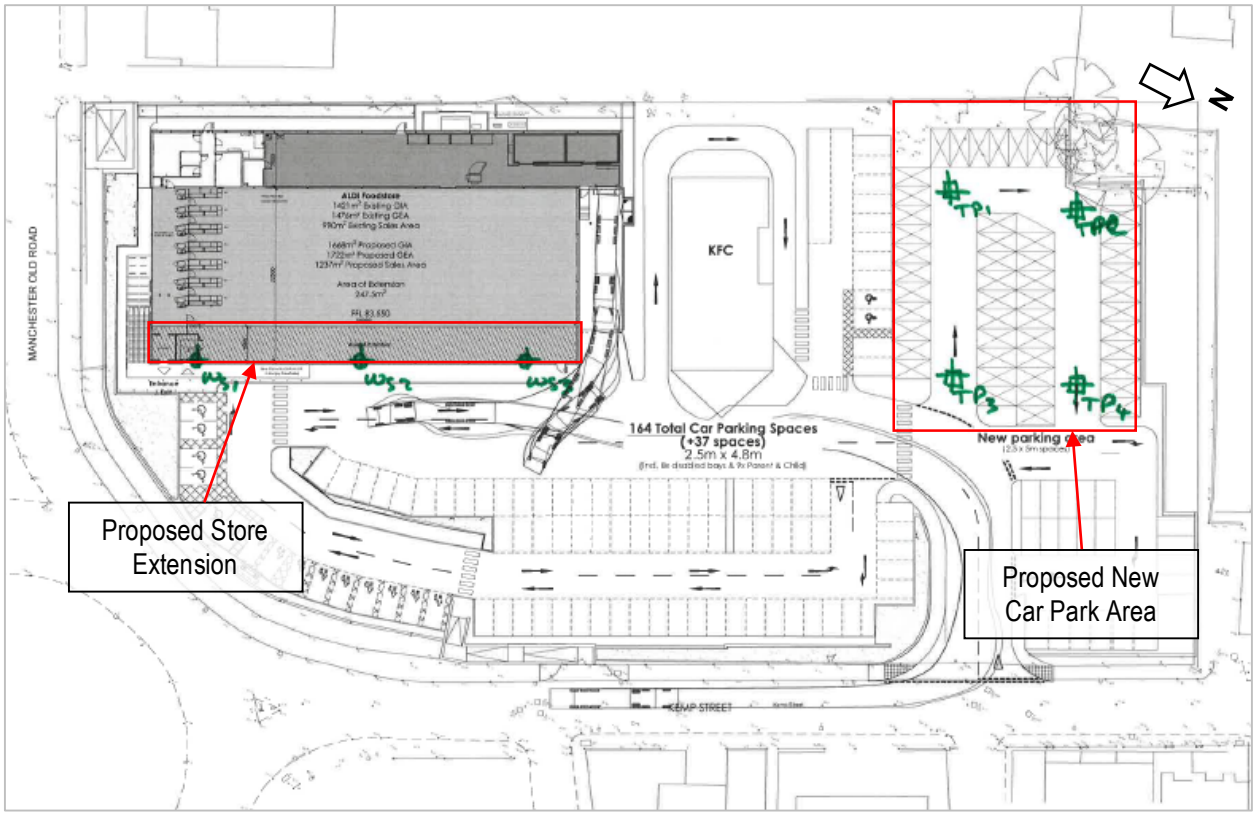


2.2 Proposed Development

It is understood that the Client intends to construct an extension to the eastern elevation of the existing food store to increase the gross internal area from of 1,421sqm to 1,668sqm. In addition, the existing vacant plot of land will be converted to additional car parking to provide circa. 50 new spaces.

Figure 8, overleaf, shows an extract from the proposed development plan.

Figure 8 Development Layout Plan



3.0 SITE INVESTIGATION

3.1 Exploratory Fieldwork

The fieldwork was carried out by EEG on 23rd November 2018 and comprised:

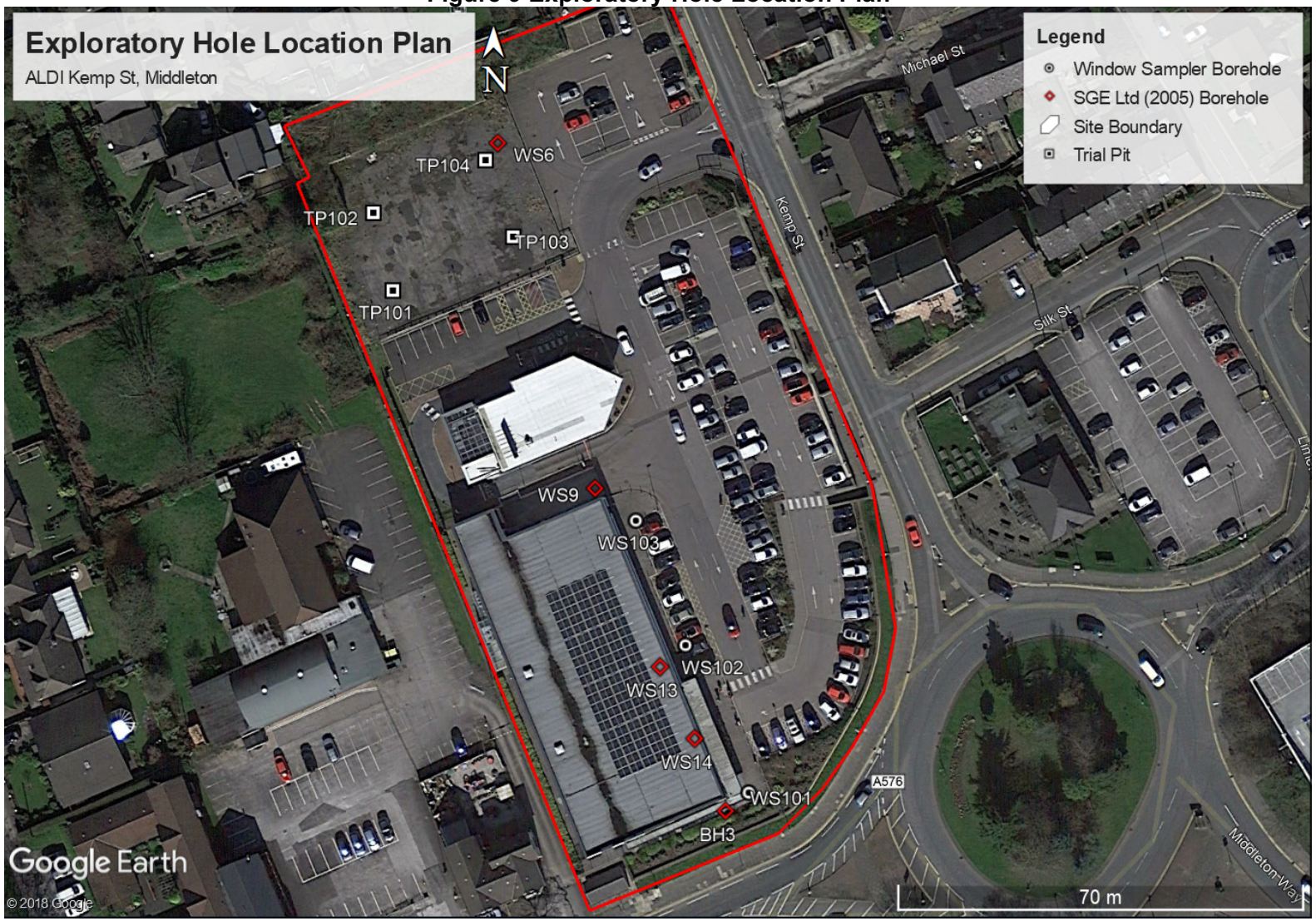
- Three window sample boreholes (designated WS101 to WS103 inclusive) were each initially hand dug to 1.2m and then drilled depths of 5.0m below existing ground level. Window sampler boring is carried out with a small, track-mounted rig, which uses a chain-driven trip hammer to drive sampling tubes or penetrometers into the ground. These tools are coupled to the anvil of the hammer by solid drill rods. Sampling tubes comprise "windowless samplers", which are plain sampler tubes in which a continuous disturbed sample is recovered within a semi-rigid plastic liner. In order to reduce friction within the borehole, sampling tubes of progressively smaller diameter are used as the borehole depth increases. Sampler diameters generally range from between approximately 90mm to 50mm. Standard Penetration Tests (SPTs) were undertaken in the boreholes in accordance with accordance with BS EN ISO 22476-3. Exploratory Hole logs are included in Appendix 1.
- One completion, all of the window sample boreholes were installed with 50mm diameter monitoring standpipes to enable subsequent gas and groundwater monitoring.
- Four trial pits (designated TP101 to TP104) were excavated to depths between 2.50m and 3.40m below existing ground level, using a JCB 3CX backhoe excavator. Representative disturbed samples were recovered from the excavated material as pitting proceeded. The trial pits were backfilled immediately on completion of sampling and testing.

The fieldwork was carried out generally in accordance with BS5930:2015 Code of Practice for Site Investigations, Eurocode 7, unless otherwise stated.

The exploratory hole locations were determined by SWF Consulting Ltd prior to the investigation taking place. Locations were chosen according to the proposed development.

Locations are shown on the Exploratory Hole Location Plan (Figure 9) overleaf. Relevant borehole locations from the previous SGE Ltd (2005) investigation (WS6, WS9, WS13, WS14 and BH3) are also included for reference.

Figure 9 Exploratory Hole Location Plan



Each exploratory location was scanned using a Cable Avoidance Tool (CAT) in order to locate unrecorded underground services, and the exploratory locations were repositioned if necessary.

On completion, all samples recovered from the site were taken to a specialist laboratory for testing.

All site investigation work was supervised full time by a representative of EEG. The logging of soils and rocks has been carried out in accordance with BS5930(2015) except where superseded by the soil and rock description methodology in BS EN14688-1(2002), BS EN 14688-2(2004) and BS EN 14689-1(2003).

All locations and elevations were surveyed by use of a hand-held Trimble GPS with antennae, capable of achieving an accuracy of less than 10cm, depending on the prevailing satellite coverage and obscuring by trees and structures.

The exploratory hole logs are presented within Appendix 1, together with relevant SGE Ltd (2007) borehole logs in Appendix 5.

A summary of exploratory holes undertaken during the investigation is presented in Table 1, below.

Table 1: Summary of Exploratory Holes Undertaken

Hole	Type	Depth (m)	Date Started	Date Finished	Backfill Details
WS101	WS	5.00	23/11/2018	23/11/2018	SP
WS102	WS	5.00	23/11/2018	23/11/2018	SP
WS103	WS	5.00	23/11/2018	23/11/2018	SP
TP101	TP	2.70	23/11/2018	23/11/2018	A
TP102	TP	2.50	23/11/2018	23/11/2018	A
TP103	TP	3.20	23/11/2018	23/11/2018	A
TP104	TP	3.40	23/11/2018	23/11/2018	A
WS=Window Sample Borehole, TP=Trial Pit SP=Monitoring Standpipe, A=Arisings					

3.2 Laboratory Testing Programme

3.2.1 *Environmental Testing*

The environmental chemistry of the ground was investigated by specialist chemical analysis of selected samples, scheduled by EEG and carried out by DETS.

Chemical analyses were carried out on seven soil samples and were submitted for the following suite of determinants:

Asbestos Screen, Arsenic, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc, Cyanide, Thiocyanate, Phenol, Sulphate (SO_4), Sulphide, pH, Sulphur, Soil Organic Matter and speciated Polyaromatic Hydrocarbons (PAH) and speciated Total Petroleum Hydrocarbons (TPH).

Waste Acceptance Criterial was also carried out on four samples.

The results of the laboratory contamination tests are discussed in Section 7 and included in Appendix 2.

4.0 GROUND CONDITIONS ENCOUNTERED

4.1 Soil Profile Encountered

The BGS mapping for the area (Sheet 85, 1:50,000, Manchester, 2011) indicates the site to be located within a buried channel and underlain predominantly by superficial deposits of Devensian Glaciofluvial Sheet Deposits (sand and gravel). Devensian Morainic Glacial Deposits (poorly sorted sand and gravel with hummocky/moundy topography) is indicated to outcrop in the northernmost part of the site. The solid geology beneath the site is shown to comprise the Pennine Lower Coal Measures Formation (mudstone, siltstone and sandstone).

The sequence of strata encountered beneath the site was:

- **Surface Cover –** Asphalt (underlain by concrete in WS102).
- **Subbase –** Light brown, silty, sandy gravel of limestone, sandstone, brick and concrete.
- **Made Ground –**
  - Brown sandy, gravelly clay with variable inclusions of sandstone, brick, concrete, wood, plastic, slate, metal, coal and clinker.
  - Greyish brown gravelly sand or sandy gravel of variable brick, concrete, wood, coal, clinker, mudstone, slate and rare piece of lead sheeting.
  - Grey/black ashy, sandy, slightly gravelly clay with inclusions of clinker, concrete, brick and mudstone.
- **Reworked Devensian Glacial Deposits –**
  - Dense (well compacted) orange brown silty, fine to medium sand with occasional cobbles of brick and concrete (encountered in TP103).
- **Devensian Glacial Deposits –**
  - Loose to dense orange brown silty, slightly gravelly, fine to coarse sand with sandstone gravel.
  - Firm, brown, silty, slightly gravelly clay with gravel of mudstone.

The depths of the various materials encountered in each of the exploratory holes are summarised in the following table.

Table 2: Summary of Ground Conditions Encountered

Hole	Depth to Stratum (m)								GROUND WATER (mbgl)
	SURFACE COVER / MADE GROUND						GLACIAL DEPOSITS		
	Asphalt	Concrete	Subbase	Cohesive Made Ground	Granular Made Ground	Ashy Made Ground	Silty Clay	Sand	
WS101	GL-0.05	-	0.05-0.20	0.20-2.00	-	2.00-2.50	-	2.50-5.00	-
WS102	GL-0.05	0.05-0.25	-	-	0.25-1.20	1.20-2.00	2.00-2.50	2.50-5.00	-
WS103	GL-0.05	-	0.05-0.25		0.25-2.20	-	4.20-5.00	2.20-4.20	-
TP101	GL-0.05	-	0.05-0.15	0.15-1.10		-	-	1.10-2.70	-
TP102	GL-0.05	-	0.05-0.15	0.15-0.65		-	-	0.65-2.50	-
TP103	GL-0.05	-	0.05-0.20	0.20-0.70	0.70-1.20 (Reworked Natural)	-	3.00-3.20	1.20-3.00	0.60*
TP104	GL-0.05	-	0.05-0.20	0.20-0.75	-	-	-	0.70-3.40	0.70*
*Perched groundwater seepage in Made Ground									

It should be noted that the ground conditions encountered during this investigation are generally consistent with the findings of the previous SGE Ltd (2005) investigation (based on nearby boreholes WS6, WS9, WS13, WS14 and BH3).

4.2 Observable Indications of Contamination

Made Ground was encountered beneath the surface cover in each of the exploratory locations to proven depths of between 0.65m (TP102) and 2.50m bgl (WS101) and contained relict demolition materials.

Notably, the Made Ground frequently contained fragments of coal and clinker, together with an ashy layer observed in WS101 and WS102.

4.3 Obstructions

A layer of concrete 0.20m thick was encountered beneath the asphalt in WS102. Cobbles of brick and concrete were also encountered within the Made Ground soils.

Several underground utilities/services are present across the site, including drainage, gas, electricity and BT.

4.4 Groundwater

Perched groundwater seepages were recorded in TP103 and TP104 during the fieldwork at depths of 0.60 and 0.70 bgl respectively. The boreholes (WS101-WS103) were recorded to be 'dry' on subsequent monitoring visits.

5.0 ENGINEERING PROPERTIES OF SOILS ENCOUNTERED

The following sections discuss the engineering properties of the strata encountered, based on results of in-situ testing obtained during this investigation.

5.1 Made Ground

Variable Made Ground was encountered to depths of between 2.00m (WS102) and 2.50m bgl (WS101) in the area of the proposed new building extension. Made ground is not typically considered to be a suitable founding material due to its variability.

Standard Penetration Tests (SPTs) were carried out in the Made Ground material, which resulted in **SPT N values** ranging from 3 to 13. The variation in results indicate that the Made Ground is heterogeneous and of variable density.

An SPT plot is presented as Figure 10 overleaf.

Sulphate content and pH value determination tests were carried out on 3 samples of the Made Ground (in the area of the proposed building extension) by the chemical laboratory. The **water-soluble sulphate** content of the samples ranged between 68 mg/l SO_4 to 423 mg/l SO_4 with **pH values** of 7.8 to 10.0.

5.2 Devensian Glaciofluvial Sheet Deposits – Clay

Clay was encountered in WS102 (2.00m to 2.50m bgl) and in WS103 (4.20m to 5.00m+ bgl).

Due to the limited extent and thickness of the Clay, only two SPT tests were carried out in the material, which resulted in **SPT N values** of 9 and 18, as shown on the SPT v Depth Plot overleaf (Figure 10).

These results suggest the Clay is firm, with an equivalent (conservative) recommended undrained shear strength of 40kN/m^2 (medium strength), based on correlations by Stroud and Butler (1974).

5.3 Devensian Glaciofluvial Sheet Deposits – Sand

Sand was encountered in each of the boreholes.

SPT tests carried out in the Sand resulted in **SPT N value**s of between 8 and 35, as shown on the SPT v Depth Plot overleaf (Figure 10). These results suggest the Sand is loose to dense overall, however, based on the trend exhibited in Figure 10, there appears to be a general increase in soil density with depth.

Figure 10 SPT vs Depth Plot

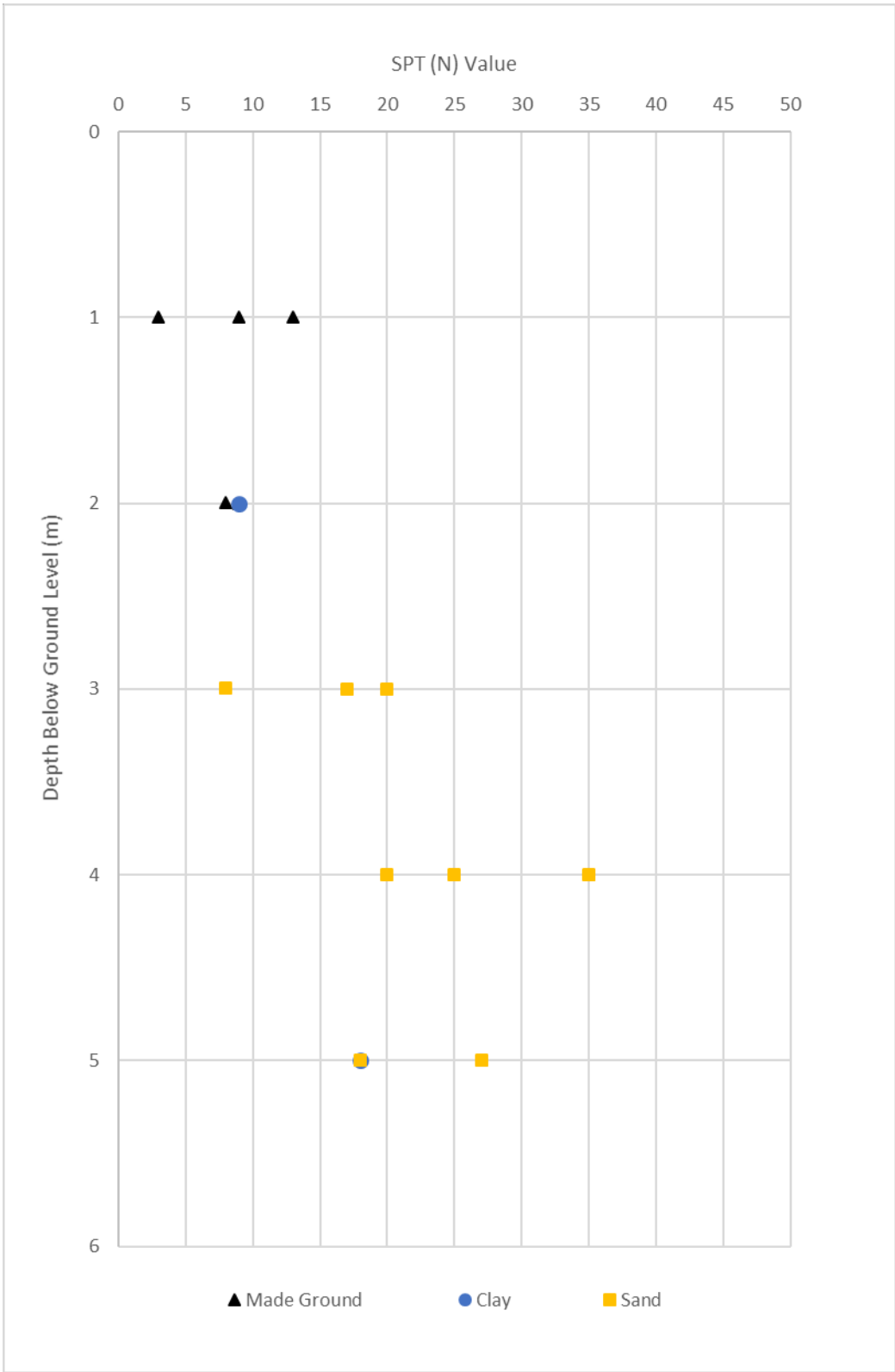


Table 3: Summary of Design Parameters (Sand)

Depth	SPT N Value Range	Design N Value*	Equivalent Soil Density	Angle of Shearing Resistance (ϕ)
3.00	8-20	12.5	Medium Dense	31
4.00	20-35	22.5	Medium Dense	34
5.00	18-27	20.25	Medium Dense	33
*Based on lower quartile of SPT N value **Based on correlations by Peck, Hanson and Thornburn (1974)				

Made Ground in the vicinity of the proposed new building extension was encountered to depths of between 2.00m (WS102) and 2.50m bgl (WS101).

It is therefore anticipated that that foundations will need to be taken down to a minimum depth of 2.00m to 2.50m below existing ground level. Where suitable natural granular material is encountered at this depth, a value of N = 12.5 (medium dense, ϕ = 31°) would be considered reasonable for foundation design based on the above table.

However, given the extent of the made ground it is likely that an alternative foundation solution may be required, such as vibro-stone columns or short bored piles.

6.0 GEOTECHNICAL ASSESSMENT

6.1 Proposed Development

It is understood that the Client intends to construct an extension to the eastern elevation of the existing food store. In addition, the existing vacant plot of land in the northwest of the site will be converted to additional car parking to provide circa. 50 new spaces.

6.2 Ground Conditions

The exploratory holes generally encountered Made Ground over Glacial Deposits comprising predominantly medium dense sand with occasional occurrences of silty clay. Groundwater was not encountered during the fieldwork or subsequent monitoring.

The Made Ground generally comprised low strength sandy, gravelly clay or gravelly sand with variable inclusions of sandstone, brick, concrete, wood, plastic, slate, metal, coal and clinker.

The material extended to depths of between 2.00m bgl and 2.50m bgl in the area of the proposed food store extension, and depths of 0.65m to 1.20m bgl in the area of the proposed new carpark.

6.3 Foundation Considerations

Conventional mass concrete foundations are considered theoretically suitable for the development, providing suitable medium density, natural, granular strata are encountered at depths shallower than 2.50m bgl across the footprint of the proposed extension.

Given that Made Ground in the boreholes extended to between 2.00m and 2.50m in the area of the proposed extension, it is considered likely that short bored piles may be required.

The following foundation options have therefore been considered:

a) Trench fill foundations
b) Piled foundations

The above options are discussed in the following sections.

6.3.1 Trench Fill Foundations

The following table summarises anticipated allowable bearing pressures for mass concrete foundations placed in medium dense sand at 2.50m bgl. The bearing capacities are calculated based on Hansen's (1978) method and assuming a factor of safety against bearing capacity failure of 3.

Groundwater has not been encountered in the exploratory holes and thus for the purposes of estimating net safe bearing pressures we have assumed the groundwater table to be a depth greater than foundation depth.

Table 4: Summary of Allowable Bearing Pressures (Trench Foundations)

Foundation Depth (m bgl)	Strata	Design Value (Section 6)	Foundation Type	Foundation Width (m)	Allowable Bearing Pressure (kN/m^2)
2.50	Medium Dense SAND	ϕ = 31 (based on Design SPT N value of 12.5)	Trench	0.60	448
				0.75	452
				0.90	455
			Pad	0.60	683
				0.75	680
				0.90	677

Foundation loadings have been assumed as 50kN/m^2 and at this bearing pressure total drained settlements have been calculated to be within tolerable limits (3-5mm). Settlement in granular soils will typically comprise immediate settlement as loads are applied. Settlements for other bearing pressures may be estimated on a pro-rata basis.

All foundation excavations should be inspected by a suitable qualified engineer to prove that the founding strata is suitable and uniform along the length of the foundation, and capable of taking the anticipated structural loadings.

All Made Ground should be penetrated and foundations extended at least 150mm into undisturbed natural soils. The formation should be inspected by a competent engineer prior to concreting. If very soft or loose pockets are encountered, these should be excavated until a medium dense deposit suitable for bearing is encountered.

6.3.2 Piled Foundations

Given the potential for Made Ground to extend beyond 2.50m, short bored pile foundations may be a more feasible foundation option compared to deep trench fill. It is recommended that piled foundation terminate at a minimum depth of 4.00m bgl, in medium dense/dense Sand.

Bored/Continuous Flight Auger (CFA) piles are considered most suitable for the proposed development, assuming medium dense sand, carrying their loads as a combination of skin friction and end bearing.

The noise and vibration associated with the installation of driven piles prevents this type of pile from being selected due to the proximity and sensitivity of the existing structure and neighbouring properties. It should also be noted that driven piles can also potentially create preferential pollutant pathways.

Careful consideration should be given to piling directly above any buried services, which are known to be present in the area of the proposed extension.

Because of the various advantages and limitations of each pile type, and the cost implications, advice should be sought from specialist piling contractors to determine the most suitable and cost-effective type. They should also be able to give recommended pile diameters and depths and likely pile capacities, with guaranteed performance. It is recommended a pile test be carried

out to confirm pile capacities. In assessing the pile capacities, contractors should make an allowance for the effects of negative skin friction, particularly in any Made Ground.

There may be differential settlement between piled structures and the surrounding ground level areas of pavement/road construction). Provision should, therefore, be made to make up ground levels at threshold positions, loading bays, vehicle access doorways, etc. Alternatively, these materials should be removed and replaced in a controlled manner by suitable existing materials or imported engineered fill.

6.4 Ground Floor Slabs

Floor slabs should be designed as suspended with a subfloor void where Made Ground of 600mm thickness or greater is present. Made ground is not considered an appropriate bearing stratum due to its variable nature.

6.5 Chemical Attack on Buried Concrete

Sulphate content and pH value determinations were carried out by the chemical laboratory on three samples of Made Ground from WS101 to WS103.

Values of water-soluble sulphate ranged from 68 mg/l SO_4 to 423 mg/l SO_4, pH values ranged from 7.8 to 10.0.

In accordance with BRE Special Digest 1 'Concrete in Aggressive Ground', (2005), on the basis of the above results and an assumption of mobile groundwater, a Design Sulphate class of DS-1 and an aggressive chemical environment for concrete (ACEC) classification of AC-1 are recommended for concrete in contact with the Made Ground.

However, a characteristic value for Total Potential Sulphate (TPS) can also be derived from the Total Sulphur (TS %) content using the following equation: TPS = 3.0 x Total Sulphur (%)

The highest value (based on a data set of less than 5 results) should then be used to determine the characteristic value. The Made Ground in this instance would therefore have a characteristic TPS % of 0.36% and would therefore be classified as DS-2 AC-2 according to BRE Special Digest 1.

6.6 Pavement Design

The ground investigation identified the soil type at subgrade level in the proposed new car park area to be Made Ground (extending to a maximum depth of 1.20m bgl.

Reference should be made to the 'Design Guidance for Road Pavement Foundations', Interim Advice Note 73/06, Revision 1 (2009), when considering the CBR value appropriate for use. However, generally, where Made Ground is present at subgrade level, a conservative design CBR value of 1% should be adopted.

Once formation level for the new road pavements has been achieved, proof rolling should be carried out using a heavy roller and any soft areas that are revealed should be excavated and a greater depth of capping provided. Also, to ensure good compaction and remove unevenness, the formation should be compacted with equipment suitable for use in the ground conditions encountered. Careful inspection of this work will also help identify any soft spots at or just below formation level.

Exposed subgrades are likely to deteriorate rapidly on exposure to wet weather and should be shaped to shed water. Subbase should be placed as soon as possible to minimise the exposure of subgrade to adverse weather conditions.

Consideration should be given to the use of geotextiles to allow reduction of capping thickness.

For example, biaxial geogrids such as Tensar SSLA20 and SSLA30 are often used to reduce subbase thickness. The advice of a suitable contractor should be sought as to the most appropriate type of geotextile to use in the ground conditions encountered at this site.

For guidance, the Table 5 below gives a comparison of granular layer thickness with and without the use of a geotextile, in accordance with the requirement of HA25/94 Part 2.

Table 5: Comparison of Capping Thickness with and without Geotextile

CBR	Unreinforced			Reinforced with Tensar Geogrid				
	Sub-base	Capping	Total	Sub-base	Capping	No. of grids	Total	Thickness saving
0.5%	Design not suitable			200mm	400mm	2	600mm	-
1.0%	150mm	600mm	750mm	400mm	0	1	400mm	350mm
1.5%	150mm	600mm	750mm	310mm	0	1	310mm	440mm
2.0%	150mm	600mm	750mm	260mm	0	1	260mm	490mm
3.0%	150mm	350mm	500mm	210mm	0	1	210mm	290mm
4.0%	150mm	300mm	450mm	175mm	0	1	175mm	275mm
5.0%	150mm	250mm	400mm	160mm	0	1	160mm	240mm
These figures are suitable for light access roads and car parks, based on 1000 standard axles. For heavier loaded pavements the advice of specialist contractor should be sought.								

It should be noted the type of construction will depend on proposed finished pavement levels across the site and it is recommended the pavement design is reviewed once these levels are known. In this context, it is essential further in situ CBR testing is carried out once formation levels are known to confirm design CBR values.

6.7 Existing Retaining Wall

A high retaining wall is present along the northern boundary of the proposed new carpark area and the foundation type and depth is unknown. Consideration should be made for the effects of excavating adjacent soils during the carpark construction phase so as not to undermine the retaining structure.

6.8 Suitability of Excavated Materials

Acceptability criteria and testing, and methods of compaction/placement will depend on the type of contract and specification used for the construction of the proposed development and it is recommended that earthworks specifications are reviewed by a suitably qualified engineer, once these have been prepared by the relevant parties.

6.9 Temporary Works

Formations in the Made Ground and natural granular soils will be susceptible to damage both by weather and trafficking, and should be protected immediately on exposure, particularly in areas where construction plant will access the site.

Excavations are likely to be unstable and should be battered back to an angle of 1 in 2, or a system of close sheeting and shoring adopted to ensure stability, and in particular where personnel are required to enter excavations. All excavations should be adequately supported where personnel are required to enter.

Groundwater seepages could be encountered near surface within excavations, particularly during the wetter months of the year. Pumping of excavations from a suitable located sump is likely to be required to keep excavations dry.

All natural materials on site should capable of being excavated using conventional excavating machinery.

7.0 SOIL CONTAMINATION RISK ASSESSMENT

7.1 Tier I Human Health Soil Risk Assessment – Groundworkers During Development

To assess the risk of soil contamination to construction and ground workers during development, guidelines from the HSE Document 'Protection of workers and the general public during development of contaminated land' (1991) are used. The document assesses soil contamination test results and classifies the site as being uncontaminated or contaminated with varying degrees of contamination from 'slight' to 'unusually heavy'.

The guideline values and laboratory test results are summarised in the following table:

Table 6: Summary of Guideline Values for Protection of Workers and the General Public During Development of Contaminated Land

Contaminant	Typical Values* for:					Test Results	Class
	Uncontaminated Soils	Slight Contamination	Contaminated	Heavy Contamination	Unusually Heavy Contamination		
	Class A	Class B	Class C	Class D	Class E		
pH (alkaline)	7 - 8	8 - 9	9 - 10	10 - 12	12	7.8-10.0	A-C
Arsenic	0 - 30	30 - 50	50 - 100	100 - 500	500	3-24	A
Cadmium	0 - 1	1 - 3	3 - 10	10 - 50	50	<0.2-0.5	A
Chromium	0 - 100	100 - 200	200 - 500	500 - 2500	2500	7-17	A
Copper	0 - 100	100 - 200	200 - 500	500 - 2500	2500	11-76	A
Lead	0 - 500	500 - 1000	1000 - 2000	2000 – 1%	1.0%	19-149	A
Mercury	0 - 1	1 - 3	3 - 10	10 - 50	50	<1	A
Nickel	0 - 20	20 - 50	50 - 200	200 - 1000	1000	5-29	A-B
Zinc	0 - 250	250 - 500	500 - 1000	1000 - 5000	5000	26-134	A
Boron	0 - 2	2 - 5	5 - 50	50 - 250	250	<1	A
Beryllium	0 - 5	5 - 10	10 - 20	20 - 50	50	<0.5-1.9	A
Vanadium	0 - 100	100 - 200	200 - 500	500 - 2500	2500	10-41	A
Sulphate	0 - 2000	2000 - 5000	5000 – 1%	1% - 5%	5.05%	<200-1848	A
Sulphide	0 - 10	10 - 20	20 - 100	100 - 500	500	<5	A
Cyanide (free)	0 - 1	1 - 5	5 - 50	50 - 100	100	<2	A
Phenol	0 - 2	2 - 5	5 - 50	50 - 250	250	<2	A

With the exception of slightly alkaline soils, there is a generally **LOW** potential risk from soil contamination to construction workers, ground workers and members of the public during construction, and appropriate measures, such as PPE, site health plans, appropriate disposal of material arisings will be required to mitigate this risk.

7.2 Tier I Human Health Soil Risk Assessment – Future Site Users

At a Tier I stage the long term (chronic) human health toxicity of the soil has been assessed with reference to DEFRA/Environment Agency Contaminated Land Exposure Assessment (CLEA) Soil Guideline Values (SGV) for generic site land uses, soils and exposure. Where Environment Agency generic guidance is absent, reference has been made to the Chartered Institute of Environmental Health (CIEH) S4ULs for human health risk assessment.

In the case of arsenic, cadmium, hexavalent chromium, lead and benzo(a)pyrene DEFRA Category 4 Screening levels have been adopted. A conservative Soil Organic Matter (SOM) of 1% has been adopted for organic chemicals for the purposes of the initial assessment. A SOM of 6% has been adopted for inorganic chemicals as detailed in 'The LQM / CIEH S4ULS for human health assessment', (2015). The soil chemical testing results are presented in Appendix 2 and summarised in Table 7, below.

Table 7: Assessment of Soil Chemical Data

Parameter	TP101 0.40m MG	TP102 0.30m MG	TP103 0.30 MG	TP104 0.10 MG	WS101 0.40m MG	WS102 1.70m MG	WS103 1.20m MG	Assessment Criteria (mg/kg)
Arsenic	4	11	8	3	9	24	11	640
Boron	< 1	< 1	< 1	< 1	< 1	< 1	< 1	240000
Beryllium	< 0.5	0.7	0.5	< 0.5	0.6	1.9	0.7	12
Cadmium	< 0.2	0.3	< 0.2	< 0.2	0.5	0.5	0.3	190
Chromium	7	12	11	16	12	17	14	8600
Free Cyanide	< 2	< 2	< 2	< 2	< 2	< 2	< 2	34
Hexavalent Chromium	< 2	< 2	< 2	< 2	< 2	< 2	< 2	33
Copper	11	22	33	11	20	76	30	68000
Lead	32	75	87	19	91	142	129	2300
Mercury	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1100
Nickel	5	11	9	19	10	29	14	980
Selenium	< 3	< 3	< 3	< 3	< 3	< 3	< 3	12000
Vanadium	10	22	19	17	19	41	22	9000
Zinc	26	62	51	79	130	134	77	730000
pH	8.8	8.1	9.5	8.5	10	7.8	9.6	N/A
Naphthalene	< 0.1	0.12	0.16	< 0.1	0.15	0.31	0.16	190 (76.4) sol
Acenaphthylene	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	84000 (57.0) sol
Acenaphthene	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	83000 (86.1) sol
Fluorene	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	63000 (30.9) sol
Phenanthrene	0.12	0.28	0.38	0.13	0.36	0.69	0.45	22000
Anthracene	< 0.1	0.2	0.23	< 0.1	0.21	0.25	0.24	520000
Fluoranthene	0.25	0.51	0.78	0.25	0.47	0.93	0.53	23000
Pyrene	0.23	0.46	0.71	0.24	0.44	0.81	0.46	54000
Benzo(a)anthracene	0.47	0.58	0.71	0.46	0.55	0.72	0.55	170
Chrysene	< 0.1	0.25	0.39	< 0.1	0.23	0.43	0.22	350
Benzo(b)fluoranthene	0.61	0.78	0.91	0.6	0.72	1	0.71	44
Benzo(k)fluoranthene	0.15	0.24	0.27	0.15	0.19	0.28	0.19	1200
Benzo(a)pyrene	0.42	0.51	0.59	0.41	0.5	0.6	0.47	35
Indeno(1,2,3-cd)pyrene	< 0.1	0.52	0.56	< 0.1	0.51	0.64	< 0.1	3.5
Di-benz(a,h)anthracene	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	500
Benzo(ghi)perylene	< 0.1	0.42	0.46	0.35	0.41	0.47	0.4	3900
Phenol	< 2	< 2	< 2	< 2	< 2	< 2	< 2	760
Benzene	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	27
Toluene	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	56000 (869) vap
Ethylbenzene	< 0.002	< 0.002	0.005	< 0.002	< 0.002	< 0.002	< 0.002	5700 (518) vap

Parameter	TP101 0.40m MG	TP102 0.30m MG	TP103 0.30 MG	TP104 0.10 MG	WS101 0.40m MG	WS102 1.70m MG	WS103 1.20m MG	Assessment Criteria (mg/kg)
Xylene	< 0.002	< 0.002	0.020	< 0.002	< 0.002	< 0.002	< 0.002	6600 (478) sol
Aliphatic >C5 - C6	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	3200 (304) sol
Aliphatic >C6 - C8	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	7800 (144) sol
Aliphatic >C8 - C10	< 2	< 2	< 2	< 2	< 2	< 2	< 2	2000 (78) sol
Aliphatic >C10 - C12	< 2	< 2	< 2	< 2	< 2	< 2	< 2	9700 (48) sol
Aliphatic >C12 - C16	< 3	< 3	< 3	< 3	< 3	< 3	< 3	59000 (24) sol
Aliphatic >C16 - C21	< 3	4	< 3	< 3	< 3	< 3	< 3	1,600,000
Aliphatic >C21 - C34	< 10	46	< 10	< 10	25	< 10	71	1,600,000
Aromatic >C5 - C7	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	26000 (1220) sol
Aromatic >C7 - C8	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	56000 (869) vap
Aromatic >C8 - C10	< 2	< 2	< 2	< 2	< 2	< 2	< 2	3500 (613) vap
Aromatic >C10 - C12	< 2	< 2	< 2	< 2	< 2	< 2	< 2	16000 (364) sol
Aromatic >C12 - C16	< 2	< 2	< 2	< 2	< 2	< 2	< 2	36000 (169) sol
Aromatic >C16 - C21	< 3	< 3	< 3	< 3	< 3	< 3	5	28000
Aromatic >C21 - C35	< 10	56	< 10	< 10	46	< 10	209	28000
Asbestos	ND	D	D	ND	D	D	D	-

Notes for Table 7
Concentrations in **red** above assessment criteria
ND = Not Detected, **D** = Detected

Based on the results of the chemical testing, none of the samples analysed contained concentrations of the contaminants tested for in exceedance of their screening criteria relevant to commercial/industrial end use.

However, asbestos was detected in five of the seven samples tested. The results of the quantification testing carried out by the laboratory are summarised in the table below.

Table 8: Asbestos Quantification

Location	Depth (m bgl)	Type	Quantity (% by mass)
TP102	0.30	Amosite fibre bundles in soil	< 0.001
TP103	0.30	Chrysotile present in microscopic bitumen fragment	< 0.001
WS101	0.40	Chrysotile fibre bundles in soil	0.001
WS102	1.70	Chrysotile small fibre bundle in soil	< 0.001
WS103	1.20	Chrysotile fibre bundles in soil	< 0.001

As shown above trace asbestos (<0.001%) was generally found in each of the samples, with one sample from WS101 containing 0.001% by mass.

7.3 Soil Waste Assessment

An assessment of the disposal characteristics of the soil in accordance with Environment Agency guidance WM3.1, edition of May 2018, "Guidance on the classification and assessment of waste" has been carried out for the soils on site using HazWasteOnline. Based on this assessment, the soils tested have been classified as Non-Hazardous.

Full results of the Soil Waste Assessment are presented in Appendix 4.

Additional Waste Acceptance Criteria testing was also carried out by the chemical laboratory on four of the soil samples to determine whether the material could be classified as Inert. The results of which are presented in the table below.

Table 9: Waste Classification of Soils

Location	Depth (m bgl)	HazWasteOnline Classification	WAC Classification
TP101	0.40	Non-Hazardous	Not Tested
TP102	0.30	Non-Hazardous	Inert
TP103	0.30	Non-Hazardous	Non-Hazardous
TP104	0.10	Non-Hazardous	Not Tested
WS101	0.40	Non-Hazardous	Inert
WS102	1.70	Non-Hazardous	Non-Hazardous
WS103	1.20	Non-Hazardous	Not Tested

As shown above, soils from TP102 and WS101 have been classified as Inert. All other soils should be regarded as Non-Hazardous for off-site disposal purposes.

8.0 GROUND GAS RISK ASSESSMENT

The potential risk associated with gases being generated in the ground (whether from natural or man-made sources) depends on the concentrations of gas and its flow rate to the surface. These factors are assessed by monitoring of the gas installations in the boreholes. The variable nature of gas generation and the effect of barometric pressure on gas flow, means that the volume of gas potentially reaching the ground surface is normally inconsistent over time.

Four monitoring visits have been completed at the site by Earth Environmental & Geotechnical Ltd.

The monitoring was conducted between 30th November 2018 and 14th November 2019 and the results obtained recorded methane (CH_4) levels ranging from 0.1% and 0.2% by volume (% v/v) and carbon dioxide (CO_2) levels ranging from 0.1% to 9.1% v/v.

Gas flow rates were recorded using a dedicated flow meter. A flow rate of 5.8l/hr was recorded during the first monitoring visit one monitoring visit, with low flow (0.0-1.0l/hr) recorded in the boreholes during the 3 other visits. Atmospheric pressure was recorded to be between 989mb and 1031mb.

Maximum concentrations of volatile organic compounds (VOCs) of 3.7ppm were also recorded.

Full results of the monitoring are presented in Appendix 3.

Table 8.5 of CIRIA Report 665 (2007), presented below as Table 9, provides information on current UK practice with respect to appropriate gas protection measures based upon a Gas Screening Value (GSV). A GSV for the site has been obtained by multiplying the maximum concentration of gas by the maximum flow rate, which represents worst-case scenario conditions.

The flow rate of 5.8l/hr on the first visit is considered to be anomalous when compared to subsequent visits, and likely to be the result of recent ground disturbance. The second highest recorded flow rate (1.0/hr) has therefore been adopted.

- Carbon dioxide: maximum flow rate = 1.0l/hr, max concentration = 9.1%
- Methane: maximum flow rate = 1.0l/hr, max concentration = 0.2%.

Based on the above figures, the GSV is calculated as:

- **Carbon dioxide**: GSV = 1.0 x 9.1 / 100 = **0.091l/hr**
- **Methane**: GSV = 1.0 x 0.2 / 100 = **0.002l/hr**

Based on carbon dioxide levels in exceedance of 5% v/v and the above results, the site can be given a classification of Characteristic Situation-1 (CS-2), i.e. ‘low risk’, in accordance with the table overleaf.

Table 10: Modified Wilson & Card Classification (CIRIA Report 665)

Characteristic Situation (CIRIA Report 149)	*Risk Classification*	*GSV (CH_4 or CO_2) (l/hr)*	*Additional Factors*	*Typical Source of Generation*
1	Very Low Risk	<0.07	Typically, methane ≤1%v/v and/or carbon dioxide ≤5% v/v. Otherwise consider increase to Situation 2.	Natural Soils with low organic content. "Typical" Made Ground.
2	Low Risk	<0.7	Borehole flow rate not to exceed 70l/hr. Otherwise increase to Situation 3.	Natural soil, high peat/organic content. "Typical" Made Ground.
3	Moderate Risk	<3.5		Old landfill, inert waste, mineworking flooded.
4	Moderate to High Risk	<15	Quantitative risk assessment required to evaluate scope of measures required.	Mineworking susceptible to flooding, completed landfill (WMP 26B criteria)
5	High Risk	<70		Mineworking unflooded inactive with shallow workings near surface.
6	Very High Risk	>70		Recent landfill site.

A CS-2 classification requires the adoption of protective measures to mitigate the risk posed by ground gases. Reference should be made to British Standard 8485 'Code of Practice for the Design of Protective Measures for Methane and Carbon-dioxide Ground Gases for New Buildings' (2015), to determine which protective measures are appropriate for adoption in the proposed scheme.

9.0 CONCEPTUAL SITE MODEL

Historically, the site is understood to have been occupied predominantly by Parkfield Mills (later Parkfield Works). Tanks and reservoirs were also recorded on-site, together with an electricity substation. Other known on-site land uses included a scrap metal merchant, a joiners, a glassworks and a garage. The site is currently occupied by an ALDI food store, fast food retailer and associated carpark (hardstanding).

The previous site investigation carried out by SGE (2007) reported Made Ground across the site prior to the development of the existing food store, and identified three locations at the site with high concentrations of lead. However, the lead concentrations at these three locations were reported to be 910mg/kg (HP1), 1200mg/kg (WS9) and 3100mg/kg (WS14). The current CLEA Soil Guideline Value (SGV) for lead relative to a commercial/industrial end use is 2000mg/kg. When applying this current value, only the sample from SGE WS14 would present an exceedance.

Based on this information, there is considered to be potential for soil contamination and ground gas generation at the site.

A Conceptual Model has therefore been prepared for the site based on the historical information together with results of the site investigation and subsequent chemical analysis and presented as Table 13, overleaf. The Conceptual Model considers the source-pathway-receptor linkages present alongside the likelihood, severity and risk level as defined within Table 11 and Table 12 below. The assessment of probability, a modified risk table, and certain consequence definitions are based on CIRIA C552 and CLR11.

Table 13, overleaf, considers whether a pollution linkage is potentially present and provides a qualitative assessment of risk based on the information currently available.

Table 11: Consequence, Probability and Risk

Probability	Consequence	Risk
High Likelihood- There is a pollution linkage and an event either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution	Very High – acute risk to the human health likely to result in significant harm. Risk of severe or irreversible effect on ground/surface water quality. Catastrophic damage to buildings / property.	Very High – there is a high potential that the source-pathway-receptor scenarios may give rise to harm to human health or the environment and remedial action is likely to be required.
Likely – there is a pollution linkage and all the elements are present, which means that it is probable an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.	High – Severe or irreversible effect on human health. Temporary severe or irreversible effect on ground/surface water quality. Reduction of water quality rendering groundwater or surface water unfit to drink and/or substantial adverse impact on groundwater dependant environmental receptors.	High – it is likely that the source-pathway-receptor scenarios may give rise to an impact on human health or the environment, which may require remediation and/or control measures to mitigate risks
Low likelihood– there is a pollutant linkage and circumstances are possible for an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term	Moderate – Long term or short-term moderate effect on human health. Moderate effect on ground/surface water quality, reversible with time. Reduced reliability of a supply at a groundwater or surface water abstraction source	Moderate – it is possible that the source-pathway-receptor scenarios may give rise to an impact on human health or the environment, however it is either relatively unlikely that such are would be severe, or if any harm were to occur it is more likely that harm would be mild.
Unlikely – there is a pollution linkage but circumstances are such that it is doubtful that an event would occur even in the very long term.	Low – Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc.) Slight effect on ground/surface water quality, reversible with time. Marginal reduced reliability of a supply at a groundwater or surface water abstraction source.	Low – it is possible that harm could arise at the source, however it is likely that the risk would at worst be mild.
		Very Low – it is unlikely that the source-pathway-receptor scenarios will give rise to an impact on human health or the environment.

Table 12: Estimation of Level of Risk

		Consequence			
		High	**Moderate**	**Low**	**Very low**
Probability	**High Likelihood**	Very High	High risk	Moderate risk	Moderate to low risk
	Likely	High risk	Moderate risk	Moderate to low risk	Low risk
	Low Likelihood	Moderate risk	Moderate to low risk	Low risk	Very low risk
	Unlikely	Moderate to low risk	Low risk	Very low risk	Very low risk

9.1 Sources of Contamination

Made Ground containing occasional ashy layers and inclusions of sandstone, brick, concrete, wood, plastic, slate, metal, coal and clinker was encountered to depths of between 2.00m bgl and 2.50m bgl in the area of the proposed food store extension, and 0.65m to 1.20m bgl in the area of the proposed new carpark.

In the samples which underwent chemical analysis, no contaminants were recorded in exceedance of the screening criteria relevant to commercial/industrial end use. However, trace asbestos (Chrysotile and Amosite fibre bundles) was detected in five of the seven soil samples tested.

The SGE (2007) site investigation also identified an exceedance of lead (concentration 3100mg/kg) in WS14, located in the vicinity of the proposed food store extension.

9.2 Receptors

The following receptors have been considered for the construction and operational stages of the proposed redevelopment.

- Current site users
- Adjacent land users
- Future land users
- Construction workers during site development works
- Underlying groundwater and nearby watercourses

9.3 Pollutant Pathways

The following pathways have been considered for the construction and operational stages of the proposed redevelopment.

- Direct contact via dermal contact, ingestion, inhalation of potentially contaminated soils
- Downward vertical migration of contaminants to groundwater and lateral migration to nearby water courses
- Vertical or lateral migration of ground gas associated with the Made Ground

Table 13: Conceptual Site Model

Source	Pathway	Receptor	Probability	Consequence	Risk	Comment
Contamination in Made Ground soils (heavy metals, hydrocarbons, organic & inorganic compounds)	Dermal contact, ingestion and inhalation of soils dust	Current Site Users	Unlikely	Moderate	Low	Contaminant concentrations in the soil samples tested during this investigation were not recorded in exceedance of commercial end use SGV. The site is currently covered by hardstanding, which breaks the potential pollutant pathway. The risk to current site users is therefore considered **LOW**.
		Adjacent land users	Unlikely	Moderate	Low	Contaminant concentrations in the soil samples tested during this investigation were not recorded in exceedance of commercial end use SGV and the site is currently covered by hardstanding, which breaks the potential pollutant pathway. The risk to adjacent land users is therefore considered **LOW**. However, usual dust control measures should be implemented as part of good site working practices during construction.
		Future land users	Unlikely	Moderate	Low	Contaminant concentrations in the soil samples tested during this investigation were not recorded in exceedance of commercial end use SGV and the site will remain covered by hardstanding, which will break any potential pollutant pathway. The risk to future end users is therefore considered **LOW**.
		Construction Workers	Low Likelihood	Moderate	Moderate to Low	Soils were noted to be slightly alkaline and an elevated concentration of Lead was recorded in the area of the proposed extension (SGE investigation 2007). Construction workers are likely to be exposed to soil during construction works, the risk is therefore considered **MODERATE to LOW**. However, adoption of appropriate health and safety measures in line with CDM and other relevant health and safety guidance will reduce the risk to **LOW**.
	Downward vertical/lateral leaching and migration of contaminants	Underlying shallow groundwater	Unlikely	Moderate	Low	Groundwater was not encountered during the site investigation or subsequent monitoring. The risk is therefore considered **LOW**.

Source	Pathway	Receptor	Probability	Consequence	Risk	Comment
Ground gas associated with Made Ground	Vertical or lateral migration	Current Site Users	Low Likelihood	Moderate	Moderate to Low	The site is currently an operational ALDI food store with car park. Maximum carbon dioxide concentrations of 9.1% v/v have been recorded, however, exposure duration of current users (shoppers) is generally short. The risk to current site users is therefore considered **MODERATE to LOW**.
		Adjacent land users	Low Likelihood	Moderate	Moderate to Low	Maximum carbon dioxide concentrations of 9.1% v/v have been recorded to date. The site is underlain by granular soils with moderate permeability. The risk to adjacent site users is therefore considered **MODERATE to LOW.**
		Future land users	Low Likelihood	Moderate	Moderate to Low	The site is currently an operational ALDI food store with car park. Maximum carbon dioxide concentrations of 9.1% v/v have been recorded. The proposed development is for a continued commercial end use with short duration exposure by future end users. The risk is therefore considered **MODERATE to LOW**. The adoption of CS-2 gas protection measures would reduce the risk to **LOW.**
		Construction Workers	Likely	Moderate	Moderate	Maximum carbon dioxide concentrations of 9.1% v/v have been recorded together with depleted oxygen levels of 5.8% v/v. Construction workers may be exposed to ground gas/depleted oxygen conditions in excavations. However, the exposure period will be of short duration. The risk to construction workers is therefore considered **MODERATE.**
Asbestos	Inhalation of fibres	Current Site Users	Unlikely	High	Low	Very low/trace amounts of asbestos were detected in the Made Ground. The site is currently an operational ALDI food store with car park covered by hardstanding. Asbestos is only harmful when disturbed. The potential for current site users to come into contact with asbestos is **LOW**.
		Adjacent land users	Low Likelihood	High	Moderate	Very low/trace amounts of asbestos were detected in the Made Ground. Asbestos is only harmful when disturbed and becomes airborne i.e. during construction/excavation works. The risk to adjacent land users during construction is therefore considered **MODERATE**. Appropriate precautions such as ensuring soils do not become dry and dusty would reduce the risk to **LOW.**

Source	Pathway	Receptor	Probability	Consequence	Risk	Comment
Asbestos	Inhalation of fibres	Future land users	Unlikely	High	Low	Very low/trace amounts of asbestos were detected in the Made Ground. The proposed development involves the extension of the existing food store and construction of a new carpark covered by hardstanding. Asbestos is only harmful when disturbed. The potential for future site users to come into contact with asbestos is **LOW**.
		Construction Workers	Likely	High	**High**	Very low/trace amounts of asbestos were detected in the Made Ground. Construction workers are likely to be exposed to soil during construction work. The risk to construction workers is therefore considered **HIGH.** Basic asbestos management will be required as a minimum and implementation of appropriate health and safety measures should be adopted in line with CDM and other relevant health and safety guidance.

10.0 CONCLUSIONS AND RECOMMENDATIONS

The following section provides a summary of the conclusions and recommendations based on the findings of the site investigation.

10.1 Soil Contamination

Ground conditions across the site generally comprise over Made Ground over Glacial Deposits comprising predominantly medium dense sand with occasional occurrences of silty clay.

The Made Ground was noted to contain inclusions of brick, concrete, wood, plastic, slate, metal, coal and clinker, together with an ashy layer in two of the boreholes. However, none of the soil samples tested in this investigation contained contaminants in exceedance of the screening criteria relevant to commercial end use.

The SGE (2007) site investigation identified an exceedance of lead (concentration 3100mg/kg) in WS14, located in the vicinity of the proposed food store extension.

Considering the proposed development and full coverage of hard-standing, the risk posed to end-users from soil contamination is concluded to be **LOW.**

There is also considered to be a **LOW** overall potential risk from soil contamination to construction workers and ground workers. Appropriate measures, such as PPE, site health plans, appropriate disposal of material arisings will mitigate any risk.

The soils have been classified as a mixture of Inert and Non-Hazardous Waste.

The groundworks contractor must provide a soil management plan including methods of dealing with any unanticipated soil contamination encountered during groundworks.

10.2 Asbestos

Asbestos in the form of Chrysotile and Amosite fibre bundles were detected in soils samples from five locations at the site.

Quantification of the asbestos revealed that four of the five samples contained <0.001% by mass (trace) asbestos, and one sample (WS101) contained 0.001%.

Considering the proposed development and full coverage of hard-standing, the risk posed to end-users from asbestos is concluded to be **LOW.**

However, the risk to groundworkers during the construction phase is considered **HIGH**, with a **MODERATE** risk to adjacent land users (due to the potential for generation of airborne fibres).

As a minimum the following precautions will be required to minimise the risk to construction workers and adjacent land users:

- Communicate the risk to site personnel at induction stage.
- Ensure soils do not dry out and become dusty.

10.3 Ground Gas

Monitoring results obtained recorded maximum methane (CH_4) levels of 0.2% v/v and maximum carbon dioxide (CO_2) levels of 9.1% v/v.

The site has been classified as Characteristic Situation-2 (CS-2) and gas protection measures will therefore be required.

10.4 Foundations and Ground Floor Slabs – Extension

Conventional mass concrete foundations are considered theoretically suitable, providing suitable medium dense granular founding strata is encountered at depths shallower than 2.50m bgl across the footprint of the proposed extension. However, given that Made Ground in the boreholes extended to between 2.00m and 2.50m, it is considered likely that deeper foundations e.g. short bored piles may be required.

Floor slabs should be designed as suspended with a subfloor void.

10.5 Pavement Design – Car Park Area

The ground investigation identified the soil type at subgrade level in the proposed new carpark area to be Made Ground (extending to a maximum depth of 1.20m bgl). In the absence of CBR testing a conservative design CBR value of 1% should be adopted.

It is recommended that in situ CBR testing is carried out once formation levels are known to determine realistic design CBR values.

Consideration should be made for the effects of excavating soils adjacent to the existing retaining wall in this part of the site during the construction phase so as not to undermine the retaining structure.

10.6 Site Personnel

As with all construction sites, personnel working on the site during the construction period should be encouraged to maintain a high standard of personal hygiene and on-site washing facilities should be available.

APPENDIX 1

EXPLORATORY HOLE LOGS

APPENDIX 2

CHEMICAL TESTING RESULTS

APPENDIX 3

GAS MONITORING RESULTS

APPENDIX 4

SOIL WASTE ASSESSMENT

APPENDIX 5

RELEVANT SGE LTD INVESTIGATION (2007)

EXPLORATORY HOLE LOGS

APPENDIX 6

REPORT LIMITATIONS

REPORT LIMITATIONS

This contract was completed by Earth Environmental & Geotechnical Ltd on the basis of a defined programme and scope of works and terms and conditions agreed with the client. This report was compiled with all reasonable skill, and care, bearing in mind the project objectives, the agreed scope of works, the prevailing site conditions, the budget and staff resources allocated to the project.

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It is Earth Environmental & Geotechnical Ltd understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was an important factor in determining the scope and level of the services. Should the purpose for which the report is used, or the proposed use of the site change, this report will no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without Earth Environmental & Geotechnical Ltd review and advice shall be at the client's sole and own risk.

The report was written in 2019 and should be read in light of any subsequent changes in legislation, statutory requirements and industry best practices. Ground conditions can also change over time and further investigations or assessment should be made if there is any significant delay in acting on the findings of this report. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of Earth Environmental & Geotechnical Ltd. In the absence of such written advice of Earth Environmental & Geotechnical Ltd, reliance on the report in the future shall be at the client's own and sole risk. Should Earth Environmental & Geotechnical Ltd be requested to review the report in the future, Earth Environmental & Geotechnical Ltd shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between Earth Environmental & Geotechnical Ltd and the client.

The observations and conclusions described in this report are based solely upon the services that were provided pursuant to the agreement between the client and Earth Environmental & Geotechnical Ltd. Earth Environmental & Geotechnical Ltd has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report.

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The services are based upon Earth Environmental & Geotechnical Ltd observations of existing physical conditions at the site gained from a walkover survey of the site together with Earth

Environmental & Geotechnical Ltd interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The findings and recommendations contained in this report are based in part upon information provided by third parties, and whilst Earth Environmental & Geotechnical Ltd have no reason to doubt the accuracy and that it has been provided in full from those it was requested from, the items relied on have not been verified.

No responsibility can be accepted for errors within third party items presented in this report. Further Earth Environmental & Geotechnical Ltd was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the services. Earth Environmental & Geotechnical Ltd is not liable for any inaccurate information, misrepresentation of data or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to Earth Environmental & Geotechnical Ltd and including the doing of any independent investigation of the information provided to Earth Environmental & Geotechnical Ltd save as otherwise provided in the terms of the contract between the client and Earth Environmental & Geotechnical Ltd.

Where field investigations have been carried out these have been restricted to a level of detail required to achieve the stated objectives of the work. Ground conditions can also be variable and as investigation excavations only allow examination of the ground at discrete locations. The potential exists for ground conditions to be encountered which are different to those considered in this report. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and Earth Environmental & Geotechnical Ltd] based on an understanding of the available operational and historical information, and it should not be inferred that other chemical species are not present.

The groundwater conditions entered on the exploratory hole records are those observed at the time of investigation. The normal speed of investigation usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions and higher groundwater levels may occur at other times of the year than were recorded during this investigation.

Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site.