

PROPOSED RETAIL STORE AND RESIDENTIAL DEVELOPMENT

NEATH ABBEY ROAD, NEATH ABBEY

GEO-ENVIRONMENTAL SITE ASSESSMENT

PROJECT NO. 641-1

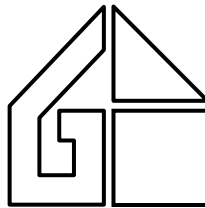
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NEATH ABBEY ROAD, NEATH ABBEY**

Geo-environmental Site Assessment Report

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EXECUTIVE SUMMARY

Aldi Stores Limited is considering the purchase of the subject site for redevelopment as a retail store (over most of the site) and possible residential properties (in the south). A Geo-environmental Site Assessment, comprising a desk study, site reconnaissance, intrusive investigation and laboratory testing, has been undertaken by Ground Investigation Limited. The key potential land quality issues identified by the assessment are summarised below:

Hazard	Anticipated Risk	Discussion
Current Site Status.	-	The site is currently occupied by the premises of CSN Precision Engineering Limited, with associated access road, car parking and grassed landscaped areas.
Identified Ground Conditions.	-	The exploratory holes have identified that the site is underlain by a thin veneer of Topsoil, hardcore gravel or hardstanding, overlying thicknesses of Made Ground, fine-grained Possible Head Deposits and Fluvio-Glacial Gravels.
Groundwater.	-	The site is underlain by a minor aquifer. Groundwater is apparently present within the Fluvio-glacial Gravels at depths of around 3.5m.
Potentially Contaminative Land Uses.	Potentially High	The site was open pasture until the 1950s, when it was developed as a TA Centre. BY 1970, it had been redeveloped as a maintenance depot. The present owners moved to the site in around 1990. Three underground fuel/oil storage tanks are understood to be present at the site.
Chronic risk to human health – Retail Store	Low	All determinands were below GAC.
Chronic risk to human health – Residential Development	Potentially High	Generally, all determinands were below GAC. However, three samples recovered from the southern part of the site contained elevated concentrations of arsenic. A clean cover is likely to be required for residential dwellings in this area.
Contamination migrating offsite.	Potentially High	Given the presence of the underground fuel/oil storage tanks and coarse-grained fluvio-glacial deposits at shallow depth, the groundwater may have been impacted by contamination, which could migrate off-site to impact on local surface water courses. Further investigation is recommended.
Abandoned mine workings and old mine entries	Low	There are coal workings beneath the site, but they are at sufficient depth that the risk from subsidence is considered to be low.
Foundation and floor slab options	-	The proposed retail store should be founded on conventional spread foundations within the Fluvio-glacial Gravels at depths between 0.6m and 2.0m. Alternatively, where this stratum is present at depths greater than 1.5m, the overlying Made Ground may be excavated and re-compacted and reinforced foundations adopted. Floor slabs may be ground bearing provided that the applied loads are low. In the south of the site, either reinforced spread foundations on excavated and re-compacted Made Ground or Vibro-ground treatment would be required. Suspended floor slabs would be required by the NHBC.
Shrinkage or swelling.	Possible	The shallow fine-grained Possible Head Deposits have a low volume change potential.
Sulphate attack on buried concrete.	Low	Laboratory testing has indicated the site is classed as AC-2 in terms of sulphate attack on buried concrete.
Slope instability	Low	The site is relatively flat and level and no significant cutting or filling is anticipated for the proposed development.
Flooding	High	The Environment Agency's indicative flood plain maps show that the site lies in an area of extreme flooding from rivers or the sea without defences. Further enquiries should be made to the Agency.
Japanese Knotweed	-	Japanese Knotweed is present on the southern margins of the site.

The above is intended to provide a summary of the assessment at the site. It does not provide a definitive assessment and reference should be made to the main body of the report.

1 INTRODUCTION

1.1 Proposed Development

Aldi Stores Limited (hereafter referred to as 'the Client') is proposing to purchase the subject site for future development as a new retail store and possibly residential properties. The site is located at Neath Abbey Road, Neath (see Figure 1) and is presently occupied by the premises of CSN Precision Engineering Limited.

We understand that the proposed development will comprise the retail store and associated car parking areas occupying the majority north of the site. The southern part of the site will not be developed as part of the store, and may, in the future, be developed as conventional residential properties with gardens.

1.2 Objectives and Scope

Ground Investigation Limited has been appointed by the Consulting Engineers for the project, Craddy Pitchers Davidson, on behalf of the Client to undertake a Geo-environmental Site Assessment (GSA) of the subject site.

The scope of work was agreed with the Client within an approved budget, and comprised the following:

- a desk study and site reconnaissance;
- machine excavated trial pits;
- windowless sample boreholes;
- laboratory geo-environmental testing;
- laboratory geotechnical testing;
- monitoring of gas and groundwater levels;
- the development of a Conceptual Site Model (CSM) and Conceptual Ground Model;
- a Tier One evaluation of human health risks using the results of analysis of soil samples;
- recommendations for foundation, floor slab and pavement design.

The contract was awarded on the basis of a competitive tender quotation, as detailed in our letter of 20th July 2007 and the assessment was performed during July and August 2007.

We are not aware of any ground-related planning conditions relating to the development.

1.3 Structure of Report

This report is presented in the following six sections, the contents of which are summarised below:

- **Section 2** describes the data collated during the desk study together with supplementary information provided by the site reconnaissance, concluding with a Phase One Conceptual Site Model;
- **Section 3** presents details of the investigation undertaken including fieldworks, laboratory testing and subsequent monitoring;
- **Section 4** presents an interpretation and assessment of the collated information and investigation data and develops a Conceptual Ground Model;
- **Section 5** presents an assessment of the risk posed to human health from soil contamination (including a revision of the Conceptual Site Model developed in the desk study assessment), and recommendations for remedial actions (if any) and foundation concrete;
- **Section 6** presents an assessment of the geotechnical characteristics of the anticipated soil strata, and an appraisal of options for foundation design and construction; and
- **Section 7** provides details of the sources of information used in the assessment.

1.4 Limitations and Exceptions of Assessment

The work presented in this report, including all assessment and interpretation, is subject to the general limitations and exceptions set out in Appendix A. The work is also subject to the following site-specific limitations and exceptions, which inhibited the investigation works:

- The site is still occupied by a precision engineering works and, therefore, available areas for the investigation were somewhat limited.
- Underground services are present at the site, and their precise position could not be determined.

2 SITE CHARACTERISATION

2.1 Location and Setting

The site is located on the south side of Neath Abbey Road approximately 1 km west of the town centre of Neath. A Site Location Plan is presented as Figure 1, and the site boundaries are shown on Figure 2.

Site Address:	CSN Precision Engineering, Neath Abbey Road, Neath, SA10 7BR
National Grid Reference:	274540 197540
Site Setting:	Mixed residential and industrial.
Surrounding Land Uses:	
North:	Neath Abbey Road followed by the Court Herbert Playing Fields.
East:	Two-storey residential properties on Roman Way.
South:	Rough, overgrown ground followed by an former mineral railway, the Tennant Canal, the A465 dual carriageway road and the River Neath.
West:	A vehicle/motorcycle testing centre followed by the Abbey Road Industrial Estate.
Site Area:	Approximately 1.33ha.
Site Dimensions and Shape :	Up to 175m (north-south) Up to 155m (east-west) Irregular in shape

2.2 Topography and Landform

2.2.1 Current Land Use and Access

The site is currently occupied by the premises of CSN Precision Engineering Limited – see Figure 2. The main works building lies in the south of the site and comprises a large, part portal-frame structure with surrounding tarmac and concrete hardstanding. We understand that this building was formerly the maintenance depot for the telecom company that previously occupied the site. The main access road to the works runs along the north-western boundary from a gate on Neath Abbey Road in the north-western corner.

2.2.2 Landform

No topographic survey has been made available at this stage of the assessment; however, recent Ordnance Survey maps indicate a spot height of 9m OD on Neath Abbey Road just to the north-east of the site. Therefore, based on this, we estimate the elevation of the site to be around 9m OD.

The site is relatively flat; however, there are minor variations in level at the site. The floor slab of the existing building and the hardstanding to the north is visually estimated to be around 1m lower than the ground to the east.

2.2.3 Topography

The existing site topography is summarised on Figure 2.

As discussed in Section 2.2.1, the works building lies in the south of the site, surrounded by tarmac and concrete hardstanding. The main access road, runs from the gate on the north-western boundary in a loop around the south of the works building and back, along the eastern

boundary to a now disused gate on the north-eastern site boundary. The road is surfaced with tarmac, with areas of rough tarmac and gravel hardstanding either side.

The majority of the north of the site, between the two lengths of access road is landscaped with grass. Remnants of possible former vehicle wash-down areas and a concrete plinth are located to the west of the landscaped area between it and the road. We understand that fuel pumps formerly stood on the concrete plinth, and that the associated underground fuel tanks remain beneath this part of the site. A further two underground tanks, used for the temporary storage of waste oils by the works, are present beneath the concrete hardstanding to the south of the main works building.

An area of rubble-surfing and rough grass and weeds is located to the east of the works building and in the south-east of the site. The rubble is believed to be remnants from the now demolished former buildings in this part of the site (see Section 2.4).

The site boundaries comprise predominantly post and wire fencing, with hedgerows and trees along the eastern and southern boundaries and a brick wall and wooden fence along part of the eastern boundary. Japanese Knotweed is present on the southern margins of the site.

2.2.4 Underground Services

Utilities information supplied by the Client and the present site occupier has indicated the following underground services within the site boundaries:

- electricity – two sub-stations are located in the north-eastern corner and on the eastern boundary of the site;
- gas – a gas house is located in the north-eastern corner;
- sewerage – the main Neath sewer is understood to run approximately north-south through the western margins of the site, approximately following the access road; and
- water.

Shallow drainage is also evident across the site.

2.3 Hydrology

2.3.1 Surface Water Features

The closest surface water features to the site are as follows:

Surface Water Feature	Distance from site	Flow direction	River Quality Grade ²
Tennant Canal	150m SE	n/a	B
River Neath	200m SE	East to west	- ³
Neath Canal	266m SE	n/a	D

1. Based on the data published by the Environment Agency (website and Envirocheck report – Appendix B).

2. River Quality Objective (RQO): river water quality target set by Environment Agency which is tested on a regular basis.

3. No data published for the River Neath close to the site.

The Environment Agency website indicates that the water quality within the closest water body, the Tennant Canal, has been marginal between 2000 and 2005. The stretch of the River Neath to the south and east of the site is tidal. An unnamed sink is indicated just to the south-east of the site and may collect the water within a former drain along the southern boundary (see Section 2.4). The water in this sink flows directly to the River Neath.

2.3.2 Discharge Consents and Pollution Incidents

A full list of discharge consents and reported pollution incidents in the area is provided within the Envirocheck Report (Appendix B). There are no incidents or consents in the immediate vicinity of the site that are likely to impact upon the site.

2.3.3 Flooding

The Environment Agency's indicative flood plain maps are presented within the Envirocheck report (Appendix B), and show that the site lies within a Zone 2 area, i.e. an area subject to extreme flooding from rivers or the sea and without defences. These maps provide a general overview of areas of land in natural floodplains and, therefore, potentially at risk of flooding from rivers or the sea. They use the best information currently available, based on historical flood records and geographical models and indicate where flooding from rivers, streams, watercourses or the sea is possible. We recommend that further details relating to flood risk should be obtained from the local Environment Agency office prior to commencing detailed design or construction.

2.4 Recent History

The recent history of the site has been inferred from historical County Series and National Grid Ordnance Survey maps, dating from 1876 to 2006 and from discussions with directors of CSN Precision Engineering Limited. Extracts from the maps are presented in Appendix C and key observations relevant to the proposed redevelopment are highlighted below:

Date of map	Features within site boundary	Features outside site boundary
1876 - 1935	The site is shown as open pasture within a larger field. Deciduous trees are shown along the southern boundary.	Glyn Leiros (believed to be a large house) and a smelting works for tin waste are shown immediately to the east. A railway and the Port Tennant Canal are shown some 50 and 100m to the south. Neath Abbey Road is shown to the north. A small stream is shown to flow from just outside the south-eastern corner of the site to the River Neath further south. The smelting works is no longer labelled by 1899, although the building remains. By 1919, a small ditch is shown outside the southern boundary, which is shown to flow from west to east on the edition of 1935.
1951 - 1965	The site had been developed as a TA Centre, with many small rectangular buildings occupying the eastern margins and an access road in the west. The TA Centre development extended to the site to the west.	Glyn Leiros remains to the east. A clothing factory and printing works are shown some 100m to the west in the area of the present-day Abbey Road Industrial Estate. A window frame factory replaced the printing works and an omnibus depot/garage was built to the west of the site by 1965. Two soil mounds are shown to the west in 1965, the southern of which encroaches onto the western margins of the site. Housing on Roman Way was built by 1965. The former drain along the southern boundary is no longer clear, but may still be present.
1970 - 1999	By 1970, the northern part of the present-day works building was constructed in the south of the site, and the site is indicated to have been occupied by the engineering department of Post Office Telephones by 1972. Many of the smaller buildings remain on the site. The works building was extended to its present-day size by 1989, and occupied by a depot. The remaining former buildings are shown to have been demolished between 1994 and 1999.	In 1972, a police headquarters is shown to the east, and the vehicle testing facility to the west. The A465 'Heads of the Valley' road was constructed by 1978.

CSN Precision Engineering Limited have advised us that they moved to the site in around 1990, replacing the former telephones company. CSN undertook the demolition of five old buildings

remaining in the north of the site at that time. They advise that the above-ground structures were demolished and some of the strip foundations removed; however, some foundations were left in-situ. The roofs of the former buildings contained asbestos materials, but these were removed by a specialist contractor. The foundations of the former buildings demolished prior to 1990 may remain in-situ.

2.5 Environmental Setting

As discussed in Section 2.1, the site is located in a mixed residential/industrial setting. A full list of the environmental features within the area of the site is presented in the Envirocheck report in Appendix B. The following features have the potential to have impact on or be impacted by the site:

2.5.1 Sensitive Land Uses

There are no sensitive land uses within 2km of the site.

2.5.2 Registered Waste Sites

The closest landfill site is located some 230m to the south-west (Map ID 68, between the A465 and the Tennant Canal), and is reported to have accepted inert, industrial, commercial, household and special waste. It is reported to have closed in 1980. A second landfill is indicated around 330m to the west (beneath the present-day Tesco store) although no details are presented in the Envirocheck report.

2.5.3 Industrial and Hazardous Substance Use

A full list of industrial land uses in the vicinity of the site is presented in the Envirocheck Report (Appendix B). CSN Precision Engineering is listed as Map ID 76. There are no other industrial land uses within 100m of the site. A number of industries are present between 100 and 300m from the site, including manufacturers of furniture, uPVC products and awnings, vehicle repair workshops, a joinery, and a car dealers, these predominantly lie on the industrial estates to the west.

2.5.4 Underground Fuel/Oil Storage Tanks

As discussed in Section 2.2.3, three underground fuel/oil storage tanks have been identified at the site. One is reportedly located close to a concrete plinth adjacent to the site access road in the north-west, and was used by the Post Office to fuel their vehicles. The other two are reportedly located beneath the concrete hardstanding to the south of the building, and is used by CSN Precision Engineering as a temporary store for waste oil before collection and disposal by a licensed contractor.

Enquiries have been made to the Local Authority Environment Department (NPT, 2007) but they have no records of either underground tank.

2.6 Geology

2.6.1 Published Geology

The published geological sheet for the area indicates the site to be underlain by Fluvio-glacial Gravel overlying sandstone within the Swansea Beds of the Carboniferous Upper Coal Measures. Based on the outcrop pattern of the strata, the dip of the bedrock in the area is to the north/north-east. Made Ground is indicated between the railway and the canal to the south-east of the site.

2.6.2 Mining

The site is underlain by bedrock of the Upper Coal Measures. A mining report has been obtained from the Coal Authority and is presented in Appendix D. This indicates the following:

- the property is in the likely zone of influence from workings in two seams of coal at 160 to 210m depth;
- these seams were last worked in 1923;
- any ground movement from these coal workings should have stopped by now;
- there are no known coal mine entries within, or within 20 m of, the boundary of the property.

The geological map shows the outcrops of three coal seams to the south-west of the site. The Swansea Five Feet, the Tir Edmond and the Graigola seams crop out some 300m, 900m and 1,000m from the site respectively, and with bedrock dipping to the north/north-east, would be expected to underlie the site. The outcrops of the latter two seams are shown as conjectural. The geological map indicates contours within the Graigola seam at around -180m OD beneath the site.

The depths at which the seams (and workings) are anticipated to underlie the site are considered deep enough not to cause significant risks at the surface. Therefore, the risk from past mining is not considered further.

2.6.3 Slope Instability

Reference to geological maps and published records has not identified any evidence to indicate that the site is affected by natural post-glacial landslipping.

2.7 Hydrogeology

2.7.1 Aquifers and Aquitards

The strata beneath the site are anticipated to have the following hydrogeological characteristics:

Stratum	Aquifer Classification	Hydrogeological Characteristics
Fluvio-glacial Gravel	Minor aquifer	Variable permeability. Intergranular flow.
Upper Coal Measures Sandstone	Minor aquifer	Moderate permeability. Possibly in connection with adjacent river. Intergranular flow.

1. Based on the data published by the Environment Agency (Envirocheck report – Appendix B).

Minor aquifers have a variable permeability and seldom produce large quantities of water for abstraction. However, they can be important for local supplies and in supplying base flow to rivers.

2.7.2 Groundwater Abstractions

No groundwater abstractions or Source Protection Zones are indicated within 2km of the site.

2.7.3 Vulnerability

An extract of the Environment Agency's (the Agency) published groundwater vulnerability map for the area is included in an Envirocheck report obtained for the site (Appendix B) and indicates that the site is underlain by soils of high leaching potential. In urban areas such as this, there is limited data available to assess the leaching potential, so the Agency classifies the soils as of high leaching potential until proven otherwise. However, the Fluvio-glacial Gravels anticipated beneath the site are likely to be of high permeability and could allow the ready migration of any contaminants present.

2.8 Radon Gas

The requirement for radon protection measures in new dwellings (housing) is assessed in the guidelines published by the Building Research Establishment (BRE, 1999). These guidelines relate to the construction of new dwellings (houses), however, the preliminary assessment of radon risk therein is also applicable to other developments, including commercial and industrial.

The BRE indicates that no radon protection measures are required for dwellings constructed at the site. Therefore, the potential risk from radon is not considered further.

2.9 Potential for Pyritic Ground

The Coal Measures bedrock underlying the site are listed by the BRE (2001) as potentially containing elevated levels of pyrite, which may oxidise to sulphates and lead to aggressive attack on buried concrete. Depending on its origin, the Made Ground and the fluvio-glacial deposits anticipated beneath the site may contain elevated levels of pyrite.

2.10 Conceptual Site Model

The potential risks are assessed by considering potential pollutant linkages. For a risk to exist, there must be a contaminant source, a receptor that may be harmed, and a pathway by which the receptor can be exposed to the contaminant. Only if all three elements are present (i.e. contamination source, pathway and receptor) can a pollutant linkage and, hence, potentially unacceptable risk exist. The Conceptual Site Model considers all three elements and the potential for pollutant linkages to exist. The following sections collate all the desk study information discussed in previous sections to identify the potential contamination sources and receptors and, hence, pollutant linkages that potentially exist.

2.10.1 Potential Contamination Sources

The available data suggests that the following may prove sources of contamination at the site:

- Made Ground – general diffuse contamination and generating combustible and noxious gas;
- Past use of the site as a depot – specifically the underground fuel storage tanks in the north-west;
- Current engineering works – specifically the waste oil tanks to the south of the building;
- Asbestos – the available information suggests that the former buildings demolished since 1990 contained asbestos products, which were disposed of by licensed contractors. However, similar buildings were demolished prior to 1990, and the treatment of asbestos products at that time is not known. Rare gravel-sized fragments of possible asbestos roof sheets were observed in the gravel-surfaced area during the site walkover.

DEFRA and the Environment Agency (CLR8, 2002) have provided guidelines that identify the key contaminants associated with various industrial land uses and these have been used to compile the following list of potential contaminants that may be present on the site:

- heavy metals and semi-metals (arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc);
- cyanide, sulphate, sulphide;
- polycyclic aromatic hydrocarbons (PAHs);
- petroleum hydrocarbons;
- phenols;
- asbestos; and
- methane and carbon dioxide.

2.10.2 Potential Vulnerable Receptors

As discussed in Section 1.1, the site is likely to be developed for two future uses, with a retail store in the north and residential properties in the south. Based on our desk study research, we consider the most vulnerable receptors at the site to be as follows:

1.	Human Receptors During Development • construction workers; • neighbours; and • trespassers. On Completion of Development • end users of the store (e.g. the general public, shop workers, etc.); • future residents, visitors etc. and • maintenance workers.
2.	Groundwater 2a. Aquifer Classification The Coal Measures bedrock is classified as a minor aquifer. The Fluvio-glacial Gravels anticipated beneath the site are likely to be of high permeability and could allow the ready migration of any contaminants present. 2b. Groundwater Abstractions / Source Protection Zones None identified in the area.
3.	Surface Water 3a. Surface Water Bodies The closest surface waters are the Tennant Canal and the River Neath. An unnamed sink is present just to the south-east of the site. 3b. Surface Water Abstractions None identified in the area.
4.	Building Materials • buried concrete; • water supply pipelines.

2.10.3 Potential Pathways

Based on the previous sections, we consider that the following are the pathways of most concern at the site, and require further investigation to allow an assessment of the potential risks posed (assuming no mitigation measures are implemented):

Human Receptors:

- Ingestion of contaminated soil/vegetables by future residents in the south of the site;
- Ingestion of contaminated soil by users of the proposed retail store;
- Dermal contact by future site users with contaminated soil;
- Inhalation of dust by future site users;
- Inhalation of vapours by future site users;
- Direct contact with contaminated soils/dust by construction/maintenance workers;
- Explosion of combustible gases (e.g. methane);
- Ingress of contamination through service pipes to drinking water supply;
- Ingestion of dust/inhalation of vapours by users of neighbouring sites.

Controlled Water Receptors:

- Contamination of groundwater beneath site by past contaminative use;
- Leaching of soluble contaminants from the Made Ground to the groundwater within the underlying strata;
- Contaminated groundwater from site migrating to surface waters, particularly the former drain and sinks to the south and south-east of the site, and then on to the River Neath;
- Contaminated groundwater from site migrating to neighbouring site.

Building Materials:

- Contamination in direct contact with buried concrete/building materials.

3 SITE INVESTIGATION

3.1 Exploratory Holes and In-situ Testing

The following exploratory holes were constructed at the site:

	Number	References	Depth range	Date of completion
Trial Pits	7	TP1 – TP7	3.2 to 3.6m	06/08/07
Windowless Sample Boreholes	6	WS1 – WS6	1.4 to 3.0m	02/08/07

The fieldworks were supervised by Ground Investigation Limited, and were executed in accordance with BS 5930:1999. The exploratory hole records are presented in Appendices E and F, and their approximate locations are shown on Figure 3.

Trial Pits:

The trial pits were excavated using a wheeled, backacting, hydraulic excavator. Disturbed samples were collected from the trial pits for laboratory testing. The trial pits were backfilled with arisings upon completion. The trial pit records are presented in Appendix E.

At the request of the present site occupier, the trial pits were restricted to areas of rough gravel and grass. No trial pits were excavated in areas of grassed landscaping or surface hardstanding.

Windowless Sample Boreholes:

The windowless sample boreholes were located in the areas of grassed landscaping or surface hardstanding where trial pits could not be excavated.

The boreholes were commenced at 101mm diameter, reducing with depth to 88mm diameter. Where present, the concrete/tarmacadam surface was cored to commence the borehole. Samples were recovered in plastic liner tubes for logging and laboratory testing. The windowless sampling provided generally good recovery to the depth of refusal. Standard Penetration Tests (SPTs) were undertaken at regular intervals in the boreholes. Where no well was installed, the boreholes were backfilled with pea gravel and arisings, and the surface reinstated with concrete. The borehole records are presented in Appendix F.

3.2 Monitoring Wells

3.2.1 Well Construction

A gas/groundwater monitoring well was installed in Borehole WS1, just to the south of the underground waste oil tanks in the south of the site with a response zone within the Possible Head Deposits/Fluvio-Glacial Gravel between 1.0 and 2.0m depth.

The well was constructed from 50mm internal diameter, high-density polyethylene (HDPE) pipe. Over the depth of the response zone (the depth zone to be monitored), the pipe was slotted and surrounded with inert, clean, granular material. A bentonite seal was constructed at the top of the response zone, and the top of the monitoring well was fitted with a gas tap and a flush lockable security cover. Details of the monitoring well are shown on the relevant borehole record, in Appendix F.

3.2.2 Monitoring

To date, the installed wells have been monitored for ground gas on three occasions between 9th and 31st August 2007. During each visit the concentrations of methane, carbon dioxide, oxygen, hydrogen sulphide and carbon monoxide were recorded, together with measurements of the atmospheric pressure, gas flow rates and standing water levels. The levels and flow rates of gas were measured using a Geotechnical Instruments GA2000 infra-red gas analyser, with a flow pod attachment. In

addition, an interface probe has been used to check for the presence of phase-separated hydrocarbons 'floating' on the top surface of the groundwater. The results of the gas/groundwater monitoring are presented in Appendix G.

3.3 Sampling Strategy and Methodology

3.3.1 Exploratory Hole Positions

The desk study assessment (Section 2.0) has identified a number of potential contamination sources from its past use including underground fuel/oil storage tanks and the Made Ground. The main objectives of the intrusive investigation were to provide information on the following:

- the levels of contamination around the potential contamination sources identified by the desk study (e.g. the underground fuel tanks);
- the general levels of soil contamination present beneath the proposed development site; and
- the geotechnical characteristics of the soils across the site, and in particular the impact these may have on future development.

The exploratory hole locations were positioned to maximise the information that could be obtained, allowing for the constraints imposed by the physical features on site.

Generally, a non-targeted, random sampling strategy was used to obtain representative information on the site as a whole. However, a number of constraints were imposed on the available sampling locations by existing buildings and site operations, and therefore a regular grid sampling pattern could not be adopted.

3.3.2 Soil Sampling

All soil samples taken for possible laboratory chemical analysis were collected in suitable clean containers provided by the testing laboratory (e.g. clean polyethylene jars with fitted lids for routine soil testing, clear or amber glass containers with screw on air-tight caps for organic contaminants, glass vials for volatile contaminants, etc.). Immediately after collection the samples were placed in sealed cool boxes where they remained during storage and transport to the laboratory.

3.4 Geo-environmental Laboratory Testing

3.4.1 General

Laboratory testing has been undertaken on selected samples of soil. The testing undertaken is summarised on Table 1. The geo-environmental analyses were carried out by a UKAS accredited testing laboratory with detection limits being generally compatible with the relevant guideline values. The results of the testing are presented in Appendix H.

3.4.2 Soil

To allow an assessment of the potential chronic risk to human health to be made, a total of ten samples of soil taken from the near surface strata have been analysed in the laboratory for the total levels of potential contaminants typically found on brownfield sites in the UK. Three samples of soil from around the underground fuel/oil tanks have also been tested for petroleum hydrocarbons.

Six further soil samples from the Fluvio-glacial Gravels were analysed to determine the concentrations of water soluble sulphate and pH value to allow an assessment of the classification in terms of foundation concrete. Due to the potential presence of pyrite, these samples were also analysed to determine the levels of total sulphur, acid soluble sulphate in accordance with the analytical methods specified in BRE Special Digest 1 (BRE, 2005).

3.5 Geotechnical Testing

The schedule of geotechnical testing comprised analysis to determine the following properties of the near surface strata:

- natural moisture contents;
- Atterberg limits;
- particle size distributions (PSDs);

All geotechnical tests were carried out by a UKAS accredited testing laboratory in accordance with BS 1377 (1990) and the results are presented in Appendix I.

4 CONCEPTUAL GROUND MODEL

4.1 Geological Strata

4.1.1 General

The exploratory holes have identified that the site is generally underlain by a thin veneer of Topsoil, hardstanding or surface gravel over varying thicknesses of Made Ground, Possible Head Deposits and Fluvio-Glacial Gravel. The sandstone bedrock of the Upper Coal Measures was not encountered within the exploratory holes.

4.1.2 Made Ground

Made Ground was encountered up to a depth of around 2.0m, and generally thickens toward the south-east of the site. It was not encountered in the northern part of the site (WS4, WS5 and WS6).

A 'wedge' of Made Ground was encountered to the south-east of the site (TP3 to TP7) to depths of between 0.8 and 2.0m, and generally comprised angular limestone (hardcore) gravel over varying fractions of fine- and coarse-grained materials consisting of clay/silt with fragments of brick, sandstone, mudstone, building stone, concrete, metal, coal and tile. The south-eastern corner of the site was observed to be around 1 to 2m higher than the adjacent properties to the south and east, with the edge of the 'fill' sloped down towards the boundary fence.

As discussed in Section 2.2.2, the eastern part of the works building appears to have been built in a cut of around 1m depth.

4.1.3 Topsoil

Topsoil was encountered at the surface of Boreholes WS3, WS5 and WS6 and Trial Pit TP1 as a soft, brown, slightly sandy, slightly gravelly, silt with frequent thin plant roots to a depth of around 0.1 to 0.25m.

4.1.4 Possible Head Deposits

Possible Head Deposits were encountered between the Made Ground and the underlying Fluvio-Glacial Gravels, and comprised of generally brown, slightly sandy, slightly gravelly clay/silt of a firm or firm-to-stiff consistency and intermediate plasticity. SPT N-values of 5 and 6 were recorded within the stratum.

4.1.5 Fluvio-Glacial Gravels

All the exploratory holes were terminated within Fluvio-glacial Gravel which was encountered at depths ranging from 0.25 to 2.50m. The gravels were typically brown-grey, clayey/silty, sandy, cobbly gravel of rounded to subangular sandstone. SPT N-values varied between 40 and greater than 50, suggesting a dense state.

4.2 Site Evidence of Soil Contamination

None of the encountered soils exhibited any visual or olfactory evidence of contamination. However, rare gravel-sized fragments of suspected cemented asbestos sheet were observed in the rough gravel surface.

4.3 Hydrogeological Conditions

Groundwater was encountered as slow to medium inflows in the south-east of the site (Trial Pits TP5, TP6 and TP7) at depths of between 3.4 and 3.5m. No other exploratory hole encountered groundwater. Monitoring of the well installed in Borehole WS1 has not identified any groundwater within 1.9m of the site surface.

The main groundwater body beneath the site is anticipated to be within the Fluvio-Glacial Gravels.

No monitoring of long-term groundwater levels has been undertaken at the site to date. However, based on the site setting and available information, we consider that the hydraulic gradient beneath the site is likely to be towards the south/south-east, i.e. towards the River Neath.

5 GEO-ENVIRONMENTAL ASSESSMENT AND RECOMMENDATIONS

5.1 General

Risk assessments have been undertaken to estimate the significance of observed levels of various contaminants detected in the ground at the site in terms of their potential to cause harm to sensitive receptors.

The potentially unacceptable pollutant linkages are identified on the Phase Two Conceptual Site Model (CSM), presented as Table 2. This Phase Two CSM is a development of the Phase One CSM presented in Section 2.10 and has been generated following the assessment of the contaminants present in the following sections. It does not include for the use of any measures to mitigate the identified risks.

The work undertaken has concentrated on assessing the following generalised pollution linkages:

- the chronic (long-term) health risks to site users arising from exposure to contaminants present in the soil;
- explosion and health risks associated with the presence of methane, carbon dioxide, and other ground gases; and
- the aggressive chemical environment for buried concrete.

Assessments of acute (short-term) health risks to construction workers, adjacent site users and the general public during the redevelopment of the site are not considered as they will depend to a large degree on the specific working methods and programmes of works used. If required, further advice can be provided once the methods of construction and programmes of work have been finalised.

Any recommendations for geo-environmental remedial works provided in this report should be agreed with the Environmental Services Department of the Local Authority and/or the Environment Agency.

5.2 Chronic Health Risks to Site Users

5.2.1 Assessment Methodology

A Tier 1 evaluation of chronic human health risks have been conducted by comparing measured soil contamination levels with appropriate Generic Assessment Criteria (GAC). If concentrations of contaminants fall below the GAC, the individual contaminants or areas of the site can be considered not to pose unacceptable chronic human health risks and can be eliminated from further consideration. However, if concentrations of contaminants exceed the GAC, it is presumed that there is sufficient evidence for potentially unacceptable chronic risks to warrant further action (e.g. more detailed investigation/assessment and/or remedial action).

For the purposes of this assessment, the published Soil Guideline Values (SGVs, DETR and Environment Agency) have been used as the GAC, where available for the proposed end use. These SGVs have been derived by the Environment Agency using the CLEA model for selected generic land uses and take into account generic assumptions about the characteristics of contaminants, pathways and receptors. However, we consider that the assumptions adopted in the generation of the SGVs are appropriate for the subject site and hence, the SGVs may be adopted as GAC for this assessment.

At the time of writing, CLEA SGVs have been published for only seven metals, two petroleum hydrocarbon compounds and phenol compounds, and a recent Environment Agency bulletin has indicated that no further SGVs will be published in the foreseeable future. Therefore, other sources are required to provide GAC for the other determinands to be assessed. Tentative GAC have been generated by Ground Investigation Limited using the SNIFFER (for non-volatile contaminants) and the BPRISC (for volatile contaminants) software tools for a number of determinands for which toxicological data is readily available (e.g. in the form of TOX reports). The GAC have been derived using UK compliant exposure models.

As the sampling has been undertaken on a non-targeted basis, the mean and maximum value tests as described in CLR 7 (DETR/Environment Agency, 2002) have been used in the assessment.

The assessment has been undertaken for both a residential end use with the growth of edible plants, and for a commercial end use (the proposed store).

The above approach should be agreed with the Local Authority Environmental Health department.

5.2.2 Evaluation of Laboratory Data

The full test results are presented in Appendix H. The risks posed by the main determinands are evaluated in Tables 3a and 3b which also provide details of the GAC used for each determinand. Table 3a evaluates the results of testing for general contaminants in the north of the site with regard to the proposed use of the site as a retail store, and in the south of the site relative to the proposed residential development. Table 3b evaluates the results of testing for petroleum hydrocarbons with regard to the proposed residential development. Where appropriate, the results of the mean value and maximum value tests described in CLR7 (2002) are shown on Tables 3a and 3b.

Soil pH values within the samples analysed ranged from 7.4 to 12.0, indicating alkaline soil conditions. Soil organic matter was found to vary between 0.8 % and 31.0 %.

Generally, the levels of all determinands were below the respective GAC. These contaminants are, therefore, not likely to be generally present at the site at concentrations that are likely to pose significant chronic human health risks to future site users.

However, the results of the analyses indicated that concentrations of arsenic were elevated above the GAC of 20mg/kg in three samples recovered from the south of the site. The concentrations of arsenic were 43mg/kg in the Made Ground recovered from Trial Pit TP5 at a depth of 0.2m, 54.7mg/kg in the Made Ground recovered from Trial Pit TP6 at a depth of 0.2m and 54.9mg/kg in the possible Head Deposits recovered from Borehole WS1 at a depth of 0.5 to 1.0m. The US_{95} value calculated for the Made Ground soils (46.2mg/kg) also exceeds the GAC in this area.

5.2.3 Conclusions

The exposure pathways of most concern from elevated concentrations of arsenic in near surface soils is the ingestion of soil and indoor dust, ingestion of soil attached to vegetables and the consumption of vegetables. Further investigation including additional sampling in the southern part of the site would be required to carry out a detailed quantitative risk assessment (DQRA) to reduce uncertainty and increase confidence in the assessment to date.

It is likely, however, that simple remedial measures, such as the provision of a clean cover system adopted in the garden areas of dwellings, would act as a barrier against the elevated concentrations of arsenic, thus removing the exposure pathways and mitigating the potentially unacceptable chronic human health risks to future site users. Typically, such a clean cover system could incorporate at least 600mm thickness of suitable inert marker soils, sub-soils and Topsoil laid on a geotextile.

5.3 Pollution Risks to Controlled Waters

As no significant groundwater ingress was identified within the exploratory holes, a quantitative risk assessment to address possible pollution risks to controlled waters has not been possible at this stage.

The underground fuel/oil storage tanks may be founded in the Fluvio-glacial Gravels beneath the site. The fine-grained content of this stratum is low (between 2 and 7% in the tested samples) and therefore, the permeability of the stratum is anticipated to be high. Given this, any contamination resulting from leaks/spills of hydrocarbons from around the tanks, or leachable contaminants within the Made Ground could impact on the groundwater beneath the site. The site is not located within a source abstraction zone and, hence, the groundwater beneath the site is not considered to be of

particular sensitivity. However, the groundwater may form a pathway for the migration of contaminants to nearby surface waters, particularly the former drain on the southern boundary and that to the south-east, which appear to flow directly to the River Neath.

We recommend that further groundwater monitoring wells be installed at the site to allow an investigation of the quality of groundwater beneath the site, particularly around the underground fuel/oil storage tanks, and an assessment of pollution risks to nearby surface waters.

5.4 Preliminary Guidance on the Re-use or Disposal of Excavation Arisings

The options for site arisings should take into account the UK Government policy to minimise disposal of soils at landfill sites as much as possible, and instead consider the reduction, re-use or recycling of such soils. The Environment Agency will expect the development proposals to have been reviewed to minimise the generation of waste (e.g. selecting a displacement foundation system rather than a non-displacement system, etc.).

The classification, transport and disposal of arisings should be undertaken in accordance with current waste management regulations.

5.5 Hazardous Ground Gas

5.5.1 Radon

As discussed in Section 2.8, no radon protection measures are required for dwellings or the store proposed at the site.

5.5.2 Methane and Carbon Dioxide

Risks arising from the possible presence of methane and carbon dioxide gas have been assessed using the methodologies described published by CIRIA (2007).

The Made Ground encountered at the site does not contain large quantities of degradable or other materials that would be capable of producing significant volumes of methane and/or carbon dioxide. However, petroleum hydrocarbons may be present, which could generate methane and carbon dioxide as they weather.

One monitoring well has been installed at the site to date, close to the reported underground storage tank in the north-west of the site. This well has been monitored on three occasions to date and the results of the gas and groundwater level monitoring are presented in Appendix G.

To date, no detectable concentrations of methane have been identified, and carbon dioxide has been found at levels of between 6.2 and 6.5%. No gas flows have been identified.

Given the above, the gas classification for the site would be Characteristic Situation 1 (CS1). However, this is based on one sampling position, and further monitoring would be required from additional monitoring positions across the site prior to evaluation of the characteristic situation for design. The recommended wells (see Section 5.3) may be fitted with gas taps to allow further monitoring.

5.6 Aggressive Chemical Environment for Concrete (ACEC) Classification

The Aggressive Chemical Environment for Concrete (ACEC) classification for the site has been assessed according to the guidelines given by the recent update of BRE in Special Digest 1 (2005). Due to the presence of Made Ground over much of the site, for the purpose of the assessment the site has been assumed to be brownfield with soils potentially containing pyrite.

5.6.1 Groundwater Conditions

No groundwater inflows were observed in the exploratory holes, which were completed within one day's work. However, for the purposes of this assessment, groundwater has been assumed to be mobile.

5.6.2 Evaluation

As identified in Section 2.9, the soils underlying the site potentially contain elevated levels of pyrite, which could oxidise to increase the proportion of sulphate in the ground. Therefore, as well as testing for pH and water soluble sulphate, further testing for acid soluble sulphate and total sulphur is required (BRE, 2001).

The pH values of the soil samples taken from the near surface soils across the site ranged from 7.4 to 12.0 indicating alkaline conditions. None of the tested soil samples have indicated pH values of less than 5.5 and therefore no consideration need be taken of chloride and nitrate in assessing the ACEC. The levels of water soluble sulphate content of the tested soil samples varied between 0.01 and 0.28g/l (with a maximum in WS2 at 1.0 to 1.5m depth).

The maximum level of acid soluble sulphate is 0.15%, and the total sulphur is 0.09%. Therefore the maximum total potential sulphate content has been calculated as 0.27%. The calculated maximum level of oxidisable sulphides is 0.18% and, as this level does not exceed 0.3% SO₄, pyrite is probably not present.

For the purposes of assessing the ACEC, the 'characteristic values' of soil sulphate and pH value are used. Based on the guidelines of BRE SD1, the following characteristic values have been determined:

pH value	Water soluble sulphate (WSS)		Total Potential Sulphate (TPS)	
Characteristic Value	Characteristic Value (mg/l)	Design Sulphate Class	Characteristic Value (%)	Design Sulphate Class
7.4	281	DS-1	0.27	DS-2

Based on the above, the Design Sulphate class for the site is DS-2, and the Aggressive Chemical Environment for Concrete (ACEC) site classification is AC-2.

6 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS

6.1 Site Preparation

Prior to commencing the ground works, all live services on, and in the vicinity of, the proposed development should be accurately located and, if necessary, diverted or protected. The readers attention is drawn to the presence of gas house and electricity sub-stations on the eastern boundary and in the north-east of the site and the main sewer which is believed to run down the western margins of the site. The ends of existing drains and sewers no longer required because of alterations to the drainage layout should be effectively sealed so as to prevent any residual or persisting seepages from adversely affecting the integrity and/or stability of the formations and/or foundations.

The available information suggests that the foundations of the former buildings may be present across much of the eastern part of the site. All old foundations and sub-structures, trees, bushes and scrub should be cleared and all root systems grubbed up. Sub-structure walls should be grubbed up to a depth of at least 1.5m below any proposed shallow foundations. Basements or service conduits, and surface voids resulting from the site preparation work, should be filled with well compacted, acceptable granular material (e.g. DoT Type 1, or similar approved).

If ground levels are to be raised, all topsoil and vegetated soil should be first stripped and stockpiled for subsequent re-use in the permanent works. Care should be taken to ensure that any Made Ground or contaminated soil is excavated and handled separately from the soils which are to be reused in the permanent works. Any unsuitable materials arising from the site clearance works should be disposed of at suitably licensed waste management facilities (see Section 5.4).

In order to protect the exposed formations from deterioration by the weather, the action of water and/or site traffic, they should be covered by a minimum 200mm thickness of suitable granular material or a thin layer of blinding concrete immediately after exposure.

Japanese Knotweed is present in the southern margins of the site.

6.2 Earthworks

6.2.1 Cutting and Filling

No significant cutting or filling is anticipated at the site.

6.2.2 Excavation Plant

On the basis of the observations made during the exploratory investigation it is considered that excavations within the near surface superficial deposits should be within the capabilities of conventional mechanical excavators. However, large capacity excavators or hydraulic breakers may be required to remove old foundations, or to excavate to depths greater than 3.5 to 4m.

6.2.3 Stability of Excavation Sides

Observations made during the excavation of the trial pits indicate that the sides of excavations in the shallow soils should generally remain stable for short periods following excavation. However, some collapse was experienced within the shallow Made Ground.

Excavations to depths of 1.2m or greater should be provided with full support to statutory requirements or sloped back at safe angles (e.g. typically 30° to the horizontal). Adequate support should also be provided to any excavation that may affect the stability or integrity of adjacent structures, roads or services.

6.2.4 Control of Groundwater

Based on the available information, we consider that excavations will encounter groundwater at depths from around 3.5m. Therefore, groundwater control will be required for excavations below this depth.

Any water arising from the works should be channelled to, and discharged at, suitable approved locations. The formal consent of the Environment Agency is required for any discharges to controlled waters, including both direct discharges to surface water courses and discharges to soakaways, and it is recommended that the Environment Agency be consulted to confirm whether a formal consent would be necessary for the proposed development activities.

The groundwater regime beneath the site may be subject to seasonal, climatic and other variations. The reported observations therefore may not be fully representative of the groundwater regime at the site and different groundwater conditions may be encountered during future investigation or development works.

6.3 Slope Stability

The site is generally flat and level and, therefore, no significant impact on the site stability is anticipated.

6.4 Foundation Options

6.4.1 Proposed Retail Store

At the time of writing the foundation loads for the proposed store have not been confirmed, therefore, the recommendations that follow should be reviewed once the foundation loads have been finalised. The following conclusions and recommendations assume that the finished ground levels will be close to existing ground levels. If any significant changes are made to existing ground levels, the following conclusions and recommendations should be reviewed and, if necessary, amended.

Based on the findings of the investigation, the ground conditions beneath the proposed store will vary. We consider that spread foundations constructed in the Fluvio-glacial Gravels would be a suitable foundation option for the proposed retail store. However, although the Fluvio-glacial Gravels appear to be present from depths of between 0.25 and 0.7m below existing ground level beneath the majority northern area of the footprint, their depth is significantly greater in the southern portion of the footprint (2.0m in TP2 and TP3).

Shallow spread foundations would be suitable over much of the footprint (at say 0.7m depth); however, in the southern portion, trench fill foundations would be required to a minimum depth of 2m. A presumed bearing value of up to 150kN/m² would be appropriate for the design of the foundations within the Fluvio-glacial Gravels, which should ensure that total and differential settlements remain within normal acceptable limits (i.e. total settlements less than 25mm).

As an alternative to trench fill foundations, the Made Ground in the southern area may be excavated and replaced with suitable granular fill compacted to an appropriate specification. Reinforced spread foundations may then be adopted. The coarse-grained Made Ground materials excavated should be predominantly suitable for re-use.

6.4.2 Proposed Residential Properties

In the south and south-east of the site, the Made Ground is up to 2.0m in thickness and the Fluvio-glacial Gravels are present at depths of between 1.6 and 2.5m below existing ground level.

On the basis of the available investigation data the use of conventional shallow foundations on untreated Made Ground cannot be recommended due to the possible occurrence of unacceptable differential settlement. Possible options would include excavation and replacement or vibro-ground treatment.

Excavation and Replacement of Made Ground:

A suitable foundation option would be either a reinforced ground beam or raft foundation constructed on compacted fill. The existing ground should be excavated to a minimum of depth of the order of 1.0m below the proposed formation level of the main structural foundations. The excavation should be replaced with suitable granular material (e.g. DoT Type 1 sub-base or similar approved) and compacted in layers in a controlled manner to a suitable specification. This ground improvement should be carried out over an area extending to a minimum of 1.0m outside the footprint of each foundation. Thickening of the foundations is likely to be required beneath the columns and any load bearing walls.

Based on our investigation it is considered that the soils to be excavated as part of this treatment would be substantially suitable for re-use as compacted materials, following the removal of unsuitable materials. The presumed bearing value would be dependent on foundation size, compacted material type and quality, compaction characteristics and foundation loading details. However, for preliminary design a presumed bearing value of up to 100kN/m^2 may be used for rigid reinforced foundations.

Vibro-Ground Treatment:

Vibro-replacement involves the installation of vibrated stone columns (VSC) into the ground to increase the load bearing characteristics. The Made Ground may respond well to this technique but the suitability and design of any specific solution based on VSC will depend on the layout and loading details of the structure together with the type of foundation and the particular ground conditions. It should be appreciated that stone columns may form pathways for the migration of ground gas or hydrocarbon contamination, and will only be suitable if any significant contamination sources (if present) are removed from the shallow soils.

The use of vibrated concrete columns (VCC) is a similar approach to VSC, but the columns are constructed on concrete vibrated into the near surface soils. VCC tends to be effective in a wider range of soils than VSC.

The advice of a specialist ground treatment contractor(s) should be sought in order to confirm the suitability of the ground with respect to their particular proprietary systems and where appropriate to provide information on suitable treatment and costs. Some pre-boring and the use of a mechanical excavator may be required to remove obstructions and old foundations if they are not removed as part of the site preparation works.

6.4.3 Potential for Shrinkage and Swelling

Laboratory testing has indicated the fine-grained Probable Head Deposits at shallow depth beneath the site to be of low volume change potential. However, this deposit is not recommended as a founding stratum and, hence, no amendment to foundation depth is considered necessary. The coarse-grained Fluvio-glacial Deposits may be considered as non-shrinkable.

6.5 Floor Slabs

6.5.1 Proposed Retail Store

The use of cast in-situ ground-bearing floor slabs is likely to be suitable for the retail store. Where the Fluvio-glacial Gravels are present close to the surface (In the northern part of the footprint), the existing ground should be compacted for a depth of at least 300mm below slab formation level. The formations should be inspected for any soft spots, which if found, should be excavated and replaced with compacted, suitable, granular fill. As an indication of performance, total settlements under a distributed floor slab loading of 5kN/m^2 are expected to be less than 15mm.

Where Made Ground is present to depth of up to 2.0m, we consider that provided that the floor slab loads are less than 10kN/m², the Made Ground soils may be left in-situ and compacted as detailed above. For heavier floor loadings, the Made Ground may need to be excavated and re-compacted to ensure that settlements are restricted to within tolerable limits.

The proposed store building lies close to the eastern boundary where a number of mature trees are present. If these trees are removed, either as part of the development or in future, the near-surface fine-grained Probable Head Deposits, identified in WS5 in the north of the proposed footprint, could suffer swelling. A tree survey should be undertaken to identify the potential amount of swelling that could occur. We recommend that within the zone of influence of trees, either the fine-grained soils should be removed and replaced with suitable compacted coarse-grained fill or a suspended floor slab with a suitably dimensioned sub-floor void adopted.

6.5.2 Proposed Residential Properties

The investigation has indicated up to 2.0m of Made Ground beneath the south of the site where the residential properties are proposed. Suspended floor slabs will be necessary to satisfy the NHBC where the thickness of fill exceeds 600mm, i.e. across this area.

6.5.3 Gas Protection

As discussed in Section 5.5, further monitoring of ground gas is recommended and appropriate protection should be provided within the floor slab construction once the risk from gas has been evaluated.

6.6 Pavement Design

CBR testing has not been undertaken at the site. However, based on experience and published guidelines, we consider that CBR values of 3 to 5% would be appropriate for the preliminary design of pavements in the north of the site where the fine-grained Probable Head Deposits are present over much of the area. In the south of the site, coarse-grained Made Ground is anticipated within the formation and we consider that CBR values of 10% would be appropriate for the preliminary design of pavements. In-situ CBR test should be carried out at designated locations once the proposed layout of the site is finalised.

Laboratory testing has indicated the plasticity indices of the fine-grained soils which are anticipated to lie within the pavement formation to be between 14 and 19%. Such soils are likely to be frost susceptible. A minimum 450mm thickness of non-frost susceptible materials should be provided above the in-situ subgrade. The coarse-grained soils in the south of the site would be expected to be non-frost susceptible and no such precautions would be required.

Prior to constructing the pavements all formations should be proof rolled and inspected by a suitably qualified and experienced engineer to ensure that the CBR value assumed in design is achieved. Any soft/loose spots should be excavated and replaced with well compacted suitable fill material (e.g. DoT Type 1 or similar approved) which should be compacted in thin horizontal layers in accordance with the DoT Specification for Highway Works (SHW).

6.7 Soakaway Design

At this stage it is not known if soakaways are to be adopted at the development. The Fluvio-glacial Gravels present across the site are predominantly coarse-grained, with a minimal proportion of fine-grained particles. Laboratory testing has indicated that the proportion of fines (silt and clay, which can fill the pore spaces between the coarse-grained fraction and reduce infiltration) within the strata in which the soakaways are likely to be constructed to vary between 3 and 7%.

Given the above, we consider that the soils underlying the site may be suitable for the successful use of soakaways. In-situ soakaway testing should be undertaken to confirm the infiltration characteristics, and hence the suitability of soakaways.

If soakaways are to be adopted, their use should be agreed with the Environment Agency. The Agency requires that the base of the soakaway be located at least 1m above the groundwater table. The investigation suggests that groundwater is present at around 3.5m depth, therefore soakaways should be constructed at a maximum depth of 2.5 m. This should be confirmed by the further recommended investigation.

7 SOURCES OF INFORMATION AND REFERENCES

7.1 Site Reconnaissance Visit

A reconnaissance visit was made to the site on 31st July 2007, during fine weather. The current site owner was present during the site visit.

7.2 Phase One Desk Study Data

An Envirocheck report has been obtained from the Landmark Information Group, which collates a wide range of information from a variety of sources including the British Geological Survey (BGS), the Environment Agency (EA), and the Countryside Council for Wales (CCW). It comprises the following elements:

- two site centred site sensitivity maps at 1:10,000 and 1:2,500 scale with buffers ranging out to a distance of 1km radius from the site boundary. The maps show reference points (Map IDs) which define the locations of the various items of information identified in the report data sheets (e.g. licensed landfill sites, pollution incidents to controlled waters, discharge consents, abstraction licences, trade effluent consents, etc.);
- the data sheets provide information relating to each reference point and include the National Grid Reference of the reference points together with their distance from the site;
- a 1:10,000 scale map showing flooding information obtained from the Environment Agency;
- a 1:10,000 scale map showing available BGS boreholes; and
- three other maps are provided to show: (i) an extract from the Environment Agency's groundwater vulnerability map; (ii) Environment Agency defined Source Protection Zones around groundwater abstractions, and (iii) sensitive land uses.

A complete copy of the Envirocheck Report is presented in Appendix B.

Historical maps have been obtained from the Landmark Information Group and are presented in Appendix C.

A mining report has been obtained from the Coal Authority and is presented in Appendix D.

7.3 Previous Investigations

We are not aware of any previous geotechnical or geo-environmental investigations or assessments at the site.

7.4 Consultations

The following have been consulted as part of this assessment:

Organisation	Consultee	Date
Neath Port Talbot (NPT) County Borough Council Petroleum Officer/Environment Dept.	Mr Luke Williams	August 2007
Environment Agency	website	August 2007
British Geological Survey	website	August 2007

Details of the responses from the above consultees are presented within the relevant sections of the report.

7.5 Map Data

The following maps have been reviewed as part of this assessment:

- Geological Survey of Great Britain. 1:10,560 scale geological sheet SS79NW, dated 1970; and
- Ordnance Survey Explorer 1:25,000 scale, Sheet 165, dated 1998.

7.6 Other References

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**PROPOSED RETAIL STORE AND RESIDENTIAL DEVELOPMENT,
NEATH ABBEY ROAD, NEATH ABBEY**

TABLE 1 – Schedule of Geo-environmental Laboratory Testing

Determinand	Soil
Heavy metals	
Arsenic	√
Boron	√
Cadmium	√
Chromium (total)	√
Copper	√
Lead	√
Mercury	√
Nickel	√
Selenium	√
Zinc	√
Inorganic determinands	
pH value	√
Asbestos screen	√
Cyanide (total)	√
Water soluble sulphate	√
Acid soluble sulphate	√
Sulphur	√
Sulphide	√
Polyaromatic Hydrocarbons	
US EPA 16 PAHs	√
Petroleum Hydrocarbons	
aliphatic and aromatic C ₈ and C ₃₅ (TPH CWG)	√
Other Organic Compounds	
Total phenols	√
Total organic carbon	√

PROPOSED RETAIL STORE AND RESIDENTIAL PROPERTIES, NEATH ABBEY ROAD, NEATH ABBEY

TABLE 2 – Phase Two Conceptual Site Model

Geo-environmental Hazards/Sources of Contamination		Vulnerable Receptors	Possible Exposure Pathways	Likelihood of Unacceptable Pollution Linkage
Description	Appraisal			
Contaminated Soil and Groundwater	- The site is presently occupied by an engineering works. A TA depot and a maintenance depot previously occupied the site. - Made Ground up to 2m in depth has been identified at the site. - The gravel surface to the east of the existing building contains rare gravel-sized fragments of suspected asbestos cement sheet. - Three underground fuel/oil storage tanks are present at the site. - No visual or olfactory evidence of contamination has been identified at the site. - Laboratory testing of soil samples has indicated elevated levels of the following contaminants above their respective GAC: - Arsenic	End users	• ingestion of soil • ingestion of contaminated vegetables • ingestion of soil attached to vegetables • dermal contact with soil • dermal contact with indoor dust • inhalation of fugitive outdoor soil dust • inhalation of fugitive indoor dust • inhalation of vapours outdoors • inhalation of vapours indoors	- P⁺ - P⁺ - P⁺ - P⁺ - P⁺ - P⁺ - P⁺ - VU⁺ - VU⁺
		Construction and maintenance workers	• ingestion of soil • dermal contact with soil • inhalation of fugitive outdoor soil dust • inhalation of vapours outdoors • inhalation of vapours in confined spaces	- P⁺ - P⁺ - P⁺ - VU⁺ - VU⁺
		Groundwater aquifer	• direct contamination of aquifer by past site use • leaching of soluble contaminants from Made Ground and infiltration	- P⁺ - P⁺
		Groundwater abstraction	• contaminated groundwater flowing to abstraction	VU ⁺
		Surface water course	• migration of contaminated groundwater to surface water course	P ⁺
		Surface water abstraction	• migration of contaminated groundwater to surface water abstraction	VU ⁺
		Building materials and services	• contact with contaminated soil or groundwater	P
		Adjacent sites and site users	• migration of contaminated groundwater or vapours beneath adjacent sites	P ⁺
		End users	• inhalation of indoor air	VU
		End users	• inhalation of indoor air • inhalation of outdoor air	P
		Construction workers	• inhalation of indoor air • inhalation of outdoor air • accumulation of noxious/combustible gas in confined spaces	P ⁺
		Buried concrete	• contact with soil or groundwater	VU

Notes:

- This Conceptual Site Model (CSM) has been developed following an intrusive investigation at the site, in order to identify the most sensitive pollutant linkages anticipated.
- The CSM is based on a proposed residential development, with edible plant uptake. Where hard cover exists (e.g. beneath buildings, concrete and tarmacadam hardstandings, etc.) and where the retail development is present, some pathways may not be applicable, and the remaining pollutant linkages may be of low sensitivity.
- Risks posed to construction and maintenance workers will depend on their construction/maintenance methods, which are unknown at present. Therefore, the above should be re-assessed once these are known.
- The Coal Measures bedrock beneath the site is classed as a minor aquifer. Assumes groundwater flow to the south/south-east (towards the River Neath).
- No groundwater or surface water abstractions have been identified in the vicinity of the site.

Key:

H = high likelihood
P = possible
U = unlikely
VU = very unlikely
Nil = pathway not present
? = likelihood uncertain

**PROPOSED ALDI STORE AND RESIDENTIAL DEVELOPMENT,
NEATH ABBEY ROAD, NEATH ABBEY**

TABLE 3a: Estimation of Chronic Human Health risks

RESIDENTIAL USE (South of the Site)	Sample Location	Depth (m)	pH value	Soil Organic Matter (%)	Arsenic	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Benzo (a) -pyrene	Benzo (a) anthracene	Dibenzo (ah) anthracene	Naphthalene	Total Cyanide	Total Phenol
GAC²					20	2	130	450	8	50	35	1.2	19	0.7	7.1	53	78
Source of GAC					SGV	SGV ⁶	SGV	SGV	SGV	SGV	SGV	SNIFFER ^{4,7}	SNIFFER ^{4,7}	SNIFFER ^{4,7}	BP RISC ^{4,7}	Acute ⁸	SGV ^{4,7}
MADE GROUND	WS2	0.4-1.0	12.0	0.95	10.0	0.11	13.5	14.6	<0.1	21.5	<0.5	<0.08	<0.08	<0.08	<0.08	<0.5	0.9
	TP3	0.3	8.8	1.84	6.3	0.42	6.9	15.8	<0.1	5.4	<0.5	<0.08	<0.08	<0.08	<0.08	<0.5	0.5
	TP3	0.8	8.0	1.98	10.0	0.17	18.1	25.5	<0.1	19.4	0.7	<0.08	<0.08	<0.08	<0.08	<0.5	0.5
	TP5	0.2	8.3	10.7	43.0	0.95	12.8	174.4	<0.1	18.9	<0.5	0.70	0.79	0.13	0.20	<0.5	0.6
	TP6	0.2	10.7	13.59	54.7	1.05	25.5	154.1	0.14*	39.3	0.6	0.44	0.42	0.13	<0.08	<0.5	0.7
Mean (upper 95th%iles)					46.15	0.96	21.96	140.67	0.1	32.43	0.65	0.55	0.59	0.13	0.08	0.5	0.8
Mean Value Test					x	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Maximum Value Test					✓	✓	✓	✓	-	✓	✓	✓	✓	✓	-	-	✓
HEAD DEPOSITS	WS1	0.5-1.0	7.4	6.24	54.9	0.71	15.3	70.2	<0.1	18.3	<0.5	<0.08	<0.08	<0.08	<0.08	<0.5	3.4
Below GAC?					x	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

RETAIL STORE (Majority of the Site)	Sample Location	Depth (m)	pH value	Soil Organic Matter (%)	Arsenic	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Benzo (a) -pyrene	Benzo (a) anthracene	Dibenzo (ah) anthracene	Naphthalene	Total Cyanide	Total Phenol
GAC³					500	1,400	5,000	750	480	5,000	8,000	37	626	44	109	53	21,900
Source of GAC					SGV	SGV	SGV	SGV	SGV	SGV	SGV	SNIFFER ^{5,7}	SNIFFER ^{5,7}	SNIFFER ^{5,7}	BP RISC ^{5,7}	Acute ⁸	SGV ⁷
MADE GROUND	WS2	0.4-1.0	12.0	0.95	10.0	0.11	13.5	14.6	<0.1	21.5	<0.5	<0.08	<0.08	<0.08	<0.08	<0.5	0.9
	TP1	0.15	7.9	1.91	10.2	0.11	18	25.6	<0.1	14.9	<0.5	<0.08	<0.08	<0.08	<0.08	<0.5	0.5
	TP3	0.3	8.8	1.84	6.3	0.42	6.9	15.8	<0.1	5.4	<0.5	<0.08	<0.08	<0.08	<0.08	<0.5	0.5
	TP3	0.8	8.0	1.98	10.0	0.17	18.1	25.5	<0.1	19.4	0.7	<0.08	<0.08	<0.08	<0.08	<0.5	0.5
Below GAC?					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
HEAD DEPOSITS	WS5	0.2-0.7	8.0	30.69	118.2	2.26	19.6	428.5	0.21	27.4	0.8	0.14	0.16	<0.08	<0.08	<0.5	0.6
	WS6	0.2-0.5	7.9	6.64	16.5	0.29	16.4	46.9	<0.1	16.5	<0.5	<0.08	0.09	<0.08	<0.08	<0.5	<0.5
FLUVIO-GLACIAL GRAVEL	WS4	0.4-1.0	8.4	0.83	6.7	<0.1	11.2	13.2	<0.1	19.1	<0.5	<0.08	<0.08	<0.08	<0.08	<0.5	0.7
Below GAC?					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes:

- Assessment undertaken in accordance with CLEA CLR7.
- GAC quoted are for 'standard' residential land use (with edible plant uptake).
- GAC quoted are for commercial/industrial end use.
- Soil assessment criteria derived using the SNIFFER and BP RISC methodologies by Ground Investigation Limited for 'standard' residential land use (with edible plant uptake).
- Soil assessment criteria derived using the SNIFFER and BP RISC methodologies by Ground Investigation Limited for commercial/industrial land use.
- SGV for cadmium is pH dependent. SGV adopted is for pH of 7 (conservative approach).
- GAC for phenol and PAHs assumes 1% soil organic matter.
- GAC for cyanide is for acute exposure.
- Unless stated, all concentration values are given in units of mg of contaminant per kg of air dried soil.
- Yellow shading indicates failure of test or exceedance of criteria.
- nd – concentrations below detection limits of laboratory instruments.
- Full test results presented in Appendix H.

Key:

- GAC = Generic Assessment Criteria.
- SGV = Soil Guideline Value.
- nbfo = no bulk asbestos fibres observed.
- ✓ = test criteria satisfied.
- x = test criteria not satisfied.
- = no data/test criteria not appropriate.
- * = indicates possible outlier.

PROPOSED ALDI STORE AND RESIDENTIAL DEVELOPMENT,
NEATH ABBEY ROAD, NEATH ABBEY

TABLE 3b: Estimation of Chronic Human Health risks
(petroleum hydrocarbons)

				BTEX compounds				Petroleum Hydrocarbons											
	Sample Identity	Depth (m)	Soil Organic Matter (%)	Benzene	Toluene	Ethyl benzene	Xylene	ALIPHATIC FRACTIONS							AROMATIC FRACTIONS				
								C5 – C6	C6 – C8	C8 – C10	C10- C12	C12 – C16	C16 - 21	C21 – C35	C8 – C10	C10 – C12	C12 – C16	C16 – C21	C21 – C35
GAC ²				0.037	3	9	8.2	1.8	3.6	0.74	3.7	17	27,000	27,000	1.2	5.8	24	70	64
Source of GAC				BP RISC ³	SGV	SGV	BP RISC ³	BP RISC ³	BP RISC ³	BP RISC ³	BP RISC ³	BP RISC ³	BP RISC ³	BP RISC ³	BP RISC ³	BP RISC ³	BP RISC ³	BP RISC ³	BP RISC ³
MADE GROUND	TP5	0.2	10.7	<0.01	<0.01	<0.01	<0.02	<0.2	<0.4	<0.2	<4	<4	<4	<8.76	<4	<4	<4	5.42	38.8
HEAD DEPOSITS	WS1	0.5-1.0	6.24	<0.025	<0.025	<0.025	<0.05	<0.5	<1.0	<0.5	<4	<4	<4	<8.76	<4	<4	<4	<4	<8.76
FLUVIO-GLACIAL GRAVELS	WS4	0.4-1.0	0.83	<0.01	<0.01	<0.01	<0.02	<0.2	<0.4	<0.2	<4	<4	<4	23.2	<4	<4	<4	<4	<8.76
Below GAC?				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes:

1. Assessment undertaken in accordance with CLEA CLR7.
2. GAC quoted are for 'standard' residential land use (with edible plant uptake).
3. Soil assessment criteria derived using the SNIFFER and BP RISC methodologies by Ground Investigation Limited for 'standard' residential land use (with edible plant uptake).
4. GAC assume 1% soil organic matter.
5. Unless stated, all concentration values are given in units of mg of contaminant per kg of air dried soil.
6. Yellow shading indicates failure of test or exceedance of criteria.
7. nd – concentrations below detection limits of laboratory instruments.
8. Full test results presented in Appendix H.

Key:

- (a) GAC = Generic Assessment Criteria.
- (b) SGV = Soil Guideline Value.
- (c) nbfo = no bulk asbestos fibres observed.
- (d) ✓ = test criteria satisfied.
- (e) x = test criteria not satisfied.
- (f) - = no data/test criteria not appropriate.
- (g) * = indicates possible outlier.

FIGURES



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GROUND INVESTIGATION

geotechnical & geo-environmental consultants



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Swansea. SA7 9FG.

Tel: 01792 411013 Fax: 01792 411014
Email: mail@ground-investigation.com

SITE: Proposed Aldi Store, Neath Abbey

CLIENT: Aldi Stores Limited

PROJECT ID: 641

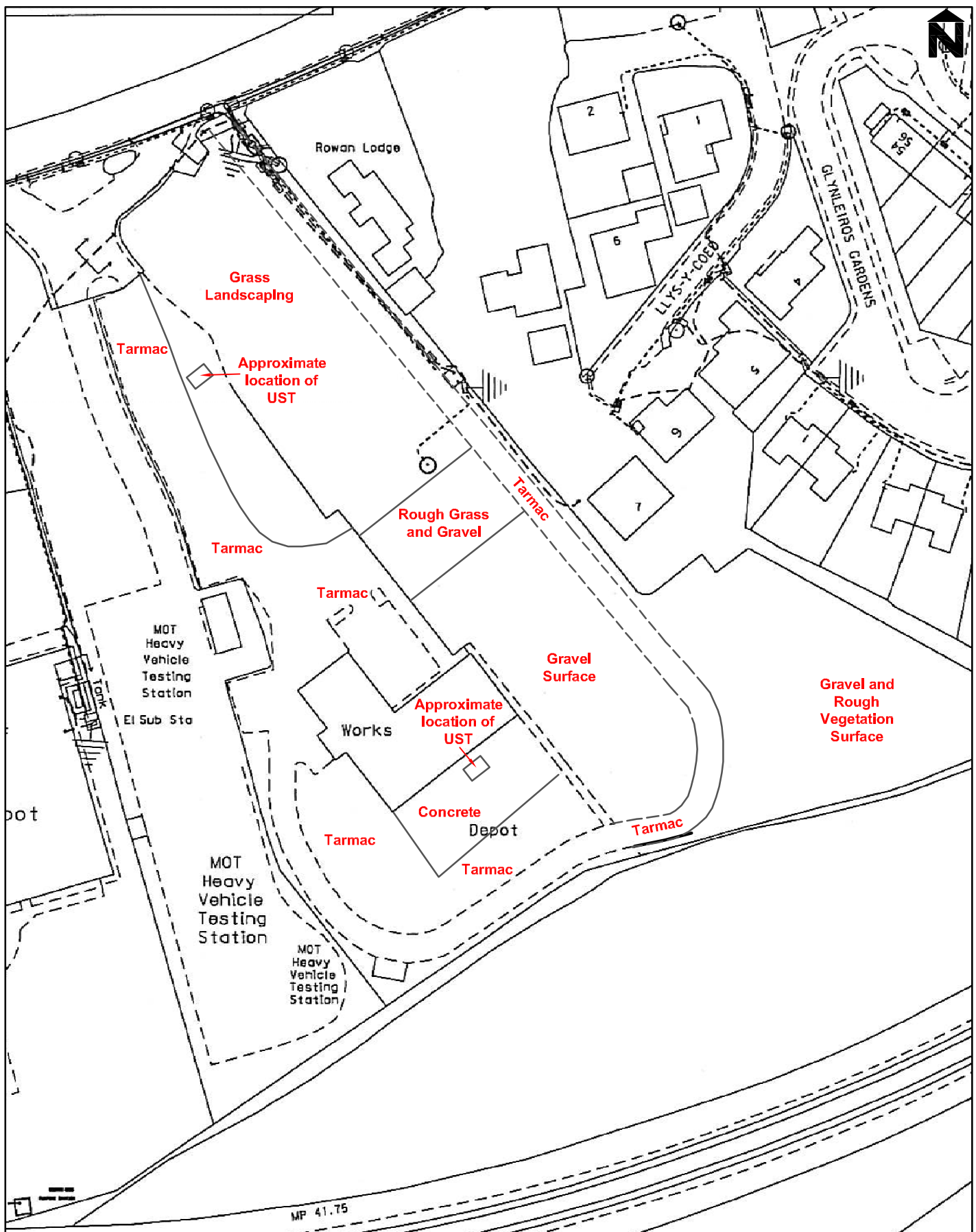
SCALE: 1:50,000

NATIONAL GRID REF: 274540 197540

FILENAME: p641.fig1.dwg

FIGURE 1

SITE LOCATION



GROUND INVESTIGATION

geotechnical & geo-environmental consultants



6 New Mill Court, Enterprise Park,
Swansea. SA7 9FG.

Tel: 01792 411013 Fax: 01792 411014
Email: mail@ground-investigation.com

SITE: Proposed Aldi Store, Neath Abbey

CLIENT: Aldi Stores Limited

PROJECT ID: 624-1

SCALE: 1:1000

FILENAME: 624-1.1.0.Figure 2.dwg

FIGURE 2

Site Topography