

ABATECH INTERNATIONAL

**LAND OFF
HOYLE MILL ROAD, BARNSELEY**

**PHASE I/II GEO-ENVIRONMENTAL
INVESTIGATION
FOR
BARRATT SHEFFIELD**

S5/028a
September 2005

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LAND OFF HOYLE MILL ROAD, BARNSELEY

PHASE I /II GEO-ENVIRONMENTAL INVESTIGATION

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EXECUTIVE SUMMARY

This summary presents the salient points of the report, and should not be referred to in isolation.

Site Location, Description and History	Location: The site is located to the east of Hoyle Mill Road, approximately 1.5 miles east of Barnsley town centre, at NGR 436860mE, 405830mN (approximate site centre). Description: The site comprises three distinct parcels, which all lie below the level of surrounding land. These are: the main J.C. Snell workshop and car parking in the west and centre of the site and two parcels of unsurfaced ground to the north and east. The combined overall area is approximately 1.32ha (approximately 3.3 Acres). An extensive area covered with Japanese Knotweed is present in the north and north-east of the site. <u>Western and Central Area</u> The western part of the site primarily comprises tarmac car parking and vehicular access to the car and heavy goods vehicle servicing bays, which lie within the garage/workshop areas of the buildings and occupy the central part of the site. These buildings are a combination of brick and portal frame construction. The buildings, which are interconnected, comprise vehicle workshops, stores and parts departments, offices and a spray-booth, accessed by various roller shutter doors. <u>Northern and Eastern Areas</u> The northern part of the site comprises rough unsurfaced ground, used for parking vehicles on and a heavily overgrown and wooded section to the far north-west. Typically, the ground slopes gently down towards the east. A now disused sales unit, formerly used by J.C. Snell 'Vans', occupies land adjacent to the northern-most site entrance. Land immediately adjacent to this unit is heavily vegetated. The eastern section of the site also comprises rough flat unsurfaced ground, being used for the storage of scrap car parts and other waste and the burning of scrap materials. Adjacent to the far eastern boundary articulated trailer units are parked-up and it is understood that Barnsley Community Transport use the site to park vehicles overnight. The boundaries to the site comprise a mixture of poorly maintained iron railings along Hoyle Mill Road, brick walling and palisade fencing. Around the eastern part of the site wooden panel fencing is present, which has mesh reinforcement attached to it. History: The historical Ordnance Survey plans dating back to 1892 indicate that the first development at the site was a brick works. By 1906 these works appear to have been demolished, with only one building remaining adjacent to the railway in the north of the site. The 1931 OS map shows a small building in the east of the site, later identified as 'Rose Dene'. A number of small buildings to the north of 'Rose Dene' also appear to have been present. A 'large' building is shown on the 1961 OS map, shown to be extended by 1974 and is identified as a 'garage'. To the north and east of the garage is a strip of land is shown to be a refuse tip. The 1987 OS map identifies three buildings on the site. These comprise the garage, a building (garage showroom) on the western boundary and a small building in the woods to the north.
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Geology & Mining, Hydrogeology and Hydrology	Geology & Mining: The site is shown on BGS Sheet 87, Barnsley, Solid and Drift Edition (1:50,000 scale series) to be underlain by the Oaks Rock (Sandstone) of the Middle Coal Measures. These strata typically weather to a stiff sandy clay near the surface. There are no drift deposits identified to be present on the site. There are no faults or lines of weakness shown to be on, or within 250m of the vicinity of the site. Information presented on the geological map sheet indicates that there is no anticipated risk associated with shallow coal mine-workings beneath the site. A Coal Authority mining report has been obtained, which confirms this. Hydrogeology: The site is shown on the groundwater vulnerability map for the area (Sheet 11, South Pennines, Scale 1:100,000) to be situated on a minor-aquifer with overlying soils of high leaching potential. Hydrology: The nearest watercourse is the River Dearne, which lies approximately 480m to the north-east of the site. Information presented in the Envirocheck Report indicates that the watercourse has been given a General Quality Assessment (GQA) river water grade of C (Fairly Good). Floodplains: The site is not shown to lie adjacent to an Environment Agency indicative fluvial floodplain.
Environmental Data Summary	Waste Management: The following licensed/registered waste management facilities are located within 500m of the site: • One BGS recorded landfill approximately 380m south-east of the site. No further information has been made available; • One licensed waste management facility located approximately 400m north-east of the site for metal recycling. This site is operated by C Soar & Sons; • Five local authority recorded landfill sites located between 3m and approximately 450m of the site. Information regarding acceptable wastes has not been provided; • Five registered landfill sites, located between 0m and 366m of the site, for the disposal of demolition rubble and naturally excavated materials. The licenses for these landfills appear to have lapsed. Two of these sites are reported to have been present on the site. Authorised wastes are indicated to have included construction and demolition wastes, slag and boiler cleanings, sand, bricks and linings, sodium carbonate and nepheline syenite (an industrial mineral used as soda ash in glass making); • Three registered waste transfer/treatment/disposal sites between approximately 260m and 450m from the site. Two of these sites are reported to be active, and licensed to handle a variety of wastes. With the exception of the two former on-site landfill sites, those identified to lie within 500m of the site are unlikely to have affected the site, or present a risk to future development. The only indication of historic landfill activity at the site is shown on the 1974 OS map (1:1,250), which identifies a long thin section to the north and west of the garage, being marked as a refuse tip. The true extent of the tip cannot be seen from the OS plans, although ground investigation works have since identified significant amounts of demolition wastes across the northern and eastern areas, consistent with the information presented in the Envirocheck report, for the two sites mentioned above.

	Pollution Incidents: There have been 3 pollution incidents within 500m of the site and 25 between 500m and 1km of the site. The majority of the incidents are reported to be Category 3, minor incidents, involving the release of oils/diesel to the River Dearne. Discharge Consents: Five discharge consents are recorded within 250m of the site, which now appear to have been revoked. These were all owned by Beatson Clark Plc and the discharges were of trade effluents (cooling waters). There have been fourteen consents between 251m and 500m of the site. Ten of these are owned by Yorkshire Water Services Ltd for the discharge of sewage. The remaining discharge consents were operated by British Coal Corporation (3) and C.G. Carlisle & Co Ltd (1) for trade effluent. All the recorded discharges are unlikely to, or have, affected the site. Radon: The BR211 (1999) Stage 2 Geological Assessment report and the Envirocheck report indicates that the site lies in an area where <u>basic</u> radon precautions are required in the construction of residential properties.
Geotechnical Assessment	Made ground was encountered in all of the exploratory trial pits and window sample holes and appears to be present across the whole of the site, having been used to raise levels. Made ground typically comprises a dark brown slightly clayey gravelly soil matrix with many bricks, much stone and concrete, some glass, ceramic, plastic and other inert debris. Some burnt shale was proven in trial pit TP5 throughout the vertical profile of the pit. Made ground in all of the trial pit excavations, and some of the window sample holes, was observed to be very unstable. Based on the findings of the ground investigation, the made ground was approximately 1.5m to 2.0m deep across the western section of the site (beneath the hard-paved car park), becoming deeper towards the northern boundary, beneath the workshops/offices and the eastern boundary, where made ground materials were proven to be on average about 3.0m to 4.0m deep. Slightly deeper areas of made ground were encountered beneath the footprint of the existing buildings (to about 4.5m bgl), whilst slightly shallower depths around the eastern perimeter (to between about 2.0m and 3.0m deep). However, in some of the holes, the vertical extent of the made ground materials was not proven, extending to depths greater than the reach of the excavator (about 4.5m). The underlying natural strata were found to comprise cohesive materials associated with the near surface weathering of the Middle Coal Measures sandstone. The Coal Measures strata, which comprised clay containing angular fragments of sandstone, were typically proven to be about 2.0m thick before less weathered sandstone was encountered. On the basis of the standard penetration tests carried out in the window sampler holes, the clays may be described as firm to stiff, becoming increasingly stiff with depth. The underlying natural clayey soils are generally considered to have a safe bearing capacity of at least 125kN/m², although some softer pockets of clay and sand have been proven in some of the investigation locations at a depth of about 4.0m to 5.0m bgl.

Environmental Assessment	On the basis of the intrusive ground investigation and subsequent laboratory testing, the principal contaminants of concern which present the greatest risk to human health are arsenic and PAH. The contamination appears to be associated with the made ground materials, which comprise a mixture of demolition rubble within a dark brown slightly clayey gravelly soil matrix and underlie most of the site. Chemical test results have been compared against the relevant guidance values including CLEA (for soil guideline values) and the Dutch Intervention Values (where no UK guideline values are available).
Recommendations	Enabling Works: Existing buildings cover a large proportion of the central part of the site, and it is anticipated that a significant quantity of rubble will arise from their demolition. It may be possible to crush and re-use some of this material below roads and areas of hardstanding, but it may be that much of the demolition material will require removal from site subject to proposed ground levels. Some of the buildings have been identified to have basements or pits (e.g. for the storage of waste oil) and deep foundation obstructions could also be present. The removal of all floor slabs, old foundations/substructures and any historic underground obstructions should be carried out as part of the demolition works. Further localised excavations may be required during demolition to check for buried obstructions. The demolition/enabling works will need to be integrated with remedial works, i.e. those required to remove waste oil tanks and any associated soil contamination, where encountered, and also to treat Japanese Knotweed. An asbestos survey of the existing buildings should be carried out prior to demolition works being undertaken, since the presence of asbestos may significantly influence the suitability of material for retention/cost of removal from site. An exemption for landfill tax would have to be submitted for soils excavated to facilitate construction works, if they pose an unacceptable risk to human health or to the environment. Foundations: On the basis of the ground investigation, made ground materials at the site are considered to be an unsuitable formation to found in. Where deep made ground is encountered, particularly to the north and east, piled foundations are likely to be the most appropriate foundation solution. Piles should be taken down through made ground into the underlying Coal Measures strata (weathered sandstone), although difficulties may be encountered where large concrete, or sandstone ‘boulder’ obstructions are present in the made ground. It may be possible to use vibro-techniques to improve the made ground, although further investigation by a vibro-contractor may be required to assess ground conditions further. The type and suitability would be dependent upon the type of housing proposed (i.e. partial depth/raft or full depth-reinforced strip/ground beam). Where shallow made ground has been proven (across the western car park area), the underlying stiff clays/sandy soils should be suitable bearing strata for traditional footings. These are likely to require widening/thickening and strengthening, dependent upon ground variability (sand/clay) and the type of housing units proposed. It may be more economic to adopt a piled or vibro solution for the whole development. Building near Trees: Precautions should be taken when building near trees/hedges, with foundations being constructed in accordance with the recommendations prescribed in NHBC Standards Chapters 4.2 and 4.5. Geotechnical testing indicates that the underlying natural clays have a low to medium volume change potential. However, given the depth of the made

	ground, trees are unlikely to influence foundation depth. Founding depths and any requirement for heave precautions would be confirmed following completion of a plot specific foundation schedule. Floor Slabs: Given that there is more than 600mm of made ground across the site, suspended floor slabs would be required. Excavations: Excavation for sewers and other deep excavations may be expected to be unstable in the made ground, particularly during prolonged periods of wet weather. All excavations in which man entry is required must be assessed and suitably supported to ensure safe working conditions. Difficulties may be encountered where bedrock is encountered at relatively shallow depth. Sulphate Precautions: In accordance with BRE Special Digest 1 it is considered that Class DS-2/ACEC-AC2 conditions should be assumed where concrete comes into contact with made ground materials. The designated mix should therefore be FND2. Road Construction: Road design will be constrained by the character of the made ground. At this stage a 600mm capping and geotextile should be assumed, with an increased construction thickness, appropriate for a 1% CBR. Road construction proposals must be approved by the Local Authority prior to finalising design. Groundwater: No groundwater or perched water was encountered during the ground investigation works. Groundwater problems are therefore not anticipated. The dewatering of excavations is unlikely to be required. Soakaways and Site Drainage: Given the extent of made ground and underlying clay materials soakaways are unlikely to be suitable for use at the site, although a network system, with engineered storage, may be feasible. If soakaways were proposed, permeability testing would have to be carried out at the appropriate depth. Radon: <u>Basic</u> radon precautions are required where residential development is proposed at the site. Precautions will comprise a polythene membrane beneath house footprints and the sealing of service entries (see ground gas - below). Ground gas: Deep made ground has been proven at the site. Given the nature of the underlying made ground it would therefore be prudent to install basic ground gas precautions in residential properties constructed at the site. This should comprise 1200 gauge membrane being taken across cavities, and taped and sealed at service entries (see 'Further Works' below). Remediation: Given the elevated concentrations of arsenic and PAH, a 600mm inert soil capping would be required as a minimum on gardens and areas of soft landscaping. The upper 200mm of this capping should comprise inert topsoil. Capping thicknesses stated are however subject to the approval of the Environmental Health Officer. A reduced capping may be able to be used in areas of soft landscaping, subject to approval. Given that there is no source of topsoil at the site, importation will be required. This topsoil should be tested at source and confirmed as suitable in agreement with the NHBC/EHO. Japanese Knotweed will need to be treated/removed during enabling/demolition works. <i>In situ</i> chemical treatment should be suitable, subject to EA approval.
Limitations on the Phase II Ground Investigation	Limitations were placed on the ground investigation by the active nature of the site, in that drilling and excavation works could not be undertaken safely where J.C. Snell employees were working.

	Site investigation works necessary to complete a full assessment of the ground conditions would have required certain areas of the workshops to close for a period of time, which was impractical. It should be noted therefore that ground conditions between investigation locations, particularly beneath the footprint of the building, may vary from those reported herein.
Further Work	Based on the outcome of the site works and the nature of the ground encountered, the following supplementary ground investigation works are recommended to confirm the environmental and geotechnical properties of the made ground, prior to finalising construction design. 1. Shell and auger boring to assess the geotechnical character (through <i>in situ</i> testing) and the depth of made ground where the vertical extent was not proven. Installations to facilitate ground gas monitoring should also be installed at this time; 2. Ground gas monitoring to assess the potential for ground gas migration egress (basic radon protective measures are however required at the site, which should also mitigate any risk from landfill gas); 3. Remedial Works Method Statement to reflect the recommendations for capping in garden/landscaped areas.

1.0 INTRODUCTION

1.1 Preamble

Abatech International Ltd (Abatech) was appointed by Barratt Sheffield to carry out a Phase I/II ground investigation at the J.C. Snell site on Hoyle Mill Road, Barnsley.

1.2 Report Status

This report provides factual and interpretive geotechnical and environmental information, together with provisional construction proposals and recommendations, in relation to the proposed redevelopment of the site. The report has been prepared for the sole use and reliance of Barratt Sheffield.

1.3 Sources and Conditions

The findings and recommendations made in this report are based on published information, site investigation data and a site walkover. Abatech International Ltd accepts no responsibility for the reliability and authenticity of published information, or for reports prepared by third parties.

Whilst every effort has been made to carry out intrusive investigations that enable a realistic and reliable characterisation of the geotechnical and environmental parameters, the possibility of significant variation in ground conditions existing between sampling locations cannot be discounted. Groundwater conditions are based on observations made at the time of the investigation, but may be subject to variation because of seasonal or other effects.

2.0 SITE LOCATION AND DESCRIPTION

2.1 Location

The site is located on Hoyle Mill Road, Barnsley, at NGR 436860mE, 405830mN (approximate site centre) as shown on the appended site location plan (Figure S5/028/001, Appendix I).

2.2 Site Description

The site comprises three distinct parcels, which all lie below the level of surrounding land. These are: the main J.C. Snell workshop and car parking in the west and centre of the site and two parcels of unsurfaced ground to the north and east. The combined overall area is approximately 1.32ha (approximately 3.3 Acres). An extensive area covered with Japanese Knotweed is present in the north and north-east of the site.

Western and Central Area

The western part of the site primarily comprises tarmac car parking and vehicular access to the car and heavy goods vehicle servicing bays, which lie within the garage/workshop areas of the buildings and occupy the central part of the site. These buildings are a combination of brick and portal frame construction. The buildings, which are interconnected, comprise vehicle workshops, stores and parts departments, offices and a spray-booth, accessed by various roller shutter doors.

Northern and Eastern Areas

The northern part of the site comprises rough unsurfaced ground, used for parking vehicles on and a heavily overgrown and wooded section to the far north-west. Typically, the ground slopes gently down towards the east. A now disused sales unit, formerly used by J.C. Snell 'Vans', occupies land adjacent to the northern-most site entrance. Land immediately adjacent to this unit is heavily vegetated.

The eastern section of the site also comprises rough flat unsurfaced ground, being used for the storage of scrap car parts and other waste and the burning of scrap materials. Adjacent to the far eastern boundary articulated trailer units are parked-up and it is understood that Barnsley Community Transport use the site to park vehicles overnight.

The boundaries to the site comprise a mixture of poorly maintained iron railings along Hoyle Mill Road, brick walling and palisade fencing. Around the eastern part of the site wooden panel fencing is present, which has mesh reinforcement attached to it.

3.0 GEOENVIRONMENTAL SETTING

3.1 Geology, Hydrogeology and Mining

Drift (superficial deposits)	There are no drift deposits identified to be present on the site.
Solid Geology	The solid strata comprises that Oaks Rock (Sandstone) of the Middle Coal Measures. These strata typically weather to a stiff sandy clay near the surface.
Discontinuities	There are no faults or lines of weakness shown to be on, or within 250m of the vicinity of the site.
Hydrogeology	The site is shown on the groundwater vulnerability map for the area (Sheet 11, South Pennines, Scale 1:100,000) to be situated on a minor-aquifer with overlying soils of high leaching potential.
Mining	Information presented on the geological map sheet indicates that there is no anticipated risk associated with shallow coal mine-workings beneath the site. A Coal Authority mining report has been obtained, which confirms this.

3.2 Environmental Data Search

The principal considerations of immediate relevance are given below. For a comprehensive list of environmental data, refer to the appended Envirocheck Report (Appendix II).

Landfill Sites	The following licensed/registered waste management facilities are located within 500m of the site: • One BGS recorded landfill approximately 380m south-east of the site. No further information has been made available; • One licensed waste management facility located approximately 400m north-east of the site for metal recycling. This site is operated by C Soar & Sons; • Five local authority recorded landfill sites located between 3m and approximately 450m of the site. Information regarding acceptable wastes has not been provided; • Five registered landfill sites, located between 0m and 366m of the site, for the disposal of demolition rubble and naturally excavated materials. The licenses for these landfills appear to have lapsed. Two of these sites are reported to have been present on the site. Authorised wastes are indicated to have included construction and demolition wastes, slag and boiler cleanings, sand, bricks and linings, sodium carbonate and nepheline syenite (an industrial mineral used as soda ash in glass making); • Three registered waste transfer/treatment/disposal sites between approximately 260m and 450m from the site. Two of these sites are reported to be active, and licensed to handle a variety of wastes. With the exception of the two former on-site landfill sites, those identified to lie within 500m of the site are unlikely to have affected the site, or present a risk to future development.
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	The only indication of historic landfill activity at the site is shown on the 1974 OS map (1:1,250), which identifies a long thin section to the north and west of the garage, being marked as a refuse tip. The true extent of the tip cannot be seen from the OS plans, although ground investigation works have since identified significant amounts of demolition wastes across the northern and eastern areas, consistent with the information presented in the Envirocheck report, for the two sites mentioned above.
Hydrology	The nearest watercourse is the River Dearne, which lies approximately 480m to the north-east of the site. Information presented in the Envirocheck Report indicates that the watercourse has been given a General Quality Assessment (GQA) river water grade of C (Fairly Good).
Pollution Incidents	There have been 3 pollution incidents within 500m of the site and 25 between 500m and 1km of the site. The majority of the incidents are reported to be Category 3, minor incidents, involving the release of oils/diesel to the River Dearne.
Discharge Consents	Five discharge consents are recorded within 250m of the site, which now appear to have been revoked. These were all owned by Beatson Clark Plc and the discharges were of trade effluents (cooling waters). There have been fourteen consents between 251m and 500m of the site. Ten of these are owned by Yorkshire Water Services Ltd for the discharge of sewage. The remaining discharge consents were operated by British Coal Corporation (3) and C.G. Carlisle & Co Ltd (1) for trade effluent. All the recorded discharges are unlikely to, or have, affected the site.
Radon	The BR211 (1999) Stage 2 Geological Assessment report and the Envirocheck report indicates that the site lies in an area where <u>basic</u> radon precautions are required in the construction of residential properties. A copy of the report is presented in Appendix III.

4.0 HISTORY OF LAND USE

The history of the site has been documented by Ordnance Survey plans, these dating back to 1892. A copy of the maps is enclosed in Appendix II.

Historical Ordnance Survey plans indicate that the site was first occupied by a brick works, which are shown to have been largely demolished by 1906. Limited development at the site appears to have been carried out until the early 1930's, at which time only a few small buildings have been constructed.

A 'large' building is shown on the 1961 Ordnance Survey plan, which is shown to have been extended by 1974. This building is labelled as a 'garage'. To the north and east of the garage is a strip of land is labelled as a refuse tip.

From the 1987 Ordnance Survey plan, three buildings are identified to be present at the site. These comprise the garage, a building (garage showroom) on the western boundary and a small building in the woods to the north.

5.0 PHASE I GEOTECHNICAL ASSESSMENT

5.1 Ground Conditions

5.1.1 Soils

It is anticipated that the soil conditions at the site are likely to comprise made ground overlying Coal Measures strata. The Coal Measures strata, which are likely to comprise interbedded layers of sandstone and mudstone, are expected to have weathered to a firm to stiff clay where they are present near the surface.

5.1.2 Groundwater

No groundwater was encountered during the ground investigation. Problems associated with shallow groundwater, or the need for dewatering excavations is not anticipated.

5.1.3 Stability Issues

Problems associated with historic mining activity are not expected at the site, although instability of excavations within the made ground should be expected. A copy of the Coal Authority Mining Report is presented in Appendix IV.

6.0 PHASE I ENVIRONMENTAL ASSESSMENT

6.1 Phase I Conceptual Model

The following is based on the desk study information and information gathered during the recent site walkover.

6.1.1 Source Characterisation

A potential source is defined as, ‘a contaminant, which is in, or under the land and has the potential to cause harm or to cause pollution of controlled waters’.

Review of available desk study information has revealed the potential on- and off-site sources of contamination, listed in Tables 6.1 and 6.2 below. Where possible, associated potential contaminants have been identified with reference to the Environment Agency (EA) and the Department for Environment, Food and Rural Affairs (DEFRA) R&D Publication CLR8: Potential Contaminants for the Assessment of Land and the relevant Department of the Environment Industry Profiles.

Table 6.1 Potential On-site Pollutant Sources and Associated Contaminants

Potential Sources	Associated Potential Contaminants ⁺	
	<i>Metals and Inorganics (not limited to)</i>	<i>Organics (not limited to)</i>
<i>Onsite</i>		
Made ground materials of unknown origin used to raise site levels	Heavy metals and phytotoxic contaminants	Hydrocarbons, PAH and phenol
Historic and Current buildings (construction /demolition materials).	Cement bound asbestos (roof and panel sheeting)	Hydrocarbons, PAH, semi/volatile organics and phenol from the storage/leakage of oils.
Electricity Transformer	Heavy metals	PCBs
Historic landfill sites	-	Methane and CO ₂ (landfill gas)

+Tables 2.3 and 2.4 DEFRA and EA R & D Publication CLR 8: Potential Contaminants for the Assessment of Land

Table 6.2 Potential Off-site Pollutant Sources and Associated Contaminants

Potential Sources	Associated Potential Contaminants ⁺	
	<i>Metals and Inorganics</i>	<i>Organics</i>
<i>Offsite</i>		
Historic landfill sites	-	Methane and CO ₂ (landfill gas)
Historic railway land to the north	Heavy metals	Hydrocarbons, PAH and Aliphatics

+Tables 2.3 and 2.4 DEFRA and EA R & D Publication CLR 8: Potential Contaminants for the Assessment of Land

6.1.2 Potential Pathways

A potential pathway is defined as ‘one or more routes or means by, or through, which a receptor is being exposed to, or affected by a contaminant, or could be so exposed or affected’.

Examination of the desk study information and features noted during the site works has identified the following potential pathways:

- Direct ingestion of soils;
- Dermal contact with soils;
- Inhalation of airborne contaminants;
- Leaching/direct movement of solid and liquid contaminants.

6.1.3 Potential Receptors

A potential receptor is defined as ‘a living organism, a group of living organisms, an ecological system or property which is being, or could be harmed, by a contaminant or controlled waters which are being, or could be polluted by a contaminant’. The following potential receptors have been identified:

- The underlying natural ground;
- Ground workers employed in redevelopment of the site;
- Neighbouring land-users/owners;
- Future end users of the site and proposed planting at the development;
- Building materials (concrete and associated services construction materials).

6.1.4 Potential Significant Pollutant Linkages

A potential pollutant linkage is defined as ‘the relationship between a contaminant, a pathway and a receptor’ where the pollutant is the contaminant in the pollutant linkage. For land to be identified as contaminated under the current UK guidance, all three elements of the pollutant linkage must be proved. In many cases there may be more than one pollutant linkage proved on a site.

From a review of available desk study information, the initial testing of soils taken from the site, and features noted during the site walkover, the potential sources,

pathways and targets listed above has lead to the following potential significant pollutant linkages (SPL) being considered:

Table 6.3 Potential Significant Pollutant Linkages

Potential Source	Pathway	Receptors					SPL
		Controlled Waters	Ground workers	End-users	Flora	Building materials	
Metal/metalloids and inorganics in the soil (including asbestos)	Direct Ingestion		✓	✓			✓
	Dermal Contact		✓	✓			✓
	Inhalation		✓	✓			✓
	Leaching/direct movement	✓			✓	✓	✓
Organics in soil (hydrocarbons) including ground gases	Direct Ingestion		✓	✓			✓
	Dermal Contact		✓	✓			✓
	Inhalation		✓	✓			✓
	Leaching/direct movement	✓			✓	✓	✓
Metal/metalloids and inorganics in groundwater	Direct Ingestion	No groundwater encountered during site investigation works					
	Dermal Contact						
	Inhalation						
	Leaching/direct movement						
Organics in groundwater (hydrocarbons)	Direct Ingestion						
	Dermal Contact						
	Inhalation						
	Leaching/direct movement						

6.2 Model Status and Uncertainty

The potential significant linkages listed above are based on the available data listed in Sections 2.0 to 4.0 above and the features noted during the site works.

Therefore, the linkages identified are tentative in nature, and are subject to the following uncertainties:

- Actual distribution of contaminants in soils;
- Water levels below the site;
- Direction of groundwater flow.

7.0 RATIONALE FOR PHASE II INVESTIGATION

The desk study and Phase II ground investigation were carried out to identify environmental and geotechnical liabilities in relation to the proposed redevelopment of the site. The works were carried out to:

- facilitate the collection of soil samples from within the made ground and natural strata to assess the degree of chemical contamination;
- facilitate the collection of soil samples for geotechnical testing;
- assess the depth and nature of made ground materials across the site, including beneath existing buildings;
- assess the strength of made ground materials and the depth to competent strata by the means of *in situ* testing;
- collect groundwater samples to assess the impact of potential contaminants (where encountered).

8.0 SITE WORKS

Site works were carried out between 17th and 19th August 2005 and comprised the drilling of eight window sampler boreholes (WS-1 to WS-8) and the excavation of eleven trial pits (TP-1 to TP-11).

The positions of the investigation locations are shown on the appended Site Investigation Plan (S5/028/002). A copy of the investigation logs are presented in Appendices V and VI.

9.0 LABORATORY ANALYSES

9.1 Chemical Analyses

The environmental analyses were scheduled by Abatech and carried out by ALcontrol Geochem, Chester. Samples of made ground and underlying natural ground were collected and tested for metals, non-metal inorganics and organics in order to assess the degree and nature of contamination within the soil. A summary of the test results is given in the following tables, whilst a copy of the individual test results is presented in Appendix VII. Risk assessment data sheets are present in Appendix VIII.

Table 9.1 Summary Table of Chemical Test Results - Soils

Contaminant	Measured Concentration		'Threshold' criteria (mg/kg)	No. of results exceeding criteria
	Min	Max		
Arsenic	6	34	20*	4 (10)
Boron	<1	3	3	0 (10)
Cadmium	<1	-	1-8*(pH dependent)	0 (10)
Chromium (Total)	74	131	130*	1 (10)
Copper	<1	37	130	0 (10)
Lead	6	205	450*	0 (10)
Mercury	<1	2	8*	0 (10)
Nickel	8	41	50*	0 (10)
Zinc	11	465	300	2 (10)
Selenium	<3	-	35*	0 (10)
PAH (Total)	2.25	250.7	1.5#	10 (10)
PAH (TEF)**	0	438	1.5#	6 (10)
Benzo[a]Pyrene	0.05	20.2	1.5#	6 (10)
TPH	32.8	3712	500°	3 (6)
pH (pH Units)	4	8.9	<5	1 (10)
Phenol Index	<0.01	0.02	5	0 (10)
Sulphate (Total)	846	23,600	2000°	7 (10)
Sulphide	<50	242	250	0 (10)

* Threshold criteria determined as the Soil Guidance Values (SGV's) with reference to CLEA;

** PAH (TEF) based on USEPA Toxic Equivalency Factor assessment (refer to Appendix VII for further guidance);

Tentative non-validated SGV based on an assessment of TOX Report 2, Benzo[a]Pyrene;

° Non-validated TPH concentration (Professional judgement);

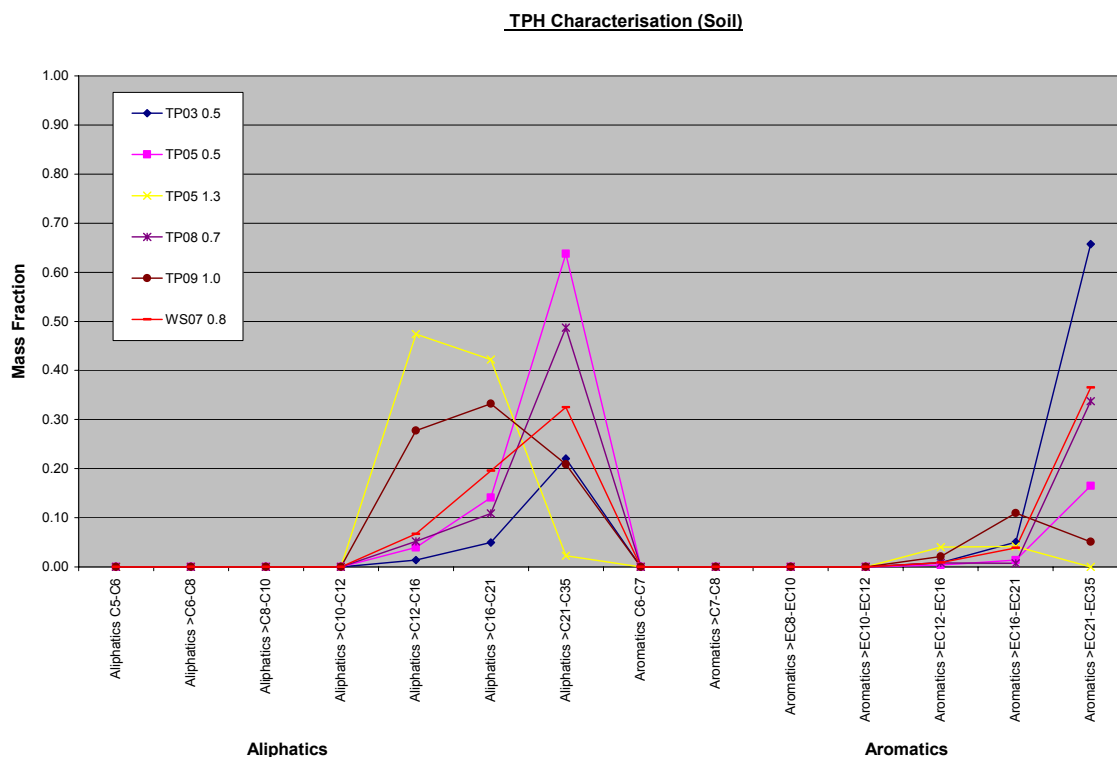
- Results reported in mg/kg unless otherwise stated;

- Number of samples tested given in brackets;

- Where < is given this indicates that the result is less than the laboratory detection limit.

The pH of the soil samples tested ranged from pH 4.0 (TP10, 0.5m) to 8.9 (WS04, 0.5m). Total and Free cyanide concentrations were not detected above the laboratory detection limit: all results were <1mg/kg.

Total Petroleum Hydrocarbon analysis, comprising the fractionation of hydrocarbons in accordance with the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG), was carried out on six of the soil samples (refer to Appendix V for individual test results). Elevated TPH concentrations were primarily identified within the made ground materials which underlie the northern and eastern car parking areas at shallow depth, at the investigation locations given on the chart below. Speciated TPH analysis indicates that the TPH comprises a mixture of both aliphatic and aromatic hydrocarbons. Contamination is anticipated to most probably be associated with the localised spillage/leakage of fuels (i.e. diesel) from heavy goods vehicles/buses that have been parked on the site over many years. The data indicates that the hydrocarbons are most probably weathered, with heavier molecular weight organics (between C12 and C35) remaining in the host soils. However, the carbon band C21-C35 is the dominant fraction for both aromatics and aliphatics. PAH identified in the soils is also most probably associated with fuel contamination.



TPH data is summarised in the following table, along with concentrations of other organic species detected in the made ground materials.

Table 9.2 Summary Table of TPH and other Organic Compounds – Soils

Trial Pit / Window Sampler Number	Concentration (mg/kg)	Details of organic compounds identified within the soil samples
TP03 (0.5m)	3712.05	TPH (C12-C35)
TP05 (0.5m)	1256.26	
TP05 (1.3m)	32.83	
TP08 (0.7m)	323.96	
TP09 (1.0m)	62.20	
WS07 (0.8m)	1020.31	
TP03 (0.5m)	0.310	4-Methylphenol ¹
TP03 (0.5m)	1.54	4-Nitrophenol ²
TP03 (0.5m)	1.73	Bis(2-ethylhexyl) phthalate ³
TP08 (0.7m)	0.60	
WS07 (1.6m)	0.94	
TP08 (0.7m)	0.17	Carbazole ⁴
TP03 (0.5m)	0.84	
WS07 (1.6m)	0.95	
TP08 (0.7m)	0.19	Dibenzofuran ⁵
TP03 (0.5m)	0.80	
TP05 (0.7m)	0.16	
WS07 (1.6m)	1.20	

Compounds commonly used in:

¹ The making of synthetic resins, in disinfectants and fumigants and as an industrial solvent (also referred to as p-Cresol);

² The treatment of leather, or in the production of acetaminophen (as used in hydrogen peroxide and photographic chemicals);

³ A plasticizer;

⁴ The manufacture of insecticides, lubricants and rubber antioxidants;

⁵ An intermediate carrier compound associated with dyes, printing and heat transfer oils.

10.0 PHASE II GEOTECHNICAL ASSESSMENT

10.1 Ground Conditions

10.1.1 Soils – Made Ground

The ground investigation encountered made ground across the whole of the site, which had been used to raise ground levels.

Made ground typically comprises a dark brown slightly clayey gravelly soil matrix with many bricks, much stone and concrete, some glass, ceramic, plastic and other inert debris. Some burnt shale was proven in trial pit TP5 throughout the vertical profile of the pit. Made ground in all of the trial pit excavations, and some of the window sample holes, was observed to be very unstable.

Although variations in thickness were observed, based on the findings of the ground investigation the made ground appears to be typically 1.5m to 2.0m deep across the western section of the site (beneath the hard-paved car park), but becoming deeper towards the northern boundary, beneath the workshops/offices and the eastern boundary, where they were proven to be on average about 3.0m to 4.0m deep. Slightly deeper areas of made ground were encountered beneath the footprint of the existing buildings (to about 4.5m bgl), whilst slightly shallower depths around the eastern perimeter (to between about 2.0m and 3.0m deep). In some of the holes, the vertical extent of the made ground materials was not proven, extending to depths greater than the reach of the excavator (about 4.5m).

No visual or olfactory evidence of contamination was observed within the made ground.

10.1.2 Soils – Natural Ground

The underlying natural strata were found to comprise cohesive materials associated with the near surface weathering of the Middle Coal Measures sandstone. The Coal Measures strata, which comprised clay containing angular fragments of sandstone, were typically proven to be about 2.0m thick before less weathered sandstone was encountered.

On the basis of the standard penetration tests carried out in the window sampler holes, the clays may be described as firm to stiff, becoming increasingly stiff with depth. The underlying natural clayey soils are generally considered to have a safe bearing capacity of at least 125kN/m², although some softer pockets of clay and sand have been proven in some of the investigation locations at a depth of about 4.0m to 5.0m bgl.

10.1.3 Mining

Based on a review of available information, risk associated with shallow mine workings is not expected at the site.

10.1.4 Groundwater

No groundwater was encountered during the ground investigation works.

10.2 Contamination and Performance of Building Materials

10.2.1 Sulphate

In accordance with BRE Special Digest 1 it is considered that Class DS2/ACEC-AC2 sulphate conditions should be assumed where concrete comes into contact with made ground. Concrete to FND-2 should therefore be used at the site.

10.2.2 Other Contaminants

Based on the results of laboratory testing, the present chemical status of the onsite soils does not include significant quantities of any other substances that are likely to be detrimental to the performance of building materials during their expected lifespan.

11.0 PHASE II ENVIRONMENTAL ASSESSMENT

11.1 Site Summary

The site has had limited development on it, with the only significant activities being the brick works and the land-raising.

Made ground materials which are present at the site have most probably, in part, come from the demolition of historic brick works buildings, which once occupied the site, as well as from other local sources (e.g. the former glass works buildings to the north) and the wider area. Materials may also be derived in part from the historic railway line which ran along the northern boundary. Residue from these types of industrial works often contain elevated concentrations of heavy metals, phytotoxic contaminants as well as some organic and hydrocarbon type contaminants.

11.2 Risk Assessment

Current UK legislation on contaminated land is principally contained in Sections 78(A) to (YC) in Part IIA of the Environmental Protection Act 1990, which was retrospectively inserted by Section 57 of the Environment Act 1995. This legislation came into effect in April 2000 and is enacted by the Contaminated Land (England) Regulations 2000.

The legislation adopts the principle of a 'suitable for use' approach for the assessment of contaminated land, the rationale reflected in the site-specific risk assessment and determination of remedial strategy. Action is only required if unacceptable risks are posed to human health or to the environment, taking into account the current land-use and geo-environmental setting.

The legislation places a responsibility on the Local Authority to determine whether the land under its jurisdiction is contaminated by consideration of whether:

- *Significant harm is being caused;*
- *There is a significant possibility of significant harm being caused;*
- *Significant pollution of controlled waters is being caused or is likely to be caused.*

The statutory guidance describes a risk assessment methodology in terms of 'significant pollutants' and 'pollutant linkages', using SOURCE-PATHWAY-RECEPTOR' scenarios for the site.

On the basis of the available data and associated guidance (CLEA, Dutch and USEPA), the site's geo-environmental setting and proposed end-use, qualitative and quantitative risk assessments have been carried out. A summary of the Source-Pathway-Receptor risk assessment table is presented below. CLEA, Dutch, and additional guidance information for the assessment of PAH, is given in Appendix IX.

Qualitative Risk Assessment Summary Table

SOURCE	PATHWAY	TARGET (RECEPTOR)	COMMENTS	RISK LEVEL	ACTION
Metals/ Metalloids In soils	Direct ingestion (active) Inhalation (passive)	Site users	End use is assumed to be residential with private gardens and landscaped areas	MEDIUM	Soil capping: (To be 600mm including 200mm inert topsoil: to be agreed with the EHO)
Metals/ Metalloids In soils	Topsoil in landscaped borders	Vegetation	As above	MEDIUM	Soil capping (as above)
Organic Compounds	As above (plus skin contact)	Site users	Mainly a short-term exposure risk to ground workers	LOW to MEDIUM	Soil capping (as above)
Leachate Burden (overall)	Sub-strata (beneath and adjacent site)	Groundwater/ Surface water	Potential for contaminants to migrate	NEGLIGIBLE	No groundwater encountered to facilitate downward/upward migration
Ground Gas (carbon dioxide and methane)	Subsurface soils/strata via services and buildings	Site users	Potential for ground gases to migrate into properties	LOW to MEDIUM	Installation of basic gas precautions
Radon	Subsurface soils/strata via services and buildings	Site users	---	LOW to MEDIUM	Basic radon precautions required
Asbestos	Inhalation	Ground/ construction workers	No evidence of asbestos found at the site	LOW	Carry out site survey with authorised disposal

Notes: LOW / MODERATE / HIGH - Risk level is assigned a low/moderate/high qualitative value, based on assessed requirement for action in context of Part II EPA 90.

Based on the findings of the laboratory testing and risk assessment, the principal contaminants of concern to human health are arsenic, PAH and Total Petroleum Hydrocarbons. Some phytotoxic contaminants (e.g. zinc) and chromium have also been proven within the made ground materials, but pose less of a risk.

It is considered that a 600mm inert soil capping would be required as a minimum across garden areas and landscaped/communal areas, although a reduced thickness may be possible in landscaped/communal areas subject to approval by the EHO (see 'Remediation' below). Wider risks to the environment (e.g. surface water and groundwater) are not considered to be significant.

Basic radon precautions are required in the construction of houses at the site (which will also mitigate any potential risk from landfill gases such as CO₂ and CH₄). This should be agreed with the local Building Control officer and the NHBC.

Japanese Knotweed, which is present within the northern car park area, will require treatment/removal.

12.0 RECOMMENDATIONS

12.1 Enabling Works

Existing buildings cover a large proportion of the central part of the site, and it is anticipated that a significant quantity of rubble will arise from their demolition. It may be possible to crush and re-use some of this material below roads and areas of hardstanding, but it may be that much of the demolition material will require removal from site subject to proposed ground levels.

Some of the buildings have been identified to have basements or pits (e.g. for the storage of waste oil) and deep foundation obstructions could also be present. The removal of all floor slabs, old foundations/substructures and any historic underground obstructions should be carried out as part of the demolition works. Further localised excavations may be required during demolition to check for buried obstructions. The demolition/enabling works will need to be integrated with remedial works, i.e. those required to remove waste oil tanks and any associated soil contamination, where encountered, and also to treat Japanese Knotweed.

An asbestos survey of the existing buildings should be carried out prior to demolition works being undertaken, since the presence of asbestos may significantly influence the suitability of material for retention/cost of removal from site. An exemption for landfill tax would have to be submitted for soils excavated to facilitate construction works, if they pose an unacceptable risk to human health or to the environment.

12.2 Foundations

Made ground materials at the site are considered to be an unsuitable formation to found in. Where deep made ground is encountered, particularly to the north and east, piled foundations are likely to be the most appropriate foundation solution. Piles should be taken down through made ground into the underlying Coal Measures strata (weathered sandstone), although difficulties may be encountered where large concrete, or sandstone ‘boulder’ obstructions are present in the made ground. It may be possible to use vibro-techniques to improve the made ground, although further investigation by a vibro-contractor may be required to assess ground conditions further. The type and suitability would be dependent upon the type of housing proposed (i.e. partial depth/raft or full depth-reinforced strip/ground beam).

Where shallow made ground has been proven (across the western car park area), the underlying stiff clays/sandy soils should be suitable bearing strata for traditional footings. However, these are likely to require widening/thickening and strengthening, dependent upon ground variability (sand/clay) and the type of housing units proposed. It may be more economic to adopt a piled or vibro solution for the whole development therefore.

12.3 Precautions Near Trees

Precautions should be taken when building near trees/hedges, with foundations being constructed in accordance with the recommendations prescribed in NHBC Standards Chapters 4.2 and 4.5.

Geotechnical testing indicates that the underlying natural clays have a low to medium volume change potential (see Appendix VII). However, given the depth of the made ground, trees are unlikely to influence foundation depth. Founding depths and any requirement for heave precautions would be confirmed following completion of a plot specific foundation schedule.

12.4 Floor Slabs

Given that there is more than 600mm of made ground across the site, suspended floor slabs would be required.

12.5 Sulphate Precautions

In accordance with BRE Special Digest 1 it is considered that Class DS2/ACEC-AC2 sulphate conditions should be assumed where concrete comes into contact with made ground. Concrete to FND-2 should therefore be used at the site.

12.6 Road Construction

Road design will be constrained by the character of the made ground. At this stage a 600mm capping and geotextile should be assumed, with an increased construction thickness, appropriate for a 1% CBR. Road construction proposals must be approved by the Local Authority prior to finalising design.

12.7 Excavations

Excavation for sewers and other deep excavations may be expected to be unstable in the made ground, particularly during prolonged periods of wet weather. All excavations in which man entry is required must be assessed and suitably supported to ensure safe working conditions. Difficulties may be encountered where bedrock is encountered at relatively shallow depth.

12.8 Groundwater

No groundwater or perched water was encountered during the ground investigation works. Groundwater problems are therefore not anticipated. The dewatering of excavations is unlikely to be required.

12.9 Soakaways and Site Drainage

Given the extent of made ground and underlying clay materials soakaways are unlikely to be suitable for use at the site, although a network system, with engineered storage, may be feasible. If soakaways were proposed, permeability testing would have to be carried out at the appropriate depth.

12.10 Radon

Basic radon precautions are required where residential development is proposed at the site. Precautions will comprise a polythene membrane beneath house footprints and the sealing of service entries (see Ground Gas, below).

12.11 Ground Gas

Deep made ground has been proven at the site. Given the nature of the underlying made ground it would therefore be prudent to install basic ground gas precautions in residential properties constructed at the site. This should comprise 1200 gauge membrane being taken across cavities, and taped and sealed at service entries (see ‘Further Works’ below).

12.12 Remediation

Risk assessment using the RSK/ENSR/NHBC (2004) software package has been carried out on the mean value test results presented in Appendix VIII. Given the elevated concentrations of arsenic, PAH and TPH, a 600mm inert soil capping would be required as a minimum on gardens and areas of soft landscaping. The upper 200mm of this capping may comprise inert topsoil.

A reduced capping may be able to be used in areas of soft landscaping, although the capping thicknesses stated are however subject to the approval of the Environmental Health Officer.

Given that there is no source of topsoil at the site, importation will be required. This topsoil should be tested at source and confirmed as suitable in agreement with the NHBC/EHO.

Japanese Knotweed will need to be treated/removed during enabling/demolition works. *In situ* chemical treatment should be suitable, subject to approval by the Environment Agency.

13.0 FURTHER WORK

It would be prudent to carry out the following additional works and surveys to assess further the nature of the made ground and the impact local surroundings may have on the proposed development:

- 1 Shell and auger boring to assess the geotechnical character (through *in situ* testing) and the depth of made ground where the vertical extent was not proven. Installations to facilitate ground gas monitoring should also be installed at this time;
- 2 Ground gas monitoring to assess the potential for ground gas migration egress (basic radon protective measures are however required at the site, which should also mitigate any risk from landfill gas);
- 3 Remedial Works Method Statement to reflect the recommendations for capping in garden/landscaped areas.

INFORMATION SOURCES

Geological data	- British Geological Survey 1:50,000 Series, Sheet 87, Barnsley, Solid and Drift Edition; - Environment Agency Groundwater Vulnerability Map 1:100,000 Series, Sheet 11, South Pennines; - Coal Mining Searches, The Law Society Guidance Notes and Directory 1998 Edition.
Environmental	- Landmark Envirocheck Report; - R&D Publication CLR 8 Potential Contaminants for the Assessment of Contaminated Land, EA and DEFRA; - Department of the Environment Industry Profiles; - Soil Guideline Values SGV1-10, Environment Agency R&D Publications, 2002. Contaminants in Soil: Collation of Toxicological Data for intake of Humans; - EA (April 2002) Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans: Benzo[a]Pyrene, Tox 2; - CIRIA Report 149: Protecting development from methane, 1995; - Environment Agency technical advice to third parties on pollution of controlled waters for Part IIA of the Environmental Protection Act 1990, December 2001; - RSK/ENSR/NHBC 'Cover Systems for Land Regeneration', 2004.