CL Associates

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SITE INVESTIGATION AND CONTAMINATION ASSESSMENT

LAND BEHIND THE OLD VICARAGE, OFF MARSH LANE, NEW MILLS, DERBYSHIRE.

SITE INVESTIGATION

Carried out for : John Rose and Associates

February 2008
Revision 0

Report No. 42062/1

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1 INTRODUCTION

In December 2002, CL Associates (CLA) were commissioned, on behalf of Mr John Swindells Esq, by John Rose Associates (letter 859C/010/SL, 4 December 2002), to carry out a ground investigation and contamination assessment of the land behind the Old Vicarage, off Marsh Lane, New Mills as proposed in CLA reference LO-02/WQ1617/aem, 11 November 2002. At the time of the investigation, the site was undeveloped however, it is understood that it has been earmarked for potential residential redevelopment.

The purpose of this report is to provide a desk study assessment, develop a conceptual model of the possible pollution linkages on the site, establish the actual baseline contamination levels at the site prior to development and to provide recommendations for the mitigation of contaminated land issues that may be required in relation to the development of the site. Some geotechnical assessment of the site was also required however, the results are limited due to the ground conditions encountered.

The information contained within this report is intended solely for use by Mr John Swindells Esq. Any other party using this report does so at their own risk unless written permission is obtained from the Director of CL Associates.

2 INFORMATION SOURCES

A list of the information sources used in the production of this report is contained within the references. The main source of desk study information was the Sitescope Environmental Disclosure Report, a copy of which is included in Appendix A. Throughout the rest of this report, references to the Sitescope Report have been abbreviated to EDR.

3 SITE DESCRIPTION

3.1 General

The site is situated on land behind the Old Vicarage, off Marsh Lane, New Mills, Derbyshire. The site is at National Grid Reference 400700mE, 385340mN, as shown in the Key Plan (Figure 1). The site plans (Figures 2 & 3) show the site to be irregular in shape. The site boundaries are defined by a pathway to the east (beyone a large embankment, terraced and semi detached housing to the west and north west and poorly maintained wire fence with a coal yard beyond to the south.

The site is currently undeveloped although it has been previously used for quarrying. Within at least the last 50 years, the site has been utilised for the tipping of waste. There is no information from tipping records on the waste type although site investigation works have detected mainly industrial wastes including asbestos. The site is generally made ground with an uneven surface, comprising of both quarry and clay/sand fills and covered by rough grassland. There are elevated and vegetated areas of apparent rock outcrops, to the south of the site and a large cliff/embankment running through the site along the eastern boundary.

The clay and sand fills mark the boundary of the waste tip. There are no obvious surface indications of the extents of the waste tipping within the quarry.

3.2 Topography

The site is located on land behind the Old Vicarage off Marsh Lane in New Mills, Derbyshire. The site is relatively flat lying, although with an uneven surface and is covered by grass, heather and a small wooded area to the north west of the site. According to the local Ordnance Survey Map, the flat lying area of the site is located at about 180m above Ordnance Datum (AOD). The site varies in elevation because of the embankment and areas of presumed rock outcrop. The embankment top lies approximately 10m above the rest of the site.

4 GEOLOGY, HYDROLOGY AND HYDROGEOLOGY

4.1 Geology

According to the published geological map, BGS Sheet 99 (1975), the site is located on bedrock of the Woodhead Hill Rock Strata of the Westphalian Coal Measures, Lower Carboniferous in age. This is a series of argillaceous rock strata. On the larger scale, the site lies within a series of north-south trending faults, generally downthrown to the east, and localised east west trending smaller scaled faults (generally downthrown to the north).

There is a faulted fold of red ash coal strata to the west of the site and a numerous folds of red ash to the east. There is also a coal crop to the north of the site. The Coal Authority Report (reference 528363-02 dated 14th December 2002) states that (according to the Coal Authority's records) the property is not within the zone of likely physical influence on the surface from past underground coal workings.

Geological Drift maps show boulder clay overlying the rock strata. However, site investigation works completed as part of this study have not identified Boulder Clay within the site.

The anticipated geology is summarised in Table 1, below:

Table 1: Summary of Inferred Geology

Expected Depth	Geology
Ground Level	Made Ground
Below made ground	Boulder Clay
Below clays	Woodhead Hill Rock strata

4.2 Hydrology

There are no surface water features on the site. The nearest surface water feature is a small tributary to the River Goyt which lies less than 250m to the east of the site. The site is situated between 500-1250 m from the fluvial floodplain. The Toddbrook Reservoir lies to the south of the site, near Whaley Bridge. To the north east of the site is a small lake near Birch Vale and the Kinder Reservoir near Farlands Booth.

4.3 Hydrogeology

The hydrogeological sensitivity of the underlying geology is shown on the Environment Agency Groundwater Vulnerability map of England and Wales (Sheet 17, Derbyshire and North Staffordshire) as minor aquifer, namely the Westphalian Woodhead Hill Rock sequence. The overlying drift deposits are indicated as having a low soil leaching potential. However, within the site itself, made ground was encountered directly overlying the solid geology. This comprised of either quarry fill (sandstone recovered as gravels, cobbles and boulders) or sandy gravelly clays, soils and associated gravelly cobbly sands.

According to the EDR, there are two groundwater abstractions between 500 m and 1250 m of the site. These are for industrial, commercial and public service and food and drink use.

5 SITE HISTORY

5.1 Summary of Historical Development

The information gained from the historical maps is summarised below. A full review of the historical maps can be seen in Appendix B.

- 1882-1887 – Brownbrow Quarry and vicarage are shown on the maps. The surrounding countryside is open landscape.
- 1890 – Several footpaths run through the site.
- 1898 – The footpaths have changed slightly and Marsh Lane has been residentially developed.
- 1921 – Church Road and Marsh Lane have gone through further residential development.
- 1968 – The extents of the refuse tip and some buildings, possibly garages, are now shown.
- 1977 – The refuse tip is no longer evident. New Mills, Low Leighton and High Lee have all been further developed.

6 OTHER ENVIRONMENTAL MATTERS

6.1 Risk of Flooding

The EDR indicates that the site is located between 500 m and 1250 m of a fluvial flood plain.

6.2 Surface water abstractions and discharges

According to the EDR, there are two surface water abstractions between 500 m and 1250 m from the site.

There are sixteen consents to discharge within 1250 m of the site. These are for sewage, trade effluent and miscellaneous discharges of surface waters.

6.3 Surface water pollution incidents

The EDR lists a total of seventy nine pollution incidents within 1250 m of the site. There have however, only been four reported within 250 m and one between 250 m and 500 m of the site.

All of the four pollution incidents within 250m of the site were in 1996 and categorised as minor incidents. These all involved either suspended solids, sewage or chemical paint and dyes in the River Sett tributary.

6.4 Radon affected areas

The EDR states that the site is not within a radon affected area (<1 percent of homes above the action level), and as such no radon protection measures are necessary.

6.5 Landfill Sites

The site itself is considered to be a former landfill although it is not clear if a waste disposal licence was granted (this would only be applicable if the site was operational from 1974 onwards). The waste type is also not identified within the EDR. The site investigation works identified mainly industry related wastes (such as bricks, slate and metal work) including asbestos, although the presence of domestic waste cannot be ruled out.

The EDR illustrates the presence of one closed landfill site on Whitle Road, New Mills. There is no record of what the waste type in the landfill is.

There are no currently operational landfill sites recorded within a 1250 m radius of the site.

6.6 Shallow Mine Workings

The EDR states that the risk of shallow mining is assessed to be low and that the postcode of the site is in or near the Lancashire Coal Area.

Coal Authority searches report no records of any past, present or proposed future coal mining activities likely to have physical influence on the surface within the site area.

7 OBSERVATIONS FROM THE SITE WALKOVER

On the site walkover (December 2002), several interesting features were noted, see Figure 2. The site is generally vegetated with rough grassland, with several elevated areas, presumably vegetated rock outcrops. There is a large cliff/embankment running north-south down the site on the eastern side. This embankment lies approximately 10m above the rest of the site. At the base of the embankment, on the south east corner of the site, there are several fuel drums and containers. It is not known whether these drums were full. Graffiti is also present on the rock face of the embankment here. Vegetation cover in the south east extents is rough grassland, heather and shrubbery.

Parallel to the embankment, towards the north of the site lies a large steel container with wooden boxes inside. Metal poles and broken glass lie on the concrete foundations of the container and there are small areas of rock spoil to the north. Behind this container is a metal trolley and small orange plastic container although it is not evident what was previously in this plastic container. In the centre of the site, slightly towards the north, areas of tipping are evident. There are railway sleepers and concrete blocks partly covered over with vegetation.

Towards the north eastern extents of the site, there is a wooded area covered by fly tipping. Plastic, plastic bags, cables, metal, a bike and a mattress were noted. The vegetation is however healthy. Just outwith the wooded area, near to house no. 6 off

Quarry road, another area of fly tipping is evident. Here, metal, brick, wood and pipework were noted.

Outwith the site, there is a coal yard to the south, semi detached and detached housing on Marsh Lane to the south west, terraced housing to the north west and a playing field to the east.

8 FIELDWORK PROCEDURES

8.1 General

The fieldwork was carried out to the design of CLA, on instruction of John Rose Associates and in general accordance with BS 5930 (1999) and BS10175. The site investigation was carried out between 2 January 2003 and 6 January 2003.

The fieldwork objectives were to establish the presence and extent of contamination by the sampling of soil, groundwater and ground gas throughout the made ground. Some geotechnical information on the ground conditions was also required.

The fieldwork design and objectives were agreed with the High Peak Borough Council before site works commenced.

8.2 Fieldwork and sampling

Twenty complete trial pits and two boreholes (restricted, on the instruction of John Rose Associates, to the suspected area of waste disposal) were utilised to characterise the ground conditions over the site. The trial pits were excavated using a Fermec 860 digger with a 0.6m bucket and were utilised for characterising the ground conditions and for sampling for subsequent contamination testing. The boreholes were excavated using a cable percussive rig with 150mm casing and were mainly used to prove the depth of the made ground and for gas monitoring installations.

Exploratory hole locations are indicated on Figure 2. The trial pit locations were evenly spread across the site in order that the former refuse tip could be adequately mapped (ie. in order to confirm the extent of waste disposal). The trial pits were excavated to a maximum depth of 5.6m or to the point where they were considered unstable. The pits were to be terminated on proving the underlying natural ground but in all cases were terminated within the made ground (due to the excessive depth of made ground). The minimum trial pit depth was 0.5m and the maximum 5.6m. A range of samples were sent for chemical testing at the TES Bretby Laboratories.

The boreholes were drilled for gas and groundwater investigation through the made ground to the top of the natural ground. The boreholes were positioned in the area of suspected previous waste disposal. Borehole depths were 6m in borehole 1 and 8m in borehole 2. Both boreholes proved bedrock and, following completion, the base of each borehole was sealed with bentonite prior to the installation of the monitoring standpipe within the made ground. Three weekly return visits were scheduled for gas monitoring. The results of the gas monitoring are presented in Appendix E.

The exploratory hole records are presented in Appendix A and should be read in conjunction with the Key included therein. The records provide descriptions, in general accordance with BS 5930, of the materials encountered and details of the samples taken, together with observations made during sampling. The installations within the boreholes are also shown on these logs.

9 GROUND AND GROUNDWATER CONDITIONS

9.1 Ground Conditions

The exploratory holes revealed differing ground conditions to those indicated on geological maps. A variable sequence of strata with depth, comprising made ground and quarry fill overlying rock head was encountered. The trial pits provide a more detailed log of the made ground. Detailed descriptions of the strata are presented on the borehole and trial pit logs in Appendix D. A summary of the ground conditions is provided in Table 2.

9.1.1 Made Ground

Made ground was proven to depths of between 5.9 and 7.6m below ground level in the boreholes.

The trial pits show that the made ground was comprised of two types of fill. The first was found all around the quarry, apart from in the area which was previously tipped 'filled area' (i.e. the 'refuse tip' of the 1968 historical maps). The quarry fill comprises yellow orange to brown sandy gravelly cobbles and boulders of sandstone, and associated locally gravelly medium grained sand.

Table 2 Summary of Ground Conditions Encountered

	Stratum	Range of Thickness (m)
A	MADE GROUND: Quarry fill consisting of yellow orange to brown sandy gravelly cobbles and boulders of sandstone, and associated locally gravelly medium grained sand. The 'refuse tip' comprises sequences of clay, soil, sand and gravels. Finer soils include sandy, gravelly, cobbly, bouldery clays or sandy gravelly cobbly slightly organic soils. Brick and sandstone with occasional plastic, metals, concrete, slate, coal, textiles localised pockets of asbestos were identified. Granular fills generally comprise of very sandy gravels of sandstone and occasional pottery or silty gravelly cobbly fine to coarse sands with occasional clay lenses. Brick, concrete, coal and plastic were noted in these soils. A slight hydrocarbon odour was noted in TP8.	0.0 to 7.6m
B	SOLID GEOLOGY: Woodhead Hill Rock Strata of the Westphalian Coal Measures (found as sandstone)	Proven to 0.5m maximum

Within the area filled area, the made ground comprises sequences of clay, soil, sand and gravels. The soils are generally sandy, gravelly, cobbly, bouldery clays or sandy gravelly cobbly slightly organic soils. The gravels and cobbles are often brick and sandstone with occasional plastic, metals, concrete, slate, coal and textiles. Localised pockets of asbestos were identified around TP7 at 3.0m, TP8 at 0.5m, TP13 at 1.0m, and TP14 at 0.8m within the soil strata. A localised pocket of a friable 'creamy' substance with a distinct odour was noted at 2.0m and 4.0m, within the soil and clay strata, in TP15.

The granular fills are generally comprised of very sandy gravels of sandstone and occasional pottery or silty gravelly cobbly fine to coarse sands. The gravels and cobbles comprise of brick, concrete, coal and plastic. There was a slight hydrocarbon odour noted in TP8 at 1.2m within this strata. Localised clay lenses were noted within the sands.

9.1.2 Solid Geology

The solid geology encountered in the boreholes forms part of the Westphalian Coal Measures. These rocks were identified as strong brown grey fine grained sandstone. The bedrock was penetrated for less than half a metre.

9.2 Groundwater conditions

Water strikes were encountered in boreholes 1 and 2 at depths of 5.9m and 5.7m respectively. The water encountered was associated with the made ground.

The water in the made ground was in the form of perched groundwater, possibly trapped above a low permeability layer within the fill. In borehole 1, the groundwater was encountered at the interface between made ground and the rockhead. Water samples were collected at the time of the initial water strikes.

The boreholes were sealed at the base prior to the installation of a monitoring well to avoid cross contamination into the bedrock. However, this sealed off the zone of groundwater strike (in borehole 1) and no significant volume groundwater accumulated in borehole 2, thereby reducing the possibility of further sample acquisition.

10 CONCEPTUAL MODEL

10.1 General

The first stage in assessing the potential risks from contaminated land is to develop a conceptual model of the site. The UK approach to risk assessment is based on the source-pathway-receptor scenario. In order for there to be a theoretical risk from contamination, there must be source, a receptor (an entity which might be affected by the contamination) and a mechanism or pathway by which the receptor can be exposed to the contaminant.

Potential sources of contamination are usually associated with current and historical industrial activities, where the processing, storage, use, transportation and disposal of raw materials, products and wastes often leads to contamination of the underlying ground. In addition to industrial processes, natural processes can also give rise to contamination such as hazardous gases.

Potential pathways can include; permeable ground conditions, underground voids, services, groundwater and surface water. The mechanisms by which a receptor can be exposed to a contaminant include direct contact, ingestion / uptake and inhalation.

Potential receptors can include human health, environmental receptors and buildings or structures.

In order to develop a site specific conceptual model, a review of the current and historical land uses in the area, and the site's environmental setting has been carried out to identify the potential sources, pathways and receptors.

10.2 Potential Sources of Contamination

Potential sources of contamination can be classified into current and historical sources both on and off the site. At the time of the investigation, the site appeared to be undeveloped and unused. It was not secured against public access.

10.2.1 On site sources

The site was previously a quarry which was later backfilled with waste. The 1968 historical map provides the earliest documented record of a 'refuse tip'. The nature of the waste tipped at this time is unclear but contaminants were potentially introduced at this time. There were previously buildings adjacent to the extents of the refuse tip. Local knowledge from the landowner indicates these may have been garages. It is not clear if these garages were used to house vehicles or if they were utilised for storage of other materials but potentially contaminative activities such as use of oils, fuels and paint products may have been associated with them.

The quarry works themselves pose a potential contamination risk as explosives may have been used on the quarry faces.

The made ground is considered to be the main source of on site contamination, especially the historically tipped area. Examples of the potential contaminants identified within the filled area include plastic, metals, concrete, slate, coal, dye pigments, textiles and asbestos. There was only one trial pit noted with a slight hydrocarbon odour. The presence of tipped materials may also give rise to the potential of landfill gas generation.

The site has been recently subject to fly tipping of various waste products including metal, cables, bikes, mattresses, rock spoil and fuel containers. There is a large steel container on the site with broken glass and metal pipework.

Potential contaminants from these sources include:

- heavy metals
- inorganic and organic compounds
- fuels
- oils
- paints
- asbestos

- hazardous gases (e.g. methane and carbon dioxide)

10.2.2 Off site sources

In 1938, historical maps showed the presence of a print works to the south of the site. The site investigation also identified an area of localised solid blue pigment within the made ground. The print works may have therefore also contributed to on site sources if the dye pigment originated from it. The Department of the Environment Industry Profile on Chemical Works – Coatings Manufacturing Work (paints and printing inks) indicates that pigments can be organic or inorganic compounds. Further contamination from the works may include inorganic and organic pigments, organic dyes, extenders, binders, organic solvents, additives, asbestos, polychlorinated biphenyls (PCB) and fuels.

The EDR shows a tank at the vicarage although it is not clear what this was utilised for (e.g. water, fuel or sewage).

The EDR shows a coal yard and haulage depot to the south of the site from 1968. It is possible that contamination from fuel spills and coal spoil may have contaminated the underlying land in the past. The yard itself currently contains spoils of coal alongside sand, gravel, concrete and pallets of various other building materials.

The potential sources of contaminants are therefore:

- dyes and pigments
- solvents
- fuels
- hydrocarbons
- inorganic and organic compounds

10.2.3 Summary of anticipated contamination

It is anticipated that the following substances may be present on and around the site in relation to the past and present land uses:

- Metals, metalloids and their compounds
- Dyes and pigments
- Fuels and oils
- Asbestos
- Inorganic and organic compounds
- Solvents

- Possible PCB's
- Methane gas and carbon dioxide, possibly generated by potential wastes on and adjacent to the site.

10.3 Potential pathways for Contamination

The potential contamination migration pathways on the site are summarised below:

- Lateral and vertical migration of contaminants through the permeable made ground and quarry fill may take place. This infers the possibility of a pathway via perched groundwater in the made ground, possibly allowing mobile contaminants to migrate to the underlying minor aquifer.
- Gas migration through the made ground is also a consideration. There has been no significant gas found to date. However, there is still the potential for the build up and migration of landfill gas within the refuse tip area.
- The site is currently open access and the presence of made ground at the surface means that direct human contact with any contamination at eh surface may occur.
- The service drawings show no services or utilities through the site. However, after construction, this may be of concern. Around services such as these, cracks and fractures in the pipe may allow the transfer of contaminants into the pipes. Also, service trench backfill is often highly permeable in nature thus giving rise to another potential contaminant pathway.
- After residential development, direct human contact may occur, especially in gardens and landscaped areas.
- There may be plant uptake of contaminants in gardens and landscaped areas.
- There is the potential for gas generated within the made ground to vent into buildings. Development of hard cover may block a current pathway for gas venting and allow a subsequent build up of gas pressures.

10.4 Potential receptors for Contamination

The most significant potential receptors are environmental and human health receptors.

10.4.1 Human Health Receptors

As there are significant waste deposits at the surface, ingestion or inhalation of contaminated soils, dust or water by anyone who enters the site is possible. Future construction workers would also be working in direct contact with the waste deposits and any subsequent gas emissions. This would be a greater risk if construction involves deep excavations.

Future occupiers of the developed site may be at risk from direct contact with or via plant uptake of contaminants within gardens or landscaped areas. Plant uptake is especially a risk if future users of the site are growing vegetables. There is a possibility of exposure of future users to hazardous gases (if present) due to accumulation within buildings.

10.4.2 Environmental Receptors

The underlying minor aquifer is considered to be a receptor. There is a medium to high risk of contamination of this aquifer if mobile contaminants are present.

Existing vegetation on the site or any future vegetation that is to be included in gardens or landscaped areas would be at risk of absorbing any mobile contaminants within the made ground and phytotoxic effects may be a risk.

10.4.3 Buildings and Foundations

Conditions in the made ground that are aggressive to concrete (e.g. low pH and high sulphate values) may pose a risk to the integrity of below ground structures such as foundations and piles.

11 LABORATORY RESULTS AND CONTAMINATION ASSESSMENT

11.1 General

A total of 21 soil and 2 water samples from the site investigation were dispatched for chemical analysis at the laboratories of TES Bretby. The results of this analysis have been compared to the soil guideline values (SGVs) derived from the DEFRA Contaminated Land Exposure and Assessment (CLEA) model. The SGVs within the new CLEA model represent 'intervention values'. Soil levels above the SGV are considered to potentially pose an unacceptable risk to the health of site users and further more detailed risk assessment or remediation would be required in these circumstances. A range of SGVs have been derived, assuming that land use falls into one of the following categories.

- residential with and without plant uptake
- allotments
- commercial/ industrial

Thus the appropriate soil guideline values derived under CLEA are dependant on exposure in the context of land use. Given that the majority of the site is to be redeveloped for residential use, the residential (with plant uptake) SGVs are considered to be the most relevant in this instance.

At present, the number of determinands which have SGV's under CLEA is very limited. Additional guideline values for the phytotoxicity of zinc and copper have been taken from The Sludge (Use in Agriculture) Regulations, 1989. Where necessary, other contaminant levels have been compared to intervention values published by the Dutch Ministry of Housing, Spatial Planning and Environment, 2000. The Dutch Intervention Values (DIV) take both human health and environmental risks into account and provide an initial indication of levels above which serious contamination may exist. As they are based on typical geological and exposure conditions in the Netherlands, they act as a guide only.

11.2 Chemical Analysis of soils

The chemical analysis results of the soils have been split into the two distinct areas of made ground, namely the quarry fill and the clay/soil/sand fill within the extents of the 'refuse tip'. The quarry fill is described as the gravels, cobbles and boulders of sandstone present around the majority of the site. The 'refuse tip' is considered to be the area indicated on the 1968 historical map.

11.2.1 Made Ground in the Filled Area

The made ground in the tipped area shows a significant concentration of arsenic (35 mg/kg) and nickel (186 mg/kg) in trial pit 9 at 2.5m. These values are 1.75 times the SGV for arsenic and 3.72 times the target SGV for nickel. There is a single chromium value of 61 mg/kg, which is not above the SGV, but which is elevated when compared to the rest of the samples tested.

Trial Pits 5, 12a and 7 all show levels of arsenic which are nearing, at or above the SGV but the mean of the arsenic results is below the SGV.

Within the made ground in TPs 7, 9 and 13a and BH2, copper and zinc were detected above the adopted guideline levels.

Total petroleum hydrocarbons (TPH) were detected at 89 mg/kg in TP 8 at 1.0m. The hydrocarbon fingerprint shows a dominance of the heavier hydrocarbon fractions, possibly lubricating oils, with the presence of some lighter fractions, possibly in the diesel range. Polyaromatic hydrocarbons (PAH) were also detected within this made ground. Total PAH values ranged from 22 mg/kg to 898 mg/kg. A maximum cyanide value of 2 mg/kg was detected.

Asbestos was identified in 4 locations within this made ground. There were two types identified, amosite and chrysotile. Both amosite and chrysotile were identified in TP 7 at 3.0m and TP 14 at 0.8m whilst low levels of chrysotile were found in TP 8 at 0.5m and TP 13 at 1.0m. The asbestos identified was highly visible to the naked eye and in the form of bundles of asbestos fibres, probably boiler insulation lagging, and cement tiles.

11.2.2 Quarry Fill

Within the remainder of the quarry area, containing general quarry fill, the contaminants tested fall within the CLEA SGVs and other adopted guideline values with the exception of a single lead result in TP16 which appears to represents a hotspot.

Total PAH concentrations of up to 140 mg/kg (TP18) were noted within the quarry fill.

11.3 Chemical Analysis of Groundwater

The chemical analysis of the groundwater collected from the boreholes can be seen in Appendix E.

According to the EDR, there are two groundwater abstractions within 500 -1250m of the site. These are for industrial, commercial and public service and food and drink use. Because of these abstractions and the possibility of contamination of the minor aquifer, the groundwater has been compared to drinking water standards.

As there was only a low yield of groundwater and none was recovered from the permanent installations, only samples obtained during drilling could be tested. Sufficient volume was available for analysis of metals and minerals but TPH and PAH analysis could not be carried out.

Water strikes were encountered in boreholes 1 and 2 at 5.4m and 5.5m respectively. The water encountered within the boreholes was associated with the made ground.

The water in the made ground was in the form of perched groundwater, held above an impervious layer, on top of the bedrock. No odours or discoloration were noted within the water.

The laboratory results from the ground water analysis show that the majority of the parameters tested are below the test detection limits and no parameters exceeded the drinking water standards (DWS).

Table 2 Summary of Chemical Test Results on Soil

	Guidance Values		Soil Values		
Determinand	CLEA SGV Residential with plant uptake	Other adopted guideline Value	Measured Concentration range. Min	Measured Concentration range. Max	No. of results exceeding guideline Value
Arsenic	20	NP	4	36	4
Boron	NP	NP	<0.5	0.8	-
Cadmium	3 (for pH8)	N/A	<1	2	0
Chromium	130	N/A	8	61	0
Copper	NP	100[1]	10	835	2
Cyanide (total)	NP	650[2]	<1	2	0
Lead	450	N/A	30	1180	1
Mercury	8	N/A	<0.5	3	0
Nickel	50	N/A	5	186	1
PAH (screen)	NP	40[2]	22	898	10
pH	NP	NP	5.3	12.8	-
Phenol Index	NP	40[3]	<0.5	<0.5	-
Selenium	35	N/A	<0.5	0.93	0
Water Soluble Sulphate (g/l)	NP	1.2 [3]	0.0149	0.269	0
Sulphur	NP	NP	<20	<20	-
Sulphide	NP	NP	<5	31	-
Zinc	NP	200[1]	36	593	4
TPH	NP	5000[2]	89	89	0
Asbestos	NP	NP	2-15%	100%	-

Notes: all results in mg/kg unless otherwise stated NP= not published, NL = no limit, NT = not tested

1. Sludge Use in Agriculture Regulations
2. Dutch intervention value
3. BRE Special Digest 1, threshold for Class 1 sulphate resistant concrete

11.4 Subsurface gas conditions

Gas monitoring was conducted on three occasions during January 2003. Waste Management Paper No 27, *Landfill Gas* provides a guideline value of 1% methane and

1.5% carbon dioxide, above which further consideration is required prior to development. Other guidance such as the Building Regulations provide threshold values for remedial action of 1% methane and 5% carbon dioxide.

Methane and hydrogen sulphide have not been detected. There were no elevated levels of carbon dioxide detected and oxygen levels were slightly depleted in relation to atmospheric conditions. The maximum carbon dioxide value detected was 1.0 %v/v whilst the minimum value was 0.1 %v/v. The minimum oxygen value was at 17.9 %v/v and the maximum level was 20.5 %v/v.

Maximum flow rates ranged from 0.1 l/hr to 3.2 l/hr. Differential pressures ranged from 0 to 2mb. Atmospheric conditions have been below 1000mb on two occasions and above 1000mb on the third. Ideally, at least one gas monitoring visit should be undertaken when pressure in below 1000mb and falling.

The full gas monitoring data are presented in Appendix D.

11.5 Geotechnical Testing

Two samples of the made ground in the filled area of the site were tested to BS 1377, on a 2:1(water: soil) extract, for sulphate attack on concrete. Trial Pit 6 at 1.0m contained a water soluble sulphate value of 26.9 mg/kg whilst TP12 at 0.5m had a value of 14.9 mg/kg.

The full table of results are shown in Appendix E.

12 DISCUSSION

Further to the conceptual model of the site discussed above, this section discusses the potential risks to the environment and human health the detected contaminants may pose currently, during construction and post development.

12.1 Chemical Contamination

12.1.1 Toxic Metals

High concentrations of lead and nickel were found within the soils of the previously tipped made ground. Nickel was also found to be elevated around TP 9, at 186 mg/kg.

This was over 3.5 times the CLEA SGV. Lead was found to be over 2.5 times the CLEA SGV in TP16 (outside the inferred waste disposal area) at 1.2m depth. This is thought to represent hotspot of lead.

Currently, the detected concentrations of metals within the made ground (due to ingestion of soils or inhalation of contaminated dust) are considered to present a low risk to human health as the existing vegetation provides a protective cover and there is no continual occupation or use of the site occurring.

During the construction phase of works, the risk to human health is considered to be higher. Construction workers involved in the groundwork are at the most risk from exposure to contaminated soils as the pathways of ingestion; inhalation and dermal contact are all plausible and likely given the close contact with the soil. However, these risks can be reduced by appropriate PPE and hygiene precautions and good working practices.

After the proposed residential development, the risk to human health is considered to be low in areas of impermeable cover such as buildings and roads. This will provide an effective barrier between contaminated soils and human contact. In gardens and areas of landscaping, the risk to plant life and the risk of human contact with contaminated soils would be higher. It will therefore be necessary to prevent the future risk of direct contact with contaminated soils following development.

12.1.2 Phytotoxic metals

Most of the samples were within the ICRCL 70/90 guideline for copper (250 mg/kg), with the exception of one sample (TP9 at 2.5m, 835 mg/kg). The risk of phytoxicity in garden and landscaped areas cannot be ruled out and is likely in any hotspots of elevated phytotoxic metals such as TP9.

12.1.3 Hydrocarbons

There was an isolated hydrocarbon odour detected within the filled ground (in TP8 at 1.0m) which gave rise to a TPH value of 89 mg/kg. The hydrocarbon fingerprint from the laboratory results shows a dominance of the heavier hydrocarbon fractions, possibly lubricating oils, with the presence of some lighter fractions, possibly in the diesel range. However, it is considered unlikely that a TPH concentration of 89mg/kg in an isolated area will present a significant risk.

PAHs were noted within the filled ground and the quarry fill. The highest value of 898mg/kg (taken from the speciated PAH analysis of the sample from TP8 at 1.0m) may be associated with the noted slight hydrocarbon odour or may be due to the presence of coal in the sample.

The presence of these hydrocarbons may be indicative of some isolated hotspots (due to fly tipping and hydrocarbons being present in waste materials. It is therefore possible that further hotspots may be detected during excavation works. A watching brief is recommended during any excavation works.

Further speciated PAH analysis would be required to fully define the risk of the hydrocarbons on the site (as certain PAH compounds are more toxic than others). However, mitigation is already a developmental requirement due to the presence of the metal and asbestos contamination. It is therefore considered that any risk from the observed levels of TPH and PAHs would be mitigated simultaneously.

The PAH concentrations are also in excess of the 50mg/kg threshold adopted by water companies for the use of plastic water supply pipes. Therefore, it is likely that water supply pipes will need to be of a barrier type material (cast iron or polythene/aluminium composite) unless they are laid completely within clean backfill material.

12.1.4 Sulphate

Of the inorganic (non metal) parameters tested, only sulphates were detected in significant concentrations. The presence of sulphate may pose a risk to the integrity of buildings as concrete foundations, piles and drainage pipes can be attacked by them.

Sulphates (acid extract) within the previously tipped made ground are considered to be reasonably high. They range from 426 mg/kg to 12600 mg/kg (in TP15 at 2.0m). In TP15 at the same depth, a cream coloured crumbly substance was noted. It is possible that this substance may account for the elevated level found here. There are also significantly elevated levels within the quarry filled areas. Concentrations here range from 318 mg/kg to 3730 mg/kg (in TP16 at 0.15m).

However, two soil samples were also tested for a 2:1 (water:soil) extract of sulphates. This geotechnical test and the associated guidelines evaluate the effect of sulphate attack on concrete and provide a guidance for the concrete that should be used for below ground structures. The tests showed no significant levels of sulphates and therefore the risk to concrete foundations and services is indicated to be low (based on these two results. In the light of the depth of made ground and the potential for further areas of elevated sulphate, it is recommended that the use of sulphate resistant concrete is considered.

12.1.5 Groundwater

The perched groundwater analysis shows no evidence of leaching of mobile contaminants, hence the risk to any deep groundwater within the minor aquifer is considered to be low. Furthermore, the absence of a significant body of groundwater within the waste and the future reduction in infiltration due to the placement of the cover system, houses and hardstanding, means that the risk of leaching of contaminants from the waste mass will be very low.

Nevertheless, during the construction phase of development, piles should be constructed so as to avoid creating new migration pathways to the minor aquifer (see section 12.4.1).

12.2 Hazardous Ground Gases

From the gas results to date, there is not considered to be a current risk from gas on the site. However, there is always the possibility of gas generation in the future from within the made ground, especially in any areas of putrescible materials and following the restriction of the current venting to atmosphere of any gases produced by the addition of hard cover.

12.3 Asbestos

Asbestos is defined as a group of naturally occurring fibrous crystalline silicates. Asbestos has been widely used throughout industry, in construction work, public buildings, in laboratories and in the home. Asbestos types and grades vary with use and requirements for chemical resistance, thermal insulation, strengthening and filtration characteristics.

There have been two types of asbestos identified on the site, namely chrysotile and amosite. The HSE Guidance Note EH35, *Probable asbestos dust concentrations at construction processes*, states that chrysotile is also known as white asbestos and is the most common form of asbestos. It is found in insulation, asbestos cement, roofing tiles, desk tiles, insulating board, fillers, plasters and coatings. Insulation materials may contain mostly chrysotile but may be mixed with crocidolite and amosite asbestos. Amosite is commonly recognised as brown asbestos and was often used to give structural strength to cement products. It is also found in thermal insulation boards, ceiling tiles and as a sprayed coating.

When inhaled, asbestos can cause serious deterioration of health and eventually death. Although asbestos has only been detected in four trial pits to date, it is likely that further isolated deposits (associated with building/demolition wastes in the filled area) are present.

The risk from asbestos is currently considered to be medium due to the risk of near surface deposits coming into contact with humans, especially as the site is considered to be open to public access. However, the deeper buried deposits are considered to be of lower risk whilst the site remains undisturbed.

The risks from asbestos during development is considered to be higher. Construction workers involved in the groundwork are at the most risk from exposure to asbestos as the inhalation pathway will be more likely to be present. However, these risks can be reduced by appropriate PPE and hygiene precautions and good working practices.

The risks from asbestos after the development of the site is considered to be low to medium if the contaminant remains underneath an impermeable cover such as housing and roadways. The risk from asbestos buried beneath gardens or landscaped areas would be greater due to the potential for its future excavation.

Guidance on the remediation of asbestos in soils (ICRCL guidance note 64/85) states that asbestos within soils can be treated as follows:

1. "excavation (where necessary) and removal from the site for disposal elsewhere"
2. "excavation (where necessary) and retention for reburial at a greater depth"
3. "covering by a suitable depth of inert material or by a permanent hard-surfaced form of development"
4. "excavation (where necessary) and treatment prior to disposal by burial on the same site or elsewhere"

As options 2 and 4 involve the re-burial of asbestos containing material, it is considered that these would not be feasible under the current waste management licensing regime as, even if the Environment Agency were to approve such a process, the regulatory controls and associated costs would be prohibitive.

The options most applicable to this site are therefore 1 and 3.

Option 1 involves removing the asbestos from the site completely. It is considered better to destroy or remove asbestos fibres than leave them buried as there is no risk of re-exposure at the surface. However, this requires a specialist contractor and would involve additional inspection of the previously filled ground and testing to ensure that any residuals of asbestos fibres are at an acceptable level. The disadvantage of this method is that a short term risk of exposure of the work force and general public would exist during the remediation exercise. In the context of this site, where the contamination potentially exists at depths of over 5m in a restricted area, adjacent to existing development, the complete removal would not be practicable or economical. It may be possible to remove asbestos to a depth below which disturbance of remaining asbestos will be highly unlikely (2m depth) but, again, this will entail disturbance of asbestos and is unlikely to be an economically viable solution.

Option 3 would entail the provision of a cover system entailing a layer of soil of 2m depth or a hard cover, laid over the whole development area. This would provide a protective barrier to future occupiers of the site from the asbestos found in the site. Such a system would also mitigate against possible toxic and phytotoxic effects from metals and PAHs identified within some of the soils. All services should be placed within this clean soil or additional controls would be required during the installation of services through asbestos containing soil. A visible 'barrier' at the base of the clean soil would provide additional protection against the accidental disturbance the asbestos contaminated soils. The presence of asbestos should be disclosed to all future residents and maintenance workers to ensure they are aware of the associated risks of any deep excavations.

In order to achieve acceptable final ground levels, it may be necessary to combine the partial removal of asbestos contaminated soils with the provision of a 2m cover layer.

Agreement with the Local Authority would be required for any development scheme on this site.

It is likely that the short term risk of asbestos disturbance during construction will need to be mitigated with a watching brief and dust suppression during key stages of the works. Any removal of asbestos contaminated soil will be subject to additional controls (as specified by the Health and Safety Executive) and Special Waste regulations.

12.4 Geotechnical Considerations

Geotechnical concerns related to construction activity over fill deposits include:

- variation in fill depth
- variation in loading over fill deposits
- chemical reactions within fill deposits e.g. volumetric expansion
- self weight settlements due to variation of groundwater levels.

Charles and Skinner (2001) show how changes in fill are not simply confined to the edges of filled areas and that differential settlement may occur where variations in fill depth occur. An example of this, relevant to this site, is the possibility of a 'highwall' where the quarry face meets the filled ground. The unknown geometry of the highwall further complicates the development over this area because it will affect the settlement pattern of the adjacent soils.

The presence of variable fill deposits and a highwall indicates that traditional foundation solutions for construction In the quarry area would be subject to significant differential settlement. Therefore it is anticipated that foundations should extend to bedrock and a piled raft foundation solution may be considered.

12.4.1 Piling

The Environment Agency Technical Report P331: 2000: *Risks of Contaminated Land to Buildings, Building Materials and Services – A Literature Review*, states that fills that include sulphate bearing waste materials amongst other things should be treated with particular caution. Contaminants within fills may cause deterioration of the foundations and services through ground movements and chemical attack. The concrete class used for piles should be selected taking into account the potential for chemical attack.

There is a potential for arisings generated during piling to contain contaminated soils which are then brought into contact with sensitive receptors. The release of asbestos fibres to atmosphere is a particular risk. Piling will mix contaminated and uncontaminated soils which will lead to an increased volume of contaminated soils which require disposal.

Displacement piles involve penetration of the soil and displacing it from the space that is to be occupied by the pile without the removal of the soil to the surface. Due to the presence of asbestos on the site, displacement piles are considered to be the preferred technique. The choice of piling technique must also consider the risk of mobilising contaminants to the underlying minor aquifer, either by providing a preferential pathway or by carrying contaminated materials down in-front of a driven pile.

13 CONCLUSIONS AND RECOMMENDATIONS

13.1 Conclusions

The site investigation comprised of twenty trial pits and two boreholes. The ground investigation works identified the made ground, comprising of quarry fill or previously tipped fill (of gravelly clays, soils or sands including waste materials) overlying the bedrock, found as weathered sandstone.

The conceptual model of the site identifies the on site sources to be the refuse tipping, historical garages and fly tipping. The offsite sources are the coal yard and haulage depot.

A contamination assessment of the site has shown that the quarry fill contained elevated levels of lead and PAHs. The previously tipped fill is contaminated with localised deposits of asbestos as well as slightly elevated arsenic, nickel copper, zinc and PAHs. Groundwater samples complied with drinking water standards, indicating that the metals and detected in the soil samples have not impacted on groundwater perched within the made ground.

Water Soluble sulphate testing of the soils indicated that the risk of sulphate attack on below ground concrete structures is low (although there is still thought to be a potential for aggressive conditions to concrete to be present within the waste deposits). There is the potential for differential settlement within the made ground due to the nature of the waste deposits and a highwall created by a buried quarry face.

The main risk from contamination at the site is to human health due to the presence of asbestos and also due to isolated areas containing elevated lead and nickel concentrations.

13.2 Recommendations

- The presence of asbestos in the soils in the previous waste disposal area will require mitigating measures to be put in place as follows:
    - The control of the release of asbestos fibres during ground works to include a watching brief for localised asbestos deposits and damping down to minimise dust generation. Atmospheric monitoring may also be required by the Local Authority during this stage of the works.
    - The provision of a barrier layer to entail hard cover or the provision of a clean soil cover with a visual barrier (such as paraweb) beneath. The depth of cover should be at least 2m in private garden areas and as close as is practicably possible in other soft landscaped areas (such as the perimeter buffer zone).
    - All services to be laid in clean backfill materials.
    - Future residents and maintenance workers (including any workers carrying out excavations) to be aware of the presence of asbestos and the necessary controls to prevent its disturbance.

  It should also be noted that the extent of the waste disposal area has not yet been confirmed, hence further investigation may be required to confirm that the measures outlined above are in place in a sufficient portion of the site.

- Future occupants of the site must be isolated from areas of heavy metal and potentially PAH contamination. The combination of hard cover and imported clean soils in the waste disposal area will achieve this but other areas may require a minimum 500mm cover in landscaped and garden areas. The selected removal of metal (and potentially PAH) hotspots may be an alternative to the need for a cover layer in all garden areas.

- Adequate health and safety procedures will be required during construction. Workers should avoid direct skin contact with soils and utilise strict hygiene procedures. Sufficient personal and respiratory protective equipment (PPE and RPE) should be provided. The potential exposure to asbestos will require additional health and safety precautions and potentially the notification of the Health and Safety Executive.

- Soil gas is not anticipated during excavation works however, gas generation in the filled ground cannot be ruled out. As a precaution, confined spaces procedures should be in place, the atmosphere tested and alarms fitted during manned entry to deep excavations. It is also recommended that further gas monitoring is carried out following the installation of the cover layer to identify any changes in gas generation and subsequent requirements for gas protection in buildings.

- From the information gained during the site investigation, significant hydrocarbon hotspots are not expected. However, a watching brief during excavation work is recommended.

- The varying fill and potential highwall that exists through the site poses geotechnical problems due to the risk from inhomogeneous ground settlement and differential loading. It is recommended that this is taken into account in the foundation design to ensure that structural damage to the proposed development via differential settlement does not occur. This may entail piled foundations, founded on the sandstone bedrock.

- Piles, if adopted, should be constructed so as to restrict migration of contaminants. Further guidance can be obtained from the National Groundwater and Contaminated Land Centre Report NC/99/73 *Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance and Pollution Prevention*.

for CL Associates

Assistant Geotechnical Engineer

Principal Scientist

REFERENCES

BS 5930 : 1999 : Code of practice for site investigation. British Standards Institution.

IGS Sheet No. 99 : 1967 : One inch to one mile scale Geological Survey of Great Britain (England and Wales), Sheet 99 (Drift), North London. Published by the Director General of the Ordnance Survey, Southampton for the Institute of Geological Sciences.

IGS Sheet No. 99 : 1975 : One inch to one mile scale Geological Survey of Great Britain (England and Wales), Sheet 99 (Strata), North London. Published by the Director General of the Ordnance Survey, Southampton for the Institute of Geological Sciences.

Ordnance Survey Landranger Series: Sheet 110: 1993: Sheffield and Huddersfield area. Published by the Ordnance Survey, Southampton.

Environment Agency Groundwater Vulnerability Map: Sheet 17: 1996: Derbyshire/ North Staffordshire. Published by HMSO

Department of the Environment Industry Profile: 1995: Chemical Works-coatings (paints and printing inks) manufacturing works.

A Guide to the Classification, Packaging and Labelling of Dangerous Substances Regulations 1984 (HS ®22) HMSO ISBN 0 11 883794 X

BRE Digest 276: Hardcore.

HSE Guidance Note EH 35: 1989: Probable asbestos dust concentrations at construction processes. Published by HSE Books

HSE Guidance Note MS 13: 1978: Asbestos. Published by HSE Books

HSE Contract Research Report 83/1996: 1996: Development and validation of an analytical method to determine the amount of asbestos in soils and loose aggregates by Davis, LST; Wetherill, GZ; McIntosh, C; McGoagle, C and Addison, J.

The Environment Agency Technical Report P331: 2000: Risks of Contaminated Land to Buildings, Building Materials and Services – A Literature Review.

Charles and Skinner (2001): The delineation of building exclusion zones over highwalls. *in* Ground Engineering, Feb 2001

FIGURES

FIGURE 1: KEY PLAN

FIGURE 2: SITE PLAN WITH OBSERVATIONS FROM SITE WALKOVER

FIGURE 3: SITE PLAN WITH APPROXIMATE BOREHOLE AND TRIAL PIT LOCATIONS

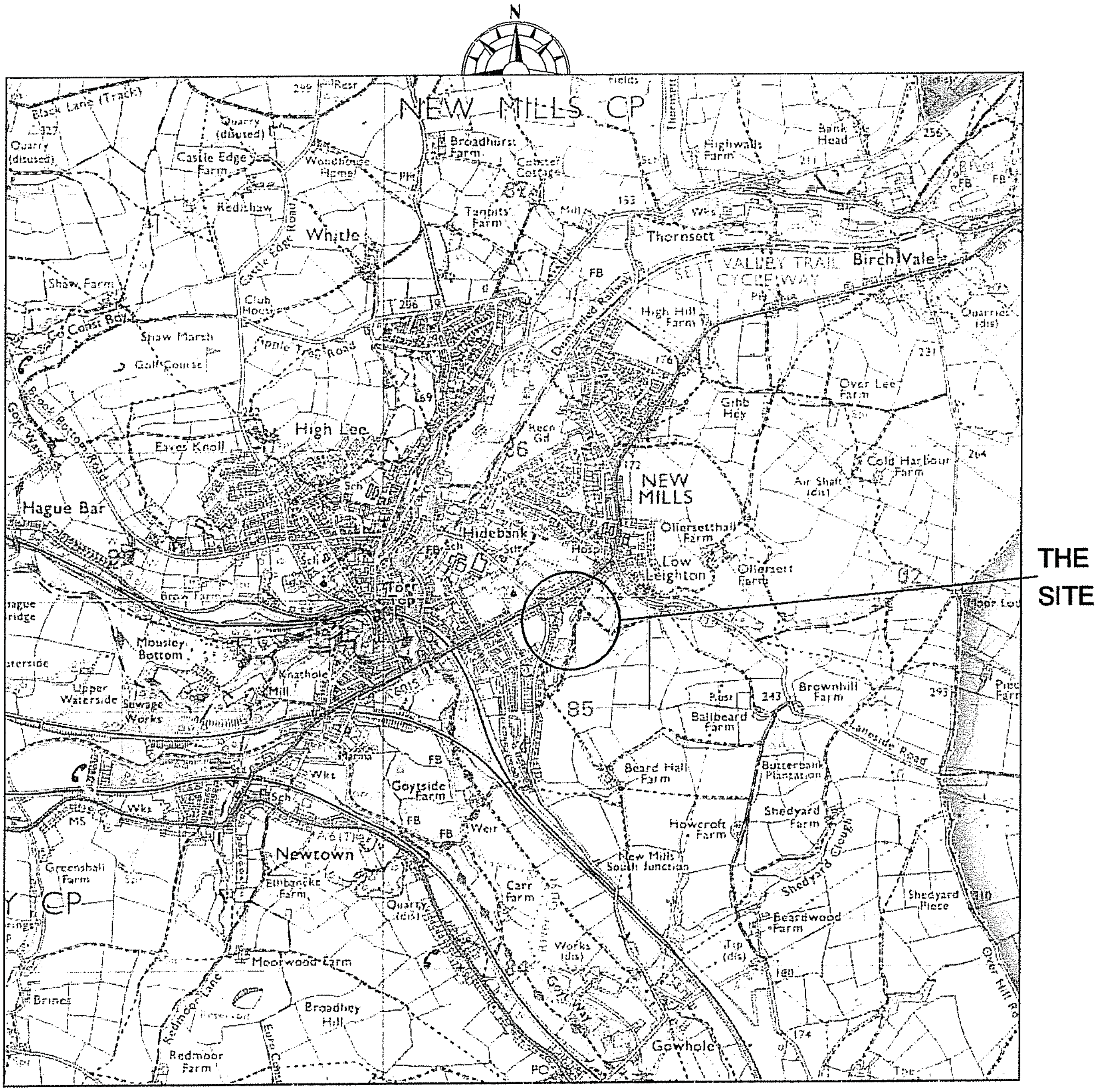
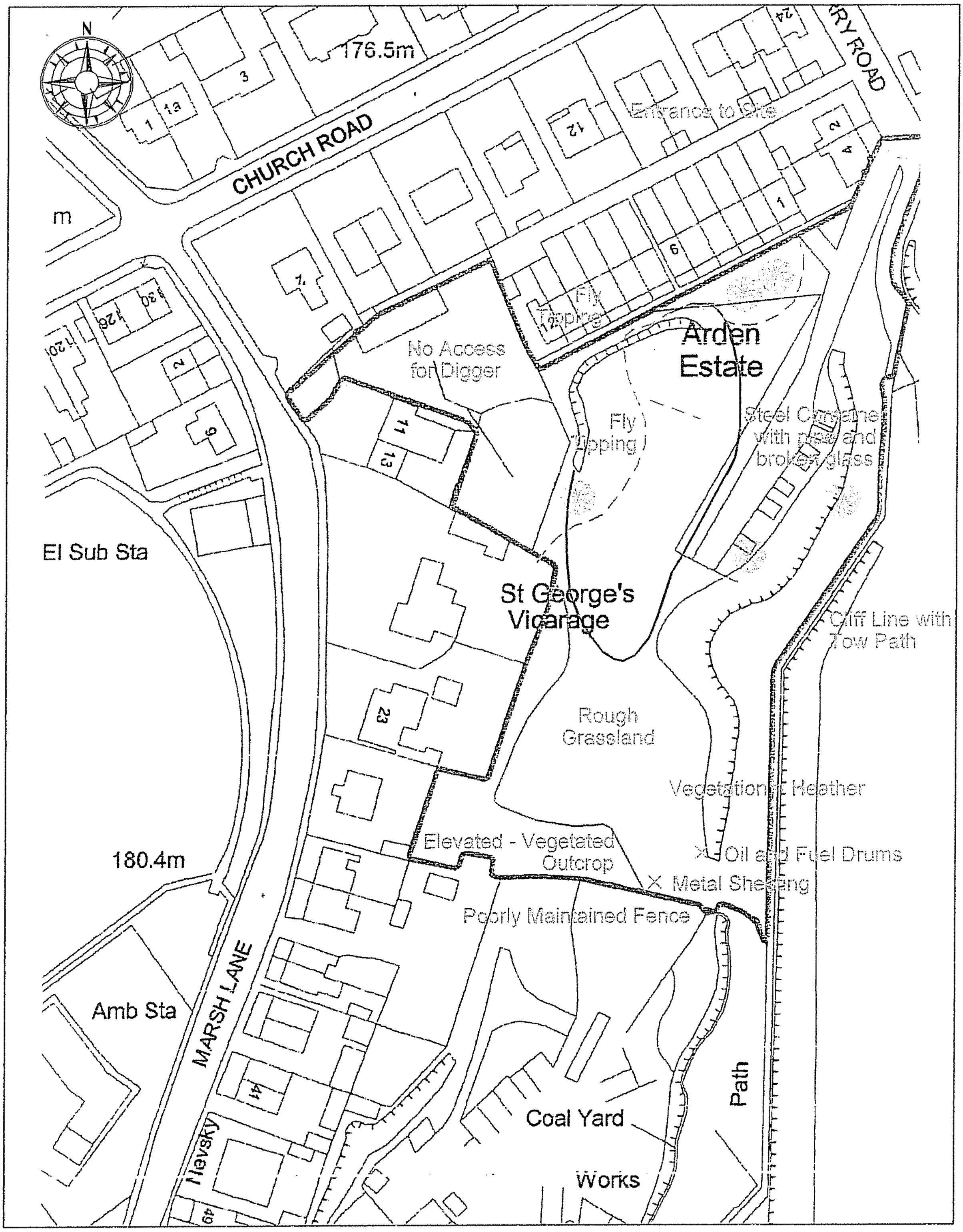


Figure 1
Key Plan
Land Behind the Old Vicarage, off Marsh Lane, New Mills
Report No 42062/1



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Legend to symbols:

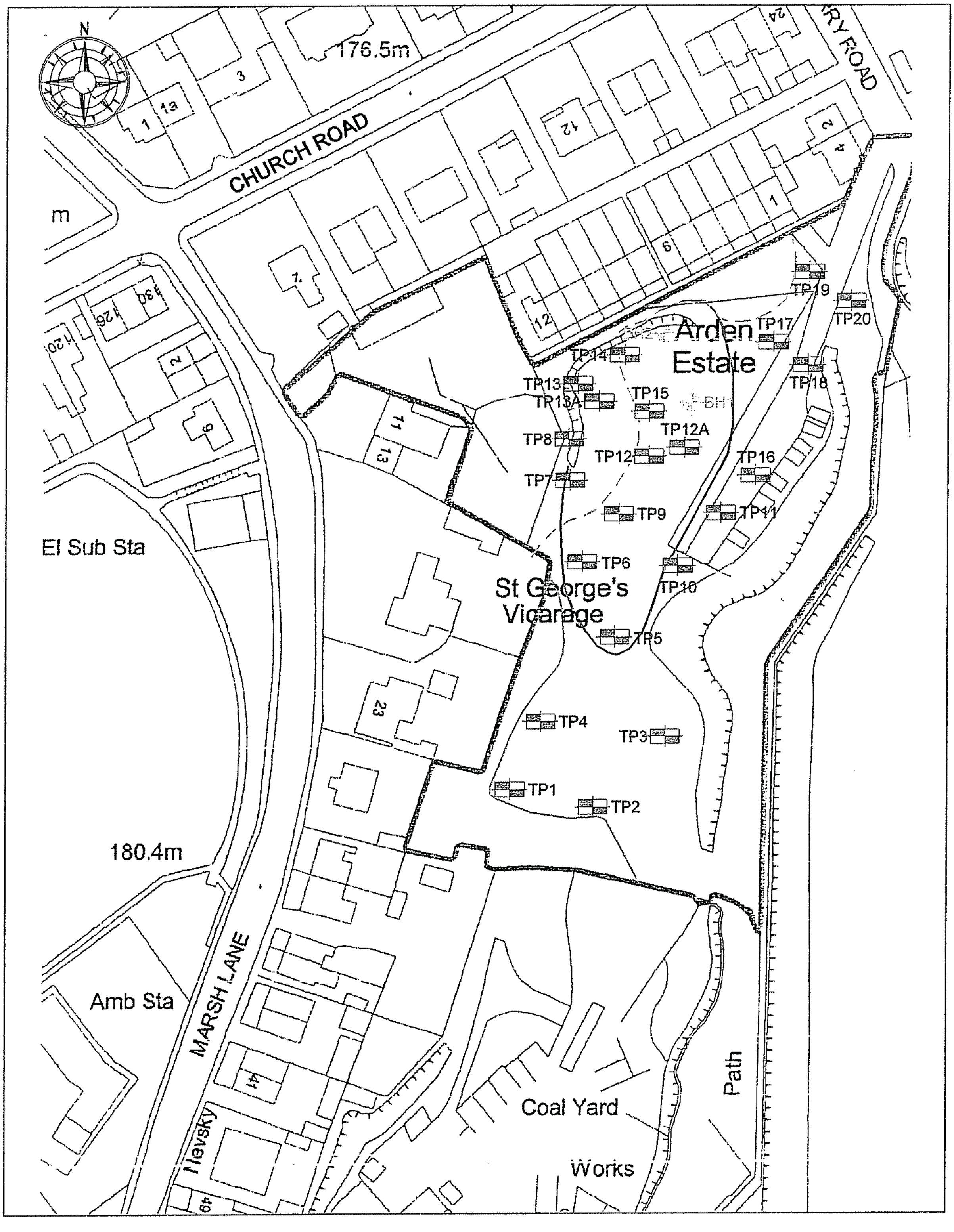
- - - - - Extents of Wooded Area
——— Extents of Refuse Tip (Inferred from combination of Historical maps and Site Investigation)
——— Elevated Areas

Figure 2

Site Plan with Observations from Site Walkover

Land Behind the old Vicarage, off Marsh Lane, New Mills

Report No 42062/1



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Legend to symbols:
- – – – – – Extents of Wooded Area
- ———— Extents of Refuse Tip (Inferred from combination of Historical maps and Site Investigation)
- ———— Elevated Areas
- Trial Pit
- Borehole

Figure 3

Site Plan with Approximate Locations of Bore Holes and Trial Pits

Land Behind the old Vicarage, off Marsh Lane, New Mills

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