

Harworth Estates

Former North Gawber Colliery, South Yorkshire

Geo-environmental site assessment

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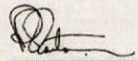
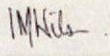
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Client: Harworth Estates, AMP Technology Centre, Brunel Way, Waverley, Rotherham, South Yorkshire, S60 5WG

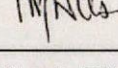
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Office: RSK Environment Limited, Fourways House, 57 Hilton Street, Manchester, M1 2EJ. Tel: +44 0161 236 2757, contact: Ian Wilson

Status: Final

Authors	Emily Jones Paul Taunton	**Technical reviewer**	Laura Aspinall Ian Wilson
Signature:	Emily Jones 	Signature:	L Aspinall 
Date:	March 2014	Date:	March 2014

Project manager Ian Wilson

Signature: 

Date: March 2014

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK Environment Ltd.

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1 INTRODUCTION

RSK Environment Limited (RSK) was commissioned by Harworth Estates to carry out a geo-environmental assessment of the site of the former North Gawber Colliery in South Yorkshire.

This report is subject to the RSK service constraints given in **Appendix A**.

1.1 Objective

The objective of this review is to assess the ground conditions, and the ground treatment required to enable the proposed future redevelopment of the land for residential use.

1.2 Scope

The scope of the investigation and layout of this report has been designed with consideration of CLR11 (Environment Agency, 2004a) and BS 10175: 2011 (BSI, 2011) and guidance on land contamination reports issued by the Environment Agency (EA) (2010a). A summary of legislation and policy relating to contaminated land is provided in **Appendix B**.

The scope of works for this report was set out in RSK's proposal reference (M)321370-T-L02 dated 22 July 2013. The brief included:

- an intrusive investigation consisting of nine cable percussion boreholes, six rotary holes and five days of trial pit excavation, with soil sampling and laboratory analysis, together with subsequent groundwater and gas monitoring
- four skip loading tests, to assess the settlement performance of the existing fill materials under loading
- development of a refined conceptual site model followed by generic quantitative risk assessment (GQRA) to assess complete pollutant linkages that may require the implementation of mitigation measures to facilitate redevelopment
- interpretation of ground conditions and geotechnical data to provide recommendations with respect to foundation and infrastructure design
- a factual and interpretative report, including a development constraints plan, and providing recommendations for further works if required.

1.3 Existing reports

Several existing reports relating to the North Gawber site were reviewed by RSK. Following that review, RSK produced the following summary report providing comment on ground conditions across the site area:

- RSK, Appraisal of Ground Conditions: Former North Gawber Colliery, South Yorkshire, March 2014 (ref. 321370-R1 (01)).

Section 2 of the present report summarises the principal points from this earlier RSK appraisal, which provides full references to the earlier reports that were consulted during its preparation.

A second report prepared by RSK detailed the mining history of the site and assessed the potential effects on the proposed development.

- RSK, Coal Mining Risk Assessment: Former North Gawber Colliery, South Yorkshire, March 2014 (ref. 321370-R2 (01)).

Again, Section 2 of the present report summarises the principal points from this earlier RSK assessment, which provides full references to the records and publications that were consulted during its preparation.

1.4 Limitations

The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels and ground gas concentrations and flows may vary from those reported due to seasonal, or other, effects.

2 SITE INFORMATION

2.1 Site location

The site is located in Mapplewell, approximately 4km north-west of Barnsley. **Figure 1** shows the site location and **Figure 2** provides information relating to the site boundary. The approximate centre of the site is located at Ordnance Survey National Grid reference 433,050E 409,650N. The site occupies an area of approximately 16 hectares and comprises three main terraces, starting at an elevation of approximately 95m above Ordnance Datum (AOD) in the northern part of the site, falling to 70m AOD in its southern part.

2.2 Site description

The site comprises an area of colliery spoil, with sparse grass and some areas covered by trees. There is a drainage ditch running north-west to south-east in the southern part of the site. Ordnance Survey mapping indicates that a public right of way runs alongside this drainage ditch.

To the north of the site there are modern warehouse and factory buildings. A car body repair garage is using a small hardstanding area of approximately 200m^2 in the north-east corner of the site to store cars. The site boundary passes along the edge of North Gawber Football Club's pitch, outside the north-west corner of the site.

There are residential properties and some industrial buildings off Carr Green Lane, which runs along the eastern boundary of the site. There are also residential properties on Spark Lane, which borders the site to the west.

A birch woodland defines the southern boundary, beyond which the reclaimed colliery tip is used as grazing land.

2.3 Proposed site use

Full planning permission is sought for the remediation and restoration of the site and outline planning permission is sought for up to 325 dwellings, open space and associated infrastructure with all matters reserved except for access. It is understood that previous planning permission was granted in January 2012.

3 PRELIMINARY RISK ASSESSMENT

More detailed information for the former North Gawber Colliery site is provided in the RSK Appraisal of Ground Conditions, report reference 321370-R1(00), and the RSK Coal Mining Risk Assessment, report reference 321370-R2(00), which should be read in conjunction with this report. A brief summary of the relevant information is included below.

3.1 Geology and hydrogeology

Published records indicate that there are no superficial geological units across the site, although thin glacial deposits have been encountered on site during previous investigations.

The bedrock is recorded as the Pennine Middle Coal Measures Formation, comprising mudstone, siltstone and sandstone with coal seams. The Kent's Thin coal seam outcrops across the northern part of the site, striking from north-west to south-east. This is underlain by the Kent's Thick seam (also known as the Mapplewell seam), which outcrops across the centre of the site. This is underlain by the Barnsley Rider coal seam, which outcrops south of the site boundary. The coal seams dip to the northeast. A seam, denoted as 'M' on the six inch geological map, which presumably refers to the Mapplewell Coal (the Kent's Thick) is shown to dip at a ratio of 1 in 21, or approximately 3 degrees.

Figure 2 shows the mapped location of the coal seam outcrops in relation to the site.

A Coal Authority mining report obtained by RSK contains the following information:

- the site is within the likely zone of influence from nine worked coal seams, from shallow depth to 340m below ground level, last worked underground in 1981
- reserves of coal exist which may be worked in the future, although this has not been licensed, nor is it awaiting a licence
- the Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 metres, since 31st October 1994
- eight mine entries are present on, or within 20m of the site. Three of these were adits, and five were shafts
- parts of the site are within the boundaries of two historical opencast sites.

The bedrock units are classified as a secondary A aquifer. There is an active groundwater abstraction point for commercial use approximately 1300m west of the site. In view of its distance from the site, and the likelihood that groundwater flow beneath the

site is towards the River Dearne, to the south, it is unlikely that the site will have any adverse effect on this abstraction. There are no groundwater source protection zones (SPZ) on or near the site.

The soils beneath the site are classified as having 'High Urban' (HU) leaching potential, defined as follows:

- HU - soil information for restored mineral workings and urban areas is based on fewer observations than elsewhere, so a worst-case vulnerability classification is assumed until proven otherwise.

3.2 Hydrology

The early historical maps indicate that a stream flowed in a southerly direction almost directly through the centre of the site. This appears to have been diverted.

Current maps show:

- a stream running from west to east across the southern part of the site, generally at a lower level than the surrounding ground and flowing partially in culvert
- issues in northwest corner of the site, flowing generally southwestwards along the approximate site boundary, sinking close to the main stream noted above
- a drain in the eastern part of the site, running southwestwards, apparently entering a culvert leading to the main stream.

It appears that site drainage generally discharges to the main stream crossing the southern part of the site, which joins the River Dearne approximately 500m south of the site. The Envirocheck database records the river quality chemistry assessment of the Dearne as generally "Grade B – Good", although it has sometimes been "Grade C – Fairly good".

No surface water abstractions are recorded on or within 2km of the site.

3.3 Waste

There are no landfill sites or waste management facilities within the site boundary, although the northern and southern parts of the site, in addition to areas to the south and east of the site, were used as colliery spoil tips.

3.4 Radon

Previous reports indicate that the site lies in an area where basic radon protection measures would be required in the construction of new houses, and this is confirmed by

the map included within the BRE publication 'Radon - Guidance on protective measures for new buildings' (2007).

However, the Envirocheck environmental database report accesses more up to date information held by the British Geological Survey (BGS), which is based on a 25m grid map, developed jointly by the BGS and the Health Protection Agency (HPA), rather than a 1km grid, as shown on the maps published in 2007 by the BRE. Thus the Envirocheck assessment is considered equivalent to a BGS stage 2 assessment.

The higher-resolution data set indicates that site is located within an intermediate probability radon area, as between 1% and 3% of homes are above the action level, as defined by the National Radiological Protection Board. Consequently, on the basis of this recent refined dataset, radon protective measures are not necessary for new housing development on the site.

3.5 Review of historical maps

Between 1854 and 1893 North Gawber Colliery was constructed in the northern and central part of the site and comprised coke ovens, an engine house, and the North Gawber Colliery Railway. An aerial ropeway passed from the main works in the centre in a south-easterly direction, and later a conveyor was constructed to take colliery spoil off site and dump it on land to the southwest of the site. Two opencast mines were excavated within the site boundary, one in the north-west corner of the site close to what is now the football pitch, and the other excavated during construction of the colliery settling lagoon near the centre of the site. Additional settling lagoons were created in the southern and south-west parts of the site. Between 1983 and 1993 the colliery and railway was dismantled, and lagoons were backfilled leaving the site as it is today.

3.6 Previous investigations

The RSK appraisal report summarised the results of the previous site investigations carried out by Scott Doherty and Associates Limited (SDA).

SDA reported that the entire site was underlain by colliery backfill/spoil including ash, and demolition material. The thickness of made ground was reported as ranging from 3.5m to 13.8m, and the thickest deposits were generally encountered in the northern part of the site. Thin deposits of glacial till were encountered in many parts of the site, overlying mudstone or sandstone.

Chemical analysis of soil samples from the made ground identified a number of exceedances of the screening values used by SDA, although in some cases the RSK screening criteria are higher than those applied by SDA. For some substances, in particular polycyclic aromatic hydrocarbons (PAHs), the RSK criteria are lower than those applied by SDA, so a reassessment of the data to current standards was required.

The contamination assessment of the made ground identified widespread contamination by arsenic, in addition to sulphate contamination in some parts of the site, acidic conditions and minor exceedances of the total petroleum hydrocarbons (TPH) and PAH assessment criteria. In the north-east part of the site there were additional minor exceedances of cadmium, chromium, nickel, zinc, and PAHs, in particular benzo(b)fluoranthene, dibenzo(ah)anthracene and benzo(a)pyrene.

Elevated concentrations of TPH and sulphates were encountered in groundwater samples retrieved from the monitoring wells. The site of the former colliery was considered to represent the principal source of contamination.

The available ground gas monitoring data, based on four rounds of monitoring in seven boreholes during 2007 and 2008, records methane concentrations were below detection limits, and concentrations of carbon dioxide up to 11.8% v/v, although gas flows were always negligible.

Cement bonded asbestos was found in one trial pit during the SDA 2009 investigation. Four additional pits were excavated nearby to assess whether there might be significant asbestos contamination in this vicinity, but no other asbestos was found. Twenty-nine samples of made ground from locations across the site were screened in the laboratory for the presence of asbestos, but none was found.

3.7 Conclusions of previous RSK reports

The RSK appraisal report concluded that a ground investigation should be undertaken to cover areas not addressed in the SDA investigations. The required scope of investigation should include the following:

- trial pit investigation to:
    - determine the depth of shallow made ground
    - determine the extent of concrete still present on the site
    - collect additional samples for chemical testing, particularly in the settlement lagoon areas and around the previously identified contamination 'hotspots'
    - collect bulk soil samples for earthworks classification, pH analysis and sulphate testing
- borehole investigations to:
    - provide information about the depth of fill material in areas of the site where this is not known
    - install shallow monitoring wells to assess the groundwater and gas regime

- locate coal seams by rotary drilling and determine whether they have been worked

- tests to monitor the settlement of the ground as a result of loading
- comparison of all contamination test results with updated soil screening criteria in line with CLR11.

The RSK coal mining report identified similar requirements, but also included the following:

- location of mine entries, by intrusive investigation and geophysics if necessary
- refinement of the development constraints plan, to assist in the adoption of an economic layout for the proposed residential development.

3.8 Initial conceptual model

The available information has been used to compile an initial conceptual model. The identified potential sources of contamination, associated contaminants and receptors have been considered with plausible pathways that may link them. The resulting potential pollutant linkages are considered in Section 6. The risk classification has been estimated in accordance with information in **Appendix C**.

3.8.1 Summary of potential contaminant sources

Potential sources and contaminants of concern identified for the site are:

- made ground, indicated by previous investigations to have concentrations of arsenic frequently above the assessment criteria, and some concentrations of metals, TPH and PAHs above the criteria
- made ground containing bio-degradable material, with the potential to release ground gases
- coal measures strata, with worked coal seams, potentially releasing ground gases
- colliery waste with a high proportion of combustible material, potentially present within made ground.

3.8.2 Sensitive receptors

The following likely sensitive receptors have been identified for this site:

- existing and future site residents and users

- proposed houses and infrastructure
- residents and commercial workers, on adjacent sites
- trees and plants in proposed landscaping
- potable water supply pipes
- groundwater in the underlying Coal Measures, designated a Secondary "A" aquifer (no abstractions identified)
- surface watercourses, including the River Dearne, 500m from the site.

Please note that construction workers have not been identified in the conceptual model as receptors, because risks are considered to be managed through site health and safety procedures compliant with the CDM regulations.

3.8.3 Summary of plausible pathways

The plausible pathways are summarised below:

- direct contact (including dermal contact and soil or dust ingestion)
- inhalation of dust, fibres, gases and vapours
- leaching of contaminants
- vertical and lateral migration of ground gases and / or groundwater
- chemical attack on water supply pipes
- plant uptake
- ignition and spreading of fires.

The possibility of sulphate attack on buried concrete is considered in the geotechnical section of the report, rather than as a contamination issue.

3.8.4 Potentially complete pollutant linkages

The outline conceptual model and an estimate of the risk associated with each linkage is summarised in Table 1. The risk classification has been undertaken in accordance with CIRIA C552 (Rudland et al., 2001), a summary of which is included in **Appendix C**.

Table 1: Risk estimation for potentially complete pollutant linkages

Potential Contaminant	Potential receptor	Possible pathway	Probability	Consequence	Risk and justification
Made ground, indicated by previous investigations to have concentrations of arsenic frequently above the SDA assessment criteria, and some concentrations of metals, TPH and PAHs above the criteria	Future site residents	Direct contact (including dermal contact and soil or dust ingestion) and inhalation of dust and vapours	Likely	Medium	**Moderate**: Based on contaminant concentrations identified in the previous investigations, with no mitigation.
	Residents and commercial workers, on adjacent sites	Dust inhalation	Unlikely	Medium	**Low**: Dust controlled during development and unlikely to be any significant dust generation potential once site developed.
	Trees and plants in proposed landscaping	Plant uptake	Likely	Mild	**Moderate/Low**:
	Potable water supply pipes	Chemical attack	Likely	Mild	**Moderate/Low**: Adverse effect on supply pipes possible from some PAH concentrations identified previously.
	Groundwater in the underlying Coal Measures, designated a Secondary "A" aquifer	Leaching and vertical migration	Likely	Mild	**Moderate/Low**: Underlying groundwater receptor not highly sensitive.
	The River Dearne, 500m from the site	Leaching and lateral migration, and via surface drainage runoff	Likely	Mild	**Moderate/Low**: Little shallow groundwater expected but may be some migration of contaminants via surface runoff and drainage.

Potential Contaminant	Potential receptor	Possible pathway	Probability	Consequence	Risk and justification
Combustible material, potentially present within made ground	Future site residents and residents and commercial workers, on adjacent sites	Ignition of material and subsequent inhalation of combustion products	Low likelihood	Medium	**Moderate/Low**: Potential short term adverse health effect.
	Site residents and users	Ignition of material and subsequent migration of combustion causing danger of falling into hot voids in ground	Unlikely	Severe	**Moderate**
	Proposed houses and infrastructure	Ignition of material and subsequent migration of combustion causing ground settlement damage or fire damage to buildings or infrastructure	Low likelihood	Mild	**Low**: Significant damage to buildings and infrastructure is normally classified as 'Mild'.
Ground gases, from the degradation of made ground, or released from underlying coal measures strata and worked coal seams	Future site residents	Ground gas migration, inhalation and possible asphyxiation.	Unlikely	Severe	**Moderate/Low:** Unlikely based on the 2007/2008 monitoring data, but requires further investigation because of the potentially severe consequences
	Proposed houses and future site residents	Ground gas migration and, accumulation in confined spaces, potentially leading to explosion, with the possibility of personal injury or death.	Unlikely	Severe	**Moderate/Low:** Unlikely based on the 2007/2008 monitoring data, but requires further investigation because of the potentially severe consequences
	Residents and commercial workers, on adjacent sites	Ground gas migration	Very unlikely	Severe	**Low:** If significant on-site risks are identified this linkage should be further assessed, because of the potentially severe consequences

The potential pollutant linkages with a risk of moderate/low or above that require further investigation are:

1. direct contact between future site users and impacted shallow soils
2. chemical attack on potable water supply pipes
3. uptake of phytotoxic contaminants by plants
4. leaching of contaminants and migration to groundwater in the underlying Secondary 'A' aquifer
5. leaching of contaminants and migration via surface water drainage to the River Dearne
6. ignition of combustible material within made ground and subsequent risks to site users from voids in the ground and inhalation of combustion products
7. migration of ground gases into future buildings on site and harm to occupants from asphyxiation or explosion.

4 SITE INVESTIGATION METHODOLOGY

RSK carried out intrusive investigation work and subsequent ground gas and groundwater monitoring between August and November 2013 to achieve the aims identified in Section 3.7.

4.1 Sampling strategy and methodology

The techniques adopted for the investigation were chosen considering the anticipated ground conditions, existing land use and the proposed development. Investigation locations were chosen to supplement previous intrusive investigations, and targeted areas of the site such as the infilled settlement lagoons and the remains of building foundations present on site.

Cable percussion boreholes were sunk using a Dando 2000 rig, through fill materials to the underlying bedrock in order to establish the depth of the made ground across the site. This drilling technique is able to penetrate through cohesive and most granular soils and into shallow weathered bedrock, and carry out Standard Penetration Tests (SPTs) during the drilling. Gas and groundwater monitoring wells were installed in each of the boreholes.

Rotary boreholes were drilled using a vehicle-mounted Massenza M.I.6 rig using an open-hole water-flush method. The objectives were to determine the depth and approximate thickness of the coal seams, identify whether they may have been worked and assess the thickness and competency of rock above any worked seams. These boreholes were backfilled with arisings and, where the volume of arisings was insufficient to fill the hole, bentonite.

In the weeks following those intrusive works return visits to the site were made to collect groundwater samples and to undertake ground gas monitoring.

4.2 Health and safety considerations

A site-specific health and safety plan was created to cover all of the works involved.

Plans showing the routes of any underground services were provided by the client in advance of intrusive works, and all investigation locations were scanned by the RSK engineer using a cable avoidance tool.

Water flush was used during the rotary drilling as this is considered a safer flush technique than compressed air. This is because it decreases the risk of combustion in the coal seams, reduces the potential for hazardous gases to migrate to the surrounding

environment and buildings and prevents the dispersion of any potentially contaminated dust into the atmosphere.

4.3 Investigation locations

The following site work was carried out between 5 August and 19 September 2013:

- twenty-seven trial pits, excavated to a maximum depth of 4.4m
- nine cable percussion boreholes, sunk to depths between 4.18m and 12.73m with SPTs at 1.5m intervals
- six rotary boreholes to depths between 9.2m and 30.0m
- nine shallow groundwater/ground gas monitoring installations installed in the cable percussion boreholes
- four skip load tests, set up to monitor the long term settlement response of the made ground under loading.

The investigation and the soil descriptions were carried out in general accordance with 'BS 5930:1999. Code of Practice for Site Investigations' (BSI, 1999). The exploratory hole records are presented in **Appendix D**.

The trial pits and boreholes were located firstly to provide additional information regarding specific site features identified in the PRA and secondly to provide additional information to supplement previous investigations. The rationale for the locations is given in Table 2. The locations of these intrusive investigations are shown in **Figure 2**.

Table 2: Exploratory hole location rationale

Exploratory hole number	Rationale
TP201 – TP205	Targeted to investigate visible surface concrete obstructions.
TP202 – TP204	Also, to delineate southern limit of area indicated by SDA to be contaminated by PAHs
TP205	Also, to delineate north-western limit of area indicated by SDA to be contaminated by PAHs
TP206 - TP207	Targeted to investigate concrete, possibly related to adit 433409 – 016
TP208 - TP212, TP226, TP227	Targeted on recorded location* of adit 433409 – 028, search area expanded when results inconclusive
TP213 - TP215, TP221, TP222 & BH203	Targeted on recorded locations of infilled lagoons in south-western part of site, to investigate whether soft made ground may be present in these areas

Exploratory hole number	Rationale
TP216 - TP218 & BH201, BH207	Targeted on recorded locations of infilled lagoons in eastern part of site, to investigate whether soft made ground may be present in these areas
TP219, TP220 & BH206	Targeted on recorded location of backfilled opencast mine workings, in eastern part of site, that were excavated before lagoon construction
TP223 – TP225	Targeted on footprint of historic building in northeast part of site
TP225	Also, to delineate south-western limit of area on northern boundary indicated by SDA to be contaminated by PAHs
BH202, BH204, BH205, BH208, BH209	To obtain additional information in areas where previous investigation boreholes were widely spaced
R201 – R204	Section across site, in direction of dip, close to recorded adit locations, to intersect the mapped locations of the Mapplewell and Kent's Thin coal seams
R205 – R206	Section across the eastern part of the site, in direction of dip, to intersect the mapped locations of the Mapplewell and Kent's Thin coal seams

*Recorded location provided in The Coal Authority Mining Report (reference 71000481021001) provided in RSK report 321370-R1 (00).

The planned investigation locations were set out initially using a hand-held GPS unit, and then, after completion, surveyed to obtain accurate coordinates and ground levels.

4.4 Soil sampling, in-situ testing and laboratory analysis

Environmental samples were taken at each trial pit location mainly from the top 3m of the soil, as this is the soil that would pose the greatest risk to human health if it was contaminated. Samples were occasionally taken from greater depths in order to provide information on deeper soils. A sample of the soils within an earth mound on the southern part of the site was also recovered. The sampling location is shown on **Figure 2**.

Soils for laboratory analysis were collected in a variety of containers appropriate to the anticipated testing suite required. Samples were stored in accordance with the RSK quality procedures to maintain sample integrity and preservation and to minimise the chance of cross contamination.

All samples are recorded together with their depths on the exploratory hole records in **Appendix D**. The samples were transported to the laboratory in chilled cool boxes. Laboratory chain of custody forms can be provided if required. A selection of samples were tested for a suite of chemicals appropriate to the potential contaminants identified in the conceptual site model. The results of the laboratory soil testing are presented in **Appendix E**.

SPTs were carried out in boreholes at 1.5m intervals during the cable percussion drilling, in accordance with part 9 of BS 1377:1990 (BSI, 1990). Test results are given on the borehole records presented in **Appendix D**. Disturbed samples were taken at 1.5m intervals for subsequent geotechnical analysis. Bulk samples for geotechnical analyses were also recovered from trial pits.

4.5 Groundwater monitoring and levelling

Depths to any groundwater were recorded using an electronic interface probe during the drilling process and then after the completion of monitoring wells on 30 July 2013. The monitoring results are presented alongside the gas monitoring data in **Appendix F**.

4.6 Groundwater developing, sampling and analysis

Subsequent to the installation of groundwater monitoring wells the installations were developed at least one week before sampling.

Groundwater samples were retrieved using a United States Environment Protection Agency (USEPA) approved low-flow purging and sampling methodology. The low-flow method relies on moving groundwater through the well screen at approximately the same rate as it flows through the geological formation. This results in a significant reduction in the volume of water extracted before sampling and significantly reduces the amount of disturbance of the water in the monitoring well during purging and sampling. Drawdown levels in the monitoring well and water quality indicator parameters (pH, temperature, electrical conductivity, redox potential and dissolved oxygen) are monitored during low-flow purging and sampling, with stabilisation indicating that purging is complete and sampling can begin. As the flow rate used for purging, in most cases, is the same or only slightly higher than the flow rate used for sampling, and because purging and sampling are conducted as one continuous operation in the field, the process is referred to as low-flow purging and sampling.

In-situ water quality measurements undertaken during the low-flow sampling process are provided in **Appendix F**. In some of the boreholes the slowest pump setting was faster than the recharge rate in the boreholes, so the groundwater level was drawn down. In these cases the in-situ water quality measurements were not taken, and samples were taken immediately.

The groundwater samples were collected in containers appropriate to the anticipated testing suite required. The containers were filled to capacity and placed in a cool box to minimise volatilisation. Samples were transported to the testing laboratory under chain of custody documentation. The results of the laboratory groundwater testing are presented in **Appendix G**.

4.7 Surface water sampling and analysis

Surface water samples were taken from the culverted stream that runs from west to east in the southern part of the site. An upstream sample, labelled 'upstream' was taken at the first available on-site point in the stream, and a downstream sample, labelled 'downstream' was taken at the last available on-site point, close to the gate that provides access to the site from Carr Green Lane.

The surface water samples were collected in containers appropriate to the anticipated testing suite required. The containers were filled to capacity and placed in a cool box to minimise volatilisation. Samples were transported to the testing laboratory under chain of custody documentation.

4.8 Ground gas monitoring

An attempt was made to locate the monitoring wells installed by SDA during earlier phases of investigation. Only one well could be located and that was seen to be unsuitable for monitoring, because the slotted casing extended above ground level, potentially permitting movement of ground gas out of, and surface water into, the well. Consequently, only the nine wells installed by RSK during the present phase of work could be monitored. Six gas monitoring rounds were undertaken.

An infrared gas meter was used to measure gas flow, concentrations of carbon dioxide (CO_2), methane (CH_4) and oxygen (O_2) in percentage by volume, while hydrogen sulphide (H_2S) and carbon monoxide (CO) were recorded in parts per million. Initial and steady state concentrations were recorded.

All monitoring results together with the temporal conditions are contained within **Appendix F** and discussed in Section 5.4.

4.9 Skip tests

Preparations for the skip load tests commenced on 18 September 2013. Four test locations were selected, to assess areas with differing thickness and type of made ground, located as follows:

- P1 –over made ground (near TP135, made ground to 3.7m)
- P2 –over deep made ground (near BH10, made ground to 8.6m)
- P3 –over made ground (near TP143, made ground to 3.7m)
- P4 – located over an infilled lagoon (near BH206, clayey made ground to 4.8m).

These test locations are shown on **Figure 2**.

Each test area was prepared by excavating any soft or loose material. Timber shuttering was then fixed in place at each location, to form a test foundation 1.5m square, and 0.5m thick. The concrete was poured on 19 September 2013. Four survey sleeves were installed, one in each face of the foundation, to form accurate survey points for the settlement measurements.

The initial foundation levels were determined for the first time on 23 September 2013, a week before the foundations were loaded. On this occasion only 3 of the 4 survey points on P1 and P2 could be monitored, as the inserts had been damaged during installation. The foundation levels were again determined early on 1 October 2013, using these original datum points, before the skips were placed on each foundation.

The load placed on each foundation comprised a pair of $6yd^3$ skips, filled with mudstone fill excavated on site, and placed one on top of the other.

The levels were again determined on 3 October 2013, after the second skips had been placed. The overhang of the skips beyond the foundation prevented the use of the original survey points, therefore it was necessary to establish new survey points on the foundation. The levels of each foundation were then determined on nine further occasions.

The preliminary results of the tests, not corrected to the original datum points, are presented in tabular form in **Appendix H**, shown graphically on **Figure 7** and are discussed in **Section 5.5**.

5 GROUND CONDITIONS

The results of the intrusive investigation and subsequent chemical analyses and geotechnical testing undertaken are detailed below. The descriptions of the strata encountered, notes regarding visual or olfactory evidence of contamination, list of samples taken, field observations of soil and groundwater, in-situ testing and details of monitoring well installations are included on the exploratory hole records presented in **Appendix D**.

5.1 Soil

The exploratory holes revealed that the site is underlain by a variable thickness of made ground over Coal Measures bedrock. In some areas of the site there was a thin layer of glacial till, although this appeared to be less extensive than was indicated by previous reports. For the purpose of discussion, the ground conditions are summarised in Table 3 below and the strata are discussed in subsequent subsections.

Table 3: General succession of strata encountered

Strata	Exploratory holes encountered	Depth to top of stratum m bgl	Reported Thickness (m)
Made ground	All boreholes and trial pits	Ground level	0.3 to 11.8
Glacial till	TP209 to TP212	2.3 to 2.9	0.3 to 0.7, but full depth not proved
Coal measures mudstone/sandstone	R201 to R206, BH201, BH203 to BH207, BH209, TP214, TP215, TP221, TP225	0.3 to 11.8	Full depth not proved
Coal	R201, R202, R203 and R206	3.2 to 23.3	0.2 to 4.8

5.1.1 Made ground

Evidence of former mining activities was observed in trial pits throughout the site area, and included concrete, pipes, steel reinforcement, wire ropes unidentified metal objects and timber.

Boulders were encountered in many trial pits, and measured up to 1.0m across. Both natural sandstone boulders and large pieces of concrete were reported. It is probable that larger boulders, especially pieces of concrete, could be present on site.

The composition of the made ground varied in different areas of the site. Where possible, these variations have been summarised in the following generalised descriptions. The thickness of the made ground as proved both in the previous phases of work and the RSK trial pits and boreholes is shown on **Figure 3**, and obstructions

encountered in the made ground during the RSK trial pit investigation are detailed on **Figure 4**.

In the old lagoons area in the eastern part of the site: Made ground ranged in thickness from 2.4m to 4.8m and generally comprised brown to black sandy gravelly clay and clayey gravelly sand with pockets of sandy gravel and cobbles. The gravel and cobbles generally consisted of mudstone, sandstone and brick. Gravel and cobbles encountered were generally very angular to subrounded mudstone and sandstone and brick. In BH206 and BH201 coal fragments were occasionally encountered. Sandstone boulders and cobbles of clinker were recorded in BH206. Soils in this area were generally finer than those found in the former railway and buildings areas.

This area is further complicated in that it was occupied by the former opencast. The full depths of made ground were proved in two boreholes, BH09 and BH206, located either side of the northern perimeter of the former opencast. Thickness of made ground encountered either side of the former opencast perimeter were proved to be 3.8m and 4.8m bgl.

In the old lagoons area in the south-western corner of the site: The made ground ranged in thickness from 1.5m to 3.7m. It generally comprised grey/brown clayey gravelly sand and sandy gravelly clay over reworked clay. Gravel consists of mudstone, sandstone, siltstone and brick. Occasional cobbles and boulders were observed. In TP214 coal fragments were observed. Soils in this area were generally finer than those found in the former railway and buildings areas.

At the site of the former railway sidings towards the western side of the middle tier: The made ground ranged in thickness from 1.8m to 11.8m, and generally consisted of black gravelly clays and sands over sandy gravel with occasional cobbles and boulders. Gravel comprises sandstone, mudstone, brick and coal fragments.

In the vicinity of former buildings: The made ground ranged in thickness from 0.3m to 3.8m comprising black gravelly sandy clay, gravelly clay, gravelly sand and sandy gravel. Gravel consisted of sandstone, mudstone, brick and coal with cobbles and boulders. Generally soils were coarser than those encountered in the lagoon areas. Demolition material was more evident in this area than the rest of the site, and TP203 comprised mostly demolition material.

In three trial pits (TP203, TP204 and TP216) hydrocarbon odours were recorded and a slight sulphurous odour was noted in TP216.

A summary of the properties of made ground derived from the RSK investigation is presented in Table 4, together with results from previous investigations for comparison.

Table 4: Summary of in-situ and laboratory test results for made ground

Soil parameter	RSK Range (Number of tests)	Reference	Previous Range
Liquid limit (%)	39 to 49 (5)	Appendix L	48 to 54
Plastic limit (%)	20 to 26 (5)	Appendix L	22 to 32
Plasticity index (%)	19 to 24 (5)	Appendix L	not stated
Plasticity term	Intermediate	Appendix L	not stated
Moisture content (%)	13 to 36 (5)	Appendix L	17 to 43
SPT 'N' values	3 to 9 (16) 10 to 50 (7)	Appendix D	0 to 5 (4) 10 to 50 (41)
Maximum dry density (Mg/m^3)	1.35 to 1.73 (6)	Appendix L	1.18 to 1.71
Optimum moisture content (%)	15 to 22 (6)	Appendix L	14 to 17

It is noted that the previous report indicated some samples of higher plasticity than the RSK samples. These higher results are comparable to the results for weathered coal measures mudstone reported in Table 5 below.

The SPT values reported in the cable percussion boreholes sunk during the 2008 investigation by SDA, BH101 to BH117, were generally higher than those reported in the RSK investigation. In only three SDA boreholes, BH112, BH113 and BH117 were SPT values in made ground of less than 10 reported, and two of these locations, BH113 and BH117, were within infilled lagoons. At only one location, BH112, was a particularly low SPT reported outside a recorded lagoon area. During the RSK investigation SPT values below 10 were reported in all nine boreholes. This in part confirms the previous finding of potentially softer/looser ground in lagoon areas, as four of the RSK boreholes (BH201, BH203, BH206 and BH207) were targeted on such areas. However, the RSK results do indicate some lower SPTs in areas not affected by recorded lagoons.

5.1.2 Superficial deposits

During previous investigations bands of glacial till were reported across large parts of the site. RSK engineers found angular mudstone, sandstone and siltstone gravels within these strata, although the colour and characteristics of the clay was clearly distinct from the strata above and below. RSK considers that much of the material previously described as glacial till is actually reworked glacial till. Material that RSK considers to be natural (i.e. in-situ) glacial till was encountered only as a thin stratum in TP209, TP210 and TP211.

5.2 Bedrock

Bedrock was encountered at depths between 2.0m (R206) and 11.8m (BH205). In most of the boreholes and trial pits grey mudstone or yellowish brown sandstone was encountered directly underlying the made ground, although in some locations the material was highly weathered. The coal measures strata penetrated by the rotary boreholes included occasional coal.

A summary of the properties of the weathered upper layers of the mudstone derived from the RSK investigation is presented in Table 5. No comparable results are available from earlier investigations.

Table 5: Summary of in-situ and laboratory test results for weathered mudstone

Parameter	Range (%) (Number of tests)	Reference
Liquid limit (%)	47 to 56 (2)	Appendix L
Plastic limit (%)	21 to 24 (2)	Appendix L
Plasticity index (%)	26 to 32 (2)	Appendix L
Plasticity term	Intermediate to high	Appendix L
Moisture content (%)	21 to 25 (2)	Appendix L
SPT 'N' values	24 to 50 (18)	Appendix D
Maximum dry density (Mg/m^3)	1.54 and 1.73 (2)	Appendix L
Optimum moisture content (%)	19 and 23 (2)	Appendix L

5.3 Groundwater

Groundwater was encountered during the excavation of trial pits TP208, TP213, TP216 to TP218 and TP222. Groundwater strikes were encountered between 0.8 and 1.5m depth and groundwater was encountered from 1.7m to 1.8m.

Water flush was used during the rotary drilling, so it is possible that groundwater could have been present but not detected in the rotary boreholes. Water was recycled back into the rotary holes, during drilling and there was never a time when water was coming back out of a borehole at a faster rate than it was being pumped into the borehole. This indicates that artesian groundwater was not encountered during the rotary drilling. Partial or complete loss of flush into suspected old coal workings was reported in three rotary boreholes, R203, R204 and R205.

Subsequent monitoring has recorded the presence of groundwater in six of the nine cable percussive boreholes, at a level between 69m and 76m AOD. The full results are presented with the gas monitoring data in **Appendix F**.

It should be noted that groundwater levels might fluctuate for a number of reasons including seasonal variations. There had been little rain on site for a number of weeks prior to or during the site investigation.

The results of the subsequent groundwater monitoring undertaken during the first gas monitoring visit are summarised in Table 6.

Table 6: Groundwater monitoring data (initial round)

Monitoring well	Depth to base of made ground (m)	Material underlying made ground	Depth to water (mb TOC)	Water level (m AOD)
BH201	5.20	Mudstone	0.956	71.884
BH202	2.20	Clay, over mudstone	4.379	70.509
BH203	3.10	Sandstone	3.905	72.195
BH204	2.40	Clay, over weathered sandstone	Dry	Below ~78.7
BH205	11.80	Mudstone	10.368	75.318
BH206	4.80	Mudstone	6.030	69.530
BH207	5.50	Mudstone	5.700	75.778
BH208	4.80	Clay over weathered mudstone and sandstone	Dry	Below ~83.3
BH209	3.80	Sandstone	Dry	Below ~85.6

The results are similar to the previous monitoring by SDA, which reported variable groundwater depths in the range 0.1m to 7.2m below ground level (bgl), although the report noted these levels were generally within the made ground.

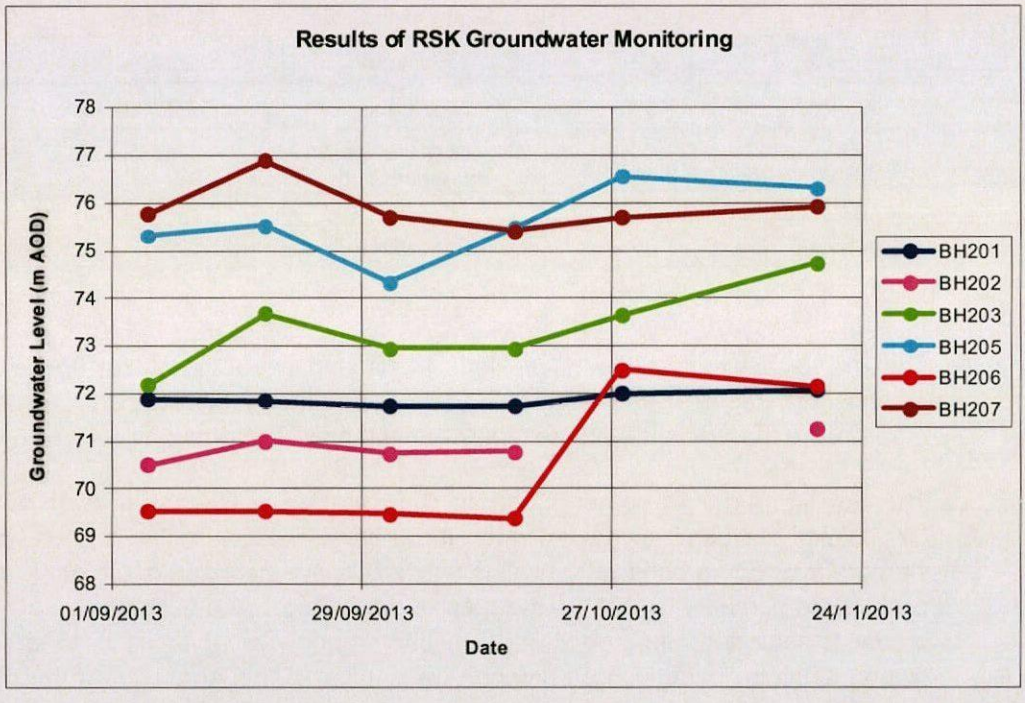
The monitoring results do not appear to show any link between the depth of the made ground and the depth to groundwater. In borehole BH205 (in the northern part of the site) the recorded groundwater level is only just above the base of the made ground. In contrast, in borehole BH201 (in the area of the infilled south-eastern lagoon) the made ground is saturated with groundwater close to ground level. It is possible that the former lagoon structure is retaining a perched water table in this area. But in the other three monitoring locations in former lagoon areas (BH203, BH206 and BH207) the groundwater level was below the base of the made ground, within the coal measures, rather than within the lagoon. In BH202 (not in a lagoon area) the groundwater level was also below the base of the made ground, within the coal measures.

During the subsequent RSK monitoring visits groundwater levels generally showed a rising trend, which appears consistent with the persistent wet weather during the monitoring period. The levels are detailed in Table 7.

Table 7: Groundwater monitoring data (long term)

Monitoring well	Level Round1 (m AOD)	Level Round2 (m AOD)	Level Round3 (m AOD)	Level Round4 (m AOD)	Level Round5 (m AOD)	Level Round6 (m AOD)
BH201	71.884	71.844	71.735	71.731	72.010	72.090
BH202	70.509	71.015	70.748	70.790	Dry	71.253
BH203	72.195	73.680	72.960	72.950	73.650	74.755
BH205	75.318	75.537	74.336	75.481	76.566	76.311
BH206	69.530	69.536	69.479	69.385	72.510	72.155
BH207	75.778	76.896	75.718	75.418	75.708	75.933

These results are shown below in graphical form:



In borehole BH201, where shallow perched groundwater was encountered within the made ground of the former lagoon, the level rose by approximately 0.2m, to within 0.7m of ground level. In two of the other three monitoring locations in former lagoon areas boreholes BH203 and BH206 large rises in level of approximately 2.6m were recorded, with the final levels monitored being within the made ground, rather than in the coal measures strata. A smaller rise of only about 0.15m was recorded in BH207, the other well within a former lagoon area. In wells BH202 and BH205, not situated in lagoon areas, rises of approximately 0.75m and 1.0m were recorded.

The check on well installation depth made during monitoring, as recorded on the field sheets presented in **Appendix F**, shows a variation of approximately 2.5m in the depth of well BH205 between several of the monitoring rounds. The well cover was vandalised, and an obstruction may have been dropped down the well. It is thought that the dipmeter sometimes catches on the obstruction, and sometimes not, giving the anomalous result that the recorded depth became shallower, then deeper again. Reasonably consistent overall installation depths were reported during the monitoring of the remaining wells.

The monitoring results do not provide a firm indication of the direction of groundwater flow, but if BH201 is omitted (as perched water) the levels are generally consistent with a southerly flow, as might be expected from the proximity of the River Dearne.

Where the made ground is underlain by glacial till or weathered mudstone the vertical permeability is likely to be of low, and hence the potential for vertical migration of any contaminants that may be present is low, but where the made ground directly overlies sandstone the permeability is likely to be higher, and vertical migration may be possible.

Laboratory chemical analysis of groundwater samples identified concentrations of water-soluble sulphate ranging between 995mg/l (BH203) and 3,860mg/l (BH207).

The groundwater analytical results are presented within **Appendix G**.

5.4 Ground gas regime

During the drilling of rotary borehole R206 violent bubbling of the water flush return was reported at 14.0m depth, in a stratum interpreted from the returns as a coal seam. No elevated concentrations of methane or carbon dioxide could be measured at the borehole casing.

The full results of the ground gas monitoring carried out to date are given in **Appendix F**. A summary of the maximum (for methane, carbon dioxide and flow) and minimum concentrations (for oxygen) recorded in Table 8.

Table 8: Summary of ground gas monitoring results

Borehole	Strata	Number of monitoring visits	Methane (% v/v) Maximum	Carbon dioxide (% v/v) Maximum	Oxygen (% v/v) Minimum	Flow rate (l/hr) Maximum
BH201	MG	6	0.1	9.4	16.6	15.2
BH202	MG	6	0.1	8.8	10.8	0.1
BH203	MG	6	0.1	6.2	13.9	0.1
BH204	MG	6	0.1	3.8	15.3	0.1
BH205	MG	6	0.1	7.2	12.6	0.1
BH206	MG	6	0.1	9.5	0.5	0.1

Borehole	Strata	Number of monitoring visits	Methane (% v/v) Maximum	Carbon dioxide (% v/v) Maximum	Oxygen (% v/v) Minimum	Flow rate (l/hr) Maximum
BH207	MG	6	0.1	8.4	12.3	0.1
BH208	MG	6	0.1	6.9	11.3	0.1
BH209	MG	6	0.1	4.6	16.2	0.1

To understand atmospheric pressure conditions in the days leading up to each of the gas monitoring visits historical weather data has been obtained from an internet resource (www.wunderground.com). The data is obtained from the closest weather station to the site, which in this case was Darton, Barnsley. For each of the gas monitoring visits the average sea level atmospheric pressure recorded on the three days leading up to the visit and on the day of the monitoring are presented in Table 9.

Table 9: Regional atmospheric pressure prior to gas monitoring

Monitoring date	Pressure 3 days before (mb)	Pressure 2 days before (mb)	Pressure 1 day before (mb)	Pressure on day of sampling	Pressure pattern
05/09/2013	1018	1020	1010	1006	Falling
18/09/2013	990	992	990	992	Constant
02/10/2013	1006	1004	1005	1005	Constant
16/10/2013	1013	1008	1010	1003	Falling
28/10/13	1000	997	986	983	Falling
19/11/13	1028	1024	1009	1012	Brief rise

5.5 Preliminary results of skip load tests

The monitoring results to date for the four test foundations, referenced P1, P2, P3 and P4, are presented in graphical form on **Figure 7** and in tabular form in **Appendix H**, which also includes the calculations showing the applied load on each foundation.

Test P1 – near TP135 (over made ground to approx. 3.7m)

The applied foundation load during this test was calculated as 88kN/m^2.

Six days after the initial loading the settlements of the four monitoring pins ranged from 7.0mm to 10.5mm, averaging 8.6mm. Subsequently, the reported settlements decreased slightly, then continued to vary, with an amplitude of approximately 2mm. At the time of the last available reading, on 10 January 2014, approximately 14 weeks after the initial loading, the maximum recorded settlements remained as 10.5mm, although

the average settlement of the four monitoring points was then 7.1mm, 1.5mm less than the initial settlement.

A maximum total settlement of 11mm, and differential settlement of up to 6mm is considered representative of Test P1.

Test P2 – near BH10 (over deep made ground to approx. 8.6m)

The applied foundation load during this test was calculated as 83kN/m^2.

Six days after the initial loading the settlements of the four monitoring pins ranged from -1.6mm to 16.8mm, a differential of 18.4mm. These early readings appear erratic, but the later readings were apparently more stable and showed smaller differentials. On 1 November 2013, approximately 4 weeks after the initial loading, the maximum recorded settlement was only 10.8mm, and the maximum differential settlement was also reduced to 6.4mm. At the time of the last available reading, on 10 January 2014, the maximum recorded settlements remained as 10.8mm, although the maximum differential settlement had reduced to 4.4mm.

A maximum total settlement of 11mm, and differential settlement of up to 5mm is considered representative of Test P2. The presence of deeper made ground at this location appears to have had little effect on the settlement characteristics.

Test P3 – near TP143, (over made ground to approx. 3.7m)

The applied foundation load during this test was calculated as 96kN/m^2.

Immediately after loading, the reported results were erratic, ranging from a settlement of 10.2mm to a heave of 5.2mm, a differential of 15.4mm. Subsequently the results remained somewhat erratic, until by 29 November 2103 much more consistent settlements were reported, ranging from 7.6mm to 9.2mm, a differential of only 1.6mm.

During subsequent rounds of levelling three of the measurement points, P3-3, appeared to heave, whist one continued to settle. At the time of the last available reading, on 10 January 2014, the maximum recorded settlement had increased to 12.2mm, and the maximum differential settlement had increased to 8.6mm. Inspection of Figure 7 suggests that the readings for monitoring point P3-3 may be erroneous, as its deflections bear no relationship to the other points monitored.

A maximum total settlement of 10mm and an average differential settlement of 4mm is considered representative of Test P3. This test result is similar to tests P1 and P2.

Tests P3 –near BH206 (over infilled lagoon, clayey made ground to 4.8m)

The applied foundation load during this test was calculated as 115kN/m^2.

Six days after the initial loading the settlements of the four monitoring pins ranged from 9.6mm to 14.8mm, a differential of 5.2mm. Some of the early readings appear erratic, but the later readings were apparently more stable. On 1 November 2013 the maximum

recorded settlement had increased to 12.9mm, and the maximum differential settlement to 8.3mm. At the time of the last available reading, on 10 January 2014, the maximum recorded settlements had increased to 15.9mm, and the maximum differential settlement had increased to 11.3mm.

A maximum total settlement of 16mm and differential settlement of up to 12mm is considered representative of Test P4. This test result suggests that over former lagoon areas both total settlements and differential settlements are likely to be greater than in areas of more typical made ground of a similar thickness.

Skip test summary

The tests indicate that total and differential settlements are generally low in the areas of typical made ground, but greater settlements are likely in locations overlying the infilled lagoons. Most of the settlement of the made ground occurred shortly after loading.

5.6 Investigation of potential shallow underground mining

5.6.1 Rotary probe drilling

Six rotary boreholes, designated R201 to R206 were drilled between 22 August and 2 September 2013 to investigate the potential presence of shallow mine workings in the area indicated by the coal mining risk assessment report. The locations of the boreholes are shown on **Figure 2** and the borehole records are presented in **Appendix D**.

5.6.2 Boreholes R201 to R204

These boreholes were intended to form a section across site, in the direction of the dip of the strata, close to the recorded adit locations, to intersect the mapped outcrops of the Mapplewell and Kent's Thin coal seams.

A section has been drawn across these boreholes, together with rotary boreholes RO1, RO2, RO3 and RO12 drilled during the SDA investigation, and is presented as **Figure 5**.

In borehole R201, located to the southwest of the mapped outcrops, a thin coal was reported between 23.3m and 23.5m depth, but there was no evidence of workings.

In borehole R202, located at or close to the expected location of the Mapplewell coal outcrop, only a thin coal was reported between 13.8m and 14.0m depth, and again there was no evidence of workings.

In borehole R203, located to the northeast of the mapped outcrop, a workable thickness of coal was reported at 10.0m depth, accompanied by some loss of flush, indicating possible workings in the vicinity. This seam appears to correlate with the expected location of the Mapplewell coal. At this point the rock cover above the roof of the seam is only about 4m, so it will be necessary to stabilise any workings in this area.

Based on the available mapping, it was expected that borehole R204, located further down-dip, would intersect the Kent's Thin seam at shallow depth but no evidence of a shallow seam was observed at this location. An open void was reported between 18.2m and 21.0m depth, accompanied by total loss of flush indicating, based on its thickness, a roadway or adit. This again appears to correlate with the expected level of the Mapplewell coal. At this point the rock cover above the roof of the seam was about 13m. This cover would be adequate for workings in the expected worked seam thickness of circa 1.0m, but would not be adequate at this particular location because of the height of the void encountered, so it will be necessary to stabilise this area.

The available data assessed in the coal mining risk assessment, including shaft records and published maps, variously indicated the dip of strata as between 1:12 and 1:21. Boreholes R203 and R204 were located 87.1m apart, and the seam was located at a level 3.01m deeper in R204, which suggests an apparent seam dip of only 1:29. As the line of section between the two holes is approximately in the direction of the expected dip, the true dip is likely to be only slightly greater than this value.

5.6.3 Boreholes R205 and R206

These boreholes were intended to form a section across the eastern part of the site, in the direction of the dip of the strata, to intersect the mapped outcrops of the Mapplewell and Kent's Thin coal seams. A section has been drawn across these boreholes, together with rotary boreholes drilled during the SDA investigation, and is presented as **Figure 6**.

In borehole R205, located to the northeast of the mapped outcrop of the Mapplewell coal, a void was reported at 10.0m depth, accompanied by total loss of flush, indicating the likely presence of old workings. This seam appears to correlate with the expected location of the Mapplewell coal. At this point the rock cover above the roof of the seam is only about 3m, so it will be necessary to stabilise any workings in this area. The level of the top of the seam was calculated as 70.11m AOD.

Based on the available mapping, and BGS shaft logs, it was expected that borehole R206, located further down-dip, would intersect the Kent's Thin seam at shallow depth, and then the Mapplewell seam approximately 20m below it. The Kent's Thin seam is recorded as typically 0.6m thick. The interpretation of this borehole is uncertain, as coal was reported at 3.2m depth and continued intermittently down to 16.0m depth. It appears possible that the principal seam was at 14.0m depth, where violent bubbling of gas was recorded. No further significant evidence of coal or workings was observed, although the borehole was extended to 30m depth. This appears to be an anomaly, as the seam located at ~70m AOD in R205 a distance of 129m up-dip should, assuming the dip to be between 1:12 and 1:29, have been intersected somewhere above 30m depth in R206.

5.6.4 Shallow mine workings

Based on the presence of coal at shallow depth, and the partial or complete loss of flush returns reported at several locations during drilling at shallow depth, is concluded that

shallow mine workings with the potential to adversely affect the development are present in the land underlying much of the north-eastern part of the site.

The area requiring treatment is limited to the southwest by the outcrop of the Mapplewell (Kent's Thick) Coal and it will be necessary to extend the treatment north-eastwards until adequate rock cover is proved to this seam. The section through boreholes R203 and R204 suggests that the seam dip, which was stated in published data as between 1:12 and 1:21 is almost certainly at the shallower end of this range, and may be as shallow as the dip of 1:29 calculated from these boreholes. It should be recognised that if the dip is less than was originally expected, the treatment area may be greater, to achieve sufficient rock cover over the workings.

The section through boreholes R205 and R206 was anomalous, but both boreholes proved areas where treatment of shallow workings is required.

The approximate extent of the area requiring drilling and grouting is shown on the Constraints Plan, **Figure 8**.

5.7 Investigation of concrete obstructions

The extent of former buildings on site and other surface concrete obstructions indicated by the topographic survey are shown on **Figure 4**.

Six of these areas were investigated by trial pitting to determine, where possible, the depth of concrete present. The results of these excavations are shown in the sketches included on **Figure 4**.

The excavations revealed typical concrete thicknesses between 0.3m and 1.6m, although it should be recognised that, in some locations, these thicknesses may be exceeded, or concrete will be encountered beneath a covering of made ground.

5.8 Investigation of mine entries

The coal mining risk assessment identified eight abandoned mine entries on or potentially affecting the site. The available desk study information regarding these entries is presented in Table 10. The full coal authority reference is stated in the table, but in the following discussion RSK has used only the last 3 digits of the reference as these are unique. The walkover inspections and, if applicable, the details of the investigations carried out at these locations are summarised in Table 11.

Table 10: Summary of mine entry information from desk study

Coal Authority Ref.	432409 026	432409 027	433409 001	433409 011	433409 005	432409 025	433409 016	432409 028
Entry name	Unknown	Unknown	North Gawber Colliery Barnsley Downcast	North Gawber Colliery No.1 Adit	North Gawber Colliery Air Shaft	Unknown	Old Adit	North Yorkshire Adit
Dimensions of Shaft (m)	Unknown	Unknown	96.0m deep 3.0m dia.	Unknown	51.0m deep	Unknown	Unknown	Unknown
Additional sources of location information	None	None	"Shaft" on OS map	"No. 1 Adit" on NCB plan	"Air Shaft" on OS map	None	Adit on abandonment plan	Adit on abandonment plan
Reliability of location information	Unknown	Unknown	Good	Unknown	Good	Unknown	Fair	Fair
On or off site	Probably off site	On site	On site	Probably off site	On site	Probably off site	On site	On site
Within area of proposed housing	If on site, in open space	Within housing	Within housing	If on site, within housing	Within housing	If on site, in open space	Within housing	Within housing
Treatment recorded	None	None	Filled 1967, capped 2005. Cap 6m x 6m, at 3.8m below ground	Filled 1987	None	None	None	None

Table 11: Summary of mine entry investigations

Coal Authority Ref.	432409 026	432409 027	433409 001	433409 011	433409 005	433409 025	433409 016	433409-28
Easting	432895	432955	433228	433126	433071	432883	433015	432997
Northing	409825	409761	409752	409830	409617	409833	409687	409705
Observations during walkover	No visible evidence of shaft seen, recorded as located off site	Depression in ground near footprint of former building	Large rectangular concrete slab, appears to be shaft cap.	No visible evidence of adit seen, recorded as located off site	No visible evidence of shaft seen, wooded area, underlain by made ground (3m approx.)	No visible evidence of shaft seen, recorded as located off site	No visible evidence of adit seen	No visible evidence of adit seen
Intrusive investigations	None	Not considered safe to investigate obvious depression using a JCB. Larger backhoe required	None	None	None	None	TP206 & TP207 were targeted to investigate concrete, possibly related to adit. Made ground and brick located, but evidence inconclusive	TP208 to TP212 targeted on recorded location of adit. Search area expanded to TP226 & TP227 when results inconclusive. Still no visible evidence of adit seen
Geophysical investigation	None	None	None	None	None	None	None	None

Shaft 001 has been treated and capped and it is considered that no further action is required, other than to ensure that a suitable no-build zone is defined around its location. Based on the recorded shaft diameter of 3m, and the expected depth of made ground in the vicinity of about 3m, (based on TP78-2008), it is suggested that a no-build zone 9m in diameter, centred on the concrete cap location, would be appropriate but it would be necessary for this distance to be agreed with the Coal Authority, the Local Authority and, if appropriate, the NHBC.

Adit 011 is recorded as treated and lying outside the site boundary. The walkover identified no evidence of a possible adit within the site boundary. It is considered that no further action is required, especially as the risk from an adit is at a minimum at its recorded entrance, since the entrance is a surface feature with zero depth.

Shafts 025 and 026 are recorded as lying outside the site boundary. The walkover identified no evidence of possible shafts within the site boundary. It is considered that no further action is required, especially as the site plan shows no development close to this steeply sloping site boundary.

Numerous trial pits were excavated in the attempt to locate adits 016 and 028, but the results were inconclusive. These trial pits were positioned based on information available at the time, which include The Coal Authority Mining Report (reference 71000481021001) and constraints plans provided by others. Additional information has been made available, post site works, which indicates the adits approximately 20m to 40m south southeast of the original anticipated location. The possible new locations are indicated in **Figure 8**. It is considered that an attempt should be made to determine the location of these adits using surface geophysics. Filling, or consolidation of any existing fill within these adits will be necessary and could be completed as part of the proposed treatment of shallow workings in this area. Alternatively, as the dip of strata is shallow, there is expected to be very little cover over the adit for a considerable distance from its recorded entrance location. As it is likely that earthmoving plant will be in use on site for re-grading and preparation of the development platforms, it may prove economic to excavate to the adit level and then replace fill material in engineered layers, rather than consolidate by drilling and grouting.

An obvious depression was observed close to the recorded location of shaft 027. It was not considered safe to investigate this depression using a JCB. A larger backhoe excavator should be used, as this is capable of standing back at a safe distance from the point of excavation. Alternatively the location could be further investigated by probe drilling from a safety platform bridging the depression.

No evidence of shaft 005 was observed and further investigation is required.

Drilling and grouting treatment of shafts 027 and 005, followed by capping, is likely to be necessary.

5.9 Refinement of the initial conceptual site model

The ground conditions encountered during the RSK intrusive investigation were generally as expected from the initial conceptual model, comprising a significant and variable thickness of made ground comprising reworked superficial deposits, sandstone, and burnt and un-burnt mudstone and siltstone, overlying coal measures bedrock. Demolition material was encountered within the made ground, particularly in the north-eastern part of the site, where most of the colliery buildings were located, and in the infilled settlement lagoons in the south-western corner of the site. Some evidence of contamination was encountered in the north-eastern part of the site, and near to the former settlement lagoons in the eastern part of the site.

Based on visual inspection of the soils at the site the potential for them to be significantly contaminated is considered to be low. Hydrocarbon odours were noted at only three locations, although anthropogenic material was encountered across the site, most notably in the north-eastern corner. Dull and vitreous coal was present.

Although the investigation encountered little visual or olfactory evidence of contaminated soils and groundwater, or likely sources of ground gas, none of the potential pollutant linkages identified in the initial conceptual site model can be discounted at this stage.

Section 6 contains discussion of the results of the analyses of soil and water samples and the monitoring of ground gases and assesses the resulting risks to the identified receptors.

6 QUANTITATIVE RISK ASSESSMENT

In line with CLR11 (EA, 2004a), there are two stages of quantitative risk assessment, generic and detailed. The GQRA comprises the comparison of soil, groundwater, soil gas and ground gas results with generic assessment criteria (GAC) that are appropriate to the linkage being assessed. This comparison can be undertaken directly against the laboratory results or following statistical analysis depending upon the sampling procedure that was adopted.

6.1 Linkages for assessment

Section 3.8 presented the initial conceptual model, which identified the potential contamination linkages that required assessment by the site investigation. None of these linkages were discounted in the consideration of the refined conceptual site model in Section 5.5. The potential linkages, together with the proposed methods of assessment, are presented in Table 12.

Table 12: Linkages for generic quantitative risk assessment

Potentially relevant pollutant linkage	Assessment method
1. Direct contact between future site users and impacted soils	Comparison of the results of laboratory soil analyses to the human health GAC for residential use, presented in Appendix I
2. Chemical attack on potable water supply pipes	Comparison of the results of laboratory soil analyses to the GAC for water supply pipes, based on UKWIR (2010) guidance, presented in Appendix J
3. Uptake of phytotoxic contamination by plants	Comparison of the results of laboratory soil analyses to the GAC for phytotoxic effects, presented in Appendix K
4. Leaching of contaminants and migration to groundwater in the underlying Secondary A aquifer	Comparison of the results of laboratory groundwater analyses and the results of previous leaching tests on soils to the GAC based on environmental quality standard (EQS) values, presented in Table 1 of Appendix K
5. Leaching of contaminants and migration via surface water drainage to the River Dearne	Comparison of the results of laboratory surface water analyses to the GAC based on environmental quality standard (EQS) values, presented in Table 1 of Appendix K
6. Ignition of combustible material within made ground and subsequent risks to site users from voids in the ground and inhalation of combustion products	Qualitative discussion, based on test results presented in previous report by SDA and Building Research Establishment (BRE) guidance

Potentially relevant pollutant linkage	Assessment method
7. Migration of ground gases into future buildings on site and harm to occupants from asphyxiation or explosion	Gas screening values (GSV) have been calculated using maximum methane and carbon dioxide concentrations with maximum flow rates recorded at the site. The GSV have been compared with guidance in *CIRIA Report C665: Assessing risks posed by hazardous ground gases to buildings* (Wilson et al., 2007).

6.2 Assessment and results

The GQRA is presented for each relevant pollutant linkage in turn.

6.2.1 Direct contact with impacted soil by future site users

6.2.1.1 Introduction

The summary of contamination issues included within the previous SDA report was as follows:

- widespread soil contamination by arsenic and sulphates, with acidic conditions
- two areas of elevated PAH concentrations, located in the north-eastern part of the site
- several other minor and localised exceedances of the assessment criteria, not considered significant.

These conclusions will be re-evaluated in the following sections, with reference both to the results of recent RSK analysis of 11 additional soil samples, and the database of previous results. Note that the presence of sulphates noted by SDA is not considered a significant risk to human health and is therefore considered in the geotechnical assessment of the aggressive chemical environment for concrete, in Section 0.

The laboratory results certificates for the RSK soil samples are presented in **Appendix E**. These results have been compared against the relevant Human Health GAC, presented in **Appendix I** for residential properties with private gardens.

During the previous investigations over 200 determinations of total organic carbon (TOC) were made. The reported TOC ranged from 0.23% to 15.7% with an average of 4.2%. Using the conversion factor given in Table 8 of **Appendix I**, these values can be converted to a soil organic matter (SOM) content of between 0.4% and 27.1%, averaging 7.24%. Based on this information, where applicable, the soil assessment criteria (SAC) based on 6% SOM have been used.

6.2.1.2 *Metals and semi-metals*

The principal contaminant identified in the previous investigation was arsenic. Seven of the 11 soil samples tested by RSK also returned arsenic concentrations in excess of the SAC of 32mg/kg. The RSK samples were taken from trial pits TP203, TP204 and TP205 in the north-eastern part of the site, and TP218, TP220 and the mound sample, in and near the lagoons in the eastern part of the site.

The database of soil test results from the several investigations includes a total of over 330 samples tested for a suite of metals and semi-metals, including arsenic. In total, 108 of these samples returned arsenic concentrations in excess of the SAC. The maximum reported concentration was 271mg/kg.

For comparison, the soil geochemistry map included within the Envirocheck database indicates an estimated soil arsenic concentration on and surrounding the site of 15 to 25mg/kg, indicating that concentrations within the site are much higher than might be expected based upon the natural geology of the area.

The reported concentrations of cadmium, copper, lead, nickel, selenium and zinc were for all RSK samples, as well as for all previous samples in the database, below the appropriate SAC. The reported concentrations of chromium were generally low, and below the SAC for chromium (III). The reported concentrations of mercury were very low, and below the SAC for inorganic and methyl mercury.

It is concluded that arsenic in soil remains a contaminant of concern for this site. Remedial measures will be necessary to ensure that future site users do not have direct contact with soil containing arsenic.

6.2.1.3 *PAHs*

RSK analysed eleven soil samples, ten from trial pits and one from the mound, for the standard suite of 16 priority PAHs. The reported concentrations for each individual PAH were compared to their respective SAC. Only two exceedances were identified. The sample from TP221, between 0.3m and 0.5m depth returned a benzo(a)pyrene concentration of 5.08mg/kg, compared to the SAC of 1.0mg/kg, based on 6% SOM. The total PAH recorded for this sample was 54.8mg/kg. This trial pit was located in the lagoon area in the south-western part of the site. During the 2008 investigation trial pit TP43 had been completed close to this point, but no PAH analysis was completed on samples from this location. The sample from TP204 between 1.8m and 2.0m depth returned a benzo(a)pyrene concentration of 1.01mg/kg, but this is not considered significant.

RSK has reviewed the results of the previous PAH analyses. The previous reports analysed a total of approximately 175 soil samples. In many cases the results were reported as total PAH <5mg/kg, but generally where concentrations above the detection limit were present speciated results are provided. Seven individual PAHs were not detected at concentrations above the SAC. Benzo(a)pyrene was detected at concentrations in excess of the SAC in 16 samples, with a maximum reported

concentration of 71.1mg/kg in the sample from trial pit TP72(2008) at 1.0m depth. Inspection of all the exceedances for benzo(a)pyrene, as a marker for elevated PAHs of concern, shows some pattern. The benzo(a)pyrene exceedances are detailed in Table 13 below.

Table 13: Location of elevated benzo(a)pyrene concentrations reported by SDA

SDA Sample Location (date)	Reported Concentration (mg/kg)	Sample Depth (m)	Site Area
TP72 (2008)	71.1	1.0	**Northern site boundary**
TP18 (2005)	2.0	2.0	**North-eastern part of site**
	8.96	2.5	
TP20 (2005)	2.78	2.2	
TP77 (2008)	2.4	1.0	
TP79 (2008)	6.5	0.5	
TP104 (2009)	28	1.8	
TP105 (2009)	3.1	0.4	
TP111 (2009)	15	2.0	
TP112 (2009)	27	0.6	
TP5 (2008)	1.9	0.2	**Western edge of site**
	1.5	1.1	
TP45 (2008)	2.7	0.2	
TP134 (2009)	6.1	2.0	
TP36 (2008)	5.0	0.2	**South central part of site**
TP26 (2008)	4.0	3.0	**Eastern site boundary**

Many of the samples listed were taken at depths where direct contact is very unlikely, but as the SAC for the inhalation pathway is 2.9mg/kg, the deeper samples may also be of concern for human health.

Inspection of the site plan of both previous and RSK investigation locations shows that the highest reported PAH concentration on the northern boundary may be an isolated hotspot, as potentially significant concentrations of benzo(a)pyrene were not detected in other nearby locations where trial pits were excavated by SDA and recently by RSK.

However, there does appear to be a large area in the north-eastern part of the site where PAH concentrations are elevated, as a group of eight nearby investigation locations, TP18 (2005), TP20 (2005), TP77 (2008), TP79 (2008), TP104 (2009), TP105 (2009), TP111 (2009) and TP112 (2009), all reported benzo(a)pyrene concentrations above the SAC. The recent trial pits excavated by RSK to the south and northwest of

this area returned generally low concentrations, therefore it appears that the extent of the affected area can be defined around the boreholes listed.

Reference to Table 13 shows that there is a second group of locations where elevated benzo(a)pyrene concentrations in the south-western part of the site, around TP5 (2008), TP45 (2008) and TP134 (2009). This area is less well defined, as the reported concentrations were below the SAC in adjacent locations and concentrations are generally lower.

It is concluded that PAH concentrations with the potential to have an adverse effect on human health by direct contact or inhalation are present on site. The highest concentrations appear to be in the northern and north-eastern parts of the site, but the investigation suggests that isolated concentrations above the SAC may be present at any location within the site. It is considered that remedial measures will be necessary to protect the future site users.

6.2.1.4 Petroleum hydrocarbons and BTEX

RSK analysed eleven samples for speciated petroleum hydrocarbons (TPH CWG). The samples tested included those from TP203 and TP204 hydrocarbon odours were noted during sampling.

In ten of the eleven samples tested by RSK all TPH concentrations were below the appropriate SAC for each specific carbon range. In the samples from TP203 at 2.1m depth the reported concentration of aliphatic hydrocarbons in the range $>C_{10}$ - C_{12} was 1090mg/kg, compared to the combined (oral and inhalation) SAC of 540mg/kg, and the SAC for the inhalation pathway only of 540mg/kg.

Fifty-six previous test results for similar testing by SDA were also assessed. Although hydrocarbon concentrations in excess of the LMDL were detected in 50 of these tests, no other exceedances of the SAC were identified.

It is concluded that slight impact by TPH, above laboratory detection limits, is widespread, but this is not generally significant for human health. Only at one location was a potentially significant TPH concentration detected.

RSK analysed eleven samples for benzene, toluene, ethylbenzene and xylenes (BTEX). The samples tested included those from TP203 and TP204 hydrocarbon odours were noted during sampling. No previous test results for BTEX testing by SDA have been identified.

In nine of the eleven samples tested by RSK all BTEX concentrations were below the LMDL of 0.01mg/kg. Xylenes were detected in the samples from TP203 at 0.7m depth and 2.1m depth, although benzene and toluene were not detected. The maximum xylene concentration was 0.14mg/kg of o-xylene, compared to the GAC of 230mg/kg. It is not considered that these reported BTEX concentrations detected present a significant risk to human health via direct contact or inhalation.

6.2.1.5 *Asbestos*

During the previous investigations SDA found a single sample of cement-bonded asbestos in one trial pit, but no asbestos fibres were detected during laboratory screening of 29 samples of made ground. RSK screened a further 5 samples of made ground, but again no asbestos was detected.

In view of the site history it is probable that asbestos was present within the buildings on the site, for example as insulation to boilers and in roofing materials. Many trial pits have been excavated on site during the several investigations, and on the basis that very little asbestos has been found, it is considered that any asbestos contamination present is unlikely to be extensive. However, it is likely that some residual asbestos remains in areas where demolition arisings are present in made ground, and site staff engaged in groundworks should maintain a watching brief, so that any suspect materials encountered can be assessed and, if necessary, appropriate remedial action taken.

6.2.1.6 *Conclusion*

It is concluded that arsenic concentrations with the potential to have an adverse effect on human health by direct contact are widespread on site.

Additionally, PAH concentrations with the potential to have an adverse effect on human health by direct contact or inhalation have been identified. These appear mainly to be found in a distinct area in the northern and north-eastern parts of the site, but the investigation suggests that, in addition to this principal area of impact, isolated concentrations above the SAC may be present at any location within the site.

Detectable impact by TPH, above laboratory detection limits, is widespread, but the laboratory results indicate that the concentrations present are not significant for human health. Only at one location was a potentially significant TPH concentration detected.

Due to the concentrations of arsenic and PAHs identified, there are potentially significant risks to human health associated with direct contact with site soils and therefore the potential pollutant linkage is still considered complete. Remedial measures will be necessary to break this linkage.

The design of an appropriate cover layer thickness has been made on the basis of the recommendations of BRE Report 465, *'Cover Systems For Land Regeneration'*, (2004). It has been assumed that all cover materials will have an arsenic concentration of 20mg/kg or less, and a concentration of each individual PAH of 0.1mg/kg or less. On this basis, a total topsoil and inert cover thickness of 500mm would be sufficient in rear gardens across the majority of the site, though this should be increased to 600mm for gardens in the north-eastern part of the site where particularly high PAH concentrations were reported. In front gardens and areas of public open space a total cover thickness of 300mm is considered sufficient. Recommendations should be agreed with the relevant statutory authorities.

6.2.2 Chemical attack on potable water supply pipes

For initial assessment purposes, the available results of laboratory soil analyses have been compared with the GAC presented in **Appendix J** for this linkage, which are reproduced from *UKWIR Report 10/WM/03/21. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (UKWIR, 2010).

Ten soil samples recovered from trial pits excavated by RSK, and the mound sample, were analysed for benzene, toluene, ethylbenzene and xylenes (BTEX). The results of analysis of two samples recovered from 0.7m and 2.1m depth in trial pit TP203, where olfactory evidence of organic contamination was recorded, indicate concentrations of BTEX to be above the threshold for both polyethylene (PE) and polyvinyl chloride (PVC) pipe materials. No previous test results are available for BTEX.

The reported PAH concentration in seven of the 11 samples exceeded the GAC for semi-volatile organic compound (SVOCs) of 2mg/kg for PE pipes and eight of the 11 samples exceeded the GAC of 1.4mg/kg for PVC pipes. Reference to the results of the previous PAH analyses by SDA shows that the laboratory method detection limit (LMDL) used was often 5mg/kg, i.e. greater than the GAC, but nevertheless many exceedances of the GAC were reported.

The previous results also show some exceedances for other parameters. Fifty-nine samples analysed for phenols returned concentrations in excess of the LMDL of 0.5mg/kg, which itself exceeded the GAC for PVC pipe of 0.4mg/kg. Some of these results also exceeded the GAC for PE pipe of 2.0mg/kg.

Given the widespread evidence of PAH in shallow soils and evidence of phenols, it is considered that neither PE or PVC water supply pipes are likely to be generally suitable, for use on the site.

It should be noted that at the time of this investigation the future routes of water supply pipes had not been established, hence the investigation and sampling strategy may not be fully compliant with UKWIR recommendations. In addition, it is recommended that the relevant water supply company be contacted at an early stage to confirm its requirements for assessment, which may not necessarily be the same as those recommended by UKWIR.

Based on the available test results and the method of assessment stated, it is considered that chemical attack on potable water supply pipes is likely in many parts of the site, hence the general adoption of mitigation measures such as the provision of barrier pipe will be necessary.

6.2.3 Uptake of phytotoxic contaminants

For assessment purposes, the results of the soil analyses have been compared with the GAC presented in **Appendix K** for this linkage. The GAC are dependant on the pH of the soil and the criteria for a pH between 5.5 and 6.0 have been assumed to be

appropriate, based on typical soil pH results for the site. None of the concentrations reported in the RSK analyses exceeded these GAC for phytotoxic determinants.

The full database of results, including the previous analyses by SDA as well as the recent RSK work, was then assessed. This assessment is summarised in Table 14 below.

Table 14: Assessment of phytotoxic contaminants

Parameter	GAC adopted (mg/kg)	Number of tests reported	Number of exceedances	Reported exceedance concentrations (mg/kg)
Copper	100	336	14	101, 102, 106, 110, 112, 127, 142, 145, 150, 160, 161, 200, 202, 328
Nickel	60	338	5	65, 65, 68, 71, 76
Zinc	200	326	4	228, 283, 374, 1706

Very few exceedances of the GAC were reported, and in almost every case these were minor, therefore it is considered that this potential pollutant linkage can be discounted.

6.2.4 Migration of contaminants to groundwater in Secondary A aquifer

The site and the wider Barnsley area has been affected by coal mining. The site does not lie within an SPZ. There is no record of potable groundwater abstractions from the coal measures in the vicinity and if such abstractions were considered, they would be unlikely to be of acceptable quality. Hence, the underlying Secondary A aquifer is not considered to be a particularly sensitive water body, although it may provide base flow to surface waters.

Previous leachate testing of 19 soils samples by SDA during 2008 showed that leachable sulphates were widespread, and there was some evidence of leachable TPH, but reported concentrations of metals, PAH and phenols were often below the applicable LMDL, and generally below or only marginally in excess of the EQS values. Previous analysis of 12 groundwater samples by SDA during the 2005 and 2009 investigations also reported concentrations of most determinants in most samples to be below LMDL, and generally below or only marginally in excess of the EQS values.

The laboratory certificates for four groundwater samples collected by RSK from the BH200 series of wells are presented in **Appendix G**. Most of the determinants are below the GACs (which are based on EQS values for freshwater) or below the LMDL. Some of these GACs are variable dependant on the hardness of the receiving surface water body. This is expected to be high, based on EA mapping within the Humber River Basin Management Plan (2009), however the lowest GACs were used for the initial assessment. Concentrations of sulphate, cadmium, copper, chromium, nickel, selenium and zinc were recorded to exceed the GACs adopted for these compounds. Table 15 shows these exceedances.

Table 15: Exceedances of EQS in groundwater

Determinant	EQS* (µg/l)	Minimum concentration (µg/l)	Maximum concentration (µg/l)	Number and location of exceedances
Metals				
Cadmium (dissolved)	0.08 – 0.25	<1	2	1 (BH207)
Copper (dissolved)	1 - 28	<1	5	2 (BH203, BH207)
Chromium (dissolved)	3.4	<1	14	2 (BH203, BH207)
Nickel (dissolved)	20	12	876	3 (BH201, BH206, BH207)
Selenium (dissolved)	10**	<1	73	1 (BH203)
Zinc (dissolved)	8 - 125	5	896	1 (BH207)
4 samples tested for each determinant. * Environmental Quality Standard (EQS) Target Concentration for Freshwater ** UK drinking water standard, as no EQS set				

It is noted that rather than the results being consistent between boreholes, as would be likely if there was a continuous groundwater table, there were wide variations in the results, suggesting localised effects, rather than widespread exceedances of the EQS. The majority of the exceedances were reported in BH203 (located in the south-western part of the site, within a former lagoon area, and BH207 (located in the east of the site, again in a former lagoon area.

The reported concentrations of copper are not considered significant, since in view of the expected hardness of local waters the applicable EQS is unlikely to be exceeded. In addition, the previous leaching tests showed no exceedances for copper.

Similarly, the single marginally elevated cadmium concentration is not considered significant, especially since the previous leaching tests showed only 2 marginal exceedances of the EQS for cadmium in the 19 samples tested.

Reference to the soil geochemistry map included within the Envirocheck database shows the site to lie within a much larger area, all of which exhibits high chromium concentrations in soil of between 120 and 180mg/kg. It appears likely that groundwater in the vicinity has locally elevated chromium concentrations as a results of the underlying geology of the area, rather than any particular on-site contaminant. Leachable chromium was not detected at a concentration above the EQS in any of the samples tested.

Concentrations of selenium and zinc somewhat in excess of the EQS were reported, each at a single location. Previous leachate testing reported only one sample marginally exceeding the EQS for selenium of 10µg/l, with a concentration of 13µg/l. Similarly, the

leachate testing reported only one sample exceeding the expected EQS for zinc of 125µg/l, with a reported concentration of 284µg/l. It is considered that based on the single concentrations reported (circa 10 times the EQS), and the lack of any identifiable leachable source, selenium and zinc are not a significant concern.

Based on the results of the testing of soils indicating that limited leachable contaminants are present, the few exceedances of the applicable EQS reported during both the SDA and RSK investigations, and the low sensitivity of the aquifer, it is considered that the site does not pose a significant overall risk to groundwater. Nevertheless, it may be necessary to remediate any hotspots of localised hydrocarbon contamination that may be identified during the development, to minimise the potential for further entry of hazardous substances or non-hazardous pollutants into groundwater.

6.2.5 Surface waters

Two water samples were collected on the same day from the watercourse crossing the site, at its upstream and downstream limits within the site, and analysed for a range of potential contaminants. The objective of the testing was to determine whether surface runoff, drainage, or groundwater within the site might be having an adverse effect on the watercourse, and thus have a potential effect on the river Dearne.

The results of the analyses were compared to the EQS values, presented in Table 1 of **Appendix K**. None of the concentrations of metals were considered significant, but several PAHs were detected at concentrations in excess of the GAC. These reported exceedances are summarised in Table 16 below.

Table 16: Exceedances of EQS for PAHs in surface waters

Determinant	EQS* (µg/l)	Upstream concentration (µg/l)	Downstream concentration (µg/l)	Number and location of exceedances
PAHs				
Benzo(a)anthracene	0.018	0.050	0.070	2 (U, D)
Benzo(a)pyrene	0.05	0.03	0.06	1 (D)
Benzo(b)fluoranthene	0.03	0.07	0.11	2 (U, D)
Benzo(ghi)perylene	0.002	0.090	0.120	2 (U, D)
Chrysene	0.01	0.07	0.10	2 (U, D)
Dibenzo(ah)anthracene	0.01	0.01	0.02	1 (D)
Fluoranthene	0.10	0.15	0.16	2 (U, D)
Indeno(123-cd)pyrene	0.002	0.080	0.110	2 (U, D)
Pyrene	0.04	0.12	0.13	2 (U, D)
Upstream (U) and downstream (D) samples tested for each determinant.				
*Environmental Quality Standard (EQS) Target Concentration for Freshwater				

The concentrations of seven PAHs exceeded the GAC at both the upstream and downstream site boundary. For only two substances were exceedances reported at the downstream boundary only. In both these cases the upstream sample returned a concentration just below the EQS and the downstream sample returned a concentration just above the EQS.

The previous analysis of surface waters, completed by SDA in 2009, was of total PAH, with a much higher LMDL of 0.1µg/l and reported concentrations were all below this limit.

It is apparent that, in every case, the reported PAH concentrations in both the upstream and downstream boundaries are very similar. It is considered that the upstream samples reflect the water quality in the watercourse as it enters the site, and although the downstream PAH concentrations are marginally higher, this is likely to be the result of ongoing minor fluctuations in the water quality of the watercourse, as well as the minor variability inherent in the sampling and analysis techniques. It is not considered that these results indicate that the site is having any significant adverse effect on the watercourse.

It is considered that linkage between PAHs present on the site and the river Dearne can be discounted.

6.2.6 Ignition of combustible material

The possibility of ignition of combustible material within the made ground must be assessed, as there are risks of (i) ongoing combustion causing the development of underground cavities, which may subsequently collapse, causing risk to life and (ii) inhalation of combustion products by future site users, and residents and workers on adjacent sites. Potential ignition sources are fires on the site surface, such as burning of demolition materials or bonfire and if coal content is high, spontaneous combustion. A further possibility is ignition by heat dissipated from very high voltage underground cables, but it assumed that if such services are proposed, a site specific investigation would be commissioned by the statutory undertaker to assess ground conditions suitable for cable laying, and suitable bedding material would be provided to mitigate any risk identified.

During the 2008 and 2009 investigations SDA submitted a total of 92 soil samples for loss on ignition (LOI) testing. The results ranged from 2.84% to 65.8%, indicating possibly significant quantities of combustible materials in the soil, averaging about 18%.

The fifteen samples with the highest reported LOI values, all greater than 25%, were submitted for testing of their calorific value during combustion. The results indicated calorific values between 1.9MJ/kg and 13.4MJ/kg, averaging approximately 7.4MJ/kg. For comparison, data published on the National Physical Laboratory website, *'Kaye and Laby, Tables of Physical and Chemical Constants, Section 3.11.4'*, indicates that coal has a gross calorific value between 32 and 42MJ/kg. Thus the site soil samples that were tested are very much less combustible than any of the typical coals listed.

The Coal Authority website includes a web page, based on historic mining data, of coal seams with a history of spontaneous combustion. These seams are consequently regarded as being at high risk of succumbing to spontaneous combustion when being entered, worked or disturbed. The list does not mention either of the seams known to outcrop within the site, the Kent's Thin Seam and the Mapplewell Seam. http://coal.decc.gov.uk/en/coal/cms/services/permits/coal_seams/coal_seams.aspx however, it can not be assumed that because the seams are not on this list, they are not capable of spontaneous combustion. The web page also lists coal seams with a high risk of spontaneous combustion, based on laboratory testing of small coal samples. The list records nine seams in South Yorkshire assessed on this basis as having a high risk of spontaneous combustion, but again the Kent's Thin and Mapplewell seams are not listed, although the absence of these seams from the list may simply mean that no coal from these seams was tested. It is recognised that the High Hazels seam, which is listed as potentially combustible, is at a similar level in the stratigraphical column to the Kent's Thin, but as it is found some distance away, in the Mansfield area, it is likely to have different properties. It is considered that since the made ground materials tested had a calorific value typically only about 25 to 30% that of pure coal, the risk of spontaneous combustion is low.

Guidance published by the BRE, *'Information Paper 2/87, Fire and Explosion Hazards Associated With The redevelopment of Contaminated Land, (1987)'*, states that laboratory testing at the Fire Research Station indicated that material with a calorific value greater than 10MJ/kg is likely to be combustible. Three soil samples, with reported calorific values of 11.0MJ/kg, 11.5MJ/kg, and 13.4MJ/kg, fell above this criterion. The guidance further states that material with a calorific value less than 2MJ/kg is highly unlikely to be combustible. Only one sample, with a calorific value of 1.9MJ/kg fell below this criterion, but this is to be expected, as only those soil samples with high reported LOI were selected for the additional combustion testing. Thus, eleven of the 15 samples tested fell into the range between 2MJ/kg and 10MJ/kg where combustibility is in doubt.

For combustion to occur, there must be both an ignition source and a supply of oxygen. At present, there is a possibility that the public, who have access to the site, could light a fire on the site surface. In this case there is some risk that surface combustion could be initiated if the fire happened to coincide with a location where soils with a high calorific value were present. As the site soils are relatively dense, the availability of oxygen is likely to be low, so it is likely that if a fire was ignited its spread would be slow and it would be extinguished relatively easily.

In the long term the risk will be very much reduced, as the site surface with be covered with buildings and roads, or a clean capping layer (minimum proposed thickness 300m), any of which would provide a barrier between ignition sources and the potentially combustible material that testing indicates is only locally present. It is considered that post-development the risks from combustible material in the made ground will not be significant.

6.2.7 Migration of ground gases into buildings on site and harm to occupants

The results have been assessed in accordance with the guidance provided in BS8576 and *CIRIA Report C665*. In the assessment of risks and selection of appropriate mitigation measures, both reports highlight the importance of the conceptual model.

CIRIA C665 identifies two types of development, termed Situation A (modified Wilson and Card method), appropriate to all development excluding traditional low-rise construction, and Situation B (National House-Building Council, NHBC) only appropriate to traditional low-rise construction with ventilated sub-floor voids.

Both methods are based on calculations of the limiting borehole gas volume flow for methane and carbon dioxide, renamed as the gas screening value (GSV). The GSV (litres of gas per hour) is calculated by multiplying borehole flow rate (litres per hour) and gas concentration (percent by volume).

In both situations, it is important to note that the GSV thresholds are guideline values and not absolute. The GSV thresholds may be exceeded in certain circumstances, if the site conceptual model indicates it is safe to do so. Similarly, consideration of additional factors such as very high concentrations of methane, should lead to consideration of the need to adopt a higher risk classification than the GSV threshold indicates.

The site is to be redeveloped with low rise housing but either Situation A or B may be appropriate, depending upon the final foundation solution adopted. Because of the presence of relatively deep made ground across the site either a piled foundation supporting a suspended floor with a ventilated sub-floor void, or a semi-rigid slab foundation without a void, may be considered appropriate. Consequently the GSVs have been compared to both the Revised Wilson and Card Classification and the NHBC "Traffic Lights".

Situation A relates to all development types except standard low-rise housing with a ventilated sub-floor void. Combining the qualitative assessment of risk (based in part upon the previous monitoring data for the site) with the recent gas monitoring results, provides a semi-quantitative estimate of risk. The method uses both gas concentrations and borehole flow rates to define a characteristic situation for a site based on the limiting borehole gas volume flows for methane and carbon dioxide. Having calculated the worst case GSVs for methane and carbon dioxide, the Characteristic Situation is then determined from Table 8.5 of CIRIA C665.

Situation B is a characterisation system developed by the NHBC (Boyle and Witherington, 2007), which relates only to low rise housing development constructed with a clear ventilated underfloor void. The system provides a risk-based approach that is designed to allow an identification of the required gas protection measures for low-rise housing by comparing the measured gas emission rates to generic "Traffic Lights". The Traffic Lights include typical maximum concentrations that are provided for initial screening purposes and risk-based GSVs for situations where the typical maximum concentrations are exceeded. Based on the typical maximum gas concentrations and

the GSVs, the appropriate Traffic Light, ranging from "Green" through "Amber 1" and "Amber 2" to "Red", is determined from Table 8.7 of CIRIA C665.

The GSV calculations for each borehole are included in **Appendix F**, showing both the RSK data (six monitoring rounds, in the nine BH200 series boreholes) and previous monitoring by SDA. (four monitoring rounds in the seven BH100 series boreholes). The gas monitoring data has identified consistently very low methane concentrations, with a recorded maximum of 0.1% v/v, but frequent moderate concentrations of carbon dioxide, with a recorded maximum of 9.5% in BH206 during the RSK monitoring, and 11.8% in BH101 during the SDA monitoring. The gas flows rates were generally negligible during monitoring by both SDA and RSK, apart from in borehole BH201. At this location potentially significant gas flows were recorded on three occasions: 4.8l/hr, 15.2l/hr and 6.8l/hr.

Borehole BH201 is located within a lagoon area, with approximately 5m depth of made ground present, and more than 50m southwest of the mapped outcrop of the Mapplewell seam. It appears probable that the gas flows recorded at this location are associated with the made ground within the lagoon, but this cannot be stated with certainty. It is considered that there is some possibility of ground gas flows from old workings underlying the site, especially since a very strong gas outflow was recorded during the drilling of rotary borehole R206 into possible old workings at approximately 14m depth.

The calculated GSVs for the site overall, based on the site-wide maximum gas concentrations and flows during the RSK monitoring are 0.02l/hr for methane and 1.44l/hr for carbon dioxide. A similar calculation for the SDA monitoring, which reported a slightly higher concentration of carbon dioxide, but minimal gas flows, gives lower GSVs of <0.01l/hr for methane and 0.04l/hr for carbon dioxide.

If the calculation is repeated on a borehole by borehole basis, using all the available data the calculated GSVs are, with one exception, 0.01l/hr or less for both methane and carbon dioxide. Only in BH201 is the calculated GSV higher, at 1.43l/hr, for carbon dioxide. It is concluded that there is no significant risk to the development from methane, but consideration must be given to the localised presence of carbon dioxide in BH201, especially in view of the high gas flow reported during the rotary drilling of borehole R206.

6.2.7.1 Ground gas assessment, Wilson & Card Classification

Based on the worst case GSV of 1.44l/hr for carbon dioxide, the site would be characterised as Characteristic Situation 3, (CS3), "moderate risk", which is applicable to values between the thresholds of 0.7l/hr and 3.5l/hr. This classification is acceptable for the construction of private houses, provided that adequate construction precautions are adopted.

However, looking at the site on a borehole by borehole basis, the classification at all locations except borehole BH201 would be CS1, "very low risk", which is applicable to values below 0.07l/hr.

Since only one of the 16 boreholes monitored has shown evidence of significant gas flows, and then only on some occasions, it appears unreasonable to classify the entire site as CS3. However, the gas outflow during the drilling of borehole R206 suggests that gas flows from the mine workings are a possibility, so some risk is certainly present.

In view of the inherent variability of the large areas of made ground and the presence of mine workings it is considered that adoption of a site-wide classification of CS2, "low risk", would be reasonable.

6.2.7.2 Ground gas assessment, NHBC Traffic Lights Classification

Based on the worst case GSV of 1.44l/hr for carbon dioxide, the site is characterised as "Amber 1", which is applicable to values between the thresholds of 0.78l/hr and 1.56l/hr for carbon dioxide. The reported maximum carbon dioxide concentrations of 9.5% during the RSK monitoring and 11.8% during the SDA monitoring are consistent with the stated typical maximum concentration of 10% applicable to this classification.

Looking at the site on a borehole by borehole basis, the classification at all locations except borehole BH201 would be "Green", which is applicable to values below 0.78l/hr. However, for a "Green" classification a typical maximum carbon dioxide concentration of 5% is considered acceptable. Although gas flows were consistently low, carbon dioxide concentrations exceeded 5% on very many occasions.

In view of the high reported concentrations of carbon dioxide and the presence of workings, it is considered that adoption of a site-wide classification of "Amber 1", would be prudent.

6.2.7.3 Ground gas assessment, conclusions

It is considered that the gas monitoring programme carried out by RSK, together with the previous monitoring by SDA, has established the 'worst-case' scenario and has characterised the ground gas regime sufficiently to enable the confident assessment of risk and subsequent design of an appropriate gas protection scheme for the proposed development.

The conclusion of the gas risk assessment, based upon the monitoring, is that the site should be classified as CS2, "low risk", according to the Wilson and Card classification, or "Amber 1" according to the NHBC traffic lights classification.

CIRIA C665 provides details of the typical scope of protective measures to be adopted for the relevant site characterisation. It should be noted that for "low risk" sites (CS2), CIRIA C665 recommends a minimum thickness of gas resistant membrane of 2000 gauge, as the report considers that the standard unreinforced 1200 gauge membrane is unlikely to survive the construction process intact.

For low-rise development, which fulfils the requirements of Situation B, the recommended gas protection measures are detailed in BRE Report 414 (2001).

In order to minimise any risks associated with mine gas emissions no buildings will be constructed over, or in the immediate vicinity of any mine entries.

6.3 Environmental assessment conclusions

- it is considered that remedial measures will be necessary to protect the future site users from direct contact with arsenic

- PAH concentrations with the potential to have an adverse effect on human health by direct contact or inhalation have been identified. These appear mainly to be found in a distinct area in the northern and north-eastern parts of the site, but the investigation suggests that, in addition to this principal area of impact, isolated concentrations above the SAC may be present at any location within the site

- to mitigate against direct contact with arsenic and PAHs a total topsoil and inert cover thickness of 500mm is proposed for rear gardens across the majority of the site. The cover layer thickness should be increased to 600mm for gardens in the north-eastern part of the site where particularly high PAH concentrations were reported. In front gardens and areas of public open space a total cover thickness of 300mm is considered sufficient

- it is concluded that slight impact by TPH, above laboratory detection limits, is widespread, but this is not generally significant for human health. Only at one location, BH203, was a potentially significant TPH concentration detected. It should be recognised that the investigation has only sampled a representative number of locations and any additional areas of localised hydrocarbon contamination that may be identified during the development will require assessment and possibly localised remediation

- the widespread evidence of PAH in shallow soils and the evidence of phenols detected by SDA suggests that chemical attack on potable water supply pipes is, based upon the method of assessment stated, likely. The general adoption of mitigation measures, such as the provision of barrier pipe, will be necessary

- none of the concentrations of phytotoxic contaminants reported in the RSK analyses exceeded the relevant GAC. The full database of results, including the analyses by SDA was then assessed. Very few exceedances of the GAC were reported, and in almost every case these were minor, therefore it is considered that this potential pollutant linkage can be discounted

- little leachable contamination was identified in soil and few exceedances of the EQS were reported in groundwater samples. Consequently, it is considered that the site does not pose a significant overall risk to groundwater. Nevertheless, it may be necessary to remediate any hotspots of localised hydrocarbon contamination that may be identified during the development, to minimise the potential for further entry of hazardous substances or non-hazardous pollutants into groundwater

- the reported PAH concentrations in surface water samples taken on the upstream and downstream site boundaries are very similar. It is considered that the upstream samples reflect the water quality in the watercourse as it enters the site, and although the downstream PAH concentrations are marginally higher, this is likely to be the result of ongoing minor fluctuations in the water quality of the watercourse, as well as the minor variability inherent in the sampling and laboratory analysis techniques. It is not considered that these results indicate that the site is having any significant adverse effect on the watercourse, and therefore the linkage between PAHs present in made ground on site and the river Dearne can be discounted

- the laboratory testing has indicated that potentially combustible material is only locally present in the made ground. Following redevelopment, the site surface with be covered in buildings, roads and clean topsoil or capping, all of which would provide a barrier between ignition sources and the combustible material. In addition, compact made ground restricts the supply of oxygen to initiate and maintain combustion. It is considered that, post-development, the risks from combustible material in the made ground will not be significant

- the conclusion of the gas risk assessment, based upon the monitoring carried out by RSK, together with the previous monitoring by SDA, is that the site should be classified as CS2, "low risk", according to the Wilson and Card classification, or "Amber 1" according to the NHBC traffic lights classification. Gas protection measures will be required in accordance with the appropriate classification

- in order to minimise any risks associated with mine gas emissions no buildings will be constructed over, or in the immediate vicinity of any mine entries

- on the basis that very little asbestos has been found during the investigations, it is considered that any asbestos contamination present is unlikely to be extensive. However, In view of the site history, it is likely that some asbestos remains in areas where demolition arisings are present. Appropriately trained site staff should maintain a watching brief during groundworks, so that any if any suspect materials are encountered, appropriate remedial action can be taken

- previous reports indicate that the site lies in an area where basic radon protection measures would be required in the construction of new houses, However, the Envirocheck environmental database report accesses more up to date information, based on a 25m grid map developed jointly by the BGS and the HPA. On the basis of this refined dataset, no radon protective measures are necessary for new housing development on the site.

7 GEOTECHNICAL SITE ASSESSMENT

7.1 Engineering considerations

It is understood that the proposed development is to involve the construction of up to 325 residential properties and associated infrastructure.

7.2 Geotechnical hazards

A summary of commonly occurring geotechnical hazards is given in Table 17 together with an assessment of whether the site may be affected by each of the stated hazards.

Table 17: Summary of main potential geotechnical hazards that may affect site

Hazard category (excluding contamination issues)	Hazard status based on investigation findings and proposed development			Engineering considerations if hazard affects site
	Found to be present on site	Could be present but not found	Unlikely to be present and/or affect site	
Sudden lateral changes in ground conditions	X	Varying thickness of made ground, especially at high wall of opencast. Where thin made ground is underlain by weathered coal measures at shallow depth, the founding material may range from clay to sandstone.		Likely to affect ground engineering and foundation design and construction
Shrinkable clay soils	X	Clay soils generally of intermediate plasticity (low or medium volume change potential)		Design to NHBC Standards Chapter 4
Highly compressible and low bearing capacity soils, (including peat and soft clay)	X	SPTs values as low as N = 3 indicate loose or soft soils in some locations. No peat encountered.		Likely to affect ground engineering and foundation design and construction
Silt-rich soils susceptible to rapid loss of strength in wet conditions	X	Some silty soils locally present in infilled lagoons		Likely to affect ground engineering and foundation design and construction

Hazard category (excluding contamination issues)	Hazard status based on investigation findings and proposed development			Engineering considerations if hazard affects site
	Found to be present on site	Could be present but not found	Unlikely to be present and/or affect site	
Running sand at and below water table			X	Likely to affect ground engineering and foundation design and construction
Karstic dissolution features (including 'swallow holes' in Chalk terrain)			X	May affect ground engineering and foundation design and construction
Evaporite dissolution features and/or subsidence			X	May affect ground engineering and foundation design and construction
Ground subject to or at risk from landslides		X	Some steep slopes on site	Require assessment or regrading
Ground subject to periglacial valley cambering with gulls possibly present			X	Likely to affect ground engineering and foundation design and construction
Ground subject to or at risk from coastal or river erosion			X	Likely to require special protection/stabilisation measures
High groundwater table (including waterlogged ground)	X	Waterlogged areas in flatter southern part of site		May affect temporary and permanent works
Rising groundwater table due to diminishing abstraction in urban area		X	Possible, since mining ceased in locality	May affect deep foundations, basements and tunnels
Underground mining	X	Shallow mining identified in northern half of site		Likely to require stabilisation
Existing sub-structures (e.g. tunnels, foundations, basements, and adjacent sub-structures)	X	Existing watercourse runs partly in culvert, other abandoned structures associated with mining history possible.		Likely to affect ground engineering and foundation design and construction
Filled and made ground (including embankments, infilled ponds and quarries)	X	Extensive areas of made ground across the site, including backfilled opencast mining and infilled settling ponds.		Likely to affect ground engineering and foundation design and construction

Hazard category (excluding contamination issues)	Hazard status based on investigation findings and proposed development			Engineering considerations if hazard affects site
	Found to be present on site	Could be present but not found	Unlikely to be present and/or affect site	
Adverse ground chemistry (including expansive slags and weathering of sulphides to sulphates)	X	Laboratory testing indicates sulphides present, high sulphate content and low pH (acidic) conditions		May affect ground engineering and foundation design and construction
Note: Seismicity is not included in the above table as this is not normally a design consideration in the UK.				

7.3 Foundations

7.3.1 General suitability

Given the significant depth of made ground encountered across most of the site, it is considered that conventional shallow strip or trench fill foundations will only be suitable in limited areas of the development, where natural soils are present at shallow depth, otherwise this method of construction would be uneconomic. The areas where such foundations will be suitable will depend to a large extent upon the final site levels following the earthworks and re-grading necessary to provide suitable development platforms. The re-grading is likely to reduce the cover of made ground in some areas and increase it in others. However current proposals for redevelopment do not require significant change in ground levels with only limited regrading across a small number of steep slopes, up to a few metres high, to allow for infrastructure development. The suitability of shallow foundations is considered further in Section 7.3.2 below.

The site history suggests that the made ground has, in general, been in-situ for a period of over 20 years and the intrusive investigation shows that, over much of the site, the fill material is predominantly granular. These conditions suggested that stiffened edge slab semi-raft foundations are likely to be suitable. To determine whether this solution would also be appropriate in areas where deeper and potentially more cohesive soils are present, such as infilled lagoons, a series of skip loading tests has been carried out. The preliminary results of these tests, which are ongoing, are reported in Section 5.5. These preliminary results indicate that raft foundations may be suitable over the majority of the site. Their use is considered further in Section 7.3.3 below.

Piled foundations might also be suitable in some areas, but there are certain constraints, particularly the possible presence of substantial reinforced concrete or steel obstructions at depth within the made ground, that may present some difficulties. The possible suitability of piled foundations is considered further in Section 7.3.4 below.

The PRA identified two infilled opencast areas located along the subcop of the Mapplewell coal seam, see **Figure 2**. Coal was removed from these areas at shallow depth and continued for a short distance in a north easterly direction along a relatively shallow dip. Depth of made ground encountered in this investigation does not appear to vary with any significance across the boundary of the opencast. These conditions suggested that stiffened edge slab semi-raft foundations are likely to be suitable. It may be prudent to consider alternative foundation solutions should ground conditions differ from those found during the investigation.

7.3.2 Shallow spread foundations

The recommendations for the design and construction of spread foundations in relation to the ground conditions are set out in Table 18.

Table 18: Design and construction of spread foundations

Design/construction considerations	Design/construction recommendations
Founding stratum	Firm to stiff natural clay, or weathered coal measures mudstone/sandstone
Depth	Foundations should be taken to a minimum depth of 0.9m below finished ground level and at least 0.1m into the founding stratum below any overlying made ground or to any greater depth required in respect of the special design considerations given below.
Special design considerations	Owing to the local presence of shrinkable clay soils, foundations should be designed taking into account all the normal precautions, including minimum founding depths, to minimise the risk of future foundation movements in accordance with NHBC standards or similar. The findings of the ground investigation indicate that foundations in natural clays should be designed for shrinkable soils of medium volume change potential. Owing to the potential variability of the founding strata, with clay or weathered mudstone and potentially coal measures sandstone being present within one foundation, consideration should be given to incorporating appropriate reinforcement into the strip foundations to minimise the risk of future differential foundation movements.
Bearing capacity	Spread foundations may be designed using a net allowable bearing pressure of 100kN/m^2.
Stability of excavations	Generally the trial pits remained stable during excavation, which indicates that foundation excavations should also remain stable in the short term. However, in about 20% of the pits groundwater flows or dampness were reported, and then some instability occurred. In the event that excavations are to remain open for longer periods, consideration should be given to the use of trench support systems.

Design/construction considerations	Design/construction recommendations
Dewatering	Groundwater was encountered in some of the trial pits. Dewatering may therefore be required to facilitate foundation excavation in some areas. Pumping from open sumps in non-cohesive soils should be avoided as this can result in instability and general loosening of the soils at the base of the excavation. However, the use of well-pointing systems or similar is likely to be problematic because of the presence of boulders and obstructions in the made ground.
Construction considerations	All foundation excavations should be inspected, and any made ground and soft, organic or otherwise unsuitable materials removed and replaced with mass concrete.

7.3.3 Raft foundations

The use of stiffened edge slab semi-raft foundations is likely to have a number of benefits:

- raft construction requires only shallow excavation, avoiding the potential instability and groundwater problems associated with deeper excavations
- the shallow excavation reduces the chance of construction being affected by buried obstructions or encountering contamination, although some consideration will be required to the presence of near surface boulders within the made ground
- the simple geometry of the raft allows effective protection of the concrete against aggressive ground condition to be achieved
- consistent repeatable design over wide areas will lead to efficiency of construction.

The preliminary results of the skip load tests, discussed in section 5.5 above, show moderate settlements. The three tests over predominantly granular fill of varying depths showed a maximum settlement of about 11mm and a maximum differential settlement of 6mm. The test over the lagoon area showed a higher but still tolerable settlement of 16mm, but this was accompanied by a differential settlement of about 12mm. It is considered that the relatively high differential settlements reported are principally the result of the small size of the foundation and relatively high load. A full size raft would bridge minor local variations in the made ground and therefore reduced differential settlements would be expected. *(**Note:** the settlement values quoted will require final verification when the loads are removed).*

It is expected that raft foundations would be a suitable foundation solution over the majority of the site.

Guidance on the design of stiffened edge slab semi-raft foundations is provided in Section 4.5 of the NHBC technical manual.

7.3.4 Piled foundations

Recommendations for the design and construction of pile foundations in relation to the ground conditions are set out in Table 19.

Table 19: Design and construction of piled foundations

Design/construction considerations	Design/construction recommendations
Pile type	The construction of both bored and driven piles is considered technically feasible at this site.
Possible constraints on choice of pile type	Given the close proximity of the site to a residential area it is considered possible that the vibration/noise associated with pile driving may not be acceptable. The presence of buried sub-structures or other obstructions within made ground may lead to difficulty during piling. The aggressive nature of the made ground, with high sulphate content and low pH, could in the long term have adverse effects on both concrete and steel piles. Given the contaminated nature of the made ground at the site it may not be cost effective to adopt bored piles at the site, as boring would raise buried contaminants to the surface and disposal of arisings could be costly. Given the presence of groundwater strikes at varying depth during the investigation, bored piles will require temporary casing throughout their depth. Alternatively, driven piles would overcome this issue
Pile design	The made ground should not be presumed to contribute to the load-carrying capacity of the piles. In fact it may be prudent to allow for negative skin friction, given that the site level is likely to be raised in some areas.

It is recommended that a specialist piling contractor is contacted to further assess the options for piled foundations.

It is considered that piled foundations may be a suitable foundation solution in areas such as the lagoons in the southern part of the site where softer cohesive soils may be present, groundwater levels are high and there is a lower probability of encountering heavy foundations or other buried obstructions.

7.3.5 Foundation works risk assessment

It is anticipated that a foundation works risk assessment report will be required for the development, because elevated concentrations of arsenic and benzo(a)pyrene are present in the shallow soils likely to be excavated and placed during foundation

construction works. However, the risks are unlikely to be significant, provided that good site working practices are employed.

7.3.6 Floor slabs

There is a significant thickness of made ground across the whole site, therefore in any areas where either conventional strip foundations or piles are used, ground-bearing floor slabs would not be appropriate and suspended floor slabs with a ventilated sub-floor void should be used.

As an alternative, raft foundations may be employed.

7.3.7 Roads, hardstanding and drainage

In the 1m to 1.5m below the proposed finished ground level the exploratory holes have revealed a soil profile comprising variable made ground. Over much of the site the coarse gravelly clay colliery waste will provide a high CBR. The potentially poorest sub-grade material within this profile is the soft sandy/gravelly clay that was encountered locally, predominantly in the infilled lagoons in the southern part of the site.

In pavement design terms, the groundwater conditions are anticipated to comprise a low water table across the majority of the site, i.e. at least 1m below the pavement formation level. However, in some areas, particularly in the old lagoons areas discussed above, including in the south-eastern part of the site around borehole BH201, groundwater has been recorded at shallow depth. The current development plan indicates that roads and drainage are to be constructed in this area.

The estimated minimum equilibrium soil-suction California bearing ratio (CBR) value for the soils and groundwater conditions described above, (a sandy clay with a plasticity index typically greater than 20%), under a completed pavement is 2.5%, based upon Table C1 in TRRL (1984) Report LR1132.

The cohesive sub-grade soils, poorly drained and with a plasticity index typically greater than 20%, can be regarded as non-frost-susceptible, based upon the criteria given in Appendix 1 of TRRL (1970) Report Road Note 29. Where the colliery spoil is predominantly granular but with a significant fines content it may be frost susceptible. This should be assessed by laboratory testing. When the sub-grade is frost-susceptible the thickness of sub-base must be sufficient to give a total thickness of non-frost-susceptible pavement construction over the soil of not less than 450mm.

7.3.8 Chemical attack on buried concrete

This assessment of the potential for chemical attack on buried concrete is based on current BRE guidance (BRE, 2005). The desk study and site walkover indicate that, for the purposes of this assessment of the aggressive chemical environment, the site should be considered as a brownfield site where disturbance of pyrite-bearing ground

could result in additional sulphate. A suite of chemical analyses appropriate to this site classification was carried out on soil and groundwater samples.

The results of pH analysis for 327 soil samples are available, therefore the characteristic value has been calculated as the mean of the lowest 20% of values, 3.9.

The results of water-soluble sulphate analysis for 105 soil samples are available, with the highest result being 3.3g/l. The characteristic concentration has been calculated as the mean of the highest 20% of values, 2.2g/l. As this value is below the limiting value of 3.0g/l consideration of magnesium is not required. Based on Table C2 in the BRE guidance, result one for Design Sulphate Class for the site is DS-3. If, instead, the highest value was used as the characteristic value the result would be DS-4.

The results of the sulphate analysis of 16 samples of groundwater are available, therefore the characteristic concentration has been calculated as the average of the 3 highest value, 5.5g/l. This value exceeds the limiting value of 3.0g/l that requires consideration of magnesium. One result of magnesium analysis is available from the recent work by RSK, but the SDA suite of groundwater analyses did not include magnesium. A characteristic magnesium ion content of 0.3g/l has been assumed, based on this single test result. Based on Table C2 in the BRE guidance, result two for Design Sulphate Class for the site is therefore DS-4.

For the purposes of this assessment the site has been classified as brownfield and pH values less than the limiting value of 5.5 have been recorded. RSK tested one sample with a particularly pH of 5.1 for chloride and nitrate ions but the results were below the LMDL. On this basis, no adjustment to the characteristic sulphate concentration is required.

Because of the possible presence of oxidisable sulphides in the coal measures a calculation was made using the concentrations of Total Sulphur and Acid Soluble Sulphate reported by SDA, of the amount of Oxidisable Sulphide present. A maximum Oxidisable Sulphide content of 6.5% was calculated. Since this value is greater than 0.3% a Total Potential Sulphate concentration of 5.1% (three times the Total Sulphur content) has been calculated. Based on this value, result three for Design Sulphate Class for the site is DS-5.

From consideration of the three results, a Design Sulphate Class of DS-5, should be adopted for the site. From consideration of the characteristic pH value of 3.9, an Aggressive Chemical Environment for Concrete classification of AC-5 may be assumed for design purposes.

8 REUSE OF MATERIALS AND WASTE

8.1 Reuse of suitable materials

In accordance with the *CL:AIRE Code of Practice* (2011) (CoP) materials are only considered waste if 'they are discarded, intended to be discarded or required to be discarded, by the holder'. Thus, contaminated material does not become waste until the aforementioned criteria are met.

Under the CoP, soils may be re-used on the site where they were produced provided they are:

- certain to be used
- are suitable for use both chemically and geotechnically
- only the required quantity is used.

The CoP requires the preparation of a materials management plan (MMP) that confirms the three criteria above will be met. This plan needs to be reviewed by a 'Qualified Person' who will then issue a declaration to the EA.

Therefore, before any excavation works begin on-site, an MMP will need to be prepared to establish whether specific materials are classified as waste and how excavated materials will be treated and/or re-used in line with *The Definition of Waste: Development Industry Code of Practice, Version 2* (CL:AIRE, 2011). The MMP is likely to be used in conjunction with the site waste management plan.

The importation of made ground soils (irrespective of contamination status) or crushed demolition materials is not currently permitted under the CoP and requires either a standard rules environmental permit or a U1 waste exemption (see below).

8.2 Treatment to meet suitable-for-use criteria

Where materials do not meet the suitable for use criteria it may be possible to treat them under an environmental permit (mobile treatment licence) to enable them to be reused onsite.

To enable the treatment options to be determined, an options appraisal and a remediation strategy document will be necessary to support discussion of the issues with regulators and third parties.

8.3 Reuse of waste materials

If material is discarded as waste then its reuse on site may still be possible. Waste soils can be reused on site under a standard rules environmental permit or a U1 waste exemption from the Environmental Permitting (England and Wales) Regulations 2010, provided that they are suitable for the proposed use. However, it should be noted that these have strict limits on the quantity of material that can be reused.

8.4 Groundwater

When there is an intention to discard groundwater, chemical test results will indicate the appropriate disposal options. This could include: tanker disposal to a waste water treatment facility; to foul sewer, under a consent issued by the water authority; or to a watercourse, under a consent issued by the EA.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Environmental

9.1.1 Conclusions

It is considered that remedial measures will be necessary to protect the future site users from direct contact with arsenic.

PAH concentrations with the potential to have an adverse effect on human health by direct contact or inhalation have been identified. These appear mainly to be found in a distinct area in the northern and north-eastern parts of the site, but the investigation suggests that, in addition to this principal area of impact, isolated concentrations above the SAC may be present at any location within the site.

It is concluded that slight impact by TPH, above laboratory detection limits, is widespread, but this is not generally significant for human health.

The evidence of PAH and phenols in shallow soils suggests that chemical attack on potable water supply pipes is likely.

Very few exceedances of the GAC for phytotoxic contaminants were reported, and in almost every case these were minor, therefore it is considered that this potential pollutant linkage can be discounted.

Little leachable contamination was identified in soil and few exceedances of the EQS were reported in groundwater samples. Consequently, it is considered that the site does not pose an overall risk to groundwater.

It is not considered that there are any significant adverse effects on the watercourse crossing the site, and therefore the potential linkage between PAHs present in made ground and the river Dearne can be discounted.

The laboratory testing has indicated that potentially combustible material is only locally present in the made ground. It is considered that, post-development, the risks from combustible material in the made ground will not be significant.

On the basis that very little asbestos has been found during the investigations, it is considered that any asbestos contamination present is unlikely to be extensive. However, In view of the site history, it is likely that some asbestos remains in areas where demolition arisings are present and allowance should be made for removing unsuitable materials from site.

Radon protective measures are not necessary for new housing development on the site.

9.1.2 Recommendations

To mitigate against direct contact with arsenic and PAHs, a total topsoil and inert cover thickness of 500mm is proposed for rear gardens across the majority of the site. The cover layer thickness should be increased to 600mm for gardens in the north-eastern part of the site where particularly high PAH concentrations were reported. In front gardens and areas of public open space a total cover thickness of 300mm is considered sufficient.

To mitigate against indoor inhalation of PAHs, including benzo(a)pyrene, a vapour barrier resistant to volatile compounds should be provided within the floor construction. It should be noted that certain commercially available barriers that incorporate aluminium, or other similar metallic foils, may be unsuitable, unless the design ensures that they can not come into contact with the made ground, as the aggressive ground conditions present could cause degradation of the membrane.

The general adoption of mitigation measures against chemical attack on potable water supply pipes, such as the provision of barrier pipe, will be necessary.

It should be recognised that the investigation has only sampled a representative number of locations and any additional areas of localised hydrocarbon contamination that may be identified during the development will require assessment and possibly remediation, to minimise the potential for further entry of hazardous substances or non-hazardous pollutants into groundwater.

Gas protection measures will be required in accordance with CS2, "low risk", according to the Wilson and Card classification, or "Amber 1" according to the NHBC traffic lights classification.

Appropriately trained site staff should maintain a watching brief during groundworks, so that any if any suspected asbestos-containing materials are encountered, appropriate remedial action can be taken.

9.2 Geotechnical

9.2.1 Conclusions

It is concluded that shallow mine workings with the potential to adversely affect the development are present in the land underlying much of the north-eastern part of the site. The area requiring treatment is limited to the southwest by the outcrop of the Mapplewell (Kent's Thick) Coal and it will be necessary to extend the treatment north-eastwards until adequate rock cover is proved to this seam. The investigation suggests that the seam dip, which was stated in published data as between 1:12 and 1:21 is almost certainly at the shallower end of this range, or shallower. It should be recognised that if the dip is less than was originally expected, the treatment area may be greater, to achieve sufficient rock cover over the workings. There was some uncertainty in the

interpretation of the strata at boreholes R205 and R206, but both boreholes indicated areas where treatment of shallow workings is required.

The investigation of concrete obstructions revealed typical concrete thicknesses between 0.3m and 1.6m, although it should be recognised that, in some locations, these thicknesses may be exceeded, or concrete could be encountered beneath a covering of made ground.

Shaft 001 has been treated and capped and it is considered that no further action is required, other than to define an appropriate no-build zone around its location. Adit 011 is recorded as treated and lying outside the site boundary and shafts 025 and 026 are recorded as lying outside the site boundary. It is considered that no further action is required at these locations. Numerous trial pits were excavated in the attempt to locate adits 016 and 028, but the results were inconclusive. An obvious depression was observed close to the recorded location of shaft 027. No evidence of shaft 005 was observed.

Given the significant depth of made ground encountered across most of the site, it is considered that conventional shallow strip or trench fill foundations will only be suitable in limited areas of the development, where natural soils are present at shallow depth, otherwise this method of construction would be uneconomic.

The site history and intrusive investigation suggest that stiffened edge slab semi-raft foundations are likely to be a suitable foundation solution on parts of the site. The preliminary results of skip loading tests indicate that such may be suitable over the majority of the site.

Piled foundations might also be suitable in some areas, but there are certain constraints, including noise, the presence of obstructions within the made ground, aggressive ground conditions and contamination issues that may present some difficulties.

9.2.2 Recommendations

The approximate extent of the area requiring drilling and grouting to consolidate old mine workings at shallow depth is shown on the Constraints Plan, **Figure 8**.

It is considered that an attempt should be made to determine the location of adits 016 and 028 using surface geophysics. Filling, or consolidation of any existing fill within these adits will be necessary and could either be completed as part of the proposed treatment of shallow workings in this area or by excavation and recompaction.

The depression at the recorded location of shaft 027 requires further investigation, either using a large backhoe excavator, or by probe drilling from a safety platform bridging the depression. Further investigation is also required to locate shaft 005. Drilling and grouting treatment of shafts 027 and 005, followed by capping, is likely to be necessary.

It will be necessary to define a suitable "no-build" zone around each shaft located on the site. Allowance should also be made at this stage for a no-build zone over adits 016 and

028, but if effective treatment of the adits has been completed, and raft foundations are adopted, it may be possible to relax this condition.

An Aggressive Chemical Environment for Concrete classification of AC-5 should be assumed for design purposes.

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www.wunderground.com.

FIGURES



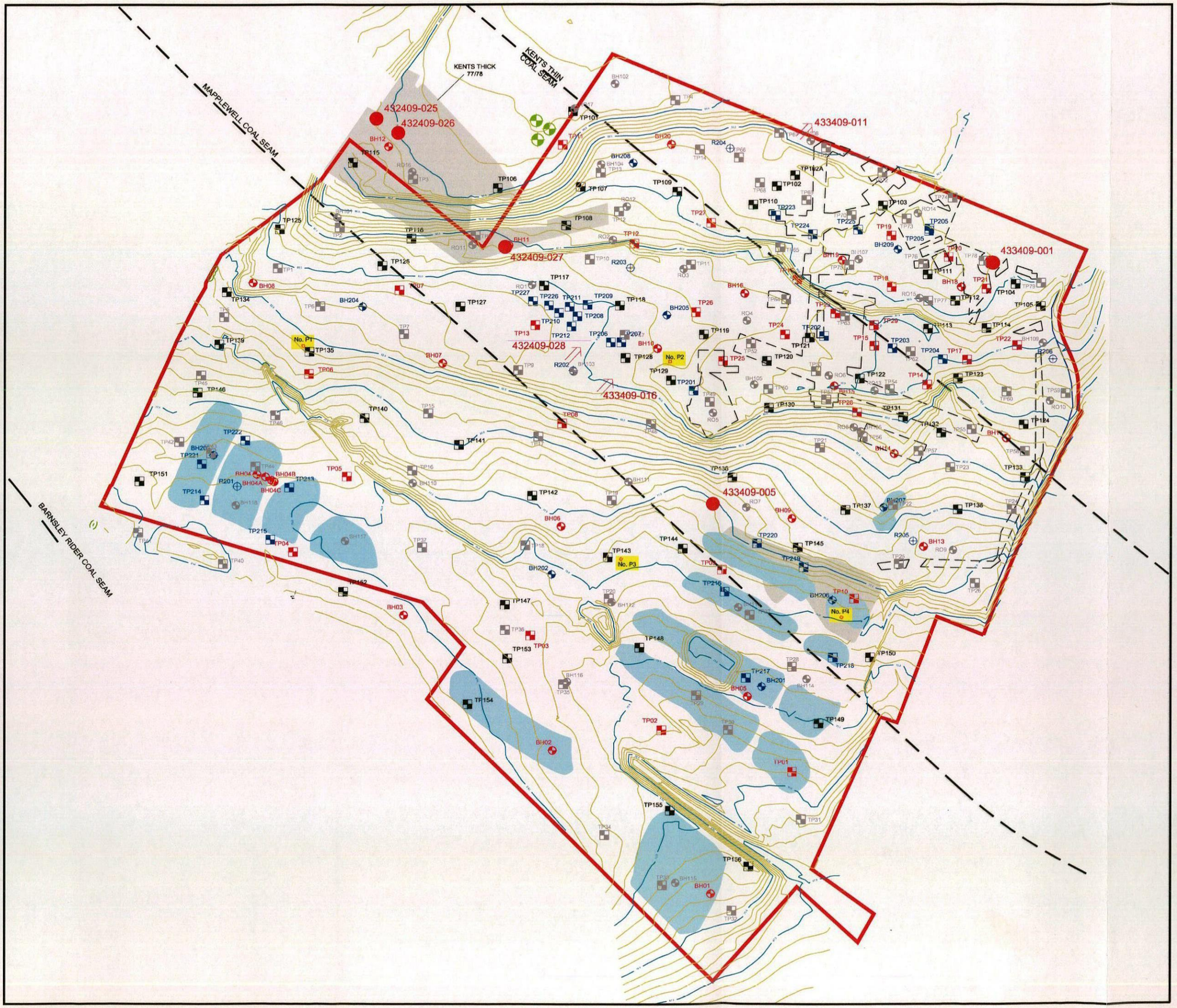
Ordnance Survey © Crown copyright 2010 of the Ordnance Survey paper map.
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RSK
Spring Lodge
172 Chester Road
Helsby
Cheshire
WA6 0AR
Tel: +44 1928 726006
Fax: +44 1928 725633
Web: www.rsk.co.uk

Client	HARWORTH ESTATES
Project Title	NORTH GAWBER
Drawing Title	SITE LOCATION PLAN

Drawn	Date	Checked	Date	Approved	Date	Project No.	Drawing File
HD	30.10.13	PT	30.10.13	PT	30.10.13	321370	321370-R3(00)D001A

Scale	Orig Size	Dimensions	Drawing No.	Rev.
NTS	A4	—	FIGURE 1	A



LEGEND:

- Indicative site boundary
- Adit (inferred)
- Shaft (inferred)
- Opencast backfill (highwall at perimeter)
- Former lagoons (infilled)
- Gas vents (from SDA Dwg No. SDA/09002/19, figure 4 dated May 2010)
- TP01 — Trial pit (2005)
- BH01 — Borehole (2005)
- TP7 — Trial pit (2008)
- BH01 — Borehole (2008)
- R017 — Rotary borehole (2008)
- TP101 — Trial pit (2009)
- BH209 — RSK borehole locations (2013)
- R206 — RSK rotary borehole locations (2013)
- TP202 — RSK trial pit locations (2013)
- Footprint of historical buildings
- Inferred coal seam subcrop (information taken from geological survey map, scale 6 inch to 1 mile, 1932 edition)
- No. P4 — Skip load test location

N

REV	DATE	DESCRIPTION	BY	CHD.	APR.
A	21.01.14	FIRST ISSUE	HD	IW	IW

Dimensions	Projection	Scale	Orig Size
m		1:2,000	A3

RSK
Spring Lodge
172 Chester Road
Helsby
Cheshire
WA6 0AR
Tel: +44 1928 726006
Fax: +44 1928 725633
Web: www.rsk.co.uk

CLIENT: HARWORTH ESTATES

PROJECT: NORTH GAWBER

TITLE: EXPLORATORY HOLE LOCATION PLAN

JOB No.:	DRAWING FILE:
321370-R3	321370-R3(00)D002A

BY:	DATE:	CONTRACT NO.		REV:
HD	21.01.14		FIGURE 2	A

Scale 1 : 2,000

0 20 40 60 80 100m



LEGEND:

- Opencast backfill (highwall at perimeter)
- Former lagoons (infilled)
- TP01 — Trial pit (2005)
- BH01 — Borehole (2005)
- TP7 — Trial pit (2008)
- BH01 — Borehole (2008)
- R017 — Rotary borehole (2008)
- TP101 — Trial pit (2009)
- BH209 — RSK borehole locations (2013)
- R206 — RSK rotary borehole locations (2013)
- TP202 — RSK trial pit locations (2013)
- Footprint of historical buildings
- 7 — Isopach lines to show indicative thickness of made ground in meters. Data taken from RSK and previous investigations (2005, 2008 and 2009). Isopach line are drawn from a Surfer plot and can only infer thickness of made ground between investigation locations.

REV	DATE	DESCRIPTION	BY	CHD.	APR.
A	31.1013	FIRST ISSUE	HD	IW	IW

Dimensions	Projection	Scale	Orig Size
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RSK
Spring Lodge
172 Chester Road
Helsby
Cheshire
WA6 0AR
Tel: +44 1928 726006
Fax: +44 1928 725633
Web: www.rsk.co.uk

CLIENT: HARWORTH ESTATES

PROJECT: NORTH GAWBER

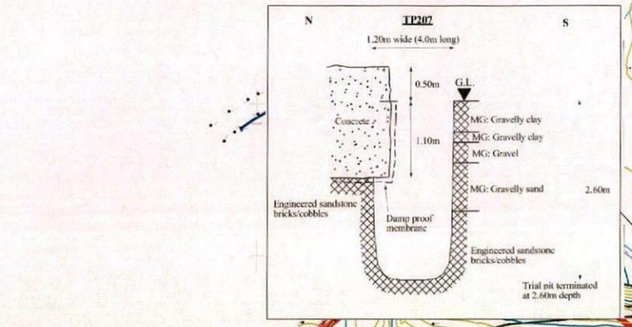
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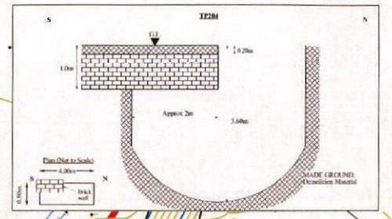
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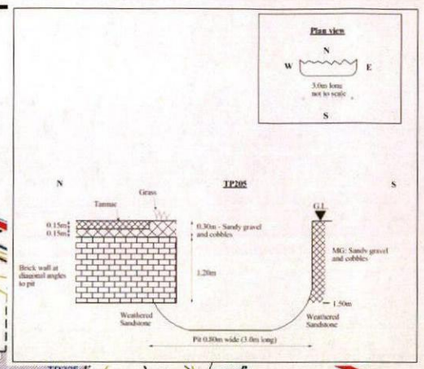
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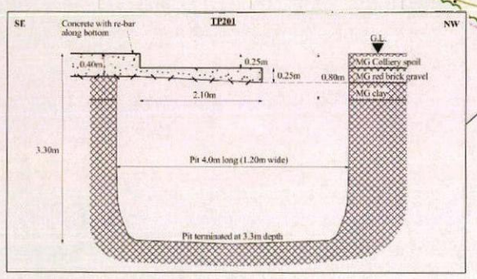
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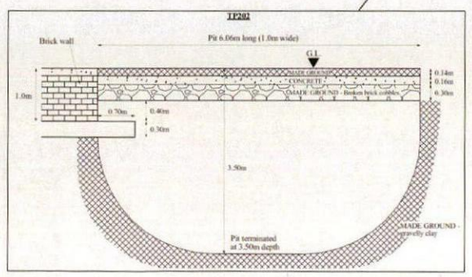
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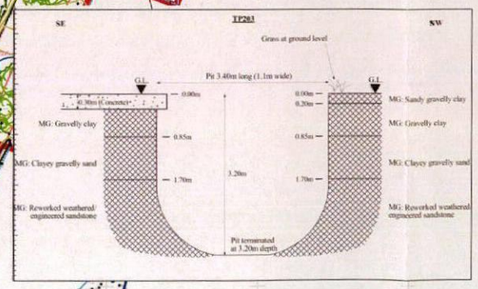












LEGEND:

- Indicative site boundary
- TP202 — RSK trial pit locations (2013)
- Identified surface concrete taken from Scott Doherty report (2008)
- Footprint of historical buildings

N

REV	DATE	DESCRIPTION	BY	CHD.	APR.
A	30.10.13	FIRST ISSUE	HD	IW	IW

Dimensions	Projection	Scale	Orig Size
m		NTS	A2

RSK
Spring Lodge
172 Chester Road
Helsby
Cheshire
WA6 0AR
Tel: +44 1928 726006
Fax: +44 1928 723633
Web: www.rsk.co.uk

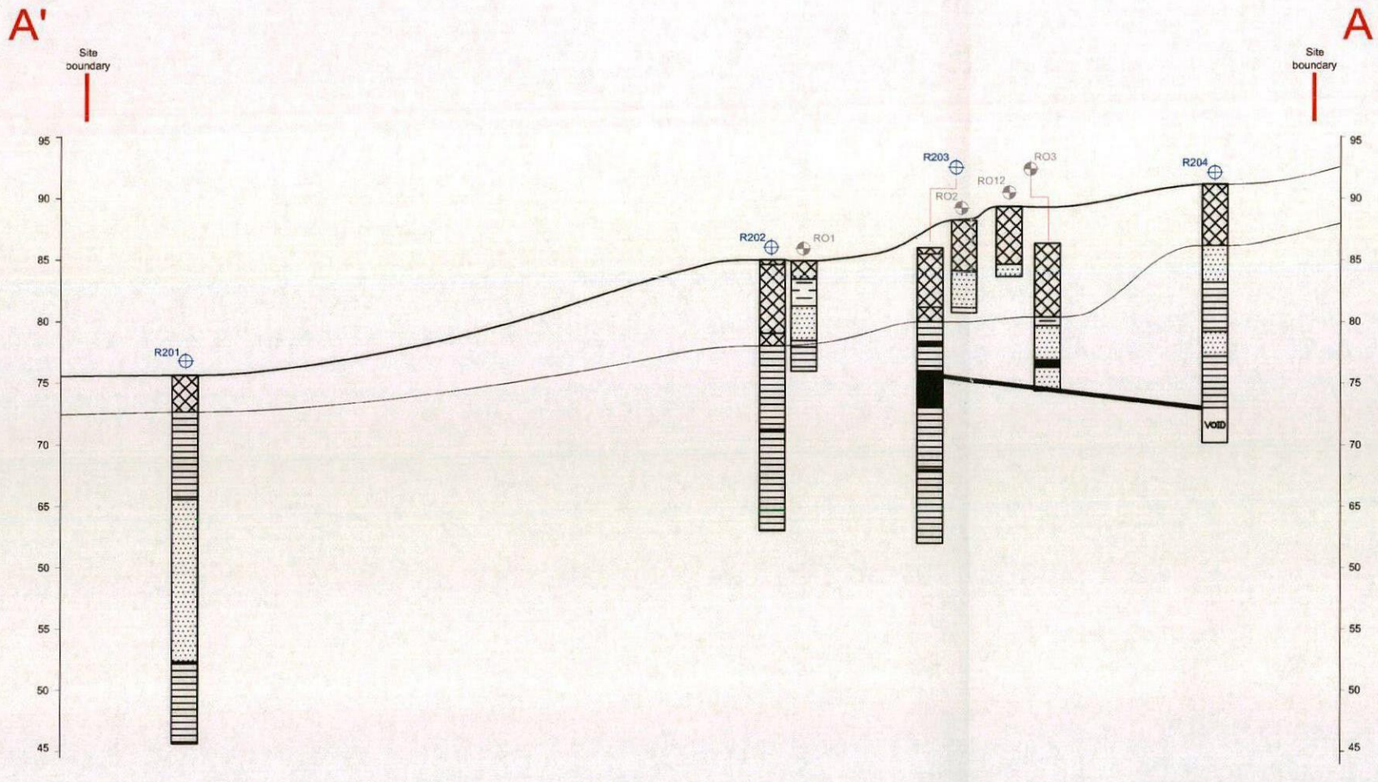
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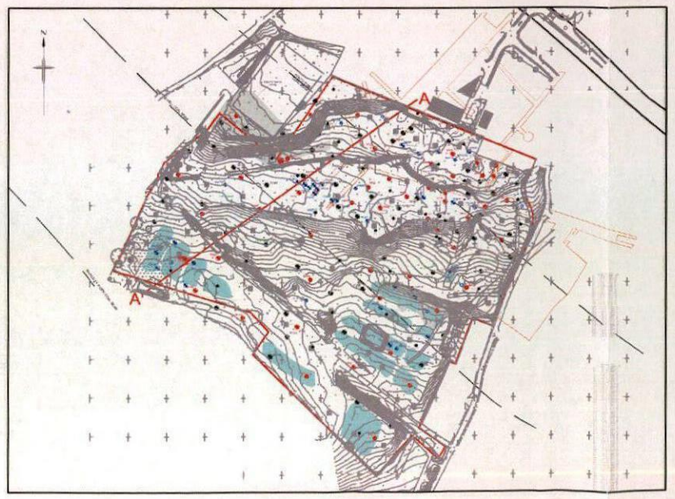
PROJECT
NORTH GAWBER

TITLE
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JOB No.:	DRAWING FILE:
321370	321370-R3(00)D004A

BY:	DATE:	CONTRACT NO.		REV:
HD	30.10.13		FIGURE 4	A





SITE LAYOUT
Not to scale

LEGEND:

- RO12 — Rotary borehole (2008)
- R204 — RSK rotary borehole locations (2013)
- Top of seam as encountered in BH203 and BH204

MATERIAL LEGENDS

- CLAY
- Mudstone
- Coal
- Sandstone
- Gravelly CLAY
- Topsoil
- MADE GROUND
- Void

REV	DATE	DESCRIPTION	BY	CHD.	APR.
A	30.10.13	FIRST ISSUE	HD	PT	PT

Dimensions	Projection	Scale	Orig Size
m		AS SHOWN	A3

RSK
Spring Lodge
172 Chester Road
Helsby
Cheshire
WA6 0AR
Tel: +44 1928 726006
Fax: +44 1928 725633
Web: www.rsk.co.uk

CLIENT: HARWORTH ESTATES

PROJECT: NORTH GAWBER

TITLE: CROSS-SECTION OF ROTARY HOLES A-A'

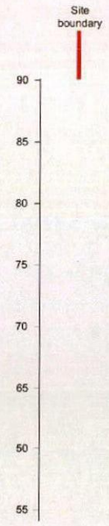
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BY:	DATE:	CONTRACT NO.		REV:
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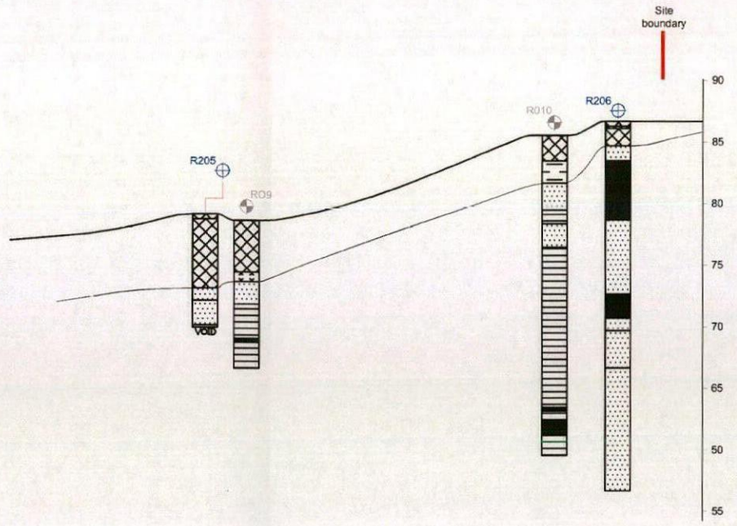
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Vertical Scale 1:250
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B'



B





SITE LAYOUT
Not to scale

LEGEND:

R012 Rotary borehole (2008)

R204 RSK rotary borehole locations (2013)

MATERIAL LEGENDS

- CLAY
- Mudstone
- Coal
- Sandstone
- Gravelly CLAY
- Topsoil
- MADE GROUND
- Void

REV	DATE	DESCRIPTION	BY	CHD.	APR.
A	03.02.14	FIRST ISSUE	HD	PT	PT

Dimensions	Projection	Scale	Orig Size
m		AS SHOWN	A3

RSK
Spring Lodge
172 Chester Road
Helsby
Cheshire
WA6 0AR
Tel: +44 1928 726006
Fax: +44 1928 725633
Web: www.rsk.co.uk

CLIENT
HARWORTH ESTATES

PROJECT
NORTH GAWBER

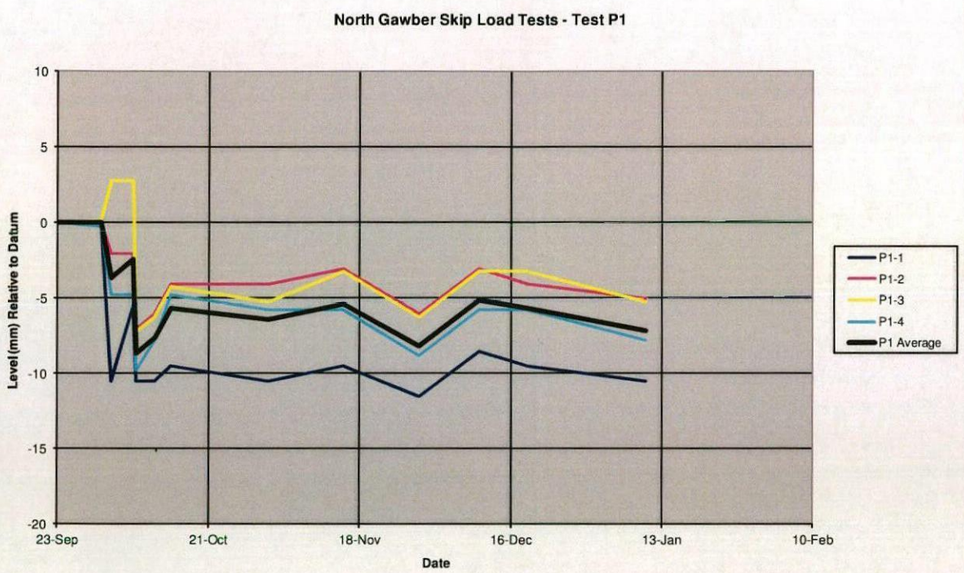
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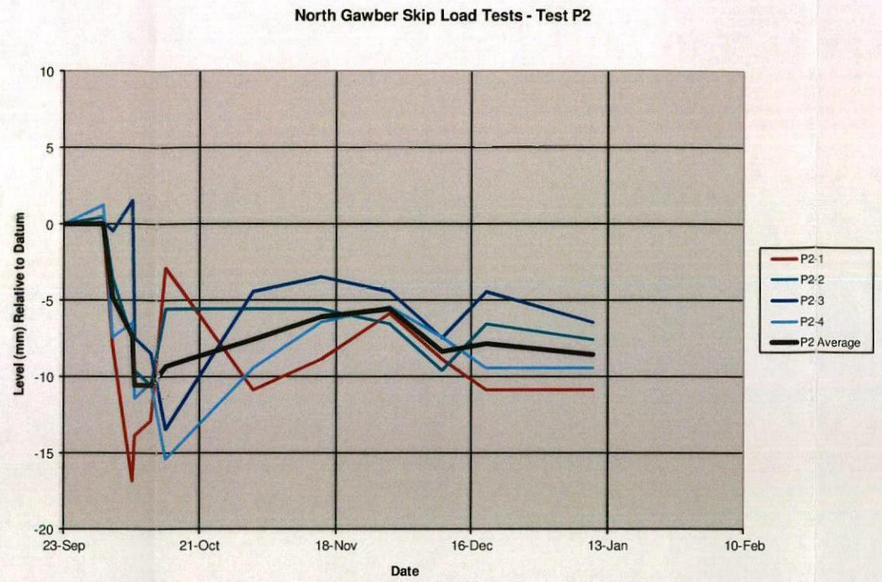
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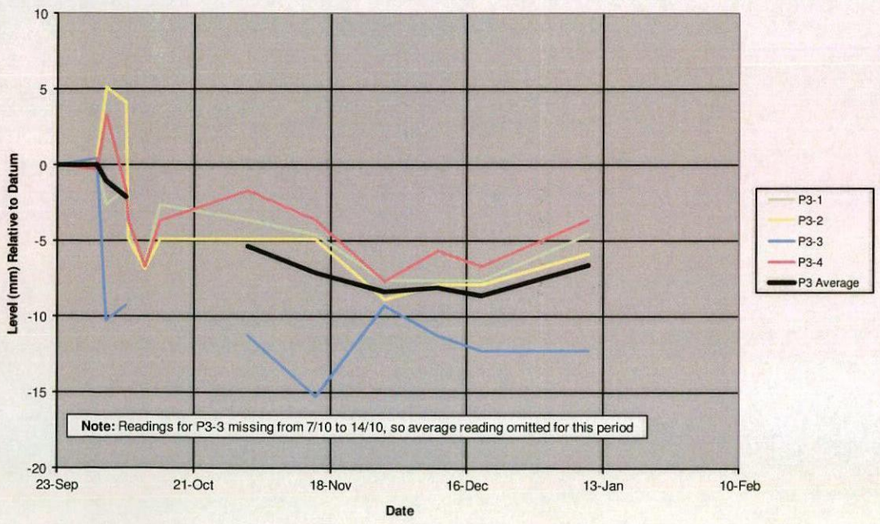
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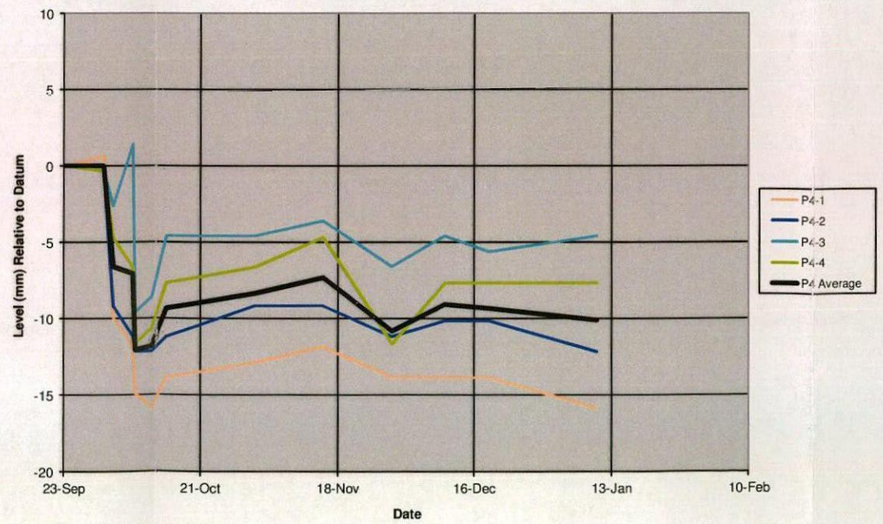
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Results of settlement monitoring for each of the four skip load tests monitoring ongoing (Jan 2014). Locations of tests shown on Figure 2.

REV	DATE	DESCRIPTION	BY	CHD.	APR.
A	31.01.14	FIRST ISSUE	HD	IW	IW

Dimensions	Projection	Scale	Orig Size
m		NTS	A3

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Spring Lodge
172 Chester Road
Helsby
Cheshire
WA6 0AR
Tel: +44 1928 726006
Fax: +44 1928 725633
Web: www.rsk.co.uk

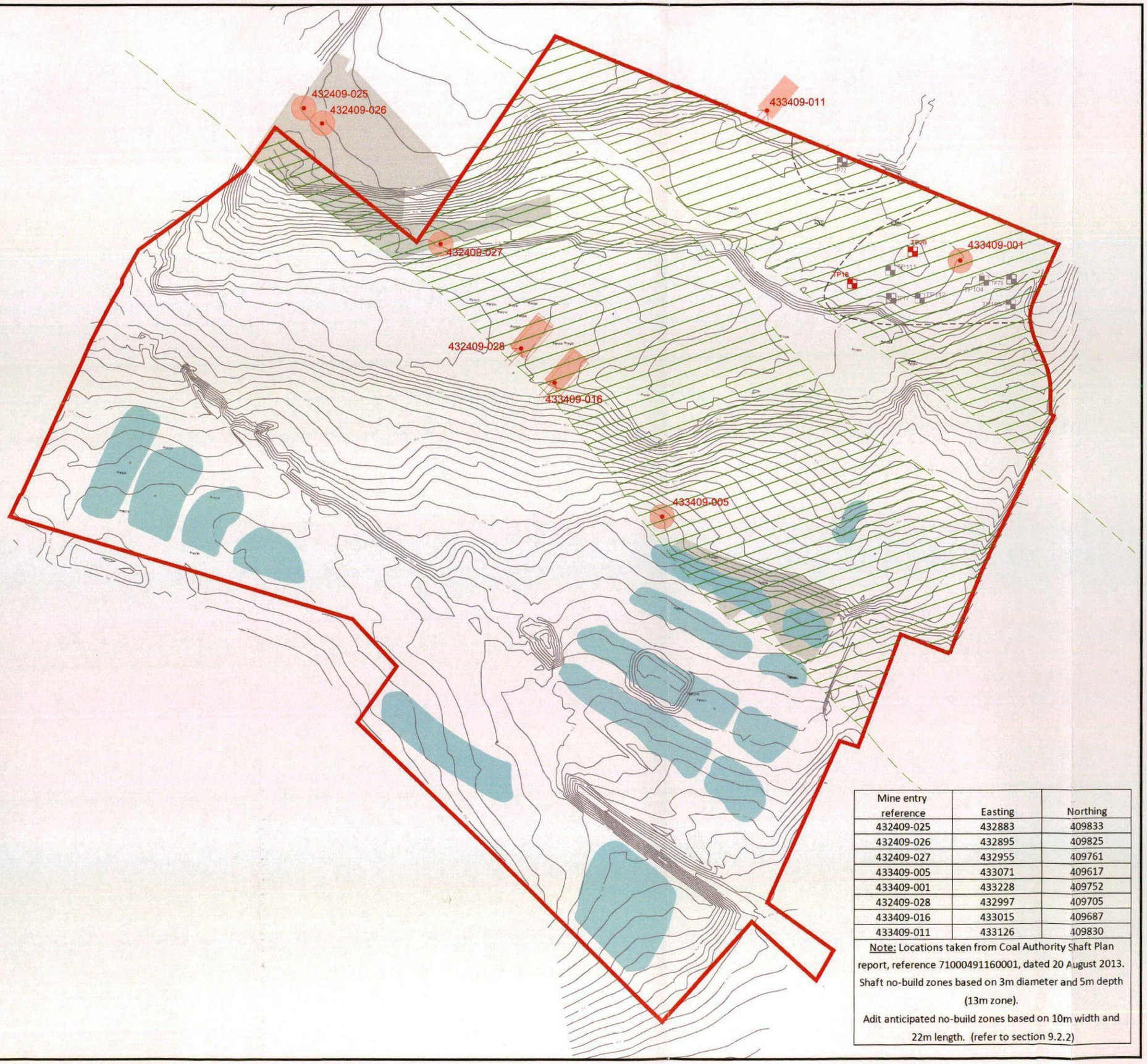
CLIENT
HARWORTH ESTATES

PROJECT
NORTH GAWBER

TITLE
RESULTS OF SKIP LOAD TESTS

JOB No.:	DRAWING FILE:
321370-R3	321370-R3(00)D007A

BY:	DATE:	CONTRACT NO.		REV:
HD	31.01.14		FIGURE 7	A



LEGEND:

- Opencast backfill (highwall at perimeter)
- Former lagoons (infilled)
- National Grid Reference of shaft (from Coal Authority Mining report) and no-build zone
- National Grid Reference of adit (from Coal Authority Mining report) and anticipated no build zone. Extent of the treatment zone may be increased. Effective treatment may allow adoption of raft foundations over this area
- Best estimate of seam outcrop based on all information received
- Area where competent overburden does not exceed ten times seam thickness
- Denotes extent of known elevated PAH concentrations which require increased inert cover thickness to proposed gardens

Mine entry reference	Easting	Northing
432409-025	432883	409833
432409-026	432895	409825
432409-027	432955	409761
433409-005	433071	409617
433409-001	433228	409752
432409-028	432997	409705
433409-016	433015	409687
433409-011	433126	409830

Note: Locations taken from Coal Authority Shaft Plan report, reference 71000491160001, dated 20 August 2013. Shaft no-build zones based on 3m diameter and 5m depth (13m zone).

Adit anticipated no-build zones based on 10m width and 22m length. (refer to section 9.2.2)

REV.	DATE	DESCRIPTION	BY	CHD.	APR.
A	13.12.13	FIRST ISSUE	HD	IW	IW

Dimensions	Projection	Scale	Orig Size
m		1:2,000	A3

RSK
Spring Lodge
172 Chester Road
Helsby
Cheshire
WA6 0AR
Tel: +44 1928 726006
Fax: +44 1928 725633
Web: www.rsk.co.uk

CLIENT
HARWORTH ESTATES

PROJECT
NORTH GAWBER

TITLE
GROUND CONDITION CONSTRAINTS PLAN
CURRENT PROPOSED HOUSING LAYOUT

JOB No.:	DRAWING FILE:
321370	321370-R3(00)D008A

BY:	DATE:	CONTRACT NO.		REV:
HD	03.02.14		FIGURE 8	A

Scale 1 : 2000
0 25 50 75 100m

APPENDIX A
SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Harworth Estates (the "client") in accordance with the terms of a contract between RSK and the "client", dated July 2013. The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.

2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.

3. Unless otherwise agreed the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be** well advised to seek independent advice from a competent environmental consultant and/or lawyer.

4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK 's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date hereof, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.

5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.

6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.

7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.

8. The phase II or intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.

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

APPENDIX B
SUMMARY OF LEGISLATION AND POLICY RELATING TO CONTAMINATED LAND

Part IIA of the Environmental Protection Act 1990 (EPA) and its associated Contaminated Land Regulations 2000 (SI 2000/227), which came into force in England on 1 April 2000, formed the basis for the current regulatory framework and the statutory regime for the identification and remediation of contaminated land. Part IIA of the EPA 1990 defines contaminated land as 'any land which appears to the Local Authority in whose area it is situated to be in such a condition by reason of substances in, on or under the land, that significant harm is being caused, or that there is significant possibility of significant harm being caused, or that pollution of controlled waters is being or is likely to be caused'. Controlled waters are considered to include all groundwater, inland waters and estuaries.

In August 2006, the Contaminated Land (England) Regulations 2006 (SI 2006/1380) were implemented, which extended the statutory regime to include Part IIA of the EPA as originally introduced on 1 April 2000, together with changes intended chiefly to address land that is contaminated by virtue of radioactivity. These have been replaced subsequently by the Contaminated Land (England) (Amendment) Regulations 2012, which now exclude land that is contaminated by virtue of radioactivity.

The intention of Part IIA of the EPA is to deal with contaminated land issues that are considered to cause significant harm on land that is not undergoing development (see Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, April 2012). This document replaces Annex III of Defra Circular 01/2006, published in September 2006 (the remainder of this document is now obsolete).

Water Framework Directive (WFD)

The Water Framework Directive 2000/60/EC is designed to:

- enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands that depend on the aquatic ecosystems
- promote the sustainable use of water
- reduce pollution of water, especially by 'priority' and 'priority hazardous' substances
- ensure progressive reduction of groundwater pollution.

The WFD requires a management plan for each river basin be developed every six years.

Groundwater Directive (GWD)

The 1980 Groundwater Directive 80/68/EEC and the 2006 Groundwater Daughter Directive 2006/118/EC of the WFD are the main European legislation in place to protect groundwater. The 1980 Directive is due to be repealed in December 2013. The European legislation has been transposed into national legislation by regulations and directions to the Environment Agency.

Environmental Permitting Regulations (EPR)

The Environmental Permitting (England and Wales) Regulations 2010 provide a single regulatory framework that streamlines and integrates waste management licensing, pollution prevention and control, water discharge consenting, groundwater authorisations, and radioactive substances regulation. Schedule 22, paragraph 6 of EPR 2010 states: 'the regulator must, in exercising its relevant functions, take all necessary measures - (a) to prevent the input of any hazardous substance to groundwater; and (b) to limit the input of non-hazardous pollutants to groundwater so as to ensure that such inputs do not cause pollution of groundwater.'

Water Resources Act (WRA)

The Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009 updated the Water Resources Act 1991, which introduced the offence of causing or knowingly permitting pollution of controlled waters. The Act provides the Environment Agency with powers to implement remediation necessary to protect controlled waters and recover all reasonable costs of doing so.

Priority Substances Directive (PSD)

The Priority Substances Directive 2008/105/EC is a 'Daughter' Directive of the WFD, which sets out a priority list of substances posing a threat to or via the aquatic environment. The PSD establishes environmental quality standards for priority substances, which have been set at concentrations that are safe for the aquatic environment and for human health. In addition, there is a further aim of reducing (or eliminating) pollution of surface water (rivers, lakes, estuaries and coastal waters) by pollutants on the list. The WFD requires that countries establish a list of dangerous substances that are being discharged and EQS for them. In England and Wales, this list is provided in the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. In order to achieve the objectives of the WFD, classification schemes are used to describe where the water environment is of good quality and where it may require improvement.

Planning Policy

Contaminated land is often dealt with through planning because of land redevelopment. This approach was documented in Planning Policy Statement: Planning and Pollution Control PPS23, which states that it remains the responsibility of the landowner and developer to identify land affected by contamination and carry out sufficient remediation to render the land suitable for use.

PPS23 was withdrawn early in 2012 and has been replaced by much reduced guidance within the National Planning Policy Framework (NPPF).

The new framework has only limited guidance on contaminated land, as follows:

- *"planning policies and decisions should also ensure that:*
    - *the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;*
    - *after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and*
    - *adequate site investigation information, prepared by a competent person, is presented".*

APPENDIX C
RISK ASSESSMENT METHODOLOGY

CLR11 outlines the framework to be followed for risk assessment in the UK. The framework is designed to be consistent with UK legislation and policies including planning. Under CLR11, three stages of risk assessment exist: preliminary, generic quantitative and detailed quantitative. An outline conceptual model should be formed at the preliminary risk assessment stage that collates all the existing information pertaining to a site in text, tabular or diagrammatic form. The outline conceptual model identifies potentially complete (termed possible) pollutant linkages (contaminant–pathway–receptor) and is used as the basis for the design of the site investigation. The outline conceptual model is updated as further information becomes available, for example as a result of the site investigation.

Production of a conceptual model requires an assessment of risk to be made. Risk is a combination of the likelihood of an event occurring and the magnitude of its consequences. Therefore, both the likelihood and the consequences of an event must be taken into account when assessing risk. RSK has adopted guidance provided in CIRIA C552 for use in the production of conceptual models.

The likelihood of an event can be classified on a four-point system using the following terms and definitions based on CIRIA C552:

- highly likely: the event appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution
- likely: it is probable that an event will occur or circumstances are such that the event is not inevitable, but possible in the short term and likely over the long term
- low likelihood: circumstances are possible under which an event could occur, but it is not certain even in the long term that an event would occur and it is less likely in the short term
- unlikely: circumstances are such that it is improbable the event would occur even in the long term.

The severity can be classified using a similar system also based on CIRIA C552. The terms and definitions relating to severity are:

- severe: short term (acute) risk to human health likely to result in 'significant harm' as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution of sensitive water resources. Catastrophic damage to buildings or property. Short-term risk to an ecosystem or organism forming part of that ecosystem (note definition of ecosystem in 'Draft Circular on Contaminated Land', DETR 2000)
- medium: chronic damage to human health ('significant harm' as defined in 'Draft Circular on Contaminated Land', DETR 2000), pollution of sensitive water resources, significant change in an ecosystem or organism forming part of that ecosystem

- mild: pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ('significant harm' as defined in 'Draft Circular on Contaminated Land', DETR 2000). Damage to sensitive buildings, structures or the environment
- minor: harm, not necessarily significant, but that could result in financial loss or expenditure to resolve. Non-permanent human health effects easily prevented by use of personal protective clothing. Easily repairable damage to buildings, structures and services.

Once the probability of an event occurring and its consequences have been classified, a risk category can be assigned according to the table below.

		Consequences			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**Highly likely**	Very high	High	Moderate	Moderate/low
	Likely	High	Moderate	Moderate/low	Low
	Low likelihood	Moderate	Moderate/low	Low	Very low
	Unlikely	Moderate/low	Low	Very low	Very low

Definitions of these risk categories are as follows together with an assessment of the further work that may be required:

- Very high: there is a high probability that severe harm could occur or there is evidence that severe harm is currently happening. This risk, if realised, could result in substantial liability; urgent investigation and remediation are likely to be required.
- High: harm is likely to occur. Realisation of the risk is likely to present a substantial liability. Urgent investigation is required. Remedial works may be necessary in the short term and are likely over the long term.
- Moderate: it is possible that harm could arise, but it is unlikely that the harm would be severe and it is more likely that the harm would be relatively mild. Investigation is normally required to clarify the risk and determine the liability. Some remedial works may be required in the longer term.
- Low: it is possible that harm could occur, but it is likely that if realised this harm would at worst normally be mild.
- Very low: there is a low possibility that harm could occur and if realised the harm is unlikely to be severe.

APPENDIX D
EXPLORATORY HOLE RECORDS

BOREHOLE LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	BH201

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	14.08.13	72.74	E:433098.8 N:409514.1	1 of 1
	End: 14.08.13			

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.40-0.80	1	B				MADE GROUND comprising sparse grass over soft grey/black sandy very gravelly ashy clay. Gravel is fine to coarse angular to subangular brick, mudstone, sandstone, coal. Rare fragments of wood. Rootlets in top 0.2m		
1.40	2	D					(3.20)	
1.50-1.95	S3	SPT	N=3					
1.50-1.95	3	B						
2.90	4	D					3.20	
3.00-3.45	S5	SPT	N=4					
3.00-3.45	6	B				MADE GROUND comprising very soft grey/black slightly gravelly clay. Gravel is fine to coarse angular to subangular brick, mudstone, sandstone, coal.	(1.10)	
4.40	7	D					4.30	
4.50-4.93	S8	SPT	N:50 for 280mm			MADE GROUND comprising stiff grey/brown/orangey slightly gravelly clay with pockets of black sandy gravelly angular coal. Gravel is fine to coarse angular to subangular brick, mudstone, sandstone, coal. Very compact	4.70	
4.50-5.00	9	B					(0.50)	
5.00	W12	EW				MADE GROUND comprising grey/brown slightly clayey gravel of fine to coarse angular to subangular mudstone and rare coal fragments	5.20	
5.90	10	D				Grey/brown weathered MUDSTONE recovered as very stiff gravelly clay	(1.14)	
6.00-6.34	S11	SPT	N:50 for 190mm				6.34	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
5.80	6.00	00:30

General Remarks

1. Hand dug pit to 1.2m
2. No groundwater but very damp/wet from 2.3m
3. Installation: 1m plain, 5m slotted. Top hat cover

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	Dando 2000	RW	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:30 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

BOREHOLE LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	BH202

Contract Ref:	Start: 15.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 15.08.13	74.74	E:432981.2 N:409577.3	1 of 1

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
0.40-0.80	1	B				TOPSOIL comprising grass over soft brown sandy gravelly clay with occasional rootlets. Gravel is angular to subangular fine mudstone and brick	0.20	
						MADE GROUND comprising grey/brown slightly clayey very gravelly fine to coarse sand. Gravel is fine to coarse angular to subangular mudstone, sandstone, coal	(0.80) 1.00	
1.40	2	D				MADE GROUND comprising soft black slightly gravelly sandy clay. Gravel is fine to coarse angular to subangular mudstone and coal. Not homogenous - some more sandy patches and some clayey patches with little gravel	(1.20) 2.20	
1.50-1.95	S3	SPT	N=5					
1.50-1.95	4	B						
2.90	5	D				Stiff light brown/orange mottled grey CLAY with rare fine gravel of subangular mudstone. Becomes friable with depth	(1.40) 3.60	
3.00-3.45	S6	SPT	N=29					
3.00-3.45	7	B						
3.40	8	D						
4.00-4.37	S9	SPT	N:50 for 220mm			Light grey/brown weathered MUDSTONE recovered as sandy clayey mudstone gravel and cobbles	(1.69) 5.29	
4.00-4.50	10	B						
4.90	11	D						
5.00-5.29	S12	SPT	N:50 for 150mm					

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
4.70	5.00	00:30

General Remarks

1. Hand dug pit to 1.2m
2. No groundwater encountered
3. Installation: 1m plain, 4m slotted. Top hat cover

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	Dando 2000	RW	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:30 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

BOREHOLE LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	BH203

Contract Ref:	Start: 12.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 12.08.13	76.00	E:432792.7 N:409644.5	1 of 2

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
						TOPSOIL occasional rootlets, fibrous peat, dark brown in colour	0.40	
0.40-0.80	B1	B				MADE GROUND comprising soft dark brown/grey slightly sandy gravelly clay. Black staining, hydrocarbon odour. Gravel is angular to subangular medium to coarse mudstone, sandstone, siltstone. Occasional cobbles. Clay is slightly damp	(2.50)	
1.40	D2	D						
1.50-1.95	S3	SPT	N=7					
1.50-1.95	B3	B						
							2.90	
2.90	D4	D				MADE GROUND comprising soft, friable light brown/grey gravelly clay with patches of dark grey clay. Gravel is angular to subangular medium to coarse mudstone, sandstone and siltstone	3.10	
3.00-3.23	S5	SPT	N:50 for 125mm					
3.00-3.50	B6	B				Light brown/grey/orange SANDSTONE. Weathered and fine grained. Recovered as sandy fine to coarse angular to subangular gravel	(1.08)	
3.80	W1	EW						
3.90	D7	D					4.18	
4.00-4.17	S8	SPT	N:50 for 90mm					

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
3.80	4.00	00:30

General Remarks

1. Hand dug pit to 1.2m
2. No environmental samples taken as TP221 was close to hole, from which samples were taken at 0.3-0.5m and 2.0-2.3m
3. Terminated at 4.0m: drilled only 0.2m in 15 minutes
4. Installation: 1m plain, 3m slotted. Top hat

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Drilled By:	Logged By:	Checkec By:
Cable percussion	Dando 2000	RW	EJones + EAtkinson	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:30 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

BOREHOLE LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	BH203

Contract Ref:	Start: 12.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 12.08.13	76.00	E:432792.7 N:409644.5	2 of 2

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

cover

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	Dando 2000	RW	EJones + EAtkinson	

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:30 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

BOREHOLE LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	BH204

Contract Ref:	Start: 12.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 12.08.13	83.60	E:432875.6 N:409727.8	1 of 1

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising soft dark brown gravelly fine to coarse sand. Gravel is fine to coarse angular to subangular sandstone, mudstone, coal. Contains occasional rootlets	0.20	
0.40-0.80	B1	B				MADE GROUND comprising black gravelly fine to coarse sand with occasional cobbles. Gravel is fine to coarse angular to subangular sandstone, mudstone, coal. Cobbles are angular to subangular brick fragments	(1.60)	
1.00-1.30	ES	ES						
1.40	D2	D					1.80	
1.50-1.95	S3	SPT	N=7					
1.50-1.95	B4	B				MADE GROUND comprising soft to firm grey mottled brown clay with occasional fibrous wood fragments and rare gravel. Gravel is fine to medium angular to subangular mudstone and siltstone	(0.60)	
							2.40	
						Firm grey mottled brown CLAY. Occasional fibrous wood and vegetation fragments.	(1.30)	
2.90	D5	D						
3.00-3.45	S6	SPT	N=36					
3.00-3.45	B7	B					3.70	
						Weathered grey/brown/orangey clayey sandstone		
3.90	D8	D						
4.00-4.37	S9	SPT	N:50 for 220mm				(1.30)	
4.00-4.50	B10	B						
4.60	D11	D						
4.70-5.00	S12	SPT	N:50 for 180mm				5.00	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
4.50	4.70	00:30

General Remarks

1. Hand dug pit to 1.3m
2. No groundwater encountered
3. Installation: 1m plain, 3.7m slotted. Top hat cover

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	Dando 2000	RW	EJones + EAtkinson	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:30 | BM.
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BOREHOLE LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	BH205

Contract Ref:	Start: 13.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 13.08.13	85.56	E:433045.1 N:409722.9	1 of 2

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.40-0.60	B1	B				MADE GROUND comprising patchy grass over grey/brown clayey very gravelly fine to coarse sand. Gravel is fine to coarse angular to subangular mudstone, sandstone, siltstone. Occasional cobbles of angular to subangular grey mudstone	(0.80)	
							0.80	
1.00	D2	D				MADE GROUND comprising black gravelly fine to coarse sand. Gravel is fine to coarse angular to subangular mudstone, sandstone, siltstone, brick	(0.70)	
							1.50	
1.40	D3	D				MADE GROUND comprising black/dark grey gravelly slightly clayey fine to coarse sand. Gravel is fine to coarse angular to subangular mudstone, sandstone, siltstone, brick. Between 1.95 and 3.0m becomes less gravelly. Occasional coal fragments between 3.45-4.95m		
1.50-1.95	S4	SPT	N=6					
1.50-1.96	B5	B						
2.90	D6	D						
3.00-3.45	S7	SPT	N=8					
3.00-3.45	B8	B					(4.40)	
4.40	D9	D						
4.50-4.95	S10	SPT	N=6					
4.50-4.95	B11	B						
							5.90	
5.90	D12	D				MADE GROUND comprising soft to firm grey mottled brown sandy slightly silty gravelly clay. Gravel is fine to medium angular to subangular mudstone, siltstone, sandstone, rare coal fragments. Lenses of black sand and gravel sized laminated coal fragments from 7.6m		
6.00-6.45	S13	SPT	N=9				(2.20)	
6.00-6.45	B14	B						
7.40	D15	D						
7.50-7.95	S16	SPT	N=22					
7.50-7.95	B17	B						
							8.10	
						MADE GROUND comprising stiff brown/orangey clay. Occasional fibrous wood and vegetation fragments. Gravel is medium subangular to rounded. Gravel consists of mudstone, sandstone, pockets of sand and gravel sized coal fragments		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
12.30	12.60	00:30

General Remarks

1. Hand dug pit to 1.2m
2. Groundwater struck at 10.4m depth, rising to 9.2m depth after 20 minutes.
3. Installation: 1m plain, 11.6m slotted. Top hat cover

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	Dando 2000	RW	EJones + EAtkinson	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:30 | BM.
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BOREHOLE LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	BH205

Contract Ref:	Start: 13.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 13.08.13	85.56	E:433045.1 N:409722.9	2 of 2

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
8.90	D18	D		1		MADE GROUND comprising stiff brown/orangey clay. Occasional fibrous wood and vegetation fragments. Gravel is medium subangular to rounded. Gravel consists of mudstone, sandstone, pockets of sand and gravel sized coal fragments *(stratum copied from 8.10m from previous sheet)*	(3.70)	
9.00-9.45	S19	SPT	N=40					
9.00-9.45	B20	B						
10.40	D21	D		1				
10.50-10.95	S22	SPT	N=22					
10.50-10.95	B22	B					11.80	
11.90	D23	D				Dark grey very fine grained MUDSTONE. Rare fibrous fragments of wood and roots, trace fossils. Recovered as friable mudstone	(0.93)	
12.00-12.18	S24	SPT	N:50 for 90mm					
12.00-12.50	B25	B						
12.00	D26	D						
12.60-12.73	S27	SPT	N:50 for 70mm				12.73	

Boring Progress and Water Observations						Chiselling / Slow Progress			General Remarks
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth	From	To	Duration (hh:mm)	

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	Dando 2000	RW	EJones + EAtkinson	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:30 | BM.
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BOREHOLE LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	BH206

Contract Ref:	Start: 15.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 16.08.13	75.45	E:433138.2 N:409562.6	1 of 1

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
						TOPSOIL comprising grass over brown clayey gravelly fine to coarse sand with many rootlets. Gravel is angular to su-angular fine to coarse mudstone, sandstone, brick	0.20	
0.40-0.80	B1	B				MADE GROUND comprising soft grey/brown sandy gravelly ashy clay with occasional cobbles. Gravel is angular to subangular fine to coarse mudstone, sandstone, brick, coal. Cobbles are angular sandstone and clinker. Rare sandstone boulders (subangular) 0.08x0.3x0.4m. Rare clinker gravel. Occasional pockets of yellow/brown sandy clay	(2.60)	
1.40	D2	D						
1.50-1.95	S3	SPT	N=5					
1.50-1.95	B4	B					2.80	
2.90	D5	D				MADE GROUND comprising soft to firm grey/brown mottled orange slightly sandy slightly gravelly reworked clay. Gravel is fine to coarse angular to subangular mudstone, sandstone, coal	(2.00)	
3.00-3.45	S6	SPT	N=8					
3.00-3.45	B7	B					4.80	
4.40	D8	D				Grey weathered MUDSTONE recovered as friable slightly sandy clayey mudstone gravel	(1.20)	
4.50-4.95	S9	SPT	N=24					
4.50-4.95	B10	B					6.00	
5.00	W1	EW				Grey laminated MUDSTONE	(0.70)	
5.90	D11	D						
6.00-6.12	S12	SPT	N:50 for 75mm					
6.00-6.50	B12	B					6.70	
6.50-6.70	S14	SPT	N:50 for 110mm					
6.50	D13	D				Borehole terminated at 6.70m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
6.30	6.50	00:30

General Remarks

1. Hand dug pit to 1.2m
2. No groundwater, but clay wet from 1.7m
3. Installation: 1m plain, 5.5m slotted. Top hat cover

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Drilled By:	Logged By:	Checkec By:
Cable percussion	Dando 2000	RW	EJones	

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BOREHOLE LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	BH207

Contract Ref:	Start: 15.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 15.08.13	81.37	E:433166.7 N:409614.9	1 of 1

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
0.40-0.60	B1	B				MADE GROUND comprising grey slightly clayey gravelly fine to coarse sand. Gravel is fine to coarse angular to subangular mudstone, sandstone, coal, brick	(0.60) 0.60	
1.40	D2	D				MADE GROUND comprising grey/black gravelly ashy fine to coarse sand with occasional angular to subangular brick cobbles. Gravel is fine to coarse angular to subangular mudstone, sandstone, clinker, brick. Clinker is shiny red/black and very dense	(3.70) 4.30	
1.50-1.95	S3	SPT	N=7					
1.50-1.95	B4	B						
2.90	D5	D						
3.00-3.45	S6	SPT	N=8					
3.00-3.45	B7	B						
4.40	D8	D				MADE GROUND comprising firm light brown/orange/grey slightly gravelly clay. Gravel is fine to medium angular to subangular mudstone. Rare pockets of black coaly sand that possibly fell in from the strata above. Becomes more gravelly and stiff with depth	(1.20) 5.50	
4.50-4.95	S9	SPT	N=30					
4.50-4.95	B10	B						
5.30	W1	EW				Light brown/grey weathered MUDSTONE recovered as very stiff clayey gravel of angular to subangular laminated mudstone	(1.28) 6.78	
5.90	D11	D						
6.00-6.36	S12	SPT	N:50 for 210mm					
6.00-6.50	B13	B						
6.50-6.78	S15	SPT	N:50 for 130mm					
6.50	D14	D						

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
6.30	6.50	00:30

General Remarks

1. Hand dug pit to 1.2m
2. No groundwater encountered
3. Installation: 1m plain, 5.5m slotted. Top hat cover

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	Dando 2000	RW	EJones	

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BOREHOLE LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	BH208

Contract Ref:	Start: 14.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 14.08.13	90.72	E:433026.3 N:409808.1	1 of 1

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.40-0.80	B1	B				MADE GROUND comprising grass over brown very gravelly slightly clayey ashy fine to medium sand. Gravel is fine to coarse angular to subangular brick, mudstone, coal. Becomes more clayey with depth	(1.80)	
1.40	D2	D					1.80	
1.50-1.95	S3	SPT	N=7					
1.50-1.95	B4	B						
						MADE GROUND comprising friable brown/black very gravelly clay. Gravel is fine to coarse angular to subangular mudstone, coal and rare brick		
2.90	D5	D					(2.60)	
3.00-3.45	S6	SPT	N=11					
3.00-3.45	B7	B						
							4.40	
4.40	D8	D				MADE GROUND comprising soft to firm grey/black slightly sandy gravelly clay with pockets of sand and gravel sized coal fragments	4.80	
4.50-4.95	S9	SPT	N=14					
4.50-4.95	B10	B						
						Firm orange/brown mottled grey sandy gravelly CLAY	(1.90)	
5.90	D11	D						
6.00-6.45	S12	SPT	N=35					
6.00-6.45	B13	B						
							6.70	
6.90	D14	D				Light brown/orange mottled grey weathered MUDSTONE and SANDSTONE recovered as orange sandy fine to coarse mudstone and sandstone gravel and cobbles	(0.89)	
7.00-7.25	S15	SPT	N:50 for 130mm					
7.00-7.50	B16	B						
							7.59	
7.50-7.59	S17	SPT	N:50 for 60mm					

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
7.30	7.50	00:30

General Remarks

1. Hand dug pit to 1.2m
2. No groundwater encountered
3. Installation: 1m plain, 6.5m slotted. Top hat cover

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	Dando 2000	RW	EJones	AGS

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BOREHOLE LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	BH209

Contract Ref:	Start: 13.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 13.08.13	90.77	E:433174.5 N:409759.8	1 of 1

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
						TOPSOIL comprising grass over dark brown sandy fibrous peat with occasional rootlets	0.20	
0.40-0.80	B1	B				MADE GROUND comprising dark grey/black gravelly fine to medium sand. Gravel is fine to coarse angular to subangular mudstone, siltstone, sandstone and brick fragments. Occasional cobbles. Occasional coal fragments. Many brick cobbles from 0.5-1.2m	(1.00)	
0.50-0.70	ES	ES					1.20	
1.20-1.40	ES	ES				MADE GROUND comprising light brown gravelly fine to medium sand. Gravel is fine to coarse angular to subangular mudstone, siltstone, sandstone and brick fragments. Occasional cobbles	1.40	
1.40	D2	D				MADE GROUND comprising dark brown/black gravelly fine to medium sand with occasional cobbles. Gravel is fine to coarse angular to subangular mudstone, siltstone, sandstone with occasional brick fragments and pockets of laminated coal	(2.10)	
1.50-1.95	S3	SPT	N=7					
1.50-1.95	B4	B						
2.90	D5	D					3.50	
3.00-3.45	S6	SPT	N=5			MADE GROUND comprising firm to stiff light brown/grey gravelly friable sandy clay with pockets of fine to medium sand. Gravel is fine to medium angular to subangular sandstone and mudstone. Occasional fibrous fragments of roots and vegetation	3.80	
3.00-3.45	B7	B				Grey/light brown medium grained SANDSTONE. Occasional fibrous fragments	(1.74)	
4.30	D8	D						
4.40-4.71	S9	SPT	N:50 for 160mm					
4.40-5.00	B10	B						
5.30	D11	D					5.54	
5.40-5.54	S12	SPT	N:50 for 85mm					

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
5.10	5.30	00:30

General Remarks

1. Hand dug pit to 1.2m
2. No groundwater encountered
3. Installation: 1m plain, 4.4m slotted. Top hat cover

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	Dando 2000	RW	EJones + EAtkinson	

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ROTARY LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	R201

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	22.08.13	75.61	E:432805.8 N:409626.9	1 of 2
	End: 22.08.13			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										MADE GROUND comprising firm light brown mottled grey gravelly clay. Gravel is fine to coarse angular to subangular mudstone, siltstone, sandstone. Contains occasional angular cobbles and brick fragments	(3.00) 3.00	
										Grey slightly clayey MUDSTONE recovered as fine to coarse gravelly clay	(7.10) 10.10	
										Yellow/brown SANDSTONE with frequent bands of grey mudstone		

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Hand dug pit to 1.2m
2. 4.5m casing.
3. Water flush technique used
4. Groundwater was not encountered

All dimensions in metres | Scale: 1:89

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Rotary open hole	Massenza M-I-6	DS	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:26 | BM.
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ROTARY LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	R201

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	22.08.13	75.61	E:432805.8 N:409626.9	2 of 2
	End: 22.08.13			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										Yellow/brown SANDSTONE with frequent bands of grey mudstone *(stratum copied from 10.10m from previous sheet)*	(13.20)	
										COAL recovered as black slightly clayey gravels of coal and grey mudstone	23.30	
										Grey MUDSTONE	23.50	
											(6.50)	
											30.00	
										Rotary borehole terminated at 30m depth.		

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: 1:89

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Rotary open hole	Massenza M-I-6	DS	EJones	

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:20 | BM.
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ROTARY LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	R202

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	27.08.13	84.97	E:432993.0 N:409691.8	1 of 2
	End: 27.08.13			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										MADE GROUND comprising patchy grass over brown very gravelly slightly clayey fine to coarse sand. Gravel is fine to coarse angular to subangular brick, mudstone, sandstone. Occasional rootlets	0.40	
										MADE GROUND comprising black very gravelly ashy fine to coarse sand. Gravel is fine to coarse angular to subangular brick, mudstone, sandstone. Rare concrete. Occasional coal fragments. Angular piece of steel (0.2x0.2x0.01m) at 1.0m	(5.60)	
											6.00	
										MADE GROUND comprising soft gravelly sandy clay. Gravel is fine to coarse sandstone	(1.00)	
											7.00	
										MUDSTONE interbedded with red/pink sandstone	(6.80)	
											13.80	
										COAL	14.00	
										MUDSTONE interbedded with yellow/brown sandstone		

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Hand dug pit to 1.2m
2. Casing to 9.0m
3. Water flush technique used
4. Groundwater was not encountered
5. Hole terminated at 22.0m as no more coal expected to be found

All dimensions in metres | Scale: 1:89

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Rotary open hole	Massenza M-I-6	DS	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:20 | BM.
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ROTARY LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	R202

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	27.08.13	84.97	E:432993.0 N:409691.8	2 of 2
	End: 27.08.13			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										MUDSTONE interbedded with yellow/brown sandstone *(stratum copied from 14.00m from previous sheet)*	(8.00)	
										Rotary borehole terminated at 22.0m depth.	22.00	

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: 1:89

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Rotary open hole	Massenza M-I-6	DS	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:20 | BM.
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ROTARY LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	R203

Contract Ref:	Start: 28.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 28.08.13	85.94	E:433024.8 N:409749.4	1 of 2

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										MADE GROUND comprising grey/brown slightly clayey gravelly fine to medium sand with occasional rootlets. Gravel is fine to coarse angular to subangular brick, mudstone, sandstone	0.50	
										MADE GROUND comprising black gravelly ashy fine to coarse sand. Gravel is fine to coarse angular to subangular brick, mudstone, sandstone	(5.50)	
											6.00	
										Yellow/brown-grey MUDSTONE	(1.70)	
											7.70	
										COAL	8.00	
										Yellow/brown-grey MUDSTONE	(2.00)	
											10.00	
										COAL recovered as fine to coarse angular vitreous coal gravel	(3.00)	
											13.00	
										Grey/brown MUDSTONE	(5.00)	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Hand dug pit to 1.2m
2. Casing to 7.0m
3. Water flush technique used
4. Partial loss of flush at 10.0m, recovered at 13.0m
5. Groundwater was not encountered
6. Terminated at 24.0m due to slow drilling process

All dimensions in metres | Scale: 1:89

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Rotary open hole	Massenza M-I-6	DS	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:23 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

ROTARY LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	R203

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	28.08.13	85.94	E:433024.8 N:409749.4	2 of 2
	End: 28.08.13			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										Grey/brown MUDSTONE *(stratum copied from 13.00m from previous sheet)*	18.00	
										COAL recovered as coal and mudstone gravel	18.20	
										Grey-brown MUDSTONE/SILTSTONE. Very hard from 23.5m. Slow drilling progress	(5.80)	
										Rotary borehole terminated at 24.0m depth.	24.00	

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: 1:89

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Rotary open hole	Massenza M-I-6	DS	EJones	

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:20 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

ROTARY LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	R204

Contract Ref:	Start: 28.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 29.08.13	91.13	E:433080.4 N:409816.5	1 of 2

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										MADE GROUND comprising grey/brown slightly clayey gravelly fine to coarse sand. Gravel is fine to coarse angular to subangular mudstone, sandstone, coal. Rare mudstone/coal cobbles. Rootlets in top 0.2m	(5.00) 5.00	
										Yellow/brown SANDSTONE	(3.00) 8.00	
										Grey/brown MUDSTONE	(4.00) 12.00	
										Yellow/Brown SANDSTONE	(2.00) 14.00	
										Grey/brown MUDSTONE		

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Hand dug pit to 1.2m
2. Casing to 9.0m
3. Water flush technique used
4. Groundwater was not encountered
5. Hole terminated at 21.0m due to fears of rods getting stuck in backfilled void - no return

All dimensions in metres | Scale: 1:89

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Rotary open hole	Massenza M-I-6	DS	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:20 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

ROTARY LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	R204

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	28.08.13 End: 29.08.13	91.13	E:433080.4 N:409816.5	2 of 2

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										Grey/brown MUDSTONE *(stratum copied from 14.00m from previous sheet)*	(4.20) 18.20	
										VOID - backfilled. No recovery/flush (drilling bit covered in clayey fine to coarse angular gravels of mudstone, sandstone and coal)	(2.80) 21.00	VOID
										Rotary borehole terminated at 21.00m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: 1:89

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Rotary open hole	Massenza M-I-6	DS	EJones	

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:20 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

ROTARY LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	R205

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	02.09.13	79.11	E:433183.3 N:409596.0	1 of 1
	End: 02.09.13			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										MADE GROUND comprising friable grey/brown gravelly slightly sandy clay with occasional rootlets. Gravel is fine to coarse angular to subangular mudstone, sandstone	0.40	
										MADE GROUND comprising black gravelly fine to coarse sand. Gravel is fine to coarse angular to subangular mudstone, sandstone and many angular brick gravels and cobbles. Brick rare from 1.2m	(5.60)	
											6.00	
										Yellow/brown SANDSTONE	(1.00)	
											7.00	
										Grey SANDSTONE and mudstone	(2.00)	
											9.00	
										VOID - loss of water. No recovery/flush. (drilling bit covered in clayey fine to coarse angular gravels of mudstone, sandstone and coal)	9.20	
										Hole terminated at 9.2m as complete loss of flush		

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Hand dug pit to 1.2m
2. Casing to 6.0m
3. Water flush technique used
4. Groundwater was not encountered
5. Hole terminated at 9.2m as complete loss of flush

All dimensions in metres | Scale: 1:89

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Rotary open hole	Massenza M-I-6	DS	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:20 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

ROTARY LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	R206

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 30.08.13	86.62	E:433261.6 N:409698.5	1 of 2

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										MADE GROUND comprising grass over friable grey/brown gravelly sandy ashy clay. Gravel is fine to coarse angular to subangular sandstone, mudstone, coal, red ash	0.40 0.60 (1.40)	
										MADE GROUND comprising light yellow/orange ashy gravelly fine to coarse sand. Gravel is angular mudstone and sandstone	2.00	
										MADE GROUND comprising black ashy gravelly fine to coarse sand. Gravel is fine to coarse angular coal, mudstone. Occasional coal and mudstone cobbles	(1.20) 3.20	
										Yellow/brown SANDSTONE COAL recovered as black vitreous angular gravel of coal (70%) and sandstone (30%)	(4.80) 8.00	
										Yellow/brown SANDSTONE recovered as sandstone and coal gravel (presumed that coal is being washed out from above the sandstone - unclear due to water flush technique).	(6.00) 14.00	
										Vitreous COAL Violent bubbling at 14.0m. No dangerous gases detected	(2.00) 16.00	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Hand dug pit to 1.2m
2. Casing to 3m
3. Water flush technique used
4. Groundwater was not encountered

All dimensions in metres | Scale: 1:89

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Rotary open hole	Massenza M-I-6	DS	EJones	

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:20 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

ROTARY LOG

Contract:	Client:	Borehole:
(M) North Gawber	Harworth Estates Ltd	R206

Contract Ref:	Start: 29.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 30.08.13	86.62	E:433261.6 N:409698.5	2 of 2

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										Yellow/brown/grey SANDSTONE and mudstone	(1.00) 17.00	
										Yellow/brown/grey SANDSTONE and mudstone with some coal arisings	(3.00) 20.00	
										Yellow/brown/grey SANDSTONE and mudstone	(10.00) 30.00	
										Rotary borehole terminated at 30.00m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: 1:89

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Rotary open hole	Massenza M-I-6	DS	EJones	

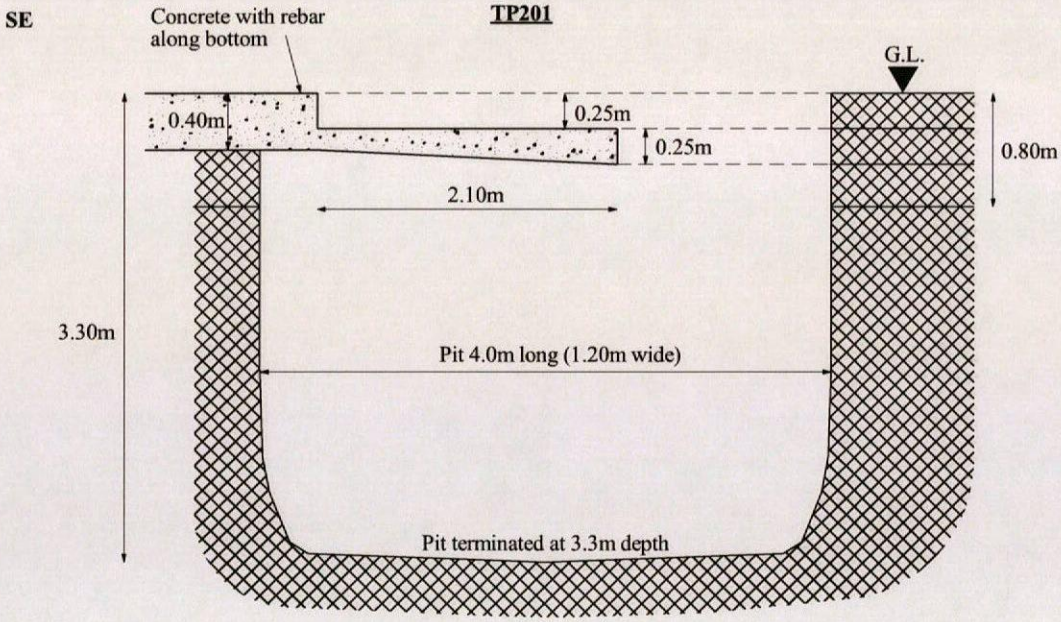
GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:20 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

TRIAL PIT LOG

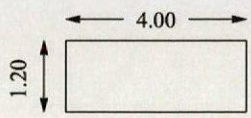
Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP201

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 05.08.13	86.40	E:433060.2 N:409680.5	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising soft grey very gravelly clay. Gravel is medium to coarse angular to subangular of mixed lithologies and occasional brick fragments	0.25	
						Concrete slab	0.50	
						MADE GROUND comprising reddish brown sandy slightly clayey gravel with occasional cobbles. Gravel is fine to coarse, gravel and cobbles are angular to subangular of mixed lithologies, brick fragments and concrete. Rare angular sandstone boulders (0.5mx0.35mx0.15m). Rare wood fragments.	0.80	
2.50-3.00	B1	B				MADE GROUND comprising firm brown/dark grey very gravelly slightly sandy clay with occasional cobbles, and rare boulders. Gravel is fine to coarse angular to subangular of mixed lithologies, occasional brick and coal fragments. Cobbles and boulders have reddish/brown iron staining. Coal fragments	(2.50)	
						Trial pit terminated at 3.30m depth.	3.30	



Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EAtkinson	PTaunton

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log XL - TRIAL PIT LOG - SPECIAL 2 | 321370 NORTH GAWBER.GPJ - v8_05 | 13/11/13 - 12:26 | JH.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

TRIAL PIT LOG

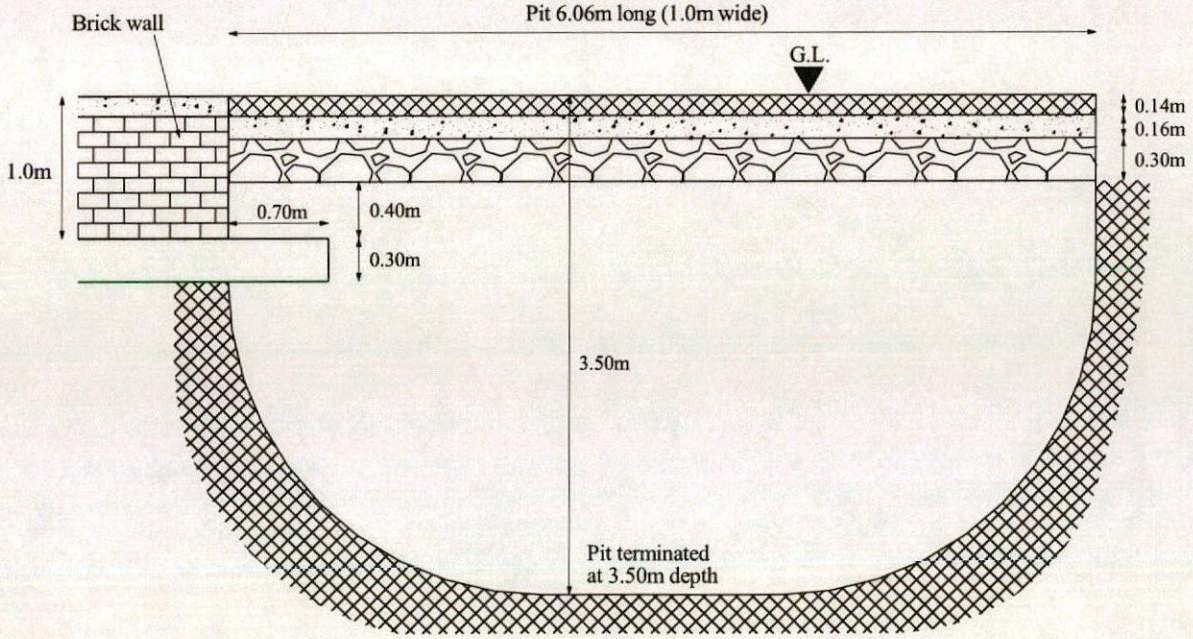
Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP202

Contract Ref:	Start: 05.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 05.08.13	87.09	E:433133.1 N:409711.2	1 of 1

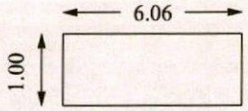
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising black organic clayey fibrous peat. Occasional angular to subangular cobbles. Occasional brick fragments. Gravel is medium to coarse angular to subangular of mixed lithologies. Occasional rootlets	0.14 0.30 0.60	
0.30-0.60	ES1	ES				Concrete slab		
						MADE GROUND slightly sandy, very gravelly angular brick cobbles. Gravel is fine to coarse angular to subangular brick fragments, conglomerate, coal, concrete. Rare concrete boulders	(1.50)	
						MADE GROUND comprising soft dark grey very gravelly clay with occasional cobbles. Gravel is fine to coarse angular to subangular of mixed lithologies with occasional brick fragments.	2.10	
2.50-3.00	ES2	ES				MADE GROUND comprising soft grey gravelly clay. Gravel is fine to coarse angular to subangular of mixed lithologies, iron staining, siltstone, sandstone, mudstone. Fragments of coal present, rare gravel sized brick fragments	(1.40)	
						Trial pit terminated at 3.50m depth.	3.50	

N S

TP202



Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EAtkinson	PTaunton

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log K1 - TRIAL PIT LOG - SPECIAL 2 | 321370 NORTH GAWBER.GPJ - v8_05 | 13/11/13 - 12:35 | JH.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk

TRIAL PIT LOG

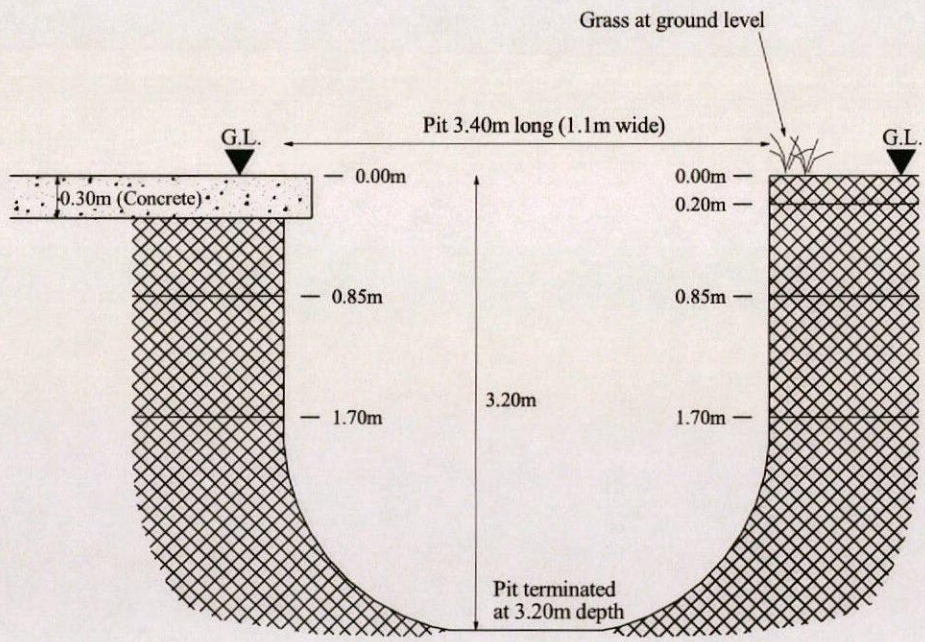
Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP203

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	07.08.13	87.74	E:433171.5 N:409704.2	1 of 1
	End: 07.08.13			

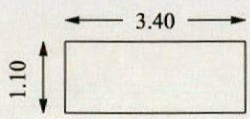
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising grass over grey sandy gravelly clay. Gravel is fine to coarse angular to subangular brick fragments, mudstone, siltstone. Occasional rootlets	0.20	
0.70-1.00	ES1	ES				MADE GROUND comprising grey very gravelly friable clay. Gravel is fine to coarse angular to subangular mainly laminated weak mudstone. Occasional mudstone cobbles. Metal pipe at 0.4m	(0.65) 0.85	
						MADE GROUND comprising black slightly clayey slightly gravelly fine to medium sand. Gravel is fine to coarse angular to subangular mudstone and siltstone. Occasional wood fragments. Strong hydrocarbon odour	(0.85) 1.70	
2.10-2.20	ES2	ES				MADE GROUND comprising orange/light brown reworked weathered sandstone recovered as gravelly fine to coarse sand with occasional subangular cobbles. Gravel is fine to coarse subangular to subrounded red sandstone. Bands of soft green/brown gravelly clay and some engineered rectangular orange/yellow sandstone blocks from 2.9m.	(1.50)	
2.70-3.20	B3	B					3.20	

Trial pit terminated at 3.20m depth.

SE **TP203** **SW**



Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. Strata unsuitable for mexecone testing
4. In-situ unidentified service at 1.0m. Metal pipe approximately 0.2m in diameter

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones + EAtkinson	PTaunton

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002] Log X1 - TRIAL PIT LOG - SPECIAL 2] 321370 NORTH GAWBER.GPJ - v8_05] 13/11/13 - 12:36] JH.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

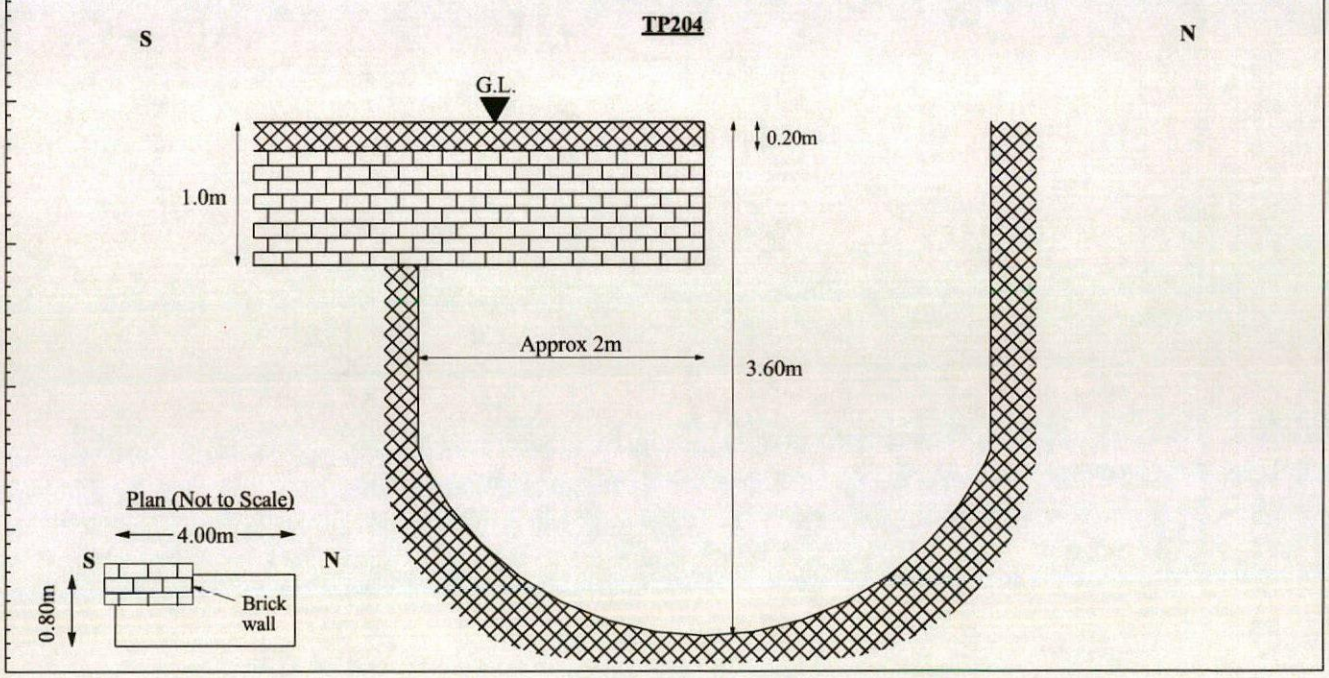
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP204

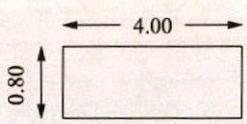
Contract Ref:	Start: 05.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 05.08.13	87.46	E:433200.9 N:409696.8	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
1.80-2.00	ES1	ES				MADE GROUND comprising grass over soft black gravelly slightly sandy clay with some cobbles. Gravel is fine to coarse angular to subangular mainly brick and mudstone. Cobbles are mainly intact bricks. Contains wood, glass, plastic pipes, metal. Many light steel railway rails and wire ropes. Wall along one side. Slight hydrocarbon odour from 1.70m.	(3.60) 3.60	

Trial pit terminated at 3.60m depth.



Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	PTaunton

AGS

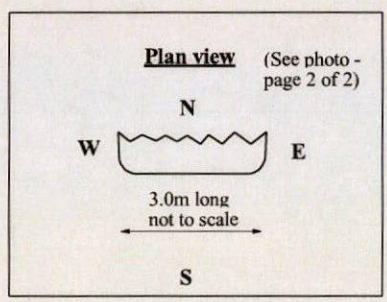
GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log X1 - TRIAL PIT LOG - SPECIAL 2 | 321370 NORTH GAWBER.GPJ - v8_05 | 13/11/13 - 12:37 | JH.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk

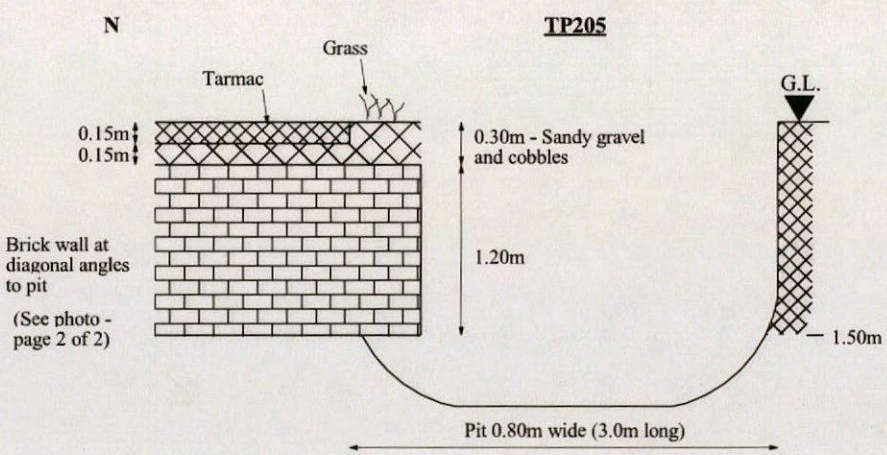
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP205

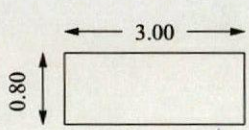
Contract Ref:	Start: 06.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 06.08.13	91.06	E:433192.1 N:409771.3	1 of 2

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
1.00-1.20	ES1	ES				MADE GROUND comprising grass over dark brown sandy gravel and cobbles of angular to subangular bricks. Very thick brick wall at diagonal angles to 1.5m. Extends underneath tarmac adjacent to pit	(1.50) 1.50	
						Orange weathered SANDSTONE recovered as red fine to coarse sand with many cobbles. Boulders extending to 0.7x0.2x0.3m. Becomes very compact at 2.0m	(0.50) 2.00	
						Trial pit terminated at 2.00m depth.		





Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	PTaunton

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log X1 - TRIAL PIT LOG - SPECIAL 2 | 321370 NORTH GAWBER.GPJ - v8_05 | 13/11/13 - 12:48 | JH.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

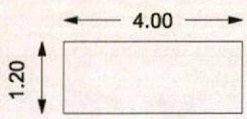
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP206

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	06.08.13	84.97	E:433014.1 N:409707.6	1 of 1
	End: 06.08.13			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising dark brown/black very soft gravelly clay. Gravel is medium to coarse angular to subangular of mixed lithologies	0.10	
0.50-0.60	ES1	ES				MADE GROUND comprising firm dark grey gravelly friable clay with occasional cobbles. Gravel is medium to coarse angular to subangular brick, mudstone, sandstone. Pockets of darker coloured clay	(0.60)	
							0.70	
						MADE GROUND comprising reddish/orange fine to medium sandstone and mudstone gravel. Occasional cobbles and boulders (0.6x0.3x0.3m), intact engineering bricks at 4.4m. Gravel is medium to coarse angular to subangular, very loose. Unidentified iron/metal object found	(3.70)	
							4.40	
						Trial pit terminated at 4.40m depth.		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EAtkinson	

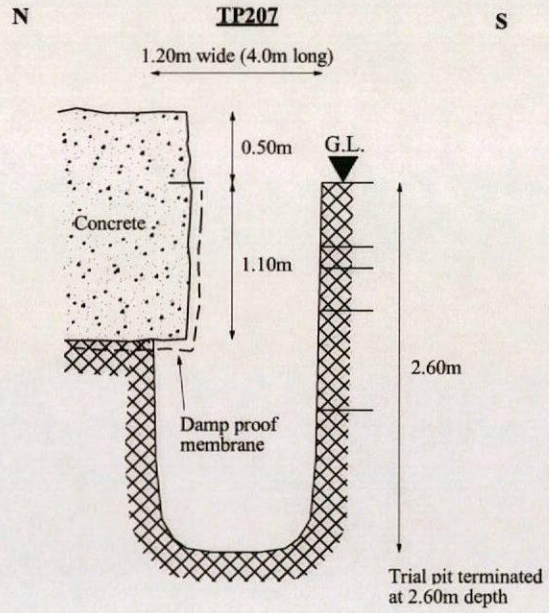
GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL_PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

TRIAL PIT LOG

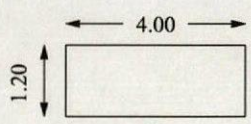
Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP207

Contract Ref:	Start: 06.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 06.08.13	85.28	E:433020.0 N:409707.7	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising soft to firm dark grey/black gravelly clay. Gravel is angular to subangular of mixed lithologies	0.45	
						MADE GROUND comprising firm dark grey gravelly friable clay with occasional cobbles. Gravel is medium to coarse, gravel and cobbles are angular to subangular brick, mudstone, sandstone.	0.60 0.90	
						MADE GROUND comprising reddish/orange loose engineered sandstone and mudstone recovered as medium to coarse angular to subangular gravels and cobbles with occasional boulders (0.6x0.3x0.3m in size).	(0.70) 1.60	
						MADE GROUND comprising dark brown/black medium to coarse gravelly sand with occasional coal. Gravel is angular to subangular mudstone, siltstone. Occasional cobbles	(1.00)	
						MADE GROUND comprising orange/red (becoming pink/brown) compact medium to coarse gravelly sand with occasional angular cobbles and boulders. Gravel is fine to coarse angular to subangular. Engineering bricks encountered at bottom of strata. Boulders up to 0.4x0.3x0.08m in size.	2.60	
						Trial pit terminated at 2.60m depth.		



Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. Thickness of conrete 1.6m (0.5m above ground level). Plastic damp-proof sheet along side of concrete and at the base
4. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EAtkinson	PTaunton

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log X1 - TRIAL PIT LOG - SPECIAL 2 | 321370 NORTH GAWBER.GPJ - v8_05 | 13/11/13 - 12:53 | JH.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

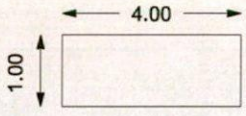
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP208

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	06.08.13	84.84	E:433995.3 N:409722.2	1 of 1
	End: 06.08.13			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising dark brown medium to coarse gravelly sand. Gravel is medium to coarse angular to subangular mudstone and mixed litholgies. Bricks at 2.6m and pockets of lighter grey gravelly sand. Occasional rootlets	(3.00)	
1.70-2.00	ES1	ES						
							3.00	
						Firm grey slightly gravelly CLAY. Gravel is medium rounded to subrounded mudstone and mixed lithologies. Occasional fibrous fragments of organic material	(0.60)	
3.30-3.60	ES2	ES						
							3.60	
						Trial pit terminated at 3.60m depth.		

Plan (Not to Scale)



General Remarks

1. Groundwater seepage at 2.8m - very slow
2. Pit unstable from 2.6-3.0m
3. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EAtkinson	

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

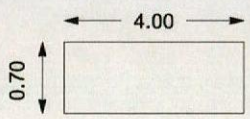
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP209

Contract Ref:	Start: 06.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 06.08.13	84.85	E:433000.9 N:409728.8	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising dark grey/black medium to coarse gravelly sand. Rootlets from 0-0.25m. Gravel is medium to coarse angular to subangular of mixed lithologies. Occasional brick	(2.50) 2.50	
						Firm grey CLAY with occasional rounded medium to coarse gravel (glacial till). Occasional fibrous fragments of organic material	(0.60) 3.10	
						Trial pit terminated at 3.10m depth.		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. No samples, as looking for adit (no evidence)

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EAtkinson	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

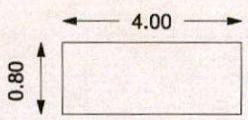
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP210

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	06.08.13	84.54	E:432985.0 N:409724.2	1 of 1
	End: 06.08.13			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising dark grey/black medium to coarse gravelly sand. Rootlets from 0-0.25m. Gravel is medium to coarse angular to subangular of mixed lithologies. Occasional brick	(0.30) 0.30	
						MADE GROUND comprising dark brown gravelly sand. Gravel is medium to coarse angular to subangular of mixed lithologies. Occasional brick	(2.00) 2.30	
						Firm grey/mottled orange CLAY with occasional rounded medium to coarse gravel (glacial till)	(0.70) 3.00	
						Trial pit terminated at 3.00m depth.		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EAtkinson	AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

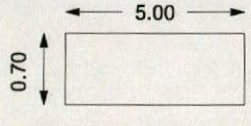
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP211

Contract Ref:	Start: 06.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 06.08.13	84.74	E:432991.0 N:409727.6	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising grey/brown very gravelly medium to coarse sand. Gravel is fine to medium angular to subangular of mixed lithologies including mudstone, siltstone, sandstone. Occasional rootlets	(0.30) 0.30	
						MADE GROUND reworked glacial till comprising firm grey mottled brown clay. Occasional medium to coarse rounded to subrounded gravel of mudstone and mixed lithologies	(0.45) 0.75	
						MADE GROUND comprising dark brown medium to coarse gravelly sand. Gravel is fine to coarse angular to subangular mudstone, siltstone. Cluster of bricks. Occasional fibrous fragments of organic material	(2.15) 2.90	
						Soft to firm grey/mottled brown gravelly CLAY. Gravel is rounded to subrounded mudstone, siltstone. Occasional fibrous fragments of organic material	(0.30) 3.20	
						Trial pit terminated at 3.20m depth.		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. Trial pit too unsafe to carry out Mexecone test

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EAtkinson	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

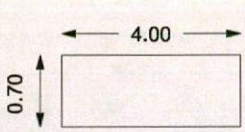
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP212

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	06.08.13	84.78	E:432992.0 N:409716.4	1 of 1
	End: 06.08.13			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising dark grey/black medium to coarse gravelly sand. Rootlets from 0.0-0.25m. Gravel is medium to coarse angular to subangular of mixed lithologies. Occasional brick	(2.50)	
							2.50	
						Firm grey mottled brown CLAY with occasional rounded medium to coarse gravel (glacial till). Occasional fibrous fragments of organic material	(0.60)	
							3.10	

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. No samples taken as looking for ardit (no evidence)

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EAtkinson	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

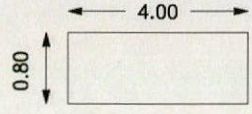
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP213

Contract Ref:	Start: 06.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 06.08.13	75.48	E:432834.9 N:409626.2	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						TOPSOIL comprising gravelly slightly clayey fibrous peat. Gravel is fine to coarse angular to subangular of mixed lithologies. Occasional rootlets	0.20	
						MADE GROUND comprising soft dark grey very gravelly clay. Gravel is fine to medium angular to subangular of mixed lithologies	0.40	
0.50-0.80	ES1	ES				MADE GROUND comprising soft dark grey/mottled brown gravelly clay. Gravel is fine to medium angular to subangular of mixed lithologies. Fibrous fragments of organic material	(0.60) 1.00	
				≈		MADE GROUND comprising light brown fine to medium gravelly sand with occasional cobbles. Gravel is fine to coarse angular to subangular mudstone, sandstone and mixed lithologies.	(0.50) 1.50	
						Trial pit terminated at 1.50m depth.		

Plan (Not to Scale)



General Remarks

1. Groundwater struck at 1.5m
2. Pit terminated at 1.5m as sides kept falling in
3. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EAtkinson	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

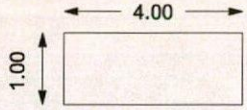
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP214

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	07.08.13	75.63	E:432787.6 N:409619.2	1 of 1
	End: 07.08.13			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising grass/reeds over dark brown slightly sandy gravelly clay with many rootlets. Gravel is fine to coarse angular to subangular of mixed lithologies	(0.30)	
							0.30	
						MADE GROUND comprising firm light brown/mottled grey gravelly clay. Gravel is fine to coarse angular to subangular mudstone, siltstone, sandstone. Occasional cobbles and brick fragments. Some pieces of steel		
0.70-0.80	ES1	ES					(1.50)	
							1.80	
						MADE GROUND comprising soft black slightly gravelly clay. Gravel is fine to coarse angular to subrounded coal, mudstone, siltstone. Occasional brick gravel	(1.20)	
							3.00	
						Light brown/grey MUDSTONE, recovered as slightly clayey angular mudstone cobbles. Difficult for JCB to break		
3.20-3.30	ES2	ES					(0.60)	
							3.60	
						Trial pit terminated at 3.60m depth.		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

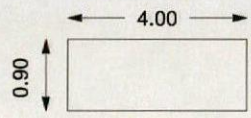
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP215

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	07.08.13	75.71	E:432824.4 N:409596.9	1 of 1
	End: 07.08.13			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising grass over soft brown sandy gravelly clay with many rootlets. Gravel is fine to coarse angular to subangular mudstone, siltstone, brick	(0.30)	
							0.30	
						MADE GROUND comprising friable sandy very gravelly clay with many cobbles, wood and steel (steel rod, possibly part of railway 1.5m long by 0.2m wide and thick). Cobbles and gravel are mainly angular to subrounded mudstone, sandstone, brick fragments. Piece of plastic cable at 2.0m Hydrocarbon odour from 1.8m with black staining (coal gravel and sand) (no sheen). Colliery spoil	(2.30)	
1.50-2.00 1.50-2.00	B1 ES2	B ES						
2.50-2.70	ES3	ES					2.60	
						Light brown/grey MUDSTONE recovered as sandy clayey angular mudstone gravel and cobbles. Difficult for the JCB to break through	(1.00)	
							3.60	
						Trial pit terminated at 3.60m depth.		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ, Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

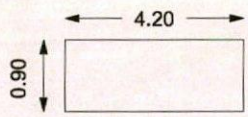
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP216

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	07.08.13	74.98	E:433078.0 N:409567.3	1 of 1
	End: 07.08.13			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising young birch trees over brown slightly clayey gravelly fine to medium sand with many rootlets. Gravel is fine to coarse angular to subrounded mudstone, sandstone, brick fragments	(0.40) 0.40	
0.50-1.00 0.50-0.70	B1 ES2	B ES				MADE GROUND comprising reddish brown slightly clayey sands and gravels with occasional cobbles. Gravel and cobbles are fine to coarse angular to subrounded mudstone, sandstone, brick fragments	(0.90) 1.30	
2.00-2.30	ES3	ES				MADE GROUND comprising soft black gravelly clay. Gravel is fine to coarse angular to subrounded mudstone, sandstone, brick fragments and fine vitreous coal. Slight sulphurous odour	(1.10) 2.40	
						MADE GROUND comprising stiff light brown/grey gravelly reworked clay. Gravel and cobbles are fine to coarse angular to subangular laminated mudstone	(1.00) 3.40	
						Trial pit terminated at 3.40m depth.		

Plan (Not to Scale)



General Remarks

1. Pit stable
2. Fast ingress of water from Southern side at 1.8m causing clay around it to fall. No sign of contamination (eg. sheen) on water
3. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

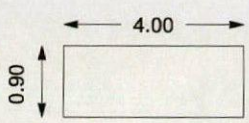
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP217

Contract Ref:	Start: 07.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 07.08.13	72.86	E:433090.0 N:409518.9	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising firm dark grey very gravelly clay with many cobbles. Gravel is fine to coarse. Gravel and cobbles are angular to subangular mudstone and brick fragments	(0.90)	
							0.90	
						MADE GROUND comprising reddish brown sandy gravel and cobbles of very angular to subangular mainly brick, siltstone and sandstone		
1.50-2.00	B1	B		1				
1.70-2.00	ES2	ES		1			(1.80)	
							2.70	
						Trial pit terminated at 2.70m depth.		

Plan (Not to Scale)



General Remarks

1. Groundwater at 1.7m - pit very unstable from here
2. Pit teminated at 2.7m due to water
3. Water rose to 1.5m after 20 minutes but pit collapsing
4. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

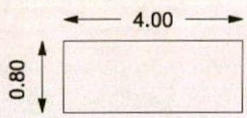
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP218

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	07.08.13	73.97	E:433137.6 N:409531.0	1 of 1
	End: 07.08.13			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising brown friable very gravelly sandy clay. Gravel is fine to coarse angular to subrounded sandstone, mudstone, brick fragments. Occasional angular cobbles	(0.80)	
0.50-0.80	B1	B					0.80	
						MADE GROUND comprising black slightly clayey sandy gravel and cobbles. Gravel is fine to coarse, gravel and cobbles are very angular to subangular sandstone, mudstone, brick fragments. Contains large wooden posts (railway sleeper), material (carpet), old pipes and cables. Strong hydrocarbon odour. Slight oily sheen on water	(2.00)	
2.00-2.50	ES2	ES					2.80	
						Trial pit terminated at 2.80m depth.		

Plan (Not to Scale)



General Remarks

1. Groundwater at 1.7m, settling at 2.1m
2. Pit falling in around water

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL_PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

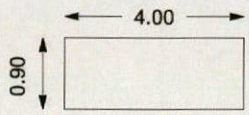
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP219

Contract Ref:	Start: 08.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 08.08.13	76.88	E:433122.1 N:409581.1	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising soft brown sandy gravelly clay with many rootlets. Gravel is fine to coarse angular to subangular brick, mudstone, sandstone	0.20	
0.50-0.80	ES1	ES				MADE GROUND comprising friable dark grey slightly sandy very gravelly clay with some cobbles. Gravel is fine to coarse angular to subangular brick, mudstone, sandstone. Cobbles are very angular to subangular, mainly bricks	(1.20)	
							1.40	
						MADE GROUND comprising pink sandy fine to coarse angular brick gravel and cobbles, becoming brick red from 1.5m	(0.30)	
							1.70	
2.00-2.50	ES2	ES				MADE GROUND comprising soft grey mottled yellow/brown/black very gravelly clay (reworked).	(2.50)	
							4.20	
						Trial pit terminated at 4.20m depth.		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

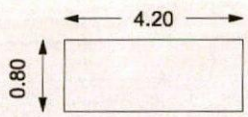
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP220

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	08.08.13	77.79	E:433096.1 N:409594.6	1 of 1
	End: 08.08.13			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising brown very gravelly clayey fine to medium sand with many roots and rootlets. Gravel is fine to coarse angular to subangular brick, mudstone, sandstone	0.20	
						MADE GROUND comprising friable dark grey very gravelly clay with occasional cobbles. Gravel is fine to coarse angular to subangular brick, mudstone, sandstone. Thick steel rope at 0.6m (50mm in diameter)	(1.80)	
0.70-1.00	ES1	ES					2.00	
						MADE GROUND comprising firm grey mottled yellow/brown/black very gravelly clay (reworked) with occasional cobbles. Gravel and cobbles are very angular to subrounded various lithologies, but mainly mudstone and sandstone with rare brick fragments	(1.90)	
3.50-3.90	ES2	ES					3.90	
						Trial pit terminated at 3.90m depth.		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
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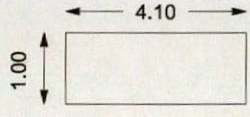
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP221

Contract Ref:	Start: 08.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 08.08.13	76.12	E:432786.1 N:409639.5	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.30-0.50	ES1	ES				MADE GROUND comprising brambles over dark brown slightly clayey gravelly fine to medium sand with many roots and rootlets. Contains three concrete boulders (kerb) 1.0x0.2x0.3m. Gravel is fine to coarse angular to subangular mudstone, brick. Occasional brick cobbles	(0.60)	
							0.60	
2.00-2.30	ES2	ES				MADE GROUND comprising soft black, occasionally light brown, gravelly clay with occasional cobbles and rare boulders. Gravel is fine to coarse, gravel and cobbles are mainly mudstone and brick fragments. Boulders are angular sandstone 0.5x0.5x0.5m. Contains plastic sheeting, metal sheeting, carpet like material at 1.2m. Becomes damp from 1.2m	(3.10)	
2.50-3.00	B3	B					3.70	
						Light brown MUDSTONE, recovered as sandy angular gravel and cobbles.	3.85	
						Trial pit terminated at 3.85m depth.		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Sides of pit collapsed below 1.3m

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:40 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

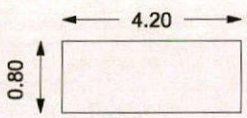
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP222

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	08.08.13	76.51	E:432810.4 N:409652.6	1 of 1
	End: 08.08.13			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising grey brown slightly clayey gravelly fine to medium sand with many rootlets. Gravel is fine to coarse angular to subangular of various lithologies including brick and mudstone	0.20	
						MADE GROUND comprising grey sandy fine to coarse gravel and cobbles with sandstone boulders. Angular to subangular sandstone, mudstone, brick. Typical size of boulders is 0.6x0.3x0.3m. Occasional clumps of brick gravel/cobbles	(0.60)	
							0.80	
						MADE GROUND comprising weathered mudstone recovered as sandy slightly clayey sandstone gravel and cobbles of angular laminated mudstone. Very compact. Terracotta land drain (dry) at 1.0m	(0.90)	
1.30-1.70 1.30-1.70	B1 ES2	B ES					1.70	
						Trial pit terminated at 1.70m depth.		

Plan (Not to Scale)



General Remarks

1. Water running in from East side between 0.8 and 1.2m (slow trickle, drain is approximately 1m away)
2. Pit quite stable
3. Mexecone could not penetrate

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:41 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

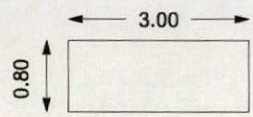
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP223

Contract Ref:	Start: 09.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 09.08.13	91.18	E:433106.2 N:409778.8	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising patchy grass over white/brown gravelly fine to coarse sand with soft white lime cement. Gravel is fine to coarse angular to subangular sandstone, mudstone, brick. Metal pipe of 0.2m diameter at 0.5m - pit terminated. Concrete slab on one edge 0-0.3m with sand and bricks underneath, with soft black gravelly clay.	(0.50)	
0.40-0.50	ES1	ES				Gravel is fine to coarse angular to subangular sandstone, mudstone, brick	0.50	
						Trial pit terminated at 0.50m depth.		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:41 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

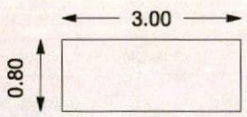
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP224

Contract Ref:	Start: 09.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 09.08.13	90.46	E:433126.8 N:409768.3	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising grass over black gravelly fine to coarse sand. Gravel is fine to coarse angular to subangular sandstone, mudstone, brick. Metal pipe of 0.2m diameter at 0.3m - pit terminated. Brick wall along one side of pit extends deeper than the pit	(0.30)	
						Trial pit terminated at 0.30m depth.	0.30	

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:41 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

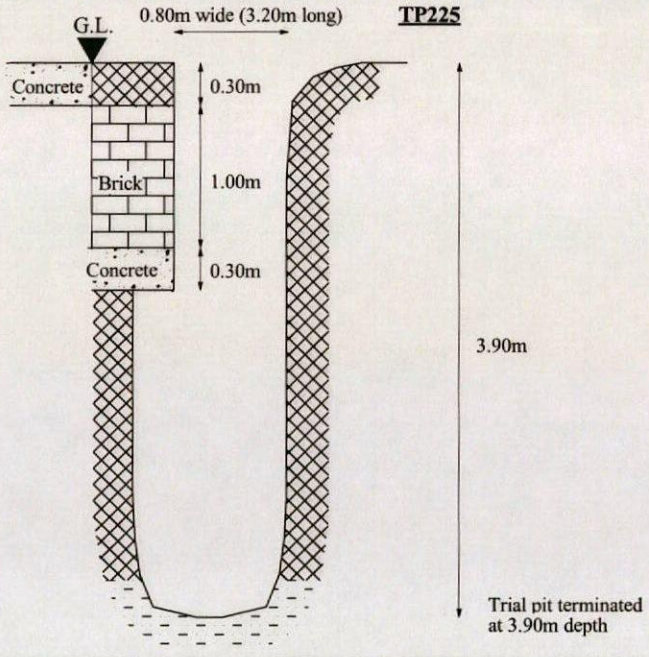
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP225

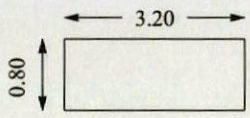
Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 09.08.13	91.12	E:433151.3 N:409772.2	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising grass over black very gravelly fine to coarse sand with many cobbles and pieces of wood (0.5x0.2x0.1m). Gravel is fine to coarse angular to subangular brick, mudstone, sandstone. Top of brick wall at 0.3m so moved to side. Wall extends to 1.3m with concrete slab beneath to 1.6m	(1.60) 1.60	
						MADE GROUND comprising light brown slightly clayey sandy fine to coarse gravel with many cobbles and occasional boulders. Gravel, cobbles and boulders are angular to subangular mainly sandstone and mudstone with rare bricks	(0.60) 2.20	
						MADE GROUND comprising black very gravelly fine to coarse sand. Gravel is fine to coarse angular to subangular mudstone and sandstone with occasional brick	(0.80) 3.00	
						MADE GROUND comprising soft brown very gravelly clay. Gravel is fine to coarse angular to subangular brick, mudstone, sandstone with coal fragments	(0.50) 3.50	
						Compact light brown MUDSTONE recovered as slightly clayey sandy angular to subangular fine to coarse mudstone gravel and cobbles	3.90	

Trial pit terminated at 3.90m depth.



Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit unstable from 1.6-2.2m
3. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:50

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	PTaunton

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log X1 - TRIAL PIT LOG - SPECIAL 2 | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 11:02 | JH.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

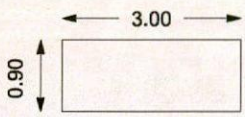
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP226

Contract Ref:	Start: 09.08.13	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	End: 09.08.13	84.50	E:432979.4 N:409728.4	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising grey/black very gravelly fine to medium sand with many cobbles and rare boulders. Gravel and cobbles are fine to coarse angular to subangular sandstone, brick, mudstone, coal. Wooden sleeper at 3.0m.	(4.00)	
						Trial pit terminated at 4.0m depth.	4.00	

Plan (Not to Scale)



General Remarks

1. No groundwater encountered but pit damp at bottom (3.8m)
2. Pit stable
3. Strata unsuitable for mexecone testing

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:41 | BM.
RSK Environment Ltd, Founways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

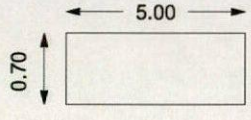
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
(M) North Gawber	Harworth Estates Ltd	TP227

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
321370	06.08.13	84.47	E:432970.5 N:409730.7	1 of 1
	End: 06.08.13			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						MADE GROUND comprising grey/brown very gravelly medium to coarse sand. Gravel is angular to subangular fine to medium of mixed lithologies including mudstone, siltstone, sandstone. Occasional rootlets	(0.30)	
							0.30	
						MADE GROUND comprising firm grey mottled brown clay. Occasional medium to coarse rounded to subrounded gravel of mudstone and mixed lithologies	(0.45)	
							0.75	
						MADE GROUND comprising dark brown medium to coarse gravelly sand. Gravel is fine to coarse angular to subangular mudstone and siltstone. Cluster of bricks. Occasional fibrous fragments of organic material	(2.15)	
							2.90	
						Soft to firm grey mottled brown gravelly CLAY. Gravel is rounded to subrounded mudstone, siltstone. Occasional fibrous fragments of organic material	(0.30)	
							3.20	
						Trial pit terminated at 3.20m depth.		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Pit stable
3. Trial pit too unsafe to carry out Mexecone test

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	EJones	

AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 321370 NORTH GAWBER.GPJ - v8_05 | 21/11/13 - 15:41 | BM.
RSK Environment Ltd, Fourways House, 57 Hilton Street, Piccadilly, Manchester, M1 2EJ. Tel: 0161 236 2757, Fax: 0161 236 7029, Web: www.rsk.co.uk.

APPENDIX E
LABORATORY CERTIFICATES FOR SOIL SAMPLES

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Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 13/03798
Issue Number: 1 **Date:** 23 August, 2013

Client:
RSK Environment Ltd Manchester
Fourways House
57 Hilton Street
Manchester
Lancashire
UK
M1 2EJ

Project Manager: Ian Wilson / Emily Jones
Project Name: North Gawber
Project Ref: 321370
Order No: Not specified
Date Samples Received: 09/08/13
Date Instructions Received: 12/08/13
Date Analysis Completed: 23/08/13

Prepared by:
MMarshall
Melanie Marshall
Laboratory Coordinator

Approved by:
Carolyn Field
Client Service Manager

MCERTS
UKAS TESTING 1247

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Envirolab Job Number: 13/03798

Client Project Name: North Gawber

Client Project Ref: 321370

Lab Sample ID	13/03798/3	13/03798/4	13/03798/5	13/03798/6	13/03798/7	13/03798/13	13/03798/14	13/03798/15	Units	Method ref
Client Sample No										
Client Sample ID	TP203	TP203	TP204	TP205	TP206	TP215	TP215	TP216		
Depth to Top	0.70	2.10	1.80	1.00	0.50	1.50	2.50	0.50		
Depth To Bottom	1.00	2.20	2.00	1.20	0.70	2.00	2.70	0.70		
Date Sampled	05-Aug-13	05-Aug-13	05-Aug-13	06-Aug-13	06-Aug-13	07-Aug-13	07-Aug-13	07-Aug-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5	1A	6AE	4ABE		5A	5A	4AB		
% Stones >10mm$_A$ #	<0.1	<0.1	<0.1	6.8	-	3.5	6.3	8.0	% w/w	A-T-044
Asbestos in soil$_D$ #	NAD	-	-	NAD	NAD	-	-	-		A-T-045
pH$_D$ M#	8.90	6.86	7.49	8.07	-	8.22	7.64	-	pH	A-T-031s
pH BRE$_D$ M#	8.90	-	7.49	8.07	-	8.22	-	5.05	pH	A-T-031s
Chloride BRE, SO4 equiv. (water sol 2:1)$_D$	-	-	-	-	-	-	-	<7	mg/l	A-T-026s
Nitrate BRE, SO4 equiv. (water sol 2:1)$_D$	-	-	-	-	-	-	-	<0.4	mg/l	A-T-026s
Sulphate (water sol 2:1)$_D$ M#	0.14	1.57	1.67	1.33	-	0.26	0.21	-	g/l	A-T-026s
Sulphate BRE (water sol 2:1)$_D$ M#	144	-	1670	1330	-	262	-	201	mg/l	A-T-026s
Sulphate (acid soluble)$_D$ M#	430	23000	12000	21000	-	840	470	-	mg/kg	A-T-028
Arsenic$_D$ M#	44	41	60	271	-	13	7	-	mg/kg	A-T-024
Cadmium$_D$ M#	0.7	0.5	0.9	2.0	-	<0.5	0.7	-	mg/kg	A-T-024
Copper$_D$ M#	52	68	63	89	-	40	22	-	mg/kg	A-T-024
Chromium$_D$ M#	59	65	58	26	-	51	39	-	mg/kg	A-T-024
Lead$_D$ M#	55	34	73	69	-	29	12	-	mg/kg	A-T-024
Mercury$_D$	0.71	0.71	0.52	0.25	-	0.39	0.21	-	mg/kg	A-T-024
Nickel$_D$ M#	36	56	43	54	-	36	37	-	mg/kg	A-T-024
Selenium$_D$ #	2	<1	3	4	-	<1	<1	-	mg/kg	A-T-024
Zinc$_D$ M#	151	95	106	82	-	72	74	-	mg/kg	A-T-024

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Envirolab Job Number: 13/03798

Client Project Name: North Gawber

Client Project Ref: 321370

Lab Sample ID	13/03798/3	13/03798/4	13/03798/5	13/03798/6	13/03798/7	13/03798/13	13/03798/14	13/03798/15	Units	Method ref
Client Sample No										
Client Sample ID	TP203	TP203	TP204	TP205	TP206	TP215	TP215	TP216		
Depth to Top	0.70	2.10	1.80	1.00	0.50	1.50	2.50	0.50		
Depth To Bottom	1.00	2.20	2.00	1.20	0.70	2.00	2.70	0.70		
Date Sampled	05-Aug-13	05-Aug-13	05-Aug-13	06-Aug-13	06-Aug-13	07-Aug-13	07-Aug-13	07-Aug-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5	1A	6AE	4ABE		5A	5A	4AB		
TPH CWG										
Ali >C5-C6$_A^\#$	0.15	<0.01	<0.01	0.02	-	<0.01	<0.01	-	mg/kg	A-T-022s
Ali >C6-C8$_A^\#$	<0.01	0.08	<0.01	<0.01	-	<0.01	<0.01	-	mg/kg	A-T-022s
Ali >C8-C10$_A^\#$	20.5	24.9	<0.01	<0.01	-	<0.01	<0.01	-	mg/kg	A-T-022s
Ali >C10-C12$_A^\#$	<0.1	1090	<0.1	<0.1	-	<0.1	<0.1	-	mg/kg	A-T-023s
Ali >C12-C16$_A^\#$	223	1160	<0.1	<0.1	-	<0.1	<0.1	-	mg/kg	A-T-023s
Ali >C16-C21$_A^\#$	198	184	<0.1	<0.1	-	<0.1	<0.1	-	mg/kg	A-T-023s
Ali >C21-C35$_A^\#$	29.7	119	<0.1	<0.1	-	<0.1	<0.1	-	mg/kg	A-T-023s
Total Aliphatics$_A$	472	2580	<0.1	<0.1	-	<0.1	<0.1	-	mg/kg	A-T-022+23s
Aro >C5-C7$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	mg/kg	A-T-022s
Aro >C7-C8$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	mg/kg	A-T-022s
Aro >C8-C9$_A^\#$	0.25	0.18	<0.01	<0.01	-	<0.01	<0.01	-	mg/kg	A-T-022s
Aro >C9-C10$_A^\#$	8.91	5.23	<0.01	<0.01	-	<0.01	<0.01	-	mg/kg	A-T-022s
Aro >C10-C12$_A^\#$	63.6	148	<0.1	<0.1	-	2.2	<0.1	-	mg/kg	A-T-023s
Aro >C12-C16$_A^\#$	82.8	263	<0.1	<0.1	-	5.5	<0.1	-	mg/kg	A-T-023s
Aro >C16-C21$_A^\#$	73.7	132	<0.1	<0.1	-	11.1	<0.1	-	mg/kg	A-T-023s
Aro >C21-C35$_A^\#$	32.3	76.8	<0.1	<0.1	-	3.9	<0.1	-	mg/kg	A-T-023s
Total Aromatics$_A$	262	625	<0.1	<0.1	-	22.7	<0.1	-	mg/kg	A-T-022+23s
TPH (Ali & Aro)$_A$	733	3200	<0.1	<0.1	-	22.7	<0.1	-	mg/kg	A-T-022+23s
BTEX - Benzene$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	mg/kg	A-T-022s
BTEX - Toluene$_A^\#$	*<0.01*	*<0.01*	*<0.01*	*<0.01*	-	*<0.01*	*<0.01*	-	mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	mg/kg	A-T-022s
BTEX - m & p Xylene$_A^\#$	0.07	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	mg/kg	A-T-022s
BTEX - o Xylene$_A^\#$	0.14	0.08	<0.01	<0.01	-	<0.01	<0.01	-	mg/kg	A-T-022s
MTBE$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	mg/kg	A-T-022s

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Envirolab Job Number: 13/03798

Client Project Name: North Gawber

Client Project Ref: 321370

Lab Sample ID	13/03798/3	13/03798/4	13/03798/5	13/03798/6	13/03798/7	13/03798/13	13/03798/14	13/03798/15	Units	Method ref
Client Sample No										
Client Sample ID	TP203	TP203	TP204	TP205	TP206	TP215	TP215	TP216		
Depth to Top	0.70	2.10	1.80	1.00	0.50	1.50	2.50	0.50		
Depth To Bottom	1.00	2.20	2.00	1.20	0.70	2.00	2.70	0.70		
Date Sampled	05-Aug-13	05-Aug-13	05-Aug-13	06-Aug-13	06-Aug-13	07-Aug-13	07-Aug-13	07-Aug-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5	1A	6AE	4ABE		5A	5A	4AB		
PAH 16										
Acenaphthene$_A^{M\#}$	1.50	2.27	0.10	<0.01	-	0.52	<0.01	-	mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	0.07	0.15	0.02	<0.01	-	0.02	<0.01	-	mg/kg	A-T-019s
Anthracene$_A^{M\#}$	0.49	0.63	0.22	0.02	-	0.33	<0.02	-	mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	0.18	0.16	0.77	0.13	-	0.23	<0.04	-	mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	0.05	0.16	1.01	0.09	-	0.15	<0.04	-	mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	0.15	0.18	1.27	0.12	-	0.26	<0.05	-	mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	0.06	0.54	0.08	-	0.09	<0.05	-	mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	0.09	0.41	0.09	-	0.11	<0.07	-	mg/kg	A-T-019s
Chrysene$_A^{M\#}$	0.24	0.29	1.29	0.20	-	0.35	<0.06	-	mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	<0.04	0.15	<0.04	-	<0.04	<0.04	-	mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	0.72	0.88	1.83	0.27	-	1.11	<0.08	-	mg/kg	A-T-019s
Fluorene$_A^{M\#}$	1.04	1.29	0.06	<0.01	-	0.46	<0.01	-	mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	<0.03	0.06	0.49	0.05	-	0.04	<0.03	-	mg/kg	A-T-019s
Naphthalene$_A^{M\#}$	5.37	3.66	0.20	0.06	-	0.83	<0.03	-	mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	1.98	2.47	1.43	0.21	-	1.95	<0.03	-	mg/kg	A-T-019s
Pyrene$_A^{M\#}$	0.55	1.12	1.83	0.21	-	0.82	<0.07	-	mg/kg	A-T-019s
PAH (total 16)$_A^{M\#}$	12.3	13.5	11.6	1.55	-	7.25	<0.08	-	mg/kg	A-T-019s

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Envirolab Job Number: 13/03798

Client Project Name: North Gawber

Client Project Ref: 321370

Lab Sample ID	13/03798/18	13/03798/21	13/03798/23	13/03798/24	13/03798/26	13/03798/27			Units	Method ref
Client Sample No										
Client Sample ID	TP218	TP220	TP221	TP221	TP223	Mound				
Depth to Top	2.00	0.70	0.30	2.00						
Depth To Bottom	2.50	1.00	0.50	2.30						
Date Sampled	07-Aug-13	08-Aug-13	08-Aug-13	08-Aug-13	09-Aug-13	07-Aug-13				
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Solid	Soil - ES				
Sample Matrix Code	6A	5A	5AE	5A	7	4AE				
% Stones >10mm$_A$ #	6.1	4.9	3.8	5.7	<0.1	<0.1			% w/w	A-T-044
Asbestos in soil$_D$ #	-	NAD	NAD	-	-	-				A-T-045
pH$_D$ M#	7.50	6.36	8.00	8.53	10.92	6.12			pH	A-T-031s
pH BRE$_D$ M#	-	6.36	8.00	-	-	-			pH	A-T-031s
Sulphate (water sol 2:1)$_D$ M#	0.38	1.59	0.27	0.32	-	0.14			g/l	A-T-026s
Sulphate BRE (water sol 2:1)$_D$ M#	-	1590	266	-	-	-			mg/l	A-T-026s
Sulphate (acid soluble)$_D$ M#	1700	9000	1900	950	-	2600			mg/kg	A-T-028
Arsenic$_D$ M#	34	35	25	28	-	33			mg/kg	A-T-024
Cadmium$_D$ M#	0.7	<0.5	<0.5	0.6	-	0.9			mg/kg	A-T-024
Calcium$_D$	-	-	-	-	331000	-			mg/kg	A-T-024
Copper$_D$ M#	51	40	38	45	-	60			mg/kg	A-T-024
Chromium$_D$ M#	43	33	89	42	-	37			mg/kg	A-T-024
Lead$_D$ M#	28	26	39	54	-	93			mg/kg	A-T-024
Mercury$_D$	0.23	0.32	0.58	0.19	-	0.35			mg/kg	A-T-024
Nickel$_D$ M#	31	39	31	35	-	31			mg/kg	A-T-024
Selenium$_D$ #	<1	<1	<1	2	-	2			mg/kg	A-T-024
Zinc$_D$ M#	78	76	88	74	-	108			mg/kg	A-T-024

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Envirolab Job Number: 13/03798

Client Project Name: North Gawber

Client Project Ref: 321370

Lab Sample ID	13/03798/18	13/03798/21	13/03798/23	13/03798/24	13/03798/26	13/03798/27			Units	Method ref
Client Sample No										
Client Sample ID	TP218	TP220	TP221	TP221	TP223	Mound				
Depth to Top	2.00	0.70	0.30	2.00						
Depth To Bottom	2.50	1.00	0.50	2.30						
Date Sampled	07-Aug-13	08-Aug-13	08-Aug-13	08-Aug-13	09-Aug-13	07-Aug-13				
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Solid	Soil - ES				
Sample Matrix Code	6A	5A	5AE	5A	7	4AE				
TPH CWG										
Ali >C5-C6$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01			mg/kg	A-T-022s
Ali >C6-C8$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01			mg/kg	A-T-022s
Ali >C8-C10$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01			mg/kg	A-T-022s
Ali >C10-C12$_A^\#$	<0.1	<0.1	<0.1	<0.1	-	<0.1			mg/kg	A-T-023s
Ali >C12-C16$_A^\#$	28.9	<0.1	<0.1	<0.1	-	<0.1			mg/kg	A-T-023s
Ali >C16-C21$_A^\#$	124	<0.1	<0.1	<0.1	-	<0.1			mg/kg	A-T-023s
Ali >C21-C35$_A^\#$	621	<0.1	<0.1	<0.1	-	<0.1			mg/kg	A-T-023s
Total Aliphatics$_A$	752	<0.1	<0.1	<0.1	-	<0.1			mg/kg	A-T-022+23s
Aro >C5-C7$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01			mg/kg	A-T-022s
Aro >C7-C8$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01			mg/kg	A-T-022s
Aro >C8-C9$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01			mg/kg	A-T-022s
Aro >C9-C10$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01			mg/kg	A-T-022s
Aro >C10-C12$_A^\#$	<0.1	<0.1	0.4	<0.1	-	<0.1			mg/kg	A-T-023s
Aro >C12-C16$_A^\#$	22.4	<0.1	2.5	<0.1	-	<0.1			mg/kg	A-T-023s
Aro >C16-C21$_A^\#$	56.5	<0.1	17.1	<0.1	-	<0.1			mg/kg	A-T-023s
Aro >C21-C35$_A^\#$	162	<0.1	69.7	<0.1	-	<0.1			mg/kg	A-T-023s
Total Aromatics$_A$	241	<0.1	89.7	<0.1	-	<0.1			mg/kg	A-T-022+23s
TPH (Ali & Aro)$_A$	994	<0.1	89.7	<0.1	-	<0.1			mg/kg	A-T-022+23s
BTEX - Benzene$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01			mg/kg	A-T-022s
BTEX - Toluene$_A^\#$	*<0.01*	*<0.01*	*<0.01*	*<0.01*	-	<0.01			mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01			mg/kg	A-T-022s
BTEX - m & p Xylene$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01			mg/kg	A-T-022s
BTEX - o Xylene$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01			mg/kg	A-T-022s
MTBE$_A^\#$	<0.01	<0.01	<0.01	<0.01	-	<0.01			mg/kg	A-T-022s

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Envirolab Job Number: 13/03798

Client Project Name: North Gawber

Client Project Ref: 321370

Lab Sample ID	13/03798/18	13/03798/21	13/03798/23	13/03798/24	13/03798/26	13/03798/27			Units	Method ref
Client Sample No										
Client Sample ID	TP218	TP220	TP221	TP221	TP223	Mound				
Depth to Top	2.00	0.70	0.30	2.00						
Depth To Bottom	2.50	1.00	0.50	2.30						
Date Sampled	07-Aug-13	08-Aug-13	08-Aug-13	08-Aug-13	09-Aug-13	07-Aug-13				
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Solid	Soil - ES				
Sample Matrix Code	6A	5A	5AE	5A	7	4AE				
PAH 16										
Acenaphthene$_A^{M\#}$	0.07	0.02	0.16	<0.01	-	0.02			mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	0.05	<0.01	0.13	<0.01	-	0.01			mg/kg	A-T-019s
Anthracene$_A^{M\#}$	0.33	0.04	1.15	<0.02	-	0.11			mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	0.24	<0.04	5.75	<0.04	-	0.41			mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	0.12	<0.04	5.08	<0.04	-	0.37			mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	0.37	<0.05	5.70	<0.05	-	0.55			mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	0.08	<0.05	2.65	<0.05	-	0.24			mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	<0.07	3.18	<0.07	-	0.24			mg/kg	A-T-019s
Chrysene$_A^{M\#}$	0.51	<0.06	5.39	<0.06	-	0.45			mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	<0.04	0.75	<0.04	-	0.07			mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	0.60	<0.08	9.89	0.10	-	0.93			mg/kg	A-T-019s
Fluorene$_A^{M\#}$	0.21	<0.01	0.16	0.01	-	0.02			mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	0.07	<0.03	2.80	<0.03	-	0.25			mg/kg	A-T-019s
Naphthalene$_A^{M\#}$	0.46	0.16	0.25	0.10	-	0.05			mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	1.31	0.56	3.61	0.17	-	0.55			mg/kg	A-T-019s
Pyrene$_A^{M\#}$	1.53	<0.07	8.07	0.09	-	0.72			mg/kg	A-T-019s
PAH (total 16)$_A^{M\#}$	5.96	0.78	54.8	0.47	-	5.02			mg/kg	A-T-019s

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REPORT NOTES

Notes - Soil analysis
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis. For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis.

Notes - General
Subscript "A" indicates analysis performed on the sample as received. "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve, unless asbestos is found to be present in which case all analysis is performed on the sample as received.
All analysis is performed on the dried and crushed sample for samples with Matrix Code 7 and this supercedes any "A" subscripts.
Superscript "M" indicates method accredited to MCERTS.
For complex, multi-compound analysis, quality control results do not always fall within chart limits for every compound and we have criteria for reporting in these situations. If results are in italic font they are associated with such quality control failures and may be unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling.

TPH analysis of water by method A-T-007
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER.
Samples with Matrix Code 7 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our MCERTS accreditation.

Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

IS indicates Insufficient sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
Superscript # indicates method accredited to ISO 17025.
Analytical results reflect the quality of the sample at the time of analysis only. Opinions and interpretations expressed are outside the scope of our accreditation.

Please contact us if you need any further information.

APPENDIX F
GROUND GAS AND GROUNDWATER MONITORING DATA

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round G7	-	-	-	-	GA2000 SN-GA10789 + Interface probe SN-3355 + Weather: Overcast + Ground: Damp + Wind: None + Air Temp: 1DegC

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH201	1	50	G7	6.00	6.20	1.00 to 6.00	30/01/2014 09:34:00	999	999	8.3	0.21	0.0	0.0	21.4	0.0	0.0	0.0	
BH201	1	50	G7		6.20	1.00 to 6.00	15 secs	999	999	16.7	0.21	9.5	0.2	12.3	4.0	0.0	0.0	
BH201	1	50	G7		6.20	1.00 to 6.00	30 secs	999	999	15.9	0.21	9.6	0.3	11.7	5.0	0.0	0.0	
BH202	1	50	G7	5.00	5.26	1.00 to 5.00	30/01/2014 11:45:00	1000	1000	0.0	1.09	0.0	0.0	21.1	0.0	0.0	0.0	
BH202	1	50	G7		5.26	1.00 to 5.00	15 secs	1000	1000	0.0	1.09	0.3	0.0	21.0	0.0	0.0	0.0	
BH202	1	50	G7		5.26	1.00 to 5.00	30 secs	1000	1000	0.0	1.09	0.3	0.0	20.8	0.0	0.0	0.0	
BH202	1	50	G7		5.26	1.00 to 5.00	60 secs	1000	1000	0.0	1.09	0.2	0.0	20.9	0.0	0.0	0.0	
BH202	1	50	G7		5.26	1.00 to 5.00	90 secs	1000	1000	-	1.09	0.2	0.0	21.0	0.0	0.0	0.0	
BH202	1	50	G7		5.26	1.00 to 5.00	120 secs	1000	1000	-	1.09	0.2	0.0	21.0	0.0	0.0	0.0	
BH202	1	50	G7		5.26	1.00 to 5.00	180 secs	1000	1000	-	1.09	0.2	0.0	21.0	0.0	0.0	0.0	
BH203	1	50	G7	4.00	4.41	1.00 to 4.00	30/01/2014 11:25:00	1000	1000	0.0	0.76	0.0	0.0	21.2	0.0	0.0	0.0	
BH203	1	50	G7		4.41	1.00 to 4.00	15 secs	1000	1000	0.0	0.76	0.4	0.0	21.2	0.0	0.0	0.0	
BH203	1	50	G7		4.41	1.00 to 4.00	30 secs	1000	1000	0.0	0.76	0.3	0.0	21.2	0.0	0.0	0.0	
BH203	1	50	G7		4.41	1.00 to 4.00	60 secs	1000	1000	0.0	0.76	0.2	0.0	21.2	0.0	0.0	0.0	
BH203	1	50	G7		4.41	1.00 to 4.00	90 secs	1000	1000	-	0.76	0.1	0.0	21.2	0.0	0.0	0.0	
BH203	1	50	G7		4.41	1.00 to 4.00	120 secs	1000	1000	-	0.76	0.1	0.0	21.2	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Fourways House
57 Hilton Street
Piccadilly
Manchester M1 2EJ

Compiled By	Date	Checked By	Date	Contract Ref:
[signature]	05/02/14			321370

Contract: (M) North Gawber

GINT_LIBRARY_V8_05.GLB : E - GAS MON - STANDARD - A4 - 7A : 321370 - NORTH GAWBER.GPJ : 05/02/14 13:46 : AW

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH203	1	50	G7		4.41	1.00 to 4.00	180 secs	1000	1000	-	0.76	0.1	0.0	21.2	0.0	0.0	0.0	
BH204	1	50	G7	4.70	4.97	1.00 to 4.70	30/01/2014 10:43:00	997	997	0.2	DRY	0.0	0.0	21.5	0.0	0.0	0.0	
BH204	1	50	G7		4.97	1.00 to 4.70	15 secs	997	997	0.1	DRY	3.0	0.0	20.1	0.0	0.0	0.0	
BH204	1	50	G7		4.97	1.00 to 4.70	30 secs	997	997	0.1	DRY	3.1	0.0	17.2	0.0	0.0	0.0	
BH204	1	50	G7		4.97	1.00 to 4.70	60 secs	997	997	0.1	DRY	3.2	0.0	16.7	0.0	0.0	0.0	
BH204	1	50	G7		4.97	1.00 to 4.70	90 secs	997	997	-	DRY	3.4	0.0	16.3	0.0	0.0	0.0	
BH204	1	50	G7		4.97	1.00 to 4.70	120 secs	997	997	-	DRY	3.7	0.0	15.8	0.0	0.0	0.0	
BH204	1	50	G7		4.97	1.00 to 4.70	180 secs	997	997	-	DRY	4.0	0.0	15.3	0.0	0.0	0.0	
BH204	1	50	G7		4.97	1.00 to 4.70	240 secs	997	997	-	DRY	4.1	0.0	15.1	0.0	0.0	0.0	
BH204	1	50	G7		4.97	1.00 to 4.70	300 secs	997	997	-	DRY	4.1	0.0	15.0	0.0	0.0	0.0	
BH205	1	50	G7	12.60	11.51	1.00 to 12.60	30/01/2014 11:00:00	1009	997	0.0	7.83	0.0	0.0	21.5	0.0	0.0	0.0	
BH205	1	50	G7		11.51	1.00 to 12.60	15 secs	1009	997	0.0	7.83	0.2	0.0	21.4	0.0	0.0	0.0	
BH205	1	50	G7		11.51	1.00 to 12.60	30 secs	1009	997	0.0	7.83	0.2	0.0	21.3	0.0	0.0	0.0	
BH205	1	50	G7		11.51	1.00 to 12.60	60 secs	1009	997	0.0	7.83	0.2	0.0	21.3	0.0	0.0	0.0	
BH205	1	50	G7		11.51	1.00 to 12.60	90 secs	1009	997	-	7.83	0.2	0.0	21.3	0.0	0.0	0.0	
BH205	1	50	G7		11.51	1.00 to 12.60	120 secs	1009	997	-	7.83	0.2	0.0	21.3	0.0	0.0	0.0	
BH205	1	50	G7		11.51	1.00 to 12.60	180 secs	1009	997	-	7.83	0.2	0.0	21.3	0.0	0.0	0.0	
BH206	1	50	G7	6.50	6.90	1.00 to 6.50	30/01/2014 13:42:00	1002	1001	0.0	1.00	0.0	0.0	21.0	0.0	0.0	0.0	
BH206	1	50	G7		6.90	1.00 to 6.50	15 secs	1002	1001	0.0	1.00	0.8	0.0	20.9	0.0	0.0	0.0	
BH206	1	50	G7		6.90	1.00 to 6.50	30 secs	1002	1001	0.0	1.00	0.6	0.0	20.9	0.0	0.0	0.0	
BH206	1	50	G7		6.90	1.00 to 6.50	60 secs	1002	1001	0.0	1.00	0.3	0.0	20.9	0.0	0.0	0.0	
BH206	1	50	G7		6.90	1.00 to 6.50	90 secs	1002	1001	-	1.00	0.3	0.0	20.9	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Fourways House
57 Hilton Street
Piccadilly
Manchester M1 2EJ

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Contract: **(M) North Gawber**

AGS

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH206	1	50	G7		6.90	1.00 to 6.50	120 secs	1002	1001	-	1.00	0.2	0.0	20.9	0.0	0.0	0.0	
BH206	1	50	G7		6.90	1.00 to 6.50	180 secs	1002	1001	-	1.00	0.2	0.0	21.0	0.0	0.0	0.0	
BH207	1	50	G7	6.50	6.44	1.00 to 6.50	30/01/2014 09:57:00	999	999	0.0	4.04	0.0	0.0	21.7	0.0	0.0	0.0	
BH207	1	50	G7		6.44	1.00 to 6.50	15 secs	999	999	0.1	4.04	3.9	0.0	18.9	0.0	0.0	0.0	
BH207	1	50	G7		6.44	1.00 to 6.50	30 secs	999	999	0.0	4.04	4.9	0.0	16.1	0.0	0.0	0.0	
BH207	1	50	G7		6.44	1.00 to 6.50	60 secs	999	999	0.0	4.04	5.1	0.0	15.5	0.0	0.0	0.0	
BH207	1	50	G7		6.44	1.00 to 6.50	90 secs	999	999	-	4.04	5.2	0.0	15.3	0.0	0.0	0.0	
BH207	1	50	G7		6.44	1.00 to 6.50	120 secs	999	999	-	4.04	5.2	0.0	15.3	0.0	0.0	0.0	
BH207	1	50	G7		6.44	1.00 to 6.50	180 secs	999	999	-	4.04	5.3	0.0	15.2	0.0	0.0	0.0	
BH207	1	50	G7		6.44	1.00 to 6.50	240 secs	999	999	-	4.04	5.5	0.0	15.0	0.0	0.0	0.0	
BH207	1	50	G7		6.44	1.00 to 6.50	300 secs	999	999	-	4.04	5.6	0.0	14.9	0.0	0.0	0.0	
BH207	1	50	G7		6.44	1.00 to 6.50	360 secs	999	999	-	4.04	6.0	0.0	14.7	0.0	0.0	0.0	
BH207	1	50	G7		6.44	1.00 to 6.50	420 secs	999	999	-	4.04	6.0	0.0	14.6	0.0	0.0	0.0	
BH208	1	50	G7	7.50	7.61	1.00 to 7.50	30/01/2014 10:27:00	997	997	0.0	DRY	0.0	0.0	21.6	0.0	0.0	0.0	
BH208	1	50	G7		7.61	1.00 to 7.50	15 secs	997	997	0.0	DRY	0.5	0.0	21.1	0.0	0.0	0.0	
BH208	1	50	G7		7.61	1.00 to 7.50	30 secs	997	997	0.0	DRY	0.5	0.0	20.9	0.0	0.0	0.0	
BH208	1	50	G7		7.61	1.00 to 7.50	60 secs	997	997	0.0	DRY	0.5	0.0	20.8	0.0	0.0	0.0	
BH208	1	50	G7		7.61	1.00 to 7.50	90 secs	997	997	-	DRY	0.5	0.0	20.8	0.0	0.0	0.0	
BH208	1	50	G7		7.61	1.00 to 7.50	120 secs	997	997	-	DRY	0.6	0.0	20.8	0.0	0.0	0.0	
BH208	1	50	G7		7.61	1.00 to 7.50	180 secs	997	997	-	DRY	0.6	0.0	20.8	0.0	0.0	0.0	
BH209	1	50	G7	5.40	5.54	1.00 to 5.40	30/01/2014 14:40:00	1000	999	0.0	DRY	0.0	0.0	21.0	0.0	0.0	0.0	
BH209	1	50	G7		5.54	1.00 to 5.40	15 secs	1000	999	0.0	DRY	0.6	0.0	21.0	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Fourways House
57 Hilton Street
Piccadilly
Manchester M1 2EJ

Compiled By	Date	Checked By	Date	Contract Ref:
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Contract: **(M) North Gawber**

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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH209	1	50	G7		5.54	1.00 to 5.40	30 secs	1000	999	0.0	DRY	1.0	0.0	20.7	0.0	0.0	0.0	
BH209	1	50	G7		5.54	1.00 to 5.40	60 secs	1000	999	0.0	DRY	1.2	0.0	20.3	0.0	0.0	0.0	
BH209	1	50	G7		5.54	1.00 to 5.40	90 secs	1000	999	-	DRY	1.3	0.0	20.2	0.0	0.0	0.0	
BH209	1	50	G7		5.54	1.00 to 5.40	120 secs	1000	999	-	DRY	1.3	0.0	20.2	0.0	0.0	0.0	
BH209	1	50	G7		5.54	1.00 to 5.40	180 secs	1000	999	-	DRY	1.3	0.0	20.2	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

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Manchester M1 2EJ

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	05/02/14			321370

Contract: (M) North Gawber

Page: 4 of 4

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round G6 Medium + Air Temp: 2DegC	-	-	-	-	GA2000 SN-GA10789 + YSI556 SN-07L100518 + PID + Interface probe SN-3355 + Weather: Sunny, clear + Ground: Dry + Wind:

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH201	1	50	G6	6.00	6.19	1.00 to 6.00	19/11/2013 12:50:00	1009	1009	3.1	0.75	0.0	0.0	21.2	0.0	-	0.0	0.0
BH201	1	50	G6		6.19	1.00 to 6.00	15 secs	1009	1009	6.8	0.75	9.2	0.0	18.1	0.0	-	0.0	0.0
BH201	1	50	G6		6.19	1.00 to 6.00	30 secs	1009	1009	6.0	0.75	9.4	0.1	16.2	1.0	-	1.0	0.0
BH201	1	50	G6		6.19	1.00 to 6.00	60 secs	1009	1009	4.8	0.75	9.4	0.1	15.8	1.0	-	1.0	0.0
BH201	1	50	G6		6.19	1.00 to 6.00	90 secs	1009	1009	-	0.75	9.4	0.1	15.6	1.0	-	1.0	0.0
BH201	1	50	G6		6.19	1.00 to 6.00	120 secs	1009	1009	-	0.75	9.4	0.1	15.6	1.0	-	1.0	0.0
BH201	1	50	G6		6.19	1.00 to 6.00	180 secs	1009	1009	-	0.75	9.4	0.1	16.6	1.0	0.3	1.0	0.0
BH202	1	50	G6	5.00	5.26	1.00 to 5.00	19/11/2013 15:30:00	1004	1004	0.0	3.64	0.0	0.0	21.5	0.0	-	0.0	0.0
BH202	1	50	G6		5.26	1.00 to 5.00	15 secs	1004	1004	0.0	3.64	4.7	0.0	18.6	0.0	-	0.0	0.0
BH202	1	50	G6		5.26	1.00 to 5.00	30 secs	1004	1004	0.0	3.64	4.8	0.0	16.9	0.0	-	0.0	0.0
BH202	1	50	G6		5.26	1.00 to 5.00	60 secs	1004	1004	0.0	3.64	4.8	0.0	16.4	0.0	-	0.0	0.0
BH202	1	50	G6		5.26	1.00 to 5.00	90 secs	1004	1004	-	3.64	4.8	0.0	16.4	0.0	-	0.0	0.0
BH202	1	50	G6		5.26	1.00 to 5.00	120 secs	1004	1004	-	3.64	4.9	0.0	16.3	0.0	-	0.0	0.0
BH202	1	50	G6		5.26	1.00 to 5.00	180 secs	1004	1004	-	3.64	5.1	0.0	16.1	0.0	-	0.0	0.0
BH202	1	50	G6		5.26	1.00 to 5.00	240 secs	1004	1004	-	3.64	5.5	0.0	15.8	0.0	-	0.0	0.0
BH202	1	50	G6		5.26	1.00 to 5.00	300 secs	1004	1004	-	3.64	6.5	0.0	14.8	0.0	-	0.0	0.0
BH202	1	50	G6		5.26	1.00 to 5.00	360 secs	1004	1004	-	3.64	8.1	0.0	13.6	0.0	-	0.0	0.0
BH202	1	50	G6		5.26	1.00 to 5.00	420 secs	1004	1004	-	3.64	8.8	0.0	13.0	0.0	-	0.0	0.0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
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Piccadilly
Manchester M1 2EJ

Compiled By	Date	Checked By	Date	Contract Ref:
[signature]	05/02/14			321370

Contract: (M) North Gawber

Page: 1 of 4

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH202	1	50	G6		5.26	1.00 to 5.00	480 secs	1004	1004	-	3.64	8.8	0.0	12.9	0.0	0.1	0.0	0.0
BH203	1	50	G6	4.00	4.42	1.00 to 4.00	19/11/2013 15:00:00	1009	1009	0.0	1.35	0.0	0.0	21.2	0.0	-	0.0	0.0
BH203	1	50	G6		4.42	1.00 to 4.00	15 secs	1009	1009	0.0	1.35	1.1	0.0	21.0	0.0	-	0.0	0.0
BH203	1	50	G6		4.42	1.00 to 4.00	30 secs	1009	1009	0.0	1.35	0.5	0.0	21.1	0.0	-	0.0	0.0
BH203	1	50	G6		4.42	1.00 to 4.00	60 secs	1009	1009	0.0	1.35	0.3	0.0	21.3	0.0	-	0.0	0.0
BH203	1	50	G6		4.42	1.00 to 4.00	90 secs	1009	1009	-	1.35	0.2	0.0	21.4	0.0	-	0.0	0.0
BH203	1	50	G6		4.42	1.00 to 4.00	120 secs	1009	1009	-	1.35	0.2	0.0	21.4	0.0	-	0.0	0.0
BH203	1	50	G6		4.42	1.00 to 4.00	180 secs	1009	1009	-	1.35	0.2	0.0	21.5	0.0	0.0	0.0	0.0
BH204	1	50	G6	4.70	4.97	1.00 to 4.70	19/11/2013 14:45:00	1004	1004	0.0	DRY	0.0	0.0	21.1	0.0	-	0.0	0.0
BH204	1	50	G6		4.97	1.00 to 4.70	15 secs	1004	1004	0.0	DRY	0.4	0.0	20.8	0.0	-	0.0	0.0
BH204	1	50	G6		4.97	1.00 to 4.70	30 secs	1004	1004	0.0	DRY	0.4	0.0	20.5	0.0	-	0.0	0.0
BH204	1	50	G6		4.97	1.00 to 4.70	60 secs	1004	1004	0.0	DRY	0.4	0.0	20.4	0.0	-	0.0	0.0
BH204	1	50	G6		4.97	1.00 to 4.70	90 secs	1004	1004	-	DRY	0.4	0.0	20.4	0.0	-	0.0	0.0
BH204	1	50	G6		4.97	1.00 to 4.70	120 secs	1004	1004	-	DRY	0.4	0.0	20.4	0.0	-	0.0	0.0
BH204	1	50	G6		4.97	1.00 to 4.70	180 secs	1004	1004	-	DRY	0.7	0.0	20.0	0.0	-	0.0	0.0
BH204	1	50	G6		4.97	1.00 to 4.70	240 secs	1004	1004	-	DRY	1.0	0.0	19.4	0.0	-	0.0	0.0
BH204	1	50	G6		4.97	1.00 to 4.70	300 secs	1004	1004	-	DRY	1.7	0.0	18.3	0.0	-	0.0	0.0
BH204	1	50	G6		4.97	1.00 to 4.70	360 secs	1004	1004	-	DRY	2.4	0.0	17.1	0.0	-	0.0	0.0
BH204	1	50	G6		4.97	1.00 to 4.70	420 secs	1004	1004	-	DRY	2.9	0.0	16.0	0.0	-	0.0	0.0
BH204	1	50	G6		4.97	1.00 to 4.70	480 secs	1004	1004	-	DRY	3.2	0.0	15.4	0.0	-	0.0	0.0
BH204	1	50	G6		4.97	1.00 to 4.70	540 secs	1004	1004	-	DRY	3.2	0.0	15.3	0.0	0.0	0.0	0.0
BH205	1	50	G6	12.60	11.50	1.00 to 12.60	19/11/2013 09:00:00	1009	1009	0.0	9.38	0.0	0.0	21.2	0.0	-	0.0	0.0
BH205	1	50	G6		11.50	1.00 to 12.60	15 secs	1009	1009	0.0	9.38	0.0	0.0	21.2	0.0	-	0.0	0.0
BH205	1	50	G6		11.50	1.00 to 12.60	30 secs	1009	1009	0.0	9.38	0.0	0.0	21.2	0.0	-	0.0	0.0
BH205	1	50	G6		11.50	1.00 to 12.60	60 secs	1009	1009	0.0	9.38	0.0	0.0	21.2	0.0	-	0.0	0.0

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RSK Environment Ltd
Fourways House
57 Hilton Street
Piccadilly
Manchester M1 2EJ

Compiled By	Date	Checked By	Date	Contract Ref:
[signature]	05/02/14			321370

Contract: (M) North Gawber

AGS

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH205	1	50	G6		11.50	1.00 to 12.60	90 secs	1009	1009	-	9.38	0.0	0.0	21.2	0.0	-	0.0	0.0
BH205	1	50	G6		11.50	1.00 to 12.60	120 secs	1009	1009	-	9.38	0.0	0.0	21.2	0.0	-	0.0	0.0
BH205	1	50	G6		11.50	1.00 to 12.60	180 secs	1009	1009	-	9.38	0.0	0.0	21.3	0.0	0.0	0.0	0.0
BH206	1	50	G6	6.50	3.90	1.00 to 6.50	19/11/2013 13:00:00	1009	1009	0.0	3.41	0.0	0.0	21.3	0.0	-	0.0	0.0
BH206	1	50	G6		3.90	1.00 to 6.50	15 secs	1009	1009	0.0	3.41	2.1	0.0	19.3	0.0	-	0.0	0.0
BH206	1	50	G6		3.90	1.00 to 6.50	30 secs	1009	1009	0.0	3.41	2.2	0.0	18.2	0.0	-	0.0	0.0
BH206	1	50	G6		3.90	1.00 to 6.50	60 secs	1009	1009	0.0	3.41	2.4	0.0	17.6	0.0	-	0.0	0.0
BH206	1	50	G6		3.90	1.00 to 6.50	90 secs	1009	1009	-	3.41	2.6	0.0	17.2	0.0	-	0.0	0.0
BH206	1	50	G6		3.90	1.00 to 6.50	120 secs	1009	1009	-	3.41	2.7	0.0	17.0	0.0	-	0.0	0.0
BH206	1	50	G6		3.90	1.00 to 6.50	180 secs	1009	1009	-	3.41	3.0	0.0	16.6	0.0	-	0.0	0.0
BH206	1	50	G6		3.90	1.00 to 6.50	240 secs	1009	1009	-	3.41	4.0	0.0	15.4	0.0	-	0.0	0.0
BH206	1	50	G6		3.90	1.00 to 6.50	300 secs	1009	1009	-	3.41	5.1	0.0	14.0	0.0	-	0.0	0.0
BH206	1	50	G6		3.90	1.00 to 6.50	360 secs	1009	1009	-	3.41	6.4	0.0	12.4	0.0	-	0.0	0.0
BH206	1	50	G6		3.90	1.00 to 6.50	420 secs	1009	1009	-	3.41	6.6	0.0	12.2	0.0	-	0.0	0.0
BH206	1	50	G6		3.90	1.00 to 6.50	480 secs	1009	1009	-	3.41	6.6	0.0	12.2	0.0	0.6	0.0	0.0
BH207	1	50	G6	6.50	6.44	1.00 to 6.50	19/11/2013 13:15:00	1009	1009	0.0	5.55	0.0	0.0	21.6	0.0	-	0.0	0.0
BH207	1	50	G6		6.44	1.00 to 6.50	15 secs	1009	1009	0.0	5.55	1.3	0.0	20.8	0.0	-	0.0	0.0
BH207	1	50	G6		6.44	1.00 to 6.50	30 secs	1009	1009	0.0	5.55	1.4	0.0	20.0	0.0	-	0.0	0.0
BH207	1	50	G6		6.44	1.00 to 6.50	60 secs	1009	1009	0.0	5.55	2.1	0.0	19.2	0.0	-	0.0	0.0
BH207	1	50	G6		6.44	1.00 to 6.50	90 secs	1009	1009	-	5.55	2.4	0.0	18.7	0.0	-	0.0	0.0
BH207	1	50	G6		6.44	1.00 to 6.50	120 secs	1009	1009	-	5.55	2.5	0.0	18.5	0.0	-	0.0	0.0
BH207	1	50	G6		6.44	1.00 to 6.50	180 secs	1009	1009	-	5.55	2.8	0.0	18.2	0.0	-	0.0	0.0
BH207	1	50	G6		6.44	1.00 to 6.50	240 secs	1009	1009	-	5.55	3.9	0.0	17.0	0.0	-	0.0	0.0
BH207	1	50	G6		6.44	1.00 to 6.50	300 secs	1009	1009	-	5.55	5.1	0.0	15.8	0.0	-	0.0	0.0
BH207	1	50	G6		6.44	1.00 to 6.50	360 secs	1009	1009	-	5.55	6.8	0.0	14.1	0.0	-	0.0	0.0

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RSK Environment Ltd
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57 Hilton Street
Piccadilly
Manchester M1 2EJ

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Contract: **(M) North Gawber**

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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH207	1	50	G6		6.44	1.00 to 6.50	420 secs	1009	1009	-	5.55	7.4	0.0	13.4	0.0	-	0.0	0.0
BH207	1	50	G6		6.44	1.00 to 6.50	480 secs	1009	1009	-	5.55	7.6	0.0	13.2	0.0	0.0	0.0	0.0
BH208	1	50	G6	7.50	7.63	1.00 to 7.50	19/11/2013 14:10:00	1009	1009	0.0	DRY	0.0	0.0	21.1	0.0	-	0.0	0.0
BH208	1	50	G6		7.63	1.00 to 7.50	15 secs	1009	1009	0.0	DRY	0.6	0.0	20.9	0.0	-	0.0	0.0
BH208	1	50	G6		7.63	1.00 to 7.50	30 secs	1009	1009	-0.1	DRY	0.6	0.0	20.6	0.0	-	0.0	0.0
BH208	1	50	G6		7.63	1.00 to 7.50	60 secs	1009	1009	0.0	DRY	0.7	0.0	20.5	0.0	-	0.0	0.0
BH208	1	50	G6		7.63	1.00 to 7.50	90 secs	1009	1009	-	DRY	0.7	0.0	20.5	0.0	-	0.0	0.0
BH208	1	50	G6		7.63	1.00 to 7.50	120 secs	1009	1009	-	DRY	0.8	0.0	20.4	0.0	-	0.0	0.0
BH208	1	50	G6		7.63	1.00 to 7.50	180 secs	1009	1009	-	DRY	0.8	0.0	20.4	0.0	0.0	0.0	0.0
BH209	1	50	G6	5.40	5.55	1.00 to 5.40	19/11/2013 13:45:00	1009	1009	0.0	DRY	0.0	0.0	21.0	0.0	-	0.0	0.0
BH209	1	50	G6		5.55	1.00 to 5.40	15 secs	1009	1009	0.0	DRY	0.1	0.0	21.0	0.0	-	0.0	0.0
BH209	1	50	G6		5.55	1.00 to 5.40	30 secs	1009	1009	0.0	DRY	0.1	0.0	21.0	0.0	-	0.0	0.0
BH209	1	50	G6		5.55	1.00 to 5.40	60 secs	1009	1009	0.0	DRY	0.2	0.0	21.0	0.0	-	0.0	0.0
BH209	1	50	G6		5.55	1.00 to 5.40	90 secs	1009	1009	-	DRY	0.2	0.0	21.0	0.0	-	0.0	0.0
BH209	1	50	G6		5.55	1.00 to 5.40	120 secs	1009	1009	-	DRY	0.2	0.0	20.9	0.0	-	0.0	0.0
BH209	1	50	G6		5.55	1.00 to 5.40	180 secs	1009	1009	-	DRY	0.4	0.0	20.9	0.0	-	0.0	0.0
BH209	1	50	G6		5.55	1.00 to 5.40	240 secs	1009	1009	-	DRY	0.4	0.0	20.8	0.0	0.1	0.0	0.0

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Contract: **(M) North Gawber**

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AGS

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round G5	-	-	-	-	GA2000 SN-GA10789 + PID + Dipmeter + Weather: Overcast + Ground: Damp + Wind: Strong + Air Temp: 15DegC

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH201	1	50	G5	6.00	6.20	1.00 to 6.00	28/10/2013 13:30:00	983	983	7.5	0.83	0.0	0.0	20.8	0.0	-	0.0	0.0
BH201	1	50	G5		6.20	1.00 to 6.00	15 secs	983	983	15.2	0.83	4.4	0.0	19.0	0.0	-	0.0	0.0
BH201	1	50	G5		6.20	1.00 to 6.00	30 secs	983	983	14.5	0.83	4.5	0.1	17.9	1.0	-	1.0	0.0
BH201	1	50	G5		6.20	1.00 to 6.00	60 secs	983	983	13.0	0.83	4.5	0.1	17.8	1.0	-	1.0	0.0
BH201	1	50	G5		6.20	1.00 to 6.00	90 secs	983	983	-	0.83	4.5	0.1	17.8	1.0	-	1.0	0.0
BH201	1	50	G5		6.20	1.00 to 6.00	120 secs	983	983	-	0.83	4.5	0.1	17.8	1.0	-	1.0	0.0
BH201	1	50	G5		6.20	1.00 to 6.00	180 secs	983	983	-	0.83	4.6	0.1	17.7	1.0	-	1.0	0.0
BH202	1	50	G5	5.00	5.26	1.00 to 5.00	28/10/2013 16:20:00	985	985	0.0	-	0.0	0.0	21.2	0.0	-	0.0	0.0
BH202	1	50	G5		5.26	1.00 to 5.00	15 secs	985	985	0.0	-	4.9	0.0	18.1	0.0	-	0.0	0.0
BH202	1	50	G5		5.26	1.00 to 5.00	30 secs	985	985	0.0	-	7.0	0.0	13.8	0.0	-	0.0	0.0
BH202	1	50	G5		5.26	1.00 to 5.00	60 secs	985	985	0.0	-	7.8	0.1	11.2	1.0	-	0.0	0.0
BH202	1	50	G5		5.26	1.00 to 5.00	90 secs	985	985	-	-	7.9	0.1	10.9	1.0	-	0.0	0.0
BH202	1	50	G5		5.26	1.00 to 5.00	120 secs	985	985	-	-	7.9	0.1	10.9	1.0	-	0.0	0.0
BH202	1	50	G5		5.26	1.00 to 5.00	180 secs	985	985	-	-	7.8	0.1	10.8	1.0	0.0	0.0	0.0
BH203	1	50	G5	4.00	4.40	1.00 to 4.00	28/10/2013 15:43:00	983	983	0.0	2.45	0.0	0.0	21.1	0.0	-	0.0	0.0
BH203	1	50	G5		4.40	1.00 to 4.00	15 secs	983	983	0.0	2.45	6.2	0.0	13.9	0.0	-	0.0	0.0
BH203	1	50	G5		4.40	1.00 to 4.00	30 secs	983	983	0.0	2.45	3.8	0.0	14.7	0.0	-	0.0	0.0
BH203	1	50	G5		4.40	1.00 to 4.00	60 secs	983	983	0.0	2.45	2.1	0.0	17.0	0.0	-	0.0	0.0

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[signature]	05/02/14			321370

Contract: **(M) North Gawber**

AGS

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH203	1	50	G5		4.40	1.00 to 4.00	90 secs	983	983	-	2.45	1.5	0.0	19.0	0.0	-	0.0	0.0
BH203	1	50	G5		4.40	1.00 to 4.00	120 secs	983	983	-	2.45	1.1	0.0	19.6	0.0	-	0.0	0.0
BH203	1	50	G5		4.40	1.00 to 4.00	180 secs	983	983	-	2.45	0.7	0.0	20.2	0.0	-	0.0	0.0
BH203	1	50	G5		4.40	1.00 to 4.00	240 secs	983	983	-	2.45	0.6	0.0	20.5	0.0	0.0	0.0	0.0
BH204	1	50	G5	4.70	4.98	1.00 to 4.70	28/10/2013 15:30:00	1013	983	0.0	4.97	0.0	0.0	21.1	0.0	-	0.0	0.0
BH204	1	50	G5		4.98	1.00 to 4.70	15 secs	1013	983	0.0	4.97	3.2	0.0	18.4	0.0	-	0.0	0.0
BH204	1	50	G5		4.98	1.00 to 4.70	30 secs	1013	983	0.0	4.97	3.3	0.0	16.5	0.0	-	0.0	0.0
BH204	1	50	G5		4.98	1.00 to 4.70	60 secs	1013	983	0.0	4.97	3.3	0.0	16.2	0.0	-	0.0	0.0
BH204	1	50	G5		4.98	1.00 to 4.70	90 secs	1013	983	-	4.97	3.4	0.0	16.2	0.0	-	0.0	0.0
BH204	1	50	G5		4.98	1.00 to 4.70	120 secs	1013	983	-	4.97	3.4	0.0	16.2	0.0	-	0.0	0.0
BH204	1	50	G5		4.98	1.00 to 4.70	180 secs	1013	983	-	4.97	3.4	0.0	16.2	0.0	0.0	0.0	0.0
BH205	1	50	G5	12.60	10.09	1.00 to 12.60	28/10/2013 15:15:00	983	983	0.0	9.12	0.0	0.0	21.0	0.0	-	0.0	0.0
BH205	1	50	G5		10.09	1.00 to 12.60	15 secs	983	983	0.0	9.12	0.6	0.0	20.6	0.0	-	0.0	0.0
BH205	1	50	G5		10.09	1.00 to 12.60	30 secs	983	983	0.0	9.12	0.7	0.0	20.4	0.0	-	0.0	0.0
BH205	1	50	G5		10.09	1.00 to 12.60	60 secs	983	983	0.0	9.12	0.8	0.0	20.3	0.0	-	0.0	0.0
BH205	1	50	G5		10.09	1.00 to 12.60	90 secs	983	983	-	9.12	0.9	0.0	20.2	0.0	-	0.0	0.0
BH205	1	50	G5		10.09	1.00 to 12.60	120 secs	983	983	-	9.12	0.9	0.0	20.1	0.0	-	0.0	0.0
BH205	1	50	G5		10.09	1.00 to 12.60	180 secs	983	983	-	9.12	0.9	0.0	20.1	0.0	0.0	0.0	0.0
BH206	1	50	G5	6.50	6.91	1.00 to 6.50	28/10/2013 13:55:00	983	983	0.0	3.05	0.0	0.0	21.0	0.0	-	0.0	0.0
BH206	1	50	G5		6.91	1.00 to 6.50	15 secs	983	983	0.0	3.05	8.3	0.0	7.2	0.0	-	1.0	0.0
BH206	1	50	G5		6.91	1.00 to 6.50	30 secs	983	983	0.0	3.05	8.5	0.0	3.7	0.0	-	1.0	0.0
BH206	1	50	G5		6.91	1.00 to 6.50	60 secs	983	983	0.0	3.05	8.6	0.0	2.6	0.0	-	0.0	0.0
BH206	1	50	G5		6.91	1.00 to 6.50	90 secs	983	983	-	3.05	8.7	0.0	2.3	0.0	-	0.0	0.0
BH206	1	50	G5		6.91	1.00 to 6.50	120 secs	983	983	-	3.05	8.7	0.0	2.1	0.0	-	0.0	0.0
BH206	1	50	G5		6.91	1.00 to 6.50	180 secs	983	983	-	3.05	8.8	0.0	1.9	0.0	-	0.0	0.0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Fourways House
57 Hilton Street
Piccadilly
Manchester M1 2EJ

Compiled By	Date	Checked By	Date	Contract Ref:
[signature]	05/02/14			321370

Contract: **(M) North Gawber**

AGS

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH206	1	50	G5		6.91	1.00 to 6.50	240 secs	983	983	-	3.05	9.0	0.0	1.6	0.0	-	0.0	0.0
BH206	1	50	G5		6.91	1.00 to 6.50	300 secs	983	983	-	3.05	9.2	0.0	1.1	0.0	-	0.0	0.0
BH206	1	50	G5		6.91	1.00 to 6.50	360 secs	983	983	-	3.05	9.4	0.0	0.6	0.0	-	0.0	0.0
BH206	1	50	G5		6.91	1.00 to 6.50	420 secs	983	983	-	3.05	9.5	0.0	0.5	0.0	0.0	0.0	0.0
BH207	1	50	G5	6.50	6.44	1.00 to 6.50	28/10/2013 13:12:00	983	983	0.0	5.77	0.0	0.0	21.0	0.0	-	0.0	0.0
BH207	1	50	G5		6.44	1.00 to 6.50	15 secs	983	983	0.0	5.77	7.8	0.0	14.4	0.0	-	0.0	0.0
BH207	1	50	G5		6.44	1.00 to 6.50	30 secs	983	983	0.0	5.77	8.3	0.0	12.8	0.0	-	0.0	0.0
BH207	1	50	G5		6.44	1.00 to 6.50	60 secs	983	983	0.0	5.77	8.3	0.0	12.4	0.0	-	0.0	0.0
BH207	1	50	G5		6.44	1.00 to 6.50	90 secs	983	983	-	5.77	8.3	0.0	12.3	0.0	-	0.0	0.0
BH207	1	50	G5		6.44	1.00 to 6.50	120 secs	983	983	-	5.77	8.3	0.0	12.3	0.0	-	0.0	0.0
BH207	1	50	G5		6.44	1.00 to 6.50	180 secs	983	983	-	5.77	8.3	0.0	12.3	0.0	0.0	0.0	0.0
BH208	1	50	G5	7.50	7.63	1.00 to 7.50	28/10/2013 14:50:00	983	983	-0.1	DRY	0.0	0.0	21.0	0.0	-	0.0	0.0
BH208	1	50	G5		7.63	1.00 to 7.50	15 secs	983	983	-0.1	DRY	1.1	0.0	20.6	0.0	-	0.0	0.0
BH208	1	50	G5		7.63	1.00 to 7.50	30 secs	983	983	-0.1	DRY	1.2	0.0	20.3	0.0	-	0.0	0.0
BH208	1	50	G5		7.63	1.00 to 7.50	60 secs	983	983	-0.1	DRY	1.3	0.0	20.2	0.0	-	0.0	0.0
BH208	1	50	G5		7.63	1.00 to 7.50	90 secs	983	983	-	DRY	1.3	0.0	20.2	0.0	-	0.0	0.0
BH208	1	50	G5		7.63	1.00 to 7.50	120 secs	983	983	-	DRY	1.3	0.0	20.2	0.0	-	0.0	0.0
BH208	1	50	G5		7.63	1.00 to 7.50	180 secs	983	983	-	DRY	1.4	0.0	20.1	0.0	0.0	0.0	0.0
BH209	1	50	G5	5.40	5.56	1.00 to 5.40	28/10/2013 14:30:00	983	983	0.0	DRY	0.0	0.0	21.1	0.0	-	0.0	0.0
BH209	1	50	G5		5.56	1.00 to 5.40	15 secs	983	983	0.0	DRY	2.7	0.0	19.3	0.0	-	0.0	0.0
BH209	1	50	G5		5.56	1.00 to 5.40	30 secs	983	983	0.0	DRY	2.9	0.0	17.8	0.0	-	0.0	0.0
BH209	1	50	G5		5.56	1.00 to 5.40	60 secs	983	983	0.0	DRY	2.9	0.0	17.7	0.0	-	0.0	0.0
BH209	1	50	G5		5.56	1.00 to 5.40	90 secs	983	983	-	DRY	2.9	0.0	17.7	0.0	-	0.0	0.0
BH209	1	50	G5		5.56	1.00 to 5.40	120 secs	983	983	-	DRY	2.9	0.0	17.7	0.0	-	0.0	0.0
BH209	1	50	G5		5.56	1.00 to 5.40	180 secs	983	983	-	DRY	2.9	0.0	17.8	0.0	0.0	0.0	0.0

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Contract: **(M) North Gawber**

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IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round G4	-	-	-	-	GA2000 SN-GA10789 + Dipmeter + Weather: Overcast + Ground: Damp + Wind: Light + Air Temp: 16DegC

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH201	1	50	G4	6.00	6.20	1.00 to 6.00	16/10/2013 10:45:00	1003	1003	2.5	1.11	0.0	0.0	21.0	0.0	-	0.0	0.0
BH201	1	50	G4		6.20	1.00 to 6.00	15 secs	1003	1003	4.8	1.11	3.9	0.0	19.9	0.0	-	0.0	0.0
BH201	1	50	G4		6.20	1.00 to 6.00	30 secs	1003	1003	4.1	1.11	4.0	0.1	19.2	1.0	-	0.0	0.0
BH201	1	50	G4		6.20	1.00 to 6.00	60 secs	1003	1003	2.9	1.11	4.0	0.1	19.2	1.0	-	0.0	0.0
BH201	1	50	G4		6.20	1.00 to 6.00	90 secs	1003	1003	-	1.11	4.0	0.1	19.1	1.0	-	0.0	0.0
BH201	1	50	G4		6.20	1.00 to 6.00	120 secs	1003	1003	-	1.11	4.0	0.1	19.2	1.0	-	0.0	0.0
BH201	1	50	G4		6.20	1.00 to 6.00	180 secs	1003	1003	-	1.11	4.0	0.1	19.2	1.0	0.0	0.0	0.0
BH202	1	50	G4	5.00	5.28	1.00 to 5.00	16/10/2013 15:00:00	997	997	0.0	4.10	0.0	0.0	21.3	0.0	-	0.0	0.0
BH202	1	50	G4		5.28	1.00 to 5.00	15 secs	997	997	0.0	4.10	4.2	0.0	17.6	0.0	-	0.0	0.0
BH202	1	50	G4		5.28	1.00 to 5.00	30 secs	997	997	0.0	4.10	4.3	0.0	16.6	0.0	-	0.0	0.0
BH202	1	50	G4		5.28	1.00 to 5.00	60 secs	997	997	0.0	4.10	4.5	0.0	16.3	0.0	-	0.0	0.0
BH202	1	50	G4		5.28	1.00 to 5.00	90 secs	997	997	-	4.10	4.6	0.0	16.2	0.0	-	0.0	0.0
BH202	1	50	G4		5.28	1.00 to 5.00	120 secs	997	997	-	4.10	4.7	0.0	16.1	0.0	-	0.0	0.0
BH202	1	50	G4		5.28	1.00 to 5.00	180 secs	997	997	-	4.10	4.8	0.0	16.0	0.0	0.0	0.0	0.0
BH203	1	50	G4	4.00	4.48	1.00 to 4.00	16/10/2013 15:30:00	997	997	0.0	3.15	0.0	0.0	21.2	0.0	-	0.0	0.0
BH203	1	50	G4		4.48	1.00 to 4.00	15 secs	997	997	0.0	3.15	2.1	0.0	17.8	0.0	-	0.0	0.0
BH203	1	50	G4		4.48	1.00 to 4.00	30 secs	997	997	0.0	3.15	1.3	0.0	19.0	0.0	-	0.0	0.0
BH203	1	50	G4		4.48	1.00 to 4.00	60 secs	997	997	0.0	3.15	0.9	0.0	20.0	0.0	-	0.0	0.0

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RSK Environment Ltd
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Manchester M1 2EJ

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Contract: (M) North Gawber

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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH203	1	50	G4		4.48	1.00 to 4.00	90 secs	997	997	-	3.15	1.7	0.0	19.2	0.0	-	0.0	0.0
BH203	1	50	G4		4.48	1.00 to 4.00	120 secs	997	997	-	3.15	0.7	0.0	20.1	0.0	-	0.0	0.0
BH203	1	50	G4		4.48	1.00 to 4.00	180 secs	997	997	-	3.15	0.7	0.0	20.5	0.0	-	0.0	0.0
BH203	1	50	G4		4.48	1.00 to 4.00	240 secs	997	997	-	3.15	0.5	0.0	20.7	0.0	-	0.0	0.0
BH203	1	50	G4		4.48	1.00 to 4.00	300 secs	997	997	-	3.15	0.4	0.0	20.8	0.0	-	0.0	0.0
BH203	1	50	G4		4.48	1.00 to 4.00	360 secs	997	997	-	3.15	0.4	0.0	20.9	0.0	0.0	0.0	0.0
BH204	1	50	G4	4.70	4.97	1.00 to 4.70	16/10/2013 13:30:00	997	997	0.0	4.94	0.0	0.0	21.2	0.0	-	0.0	0.0
BH204	1	50	G4		4.97	1.00 to 4.70	15 secs	997	997	0.0	4.94	3.0	0.0	19.6	0.0	-	0.0	0.0
BH204	1	50	G4		4.97	1.00 to 4.70	30 secs	997	997	0.1	4.94	3.1	0.0	18.4	0.0	-	0.0	0.0
BH204	1	50	G4		4.97	1.00 to 4.70	60 secs	997	997	0.0	4.94	3.1	0.0	18.3	0.0	-	0.0	0.0
BH204	1	50	G4		4.97	1.00 to 4.70	90 secs	997	997	-	4.94	3.1	0.0	18.3	0.0	-	0.0	0.0
BH204	1	50	G4		4.97	1.00 to 4.70	120 secs	997	997	-	4.94	3.1	0.0	18.3	0.0	-	0.0	0.0
BH204	1	50	G4		4.97	1.00 to 4.70	180 secs	997	997	-	4.94	3.1	0.0	18.2	0.0	0.0	0.0	0.0
BH205	1	50	G4	12.60	11.44	1.00 to 12.60	16/10/2013 14:00:00	997	997	0.1	10.21	0.0	0.0	21.4	0.0	-	0.0	0.0
BH205	1	50	G4		11.44	1.00 to 12.60	15 secs	997	997	0.0	10.21	0.9	0.0	20.9	0.0	-	0.0	0.0
BH205	1	50	G4		11.44	1.00 to 12.60	30 secs	997	997	0.1	10.21	0.9	0.0	20.7	0.0	-	0.0	0.0
BH205	1	50	G4		11.44	1.00 to 12.60	60 secs	997	997	0.1	10.21	1.1	0.0	20.6	0.0	-	0.0	0.0
BH205	1	50	G4		11.44	1.00 to 12.60	90 secs	997	997	-	10.21	1.3	0.0	20.4	0.0	-	0.0	0.0
BH205	1	50	G4		11.44	1.00 to 12.60	120 secs	997	997	-	10.21	1.6	0.0	20.2	0.0	-	0.0	0.0
BH205	1	50	G4		11.44	1.00 to 12.60	180 secs	997	997	-	10.21	2.6	0.0	19.3	0.0	-	0.0	0.0
BH205	1	50	G4		11.44	1.00 to 12.60	240 secs	997	997	-	10.21	3.6	0.0	18.3	0.0	-	0.0	0.0
BH205	1	50	G4		11.44	1.00 to 12.60	300 secs	997	997	-	10.21	3.7	0.0	18.1	0.0	-	0.0	0.0
BH205	1	50	G4		11.44	1.00 to 12.60	360 secs	997	997	-	10.21	3.8	0.0	18.0	0.0	0.0	0.0	0.0
BH206	1	50	G4	6.50	6.91	1.00 to 6.50	16/10/2013 11:15:00	1003	1003	0.0	6.18	0.0	0.0	21.2	0.0	-	0.0	0.0
BH206	1	50	G4		6.91	1.00 to 6.50	15 secs	1003	1003	0.0	6.18	5.1	0.0	14.1	0.0	-	0.0	0.0

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Compiled By	Date	Checked By	Date	Contract Ref:
[signature]	05/02/14			321370

Contract: (M) North Gawber

AGS

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH206	1	50	G4		6.91	1.00 to 6.50	30 secs	1003	1003	0.0	6.18	5.2	0.0	11.8	0.0	-	0.0	0.0
BH206	1	50	G4		6.91	1.00 to 6.50	60 secs	1003	1003	-	6.18	5.5	0.0	11.2	0.0	-	0.0	0.0
BH206	1	50	G4		6.91	1.00 to 6.50	90 secs	1003	1003	-	6.18	5.6	0.0	10.9	0.0	-	0.0	0.0
BH206	1	50	G4		6.91	1.00 to 6.50	120 secs	1003	1003	-	6.18	5.7	0.0	10.7	0.0	-	0.0	0.0
BH206	1	50	G4		6.91	1.00 to 6.50	180 secs	1003	1003	-	6.18	6.1	0.0	10.1	0.0	-	0.0	0.0
BH206	1	50	G4		6.91	1.00 to 6.50	240 secs	1003	1003	-	6.18	6.8	0.0	8.9	0.0	-	0.0	0.0
BH206	1	50	G4		6.91	1.00 to 6.50	300 secs	1003	1003	-	6.18	7.8	0.0	7.3	0.0	-	0.0	0.0
BH206	1	50	G4		6.91	1.00 to 6.50	360 secs	1003	1003	-	6.18	8.7	0.0	5.9	0.0	-	0.0	0.0
BH206	1	50	G4		6.91	1.00 to 6.50	420 secs	1003	1003	-	6.18	8.9	0.0	5.5	0.0	-	0.0	0.0
BH206	1	50	G4		6.91	1.00 to 6.50	480 secs	1003	1003	-	6.18	8.9	0.0	5.3	0.0	-	0.0	0.0
BH206	1	50	G4		6.91	1.00 to 6.50	540 secs	1003	1003	-	6.18	9.0	0.0	5.2	0.0	0.0	0.0	0.0
BH207	1	50	G4	6.50	6.49	1.00 to 6.50	16/10/2013 11:40:00	1000	1000	0.0	6.06	0.0	0.0	21.4	0.0	-	0.0	0.0
BH207	1	50	G4		6.49	1.00 to 6.50	15 secs	1000	1000	0.0	6.06	7.7	0.0	15.9	0.0	-	0.0	0.0
BH207	1	50	G4		6.49	1.00 to 6.50	30 secs	1000	1000	0.0	6.06	8.0	0.0	13.2	0.0	-	0.0	0.0
BH207	1	50	G4		6.49	1.00 to 6.50	60 secs	1000	1000	0.0	6.06	8.0	0.0	13.0	0.0	-	0.0	0.0
BH207	1	50	G4		6.49	1.00 to 6.50	90 secs	1000	1000	-	6.06	8.0	0.0	12.9	0.0	-	0.0	0.0
BH207	1	50	G4		6.49	1.00 to 6.50	120 secs	1000	1000	-	6.06	8.0	0.0	12.9	0.0	-	0.0	0.0
BH207	1	50	G4		6.49	1.00 to 6.50	180 secs	1000	1000	-	6.06	8.0	0.0	12.9	0.0	0.0	0.0	0.0
BH208	1	50	G4	7.50	7.65	1.00 to 7.50	16/10/2013 12:30:00	998	998	0.0	7.63	0.0	0.0	21.3	0.0	-	0.0	0.0
BH208	1	50	G4		7.65	1.00 to 7.50	15 secs	998	998	0.0	7.63	4.0	0.0	18.8	0.0	-	0.0	0.0
BH208	1	50	G4		7.65	1.00 to 7.50	30 secs	998	998	0.0	7.63	4.1	0.0	16.3	0.0	-	0.0	0.0
BH208	1	50	G4		7.65	1.00 to 7.50	60 secs	998	998	0.0	7.63	4.2	0.0	16.2	0.0	-	0.0	0.0
BH208	1	50	G4		7.65	1.00 to 7.50	90 secs	998	998	-	7.63	4.2	0.0	16.1	0.0	-	0.0	0.0
BH208	1	50	G4		7.65	1.00 to 7.50	120 secs	998	998	-	7.63	4.4	0.0	16.0	0.0	-	0.0	0.0
BH208	1	50	G4		7.65	1.00 to 7.50	180 secs	998	998	-	7.63	4.5	0.0	15.9	0.0	-	0.0	0.0

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Contract: (M) North Gawber

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AGS

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	PID (ppm)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
BH208	1	50	G4		7.65	1.00 to 7.50	240 secs	998	998	-	7.63	5.0	0.0	15.6	0.0	-	0.0	0.0
BH208	1	50	G4		7.65	1.00 to 7.50	300 secs	998	998	-	7.63	5.8	0.0	15.0	0.0	-	0.0	0.0
BH208	1	50	G4		7.65	1.00 to 7.50	360 secs	998	998	-	7.63	6.1	0.0	14.7	0.0	-	0.0	0.0
BH208	1	50	G4		7.65	1.00 to 7.50	420 secs	998	998	-	7.63	6.1	0.0	14.6	0.0	0.0	0.0	0.0
BH209	1	50	G4	5.40	5.57	1.00 to 5.40	16/10/2013 12:00:00	1000	1000	0.0	DRY	0.0	0.0	21.4	0.0	-	0.0	0.0
BH209	1	50	G4		5.57	1.00 to 5.40	15 secs	1000	1000	0.0	DRY	4.4	0.0	18.2	0.0	-	0.0	0.0
BH209	1	50	G4		5.57	1.00 to 5.40	30 secs	1000	1000	0.0	DRY	4.6	0.0	16.3	0.0	-	0.0	0.0
BH209	1	50	G4		5.57	1.00 to 5.40	60 secs	1000	1000	0.0	DRY	4.6	0.0	16.2	0.0	-	0.0	0.0
BH209	1	50	G4		5.57	1.00 to 5.40	90 secs	1000	1000	-	DRY	4.6	0.0	16.1	0.0	-	0.0	0.0
BH209	1	50	G4		5.57	1.00 to 5.40	120 secs	1000	1000	-	DRY	4.5	0.0	16.1	0.0	-	0.0	0.0
BH209	1	50	G4		5.57	1.00 to 5.40	180 secs	1000	1000	-	DRY	4.6	0.0	16.2	0.0	-	0.0	0.0
BH209	1	50	G4		5.57	1.00 to 5.40	240 secs	1000	1000	-	DRY	4.6	0.0	16.2	0.0	0.0	0.0	0.0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Fourways House
57 Hilton Street
Piccadilly
Manchester M1 2EJ

Compiled By	Date	Checked By	Date	Contract Ref:
	05/02/14			321370

Contract: (M) North Gawber

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IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round G3	-	-	-	-	GA2000 SN-MA088 + Weather: Drizzle + Ground: Wet + Wind: Light + Air Temp: 16DegC

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH201	1	50	G3	6.00	6.28	1.00 to 6.00	02/10/2013 14:10:00	1004	1004	0.3	1.11	0.0	0.0	21.1	0.0	0.0	0.0	
BH201	1	50	G3		6.28	1.00 to 6.00	15 secs	1004	1004	0.7	1.11	2.1	0.0	20.4	0.0	0.0	0.0	
BH201	1	50	G3		6.28	1.00 to 6.00	30 secs	1004	1004	0.4	1.11	2.1	0.0	20.2	0.0	0.0	0.0	
BH201	1	50	G3		6.28	1.00 to 6.00	60 secs	1004	1004	0.0	1.11	2.1	0.0	20.2	0.0	0.0	0.0	
BH201	1	50	G3		6.28	1.00 to 6.00	90 secs	1004	1004	0.0	1.11	2.1	0.0	20.2	0.0	0.0	0.0	
BH201	1	50	G3		6.28	1.00 to 6.00	120 secs	1004	1004	-	1.11	2.1	0.0	20.2	0.0	0.0	0.0	
BH201	1	50	G3		6.28	1.00 to 6.00	180 secs	1004	1004	-	1.11	2.1	0.0	20.2	0.0	0.0	0.0	
BH202	1	50	G3	5.00	5.28	1.00 to 5.00	02/10/2013 15:55:00	1003	1003	0.0	4.14	0.0	0.0	20.9	0.0	0.0	0.0	
BH202	1	50	G3		5.28	1.00 to 5.00	15 secs	1003	1003	0.0	4.14	2.1	0.0	19.6	0.0	0.0	0.0	
BH202	1	50	G3		5.28	1.00 to 5.00	30 secs	1003	1003	0.0	4.14	2.1	0.0	19.1	0.0	0.0	0.0	
BH202	1	50	G3		5.28	1.00 to 5.00	60 secs	1003	1003	0.0	4.14	2.3	0.0	18.9	0.0	0.0	0.0	
BH202	1	50	G3		5.28	1.00 to 5.00	90 secs	1003	1003	-	4.14	2.5	0.0	18.8	0.0	0.0	0.0	
BH202	1	50	G3		5.28	1.00 to 5.00	120 secs	1003	1003	-	4.14	2.6	0.0	18.7	0.0	0.0	0.0	
BH202	1	50	G3		5.28	1.00 to 5.00	180 secs	1003	1003	-	4.14	3.0	0.0	18.5	0.0	0.0	0.0	
BH202	1	50	G3		5.28	1.00 to 5.00	240 secs	1003	1003	-	4.14	3.4	0.0	18.3	0.0	0.0	0.0	
BH202	1	50	G3		5.28	1.00 to 5.00	300 secs	1003	1003	-	4.14	3.4	0.0	18.0	0.0	0.0	0.0	
BH202	1	50	G3		5.28	1.00 to 5.00	360 secs	1003	1003	-	4.14	4.5	0.0	17.6	0.0	0.0	0.0	
BH202	1	50	G3		5.28	1.00 to 5.00	420 secs	1003	1003	-	4.14	5.0	0.0	17.2	0.0	0.0	0.0	

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Contract: **(M) North Gawber**

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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH202	1	50	G3		5.28	1.00 to 5.00	480 secs	1003	1003	-	4.14	5.5	0.0	17.0	0.0	0.0	0.0	
BH202	1	50	G3		5.28	1.00 to 5.00	540 secs	1003	1003	-	4.14	5.5	0.0	16.9	0.0	0.0	0.0	
BH203	1	50	G3	4.00	4.41	1.00 to 4.00	02/10/2013 09:00:00	997	997	-	3.14	0.1	0.1	21.0	-	0.1	0.1	
BH203	1	50	G3		4.41	1.00 to 4.00	15 secs	997	997	-	3.14	3.1	0.1	18.9	-	0.1	0.1	
BH203	1	50	G3		4.41	1.00 to 4.00	30 secs	997	997	-	3.14	1.4	0.1	18.6	-	0.1	0.1	
BH203	1	50	G3		4.41	1.00 to 4.00	60 secs	997	997	-	3.14	1.1	0.1	19.5	-	0.1	0.1	
BH203	1	50	G3		4.41	1.00 to 4.00	90 secs	997	997	-	3.14	0.8	0.1	19.9	-	0.1	0.1	
BH203	1	50	G3		4.41	1.00 to 4.00	120 secs	997	997	-	3.14	0.7	0.1	20.1	-	0.1	0.1	
BH203	1	50	G3		4.41	1.00 to 4.00	180 secs	997	997	-	3.14	0.6	0.1	20.3	-	0.1	0.1	
BH204	1	50	G3	4.70	4.96	1.00 to 4.70	02/10/2013 09:00:00	996	996	-	DRY	0.1	0.1	21.2	-	0.1	0.1	
BH204	1	50	G3		4.96	1.00 to 4.70	15 secs	996	996	-	DRY	2.2	0.1	20.0	-	0.1	0.1	
BH204	1	50	G3		4.96	1.00 to 4.70	30 secs	996	996	-	DRY	2.4	0.1	19.4	-	0.1	0.1	
BH204	1	50	G3		4.96	1.00 to 4.70	60 secs	996	996	-	DRY	2.4	0.1	19.2	-	0.1	0.1	
BH204	1	50	G3		4.96	1.00 to 4.70	90 secs	996	996	-	DRY	2.5	0.1	19.2	-	0.1	0.1	
BH204	1	50	G3		4.96	1.00 to 4.70	120 secs	996	996	-	DRY	2.7	0.1	19.1	-	0.1	0.1	
BH204	1	50	G3		4.96	1.00 to 4.70	180 secs	996	996	-	DRY	3.0	0.1	18.8	-	0.1	0.1	
BH204	1	50	G3		4.96	1.00 to 4.70	240 secs	996	996	-	DRY	3.3	0.1	18.6	-	0.1	0.1	
BH204	1	50	G3		4.96	1.00 to 4.70	300 secs	996	996	-	DRY	3.6	0.1	18.3	-	0.1	0.1	
BH205	1	50	G3	12.60	11.48	1.00 to 12.60	02/10/2013 09:00:00	996	996	-	11.35	0.1	0.1	0.1	-	0.1	0.1	
BH205	1	50	G3		11.48	1.00 to 12.60	15 secs	996	996	-	11.35	0.1	0.1	0.1	-	0.1	0.1	
BH205	1	50	G3		11.48	1.00 to 12.60	30 secs	996	996	-	11.35	0.1	0.1	0.1	-	0.1	0.1	
BH205	1	50	G3		11.48	1.00 to 12.60	60 secs	996	996	-	11.35	0.1	0.1	0.1	-	0.1	0.1	
BH205	1	50	G3		11.48	1.00 to 12.60	90 secs	996	996	-	11.35	0.1	0.1	0.1	-	0.1	0.1	
BH205	1	50	G3		11.48	1.00 to 12.60	120 secs	996	996	-	11.35	0.1	0.1	0.1	-	0.1	0.1	
BH205	1	50	G3		11.48	1.00 to 12.60	180 secs	996	996	-	11.35	0.1	0.1	0.1	-	0.1	0.1	

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Contract: **(M) North Gawber**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH206	1	50	G3	6.50	6.89	1.00 to 6.50	02/10/2013 14:00:00	997	997	-	6.08	0.1	0.1	21.0	-	0.1	0.1	
BH206	1	50	G3		6.89	1.00 to 6.50	15 secs	997	997	-	6.08	4.0	0.1	18.3	-	0.1	0.1	
BH206	1	50	G3		6.89	1.00 to 6.50	30 secs	997	997	-	6.08	4.4	0.1	13.7	-	0.1	0.1	
BH206	1	50	G3		6.89	1.00 to 6.50	60 secs	997	997	-	6.08	4.8	0.1	12.9	-	0.1	0.1	
BH206	1	50	G3		6.89	1.00 to 6.50	90 secs	997	997	-	6.08	5.2	0.1	12.2	-	0.1	0.1	
BH206	1	50	G3		6.89	1.00 to 6.50	120 secs	997	997	-	6.08	5.3	0.1	11.8	-	0.1	0.1	
BH206	1	50	G3		6.89	1.00 to 6.50	180 secs	997	997	-	6.08	6.1	0.1	10.5	-	0.1	0.1	
BH206	1	50	G3		6.89	1.00 to 6.50	240 secs	997	997	-	6.08	7.4	0.1	8.4	-	0.1	0.1	
BH206	1	50	G3		6.89	1.00 to 6.50	300 secs	997	997	-	6.08	8.6	0.1	6.6	-	0.1	0.1	
BH207	1	50	G3	6.50	6.48	1.00 to 6.50	02/10/2013 14:00:00	1002	1002	-0.1	5.78	-	-	21.0	-	-	-	
BH207	1	50	G3		6.48	1.00 to 6.50	15 secs	1002	1002	0.0	5.78	4.8	0.0	18.4	0.0	0.0	0.0	
BH207	1	50	G3		6.48	1.00 to 6.50	30 secs	1002	1002	0.0	5.78	4.9	0.0	16.3	0.0	0.0	0.0	
BH207	1	50	G3		6.48	1.00 to 6.50	60 secs	1002	1002	0.0	5.78	5.0	0.0	16.0	0.0	0.0	0.0	
BH207	1	50	G3		6.48	1.00 to 6.50	90 secs	1002	1002	-	5.78	5.0	0.0	16.0	0.0	0.0	0.0	
BH207	1	50	G3		6.48	1.00 to 6.50	120 secs	1002	1002	-	5.78	5.0	0.0	15.9	0.0	0.0	0.0	
BH207	1	50	G3		6.48	1.00 to 6.50	180 secs	1002	1002	-	5.78	5.2	0.0	15.7	0.0	0.0	0.0	
BH207	1	50	G3		6.48	1.00 to 6.50	240 secs	1002	1002	-	5.78	5.7	0.0	15.3	0.0	0.0	0.0	
BH207	1	50	G3		6.48	1.00 to 6.50	300 secs	1002	1002	-	5.78	6.3	0.0	14.7	0.0	0.0	0.0	
BH207	1	50	G3		6.48	1.00 to 6.50	360 secs	1002	1002	-	5.78	7.1	0.0	14.0	0.0	0.0	0.0	
BH207	1	50	G3		6.48	1.00 to 6.50	420 secs	1002	1002	-	5.78	7.5	0.0	13.7	0.0	0.0	0.0	
BH207	1	50	G3		6.48	1.00 to 6.50	480 secs	1002	1002	-	5.78	7.7	0.0	13.5	0.0	0.0	0.0	
BH207	1	50	G3		6.48	1.00 to 6.50	540 secs	1002	1002	-	5.78	7.7	0.0	13.5	0.0	0.0	0.0	
BH208	1	50	G3	7.50	7.60	1.00 to 7.50	02/10/2013 09:00:00	996	996	-	-	0.1	0.1	21.1	-	0.1	0.1	
BH208	1	50	G3		7.60	1.00 to 7.50	15 secs	996	996	-	-	2.6	0.1	19.7	-	0.1	0.1	
BH208	1	50	G3		7.60	1.00 to 7.50	30 secs	996	996	-	-	2.9	0.1	17.3	-	0.1	0.1	

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Contract: **(M) North Gawber**

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AGS

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH208	1	50	G3		7.60	1.00 to 7.50	60 secs	996	996	-	-	3.5	0.1	16.3	-	0.1	0.1	
BH208	1	50	G3		7.60	1.00 to 7.50	90 secs	996	996	-	-	3.9	0.1	15.7	-	0.1	0.1	
BH208	1	50	G3		7.60	1.00 to 7.50	120 secs	996	996	-	-	4.4	0.1	15.0	-	0.1	0.1	
BH208	1	50	G3		7.60	1.00 to 7.50	180 secs	996	996	-	-	5.4	0.1	13.6	-	0.1	0.1	
BH208	1	50	G3		7.60	1.00 to 7.50	240 secs	996	996	-	-	6.4	0.1	12.2	-	0.1	0.1	
BH208	1	50	G3		7.60	1.00 to 7.50	300 secs	996	996	-	-	6.9	0.1	11.3	-	0.1	0.1	
BH209	1	50	G3	5.40	5.57	1.00 to 5.40	02/10/2013 15:25:00	1001	1001	0.0	DRY	0.0	0.0	21.0	0.0	0.0	0.0	
BH209	1	50	G3		5.57	1.00 to 5.40	15 secs	1001	1001	0.0	DRY	3.5	0.0	18.5	0.0	0.0	0.0	
BH209	1	50	G3		5.57	1.00 to 5.40	30 secs	1001	1001	0.0	DRY	3.6	0.0	17.1	0.0	0.0	0.0	
BH209	1	50	G3		5.57	1.00 to 5.40	60 secs	1001	1001	0.0	DRY	3.6	0.0	16.9	0.0	0.0	0.0	
BH209	1	50	G3		5.57	1.00 to 5.40	90 secs	1001	1001	-	DRY	3.6	0.0	16.8	0.0	0.0	0.0	
BH209	1	50	G3		5.57	1.00 to 5.40	120 secs	1001	1001	-	DRY	3.6	0.0	16.8	0.0	0.0	0.0	
BH209	1	50	G3		5.57	1.00 to 5.40	180 secs	1001	1001	-	DRY	3.7	0.0	16.7	0.0	0.0	0.0	
BH209	1	50	G3		5.57	1.00 to 5.40	240 secs	1001	1001	-	DRY	3.7	0.0	16.7	0.0	0.0	0.0	

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IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round G2	-	-	-	-	GA2000 SN-GA10789 + YSI556 SN-07L100518 + Weather: Cloudy + Ground: Damp + Wind: Light + Air Temp: 11DegC

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH201	1	50	G2	6.00	6.18	1.00 to 6.00	18/09/2013 09:00:00	995	995	0.0	1.00	0.0	0.0	20.9	-	0.0	0.0	
BH201	1	50	G2		6.18	1.00 to 6.00	15 secs	995	995	0.0	1.00	0.8	0.0	20.8	-	0.0	0.0	
BH201	1	50	G2		6.18	1.00 to 6.00	30 secs	995	995	0.0	1.00	0.9	0.0	20.6	-	0.0	0.0	
BH201	1	50	G2		6.18	1.00 to 6.00	60 secs	995	995	0.0	1.00	0.9	0.0	20.6	-	0.0	0.0	
BH201	1	50	G2		6.18	1.00 to 6.00	90 secs	995	995	-	1.00	0.9	0.0	20.6	-	0.0	0.0	
BH201	1	50	G2		6.18	1.00 to 6.00	120 secs	995	995	-	1.00	0.9	0.0	20.6	-	0.0	0.0	
BH201	1	50	G2		6.18	1.00 to 6.00	180 secs	995	995	-	1.00	0.9	0.0	20.7	-	0.0	0.0	
BH202	1	50	G2	5.00	5.25	1.00 to 5.00	18/09/2013 10:25:00	996	996	0.0	3.87	0.0	0.0	21.0	0.0	0.0	0.0	
BH202	1	50	G2		5.25	1.00 to 5.00	15 secs	996	996	0.0	3.87	2.4	0.0	20.1	0.0	1.0	0.0	
BH202	1	50	G2		5.25	1.00 to 5.00	30 secs	996	996	0.0	3.87	2.6	0.0	19.0	0.0	0.0	0.0	
BH202	1	50	G2		5.25	1.00 to 5.00	60 secs	996	996	0.0	3.87	2.8	0.0	18.7	0.0	0.0	0.0	
BH202	1	50	G2		5.25	1.00 to 5.00	90 secs	996	996	-	3.87	2.9	0.0	18.5	0.0	0.0	0.0	
BH202	1	50	G2		5.25	1.00 to 5.00	120 secs	996	996	-	3.87	3.0	0.0	18.4	0.0	0.0	0.0	
BH202	1	50	G2		5.25	1.00 to 5.00	180 secs	996	996	-	3.87	3.2	0.0	18.3	0.0	0.0	0.0	
BH202	1	50	G2		5.25	1.00 to 5.00	240 secs	996	996	-	3.87	3.6	0.0	17.9	0.0	0.0	0.0	
BH202	1	50	G2		5.25	1.00 to 5.00	300 secs	996	996	-	3.87	4.4	0.0	17.3	0.0	0.0	0.0	
BH202	1	50	G2		5.25	1.00 to 5.00	360 secs	996	996	-	3.87	5.5	0.0	16.6	0.0	0.0	0.0	
BH202	1	50	G2		5.25	1.00 to 5.00	420 secs	996	996	-	3.87	6.6	0.0	15.9	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Fourways House
57 Hilton Street
Piccadilly
Manchester M1 2EJ

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[signature]	05/02/14			321370

Contract: (M) North Gawber

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AGS

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH202	1	50	G2		5.25	1.00 to 5.00	480 secs	996	996	-	3.87	6.6	0.0	15.8	0.0	0.0	0.0	
BH202	1	50	G2		5.25	1.00 to 5.00	540 secs	996	996	-	3.87	6.5	0.0	15.8	0.0	0.0	0.0	
BH202	1	50	G2		5.25	1.00 to 5.00	600 secs	996	996	-	3.87	6.4	0.0	15.8	0.0	0.0	0.0	
BH203	1	50	G2	4.00	4.41	1.00 to 4.00	18/09/2013 09:00:00	-	-	0.0	2.42	0.1	0.0	21.1	0.0	0.0	0.0	
BH203	1	50	G2		4.41	1.00 to 4.00	15 secs	-	-	0.0	2.42	1.0	0.0	19.1	0.0	0.0	0.0	
BH203	1	50	G2		4.41	1.00 to 4.00	30 secs	-	-	0.0	2.42	0.4	0.0	20.1	0.0	0.0	0.0	
BH203	1	50	G2		4.41	1.00 to 4.00	60 secs	-	-	0.0	2.42	0.3	0.0	20.5	0.0	0.0	0.0	
BH203	1	50	G2		4.41	1.00 to 4.00	90 secs	-	-	-	2.42	0.2	0.0	20.7	0.0	0.0	0.0	
BH203	1	50	G2		4.41	1.00 to 4.00	120 secs	-	-	-	2.42	0.2	0.0	20.7	0.0	0.0	0.0	
BH203	1	50	G2		4.41	1.00 to 4.00	180 secs	-	-	-	2.42	0.1	0.0	20.8	0.0	0.0	0.0	
BH203	1	50	G2		4.41	1.00 to 4.00	240 secs	-	-	-	2.42	0.1	0.0	20.8	0.0	0.0	0.0	
BH204	1	50	G2	4.70	---	1.00 to 4.70	18/09/2013 15:45:00	996	996	-	-	0.0	0.0	20.8	-	0.0	0.0	
BH204	1	50	G2		---	1.00 to 4.70	15 secs	996	996	-	-	1.3	0.0	17.9	-	2.0	0.0	
BH204	1	50	G2		---	1.00 to 4.70	30 secs	996	996	-	-	1.5	0.0	19.7	-	1.0	0.0	
BH204	1	50	G2		---	1.00 to 4.70	60 secs	996	996	-	-	1.7	0.0	19.5	-	0.0	0.0	
BH204	1	50	G2		---	1.00 to 4.70	90 secs	996	996	-	-	1.7	0.0	19.4	-	0.0	0.0	
BH204	1	50	G2		---	1.00 to 4.70	120 secs	996	996	-	-	1.9	0.0	19.3	-	0.0	0.0	
BH204	1	50	G2		---	1.00 to 4.70	180 secs	996	996	-	-	2.1	0.0	19.1	-	0.0	0.0	
BH204	1	50	G2		---	1.00 to 4.70	240 secs	996	996	-	-	2.6	0.0	18.8	-	0.0	0.0	
BH204	1	50	G2		---	1.00 to 4.70	300 secs	996	996	-	-	2.9	0.0	18.5	-	0.0	0.0	
BH204	1	50	G2		---	1.00 to 4.70	360 secs	996	996	-	-	3.3	0.0	18.2	-	0.0	0.0	
BH204	1	50	G2		---	1.00 to 4.70	420 secs	996	996	-	-	3.4	0.0	18.0	-	0.0	0.0	
BH204	1	50	G2		---	1.00 to 4.70	480 secs	996	996	-	-	3.7	0.0	18.0	-	0.0	0.0	
BH204	1	50	G2		---	1.00 to 4.70	540 secs	996	996	-	-	3.4	0.0	18.1	-	0.0	0.0	
BH204	1	50	G2		---	1.00 to 4.70	600 secs	996	996	-	-	3.6	0.0	17.9	-	0.0	0.0	

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Contract: **(M) North Gawber**

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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH205	1	50	G2	12.60	12.71	1.00 to 12.60	18/09/2013 13:20:00	-	995	0.0	10.15	0.3	0.0	20.5	0.0	0.0	0.0	
BH205	1	50	G2		12.71	1.00 to 12.60	15 secs	-	995	0.0	10.15	0.5	0.0	20.4	0.0	9.0	0.0	
BH205	1	50	G2		12.71	1.00 to 12.60	30 secs	-	995	0.0	10.15	0.8	0.0	20.2	0.0	1.0	0.0	
BH205	1	50	G2		12.71	1.00 to 12.60	60 secs	-	995	0.0	10.15	2.0	0.0	18.9	0.0	0.0	0.0	
BH205	1	50	G2		12.71	1.00 to 12.60	90 secs	-	995	-	10.15	2.3	0.0	18.3	0.0	0.0	0.0	
BH205	1	50	G2		12.71	1.00 to 12.60	120 secs	-	995	-	10.15	2.4	0.0	18.1	0.0	0.0	0.0	
BH205	1	50	G2		12.71	1.00 to 12.60	180 secs	-	995	-	10.15	2.4	0.0	18.2	0.0	0.0	0.0	
BH206	1	50	G2	6.50	6.87	1.00 to 6.50	18/09/2013 12:15:00	995	995	0.0	6.02	0.2	0.0	20.5	0.0	0.0	0.0	
BH206	1	50	G2		6.87	1.00 to 6.50	15 secs	995	995	0.0	6.02	5.2	0.0	15.0	0.0	14.0	0.0	
BH206	1	50	G2		6.87	1.00 to 6.50	30 secs	995	995	0.0	6.02	5.2	0.0	12.6	0.0	1.0	0.0	
BH206	1	50	G2		6.87	1.00 to 6.50	60 secs	995	995	0.0	6.02	5.5	0.0	12.1	0.0	1.0	0.0	
BH206	1	50	G2		6.87	1.00 to 6.50	90 secs	995	995	-	6.02	5.6	0.0	11.8	0.0	0.0	0.0	
BH206	1	50	G2		6.87	1.00 to 6.50	120 secs	995	995	-	6.02	5.7	0.0	11.7	0.0	0.0	0.0	
BH206	1	50	G2		6.87	1.00 to 6.50	180 secs	995	995	-	6.02	6.0	0.0	11.4	0.0	0.0	0.0	
BH206	1	50	G2		6.87	1.00 to 6.50	240 secs	995	995	-	6.02	6.7	0.0	10.4	0.0	0.0	0.0	
BH206	1	50	G2		6.87	1.00 to 6.50	300 secs	995	995	-	6.02	7.8	0.0	8.5	0.0	0.0	0.0	
BH206	1	50	G2		6.87	1.00 to 6.50	360 secs	995	995	-	6.02	8.9	0.0	7.1	0.0	0.0	0.0	
BH206	1	50	G2		6.87	1.00 to 6.50	420 secs	995	995	-	6.02	9.0	0.0	6.8	0.0	0.0	0.0	
BH206	1	50	G2		6.87	1.00 to 6.50	480 secs	995	995	-	6.02	9.1	0.0	6.7	0.0	0.0	0.0	
BH206	1	50	G2		6.87	1.00 to 6.50	540 secs	995	995	-	6.02	9.1	0.0	6.6	0.0	0.0	0.0	
BH207	1	50	G2	6.50	6.42	1.00 to 6.50	18/09/2013 11:15:00	-	-	0.0	4.58	0.2	0.0	20.7	0.0	0.0	0.0	
BH207	1	50	G2		6.42	1.00 to 6.50	15 secs	-	-	0.0	4.58	6.7	0.0	17.0	0.0	1.0	0.0	
BH207	1	50	G2		6.42	1.00 to 6.50	30 secs	-	-	0.0	4.58	7.2	0.0	14.3	0.0	0.0	0.0	
BH207	1	50	G2		6.42	1.00 to 6.50	60 secs	-	-	-	4.58	7.3	0.0	13.7	0.0	0.0	0.0	
BH207	1	50	G2		6.42	1.00 to 6.50	90 secs	-	-	-	4.58	7.4	0.0	13.6	0.0	0.0	0.0	

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Contract: (M) North Gawber

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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH207	1	50	G2		6.42	1.00 to 6.50	120 secs	-	-	-	4.58	7.4	0.0	13.6	0.0	2.0	0.0	
BH207	1	50	G2		6.42	1.00 to 6.50	180 secs	-	-	-	4.58	7.5	0.0	13.4	0.0	0.0	0.0	
BH207	1	50	G2		6.42	1.00 to 6.50	240 secs	-	-	-	4.58	7.6	0.0	13.3	0.0	0.0	0.0	
BH207	1	50	G2		6.42	1.00 to 6.50	300 secs	-	-	-	4.58	7.9	0.0	13.0	0.0	0.0	0.0	
BH207	1	50	G2		6.42	1.00 to 6.50	360 secs	-	-	-	4.58	8.2	0.0	12.7	0.0	0.0	0.0	
BH207	1	50	G2		6.42	1.00 to 6.50	420 secs	-	-	-	4.58	8.3	0.0	12.6	0.0	0.0	0.0	
BH207	1	50	G2		6.42	1.00 to 6.50	480 secs	-	-	-	4.58	8.4	0.0	12.5	0.0	0.0	0.0	
BH207	1	50	G2		6.42	1.00 to 6.50	540 secs	-	-	-	4.58	8.4	0.0	12.5	0.0	0.0	0.0	
BH208	1	50	G2	7.50	7.60	1.00 to 7.50	18/09/2013 13:55:00	994	994	0.0	DRY	0.0	0.0	20.9	0.0	0.0	0.0	
BH208	1	50	G2		7.60	1.00 to 7.50	15 secs	994	994	0.0	DRY	0.8	0.0	20.3	0.0	0.0	0.0	
BH208	1	50	G2		7.60	1.00 to 7.50	30 secs	994	994	0.0	DRY	1.0	0.0	20.1	0.0	0.0	0.0	
BH208	1	50	G2		7.60	1.00 to 7.50	60 secs	994	994	0.0	DRY	1.2	0.0	19.9	0.0	0.0	0.0	
BH208	1	50	G2		7.60	1.00 to 7.50	90 secs	994	994	-	DRY	1.3	0.0	19.7	0.0	0.0	0.0	
BH208	1	50	G2		7.60	1.00 to 7.50	120 secs	994	994	-	DRY	1.4	0.0	19.7	0.0	0.0	0.0	
BH208	1	50	G2		7.60	1.00 to 7.50	180 secs	994	994	-	DRY	1.4	0.0	19.6	0.0	0.0	0.0	
BH208	1	50	G2		7.60	1.00 to 7.50	240 secs	994	994	-	DRY	1.6	0.0	19.4	0.0	0.0	0.0	
BH208	1	50	G2		7.60	1.00 to 7.50	300 secs	994	994	-	DRY	2.1	0.0	18.7	0.0	0.0	0.0	
BH208	1	50	G2		7.60	1.00 to 7.50	360 secs	994	994	-	DRY	2.3	0.0	18.5	0.0	0.0	0.0	
BH208	1	50	G2		7.60	1.00 to 7.50	420 secs	994	994	-	DRY	2.3	0.0	18.5	0.0	0.0	0.0	
BH209	1	50	G2	5.40	5.53	1.00 to 5.40	18/09/2013 14:12:00	994	994	0.0	DRY	0.1	0.0	20.8	0.0	0.0	0.0	
BH209	1	50	G2		5.53	1.00 to 5.40	15 secs	994	994	0.0	DRY	1.4	0.0	19.8	0.0	1.0	0.0	
BH209	1	50	G2		5.53	1.00 to 5.40	30 secs	994	994	0.0	DRY	1.6	0.0	19.1	0.0	0.0	0.0	
BH209	1	50	G2		5.53	1.00 to 5.40	60 secs	994	994	0.0	DRY	1.6	0.0	19.0	0.0	0.0	0.0	
BH209	1	50	G2		5.53	1.00 to 5.40	90 secs	994	994	-	DRY	1.8	0.0	18.8	0.0	0.0	0.0	
BH209	1	50	G2		5.53	1.00 to 5.40	120 secs	994	994	-	DRY	1.9	0.0	18.7	0.0	0.0	0.0	

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Compiled By	Date	Checked By	Date	Contract Ref:
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Contract: **(M) North Gawber**

AGS

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH209	1	50	G2		5.53	1.00 to 5.40	180 secs	994	994	-	DRY	1.9	0.0	18.6	0.0	0.0	0.0	
BH209	1	50	G2		5.53	1.00 to 5.40	240 secs	994	994	-	DRY	2.1	0.0	18.6	0.0	0.0	0.0	
BH209	1	50	G2		5.53	1.00 to 5.40	300 secs	994	994	-	DRY	2.1	0.0	18.6	0.0	0.0	0.0	

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IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round G1	-	-	-	-	GA2000 SN-GA10789 + YSI556 SN-07L100518 + Weather: Sunny + Ground: Dry + Wind: Light + Air Temp: 20DegC

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH201	1	50	G1	6.00	6.18	1.00 to 6.00	05/09/2013 09:00:00	1005	1005	0.1	0.96	0.1	0.0	20.8	0.0	0.0	0.0	
BH201	1	50	G1		6.18	1.00 to 6.00	15 secs	1005	1005	0.0	0.96	1.0	0.0	20.5	0.0	0.0	0.0	
BH201	1	50	G1		6.18	1.00 to 6.00	30 secs	1005	1005	0.0	0.96	1.1	0.0	20.4	0.0	0.0	0.0	
BH201	1	50	G1		6.18	1.00 to 6.00	60 secs	1005	1005	-	0.96	1.1	0.0	20.4	0.0	0.0	0.0	
BH201	1	50	G1		6.18	1.00 to 6.00	90 secs	1005	1005	-	0.96	1.1	0.0	20.4	0.0	0.0	0.0	
BH201	1	50	G1		6.18	1.00 to 6.00	120 secs	1005	1005	-	0.96	1.1	0.0	20.3	0.0	0.0	0.0	
BH201	1	50	G1		6.18	1.00 to 6.00	180 secs	1005	1005	-	0.96	1.1	0.0	20.3	0.0	0.0	0.0	
BH202	1	50	G1	5.00	5.25	1.00 to 5.00	05/09/2013 12:48:00	-	-	-0.1	4.37	0.3	0.0	19.1	0.0	0.0	0.0	
BH202	1	50	G1		5.25	1.00 to 5.00	15 secs	-	-	0.0	4.37	5.6	0.0	16.7	0.0	0.2	0.0	
BH202	1	50	G1		5.25	1.00 to 5.00	30 secs	-	-	0.0	4.37	5.8	0.0	16.3	0.0	0.0	0.0	
BH202	1	50	G1		5.25	1.00 to 5.00	60 secs	-	-	0.0	4.37	5.9	0.0	16.3	0.0	0.0	0.0	
BH202	1	50	G1		5.25	1.00 to 5.00	90 secs	-	-	-	4.37	5.9	0.0	16.2	0.0	0.0	0.0	
BH202	1	50	G1		5.25	1.00 to 5.00	120 secs	-	-	-	4.37	6.0	0.0	16.2	0.0	0.0	0.0	
BH202	1	50	G1		5.25	1.00 to 5.00	180 secs	-	-	-	4.37	6.1	0.0	16.2	0.0	0.0	0.0	
BH202	1	50	G1		5.25	1.00 to 5.00	240 secs	-	-	-	4.37	6.3	0.0	16.0	0.0	0.0	0.0	
BH202	1	50	G1		5.25	1.00 to 5.00	300 secs	-	-	-	4.37	6.5	0.0	15.9	0.0	0.0	0.0	
BH202	1	50	G1		5.25	1.00 to 5.00	360 secs	-	-	-	4.37	6.8	0.0	15.7	0.0	0.0	0.0	
BH202	1	50	G1		5.25	1.00 to 5.00	420 secs	-	-	-	4.37	6.9	0.0	15.7	0.0	0.0	0.0	

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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH202	1	50	G1		5.25	1.00 to 5.00	480 secs	-	-	-	4.37	7.0	0.0	15.7	0.0	0.0	0.0	
BH202	1	50	G1		5.25	1.00 to 5.00	540 secs	-	-	-	4.37	6.9	0.0	15.7	0.0	0.0	0.0	
BH203	1	50	G1	4.00	4.41	1.00 to 4.00	05/09/2013 12:15:00	-	1003	0.0	3.91	0.0	0.0	20.6	0.0	0.0	0.0	
BH203	1	50	G1		4.41	1.00 to 4.00	15 secs	-	1003	0.0	3.91	1.2	0.0	19.7	0.0	0.1	0.0	
BH203	1	50	G1		4.41	1.00 to 4.00	30 secs	-	1003	0.0	3.91	1.3	0.0	19.4	0.0	0.0	0.0	
BH203	1	50	G1		4.41	1.00 to 4.00	60 secs	-	1003	0.0	3.91	1.4	0.0	19.3	0.0	0.0	0.0	
BH203	1	50	G1		4.41	1.00 to 4.00	90 secs	-	1003	-	3.91	1.6	0.0	19.2	0.0	0.0	0.0	
BH203	1	50	G1		4.41	1.00 to 4.00	120 secs	-	1003	-	3.91	1.7	0.0	19.0	0.0	0.0	0.0	
BH203	1	50	G1		4.41	1.00 to 4.00	180 secs	-	1003	-	3.91	2.1	0.0	18.8	0.0	0.0	0.0	
BH203	1	50	G1		4.41	1.00 to 4.00	240 secs	-	1003	-	3.91	2.4	0.0	18.5	0.0	0.0	0.0	
BH203	1	50	G1		4.41	1.00 to 4.00	300 secs	-	1003	-	3.91	2.9	0.0	18.1	0.0	0.0	0.0	
BH203	1	50	G1		4.41	1.00 to 4.00	360 secs	-	1003	-	3.91	3.3	0.0	17.8	0.0	0.0	0.0	
BH203	1	50	G1		4.41	1.00 to 4.00	420 secs	-	1003	-	3.91	3.8	0.0	17.4	0.0	0.0	0.0	
BH203	1	50	G1		4.41	1.00 to 4.00	480 secs	-	1003	-	3.91	3.9	0.0	17.3	0.0	0.0	0.0	
BH203	1	50	G1		4.41	1.00 to 4.00	540 secs	-	1003	-	3.91	3.9	0.0	17.3	0.0	0.0	0.0	
BH204	1	50	G1	4.70	4.96	1.00 to 4.70	05/09/2013 11:55:00	1003	1003	0.1	DRY	0.1	0.0	20.4	0.0	0.0	0.0	
BH204	1	50	G1		4.96	1.00 to 4.70	15 secs	1003	1003	0.0	DRY	2.3	0.0	18.9	0.0	5.0	0.0	
BH204	1	50	G1		4.96	1.00 to 4.70	30 secs	1003	1003	0.0	DRY	2.3	0.1	18.8	0.1	1.0	0.0	
BH204	1	50	G1		4.96	1.00 to 4.70	60 secs	1003	1003	0.0	DRY	2.4	0.1	18.8	0.1	0.0	0.0	
BH204	1	50	G1		4.96	1.00 to 4.70	90 secs	1003	1003	-	DRY	2.4	0.1	18.7	1.0	0.0	0.0	
BH204	1	50	G1		4.96	1.00 to 4.70	120 secs	1003	1003	-	DRY	2.6	0.1	18.6	1.0	0.0	0.0	
BH204	1	50	G1		4.96	1.00 to 4.70	180 secs	1003	1003	-	DRY	2.9	0.1	18.4	1.0	0.0	0.0	
BH204	1	50	G1		4.96	1.00 to 4.70	240 secs	1003	1003	-	DRY	3.3	0.1	18.1	1.0	0.0	0.0	
BH204	1	50	G1		4.96	1.00 to 4.70	300 secs	1003	1003	-	DRY	3.4	0.1	18.0	1.0	0.0	0.0	
BH204	1	50	G1		4.96	1.00 to 4.70	360 secs	1003	1003	-	DRY	3.7	0.1	17.8	1.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Fourways House
57 Hilton Street
Piccadilly
Manchester M1 2EJ

Compiled By	Date	Checked By	Date	Contract Ref:
[signature]	05/02/14			321370

Contract: (M) North Gawber

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AGS

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH204	1	50	G1		4.96	1.00 to 4.70	420 secs	1003	1003	-	DRY	3.8	0.1	17.7	1.0	0.0	0.0	
BH204	1	50	G1		4.96	1.00 to 4.70	480 secs	1003	1003	-	DRY	3.8	0.1	17.7	1.0	0.0	0.0	
BH205	1	50	G1	12.60	12.74	1.00 to 12.60	05/09/2013 10:50:00	1004	1004	0.0	10.37	0.2	0.0	20.2	0.0	0.0	0.0	
BH205	1	50	G1		12.74	1.00 to 12.60	15 secs	1004	1004	0.0	10.37	3.0	0.0	18.5	0.0	0.0	0.0	
BH205	1	50	G1		12.74	1.00 to 12.60	30 secs	1004	1004	0.0	10.37	3.5	0.0	17.2	0.0	0.0	0.0	
BH205	1	50	G1		12.74	1.00 to 12.60	60 secs	1004	1004	0.0	10.37	4.4	0.0	16.4	0.0	0.0	0.0	
BH205	1	50	G1		12.74	1.00 to 12.60	90 secs	1004	1004	-	10.37	4.3	0.0	16.2	0.0	0.0	0.0	
BH205	1	50	G1		12.74	1.00 to 12.60	120 secs	1004	1004	-	10.37	4.5	0.0	15.7	0.0	0.0	0.0	
BH205	1	50	G1		12.74	1.00 to 12.60	180 secs	1004	1004	-	10.37	6.6	0.0	13.5	0.0	0.0	0.0	
BH205	1	50	G1		12.74	1.00 to 12.60	240 secs	1004	1004	-	10.37	8.8	0.0	11.3	0.0	0.0	0.0	
BH205	1	50	G1		12.74	1.00 to 12.60	300 secs	1004	1004	-	10.37	9.1	0.0	10.7	0.0	0.0	0.0	
BH205	1	50	G1		12.74	1.00 to 12.60	360 secs	1004	1004	-	10.37	9.0	0.0	10.7	0.0	0.0	0.0	
BH205	1	50	G1		12.74	1.00 to 12.60	420 secs	1004	1004	-	10.37	7.5	0.0	12.3	0.0	0.0	0.0	
BH205	1	50	G1		12.74	1.00 to 12.60	480 secs	1004	1004	-	10.37	7.6	0.0	12.1	0.0	0.0	0.0	
BH205	1	50	G1		12.74	1.00 to 12.60	540 secs	1004	1004	-	10.37	8.1	0.0	11.6	0.0	0.0	0.0	
BH205	1	50	G1		12.74	1.00 to 12.60	600 secs	1004	1004	-	10.37	7.2	0.0	12.6	0.0	0.0	0.0	
BH206	1	50	G1	6.50	6.87	1.00 to 6.50	05/09/2013 12:30:00	1002	1003	-0.1	6.03	0.1	0.0	20.4	0.0	0.0	0.0	
BH206	1	50	G1		6.87	1.00 to 6.50	15 secs	1002	1003	0.0	6.03	5.3	0.0	11.7	0.0	0.2	0.0	
BH206	1	50	G1		6.87	1.00 to 6.50	30 secs	1002	1003	0.0	6.03	5.5	0.0	10.6	0.0	1.0	0.0	
BH206	1	50	G1		6.87	1.00 to 6.50	60 secs	1002	1003	0.0	6.03	5.7	0.0	10.1	0.0	0.0	0.0	
BH206	1	50	G1		6.87	1.00 to 6.50	90 secs	1002	1003	-	6.03	5.9	0.0	9.7	0.0	0.0	0.0	
BH206	1	50	G1		6.87	1.00 to 6.50	120 secs	1002	1003	-	6.03	6.3	0.0	8.9	0.0	0.1	0.0	
BH206	1	50	G1		6.87	1.00 to 6.50	180 secs	1002	1003	-	6.03	6.8	0.0	8.1	0.0	1.0	0.0	
BH206	1	50	G1		6.87	1.00 to 6.50	240 secs	1002	1003	-	6.03	7.6	0.0	6.7	0.0	1.0	0.0	
BH206	1	50	G1		6.87	1.00 to 6.50	300 secs	1002	1003	-	6.03	8.5	0.0	5.1	0.0	1.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

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Contract: **(M) North Gawber**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH206	1	50	G1		6.87	1.00 to 6.50	360 secs	1002	1003	-	6.03	9.1	0.0	4.2	0.0	0.0	0.0	
BH206	1	50	G1		6.87	1.00 to 6.50	420 secs	1002	1003	-	6.03	9.4	0.0	3.8	0.0	0.1	0.0	
BH206	1	50	G1		6.87	1.00 to 6.50	480 secs	1002	1003	-	6.03	9.4	0.0	3.7	0.0	1.0	0.0	
BH206	1	50	G1		6.87	1.00 to 6.50	540 secs	1002	1003	-	6.03	9.4	0.0	3.6	0.0	1.0	0.0	
BH206	1	50	G1		6.87	1.00 to 6.50	600 secs	1002	1003	-	6.03	9.4	0.0	3.5	0.0	1.0	0.0	
BH207	1	50	G1	6.50	6.42	1.00 to 6.50	05/09/2013 10:35:00	1004	1004	0.0	5.70	0.0	0.0	20.8	0.0	0.0	0.0	
BH207	1	50	G1		6.42	1.00 to 6.50	15 secs	1004	1004	0.0	5.70	3.3	0.0	17.9	0.0	0.2	0.0	
BH207	1	50	G1		6.42	1.00 to 6.50	30 secs	1004	1004	0.0	5.70	3.6	0.0	17.2	0.0	0.0	0.0	
BH207	1	50	G1		6.42	1.00 to 6.50	60 secs	1004	1004	0.0	5.70	4.3	0.0	16.5	0.0	0.0	0.0	
BH207	1	50	G1		6.42	1.00 to 6.50	90 secs	1004	1004	-	5.70	4.8	0.0	16.0	0.0	0.0	0.0	
BH207	1	50	G1		6.42	1.00 to 6.50	120 secs	1004	1004	-	5.70	4.9	0.0	15.7	0.0	0.0	0.0	
BH207	1	50	G1		6.42	1.00 to 6.50	180 secs	1004	1004	-	5.70	5.4	0.0	15.2	0.0	0.0	0.0	
BH207	1	50	G1		6.42	1.00 to 6.50	240 secs	1004	1004	-	5.70	6.0	0.0	14.6	0.0	0.0	0.0	
BH207	1	50	G1		6.42	1.00 to 6.50	300 secs	1004	1004	-	5.70	6.7	0.0	13.9	0.0	0.0	0.0	
BH207	1	50	G1		6.42	1.00 to 6.50	360 secs	1004	1004	-	5.70	7.8	0.0	13.0	0.0	0.0	0.0	
BH207	1	50	G1		6.42	1.00 to 6.50	420 secs	1004	1004	-	5.70	8.0	0.0	12.8	0.0	0.0	0.0	
BH207	1	50	G1		6.42	1.00 to 6.50	480 secs	1004	1004	-	5.70	8.1	0.0	12.7	0.0	0.0	0.0	
BH207	1	50	G1		6.42	1.00 to 6.50	540 secs	1004	1004	-	5.70	8.1	0.0	12.7	0.0	0.0	0.0	
BH208	1	50	G1	7.50	7.60	1.00 to 7.50	05/09/2013 11:15:00	1004	1004	-0.1	DRY	0.2	0.0	20.2	0.0	0.0	0.0	
BH208	1	50	G1		7.60	1.00 to 7.50	15 secs	1004	1004	0.0	DRY	5.3	0.0	14.6	0.0	1.0	0.0	
BH208	1	50	G1		7.60	1.00 to 7.50	30 secs	1004	1004	0.0	DRY	5.4	0.0	13.5	0.0	0.0	0.0	
BH208	1	50	G1		7.60	1.00 to 7.50	60 secs	1004	1004	0.0	DRY	5.6	0.0	13.2	0.0	0.0	0.0	
BH208	1	50	G1		7.60	1.00 to 7.50	90 secs	1004	1004	-	DRY	5.7	0.0	2.9	0.0	0.0	0.0	
BH208	1	50	G1		7.60	1.00 to 7.50	120 secs	1004	1004	-	DRY	5.8	0.0	12.7	0.0	0.0	0.0	
BH208	1	50	G1		7.60	1.00 to 7.50	180 secs	1004	1004	-	DRY	6.0	0.0	12.4	0.0	0.0	0.0	

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Contract: **(M) North Gawber**

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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
BH208	1	50	G1		7.60	1.00 to 7.50	240 secs	1004	1004	-	DRY	6.1	0.0	12.1	0.0	0.0	0.0	
BH208	1	50	G1		7.60	1.00 to 7.50	300 secs	1004	1004	-	DRY	6.2	0.0	12.0	0.0	0.0	0.0	
BH208	1	50	G1		7.60	1.00 to 7.50	360 secs	1004	1004	-	DRY	6.3	0.0	11.8	0.0	0.0	0.0	
BH209	1	50	G1	5.40	5.54	1.00 to 5.40	05/09/2013 11:25:00	1004	1004	0.0	DRY	0.2	0.0	20.0	0.0	0.0	0.0	
BH209	1	50	G1		5.54	1.00 to 5.40	15 secs	1004	1004	0.0	DRY	0.0	0.0	20.8	0.0	2.0	0.0	
BH209	1	50	G1		5.54	1.00 to 5.40	30 secs	1004	1004	0.0	DRY	0.0	0.0	20.9	0.0	0.0	0.0	
BH209	1	50	G1		5.54	1.00 to 5.40	60 secs	1004	1004	0.0	DRY	0.0	0.0	20.9	0.0	0.0	0.0	
BH209	1	50	G1		5.54	1.00 to 5.40	90 secs	1004	1004	-	DRY	0.0	0.0	20.9	0.0	0.0	0.0	
BH209	1	50	G1		5.54	1.00 to 5.40	120 secs	1004	1004	-	DRY	0.0	0.0	20.9	0.0	0.0	0.0	
BH209	1	50	G1		5.54	1.00 to 5.40	180 secs	1004	1004	-	DRY	0.0	0.0	20.9	0.0	0.0	0.0	

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Contract: (M) North Gawber

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North Gawber - Gas Monitoring Results

Borehole	Reading	5-Dec-07	21-Jan-08	18-Feb-08	4-Mar-08
BH101	Methane (%)	0.0	0.0	0.0	0.0
	Carbon Dioxide (%)	7.9	11.8	9.8	8.4
	Oxygen (%)	7.6	4.1	12.2	1.6
	Air Pressure (mB)	992	996	1030	1024
BH104	Methane (%)	0.0	0.0	0.0	0.0
	Carbon Dioxide (%)	2.0	3.1	1.9	2.3
	Oxygen (%)	17.1	17.0	16.8	14.5
	Air Pressure (mB)	994	996	1031	1024
BH105	Methane (%)	0.0	0.0	0.0	0.0
	Carbon Dioxide (%)	5.3	6.4	7.8	2.9
	Oxygen (%)	12.1	6.8	9.5	16.0
	Air Pressure (mB)	993.0	996	1031	1023
BH109	Methane (%)	0.0	0.0	0.0	0.0
	Carbon Dioxide (%)	7.7	2.0	0.4	0.0
	Oxygen (%)	6.8	16.3	16.8	19.4
	Air Pressure (mB)	994	996	1030	1024
BH112	Methane (%)	0.0	FLOODED	0.0	0.0
	Carbon Dioxide (%)	2.7		0.0	0.0
	Oxygen (%)	18.5		19.1	19.4
	Air Pressure (mB)	993		1031	1024
BH115	Methane (%)	0.1	0.0	0.0	0.0
	Carbon Dioxide (%)	11.5	4.8	5.3	6.9
	Oxygen (%)	1.2	10.9	5.4	8.2
	Air Pressure (mB)	994	997	1031	1024
BH118	Methane (%)	0.0	0.0	0.0	0.0
	Carbon Dioxide (%)	0.0	2.3	3.4	2.1
	Oxygen (%)	20.1	19.9	17.8	16.0
	Air Pressure (mB)	995	997	1030	1024

North Gawber - Flow Monitoring Results					
Borehole	**Reading**	**5-Dec-07**	**21-Jan-08**	**18-Feb-08**	**4-Mar-08**
BH101	Total av. Litres/per hour	0.0	0.0	0.0	0.0
BH104	Total av. Litres/per hour	0.0	0.0	0.0	0.0
BH105	Total av. Litres/per hour	0.0	0.0	0.0	0.0
BH109	Total av. Litres/per hour	0.0	0.0	0.0	0.0
BH112	Total av. Litres/per hour	0.3	FLOODED	0.0	0.0
BH115	Total av. Litres/per hour	0.0	0.0	0.0	0.0
BH118	Total av. Litres/per hour	0.0	0.0	0.0	0.0

North Gawber - Groundwater Readings				
Borehole	**5-Dec-07**	**21-Jan-08**	**18-Feb-08**	**4-Mar-08**
BH101	DRY	4.05	3.85	3.80
BH104	DRY	5.93	5.82	5.76
BH105	6.97	7.03	7.20	7.15
BH109	1.79	1.03	1.60	1.90
BH112	0.42	FLOODED	0.10	0.32
BH115	5.47	4.38	4.17	4.01
BH118	0.34	0.30	0.15	0.22

IN-SITU WATER MONITORING RESULTS

	Weather	Ground Conditions	Wind Conditions	Air Temperature (°C)	Equipment Used & Remarks
Round GW1	Cloudy	Wet	Light	11	Eijkelkamp peristaltic pump SN-27278323 + YSI SN-MA054

Exploratory Position ID	Pipe Ref	Pipe Diameter	Monitoring Round / Test Number	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring	Water Depth (mbgl)	pH	Redox (mV)	Conduc-tivity (uS/cm)	Temp-erature (°C)	Dissolved Oxygen (mg/l)	Remarks
BH201	1	50	GW1 / 1	6.00	6.18	1.00 to 6.00	18/09/2013 09:34	1.00	6.29	-17	3473	13.2	2.7	General Remarks: Water is slightly cloudy with no odour.
BH201	1	50	GW1 / 1		6.18		18/09/2013 09:37	1.00	5.89	-4	3544	13.3	0.6	
BH201	1	50	GW1 / 1		6.18		18/09/2013 09:40	1.00	6.20	2	3486	13.4	1.0	
BH201	1	50	GW1 / 1		6.18		18/09/2013 09:43	1.00	5.78	6	3472	13.5	1.0	
BH201	1	50	GW1 / 1		6.18		18/09/2013 09:46	1.00	6.11	3	3469	13.6	0.8	
BH201	1	50	GW1 / 1		6.18		18/09/2013 09:49	1.00	6.18	5	3469	13.6	0.7	
BH201	1	50	GW1 / 1		6.18		18/09/2013 09:52	1.00	6.11	6	3472	13.6	0.7	
BH203	1	50	GW1 / 1	4.00	4.41	1.00 to 4.00	18/09/2013 09:00	2.42	---	---	---	---	---	General Remarks: Water is clear with no odour. Did not monitor with
														YSI as recharge is slower than the drawdown on slowest pump setting
														(losing approximately 1cm/minute).
BH206	1	50	GW1 / 1	6.50	NDA	1.00 to 6.50	18/09/2013 12:30	---	---	---	---	---	---	General Remarks: Slightly cloudy water, no odour. no monitoring -
														recharge too slow.
BH207	1	50	GW1 / 1	6.50	6.42	1.00 to 6.50	18/09/2013 11:39	4.68	5.57	127	3417	13.4	13.0	General Remarks: Stopped monitoring as recharge is slower
														than slowest setting on the pump. Water is slightly cloudy with
														occasional black particles. No odour.
BH207	1	50	GW1 / 1		6.42		18/09/2013 11:42	4.74	5.45	132	3426	13.0	5.2	
BH207	1	50	GW1 / 1		6.42		18/09/2013 11:45	4.83	5.36	138	3431	13.1	5.1	

Key: NDA denotes 'no data available'.

RSK Environment Ltd
Fourways House
57 Hilton Street
Piccadilly
Manchester M1 2EJ

Compiled By	Date	Checked By	Date	Contract Ref:
	05/02/14			321370

Contract: (M) North Gawber

Page: 1 of 1

APPENDIX G
LABORATORY CERTIFICATES FOR GROUNDWATER ANALYSIS

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Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 13/04916
Issue Number: 1 **Date:** 24 October, 2013

Client: RSK Environment Ltd Manchester
Fourways House
57 Hilton Street
Manchester
Lancashire
UK
M1 2EJ

Project Manager: Emily Jones / Emma Atkinson
Project Name: North Gawber
Project Ref: 321370
Order No: Not specified
Date Samples Received: 17/10/13
Date Instructions Received: 18/10/13
Date Analysis Completed: 24/10/13

Prepared by:

MMarshall

Melanie Marshall
Laboratory Coordinator

Approved by:

Liz Oliver
Client Service Manager

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Envirolab Job Number: 13/04916

Client Project Name: North Gawber

Client Project Ref: 321370

Lab Sample ID	13/04916/1	13/04916/2							Units	Method ref
Client Sample No										
Client Sample ID	Upstream	Downstream								
Depth to Top										
Depth To Bottom										
Date Sampled	16-Oct-13	16-Oct-13								
Sample Type	Water - EW	Water - EW								
Sample Matrix Code										
pH (w)$_A^\#$	7.19	6.98							pH	A-T-031w
pH BRE (w)$_A^\#$	7.19	6.98							pH	A-T-031w
Sulphate (w)$_A^\#$	10	62							mg/l	A-T-026w
Sulphate BRE (w)$_A^\#$	10	62							mg/l	A-T-026w
Arsenic (dissolved)$_A^\#$	2	1							µg/l	A-T-025
Boron (dissolved)$_A^\#$	16	26							µg/l	A-T-025
Cadmium (dissolved)$_A^\#$	<1	<1							µg/l	A-T-025
Copper (dissolved)$_A^\#$	2	2							µg/l	A-T-025
Chromium (dissolved)$_A^\#$	2	<1							µg/l	A-T-025
Lead (dissolved)$_A^\#$	<1	<1							µg/l	A-T-025
Mercury (dissolved)$_A^\#$	<0.1	<0.1							µg/l	A-T-025
Nickel (dissolved)$_A^\#$	<1	4							µg/l	A-T-025
Selenium (dissolved)$_A^\#$	<1	<1							µg/l	A-T-025
Zinc (dissolved)$_A^\#$	6	8							µg/l	A-T-025

envirolab

Envirolab Job Number: 13/04916

Client Project Name: North Gawber

Client Project Ref: 321370

Lab Sample ID	13/04916/1	13/04916/2							Units	Method ref
Client Sample No										
Client Sample ID	Upstream	Downstream								
Depth to Top										
Depth To Bottom										
Date Sampled	16-Oct-13	16-Oct-13								
Sample Type	Water - EW	Water - EW								
Sample Matrix Code										
TPH CWG										
Ali >C5-C6 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Ali >C6-C8 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Ali >C8-C10 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Ali >C10-C12 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Ali >C12-C16 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Ali >C16-C21 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Ali >C21-C35 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Total Aliphatics $(w)_A$	<5	<5							µg/l	A-T-022+23w
Aro >C5-C7 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Aro >C7-C8 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Aro >C8-C9 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Aro >C9-C10 $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
Aro >C10-C12 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Aro >C12-C16 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Aro >C16-C21 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Aro >C21-C35 $(w)_A^{\#}$	<5	<5							µg/l	A-T-023w
Total Aromatics $(w)_A$	<5	<5							µg/l	A-T-022+23w
TPH (Ali & Aro) $(w)_A$	<5	<5							µg/l	A-T-022+23w
BTEX - Benzene $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
BTEX - Toluene $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
BTEX - Ethyl Benzene $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
BTEX - m & p Xylene $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
BTEX - o Xylene $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w
MTBE $(w)_A^{\#}$	<1	<1							µg/l	A-T-022w

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Envirolab Job Number: 13/04916

Client Project Name: North Gawber

Client Project Ref: 321370

Lab Sample ID	13/04916/1	13/04916/2							Units	Method ref
Client Sample No										
Client Sample ID	Upstream	Downstream								
Depth to Top										
Depth To Bottom										
Date Sampled	16-Oct-13	16-Oct-13								
Sample Type	Water - EW	Water - EW								
Sample Matrix Code										
PAH 16MS (w)										
Acenaphthene (w)$_A^{\#}$	<0.01	0.01							µg/l	A-T-019w
Acenaphthylene (w)$_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Anthracene (w)$_A^{\#}$	0.01	0.02							µg/l	A-T-019w
Benzo(a)anthracene (w)$_A^{\#}$	0.05	0.07							µg/l	A-T-019w
Benzo(a)pyrene (w)$_A^{\#}$	0.03	0.06							µg/l	A-T-019w
Benzo(b)fluoranthene (w)$_A^{\#}$	0.07	0.11							µg/l	A-T-019w
Benzo(ghi)perylene (w)$_A^{\#}$	0.09	0.12							µg/l	A-T-019w
Benzo(k)fluoranthene (w)$_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Chrysene (w)$_A^{\#}$	0.07	0.10							µg/l	A-T-019w
Dibenzo(ah)anthracene (w)$_A^{\#}$	0.01	0.02							µg/l	A-T-019w
Fluoranthene (w)$_A^{\#}$	0.15	0.16							µg/l	A-T-019w
Fluorene (w)$_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Indeno(123-cd)pyrene (w)$_A^{\#}$	0.08	0.11							µg/l	A-T-019w
Naphthalene (w)$_A^{\#}$	<0.01	<0.01							µg/l	A-T-019w
Phenanthrene (w)$_A^{\#}$	0.04	0.03							µg/l	A-T-019w
Pyrene (w)$_A^{\#}$	0.12	0.13							µg/l	A-T-019w
PAH (total 16) (w)$_A^{\#}$	0.72	0.94							µg/l	A-T-019w

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REPORT NOTES

Notes - Soil analysis
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis. For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis.

Notes - General
Subscript "A" indicates analysis performed on the sample as received. "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve, unless asbestos is found to be present in which case all analysis is performed on the sample as received.
All analysis is performed on the dried and crushed sample for samples with Matrix Code 7 and this supercedes any "A" subscripts.
Superscript "M" indicates method accredited to MCERTS.
For complex, multi-compound analysis, quality control results do not always fall within chart limits for every compound and we have criteria for reporting in these situations. If results are in italic font they are associated with such quality control failures and may be unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling.

TPH analysis of water by method A-T-007
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Asbestos in soil
Asbestos in soil analysis is performed on an aliquot of the submitted sample and cannot guarantee to identify asbestos if present at low concentrations or as discrete fibres/fragments.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified a being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER.
Samples with Matrix Code 7 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our MCERTS accreditation.

Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

IS indicates Insufficient sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Analytical results reflect the quality of the sample at the time of analysis only. Opinions and interpretations expressed are outside the scope of our accreditation.

Please contact us if you need any further information.

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 13/04436
Issue Number: 2 **Date:** 31 January, 2014

Client:
RSK Environment Ltd Manchester
Fourways House
57 Hilton Street
Manchester
Lancashire
UK
M1 2EJ

Project Manager: Ian Wilson/ Emily Jones
Project Name: Harworth Estates North Gawber
Project Ref: 321370
Order No: Not specified
Date Samples Received: 19/09/13
Date Instructions Received: 23/09/13
Date Analysis Completed: 04/10/13

Prepared by:

MMarshall

Melanie Marshall
Laboratory Coordinator

Approved by:

Liz Oliver
Client Service Manager

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1247

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Envirolab Job Number: 13/04436

Client Project Name: Harworth Estates North Gawber

Client Project Ref: 321370

Lab Sample ID	13/04436/1	13/04436/2	13/04436/3	13/04436/4					Units	Method ref
Client Sample No										
Client Sample ID	BH201	BH203	BH206	BH207						
Depth to Top	5.00	4.20	6.50	5.30						
Depth To Bottom										
Date Sampled	18-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code										
pH (w)$_A^\#$	6.04	7.05	6.59	5.54					pH	A-T-031w
pH BRE (w)$_A^\#$	6.04	7.05	6.59	5.54					pH	A-T-031w
Sulphate (w)$_A^\#$	3604	995	1328	3860					mg/l	A-T-026w
Sulphate BRE (w)$_A^\#$	3600	995	1330	3860					mg/l	A-T-026w
Arsenic (dissolved)$_A^\#$	39	1	<1	<1					µg/l	A-T-025
Boron (dissolved)$_A^\#$	185	163	211	658					µg/l	A-T-025
Cadmium (dissolved)$_A^\#$	<1	<1	<1	2					µg/l	A-T-025
Copper (dissolved)$_A^\#$	<1	5	1	3					µg/l	A-T-025
Chromium (dissolved)$_A^\#$	<1	14	<1	5					µg/l	A-T-025
Lead (dissolved)$_A^\#$	<1	<1	<1	<1					µg/l	A-T-025
Magnesium BRE (dissolved)$_A$	341	-	-	-					mg/l	A-T-049
Mercury (dissolved)$_A^\#$	<0.1	<0.1	<0.1	<0.1					µg/l	A-T-025
Nickel (dissolved)$_A^\#$	60	12	43	876					µg/l	A-T-025
Selenium (dissolved)$_A^\#$	<1	73	2	3					µg/l	A-T-025
Zinc (dissolved)$_A^\#$	10	5	29	896					µg/l	A-T-025

Envirolab Job Number: 13/04436

Client Project Name: Harworth Estates North Gawber

Client Project Ref: 321370

Lab Sample ID	13/04436/1	13/04436/2	13/04436/3	13/04436/4					Units	Method ref
Client Sample No										
Client Sample ID	BH201	BH203	BH206	BH207						
Depth to Top	5.00	4.20	6.50	5.30						
Depth To Bottom										
Date Sampled	18-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code										
TPH CWG										
Ali >C5-C6 $(w)_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
Ali >C6-C8 $(w)_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
Ali >C8-C10 $(w)_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
Ali >C10-C12 $(w)_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-023w
Ali >C12-C16 $(w)_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-023w
Ali >C16-C21 $(w)_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-023w
Ali >C21-C35 $(w)_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-023w
Total Aliphatics $(w)_A$	<5	<5	<5	<5					µg/l	A-T-022+23w
Aro >C5-C7 $(w)_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
Aro >C7-C8 $(w)_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
Aro >C8-C9 $(w)_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
Aro >C9-C10 $(w)_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
Aro >C10-C12 $(w)_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-023w
Aro >C12-C16 $(w)_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-023w
Aro >C16-C21 $(w)_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-023w
Aro >C21-C35 $(w)_A^{\#}$	<5	<5	<5	<5					µg/l	A-T-023w
Total Aromatics $(w)_A$	<5	<5	<5	<5					µg/l	A-T-022+23w
TPH (Ali & Aro) $(w)_A$	<5	<5	<5	<5					µg/l	A-T-022+23w
BTEX - Benzene $(w)_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
BTEX - Toluene $(w)_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
BTEX - Ethyl Benzene $(w)_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
BTEX - m & p Xylene $(w)_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
BTEX - o Xylene $(w)_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w
MTBE $(w)_A^{\#}$	<1	<1	<1	<1					µg/l	A-T-022w

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Envirolab Job Number: 13/04436

Client Project Name: Harworth Estates North Gawber

Client Project Ref: 321370

Lab Sample ID	13/04436/1	13/04436/2	13/04436/3	13/04436/4					Units	Method ref
Client Sample No										
Client Sample ID	BH201	BH203	BH206	BH207						
Depth to Top	5.00	4.20	6.50	5.30						
Depth To Bottom										
Date Sampled	18-Sep-13	18-Sep-13	18-Sep-13	18-Sep-13						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code										
PAH 16MS (w)										
Acenaphthene (w)$_A^{\#}$	<0.01	<0.01	<0.01	<0.01					µg/l	A-T-019w
Acenaphthylene (w)$_A^{\#}$	<0.01	<0.01	<0.01	<0.01					µg/l	A-T-019w
Anthracene (w)$_A^{\#}$	<0.01	<0.01	<0.01	<0.01					µg/l	A-T-019w
Benzo(a)anthracene (w)$_A^{\#}$	<0.01	<0.01	<0.01	<0.01					µg/l	A-T-019w
Benzo(a)pyrene (w)$_A^{\#}$	<0.01	<0.01	<0.01	<0.01					µg/l	A-T-019w
Benzo(b)fluoranthene (w)$_A^{\#}$	<0.01	<0.01	<0.01	<0.01					µg/l	A-T-019w
Benzo(ghi)perylene (w)$_A^{\#}$	<0.01	<0.01	<0.01	<0.01					µg/l	A-T-019w
Benzo(k)fluoranthene (w)$_A^{\#}$	<0.01	<0.01	<0.01	<0.01					µg/l	A-T-019w
Chrysene (w)$_A^{\#}$	<0.01	0.01	<0.01	<0.01					µg/l	A-T-019w
Dibenzo(ah)anthracene (w)$_A^{\#}$	<0.01	<0.01	<0.01	<0.01					µg/l	A-T-019w
Fluoranthene (w)$_A^{\#}$	<0.01	0.03	<0.01	<0.01					µg/l	A-T-019w
Fluorene (w)$_A^{\#}$	<0.01	<0.01	<0.01	<0.01					µg/l	A-T-019w
Indeno(123-cd)pyrene (w)$_A^{\#}$	<0.01	<0.01	<0.01	<0.01					µg/l	A-T-019w
Naphthalene (w)$_A^{\#}$	<0.01	<0.01	<0.01	<0.01					µg/l	A-T-019w
Phenanthrene (w)$_A^{\#}$	<0.01	<0.01	<0.01	<0.01					µg/l	A-T-019w
Pyrene (w)$_A^{\#}$	<0.01	0.03	<0.01	<0.01					µg/l	A-T-019w
PAH (total 16) (w)$_A^{\#}$	<0.01	0.07	<0.01	<0.01					µg/l	A-T-019w

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REPORT NOTES

Notes - Soil chemical analysis
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis. For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis.

Notes - General
Subscript "A" indicates analysis performed on the sample as received. "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve, unless asbestos is found to be present in which case all analysis is performed on the sample as received.
All analysis is performed on the dried and crushed sample for samples with Matrix Code 7 and this supercedes any "A" subscripts.
All analysis is performed on the sample as received for soil samples from outside the European Union and this supercedes any "D" subscripts.
Superscript "M" indicates method accredited to MCERTS.
For complex, multi-compound analysis, quality control results do not always fall within chart limits for every compound and we have criteria for reporting in these situations. If results are in italic font they are associated with such quality control failures and may be unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling.

TPH analysis of water by method A-T-007
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Asbestos in soil
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if present as discrete fibres/fragments. Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified a being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER.
Samples with Matrix Code 7 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our MCERTS accreditation.

Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

IS indicates Insufficient sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Analytical results reflect the quality of the sample at the time of analysis only. Opinions and interpretations expressed are outside the scope of our accreditation.

Please contact us if you need any further information.

APPENDIX H
SKIP TESTS

Date	23-Sep	01-Oct	03-Oct	07-Oct	07-Oct	11-Oct
P1-1	0.00	0.00	-10.52	-5.52	-10.5	-10.52
P1-2	0.00	0.12	-2.05	-2.05	-7.0	-6.05
P1-3	0.00	0.13	2.77	2.77	-7.2	-6.23
P1-4	0.00	-0.25	-4.78	-4.78	-9.8	-7.78
P1 Average	0.00	0.00	-3.65	-2.39	-8.6	-7.65
P2-1	0.00	0.00	-7.84	-16.84	-13.8	-12.84
P2-2	0.00	0.47	-3.54	-7.54	-9.5	-10.54
P2-3	0.00	0.14	-0.43	1.57	-7.4	-8.43
P2-4	0.00	1.26	-7.41	-6.41	-11.4	-10.41
P2 Average	0.00	0.00	-4.80	-7.30	-10.6	-10.56
P3-1	0.00	-0.03	-2.58	-1.58	-4.6	-6.58
P3-2	0.00	0.36	5.15	4.15	-4.9	-6.85
P3-3	0.00	0.42	-10.23	-9.23		
P3-4	0.00	-0.27	3.35	-1.65	-3.6	-6.65
P3 Average	0.00	0.00	-1.08	-2.08		
P4-1	0.00	0.67	-9.85	-11.85	-14.8	-15.85
P4-2	0.00	-0.31	-9.14	-11.14	-12.1	-12.14
P4-3	0.00	-0.26	-2.58	1.42	-9.6	-8.58
P4-4	0.00	-0.35	-4.64	-6.64	-11.6	-10.64
P4 Average	0.00	0.00	-6.55	-7.05	-12.1	-11.80
Weather	Dry/Warm	Dry/Warm	Wet/Cold		Dry/Warm	Dry/Cold

Notes

N/A	Didn't have enough plastic inserts as two where damaged during installation
	DNA03 Digital Level & Levelling Spigot
	Leica1201 & Prefab Spigot
	Leica 1201 & Precise Spigot

14-Oct	01-Nov	15-Nov	29-Nov	10-Dec	19-Dec	10-Jan
-9.52	-10.52	-9.52	-11.52	-8.52	-9.52	-10.5
-4.05	-4.05	-3.05	-6.05	-3.05	-4.05	-5.0
-4.23	-5.23	-3.23	-6.23	-3.23	-3.23	-5.2
-4.78	-5.78	-5.78	-8.78	-5.78	-5.78	-7.8
-5.65	-6.40	-5.40	-8.15	-5.15	-5.65	-7.1
-2.84	-10.84	-8.84	-5.84	-8.84	-10.84	-10.8
-5.54	-5.54	-5.54	-6.54	-9.54	-6.54	-7.5
-13.43	-4.43	-3.43	-4.43	-7.43	-4.43	-6.4
-15.41	-9.41	-6.41	-5.41	-7.41	-9.41	-9.4
-9.31	-7.55	-6.05	-5.56	-8.31	-7.80	-8.6
-2.58	-3.58	-4.58	-7.58	-7.58	-7.58	-4.6
-4.85	-4.85	-4.85	-8.85	-7.85	-7.85	-5.9
	-11.23	-15.23	-9.23	-11.23	-12.23	-12.2
-3.65	-1.65	-3.65	-7.65	-5.65	-6.65	-3.6
	-5.33	-7.08	-8.33	-8.08	-8.58	-6.6
-13.85	-12.85	-11.85	-13.85	-13.85	-13.85	-15.9
-11.14	-9.14	-9.14	-11.14	-10.14	-10.14	-12.1
-4.58	-4.58	-3.58	-6.58	-4.58	-5.58	-4.6
-7.64	-6.64	-4.64	-11.64	-7.64	-7.64	-7.6
-9.30	-8.30	-7.30	-10.80	-9.05	-9.30	-10.1
Heavy Rain	Heavy Rain	Dry/Cold	Dry/Cold	Dry/Warm	Dry/Cold	Dry/Cold

APPENDIX I
HUMAN HEALTH GENERIC ASSESSMENT CRITERIA, RESIDENTIAL USE

Generic assessment criteria for human health: residential scenario – private gardens

The human health generic assessment criteria (GAC) have been developed during a period of regulatory review and updating of the Contaminated Land Exposure Assessment (CLEA) project. Therefore, the Environment Agency (EA) is in the process of publishing updated reports relating to the CLEA project and the GAC presented in this document may change to reflect these updates. This issue was prepared following the publication of soil guideline value (SGV) reports and associated publications[1] for mercury, selenium, benzene, toluene, ethylbenzene and xylene in March 2009, arsenic and nickel in May 2009, cadmium and phenol in June 2009, dioxins, furans and dioxin-like polychlorinated biphenyls (PCBs) in September 2009. It was also produced following publication of GAC by LQM[6]. Where available, the published soil guideline values (SGV)[1] were used as the GAC. The GAC for lead is discussed separately below owing to it not being derived using the same approach as other compounds.

Lead GAC derivation

The Environment Agency SGV and Tox reports for lead were withdrawn in 2009. In addition, the provisional tolerable weekly intake data published in the Netherlands were withdrawn in 2010 owing to concerns that they were not suitably protective of human health. The withdrawn SGVs were based on a target blood lead concentration of 10µg/dl. In the absence of current guidelines many consultants continue to use the withdrawn SGV. However, as this is not considered sufficiently protective of human health, after attendance at the SOBRA summer workshop June 2011, RSK has revised its GAC and is currently undertaking a review of recent toxicological developments that will be used to refine this GAC further in the coming months. In the meantime, RSK has undertaken sensitivity analysis using the Society of Environmental Geochemistry and Health (SEGH) equation and the CLEA model to produce an interim GAC value. The results are summarised below:

- Using CLEA with the former provisional tolerable weekly intake (PTWI) (25 µg/kg bw), assuming 100% lead is bioavailable, produces a GAC of 212 mg/kg
- Using CLEA with the former PTWI, assuming 50% lead is bioavailable, produces a GAC of 478 mg/kg
- Using the SEGH equation amended for a blood target concentration of 5.6 µg/dl (equal to the LOAEL for IQ defects) gives a negative GAC number unless other factors such as child background blood concentration or delta are amended. Without undertaking further research into these numbers, RSK can present sensitivity analysis to demonstrate the sensitivity of these input parameters but cannot justify one parameter over another. The results are:
    - GAC between 39mg/kg and 99mg/kg if the value of delta (the slope or response of blood Pb versus soil and dust Pb relationship) only is amended from 5 to 2µg/dl/1000µg/g. The value of 2 was chosen as it is within the reasonable range quoted in the former SGV report
    - GAC between 244mg/kg and 610mg/kg if the geometric mean of blood lead concentration in young children is reduced from 3.4µg/dl to 2µg/dl. This decrease has been simulated on the basis that blood concentrations are likely to decrease over time across the UK owing to a ban on lead in petrol, lead within paint used internally and water pipe replacement. This decrease is considered reasonable as the site is a new development

so lead-based paints will not be used internally and lead water supply pipelines will be absent.

Therefore, given the results above RSK proposes to use a GAC of **300mg/kg** for a residential end use. This value is broadly in the middle of the range of sensitivity modelling results quoted above when background mean blood lead concentrations in children are reduced to reflect a new development. The value is also broadly in the middle of the range of sensitivity modelling results for a range of bioavailability of lead between 50% and 100%. This number is considered reasonably protective of human health while being practical for use.

GAC derivation for other metals and organic compounds

Model selection

Soil assessment criteria (SAC) were calculated using CLEA v1.06 and the supporting UK guidance[1–6]. Groundwater assessment criteria (GrAC) protective of human health via the inhalation pathway were derived using the RBCA 1.3b model. RSK has updated the inputs within RBCA to reflect the UK guidance[1–5]. The SAC and GrAC collectively are termed GAC.

Conceptual model

In accordance with EA Science Report SC050221/SR3[3], the residential with private garden scenario considers risks to a female child between the ages of 0 and 6 years old. In accordance with Box 3.1, SR3[3], the pathways considered for production of the SAC in the residential with gardens scenario are:

- direct soil and dust ingestion;
- consumption of home-grown produce;
- consumption of soil attached to home-grown produce;
- dermal contact with soil and indoor dust, and
- inhalation of indoor and outdoor dust and vapours.

Figure 1 is a conceptual model illustrating these linkages.

The pathway considered in production of the GrAC is the volatilisation of compounds from groundwater and subsequent vapour inhalation by residents while indoors. Figure 2 illustrates this linkage. Although the outdoor air inhalation pathway is also valid, this contributes little to the overall risks owing to the dilution in outdoor air. Within RBCA, the solubility limit of the determinant restricts the extent of volatilisation, which in turn drives the indoor air inhalation pathway. While the same restriction is not built into the CLEA model, the CLEA model output cells are flagged red where the soil saturation limit has been exceeded.

An assumption used in the CLEA model is that of simple linear partitioning of a chemical in the soil between the sorbed, dissolved and vapour phase[4]. The upper boundaries of this partitioning are represented by the aqueous solubility and pure saturated vapour concentration of the chemical. The CLEA software uses a traffic light system to identify when individual and/or combined assessment criteria exceed the lower of either the aqueous-based or the vapour based

saturation limits. Where model output cells are flagged red the soil or vapour saturation limit has been exceeded and further consideration of the SAC to be used within the assessment is required. One approach that could be adopted is to use the 'modelled' solubility saturation limit or vapour saturation limit of the compound as the SAC. However, as stated within the CLEA handbook[4] this is likely to not be practical in many cases because of the very low limits and, in any case, is highly conservative. Unless free-phase product is present, concentrations of the chemical are unlikely to be present at sufficient concentration to result in an exceedance of the health criteria value (HCV).

RSK has adopted an approach for petroleum hydrocarbons in accordance with LQM/CIEH[6] whereby the concentration modelled for each petroleum hydrocarbon fraction has been tabulated as the SAC with the corresponding solubility or vapour saturation limit given in brackets. Therefore, when using the SAC to screen laboratory analysis the assessor should take note if a given SAC has a corresponding solubility or vapour saturation limit (in brackets), and subsequently incorporate this piece of information within the screening analytical discussion. If further assessment is required following this process then an additional approach can be utilised as detailed within Section 4.12 of the CLEA model handbook[4], which explains how to calculate an effective assessment criterion manually.

Input selection

Chemical data was obtained from EA Report SC050021/SR7[5] and the health criteria values (HCV) from the UK TOX[1] reports where available. For SAC for total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH), toxicological and chemical specific parameters were obtained from the LQM/CIEH report[6]. Similarly, toxicological and specific chemical parameters for the volatile organic compound 1,2,4-trimethylbenzene were obtained from EIC/AGS/CL:AIRE[7].

For total petroleum hydrocarbons (TPH), aromatic hydrocarbons C_5-C_8 were not modelled since benzene and toluene are being modelled separately. The aromatic C_8-C_9 hydrocarbon fraction comprises ethylbenzene, xylene and styrene. Since ethylbenzene and xylene are being modelled separately, the physical, chemical and toxicological data for this band has been taken from styrene.

Owing to the lack of UK-specific data, default information in the RBCA model was used to evaluate methyl tertiary butyl ether (MTBE). No published UK data was available for 1,3,5-trimethylbenzene, so information was obtained from the US EPA as in the RBCA model. RBCA uses toxicity data for the inhalation pathway in different units to the CLEA model and cannot consider separately the mean daily intake (MDI), occupancy periods or breathing rates. Therefore, the HCV in RBCA was amended to take account of:

- amendments to the MDI using Table 3.4 of SR2[2]
- a child weighing 13.3kg (average of 0–6 year old female in accordance with Table 4.6 of SR3[3]) and breathing 11.85m^3 (average daily inhalation rate for a 0–6-year old female in accordance with Table 4.14 of SR3[3]

1. The 50% rule (for petroleum hydrocarbons, trimethylbenzenes and MTBE)[2] where MDI data is not available but background exposure is considered important in the overall exposure.

Physical parameters

For the residential with private gardens scenario, the CLEA default building is a small two-storey terrace house with concrete ground-bearing slab. The house is assumed to have a 100m^2 private garden consisting of lawn, flowerbeds and incorporating a 20m^2 plot for growing fruit and vegetables consumed by the residents. SR3[3] notes this residential building type to be the most conservative in terms of protection from vapour intrusion. The building parameters are outlined in Table 5.

The parameters for a sandy loam soil type were used in line with SR3[3]. This includes a value of 6% for the percentage of soil organic matter (SOM) within the soil. In RSK's experience, this is rather high for many sites. To avoid undertaking site-specific risk assessments for this parameter, RSK has produced an additional set of SAC for an SOM of 1% and 2.5%. For the GrAC, the depth to groundwater was taken as 2.5m based on RSK's experience of assessing the volatilisation pathway from groundwater.

GAC

The SAC were produced using the input parameters in Tables 1 to 5 and the GrAC using input parameters in Table 6. The final selected GAC are presented by pathway in Table 7 and the combined GAC in Table 8.

Figure 1: Conceptual model for CLEA residential scenario – private gardens

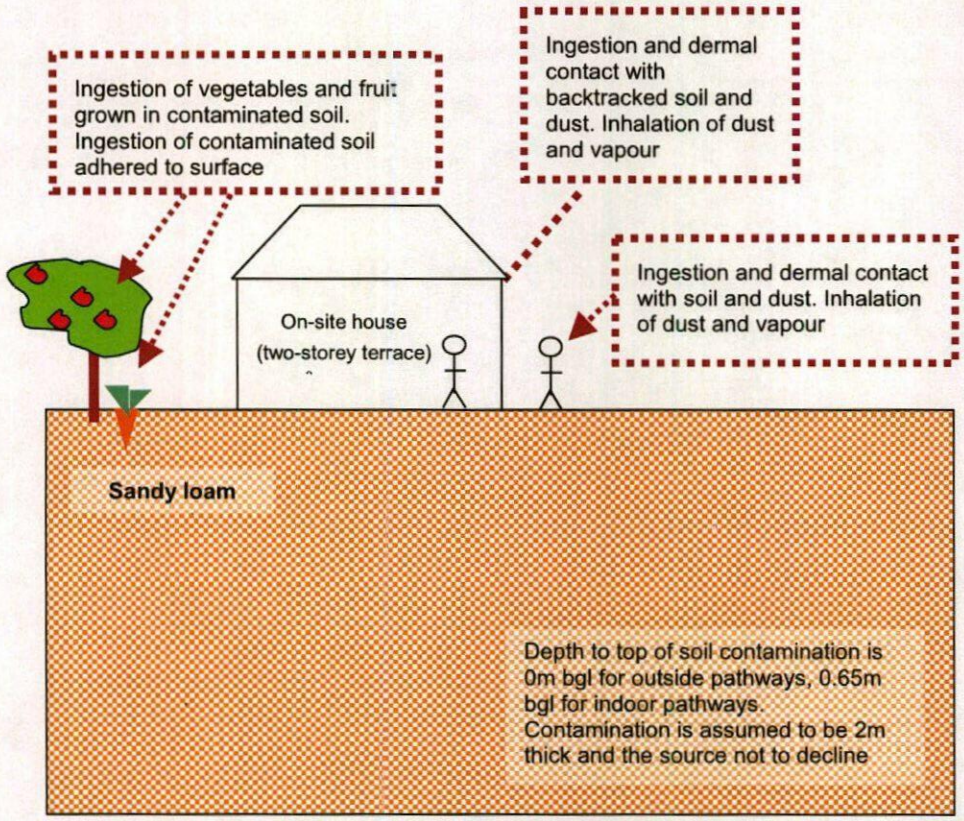


Table 1: Exposure assessment parameters for residential scenario - private gardens – inputs for CLEA model

Parameter	Value	Justification
Land use	Residential with homegrown produce	Chosen land use
Receptor	Female child age 1 to 6	Key generic assumption given in Box 3.1, report SC050021/SR3[3]
Building	Small terraced house	Key generic assumption given in Box 3.1, report SC050021/SR3. Two storey small terraced house chosen as it is the most conservative residential building type in terms of protection from vapor intrusion (Section 3.4.6, report SC050021/SR3)[3]
Soil type	Sandy Loam	Most common UK soil type (Section 4.3.1, From Table 3.1, report SC050021/SR3)[3]
Start AC (age class)	1	Range of age classes corresponding to key generic assumption that the critical receptor is a young female child aged zero to six. From Box 3.1, report SC050021/SR3[3]
End AC (age class)	6	
SOM (%)	6	Representative of sandy loamy soil according to EA guidance note dated January 2009 entitled 'Changes We Have Made to the CLEA Framework Documents'[8]
	1	To provide SAC for sites where SOM <6% as often observed by RSK
	2.5	
pH	7	Model default

Table 2: Residential with private gardens –home-grown produce data for CLEA model

	Consumption rate (g FW kg^{-1} BW day^{-1}) by age class						Dry weight conversion factor	Home-grown fraction (average)	Home-grown fraction (high end)	Soil loading factor	Preparation correction factor
Name	1	2	3	4	5	6	g DW g^{-1} FW	-	-	g g^{-1} DW	-
Green vegetables	7.12	6.85	6.85	6.85	3.74	3.74	0.096	0.05	0.33	1.00E-03	2.00E-01
Root vegetables	10.69	3.30	3.30	3.30	1.77	1.77	0.103	0.06	0.4	1.00E-03	1.00E+00
Tuber vegetables	16.03	5.46	5.46	5.46	3.38	3.38	0.21	0.02	0.13	1.00E-03	1.00E+00
Herbaceous fruit	1.83	3.96	3.96	3.96	1.85	1.85	0.058	0.06	0.4	1.00E-03	6.00E-01
Shrub fruit	2.23	0.54	0.54	0.54	0.16	0.16	0.166	0.09	0.6	1.00E-03	6.00E-01
Tree fruit	3.82	11.96	11.96	11.96	4.26	4.26	0.157	0.04	0.27	1.00E-03	6.00E-01
Justification	Table 4.17, SR3[3]						Table 6.3, SR3[3]	Table 4.19, SR3[3]		Table 6.3, SR3[3]	

Table 3: Residential with private gardens – land use data for CLEA model

Parameter	Unit	Age class					
		1	2	3	4	5	6
EF (soil and dust ingestion)	day yr^{-1}	180	365	365	365	365	365
EF (consumption of home-grown produce)	day yr^{-1}	180	365	365	365	365	365
EF (skin contact, indoor)	day yr^{-1}	180	365	365	365	365	365
EF (skin contact, outdoor)	day yr^{-1}	180	365	365	365	365	365
EF (inhalation of dust and vapour, indoor)	day yr^{-1}	365	365	365	365	365	365
EF (inhalation of dust and vapour, outdoor)	day yr^{-1}	365	365	365	365	365	365
Justification		Table 3.1, SR3[3]					
Occupancy period (indoor)	hr day^{-1}	23	23	23	23	19	19
Occupancy period (outdoor)	hr day^{-1}	1	1	1	1	1	1
Justification		Table 3.2, SR3[3]					
Soil to skin adherence factor (indoor)	mg cm^{-2} day^{-1}	6.00E-02	6.00E-02	6.00E-02	6.00E-02	6.00E-02	6.00E-02
Soil to skin adherence factor (outdoor)	mg cm^{-2} day^{-1}	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Justification		Table 8.1, SR3[3]					
Soil and dust ingestion rate	g day^{-1}	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01
Justification		Table 6.2, SR3[3]					

Of note, for **cadmium**, the exposure assessment for a residential land use is based on estimates representative of lifetime exposure AC1-18. This is because the TDI_{oral} and TDI_{inh} – are based on considerations of the kidney burden accumulated over 50 years. It is therefore reasonable to consider exposure not only in childhood but averaged over a longer time period. See the Environment Agency Science report: SC05002 / TOX 3 [1] and Science Report SC050021/Cadmium SGV [1] for more information.

Table 4: Residential with private gardens – receptor data for CLEA model

Parameter	Unit	Age Class						Justification
		1	2	3	4	5	6	
Body weight	kg	5.6	9.8	12.7	15.1	16.9	19.7	Table 4.6, SR3[3]
Body height	m	0.7	0.8	0.9	0.9	1	1.1	
Inhalation rate	m^3 day^{-1}	8.5	13.3	12.7	12.2	12.2	12.2	Table 4.14, SR3[3]
Max exposed skin fraction (indoor)	m^2 m^{-2}	0.32	0.33	0.32	0.35	0.35	0.33	Table 4.8, SR3[3]
Max exposed skin fraction (outdoor)	m^2 m^{-2}	0.26	0.26	0.25	0.28	0.28	0.26	

See cadmium note as per Table 3 above.

Table 5: Residential with private gardens – soil and building inputs for CLEA model

Parameter	Unit	Value	Justification
Soil properties for sandy loam			
Porosity, total	cm^3 cm^{-3}	0.53	Default soil type is sandy loam, Section 4.3.1, SR3[3] Parameters for sandy loam from Table 4.4, SR3[3]
Porosity, air filled	cm^3 cm^{-3}	0.20	
Porosity, water filled	cm^3 cm^{-3}	0.33	
Residual soil water content	cm^3 cm^{-3}	0.12	
Saturated hydraulic conductivity	cm s^{-1}	3.56E-03	
van Genuchten shape parameter (*m*)	-	3.20E-01	
Bulk density	g cm^{-3}	1.21	
Threshold value of wind speed at 10m	m s^{-1}	7.20	Default value taken from Section 9.2.2, SR3[3]
Empirical function (F_x) for dust model	-	1.22	Value taken from Section 9.2.2, SR3[3]
Ambient soil temperature	K	283	Annual average soil temperature representative of UK surface soils. Section 4.3.1, SR3[3]
Air dispersion model			
Mean annual wind speed (10m)	m s^{-1}	5.00	Default value taken from Section 9.2.2, SR3[3]
Air dispersion factor at height of 0.8m	g m^{-2} s^{-1} per kg m^{-3}	2400	Values for a 0.01 ha site, appropriate to a residential land use in Newcastle (most representative city for UK). (from Table 9.1, SR3)[3] Assumed child of 6 is not tall enough to reach 1.6m
Air dispersion factor at height of 1.6m	g m^{-2} s^{-1} per kg m^{-3}	0	
Fraction of site with hard or vegetative cover	m^2 m^{-2}	0.75	Section 3.2.6, SR3 [3] based on residential land use

Parameter	Unit	Value	Justification
Building properties for small terrace house with ground-bearing floor slab			
Building footprint	m^2	28	From Table 3.3 and 4.21, SR3[3]
Living space air exchange rate	hr^{-1}	0.50	
Living space height (above ground)	m	4.8	
Living space height (below ground)	m	0.0	Assumed no basement
Pressure difference (soil to enclosed space)	Pa	3.1	From Table 3.3, SR3[3]
Foundation thickness	m	0.15	
Floor crack area	cm^2	423	
Dust loading factor	$\mu g\ m^{-3}$	50	Default value for a residential site taken from Section 9.3, SR3[3]
Vapour model			
Default soil gas ingress rate	$cm^3\ s^{-1}$	25	Generic flow rate, Section 10.3, SR3[3]
Depth to top of source (beneath building)	cm	50	Section 3.2.6, SR3 [3] states source is 50cm below building or 65cm below ground surface
Depth to top of source (no building)	cm	0	Section 10.2, SR3 [3] assumes impact from 0m to 1m for outdoor inhalation pathway
Thickness of contaminant layer	cm	200	Model default for indoor air, Section 4.9, SR4[4]
Time average period for surface emissions	years	6	Time period of a 0 to 6 year old, Box 3.5, SR3[3]
User-defined effective air permeability	cm^2	3.05E-08	Calculated for sandy loam using equations in Appendix 1, SR3[3]

Figure 2: GrAC conceptual model for RBCA residential with private gardens scenario

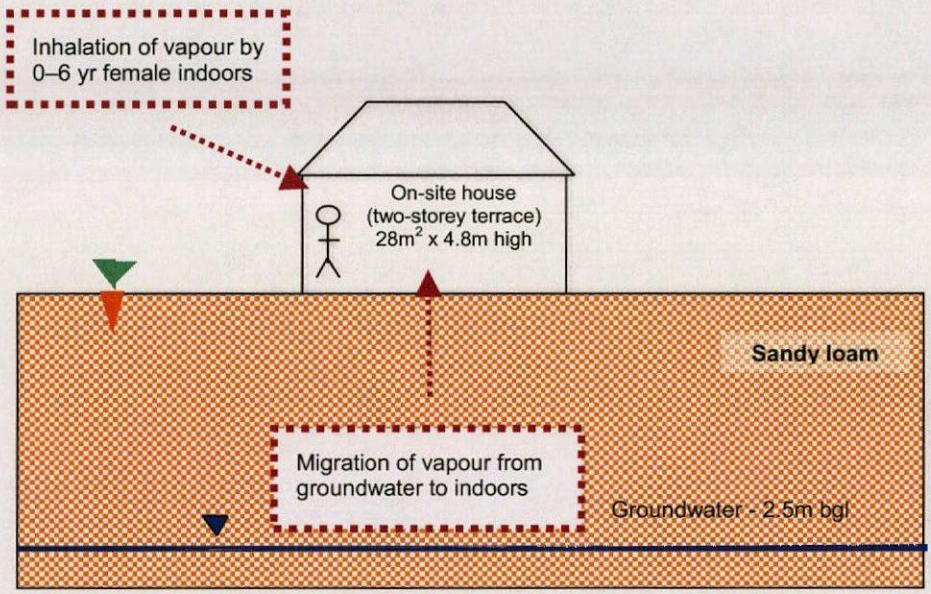


Table 6: Residential with private gardens – RBCA inputs

Parameter	Unit	Value	Justification
Receptor			
Averaging time	Years	6	From Box 3.1, SR3[3]
Receptor weight	kg	13.3	Average of CLEA 0–6 year old female data, Table 4.6, SR3[3]
Exposure duration	Years	6	From Box 3.1, report, SR3[3]
Exposure frequency	Days/yr	350	Weighted using occupancy period of 23 hours per day for 365 days of the year
Soil type – sandy loam			
Total porosity	-	0.53	CLEA value for sandy loam. Parameters for sandy loam from Table 4.4, SR3[3]
Volumetric water content	-	0.33	
Volumetric air content	-	0.20	
Dry bulk density	g cm^{-3}	1.21	
Vertical hydraulic conductivity	cm s^{-1}	3.56E-3	CLEA value for saturated conductivity of sandy loam, Table 4.4, SR3[3]
Vapour permeability	m^2	3.05E-12	Calculated for sandy loam using equations in Appendix 1, SR3[3]
Capillary zone thickness	m	0.1	Professional judgement

Parameter	Unit	Value	Justification
Fraction organic carbon	%	(i) 0.0348	Representative of sandy loam according to EA guidance note dated January 2009 entitled 'Changes We Have Made to the CLEA Framework Documents'[8]
		(ii) 0.0058	To provide SAC for sites where SOM < 6% as often observed by RSK
Building			
Building volume/area ratio	m	4.8	Table 3.3, SR3[3]
Foundation area	m^2	28	
Foundation perimeter	m	22	Calculated assuming building measures 7m x 4m to give 28m^2 foundation area
Building air exchange rate	d^{-1}	12	Table 3.3, SR3[3]
Depth to bottom of foundation slab	m	0.15	
Foundation thickness	m	0.15	
Foundation crack fraction	-	0.0151	Calculated from floor crack area of 423 cm^2 and building footprint of 28m^2 in Table 4.21, SR3[3]
Volumetric water content of cracks	-	0.33	Assumed equal to underlying soil type in assumption that cracks become filled with soil over time. Parameters for sandy loam from Table 4.4, SR3[3]
Volumetric air content of cracks	-	0.2	
Indoor/outdoor differential pressure	Pa	3.1	From Table 3.3, SR3[3]

References

1. Environment Agency (2009), 'Science Report SC050021/benzene SGV, toluene SGV, ethylbenzene SGV, xylene SGV, mercury SGV, selenium SGV, nickel SGV, arsenic SGV, cadmium SGV, phenol SGV, dioxins, furans and dioxin like PCBs SGVs', 'Supplementary information for the derivation of SGV for: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', and 'Contaminants in soil: updated collation of toxicological data and intake values for humans: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', March 2009, May 2009 and September 2009.

2. Environment Agency (2009), *Human health toxicological assessment of contaminants in soil. Science Report – Final SC050021/SR2*, January (Bristol: Environment Agency).

3. Environment Agency (2009), *Science Report – SC050021/SR3. Updated technical background to the CLEA model* (Bristol: Environment Agency).

4. Environment Agency (2009), Contaminated Land Exposure Assessment (CLEA) software, version 1.06.

5. Environment Agency (2008), *Science Report SC050021/SR7. Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values* (Bristol: Environment Agency).

6. Chartered Institute for Environmental Health and Land Quality Management (2009), 'The LQM/CIEH Generic Assessment Criteria for Human Health', second edition.

7. CL:AIRE (2009), *Soil Generic Assessment Criteria for Human Health Risk Assessment* (London: CL:AIRE).

8. Changes made to the CLEA framework documents after the three-month evaluation period in 2008, released January 2009 by the Environment Agency.

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITH PRIVATE GARDENS

Table 7

Human Health Generic Assessment Criteria by Pathway for Residential Scenario - Private Gardens

RSK

Compound	Notes	GrAC (mg/l)	SAC Appropriate to Pathway SOM 1% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 2.5% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 6% (mg/kg)			Soil Saturation Limit (mg/kg)
			Oral	Inhalation	Combined		Oral	Inhalation	Combined		Oral	Inhalation	Combined	
Metals														
Arsenic	(b)(c)	-	3.24E+01	8.50E+01	-	NR	3.24E+01	8.50E+01	-	NR	3.24E+01	8.50E+01	-	NR
Cadmium	(b)	-	1.12E+01	1.85E+02	1.10E+01	NR	1.12E+01	1.85E+02	1.10E+01	NR	1.12E+01	1.85E+02	1.10E+01	NR
Chromium (III) - oxide		-	1.84E+04	3.55E+03	2.98E+03	NR	1.84E+04	3.55E+03	2.98E+03	NR	1.84E+04	3.55E+03	2.98E+03	NR
Chromium (VI) - hexavalent		-	1.02E+01	4.25E+00	3.21E+00	NR	1.02E+01	4.25E+00	3.21E+00	NR	1.02E+01	4.25E+00	3.21E+00	NR
Copper		-	2.66E+03	1.04E+04	2.33E+03	NR	2.66E+03	1.04E+04	2.33E+03	NR	2.66E+03	1.04E+04	2.33E+03	NR
Lead	(a)	-	3.00E+02	-	-	NR	3.00E+02	-	-	NR	3.00E+02	-	-	NR
Elemental Mercury (Hg^0)	(b)(d)	9.40E-03	-	1.70E-01	-	4.31E+00	-	4.24E-01	-	1.07E+01	-	1.02E+00	-	2.58E+01
Inorganic Mercury (Hg^{2+})	(b)	-	1.81E+02	2.55E+03	1.69E+02	NR	1.81E+02	2.55E+03	1.69E+02	NR	1.81E+02	2.55E+03	1.69E+02	NR
Methyl Mercury (Hg^{2+})	(b)	2.00E+01	1.39E+01	1.59E+01	7.40E+00	7.33E+01	1.39E+01	3.08E+01	9.55E+00	1.42E+02	1.39E+01	6.53E+01	1.14E+01	3.04E+02
Nickel	(b)(d)	-	5.31E+02	1.27E+02	-	NR	5.31E+02	1.27E+02	-	NR	5.31E+02	1.27E+02	-	NR
Selenium	(b)(c)	-	3.50E+02	-	-	NR	3.50E+02	NR	-	NR	3.50E+02	-	-	NR
Zinc	(c)	-	3.75E+03	2.55E+07	-	NR	3.75E+03	2.55E+07	-	NR	3.75E+03	2.55E+07	-	NR
Cyanide		-	2.66E+01	3.97E+00	3.68E+00	NR	2.66E+01	3.97E+00	3.68E+00	NR	2.66E+01	3.97E+00	3.68E+00	NR
Volatile Organic Compounds														
Benzene	(b)	7.20E+00	1.12E-01	2.69E-01	7.92E-02	1.22E+03	2.28E-01	4.99E-01	1.57E-01	2.26E+03	4.89E-01	1.04E+00	3.32E-01	4.71E+03
Toluene	(b)	1.90E+03	1.47E+02	6.26E+02	1.19E+02	8.69E+02	3.35E+02	1.38E+03	2.70E+02	1.92E+03	7.59E+02	3.14E+03	6.11E+02	4.36E+03
Ethylbenzene	(b)	2.60E+02	1.06E+02	1.70E+02	6.52E+01	5.18E+02	2.51E+02	3.98E+02	1.54E+02	1.22E+03	5.70E+02	9.32E+02	3.54E+02	2.84E+03
Xylene - m		8.40E+01	2.02E+02	5.56E+01	4.36E+01	6.25E+02	4.80E+02	1.31E+02	1.03E+02	1.47E+03	1.09E+03	3.07E+02	2.40E+02	3.46E+03
Xylene - o	(b)	1.00E+02	1.85E+02	5.98E+01	4.52E+01	4.78E+02	4.38E+02	1.40E+02	1.06E+02	1.12E+03	9.96E+02	3.27E+02	2.46E+02	2.62E+03
Xylene - p		8.70E+01	1.91E+02	5.34E+01	4.17E+01	5.76E+02	4.51E+02	1.26E+02	9.82E+01	1.35E+03	1.02E+03	2.94E+02	2.28E+02	3.17E+03
Total xylene		8.40E+01	2.02E+02	5.56E+01	4.36E+01	6.25E+02	4.80E+02	1.31E+02	1.03E+02	1.47E+03	1.09E+03	3.07E+02	2.40E+02	3.46E+03
Methyl t-Butyl ether		2.20E+03	1.75E+00	1.84E+02	1.75E+00	1.66E+04	3.68E+00	2.40E+02	3.67E+00	2.16E+04	7.41E+00	3.70E+02	7.37E+00	3.34E+04
Trichloroethene		1.80E+00	2.83E+00	1.10E-01	1.06E-01	1.54E+03	6.25E+00	2.30E-01	2.22E-01	3.22E+03	1.40E+01	5.11E-01	4.93E-01	7.14E+03
Tetrachloroethene		3.60E+00	1.06E+01	1.03E+00	9.36E-01	4.24E+02	2.44E+01	2.30E+00	2.10E+00	9.51E+02	5.55E+01	5.28E+00	4.82E+00	2.18E+03
1,1,1-Trichloroethane		2.60E+01	3.20E+02	6.33E+00	6.21E+00	1.43E+03	6.97E+02	1.29E+01	1.27E+01	2.92E+03	1.55E+03	2.84E+01	2.79E+01	6.39E+03
1,1,1,2 Tetrachloroethane		1.40E+01	5.19E+00	1.08E+00	8.93E-01	2.60E+03	1.22E+01	2.50E+00	2.08E+00	6.02E+03	2.78E+01	5.83E+00	4.82E+00	1.40E+04
1,1,2,2-Tetrachloroethane		1.40E+01	2.70E+00	2.76E+00	1.37E+00	2.67E+03	5.85E+00	5.65E+00	2.87E+00	5.46E+03	1.30E+01	1.24E+01	6.34E+00	1.20E+04
Carbon Tetrachloride		5.50E-02	1.05E+00	1.81E-02	1.79E-02	1.52E+03	2.41E+00	3.97E-02	3.93E-02	3.32E+03	5.44E+00	8.99E-02	8.92E-02	7.54E+03
1,2-Dichloroethane		3.00E-01	3.06E-02	6.46E-03	5.34E-03	3.41E+03	5.53E-02	9.32E-03	7.98E-03	4.91E+03	1.05E-01	1.60E-02	1.39E-02	8.43E+03
Vinyl Chloride		1.90E-02	3.69E-03	5.43E-04	4.73E-04	1.36E+03	6.64E-03	7.02E-04	6.35E-04	1.76E+03	1.21E-02	1.07E-03	9.86E-04	2.69E+03
1,2,4-Trimethylbenzene		7.50E-02	-	3.51E-01	-	5.57E+02	-	8.55E-01	-	1.36E+03	-	2.10E+00	-	3.25E+03
1,3,5-Trimethylbenzene		4.70E-02	1.45E+01	4.60E-01	4.56E-01	9.47E+01	3.47E+01	1.10E+00	1.09E+00	2.26E+02	7.94E+01	2.59E+00	2.56E+00	5.33E+02
Semi-Volatile Organic Compounds														
Acenaphthene		3.20E+00	2.18E+02	3.46E+03	2.05E+02	5.70E+01	5.08E+02	8.54E+03	4.79E+02	1.41E+02	1.06E+03	2.03E+04	1.01E+03	3.36E+02
Acenaphthylene		4.20E+00	1.78E+02	3.27E+03	1.68E+02	8.61E+01	4.17E+02	8.03E+03	3.97E+02	2.12E+02	8.90E+02	1.91E+04	8.51E+02	5.06E+02
Anthracene		2.10E-02	2.31E+03	1.08E+05	2.26E+03	1.17E+00	5.03E+03	2.65E+05	4.93E+03	2.91E+00	9.33E+03	6.15E+05	9.19E+03	6.96E+00
Benzo(a)anthracene		3.80E-03	7.00E+00	5.55E+00	3.10E+00	1.71E+00	8.98E+00	9.83E+00	4.69E+00	4.28E+00	1.01E+01	1.41E+01	5.88E+00	1.03E+01
Benzo(b)fluoranthene		2.00E-03	8.06E+00	1.79E+01	5.56E+00	1.22E+00	9.78E+00	1.97E+01	6.53E+00	3.04E+00	1.07E+01	2.05E+01	7.02E+00	7.29E+00
Benzo(g,h,i)perylene		2.60E-04	6.68E+01	1.27E+02	4.38E+01	1.54E-02	7.04E+01	1.32E+02	4.59E+01	3.85E-02	7.19E+01	1.34E+02	4.68E+01	9.23E-02
Benzo(k)fluoranthene		5.00E-04	1.25E+01	2.66E+01	8.51E+00	6.87E-01	1.44E+01	2.83E+01	9.56E+00	1.72E+00	1.53E+01	2.91E+01	1.00E+01	4.12E+00
Chrysene		2.00E-03	8.76E+00	1.95E+01	6.00E+00	4.40E-01	1.20E+01	2.45E+01	8.04E+00	1.10E+00	1.41E+01	2.72E+01	9.27E+00	2.64E+00
Dibenzo(a,h)anthracene		6.00E-04	1.19E+00	2.13E+00	7.62E-01	3.93E-03	1.33E+00	2.42E+00	8.58E-01	9.82E-03	1.39E+00	2.56E+00	9.03E-01	2.36E-02
Fluoranthene		2.30E-01	2.59E+02	2.69E+04	2.57E+02	1.89E+01	4.67E+02	6.23E+04	4.63E+02	4.73E+01	6.78E+02	1.28E+05	6.74E+02	1.13E+02
Fluorene		1.90E+00	1.70E+02	4.35E+03	1.63E+02	3.09E+01	3.91E+02	1.07E+04	3.77E+02	7.65E+01	8.00E+02	2.54E+04	7.76E+02	1.83E+02
Indeno(1,2,3-cd)pyrene		2.00E-04	4.58E+00	1.04E+01	3.18E+00	6.13E-02	5.74E+00	1.17E+01	3.85E+00	1.53E-01	6.37E+00	1.22E+01	4.19E+00	3.68E-01
Phenanthrene		5.30E-01	9.35E+01	5.04E+03	9.18E+01	3.60E+01	2.04E+02	1.23E+04	2.01E+02	8.96E+01	3.81E+02	2.86E+04	3.76E+02	2.14E+02
Pyrene		1.30E-01	5.69E+02	6.18E+04	5.63E+02	2.20E+00	1.05E+03	1.44E+05	1.04E+03	5.49E+00	1.56E+03	2.97E+05	1.56E+03	1.32E+01
Benzo(a)pyrene		3.80E-03	1.21E+00	2.62E+00	8.26E-01	9.11E-01	1.42E+00	2.81E+00	9.43E-01	2.28E+00	1.52E+00	2.90E+00	9.98E-01	5.46E+00
Naphthalene		1.90E+01	2.68E+01	1.64E+00	1.54E+00	7.64E+01	6.36E+01	3.93E+00	3.70E+00	1.83E+02	1.43E+02	9.27E+00	8.71E+00	4.32E+02
Phenol	(b)	-	4.51E+02	3.11E+02	1.84E+02	4.16E+04	9.38E+02	4.20E+02	2.90E+02	8.15E+04	2.04E+03	5.21E+02	4.15E+02	1.74E+05

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITH PRIVATE GARDENS

Table 7

Human Health Generic Assessment Criteria by Pathway for Residential Scenario - Private Gardens

Compound	Notes	GrAC (mg/l)	SAC Appropriate to Pathway SOM 1% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 2.5% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 6% (mg/kg)			Soil Saturation Limit (mg/kg)
			Oral	Inhalation	Combined		Oral	Inhalation	Combined		Oral	Inhalation	Combined	
Total Petroleum Hydrocarbons														
Aliphatic hydrocarbons EC_5-EC_6		1.00E+01	4.79E+03	2.98E+01	2.97E+01	3.04E+02	1.08E+04	5.47E+01	5.46E+01	5.58E+02	2.35E+04	1.13E+02	1.13E+02	1.15E+03
Aliphatic hydrocarbons >EC_6-EC_8		5.40E+00	1.43E+04	7.27E+01	7.26E+01	1.44E+02	3.21E+04	1.62E+02	1.62E+02	3.22E+02	6.36E+04	3.72E+02	3.71E+02	7.36E+02
Aliphatic hydrocarbons >EC_8-EC_{10}		2.30E-01	1.46E+03	1.89E+01	1.83E+01	7.77E+01	2.44E+03	4.60E+01	4.58E+01	1.90E+02	3.30E+03	1.09E+02	1.08E+02	4.51E+02
Aliphatic hydrocarbons >EC_{10}-EC_{12}		3.40E-02	3.52E+03	9.34E+01	9.28E+01	4.75E+01	4.01E+03	2.32E+02	2.29E+02	1.18E+02	4.24E+03	5.57E+02	5.37E+02	2.83E+02
Aliphatic hydrocarbons >EC_{12}-EC_{16}		7.60E-04	4.37E+03	7.82E+02	7.44E+02	2.37E+01	4.40E+03	1.95E+03	1.69E+03	5.91E+01	4.41E+03	4.68E+03	3.03E+03	1.42E+00
Aliphatic hydrocarbons >EC_{16}-EC_{35}	(c)	-	4.51E+04	-	-	8.48E+00	6.38E+04	-	-	2.12E+01	7.61E+04	-	-	5.09E+01
Aliphatic hydrocarbons >EC_{35}-EC_{44}	(c)	-	4.51E+04	-	-	8.48E+00	6.38E+04	-	-	2.12E+01	7.61E+04	-	-	5.09E+01
Aromatic hydrocarbons >EC_8-EC_9 (styrene)		7.40E+00	1.66E+02	2.65E+02	1.33E+02	6.20E+02	3.92E+02	6.47E+02	3.16E+02	1.52E+03	8.50E+02	1.54E+03	7.02E+02	3.61E+03
Aromatic hydrocarbons >EC_9-EC_{10}		7.40E+00	5.55E+01	3.33E+01	2.69E+01	6.13E+02	1.31E+02	8.16E+01	6.54E+01	1.50E+03	2.84E+02	1.94E+02	1.51E+02	3.58E+02
Aromatic hydrocarbons >EC_{10}-EC_{12}		2.50E+01	7.97E+01	1.82E+02	6.91E+01	3.64E+02	1.86E+02	4.48E+02	1.62E+02	8.99E+02	3.87E+02	1.07E+03	3.46E+02	2.15E+03
Aromatic hydrocarbons >EC_{12}-EC_{16}		5.80E+00	1.40E+02	2.00E+03	1.38E+02	1.69E+02	3.13E+02	4.96E+03	3.08E+02	4.19E+02	6.01E+02	1.18E+04	5.93E+02	1.00E+03
Aromatic hydrocarbons >EC_{16}-EC_{21}	(c)	-	2.47E+02	-	-	5.37E+01	4.82E+02	-	-	1.34E+02	7.66E+02	-	-	3.21E+02
Aromatic hydrocarbons >EC_{21}-EC_{35}	(c)	-	8.88E+02	-	-	4.83E+00	1.11E+03	-	-	1.21E+01	1.22E+03	-	-	2.90E+01
Aromatic hydrocarbons >EC_{35}-EC_{44}	(c)	-	8.88E+02	-	-	4.83E+00	1.11E+03	-	-	1.21E+01	1.22E+03	-	-	2.90E+01

Notes:

'-' Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway, or an absence of toxicological data.

NR - the compound is not volatile and therefore a soil saturation limit not calculated within CLEA

EC - equivalent carbon. GrAC - groundwater assessment criteria. SAC - soil assessment criteria.

The CLEA model output is colour coded depending upon whether the soil saturation limit has been exceeded.

Calculated SAC exceeds soil saturation limit and may significantly effect the interpretation of any exceedances since the contribution of the indoor and outdoor vapour pathway to total exposure is >10%. This shading has also been used for the RBCA output where the theoretical solubility limit has been exceeded. The SAC has been set as the model calculated SAC with the saturation limits shown in brackets.

Calculated SAC exceeds soil saturation limit but will not effect the SSV significantly since the contribution of the indoor and outdoor vapour pathway to total exposure is <10%.

Calculated SAC does not exceed the soil saturation limit.

For consistency where the theoretical solubility limit within RBCA has been exceeded in production of the GrAC, these cellls have also been hatched red.

The SAC for organic compounds are dependant upon soil organic matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58. 1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.

SAC for TPH fractions, polycyclic aromatic hydrocarbons, MTBE, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3

(a) Sensitivity analysis undertaken on SEGH equation and CLEA model, considered reasonable in absence of UK specific data

(b) GAC taken from the Environment Agency SGV reports published 2009.

(c) SAC for selenium, aliphatic and aromatic hydrocarbons >EC16 does not include inhalation pathway owing to absence of toxicity data. SAC for arsenic is only based on oral contribution (rather than combined) owing to the relative small contribution from inhalation in accordance with the SGV report. The same approach has been adopted for zinc.

(d) SAC for elemental mercury, chromium VI and nickel is based on the inhalation pathway only owing to an absence of toxicity for elemental mercury, in accordance with the SGV report for nickel and LQM report for chromium VI.

Table 8
Human Health Generic Assessment Criteria for Residential Scenario - Private Gardens

Compound	GrAC for Groundwater (mg/l)	SAC for Soil SOM 1% (mg/kg)	SAC for Soil SOM 2.5% (mg/kg)	SAC for Soil SOM 6% (mg/kg)
Metals				
Arsenic	-	32	32	32
Cadmium	-	10	10	10
Chormium (III) - oxide	-	3,000	3,000	3,000
Chromium (VI) - hexavalent	-	4.3	4.3	4.3
Copper	-	2,300	2,300	2,300
Lead	-	300	300	300
Elemental Mercury (Hg^0)	0.009	0.17	0.42	1.0
Inorganic Mercury (Hg^{2+})	-	170	170	170
Methyl Mercury (Hg^{4+})	20	7.4	9.6	11
Nickel	-	130	130	130
Selenium	-	350	350	350
Zinc	-	3,800	3,800	3,800
Cyanide	-	3.7	3.7	3.7
Volatile Organic Compounds				
Benzene	7	0.079	0.157	0.33
Toluene	1,900	120	270	610
Ethylbenzene	260	65	154	350
Xylene - m	100	44	103	240
Xylene - o	87	45	106	250
Xylene - p	84	42	98	230
Total xylene	84	44	103	240
Methyl tertiary butyl ether (MTBE)	2,200	1.8	3.7	7.4
Trichloroethene	1.8	0.11	0.2	0.49
Tetrachloroethene	3.6	0.94	2.1	4.8
1,1,1-Trichloroethane	26	6.2	12.7	28
1,1,1,2Tetrachloroethane	14	0.89	2.1	4.8
1,1,2,2-Tetrachloroethane	14	1.4	2.87	6.3
Carbon Tetrachloride	0.055	0.018	0.039	0.089
1,2-Dichloroethane	0.30	0.0053	0.0080	0.014
Vinyl Chloride	0.019	0.00047	0.0006	0.001
1,2,4-Trimethylbenzene	0.075	0.35	0.85	2.1
1,3,5-Trimethylbenzene	0.047	0.46	1.1	2.6
Semi-Volatile Organic Compounds				
Acenaphthene	3.2	210	480	1,000
Acenaphthylene	4.2	170	400	850
Anthracene	0.021	2,300	4,900	9,200
Benzo(a)anthracene	0.0038	3.1	4.7	5.9
Benzo(b)fluoranthene	0.0020	5.6	6.5	7.0
Benzo(g,h,i)perylene	0.00026	44	46	47
Benzo(k)fluoranthene	0.00080	8.5	9.6	10
Chrysene	0.0020	6.0	8.0	9.3
Dibenzo(a,h)anthracene	0.00060	0.76	0.86	0.90
Fluoranthene	0.23	260	460	670
Fluorene	1.9	160	380	780
Indeno(1,2,3-cd)pyrene	0.0002	3.2	3.8	4.2
Phenanthrene	0.53	92	200	380
Pyrene	0.13	560	1,000	1,600
Benzo(a)pyrene	0.0038	0.83	0.94	1.0
Naphthalene	19	1.5	3.7	8.7
Phenol	-	180	290	420
Total Petroleum Hydrocarbons				
Aliphatic hydrocarbons EC_5-EC_6	10	30	55	110
Aliphatic hydrocarbons >EC_6-EC_8	5.4	73	160	370
Aliphatic hydrocarbons >EC_8-EC_{10}	0.23	19	46	110
Aliphatic hydrocarbons >EC_{10}-EC_{12}	0.034	93 (48)	230 (118)	540 (283)
Aliphatic hydrocarbons >EC_{12}-EC_{16}	0.00076	744 (24)	1,700 (59)	3,000 (142)
Aliphatic hydrocarbons >EC_{16}-EC_{35}	-	45,100 (8.48)	64,000 (21)	76,000
Aliphatic hydrocarbons >EC_{35}-EC_{44}	-	45,100 (8.48)	64,000 (21)	76,000
Aromatic hydrocarbons >EC_5-EC_8 (styrene)	7.4	130	316	700
Aromatic hydrocarbons >EC_8-EC_{10}	7.4	27	65	150
Aromatic hydrocarbons >EC_{10}-EC_{12}	25	69	160	346
Aromatic hydrocarbons >EC_{12}-EC_{16}	5.8	140	310	593
Aromatic hydrocarbons >EC_{16}-EC_{21}	-	250	480	770
Aromatic hydrocarbons >EC_{21}-EC_{35}	-	890	1,100	1,230
Aromatic hydrocarbons >EC_{35}-EC_{44}	-	890	1,100	1,230

Notes:

'-' Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway, or an absence of toxicological data.

EC - equivalent carbon. GrAC - groundwater assessment criteria. SAC - soil assessment criteria.

The SAC for organic compounds are dependent on Soil Organic Matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58. 1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.

SAC for TPH fractions, polycyclic aromatic hydrocarbons, MTBE, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3.

The SAC has been set as the model calculated SAC with the saturation limit shown in brackets. For consistency where the GrAC exceeds the solubility limit, GrAC has been set at the solubility limit. The GrAC conservative since concentrations of the chemical are very unlikely to be at sufficient concentration to result in an exceedance of the health criteria value at the point of exposure (i.e. indoor air) provided free-phase product is absent.

APPENDIX J
GENERIC ASSESSMENT CRITERIA FOR POTABLE WATER SUPPLY PIPES

A range of pipe materials is available and careful selection, design and installation is required to ensure that water supply pipes are satisfactorily installed and meet the requirements of the Water Supply (Water Fittings) Regulations 1999 in England and Wales, the Byelaws 2000 in Scotland and the Northern Ireland Water Regulations. The regulations include a requirement to use only suitable materials when laying water pipes and laying water pipes without protection is not permitted at contaminated sites. The water supply company has a statutory duty to enforce the regulations.

Contaminants in the ground can pose a risk to human health by permeating potable water supply pipes. To fulfil their statutory obligation, UK water supply companies require robust evidence from developers to demonstrate either that the ground in which new plastic supply pipes will be laid is free from specific contaminants, or that the proposed remedial strategy will mitigate any existing risk. If these requirements cannot be demonstrated to the satisfaction of the relevant water company, it becomes necessary to specify an alternative pipe material on the whole development or in specific zones.

In 2010, UK Water Industry Research (UKWIR) published *Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (Report Ref. No. 10/WM/03/21). This report reviewed previously published industry guidelines and threshold concentrations adopted by individual water supply companies.

The focus of the UKWIR research project was to develop clear and concise procedures, which provide consistency in the pipe selection decision process. It was intended to provide guidance that can be used to ensure compliance with current regulations and to prevent water supply pipe failing prematurely due to the presence of contamination.

The report concluded that in most circumstances only organic contaminants pose a potential risk to plastic pipe materials and Table 3.1 of the report provides threshold concentrations for polyethylene (PE) and polyvinyl chloride (PVC) pipes for the organic contaminants of concern. The report also makes recommendations for the procedures to be adopted in the design of site investigations and sampling strategies, and the assessment of data, to ensure that the ground through which water supply pipes will be laid is adequately characterised.

Risks to water supply pipes have therefore been assessed against the threshold concentrations for PE and PVC pipe specified in Table 3.1 of Report 10/WM/03/21, which have been adopted as the GAC for this linkage and are reproduced in Table A3 below.

Since water supply pipes are typically laid at a minimum depth of 0.75m below finished ground levels, sample results from depths between 0.5m and 1.5m below finished level are generally considered suitable for assessing risks to water supply. Samples outside these depths can be

used, providing the stratum is the same as that in which water supply pipes are likely to be located. The report specifies that sampling should characterise the ground conditions to a minimum of 0.5m below the proposed depth of the pipe.

It should be noted that the assessment provided in this report is a guide and the method of assessment and recommendations should be checked with the relevant water supply company.

Table A3: Generic assessment criteria for water supply pipes

		Pipe material	
		GAC (mg/kg)	
	Parameter group	PE	PVC
1	Extended VOC suite by purge and trap or head space and GC-MS with TIC (Not including compounds within group 1a)	0.5	0.125
1a	• BTEX + MTBE	0.1	0.03
2	SVOCs TIC by purge and trap or head space and GC-MS with TIC (aliphatic and aromatic C_5–C_{10}) (Not including compounds within group 2e and 2f)	2	1.4
2e	• Phenols	2	0.4
2f	• Cresols and chlorinated phenols	2	0.04
3	Mineral oil C_{11}–C_{20}	10	Suitable
4	Mineral oil C_{21}–C_{40}	500	Suitable
5	Corrosive (conductivity, redox and pH)	Suitable	Suitable
Specific suite identified as relevant following site investigation			
2a	Ethers	0.5	1
2b	Nitrobenzene	0.5	0.4
2c	Ketones	0.5	0.02
2d	Aldehydes	0.5	0.02
6	Amines	Not suitable	Suitable
Notes: where indicated as 'suitable', the material is considered resistant to permeation or degradation and no threshold concentration has been specified by UKWIR.			

APPENDIX K
GENERIC ASSESSMENT CRITERIA FOR PHYTOTOXIC EFFECTS AND CONTROLLED WATERS

GENERIC ASSESSMENT CRITERIA FOR PHYTOTOXIC EFFECTS

Several compounds can inhibit plant growth; hence it is important to have generic assessment criteria (GAC) to promote healthy plant growth. In the absence of other published GAC, the GAC have been obtained from legislation (UK and European) and guidance related to the use of sewage sludge on agricultural fields.

The Council of European Communities Sewage Sludge Directive (86/278/EEC) dated 1986, has been transposed into UK law by Statutory Instrument No. 1263, The Sludge (use in Agriculture) Regulations 1989 (Public Health England, Wales and Scotland), as ammended in 1990 and The Sludge (use in Agriculture) Regulations (Northern Ireland) SR No, 245, 1990. In addition the Department of Environment (DoE) produced a Code of Practice (CoP) (Updated 2nd Edition) in 2006 which provided guidance on the application of sewage sludge on agricultural land (however the status of this document is unclear as it is on the archive section of the Defra website).

The directive seeks to encourage the use of sewage sludge in agriculture and to regulate its use in such a way as to "***prevent harmful effects on soil, vegetation, animals and man".*** To this end, it prohibits the use of untreated sludge on agricultural land unless it is injected or incorporated into the soil. Treated sludge is defined as having undergone "biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use". To provide protection against potential health risks from residual pathogens, sludge must not be applied to soil in which fruit and vegetable crops are growing, or less than ten months before fruit and vegetable crops are to be harvested. Grazing animals must not be allowed access to grassland or forage land less than three weeks after the application of sludge.

The specified limits of concentrations of selected elements in soil are presented in Table 4 of the updated 2nd Edition of the DoE Code of Practice and are designed to protect plant growth. It is noted that these values are more stringent than the values set in current UK regulations. However since they were ammended following recommendations from the Independent Scientific Committee in 1993. (MAFF/DOE 1993). The GAC are presented in Table 1.

Table 1: Generic assessment criteria

Determinant	Generic assessment criteria (mg/kg)			
	pH 5.0 < 5.5	pH 5.5 < 6.0	pH 6.0 < 7.0	pH >7.0
Zinc	200	200	200	300
Copper	80	100	135	200
Nickel	50	60	75	110
Lead	300	300	300	300
Cadmium	3	3	3	3
Mercury	1	1	1	1

Note: Only compounds with assessment criteria documented within the Directive 86/278/EEC have been included, although criteria for 5 additional compounds have been presented within the 2006 CoP.

GENERIC ASSESSMENT CRITERIA FOR CONTROLLED WATERS

The water environment in England and Wales is protected under a number of regulatory regimes, many regulated by the Environment Agency. The Environment Agency is consulted where there may be a risk that pollution of 'controlled waters' may occur or may have occurred in the past. Controlled waters are coastal waters, inland freshwaters and groundwaters. The EU Water Framework Directive (WFD) (2000/60/EC) is implemented via various regulations and guidance, covering aspects of groundwater, surface water and drinking water supply policy. The regulations mainly apply to England and Wales, therefore if you are working on a site in Scotland or Northern Ireland, please review the equivalent legislation and guidance provided by the Scottish Environmental Protection Agency (SEPA) or the Northern Ireland Environment Agency (NIEA).

The main objectives of the protection and remediation of groundwater under threat from land contamination are set out in the Environment Agency's Groundwater Protection: Principles and Practice (GP3) series of documents[1]. When assessing risks to groundwater the following need to be taken into consideration:

- Where pollutants have not yet entered groundwater, all necessary and reasonable measures must be taken to:
    - *Prevent the input of hazardous substances into groundwater (see description of hazardous substances below)*
    - *Limit the entry of other (non-hazardous) pollutants into groundwater so as to avoid pollution, and to avoid deterioration of the status of groundwater bodies or sustained, upward trends in pollutant concentration*
- Where hazardous substances or non-hazardous pollutants have already entered groundwater, the priority is to:
    - *Minimise further entry of hazardous substances and non-hazardous pollutants into groundwater*
    - *Take necessary and reasonable measures to limit the pollution of groundwater or impact on the status of the groundwater body from the future expansion of a contaminant 'plume', if necessary by actively reducing its extent.*

Definitions

Hazardous Substances are defined in the Water Framework Directive 2000/60/EC as 'substances or groups of substances that are toxic, persistent and liable to bio-accumulate, and other substances or groups of substances which give rise to an equivalent level of concern. All List 1 substances under the old Groundwater Directive (80/68/EEC) are hazardous substances, all radioactive substances are hazardous substances.

Non-hazardous Substances are defined as 'substances capable of causing pollution that have not been classified as hazardous substances'. The non-hazardous list of pollutants does not simply replace the old WFD List II but includes a wider range.

For the current list of classified substances please visit the UKTAG website www.wfduk.org./jagdag/

When assessing the risks to surface waters, various standards apply, including Environmental Quality Standards which are protective of the water ecology[14].

The Water Supply (Water Quality) Regulations[2,3] are the primary source for assessing water bodies which may be used for public water supplies. There are also Private Water Supply Regulations which may be applicable in some cases.

This appendix presents the generic assessment criteria (GAC) that RSK considers are suitable for assessing risks to controlled waters.

The RSK GAC for controlled waters are presented in Table 1. In line with the Environment Agency's (2006b) Remedial Targets Methodology, the GAC for controlled waters are termed 'target concentrations'.

The target concentration can be derived by several means with consideration to:

- whether the substance is classified as hazardous or non-hazardous by the EU under the Water Framework Directive (2000/60/EC) and Groundwater Daughter Directive (2006/118/EC) implemented though the Environmental Permitting Regulations 2010
- background concentrations in the aquifer
- published guidance such as Environmental Quality Standards that are protective of ecology or The Water Supply (Water Quality) Regulations 2010 that are protective of drinking water
- Minimum Reporting Values (or method detection limits if MRV are not provided).

Table 1: Target concentrations for Controlled Waters

Analytes in bold are hazardous, *analytes in italics are non hazardous*, analytes in plain text are unclassified; according to JAGDAG Determination List June 2010

Target Concentrations shaded in GREEN are Statutory Values ORANGE are Non-Statutory Values

Determinant	Target concentrations (mg/l)			
	Minimum Reporting Value	UK Drinking Water Standard or Best Equivalent	Environmental Quality Standard or Best Equivalent	
			Freshwater	Transitional (estuaries) and Coastal Waters
Metals				
Arsenic	-	0.01[2]	0.05[13a]	0.025[13a]
Cadmium	0.0001[4]	0.005[2]	≤0.00008, 0.00008, 0.00009, 0.00015, 0.00025 [13b]	0.0002[13c]
Chromium (total)	-	0.05[2]	Use values for chromium III and VI	
Chromium (III)	-	Use value for total chromium	0.0047 [13a]	0.032[13c]
Chromium (VI)			0.0034 [13a]	0.0006[13a]
Copper	-	2.0[2]	0.001, 0.006, 0.01, 0.028[13e]	0.005[13a]
Lead	-	0.025 (before 25/12/2013), 0.01 (after 25/12/2013)[2]	0.0072[13c]	0.0072[13c]
Mercury	0.00001[4]	0.001[2]	0.00005[13c]	0.00005[13c]

Determinant	Target concentrations (mg/l)			
	Minimum Reporting Value	UK Drinking Water Standard or Best Equivalent	Environmental Quality Standard or Best Equivalent	
			Freshwater	Transitional (estuaries) and Coastal Waters
Nickel	-	0.02[2]	0.02[13c]	0.02[13c]
Selenium	-	0.01[2]	-	-
Zinc	-	5[3]	0.008, 0.05, 0.075, 0.125 [13e]	0.04[13a]
Chlorinated solvents				
Trichloroethene	0.0001[4]	0.01[2]	0.01[13c]	0.01[13c]
Tetrachloroethene	0.0001[4]	0.01[2]	0.01[13c]	0.01[13c]
1,1,1-Trichloroethane	0.0001[4]	-	0.1[13c]	0.1[13c]
1,1,2-Trichloroethane	0.0001[4]	-	0.4[13c]	0.3[13c]
Carbon tetrachloride (Tetrachloromethane)	0.0001[4]	0.003[2]	0.012[13c]	0.012[13c]
1,2-Dichloroethane	0.001[4]	0.003[2]	0.01[13c]	0.01[13c]
Vinyl chloride (Chloroethene)	-	0.0005[2]	-	-
Trihalomethanes	-	0.1[2, 5]	-	-
Chloroform (Trichloromethane) (one of the trihalomethanes included above)	0.0001[4]	0.1[2, 5]	0.0025[13c]	0.0025[13c]
Polycyclic aromatic hydrocarbons				
Acenaphthene	-	-	0.0058[10]	
Acenaphthylene	-	-	0.0058[10]	
Anthracene	-	-	0.0001[13c]	0.0001[13c]

Determinant	Target concentrations (mg/l)			
	Minimum Reporting Value	UK Drinking Water Standard or Best Equivalent	Environmental Quality Standard or Best Equivalent	
			Freshwater	Transitional (estuaries) and Coastal Waters
Benzo(a)anthracene	-	-	0.000018[10]	
Benzo(b)fluoranthene	-	0.0001[2]	0.00003[13f]	0.00003[13f]
Benzo(k)fluoranthene	-			
Benzo(g,h,i)perylene	-		0.000002[13g]	0.000002[13g]
Indeno(1,2,3-cd)pyrene	-			
Chrysene	-	-	0.00001[10]	
Dibenzo(a,h)anthracene	-	-	0.00001[10]	
Fluoranthene	-	-	0.0001[13c]	0.0001[13c]
Fluorene	-	-	0.0021[10]	
Phenanthrene	-	-	0.003[10]	
Pyrene	-	-	0.00004[10]	
Benzo(a)pyrene	-	0.00001[2]	0.00005[13c]	0.00005[13c]
Naphthalene	-	-	0.0024[13c]	0.0012[13c]
Petroleum hydrocarbons				
Total petroleum hydrocarbons	-	0.01[3]	0.01[3, 11]	
Benzene	0.001[4]	0.001[2]	0.01[13c]	0.008[13c
Toluene	0.004[4]	0.7[9]	0.05[13a]	0.04[13a]
Ethylbenzene	-	0.3[9]	0.02[12]	0.02[12]
Xylene	0.003[4]	0.5[9]	0.03[13c]	0.03[13c]

Determinant	Target concentrations (mg/l)			
	Minimum Reporting Value	UK Drinking Water Standard or Best Equivalent	Environmental Quality Standard or Best Equivalent	
			Freshwater	Transitional (estuaries) and Coastal Waters
Methyl tertiary butyl ether	-	0.015[7]		
Pesticides and herbicides				
Aldrin	0.000003[4]	0.00003[2]	0.00001[13d]	0.000005[13d]
Dieldrin	0.003[4]	0.00003[2]		
Endrin	0.000003[4]	0.0006[9]		
Isodrin	0.000003[4]	-		
Heptachlor	-	0.00003[2]		
Heptachlor epoxide	-	0.00003[2]		
Other pesticides	-	0.0001[2]		
Total pesticides	-	0.0005[2]		
Total DDT	0.000004[4]	0.001[9]	0.000025[13c]	0.000025[13c]
Azinphos – methyl	0.000001[4]	-	0.00001[1]	
Cyfluthrin	0.0001[4]	-	0.000001[14]	
Demeton	0.00005[4]	-	0.0005[14	
Dichlorvos	-	-	0.000001[13c]	0.00004[13c]
Dimethoate	0.00001[4]	-	0.00048[13a]	0.00048[13a]
Endosulphan	0.000005[4]	-	0.000005[13c]	0.0000005[13c]
Fenitrothion	0.000001[4]	-	0.00001[13c]	0.00001[13c]
Flucofuron	0.0001[4]	-	0.001[14]	

Determinant	Target concentrations (mg/l)			
	Minimum Reporting Value	UK Drinking Water Standard or Best Equivalent	Environmental Quality Standard or Best Equivalent	
			Freshwater	Transitional (estuaries) and Coastal Waters
Malathion	0.000001[4]	-	0.00001[13c]	0.00002[13c]
Mevinphos	0.000005[4]	-	0.00002[14]	-
Omethoate	0.0001[4]	-	0.00001[14]	
PCSDs (cyfluthrin, sulcofuron, flucofuron and **permethrin**)	-	-	0.00005[15]	
Permethrin	0.000001[4]	-	0.00001[13a]	0.00001[13]
Sulcofuron	0.0001[4]	-	0.025[8,14]	
Triazaphos	0.0001[4]	-	0.000005[8]	
Atrazine	0.00003[4]	-	0.0006[13c]	0.0006[13c]
Simazine	0.00003[4]	-	0.001[13c]	0.001[13c]
Bentazone	0.1[4]	-	0.5[13c]	0.5[13a]
Linuron	0.0001[4]	-	0.0005[13a]	0.0005[13a]
Mecoprop	0.00004[4]	-	0.018[13a]	0.018[13a]
Trifluralin	0.00001[4]	-	0.00003[13c]	0.00003[13c]
Miscellaneous				
Cyanide (Hydrogen cyanide)	-	0.05[2]	0.001[13a]	0.001[13a]
Phenol	0.0005[4]	-	0.0077[13a]	0.0077[13a]
Sodium	-	200[2]	-	
Chloride	-	250[2]	250[6,14]	-

Determinant	Target concentrations (mg/l)			
	Minimum Reporting Value	UK Drinking Water Standard or Best Equivalent	Environmental Quality Standard or Best Equivalent	
			Freshwater	Transitional (estuaries) and Coastal Waters
Ammonium (as NH_4^+)	-	0.5[2]	0.3[13a]	
Ammonia (NH_3)	-	-	0.025[15]	0.021[13a]
Sulphate	-	250[2]	400[6,14]	-
Iron	-	0.20[2]	1[13a]	1[13a]
Manganese	-	0.05[2]	0.03[6,14]	No EQS required [12]
Aluminium	-	0.2[2]	-	
Nitrate (as NO_3)	-	50[2]	-	
Nitrite (as NO_2)	-	0.1[2]	0.01[15]	-

Analytes in bold are hazardous, *analytes in italics are non hazardous*, analytes in plain text are unclassified;
according to JAGDAG Determination List June 2010

Notes:

1. Environment Agency. Groundwater Protection: Principles and Policy (GP3). Part 1 – 4. Part 4 and 5 under consultation.
2. Statutory Instrument 2000 No. 3184. The Water Supply (Water Quality) Regulations 2000, as amended by SI 2001/2885, SI 2002/2469, SI 2005/2035, SI 2007/2734 and SI 2010/991 (applying from April 20 2010)
3. Statutory Instrument 1989 No. 1147. The Water Supply (Water Quality) Regulations 1989, as amended.
4. Minimum reporting values listed in Annex (j) of Horizontal Guidance Note H1 (H1 Environmental Risk Assessment Framework, Environment Agency, April 2010 v2.0). Note target concentration for xylenes is 0.003mg/l each for o-xylene and m/p xylene.
5. Statutory Instrument 2000 No. 3184. The Water Supply (Water Quality) Regulations 2000 – sum of chloroform, bromoform, dibromochloromethane and bromodichloromethane.
6. Proposed list of EQS for implementation of the Dangerous Substances Directive (76/464.EEC).
7. Environment Agency MTBE guidance, 2006.
8. Freshwater Environmental Quality Standards: The Water Framework Directive 200/60/EC.
9. WHO (2004) guidelines for drinking-water quality.
10. WRc plc (2002), R&D Technical Report P45. Where predicted no-effect concentration is below the laboratory method detection limit (LMDL) for chrysene, dibenzo(a,h)anthracene and fluoranthene, the target concentration has been set at the LMDL of 0.00001mg/l.
11. Please note this is a very conservative value. If necessary please refer to EA, 2009. *Petroleum hydrocarbons in Groundwater Supplementary Guidance for Hydrogeological Risk Assessment, which* provides advice on risk rankings of TPH CWG fractions. It may be possible to eliminate low risk fractions and/or those not detected above LMDL from concern.
12. Environment Agency Chemical Standards Database (May 2011). http://evidence.environment-agency.gov.uk/ChemicalStandards/home.aspx
13. The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010.
    - 13a. Annual mean concentration (mg/l) for 'Good' standard.
    - 13b. Applies to hardness ranges of <40mg/l $CaCO_3$, 40–<50mg/l $CaCO_3$, 50–<100mg/l $CaCO_3$, 100–<200mg/l $CaCO_3$ and >/=200mg/l $CaCO_3$. The target concentrations included in Table 1 are listed in order of increasing calcium carbonate concentrations.
    - 13c Annual Average EQS (surface waters).
    - 13d. Sum of aldrin, dieldrin, endrin and isodrin.
    - 13e. Applies to hardness ranges of 0–50mg/l $CaCO_3$, 50–100mg/l $CaCO_3$, 100–250mg/l $CaCO_3$ and >250mg/l $CaCO_3$. The target concentrations included in Table 1 are listed in order of increasing calcium carbonate concentrations; applies to annual mean concentration (mg/l) of $CaCO_3$. Applies to annual mean concentration of metal (mg/l) for 'Good' standard.

13f. Sum of benzo(b)fluoranthene and benzo(k)fluoranthene.

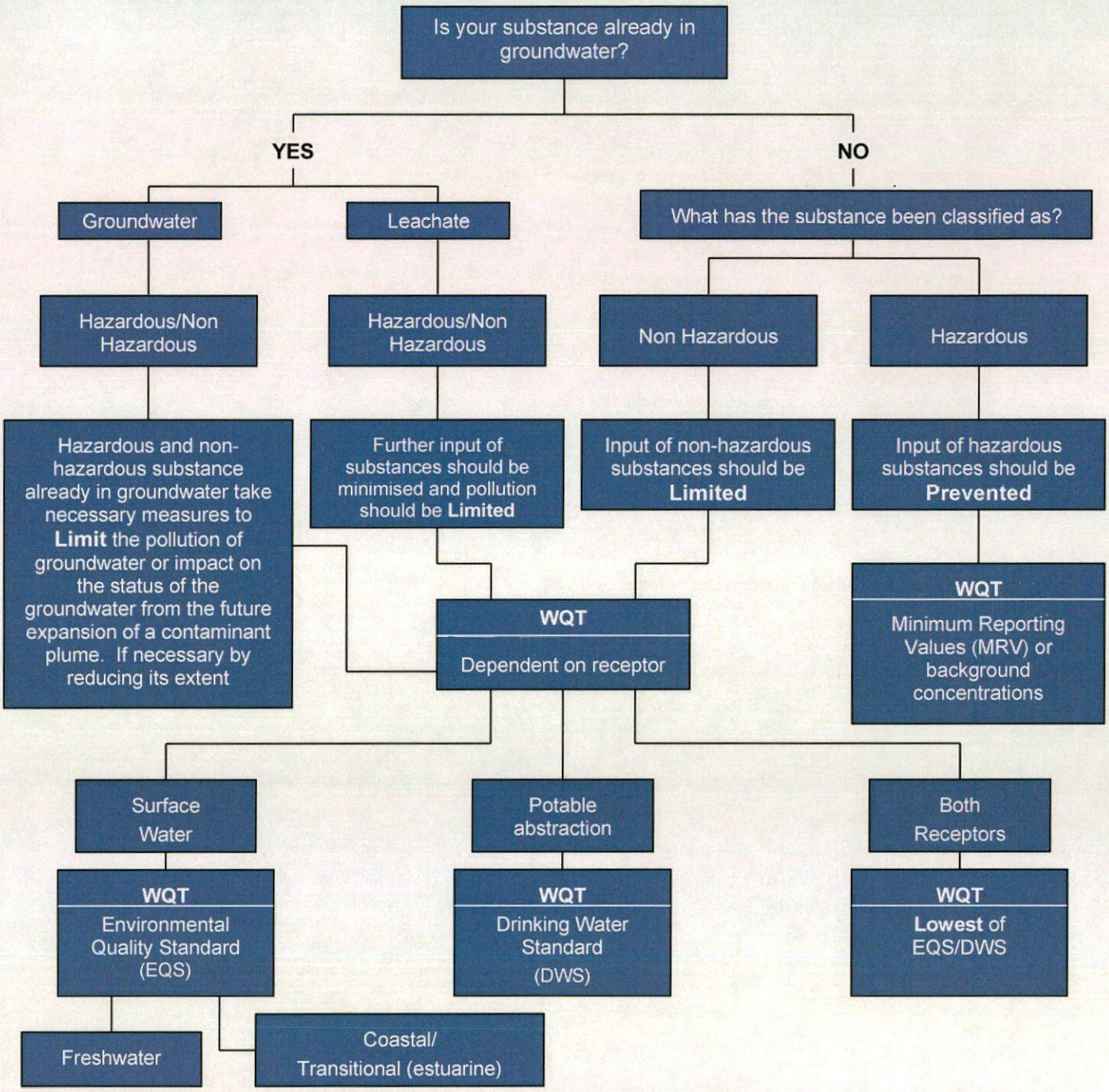
13g. Sum of benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene.

14. Council Directive on Pollution Caused by Certain Dangerous Substances Discharged into the Aquatic Environment of the Community (Dangerous Substances Directive) - List II Substances. Council Directive 76/464/EEC and Surface Waters (Dangerous Substances) (Classification) Regulations 1998

15. Council Directive on the Quality of Fresh Waters Needing Protection or Improvement in Order to Support Fish Life (Freshwater Fish Directive). Surface Waters (Fishlife) (Classification) Regulations 1997.

Note: '-' A target concentration is not available.

FLOW CHART TO ASSIST WITH SELECTION OF TARGET CONCENTRATIONS



WQT = Water Quality Target

When leachate is being assessed the 'compliance point' is the groundwater body. Therefore dilution within the groundwater body may be applied with caution before comparing with the WQT.

When directly assessing a receptor, e.g., a river, the appropriate WQT should be selected.

APPENDIX L
CERTIFICATES OF GEOTECHNICAL ANALYSIS

STRUCTURAL SOILS LTD

TEST REPORT

Report No. 781047 R2

Date	04-December-2013	Contract	North Gawber

Client RSK Environment Ltd
Address Spring Lodge
172 Chester Road
Helsby
Cheshire WA6 0AR

For the Attention of Emily jones

Samples submitted by client	20/11/2013	Client Reference	321370
Testing Started	21/11/2013	Client Order No.	
Testing Completed	04/12/2013	Instruction Type	Written

Ukas Accredited Tests Underatken

Moisture Content (oven drying method) BS1377:Part 2:1990,clause 3.2
Liquid Limit (one point method) BS1377:Part 2:1990,clause 4.3
Plastic Limit BS1377:Part 2:1990,clause 5.3
Plasticity Index Derivation BS1377:Part 2:1990,clause 5.4
Particle Size Distribution wet sieve method BS1377:Part 2:1990,clause 9.2
Dry density/moisture content relationship 2.5kg rammer method BS1377 Part 4:1990,clause 3.3/.3.4

Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	% <425um	Description of Sample
BH201	2	D	1.40	20	45	23	22	61	Grey slightly sandy slightly gravelly CLAY
BH202	2	D	1.40	36	39	20	19	81	Dark grey slightly sandy slightly gravelly CLAY
BH202	5	D	2.90	21	47	21	26	100	Grey mottled orange slightly sandy CLAY
BH204	5	D	2.90	25	56	24	32	96	Grey slightly sandy slightly gravelly CLAY
BH206	2	D	1.40	26	44	20	24	75	Grey slightly sandy slightly gravelly CLAY
TP203	3	B	2.70	27	49	26	23	46	Orange brown slightly sandy gravelly CLAY
TP215	1	B	1.50	13	40	21	19	46	Dark grey slightly sandy slgihtly gravelly CLAY

STRUCTURAL SOILS LTD

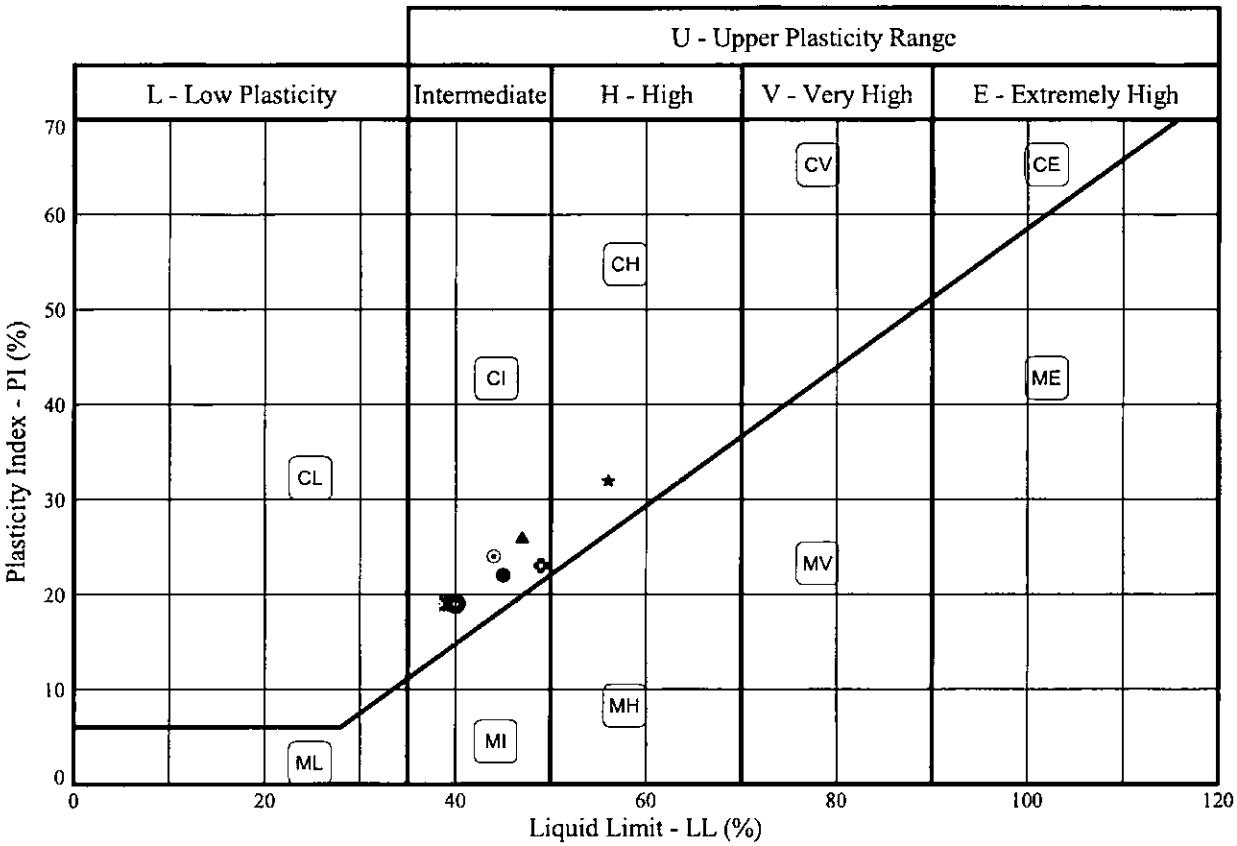
Contract: **North Gawber**

Contract Ref: **781047**

AGS

PLASTICITY CHART - PI Vs LL

In accordance with clause 42.3 of BS5930:1999
Testing in accordance with BS1377-2:1990



Sample Identification				BS Test Method #	Preparation Method +	MC	LL	PL	PI	<425um
	Exploratory Position ID	Sample	Depth (m)			%	%	%	%	%
●	BH201	2D	1.40	3.2/4.4/5.3/5.4	4.2.4	20	45	23	22	61
⧗	BH202	2D	1.40	3.2/4.4/5.3/5.4	4.2.4	36	39	20	19	81
▲	BH202	5D	2.90	3.2/4.4/5.3/5.4	4.2.3	21	47	21	26	100
★	BH204	5D	2.90	3.2/4.4/5.3/5.4	4.2.4	25	56	24	32	96
⊙	BH206	2D	1.40	3.2/4.4/5.3/5.4	4.2.4	26	44	20	24	75
✿	TP203	3B	2.70	3.2/4.4/5.3/5.4	4.2.4	27	49	26	23	46
◉	TP215	1B	1.50	3.2/4.4/5.3/5.4	4.2.4	13	40	21	19	46

Tested in accordance with the following clauses of BS1377-2:1990.

3.2 - Moisture Content
4.3 - Cone Penetrometer Method
4.4 - One Point Cone Penetrometer Method
4.6 - One Point Casagrande Method
5.3 - Plastic Limit Method
5.4 - Plasticity Index

+ Tested in accordance with the following clauses of BS1377-2:1990.

4.2.3 - Natural State
4.2.4 - Wet Sieved

Key: * = Non standard test, NP = Non plastic.

Approved Signatories: J.BARRETT M.ATHORNE A.FROST M.RANDERSON R.CLARKSON M.FISHER C.COLE M.STOKES

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The Potteries
Pottery Street
Castleford
W. Yorkshire WF10 1NJ

Compiled By		Date
M. Fisher	MAUREEN FISHER	04/12/13

Contract	Contract Ref:
North Gawber	781047

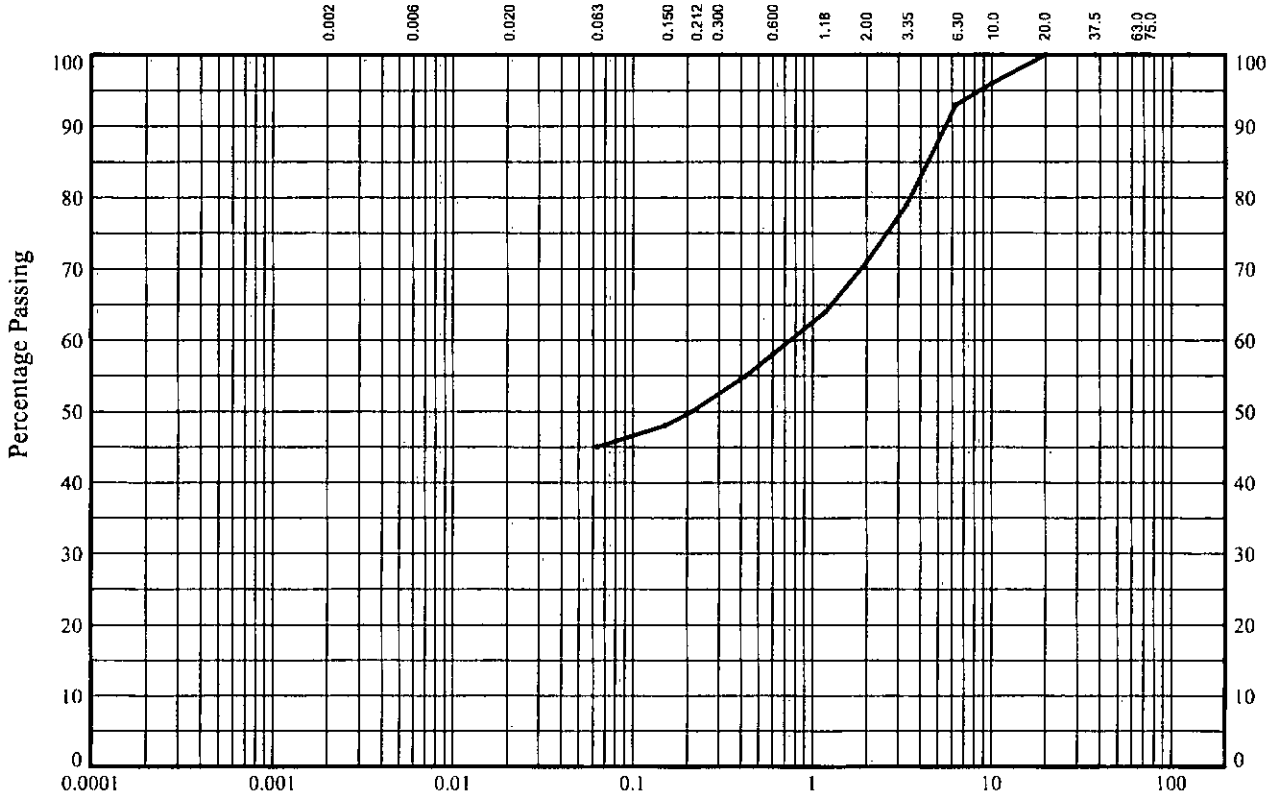
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PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

Borehole : **BH205** Sample Ref: **8** Sample Type: **B** Depth (m): **3.00**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	100
63.0	100
37.5	100
20.0	100
10.0	96
6.30	93
3.35	79
2.00	71
1.18	64
0.600	58
0.425	55
0.212	50
0.150	48
0.063	45

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
GRAVEL	**29**
SAND	**26**
SILT/CLAY	**45**

Soil Description:
Dark brown slightly sandy slightly gravelly CLAY

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The Potteries
Pottery Street
Castleford
W. Yorkshire WF10 1NJ

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M. Fisher	MAUREEN FISHER	04/12/13

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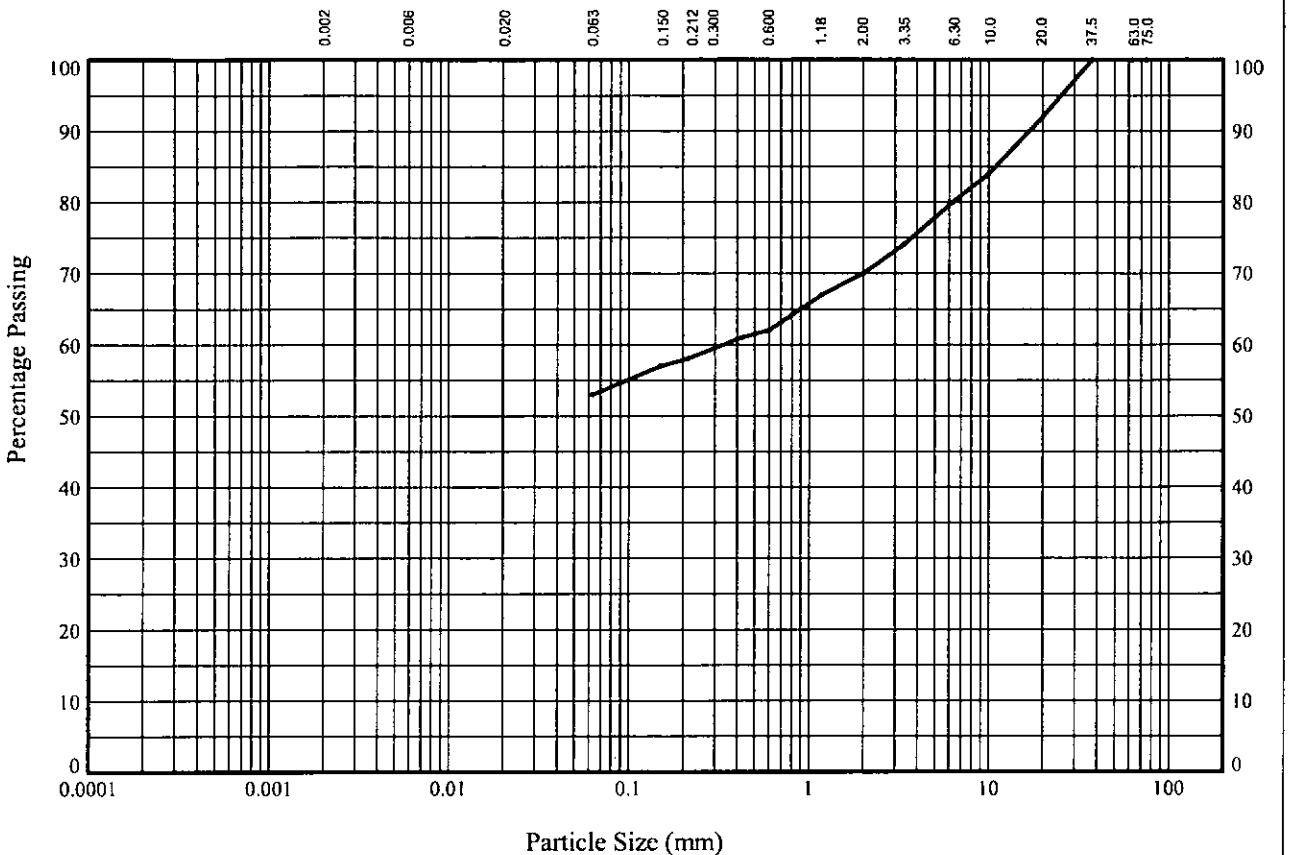
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PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

Borehole : **BH206** Sample Ref: **4** Sample Type: **B** Depth (m): **1.50**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	100
63.0	100
37.5	100
20.0	92
10.0	84
6.30	80
3.35	74
2.00	70
1.18	67
0.600	62
0.425	61
0.212	58
0.150	57
0.063	53

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
GRAVEL	**30**
SAND	**17**
SILT/CLAY	**53**

Soil Description:
Grey slightly sandy slightly gravelly CLAY

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W. Yorkshire WF10 1NJ

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M. Fisher	**MAUREEN FISHER**	**04/12/13**

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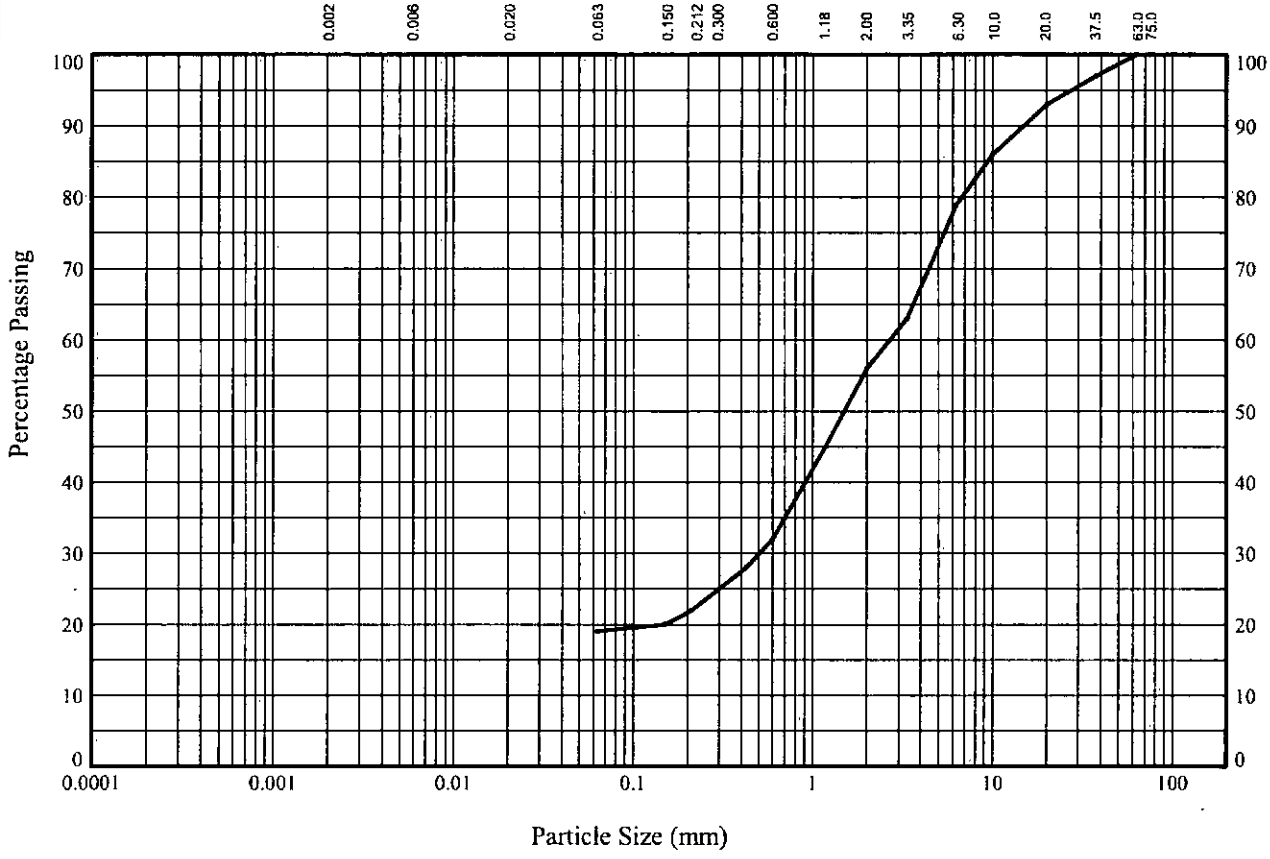
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PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

Borehole : **BH207** Sample Ref: 7 Sample Type: **B** Depth (m): **3.00**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	100
63.0	100
37.5	97
20.0	93
10.0	86
6.30	79
3.35	63
2.00	56
1.18	45
0.600	32
0.425	28
0.212	22
0.150	20
0.063	19

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
GRAVEL	**44**
SAND	**37**
SILT/CLAY	**19**

Soil Description:
Dark brown sandy gravelly CLAY

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Pottery Street
Castleford
W. Yorkshire WF10 1NJ

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M. Fisher	MAUREEN FISHER	04/12/13

Contract	Contract Ref:
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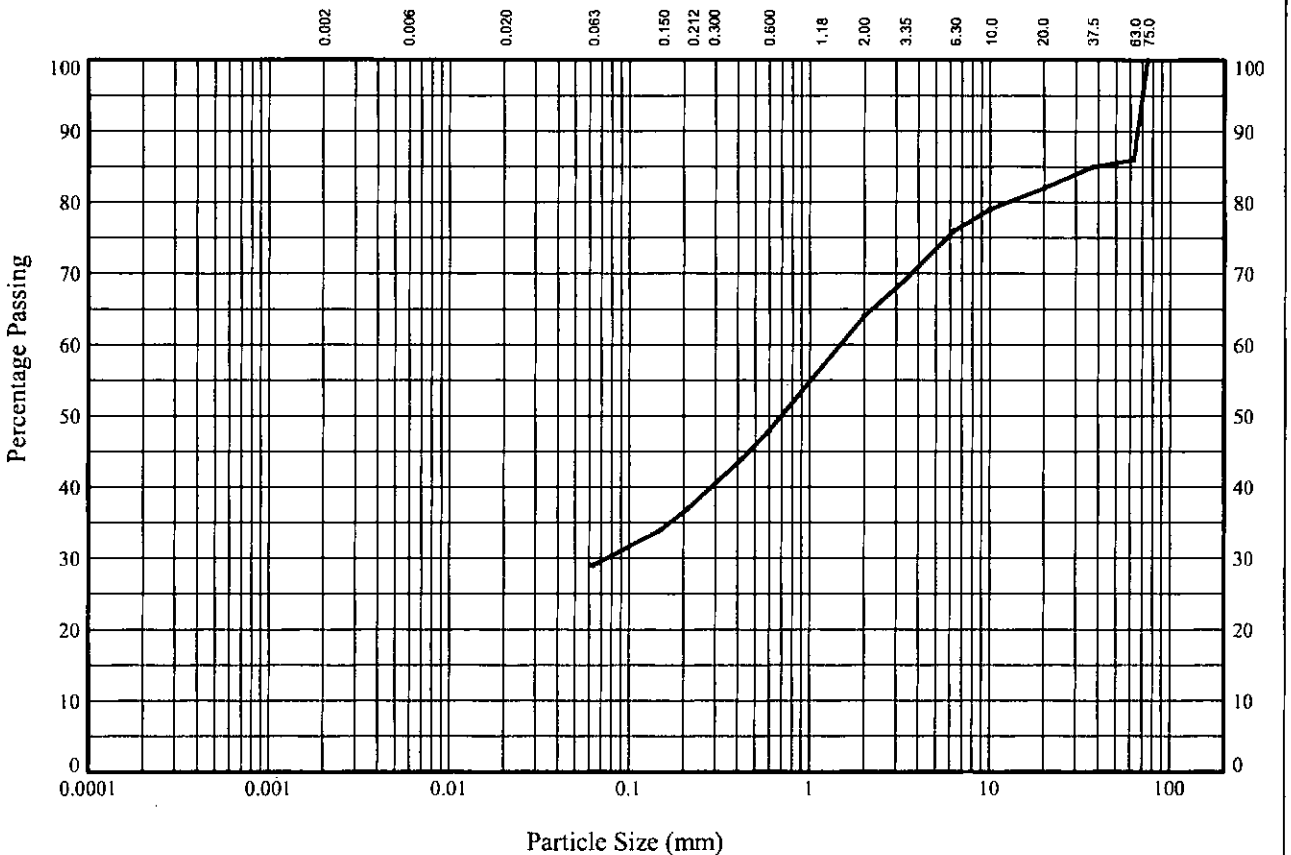
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PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

Borehole : **BH208** Sample Ref: **1** Sample Type: **B** Depth (m): **0.40**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	100
63.0	86
37.5	85
20.0	82
10.0	79
6.30	76
3.35	69
2.00	64
1.18	57
0.600	48
0.425	44
0.212	37
0.150	34
0.063	29

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
COBBLES	**14**
GRAVEL	**22**
SAND	**35**
SILT/CLAY	**29**

Soil Description:
Dark brown sandy slightly gravelly CLAY with some cobbles

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Pottery Street
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W. Yorkshire WF10 1NJ

Compiled By		Date
M. Fisher	**MAUREEN FISHER**	**04/12/13**

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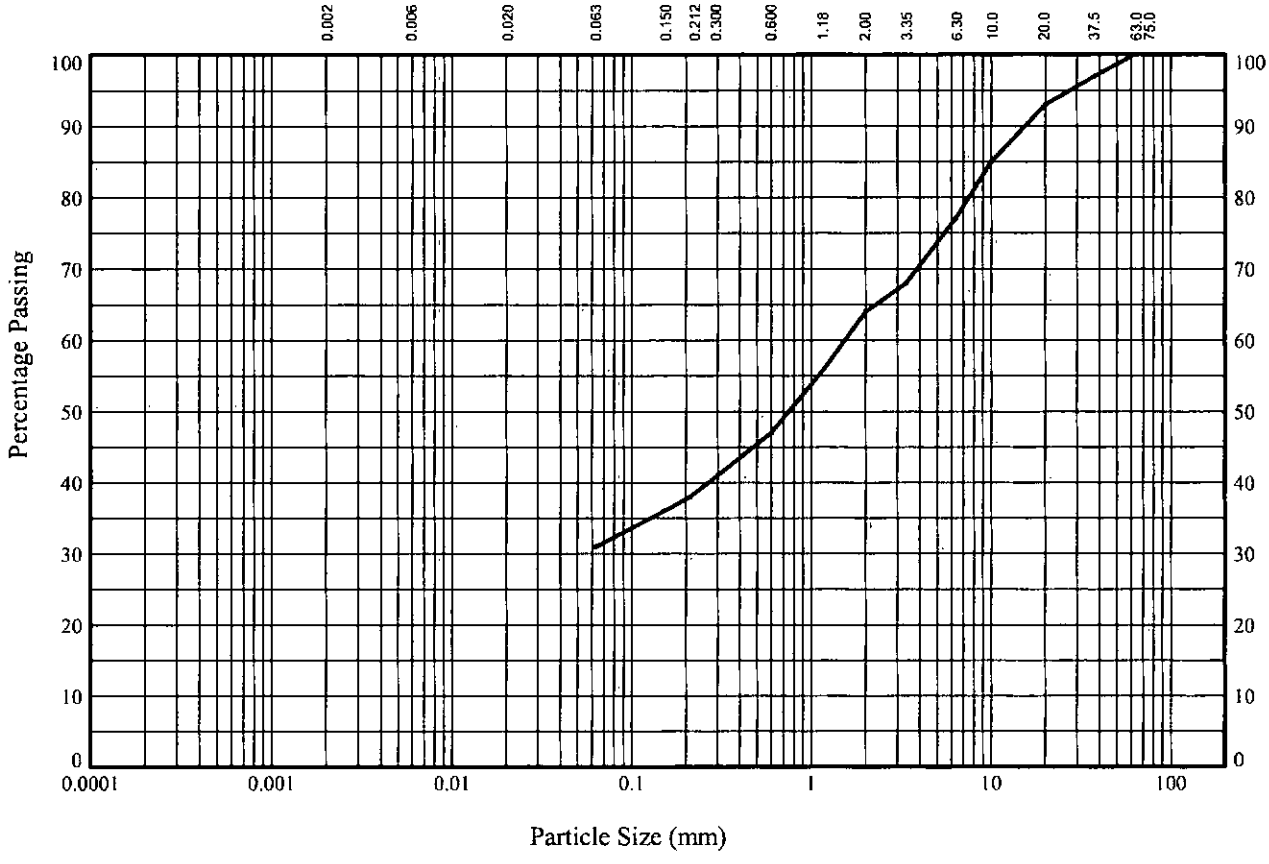
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PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

Borehole : **BH209** Sample Ref: 7 Sample Type: **B** Depth (m): **3.00**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	100
63.0	100
37.5	97
20.0	93
10.0	85
6.30	77
3.35	68
2.00	64
1.18	56
0.600	47
0.425	44
0.212	38
0.150	36
0.063	31

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
GRAVEL	**36**
SAND	**33**
SILT/CLAY	**31**

Soil Description:
Dark brown slightly sandy gravelly CLAY

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The Potteries
Pottery Street
Castleford
W. Yorkshire WF10 1NJ

Compiled By		Date
M. Fisher	MAUREEN FISHER	04/12/13

Contract	Contract Ref:
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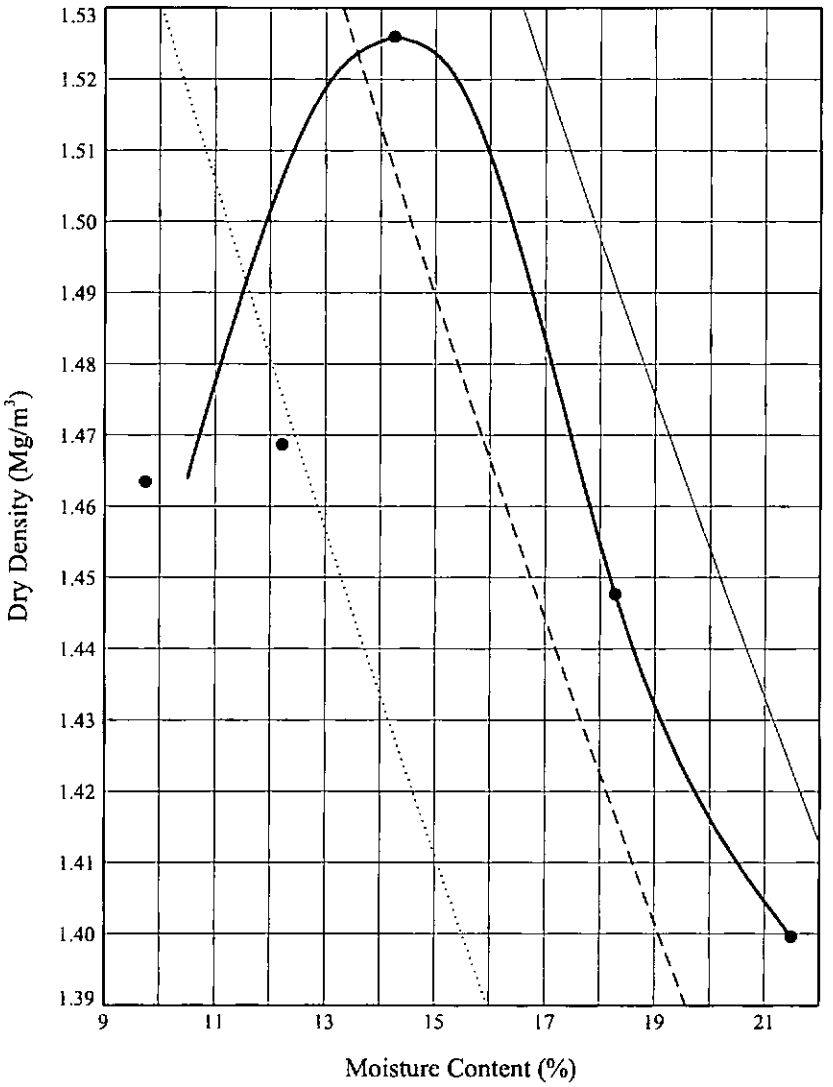
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DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

In accordance with clauses 3.3,3.4,3.5,3.6,3.7 of BS1377:Part 4:1990

Borehole : **BH201** Sample Ref: **3** Sample Type: **B** Depth (m): **1.50**



Initial Sample Conditions			Test Details		Test Results		
Initial Moisture Content (%)	:	**21**	Compaction Type	: **Light**	Maximum Dry Density (Mg/m^3)	:	**1.53**
% Retained on 37.5mm BS Sieve	:	**0**	Mass of Rammer (kg):	**2.5**	Optimum Moisture Content (%)	:	**15**
% Retained on 20.0mm BS Sieve	:	**6**	Type of Mould	: **Proctor**	Method Used: **Clause 3.3**		
Particle Density - assumed (Mg/m^3)	:	**2.05**			Remarks:		
Size of Soil Pieces	:	**<20mm**	Separate samples were used.				

Sample Description	Key to Air Voids Lines		
Dark brown slightly sandy slightly gravelly CLAY with ash	—— 0%	- - - - 5%	····· 10%

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The Potteries
Pottery Street
Castleford
W. Yorkshire WF10 1NJ

Compiled By		Date
MRanderson	**MICK RANDERSON**	**04/12/13**

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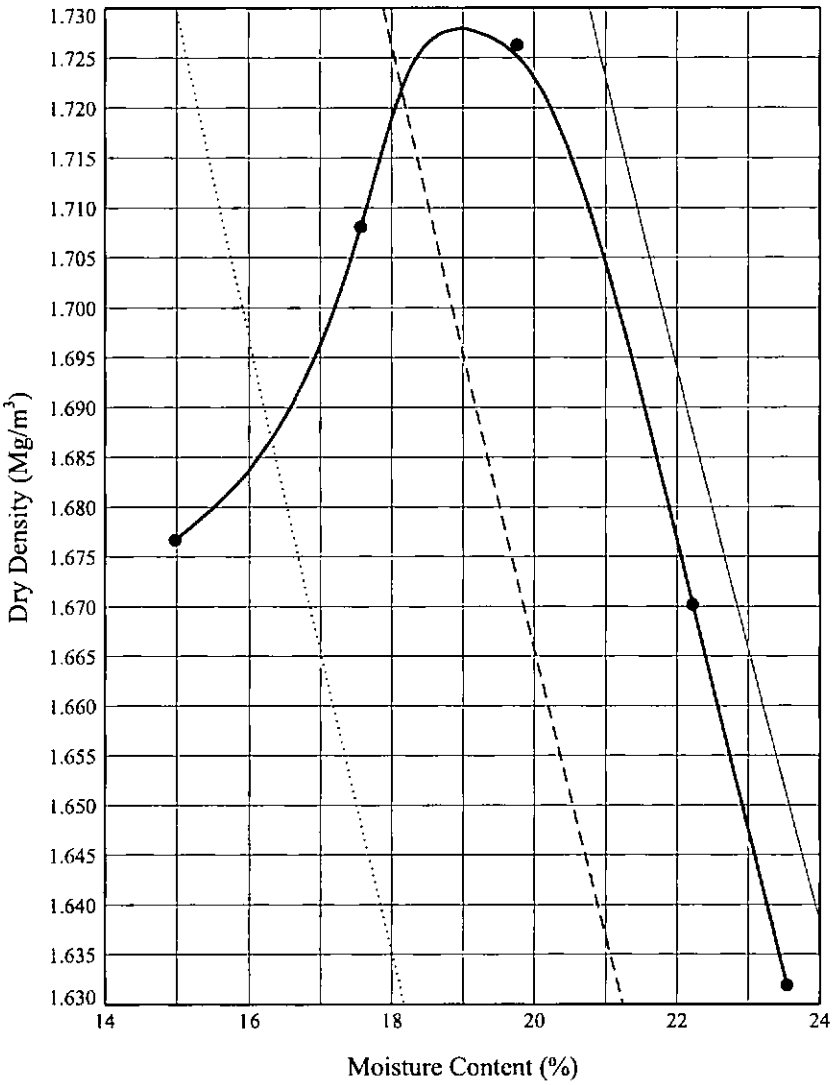
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DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

In accordance with clauses 3.3,3.4,3.5,3.6,3.7 of BS1377:Part 4:1990

Borehole : **BH202** Sample Ref: **7** Sample Type: **B** Depth (m): **3.00**



Initial Sample Conditions		Test Details	Test Results
Initial Moisture Content (%)	: **20**	Compaction Type : **Light**	Maximum Dry Density (Mg/m³) : **1.73**
% Retained on 37.5mm BS Sieve	: **0**	Mass of Rammer (kg): **2.5**	Optimum Moisture Content (%) : **19**
% Retained on 20.0mm BS Sieve	: **0**	Type of Mould : **Proctor**	Method Used: **Clause 3.3**
Particle Density - assumed (Mg/m³)	: **2.70**		Remarks:
Size of Soil Pieces	: **<20mm**	Separate samples were used.	

Sample Description	Key to Air Voids Lines		
Light brown/grey CLAY	—— 0%	- - - - 5%	····· 10%

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Compiled By		Date
M. Athorne	MARK ATHORNE	04/12/13

Contract	Contract Ref:
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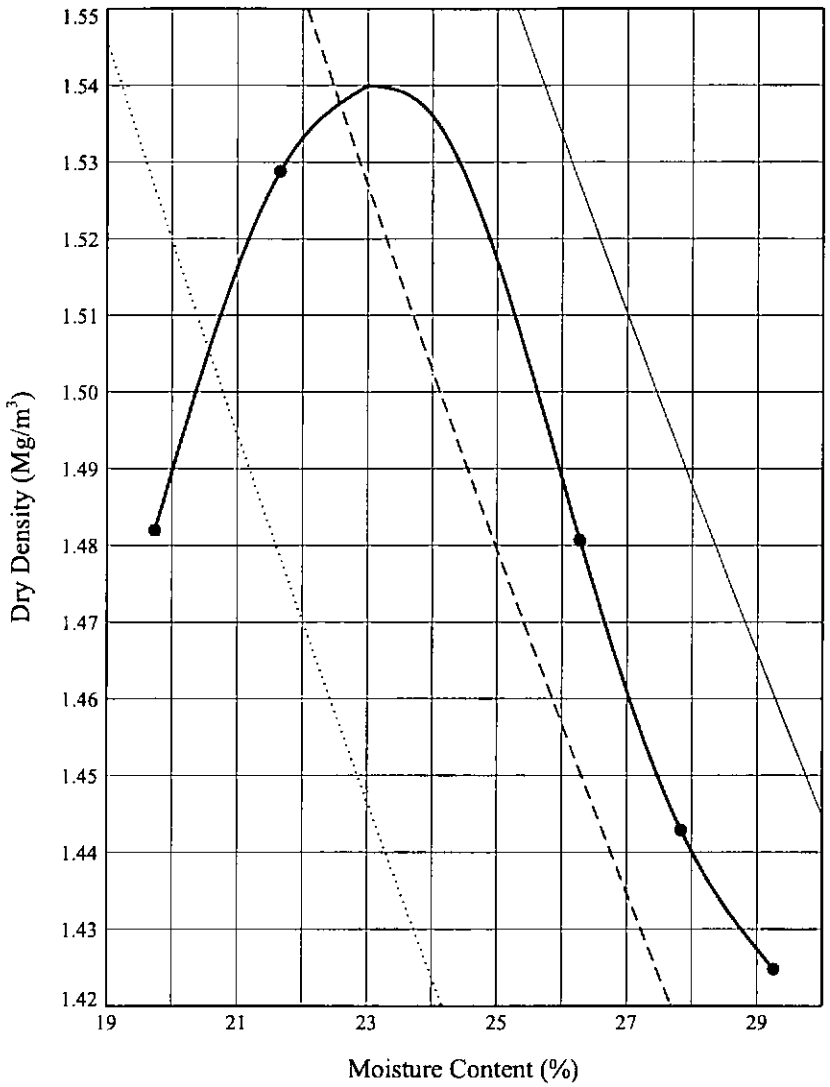
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DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

In accordance with clauses 3.3,3.4,3.5,3.6,3.7 of BS1377:Part 4:1990

Borehole : **BH204** Sample Ref: **7** Sample Type: **B** Depth (m): **3.00**



Initial Sample Conditions			Test Details		Test Results		
Initial Moisture Content (%)	:	**26**	Compaction Type	: **Light**	Maximum Dry Density (Mg/m³)	:	**1.54**
% Retained on 37.5mm BS Sieve	:	**0**	Mass of Rammer (kg):	**2.5**	Optimum Moisture Content (%)	:	**23**
% Retained on 20.0mm BS Sieve	:	**0**	Type of Mould	: **Proctor**	Method Used: **Clause 3.3**		
Particle Density - assumed (Mg/m³)	:	**2.55**			Remarks:		
Size of Soil Pieces	:	**<20mm**	Separate samples were used.				

Sample Description	Key to Air Voids Lines		
Dark grey/brown CLAY with ash	—— 0%	- - - - 5%	····· 10%

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The Potteries
Pottery Street
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W. Yorkshire WF10 1NJ

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M. Athorne	MARK ATHORNE 04/12/13

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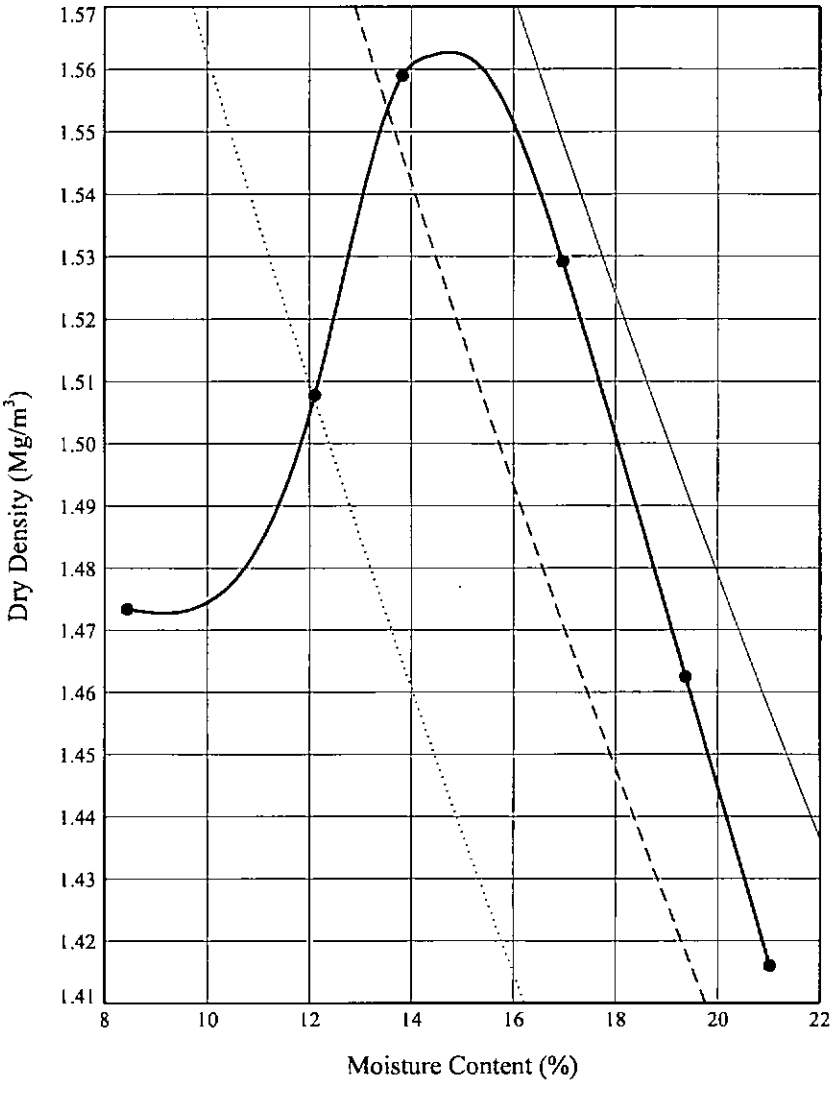
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DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

In accordance with clauses 3.3,3.4,3.5,3.6,3.7 of BS1377:Part 4:1990

Borehole : **BH205** Sample Ref: **5** Sample Type: **B** Depth (m): **1.50**



Initial Sample Conditions			Test Details		Test Results		
Initial Moisture Content (%)	:	**12**	Compaction Type	: **Light**	Maximum Dry Density (Mg/m³)	:	**1.56**
% Retained on 37.5mm BS Sieve	:	**0**	Mass of Rammer (kg):	**2.5**	Optimum Moisture Content (%)	:	**15**
% Retained on 20.0mm BS Sieve	:	**4**	Type of Mould	: **Proctor**	Method Used: **Clause 3.3**		
Particle Density - assumed (Mg/m³)	:	**2.10**			Remarks:		
Size of Soil Pieces	:	**<20mm**	Separate samples were used.				

Sample Description	Key to Air Voids Lines		
Dark brown slightly gravelly ASH	—— 0%	- - - - 5%	····· 10%

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The Potteries
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M. Athorne	MARK ATHORNE	04/12/13

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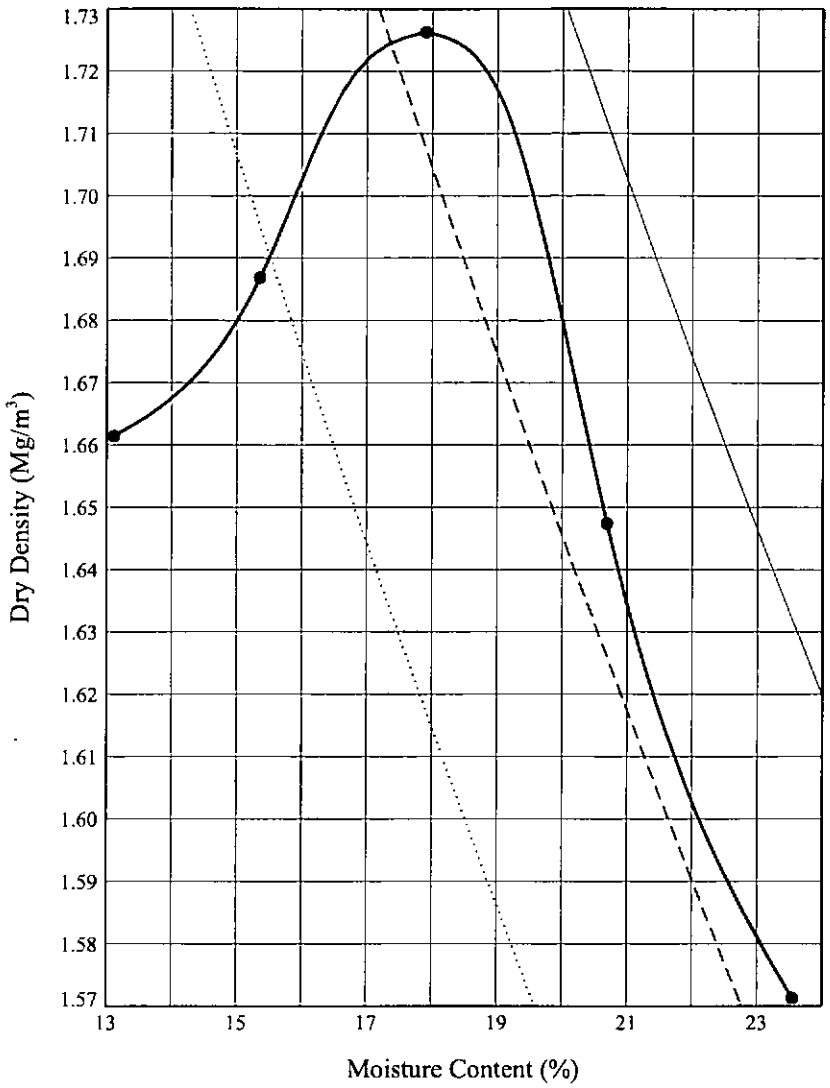
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DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

In accordance with clauses 3.3,3.4,3.5,3.6,3.7 of BS1377:Part 4:1990

Borehole : **BH206** Sample Ref: **7** Sample Type: **B** Depth (m): **3.00**



Initial Sample Conditions			Test Details		Test Results		
Initial Moisture Content (%)	:	**24**	Compaction Type	: **Light**	Maximum Dry Density (Mg/m³)	:	**1.73**
% Retained on 37.5mm BS Sieve	:	**0**	Mass of Rammer (kg):	**2.5**	Optimum Moisture Content (%)	:	**19**
% Retained on 20.0mm BS Sieve	:	**2**	Type of Mould	: **Proctor**	Method Used: **Clause 3.3**		
Particle Density - assumed (Mg/m³)	:	**2.65**			Remarks:		
Size of Soil Pieces	:	**<20mm**	Separate samples were used.				

Sample Description	Key to Air Voids Lines		
Grey CLAY/MUDSTONE	—— 0%	- - - - 5%	····· 10%

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The Potteries
Pottery Street
Castleford
W. Yorkshire WF10 1NJ

Compiled By		Date
M. Athorne	**MARK ATHORNE**	**04/12/13**

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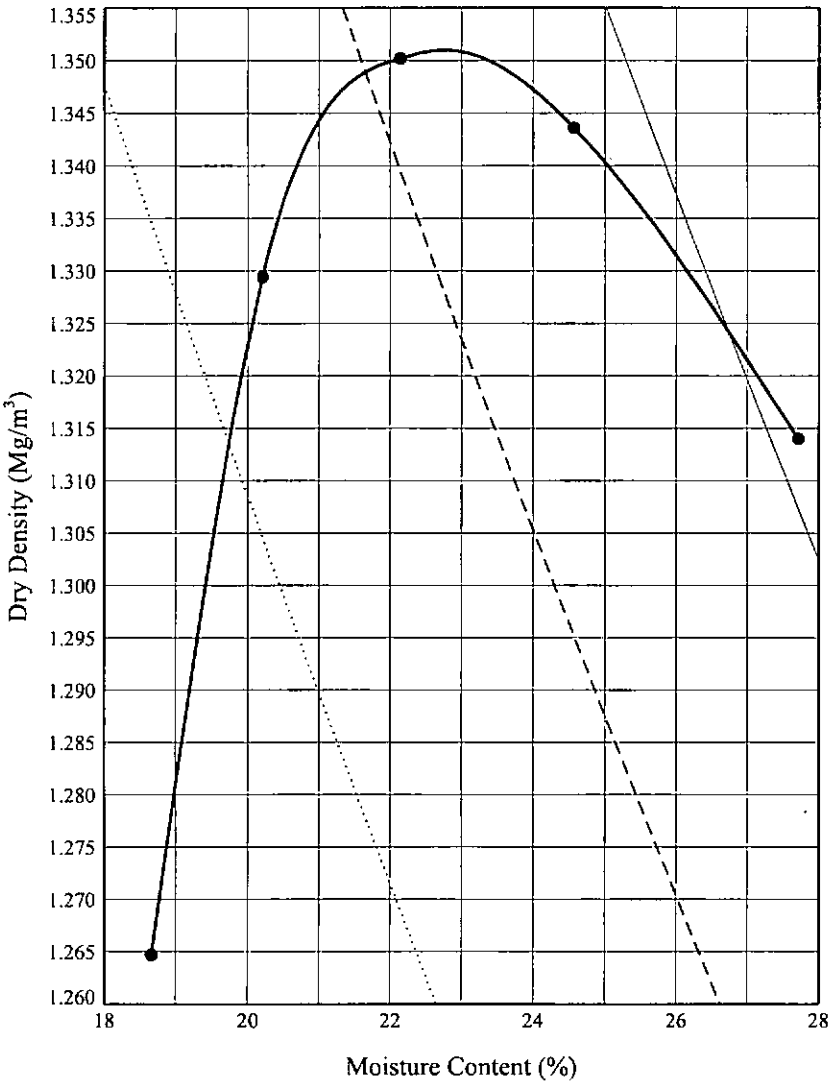
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DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

In accordance with clauses 3.3,3.4,3.5,3.6,3.7 of BS1377:Part 4:1990

Borehole : **BH207** Sample Ref: **4** Sample Type: **B** Depth (m): **1.50**



Initial Sample Conditions			Test Details			Test Results		
Initial Moisture Content (%)	:	**19**	Compaction Type	:	**Light**	Maximum Dry Density (Mg/m³)	:	**1.35**
% Retained on 37.5mm BS Sieve	:	**0**	Mass of Rammer (kg):		**2.5**	Optimum Moisture Content (%)	:	**22**
% Retained on 20.0mm BS Sieve	:	**0**	Type of Mould	:	**Proctor**	Method Used: **Clause 3.3**		
Particle Density - assumed (Mg/m³)	:	**2.05**				Remarks:		
Size of Soil Pieces	:	**<20mm**	Separate samples were used.					

Sample Description	Key to Air Voids Lines		
Black slightly gravelly ASH	—— 0%	- - - - 5%	····· 10%

Approved Signatories: J.BARRETT M.ATHORNE A.FROST M.RANDERSON R.CLARKSON M.FISHER C.COLE M.STOKES

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Castleford
W. Yorkshire WF10 1NJ

Compiled By	Date
M. Athorne	MARK ATHORNE 04/12/13

Contract	Contract Ref:
North Gawber	**781047**

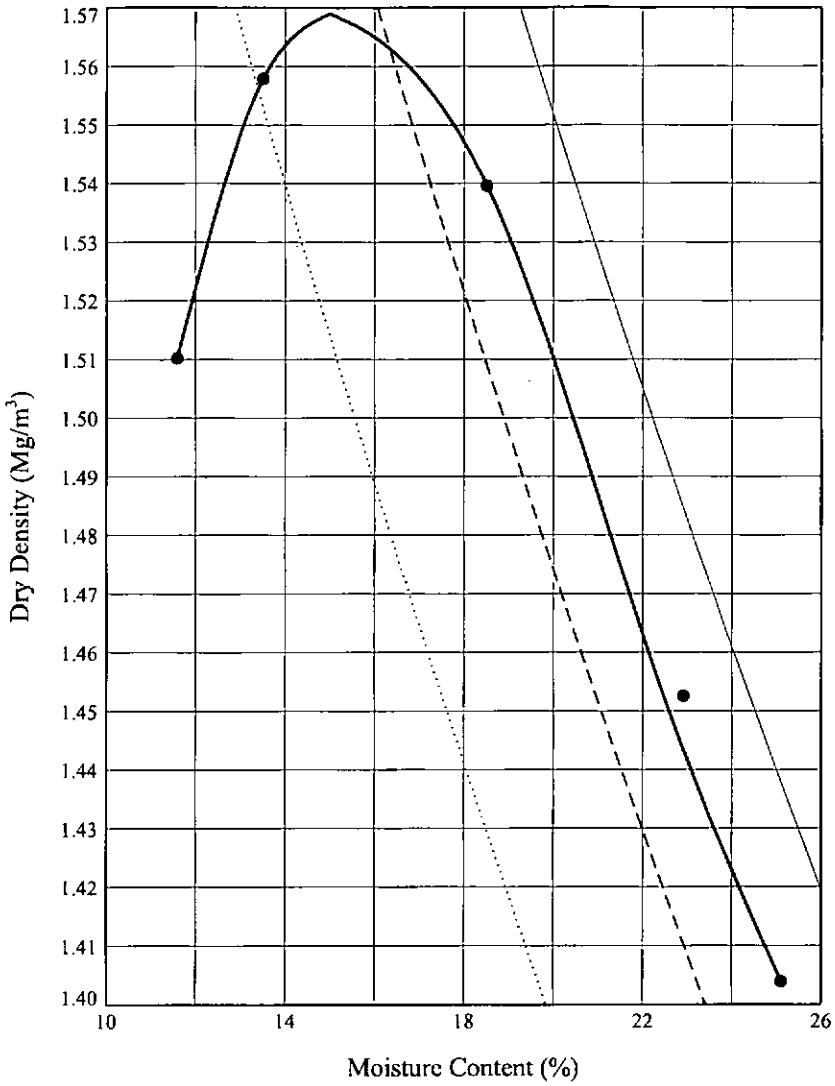
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GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Geotech Lab-Castleford - 0002 | Graph L - COMPACTIONS | 781047 - NORTH GAWBER.GPJ - v8_05 | 04/12/13 - 16:53 | MF.
Structural Soils Ltd. Branch Office - Castleford: The Potteries, Pottery Street, Castleford, West Yorkshire, WF10 1NJ. Tel: 01977-552255, Fax: 01977-552299, Web: www.soils.co.uk, Email: nsk@soils.co.uk.

DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

In accordance with clauses 3.3,3.4,3.5,3.6,3.7 of BS1377:Part 4:1990

Borehole : **BH208** Sample Ref: **7** Sample Type: **B** Depth (m): **3.00**



Initial Sample Conditions		Test Details		Test Results	
Initial Moisture Content (%)	: **14**	Compaction Type	: **Light**	Maximum Dry Density (Mg/m³)	: **1.57**
% Retained on 37.5mm BS Sieve	: **0**	Mass of Rammer (kg):	**2.5**	Optimum Moisture Content (%)	: **15**
% Retained on 20.0mm BS Sieve	: **0**	Type of Mould	: **Proctor**	Method Used: **Clause 3.3**	
Particle Density - assumed (Mg/m³)	: **2.25**			Remarks:	
Size of Soil Pieces	: **<20mm**	Separate samples were used.			

Sample Description	Key to Air Voids Lines		
Black ASH	—— 0%	- - - - 5%	····· 10%

Approved Signatories: J.BARRETT M.ATHORNE A.FROST M.RANDERSON R.CLARKSON M.FISHER C.COLE M.STOKES

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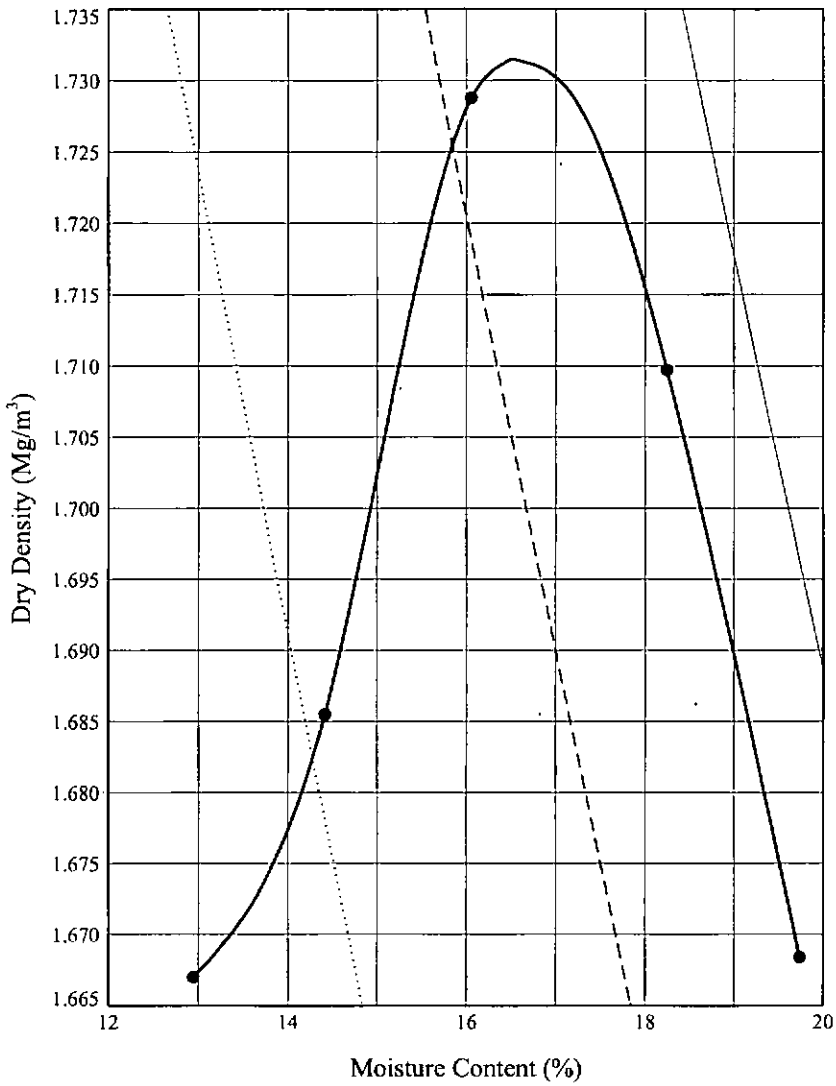
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DRY DENSITY / MOISTURE CONTENT RELATIONSHIP TEST

In accordance with clauses 3.3,3.4,3.5,3.6,3.7 of BS1377:Part 4:1990

Borehole : **BH209** Sample Ref: **4** Sample Type: **B** Depth (m): **1.50**



Initial Sample Conditions			Test Details			Test Results		
Initial Moisture Content (%)	:	**16**	Compaction Type	:	**Light**	Maximum Dry Density (Mg/m³)	:	**1.73**
% Retained on 37.5mm BS Sieve	:	**0**	Mass of Rammer (kg):		**2.5**	Optimum Moisture Content (%)	:	**16**
% Retained on 20.0mm BS Sieve	:	**16**	Type of Mould	:	**CBR**	Method Used: **Clause 3.4**		
Particle Density - assumed (Mg/m³)	:	**2.55**				Remarks:		
Size of Soil Pieces	:	**<20mm**	Separate samples were used.					

Sample Description	Key to Air Voids Lines		
Brown slightly sandy gravelly CLAY	—— 0%	- - - - 5%	····· 10%

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TESTING VERIFICATION CERTIFICATE

UKAS TESTING
1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

In accordance with Structural Soils Ltd Laboratory Quality Assurance Manual, Issue 6, January 2010 all results sheets and summaries of results issued by the laboratory are checked by an approved signatory. This check will also involve checking of at least 10% of calculations for each test type to ensure that data has been correctly entered into the computer and calculated. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Assurance Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **04/12/2013 17:11:05**.

Testing reported after this date is not covered by this Verification Certificate.

Approved Signatory
Mark Athorne (Laboratory Quality Manager)

STRUCTURAL SOILS The Potteries Pottery Street Castleford W. Yorkshire WF10 1NJ	Contract: **North Gawber**	Job No: **781047**

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