

Westchurch Homes

Ground Investigation Report

for

Land at Radcliffe Moor Road

July 2021

REPORT NO: 20WCH011/GI

- *Desk Studies and Site Walkovers*
- *Intrusive Contaminated Land Investigations*
- *Geotechnical Appraisals and Ground Investigations*
- *Landfill Gas Assessments and Remedial Design*
- *Remediation Design and Implementation*
- *Remediation Project Management and Supervision*
- *Site Abnormal Assessments (Foundations and Contaminated Land)*

GEOTECHNICAL - CONTAMINATED LAND - FLOOD RISK

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DOCUMENT ISSUE RECORD

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Prepared by:



K Rodway

Checked by:



M Fawcett

Authorised by:



M Fawcett

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1 EXECUTIVE SUMMARY

Note – The following summary is not exhaustive and is to be used for guidance purposes only. The full report should be consulted for full details.

1. Site Location

The site is located to the south of Bury New Road and either side of Radcliffe Moor Road, Bury, BL2 6QU. The coordinates on the British National Grid CRS are 375680, 408903.

2. Site Description

On Site

Site was visited by a Geo-Environmental Engineer on 19th October 2020 and the following section outlines the main features of site.

The overall development site is split across two (2 No.) parcels of land and are located to the south of Bury New Road on both sites of Radcliffe Moor Road. The two parcels are irregular in plan form and comprise several fields. The section of the site of which application is required is the section in the west, therefore this section will be referred to as the "site" from now on and the "overall development site" when considering both parcels. The site is currently laid down to rough grass with a hedgerow dividing the parcel into two fields. The area in the south of the site was noted as being wet and soft underfoot and is generally lower at circa 100m AOD with the northern end lying at circa 115m AOD. Approximately halfway along the eastern boundary a small hump with bushes and rush/sedge vegetation was noted. This is where the former coal mine was located and is discussed in more detail in the sections below. A high-pressure gas pipeline was noted running across the middle of the site orientated east-west with marker posts close where it crosses hedges. In the north of the site an area of vehicular related rubbish was noted at the boundary with an adjacent garage and Himalayan Balsam also present here.

Surrounding Area

Surrounding land uses for the site are as follows:

- North – Immediately north is Bury New Road followed by a row of residential properties. Beyond is a mixture of agricultural land and a large farm.
- East – 0m – 500m E is agricultural land.
- South – Immediately south is a reservoir followed by Browns Road. Beyond Browns Road is an industrial estate to 350m S with residential properties beyond.
- West – 0m – 250m W are agricultural fields followed by a Brinks Lane, a watercourse and residential properties.

3. Proposed Development

The proposed development consists of sports pitches with associated sports pavilion and changing rooms.

4. Site History

On Site

The site has a number of historic uses including a former well, a pumping pit (for drainage of coal mines), possible mound of made / reworked ground (central west) and former houses along the boundary edge.

5. Published Geology

The BGS map shows the geology beneath the following:

- **Drift – Glacial Till** – Sandy gravelly silty CLAY.
- Very north and south - **Pennine Lower Coal Measures Formation** – Mudstone, Siltstone and Sandstone
- Centre of site - **Cannel Rock (south Lancashire)** – Sandstone and **Trencherbone Rock** - Sandstone

6. Hydrogeology and Hydrology

- The Superficial deposits of the Glacial Till are classed as a Secondary Aquifer – Undifferentiated.
- The bedrock deposits of the Sandstone and Pennine Coal Measure are classed as a Secondary A Aquifer – High Permeability.

- The site does not lie within Groundwater Source Protection Zone as defined by Natural Resources Wales.
- There are no current licenced groundwater water abstractions within 250m of site although there are four (4 No) historic licenses.
- The nearest surface water features are the reservoirs located immediately southwest of site.

7. Summary of Environmental Data

Possible Contamination Sources

- Current Land Use on Site – **No**
- Historical Land Use – On Site – **Possible (localised)**
- Surrounding Land Uses – Within 250m of site – Possible – **Possible**

Pathways and Receptors

- Aquifer below site – **Possible**.
- Site End Users – **Possible**.
- Construction Workers – **Yes**.

In this qualitative risk assessment, a **Low – High (development proposal dependent)** risk of contamination and ground gas exists. Remedial action is unlikely to be necessary however, the extent of the remedial action cannot be confirmed until the additional ground investigation is carried out.

8. Scope of Investigation

The fieldwork was carried out between 6th April and 18th May on non-consecutive days, and comprised the below;

- Four (4no) window sample boreholes to depths of 3.00mbgl. Targeted to the new Clubhouse
- Eight (8no) trial pits to depths between 2.00mbgl and 3.30mbgl (TP02). Coverage for pitches where cut is proposed – to assess material initially for suitability
- Seven (7no) rotary boreholes to depths between 12.00mbgl and 30.00mbgl – targeted to new clubhouse
- Chemical analysis (Metals, PAH's, TPH's) of six (6no) samples. Targeted to clubhouse
- Screening of six (6no) samples for asbestos. Targeted to clubhouse

9. Ground Conditions Encountered

Ground conditions can generally be summarised as TOPSOIL / MADE GROUND over shallow superficial deposits of both granular (sand and gravels) and cohesive (clay and silt) materials.

Superficial deposits were underlain by solid deposits of shale over sandstone.

MADE GROUND was recorded in TP01 only and was of CLAY with minor anthropogenic constituents.

10. Contamination Encountered

Marginally elevated concentrations of Arsenic (35mg/kg) and Lead (202mg/kg) have been observed in WS2 and WS1 respectively. Further to this, statistical analysis, using a Mean Value Test (US95), of the metals gives a US95 value of 29.53mg/kg for Arsenic and 185.93mg/kg Lead, which are significantly lower than the residential thresholds.

On the basis of the above, both metals may be discounted as it poses negligible to risk to sensitive receptors and is not representative of the wider site soils.

11. Remedial Actions

Soils

The site has no significant former contaminated uses identified. No significant contamination was encountered on site, therefore no specialist remedial action is required.

Where possible, identified Made Ground should be segregated to ensure no constituents such as glass end up within capping materials.

Further testing of topsoil and subsoil may be required for reuse criteria.

Groundwater and Aquifer Risk

No significant contamination sources have been identified within the soils onsite and given the presence of low permeability soils, the risk to groundwaters and the aquifer from site is considered very low.

12. Off-Site Disposal of Surplus Soil

It is recommended that the results of the contamination testing (including the history of the site) be presented to the proposed landfills, to obtain their acceptance of the information to date and to determine the actual WAC limits used by them. Segregation of made ground and natural should be possible given the chemical analysis and very different visual identification.

13. Specialist Ground Gas Measures

Due to the desk study report identifying no significant ground gas sources and no elevated concentrations recorded within the gas wells, the site has initially been classified as CS1.

As five visits have been undertaken to date, this will be confirmed on review of further results however for the purpose of pricing it would be prudent to assume CS2 protection will be required until the completion of the monitoring programme and the updating of the above ground gas risk assessment.

14. Foundations

The following bearing capacities can be assumed for conventional footings:

- Firm sandy CLAY with an allowable bearing pressure of 100kN/m².
- Firm to stiff sandy CLAY with an allowable bearing pressure of 100-125kN/m².

Areas of Granular strata, where water is not present:

- Medium dense SAND & GRAVEL with an allowable bearing pressure of 100kN/m².

Where water is present the ABP may be halved.

In the area of MADE GROUND around TP01, a trench fill solution may be used:

- Stiff sandy CLAY with an allowable bearing pressure of 125-150kN/m².

Localised deepening of foundations and / or piled foundations are likely to be required in the vicinity of trees – current layout avoids trees.

Foundations should be excavated wholly on one stratum. Should proposed foundations span different strata, trenching and stepping of foundations and/or nominal reinforcement will be required. A foundation zoning plan should be undertaken when proposed levels are made available.

Calculations on the allowable bearing capacity indicate settlements of less than 25mm for a square pad using the above allowable bearing capacity.

15. Highway / Sports Pitch

According to the criteria of Highways Agency HD 25/95 Volume 7 Section 2 Part 2 HD 25/94, a CBR value of 3-5% on the firm to stiff clay is anticipated and CBR values of 5% on the granular material encountered.

Preliminary CBR values undertaken at the Trial pit locations using a Mexicone gave results between 4 and 7% however in-situ CBR's should be undertaken during construction to confirm. Placement of geotextiles within the areas of roads / parking could also be designed to minimise the subgrade thickness.

Following liaison with a pitch construction specialist the following design parameters for a sports pitch

- 3% natural
- 5% on reworked

As such it is advised that the earthworks to achieve these will be very much weather / season dependant. Advice from a specialist Contractor is advised. Once formation levels are confirmed additional CBR testing is recommended.

16. Heave / Shrinkage Potential

Plasticity testing was not undertaken.

17. Ground Floor Construction

Shrinkable soils are present at shallow depth across the site and it is therefore recommended that suspended floor construction (e.g. either in-situ RC slabs or block and beam flooring) is adopted in accordance with NHBC guidance.

18. Control of Groundwater

Limited groundwater was encountered on site, however it is likely that provision of pumping/shuttering will be necessary during excavation of foundation trenches during wet weather and to deeper excavations for sewers etc. It is good practice to have such equipment on standby in case of seasonal / abnormal weather conditions.

19. Concrete Design

It is considered for concrete design purposes that a greenfield site and static groundwater conditions are applicable, and the results are summarised below:

Concrete Classification	
Design Sulphate Class	DS-1
ACEC Class	AC-1
Design Chemical Class	DC-1

20. Mining

7 boreholes were drilled to up to 30m on the site in the location of the proposed clubhouse. Three holes were drilled to 30m depth and a further 4 shallow holes to prove rockhead depth and search for the outcrop of the Trencherbone Mine. The Cannel Rock was encountered in every hole and there was no evidence of any coal or old mine workings, therefore a Low Risk to the proposed development.

2 SITE DESCRIPTION

2.1 Introduction

This investigation was carried out on the instruction of Westchurch Homes. The purpose of the work was to undertake ground investigation works based on the desk study findings to provide geotechnical and contamination risk information for the proposed construction of Sports Pitches, Club House and associated parking, new access road and associated infrastructure. The proposed site layout (sketch) can be seen below;



2.2 Site Location

The development site is located to the south of Bury New Road and to the west of Radcliffe Moor Road, Bury, BL2 6QU. The coordinates on the British National Grid CRS are 375680, 408903. The overall development site is approximately 11.73 hectares in total. See Site Location Plan in Appendix A.

2.3 Site Description

2.3.1 On Site

Site was visited by a Geo-Environmental Engineer on 19th October 2020 and the following section outlines the main features of site.

The overall development site is split across two (2 No.) parcels of land and are located to the south of Bury New Road on both sites of Radcliffe Moor Road. The two parcels are irregular in plan form and comprise several fields. The section of the site of which application is required is the section in the west, therefore this section will be referred to as the “site” from now on and the “overall development site” when considering both parcels. The site is currently laid down to rough grass with a hedgerow dividing the parcel into two fields. The area in the south of the site was noted as being wet and soft underfoot and is generally lower at circa 100m AOD with the northern end lying at circa 115m AOD. Approximately halfway along the eastern boundary a small hump with bushes and rush/sedge vegetation was noted. This is where the former coal mine was located and is discussed in more detail in the sections below. A high-pressure gas pipeline was noted running across the middle of the site orientated east-west with marker posts close where it crosses hedges. In the north of the site an area of vehicular related rubbish was noted at the boundary with an adjacent garage and Himalayan Balsam also present here.

2.3.2 Surrounding Area

Surrounding land uses for the site are as follows:

- **North** – Immediately north is Bury New Road followed by a row of residential properties. Beyond is a mixture of agricultural land and a large farm.
- **East** – 0m – 500m E is agricultural land.
- **South** – Immediately south is a reservoir followed by Browns Road. Beyond Browns Road is an industrial estate to 350m S with residential properties beyond.
- **West** – 0m – 250m W are agricultural fields followed by a Brinks Lane, a watercourse and residential properties.

3 ENVIRONMENTAL SETTING AND DATA

3.1 Previously Undertaken Reports / Investigation

Westchurch Homes previously commissioned Betts Geo to undertake a Desk Study Report, this report is referenced as follows;

- Land at Radcliffe Moor Road, Bury – Desk Study Report by Betts Geo – September 2021 (report reference 20WCH011/DS rev 1).

Where necessary the above report has been used throughout this report and referenced accordingly. The following 'Site History Summary', 'Geology' and 'Environmental Data' has been summarised the above report.

It should be noted that the above report covered the overall development site (two parcels of land to the east and west of Radcliffe Moor Road) however, as stated in section 2.3 above the development site which requires a planning application is in relation to the western parcel which is referred to as the "site" in this report.

3.2 Summary of Site History

3.2.1 On Site

The site has a number of historic uses including a former well, a pumping pit (for drainage of coal mines), possible mound of made / reworked ground (central west) and former houses along the boundary edge. The



suspected approximate locations are shown below;

3.2.2 Surrounding Area

The following table summarises the significant changes in historical use surrounding the site:

Date First Shown	Land Uses
1850	10m S – Reservoir (no longer shown circa 1890) 150m NW – Cotton Mill (shown as mill circa 1890. Shown as Bleach and dye works circa 1910). 260m SW – Bleaching Works with associated sluices (shown as print works circa 1890) 300m NW – Smithy (shown as mill circa 1890) 265m S – Railway line (shown as dismantled circa 1980) 400m N – Sandstone Quarry (no longer shown circa 1890) Within 500m – a number of coal pits to the S and W (no longer shown circa 1890) 700m S – Tonge Lane Colliery (shown as Bradley Fold Pottery circa 1890. Shown as saw mill circa 1974 and depot circa 1980 and residential circa 2010)
1890	10m SW – Reservoirs (expands circa 1937. Still present) 15m and 45m S – Old shafts (no longer shown circa 1937) 100m N – Old Shaft (no longer shown circa 1930) 400m N – Reservoir – still present
1910	0m N – Tramway (no longer shown circa 1937) 0m S – Pond (no longer shown circa 1972). 20m S – Refuse tip (no longer shown circa 1955). 250m SW – Bradley Fold Works (expands circa 1927. Labelled as works circa 1965 and trading estate circa 1980 to present)
1927	10m N – Tennis Ground (no longer shown circa 1955) 40m N – Small residential development (still present). 60m S – Soap Works (no longer shown circa 1955). 100m N – Filter Tank (no longer shown circa 1955). 250m S – Bradley Fold Mill (no longer labelled as mill circa 2020).
1937	5m SW – Reservoir (still present) 60m NE – small residential development (still present)
1955	10m S – Works (saw mill) (shown as metal works circa 1972. No longer labelled circa 2001. Building still present). 20m N – St Oswalds Church (shown as Masonic hall circa 1986).
1965	5m S – Additional reservoir (still present). 400m – 500m NW – Residential development (still present).
1974	270m – 400m W – Large residential development (still present).
1980	150m S – Residential Development (still present).
1991	60m SSE – Garden centre (no longer labelled as such circa 2020).
2001	260m SW – Large residential development (still present).
2010	No significant changes
2020	No significant changes

4 GEOLOGY

The following section details the published and available geological data available for the site and the surrounding area. This summary is taken from the reports referenced in Section 3.1 above. For full details, please refer to these reports. The geology maps are from the Desk Study report which shows the whole site not just the section of site relevant to the planning application.

4.1 Published Geology

The documented geology of the site is summarised on the British Geological Survey map principally, with further site-specific details detailed below.

Geology	Artificial Ground & Land Slip	Drift	Solid
1:10,000	Very southern area - Made Ground	Glacial Till – Sandy gravelly clay.	Very north and south - Pennine Lower Coal Measures Formation – Mudstone, Siltstone and Sandstone Centre of site - Cannel Rock (south Lancashire) – Sandstone and Trencherbone Rock - Sandstone

Artificial Ground & Land Slip

ID	Location	LEX Code	Description	Rock description
A	On site	MGR-ARTDP	Made Ground (Undivided)	Artificial Deposit



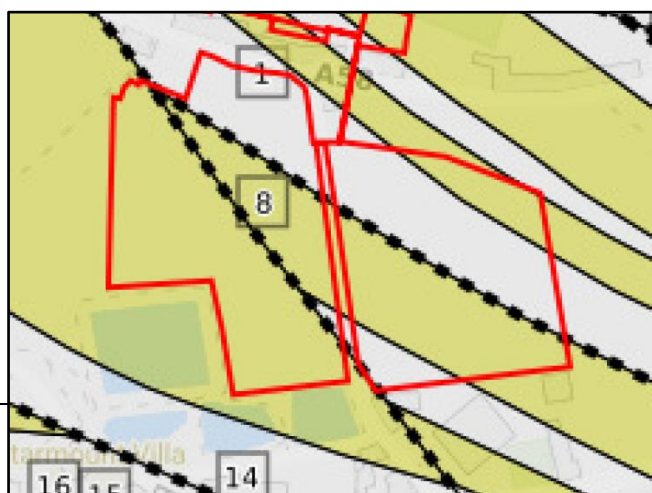
Superficial Geology

ID	Location	LEX Code	Description	Rock description
1	On site	TILLD-DMTN	Till, Devensian - Diamicton	Diamicton



Bedrock Geology

ID	Location	LEX Code	Description	Rock age
1	On site	PLCM-MDSS	Pennine Lower Coal Measures Formation - Mudstone, Siltstone And Sandstone	Langsettian Sub-age
2	On site	PLCM-MDSS	Pennine Lower Coal Measures Formation - Mudstone, Siltstone And Sandstone	Langsettian Sub-age
3	On site	CAR-SDST	Cannel Rock (south Lancashire) - Sandstone	Langsettian Sub-age
4	On site	TRBR-SDST	Trencherbone Rock - Sandstone	Langsettian Sub-age
5	On site	PLCM-MDSS	Pennine Lower Coal Measures Formation - Mudstone, Siltstone And Sandstone	Langsettian Sub-age
6	On site	CAR-SDST	Cannel Rock (south Lancashire) - Sandstone	Langsettian Sub-age



4.1.1 Linear Features

There are two (2 No) linear features on site (one coal seam and one fault line) and a further five (5 No) linear features within 250m of site (two coal seams and three faults). These are detailed below.

ID	Location	Category	Description
7	On site	ROCK	Coal seam, inferred coincident with bedrock geology boundary
8	On site	FAULT	Normal fault, inferred; crossmarks on downthrow side
13	95m NE	FAULT	Normal fault, inferred; crossmarks on downthrow side
14	106m SW	FAULT	Normal fault, inferred; crossmarks on downthrow side
16	143m S	ROCK	Coal seam, inferred
18	202m NE	ROCK	Coal seam, inferred
21	236m S	FAULT	Normal fault, inferred; crossmarks on downthrow side

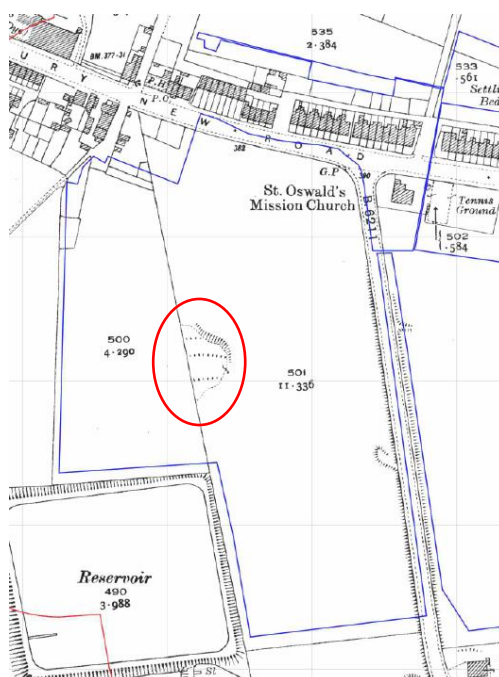
4.2 Geological Features

4.2.1 Surface Ground Workings

There are six (6 No) surface ground workings recorded on site with a further sixty one (61 No) identified within 250m of site. Those on site are detailed below. For further details please refer to the Groundsure report.

ID	Location	Land Use	Year of mapping	Mapping scale
1	On site	Refuse Heap	1955	1:10560
A	On site	Unspecified Heap	1965	1:10560
B	On site	Ponds	1965	1:10560
C	On site	Unspecified Heap	1927	1:10560
C	On site	Unspecified Ground Workings	1955	1:10560
C	On site	Pumping Pit	1890	1:10560

Note: the Groundsure reference to refuse heap is believed to be misleading – this areas as shown below is more likley to be associated with mine fill or earthowrks at this locality. Note this feature is in the proximity of the live high pressure gas main so cannot be investigated.



4.2.2 Under Ground Workings

There are eight (8 No) underground workings recorded within 250m of site. These are detailed overleaf, and all relate to old shafts;

ID	Location	Land Use	Year of mapping	Mapping scale
A	20m S	Unspecified Old Shafts	1890	1:10560
D	24m SE	Unspecified Old Shaft	1890	1:10560
A	26m S	Unspecified Old Shafts	1908	1:10560
D	28m SE	Unspecified Old Shaft	1908	1:10560
A	65m S	Unspecified Disused Shaft	1977	1:10000
A	67m S	Unspecified Old Shafts	1890	1:10560
A	74m S	Unspecified Old Shafts	1908	1:10560
A	78m S	Unspecified Old Shaft	1927	1:10560

4.2.3 Radon

The site boundary is in a lower probability area, as less than 1% of properties are above the action level.

Therefore, no radon protective measures are necessary in the construction of new dwellings or extensions.

4.2.4 Coal Mining

The site lies within an area affected by historical coal mining and a Coal Authority Report was obtained; the full report is available in the Betts Geo Desk Study report however, extracts are shown below. The Coal Authority Report refers to the overall development, not the planning application site.

Past underground mining

Colliery	Seam	Mineral	Coal Authority reference	Depth (m)	Direction to working	Dipping rate of seam worked (degrees)	Dipped direction of seam worked	Extraction thickness (cm)	Year last mined
unnamed	CANNEL	Coal	3Y5I	16	Beneath Property	14.0	South	150	1900
unnamed	TRENCHERB ONE	Coal	3Y96	23	Beneath Property	14.0	South	160	1908
unnamed	CANNEL	Coal	3Y5L	32	Beneath Property	14.0	South	150	1870
unnamed	CANNEL	Coal	3Y5K	33	Beneath Property	14.0	South	150	1900

Probable unrecorded shallow workings

Yes.

Remediated sites

Distance to site remediation (m)	Direction
37.1	South

See Section 4 for further information.

Mine entries

Entry type	Reference	Grid reference	Treatment description	Mineral	Conveyancing details
Shaft	375408-006	375761 408850		Coal	
Shaft	375408-007	375896 408720	This shaft was located in May 1989 by a prospective developer but there is no record of any treatment being afforded to the shaft.	Coal	
Shaft	375408-008	375873 408666	This shaft was located in May 1989 by a prospective developer but there is no record of any treatment being afforded to the shaft.	Coal	
Shaft	375409-001	375847 409128		Coal	
Shaft	375409-002	375871 409073	A visual inspection of the site in July 2002 revealed a shaft of about 3m in diameter filled with unknown material. A reinforced concrete cap was constructed in November 2002 by JMC Mining Services Ltd acting on behalf of the Coal Authority. The cap measures 5 metres square by 600mm thick and is sited 1.5 metres below ground level.	Coal	

Abandoned mine plan catalogue numbers

The following abandoned mine plan catalogue numbers intersect with some, or all, of the enquiry boundary:

NW362	5419	NW1157
16820	PO0	

Please contact us on 0345 762 6848 to determine the exact abandoned mine plans you require based on your needs.

Outcrops

Seam name	Mineral	Seam workable	Distance to outcrop (m)	Direction to outcrop	Bearing of outcrop
CANNEL	Coal	Yes	121.1	East	128
TRENCHERBONE	Coal	Yes	Within	N/A	94
TRENCHERBONE	Coal	Yes	Within	N/A	102
TRENCHERBONE	Coal	Yes	Within	N/A	296
TRENCHERBONE	Coal	Yes	Within	N/A	300

Geological faults, fissures and breaklines

Please refer to the 'Summary of findings' map (on separate sheet) for details of any geological faults, fissures or breaklines either within or intersecting the enquiry boundary.

Faults under or close to the property recorded.

Opencast mines

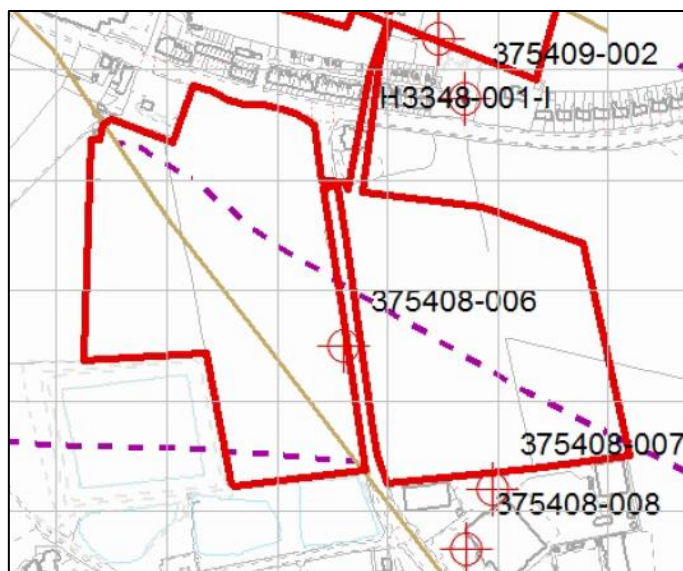
None recorded within 500 metres of the enquiry boundary.

Coal Authority managed tips

None recorded within 500 metres of the enquiry boundary.

4.2.5 Shafts

According to the Coal Authority records, there are one (1 No.) shaft located on site and a further four (4 No.) in the immediate area. An extract of this record is shown below.



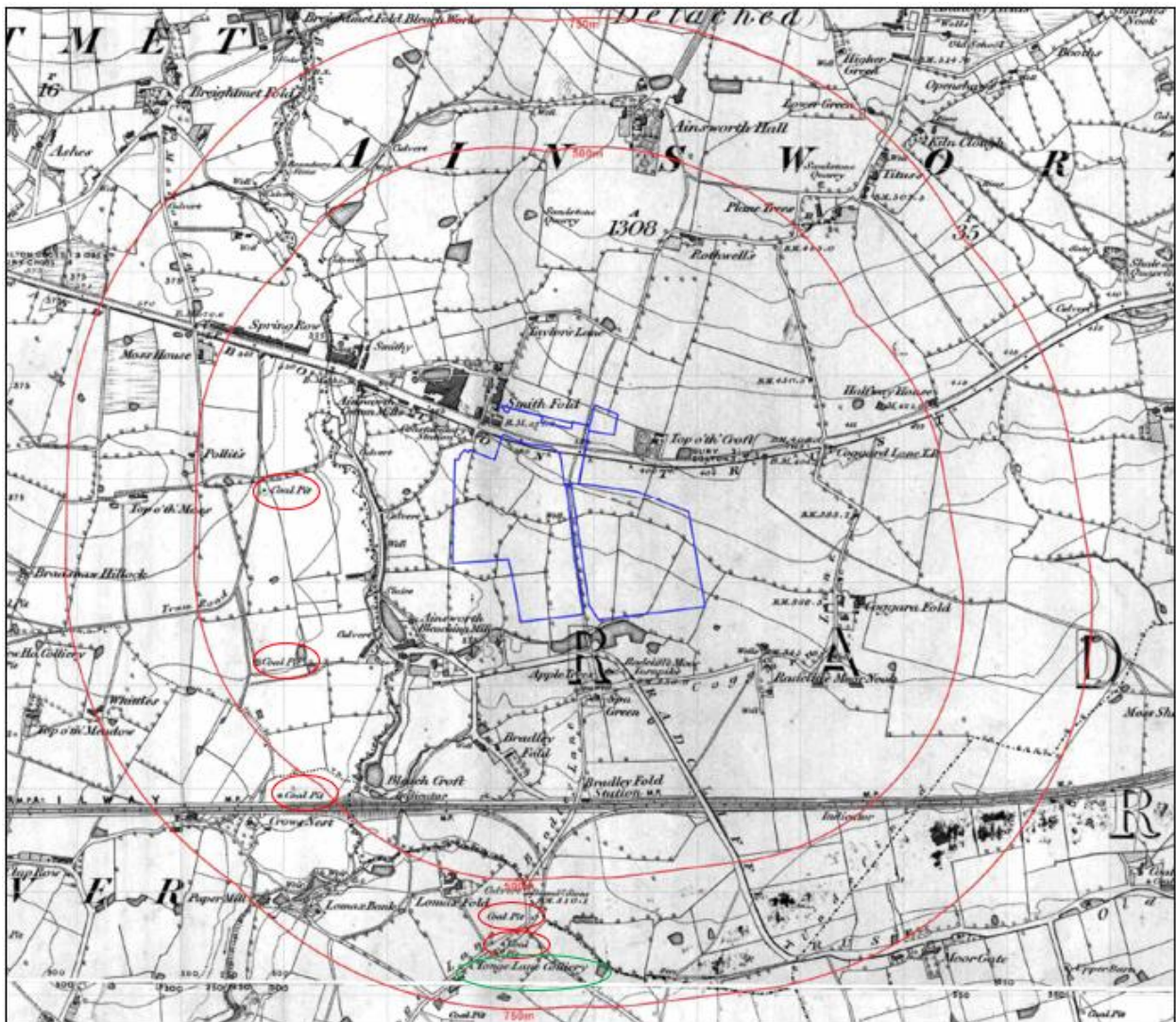
A further coal seam is also shown on site on the Coal Authority plans which is not shown on the Geology maps in Section 4.1.

Adits and day holes indicate shallow workings, as they are horizontal/near horizontal mine entrances, the

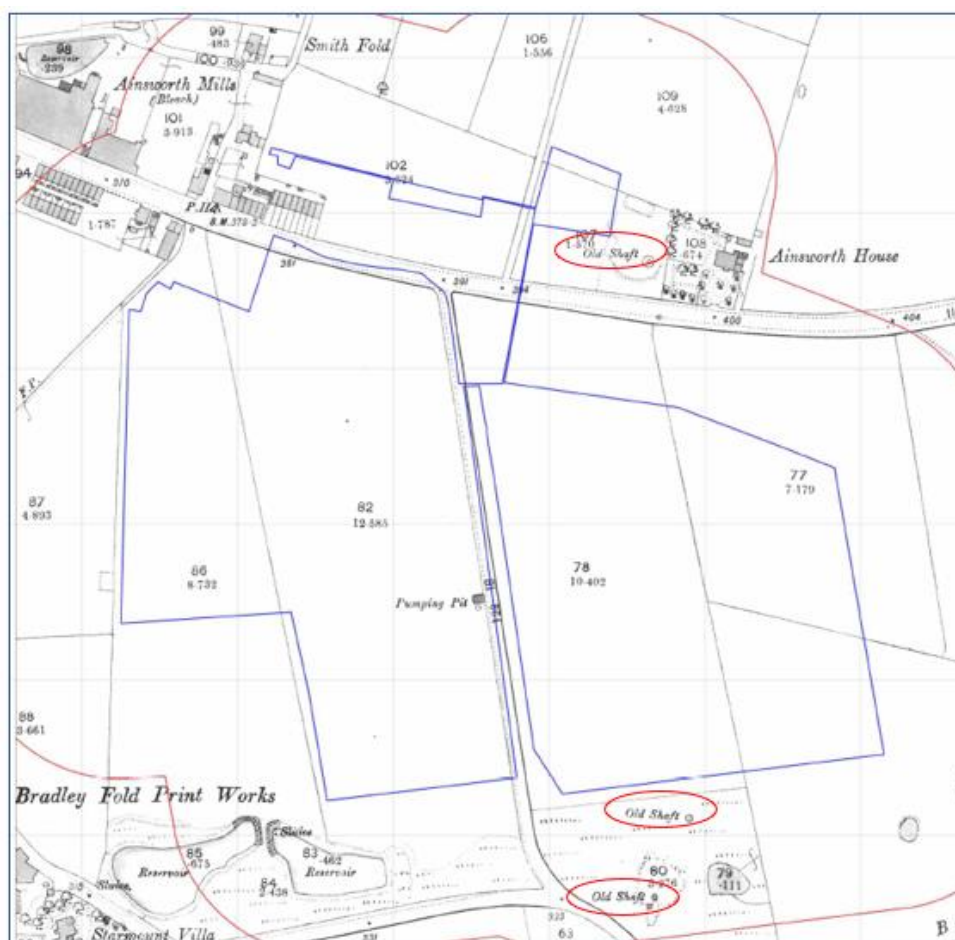
site is likely to have unknown adits, shallow bell pits and shafts that pre-date the recording of coal mine shafts in the area (pre 1850's).

4.2.6 Mining History

The earliest sign of mining is shown the 1850 1:10,560 map with numerous coal pits to the south and west of the site. One (1 No) colliery is also located within 750m of site – Tonge Lane Colliery. An extract of the map can be seen below with any coal mining features highlighted.



Circa 1890, several old shafts are shown immediately adjacent to the overall development site on the 1:2,500 map. An extract is shown overleaf.



4.2.7 Hydrogeology

- The Superficial deposits of the Glacial Till are classed as a Secondary Aquifer – Undifferentiated.
- The bedrock deposits of the Sandstone and Pennine Coal Measure are classed as a Secondary A Aquifer – High Permeability.
- The site does not lie within Groundwater Source Protection Zone as defined by Natural Resources Wales.
- There are no current licenced groundwater water abstractions within 250m of site although there are four (4 No) historic licenses.
- The nearest surface water features are the reservoirs located immediately southwest of site.

5 ENVIRONMENTAL DATA

The following section details environmental data available for the site and the surrounding area. Full details can be found in the Groundsure Report by located in the Betts Geo Desk Study report. The distances are in reference to the overall development site.

The section below summarises the presence/absence of any waste, hazardous substance sites of industrial land uses within 250m of the proposed site.

5.1 Current Industrial Land Use

5.1.1 Recent Industrial Land Uses

There are twenty-one (21 No) entries within 250m of site. Those within 100m are detailed below. For full details please refer to the Groundsure Report;

ID	Location	Company	Address	Activity	Category
1	5m E	Electricity Sub Station	Greater Manchester, BL2	Electrical Features	Infrastructure and Facilities
A	11m S	Les Williams & Co Electrical Insulation Ltd	Carlton Works 250, Radcliffe Moor Road, Bolton, Greater Manchester, BL2 6RE	Electrical and Electronic Engineers	Engineering Services
2	45m NW	Tank	Greater Manchester, BL2	Tanks (Generic)	Industrial Features
3	70m S	Radmoor Car Sales	Radcliffe Moor Road, Bolton, Greater Manchester, BL2 6RE	Secondhand Vehicles	Motoring

5.1.2 Licenced Industrial Activities

There is one (1 No) Licenced Industrial Activity within 250m of site as detailed below;

ID	Location	Details
B	99m NW	Operator: AINSWORTH FINISHING COMPANY LIMITED Installation Name: AINSWORTH FINISHING CO LTD Process: COATING, PRINTING AND TEXTILES; PRE-TREATING BY WASHING ETC >10T/DAY Permit Number: WP3636SP Original Permit Number: BM9165IK EPR Reference: - Issue Date: 06/09/2005 Effective Date: 07/09/2005 Last date noted as effective: 28/09/2020 Status: REVOKED

5.1.3 Licenced Pollutant Release

There is one (1 No) Licenced Pollutant Release within 250m of site as detailed below;

ID	Location	Address	Details	
B	130m W	Ainsworth Finishing Co, Ainsworth Mill, Bury New Road, BL2 7QL	Process: Coating Processes Status: Historical Permit Permit Type: Part B	Enforcement: No Enforcements Notified Date of enforcement: No Enforcements Notified Comment: No Enforcements Notified
13	368m NW	Tarmac Topmix, Vale Street, BL2 6QF	Process: Use of Bulk Cement Status: Historical Permit Permit Type: Part B	Enforcement: No Enforcements Notified Date of enforcement: No Enforcements Notified Comment: No Enforcements Notified

5.1.4 Licenced Discharge to Controlled Waters

There is one (1 No) Licenced Discharge to Controlled Waters within 250m of site as detailed below;

ID	Location	Address	Details	
A	27m S	GARDEN STORE LTD SWO, RADCLIFFE MOOR ROAD, RADCLIFFE, BURY, GREATER MANCHESTER	Effluent Type: MISCELLANEOUS DISCHARGES - SURFACE WATER Permit Number: 016991449 Permit Version: 1 Receiving Water: COASTAL TRIB FOR DA 68/69	Status: REVOKED - UNSPECIFIED Issue date: - Effective Date: 01/04/1992 Revocation Date: 01/04/1992

5.1.5 List 1 Dangerous Substance

There is one (1 No) List 1 Dangerous Substance within 250m of site as detailed below;

ID	Location	Name	Status	Receiving Water	Authorised Substances
B	101m NW	Ainsworth Finishing Company Ltd	Active	-	Mercury (other), Pentachlorophenol

5.1.6 Pollution Incidents (EA/NRW)

There is one (1 No) pollution incident recorded within 250m of site as detailed below;

ID	Location	Details	
A	34m S	Incident Date: 22/09/2001 Incident Identification: 32300 Pollutant: Other Pollutant Pollutant Description: Natural Ochre	Water Impact: Category 3 (Minor) Land Impact: Category 4 (No Impact) Air Impact: Category 4 (No Impact)
11	319m S	Incident Date: 12/06/2001 Incident Identification: 8753 Pollutant: Other Pollutant Pollutant Description: Other	Water Impact: Category 2 (Significant) Land Impact: Category 4 (No Impact) Air Impact: Category 4 (No Impact)
12	344m NW	Incident Date: 08/09/2001 Incident Identification: 29669 Pollutant: Specific Waste Materials Pollutant Description: Organic Chemical Wastes	Water Impact: Category 4 (No Impact) Land Impact: Category 3 (Minor) Air Impact: Category 4 (No Impact)

5.2 Waste and Landfill

5.2.1 Historical Waste Sites

There is one (1 No) historic waste site recorded within 250m of site as detailed below:

ID	Location	Address	Further Details	Date
A	22m W	Site Address: Land at Ainsworth Mill, Bury New Road, Breightmet, Bolton, Greater Manchester, BL2 6QB	Type of Site: Recycling Centre (Conversion/Alterations) Planning application reference: 56933 Description: Scheme comprises change of use of land to metal recycling/storage (Sui Generis) and siting of containers 2 and refurbishment of temporary building for office use. Data source: Historic Planning Application Data Type: Point	-

5.2.2 Licensed Waste Sites (EA/NRW)

There are two (2 No) Licensed waste sites recorded within 250m of site as detailed below;

ID	Location	Details		
A	76m N	Site Name: Ainsworth Mill Site Address: Ainsworth Mill, Bury New Road, Breightmet, Bolton, Lancashire, BL2 6QB Correspondence Address: -	Type of Site: Metal Recycling Site 25000 tps Size: 25000 tonnes Environmental Permitting Regulations (Waste) Licence Number: HAM052 EPR reference: EA/EPR/AB3604KG/A001 Operator: Hamer Mr Laszlo Waste Management licence No: 400747 Annual Tonnage: 24999	Issue Date: 06/03/2014 Effective Date: - Modified: - Surrendered Date: - Expiry Date: - Cancelled Date: - Status: Expired
A	76m N	Site Name: Ainsworth Mill Site Address: Ainsworth Mill, Bury New Road, Breightmet, Bolton, Lancashire, BL2 6QB Correspondence Address: -	Type of Site: Metal Recycling Site 25000 tps Size: 25000 tonnes Environmental Permitting Regulations (Waste) Licence Number: HAM052 EPR reference: EA/EPR/AB3604KG/A001 Operator: Hamer Laszlo Waste Management licence No: 400747 Annual Tonnage: 24999	Issue Date: 06/03/2014 Effective Date: - Modified: - Surrendered Date: - Expiry Date: - Cancelled Date: - Status: Issued

5.2.3 Waste Exemptions

There are nineteen (19 No) Waste Exemptions recorded within 250m of site. The closest three have been

detailed below. For full details please refer to the Groundsure Report;

ID	Location	Site	Reference	Category	Sub-Category	Description
1	71m S	RADCLIFFE MOOR ROAD, BOLTON, BL2 6RE	WEX037268	Using waste exemption	Not on a farm	Use of waste for a specified purpose
2	196m S	FOLD MILL, BRADLEY LANE, BOLTON, BL2 6RA	WEX224958	Using waste exemption	Not on a farm	Use of waste to manufacture finished goods
B	224m SE	UNIT 8, BRADLEY FOLD TRADING ESTATE, RADCLIFFE MOOR ROAD, BRADLEY FOLD, BOLTON, BL2 6RT	WEX007495	Treating waste exemption	Not on a farm	Preparatory treatments (baling, sorting, shredding etc)

5.3 Past Land Use

5.3.1 Historical Industrial Land Uses

There are eight (8 No) historical land uses recorded on site with a further sixty six (66 No.) located within 250m of site. Those located on site are detailed below. For full details please refer to the Groundsure Report;

ID	Location	Land use	Dates present	Group ID
1	On site	Refuse Heap	1955	678009
A	On site	Unspecified Ground Workings	1955	645699
A	On site	Unspecified Heap	1927	650890
A	On site	Pumping Pit	1890	653313
B	On site	Pumping Station	1927	742474
C	On site	Unspecified Heap	1965	650891
C	On site	Unspecified Works	1988 - 1991	743909
D	On site	Garage	1988 - 1991	769930

5.3.2 Historical Tanks

There are twenty seven (27 No.) entries for historical tanks located within 250m of site, one (1 No.) of which is on site and is detailed below. For full details please refer to the Groundsure Report;

ID	Location	Land use	Dates present	Group ID
A	On site	Unspecified Tank	1890	84788

5.3.3 Historical Energy Features

There are seven (7 No.) entries for historical energy features located within 250m of site, one of which is on site and is detailed below;

ID	Location	Land use	Dates present	Group ID
B	On site	Electricity Substation	1987 - 1992	48115

5.3.4 Historical Garages

There are six (6 No.) entries for historical garages located within 250m of site, one of which is on site and is detailed below;

ID	Location	Land use	Dates present	Group ID
D	On site	Garage	1987	16599

It is important to note that this garage is now off site as a result of the change in site boundary.

6 SUMMARY OF ENVIRONMENTAL SENSITIVITY

The following section is a review of the environmental sensitivity of the site as discussed in Sections 2-6. Significant potential risks are discussed in the following subsections and will then be evaluated as part of the Site Conceptual Model in Section 7.

Sources are defined as where pollution comes from, pathways are a route in which the pollution travels and receptors are anything affected by a pollutant. Further details on Source-Pathway-Receptor methodology can be found in Appendix F.

The table below focuses on significant site-specific sources, pathways and receptors. More 'generic' pathways and receptors (such as site end uses) will be covered as part of the full Site Conceptual Model in Section 14.

6.1 Sources

Source	Distance/ Direction	Details	Significant Risk
Current Site Use	On Site	The site is currently used for agricultural purposes. Low risk of contamination from current use.	No
Historic Site Use	On Site	Site has historically been open fields with scattering of other uses (see below for individual sources). Generally low risk of contamination, apart from former refuse tip area and coal mining area all of which are on the western parcel.	See Below
Coal Mining	On Site	The site has been identified by Coal Authority as potential shallow coal mining historically, possible bell pits, shallow shafts and possible adits. One known shaft on site and many in the immediate vicinity. Abandonment Plans to be consulted.	Yes
Refuse Tip	On Site	Mound / excavation? shown in the centre of the western parcel circa 1930 – 1955. Likely to contain colliery spoil given the coal mining on site. Unknown material within tip could contain heavy metals, TPH's and PAH's. Also potential ground gas source. Ground investigation to confirm, however inaccessible due to Gas main	Yes
Wells	On Site	Wells shown from 1850's to 1890's, unknown size and sort. Investigation and delineation required to assess risk.	Yes
Infilled Reservoirs/Ponds	Immediately S	Infilled reservoirs/ponds located to the S of site. Unknown material within the area could contain heavy metals, TPH's and PAH's. Also potential ground gas source. Age of infilling being greater than 50 years ago lowers any risk. Ground investigation to confirm.	Possible
Historical Bleach and Dye Works	Within 250m of site	A number of historic bleach and dye works located to the NW, S and SW of site. Possible courses of contamination include heavy metals, TPH's, PAH's, asbestos, SVOC's, VOC's, phenols and cyanides. Site anticipated to be surrounded by cohesive superficial geology limiting any migration pathway. Ground investigation to confirm.	Possible
Collieries	700m S	Collieries surrounding site, possible shallow workings interconnecting beneath site. Number of known shafts shown on OS Maps. Possible ground gas source due to methane from shallow coal and shafts/adits acting as pathway.	Yes

6.2 Pathways and Receptors

Pathways and Receptors	Distance/ Direction	Details	Significant Risk
Aquifers	Below Site	Bedrock aquifer designated as a Secondary A Aquifer however the anticipated cohesive glacial till should limit significant lateral and vertical spread of contamination as it is classed as an unproductive strata. No active groundwater abstractions within 250m of site however significant contamination anticipated on site. Former coal shafts may act as a pathway.	Possible
Reservoirs	Immediately S	Possible pathway and receptor for any contamination however the anticipated cohesive glacial till should limit significant lateral and vertical spread of contamination as they are classed as an	Possible

		unproductive stratum. Significant contamination anticipated on site.	
Site End Users/ Construction Workers	On Site	Significant contamination anticipated on site however current proposals are for a football pitch with associated pavilion and changing rooms. If the proposals are to include ground breaking works then there is a significant risk to site end users and construction workers.	Yes

7 INITIAL CONCEPTUAL SITE MODEL

For details on how the conceptual model is evaluated please refer to Appendix F.

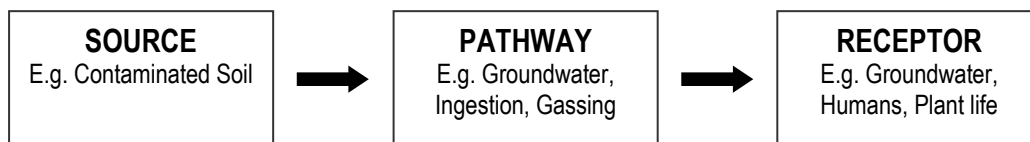
This section of the report aims to identify land which could potentially be affected by contamination, such that it could affect the value or re-use of the land, or such that mitigation would be required for certain proposed end uses of the land.

Potential contamination sources and environmentally sensitive receptors have been discussed in Section 6. Potentially significant risks are evaluated as part of the subsequent sub-sections.

7.1 Source-Pathway-Receptor Linkages

The risk assessment uses a 'Source-Pathway-Receptor' methodology for assessing whether a source of contamination could potentially lead to harmful consequences. This means that there needs to be a pollutant linkage from source to receptor for harm to be caused, this linkage consisting of: a source of pollution; a pathway for the pollutant to move along; a receptor that is affected by the pollutant.

The current potential risks to site arising from various source-pathway-receptor linkages are assessed below. A risk may be considered significant if all three of the stages are present and therefore providing a pollution linkage. The various sources, pathways and receptors are considered separately. The assessment is based on the future use, which is understood to be sports pitches, club house and associated infrastructure.



Type of Contamination	Potential Sources	Potential Pathway	Potential Receptors	Pollution Linkage	Comment	Estimated Level of Risk
Ground Gas	Coal Mining on Site	Inhalation of Vapours	Construction/ Maintenance Workers	Potentially Active	Possible ground gas from localised Made Ground in infilled ponds/reservoirs immediately off site and former refuse tip on site (in western parcel). High risk of ground gas from coal mining on site and in immediate area. Site anticipated to have cohesive superficial geology. Ground investigation and ground gas monitoring to confirm. PPE to minimise risk.	High
	Made Ground On Site					
Ground Gas	Former Well on Site	Vapours Penetrating Unprotected Buildings	Future Site Users	Potentially Active	Although ground gas sources have been identified on site the proposed site use is a football pitch with associated pavilion and changing rooms. Highest risk to proposed buildings on site but site end users won't be in the buildings for long and type of building proposed should allow for sufficient ventilation or ground has protection measures.	High
	Infilled Reservoir/ Pond immediately S					
Surface and Near Surface Contaminants Within Soils	As above	Ingestion, Inhalation, Dermal Contact	Current Site Users	Potentially Active	Possible contamination from all sources mentioned in table 6.1 however the current site use is open space/agricultural land which lowers any risk.	Low/ Moderate
			Construction Workers	Potentially Active	Significant contamination anticipated on site however current proposals are for a football pitch with associated pavilion and changing rooms. If the proposals are to include ground breaking works then there is a significant risk to site end users and construction workers.	Moderate
			Future Site Users	Potentially Active	Although contamination sources have been identified on site the proposed site use is a football pitch with associated pavilion and changing rooms. Highest risk from coal mining on site. Ground investigation to confirm.	Moderate
			Adjacent Land Users	Potentially Active	Majority of surrounding area is either industrial or commercial use.	Low
		Direct Contact	Structures	Potentially Active	Large number of contamination sources identified from desk study however limited structures are anticipated as part of the proposed development. Anticipated that the buildings will be placed on elevated steel frames so the risk is lowered.	Low if properties placed on elevated steel frames. Moderate if properties placed directly into ground
		Absorption in Root Zone	Plants	Potentially Active	Large number of contamination sources identified from desk study however no gardens are proposed as part of the proposed development.	Low

Type of Contamination	Potential Sources	Potential Pathway	Potential Receptors	Pollution Linkage	Comment	Estimated Level of Risk
Mobile Contaminants, Leachables e.g. from Pollution Sources Adjacent to Site/On Site	As above	Leaching into Groundwater	Groundwater	Potentially Active	Superficial geology is classed as an Unproductive Strata. Significant contamination anticipated on site. Ground investigation to confirm.	Moderate
		Off-site Migration in Groundwater	Abstractions	Potentially Active	No current licensed groundwater abstractions within 250m. Not in a Groundwater Source Protection Zone.	Low
			Controlled Waters	Potentially Active	Closest surface water features are the reservoirs immediately S. Possible receptor but anticipated cohesive superficial geology limits any migration pathway.	Moderate.
Organic and Inorganic Contaminants Within Soils / Groundwater	As above	Potable Water Supply Pipes	Utilities Workers	Potentially Active	Possible localised solvents, TPH and PAH contamination from former uses and neighbouring uses. Ground investigation to confirm, then liaise with local water authority supplier.	Low if no ground breaking works proposed High if ground breaking works and new pipelines are proposed.

7.2 Contamination Summary

In this qualitative risk assessment, a Moderate risk for ground gas and contamination exists across the site, with the higher risk existing on the western parcel, but is dependant upon the proposed layout / type of structures. Targeted investigation to the proposed club house is to be undertaken.

However, the proposed development simply involves a football pitch with associated small buildings – changing rooms and pavilion. If the development consists of placing units on hardstanding or placing on elevated steel frames, and the units have no garden areas then the risk is deemed low as no significant pathway to site end users is anticipated. See section 8 for more details.

7.3 Geotechnical Constraints

- Existing and redundant services across site.
- Extent of Made Ground on site in vicinity of former reservoirs/ponds to the south and in the vicinity of the known 'refuse tip' (inaccessible due to live gas services)
- High risk of shallow coal mining, bell pits and shafts.
- Former well
- One (1 No.) known shaft along the boundary of the site. Area around shaft should be avoided for

buildings. Easement to known shafts should be anticipated.

- Potential tree heave should cohesive stratum be encountered on site (anticipated).

In regards to the former well and 'refuse tip' area – these are within the Cadent easement for no excavation with plant and as such could not be investigated.

8 FIELDWORK

8.1 Fieldwork Objectives

The objectives of the intrusive ground investigation will be to:

- Clarify the 'Initial Contamination Conceptual Model'
- Clarify the Initial Risk Assessment.
- Benchmark the contamination status of the site.
- Provide data for the design of any remedial works that may be required.
- Provide geotechnical information to be used for the design and specification of foundations and substructure requirements.

8.2 Fieldwork Scope

The fieldwork was carried out between 6th April and 18th May on non-consecutive days, and comprised the below;

- Four (4 No.) window sample boreholes to depths of 3.00mbgl. Targeted to the new Clubhouse
- Eight (8 No.) trial pits to depths between 2.00mbgl and 3.30mbgl (TP02). Coverage for pitches where cut is proposed – to assess material initially for suitability
- Seven (7 No.) rotary boreholes to depths between 12.00mbgl and 30.00mbgl – targeted to new clubhouse
- Chemical analysis (Metals, PAH's, TPH's) of six (6no) samples. Targeted to clubhouse
- Screening of six (6 No.) samples for asbestos. Targeted to clubhouse

Note: due to the Cadent Gas Pipeline access was restricted to ground investigation within 15m easement of the line (marked on site previously by Cadent).

An exploratory hole location plan can be found in Appendix B.

9 GROUND CONDITIONS

9.1 General

The exploratory holes were logged by a Betts Engineer in general accordance with the recommendations of BS5930:1999+A2:2010 Detailed descriptions, together with relevant comments, are given in the exploratory hole logs included in Appendix C. The ground investigation was only carried out in the section of the site which requires a planning application.

9.2 Ground Conditions Summary

Ground conditions can generally be summarised as TOPSOIL / MADE GROUND over shallow superficial deposits of both granular (sand and gravels) and cohesive (clay and silt) materials.

Superficial deposits were underlain by solid deposits of shale over sandstone.

MADE GROUND was recorded in TP01 only and was of CLAY with minor anthropogenic constituents.

9.2.1 Topsoil

Topsoil was recorded in all locations to a maximum depth of 0.40mbgl and was generally described as 'brown sandy CLAY'.

The rotary holes also had topsoil present but was not logged due to the drilling process.

9.2.2 Cohesive Strata

Cohesive strata in the form of CLAY was generally recorded below the topsoil. CLAY was generally described as 'greyish orange grey / dark grey silty CLAY with occasional fine gravel'. Generally, the deeper grey clays were described as stiff to hard. Compared to the shallower firm to stiff strengths of the orangish grey CLAY.

Clay was recorded to a maximum depth of 9.40mbgl in rotary BH6.

SILT was only recorded in WS4 between 0.40mbgl and 1.50mbgl and was described as 'Compact greyish orange clayey SILT with occasional fine gravel of coal'.

Due to the rotary drilling process CLAY / SILT would have been very hard to determine any differences.

9.2.3 Granular Superficial Strata

Granular strata were only observed in TP02-TP05 and were generally described as 'clayey silty SAND & GRAVEL with occasional cobbles' or 'cobbly sandy GRAVEL with occasional silt'.

The SAND & GRAVEL were observed from shallower depths between 0.30mbgl -1.50mbgl (TP02). The deeper GRAVEL was recorded between 1.80mbgl and 2.80mbgl (TP02).

9.2.4 Solid Geology

Solid geology of SANDSTONE was recorded in TP02 and TP03 and all rotary locations (BH1-BH7) and was observed from 2.30mbgl.

The sandstone was generally described as 'brownish orange and red banded SANDSTONE' of firm drilling.

Sandstone was recorded to a maximum, unproven, depth of 30.00mbgl. No workings or coal was observed.

9.2.5 Made Ground

MADE GROUND was only observed in TP201. MADE GROUND was recorded from 0.30-1.80mbgl and was described as 'Cobbles with sand and gravel and occasional pockets of clay' reworked natural.

9.3 Visual and Olfactory Contamination

Other than MADE GROUND of reworked natural, no visual or olfactory contamination was observed.

9.4 Obstructions

Other than solid geology, no obstructions were encountered within the exploratory holes during the fieldwork.

9.5 Groundwater – Fieldwork

The following exploratory holes encountered groundwater during the fieldwork:

Exploratory Hole	Depth (mbgl)	Strata	Remark
TP01	1.80	MADE GROUND / CLAY Interface	Slight seepage
TP03	2.60	SANDSTONE	Wet
TP08	0.40-2.00	CLAY	Damp
All window sample boreholes were deemed wet due to perched water at surface.			

9.6 Groundwater – Fieldwork

Exploratory Hole	Depth (mbgl)
WS01	0.82
WS02	0.90
WS03	0.72

10 LABORATORY TESTING

10.1 General

An assessment of potential determinants associated with the former land uses has been undertaken.

Determinants originating from the current/former site uses include metals, polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPHs) and asbestos.

10.2 Scheduled Chemical Testing: Soils

Soil was sent to a UKAS accredited laboratory, and were generally analysed in accordance with ISO 17025 and/or MCERTS accreditation. The results are summarised in tabular and/or graphical form in Appendix D.

Chemical Test	No. of Samples	Comment/Method
pH Values	6	Determination of pH (using Cyberscan pH meter).
Sulphate - Soluble 2:1 Extract	6	Dionex.
Arsenic, Cadmium, Chromium VI, Chromium III, Total Chromium, Lead, Mercury, Selenium, Copper, Nickel, Complex and Free Cyanide and Zinc.	6	Soil samples were analysed in accordance with UKAS/MCERTS standards Inductively coupled plasma atomic emission spectroscopy (ICP-OES)
Speciated Polycyclic Aromatic Hydrocarbons (PAH),	6	Determination of Polycyclic Aromatic Hydrocarbons by GC-MS. End/end extraction using DCM on as received sample. In house method modified USEPA 8270. Include coronene if required.
TPH CWG	6	TPH CWG (Aliphatics C5-6,>6-8,>8-10,>10-12,>12-16,>16-21,>21-35) (aromatics >C5-7,>7-8,>8-10,>10-12,>12-16,>16-21,>21-35) C5-8 fractions by Headspace GC-MS (003S). C8-35 fractions on as received sample extracted with hexane/acetone, aliphatic/aromatic splits run by GC-FID (005S), banded as listed above.
GRO/BTEX/MTBE by GC-FID (C5-10; C10-C12)	6	Determination of Gasoline Range Hydrocarbons (GRO) and BTEX (MTBE) compounds by Headspace GC-FID (C4-C12).
Organic Matter	6	Determination of Organic Matter by combustion.
Asbestos Screen	6	Visual Screening for Fibres and PLM

11 CONTAMINATION ASSESSMENT

11.1 General

Contaminants of concern recorded at concentrations above relevant screening values are summarised below. For ease of description, the identification of contaminant sources and possible re-use of material, Topsoil, Made Ground, Natural Strata and Groundwater will be dealt with in separate sub-headings in this section of the report where required.

Our assessment is based on the following assumptions:

- The proposed site end use is of a high-risk rating (residential dwellings with proposed gardens). For analysis purposes, 'residential with home grown produce' is deemed the most appropriate end use.
- The superficial deposits are classed as a Secondary Undifferentiated Aquifer (Low Permeability) and Secondary A Aquifer (Moderate Permeability).
- The bedrock deposits are classed as a Secondary A Aquifer (Moderate Permeability).
- It is deemed that some statistical analysis is appropriate. Where sample data numbers are low and/or targeted, each determinant result is however reviewed further as an individual result as opposed to an average across the site.
- Site history has indicated a **Low – Low/Moderate** risk of contamination and ground gas.
- Statistical analysis of the chemical test results has been undertaken in general accordance with Environment Agency 2009 SGV Guidance and AtRisk 2017 using the combined assessment criterion given by CLEA (Note: all SSVs for EA derivation are for a SOM of 6% in line with Environment Agency Report SC050021/SR4 – this figure is deemed representative as an average value for sandy loam soil). AtRisk 2017 are used to the nearest SOM percentage deemed appropriate.
- No free product, visual or olfactory evidence of contamination was noted in the exploratory holes.
- Following the withdrawal of CLR7-10 Guidance documents by the Environment Agency, statistical analysis has been undertaken in accordance with the CIEH/CL:AIRE 'Guidance on Comparing Soil Contamination Data with a Critical Concentration' (May 2008). As such, the use of the mean value test alone is not considered.

A full risk assessment is detailed within Section 12 of this report.

The notes on the conceptual site model are in Appendix E.

11.2 Soils Contamination Summary

Topsoil

All determinants for TPH's, PAH's and Metals fell below the residential home grown produce guidance levels within the Topsoil, with the exception of WS1 at 0.30,mbgl.

The exceedance is detailed below;

Location	Depth (mbgl)	Strata	Determinant	Observed Concentration (mg/kg)	AtRisk 2017 Threshold Concentration (mg/kg)	DEFRA C4SL Threshold (mg/kg)
WS1	0.30	TOPSOIL	Lead	202	-	202

Natural Strata

All determinants for TPH's, PAH's and Metals fell below the residential home grown produce guidance levels within the natural, with the exception of WS2 at 0.30,mbgl.

The exceedance is detailed below;

Location	Depth (mbgl)	Strata	Determinant	Observed Concentration (mg/kg)	AtRisk 2017 Threshold Concentration (mg/kg)	DEFRA C4SL Threshold (mg/kg)
WS2	0.30	CLAY	Arsenic	35	32	37

Asbestos

No asbestos was identified in the samples analysed.

12 ENVIRONMENTAL RISK ASSESSMENT

12.1 General

This section assesses likely risks to the identified receptors, arising from potential contamination sources. It provides a final qualitative assessment of the risks involved, indicating whether (where appropriate) any immediate action is required to mitigate certain risks.

In assessing the risk qualitatively, it is appropriate to use the methods outlined in the CIRIA document C552, "Contaminated Land Risk Assessment a Guide to Good Practice". It uses a classification of risk based on the magnitude of the potential consequence or severity of risk occurring, compared with the magnitude of the probability or likelihood of the risk occurring. These are indicated on the attached tables in Appendix E.

The worst-case superficial deposits and underlying solid geology are classed as a Secondary A Aquifer (Moderate Permeability). With respect to human health, the proposed end use (residential with home grown produce) is of high sensitivity. Therefore, the site's environmental setting is considered to be a moderate to high environmental sensitivity. Transient risks to construction workers can be addressed by the adoption of appropriate health and safety measures (see Section 14.2), therefore, the primary residual risks that require assessment are Site End Users. The following sections are split into soils and groundwater for clarity.

12.2 Assessment of Contamination Analytical Results

Soils

Marginally elevated concentrations of Arsenic (35mg/kg) and Lead (202mg/kg) have been observed in WS2 and WS1 respectively. Further to this, statistical analysis, using a Mean Value Test (US₉₅), of the metals gives a US₉₅ value of 29.53mg/kg for Arsenic and 185.93mg/kg Lead, which are significantly lower than the residential thresholds, as detailed below;

Determinant	Observed Concentration (mg/kg)	US ₉₅ Value	AtRisk 2017 Threshold Concentration (mg/kg)	DEFRA C4SL Threshold (mg/kg)
Arsenic	32	29.53	32	37
Lead	202	185.93	-	200

On the basis of the above, both metals may be discounted as it poses negligible to risk to sensitive receptors and is not representative of the wider site soils.

Groundwater and Aquifer Risk

No significant contamination sources have been identified within the soils onsite and given the general presence of site-wide low permeability soils, the risk to groundwaters and the aquifer from site is considered very low.

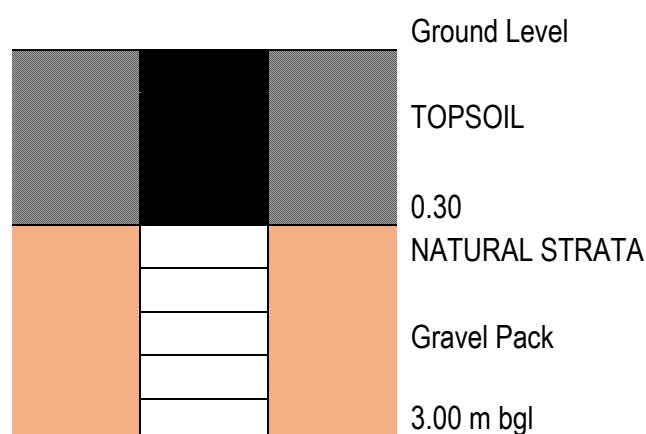
13 PRELIMINARY GROUND GAS ASSESSMENT

13.1 Ground Gas Requirements – Radon

BRE211 (2007) Radon: guidance on protective measures for new buildings shows it is in a lower probability area, as less than 1% of homes are above the action level. Therefore, no Radon protective measures are necessary in the construction of new dwellings or extensions.

13.2 Ground Gas Boreholes Installations

Three (3 No.) window sample boreholes were installed to 3.00mbgl into Natural Strata. An example installation is shown below;



13.3 Summary of Results

Five rounds of gas monitoring visits have been undertaken, with one further visit required. Ground Gas monitoring results can be found in Appendix F.

No significantly elevated flows or concentrations have been identified.

The maximum Carbon Dioxide concentration was recorded in WS02 at 2.6% and the maximum Methane concentration of 0.2% was recorded in WS01.

The peak site flow was recorded at 0.3l/h.

The data is detailed below;

Borehole Number	Peak Flow (l/hr)	Baro. Pressure (mB)	Peak Methane (%)	Peak Carbon Dioxide (%)	Minimum Oxygen (%)	GSV CH ₄	GSV CO ₂	No. of Visits
WS01	0.3	988 - 1020	0.2	0.5	19.5	<0.0001	0.002	5/6
WS02	0.1	988 - 1020	0.1	2.6	18.2	<0.0001	0.003	5/6
WS03	0.2	988 - 1020	0.1	0.2	20.0	<0.0001	0.000	5/6

13.4 Guidance

Three recent publications are used for ground gas risk assessment:

- 'Guidance on Evaluation of Development Proposals on Sites Where Methane and Carbon Dioxide are Present', Report Edition No.04 March 2007 NHBC – designed for use with low rise residential properties.
- CIRIA C665 'Assessing risks posed by hazardous ground gases for buildings' 2007 - for high rise residential / flats.
- BS8485:2015 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'.

Further details / accompanying notes for the following gas risk assessment are enclosed in Appendix F. The proposed development at the site is Commercial Maintained, therefore assessments using the British Standard are deemed most appropriate.

13.5 Ground Gas Classification and Recommendations (Preliminary)

Due to the desk study report identifying no significant ground gas sources and no elevated concentrations recorded within the gas wells, the site has initially been classified as CS1.

As five visits have been undertaken to date, this will be confirmed on review of the final monitoring results however for the purpose of pricing it would be prudent to assume CS2 protection will be required until the completion of the monitoring programme and the updating of the above ground gas risk assessment.

14 REVISED CONCEPTUAL SITE MODEL

14.1 General

The Initial Conceptual Site Model has been amended in light of data obtained during the ground investigation, most notably the absence of any significantly contaminated soil in relation to the screening criteria for the proposed end use.

14.2 Final Conceptual Site Model

This section reassesses likely risks to the identified receptors, arising from potential contamination sources. It provides a final qualitative assessment of the risks involved, indicating whether (where appropriate) any immediate action is required to mitigate certain risks. It also discusses (where appropriate) what longer term measures or remedial works may be required in the future if the site were to be developed. It is considered that the site has not been assessed by the Local Authority as a contaminated site under the terms of the Environmental Protection Act 1990 Part IIa.

Target (Receptor)	Potential Source-Pathway Linkage	Remedial Action Required (where appropriate)	Est. Degree of Risk to Target Following Remedial Action Where Necessary
Site End Users	Inhalation of soil gases, odours or dust.	No risk of ground gas anticipated. Site can be presumed as 'CS1' – no protection measures required.	Low
Site End Users	Ingestion of, and skin contact with, contaminated soil.	N/A	Low
Site End Users	Ingestion of contaminants in vegetables etc. or in soils adhering to vegetables, etc	N/A for end use	Low
Construction/Maintenance Workers	Inhalation of soil gases, odours or dust.	PPE	Low (assumed basic PPE is used)
Construction/Maintenance Workers	Ingestion of, and skin contact with, contaminated soil	PPE	Low (assumed basic PPE is used)
Plants	Adverse effects on growth caused by presence of contaminants in soil	N/A	Low
Buildings and Structures	Flow of ground gas into buildings. Asphyxiation, toxicity, explosion and fire hazards	No risk of ground gas anticipated. Site can be presumed as CS1 – no protection measures required.	Low
Foundations	Sulphate attack of foundations	Foundations to be designed as per section 16.4.	Low
Water Supplies	Hydrocarbons penetrating plastic water supply pipes.	United Utilities pipeline risk assessment required.	Low
Groundwater	Migration of soluble contaminants into groundwater on or off site	No remedial action required.	Low

Surface Water	Migration of soluble contaminants and/or direct run-off of contaminants	No remedial action required.	Low
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15 OUTLINE STRATEGY FOR RISK REDUCTION / REMEDIATION STRATEGY

15.1 General

The following section details any recommendations and to reduce risk on site and recommended remedial actions (as per the previous sections of this report). For clarity, the section is split into sub-sections as per the conceptual site model (Section 15).

15.2 Construction/Maintenance Workers

Although no significant contamination was encountered on site, the following recommendations should be adhered to during site works:

- Site workers should wear gloves, boots and overalls and wash their hands before eating, drinking and smoking. Excessive dust generation should be avoided.
- It is recommended that during all excavations adequate ventilation should be maintained. If man entry is required, gas monitoring should be carried out as a precaution.
- If areas of suspected contamination are found then a suitably qualified person should undertake appropriate sampling, testing and further risk assessment.
- Although asbestos was not encountered on site, vigilance should be adhered, and any suspected asbestos should be notified and a suitably qualified person appointed to inspect.

15.3 Site-End Users

The site has no significant former contaminated uses identified. No significant contamination was encountered on site, therefore no specialist remedial action is required.

Where possible, identified Made Ground should be segregated to ensure no constituents such as glass end up within capping materials.

Further testing of topsoil and subsoil may be required for reuse criteria.

15.4 Ground Gas Protection Measures (Preliminary)

Due to there being no significantly elevated ground gas or flow readings, the site has initially been classed as CS1.

15.5 Piped Drinking Water Supplies

The use of Protect-a-Line is not anticipated, however a pipeline assessment should be undertaken and confirmed with United Utilities.

15.6 Off-Site Disposal of Surplus Soil

If there is the need to remove soil / Made Ground off-site, it is recommended that the results of the contamination testing (including the history of the site) be presented to the proposed landfills to obtain their acceptance of the information to date and to determine the actual WAC limits used by them (see Appendix L for further guidance).

Segregation of Made Ground and Natural Strata should be possible given the chemical analysis and very different visual identification. If moved to other sites for use, it is proposed to use the results of the contamination testing to determine if it is deemed suitable for re-use as topsoil or subsoil.

Notes on offsite soil disposal can be found in Appendix G.

15.7 Design Statement

Chemical analysis of the site soils has shown that they pose a negligible risk to both human health and controlled waters.

The ground investigation has identified that excavated site soils should be suitable for re-use as general fill and within the growing medium on the site, without any requirement for treatment other than compaction. Further sampling will be required to conform with Local Authority testing ratios.

The quality of the material will be inspected during the site enabling works to ensure that it is as reported within the ground investigation and that no unforeseen contamination is present.

16 GEOTECHNICAL ASSESSMENT

16.1 Introduction

It is understood that the proposed development will comprise 3 sports pitches / car park and clubhouse with associated, public open spaces, new road and associated infrastructure. Associated foundation loadings are anticipated to be low.

16.2 Site Preparation and Excavation

All excavations should be planned, and due consideration should be given to providing temporary support or suitable battering. Excavations should be regularly inspected by a competent person to ensure continued safety. Further advice on the safety of excavations is given in *Health and Safety in Construction*. Shallow (<1.20mbgl) excavations for service trenches could be complicated by collapsing sands, silts/clays, and care should be taken.

16.3 Control of Groundwater

Small quantities of groundwater were encountered on site however it is likely that provision of pumping/shuttering will be necessary during excavation of foundation trenches during wet weather and to deeper excavations for sewers etc. It is good practice to have such equipment on standby in case of seasonal / abnormal weather conditions.

16.4 Foundations

Ground conditions generally consisted of either TOPSOIL to a maximum depth of 0.40mbgl overlying firm to stiff sandy CLAY. Recommended foundations, for areas of cohesive strata, are therefore conventional strip / trench founded upon the firm to stiff CLAY. The following bearing capacities can be assumed for conventional footings:

- Firm sandy CLAY with an allowable bearing pressure of 100kN/m².
- Firm to stiff sandy CLAY with an allowable bearing pressure of 100-125kN/m².

Areas of Granular strata, where water is not present:

- Medium dense SAND & GRAVEL with an allowable bearing pressure of 100kN/m².

Where water is present the ABP may be halved.

In the area of MADE GROUND around TP01, a trench fill solution may be used:

- Stiff sandy CLAY with an allowable bearing pressure of 125-150kN/m².

Localised deepening of foundations and / or piled foundations are likely to be required in the vicinity of trees – current layout avoids trees.

Foundations should be excavated wholly on one stratum. Should proposed foundations span different strata, trenching and stepping of foundations and/or nominal reinforcement will be required. A foundation zoning plan should be undertaken when proposed levels are made available.

Calculations on the allowable bearing capacity indicate settlements of less than 25mm for a square pad using the above allowable bearing capacity.

16.5 Coal Mining Risk

The site lies at the lowest part on the Manchester Coalfield, part of the Carboniferous Pennine Upper Coal Measures of Langsettian Westphalian 'A' age. Successive Geological Surveys since 1836 inferred the presence of the Arley Mine (1836 to 1930), the Gingham Mine (1930), and currently the Trencherbone Mine at shallow depth in the north of the site and dipping south-east at 1 in 4.

A large fault with a calculated displacement of 80m is shown on Coal Authority records as possibly outcropping with a north-west orientation across the site. Coal mining in the Brightmet area is first recorded in 1246 when Adam de Radelclyve was fined for trespassing on coal workings.

There are no mineplans of any past shallow mining activity in the Trencherbone Mine under the site because any workings will have pre-dated the Mines Act of 1887, but there are detailed abandonment plans of workings in this seam dating from 1908 of Radcliffe Moor Colliery, 200m south-east of the proposed clubhouse. These workings were inspected and the plans annotated at the time by the Mines Inspector John Gerrard and show the strata to be heavily faulted, the workings towards outcrop terminating in 'bad coal' but with no evidence of older old workings although mining practice at this date could have involved in-seam drilling to probe ahead of proposed workings.

The Trencherbone Mine is a high quality seam, extensively mined throughout the coalfield and overlies the equally important Cannel Mine which will lie at a depth of over 30m here. The Cannel Mine was last mined from an adit and a 6m deep shaft by Bury Road Colliery, 1km east of the site from 1931 to 1949 but there are Cannel Mine workings under the site at depth from Red House Colliery dating from 1870 and accessed from shafts west of the site. The coal was totally extracted.

7 boreholes were drilled to up to 30m on the site last week in the location of the proposed clubhouse. Three holes were drilled to 30m depth and a further 4 shallow holes to prove rockhead depth and search for the outcrop of the Trencherbone Mine. The Cannel Rock was encountered in every hole and there was no evidence of any coal or old mine workings, therefore a Low Risk to the proposed development.

The Cannel Rock has a distinctive red colouration throughout the Manchester Coalfield and has a recorded thickness of up to 55m. A stiff grey glacial clay with a thickness varying from 7.2m to 9.4m overlies the red and orange sandstone rockhead.

Shaft 375408-006 is located 30m south-east of the proposed clubhouse. An overgrown colliery spoil heap with a central rubbish filled depression is visible here. The shaft is labelled as 'Pumping Pit' on the 1889 Ordnance Survey and is shown on the Cannel Mine workings plan of Red House Colliery as an isolated shaft east of their workings. The shaft was not investigated but Bhs 3 and 6 closest to the shaft show rockhead to lie at a depths of 8.5m to 9.4m. An easement of 10m to the shaft location is advised as worst case for no build.

16.6 Ground Floor Construction

Shrinkable soils are present at shallow depth across the site and it is therefore recommended that suspended floor construction (e.g. either in-situ RC slabs or block and beam flooring) is adopted in accordance with current best practice guidance.

16.7 Highway / Sports Pitches

According to the criteria of Highways Agency HD 25/95 Volume 7 Section 2 Part 2 HD 25/94, a CBR value of 3-5% on the firm to stiff clay is anticipated and CBR values of 5% on the granular material encountered.

Preliminary CBR values undertaken at the Trial pit locations using a Mexicone gave results between 4 and 7% however in-situ CBR's should be undertaken during construction to confirm. Placement of geotextiles within the areas of roads / parking could also be designed to minimise the subgrade thickness.

Following liaison with a pitch construction specialist the following design parameters for a sports pitch

- 3% natural
- 5% on reworked

As such it is advised that the earthworks to achieve these will be very much weather / season dependant. Advice from a specialist Contractor is advised. Once formation levels are confirmed additional CBR testing is recommended.

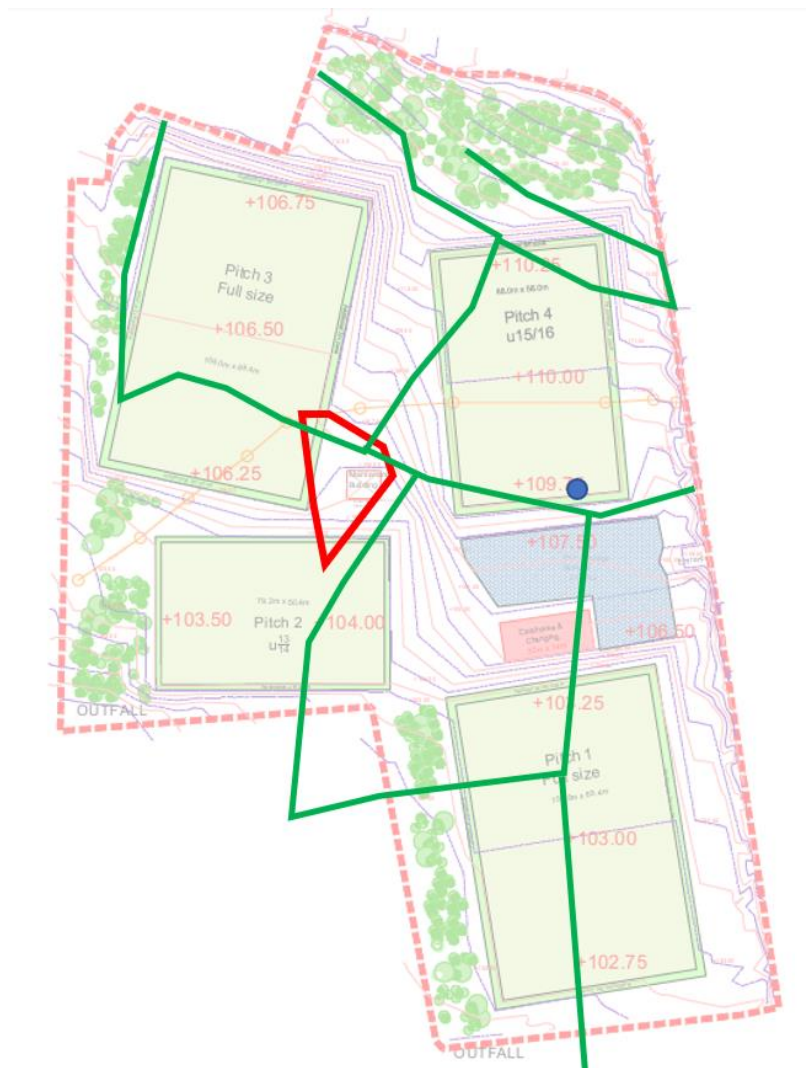
16.8 Protection of Buried Concrete

It is considered for concrete design purposes that a greenfield site and static groundwater conditions are applicable, and the results are summarised below:

Concrete Classification	
Design Sulphate Class	DS-1
ACEC Class	AC-1
Design Chemical Class	DC-1

16.9 Additional Work

- In regards to the former Well (blue circle) and 'tip' area (red triangle)– these are within the Cadent easement for no excavation with plant for the intrusive works and as such could not be investigated. These are shown on the plan below and will require site vigilance and removal / decommission during earthworks with detailed methodology with Cadent and the Earthworks Contractor.
- Additionally, on the below former filed boundaries are shown sketched onto the proposed layout – land drainage should be anticipated in these localities and will need dealing with during the earthworks.



- Additional sampling for compaction testing, targeted depth CBR's would be prudent.

- Additional near surface chemical testing for topsoil and subsoil is advised to allow cost effective removal / sale / reuse.

Notes on validation report guidance and limitations of this report are found in Appendix H and I respectively.

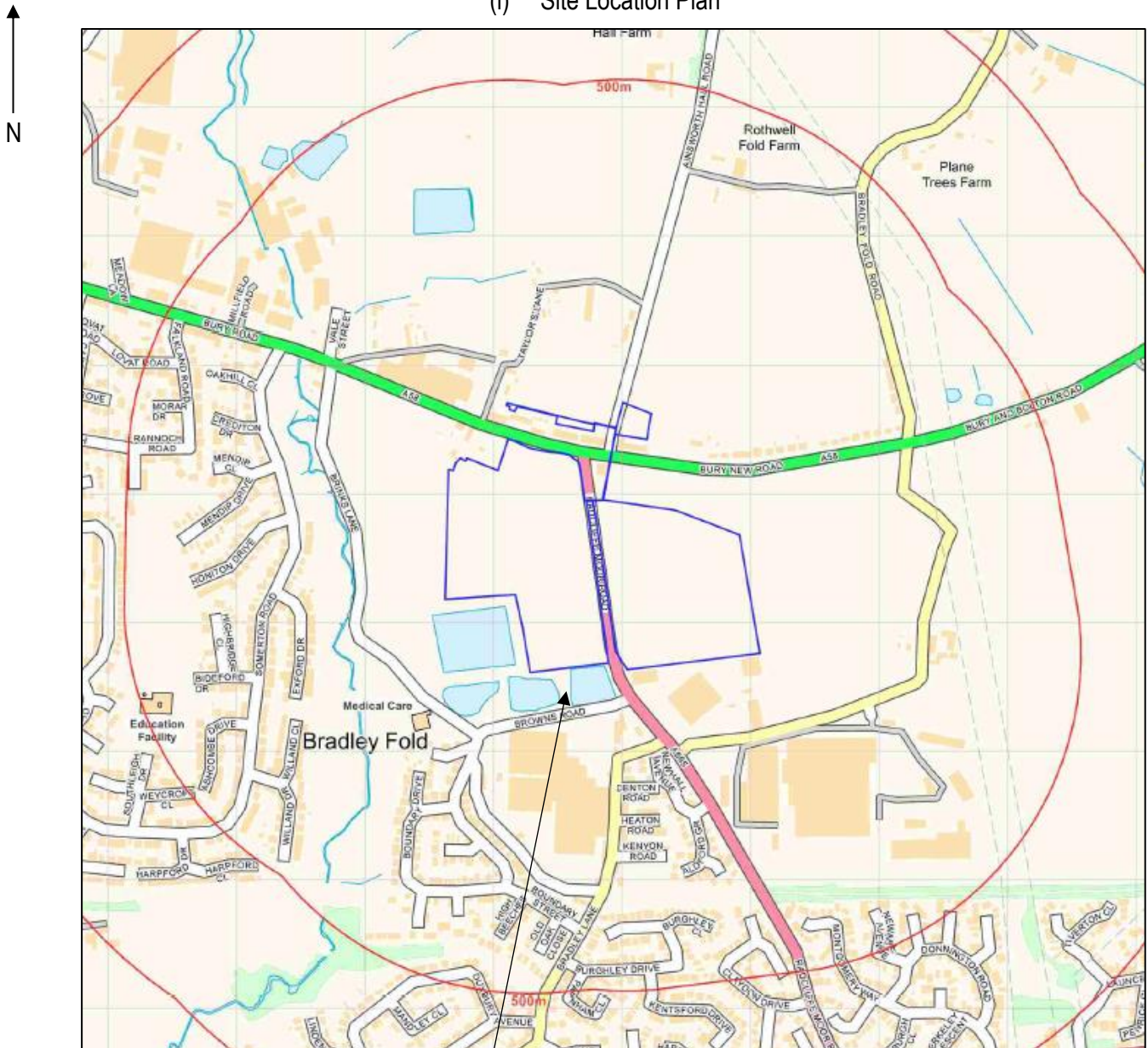
17 REFERENCES

- 17.1 *BS 5930:2015 Code of Practice for Site Investigation.*
- 17.2 *BS1377: 2016 Methods of Test for Soils for Civil Engineering Purposes*
- 17.3 *Assessment of risks to human health from land contamination: an overview of the development of guideline values and related research. EA, 2002.*
- 17.4 *Contaminated Land Risk Assessment; A Guide to Good Practice; CIRIA C552: 2001.*
- 17.5 *Health and Safety in Construction, HSG150, HSE, 1996.*
- 17.6 *Hazardous Waste: Interpretation of the Definition and Classification of Hazardous Waste, Environment Agency, WM2 Version 1.0, June 2003.*
- 17.7 *DoE (1991), The Building Regulations Approved Document C, Site Preparation and Resistance to Moisture, HMSO.*
- 17.8 *Baker W (1987), Investigation Strategy - lecture at City of Birmingham Development Department Symposium on Methane Generating Sites, 9 December 1987, Industrial Research Laboratories, Birmingham.*
- 17.9 *NHBC Standards, Chapter 4.2, 2017 Building Near Trees.*
- 17.10 *Highways Agency HD 25/95 volume 7 section 2 Part 2 HD 25/94.*
- 17.11 *Water Regulations Advisory Scheme (2002) The selection of materials for water supply pipes to be laid in contaminated land.*
- 17.12 *Anon (1997) Dutch in Policy Retreat on Contaminated Land ENDS (Environmental Data Services), 269, 46.*
- 17.13 *Water Regulations Advisory Scheme (2002) The selection of materials for water supply pipes to be laid in contaminated land.*
- 17.14 *Piling In Layered Ground: Risks to Groundwater and Archaeology Science Report SC020074/SR Environment Agency October 2006.*
- 17.15 *Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention National Groundwater & Contaminated Land Centre report NC/99/73 F J Westcott, C M B Lean & M L Cunningham May 2001.*
- 17.16 *'Guidance on Evaluation of Development Proposals on Sites Where Methane and Carbon Dioxide are Present', Report Edition No.04 March 2007 NHBC – designed for use with low rise residential properties.*
- 17.17 *CIRIA C665 'Assessing risks posed by hazardous ground gases for buildings' 2007 - for high rise residential / flats*

- 17.18** *BS8485:2015 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'.*
- 17.19** *BRE 414 'Protective measures for housing on gas-contaminated land' Roger Johnson, Parkman Environment 2001.*
- 17.20** *BS 8500- 1:2006 'Concrete – Complementary British Standard to BS EN 206-1 – Part 1: Method of specifying and guidance for the specifier' November 2006.*
- 17.21** *'Planning Policy 23:Planning and Pollution Control' Office of the Deputy Prime Minister 2004.*
- 17.22** *CLR11 'Model Procedures for the Management of Land Contamination' DEFRA 2004.*
- 17.23** *BRE 465 'Cover Systems for Land Regeneration' 2004.*
- 17.24** *'The UK Approach for Evaluating the Human Health Risks from Petroleum Hydrocarbons in Soils, Environment Agency Science Report P5-080/TR3', Environment Agency (May 2005).*
- 17.25** *TOX12- Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Dioxins, Furans and Dioxin-like PCBs' Environment Agency 2003.*
- 17.26** *Atkins 2017 AtRisksoil.co.uk SSV's derived using CLEA for 1 or 6% SOM. Residential with homegrown produce.*
- 17.27** *A pragmatic approach to ground gas risk assessment for the 21st Century CIRIA/Environmental Protection UK Ground gas seminar – 22nd June 2011 and 13th September 2011 Geoff Card1 and Steve Wilson.*

APPENDIX A

(i) Site Location Plan

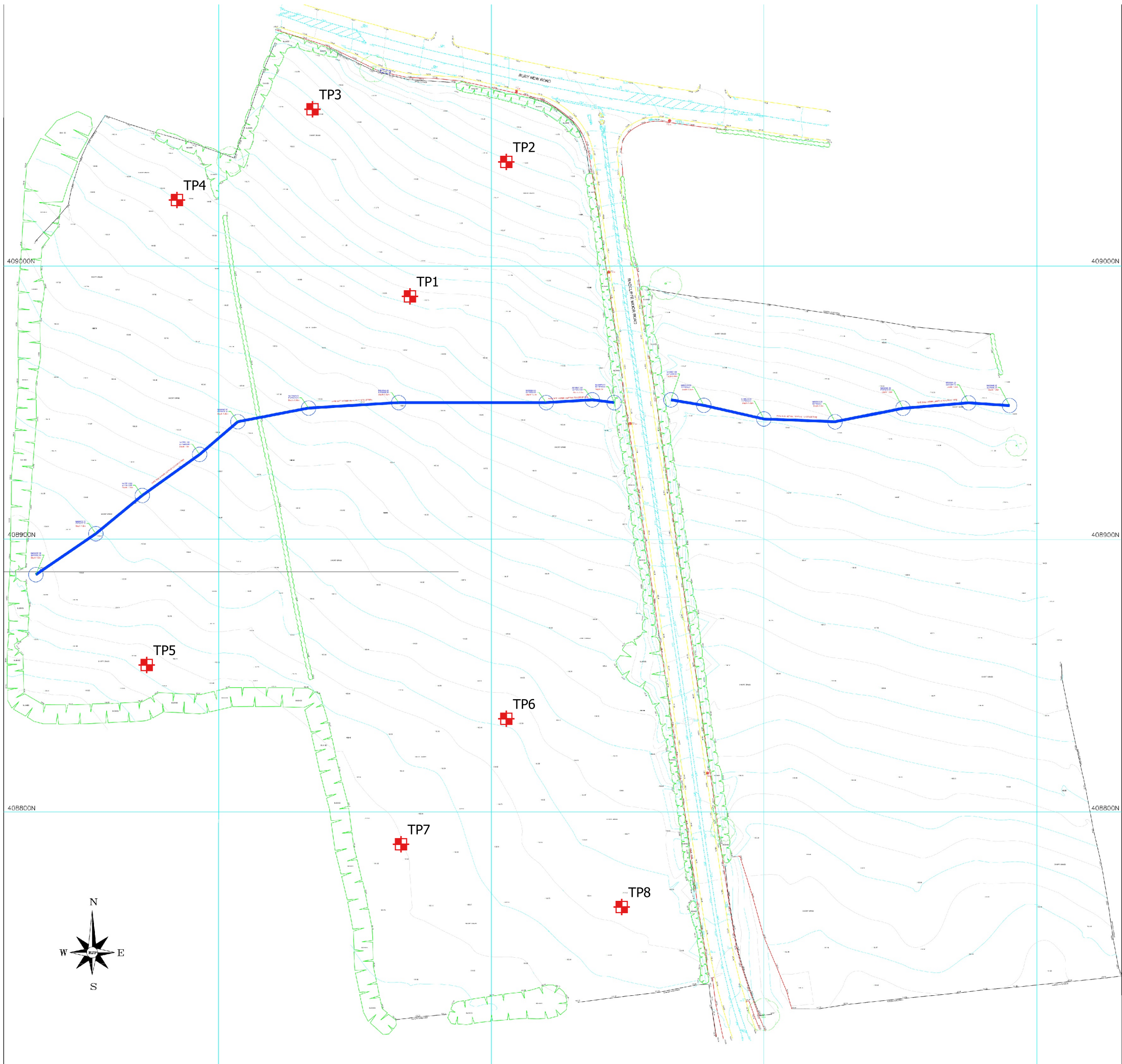


Site Location Plan

The site is located to the south of Bury New Road and either side of Radcliffe Moor Road, Bury, BL2 6QU. The coordinates on the British National Grid CRS are 375680, 408903. The proposed site is approximately 11.73 hectares in total.

APPENDIX B

- (i) Betts Exploratory Hole Location Plan



DO NOT SCALE

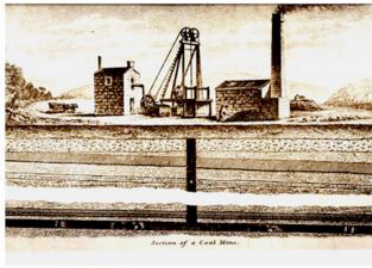
Background image is:

Proposed Development at Bury New Road,
Little Lever for Westchurch Homes,
Topographical Survey by RJP. Drawing No.
WC045/T00

REV	DATE	BY	DESCRIPTION	CHK
DRAWING STATUS:				
 BETTS GEO CONSULTING ENGINEERS Unit 6, Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY Tel: 01244 288178 enquiries@betts-associates.co.uk				
PROJECT: LAND AT RADCLIFFE MOOR ROAD				
TITLE: EXPLORATORY HOLE LOCATION PLAN				
DATE: 21/04/21	SCALE @ SIZE: NTS	DRAWN: LH	CHECKED: MJF	
PROJECT No: 20WCH011	DRAWING No: 1	REV: A		

APPENDIX C

(i) Betts Exploratory Hole Logs



Bh 1

REF 2032
Bh 1

SITE CLIENT
Radcliffe Moor Road, Breightmet
Betts Geo-environmental

TITLE
ORIGIN
printout direct from rig on site
drilled & logged by Neil Catlow

PRINTOUT SCALE
GL AOD
RIG
ORIENTATION
FLUSH
BIT

7 April 2021
1:200
Montabert Hydrofore
vertical
reservoir water supply
75mm T/C

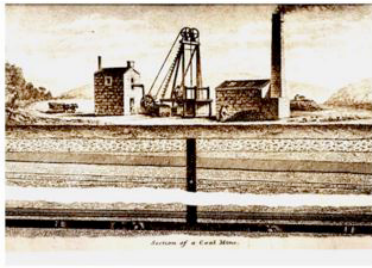
DEPTH	STRATA	GRAPHIC	DESCRIPTION	SPT N value	INTERPRETATION
0.0	0.0	clay	brown, silty, soft	not taken	ground level
0.5					
1.0					
1.5					
2.0	2.0	clay	grey with grey shale boulders, stiff occasional brown weathered layers		
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					
5.5					
6.0					
6.5					
7.0	7.2	sandstone	brown and orange, firm drilling layers of red sandstone		rockhead Cannel Rock
7.5					
8.0					
8.5					
9.0					
9.5					
10.0					
10.5					
11.0					
11.5					
12.0					
12.5					
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25.5					
26.0					
26.5					
27.0					
27.5					
28.0					
28.5					
29.0					
29.5					
30.0	30.0		bottom of hole		

drilled and logged by
Neil Catlow B.Sc FGS

IN HOLE GAS TESTING

% O2	20.6
% CH4	0.0
% CO2	0.0
% LEL	0.0
ppm H2S	0.0
ppm CO	0.0

Nkc Geotech Ltd
25 Grosvenor Road
Wrexham
LL11 1BT
www.nkc.co.uk



Bh 2

REF 2032
Bh 2

SITE CLIENT
Radcliffe Moor Road, Breightmet
Betts Geo-environmental

TITLE
ORIGIN
printout direct from rig on site
drilled & logged by Neil Catlow

PRINTOUT SCALE
GL AOD
RIG
ORIENTATION
FLUSH
BIT

7 April 2021
1:200
Montabert Hydrofore
vertical
reservoir water supply
75mm T/C

DEPTH	STRATA	GRAPHIC	DESCRIPTION	SPT N value	INTERPRETATION
0.0	0.0		brown, silty, soft	not taken	ground level
0.5					
1.0					
1.5					
2.0	2.0		grey with grey shale boulders, stiff		
2.5			occasional brown weathered layers		
3.0					
3.5					
4.0					
4.5					
5.0					
5.5					
6.0					
6.5					
7.0					
7.5					
8.0	8.2		orange, firm drilling		rockhead
8.5					
9.0					Cannel Rock
9.5					
10.0					
10.5					
11.0					
11.5					
12.0					
12.5					
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26.0					
26.5					
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27.5					
28.0					
28.5					
29.0					
29.5					
30.0	30.0		bottom of hole		

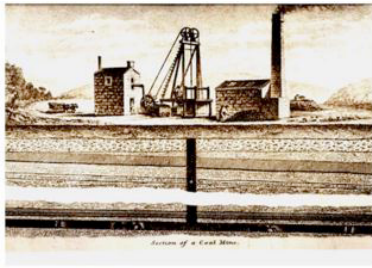
drilled and logged by
Neil Catlow B.Sc FGS

IN HOLE GAS TESTING

% O2	20.6
% CH4	0.0
% CO2	0.0
% LEL	0.0
ppm H2S	0.0
ppm CO	0.0

Nkc Geotech Ltd
25 Grosvenor Road
Wrexham
LL11 1BT

www.nkc.co.uk



Bh 3

REF 2032
Bh 3

SITE
CLIENT

Radcliffe Moor Road, Breightmet
Betts Geo-environmental

PRINTOUT
SCALE

7 April 2021
1:200

TITLE

ORIGIN

printout direct from rig on site
drilled & logged by Neil Catlow

RIG

Montabert Hydrofore

ORIENTATION

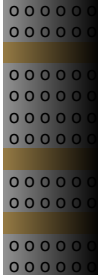
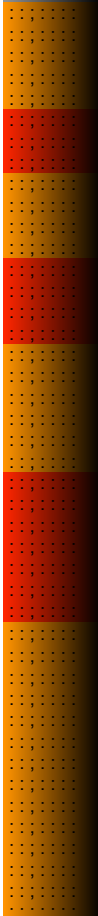
vertical

FLUSH

reservoir water supply

BIT

75mm T/C

	DEPTH	STRATA	GRAPHIC	DESCRIPTION	SPT N value	INTERPRETATION						
0.0	0.0	clay		brown, silty, soft	not taken	ground level						
0.5												
1.0												
1.5												
2.0												
2.5	2.0	clay		grey with grey shale boulders, stiff occasional brown weathered layers								
3.0												
3.5												
4.0												
4.5												
5.0												
5.5												
6.0												
6.5												
7.0												
7.5												
8.0												
8.5							8.5	sandstone		orange, firm drilling		rockhead
9.0												
9.5												
10.0												
10.5												
11.0												
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12.0												
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26.5												
27.0												
27.5												
28.0												
28.5												
29.0												
29.5												
30.0	30.0			bottom of hole	IN HOLE GAS TESTING							

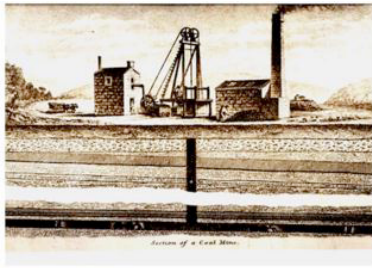


drilled and logged by
Neil Catlow B.Sc FGS

IN HOLE GAS TESTING

%	O2	20.6
%	CH4	0.0
%	CO2	0.0
%	LEL	0.0
ppm	H2S	0.0
ppm	CO	0.0

Nkc Geotech Ltd
25 Grosvenor Road
Wrexham
LL11 1BT
www.nkc.co.uk



REF 2032
Bh 4

SITE CLIENT Radcliffe Moor Road, Breightmet
Betts Geo-environmental

TITLE

ORIGIN printout direct from rig on site
drilled & logged by Neil Catlow

PRINTOUT SCALE 7 April 2021
1:200

GL AOD

RIG ORIENTATION Montabert Hydrofore
vertical

FLUSH reservoir water supply

BIT 75mm T/C

DEPTH	STRATA	GRAPHIC	DESCRIPTION	SPT N value	INTERPRETATION
0.0	0.0	clay	brown, silty, soft	not taken	ground level
0.5					
1.0					
1.5					
2.0	2.0	clay	grey with grey shale boulders, stiff occasional brown weathered layers		
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					
5.5					
6.0					
6.5					
7.0	7.4	sandstone	orange, firm drilling		rockhead
7.5					
8.0					Cannel Rock
8.5					
9.0					
9.5					
10.0					
10.5					
11.0					
11.5					
12.0			bottom of hole		
12.5					
13.0					
13.5					
14.0					
14.5					
15.0					
15.5					
16.0					
16.5					
17.0					
17.5					
18.0					
18.5					
19.0					
19.5					
20.0	20.0		bottom of hole		
20.5					
21.0					
21.5					
22.0					
22.5					
23.0					
23.5					
24.0					
24.5					
25.0					
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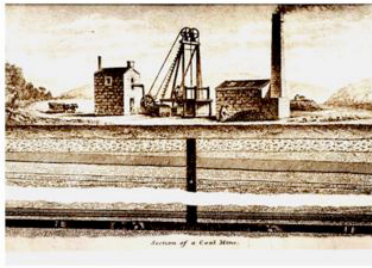
drilled and logged by
Neil Catlow B.Sc FGS

IN HOLE GAS TESTING

%	O2	20.6
%	CH4	0.0
%	CO2	0.0
%	LEL	0.0
ppm	H2S	0.0
ppm	CO	0.0

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Bh 5

REF 2032
Bh 5

SITE
CLIENT

Radcliffe Moor Road, Breightmet
Betts Geo-environmental

PRINTOUT
SCALE
GL AOD

7 April 2021
1:200

TITLE

ORIGIN

printout direct from rig on site
drilled & logged by Neil Catlow

RIG
ORIENTATION
FLUSH
BIT

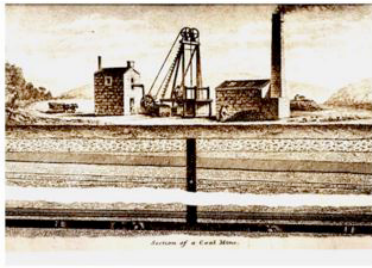
Montabert Hydrofore
vertical
reservoir water supply
75mm T/C

DEPTH	STRATA	GRAPHIC	DESCRIPTION	SPT N value	INTERPRETATION
0.0	0.0	clay	brown, silty, soft	not taken	ground level
0.5					
1.0					
1.5					
2.0	2.0	clay	grey with grey shale boulders, stiff occasional brown weathered layers		
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					
5.5					
6.0					
6.5					
7.0					
7.5					
8.0	8.3	sandstone	orange, firm drilling		rockhead
8.5					Cannel Rock
9.0					
9.5					
10.0					
10.5					
11.0					
11.5	12.0		bottom of hole		
12.0					
12.5					
13.0					
13.5					
14.0					
14.5					
15.0					
15.5					
16.0					
16.5					
17.0					
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25.5					
26.0					
26.5					
27.0					
27.5					
28.0					
28.5					
29.0					
29.5					
30.0					



drilled and logged by
Neil Catlow B.Sc FGS

Nkc Geotech Ltd
25 Grosvenor Road
Wrexham
LL11 1BT
www.nkc.co.uk



Bh 6

REF 2032
Bh 6

SITE CLIENT
Radcliffe Moor Road, Breightmet
Betts Geo-environmental

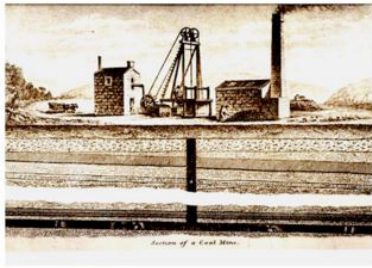
TITLE
ORIGIN
printout direct from rig on site
drilled & logged by Neil Catlow

PRINTOUT SCALE
GL AOD
RIG
ORIENTATION
FLUSH
BIT

7 April 2021
1:200
Montabert Hydrofore
vertical
reservoir water supply
75mm T/C

DEPTH	STRATA	GRAPHIC	DESCRIPTION	SPT N value	INTERPRETATION
0.0	0.0	clay	brown, silty, soft	not taken	ground level
0.5					
1.0					
1.5					
2.0	2.0	clay	grey with grey shale boulders, stiff occasional brown weathered layers		
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					
5.5					
6.0					
6.5					
7.0					
7.5					
8.0					
8.5					
9.0					
9.5	9.4	sandstone	orange, firm drilling		rockhead
10.0					
10.5					Cannel Rock
11.0					
11.5					
12.0	12.0		bottom of hole		
12.5					
13.0					
13.5					
14.0					
14.5					
15.0					
15.5					
16.0					
16.5					
17.0					
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26.0					
26.5					
27.0					
27.5					
28.0					
28.5					
29.0					
29.5					
30.0					

drilled and logged by
Neil Catlow B.Sc FGS



Bh 7

REF 2032
Bh 7

SITE CLIENT
Radcliffe Moor Road, Breightmet
Betts Geo-environmental

TITLE
ORIGIN
printout direct from rig on site
drilled & logged by Neil Catlow

PRINTOUT
SCALE
GL AOD
RIG
ORIENTATION
FLUSH
BIT

7 April 2021
1:200
Montabert Hydrofore
vertical
reservoir water supply
75mm T/C

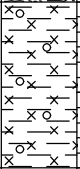
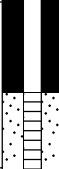
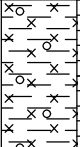
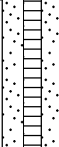
DEPTH	STRATA	GRAPHIC	DESCRIPTION	SPT N value	INTERPRETATION
0.0	0.0		brown, silty, soft	not taken	ground level
0.5					
1.0					
1.5					
2.0	2.0		grey with grey shale boulders, stiff		
2.5			occasional brown weathered layers		
3.0					
3.5					
4.0					
4.5					
5.0					
5.5					
6.0					
6.5					
7.0					
7.5					
8.0					
8.5					
9.0	9.0		orange, firm drilling		rockhead
9.5					Cannel Rock
10.0					
10.5					
11.0					
11.5					
12.0	12.0		bottom of hole		
12.5					
13.0					
13.5					
14.0					
14.5					
15.0					
15.5					
16.0					
16.5					
17.0					
17.5					
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25.5					
26.0					
26.5					
27.0					
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29.0					
29.5					
30.0					



drilled and logged by
Neil Catlow B.Sc FGS

BOREHOLE LOG

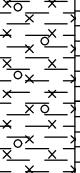
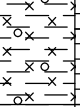
Project Land at Radcliffe Moor Road				BOREHOLE No WS1	
Job No 20WCH011	Date 18-05-21 18-05-21	Ground Level (m)	Co-Ordinates ()		
Contractor				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
0.30	ES1	N16			(0.40) 0.40	TOPSOIL: Brown sandy CLAY			
1.00 1.00	ES2				(1.10) 1.50	Firm greyish orange silty CLAY with occasional fine gravel of coal			
2.00	CBR1		N31			(1.00) 2.50	Firm to stiff greyish orange silty CLAY with occasional fine gravel of coal		
2.50					(0.50) 3.00	Stiff dark grey silty CLAY with occasional fine gravel			
3.00	N12								

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Dia. mm	Water Dpt	From	To	Hours	From	To	
											Wet from perched water at topsoil interface
All dimensions in metres Scale 1:50			Client Westchurch Homes			Method/ Plant Used Competitor Rig			Logged By		

BOREHOLE LOG

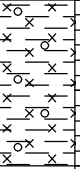
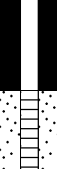
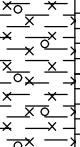
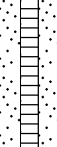
Project Land at Radcliffe Moor Road				BOREHOLE No WS2	
Job No 20WCH011	Date 18-05-21 18-05-21	Ground Level (m)	Co-Ordinates ()		
Contractor				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.30	ES1	N15				0.30	TOPSOIL: Brown sandy CLAY		
1.00						(1.20)	Firm greyish orange silty CLAY with occasional fine gravel of coal		
1.50	ES2					1.50	Stiff greyish orange silty CLAY with occasional fine gravel of coal		
2.00		N27				(1.00)			
2.50	CBR1	N13				2.50	Stiff dark grey silty CLAY with occasional fine gravel		
3.00						(0.50) 3.00			

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Dia. mm	Water Dpt	From	To	Hours	From	To	
											Wet from perched water at topsoil interface
All dimensions in metres Scale 1:50			Client Westchurch Homes			Method/ Plant Used Competitor Rig			Logged By		

BOREHOLE LOG

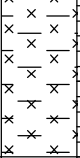
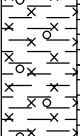
Project Land at Radcliffe Moor Road				BOREHOLE No WS3	
Job No 20WCH011	Date 18-05-21 18-05-21	Ground Level (m)	Co-Ordinates ()		
Contractor				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.30	ES1	N17				(0.40) 0.40	TOPSOIL: Brown sandy CLAY		
1.00 1.00	ES2					(1.10) 1.50	Firm greyish orange silty CLAY with occasional fine gravel of coal		
2.00	CBR1	N24				(1.00) 2.50	Firm to stiff greyish orange silty CLAY with occasional fine gravel of coal		
2.50 3.00						(0.50) 3.00	Stiff dark grey silty CLAY with occasional fine gravel		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Dia. mm	Water Dpt	From	To	Hours	From	To	
											Wet from perched water at topsoil interface
All dimensions in metres Scale 1:50			Client Westchurch Homes			Method/ Plant Used Competitor Rig			Logged By		

BOREHOLE LOG

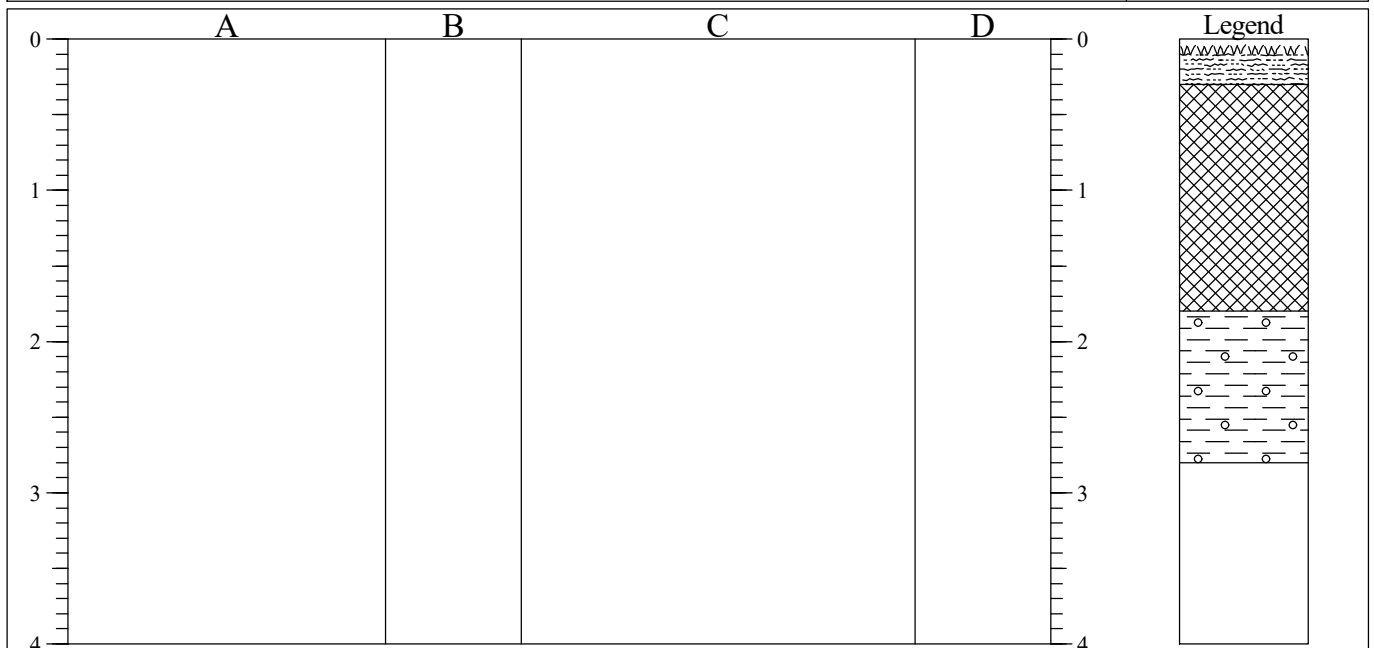
Project Land at Radcliffe Moor Road				BOREHOLE No WS4	
Job No 20WCH011	Date 18-05-21 18-05-21	Ground Level (m)	Co-Ordinates ()		
Contractor				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
0.30	ES1					(0.40) 0.40	TOPSOIL: Brown sandy CLAY		
1.00	ES2					(1.10) 1.50	Compact greyish orange clayey SILT with occasional fine gravel of coal		
2.50	CBR1					(1.00) 2.50	Firm to stiff greyish orange silty CLAY with occasional fine gravel of coal		
						(0.50) 3.00	Stiff to hard dark grey silty CLAY with occasional fine gravel		

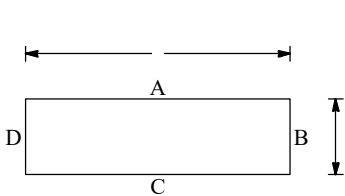
Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Dia. mm	Water Dpt	From	To	Hours	From	To	
											Wet from perched water at topsoil interface
All dimensions in metres Scale 1:50			Client Westchurch Homes			Method/ Plant Used Competitor Rig			Logged By		

TRIAL PIT LOG

Project Land at Radcliffe Moor Road				TRIAL PIT No TP01
Job No 20WCH011	Date 06-04-21 06-04-21	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



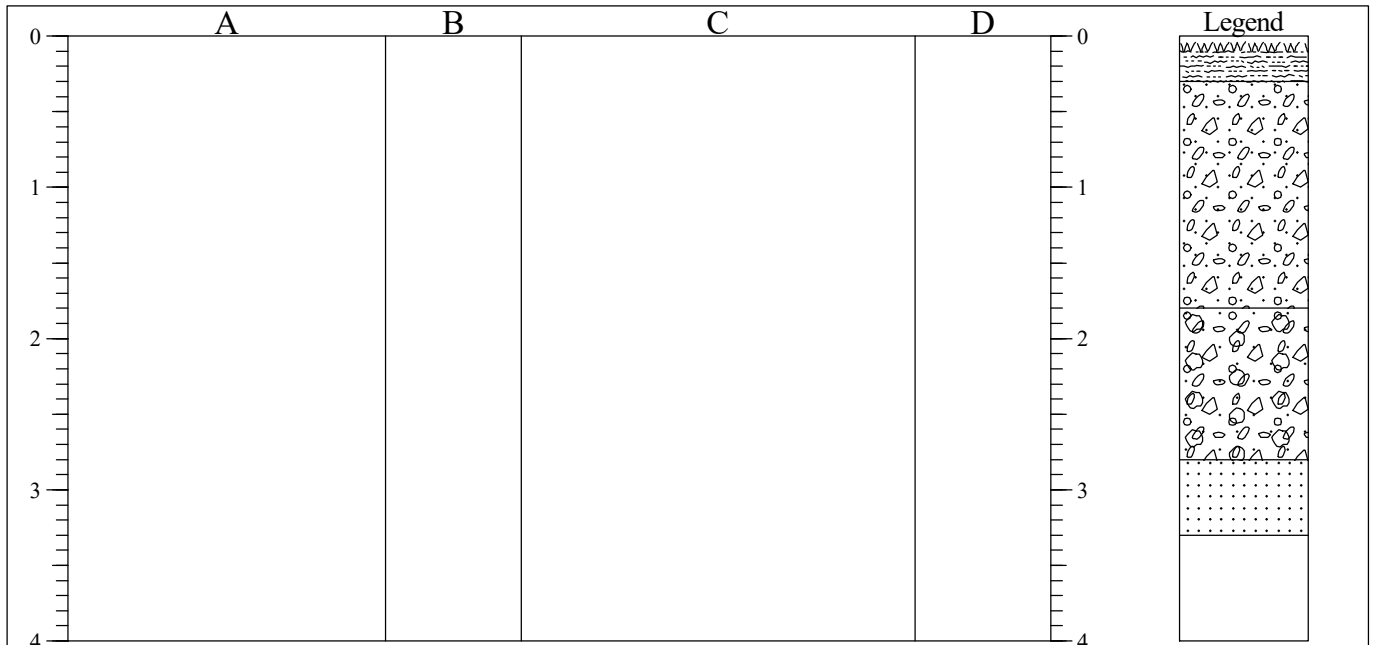
STRATA				SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests	
0.00-0.30		TOPSOIL: Brown sandy clay				
0.30-1.80		MADE GROUND: Cobbles with sand and gravel and occasional pockets of clay				
1.80-2.80		Stiff cobbly gravelly CLAY				

Shoring/Support: Stability: 	GENERAL REMARKS
	Stable. Slight seepage at 1.8 m bgl.

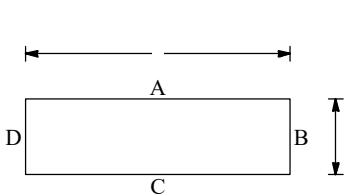
All dimensions in metres Scale 1:50	Client Westchurch Homes	Method/ Plant Used 13t tracked excavator	Logged By
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TRIAL PIT LOG

Project Land at Radcliffe Moor Road				TRIAL PIT No TP02
Job No 20WCH011	Date 06-04-21 06-04-21	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



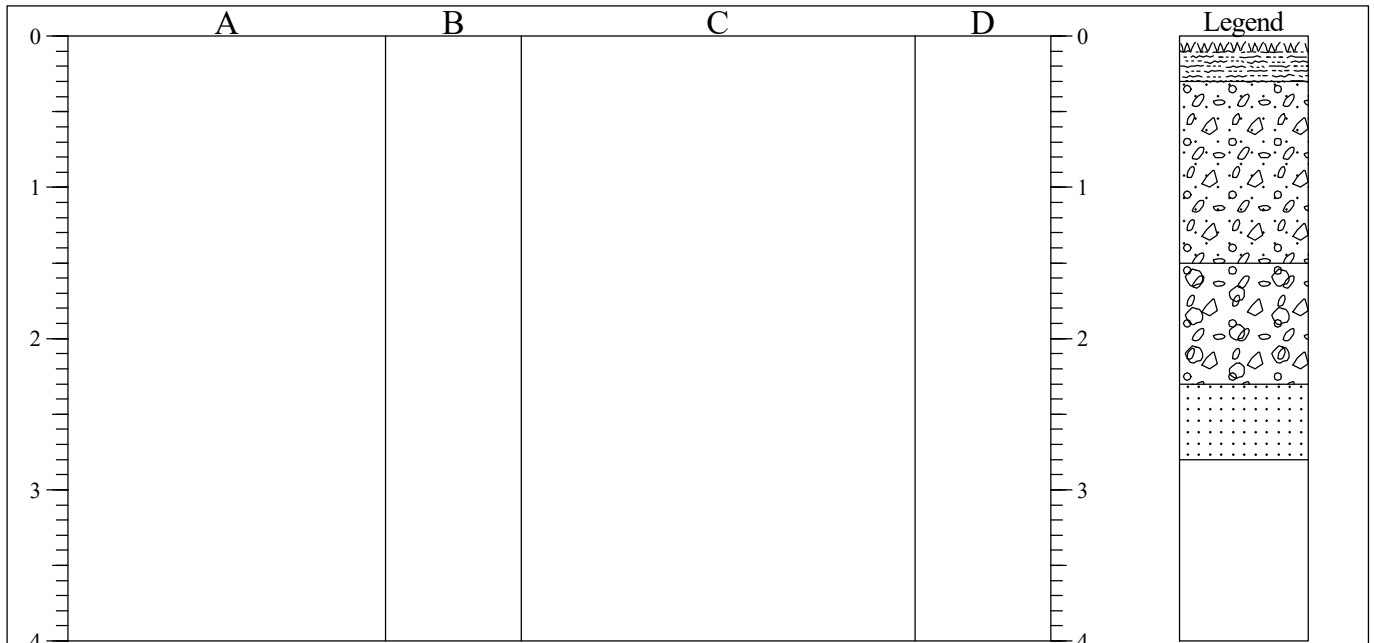
STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		TOPSOIL: Brown sandy clay			
0.30-1.80		Slightly clayey, silty SAND & GRAVEL with occasional cobble			
1.80-2.80		Cobbly sandy GRAVEL with occasional clay pockets			
2.80-3.30		Weathered sand/ siltstone recovered as plates (cobble size)			

Shoring/Support: Stability: 	GENERAL REMARKS Stable. Dry. Difficult to dig at 2.8 m bgl.

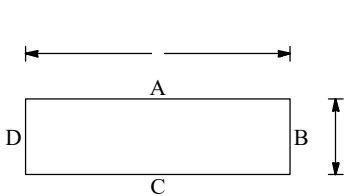
All dimensions in metres Scale 1:50	Client Westchurch Homes	Method/ Plant Used 13t tracked excavator	Logged By
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TRIAL PIT LOG

Project Land at Radcliffe Moor Road				TRIAL PIT No TP03
Job No 20WCH011	Date 06-04-21 06-04-21	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



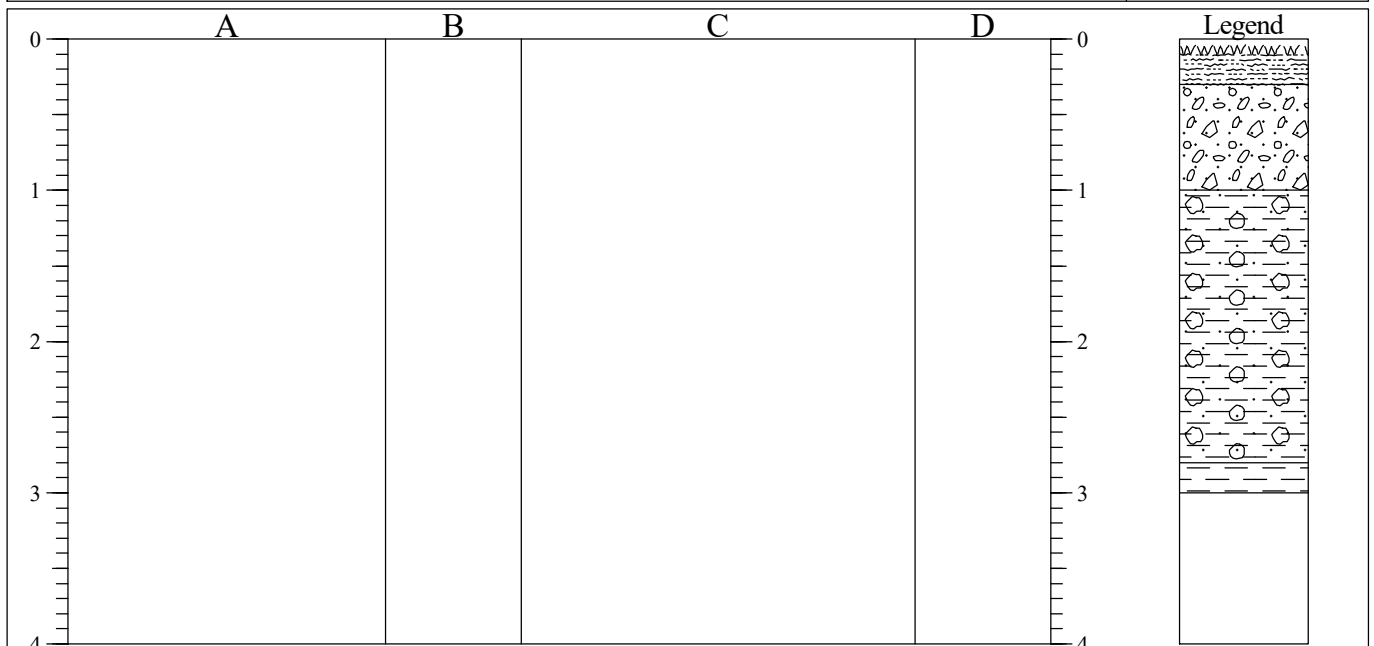
STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		TOPSOIL: Brown sandy clay			
0.30-1.50		Slightly clayey silty SAND & GRAVEL with occasional cobbles.			
1.50-2.30		Cobbly sandy GRAVEL with occasional silt			
2.30-2.80		Weathered sand/ siltstone recovered as plates (cobble size)			

Shoring/Support: Stability: 	GENERAL REMARKS
	Stable. Wet at 2.6 m bgl. Difficult to dig at 2.8 m bgl.

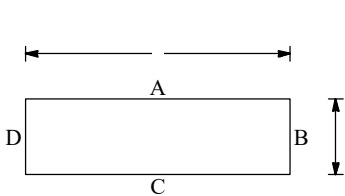
All dimensions in metres Scale 1:50	Client Westchurch Homes	Method/ Plant Used 13t tracked excavator	Logged By
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TRIAL PIT LOG

Project Land at Radcliffe Moor Road				TRIAL PIT No TP04
Job No 20WCH011	Date 06-04-21 06-04-21	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



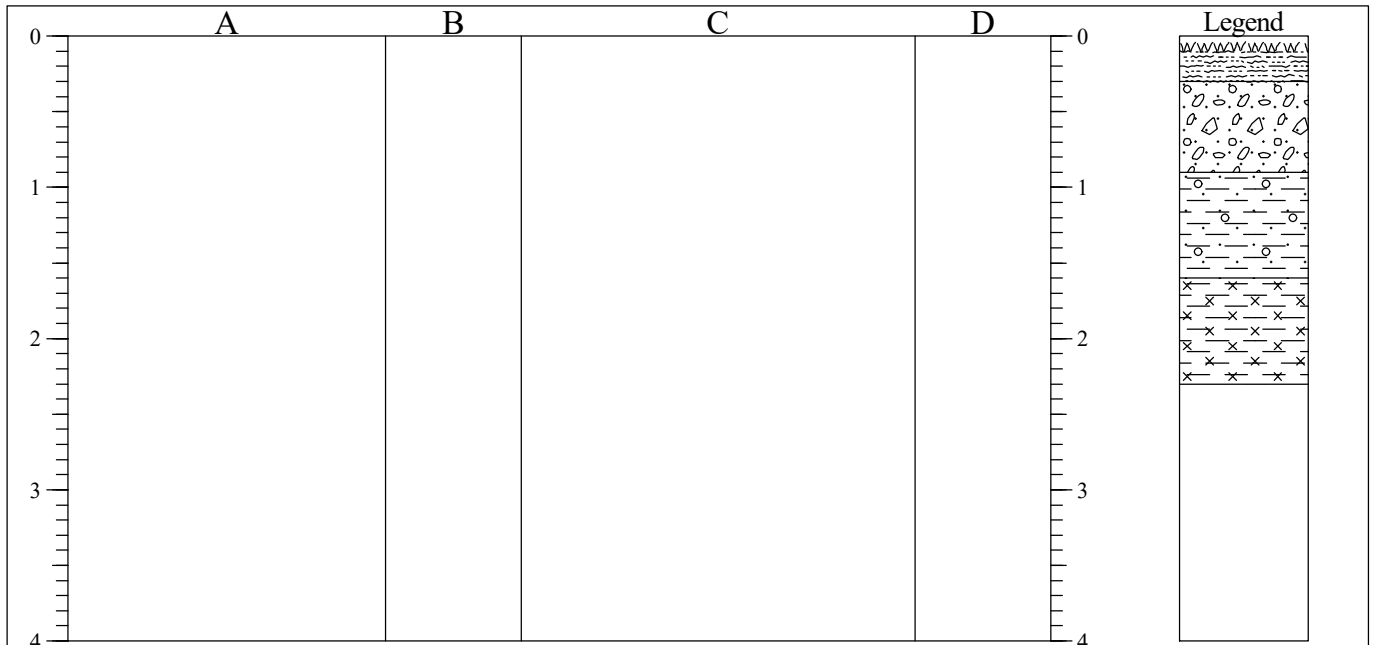
STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		TOPSOIL: Brown sandy clay			
0.30-1.00		Slightly clayey silty SAND & GRAVEL with occasional cobbles			
1.00-2.80		Stiff silty cobbly sandy gravelley CLAY			
2.80-3.00		Hard friable silty CLAY with rare specs of coal, possible decomposed mudstone			

Shoring/Support: Stability: 	GENERAL REMARKS Stable. Dry. Difficult to dig at 2.8 m bgl.
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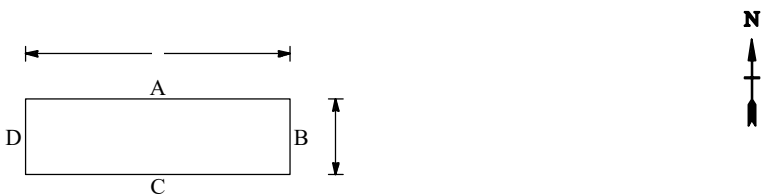
All dimensions in metres Scale 1:50	Client Westchurch Homes	Method/ Plant Used 13t tracked excavator	Logged By
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TRIAL PIT LOG

Project Land at Radcliffe Moor Road				TRIAL PIT No TP05
Job No 20WCH011	Date 06-04-21 06-04-21	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



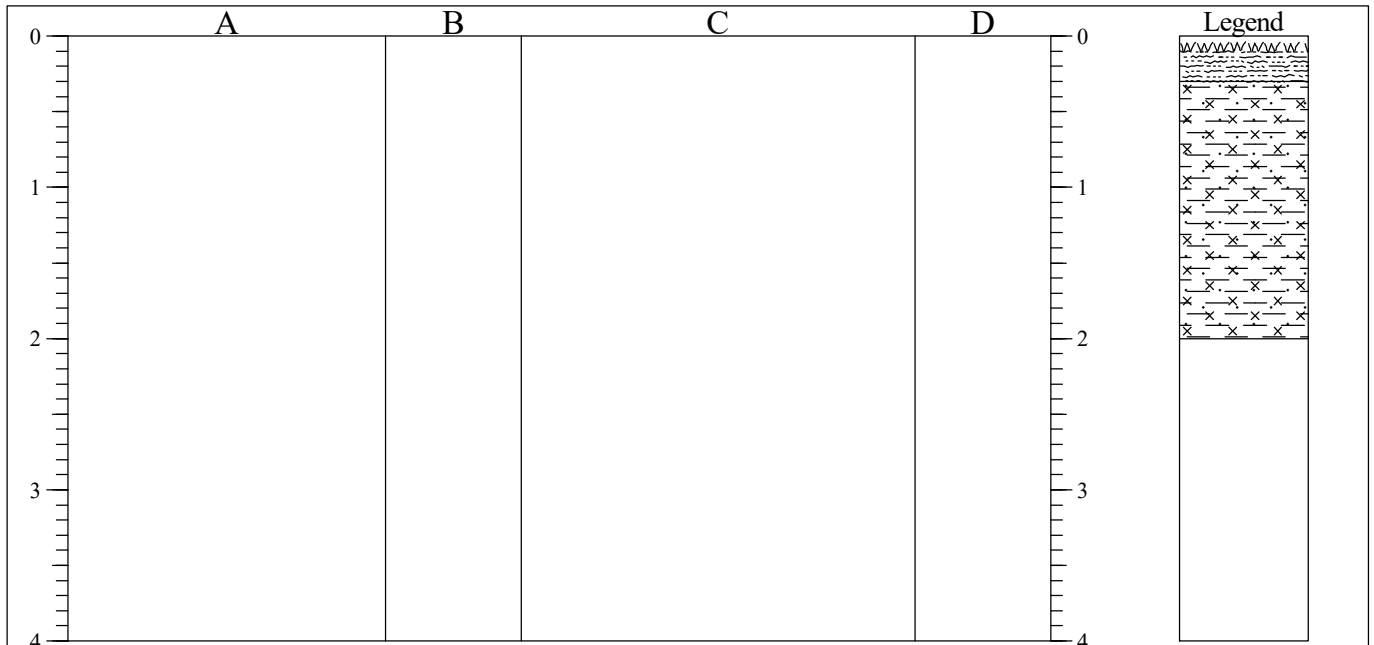
STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		TOPSOIL: Brown sandy clay			
0.30-0.90		Silty SAND & GRAVEL with occasional cobbles			
0.90-1.60		Stiff silty cobbly gravelly sandy CLAY			
1.60-2.30		Hard friable silty CLAY with occasional coal (possible decomposed mudstone)			

Shoring/Support: Stability:		GENERAL REMARKS Stable. Dry. Reeds at surface.
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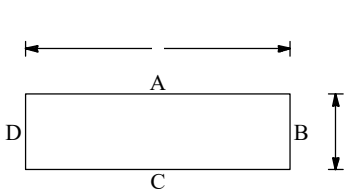
All dimensions in metres Scale 1:50	Client Westchurch Homes	Method/ Plant Used 13t tracked excavator	Logged By
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TRIAL PIT LOG

Project Land at Radcliffe Moor Road				TRIAL PIT No TP06
Job No 20WCH011	Date 06-04-21 06-04-21	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



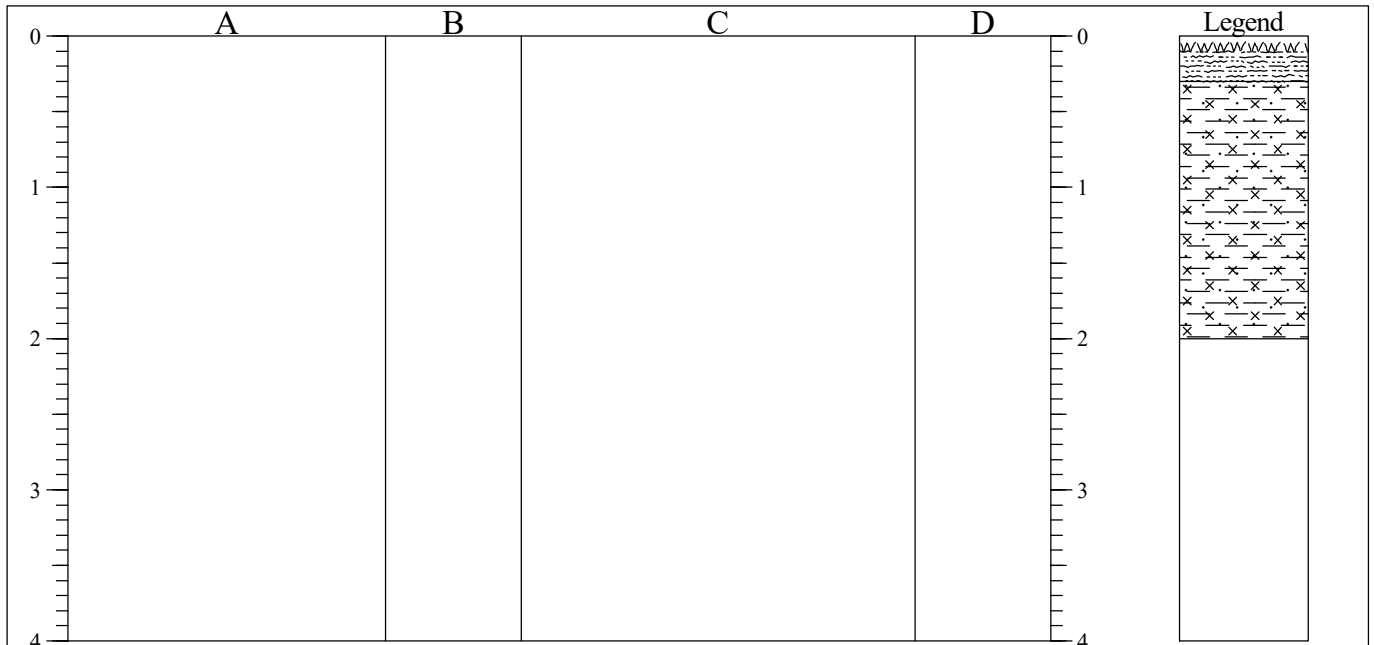
STRATA				SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests	
0.00-0.30		TOPSOIL: Brown sandy clay				
0.30-2.00		Firm to stiff grey and orange silty sandy CLAY				

Shoring/Support: Stability: 	GENERAL REMARKS Stable. Dry.
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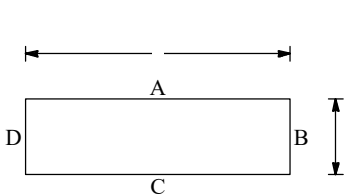
All dimensions in metres Scale 1:50	Client Westchurch Homes	Method/ Plant Used 13t tracked excavator	Logged By
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TRIAL PIT LOG

Project Land at Radcliffe Moor Road				TRIAL PIT No TP07
Job No 20WCH011	Date 06-04-21 06-04-21	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



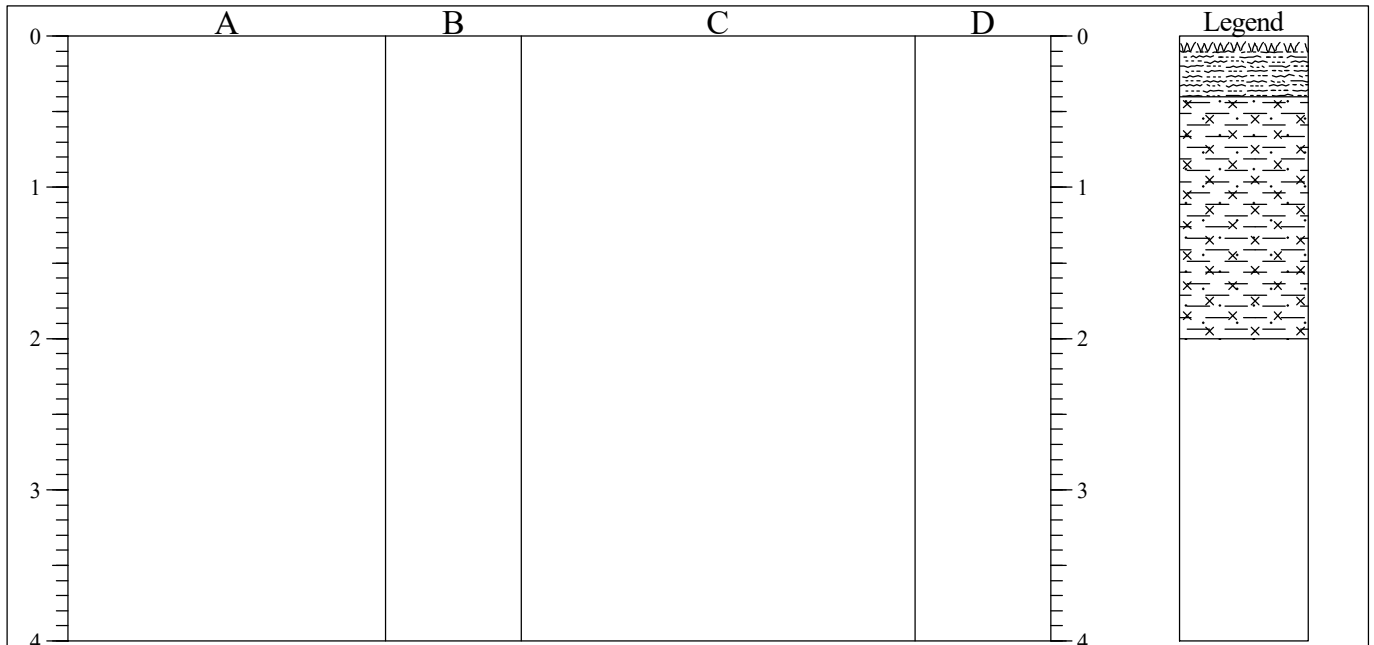
STRATA				SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests	
0.00-0.30		TOPSOIL: Brown sandy clay				
0.30-2.00		Firm to stiff grey and orange silty sandy CLAY				

Shoring/Support: Stability: 	GENERAL REMARKS Stable. Dry. Reeds at surface.
---	--

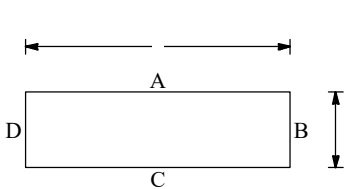
All dimensions in metres Scale 1:50	Client Westchurch Homes	Method/ Plant Used 13t tracked excavator	Logged By
--	----------------------------	--	-----------

TRIAL PIT LOG

Project Land at Radcliffe Moor Road				TRIAL PIT No TP08
Job No 20WCH011	Date 06-04-21 06-04-21	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



STRATA				SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests	
0.00-0.40		TOPSOIL: Brown sandy clay				
0.40-2.00		Firm grey and orange silty sandy CLAY with occasional sand partings				

Shoring/Support: Stability: 	GENERAL REMARKS Stable. Damp.
---	---

All dimensions in metres Scale 1:50	Client Westchurch Homes	Method/ Plant Used 13t tracked excavator	Logged By
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APPENDIX D

(i) Contamination Test Results

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 21/05715
Issue Number: 1
Date: 01 June, 2021

Client: Betts Geo Environmental
Old Marsh Farm Barns
Welsh Road
Sealand
Flintshire
UK
CH5 2LY

Project Manager: Betts Geolab/Marc Fawcett
Project Name: Radcliffe Moor, Bolton
Project Ref: 20WCH011
Order No: BG4191
Date Samples Received: 21/05/21
Date Instructions Received: 25/05/21
Date Analysis Completed: 01/06/21

Prepared by:



Michael Knight
Laboratory Manager

Approved by:



Holly Neary-King
Client Services Supervisor

Envirolab Job Number: 21/05715

Client Project Name: Radcliffe Moor, Bolton

Client Project Ref: 20WCH011

Lab Sample ID	21/05715/1	21/05715/2	21/05715/3	21/05715/4	21/05715/5	21/05715/6		Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	WS1	WS1	WS2	WS2	WS3	WS3				
Depth to Top	0.30	1.00	1.50	0.30	0.30	1.00				
Depth To Bottom										
Date Sampled	18-May-21	18-May-21	18-May-21	18-May-21	18-May-21	18-May-21				
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES				
Sample Matrix Code	6AE	3A	6AE	6AE	6AE	3A				
% Stones >10mm _A	2.5	2.0	<0.1	<0.1	<0.1	<0.1		% w/w	0.1	A-T-044
pH _D ^{M#}	6.51	6.65	6.39	5.64	6.05	6.71		pH	0.01	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	<0.01	<0.01	<0.01	<0.01	<0.01	0.06		g/l	0.01	A-T-026s
Organic matter _D ^{M#}	8.3	2.5	4.4	12.5	10.6	1.7		% w/w	0.1	A-T-032 OM
Arsenic _D ^{M#}	32	3	6	35	24	7		mg/kg	1	A-T-024s
Cadmium _D ^{M#}	2.9	0.9	0.8	1.8	1.7	2.0		mg/kg	0.5	A-T-024s
Copper _D ^{M#}	79	17	17	80	61	15		mg/kg	1	A-T-024s
Chromium (hexavalent) _D	<1	<1	<1	<1	<1	1		mg/kg	1	A-T-040s
Lead _D ^{M#}	202	11	49	184	194	16		mg/kg	1	A-T-024s
Mercury _D	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17		mg/kg	0.17	A-T-024s
Nickel _D ^{M#}	27	11	12	30	25	12		mg/kg	1	A-T-024s
Selenium _D ^{M#}	<1	<1	<1	<1	<1	<1		mg/kg	1	A-T-024s
Zinc _D ^{M#}	262	25	41	177	177	25		mg/kg	5	A-T-024s
VPH total (>C5-C10)	<1	<1	<1	1	<1	<1		mg/kg	1	Calc-stone+mols

Envirolab Job Number: 21/05715

Client Project Name: Radcliffe Moor, Bolton

Client Project Ref: 20WCH011

Lab Sample ID	21/05715/1	21/05715/2	21/05715/3	21/05715/4	21/05715/5	21/05715/6		Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	WS1	WS1	WS2	WS2	WS3	WS3				
Depth to Top	0.30	1.00	1.50	0.30	0.30	1.00				
Depth To Bottom										
Date Sampled	18-May-21	18-May-21	18-May-21	18-May-21	18-May-21	18-May-21				
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES				
Sample Matrix Code	6AE	3A	6AE	6AE	6AE	3A				
Asbestos in Soil (inc. matrix)										
Asbestos in soil [#]	NAD	NAD	NAD	NAD	NAD	NAD				A-T-045
Asbestos ACM - Suitable for Water Absorption Test? _D	N/A	N/A	N/A	N/A	N/A	N/A				A-T-045

Envirolab Job Number: 21/05715

Client Project Name: Radcliffe Moor, Bolton

Client Project Ref: 20WCH011

Lab Sample ID	21/05715/1	21/05715/2	21/05715/3	21/05715/4	21/05715/5	21/05715/6		Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	WS1	WS1	WS2	WS2	WS3	WS3				
Depth to Top	0.30	1.00	1.50	0.30	0.30	1.00				
Depth To Bottom										
Date Sampled	18-May-21	18-May-21	18-May-21	18-May-21	18-May-21	18-May-21				
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES				
Sample Matrix Code	6AE	3A	6AE	6AE	6AE	3A				
PAH-16MS										
Acenaphthene _A ^{M#}	0.03	<0.01	<0.01	0.11	0.14	<0.01		mg/kg	0.01	A-T-019s
Acenaphthylene _A ^{M#}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		mg/kg	0.01	A-T-019s
Anthracene _A ^{M#}	0.03	<0.02	<0.02	0.16	0.22	<0.02		mg/kg	0.02	A-T-019s
Benzo(a)anthracene _A ^{M#}	0.08	<0.04	<0.04	0.53	0.83	<0.04		mg/kg	0.04	A-T-019s
Benzo(a)pyrene _A ^{M#}	0.08	<0.04	<0.04	0.52	0.84	<0.04		mg/kg	0.04	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	0.09	<0.05	<0.05	0.59	1.03	<0.05		mg/kg	0.05	A-T-019s
Benzo(ghi)perylene _A ^{M#}	<0.05	<0.05	<0.05	0.25	0.37	<0.05		mg/kg	0.05	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	<0.07	<0.07	<0.07	0.26	0.36	<0.07		mg/kg	0.07	A-T-019s
Chrysene _A ^{M#}	0.12	<0.06	<0.06	0.64	1.00	<0.06		mg/kg	0.06	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	<0.04	<0.04	<0.04	<0.04	0.07	<0.04		mg/kg	0.04	A-T-019s
Fluoranthene _A ^{M#}	0.28	<0.08	<0.08	1.35	2.02	<0.08		mg/kg	0.08	A-T-019s
Fluorene _A ^{M#}	<0.01	<0.01	<0.01	0.05	0.08	<0.01		mg/kg	0.01	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	<0.03	<0.03	<0.03	0.26	0.42	<0.03		mg/kg	0.03	A-T-019s
Naphthalene _A ^{M#}	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03		mg/kg	0.03	A-T-019s
Phenanthrene _A ^{M#}	0.15	<0.03	<0.03	0.82	1.07	<0.03		mg/kg	0.03	A-T-019s
Pyrene _A ^{M#}	0.25	<0.07	<0.07	1.21	1.81	<0.07		mg/kg	0.07	A-T-019s
Total PAH-16MS _A ^{M#}	1.11	<0.08	<0.08	6.75	10.3	<0.08		mg/kg	0.01	A-T-019s

Envirolab Job Number: 21/05715

Client Project Name: Radcliffe Moor, Bolton

Client Project Ref: 20WCH011

Lab Sample ID	21/05715/1	21/05715/2	21/05715/3	21/05715/4	21/05715/5	21/05715/6		Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	WS1	WS1	WS2	WS2	WS3	WS3				
Depth to Top	0.30	1.00	1.50	0.30	0.30	1.00				
Depth To Bottom										
Date Sampled	18-May-21	18-May-21	18-May-21	18-May-21	18-May-21	18-May-21				
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES				
Sample Matrix Code	6AE	3A	6AE	6AE	6AE	3A				
TPH CWG										
Ali >C5-C6 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		mg/kg	0.01	A-T-022s
Ali >C6-C8 _A [#]	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04		mg/kg	0.01	A-T-022s
Ali >C8-C10 _A	<1	<1	<1	1	<1	<1		mg/kg	1	A-T-055s
Ali >C10-C12 _A ^{M#}	<1	<1	<1	<1	<1	<1		mg/kg	1	A-T-055s
Ali >C12-C16 _A ^{M#}	<1	<1	<1	1	<1	<1		mg/kg	1	A-T-055s
Ali >C16-C21 _A ^{M#}	1	<1	<1	1	1	<1		mg/kg	1	A-T-055s
Ali >C21-C35 _A ^{M#}	16	1	7	12	14	<1		mg/kg	1	A-T-055s
Total Aliphatics _A	17	1	7	16	16	<1		mg/kg	1	A-T-055s
Aro >C5-C7 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		mg/kg	0.01	A-T-022s
Aro >C7-C8 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		mg/kg	0.01	A-T-022s
Aro >C8-C10 _A	<1	<1	<1	<1	<1	<1		mg/kg	1	A-T-055s
Aro >C10-C12 _A	<1	<1	<1	1	<1	<1		mg/kg	1	A-T-055s
Aro >C12-C16 _A	4	<1	<1	10	9	<1		mg/kg	1	A-T-055s
Aro >C16-C21 _A ^{M#}	11	<1	<1	23	32	<1		mg/kg	1	A-T-055s
Aro >C21-C35 _A ^{M#}	36	<1	2	49	74	<1		mg/kg	1	A-T-055s
Total Aromatics _A	51	<1	2	83	115	<1		mg/kg	1	A-T-055s
TPH (Ali & Aro >C5-C35) _A	68	1	10	99	130	<1		mg/kg	1	A-T-055s
BTEX - Benzene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		mg/kg	0.01	A-T-022s
BTEX - Toluene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		mg/kg	0.01	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		mg/kg	0.01	A-T-022s
BTEX - m & p Xylene _A [#]	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		mg/kg	0.01	A-T-022s
BTEX - o Xylene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		mg/kg	0.01	A-T-022s
MTBE _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		mg/kg	0.01	A-T-022s

REPORT NOTES

General

This report shall not be reproduced, except in full, without written approval from Envirolab.

The results reported herein relate only to the material supplied to the laboratory.

The residue of any samples contained within this report, and any received with the same delivery, will be disposed of six weeks after initial scheduling. For samples tested for Asbestos we will retain a portion of the dried sample for a minimum of six months after the initial Asbestos testing is completed.

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.

If results are in italic font they are associated with an AQC failure, these are not accredited and are 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 and, as a result, may be invalid.

The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

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.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

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 as 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, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable 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.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client: Betts Geo Environmental, Old Marsh Farm Barns, Welsh Road, Sealand,
Flintshire, UK, CH5 2LY

Project: Radcliffe Moor, Bolton

Clients Project No: 20WCH011

Project No: 21/05715

Date Received: 25/05/2021 (am)

Cool Box Temperatures (°C): 7.4

NO DEVIATIONS IDENTIFIED with respect to sampling dates or containers received.

Note: If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3 (for water samples $5 \pm 3^{\circ}\text{C}$), ISO 18400-120:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

APPENDIX E

(i) Conceptual Model

The report aims to identify land which could potentially be affected by contamination, such that it could affect the value or re-use of the land, or such that mitigation would be required for certain proposed end uses of the land.

The assessment also aims to identify land which would be regarded as 'contaminated land' under the terms of the Environmental Protection Act 1990, Part IIa. This act includes a stricter test for contaminated land than that outlined above. Land is considered to be contaminated if either:

- the land is causing significant harm to people, ecosystems or infrastructure; or
- there is a significant possibility that such harm could be caused; or
- Pollution of controlled waters is being, or is likely to be, caused.

The following situations are defined as being where harm is to be regarded as significant:

- chronic or quite toxic effect, serious injury or death to humans;
- irreversible or other adverse harm to the ecological system;
- substantial damage to or failure of buildings;
- death of, or disease or other physical damage affecting, livestock or crops;
- Pollution of controlled waters.

The risk assessment uses a 'Source-Pathway-Receptor' methodology for assessing whether a source of contamination could potentially lead to harmful consequences. This means that there needs to be a pollutant linkage from source to receptor for harm to be caused, this linkage consisting of:

- a source of pollution;
- a pathway for the pollutant to move along;
- A receptor that is affected by the pollutant.

As an example, the pollutant source could be an identified leak of oil or an area of dumped waste.



The pathways could include transport of the contaminant by groundwater, surface water, windblown dust, or vapours, and for human receptors will include the means, by which contaminants enter the body, for example skin contact, ingestion and inhalation.

Receptors include people, other living organisms, the built environment and groundwater and surface waters (these latter two also being contaminant pathways).

The source-pathway-receptor methodology relationship allows an assessment of the environmental risk to be determined, based on the nature of the source, the degree of exposure of the receptor to the source and the sensitivity of the receptor.

This section of the report is based on the information set out in the previous sections of the report and should not be read independently of such sections.

Initial Conceptual Model

From the available information the preliminary conceptual model is visualised as follows:

Target (Receptor)	POTENTIAL SOURCE-PATHWAY LINKAGE
Site users / residents	Inhalation of soil gas, odours or dust.
	Ingestion of, and skin contact with, contaminated soil.
	Ingestion of contaminants in vegetables etc. or in soils adhering to vegetables, etc.
Construction/ maintenance workers.	Inhalation of soil gas, odours or dust
	Ingestion of, and skin contact with, contaminated soil
Plants	Adverse effects on growth caused by presence of contaminants in soil
Buildings and Structures	Flow of ground gas into buildings. Asphyxiation, toxicity, explosion and fire hazards
	Sulphate attack of foundations
	Hydrocarbons penetrating plastic water supply pipes
Groundwater	Migration of soluble contaminants into groundwater on or off site. Migration of oils into groundwater on or off site.
Surface water	Migration of soluble contaminants and/or direct run-off of contaminants. Migration of oils into groundwater on or off site.

Initial Environmental Risk Assessment

General

It is accepted that an environmental risk assessment can be based on a source-pathway-target model. An examination is carried out as to whether a target will be at risk from a contamination source, that a source exists, and whether there are any pathways (routes of exposure) which might actually link the source to the target.

Environmental risk assessments rely heavily on numerical trigger concentrations or guidelines because exposure of targets to contamination is difficult to quantify directly. Quantification of risk is therefore mainly undertaken for general scenarios in order to derive trigger levels. These are derived for various contaminants for particular targets and routes of exposure. An example of a sensitive target would be users of a domestic back garden, where routes of exposure might be skin contact, dust inhalation, direct ingestion and indirect ingestion via cultivation and consumption of fruit and vegetables.

In March 2002, the first parts of the new CLEA risk assessment guidance were released by DEFRA/Environment Agency.

The risk assessment approach is an extension of the 'fit for use' concept whereby land is cleaned up to a standard fit for the proposed use, that is, so all remaining risks are acceptable. However, as well as being 'fit for use', the environmental risk assessment approach also addresses the soil and water environment so that these are also safeguarded where necessary. For example if a site was contaminated with heavy metals and the development comprised the proposed construction of hard standings and buildings only, the fit-for-use approach might require no remediation for the site. However, consideration of the wider environment needs to address whether groundwater is being contaminated, and if so whether remediation is required for this reason.

The following classification presented by CIRIA has been used in the assessment of risk:

Estimation of risk from consideration of magnitude, consequences and probabilities				
Probability	Consequences			
	Severe	Moderate	Mild	Minor
High	Very high	High	Moderate	Moderate / Low
Medium	High	Moderate	Moderate / Low	Low
Low	Moderate	Moderate / Low	Low	Very Low
Unlikely	Moderate / Low	Low	Very Low	Very Low

Reference: Contaminated Land Risk Management; A Guide to Good Practice, CIRIA C552:2001

CIRIA C665 Situation A Ground Gas Conceptual Model

The risk table contained in C665 is basically a modified risk assessment from CIRIA 152 1995, by which a conceptual model and semi-quantitative risk assessment can be made.

APPENDIX F

(i) Gas Monitoring Results

Date of Monitoring: 16/06/21

Relevant Information at the Time of Monitoring	
Monitored by:	TM
Weather:	Warm, sunny.
Equipment Used:	GA5000
	Solinst Mini Interface Meter
Visible signs of damage/stress:	N/A
Other Comments/Observations:	Pressure falling.

Date of Monitoring: 25/06/21

Relevant Information at the Time of Monitoring	
Monitored by:	tm/rd
Weather:	raining mild
Equipment Used:	GA5000
	Solinst Mini Interface Meter
Visible signs of damage/stress:	n/a
Other Comments/Observations:	

Date of Monitoring: 15/07/21



Notes: Monitoring order is left to right across the table Monitoring should be for not less than 3 minutes. However, if high concentrations of gases are initially recorded, monitoring should be for up to 10 minutes

Relevant Information at the Time of Monitoring	
Monitored by:	Tommy
Weather:	warm and dry
Equipment Used:	GA5000
	Solinst Mini Interface Meter
Visible signs of damage/stress:	
Other Comments/Observations:	

Site: Radcliffe Moor Road
Job Number: 20wch011
Date of Monitoring: 11/08/2021



Ground Gas Monitoring Round 4

Borehole	Gas Flow (l/hr)	Atmospheric Pressure (mB)	Methane CH ₄ (%v/v)		Carbon Dioxide CO ₂ (% v/v)		Oxygen (%v/v)		Other Gases			Depth to Water	
			Peak	Steady	Peak	Steady	Min	Steady	PID	H ₂ S	CO	(mbgl)	BH depth
ws01	0	1004	0.2	0.1	0.1	0.1	19.5	21.3	-	-	1	0.50	2.85
ws02	0	1004	0.1	0.1	0.3	0.3	21.1	21.1	-	-	1	0.60	2.55
ws03	0	0.1	0.1	0.1	0.1	0.1	21.2	21.2	-	1	1	0.45	2.70

Notes:

Monitoring order is left to right across the table

Monitoring should be for not less than 3 minutes. However, if high concentrations of gases are initially recorded, monitoring should be for up to 10 minutes

Relevant Information at the Time of Monitoring	
Monitored by:	Tommy
Weather:	Warm and Dry
Equipment Used:	GA5000
	Solinst Mini Interface Meter
Visible signs of damage/stress:	
Other Comments/Observations:	

Site:Radcliffe Moor Bolton
Job Number: 20WCH011
Date of Monitoring: 09/09/2011



Ground Gas Monitoring Round 5

Borehole	Gas Flow (l/hr)	Atmospheric Pressure (mB)	Methane CH ₄ (%v/v)		Carbon Dioxide CO ₂ (% v/v)		Oxygen (%v/v)		Other Gases			Depth to Water	
			Peak	Steady	Peak	Steady	Min	Steady	PID	H ₂ S	CO	(mbgl)	BH depth
WS01	0	988	0.1	0.1	0.1	0.1	20.8	20.0	-	-	-	DRY	2.70
WS02	0	988	0	0	0.3	0.3	20.6	20.6	-	1	1	DRY	2.50
WS03	0	988	0	0	0.1	0.1	20.8	19	-	1	1	DRY	2.75

Notes:

Monitoring order is left to right across the table

Monitoring should be for not less than 3 minutes. However, if high concentrations of gases are initially recorded, monitoring should be for up to 10 minutes

Relevant Information at the Time of Monitoring	
Monitored by:	TOMMY
Weather:	DRY WARM
Equipment Used:	GA5000
	Solinst Mini Interface Meter
Visible signs of damage/stress:	
Other Comments/Observations:	

(ii) Notes on Ground Gas

Ground Gas

The Building Regulations and BRE Report 212 state that precautions are not mandatory against carbon dioxide unless 5.0% volume is exceeded. These documents do not give a threshold level for methane, but Baker suggests that this level is 0.1% volume. For methane up to 1.0% volume, and carbon dioxide above 5.0% volume, the Building Regulations and BRE Report state that passive measures may be adopted. Above 1.0% methane further specific guidance must be sought.

CIRIA Report 149 gives further guidance on the appropriate precautions for various gas regimes, called characteristic situations in this report. In the DETR Guide for Design by Ove Arup, various types of passive measures are assessed for performance with different gas regimes. The assessments used computational fluid dynamic (CFD) modelling.

A gas regime is essentially defined by two parameters:

- i) The concentration of the gas (e.g. % methane)
- ii) The emission rate of the gas from the ground.

The fact that two parameters are used is problematic if the site is to be classified on the basis of Table 28 in CIRIA Report 149. This is because high gas concentrations are often encountered which fall into an onerous gas regime; whereas the low flow rates which are also frequently encountered fall into less onerous gas regimes.

In order to use the Guide for Design to decide if passive measures are suitable, it is necessary to combine the gas concentration and the emission rate.

Three recent publications are used for ground gas risk assessment:

- CIRIA C665 for high rise residential / flats
- 'Guidance on Evaluation of Development Proposals on Sites Where Methane and Carbon Dioxide are Present' Report Edition No.04 March 2007 NHBC – designed for use with low rise residential properties
- BS8485:2007 'Code of practice for the characterization and remediation from ground gas in affected developments'

These documents improve upon the approach used in previous CIRIA and Wilson /Card Papers, by placing emphasis on gas flow rates, but still retain some reliance on the gas concentrations themselves.

CIRIA C665 Situation A Ground Gas Conceptual Model

The risk table contained in C665 is basically a modified risk assessment from CIRIA 152 1995, by which a conceptual model and semi-quantitative risk assessment can be made.

High Rise / Flats (CIRIA 665 Table 8.5)

Characteristic Situation (CIRIA Report 149)	Risk Classification	Gas Screening Value (CH₄ or CO₂) (l/hr) ¹	Additional factors	Typical source of generation
1	Very low risk	<0.07	Typically methane ≤1%v/v and/or carbon dioxide ≤5%v/v. Otherwise consider increase to Situation 2	Natural soils with low Organic content. "Typical" Made Ground
2	Low risk	<0.7	Borehole flow rate not to exceed 70l/hr. Otherwise consider increase to Situation 3	Natural soil, high peat/organic content. "Typical" Made Ground
3	Moderate risk	<3.5		Old landfill, inert waste, mineworking flooded
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures	Mineworking susceptible to flooding, completed landfill (WMP 26B criteria)
5	High risk	<70		Mineworking unflooded inactive with shallow workings near surface
6	Very high risk	>70		Recent landfill site

Notes:

1. Gas screening value: litres of gas/hour is calculated by multiplying the gas concentration (%) by the measured borehole flow rate (l/hr);
2. Site characterisation should be based on gas monitoring of concentrations and borehole flow rates for the minimum periods as defined within CIRIA Report 665;
3. Source of gas and generation potential/performance must be identified;
4. Soil gas investigation to be in accordance with guidance contained within CIRIA Report 665;
5. If there is no detectable flow, use the limit of detection of the instrument;
6. The boundaries between the Partners in Technology classifications do not fit exactly with the boundaries for the above classification.

Typical scope of protective measures (extract from CIRIA Report 665 Table 8.6)

Characteristic Situation (from Table 8.5)	Number of levels of protection	Typical scope of protective measures for residential building (not low-rise traditional housing) ¹
1	None	No special precautions
2	2	a) Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft) with at least 1200g DPM and under-floor venting b) Beam and block or pre-cast concrete and 2000 g DPM/reinforced gas membrane and under-floor venting. All joints and penetrations sealed.
3	2	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised under-floor sub-space.
4	3	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated under-floor subspace or positively pressurised under-floor sub-space, over-site capping or blinding and in ground venting layer
5	4	Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and ventilated or positively pressurised under-floor sub-space, over-site capping and in ground venting layer and in ground venting wells or barriers.
6	5	Not suitable unless gas regime is reduced first and quantitative risk assessment carried out to assess design of protection measures in conjunction with foundation design.

Notes:

1. Not suitable for use with low rise traditional housing. (Use the NHBC document instead);
2. Typical scope of protective measures may be rationalised for specific developments on the basis of quantitative risk assessments;
3. Note the type of protection is given for illustration purposes only. Information on the detailing and construction of passive protection measures is given in BR414 (Johnson, 2001). Individual site specific designs should provide the same number of separate protective methods for any given characteristic situation. See CIRIA Report 49;
4. In all cases there should be minimum penetration of ground slabs by services and minimum number of confined spaces such as cupboards above the ground slab. Any confined spaces should be ventilated;
5. Foundation design must minimise differential settlement particularly between structural elements and ground-bearing slabs;
6. Commercial buildings with basement car parks, provided with ventilation in accordance with the Building Regulations, may not require gas protection for Characteristic Situations 3 and 4;
7. Floor slabs should provide an acceptable formation on which to lay the gas membrane. If a block beam floor is used it should be well detailed so it has no voids in it that membranes have to span, and all holes for service penetrations should be filled. The minimum density of the blocks should be 600kg/m³ and the top surface should have a 4:1 ratio sand to cement grout brushed into all joints before placing any membrane (this is also good practice to stabilise the floor and should be carried out regardless of the need for ground gas membranes);
8. The ground gas-resistant membrane can also act as the damp-proof membrane;
9. Based on Building Regulations Approved Document C (Office of the Deputy Prime Minister, 2004a), which states that "a membrane below the concrete could be formed with a sheet of polyethylene, which should be at least 300µ thick (1200 gauge)". Please note the alteration from 300mm (as stated in the Approved Document C) to 300µ, as 300mm is a typographical error that has been recognised and corrected for within this report and CIRIA Report 665.

Low Rise Residential (NHBC)

Table 14.1: Gas Risk Assessment - Traffic Lights with Typical Maximum Concentrations and Gas Screening Values

Classification	Methane ¹		Carbon Dioxide ¹	
	Typical Maximum Concentration ³ (%v/v)	Gas Screening Value ^{2,4} (l/hr)	Typical Maximum Concentration ³ (%v/v)	Gas Screening Value ^{2,4} (l/hr)
Green				
Amber 1	1	0.13	5	0.78
	5	0.63	10	1.60
Amber 2	20	1.60	30	3.10
Red				

Notes:

1. The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst case temporal conditions that the site may be expected to encounter will be the decider as to what Traffic Light is allocated;
2. Borehole Gas Volume Flow Rate, in litres per hour as defined in Wilson and Card (1999), is the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered;
3. The Typical Maximum Concentrations can be exceeded in certain circumstances should the Conceptual Site Model indicate it is safe to do so;
4. The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.

Table 14.2: Ground Gas Protection Measures Required for the Traffic Lights

Traffic Light	Ground Gas Protection Measures Required
Green	Ground gas protection measures are not required. (note based on standard NHBC house detail with 150mm void space under suspended floor)
Amber 1	Low-level ground gas protection measures are required, using a membrane and ventilated sub-floor void that creates a permeability contrast to limit the ingress of gas into buildings. Gas protection measures are to be installed as prescribed in BRE 414. Ventilation of the sub-floor void should be designed to provide a minimum of one complete volume change per 24 hours.
Amber 2	High-level ground gas protection measures are required, creating a permeability contrast to prevent ingress of gas into buildings. Gas protection measures are to be installed as prescribed in BRE 414. Membranes used should always be fitted by a specialist contractor and should be fully certified (see Appendix G). As with Amber 1, ventilation of the sub-floor void should be designed to provide a minimum of one complete volume change per 24 hours.
Red	Standard residential housing is not normally acceptable without further Ground Gas Risk Assessment and/or possible remedial mitigation measures to reduce/remove the source of the ground gases. In certain circumstances, active protection methods could be applied, but only when there is a legal agreement assuring the management and maintenance of the system for the life of the property.

BS8485: 2007**Table 2: Required Gas Protection By Characteristic Gas Situation & Type Of Building**

Characteristic gas situation, CS	NHBC traffic light	Required gas protection			
		Non-managed property, e.g. private housing	Public building ^{A)}	Commercial buildings	Industrial buildings ^{B)}
1	Green	0	0	0	0
2	Amber 1	3	3	2	1 ^{C)}
3	Amber 2	4	3	2	2
4	Red	6 ^{D)}	5 ^{D)}	4	3
5			6 ^{E)}	5	4
6				7	6

NOTE Traffic light indications are taken from NHBC Report no.: 10627-R01 (04) [3] and are mainly applicable to low-rise residential housing. These are for comparative purposes but the boundaries between the traffic light indications and CS values do not coincide.

A) Public buildings include, for example, managed apartments, schools and hospitals.

B) Industrial buildings are generally open and well ventilated. However, areas such as office pods might require a separate assessment and may be classified as commercial buildings and require a different scope of gas protection to the main building.

C) Maximum methane concentration 20% otherwise consider an increase to CS3.

D) Residential building on higher traffic light/CS sites is not recommended unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.

E) Consideration of issues such as ease of evacuation and how false alarms will be handled are needed when completing the design specification of any protection scheme.

Table 3: Solutions Scores

PROTECTION ELEMENT/SYSTEM		SCORE	COMMENTS
a) Venting/dilution (See Annex A)			
Passive sub floor ventilation (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.) A)	Very good performance	2.5	Ventilation performance in accordance with Annex A.
	Good performance	1	If passive ventilation is poor this is generally unacceptable and some form of active system will be required.
Subfloor ventilation with active abstraction/pressurization (venting layer can be a clear void or formed using gravel,		2.5	There have to be robust management systems in place to ensure the continued maintenance of any ventilation system.

geocomposites, polystyrene void formers, etc.) A)			Active ventilation can always be designed to meet good performance. Mechanically assisted systems come in two main forms: extraction and positive pressurization.
Ventilated car park (basement or undercroft)		4	Assumes car park is vented to deal with car exhaust fumes, designed to Building Regulations Document F [5] and IStructE guidance [6].
b) Barriers			
Floor slabs			It is good practice to install ventilation in all foundation systems to effect pressure relief as a minimum. Breaches in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances.
Block and beam floor slab		0	
Reinforced concrete ground bearing floor slab		0.5	
Reinforced concrete ground bearing foundation raft with limited service penetrations that are cast into slab		1.5	
Reinforced concrete cast in situ suspended slab with minimal service penetrations and water bars around all slab penetrations and at joints		1.5	
Fully tanked basement		2	
c) Membranes			
Taped and sealed membrane to reasonable levels of workmanship/in line with current good practice with validation B), C)		0.5	The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation, and the integrity of joints
Proprietary gas resistant membrane to reasonable levels of workmanship/in line with current good practice under independent inspection (CQA) B), C)		1	
Proprietary gas resistant membrane installed to reasonable levels of workmanship/in line with current good practice under CQA with integrity testing and independent validation		2	
d) Monitoring and detection (not applicable to non-managed property, or in isolation)			
Intermittent monitoring using hand held equipment		0.5	
Permanent monitoring and alarm system A)	Installed in the underfloor venting/dilution system	2	Where fitted, permanent monitoring systems ought to be installed in the underfloor venting/dilution system in the first instance but can also be provided within the occupied space as a fail safe
	Installed in the building	1	
e) Pathway Intervention			
Pathway intervention		-	This can consist of site protection measures for off-site or on-site sources (see Annex A).

NOTE In practice the choice of materials might well rely on factors such as construction method and the risk of damage after installation. It is important to ensure that the chosen combination gives an appropriate level of protection

A) It is possible to test ventilation systems by installing monitoring probes for post installation validation.

B) If a 1 200 g DPM material is to function as a gas barrier it should be installed according to BRE 212 [8]/BRE 414 [9], being taped and sealed to all penetrations.

C) Polymeric Materials >1 200 g can be used to improve confidence in the barrier. Remember that their gas resistance is robust and resistant to site damage.

APPENDIX G

(i) Off-site Disposal of Surplus Soil Guidance Notes

The disposal of waste (including surplus soils and contaminated soils) to landfill sites is governed by the *Landfill (England & Wales) Regulations 2002*, the *Hazardous Waste Technical Guidance document WM2 (2003)* and associated legislation.

One of the aims of the above legislation is to encourage waste producers (including developers disposing of surplus soils etc) to reduce their waste (and not just discard and disown it). This can be achieved by recycling or reusing the waste. In the case of contaminated sites where leaving contaminated material in-situ poses a risk to a potential receptor such as groundwater resources, further testing and assessment for such risk could reduce the quantities requiring disposal. If there is still unacceptable risk from contaminated soil being left in place, then it may be possible to reduce the risk to an acceptable level (such that the material can be left in place) by in-situ or ex-situ clean-up of the soils.

Before waste can be disposed of, the producer of the waste must undertake a number of steps. '*Initial Waste Testing and Characterisation*' is firstly undertaken to determine whether the waste is non-hazardous or hazardous. The exceptions are that some wastes such as coal tars, 'tank bottom sludge's', etc are immediately classed as hazardous, regardless of any testing or threshold concentrations.

Any inert or hazardous waste destined for landfill must undergo '*Compliance Testing*' using the Waste Acceptance Criteria (WAC). There are different inert and hazardous WAC limits relating to landfill sites that are correspondingly licensed to accept inert or hazardous waste.

If the '*Initial Waste Testing and Characterisation*' shows a waste to be hazardous, then it is a requirement that the material be tested against the WAC-hazardous suite of tests. If it *passes* the WAC-hazardous testing, then it can be taken to a hazardous waste landfill site. If the material *fails* the WAC-hazardous testing, then the material must be treated before undergoing re-characterisation, further WAC-hazardous testing and then potential disposal at a hazardous waste disposal site.

If the '*Initial Waste Testing and Characterisation*' shows a waste to be non-hazardous, then it can be taken to a non hazardous waste landfill site, without further testing. The producer may however decide to undertake WAC-inert testing, in an attempt to reclassify the waste as inert, in which case the waste could then go to an inert landfill site.

The volumes of soils associated with potential hotspots on a site (be they hazardous or non hazardous) which might require off-site disposal, could potentially be reduced by further on-site sampling and subsequent testing.

With regard to the *Compliance Testing*, it should be noted that some landfill sites are permitted to increase the standard WAC-hazardous/inert limit concentrations, such that they might accept waste that would normally fail such limits.

We would recommend that the contamination testing results (including the history of the site) be presented to the proposed landfills, to determine if they will accept waste generated at the site and what classification they would impose.

APPENDIX H

(i) Validation Report Guidance Notes

Unforeseen Hotspots of Contamination

Given the existence of made ground on the site it would be prudent to maintain vigilance during site clearance and construction, in case any further areas of suspected contamination are encountered.

If areas are found then a suitably qualified person should undertake appropriate sampling, testing and further risk assessment.

Any hotspots encountered during site clearance, not previously encountered in the ground investigation, are to be removed to a suitably licensed landfill site.

A validation report (see below) will be produced on completion of these works. This report will serve to confirm that the works were undertaken in accordance with the relevant legislation, the method statement, specification and planning conditions.

Validation Report Recommendations

It is suggested that the following records will be kept on site to provide a basis for the validation report:

- Daily record sheets of the remediation works to include a summary of the day's activities
- Weather conditions
- Plant, personnel and visitors to the remediation site
- Aspects relating to Health & Safety, environmental control or non-compliance with the specification or the Method Statements.
- All in situ and laboratory testing results.

All requirements of the remediation specification should be complied with; on completion of the remediation a validation report should be provided. This report will comprise the relevant site records and act as certification that the remedial and ground preparation works have been carried out in accordance with the specification.

The validation report will include the following:

- A description of the works undertaken.
- Records of any remediation works, including daily diary sheets.
- Progress photographs.
- Any chemical and geotechnical validation test results.
- As built surveys, including base excavations and top and bottom of capping layer.
- A statement that the works have been undertaken in accordance with the agreed specification

APPENDIX I

(i) Notes on Limitations

This report does not consider ecological impacts (e.g. bats) or botanical risks (e.g. Japanese knotweed). It is recommended that these are considered as part of the assessment of development constraints for the site.

The ground conditions described in the above reports relate only to the points of investigation and do not necessarily guarantee a continuation of the ground conditions throughout the non-inspected area of the site. Whilst such exploratory holes would usually provide a reasonable indication as to the general ground conditions, these cannot be determined with complete certainty. Betts Geo has endeavoured to assess all information provided to them, but makes no guarantees or warranties as to the accuracy or completeness of this information.

The assessment and judgements given in this report are directed by both the finite data on which they are based and the proposed works to which they are addressed. The data essentially comprised a study of available documented information from various sources (including Client Furnished reports) together with discussions with relevant authorities and other interested parties. There may also be circumstances at the site that are not documented. The information reviewed is not exhaustive and has been accepted in good faith as providing representative and true data pertaining to site conditions. If additional information becomes available which might impact our environmental conclusions, we request the opportunity to review the information, reassess the potential concerns and modify our opinion if warranted.

It should be noted that any risks identified in this report are perceived risks based on the available information. Actual risks can only be assessed following a physical investigation of the site.

The site investigation has been carried out to provide information concerning the type and degree of contamination, and ground and groundwater conditions to allow a reasonable risk assessment to be made. Betts Geo Environmental Ltd undertake to exercise all reasonable skill, care and due diligence in the exercise of the investigation with respect to sampling techniques, sample storage and report interpretation.

The assessments and judgement given in this report are directed by both the finite data on which they are based and the proposed works to which they are addressed. Data acquisition is subject to the limitations of the methods of investigation used. Exploratory holes undertaken during fieldwork investigate small a small volume of ground in relation to the size of the site and as such can only provide an indication of site conditions. There may be conditions pertaining to the site and the proposed development i.e. localised “hotspots” of contamination, which have not been disclosed by the investigations.

The findings and opinions are relevant to the dates of our site works and should not be relied upon to represent conditions at substantially later dates. Conditions at the site will change over time due to natural variations and anthropogenic activities. Groundwater, surface water and soil gas conditions should be anticipated to change with diurnal, seasonal and meteorological variations.

The opinions expressed in this report regarding any contamination are based on simple statistical analysis and comparison with available guidance values. No liability can be accepted for the retrospective effects of any changes or amendments to these values.

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