T J BOOTH ASSOCIATES

CONSULTING CIVIL & GEOTECHNICAL ENGINEERS

PHASE I ENVIRONMENTAL AUDIT.
174 Bury Old Road, Heywood,
Rochdale. OL10 3LN.

Client:	Mr M J Brooks.
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1. INTRODUCTION.

T. J. Booth Associates have been appointed Mr. M J Brooks to undertake a Phase I Environmental Audit to the above Site and surrounding area. This report will accompany a new planning application to address Town & Country Planning requirements for development.

The Site currently comprises a residential dwelling to the front (S side) of the Site dating back to before the 1850s, with vehicle repair workshops lining the E boundary. The remainder of the Site is currently used for storage of recovery vehicles. The Site had previously been used for the breaking of vehicles historically. It is surrounded by residential properties, and the Boohole Landfill Site to the N (previously designated contaminated land under Part 2A of the Environmental Protection Act 1990, now remediated and vented).

This preliminary risk assessment (PRA) will provide a desk based study to assess the potential for contamination at the Site, and will assess the effects on potential receptors. Data gathered from various sources will be accessed including information on historic and current maps, landfill activity, industrial activity, geological and mining hazards, and flooding etc.

Recommendations in line with current best practice (CIRIA/CLEA/CLAIRE/LQM/NHBC) will be put forward at the end of the report.

2. PROPOSED DEVELOPMENT.

The proposed development is for the redevelopment of the Site in to a residential usage. At the time of writing the proposed plans had not been finalised and thus referral to the amount or type of residential dwelling is subject to change.

The draft development plan is for the construction of 8 detached/semidetached residential dwellings. The dwellings will comprise driveways and soft landscaping to the front and further soft landscaping to the rear.

The Site will be accessed via an adoptable turning head to LPA standards accessed via Bury Old Road. Refer to draft proposed development plan in appendix.

3. MAP REVIEW.

3.1. Historic Maps.

Historic mapping data (digital, online & paper format) was reviewed at nominally 1:1250, 1:2500 and 1:10000 scales of the Site and the surrounding area; and is tabulated below.

Date	On Site	Off Site / Surrounding Area
c1850	Dwelling as existing to SE, with outbuildings to the NW side. Centre and NE side of the Site appear agricultural/field.	Boohole sandpit noted 280m to NW. Unnamed sandpit noted 175m NE. Much of the local area is agricultural. Some wells noted in the area.
c1890	Dwelling noted as Heap Cottage. Road/Lane through Wside of Site past buildings exiting to the N. Centre of the Site is part of garden area. N & NE of Site are separately partitioned with single buildings indicated (allotments).	Boohole sandpit now within 220m of Site indicated to be at Boohole Farm. Unnamed sandpit to the NE now within 125m of Site. Minor development to the E/NE of the area. Dyeworks note approx. 350m E.
c1910	Garden area to centre of Site now indicated as empty plot of land.	Unnamed sandpit to the N now within 90m of Site.
c1930s	No change.	Boohole sandpit now within 175m of Site. Unnamed sandpit to the NE now allotment land. Some residential dwellings to Bury Old Rd. Prettywood Sandpit noted 420m W/NW.
c1940	No change.	Further expansion of Boohole Sandpit.
c1950s	Outbuildings to the NW & NE corners of the Site indicated as ruins. No other change.	Boohole sandpit now within 60m of N Site boundary. Construction of housing estate within unnamed sandpit to NE. Prettywood Sandpit noted as disused.
c1960s	No overall change.	Complete urban infill of the local area to the N, E and S. Boohole Sandpit now within 30m of the N Site boundary.
c1980s-90s	No overall change.	Boohole Sandpit still noted as such.

3.2. Present Day Maps.

Present mapping data (digital, online & paper format) was reviewed for the Site and the surrounding area and is tabulated below.

Present Day Mapping Data Summary	
Site Boundaries, Outlines of Structures and Buildings:	Current mapping data shows the Site to be an L shaped plot of land, wider at the rear of the Site extending behind neighbouring residential dwellings to the E side. The buildings generally remain the same as historically, with the residential cottage to the front of the Site and workshops lining the east boundary. The local area comprises predominantly residential and

	agricultural use.
Ground Contours, Natural Drainage Features:	Digital mapping data shows the land to be relatively flat most likely from historic fill operations over the Site. Local contours suggest that overall, elevation falls to the N and W, and thus natural drainage is in these directions although much of the local area is developed and comprises man-made drainage and piped services/sewers.
Water Courses:	River Roch 825m N.
Below Ground Obstructions:	None noted.

3.3. Geological Maps.

The local geology was accessed via the BGS digital online mapping data service, and paper copies of Manchester Sheet 85, 1:50000 Series (solid & superficial).

Geology Data Summary	
Bedrock Geology:	Westphalian Carboniferous Pennine Lower Coal Measures – generally undifferentiated sandstone, mudstone and coal seams. Strata dips ~10deg S. There is a fault which delineates the Site trending NW/SE to the E boundary.
Superficial Geology:	Site situated upon sand & gravel deposits.
Coal Seams.	The Lower Mountain Mine coal seam subcrops nominally at the SE corner of the Site.

4. ENVIRONMENTAL DATA SEARCH.

4.1. Environment Agency Data.

The Environment Agency maintains various environmental datasets for England and Wales such as flooding, landfill, and groundwater & pollution data, refer to appendix for maps; data tabulated below.

Environment Agency Data Summary	
Flood zone:	Flood zone 1.
Historic Landfill:	Closest landfill sites are noted as "Boohole Sand Quarry Extension" immediately to the N boundary of the Site. The site was active as a landfill from the 1970s-1990s and accepted inert, industrial, commercial, household, special wastes, and liquids & sludge.
Current Landfill:	Prettywood Easterly Extension Landfill Site approx. 450m NW. The site is now closed and did accept no biodegradable wastes.
Groundwater source protection zone:	Not in protection zone.

Superficial aquifer:	Secondary A aquifer.
Bedrock aquifer:	Secondary A aquifer.

4.2. Coal Authority.

The Coal Authority interactive digital online mapping data was accessed in July 2015, refer to appendix for report & map; data tabulated below.

Coal Authority Data Summary	
Mine Shafts, Pits, Adits/Entries:	None note within the site or within 20m of the site boundaries. Closest shaft approximately 800m distant.
Past/Present Underground Mining.	None indicated although seams do subcrop beneath the east died of the Site noted within the local area.
Past Underground Shallow Workings:	No records of shallow workings identified.
Probable/Potential Shallow Underground Workings:	Noted to the S off-site.
Past/Present Surface Mining:	None noted.
Development Referral Area:	Part of the SE corner of the Site may just lie within a development referral area a development referral area.

4.3. BGS Borehole Data.

No boreholes were located in close proximity to the Site.

4.4. BGS/Health Protection Agency.

UK Radon Maps indicate that the Site is within an area where there is an intermediate probability of 1-3% of homes being above the radon action level (Class 2 Area). No radon protection required in Class 2 radon areas, refer to appendix for map & tables.

4.5. Local Knowledge, Local Developments/Reports.

4.5.1. Owner Knowledge/Site History.

A brief history of the Site is summarised below:

Ownership Dates	Site Use
1939~1960	Site used as an abattoir.
1960-1984	Site used for agricultural storage, machinery storage & rebuilding/repair.
	Site was used for breaking Gardner Engines 1964-1984. Between 1968-1970, a sand drying machine named the Dryerific Mk II was produced on-site.
1984-pres	Under the current ownership the Site has been used under a Class 4 Industrial Use for the recovery, repair, and storage of road vehicles.

4.5.2. RMBC Boohole Landfill.

The Boohole Landfill to the N boundary of the Site, was remediated by RMBC in the 2000s. The recent history of the is summarised below:

Date	Action/Event
2002/3	RMBC became aware that the landfill site was producing gas.
2005	RMBC commissioned investigations to assess gas migration from the landfill. Gas monitoring in properties on Bury Old Road was undertaken. Results did not identify the presence of landfill gas in properties but did indicate ground gas was migrating in the underlying natural sand deposits.
2008	Further investigations confirmed the presence of landfill gas migrating from the site at a minimal rate. Due to the risks, the site was declared as contaminated land under Part 2A of the Environmental Protection Act 1990.
2010	Remediation was undertaken which comprised a virtual barrier and vent stacks to the south & east boundaries of the landfill.
2010/11	Post remediation monitoring confirmed that the remediation had been effective in lowering the gas migration to levels that the "possibility of causing significant harm" no longer existed.
2011	Completion letters were sent out to residents indicating that remediation had been successful.

T J Booth Associates contacted the RMBC contaminated land team in July 2015. RMBC indicated that four boreholes were placed in the Development Site area by the owner as part of their investigation which identified very high levels of methane. The monitoring of these boreholes after 2005 appears to be patchy (lost/ vandalised/gas tap missing etc).

RMBC indicated that in addition to historic records for the Development Site, further gas monitoring should be undertaken.

5. FIELDWORK.

5.1. Site Reconnaissance.

A Site reconnaissance was undertaken on the 18th June 2015. The weather was warm, dry and sunny.

Site Reconnaissance Summary	
Details of Existing Structures:	The development was accessed from the S side of the Site adjacent a masonry residential dwelling/cottage off Bury Old Road. Behind the dwelling off the east perimeter were masonry/steel framed sheds/outbuildings cladded in steel sheeting with some asbestos cement sheet roofing.

	The main outbuildings were used as a vehicle repair garage. Two smaller dilapidated masonry sheds were noted towards the NE corner of the Site, one of which contained a partially dismantled Gardner Engine. The remainder of the Site was used for vehicle storage. There were scrap heap piles comprising tyres, metals, wiring etc around the Site. Much of the Site comprised macadam hardstanding. Road planings, MOT, concrete and building rubble were also noted on the ground surface and in stockpiles. A 205l drum (white spirit) was noted to the NW corner of the Site.
Adjacent Properties:	Remediated landfill to the N. Residential dwellings and gardens to the W, E, and beyond Bury Old Rd to the S.
Water Levels, Directions of Flow and Rates in Rivers:	None noted on Site reconnaissance.
Old Mine or Quarry Workings:	Landfill Site to N boundary previously a quarry. Vent stacks visible within 3m of the Site boundary.
Obvious/Immediate Hazards to Health/Safety:	None noted on Site reconnaissance.
Areas of Discoloured Soil, Polluted Water, Vegetation, and Significant Odours:	Made ground noted across much of the Site. There was an odour of hydrocarbons in the air around the dilapidated shed to the NW corner of the Site.
Relevant Ground Levels, Ground Water Levels, Positions of Wells and Springs:	The Site was relatively flat. However, from the adjacent land to the N & E of the Site, it was apparent that the Site level had been built up in excess of 1-1.5m in the NE corner. The owner suggested that there was approx. 450mm of made ground (hardcore & macadam) to the centre of the Site.

6. INDUSTRY PROFILE.

Note used.

7. DISCUSSION FROM THE DESK STUDY AND FIELDWORK.

7.1. Preliminary Conceptual Model.

7.1.1. Site Summary.

The Development Site currently comprises vehicle recovery, repair, and storage yard which has a Class 4 Industrial Usage since 1984. The Site had previously been used as a place for breaking Gardner Diesel Engines between 1964 & 1984 as well as general agricultural storage and repair. On Site reconnaissance, scrap metal, tyres

wiring, as well as road planings building rubble were noted across the Site. A hydrocarbon odour was noted to the NW corner of the Site.

Off Site, the main source of risk is to the N. The Boohole Landfill site was previously used to dispose of grades of waste (inert, industrial, commercial, household, special wastes, and liquids & sludge). The Site had previously been designated as contaminated land due to high levels of CH4 & CO2 migration but has since been remediated.

Coal seams do exist to the SE/E boundary of the Site but are generally faulted out beneath the remainder of the Site. No evidence of historic mining was noted in the desk study. The Site is within a radon class 2 area however, radon protection measures are not required for the development.

7.1.2. Potential Contaminants/Source.

Source/s	Contaminant/s
Site (present & past uses) as scrap yard, and/or vehicle storage, breaking, and repair.	Metals, PAH, hydrocarbons & asbestos.
Made ground on Site.	Metals, PAH, inorganics, sulphates, hydrocarbons & asbestos. Ground gas: CH4, CO2.
Boohole Landfill	Ground gas: CH4, CO2 from landfill operations.

7.1.3. Potential Pathways.

The CLEA model proposes 8 potential pathways:

Pathway	Media	Present	
		YES	NO
Soil and dust ingestion	Soil and indoor dust	X	
Consumption of home grown fruit and vegetables	Produce	X	
Skin contact (indoors)	Indoor dust	X	
Skin contact (outdoors)	Soil	X	
Inhalation of dust (indoors)	Air	X	
Inhalation of dust (outdoors)	Air	X	
Inhalation of vapours (indoors)	Air	X	
Inhalation of vapours (outdoors)	Air	X	

7.1.4. Potential Receptors.

Receptors include construction workers, potential future residents.

7.1.5. Potential Pollutant Linkages.

Below is a tabulated form of the conceptual model.

	Source	Pathway	Receptor	Linkage Present
1	On site surface soils.	Direct ingestion, aerial ingestion, dermal contact, drinking water.	Site construction operatives & future occupants.	YES
2	Subsoils.	Contact with potential hazards.	Site buildings.	YES
3	Ground gas from geological strata.	Diffusion through soil, aerial inhalation.	Future occupants. Explosion, suffocation.	YES
4	Ground gas from waste, landfill sites or other sources.	Diffusion through soil, aerial inhalation.	Future occupants. Explosion, suffocation.	YES
5	Contaminated ground and surface water.	Permeation through soils into excavations / basements, dermal contact & ingestion.	Site construction operatives & future occupants.	YES
6	Aerial contaminants, settled dust, fumes, from local industrial processes.	Dermal contact & aerial inhalation.	All site users / occupants.	YES

8. CONCLUSIONS.

8.1. Final Contaminant Risk Assessment.

Regarding potential pollutant linkage 1, site soils are thought to pose a potential risk to receptors. The desk study has identified a multiple sources and past uses regarding general contaminants associated with scrap/vehicle repair & breakers yards. There is also made ground across the Site.

Regarding potential pollutant linkage 2, there is also potential for underground hazards such as potable water pipe coming into contact with contaminated soils, or concrete foundations with sulphates. This could occur in areas beneath permanent hardstanding where minor contaminated material can remain buried.

Regarding potential pollutant linkage 3, risks from geological strata such as coal seams are not though to pose a credible risk to the site. Coal seams are not thought to have been worked in the local area where the main source of quarrying was sand. No historic pits are noted in the area and the Lower Mountain Mine subcrops to the SE corner of the Site dipping S away from Site. The Site is not within a radon protection area.

Ground gas from waste/landfill sites or other sources in potential pollutant linkage 4 are considered to pose a risk to the development. Although the landfill Site to the N has been remediated, gas is still being produced and there remains a minor risk which requires quantification. In addition, landfilling has been undertaken to the

Development Site with up to nominally 1.5m of fill estimated to have been tipped to the E of the Site. This could potentially contain putrescible material which could degrade leading to ground gas.

Regarding potential pollutant linkage 5, no surface water was noted on Site. However, ground water could potentially be contaminated by the overlying soils. The Site is not within a source protection zone and it is thought the hydrological regime will flow towards the landfill.

Potential pollutant linkage 6 is not considered to pose a risk. Present legislation regarding the release of aerial contaminants is regulated and licensed, however past releases would have been unregulated and would now be present as shallow ground contamination in Potential Pollutant Linkage 1.

9. RECOMMENDATIONS.

Shallow Soil Contamination:

Due to the past Site uses is it likely the ground on Site has been contaminated. Thus it is recommended that further Site investigation need to be undertaken for geotechnical & geo-environmental purposes.

The site investigations should comprise trial holes and boreholes to categorise the stratigraphy below the Site and identify the depth make-up of made ground. In addition a soil sampling regime should be undertaken to better categorise the potential contamination risk in accordance with BS 10175:2011+A1:2013 & R&D Technical Report P5-066/TR.

Soils should be tested for metals, speciated PAH, inorganics, sulphates, SOM, TPH (CWG) & asbestos screen. Testing suites should be analysed to common threshold comparison data specifically the Defra Category 4 Screening Levels (C4SL) where available, and to EA/DEFRA SGV (2009) data; and to LQM/CIEH GAC 2nd edition (2009) & erratum (2011) thereafter, for use in a residential end use setting.

Any potable water services routed through contaminated material should be protected by barrier pipe.

Gas Risk:

Due to the above it is recommended that ground gas monitoring be undertaken to quantify the risk to Site receptors. Boreholes undertaken to the Site should be turned in to gas monitoring wells (number and location to be in accordance with CIRIA c665). Gas monitoring should be undertaken for fortnightly intervals for a period of not less than 3 months (6 readings), and encounter high, low & falling periods of barometric pressure. Monitoring should be undertaken for methane/carbon dioxide/oxygen concentrations, as well as borehole flow rates and barometric pressure.

Watching Brief:

During the construction/any site investigation phase of the development, and during any ground works thereafter; care should be taken to identify any suspected ground contamination <u>not</u> previously identified, and managed as follows:

- Should any suspected contamination be encountered, the suspect area should be isolated, professional advice sought, and the LPA informed.
- Suspected material should undergo testing to identify any contaminants present by suitably qualified personnel in accord with current best practice & guidelines, and compared/risk-assessed to current published data suitable for the proposed residential end use.
- Should any hazardous contamination be identified, a method for its removal should be produced in line with current best practice & regulations, tailored to the type of contamination present.
- Should any general low level contamination be identified it should be carefully removed & stockpiled separate to on-site soils i.e. on hard-standing or temporary barrier membrane to avoid contamination to the remainder of the site.
- Contaminated material should be disposed of to a suitably licenced landfill site identified by testing certs & contaminants.
- Details of any such operations should be included within a final validation/completion report as normal procedure.

Phase 2 & Validation:

The above site investigations should be included within a phase 2 site investigation report. Further recommendations/review of this risk assessment should be undertaken dependent of the findings.

Should any remediation of the Site be recommended, or any imported soil be required; then a final validation report should be undertaken for the Site and include documentary/photographic evidence of any remedial measures undertaken and include any subsoil/topsoil import sample results. The report should be submitted to the LPA to obtain discharge of the environmental planning condition.

Signed……

D.S.Slattery BSc (Hons).

T J Booth Associates.

Authorised……

T J Booth BSc (Hons), C. Eng. C. Env. MICE.

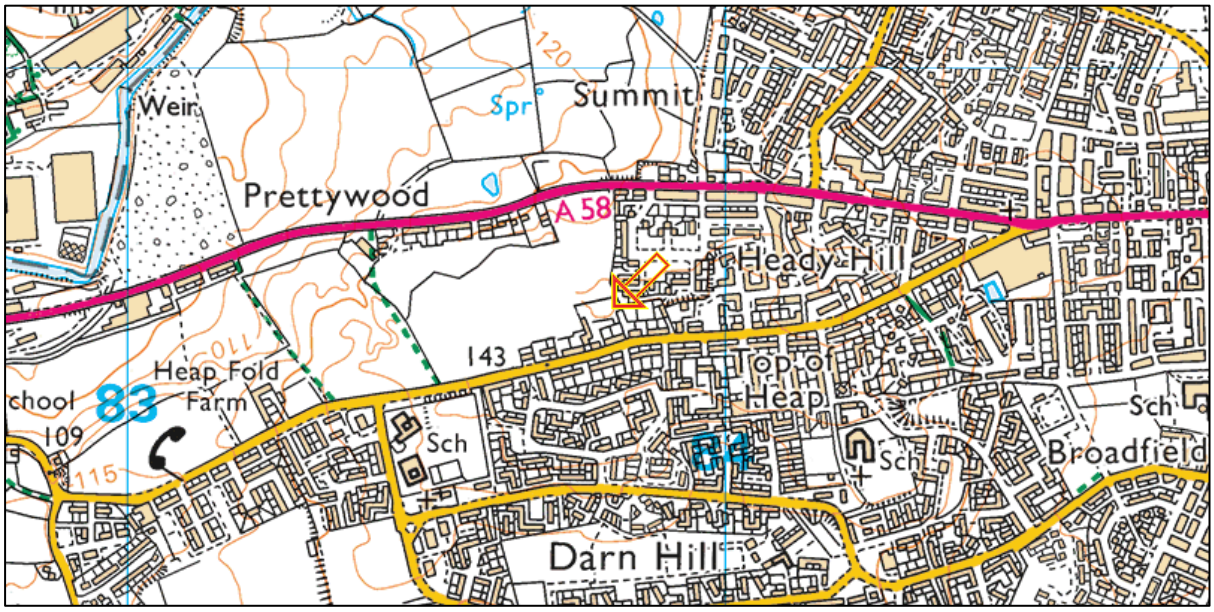
T J Booth Associates.

10. REFERENCES.

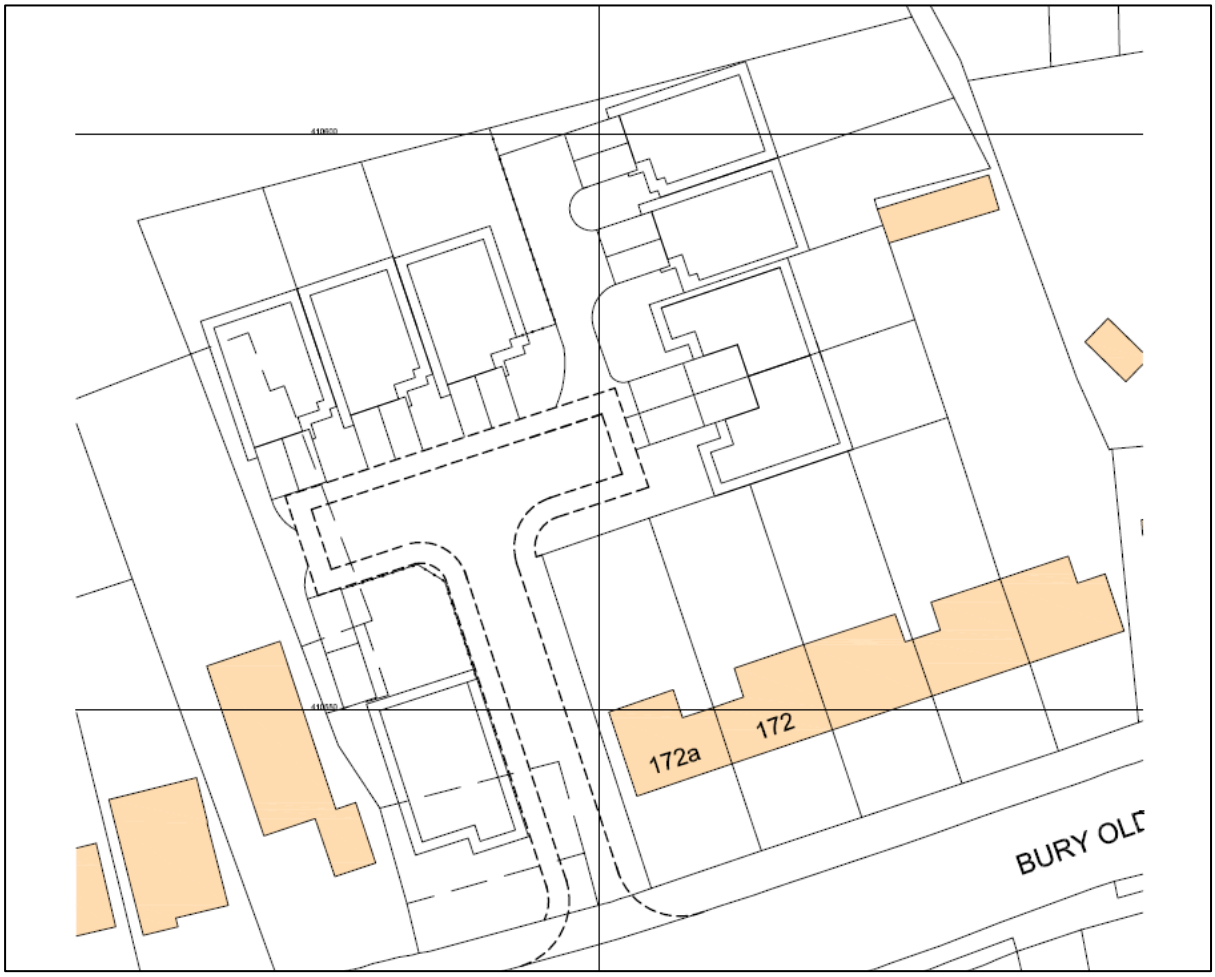
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11. APPENDIX A: FIGURES.

11.1. Location Plan.



11.2. Proposed Site Plan.



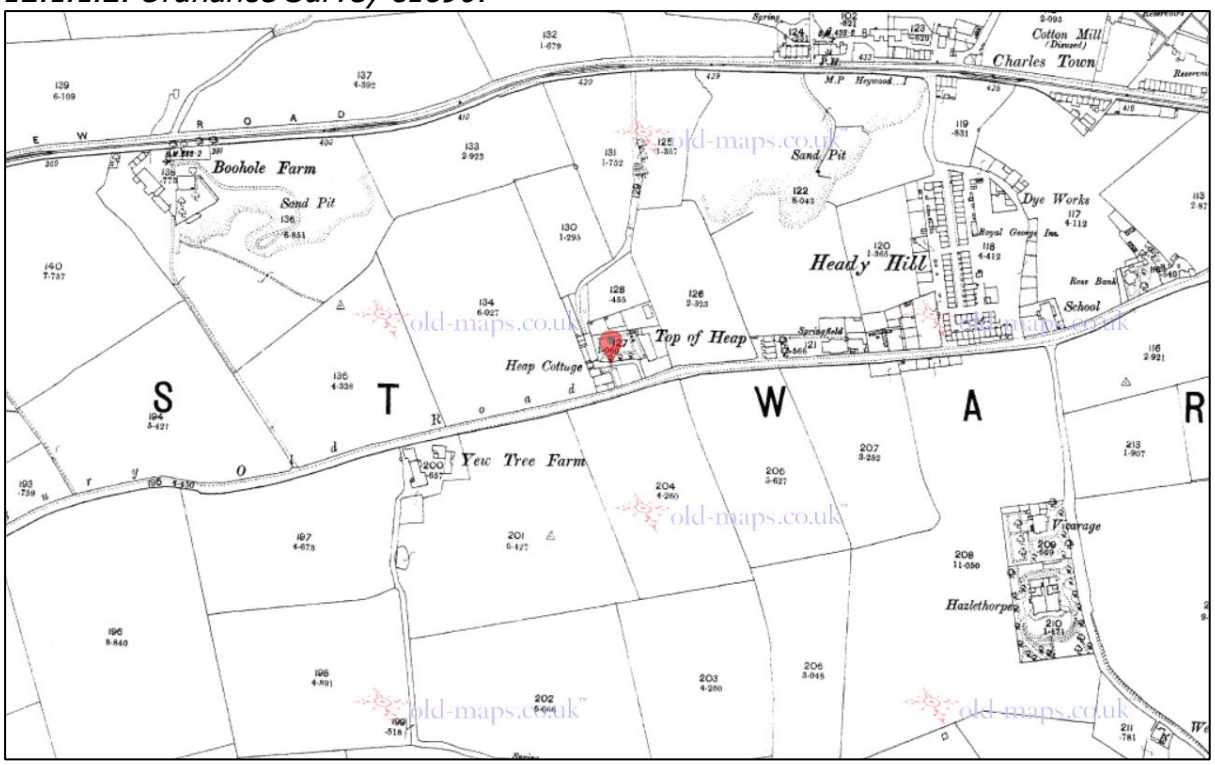
12. APPENDIX B: MAPS.

12.1. Historic Maps.

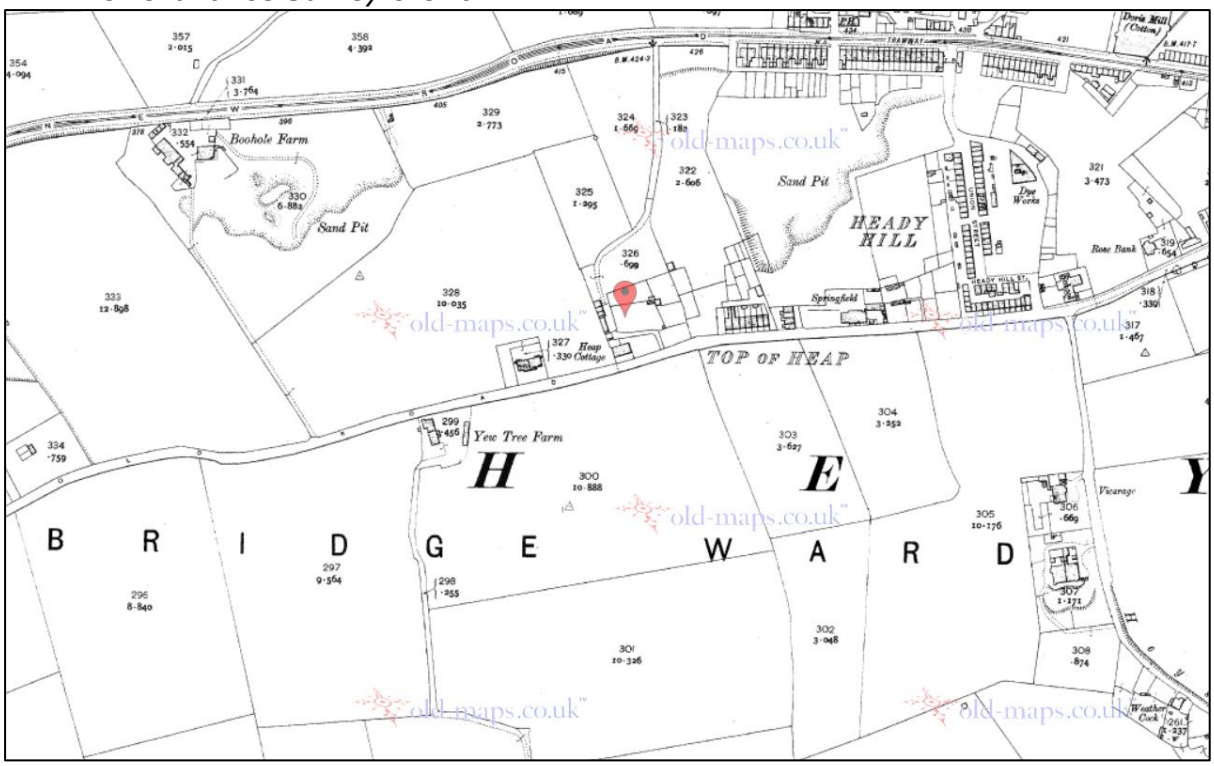
12.1.1.1. Ordnance Survey c1850.



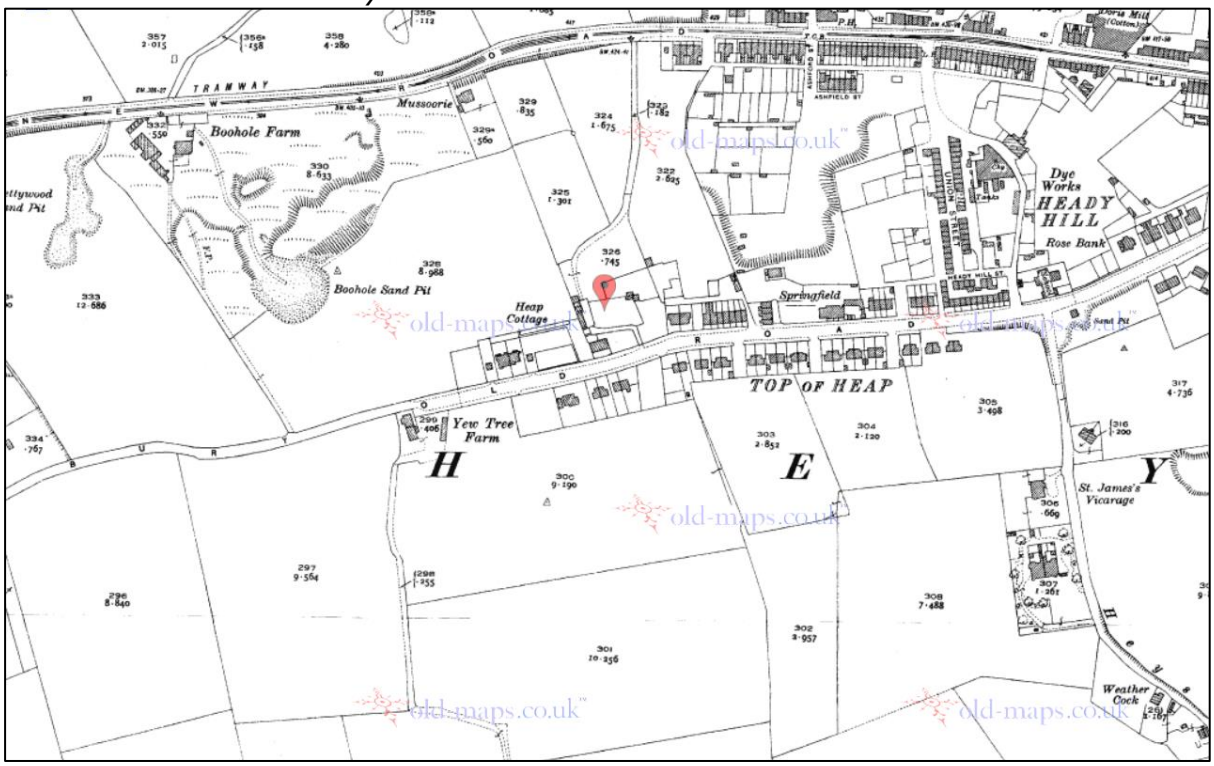
12.1.1.2. Ordnance Survey c1890.



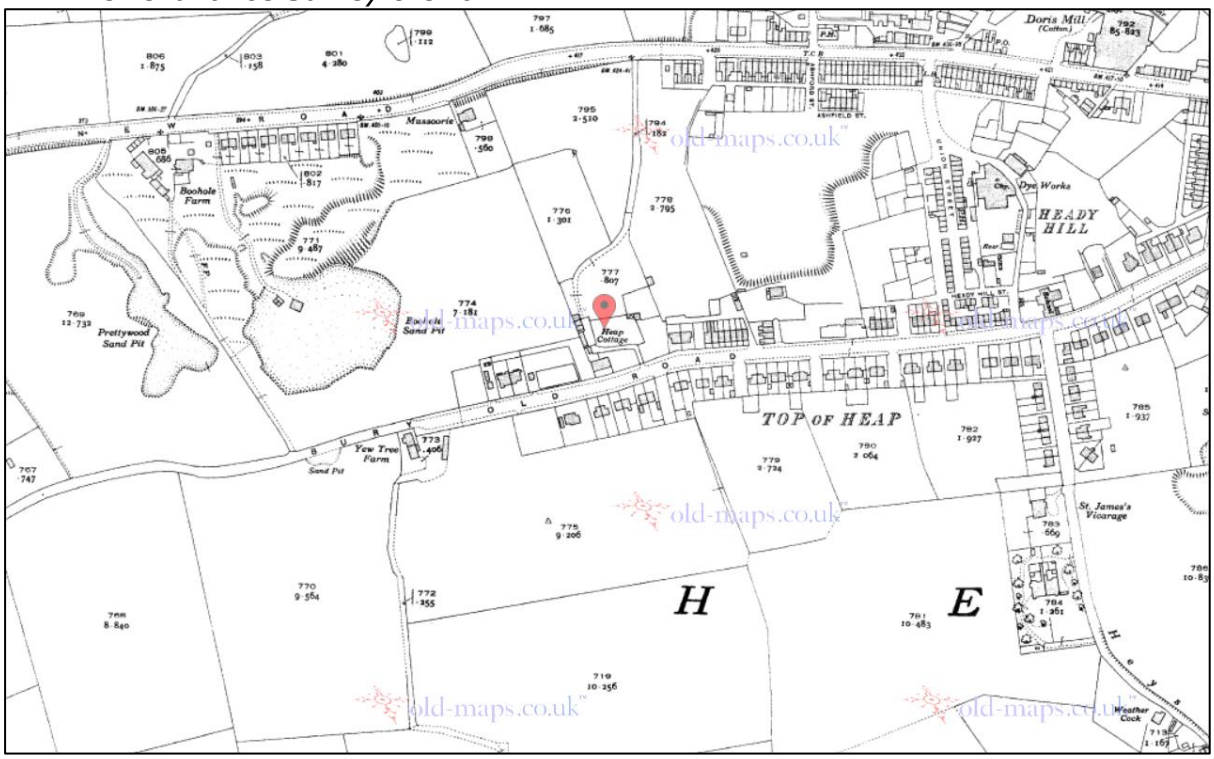
12.1.1.3. Ordnance Survey c1910.



12.1.1.4. Ordnance Survey c1930.



12.1.1.5. Ordnance Survey c1940.



12.1.1.6. Ordnance Survey c1950s.



12.1.1.7. Ordnance Survey c1960s.

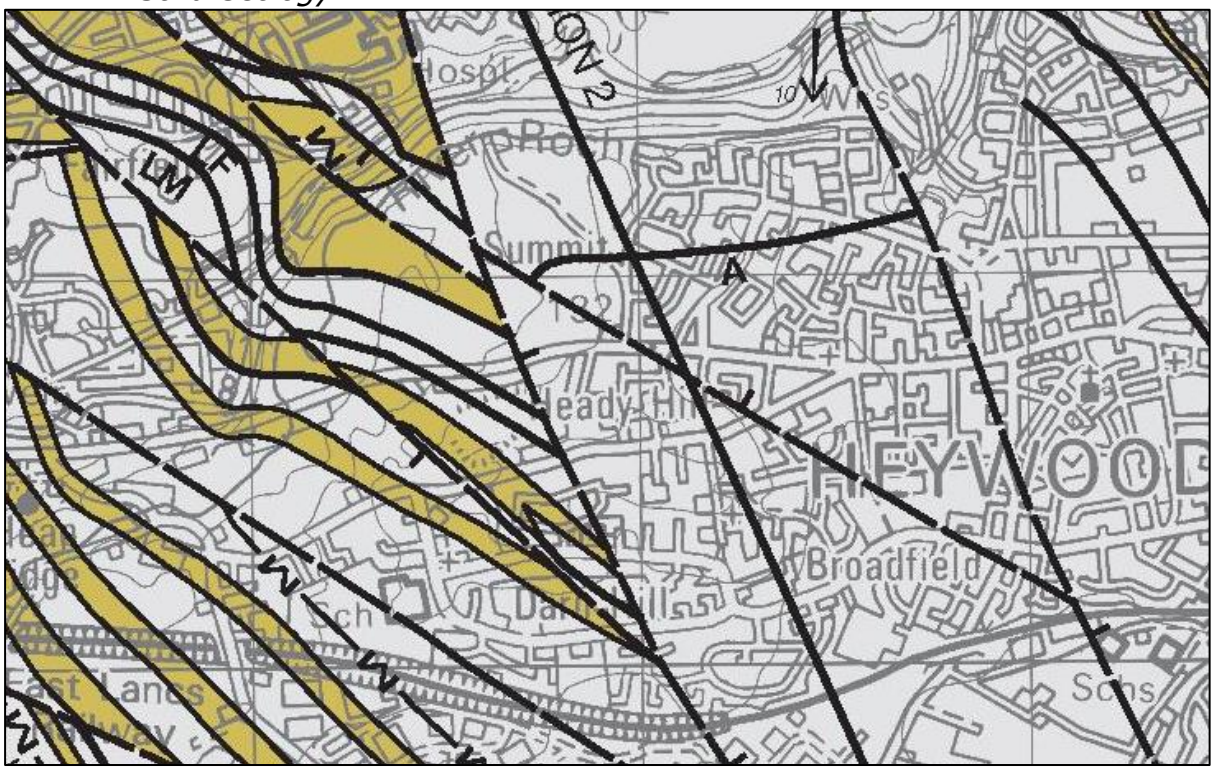


12.1.1.8. Ordnance Survey c1980-90s.

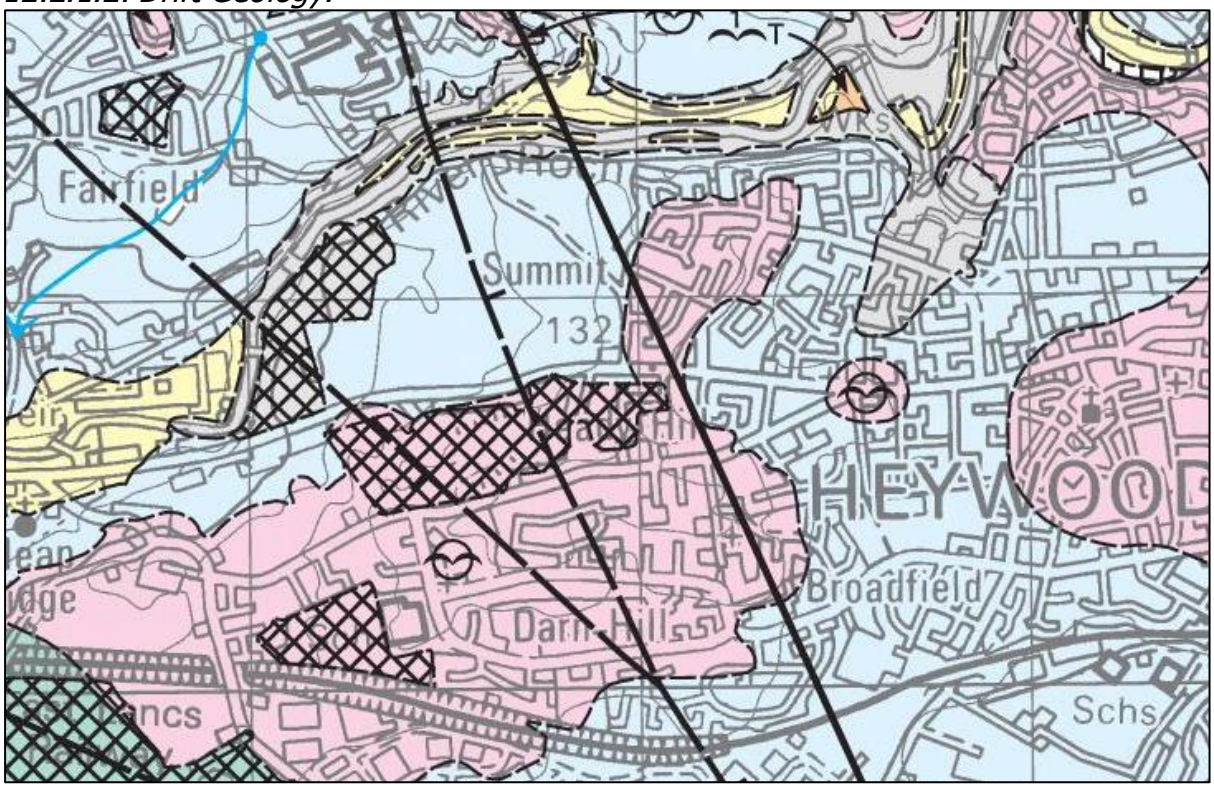


12.2. Geological Maps.

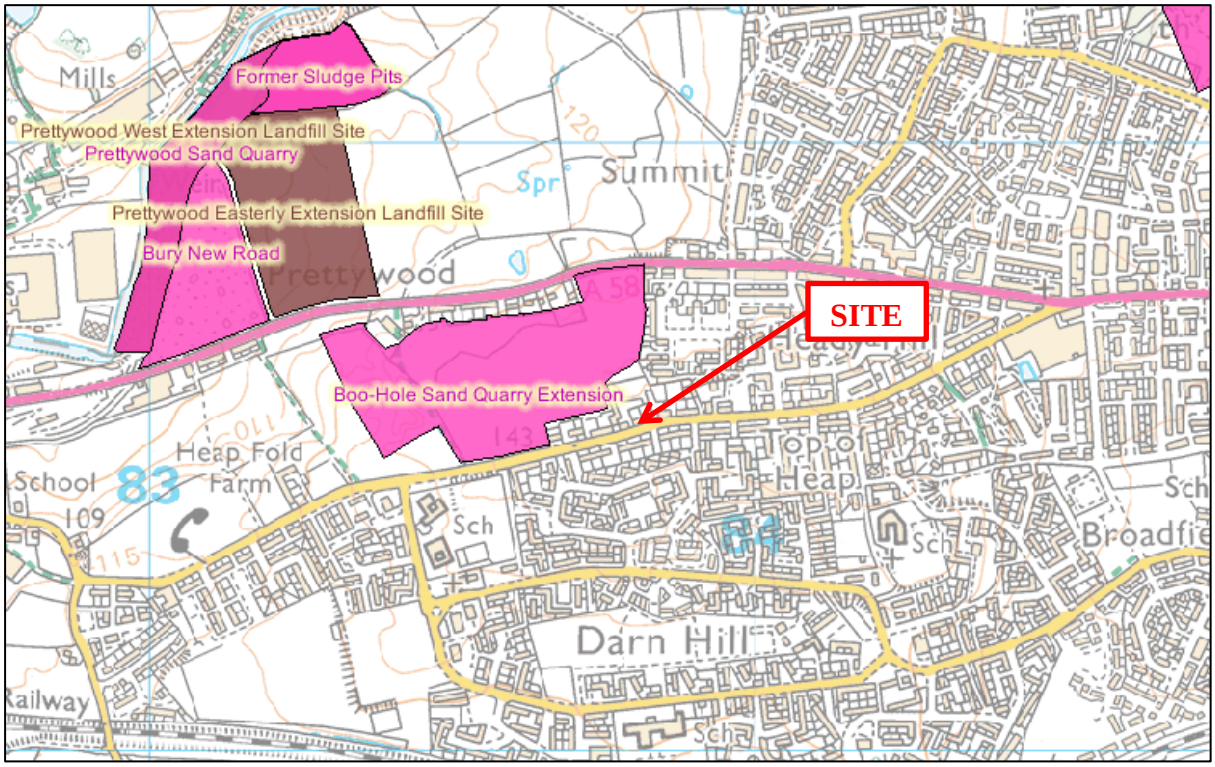
12.2.1.1. Solid Geology.



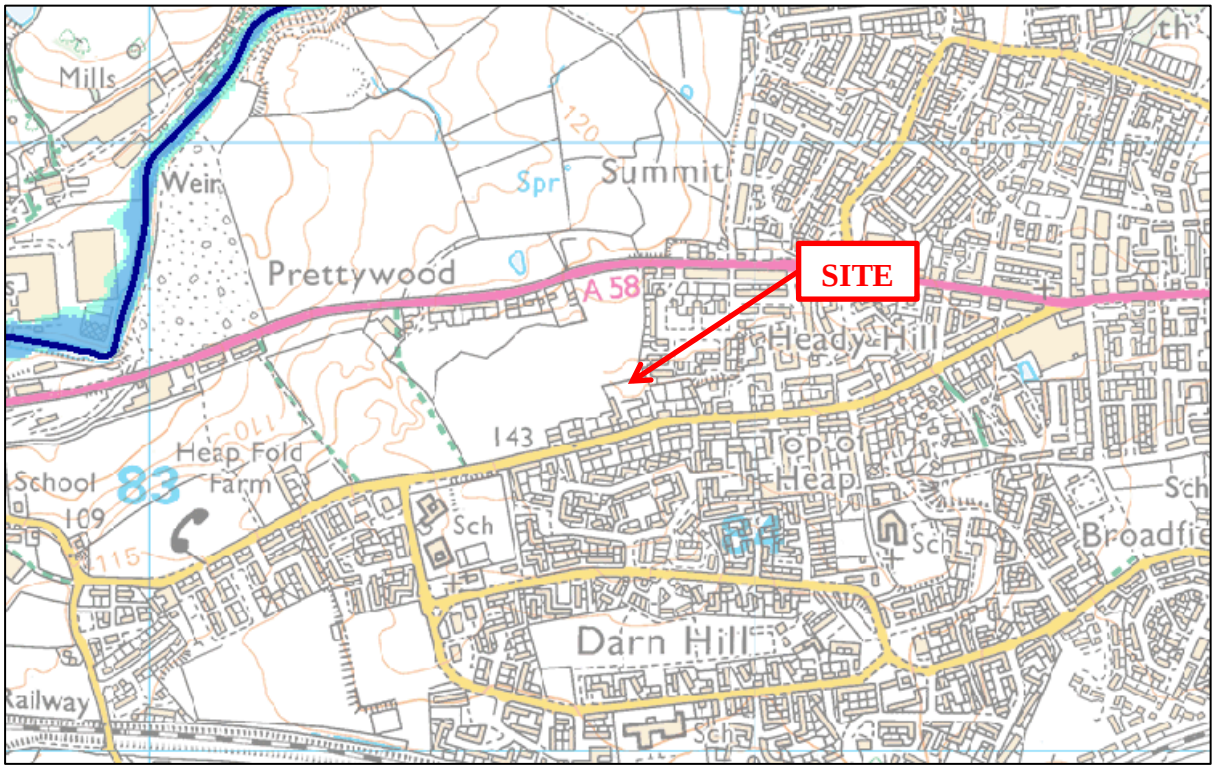
12.2.1.2. Drift Geology.



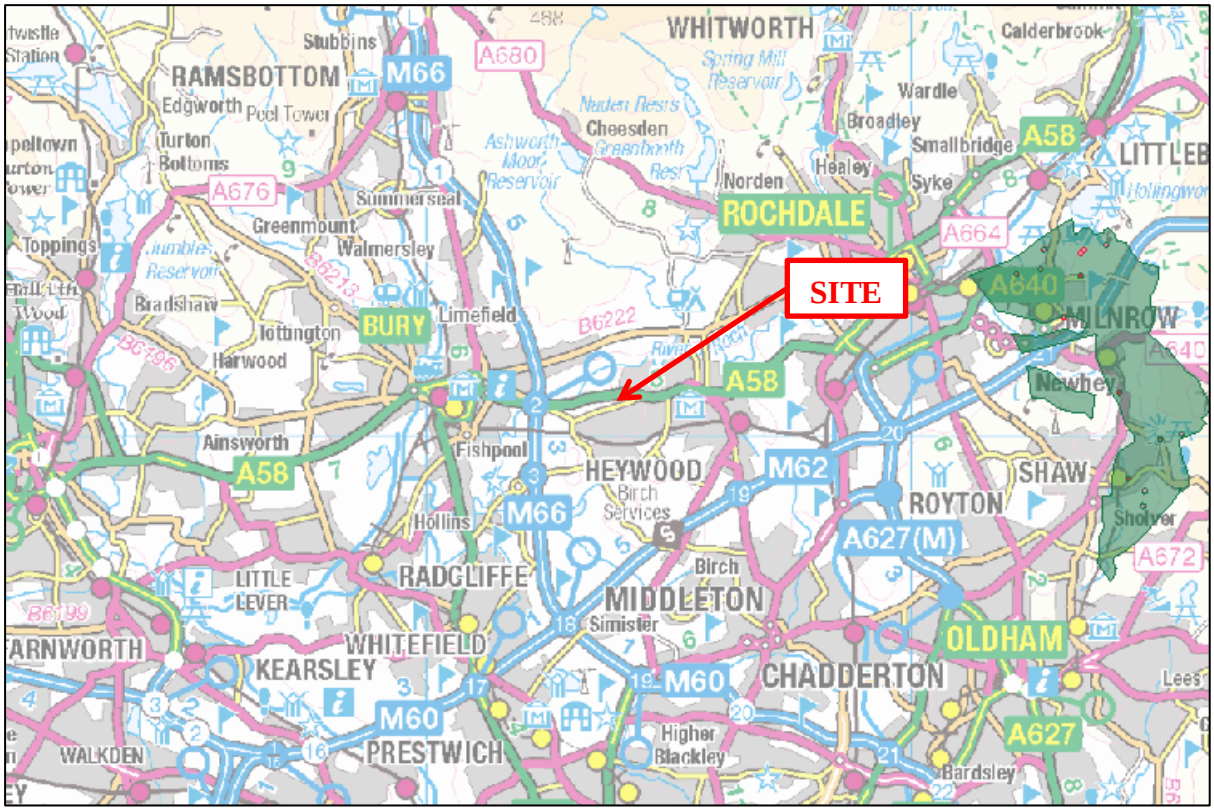
12.3. Environment Agency Landfill Map.



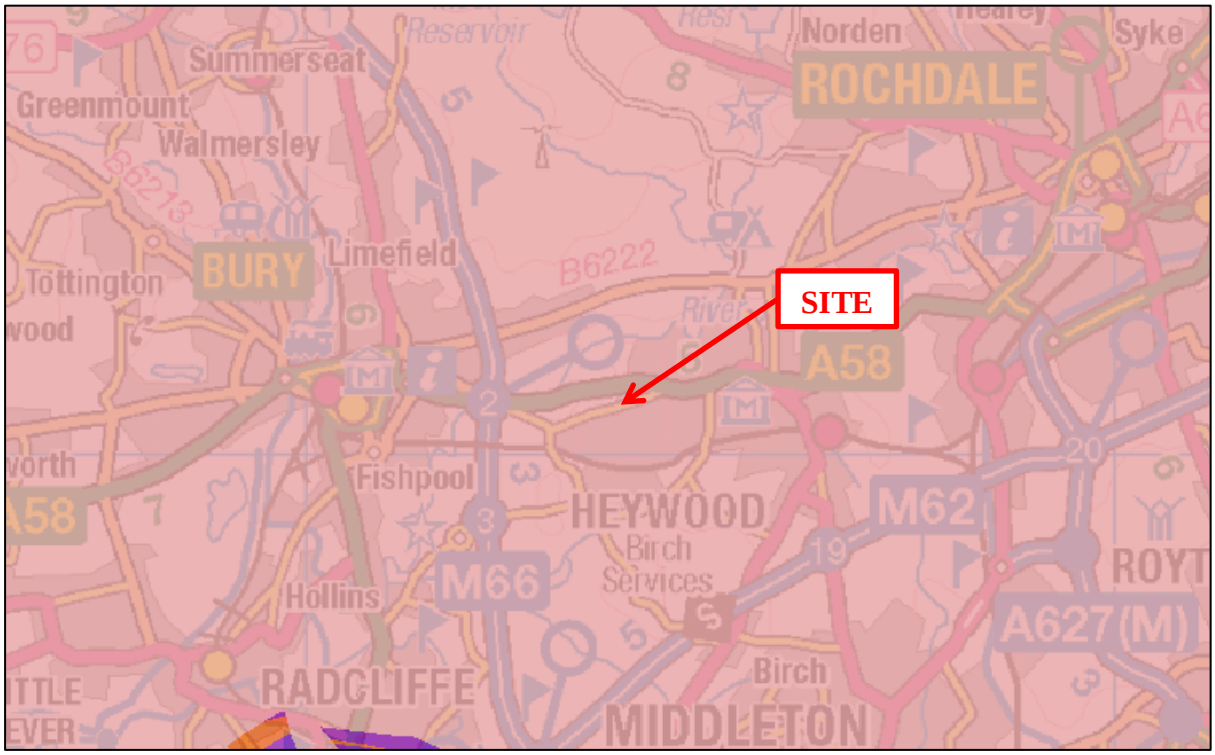
12.4. Environment Agency Flood Map.



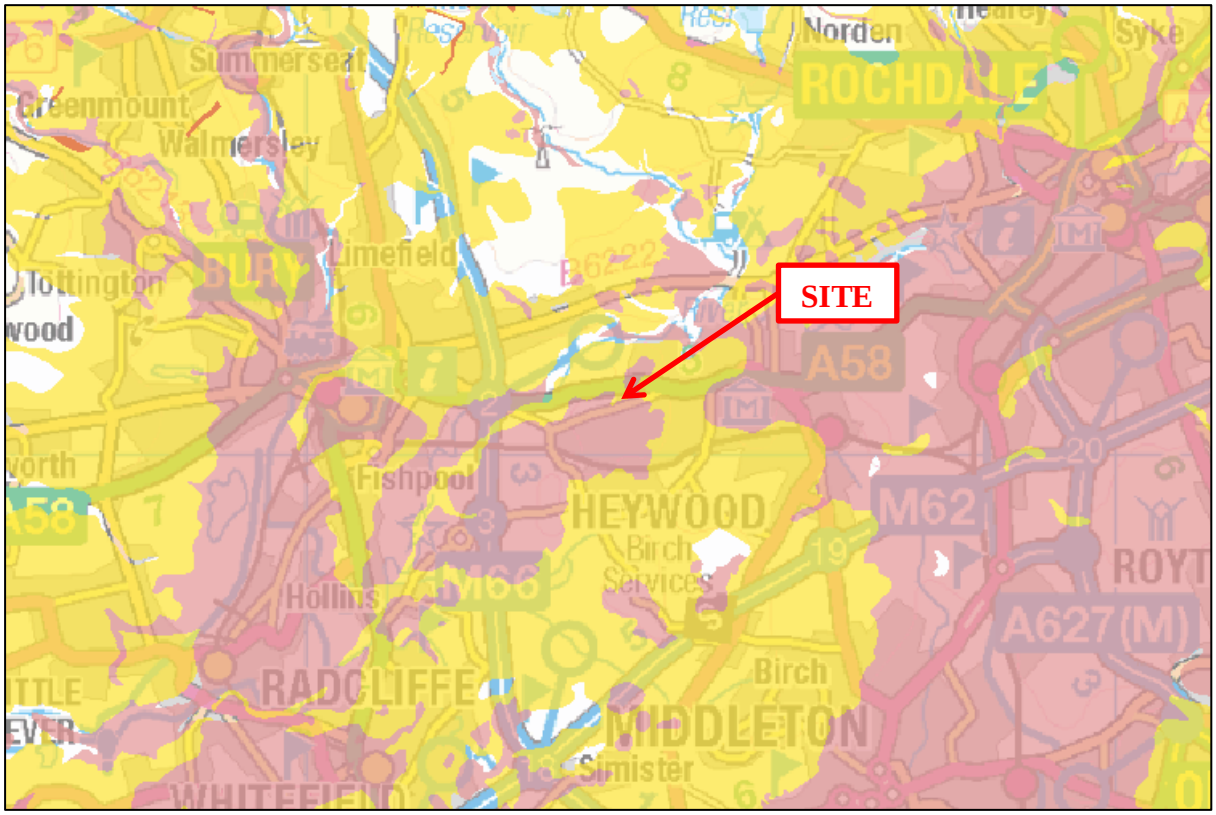
12.5. EA Groundwater Source Protection Zone Map.



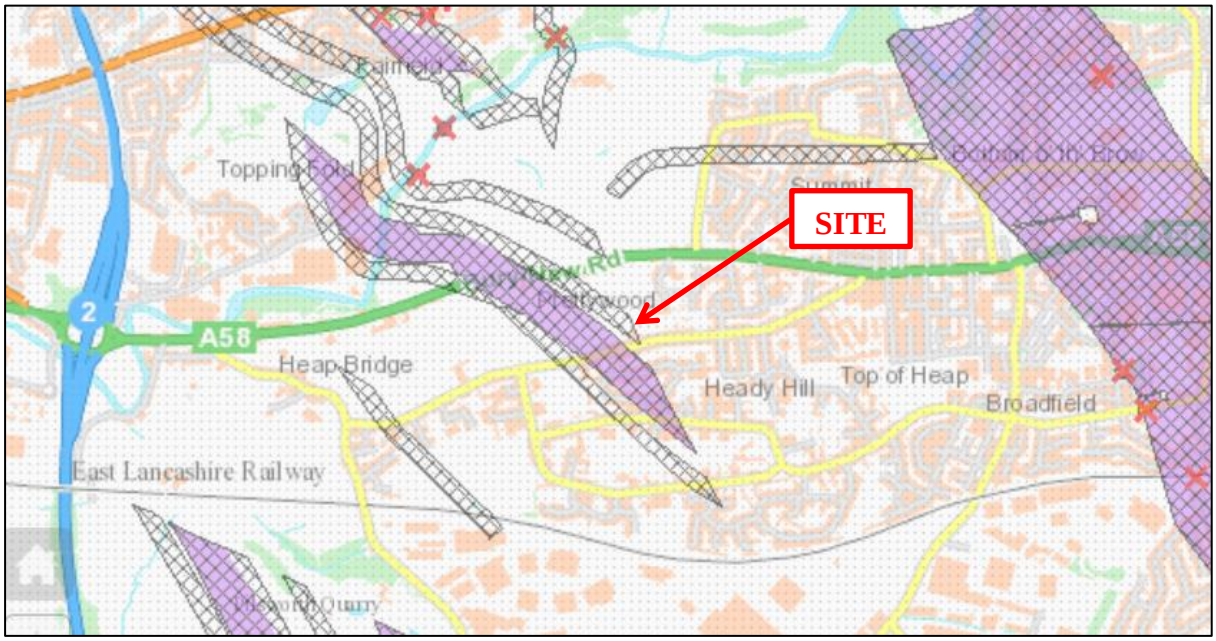
12.6. EA Bedrock Aquifer Map.



12.7. EA Superficial Aquifer Map.

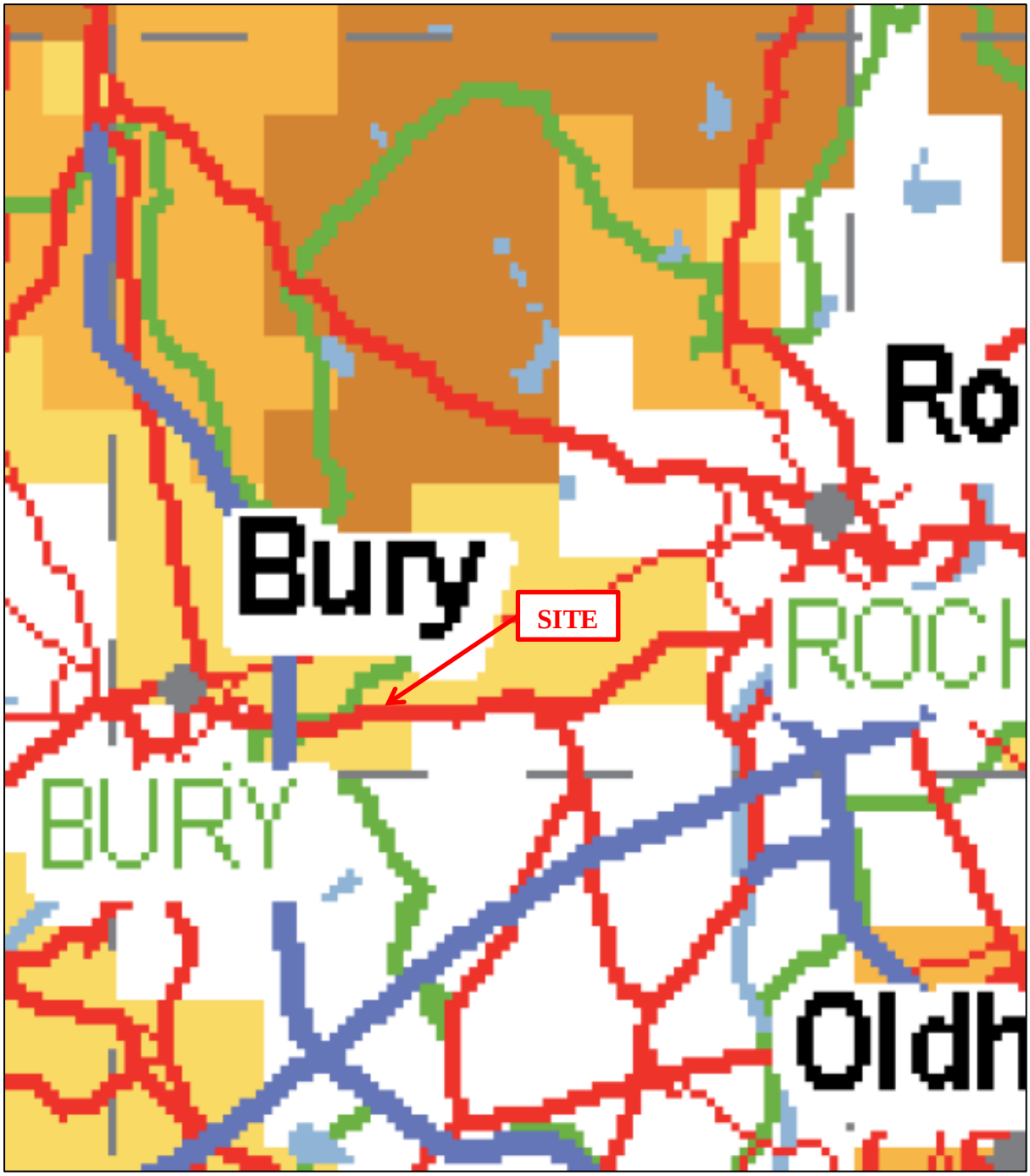


12.8. Coal Authority Interactive Map.



X = shaft; **X** = adit; Blue shading = past shallow coal workings; Purple shading = probable shallow workings; grey shading = past/current surface mining; Cross hatching = development referral area.

12.9. The BGS/HPA Joint Radon Map



13. APPENDIX D: TABLES.

13.1. CIRIA SP 78, TABLE 15, Contaminant hazards related to end use.

	Targets and associated hazards[1]						
	1	2	3	4	5	6	7
	Site works	Water resources	Buildings and services	Buildings and services	Garden amenities	Allotments, agriculture	Plant growing
Critical Contamination[2]	Harm to workers[3]	Leachate pollution[4]	Fire and explosion	Corrosion or expansion damage[4]	Harm to children[5]	Crop uptake of contaminant[4]	Phyto-toxicity[4]
Arsenic	O	O			●	O	
Cadmium		O			●	●[15]	
Lead		O		O[11]	●	●[15]	
Cyanide	O	●			●[14]		
PAH[6]	●		O		●		O
Phenols	●	●		●	●		O
Copper		O		O[11]	O		●[16]
Nickel		O		O[11]			●[16]
Zinc		O		O[11]			●[16]
Sulphate		●		●[12]	●		O
Sulphide		O		●			
Chloride		O		●			O
Mineral oils	●[8]	O	O	●	O		
Ammonium ion				●			
Methane	O[9]		●[9]				O
Sulphur			●	O[13]			
Combustibles	O		●[7]				
Oily, tarry substances	●	O	O	●			O
Asbestos	●	O[10]					
Radioactive materials	●	O			O	O	
Soluble metals		●		O	O		
pH	O	●		●		●	●
Solvents and organics	O	O	O				
Boron		O					O
Expansives				O[17]			

● Listed contamination hazards (from BS,DD 175 1988, and ICRCL Note 59/83 2nd edition 1987).

O Non-listed contamination hazards.

Notes.
1. Combinations of hazards may need investigation.
2. Local factors may involve other contaminants.
3. Workers at risk from contact, inhalation, explosion, fire and ground pH.
4. Soil pH affects incidence of these hazards.
5. Children at risk from inhalation, ingestion and contact.
6. PAH polynuclear aromatic hydrocarbons.
7. Combustibles include coal, oils, tars, refuse, rubber, etc Determine calorific value, loss on ignition, ash and volatile contents, total organic carbon.
8. Mineral oils are industrial hygiene problem, with or without PCB contamination.
9. Continuous on-site monitoring.
10. Hazard if run-off carries friable asbestos into streams.
11. Electrolytic action if free metal present.
12. Total and soluble sulphate (See also Section 1 1.4.4).
13. Corrosion induced by sulphur consuming bacteria.
14. Free' cyanide.
15. Total and 'plant-available' metals.
16. Total, 'plant-available' and 'zinc equivalent' values.
17. Expansives include: blast-furnace and steel slags, mining spoils and pyritic materials. Determine: total sulphur and acid soluble sulphate, calcite, and calcium as CaO.

13.2. CLR 8, Table2.1.

Table 2.1 Potential inorganic contaminants for the assessment of industrial land and their receptors

Contaminants [a, b]	Receptors			
	Humans	Water	Vegetation and the ecosystem	Construction materials
Metals				
Barium		✓		
Beryllium	✓	✓	✓	
Cadmium	✓	✓	✓	
Chromium	✓	✓		
Copper		✓	✓	
Lead	✓	✓	✓	
Mercury	✓	✓	✓	
Nickel	✓	✓	✓	
Vanadium	✓	✓		
Zinc		✓	✓	
Semi-metals and non-metals				
Arsenic	✓	✓		
Boron		✓	✓	
Selenium	✓	✓	✓	
Sulphur	✓		✓	✓
Inorganic chemicals				
Cyanide (complex)	✓	✓	✓	✓
Cyanide (free)[c]	✓	✓	✓	
Nitrate		✓		
Sulphate		✓	✓	✓
Sulphide		✓	✓	✓
Other				
Asbestos	✓			
pH (acidity/alkalinity)	✓	✓	✓	✓

Notes

[a] The list should not be regarded as a comprehensive list that should be taken into account in any particular site investigation. Some contaminants will be of no importance on certain types of site, while some sites may be contaminated by elevated concentrations of particular substances, which may not be selected because of their infrequent occurrence generally.

[b] For references to synonyms of substances refer to Appendix C.

[c] Free cyanide is broadly equivalent to "easily liberatable cyanide", which covers compounds that can release hydrogen cyanide at pH 4 and 100°C (see paragraph B.15 in Appendix B).

13.3. CLR 8, Table2.2.

Table 2.2 Potential organic contaminants for the assessment of industrial land and their receptors

Contaminants [a, b]	Receptors			
	Humans	Water	Vegetation and the ecosystem	Construction materials
Acetone	✓	✓		
Oil/fuel hydrocarbons	✓	✓	✓	✓[c]
Aromatic Hydrocarbons				
Benzene	✓	✓	✓	✓[c]
Chlorophenols	✓	✓	✓	✓[c]
Ethylbenzene	✓	✓	✓	✓[c]
Phenol	✓	✓	✓	✓[c]
Toluene	✓	✓	✓	✓[c]
o-Xylene	✓	✓	✓	✓[c]
m,p-Xylene	✓	✓	✓	✓[c]
Polycyclic Aromatic Hydrocarbons	✓	✓		
Chlorinated Aliphatic Hydrocarbons [d]				
Chloroform	✓	✓	✓	
Carbon tetrachloride	✓	✓	✓	✓[c]
Vinyl chloride	✓	✓		
1,2-Dichloroethane	✓	✓	✓	✓[c]
1,1,1-Trichloroethane	✓	✓	✓	✓[c]
Trichloroethene	✓	✓	✓	✓[c]
Tetrachloroethene	✓	✓	✓	✓[c]
Hexachlorobuta-1,3-diene	✓	✓	✓	
Hexachlorocyclohexanes	✓	✓	✓	
Dieldrin	✓	✓	✓	
Chlorinated Aromatic Hydrocarbons				
Chlorobenzenes	✓	✓	✓	
Chlorotoluenes	✓	✓	✓	
Pentachlorophenol	✓	✓	✓	
Polychlorinated biphenyls[e]	✓	✓	✓	
Dioxins and furans[f]	✓	✓	✓	
Organometallics				
Organolead compounds	✓		✓	
Organotin compounds	✓	✓		

Notes

[a] The list should not be regarded as a comprehensive list that should be taken into account in any particular site investigation. Some contaminants will be of no importance on certain types of site, while some sites may be contaminated by elevated concentrations of particular substances, which may not be selected because of their infrequent occurrence generally.

[b] For references to synonyms of substances refer to Appendix C.

[c] The impact of chlorinated hydrocarbons and other organic substances is probably limited to concentrations in the free phase.

[d] Some chlorinated aliphatic hydrocarbons are considered to be of secondary importance (see paragraphs B.16 and B.17 in Appendix B) and are therefore excluded because they are less toxic, highly volatile or have limited industrial use. However, some highly volatile substances may be significant due to their solubility and are not excluded on grounds of volatility alone.

[e] There are 209 polychlorinated biphenyl (PCB) congeners, the significance of which can be expressed using toxic equivalency factors (TEFs) relative to the best-characterised member of the group.

[f] There are 210 possible isomers of chlorinated dioxins and furans, of which the most studied and most toxic representative of the group is 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD). Other dioxins and furans could be expressed in terms of TEFs relative to 2,3,7,8-TCDD.

13.4. CIRIA (Report c665) Wilson and Card Classification.

Modified Wilson and Card classification

	Characteristic situation (CIRIA R149)	Comparable classification in DETR *et al* (1999)	Risk classification	Gas screening value (GSV) (CH_4 or CO_2) (l/hr)[1] Threshold	Additional factors	Typical source of generation
	1	A	Very low risk	<0.07	Typically methane <1 % and/or carbon dioxide <5 %. Otherwise consider increase to Situation 2	Natural soils with low organic content "Typical" made ground
	2	B	Low risk	<0.7	Borehole air flow rate not to exceed 70l/hr. Otherwise consider increase to characteristic Situation 3	Natural soil, high peat/organic content. "Typical" made ground
	3	C	Moderate risk	<3.5		Old landfill, inert waste, mineworking flooded
	4	D	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	E	High risk	<70		Mineworking unflooded inactive with shallow workings near surface
	6	F	Very high risk	>70		Recent landfill site

Notes on the use of Table 8.5

1 Gas screening value: (Litres of gas/hour) is calculated by multiplying the maximum gas concentration (%) by the maximum measured borehole flow rate (l/hr) – see Glossary.

2 Site characterisation should be based on gas monitoring of concentrations and borehole flow rates for the minimum periods defined in Table 5.5.

3 Source of gas and generation potential/performance should be identified.

4 Soil gas investigation should be in accordance with guidance provided in Chapters 4 to 6.

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 CIRIA classification.

13.5. CIRIA (Report c665) Wilson and Card Protective Measures.

Typical scope of gas protective measures

Characteristic situation	Residential building (not those which belong to Situation B)[1]		Office/commercial/industrial development	
(From Table 8.5)	Number of levels of protection	Typical scope of protective measures	Number of levels of protection	Typical scope of protective measures
1	None	No special precautions	None	No special precautions
2	2	a. Reinforced concrete cast *in situ* floor slab (suspended, non-suspended or raft) with at least 1200 g DPM and underfloor venting. b. Beam and block or pre-cast concrete and 2000 g DPM/ reinforced gas membrane and underfloor venting. All joints and penetrations sealed.	1 to 2	a) Reinforced concrete cast *in situ* floor slab (suspended, non-suspended or raft) with at least 1200 g DPM. b) Beam and block or pre cast concrete slab and minimum 2000 g DPM/reinforced gas membrane. c) Possibly underfloor venting or pressurisation in combination with a) and b) depending on use. 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 underfloor sub-space.	1 to 2	All types of floor slab as above. All joints and penetrations sealed. Minimum 2000 g/ reinforced gas proof membrane and passively ventilated underfloor sub-space or positively pressurised underfloor sub-space
	3	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated underfloor subspace or positively pressurised underfloor sub-space, oversite capping or blinding and in-ground venting layer.	2 to 3	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility.
	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 underfloor sub-space, oversite capping and in-ground venting layer and in-ground venting wells or barriers.	3 to 4	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility. In ground venting wells or barriers.
	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.	4 to 5	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and actively ventilated or positively pressurised underfloor sub-space with monitoring facility, with monitoring. In ground venting wells and reduction of gas regime.

Note:

1 For low rise traditional housing with ventilated clear underfloor void (ie Situation B. See Table 8.7, Box 8.4 and Section 8.3.2).

13.6. BGS/HPA report IR/11/044 – Radon Potential Class Identification

Radon Potential Class*	Is the property in a Radon Affected Area?	Additional information
1	No	The property is in a Lower probability radon area (less than 1% of homes are estimated to be at or above the Action Level). The property is not in a radon affected area.
2	Yes	The property is in an Intermediate probability radon area (1 to 3% of homes are estimated to be at or above the Action Level). The property is in a radon affected area.
3	Yes	The property is an Intermediate probability radon area (3 to 5% of homes are estimated to be at or above the Action Level). The property is in a radon affected area.
4	Yes	The property is in an Intermediate probability radon area (5 to 10% of homes are estimated to be at or above the Action Level). The property is in a radon affected area.
5	Yes	The property is in a Higher probability radon area (10 to 30% of homes are estimated to be at or above the Action Level). The property is in a radon affected area.
6	Yes	The property is in a Higher probability radon area (more than 30% of homes are estimated to be at or above the Action Level). The property is in a radon affected area.

13.7. BGS/HPA report IR/11/044 – Radon Potential Class/Protection Measures Identification

Radon Potential Class*	What level of radon protective measures are required for new buildings in England and Wales?	What level of radon protective measures are required for new dwellings in Scotland?
1	None**	None**
2	None	Stage 1
3	Basic	Stage 1
4	Basic	Stage 1
5	Full	Stage 2
6	Full	Stage 2