**Remediation and Verification Strategy**

**21 WESTCLIFFE RISE**
**CLECKHEATON**
**BD19 5HX**

for

**Mr. A. Senior**

Report Number 4536

April 2026

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# Remediation and Verification Strategy

# 21 WESTCLIFFE RISE, CLECKHEATON, BD19 5HX

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# 1 INTRODUCTION

1.1 At the request of J.A. Oldroyd and Sons Limited, acting on behalf of Mr. A. Senior, a Remediation and Verification Strategy has been produced for land adjacent to 21 Westcliffe Rise in Cleckheaton. It is proposed to construct a pair of semi-detached residential properties on the site, as shown on figure 1.

1.2 This Remediation and Verification Strategy is based on the findings of the following investigation;

- Phase 1 Environmental Desk Study and Coal Mining Risk Assessment - Land adjacent to 21 Westcliffe Rise, Cleckheaton - Rogers Geotechnical Services Limited - Report No. C3383/23/E/5124, dated June 2023.

- Phase 2 Geo-environmental Report - Land adjacent to 21 Westcliffe Rise, Cleckheaton - Rogers Geotechnical Services Limited - Report No. C5245/25/E/8048, dated August 2025.

## 2 THE SITE

2.1 The following is derived from the Rogers Geotechnical Services Limited (RGS) reports;

*The site comprises a plot of land between the semi-detached property 21 Westcliffe Rise and the row of terraced houses on Westcliffe Road. The site is approximately 0.05 hectares in size and its National Grid Reference is centred around 418358, 425322.*

*It is understood that the development proposals currently comprise the erection of three new residential dwellings with associated garden areas and parking. In order to assist with this decision-making process, and any planning and construction aspects of the development, a Phase One environmental desk study has been commissioned and is the subject of this report.*

*In accordance with issued guidance, a site walkover was conducted on the 19th May 2023 and the following observations were made:*

***General Site Description/Current Site Use***

*The site comprises a plot of land, location within a residential setting.*

***Site Boundaries/Access***

*The site is accessible via Westcliffe Rise.*

***Topography***

*The site is relatively flat, however, the local topography slopes upwards to the north.*

***Surface Cover of Site***

*At the time of the walkover the garage premises had been demolished; the surface of the site comprised graded ground and all hardstanding had been removed.*

***Visible Evidence of Contamination/Contaminative Sources***

*A mound of spoil of what appears to be demolition rubble and waste is present on the west of the site.*

| | | |
|---|---|---|
| ***Development*** | *Erection of 2 No. residential dwellings with associated garden area and parking.* | *Section 1.* |
| ***Geology*** | *Solid geology - Pennine Lower Coal Measures Formation.* | *Section 5.* |
| ***Strata Conditions*** | *Made Ground present to between 0.5m and 0.8m depth, over firm friable slightly sandy slightly gravelly clay.* | *Section 6.* |
| ***Groundwater*** | *None encountered during investigation.* | *Section 6.2* |
| ***Foundation Design*** | *Shallow foundation solution.* | *Section 10.1* |

Continued.

| | | |
|---|---|---|
| ***Effect of Sulphates*** | *Concrete class DC-1.* | *Section 10.5* |
| ***Contamination*** | *The site is uncontaminated in regards to the intended end use.* | *Section 11.* |
| ***Ground Gas*** | *Site is Characteristic Situation Level 2 and some remediation measures will be required.*<br><br>***Note:*** *A Phase 3 Remediation Strategy and Phase 4 Verification report will be required in relation to a gas protection system.* | *Section 11.* |

2.2 As of 23rd April 2026, the site has remained unchanged.

## 3 QUANTATITIVE RISK ASSESSMENT

3.1 The contaminated land issues related to the site are within the Phase 2 Geo-environmental report by Rogers Geotechnical Services Limited. According to RGS, these are;

- *To protect the end user from the elevated levels of carbon dioxide.*
- *To protect plastic services from being penetrated by, or degrading due to the presence of, contamination in the soil or groundwaters.*

In addition, Section 11.5 refers to the need for a clean cover to garden areas, where Made Ground remains in situ. RGS state;

- *Photographic and logged evidence the clean material has been handled on site and placed in a sufficient thickness over areas where Made Ground remains. This may be either at the time of placement or after placement by means of hand excavated trial pits. Photographs should include visual site references or reference boards to prove the location and date taken. A measurement reference should be visible in the photographs to substantiate the thickness of material placed. Please note that it may be necessary to undertake a topographical survey and the requirement for which should be checked with any statutory authorities.*

# 4 CONCEPTUAL SITE MODEL

## Conceptual Site Model

4.1 The process of risk assessment is set out in Contaminated Land Report 11 (2014) "Model Procedures for the Management of Land Contamination" and in Part IIA of the Environment Protection Act 1990 and amended in part by The Water Act 2003. This defines contaminated land as *"any land which appears to the local authority in whose area it is situated to be in such a condition by reason of substances in, on or under the land, that there is a significant possibility of significant harm being caused, or that significant pollution of controlled waters is being caused or there is a significant possibility of such pollution being caused".*

4.2 The Act introduces the concept of a pollution linkage. This linkage consists of a pollution (contaminative) source or hazard and a receptor, together with an established pathway between the two. For land to be contaminated and require remediation, a pollution linkage (hazard-pathway-receptor) must exist. This forms a so-called 'conceptual model' of the site.

4.3 Examples of pathways and effects from land contamination are given below, and these are illustrated on figure 2.

## 4.4 Human Health (Pathways 1-5, Receptors A – C)

**Uptake of contaminants by food plants grown in contaminated soil** - Uptake will depend on the concentration of a contaminant in soil, its chemical form, soil pH, plant species and prominence in diet.

**Ingestion and inhalation** - Substances may be ingested directly by young children playing on contaminated soil, or by eating plants which have absorbed metals or are contaminated with soil or dust. Ingestion may also occur via contaminated water supplies. Metals and some organic material substances may be inhaled from dusts and soils. Land gas, radon and volatile organic compounds can be inhaled directly.

**Skin contact -** Soil containing tars, oils and corrosive substances may cause irritation to the skin through direct contact. Some substances (e.g. phenols) may be absorbed into the body through the skin or through cuts and abrasions.

**Irradiation -** As well as being inhaled and absorbed through the skin, radioactive materials emitting gamma rays can cause a radiation response.

**Fire and explosion** - Materials such as coal, coke particles, oil, tar, pitch, rubber, plastic and domestic waste are all combustible. Both underground fires and biodegradation of organic materials may produce toxic or flammable gases. Methane and other gases may explode if allowed to accumulate in confined spaces.

## 4.5 Buildings (Pathways 7 and 8)

**Fire and explosion** - Underground fires may cause ground subsidence and cause structural damage. Accumulations of flammable gases in confined space leads to a risk of explosion. Underground fires may damage services.

**Chemical attack on building materials and services -** Sulphates may attack concrete structures. Acids, oils and tarry substances may accelerate corrosion of metals or attack plastics, rubber and other polymeric materials used in pipework and service conduits or as jointing seals and protective coatings to concrete and metals.

**Physical -** Blast-furnace and steel-making slag (and some natural materials) may expand. Degradation of fills may cause settlement and voids in buried tanks and drums may collapse as corrosion occurs or under loading.

## 4.6 Natural Environment (Pathway 6, Receptors D - E)

**Phytotoxicity (prevention/inhibition of plant growth)** - Some metals essential for plant growth at low levels are phytotoxic at higher concentrations. Methane and other gases may give rise to phytotoxic effects.

**Contamination of water resources** - Soil has a limited capacity to absorb, degrade or attenuate the effects of pollutants. When this is exceeded, polluting substances may enter into surface and groundwaters.

**Ecotoxological effects -** Contaminants in soil may affect microbial, animal and plant populations. Ecosystems or individual species on the site, in surface waters or areas affected by migration from the site may be affected.

4.7 For any contaminant source identified, judgement is used regarding the probability of a pollution linkage occurring and the potential consequences of that linkage. Based on the probability and likely consequences, the overall risk (significance) can be established. The definitions that have been used for this purpose are given in Standard Appendix B. The probability of a hazard, combined with its consequences, can be used to assess risk. This forms the so-called Conceptual Site Model.

**Table 1: Risk Assessment based on Conceptual Site Model**

**Summary of Hazards, Pathways and Receptors**

| Source/ Contamination | Pathways | Receptor | Remediation Required |
|---|---|---|---|
| **Made Ground deposits on-site.** | 1 - 5 | A. Present Occupants. | None. Not applicable. |
| | | B. Groundworkers. | **Low Risk.** Assuming the short-term risks of any contact with potential contaminants would be mitigated by use of appropriate PPE, provision of suitable welfare facilities, and implementation of a hotspot protocol. Potential risks should be communicated to construction/maintenance workers disturbing Made Ground through toolbox talks. |
| | | C. Future Residents. | **Low to Medium Risk.** Clean cover required to garden and landscaped areas. Clean cover to comprise 150mm of topsoil over 450mm of subsoil to garden areas and 450mm of clean cover to landscaped areas where Made Ground remains. |
| | 6 | D. Controlled Waters. | **Low Risk.** |
| | | E. Ecosystems. | **Low Risk.** |
| **Ground Gases, Former Mining.** | 8 | A - F | **Medium Risk**. Basic gas protection measures are required as confirmed by initial gas monitoring. |

# 5 SOIL AND GAS REMEDIATION METHODOLOGY

## Objectives

5.1 As the site is proposed for residential development, there is a risk to human health from soil contamination and ground gases. The remediation scheme is intended to break the Source-Pathway-Receptor linkage, such that the site is suitable for its intended end-use.

## Remediation Strategy

5.2 The Remediation Strategy shall comprise;

**i.** Any redundant services to be decommissioned. Any retained services to be inspected to ensure they are fully functional.

**ii.** General site clearance of surface materials and vegetation. Removal of any remaining relict foundations. Stockpile and test in respect of disposal.

**iii.** Provide a clean cover comprising 450mm of subsoil, and a minimum of 150mm topsoil to rear garden areas. A 450mm clean cover should be provided to landscaped areas. The clean cover will break the pollution linkage between any remaining Made Ground and future residents. The clean cover thickness can be reduced should natural ground be encountered during the reduced level excavation. **As such, the clean cover is only required where Made Ground remains following the reduced level excavation.** The preferred approach is to remove Made Ground from garden areas and reinstate with clean subsoils from

foundation and service excavations, together with 150mm of clean imported topsoil.

**iv.** Provide basic gas protection measures to the properties.

**v.** Consultation with Yorkshire Water in respect of any specific requirements it may have for new plastic water supply pipes.

**Clean Cover (Only required where Made Ground remains following reduced level dig)**

5.3 According to the Environment Agency's Remediation Position Statements, the placement of a cover system using "clean" material is not treatment of waste. Consequently, no licensing/permitting position statements are applicable to this type of remediation. If the cover system uses 'waste materials' in its construction, waste management licensing exemption paragraph 9A may be applicable to its installation. If the installation of the proposed cover system does not meet the criteria for registration of this exemption, the activity may be regulated through a waste management site licence.

5.4 The clean cover system should be validated in accordance with the "Verification Requirements for Cover Systems – Technical Guidance for Developers, Landowners and Consultants" (Version 4.1). This document has been issued by the Yorkshire and Humberside Pollution Advisory Council and adopted by Local Authorities in Yorkshire, Humberside and Lincolnshire. Where applicable, it should also be in accordance with the requirements of the NHBC as set out in Standards Extra 47 (June 2010) "Contaminated Land – Cover System Validation".

## Source of Material

5.5 As it will be necessary to import topsoil and subsoil for the clean cover, the soil concentrations should not exceed any of the levels given in Table 2. The material supplier should be made aware of these. The topsoil should also comply with BS3882: 2015: Specification for Topsoil. The subsoil should comply with BS8601: 2015: Specification for Subsoil and requirements for use. Test certification should be provided in advance of importation, and no testing should be more than 30 days old. **Clean excavated subsoil from foundations and service trenches can be used as subsoil and to raise external levels.**

## Characterisation of Material

5.6 It is essential that material is inert and suitable for its intended use. Sampling of materials should be undertaken as early as possible i.e. *prior to placement* (for site won material) and *prior to importation* (for imported material). This is to avoid the costly exercise of re-excavating *unsuitable* materials and the possibility of cross contamination.

## Certificates from Commercial Suppliers

5.7 Where material is provided by a commercial company, certificates or other industry Quality Protocol compliance i.e. WRAP, will normally be accepted. Caution should be given to importing materials, specifically soils that have been recycled from demolition or skip waste as they could be contaminated.

### Initial Screening

5.8 A visual / olfactory inspection of the imported topsoil and subsoil should be carried out by an Environmental Engineer from Michael D Joyce Associates LLP to ensure that:

- It is a suitable growing medium.
- It is free from obvious contamination i.e staining / free product etc.
- It has not come from areas where Japanese Knotweed or other invasive or injurious plants, as specified by the Environment Agency are suspected to have been growing.
- It is not odorous (could be considered a statutory nuisance).
- It is free from unsuitable materials i.e. bricks, brick ties, timber and glass etc).
- There are no visible signs of asbestos containing materials (ACM's).

### Testing Schedule and Number of Samples

5.9 Chemical testing will normally be required on any materials that are to be used as cover material, even where this includes first generation quarried material. This should be carried out by Michael D Joyce Associates LLP.

### Suitability of Material

5.10 Based on the characterisation of materials, they should be either deemed suitable or unsuitable. The soil concentrations should not exceed any of the following levels, and as such the material supplier should be made aware of these.

**Table 2: Maximum Permitted Concentrations for Topsoil and Subsoil**

| Analyte | Maximum Permitted Concentrations (mg/kg) |
|---|---|
| Arsenic (total) | 37 (1) |
| Cadmium (total) | 22 (1) |
| Chromium (VI) | 21 (1) |
| Copper (total) | 2400 (2) |
| Lead (total) | 200 (1) |
| Mercury (total) | 40 (2) |
| Nickel (total) | 130 (2) |
| Selenium (total) | 250 (2) |
| Zinc (total) | 3700 (2) |
| Phenols (total) | 420 (1) |
| Naphthalene | 2.3 (2) |
| Acenaphthylene | 170 (2) |
| Acenaphthene | 2400 (2) |
| Fluorene | 170 (2) |
| Phenanthrene | 85 (2) |
| Anthracene | 2400 (2) |
| Fluoranthene | 280 (2) |
| Pyrene | 620 (2) |
| Benzo (a) anthracene | 7.2 (2) |
| Chrysene | 15 (2) |
| Benzo (b) fluoranthene | 2.6 (2) |
| Benzo (k) fluoranthene | 77 (2) |
| Benzo (a) pyrene | 5.0 (1) |
| Indeno (1,2,3 cd) pyrene | 2.7 (2) |
| Dibenz (a,h) anthracene | 0.24 (2) |
| Benzo (g,h,l) perylene | 320 (2) |
| Asbestos | None |

***(1)*** *C4SL published 2014.*

***(2)*** *Suitable for Use Values derived by LQM/CIEH "Generic Assessment Criteria for Human Health Risk Assessment" 2009. For organics a SOM of 1.0% assumed.*

## Stockpiling and Quarantining of Material

5.11 It is essential that 'suitable' material is either placed in its intended area straight away i.e soft / landscaped areas or stockpiled in a suitable quarantine area to prevent on-site contamination, i.e. for example, fuel leakage from machinery.

## Verification of Required Depth

5.12 Should a clean cover be necessary, it is important to establish that the required depth has been achieved and is consistent across the site. The main way to achieve this:

- *Depth testing in-situ* – small trial pit excavated to allow measurement of its depth by tape measure or measuring staff. This is the most used method.

5.13 The verification of depth and confirmation of such layers should be carried out by Michael D Joyce Associates LLP at **a rate of 1 per plot.** In addition, samples will be taken for analysis of both the topsoil and subsoil at **a rate of 1 per 250m$^3$,** subject to a minimum of 3 tests of each of the topsoil and subsoil. The results should comply with the Maximum Permitted Concentrations given in Table 2.

## Reporting

5.14 The purpose of verification documentation is to provide transparent reasoning as to why the remediation, was required, a methodology about how it was to be undertaken and proof that the specified works have been undertaken so as to provide confirmation that the site is 'suitable for its intended use'.

5.15 The document is utilised not only to satisfy conditions of planning permissions but also is to be kept on record by the Local Authority should queries be raised during the lifetime of the development and to confirm to future purchasers that the site is suitable for use. The report should be carried out by Michael D Joyce Associates LLP.

5.16 The Local Authority ideally would recommend the following programme of photographs to be undertaken of the placement of inert cover:

- Photographs of any stockpiles and quarantine areas.
- Proof that the depth of inert cover has been installed.
- Proof that the quality of the material to be used as inert cover.
- Proof of the method of placement and different layers if appropriate.
- Proof of the completed project.
- Inclusion of geographic background features which will aid locating the photograph.
- Inclusion of site identification boards within the photos which show the date, position taken i.e. corner of plot 3 and the site name.

5.17 When hardstanding is proposed, the link between the potential contaminants in the soil and the end users will no longer exist. As such, no special precautions are necessary.

**Groundworkers**

5.18 All groundworkers shall undergo site specific health and safety induction prior to commencing on site. Personnel shall be provided with appropriate protective clothing, footwear, eyewear and gloves and all work shall be carried out in accordance with HSE Document, *"Protection of Workers and the General Public during the Redevelopment of Contaminated Land".* There shall be no entry into confined spaces

without appropriate training and monitoring. The site should be secured against general access to public.

## Contingency Planning

5.19 Should any contamination be encountered on site such as hotspots, or if ground conditions are different from those predicted, they should be referred back to Michael D Joyce Associates LLP for appropriate advice. The Local Authority shall be informed in writing immediately.

## Ground Gas

5.20 The Ground Gas Risk Assessment carried out to date recommends the following;

*Characteristic Situation 2 (CS2) gas conditions should be adopted within new houses and garages on site. This is equivalent to NHBC's Traffic Light Classification of* ***Amber 1.***

*Table 4 of BS8485 states that CS2 conditions require a minimum gas protection score of 3.5 points for a low-rise residential end-use (Type A buildings).*

*The required gas protection score could be achieved by utilising a suitable combination of gas-resistant membrane and sub-floor ventilation measures, installed and verified in accordance with CIRIA Report C735*[4].

([4] CIRIA. 2014. Good Practice on the Testing and Verification of Protection Systems for Buildings against Hazardous Ground Gases).

*This may include:*

- *A beam and block floor, which achieves 0 points.*
- *A minimum 150mm ventilated sub-floor void, which achieves at least 'good performance' and 1.5 points.*
- *A ground gas protection membrane (meeting the requirements of BS8485 Table 7), installed above the ventilated void with beam and block floor system in accordance with the recommendations provided within Table 7 of BS8485. Subject to the satisfactory installation of the membrane, plus independent verification of selected plots, this would achieve a protection score of 2 points.*

*Prior to undertaking any construction works on the site, the proposed design of gas protection measures, and strategy for verification should be agreed with the Local Authority and if applicable the NHBC or relevant warranty provider.*

***The site is recorded to be located within a lower probability radon area. Therefore, no radon protection measures are required for the proposed development.***

5.21 The site manager shall provide instruction to all relevant site personnel of the gas protection measures and the importance that these measures are not disturbed or damaged. Following installation of the measures, access to them shall be restricted until such time that the protection measures have been inspected and subsequently covered over.

5.22 The verification requirements are set out in the Yorkshire and Lincolnshire Pollution Advisory Group (YALPAG) document "Verification Requirements for Gas Protection

Systems - Technical Guidance for Developers, Landowners and Consultants", Version 1.1 - December 2016, and presented in Appendix 2.

5.23 On completion of the installation of the gas protection measures for the property, the following procedures for verification must be followed, in line with YALPAG requirements and CIRIA C735, namely;

- The installation shall be inspected by a Chartered Engineer from Michael D Joyce Associates LLP (the Consultant).

- The above individuals shall ensure that component specification and installation for all the plots comply with both the manufacturer's guidelines/instructions and this strategy.

- All components of the agreed gas protection system (set out in Sections 2 and 3) have been subject to verification by way of visual inspection. Evidence in the form of a checklist of YALPAG guidance, Appendix 2 will be required and shall itemise the specification and inspection of all the individual gas protection components and their correct installation to all the plots;

- Photographic evidence clearly illustrating the points on the checklist and correct installation of the gas protection components shall be required.

5.24 A report should be prepared to demonstrate how the gas protection measures have been installed for each plot and what verification information has been provided to demonstrate the installation has been carried out in accordance with the appropriate guidance.

5.25 As a minimum, the Verification Report for the plots should include (but not be limited to):

- Any formal qualifications/experience/training of the general builder carrying out the installation.

- Formal qualifications/experience/training of the persons carrying out the verification of the void and telescopic vents, and the person carrying out the verification of the membrane (namely the Consultant).

- Clear demonstration of the independence of the Consultant carrying out the verification.

- The manufacturer's specification of the gas protection membrane to be used.

- Details of how any non-conformance will be dealt with.

- Timeline of when during the build, each of the gas protection measures have been installed.

- Details of management measures proposed to ensure how damage to the membrane will be prevented prior to the floor being installed and post installation.

- Details of how all relevant site personnel will be made aware of the presence of the membrane and that damage to the membrane must be prevented.

- Details of the extent of overlap and method of sealing (these must be in line with manufacturer's instructions and evidence provided).

- Confirmation with a signed statement confirming that the gas protection measures were installed as agreed and that the membrane was free from tears and punctures and was lapped and sealed as agreed as joins and around services and sub-floor voids were clear and free from debris will be included in the Verification Report.

- Confirmation with specific photographs showing the installed membrane will be included in the Verification Report. This shall cover both plots.

## 6 WASTE CLASSIFICATION

6.1 Waste soils to be removed from site must be via a licensed waste transfer company. Removal of soils should only commence once the receiving landfill or waste management operator has received the test results and has given their consent to receive the waste soils.

6.2 If waste soil is to be exported from the site, it must be classified in accordance with the guidance provided by the Environment Agency's publication Technical Guidance WM3: Waste Classification - Guidance on the classification and assessment of waste. The waste will end up classified as either:

- Hazardous waste with the waste code 17-05-03 (soil and stones containing hazardous substances)
- Non-Hazardous waste with code 17-05-04 (soil and stones other than those mentioned in 17-05-03).

6.3 Initial Waste Acceptance Criteria (WAC) testing indicates that the Made Ground will be classed as "Stable Non-Reactive Hazardous Waste in a Non-Hazardous Landfill." One sample recorded an elevated organic content, such that it fell within the "Hazardous Waste" category. However, the technical guidance suggests it should be more appropriately categorised as "Stable Non-Reactive Hazardous Waste".

6.4 To minimise future costs, it is recommended that Made Ground is stockpiled separately from clean excavated soils, as the latter are very unlikely to be contaminated.

6.5 All waste transfer activities must be accompanied by appropriate paperwork, specifically Waste Transfer Notes that clearly state the origin and destination of the waste soils; the volume of tonnage or material removed; and the date of the transfer.

6.6 Waste Acceptance Criteria testing does not provide a measure of the total hazardous content of the soil (only the leachable content), so WAC data cannot and must not be used for waste classification.

6.7 For non-hazardous waste, no WAC leaching thresholds have been set, so no WAC testing is required.

6.8 Soils being sent to landfill as a hazardous waste or an inert waste will usually require WAC testing to confirm that the material will not produce a hazardous leachate and that it does not contain a significant organic content or sulphate concentration, such that it would breach the licensing requirements of the tip.

6.9 Uncontaminated natural soils that are excavated in the course of construction and are to be reused for the purposes of construction are not considered to be waste, and can be reused freely on the same site. If these natural uncontaminated soils are to be reused as a fill material on a different site, you will need one of the following:

- A U1 exemption from the Environment Agency (free of charge but generally limited to 1000 tonnes);
- A Materials Management Plan (MMP) prepared in accordance with the CL:AIRE DoWCoP (Definition of Waste Code of Practice) under which all activity must be carried out.

A D Joyce

BSc MSc ARSM CEng CGeol CEnv MICE FGS SiLC SQP

April 2026

**Procedure Notes**

Where applicable, the supplementary ground investigation has been carried out using reasonable skill and care in accordance with the principles of Ground Investigation and Testing", BS5930: 2013 and BS10175:2011+A1:2013, and the terms of the client's brief. The report has been prepared for the specific purposes notified at the time of the initial enquiry.

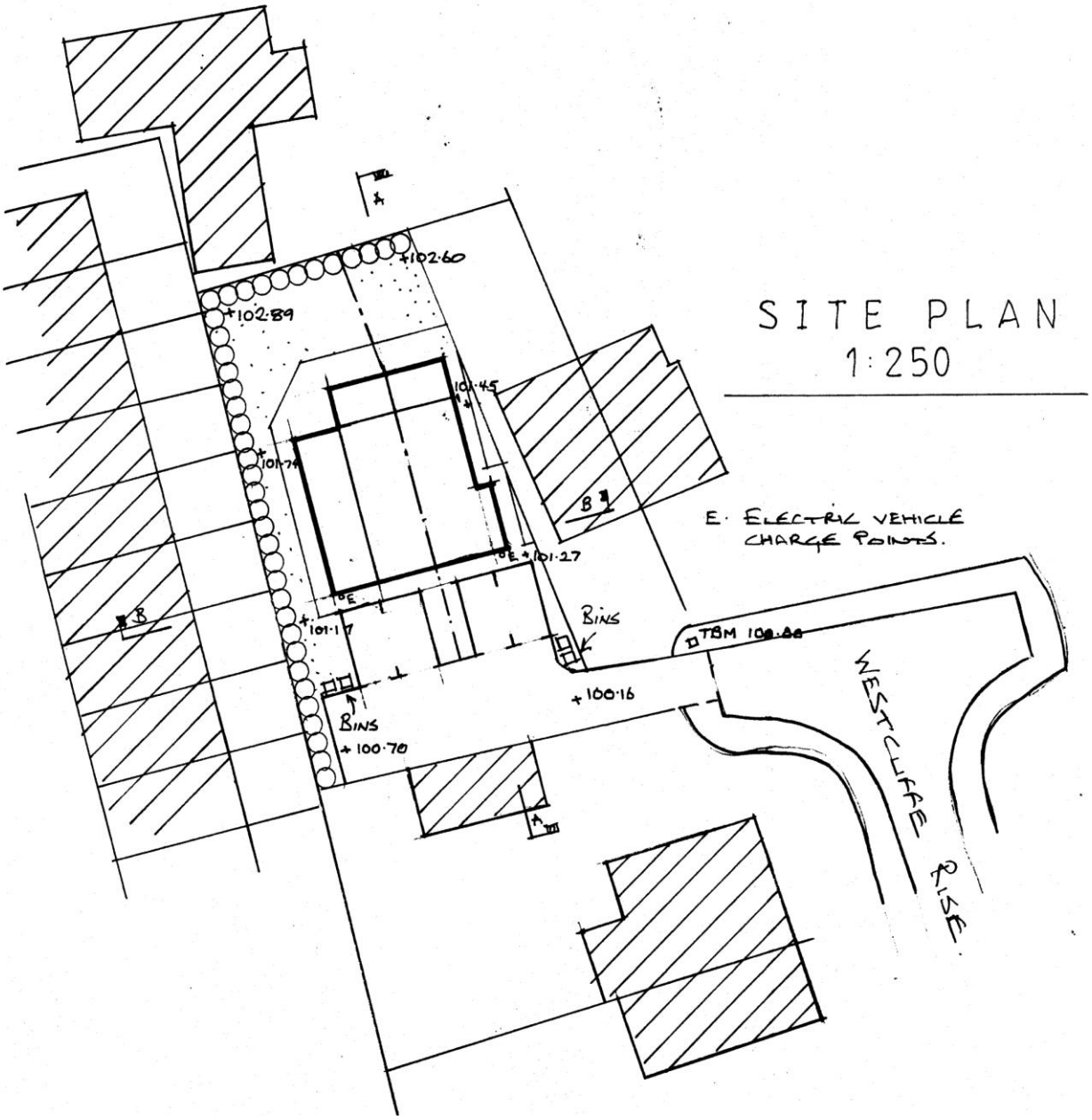
By its very nature any ground investigation only encounters and samples a small percentage of the ground. Consequently changes in ground conditions and soil properties can occur between any two exploratory points, for example local features such as soft ground, pockets of contamination and faults. This is also true of the exploration of mineworkings and such features can extend beneath parts of the site not investigated. Unrecorded bell pits and shafts can also exist between exploratory points. The ground investigation is designed to minimize such risks. Conclusions and recommendations are based on the information presented in this report, but unforeseen features may exist. No liability can be accepted for conditions not revealed by the exploratory holes. Therefore, actual ground conditions shall be noted during construction and further advice sought if they differ from those predicted. Michael D. Joyce LLP reserves the right to amend the conclusions and recommendations in the light of further information. Actual methods of construction or alternative designs shall be notified to Michael D. Joyce Associates LLP, such that the recommendations made can be reconsidered in the light of any changes.

Further investigation can be carried out to further reduce uncertainty and risk but ultimately these risks cannot be eliminated. Similarly a desk study normally only considers readily available information and further information could be held by other sources. In commissioning further research or investigation the cost/benefit of doing so must be considered.

It is assumed that groundlevels shall not change significantly from those at present. The groundwater conditions are based on observations made at the time of the investigation, unless stated otherwise. It shall be noted that the observations are subject to the method of the boring or excavation and that groundwater levels shall vary due to seasonal or other effects.

Where buildings are present on a site, structural and asbestos surveys have not been carried out, unless specifically stated. An Unexploded Ordnance Survey has not been carried out unless specifically stated. In relevant situations it would be prudent to commission such surveys.

Where information has been obtained from Third Parties, no liability can be accepted for the accuracy or completeness of this information. Where anecdotal evidence or speculations are presented, they must be treated as such and cannot be relied upon.



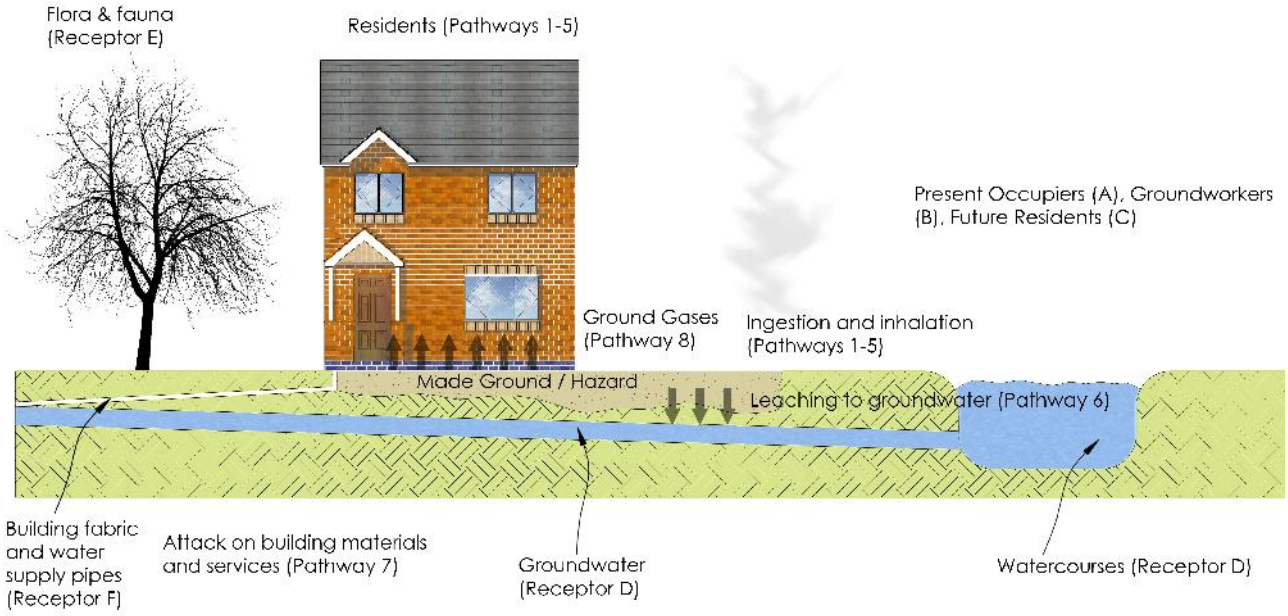

**21 Westcliffe Rise, Cleckheaton**
Development Proposals

Michael D Joyce Associates LLP
Geotechnical and Geoenvironmental Consultants



Scale: NTS

Figure: 2




**Pathways**

1. Ingestion of contaminated soil/dust
2. Ingestion of contaminated food
3. Ingestion of contaminated water
4. Inhalation of contaminated vapours
5. Dermal contact with contaminated soil/dust or water
6. Pollution of controlled water and off site migration
7. Attack on building materials and services
8. Migration of landfill gases and radon

**Receptors**

A. Present site occupiers
B. Site development personnel
C. Future residents
D. Controlled waters
E. Flora and fauna
F. Building and services

Schematic Representation of Conceptual Site Model

**Schematic Representation of Conceptual Site Model**

Michael D Joyce Associates LLP

**Geotechnical and Geoenvironmental Consultants**

Figure: 3

**Appendix 1**

YALPAG: "Verification Requirements for Cover Systems", June 2021

# VERIFICATION REQUIREMENTS FOR COVER SYSTEMS

## Technical Guidance for Developers, Landowners and Consultants

**Yorkshire and Lincolnshire Pollution Advisory Group**

**Version 4.1 – June 2021**

The purpose of this guidance is to promote consistency and good practice for development on land affected by contamination. The Local Authorities in Yorkshire, Lincolnshire, the North East of England, East Anglia, Greater Manchester and St Helens who have adopted this guidance are shown below:






































# Contents



**Disclaimer**

**This guidance is intended to serve as an informative and helpful source of advice. YALPAG will review this guidance every three years, but readers must note that legislation, guidance and practical methods are inevitably subject to change and therefore should be aware of current UK policy and best practice. This note should be read in conjunction with prevailing legislation and guidance, as amended, whether mentioned here or not. Where legislation and documents are summarised this is for general advice and convenience, and must not be relied upon as a comprehensive or authoritative interpretation. Ultimately it is the responsibility of the person/company involved in the development or assessment of land to apply up-to-date working practices to determine the contamination status of a site and the remediation and verification requirements.**

**Acknowledgments**

**YALPAG would like to thank North Lincolnshire Council, Leeds City Council, City of Bradford Metropolitan District Council, Barnsley Metropolitan Borough Council, Rotherham Metropolitan Borough Council, Wakefield Council, and Tameside Metropolitan Borough Council, for producing this guidance.**

YALPAG would also like to acknowledge Liverpool City Council's Contaminated Land Team, Coopers Consulting Engineers for allowing us to use their guidance document and photographs and WSP Environmental Ltd for also donating photographs.

**Consultation**

39 Local Authorities and 6 Environmental Consultants were consulted over a four week period in 2010 during the production of the initial guidance. At that time, consultation comments were considered by the review panel and a number of revisions were made to the guidance to reflect these comments.

49 Local Authorities and 25 Environmental Consultants were consulted in 2021, during the production of this version [4.1] of the guidance. Consultation comments were considered by the review panel and a number of revisions were made to the guidance to reflect these comments.

# Introduction

This guidance has been produced to help developers ensure that they can demonstrate that material brought onto a development site for gardens or areas of soft landscaping are suitable for use and do not present harm to people, the environment and/or property. It is intended to improve the quality of reports submitted to Local Authorities on this matter and to give contractors/consultants a point of reference to obtain approval for such work from their client. This guidance does not cover the geotechnical suitability of soils or materials, chemical suitability that does not affect human health e.g. sulphates, or importing soils contaminated with invasive (or injurious) plants.

The verification of cover systems should be an integral part of the remediation project and agreed between developers and regulators at an early stage in the project.

UK guidelines for remediation verification are set out within Land Contamination Risk Management[1] (LCRM) and the document on Verification of Remediation of Land Contamination[2]. This guidance note should be considered as supplementary advice in conjunction with these documents.

This guidance relates to the remediation of land contamination by using cover systems; however, the verification of the quality of imported material is equally important in other situations, such as raising levels for flood prevention or general landscaping works. This guidance could also be used in such instances.

# The Process of Verification

Implementation plans for remedial works should always be site specific. Where a cover system and potentially, excavation, is the main remedial method or a component of an overall site remediation, specific goals will need to be set that are linked directly to the risk management strategy for the site in question.

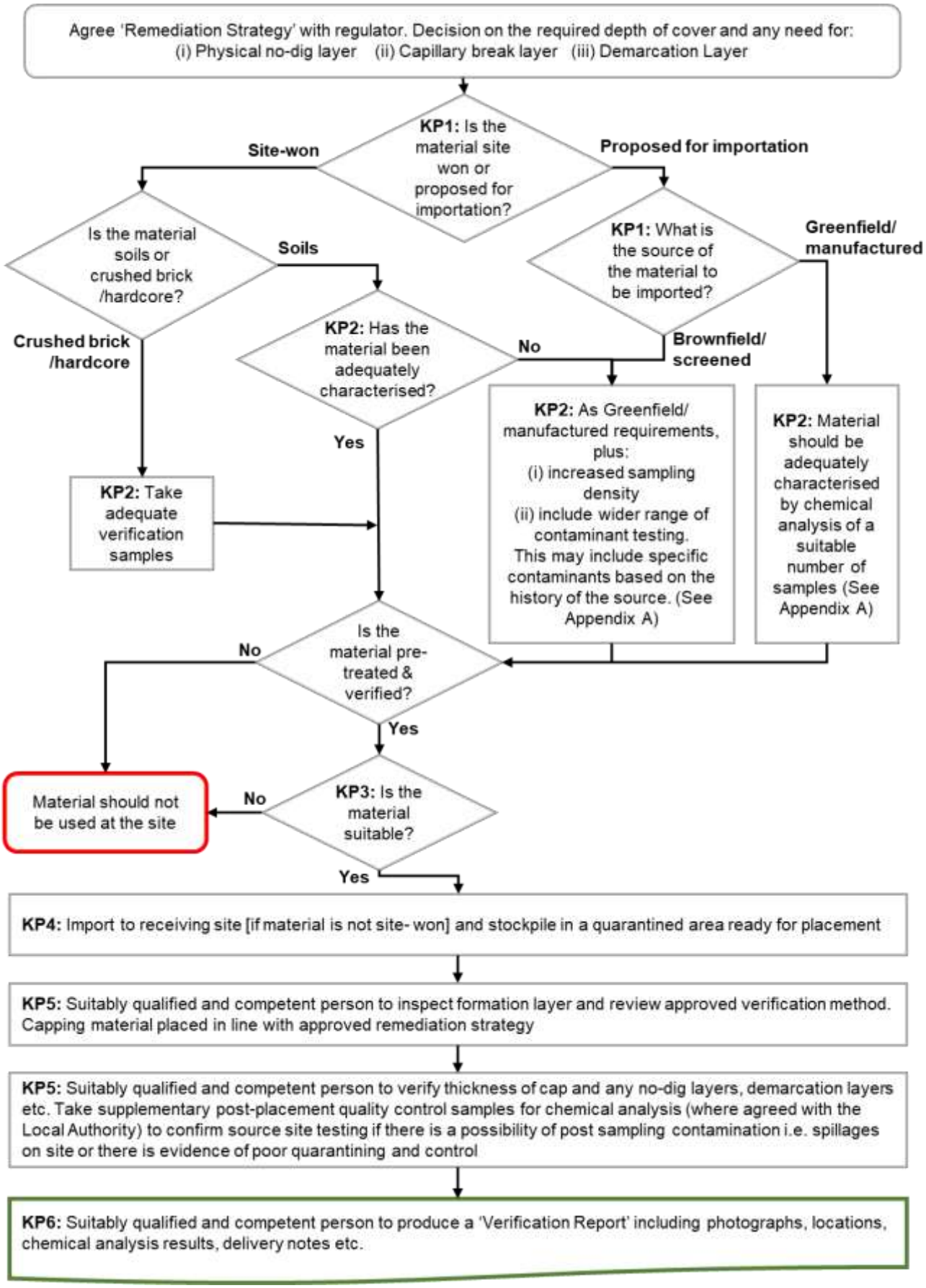
For cover and containment systems, verification will normally depend upon the provision of defensible measurements, observations and records. Critical factors to be considered are:

- What should be measured?
- When should they be measured?
- Where measurements need to be taken, what is the appropriate monitoring regime i.e. number and frequency of samples?
- Statistical constraints on sampling.

National Planning Policy Framework (NPPF) states that “planning policies and decisions should ensure that after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990”. The Verification Report is a key document to demonstrate compliance with NPPF, and the responsibility rests with the developer/applicant to submit the required Verification Report to complete the remediation and to discharge any planning conditions.

[1] Land Contamination Risk Management, Environment Agency, Oct 2020
[2] Verification of Remediation of Land Contamination. Environment Agency, Feb 2010

# Overview Flowchart



# Key Points

## KP1: Source of Material

Material can be sourced from site won material i.e. crushed brick/hardcore or site-won soils from existing open or landscaped areas. In the interest of sustainability, Local Authorities promote the use of such site-won material providing that they are suitable for the intended end use of the site.

Alternatively, material can be sourced from other developments and commercial companies. Dependent on the source of the material it can be classified as either from a 'Greenfield/Manufactured' or 'Brownfield/Screened' source.

Broadly speaking material can be classified as follows:

**Greenfield** – Where documentary evidence is provided confirming that the source site has not been developed and that no past contaminative uses have occurred. Should evidence not be provided or approved by the Local Authority, please note that the source would be expected to be assessed as though it were a brownfield source.

**Manufactured** – from a commercial company who manufacture material by mixing or blending mineral soils (subsoil or sand) with an organic amendment (compost). If other soil component sources are used, documentary evidence should be provided confirming that the source site has not been developed and that no past contaminative uses have occurred. Should documentary evidence not be provided or approved by the Local Authority, please note that the source would be expected to be assessed as though it were a brownfield source.

**Brownfield** – material from a donor site that has previously been developed

**Screened** – material from a company who deal with skip/demolition waste which is screened for unsuitable material i.e. bricks, wood, plastic etc.

## KP2: Characterisation of Material

It is essential that material is suitable for its intended use. Documentary evidence of the source of the material should be provided to the Local Authority. This may include desk study or site investigation reports. A defensible method is required to ensure the verification proposals are site specific and that the level of sampling reflects the need to ensure that imported material are suitable for their intended use.

Due to the diminishing supply of suitable Greenfield topsoil sources it has been found that the chemical quality of Greenfield sources is less reliable in certain areas. As a result the recommended analytical rate for the intended use of the development may vary between Local Authorities [see **Appendix 1a**].

### When should this be done?

Sampling of material should be undertaken as early as possible i.e. prior to placement [for site won material] and prior to importation [for imported material]. This is to avoid the costly exercise of re-excavating unsuitable material and the possibility of cross contamination. Where the assessor has confidence that the material is of sufficient quality (i.e. tested by supplier, used previously) it is acceptable to test the material on site. Although, if it is deemed unsuitable it would have to be either removed off site or pre-treated at the cost and time of the developer. It is recommended that some verification samples are also taken once this material has been delivered to site to confirm suitability for use. Soils can become contaminated during transportation or when stockpiled on site.

## What about certificates from commercial suppliers?

Where the material is provided by a commercial company, certificates or other industry Quality Protocol compliance i.e. WRAP, DoWCoP, will normally be accepted. This is on the proviso that it: (i) relates to the actual material being imported to the site and the type and amount of analysis is in line with what is prescribed in Appendix 1a; and, (ii) the certificates are less than two months old.

It is recommended that some additional verification samples are taken once this material has been delivered to site. Soils can become contaminated during transportation or when stockpiled on site.

Extreme caution should be given to importing material that has been recycled from demolition or skip waste as they could easily be contaminated e.g. asbestos containing materials. Please refer to "questions you should be asking your supplier" in **Appendix 1b** and include the responses in your report.

## British Standard

Imported soils should be as specified in BS 3882:2015 for topsoil and BS8601:2013 for subsoil as 'suitable for their intended purpose'. Both British Standards relate mostly to nutrient content of topsoil and phytotoxic contamination and they do not consider contaminants that pose a risk specifically to human health. Soils should be tested for contaminants that are considered to pose a risk to human health in addition to those specified in the relevant British Standards to ensure that they are suitable for their intended use.

## Initial screening

A visual / olfactory inspection of the material should be carried out by a suitably qualified and competent person to ensure that:

- It is a suitable growing medium;
- It is free from obvious contamination i.e. staining/free product etc.;
- It has not come from areas where Japanese Knotweed or other invasive or injurious plants, as specified by the Environment Agency, are suspected to have been growing;
- It is not odorous (could be considered a statutory nuisance);
- It is free from unsuitable material i.e. bricks, brick ties, timber and glass etc.); and,
- There are no visible signs of asbestos containing material (ACMs).

## Testing schedule & number of samples

Chemical testing will normally be required on any materials that are to be used as cover material, even where this includes first generation quarried material. This should be carried out by a suitably qualified and competent person.

**Appendix 1a** explains in detail the sampling and testing requirements for a typical residential development. These are only guidelines and it may be necessary to deviate away from them depending on local and site-specific factors. It is recommended that the developer discusses any deviation with the Local Authority.

The following criteria sets out the requirements for sampling and testing:

- **Virgin Quarried Material** sampling needs to be 1 or 2 samples depending on the type of stone utilised, to confirm the inert nature of the material. Testing to include standard metals/metalloids (should include as a minimum As, Cd, Cr, CrVI, Cu, Hg, Ni, Pb, Se, Zn).

- **Crushed Hardcore, Stone, Brick (excluding asphalt)** a minimum of 1 sample per 500m$^3$. Testing to include standard metals/metalloids (as above), PAH (16 USEPA speciation), asbestos, total TPH. Any additional analysis dependant on the history of the donor site (e.g. phenol, total cyanide, BTEX, MTBE).

- **Greenfield/ Manufactured Soils** a minimum of 3 samples or, dependent on source and receptor, between 1 per 50m$^3$ and 1 per 250m$^3$. Testing to include standard metals/metalloids (as above), PAH (16 USEPA speciation), asbestos, pH and soil organic matter (SOM) (or calculated from total organic carbon (TOC)).

- **Brownfield/ Screened Soils** a minimum of 6 samples or dependent on source and receptor, between 1 per 50m$^3$ and 1 per 100m$^3$. Standard metals/ metalloids (as above), PAH (16 USEPA speciation), TPH (CWG banded), asbestos, pH and SOM (or calculated from TOC). Any additional analysis dependant on the history of the donor site (e.g. phenol, total cyanide, BTEX, MTBE).

The assessment criteria need to be UK based, e.g. LQM S4ULs, Defra C4SLs or other similarly derived GACs.

## KP3: Suitability of Material

Based on the characterisation of material above, the material should be either deemed suitable or unsuitable. Obviously unsuitable material should not be used (unless it is treated to reduce levels of contaminants below agreed target levels i.e. bioremediation – this would have to be agreed and included within the Remediation Strategy) and an alternative source of material should be sought by the developer. If the material is considered suitable it can be imported (if not site won) and stockpiled in a suitably quarantined area [refer to **KP4**].

## KP4: Stockpiling & Quarantining of Material

It is essential that the 'suitable' material is either placed in its intended area straight away i.e. soft/landscaped areas or stockpiled in a suitable quarantine area to prevent on-site contamination.

In the event that an assessor finds material has been stored in an unsuitable area, samples should be taken to confirm that no cross contamination has occurred (including a visual/olfactory check of the material). The material should then be suitably quarantined or placed at its intended location immediately.

## KP5: Verification of Required Depth

In line with the agreed Remediation Strategy, it is important to establish that the required depth has been achieved and is consistent across the site. There are two main ways to achieve this:

Depth testing in situ – small trial pit excavated to allow measurement of its depth by standardised tape measure or measuring staff.

Topographical surveys – accurate survey of the base and final formation layer height to establish the depth of cover.

### Specific Local Authority Policy

Please check with the local Contaminated Land Officer to establish:

- Which type of method for testing depth is accepted; and,
- The number of verification areas per property, plot, landscaped area or garden area (some Local Authorities recommend at least 2 per plot for residential developments).

**Important Note:** Where demarcation, physical no-dig and capillary break layers exist they should be verified for their thickness and presence during the time of their installation. Details of the demarcation layer should be agreed with the Contaminated Land Officer prior to placement. This will include the design, type and strength of the geotextile separator or visual warning membrane. The verification of depth and confirmation of such layers should be carried out by a suitably qualified and competent person.

## KP6: Reporting

The purpose of verification documentation is to provide transparent reasoning why the remediation was required, a methodology about how it was to be undertaken and proof that the specified works have been undertaken and to provide confirmation that the site is "suitable for its intended use".

The document is utilised not only to satisfy conditions of planning permissions but also is to be kept on record by the Local Authority should queries be raised during the lifetime of the development and to confirm to future purchasers that the site is suitable for use.

National Planning Policy Framework (NPPF) states that "planning policies and decisions should ensure that after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990". The Verification Report is a key document to demonstrate compliance with NPPF, and the responsibility rests with the developer/applicant to submit the required Verification Report to complete the remediation and to discharge any planning conditions.

It is also essential that other supporting documentation is included within a report carried out by a suitably qualified and competent person e.g. laboratory analysis results, delivery tickets for material, certificates for imported material (or if unavailable, documented evidence of the source of the Greenfield material), trial pit logs etc. A checklist has been included in **Appendix 2** to give an idea on what information should be recorded.

Additionally, any reporting should include details of any measures required to maintain the cover system integrity in the future e.g. successive construction phases (management plans) and longer term (restrictive covenants on title deeds).

## Photographic evidence for validating the depth of cover

The Local Authority ideally would recommend the following programme of photographs to be taken of the placement of inert cover:

- Photographs of any stockpiles and quarantine areas
- Proof that the depth of inert cover has been installed
- Proof of the quality of the material to be used as inert cover
- Proof there is a geotextile separator and visual warning membranes if used between the underlying material and suitable for use soils.
- Proof of the method of placement and different layers if appropriate
- Proof of the completed project
- Inclusion of background features which will aid locating the photograph
- Inclusion of site identification boards within the photos which show the date, position taken i.e. corner of plot 3 and the site name.
- Inclusion of photographs of site stockpiles and quarantine areas.

The presence of good quality photographs is essential to prove beyond doubt that the remediation has been done as specified both by method and position, and that the images have been taken from the specific area stated.

Refer to **Appendix 3** for examples of good photographic evidence.

# Appendix 1a – Sampling & Testing Matrix

| Type | Number of Samples | Testing Schedule | Assessment Criteria |
|---|---|---|---|
| | **Please note that these guidelines apply to a typical residential development, and relaxation of the guidelines or more stringent requirements may apply dependent on local and site specific factors. Therefore, <u>all parameters need to be agreed with the Local Authority</u>.** | | |
| Virgin Quarried Material | 1 or 2 depending on the type of stone utilised, to confirm the inert nature of the material. | Standard metals/metalloids (should include as a minimum As, Cd, Cr, CrVI, Cu, Hg, Ni, Pb, Se, Zn) | The assessment criteria need to be UK based, e.g. LQM S4ULs, Defra C4SLs or other similarly derived GACs. |
| Crushed Hardcore, Stone, Brick (excluding asphalt) | Minimum 1 per 500$m^3$ | Standard metals/metalloids (as above), PAH (16 USEPA speciation), asbestos, total TPH.<br><br>Any additional analysis dependant on the history of the donor site (e.g. phenol, total cyanide, BTEX, MTBE). | |
| Greenfield/ Manufactured Soils | Minimum 3<br><br>Dependent on source and receptor, between 1 per 50$m^3$ and 1 per 250$m^3$ | Standard metals/metalloids (as above), PAH (16 USEPA speciation), asbestos, pH and soil organic matter (SOM) (or calculated from total organic carbon (TOC)). | |
| Brownfield/ Screened Soils | Minimum 6<br><br>Dependent on source and receptor, between 1 per 50$m^3$ and 1 per 100$m^3$ | Standard metals/ metalloids (as above), PAH (16 USEPA speciation), TPH (CWG banded), asbestos, pH and SOM (or calculated from TOC).<br><br>Any additional analysis dependant on the history of the donor site (e.g. phenol, total cyanide, BTEX, MTBE). | |

# Appendix 1b – Questions to Ask Your Soil Supplier Relating to Soil Quality

- What is the source of the material (refer to KP1)? If the source is Greenfield, can they provide evidence of this?
- Will all of the material be coming from the same source?
- Are you satisfied that the material is a suitable growing medium for the proposed end use?
- Has the supplier used an appropriate sampling protocol to ensure a representative sample is analysed? What volume of soil is represented by the analysis and does it comply with Appendix 1a?
- Does the testing include analysis of contaminants identified in Appendix 1a?
- Does the laboratory conducting the analysis have UKAS and MCERTS accreditation for the tests they are carrying out?
- Does the material comply with relevant waste regulations?
- Can I have a copy of the whole analysts report and does it include an interpretive section?
- Will the provided certificate be dated within the last 2 months?

# Appendix 2 – Checklist for Verification Reports

**Example only. Not to be considered as typical minimum requirements. Additional information should be included for non-cover systems aspects of the remediation i.e. gas protection measures etc.**

| **Site Details** | |
|---|---|
| Site Name / location | |
| Developer name | |
| Development use | |
| Plot No / description of landscaped area (inc plan of inspection areas) | |
| National Grid Reference | |
| Inspection visit date | |
| **Supporting Evidence** | |
| Description of remediation (as per agreed Remediation Method Statement including depths / thickness checks, topographical readings) | |
| Material tracking information (including way tickets etc.) | |
| Name of groundwork's remediation contractor | |
| Name of supervising environmental consultant | |
| Site Specific chemical analysis results | |
| Verification Photographs (inc. remarks) | |
| **Recommendations** | |
| Pass/fail | |
| If material fails, how will this be managed i.e. removed, treated | |
| Detail any further remedial works and/or inspection | |
| Signed off | |

**Failure to provide any of the above information may prevent planning conditions from being discharged.**

# Appendix 3 – Examples of Good Quality Photographs

**© Coopers Consulting Engineers**

Photograph 1:
Depth check of inert cover within area of public open space. Physical break layer and topsoil visible.


**© WSP**

Photograph 2:
Depth check of inert cover with Site & Location Information Board.

**© Coopers Consulting Engineers**

Photograph 3:
Depth check of inert cover within areas of front gardens.

**© Coopers Consulting Engineers**

Photograph 4:
Depth check of inert cover within areas of front gardens.

**© Coopers Consulting Engineers**

Photograph 5:
Depth check of inert cover within rear gardens. Taut string line spans across excavation.

**© Coopers Consulting Engineers**

Photograph 6: Depth check of inert cover within rear gardens. Taut string line spans across excavation.

**© Coopers Consulting Engineers**

Photograph 7: Shows the spatial location of the verification pit.

**© Coopers Consulting Engineers**

Photograph 8: Excavation within public open space and verification pit showing the presence of a remediation break layer at the base, a crushed sandstone inert fill overlain by topsoil.

**© Coopers Consulting Engineers**

Photograph 9: Inert crushed sandstone being delivered. The spatial area of the remediation can be observed from these photographs (old terrace housing).

**© Coopers Consulting Engineers**

Photograph 10: Inert crushed sandstone being delivered with visible remediation break layer. The spatial area of the remediation can be observed from these photographs (traffic lights).

**© Coopers Consulting Engineers**

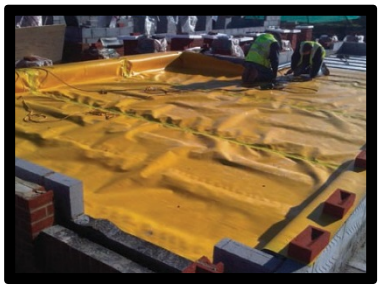
Photograph 11:
Shows the remediation of the rear garden, with a significant depth (1.0m) of inert cover. This photograph has been stitched to form a panoramic photograph and hence there is slight distortion

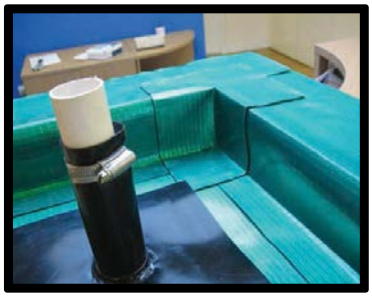
**© Coopers Consulting Engineers**

Photograph 12:
Shows the remediation of the rear garden, with a significant depth (1.0m) of inert cover. Remediation break layer visible at the base of the excavation.

**Appendix 2**

YALPAG: "Verification Requirements for Gas Protection Systems" December 2016





# VERIFICATION REQUIREMENTS FOR GAS PROTECTION SYSTEMS

## Technical Guidance for Developers, Landowners and Consultants

**Yorkshire and Lincolnshire Pollution Advisory Group**

**Version 1.1 – December 2016**

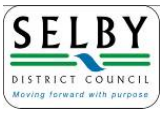
The purpose of this guidance is to promote consistency and good practice for development on land affected by contamination. The Local Planning Authorities in Yorkshire, Lincolnshire and the North East of England who have adopted this guidance are shown below:





































# Contents Page



**Disclaimer**

This guidance is intended to serve as an informative and helpful source of advice. It is intended to review this guidance annually, but readers must note that legislation, guidance and practical methods are inevitably subject to change and therefore should be aware of current UK policy and best practice. This note should be read in conjunction with prevailing legislation and guidance, as amended, whether mentioned here or not. Where legislation and documents are summarised this is for general advice and convenience, and must not be relied upon as a comprehensive or authoritative interpretation. Ultimately it is the responsibility of the person/company involved in the verification of land contamination to apply up-to-date working practices and requirements.

**Acknowledgments**

The authors and YALPAG would like to specifically acknowledge and thank CIRIA for the permission to use sections, including tables and photographs, of the CIRIA C735 document. Mallett, H, Cox (nee Taffel-Andureau), L, Wilson, S, Corban, M (2014) *Good practice on the testing and verification of protection systems for buildings against hazardous ground gases*, CIRIA, C735, London (ISBN: 978-0-86017-739-5). Go to: www.ciria.org

The author, Leeds City Council (Brad Hall, Julia Reynolds), would like to acknowledge the assistance provided by the following people and organisations: East Riding of Yorkshire Council, Doncaster Metropolitan Borough Council, Wakefield Council, Hugh Mallett of BuroHappold, Neil Salvage of PAGeotechnical and John Naylor of Ground-Gas Solutions.

**Consultation**

The YALPAG Local Planning Authorities were consulted over a four week period in 2015 during the production of this guidance. Consultation comments were considered by the review panel and a number of revisions were made to the guidance to reflect these comments.

# Introduction

This guidance has been produced to help developers ensure that they can demonstrate that gas protection systems are appropriate for the development and level of risk associated with a site and that they have been installed correctly and can be relied upon to provide the required level of protection and ultimately demonstrate that, in terms of gas risk, the development is suitable for use. It is intended to improve the quality of reports submitted to Local Planning Authorities on this matter and to give contractors/consultants a point of reference to obtain approval for such work from their client.

The verification of gas protection systems should be an integral part of remediation and agreed between developers and Local Planning Authorities at an early stage in the development.

Failure to comply with this guidance may result in delays to the development. Relevant planning conditions cannot be discharged until the Local Planning Authority is satisfied appropriate verification has been undertaken to confirm that the development is safe.

Available UK guidance regarding gas risk assessment includes:

- CIRIA C665 Assessing risks posed by hazardous ground gases to buildings;
- NHBC Report Edition No: 4 Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present;
- BS 8485:2015 Code of practice for the design of proactive measures for methane and carbon dioxide ground gases for new buildings.

In particular, readers of this document should refer to the detailed guidance on verification published by CIRIA (CIRIA C735 Good Practice on the testing and verification of protection systems for buildings against hazardous ground gases, 2014). This guidance note should be considered as supplementary advice to be used in conjunction with these documents.

This document does not cover risks associated with radon. Please contact individual Local Planning Authority for further information.

The following YALPAG technical guidance documents for developers, landowners and consultants are also available;

- Verification Requirements for Cover Systems.
- Development on Land Affected by Contamination.

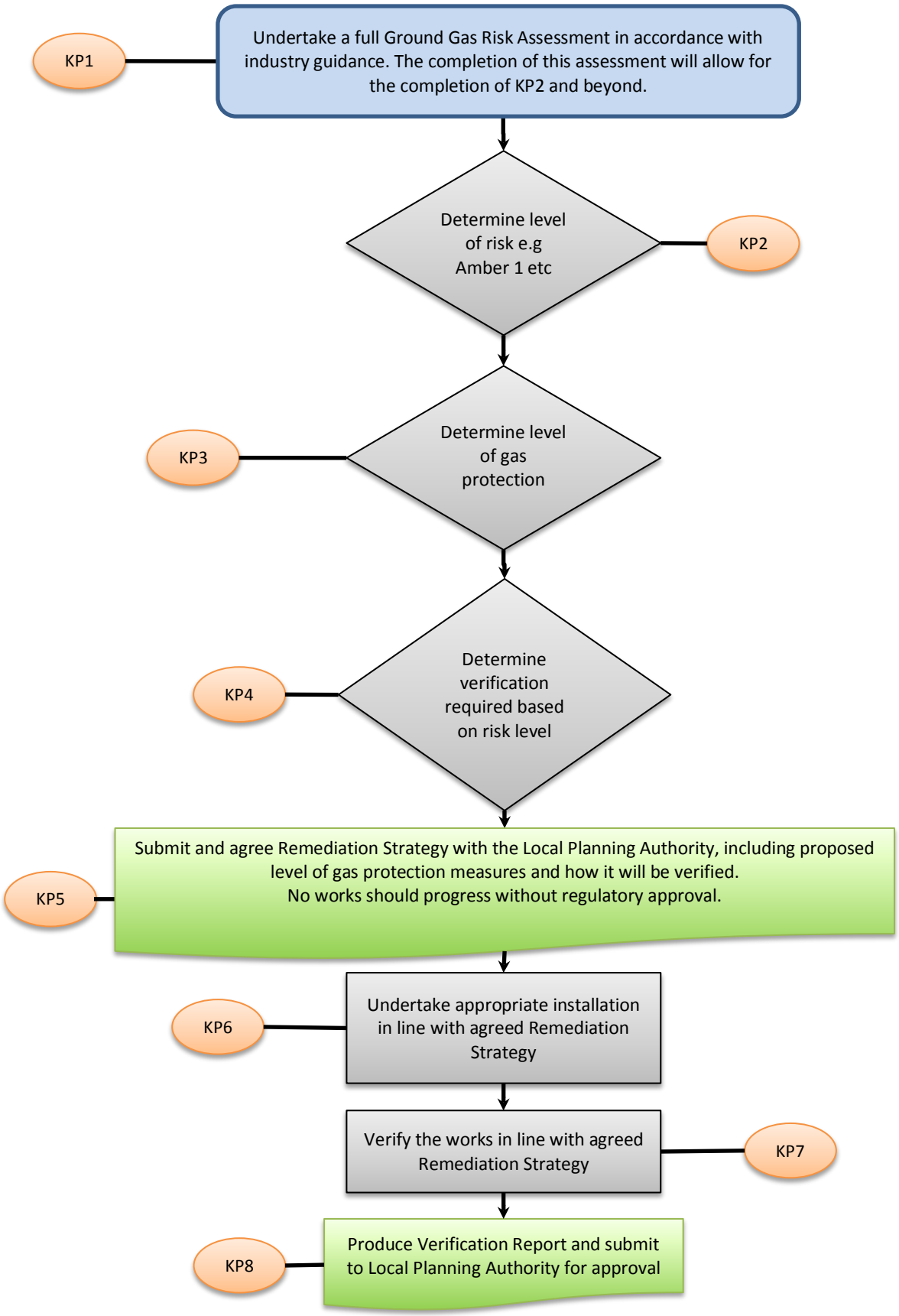
# The Process of Verification

Implementation and verification plans for gas protection systems should always be site specific and based on the gas risk assessment and conceptual site model (CSM) for the site in question.

For gas protection systems, acceptable verification will normally comprise the provision of clear evidence that the level of protection is appropriate to the established risk and has been installed by suitably experienced personnel in line with the manufacturer's instructions and appropriate guidance. Critical factors to be considered are:

- What should be installed?
- How should it be installed?
- Who should install it?
- How will correct installation be demonstrated?

# Overview Flowchart



# Key Points

| | |
|---|---|
| KP1<br><br>Ground Gas Risk Assessment | Undertake an appropriate gas risk assessment for the site in accordance with industry guidance*. On completion of the risk assessment and the generation of the appropriate Gas Screening Value (where required) and on a full understanding of the gas regime/ CSM, move to KP2 to determine the level of risk for the site.<br><br>**Where the desk study has identified the need for gas monitoring to be carried out it would always be **expected** that site specific gas monitoring data would be used in the gas risk assessment.* |
| KP2<br><br>Level of Risk | The level of gas risk needs to be determined by using the appropriate gas guidance document/s relative to the development (e.g. low rise housing, residential apartment blocks with areas of public open space, commercial or public buildings etc).<br><br>For example Amber 1 (Low rise housing) equates to Low Risk in Table A1 CIRIA 735.<br><br>Once the level of risk has been determined move to KP3 and determine the appropriate level of gas protection. |
| KP3<br><br>Level of Gas Protection | The level of gas protection should be based on the level of risk established by the gas risk assessment and CSM. It should provide the appropriate gas protection for the ***lifetime of the development***.<br><br>Detailed specification of gas protection measures in accordance with appropriate guidance to include (but not be limited to):<br>• Submission of appropriate drawings (site specific plans and details to clearly show where the measures will be installed and how they fit into the design of the building and foundations).<br>• Full written description of the protection measures to be included.<br>• Detailed justification of the protection measures being used along with reference to the guidance document(s) being used. |
| KP4<br><br>Level of Verification Required | The level of qualification and experience of the installer will determine the level of verification required. Verification should always be carried out by an appropriate independent person such as an experienced and suitably trained verification consultant or third party qualified **and** experienced installer (see KP6).<br><br>**See Appendix 1 for full details of verification requirements for installation of gas protection measures and the associated verification requirements.** |

| | |
|---|---|
| KP5<br><br>Submission and Agreement of Remediation Strategy | No installation of gas protection measures should be carried out at the site until the full details (KP1 to KP4) have been approved by the Local Planning Authority and formalised in an agreed Remediation Strategy (including Verification Plan).<br><br>The Remediation Strategy, incorporating the detailed Verification Plan, should include (but not be limited to):<br>• A summary of the ground gas risk assessment.<br>• The gas protection measures proposed.<br>• Who will undertake the installation including levels of experience and/ or qualifications.<br>• How the works will be verified/ tested and by who.<br>• How the works will be reported to the Local Planning Authority.<br><br>**See Appendix 2 for details of Remediation Strategy requirements.** |
| KP6<br><br>Installation of Gas Protection | Installation should only be done once the Remediation Strategy has been agreed with the Local Planning Authority and should be carried out in line with the agreed Remediation Strategy.<br><br>Any deviation away from the agreed Remediation Strategy should be agreed in writing with the Local Planning Authority prior to commencement of installation.<br><br>**See Appendix 4 for examples of good and poor gas protection installation.** |
| KP7<br><br>Verification of Gas Protection | The verification of the gas protection measures should be undertaken in accordance with the Verification Plan set out in the agreed Remediation Strategy.<br><br>Any deviation to works away from the agreed Remediation Strategy should be agreed in writing with the Local Planning Authority prior to installation.<br><br>**See Appendix 5 for an example Verification proforma.** |
| KP8<br><br>Submission of Verification Report | The Verification Report must be produced in line with the agreed Remediation Strategy and Verification Plan. All aspects of the Remediation Strategy must be addressed in the Verification Report along with full details and justification of any deviation.<br><br>**See Appendix 3 for details of the required contents of the Verification Report. Please note, the required contents should be agreed within the submitted and approved Remediation Strategy at KP 5.** |

# Appendix 1 – Requirement for Installation and Verification

Copied directly from Annex 1 CIRIA C735

Mallett, H, Cox (nee Taffel-Andureau), L, Wilson, S, Corban, M (2014) Good practice on the testing and verification of protection systems for buildings against hazardous ground gases, CIRIA, C735, London (ISBN: 978-0-86017-739-5). Go to: www.ciria.org

The tables in this appendix should be used for guidance only and are not intended to be used in lieu of sound professional judgment, which should take into account the risk factors affecting the development (the gas regime, the number of buildings, the complexity of design, and the expertise of the installation workforce) on a site-specific basis. The tables should not be used independent of, and without reference to, the accompanying text in the main guide C735.

***Situation A – all development types except situation B – non reinforced slabs (from Wilson et al, 2007)***

| Gas regime/risk | Slab type | Installer experience | Suggested levels of verification and integrity testing |
|---|---|---|---|
| ***Low risk***<br>CS2 (*with venting)<br>Basic radon protection area | Non reinforced<br>All slabs | General builder/ groundworker/ landfill operative (no relevant qualification[1]) | Verifier (consultant[4] or qualified and experienced installer[1]) to conduct a thorough verification (visual) inspection prior to all concrete pours. Contractor to supply sign off sheets (verification evidence) including photographs to independent verifier. |
| | | Qualified[1] and experienced installer (minimum one operative to hold qualification) | Verifier (consultant[4] or third party qualified and experienced installer) to conduct a thorough verification (visual) inspection prior to 25 to 50 per cent of concrete pours (min one visit). Installer to supply sign off sheets (verification evidence) including photographs to independent verifier for all other pours. |
| ***Intermediate risk***<br>CS2 (no venting) or<br>CS3 (*with venting)<br>Full radon protection area | | General builder/ groundworker/ landfill operative (no relevant qualification[1]) | Verifier (consultant[4] or qualified and experienced installer[1]) to conduct a thorough verification (visual) inspection prior to all concrete pours. All joints, pipe penetrations etc independently air lanced to ASTM D4437. Contractor to supply sign off sheets (verification evidence) including photographs to verifier. Consideration given to need for/scope of integrity testing (eg initially on say 25 to 50 per cent of pours then falling to 10 to 25 per cent if acceptable results obtained and no concerns raised by visual inspections). |
| **Gas regime/risk** | **Slab type** | **Installer experience** | **Suggested levels of verification and integrity testing** |
| ***Intermediate risk***<br>CS2 (no venting) or<br>CS3 (*with venting)<br>Full radon protection area | Non reinforced<br>All slabs | Qualified[1] and experienced installer (minimum one operative to hold qualification) | Verifier (consultant[4] or third party qualified and experienced installer[1]) to conduct a thorough verification (visual) inspection prior to 25 to 50 per cent of concrete pours (min two visits). 25 per cent all joints, pipe penetrations etc independently air lanced to ASTM D 4437. Remaining 75 per cent joints, pipe penetrations etc tested to recognised standard by installer (as detailed in method statement/CQA plan). Installer to supply sign off sheets (verification evidence) to verifier for all other pours. Consideration given to need for/scope of integrity testing (eg initially on 10 to 25 per cent of pours then falling to 0 to 10 per cent if acceptable results obtained and no concerns raised by visual inspections). |
| ***High risk***<br>VOCs etc<br>CS3 (no venting) or<br>CS4 and above (*with venting) | | Qualified[1] and experienced installer (50 per cent of operatives to hold qualification) | Verifier (consultant[4] or third party qualified and experienced installer[1]) to conduct a thorough verification (visual) inspection prior to all concrete pours. All joints, pipe penetrations independently air lanced to ASTM D 4437. Installer to supply sign off sheets (verification evidence) to verifier for all pours. Consideration given to need for scope of integrity testing (eg initially on 25 to 50 per cent of pours then falling to 10 to 25 per cent if acceptable results obtained and no concerns raised by visual inspections). |

**Notes**

* Assumes venting designed to keep steady state concentration of CH4 below one per cent in void, sites designed with higher levels of gas in the void should adjust the frequency of inspection and testing as appropriate

1 Relevant qualification is NVQ Level 2 in gas protection installation (see Section 3.3).

2 Before works start the contractor should produce a detailed installation plan including method statement, CQA procedures and qualifications, on receipt of these the verification protocol could be increased or reduced.

3 Consideration should be given to carrying out leak detection (ie smoke, tracer gas or dielectric testing) on the first plots on higher end sites CS3 and above. If an unacceptable amount of holes are found during these tests then the verification consultant should discuss with the relevant personnel, strategies to prevent this occurring, these could include changing material, improving subgrade preparation, putting up warning signs to reduce the amount of trafficking etc.

4 Verification consultant should be competent, experienced and suitably trained (see Section 3.2). A statement detailing their qualifications and relevant experience should be included in the verification plan.

5 Air lancing is the only integrity test that has an independently recognised international standard that is suitable for testing taped and welded seams.

***Situation A – all development types except situation B – reinforced slabs (from Wilson et al, 2007)***

| Gas regime/risk | Slab type | Installer experience | Suggested levels of verification and integrity testing |
|---|---|---|---|
| ***Low risk*** CS2 (*with venting) Basic radon protection area | Reinforced All slabs | General builder/ groundworker/ landfill operative (no relevant qualification[1]) | Verifier (consultant[4] or qualified and experienced installer[1]) to conduct a thorough verification (visual) inspection prior to all concrete pours. Contractor to supply sign off sheets (verification evidence) including sub grade acceptance forms and photographs to independent verifier. |
| | | Qualified[1] and experienced installer (minimum one operative to hold qualification) | Verifier (consultant[4] or third party qualified and experienced installer[1]) to conduct a thorough verification (visual) inspection prior to 25 per cent concrete pours (min two visits), including vented void, subgrade etc. Installer to supply sign off sheets (verification evidence) including, sub grade acceptance forms, photographs to independent verifier for all other pours. |
| ***Intermediate risk*** CS2 (no venting) or CS3 (*with venting) Full radon protection area | | General builder/ groundworker/ landfill operative (no relevant qualification[1]) | Verifier (consultant[4] or qualified and experienced installer[1]) to conduct a thorough verification (visual) inspection prior to all concrete pours including vented void, subgrade etc. All joints, pipe penetrations etc independently air lanced to ASTM D4437. Consideration given to the need for and scope of integrity testing (eg initially on say 50 to 25 per cent of pours then falling to 25 to 10 per cent if acceptable results obtained and no concerns raised by visual inspections. |
| | | Qualified[1] and experienced installer (minimum one operative to hold qualification) | Verifier (consultant[4] or third party qualified and experienced installer[1]) to conduct a thorough verification (visual) inspection prior to 50 per cent of concrete pours, including vented void, subgrade etc 25 per cent of joints, pipe penetrations etc independently air lanced to ASTM D4437. Remaining joints, pipe penetrations, corners etc tested to a recognised standard by installer (as detailed in method statement and CQA plan). Installer to supply sign off sheets (verification evidence) including, sub grade acceptance forms, photographs etc to independent verifier for all other pours. Consideration given to need for/scope of integrity testing (eg initially on 10 to 25 per cent of pours then falling to 0 to 10 per cent if acceptable results and no concerns raised by visual inspections). |
| ***High risk*** VOC and hydrocarbons CS3 (no venting) or CS4 and above (*with venting) | | Qualified[1] and experienced installer (50 per cent of operatives to hold qualification) | Verifier (consultant[4] or third party qualified and experienced installer[1]) to conduct a thorough verification (visual) inspection prior to all concrete pours including vented void, subgrade etc. All joints, pipe penetrations etc independently air lanced to ASTM D4437. 100 per cent leak detection considered on VOC/ hydrocarbon contaminated sites.. Consideration given to need for/scope of integrity testing (eg initially on 50 to 25 per cent of pours then falling to 25 to 10 per cent if acceptable results obtained and no concerns raised by visual inspections). |

**Notes**

* Assumes venting designed to keep steady state concentration of CH4 below one per cent in void, sites designed with higher levels of gas in the void should adjust the frequency of inspection and testing as appropriate.

1 Relevant qualification is NVQ Level 2 in gas protection installation (see Section 3.3).

2 Before works start the contractor should produce a detailed installation plan including method statement, CQA procedures and qualifications, on receipt of these the verification protocol could be increased or reduced.

3 Consideration should be given to carrying out leak detection (ie smoke, tracer gas or dielectric testing) on the first plots on higher end sites CS3 and above. If an unacceptable amount of holes are found during these tests then the verifier should discuss with the relevant personnel, strategies to prevent this occurring, these could include changing material, improving subgrade preparation, putting up warning signs to reduce the amount of trafficking etc.

4 Verification consultant should be competent, experienced and suitably trained (see Section 3.2). A statement detailing their qualifications and relevant experience should be included in the verification plan.

5 Air lancing is the only integrity test that has an independently recognised international standard that is suitable for testing taped and welded seams.

6 Where a sufficiently robust protection layer (protection fleece, protection boards or insulation) are laid directly on the membrane, inspection after placement of the reinforcement should not be necessary.

***Situation B – low rise housing with ventilated void (from NHBC and Wilson et al, 2007)***

| Gas regime/risk | Slab type | Installer experience | Suggested levels of verification and integrity testing |
|---|---|---|---|
| ***Low risk***<br>Amber 1 | All slabs with min 150 mm ventilated sub floor void | General builder/ groundworker/ landfill operative (no relevant qualification[1]) | Verifier (consultant[4] or qualified and experienced installer[1]) to conduct thorough verification (visual) inspection of first plot and after placement of reinforcement if no protection provided. Subsequent inspections carried out at approx. frequency of 1 in 10 plots (minimum 5). Contractor to supply sign off sheets (verification evidence) including photographs for all other plots. Consideration given to need for/scope of integrity testing if concerns identified by visual inspections[3]. |
| | | Qualified[1] and experienced installer (minimum one operative to hold qualification) | Verifier (consultant[4] or third party qualified and experienced installer[1]) to conduct thorough verification (visual) inspection of first plot and after placement of reinforcement if no protection provided. Subsequent inspections carried out at approx. frequency of 1 in 20 plots. Contractor to supply sign off sheets (verification evidence) including photographs for all other plots. Consideration given to need for/scope of integrity testing if concerns identified by visual inspections[3]. |
| ***Intermediate risk***<br>Amber 2 | | General builder/ groundworker/ landfill operative (no relevant qualification[1]) | Verifier (consultant[4] or qualified and experienced installer[1]) to conduct thorough verification (visual) inspection of first 10 plots and after placement of reinforcement if no protection provided. All joints, pipe penetrations etc air lanced to ASTM D4437. Subsequent inspections (including air lancing) carried out at approx. frequency of 1 in 20 plots Contractor to supply sign off sheets (verification evidence) including photographs for all other plots. Consideration given to need for/scope of integrity testing (eg initially on 30 to 50 per cent of plots then falling to 0 to 10 per cent of plots if acceptable results obtained and no concerns raised by visual inspections). |
| | | Qualified[1] and experienced installer (minimum one operative to hold qualification) | Verifier (consultant[4] or third party qualified and experienced installer[1]) to conduct thorough verification (visual) inspection of the first 5 plots and after placement of reinforcement if no protection provided. All joints, pipe penetrations etc air lanced to ASTM D4437. Subsequent inspections (including air lancing) carried out at a frequency of about 1 in 20 plots. Contractor to supply sign off sheets (verification evidence) including photographs for all other plots. Consideration given to need for/ scope of integrity testing (eg initially on 10 to 25 per cent of plots then falling to 0 5 per cent of plots if acceptable results obtained and no concerns raised by visual inspections)[3]. |
| ***High risk***<br>Red<br>VOC and hydrocarbons | | Qualified[1] and experienced installer (all operatives to hold qualification) | Verifier (consultant[4] or third party qualified and experienced installer[1]) to conduct thorough verification (visual) inspection of all plots, and after placement of reinforcement if no protection provided. All joints, pipe penetrations etc air lanced to ASTM D4437. Consideration given to need for/scope of integrity testing (eg initially on 30 to 50 per cent of plots then falling to 0 to 10 per cent of plots if acceptable results obtained and no concerns raised by visual inspections)[3]. |

**Notes**

* Gas regime defined by characteristic situation as set out by Wilson *et al* (2007), and all other recent good practice guidance and British Standards.

** Assumes venting designed to keep steady state concentration of CH4 below one per cent in void, sites designed with higher levels of gas in the void should adjust the frequency of inspection and testing as appropriate.

1 Relevant qualification is NVQ Level 2 in gas protection installation (see Section 3.3).

2 Before the works start the contractor should produce a detailed installation plan including method statement, CQA procedures and qualifications, on receipt of these the verification protocol could be increased or reduced.

3 Consideration should be given to carrying out integrity testing/leak detection (ie smoke, tracer gas or dielectric testing) on the above basis and/or if an unacceptable amount of damage/loss of integrity is found during visual inspections. In this instance the consultant should discuss with the relevant personnel, strategies to prevent this recurring. This could include changing material, improving subgrade preparation, putting up warning signs to reduce the amount of trafficking etc.

4 Verification consultant should be competent, experienced and suitably trained (see Section 3.2). A statement detailing their qualifications and relevant experience should be included in the verification plan.

5 Air lancing is the only integrity test that has an independently recognised international standard suitable for testing taped and welded seams and should be used at the frequency suggested in the table.

# Appendix 2 – Remediation Strategy and Verification Plan for Gas Protection Systems

The Remediation Strategy should include a detailed verification method statement. This should address how the gas protection measures will be installed and what verification information will be provided to demonstrate the installation has been carried out in accordance with the appropriate guidance.

As a minimum the report should include (but not be limited to):

- A summary of the gas risk assessment.
- The gas protection measures proposed (including reference to the appropriate guidance documents) and confirmation they will meet the gas protection requirements for the lifetime of the development.
- Technical drawings showing how the gas protection measures will be incorporated.
- Formal qualifications/experience/training of the person carrying out the installation.
- Formal qualifications/experience/training of the person carrying out the verification.
- Clear demonstration of the independence of the person carrying out the verification.
- The manufacturer's specification of the gas protection membrane to be used.
- Full details of what the verification process will comprise and at what stage verification will be carried out.
- Details of how any non-conformance will be dealt with.
- Details of the number of plots to be validated. (Deviation from verification of every plot will need to be justified and agreed with the Local Planning Authority in line with Appendix 1 of this document).
- Timeline of when during the build, each of the gas protection measures will be installed.
- Details of management measures proposed to ensure how damage to the membrane will be prevented prior to the floor being installed, post installation.
- Details of how **all** site personnel (including follow on trades) will be made aware of the presence of the membrane and that damage to the membrane must be prevented.
- Details of the extent of overlap and method of sealing (these must be in line with manufacturer's instructions and evidence provided).
- Confirmation that a signed (plot specific unless agreed otherwise) statement confirming that the gas protection measures were installed as agreed and that the membrane was free from tears and punctures and was lapped and sealed as agreed at joins and around services and sub floor voids were clear and free from debris will be included in the Verification Report.
- Confirmation that plot specific photographs showing the installed membrane will be included in the Verification Report.

# Appendix 3 – Checklist for Gas Verification Reports

The Verification Report should include a summary of all the works undertaken, relating to gas protection measures including all elements detailed within the Remediation Strategy.

As a minimum the report should include (but not be limited to):

- Site details.
- Planning Application details.
- Summary of Gas Risk Assessment (including original CSM).
- Details of who carried out installation (qualifications/experience/training).
- Details of who carried out verification (qualifications/experience/training).
- Description of protection measures installed with reference to method statements and drawings and manufacturers specification of the materials used.
- Details of the verification inspection regime.
- Supporting information, plans, air vent installation, photographs, as built drawings.
- Summary of verification data (completed proformas, test results)
- Details of non-conformances and how they were rectified.
- Clear statement saying remedial objectives been achieved supported by lines of evidence including reference to CSM.
- Where necessary further works and/ or long term management.

# Appendix 4 – Examples of Good and Poor Installation

Copied directly from Appendix A4 CIRIA C735

Mallett, H, Cox (nee Taffel-Andureau), L, Wilson, S, Corban, M (2014) Good practice on the testing and verification of protection systems for buildings against hazardous ground gases, CIRIA, C735, London (ISBN: 978-0-86017-739-5). Go to: www.ciria.org

## GOOD PRACTICE PHOTOGRAPHS

*Figure A4.7* *Geovent protruding out of the frontage of the unit. Gas membrane along the sides of the slab preventing lateral gas ingress (courtesy Alderburgh Group)*

*Figure A4.8* *Geovent beneath the 2000g taped gas membrane lined up with collector pipes (courtesy Alderburgh Group)*

*Figure A4.9* *On site schematics to aid construction workers build the gas protection system (courtesy Alderburgh Group)*

*Figure A4.10* *Almost complete coverage available for inspection, minimal jointing, service entries suitable distance from walls, light traffic (courtesy Smith Grant)*

*Figure A4.11* *Gas membrane continued through cavity wall and above air bricks (courtesy Hydrock)*

*Figure A4.12* *Good edge detail across cavity (courtesy PAGeotechnical Ltd)*

*Figure A4.13 Gas proof DPC adhered on top of gas membrane using butyl strips across cavity space (courtesy NHBC)*

*Figure A4.14 Good perimeter seal (courtesy PAGeotechnical Ltd)*

*Figure A4.15 LDPE type gas membrane overlap and double sided tape. Sand blinding to protect underside of gas membrane (courtesy A Proctor Group)*

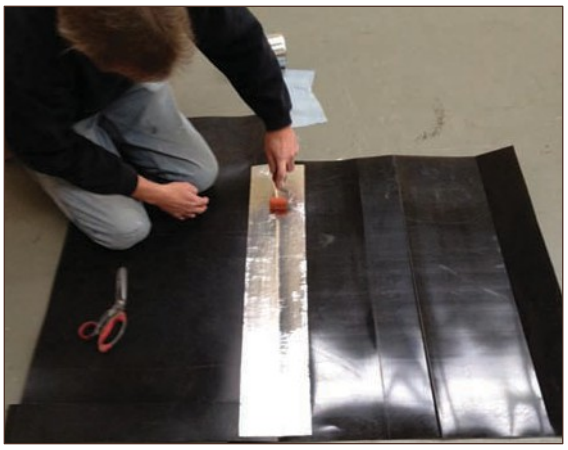


*Figure A4.16 Example HDPE type gas membrane and steam roller used to ensure self-adhesive tape is correctly installed (courtesy A Proctor Group)*

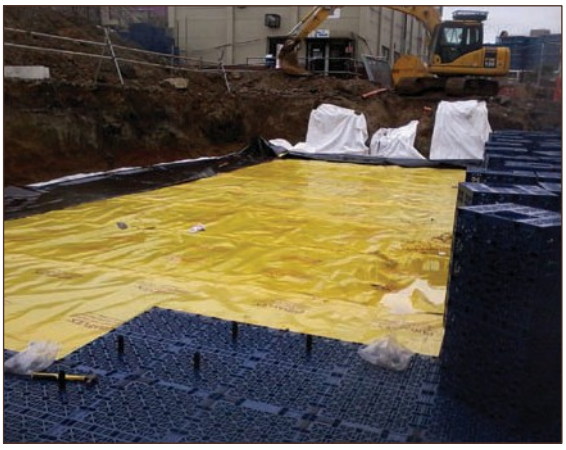


*Figure A4.17 Gas membrane installed in attenuation tank (courtesy Industrial Textiles & Plastics Ltd)*

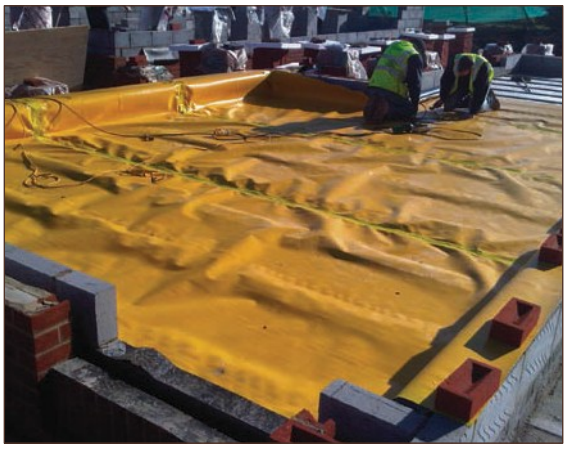


*Figure A4.18 Gas membrane installed as part of foundation barrier (courtesy Industrial Textiles & Plastics Ltd)*

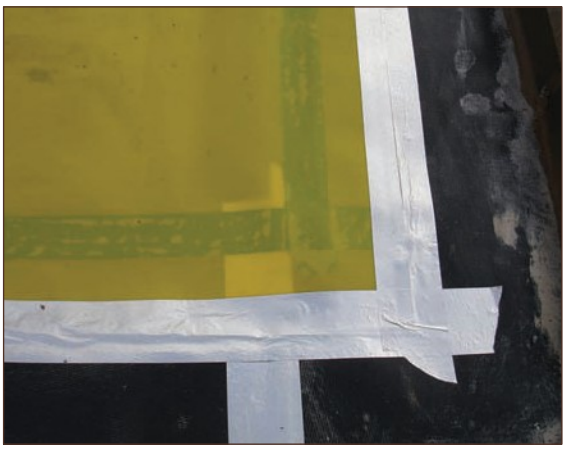


*Figure A4.19* *Well-constructed joints with gas resistant DPC, lap and double sided butyl joints visible beneath semi-transparent gas membrane, secondary seal with proprietary single sided tape (courtesy Smith Grant)*

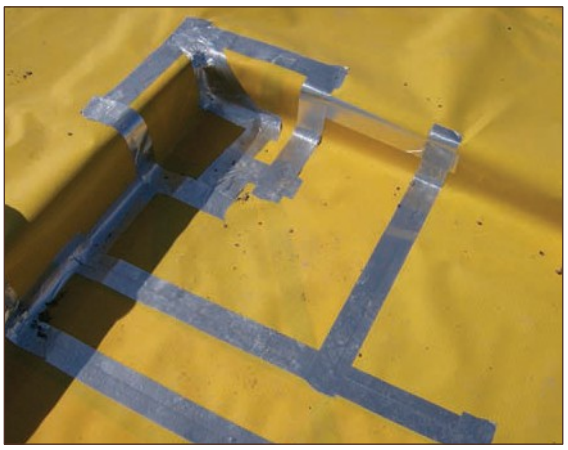


*Figure A4.20* *A pre-formed corner unit would have been preferable as fewer joints would have been formed, however the installer has achieved a good level of workmanship in this corner detail (courtesy Smith Grant)*

*Figure A4.21* *Good prefabricated corner detail (courtesy MEC Environmental Ltd)*

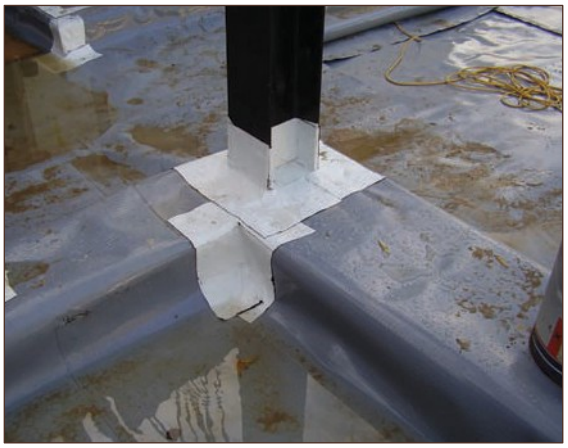


*Figure A4.22* *Good detail around stanchion and corner (courtesy PAGeotechnical Ltd)*

*Figure A4.23* *Complex column seal (courtesy PAGeotechnical Ltd)*

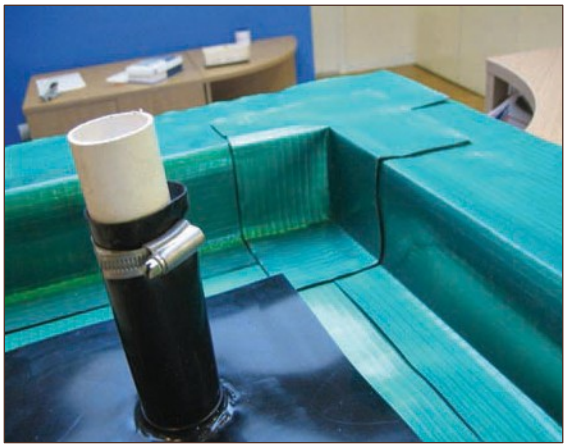


*Figure A4.24* *Prefabricated corner detail and top hat (courtesy A Proctor Group)*

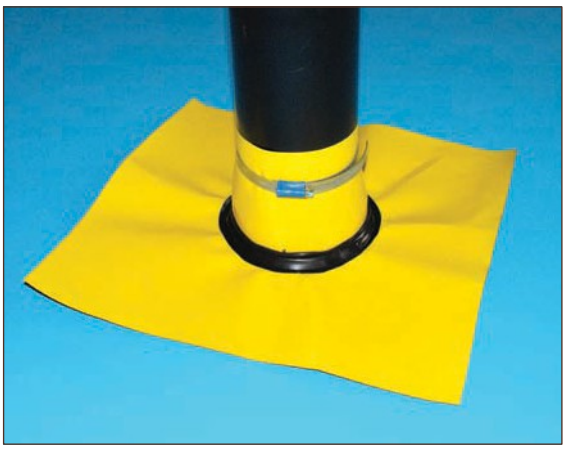


*Figure A4.25* *Top hat around service entry (courtesy Industrial Textiles & Plastics Ltd)*

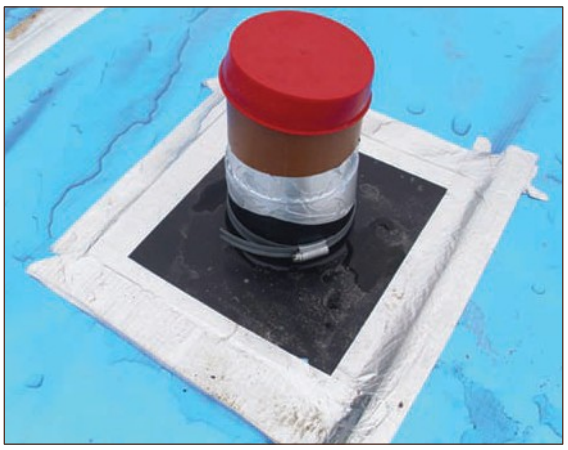


*Figure A4.26* *Well-constructed service entry: top hat fits well with service pipe and taped down to gas membrane, secondary seal with proprietary single sided tape (courtesy Smith Grant)*

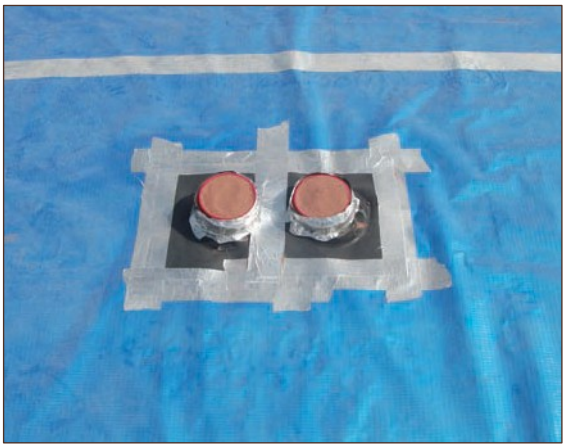


*Figure A4.27* *Top hats placed around service entries secured with jubilee clip seals. Top hats secured to gas membrane with double sided butyl tape (courtesy Hydrock)*

*Figure A4.28* *Bead of double sided butyl tape provided between interfaces of ID top hat and OD service pipe. When compressed with jubilee clip, forms an effective seal (courtesy Smith Grant)*


*Figure A4.29* *Extrusion welding technique (courtesy Industrial Textiles & Plastics Ltd)*

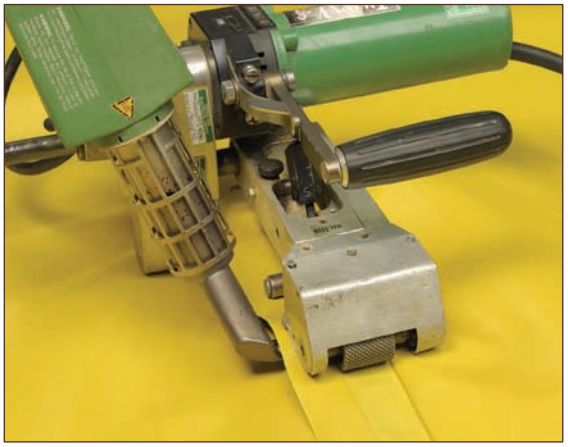


*Figure A4.30* *Thermal welding technique (courtesy Industrial Textiles & Plastics Ltd)*

*Figure A4.31 Extrusion welding (courtesy PAGeotechnical Ltd)*

*Figure A4.32 High quality installation of liquid gas membrane to lift pits, including resin gas protection on all screw penetrations (courtesy Card Geotechnics Limited)*

## A4.2.2 Good practice – passive venting systems

*Figure A4.33 Good ventilation in internal sleeper walls, cast into prefabricated beams (courtesy Smith Grant)*

*Figure A4.34 Open void >300mm deep, good ventilation through internal sleeper walls (courtesy Smith Grant)*

*Figure A4.35 Good installation of passive gas venting trenches and 'egg-crate' (courtesy Card Geotechnics Limited)*

*Figure A4.36 Raised air bricks are preferable due to the reduced potential for blockade but the vent trench specified is provided with clean single sized stone (courtesy Smith Grant)*

## A4.2.3 Good practice – integrity testing

*Figure A4.37 Tracer gas testing, whereby gas or smoke is applied under pressure beneath the installed gas membrane and detectors are used to screen for leaks above (courtesy NHBC)*

*Figure A4.38 Tracer gas testing (courtesy PAGeotechnical Ltd)*

*Figure A4.39 Scanning for leaks (courtesy PAGeotechnical Ltd)*

*Figure A4.40 $CO_2$ injection integrity testing (courtesy Landline Ltd)*

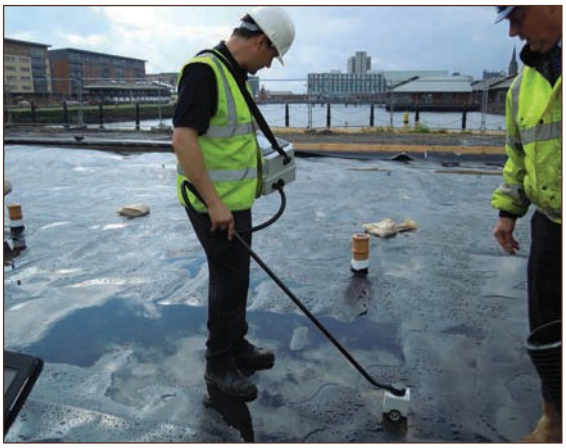


*Figure A4.41 Small sand bags are marking holes made in the gas membrane used to check whether injected CO2 has worked its way beneath whole area (courtesy Landline Ltd)*

*Figure A4.42 Air pressure testing (courtesy GSE Environmental)*

*Figure A4.43 Dielectric porosity testing for housing scheme (courtesy NHBC)*

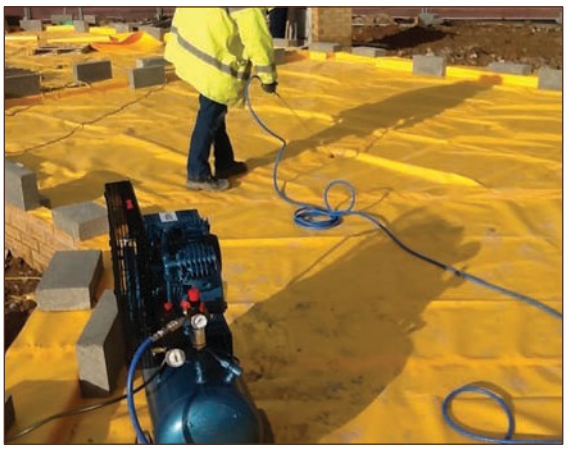


*Figure A4.44 Air lance test, used to test the quality of welded seams along gas membrane joints (courtesy MEC Environmental Ltd)*


*Figure A4.45 Spark testing (courtesy GSE Environmental)*

*Figure A4.46 Testing a weld with 'dog bone' grips (courtesy MEC Environmental Ltd)*

# BAD PRACTICE PHOTOGRAPHS

*Figure A4.47 Follow-on works purposefully penetrating gas membrane (courtesy Card Geotechnics Limited)*

*Figure A4.48 Loose nails and over construction debris likely to be left in place beneath gas membrane – poor preparation of gas membrane prior to sealing service penetration (courtesy Card Geotechnics Limited)*

*Figure A4.49 Lifted gas membrane at corner position. Light penetrating through confirms damage to aluminium internal core layer (courtesy NHBC)*

*Figure A4.50 Large/heavy/sharp objects being moved over unprotected gas membrane (courtesy Card Geotechnics Limited)*

*Figure A4.51 Gas membrane torn by reinforcement (courtesy MEC Environmental Ltd)*

*Figure A4.52 Gas membrane cut by scaffolders and bricklayers after installation (courtesy MEC Environmental Ltd)*

*Figure A4.53 Gas membrane left exposed for long period of time, shows significant fraying at cavity edge (courtesy NHBC)*

*Figure A4.54 Gas membrane damage/tearing at edge of ground floor slab screed layer where it was left exposed to elements for period of time (courtesy NHBC)*

*Figure A4.55 Gas membrane at stepped junction of slab to integral garage, appears to be susceptible to tearing when screed is poured. Screed may also weigh down on gas membrane if fitted too tight (courtesy NHBC)*

*Figure A4.56 Gas membrane at edge of concrete screed. Screed has been grinded to achieve desired levels, gas membrane shows extreme wear and damage as a result (courtesy NHBC)*

*Figure A4.57 Unprotected gas membrane damaged by heavy traffic (courtesy MEC Environmental Ltd)*

*Figure A4.58 Damage caused to gas membrane by follow-on trade who cut/shaped the dry lining board directly on the unprotected installed gas membrane (courtesy NHBC)*

*Figure A4.59 Gas membrane slit at the bottom of a cavity tray to enable water to drain away (courtesy Smith Grant)*

*Figure A4.60 Some stones could penetrate gas membrane if sufficient force is applied (courtesy Smith Grant)*

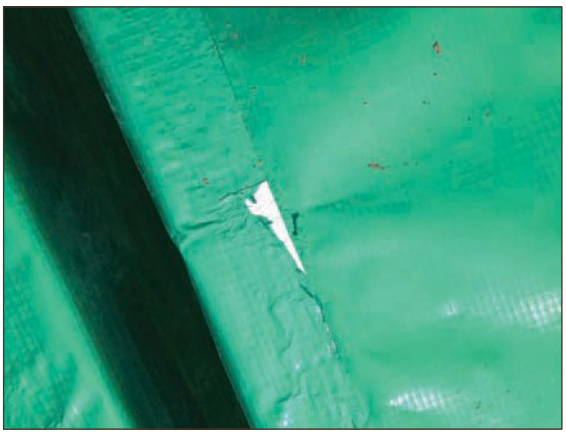


*Figure A4.61* *'Stripping' occurs on gas membranes that contain aluminium foil. The foil gets too hot under the outer layer of LDPE or PP and the top layer of the gas membrane sticks to the roller which strips it off, leaving the aluminium completely exposed (courtesy MEC Environmental Ltd)*

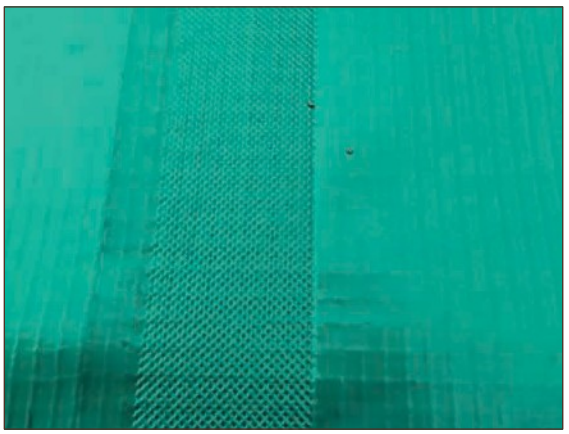


*Figure A4.62* *Wedge weld on an LDPE aluminium gas membrane, where the installer used metal nip rollers. This destroyed the top layer and probably the bottom layer, leaving aluminium exposed between the weaves. This failed dielectric testing along all joints (courtesy MEC Environmental Ltd)*

## A4.3.2 Bad practice – gas membranes installed incorrectly

*Figure A4.63* *Absence of surface preparation prior to laying of gas membrane, debris likely to pierce gas membrane (courtesy Card Geotechnics Limited)*

*Figure A4.64* *Insufficient length of gas membrane protruding through wall to overlap with gas membrane within building (courtesy Card Geotechnics Limited)*


*Figure A4.65* *Wrinkling of gas membrane over joint has resulted in gaps (only visible due to the use of a transparent gas membrane) and the secondary seal uses ordinary gaffer tape rather than a proprietary product (courtesy Smith Grant)*

*Figure A4.66* *Follow-on trades proceeded work before gas membrane joints sealed (courtesy Card Geotechnics Limited)*

*Figure A4.67* *Traffic over mesh resulted in several punctures, in addition most joints were found to be poorly constructed. Taped joints are difficult to construct in adverse weather (courtesy Smith Grant)*

*Figure A4.68* *A pre-formed corner unit would have been preferable. The installer could not produce sufficient quality despite the amount of tape applied (courtesy Smith Grant)*

*Figure A4.69* *Attempt at corner detailing using non-proprietary duct tape (courtesy Smith Grant)*

*Figure A4.70* *Inadequate corner detailing. The use of preformed proprietary products would have avoided such bad practice (courtesy NHBC)*

*Figure A4.71* *No corner detailing leading to stress point on gas membrane (courtesy Smith Grant)*

*Figure A4.72* *Joint between top hat and gas membrane has lifted due to poor fit and attempt to construct in very wet conditions (courtesy Smith Grant)*

*Figure A4.73* *No bead of double sided butyl tape provided between interfaces of ID top had and OD service pipe: cannot be compressed enough to form seal (courtesy Smith Grant)*

*Figure A4.74* *Gap between OD of service pipe and ID of top hat to large: cannot be compressed enough to form seal, even with the application of additional tape (courtesy Smith Grant)*

*Figure A4.75* *Jubilee clip on service entry insufficiently tightened so joint is uncompressed (courtesy Smith Grant)*

*Figure A4.76* *No double sided tape used in joints (courtesy Smith Grant)*

*Figure A4.77* *Small lap and no single sided tape used to achieve secondary seal (courtesy Smith Grant)*

*Figure A4.78* *Gap in jointing over wall cavity big enough to insert fist (courtesy Smith Grant)*

*Figure A4.79 Gas membrane not continuous over internal wall. It had been deliberately cut open for unknown purpose (courtesy Smith Grant)*

*Figure A4.80 Column left unsealed (courtesy PAGeotechnical Ltd)*

*Figure A4.81 No seal to perimeter pipe (courtesy PAGeotechnical Ltd)*

*Figure A4.82 Gas membrane used to bridge cavity wall instead of DPC, leaving it exposed to damage by follow-on trades (courtesy Smith Grant)*

*Figure A4.83 Poor quality installation of liquid gas membrane. Liquid gas membranes come in two colours (black and white) allowing coverage of each coat to be easily assessed. Here the gas membrane has been spread too thinly and inconsistently. In addition, it appears to have been applied to a damp surface, causing blistering (courtesy Card Geotechnics Limited)*

*Figure A4.84 Taped joints are difficult to construct in adverse weather. Also difficult to inspect if covered with snow (courtesy Smith Grant)*

## A4.3.3 Bad practice – passive venting systems

*Figure A4.85* *Clean single sized stones with no fines acting as venting media, however no ventilation gaps in internal sleeper walls (courtesy Smith Grant)*

*Figure A4.86* *Cavity is becoming blocked with detritus. The vent holes in the beam are no longer visible (courtesy Smith Grant)*

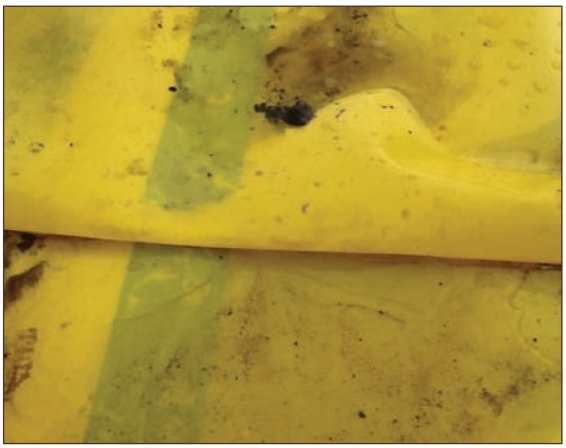


*Figure A4.87* *Tape joint with crease running through and air bubbles where gas membrane not in complete contact with tape. Rollers should have been used to produce a consistent seal (courtesy MEC Environmental Ltd)*

*Figure A4.88* *Ventilator becoming detached to fit to external block work. This is due to builders requiring increased cavity widths to achieve thermal properties expected by Building Regulations (courtesy NHBC)*

*Figure A4.89* *No ventilation in internal sleeper wall (courtesy Smith Grant)*

# Appendix 5 –Verification Proforma

Copied Directly From Appendix A5 CIRIA C735

Mallett, H, Cox (nee Taffel-Andureau), L, Wilson, S, Corban, M (2014) Good practice on the testing and verification of protection systems for buildings against hazardous ground gases, CIRIA, C735, London (ISBN: 978-0-86017-739-5). Go to: www.ciria.org

## VISUAL INSPECTION OF GAS PROTECTION MEASURES

| | |
|---|---|
| Site name: | Gas characteristic situation: |
| Job number: | Type of development and building/block checked: (residential/ commercial/other) |
| Date: | Building description: |
| Visit by: | Foundation type: (suspended floor/raft/other) |
| Weather at time of inspection: | Gas protection type: passive/active |

| No. | Item | Comments (see notes) |
|---|---|---|
| ***1 Gas membrane*** | | |
| 1.1 | Condition of sub-grade and underside of gas membrane | |
| 1.2 | Gas membrane type | |
| 1.3 | Gas membrane condition | |
| 1.4 | Joining tape product | |
| 1.5 | Lapping design | |
| 1.6 | Laps, welds and joints seals | |
| 1.7 | Service entries seals | |
| ***2 Passive venting*** | | |
| 2.1 | Sub-floor void | |
| 2.2 | External wall airbricks | |
| 2.3 | Internal sleeper walls | |
| 2.4 | External vent trenches/ducts | |
| ***3 Active venting*** | | |
| 3.1 | System details | |
| ***Additional notes:*** | | |

## *Notes: inspection checklist*

| | | |
|---|---|---|
| 1.1 | Underside of gas membrane | Check that the sub grade does not contain rough/uneven surfaces, is appropriately clean and that there are no hard/sharp objects. That protective sand blinding or geotextile (if specified) is present and meets the design criteria. |
| 1.2 | Gas membrane type | Manufacturer and product specification, gauge, colour, brand/name, material batch/roll numbers, storage arrangements (protected from dirt/damage?) |
| 1.3 | Gas membrane condition | Open punctures, tears, rips, stretching? Excessive footprints/evidence of traffic? Presence of debris? Repairs? Signs of weakness such as raised or sunken indentations? Protection plan in place to restrict access to lain gas membrane? |
| 1.4 | Joining tape product | Product type, brand, thickness, material, width, colour? Use of double sided tape? |
| 1.5 | Lapping design | Joints lapped and sealed in accordance with manufacturer's requirements/ specification? Minimum overlap insured? Sections taped twice? |
| 1.6 | Laps and joints sealed | Welds complete? Appropriate joining/double sided tape used? |
| 1.7 | Service entries sealed | Top hats seal arrangements fixed around service entries? Use of Jubilee clips? |
| 2.1 | Sub-floor void | Is a check possible? Void former? Gravel (type/specification)? Height of void space? Is it clear? |
| 2.2 | External wall airbricks | Numbers, size, positions as design drawing? |
| 2.3 | Internal sleeper walls | Ventilation holes (honeycomb brickwork/pipe crossings?) – size, spacing, location in accordance with design? |
| 2.4 | External vent trenches/ducts | Located and constructed in accordance with design drawings? If open-topped gravel – gravel type/presence of fines? If pipe or other vent, check position and construction for functionality and absence of blockages. Ability of void former to withstand bearing of the superstructure? |
| 3.1 | Active venting | Type of air supply: mechanical, natural, combined? Location/condition/number of fans and vents? Location and size of inlets? Provision of air-cleaning devices and air heaters? Supply and exhaust ductwork? Alarm provision/installation? Gas monitoring system in under-floor void? |

## *Photographs*

| **No.** | **Description** |
|---|---|
| | |
| | |
| | |
| | |

| | |
|---|---|
| The gas protection measures inspected: | a Are acceptable and comply with the specification |
| | b Are acceptable but attention is drawn to issues related to item no. xxx |
| | c Are not acceptable due to the issues related to item no. xxx |

**Name:** **Signature:** **Date:**

**Standard Appendices A and B**

## STANDARD APPENDIX A

## NOTES ON SITE INVESTIGATION PROCEDURE (Dec 2023)

1. **GENERAL.** The ground investigation has been carried out in accordance with the requirements of BS5930: 2015 and A1: 2020 and BS10175: 2011+A1: 2017. By its very nature, any ground investigation only samples a small percentage of the ground. Consequently, changes in ground conditions and soil properties can occur between any two exploratory points, for example local features such as soft ground, pockets of contamination and faults. This is also true of the exploration of mineworkings and such features can extend beneath parts of the site not investigated. Unrecorded bell pits and shafts can also exist between exploratory points. The ground investigation is designed to minimise such risks but they cannot be eliminated.

2. **GROUND INVESTIGATION.**

2.1 **BOREHOLE AND TRIAL PIT RECORDS.** These illustrate the ground conditions only at the location of the particular borehole or trial pit. Correlation between boreholes is for guidance only and its accuracy cannot be guaranteed.

2.2 **SHELL AND AUGER BORING.** This technique uses a tripod winch and an essentially percussive action using a variety of tools. Disturbed and undisturbed samples can be taken. This is the most suitable method for soft ground investigation, enabling the maximum amount of information to be obtained. However, minor changes in lithology may be overlooked unless continuous undisturbed sampling is used.

2.3 **GROUNDWATER**. Groundwater levels vary seasonally and the details given on the borehole logs relate only to the dates and the conditions described in the borehole records. The rate of boring may not have allowed an equilibrium water level to be established and the use of casing may seal off certain seepages.

2.4 **SAMPLING.** Disturbed samples of soils are taken for identification and classification purposes. In cohesive soils 'undisturbed' samples 100mm in diameter are taken by open drive sampler for laboratory testing of strength, permeability and consolidation characteristics.

2.5 **STANDARD PENETRATION TESTS**. S.P.T tests are used in granular and cohesive materials and in soft or weathered rocks. Difficulties in obtaining true 'N' values mean they must only be used as a guide and not as an absolute value in foundation design.

2.6 **ROTARY DRILLING.** Two main types of rotary drilling are carried out in rock. Rock coring using diamond or tungsten carbide tipped core bits provides samples and information on rock types, fissuring and weathering. Openhole drilling only produces small particles for identification purposes and the information gained is therefore limited. The latter is, however, useful as a quick method for detecting major strata changes and for the location of coal seams and old workings. Water, air, foam or drilling muds may be used as the flushing medium in either case.

2.7 **PERMEABILITY TESTS.** These can be carried out in boreholes or trial pits and gives a good indication of in-situ permeability.

2.8 **TRIAL PITTING.** This enables soil conditions to be closely examined at any specific point and samples taken. It also gives useful information on the stability of excavations and ingress of water.

2.9 **WINDOW SAMPLING**. Window sampling consists of driving a series of 1m-long tubes into the ground using a dropping weight. On completion of each 1m run, the tube is withdrawn. The next tube is then inserted and the process repeated to provide a continuous profile of the ground. On each run the tube diameter is reduced in order to assist in its recovery.

2.10 **GAS MONITORING.** This is routinely carried out in trial pits or probe holes to check for elevated levels of methane and carbon dioxide or oxygen deficiency, particularly since risks can exist from natural gases, landfill sites and rising groundwater levels in mine workings below ground. Longer term monitoring is carried out with gas monitoring standpipes.

3. **SOIL DESCRIPTION.** Samples from borings or trial pits are described as specified in the standard procedure outlined in the British Standards. The description includes colour, consistency, structure, weathering, lithological type, inclusions and origin. All descriptions are based on visual and manual identification.

**Fire Soils** (Cohesive Soils)

The following field terms are used:

| Soil Type | Description |
|---|---|
| Very soft | Exudes between fingers |
| Soft | Moulded by light finger pressure |
| Firm | Cannot be moulded by the fingers but can be rolled in hand to 3mm threads. |
| Stiff | Crumbles and breaks when rolled to 3mm threads but can be remoulded to a lump. |
| Very stiff | No longer moulded but crumbles under pressure. Can be indented with thumbs. |

The following terms are used in accordance with the results of laboratory and field tests.

| Description | Undrained Shear Strength Cu (kPa) |
|---|---|
| Extremely Low | <10 |
| Very Low | 10 - 20 |
| Low | 20 - 40 |
| Medium | 40 - 75 |
| High | 75 - 150 |
| Very High | 150 - 300 |

Fine soils can also be classified according to their sensitivity, which is the ratio between undisturbed and remoulded undrained shear strength.

| Sensitivity | Ratio |
|---|---|
| Low | 8 |
| Medium | 8 - 30 |
| High | >30 |
| Quick | >50 |

**Granular Soils** (Non-Cohesive)

The following descriptions are used for granular soils.

| Description | Normalised Blow Count $(N_1)$ 60 |
|---|---|
| Very Loose | 0 - 4 |
| Loose | 4 - 10 |
| Medium | 10 - 30 |
| Dense | 30 - 50 |
| Very Dense | >50 |

4. **NATURAL OR IN-SITU MOISTURE CONTENT**. The natural or in-situ moisture content of a soil is defined as the weight of water contained in the pore space, expressed as a percentage of the dry weight of solid matter present in the soil. Soil properties are greatly affected by the moisture content and the test can help to give an indication of likely engineering behaviour.

5. **LIQUID AND PLASTIC LIMITS**. Two simple classification tests are known as the liquid and plastic limits. If a cohesive soil is remoulded with increasing amounts of water, a point will be reached at which it ceases to behave as a plastic material and becomes essentially a viscous fluid. The moisture content corresponding to this change is arbitrarily determined by the liquid limit test. 'Fat' clays, which have high contents of colloidal particles, have high liquid limits; 'lean' clays, having low colloidal particle contents have correspondingly low liquid limits. An increase in the organic content of a clay is reflected by an increase in the liquid and plastic limits.

   If a cohesive soil is allowed to dry progressively, a point is reached at which it ceases to behave as a plastic material, which can be moulded in the fingers, and it becomes friable. The moisture content of the soil at this point is known as the 'plastic limit' of the soil.

   The range of water content over which a cohesive soil behaves plastically, i.e. the range lying between the liquid and plastic limits, is defined as the plasticity index.

   A cohesive soil with a natural water content towards its liquid limit will, in general, be an extremely soft material whereas a cohesive soil with a natural water content below its plastic limit will tend to be a stiff material.

6. **PARTICLE-SIZE DISTRIBUTION.** A knowledge of particle-size distribution is used to classify soils and to indicate likely engineering behaviour. British Standards define soils in relation to their particle-size as shown below:-

| | | | |
|---|---|---|---|
| Boulders | >200mm | Coarse Sand | 2.0 to 0.63mm |
| Cobbles | 200 to 63mm | Medium Sand | 0.63 to 0.2mm |
| | | Fine Sand | 0.2 to 0.063mm |
| Coarse Gravel | 63 to 20mm | Coarse Silt | 0.063 to 0.02mm |
| Medium Gravel | 20 to 6.3mm | Medium Silt | 0.02 to 0.0063mm |
| Fine Gravel | 6.3 to 2mm | Fine Silt | 0.0063 to 0.002mm |
| | | Clay | <0.002mm |

7. **BULK DENSITY.** The bulk density of a material is the weight of that material per unit volume and includes the effects of voids whether filled with air or water. The 'dry density' of a soil is defined as the weight of solids contained in a unit volume of the soil.

8. **PERMEABILITY.** The permeability of a material is defined as the rate at which water flows through it per unit area of soil under unit hydraulic gradient.

9. **CONSOLIDATION CHARACTERISTICS.** When subjected to pressure, a soil tends to consolidate as the air or water in the pore space is forced out and the grains assume a denser state of packing. The decrease in volume per unit of pressure is defined as the 'compressibility' of the soil, and a measure of the rate at which consolidation proceeds is given by the 'coefficient of consolidation' of the soil. These two characteristics Mv and Cv are determined in the consolidation test and the results are used to determine settlement of structures or earthworks.

10. **STRENGTH CHARACTERISTICS.** The strength of geological materials is generally expressed as the maximum resistance that they offer to deformation or fracture by applied shear or compressive stress. The strength characteristics of geological materials depend to an important degree on their previous history and on the conditions under which they will be stressed in practice. Consequently, it is necessary to simulate in the laboratory tests the conditions under which the material will be stressed in the field.

In general, the only test carried out on hard rocks is the determination of their compressive strength but consideration must be given to fissuring, jointing and bedding planes.

The tests at present in use for soils and soft rocks fall into two main categories. Firstly, those in which the material is stressed under conditions of no moisture content change, and secondly those in which full opportunity is permitted for moisture content changes under the applied stresses. Tests in the first category are known as undrained (immediate or quick) tests, while those in the second category are known as drained (slow or equilibrium) tests. The tests are normally carried out in the triaxial compression apparatus but granular materials may be tested in the shear box apparatus.

The undrained triaxial test gives the apparent cohesion $C_u$ and the angle of shearing resistance $\emptyset_u$. In dry sands, $C_u = 0$ and $\emptyset_u$ is equal to the angle of internal friction whereas with saturated non-fissured clays $\emptyset u$ tends to 0 and the apparent cohesion $C_u$ is equal to one-half the unconfined compression strength qu. On site the vane test gives an approximate measure of shear strength.

For some stability problems use is made of a variant of the undrained triaxial test in which the specimen is allowed to consolidate fully under the hydrostatic pressure and is then tested to failure under conditions of no moisture content change. This is known as the consolidated undrained triaxial test. Pore water pressures may be measured during this test or a fully drained test may be carried out. In either case the effective shear strength parameters C' and $\emptyset'$ can be obtained which can be used to calculate shear strength at any given pore water pressure.

11. **COMPACTION.** The density at which any soil can be placed in an earth dam, embankment or road depends on its moisture content and on the amount of work which is used in compaction. The influence of these two factors can be studied in compaction tests, which can determine the maximum dry density (MDD) achievable at a certain optimum moisture content (OMC).

12. **CALIFORNIA BEARING RATIO TEST.** In flexible pavement design a knowledge of the bearing capacity of the subgrade is necessary to enable the thickness of pavement for any particular combination of traffic and site conditions to be determined. The quality of the subgrade can be assessed by means of the California Bearing Ratio Test or approximately by the MEXE cone penetrometer.

13. **ROCK DESCRIPTION.** This is based on;

(i) Strength

| **Term** | **Field Identification** | **Unconfined Compressive Strength (MPa)** |
|---|---|---|
| Extremely Weak[a] | Indented by thumbnail. | Less than 1 |
| Very Weak | Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife. | 1 to 5 |
| Weak | Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer. | 5 to 25 |
| Medium Strong | Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer. | 25 to 50 |
| Strong | Specimen required more than one blow of geological hammer to fracture it. | 50 to 100 |
| Very Strong | Specimen requires many blows of geological hammer to fracture it. | 100 to 250 |
| Extremely Strong | Specimen can only be chipped with geological hammer. | Greater than 250 |

[a] Some extremely weak rocks will behave as soils and should be described as soils.

(ii) Structure

| **Thickness Term** | **Spacing Term** | **Thickness or spacing** |
|---|---|---|
| Very thickly | Extremely wide | >6m |
| Very thickly | Very wide | 2m – 6m |
| Thickly | Wide | 600mm – 2m |
| Medium | Medium | 200mm – 600mm |
| Thinly | Close | 60mm – 200mm |
| Very thinly | Very close | 20mm – 60mm |
| Thickly laminated (Sedimentary) | | |
| Narrowly (Metamorphic and Igneous | Extremely close | 6mm – 20mm |
| Thinly laminated (Sedimentary) | | |
| Very narrowly (Metamorphic and Igneous) | Extremely close | <6mm |

(iii) Colour
(iv) Texture
(v) Grain size

| Description | Predominate Grain Size (mm) |
|---|---|
| Conglomerate | >2 |
| Coarse - grained | 2 - 0.63 |
| Medium - grained | 0.63 - 0.20 |
| Fine - grained | 0.20 - 0.063 |
| Siltstone | 0.063 - 0.002 |
| Mudstone | <0.002 |

(vi) Rock Name
(vii) Stability
(viii) Weathering

| Term | Description | Grades |
|---|---|---|
| Fresh/unweathered | No visible sign of rock material weathering; perhaps slight discolouration on major discontinuity surfaces. | 0 |
| Slightly weathered | Slight discolouration indicates weathering of rock material and discontinuity surfaces. | 1 |
| Moderately weathered/Distinctly weathered | Less than half of the rock material is decomposed or disintegrated. Fresh or discoloured rock is present either as a continuous framework or as core stones. | 2 |
| Highly weathered/ Destructed | More than half of the rock material is decomposed or disintegrated. Fresh or discoloured rock is present either as a continuous framework or as core stones. | 3 |
| Completely weathered | All rock material is decomposed and/or disintegrated to soil. The original mass structure is still apparent. | 4 |
| Residual soil | All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soils has not been significantly transported. | 5 |

(ix) Discontinuities
(x) Weathered of Rock Mass

14. **CHEMICAL TESTS.** A knowledge of water soluble sulphate content and pH of soils and groundwater is important in determining the protection required for concrete or steel in contact with the ground. Other specialist tests may be carried out on sites suspected of being contaminated (see standard appendix B).

15. **REFERENCES**

BS5930: 2015+A1:2020 British Standard Code of Practice for Site Investigations
BS10175: 2011+A1:2017 British Standard Code of Practice for the Investigation of Potentially Contaminated Sites
BS EN ISO 14688-1: 2018 Geotechnical Investigation and Testing: Identification and Classification of Soil
BS EN ISO 14688-2: 2018 Geotechnical Investigation and Testing: Identification and Classification of Soil

## STANDARD APPENDIX B

## NOTES ON CONTAMINATION INVESTIGATION PROCEDURE (June 2021)

mdja

**1.** **GENERAL.** The desk study and/or intrusive ground investigation is typically carried out in accordance with the Environment Agency's "Land Contamination Risk Management (LCRM) documents and the requirements of BS5930: 2015 and BS10175: 2011+A1: 2020. In relation to contamination the desk study is referred to as the preliminary investigation in BS10175 and the intrusive ground investigation is referred to as the Exploratory Investigation. This appendix briefly describes the nature of the work carried out and explains the standards against which contamination data has been assessed. The nature of any contamination investigation is such that only a small percentage of the ground, and therefore potential contamination, is sampled. Consequently variations in both ground conditions and contaminant levels can occur between any two sampling positions. The contamination investigation is designed to minimise such risks, but they cannot be eliminated.

**2.** **REVIEW OF CONTAMINATION ISSUES –** The National Planning Policy Framework (NPPF) and Part 2A of the Environmental Protection Act 1990 create a new regime for the identification and remediation of contaminated land. It introduced a definition of contaminated land described in Section 78A(2) of the Act of:

"any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) significant pollution of controlled waters is being caused or there is a significant possibility of such pollution being caused:

Both Part 2A and the planning regime embrace the "suitable for use" approach. In the context of Part IIA, action is necessary only where there are unacceptable risks to health or to the environment, taking into account the current use of the land and its environmental setting.

For humans, significant harm is defined as "death, disease, serious injury ". Specifically, disease is taken to mean an unhealthy condition of the body or part of it. "Significant possibility of significant harm" is described as health effects arising from the intake of a contaminant or other direct bodily contact with the contaminant where the intake or exposure is unacceptable. The assessment should also take into account the total intake from all sources, the relative contribution of the pollutant linkage in question, and the duration of intake or exposure. The various statutory definitions are given overleaf.

The presence of unnatural substances does not automatically constitute a risk unless there is a link or pathway between the contamination (the hazard) and the receptor (the target) be it humans, the environment or property. Therefore the assessment needs to determine whether a hazard is present and whether the necessary pathway exists the so-called "pollution linkage" or "conceptual site model".

The effect of any hazard on a site depends primarily on the site use and groundwater conditions since these determine who and what may be at risk and the routes by which they may be exposed to the hazard. Site uses can include allotments, domestic gardens on residential developments, amenity and recreational areas, public open space and industrial and commercial buildings. On any site, the potential contaminants have to be identified together with the potential receptors. The pathway for that contaminant to reach its target has then to be considered.

**3.** **PRELIMINARY INVESTIGATION.** The preliminary Phase I Geoenvironmental Assessment (desk study) report normally considers the following key sections:

| | |
|---|---|
| Introduction | |
| The Site | Contaminated Land |
| Site History | Radon |
| Geology and Mining | Geoenvironmental Risk Assessment |
| Hydrogeology | Geotechnical Assessment |
| Groundsure Geo-Insight and Enviro-Insight | Ground Investigation (Recommendations) |

The report will summarise the findings and also relate our opinions to the potential for a site to be geoenvironmentally impaired, at levels likely to warrant mitigation or further consideration appropriate to the current or future use. Findings are based on information obtained and described during the desk study and site inspection without intrusive ground investigation. It is possible that further information exists. The absence of indicators of impairment does not mean that such impairment does not exist. Additional investigation including intrusive methods can reduce the risks but cannot eliminate them and may not be cost effective. We can advise on the additional research opportunities, their cost and their possible impact on mitigating risk. Recommendations are normally given based on the redevelopment proposals for the site.

| Type of Receptor | Description of harm that is to be regarded as significant harm | Conditions For There Being A Significant Possibility Of Significant Harm |
|---|---|---|
| 1. Human beings | Death, disease, serious injury, genetic mutation, birth defects or the impairment of reproductive functions.<br><br>For these purposes, disease is to be taken to mean an unhealthy condition of the body or a part of it and can include, for example, cancer, liver dysfunction or extensive skin ailments. Mental dysfunction is included only insofar as it is attributable to the effects of a pollutant on the body of the person concerned. | If the amount of the pollutant in the pollutant linkage represents an unacceptable intake or direct bodily contact, assessed on the basis of relevant information on the toxicological properties of that pollutant.<br><br>Such an assessment should take into account:<br>• the likely total intake of, or exposure to, the substance or substances which form the pollutant, from all sources including that from the pollutant linkage in question;<br>• the relative contribution of the pollutant linkage in question to the likely aggregate intake of, or exposure to, the relevant substance or substances; and<br>• the duration of intake or exposure resulting from the pollutant linkage in question.<br><br>The question of whether an intake or exposure is unacceptable is independent of the number of people who might experience or be affected by that intake or exposure.<br><br>Toxicological properties should be taken to include carcinogenic, mutagenic, teratogenic, pathogenic, endocrine-disrupting and other similar properties. |
| 2. All other human health effects (particularly by way of explosion or fire) | | If the probability, or frequency, of significant harm of that description is unacceptable. The pollutant linkage might cause "significant harm which"<br><br>• would be irreversible or incapable of being treated;<br>• would affect a substantial number of people;<br>• would result from a single incident such as a fire or an explosion; or<br>• would be likely to result from a short-term (lees than 24-hour) exposure to the pollutant. |
| 3. Any ecological system, or living organism forming part of such a system, within a location which is protected. | For any protected location:<br>• harm which results in an irreversible adverse change, or in some other substantial adverse change, in the functioning of the ecological system within any substantial part of that location; or<br>• harm which affects any species of special interest within that location and which endangers the long-term maintenance of the population of that species at that location. | If either:<br>• significant harm of that description is more likely than not to result from the pollutant linkage; or<br>• there is a reasonable possibility of significant harm of that description being caused, and if that harm were to occur, it would result in such a degree of damage to features of special interest at the location in question that they would be beyond any practicable possibility of restoration. |
| 4. Property in the form of:<br>• crops, including timber;<br>• produce grown domestically, or on allotments, for consumption;<br>• livestock;<br>• other owned or domesticated animals;<br>• wild animals which are the subject of shooting or fishing rights. | For crops, a substantial diminution in yield or other substantial loss in the value resulting from death, disease or other physical damage. For domestic pets, death, serious disease or serious physical damage. For other property in this category, a substantial loss in its value resulting from death, disease or other serious physical damage. | If significant harm of that description is more likely than not to result from the pollutant linkage in question. |
| 5. Property in the form of buildings. | Structural failure, substantial damage or substantial interference with any right of occupation. | If significant harm of that description is more likely than not to result from the pollutant linkage in question during the expected economic life of the building. |
| 6. Controlled waters. | | |

**4.** **INTRUSIVE INVESTIGATION.** BS10175 describes this as an exploratory investigation. Intrusive ground investigation is described in Standard Appendix A. During the investigation representative or indicative samples are obtained for testing by an accredited laboratory. The aim is to determine (with a degree of confidence appropriate to the objectives), the presence, concentration and distribution of contaminants in respect of those points investigated. The extent of any necessary intrusive investigation will depend on the size of the site and any hazards, either known or suspected.

**5.** **ASSESSMENT OF CONTAMINATION.** The assessment of contaminated land under the terms of Part II A of the Environmental Protection Act 1990 is based upon pollution linkage (source - pathway - receptor model) and the principles of the Environment Agency's "Contamination Land Risk Management" documentation.

DEFRA previously issued "Outcome of the Way Forward Exercise on Soil Guideline Values". This document was intended to provide guidance to determine if there is a Significant Possibility of Significant Harm (SPOSH) i.e. whether land meets the legal trigger of being contaminated land.

In the context of Part 2A, a risk assessor using an SGV would conclude the following (DEFRA, 2008).

- At a representative average soil concentration at or below an SGV, it is very unlikely that there will be a *significant possibility of significant harm (SPOSH)*.

- At a representative average soil concentration above an SGV, there *might* be a *significant possibility of significant harm* with the significance linked to the margin of exceedance, the duration and frequency of exposure, and other site-specific factors that the enforcing authority may wish to take into account. Further investigation and/or detailed evaluation will usually be required.

It should be stressed that where there is any uncertainty as to whether or not there is a SPOSH, it was the policy of this practice to adopt a conservative approach, particularly in the adoption of clean cover systems.

In April 2012, Defra both published new Statutory Guidance which forms a major part of their contaminated land regimes under Part 2A of the Environment Protection Act 1990. The regime provides a means of dealing with contaminated land which poses a significant risk to human health or the environment where there is no alternative solution. It also works alongside planning rules and building regulations to help ensure that affected land is made suitable for use when it is redeveloped.

Since the regime was introduced in 2000 there has been considerable uncertainty over how to decide when land is, and is not contaminated land on grounds of the legal test of *significant possibility of significant harm to human health or the environment*.

To help address this, one of the main changes set out in the new Statutory Guidance, is the introduction of a new four category test to help decide when land is, and is not, contaminated land on grounds of *significant possibility of significant harm to human health*. Under the new four category test:

- Category 1 describes land that is clearly contaminated land, for example because similar land is known to have caused significant harm in the past.

- Categories 2 and 3 cover less straightforward land where more detailed consideration is needed before the regulator can decide either: (a) that there is a strong case for regulatory action, in which case the land would be in Category 2 and be classified as contaminated land under Part 2A; or (b) that such a case does not exist, in which case the land would be in Category 3 and not be classified as contaminated land under Part 2A.

- Category 4 describes land that is clearly not contaminated land, as discussed below.

One of the main purposes of including the Categories in the Statutory Guidance is to provide a legal framework against which new technical tools can be developed by the land contamination sector to describe the Categories in more detail with regard to specific substances and/or situations.

The new Category 4 test is particularly important in terms of reducing uncertainty over when land is definitely not caught by the regime.

The new Statutory Guidance makes clear what land should be placed into Category 4, for example:

(a) Land where no relevant contaminant linkage has been established.

(b) Land where there are only normal levels of contaminants in soil (as explained in Section 3 of the guidance), unless there is a particular reason to consider otherwise. In other words land with normal background concentrations in the soil.

(c) Land that has been excluded from the need for further inspection and assessment under Part 2A because contaminant levels do not exceed relevant generic assessment criteria in accordance with Section 3 of the guidance, or relevant technical tools or advice that may be developed in accordance with paragraph 3.30 of the guidance, e.g. Category 4 Screening Levels.

(d) Land where estimated levels of exposure to contaminants in soil are likely to form only a small proportion of what a receptor might be exposed to anyway through other sources of environmental exposure (e.g. in relation to average estimated national levels of exposure to substances commonly found in the environment, to which receptors are likely to be exposed to in the normal course of their lives).

The guidance clarifies how generic assessment criteria (including the currently available SGVs/GACs) should and should not be used. It states that:

*3.27 It is common practice in contaminated land risk assessment to use "generic assessment criteria" (GACs) as screening tools in generic quantitative human health risk assessment to help assessors decide when land can be excluded from the need for further inspection and assessment, or when further work may be warranted.*

*3.28 Local authorities may use GACs and other technical tools to inform certain decisions under the Part 2A regime, provided: (i) they understand how they were derived and how they can be used appropriately; (ii) they have been produced in an objective, scientifically robust and expert manner by reputable organizations; and (iii) they are only used in a manner that is in accordance with Part 2A and this Guidance.*

*3.29 GACs relating to human health risk assessment represent cautious estimates of levels of contaminants in soil at which there is considered to be no risk to health or, at most, a minimal risk to health. With regard to such GACs:*

(a) They may be used to indicate when land is very unlikely to pose a significant possibility of significant harm to human health. This is on the basis that they are designed to estimate levels of contamination at which risks are likely to be negligible or minimal and far from posing a significant possibility of significant harm to human health.

(b) They should not be used as direct indicators of whether a significant possibility of significant harm to human health may exist. Also, the local authority should not view the degree by which GACs are exceeded (in itself) as being particularly relevant to this consideration, given that the degree of risk posed by land would normally depend on many factors other than simply the amount of contaminants in soil.

(c) They should not be seen as screening levels which describe the boundary between Categories 3 and 4 in terms of Section 4 (i.e. the two Categories in which land would not be contaminated land on grounds of risks to human health). In the very large majority of cases, these SGVs/GACs describe levels of contamination from which risks should be considered to be comfortably within Category 4.

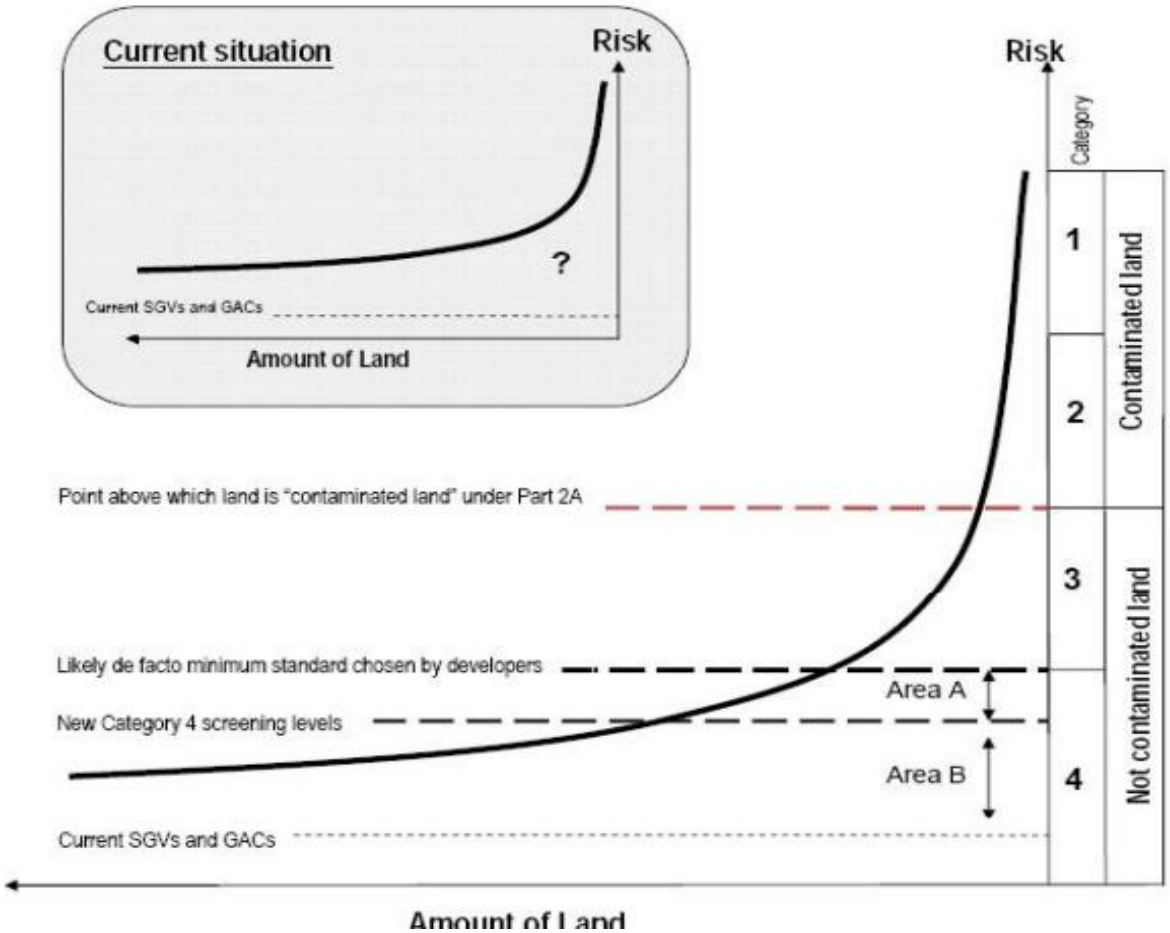
(d) They should not be viewed as indicators of levels of contamination above which detailed risk assessment would automatically be required under Part 2A.

(e) They should not be used as generic remediation targets under the Part 2A regime. Nor should they be used in this way under the planning system, for example in relation to ensuring that land affected by contamination does not meet the Part 2A definition of contaminated land after it has been developed.

The way in which the new four category system is intended to operate and the place of the C4SLs within that system, was explained in detail in the Impact Assessment which accompanied the Statutory Guidance. Please note that although the detail of the Impact Assessment is included here to provide clarity on the job expected of C4SLs, the Statutory Guidance, itself, sets out the regime that needs to be delivered under Part 2A.

Paragraph 47 of the Impact Assessment describes the diagram in detail. Of particular relevance to this project is the description of the overall diagram (sub-paragraph a), description of category 4 (sub-paragraphs c (part iv) and h) and the description of how the monetised benefits of the new system will be realised (sub-paragraph h). These sub-paragraphs are reproduced below.

**Diagram showing the new Category 1-4 system (compared to current situation)**




The diagram above seeks to illustrate, in a simplified manner, broadly what the changes to the statutory guidance on significant possibility of significant harm to human health are intended to achieve. To explain:

(a) The curved line and axes illustrate the spectrum of risk presented by land contamination. The idea is to show that a very large amount of land is low risk, and only a small amount of land would pose sufficient risk to be contaminated land in the legal sense. The axes and lines in the diagrams are not to scale, and they have been compressed for the purposes of illustration (in reality the risks on Category 1 land would probably be orders of magnitude above Category 4 risks, and vastly more land would be in Category 4 compared to the other Categories).

(b) The smaller diagram summarizes the current situation. In the area below the SGV/GACs there is near certainty that land is not contaminated land, however, above the line there is increasing uncertainty. As explained above, currently remediation usually occurs to just below the SGV/GAC level because they are perceived as offering the only cast-iron guarantee of when land is definitely not contaminated land. Sometimes consultants are employed to justify remediating to levels above the SGV/GACs, however the further they go away from the SGV/GACs the more legal risk they and their clients are exposed to.

(c) The new statutory guidance will end the current situation, and it would not be legally possible e.g. for individual regulators to ignore the changes being made. For example, as explained above, the new statutory guidance will specifically say:

(i) that Part 2A cannot be used to force remediation to below a point where it ceases to be contaminated land in the legal sense i.e. the Category 2/3 border in terms of the diagram), although responsible parties can choose to go further;

(ii) that SGV/GACs cannot be used as one size fits all remediation thresholds under either Part 2A of the planning system;

(iii) that normal background levels of contamination are not caught by Part 2A; and

(iv) that SGV/GACs are well into Category 4, sometimes by only a few times and sometimes by orders of magnitude. These changes and others also provide the legal backing for the development e.g. of Category 4 screening levels, as discussed below.

(d) The new Category 1-4 system divides the spectrum of risk posed by contaminated land into four different categories, and the statutory guidance will explain how to decide when land falls into each Category. This is more sophisticated than the current statutory guidance, which in effect has only two categories (contaminated land or not) and does not explain how to decide which category land falls into. The new Category 1-4 system

reflects what assessors find when they investigate real sites i.e. some are clearly contaminated land (Category 1) ; some clearly are not (Category 4) and some are less-straightforward and need some level of detailed assessment before a decision can be taken as to whether or not they are contaminated land (Categories 2 and 3).

(e) In the case of Category 2 and 3 sites, the regulator will have flexibility to take decisions within the parameters set by the new Guidance. There would be less flexibility for Category 2 and 3 sites that clearly pose either a high or low risk. However, the regulator will have considerable flexibility for sites closer to the Category 2/3 border to judge which side of the border a site would fall (e.g. taking account of their understanding of the risks, uncertainties and the interests of the local community). These are often complex decisions which need to be taken case-by-case given the many factors involved.

(f) In the case of Categories 1 and 4 the regulator will have far less flexibility. For example, if a regulator claimed that a site matching the Category 1 description was not contaminated land, or that a site matching the Category 4 description was contaminated land, they would be acting directly against the statutory guidance which the Act requires that they follow, and decisions could be challenged (e.g. in a law court) with a high chance that the challenge would be successful. Among other things, the intention of doing this is to create far more legal certainty around when land is definitely not contaminated land in the legal sense. With the specific wording of the new statutory guidance, and the supporting tools such as the new Category 4 screening levels, it would be very difficult for a regulator e.g. to threaten landowners with the Part 2A regime, and if they tried to determine land as contaminated land they would be operating in direct opposition to the statutory guidance.

(g) In the many consultation meetings held in developing the Category 1-4 system, all the developers, landowners and consultants we spoke to were strongly of the view that they would want the ensure their land is safely within Category 4 (even though in theory they could remediate to a level within Category 3 and still satisfy Part 2A and planning rules). They would do this for various reasons, including the fact that the flexibility granted to regulators in Categories 2 and 3 means that the further into Category 3 a site gets, the greater the risk that the regulator might decide it is in Category 2. Also they would want to be in Category 4 for reasons of marketability, future proofing etc. So developers and others would have a strong incentive to seek the regulatory certainty of being safely within Category 4. Thus, as far as development taking place under the planning system is concerned, Category 3 would, in effect, normally be a buffer which provides added reassurance that development falling within Category 4 will not be caught by the Part 2A regime.

(h) The new statutory guidance will bring about a situation where the current SGV/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land. Above the C4SLs, in Area A on the diagram, there will be much stronger legal backing for experts to use their judgement to make sensible and precautionary decisions on when land should be considered to be towards the top end of Category 4, without fear that land may be caught as contaminated land. This recognizes that the generic C4SLs will not be able to describe the Category 3/4 border itself because they are generic and would therefore have to err on the side of caution whilst a detailed site specific assessment would be able to push further by looking at specific circumstances relating to a specific site.

(i) The very large majority of the monetized benefits of the changes to the regime discussed in this Impact Assessment manifest themselves in Category 4, and in particular in Areas A and B on the diagram. The main effects of moving to the new system would include Low risk land falling within Area B (pre-development) on the diagram would no longer have to be remediated because it would fall below the new C4SLs. Similarly land which is in Area A pre-development would no longer need to be remediated if justified by a detailed site-specific assessment. For these sites the cost of remediation would be removed altogether. The cost of remediating land which is initially in Categories 3, 2 or 1 would fall because it would be remediated to the new C4SL levels (or somewhere within Area A if there has been a detailed assessment) rather than the SGV/GAC level. This will have the overall effect of reducing the cost of remediation, with the effect varying according to specific site circumstances, the type of remediation etc. Generally the cost of remediation would fall for many affected brownfield land sites. This would have the general effect of making such land more economically viable for development. It would also mean that some land that is not currently economically viable to develop becomes reduce pressure to develop Greenfield land in some cases. The C4SLs will also speed up regulatory decisions on the reuse of brownfield land by providing a simple remediation standard.

The C4SLs are intended as "*relevant technical tools*" (in relation to Paragraph 4.2.1(c)) provides to help local authorities and others when deciding to stop further assessment of a site, on the grounds that it falls within Category 4 (Human Health).

The Impact Assessment (IA), which accompanied the revised SG (Defra, 2012b) provides further information on the nature and potential role of the C4SLs. Paragraph 47(h) of the IA states that:

> *"The new statutory guidance with bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land".*

A key distinction between the Soil Guideline Values (SGVs) and the C4SLs is the level of risk that they describe. As described by the Environment Agency (2009a):

> *"SGVs are guidelines on the level of long-term human exposure to individual chemicals in soils that, unless stated otherwise, are tolerable or pose a minimal risk to human health".*

C4SLs, therefore, should not be viewed as "SPOSH levels" and they should not be used as a legal trigger for the determination of land under Part 2A.

CL:AIRE (Contaminated Land: Application in Real Environments) has published "*Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination*". In it a series of C4SLs were proposed as follows;

| Analyte | Residential (with home grown produce) (mg/kg) | Residential (without home grown produce) (mg/kg) | Allotments (mg/kg) | Commercial (mg/kg) | POS (mg/kg) |
|---|---|---|---|---|---|
| Arsenic | 37 | 40 | 49 | 640 | 79 |
| Benzene | 0.87 | 3.3 | 0.18 | 98 | 140 |
| Benzo(a)Pyrene | 5 | 5.3 | 5.7 | 77 | 10 |
| Cadmium | 22 | 150 | 3.9 | 410 | 880 |
| Chromium (vi) | 21 | 21 | 170 | 49 | 21 |
| Lead | 200 | 310 | 80 | 2300 | 630 |

Where C4SL's are not available, Generic Assessment Criteria have been used as follows;

## Generic Assessment Criteria for Human Health Risk Assessment Comparison
## METALS/CYANIDE

**Based on sandy loam soil as defined in SR3 (Environment Agency, 2009) and based on 6% soil organic matter (SOM)**
**Values are expressed in mg/kg**

| | S4UL | | | | | | C4SL | | | | | | EA SGV | | | EIC/AGS/CL:AIRE or *ATRISKSOIL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Residential with homegrown produce | Residential without homegrown produce | Allotment | Commercial | POSresi | POSpark | Residential with homegrown produce | Residential without homegrown produce | Allotment | Commercial | POSresi | POSpark | Residential | Allotment | Commercial | Residential without consumption of homegrown produce | Allotment | Commercial |
| Antimony[1] | | | | | | | | | | | | | | | | 550 | ND | 7500 |
| Arsenic (6% SOM) | 37 | 40 | 43 | 640 | 79 | 170 | 37 | 40 | 49 | 640 | 79 | 170 | 32 | 43 | 640 | | | |
| Barium[1] | | | | | | | | | | | | | | | | 1300 | ND | 22000 |
| Beryllium (6% SOM) | 1.7 | 1.7 | 35 | 12 | 2.2 | 63 | | | | | | | | | | | | |
| Boron (6% SOM) | 290 | 11000 | 45 | 240000 | 21000 | 46000 | | | | | | | | | | | | |
| Cadmium (6% SOM) | 11 | 85 | 1.9 | 190 | 120 | 560 | 22 | 150 | 3.9 | 410 | 220 | 880 | 10 | 1.8 | 230 | | | |
| Chromium (III) (6% SOM) | 910 | 910 | 18000 | 8600 | 1500 | 33000 | | | | | | | | | | | | |
| Chromium (VI) (6% SOM) | 6 | 6 | 1.8 | 33 | 7.7 | 220 | 21 | 21 | 170 | 49 | 21 | 250 | | | | | | |
| Copper (6% SOM) | 2400 | 7100 | 520 | 68000 | 12000 | 44000 | | | | | | | | | | | | |
| Cyanide (AtriskSoil) | | | | | | | | | | | | | | | | 34* | 34* | 34* |
| Lead (6% SOM) | | | | | | | 200 | 310 | 80 | 2300 | 630 | 1300 | | | | | | |
| Nickel (6%SOM) | 130 | 180 | 53 | 980 | 230 | 800 | | | | | | | | | | | | |
| Mercury (Elemental) (6% SOM) | 1.2 | 1.2 | 21 | 58 | 16 | 30 | | | | | | | 1.0 | 26 | 26 | | | |
| Mercury (Inorganic) (6% SOM) | 40 | 56 | 19 | 1100 | 120 | 240 | | | | | | | 170 | 80 | 3600 | | | |
| Mercury (Methyl) (6% SOM) | 11 | 15 | 6 | 320 | 40 | 68 | | | | | | | 11 | 8 | 410 | | | |
| Molybdbenum[1] | | | | | | | | | | | | | | | | 670 | ND | 17000 |
| Selenium (6% SOM) | 250 | 430 | 88 | 12000 | 1100 | 1800 | | | | | | | 350 | 120 | 13000 | | | |
| Vanadium (6% SOM) | 410 | 1200 | 91 | 9000 | 2000 | 5000 | | | | | | | | | | | | |
| Zinc (6% SOM) | 3700 | 40000 | 620 | 730000 | 81000 | 170000 | | | | | | | | | | | | |

**Additional notes for EIC/AGS/CL:AIRE GAC**

1 Due to the limitations in time and scope of the EIC/AGS/CL:AIRE project, plant uptake factors were not derived for metals and therefore the metals GAC have only been produced for residential without consumption of homegrown produce and commercial land-uses. Note that the derived GAC are not dependent on SOM.

## PETROLEUM HYDROCARBONS

**Based on sandy loam soil as defined in SR3 (Environment Agency, 2009) and 1%, 2.5% and 6% soil organic matter (SOM).**
**SGVs based on 6% SOM, at a lower SOM the SGV may not be sufficiently protective.**
**Generic assessment criteria for Petroleum Hydrocarbons will vary according to SOM for all land values**
**Values are expressed in mg/kg**
**GACs assume that free phase contamination is not present**
**GACs are based on sub-surface soil to indoor air correction factor of 10**

| | S4UL | | | | | | C4SL | | | | | | EA SGV | | | EIC/AGS/CL:AIRE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Compound** | **Residential with homegrown produce** | **Residential without homegrown produce** | **Allotment** | **Commercial** | **POSresi** | **POSpark** | **Residential with homegrown produce** | **Residential without homegrown produce** | **Allotment** | **Commercial** | **POSresi** | **POSpark** | **Residential** | **Allotment** | **Commercial** | **Residential with consumption of homegrown produce** | **Residential without consumption of homegrown produce** | **Allotment** | **Commercial** |
| Aliphatic EC 5-6 (1% SOM) | 42 | 42 | 730 | 3200 (340) | 570000 (304) | 95000 (304) | | | | | | | | | | | | | |
| Aliphatic EC 5-6 (2.5% SOM) | 78 | 78 | 1700 | 5900 (558) | 590000 | 130000 (558) | | | | | | | | | | | | | |
| Aliphatic EC 5-6 (6% SOM) | 160 | 160 | 3900 | 12000 (1150) | 600000 | 18000 (1550) | | | | | | | | | | | | | |
| Aliphatic EC>6-8 (1% SOM) | 100 | 100 | 2300 | 7800 (144) | 600000 | 150000 (144) | | | | | | | | | | | | | |
| Aliphatic EC>6-8 (2.5% SOM) | 230 | 230 | 5600 | 17000 (322) | 610000 | 220000 (322) | | | | | | | | | | | | | |
| Aliphatic EC>6-8 (6% SOM) | 530 | 530 | 13000 | 40000 (736) | 620000 | 320000 (736) | | | | | | | | | | | | | |
| Aliphatic EC>8-10 (1% SOM) | 27 | 27 | 320 | 2000 (78) | 13000 | 14000 (78) | | | | | | | | | | | | | |
| Aliphatic EC>8-10 (2.5% SOM) | 65 | 65 | 770 | 4800 (190) | 13000 | 18000 (190) | | | | | | | | | | | | | |
| Aliphatic EC>8-10 (6% SOM) | 150 | 150 | 1700 | 11000 (451) | 13000 | 21000 (451) | | | | | | | | | | | | | |
| Aliphatic EC>10-12 (1% SOM) | 130 (48) | 130 (48) | 2200 | 9700 (48) | 13000 | 21000 (48) | | | | | | | | | | | | | |
| Aliphatic EC>10-12 (2.5% SOM) | 330 (118) | 330 (118) | 4400 | 23000 (118) | 13000 | 23000 (118) | | | | | | | | | | | | | |
| Aliphatic EC>10-12 (6%SOM) | 760 (283) | 770 (283) | 7300 | 47000 (283) | 13000 | 24000 (283) | | | | | | | | | | | | | |
| Aliphatic EC>12-16 (1% SOM) | 1100 (24) | 1100 (24) | 11000 | 59000 (24) | 13000 | 25000 (24) | | | | | | | | | | | | | |
| Aliphatic EC>12-16 (2.5% SOM) | 2400 (59) | 2400 (59) | 13000 | 82000 (59) | 13000 | 25000 (59) | | | | | | | | | | | | | |
| Aliphatic EC>12-16 (6% SOM) | 4300 (142) | 4300 (142) | 13000 | 90000 (142) | 13000 | 26000 (142) | | | | | | | | | | | | | |
| Aliphatic EC>16-35 (1% SOM) | 65000 (8.48) | 65000 (8.48) | 260000 | 1600000 | 250000 | 450000 | | | | | | | | | | | | | |
| Aliphatic EC>16-35 (2.5% SOM) | 92000 (21) | 92000 (21) | 270000 | 1700000 | 250000 | 480000 | | | | | | | | | | | | | |
| Aliphatic EC>16-35 (6% SOM) | 110000 | 110000 | 270000 | 1800000 | 250000 | 490000 | | | | | | | | | | | | | |
| Aliphatic EC>35-44 (1% SOM) | 65000 (8.48) | 65000 (8.48) | 260000 | 1600000 | 250000 | 450000 | | | | | | | | | | | | | |
| Aliphatic EC>35-44 (2.5% SOM) | 92000 (21) | 92000 (21) | 270000 | 1700000 | 250000 | 480000 | | | | | | | | | | | | | |
| Aliphatic EC>35-44 (6% SOM) | 110000 | 110000 | 270000 | 1800000 | 250000 | 490000 | | | | | | | | | | | | | |
| Aromatic EC 5-7 (1% SOM) | 70 | 370 | 13 | 26000 (1220) | 56000 | 76000 (1220) | | | | | | | | | | | | | |
| Aromatic EC 5-7 (2.5% SOM) | 140 | 690 | 27 | 46000 (2260) | 56000 | 84000 (2260) | | | | | | | | | | | | | |
| Aromatic EC 5-7 (6% SOM) | 300 | 1400 | 57 | 86000 (4710) | 56000 | 92000 (4710) | | | | | | | | | | | | | |
| Aromatic EC>7-8 (1% SOM) | 130 | 860 | 22 | 56000 (869) | 56000 | 87000 (869) | | | | | | | | | | | | | |
| Aromatic EC>7-8 (2.5% SOM) | 290 | 1800 | 51 | 110000 (1920) | 56000 | 95000 (1920) | | | | | | | | | | | | | |
| Aromatic EC>7-8 (6% SOM) | 660 | 3900 | 120 | 180000 (4360) | 56000 | 100000 (4360) | | | | | | | | | | | | | |
| Aromatic EC>8-10 (1% SOM) | 34 | 47 | 8.6 | 3500 (613) | 5000 | 7200 (613) | | | | | | | | | | | | | |
| Aromatic EC>8-10 (2.5% SOM) | 83 | 110 | 21 | 8100 (1500) | 5000 | 8500 (1500) | | | | | | | | | | | | | |
| Aromatic EC>8-10 (6% SOM) | 190 | 270 | 51 | 17000 (3580) | 5000 | 9300 (3580) | | | | | | | | | | | | | |
| Aromatic EC>10-12 (1% SOM) | 74 | 250 | 13 | 16000 (364) | 5000 | 9200 (364) | | | | | | | | | | | | | |
| Aromatic EC>10-12 (2.5% SOM) | 180 | 590 | 31 | 28000 (899) | 5000 | 9700 (899) | | | | | | | | | | | | | |
| Aromatic EC>10-12 (6% SOM) | 380 | 1200 | 74 | 34000 (2150) | 5000 | 10000 | | | | | | | | | | | | | |
| Aromatic EC>12-16 (1% SOM) | 140 | 1800 | 23 | 36000 (169) | 5100 | 10000 | | | | | | | | | | | | | |
| Aromatic EC>12-16 (2.5% SOM) | 330 | 2300 (419) | 57 | 37000 | 5100 | 10000 | | | | | | | | | | | | | |
| Aromatic EC>12-16 (6% SOM) | 660 | 2500 | 130 | 38000 | 5000 | 10000 | | | | | | | | | | | | | |
| Aromatic EC>16-21 (1% SOM) | 260 | 1900 | 46 | 28000 | 3800 | 7600 | | | | | | | | | | | | | |
| Aromatic EC>16-21 (2.5% SOM) | 540 | 1900 | 110 | 28000 | 3800 | 7700 | | | | | | | | | | | | | |
| Aromatic EC>16-21 (6% SOM) | 930 | 1900 | 260 | 28000 | 3800 | 7800 | | | | | | | | | | | | | |
| Aromatic EC>21-35 (1% SOM) | 1100 | 1900 | 370 | 28000 | 3800 | 7800 | | | | | | | | | | | | | |
| Aromatic EC>21-35 (2.5% SOM) | 1500 | 1900 | 820 | 28000 | 3800 | 7800 | | | | | | | | | | | | | |
| Aromatic EC>21-35 (6% SOM) | 1700 | 1900 | 1600 | 28000 | 3800 | 7900 | | | | | | | | | | | | | |
| Aromatic EC>35-44 (1% SOM) | 1100 | 1900 | 370 | 28000 | 3800 | 7800 | | | | | | | | | | | | | |
| Aromatic EC>35-44 (2.5% SOM) | 1500 | 1900 | 820 | 28000 | 3800 | 7800 | | | | | | | | | | | | | |
| Aromatic EC>35-44 (6% SOM) | 1700 | 1900 | 1600 | 28000 | 3800 | 7900 | | | | | | | | | | | | | |
| Aliphatic + Aromatic EC>44-70 ( | 1600 | 1900 | 1200 | 28000 | 3800 | 7800 | | | | | | | | | | | | | |
| Aliphatic + Aromatic EC>44-70 ( | 1800 | 1900 | 2100 | 28000 | 3800 | 7800 | | | | | | | | | | | | | |
| Aliphatic + Aromatic EC>44-70 ( | 1900 | 1900 | 3000 | 28000 | 3800 | 7800 | | | | | | | | | | | | | |

| | S4UL | | | | | | C4SL | | | | | | EA SGV | | | EIC/AGS/CL:AIRE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Compound** | **Residential with homegrown produce** | **Residential without homegrown produce** | **Allotment** | **Commercial** | **POSresi** | **POSpark** | **Residential with homegrown produce** | **Residential without homegrown produce** | **Allotment** | **Commercial** | **POSresi** | **POSpark** | **Residential** | **Allotment** | **Commercial** | **Residential with consumption of homegrown produce** | **Residential without consumption of homegrown produce** | **Allotment** | **Commercial** |
| Benzene (1% SOM) | 0.087 | 0.38 | 0.017 | 27 | 72 | 90 | | | | | | | | | | | | | |
| Benzene (2.5% SOM) | 0.17 | 0.7 | 0.034 | 47 | 72 | 100 | | | | | | | | | | | | | |
| Benzene (6% SOM) | 0.37 | 1.4 | 0.075 | 90 | 73 | 110 | 0.87 | 3.3 | 0.18 | 98 | 140 | 230 | 0.33 | 0.07 | 95 | | | | |
| Toluene (1% SOM) | 130 | 880 (869) | 22 | 56000 (869) | 56000 | 87000 (869) | | | | | | | | | | | | | |
| Toluene (2.5% SOM) | 290 | 1900 | 51 | 110000 (1920) | 56000 | 95000 (1920) | | | | | | | | | | | | | |
| Toluene (6% SOM) | 660 | 3900 | 120 | 180000 (4360) | 56000 | 100000 (4360) | | | | | | | 610 | 120 | $4.4x10^3$ | | | | |
| Ethyl benzene (1% SOM) | 47 | 83 | 16 | 5700 (518) | 24000 | 17000 (518) | | | | | | | | | | | | | |
| Ethyl benzene (2.5% SOM) | 110 | 190 | 39 | 13000 (1220) | 24000 | 22000 (1220) | | | | | | | | | | | | | |
| Ethyl benzene (6% SOM) | 260 | 440 | 91 | 27000 (2840) | 25000 | 27000 (2840) | | | | | | | 350 | 90 | $2.8x10^3$ | | | | |
| o-xylene (1%SOM) | 60 | 88 | 28 | 6600 (478) | 41000 | 17000 (478) | | | | | | | | | | | | | |
| o-xylene (2.5% SOM) | 140 | 210 | 67 | 15000 (1120) | 42000 | 24000 (1120) | | | | | | | | | | | | | |
| o-xylene (6% SOM) | 330 | 480 | 160 | 33000 (2620) | 43000 | 33000 (2620) | | | | | | | 250 | 160 | $2.6x10^3$ | | | | |
| m-xylene (1% SOM) | 59 | 82 | 31 | 6200 (625) | 41000 | 17000 (625) | | | | | | | | | | | | | |
| m-xylene (2.5% SOM) | 140 | 190 | 74 | 14000 (1470) | 42000 | 24000 (1470) | | | | | | | | | | | | | |
| m-xylene (6% SOM) | 320 | 450 | 170 | 31000 (3460) | 43000 | 32000 (3469) | | | | | | | 240 | 180 | $3.5x10^3$ | | | | |
| p-xylene (1% SOM) | 56 | 79 | 29 | 5900 (576) | 41000 | 17000 (478) | | | | | | | | | | | | | |
| p-xylene (2.5% SOM) | 130 | 180 | 69 | 14000 (1350) | 42000 | 23000 (1350) | | | | | | | | | | | | | |
| p-xylene (6% SOM) | 310 | 430 | 160 | 30000 (3170) | 43000 | 31000 (3170) | | | | | | | 230 | 160 | $3.2x10^3$ | | | | |
| Methyl tert-butyl ether (1% SOM) | | | | | | | | | | | | | | | | 49 | 73 | 23 | 7900 |
| Methyl tert-butyl ether (2.5% SOM) | | | | | | | | | | | | | | | | 84 | 120 | 44 | 13000 |
| Methyl tert-butyl ether (6% SOM) | | | | | | | | | | | | | | | | 160 | 220 | 90 | 24000 |

**Additional Notes for LQM/CIEH Generic Assessment Criteria**

1 For residential land use the inhalation of vapours indoors exposure pathway is the most significant exposure pathway for the lighter end aliphatic and aromatic fractions (up to aliphatic EC>12-16 and aromatic EC>10-12). The ingestion of soil and indoor dust and consumption of homegrown produce exposure pathways are the most significant for the higher end fractions (aliphatics EC>16-35 and EC>35-44; aromatics EC>12-16, EC16-21, EC>21-35, EC>35-44 and EC44-70).

2 For the allotment land use the consumption of homegrown produce exposure pathway is the most significant for the aromatic and lighter end aliphatic fractions. The ingestion of soil and and indoor dust is the most significant exposure pathway for the higher end aliphatics EC>12-16, EC>16-35 and EC35-44.

3 For the commercial land use the indoor inhalation of vapour exposure pathway is a significant exposure pathway for the lighter end aliphatic and aromatic fractions (up to aliphatic EC>12-16 and aromatic EC>10-12.

4 Background exposure represents a significant proportion of the total exposure for all fractions expect aromatic fractions EC>5-7 and EC>7-8 in all land uses.

**Notes for SGVs**

1 Based on a sandy loam as defined in Environment Agency (2009b) and 6% SOM. At a lower SOM, SGVs may not be sufficient protective.
2 Generic assessment criteria will vary according to SOM for all land uses.
3 SGVs assume that free phase contamination is not present.
4 SGVs based on a sub-surface soil to indoor air correction air correction factor of 10.
5 SGV presented for Toluene Commercial based on the vapour saturation limit.
6 SGV presented for Ethylbenzene Allotment and Xylene Allotment - in applying the rules for non-soil background, the inhalation background ADE is limited to being no larger than the contribution of the inhalation soil ADE.
7 Exposure of all isomers of xylene should be considered together, because the HCV applied is based on intake of total xylene and not an individual isomer in isolation.

**Notes for EIC/AGS/CL:AIRE Generic Assessment Criteria**

1 GAC have been derived for 4 generic land uses; residential with consumption of homegrown produce, residential without consumption of homegrown produce, allotments and commercial land-use.

## POLYAROMATIC HYDROCARBONS

**Based on sandy loam soil as defined in SR3 (Environment Agency, 2009) and 1%, 2.5% and 6% soil organic matter (SOM)**
**Generic assessment criteria for Polycyclic Aromatic Hydrocarbons will vary according to SOM for all land values**
**Values are expressed in mg/kg**
**GACs assume that free phase contamination is not present**
**GACs are based on sub-surface soil to indoor air correction factor of 1**

| | LQM/CIEH | | | | | | C4SL | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Compound** | **Residential with home grown produce** | **Residential without home grown produce** | **Allotment** | **Commercial** | **POSresi** | **POSpark** | **Residential with home grown produce** | **Residential without home grown produce** | **Allotment** | **Commercial** | **POSresi** | **POSpark** |
| Acenaphthene (1% SOM) | 210 | 3000 (57) | 34 | 84000 (57) | 15000 | 29000 | | | | | | |
| Acenaphthene (2.5% SOM) | 510 | 4700 (141) | 85 | 97000 (141) | 15000 | 30000 | | | | | | |
| Acenaphthene (6% SOM) | 1100 | 6000 (336) | 200 | 100000 | 15000 | 30000 | | | | | | |
| Acenaphthylene (1% SOM) | 170 | 2900 (86.1) | 28 | 83000 (86.1) | 15000 | 29000 | | | | | | |
| Acenaphthylene (2.5% SOM) | 420 | 4600 (212) | 69 | 97000 (212) | 15000 | 30000 | | | | | | |
| Acenaphthylene (6% SOM) | 920 | 6000 (506) | 160 | 100000 | 15000 | 30000 | | | | | | |
| Anthracene (1% SOM) | 2400 | 31000 (1.17) | 380 | 520000 | 74000 | 150000 | | | | | | |
| Anthracene (2.5% SOM) | 5400 | 35000 | 950 | 540000 | 74000 | 150000 | | | | | | |
| Anthracene (6% SOM) | 11000 | 37000 | 2200 | 540000 | 74000 | 150000 | | | | | | |
| Benz(a)anthracene (1% SOM) | 7.2 | 11 | 2.9 | 170 | 29 | 49 | | | | | | |
| Benz(a)anthracene (2.5% SOM) | 11 | 14 | 6.5 | 170 | 29 | 56 | | | | | | |
| Benz(a)anthracene (6% SOM) | 13 | 15 | 13 | 180 | 29 | 62 | | | | | | |
| Benzo(a)pyrene (1% SOM) | 2.2 | 3.2 | 0.97 | 35 | 5.7 | 11 | | | | | | |
| Benzo(a)pyrene (2.5% SOM) | 2.7 | 3.2 | 2.0 | 35 | 5.7 | 12 | | | | | | |
| Benzo(a)pyrene (6% SOM) | 3.0 | 3.2 | 3.5 | 36 | 5.7 | 13 | 5.0 | 5.3 | 5.7 | 77 | 10 | 21 |
| Benzo(b)fluoranthene (1% SOM) | 2.6 | 3.9 | 0.99 | 44 | 7.1 | 13 | | | | | | |
| Benzo(b)fluoranthene (2.5% SOI | 3.3 | 4.0 | 2.1 | 44 | 7.2 | 15 | | | | | | |
| Benzo(b)fluoranthene (6% SOM) | 3.7 | 4.0 | 3.9 | 45 | 7.2 | 16 | | | | | | |
| Benzo(ghi)perylene (1% SOM) | 320 | 360 | 290 | 3900 | 640 | 1400 | | | | | | |
| Benzo(ghi)perylene (2.5% SOM) | 340 | 360 | 470 | 4000 | 640 | 1500 | | | | | | |
| Benzo(ghi)perylene (6% SOM) | 350 | 360 | 640 | 4000 | 640 | 1600 | | | | | | |
| Benzo(k)fluoranthene (1% SOM) | 77 | 110 | 37 | 1200 | 190 | 370 | | | | | | |
| Benzo(k)fluoranthene (2.5% SOI | 93 | 110 | 75 | 1200 | 190 | 410 | | | | | | |
| Benzo(k)fluoranthene (6% SOM) | 100 | 110 | 130 | 1200 | 190 | 440 | | | | | | |
| Chrysene (1% SOM) | 15 | 30 | 4.1 | 350 | 57 | 93 | | | | | | |
| Chrysene (2.5% SOM) | 22 | 31 | 9.4 | 350 | 57 | 110 | | | | | | |
| Chrysene (6% SOM) | 27 | 32 | 19 | 350 | 57 | 120 | | | | | | |
| Dibenzo(ah)anthracene (1% SOI | 0.24 | 0.31 | 0.14 | 3.5 | 0.57 | 1.1 | | | | | | |
| Dibenzo(ah)anthracene (2.5% S | 0.28 | 0.32 | 0.27 | 3.6 | 0.57 | 1.3 | | | | | | |
| Dibenzo(ah)anthracene (6% SOI | 0.3 | 0.32 | 0.43 | 3.6 | 0.58 | 1.4 | | | | | | |
| Fluoranthene (1% SOM) | 280 | 1500 | 52 | 23000 | 3100 | 6300 | | | | | | |
| Fluoranthene (2.5% SOM) | 560 | 1600 | 130 | 23000 | 3100 | 6300 | | | | | | |
| Fluoranthene (6% SOM) | 890 | 1600 | 290 | 23000 | 3100 | 6400 | | | | | | |
| Fluorene (1% SOM) | 170 | 2800 (30.9) | 27 | 63000 (30.9) | 9900 | 20000 | | | | | | |
| Fluorene (2.5% SOM) | 400 | 3800 (76.5) | 67 | 68000 | 9900 | 20000 | | | | | | |
| Fluorene (6% SOM) | 860 | 4500 (183) | 160 | 71000 | 9900 | 20000 | | | | | | |
| Indeno(123cd)pyrene (1% SOM) | 27 | 45 | 9.5 | 500 | 82 | 150 | | | | | | |
| Indeno(123cd)pyrene (2.5% SOI | 36 | 46 | 21 | 510 | 82 | 170 | | | | | | |
| Indeno(123cd)pyrene (6% SOM) | 41 | 46 | 39 | 510 | 82 | 180 | | | | | | |
| Naphthalene (1% SOM) | 2.3 | 2.3 | 4.1 | 190 (76.4) | 4900 | 1200 (76.4) | | | | | | |
| Naphthalene (2.5% SOM) | 5.6 | 5.6 | 10 | 460 (183) | 4900 | 1900 (183) | | | | | | |
| Naphthalene (6% SOM) | 13 | 13 | 24 | 1100 (432) | 4900 | 3000 | | | | | | |
| Phenanthrene (1% SOM) | 95 | 1300 (36) | 15 | 22000 | 3100 | 6200 | | | | | | |
| Phenanthrene (2.5% SOM) | 220 | 1500 | 38 | 22000 | 3100 | 6200 | | | | | | |
| Phenanthrene (6% SOM) | 440 | 1500 | 90 | 22000 | 3100 | 6300 | | | | | | |
| Pyrene (1% SOM) | 620 | 3700 | 110 | 54000 | 7400 | 15000 | | | | | | |
| Pyrene (2.5% SOM) | 1200 | 3800 | 270 | 54000 | 7400 | 15000 | | | | | | |
| Pyrene (6% SOM) | 2000 | 3800 | 620 | 54000 | 7400 | 15000 | | | | | | |
| Coal Tar (BaP as surrogate marl | 0.79 | 1.2 | 0.32 | 15 | 2.2 | 4.4 | | | | | | |
| Coal Tar (BaP as surrogate marl | 0.98 | 1.2 | 0.67 | 15 | 2.2 | 4.7 | | | | | | |
| Coal Tar (BaP as surrogate marl | 1.1 | 1.2 | 1.2 | 15 | 2.2 | 4.9 | | | | | | |

## CHLOROALCANES AND ALKANES

**Based on sandy loam soil as defined in SR3 (Environment Agency, 2009) and 1%, 2.5% and 6% soil organic matter (SOM)**
**Generic assessment criteria will vary according to SOM for all land values**
**Values are expressed in mg/kg**
**GACs assume that free phase contamination is not present**
**GACs are based on sub-surface soil to indoor air correction factor of 1**

| | S4UL | | | | | | EIC/AGS/CL:AIRE | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Compound** | **Residential with home grown produce** | **Residential without home grown produce** | **Allotment** | **Commercial** | **POSresi** | **POSpark** | **Residential with consumption of homegrown produce** | **Residential without consumption of homegrown produce** | **Allotment** | **Commercial** |
| 1,1-Dichloroethane (1% SOM) | | | | | | | 2.4 | 2.5 | 9.2 | 280 |
| 1,1-Dichloroethane (2.5% SOM) | | | | | | | 3.9 | 4.1 | 17 | 450 |
| 1,1-Dichloroethane (6% SOM) | | | | | | | 7.4 | 7.7 | 35 | 850 |
| 1,2-Dichloroethane (1% SOM) | 0.0071 | 0.0092 | 0.0046 | 0.67 | 29 | 21 | | | | |
| 1,2-Dichloroethane (2.5% SOM) | 0.011 | 0.013 | 0.0083 | 0.97 | 29 | 24 | | | | |
| 1,2-Dichloroethane (6% SOM) | 0.019 | 0.023 | 0.016 | 1.7 | 29 | 28 | | | | |
| 1,1,1-Trichloroethane (1% SOM) | 8.8 | 9 | 48 | 660 | 140000 | 57000 (1425) | | | | |
| 1,1,1-Trichloroethane (2.5% SOI | 18 | 18 | 110 | 1300 | 140000 | 76000 (2915) | | | | |
| 1,1,1-Trichloroethane (6% SOM) | 39 | 40 | 240 | 3000 | 140000 | 100000 (6392) | | | | |
| 1,1,2-Trichloroethane (1% SOM) | | | | | | | 0.6 | 0.88 | 0.28 | 94 |
| 1,1,2-Trichloroethane (2.5% SOM) | | | | | | | 1.2 | 1.8 | 0.61 | 190 |
| 1,1,2-Trichloroethane (6% SOM) | | | | | | | 2.7 | 3.9 | 1.4 | 400 |
| 1,1,1,2-Tetrachloroethane (1% S | 1.2 | 1.5 | 0.79 | 110 | 1400 | 1500 | | | | |
| 1,1,1,2-Tetrachloroethane (2.5% | 2.8 | 3.5 | 1.9 | 250 | 1400 | 1800 | | | | |
| 1,1,1,2-Tetrachloroethane (6% S | 6.4 | 8.2 | 4.4 | 560 | 1400 | 2100 | | | | |
| 1,1,2,2-Tetrachloroethane (1%SI | 1.6 | 3.9 | 0.41 | 270 | 1400 | 1800 | | | | |
| 1,1,2,2-Tetrachloroethane (2.5% | 3.4 | 8.0 | 0.89 | 550 | 1400 | 2100 | | | | |
| 1,1,2,2-Tetrachloroethane (6%SI | 7.5 | 17 | 2.0 | 1100 | 1400 | 2300 | | | | |
| 1,1-Dichloroethene (1% SOM) | | | | | | | 0.23 | 0.23 | 2.8 | 26 |
| 1,1-Dichloroethene (2.5% SOM) | | | | | | | 0.40 | 0.41 | 5.6 | 46 |
| 1,1-Dichloroethene (6% SOM) | | | | | | | 0.82 | 0.82 | 12 | 92 |
| Tetrachloroethene (1% SOM) | 0.18 | 0.18 | 0.65 | 19 | 1400 | 810 (424) | | | | |
| Tetrachloroethene (2.5% SOM) | 0.39 | 0.40 | 1.5 | 42 | 1400 | 1100 (951) | | | | |
| Tetrachloroethene (6% SOM) | 0.9 | 0.92 | 3.6 | 95 | 1400 | 1500 | | | | |
| Tetrachloromethane (1% SOM) | 0.026 | 0.026 | 0.45 | 2.9 | 890 | 190 | | | | |
| Tetrachloromethane (2.5% SOM | 0.056 | 0.056 | 1.0 | 6.3 | 920 | 270 | | | | |
| Tetrachloromethane (6% SOM) | 0.13 | 0.13 | 2.4 | 14 | 950 | 400 | | | | |
| Trichloroethene (1% SOM) | 0.016 | 0.017 | 0.041 | 1.2 | 120 | 70 | | | | |
| Trichloroethene (2.5% SOM) | 0.034 | 0.036 | 0.091 | 2.6 | 120 | 91 | | | | |
| Trichloroethene (6% SOM) | 0.075 | 0.080 | 0.21 | 5.7 | 120 | 120 | | | | |
| Trichloromethane (1% SOM) | 0.91 | 1.2 | 0.42 | 99 | 2500 | 2600 | | | | |
| Trichloromethane (2.5% SOM) | 1.7 | 2.1 | 0.83 | 170 | 2500 | 2800 | | | | |
| Trichloromethane (6% SOM) | 3.4 | 4.3 | 1.7 | 350 | 2500 | 3100 | | | | |
| Vinyl Chloride (1% SOM) | 0.00064 | 0.00077 | 0.00055 | 0.059 | 3.5 | 4.8 | | | | |
| Vinyl Chloride (2.5% SOM) | 0.00087 | 0.0010 | 0.0010 | 0.077 | 3.5 | 5.0 | | | | |
| Vinyl Chloride (6% SOM) | 0.0014 | 0.0015 | 0.0018 | 0.12 | 3.5 | 5.4 | | | | |
| Chloroethane (1% SOM) | | | | | | | 8.3 | 8.4 | 110 | 960 |
| Chloroethane (2.5% SOM) | | | | | | | 11 | 11 | 200 | 1300 |
| Chloroethane (6% SOM) | | | | | | | 18 | 18 | 380 | 2100 |
| 1,2-Dichloropropane (1% SOM) | | | | | | | 0.024 | 0.024 | 0.62 | 3.3 |
| 1,2-Dichloropropane (2.5% SOM) | | | | | | | 0.042 | 0.042 | 1.2 | 5.9 |
| 1,2-Dichloropropane (6% SOM) | | | | | | | 0.084 | 0.085 | 2.6 | 12 |
| 2-Chloronaphthalene (1% SOM) | | | | | | | 3.7 | 3.8 | 40 | 390 |
| 2-Chloronaphthalene (2.5% SOM) | | | | | | | 9.2 | 9.3 | 98 | 960 |
| 2-Chloronaphthalene (6% SOM) | | | | | | | 22 | 22 | 230 | 2200 |
| Bromodichloromethane (1% SOM) | | | | | | | 0.016 | 0.019 | 0.016 | 2.1 |
| Bromodichloromethane (2.5% SOM) | | | | | | | 0.030 | 0.034 | 0.032 | 3.7 |
| Bromodichloromethane (6% SOM) | | | | | | | 0.061 | 0.07 | 0.068 | 7.6 |
| Chloromethane (1% SOM) | | | | | | | 0.0083 | 0.0085 | 0.066 | 1 |
| Chloromethane (2.5% SOM) | | | | | | | 0.0098 | 0.0099 | 0.13 | 1.2 |
| Chloromethane (6% SOM) | | | | | | | 18 | 18 | 380 | 2100 |

| | S4UL | | | | | | EIC/AGS/CL:AIRE | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Compound** | **Residential with home grown produce** | **Residential without home grown produce** | **Allotment** | **Commercial** | **POSresi** | **POSpark** | **Residential with consumption of homegrown produce** | **Residential without consumption of homegrown produce** | **Allotment** | **Commercial** |
| *cis* -1,2 Dichloroethene (2.5% SOM) | | | | | | | 0.19 | 0.20 | 0.50 | 24 |
| *cis* -1,2 Dichloroethene (6% SOM) | | | | | | | 0.37 | 0.39 | 1.0 | 47 |
| *trans* -1,2 Dichloroethene (1% SOM) | | | | | | | 0.19 | 0.19 | 0.93 | 22 |
| *trans* -1,2 Dichloroethene (2.5% SOM) | | | | | | | 0.34 | 0.35 | 1.9 | 40 |
| *trans* -1,2 Dichloroethene (6% SOM) | | | | | | | 0.70 | 0.71 | 4.0 | 81 |
| Dichloromethane (1% SOM) | | | | | | | 0.58 | 2.1 | 0.1 | 270 |
| Dichloromethane (2.5% SOM) | | | | | | | 0.98 | 2.8 | 0.19 | 360 |
| Dichloromethane (6% SOM) | | | | | | | 1.7 | 4.5 | 0.34 | 560 |
| Hexachloroethane (1% SOM) | | | | | | | 0.2 | 0.22 | 0.27 | 22 |
| Hexachloroethane (2.5% SOM) | | | | | | | 0.48 | 0.54 | 0.67 | 53 |
| Hexachloroethane (6% SOM) | | | | | | | 1.1 | 1.3 | 1.6 | 120 |

**Notes for EIC/AGS/CL:AIRE Generic Assessment Criteria**

1 GAC have been derived for 4 generic land uses; residential with consumption of homegrown produce, residential without consumption of homegrown produce, allotments and commercial land-use.

## EXPLOSIVES

**Based on sandy loam soil as defined in SR3 (Environment Agency, 2009) and 1%, 2.5% and 6% soil organic matter (SOM)**
**Generic assessment criteria will vary according to SOM for all land values**
**Values are expressed in mg/kg**
**GACs assume that free phase contamination is not present**
**GACs are based on sub-surface soil to indoor air correction factor of 1**

| | S4UL | | | | | |
|---|---|---|---|---|---|---|
| **Compound** | **Residential with home grown produce** | **Residential without home grown produce** | **Allotment** | **Commercial** | **POSresi** | **POSpark** |
| RDX (1% SOM) | 120 | 13000 | 17 | 210000 | 210000 | 210000 |
| RDX (2.5% SOM) | 250 | 13000 | 38 | 210000 | 26000 | 49000 (18.7) |
| RDX (6% SOM) | 540 | 13000 | 85.0 | 210000 | 27000 | 53000 |
| HMX (1% SOM) | 5.7 | 6700 | 0.86 | 110000 | 13000 | 23000 (0.35) |
| HMX (2.5% SOM) | 13 | 6700 | 1.9 | 110000 | 13000 | 23000 (0.39) |
| HMX (6% SOM) | 26 | 6700 | 3.9 | 110000 | 13000 | 24000 (0.48) |

## PESTICIDES

**Based on sandy loam soil as defined in SR3 (Environment Agency, 2009) and 1%, 2.5% and 6% soil organic matter (SOM)**
**Generic assessment criteria will vary according to SOM for all land values**
**Values are expressed in mg/kg**
**GACs assume that free phase contamination is not present**
**GACs are based on sub-surface soil to indoor air correction factor of 1**

| Compound | S4UL Residential with home grown produce | Residential without home grown produce | Allotment | Commercial | POSresi | POSpark |
|---|---|---|---|---|---|---|
| Aldrin (1% SOM) | 5.7 | 7.3 | 3.2 | 170 | 18 | 30 |
| Aldrin (2.5% SOM) | 6.6 | 7.4 | 6.1 | 170 | 18 | 31 |
| Aldrin (6% SOM) | 7.1 | 7.5 | 9.6 | 170 | 18 | 31 |
| | | | | | | |
| Dieldrin (1% SOM) | 0.97 | 7 | 0.17 | 170 | 18 | 30 |
| Dieldrin (2.5% SOM) | 2 | 7.3 | 0.41 | 170 | 18 | 30 |
| Dieldrin (6% SOM) | 3.5 | 7.4 | 0.96 | 170 | 18 | 31 |
| | | | | | | |
| Atrazine (1% SOM) | 3.3 | 610 | 0.5 | 9300 | 1200 | 2300 |
| Atrazine (2.5% SOM) | 7.6 | 620 | 1.2 | 9400 | 1200 | 2400 |
| Atrazine (6% SOM) | 17.4 | 620 | 2.7 | 9400 | 1200 | 2400 |
| | | | | | | |
| Dichlorovos (1% SOM) | 0.032 | 6.4 | 0.0049 | 140 | 16 | 26 |
| Dichlorovos (2.5% SOM) | 0.066 | 6.5 | 0.010 | 140 | 16 | 26 |
| Dichlorovos (6% SOM) | 0.14 | 6.6 | 0.022 | 140 | 16 | 27 |
| | | | | | | |
| Alpha-Endosulfan (1% SOM) | 7.4 | 160 (0.003) | 1.2 | 5600 (0.003) | 1200 | 2400 |
| Alpha-Endosulfan (2.5% SOM) | 18 | 280 (0.007) | 2.9 | 7400 (0.007) | 1200 | 2400 |
| Alpha-Endosulfan (6% SOM) | 41 | 410 (0.016) | 6.8 | 8400 (0.016) | 1200 | 2500 |
| | | | | | | |
| Beta-Endosulfan (1% SOM) | 7 | 190 (0.00007) | 1.1 | 6300 (0.00007) | 1200 | 2400 |
| Beta-Endosulfan (2.5% SOM) | 17 | 320 (0.0002) | 2.7 | 7800 (0.0002) | 1200 | 2400 |
| Beta-Endosulfan (6% SOM) | 39 | 440 (0.0004) | 6.4 | 8700 | 1200 | 2500 |
| | | | | | | |
| Alpha-Hexachlorocyclohexanes ( | 0.23 | 6.9 | 0.035 | 170 | 24 | 47 |
| Alpha-Hexachlorocyclohexanes ( | 0.55 | 9.2 | 0.087 | 180 | 24 | 48 |
| Alpha-Hexachlorocyclohexanes ( | 1.2 | 11 | 0.21 | 180 | 24 | 48 |
| | | | | | | |
| Beta-Hexachlorocyclohexanes (1 | 0.085 | 3.7 | 0.013 | 65 | 8.1 | 15 |
| Beta-Hexachlorocyclohexanes (2 | 0.2 | 3.8 | 0.032 | 65 | 8.1 | 15 |
| Beta-Hexachlorocyclohexanes (6 | 0.46 | 3.8 | 0.077 | 65 | 8.1 | 16 |
| | | | | | | |
| Gamma-Hexachlorocyclohexane | 0.06 | 2.9 | 0.0092 | 67 | 8.2 | 14 |
| Gamma-Hexachlorocyclohexane | 0.14 | 3.3 | 0.023 | 69 | 8.2 | 15 |
| Gamma-Hexachlorocyclohexane | 0.33 | 3.5 | 0.054 | 70 | 8.2 | 15 |

## CHLOROBENZENES & METHYLBENZENES

**Based on sandy loam soil as defined in SR3 (Environment Agency, 2009) and 1%, 2.5% and 6% soil organic matter (SOM)**
**Generic assessment criteria will vary according to SOM for all land values**
**Values are expressed in mg/kg**
**GACs assume that free phase contamination is not present**
**GACs are based on sub-surface soil to indoor air correction factor of 1**

| | S4UL | | | | | | EIC/AGS/CL:AIRE | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Compound** | **Residential with homegrown produce** | **Residential without homegrown produce** | **Allotment** | **Commercial** | **POSresi** | **POSpark** | **Residential with consumption of homegrown produce** | **Residential without consumption of homegrown produce** | **Allotment** | **Commercial** |
| Chlorobenzene (1% SOM) | 0.46 | 0.46 | 5.9 | 56 | 11000 | 1300 (675) | | | | |
| Chlorobenzene (2.5% SOM) | 1.0 | 1.0 | 14 | 130 | 13000 | 2000 (1520) | | | | |
| Chlorobenzene (6% SOM) | 2.4 | 2.4 | 32 | 290 | 14000 | 2900 | | | | |
| 1,2-Dichlorobenzene (1% SOM) | 23 | 24 | 94 | 2000 (571) | 90000 | 24000 (571) | | | | |
| 1,2-Dichlorobenzene (2.5% SOM | 55 | 57 | 230 | 4800 (1370) | 95000 | 36000 (1370) | | | | |
| 1,2-Dichlorobenzene (6% SOM) | 130 | 130 | 540 | 11000 (3240) | 98000 | 51000 (3270) | | | | |
| 1,3-Dichlorobenzene (1% SOM) | 0.40 | 0.44 | 0.25 | 30 | 300 | 390 | | | | |
| 1,3-Dichlorobenzene (2.5% SOM | 1.0 | 1.1 | 0.6 | 73 | 300 | 440 | | | | |
| 1,3-Dichlorobenzene (6% SOM) | 2.3 | 2.5 | 1.5 | 170 | 300 | 470 | | | | |
| 1,4-Dichlorobenzene (1% SOM) | 61 | 61 | 15 | 4400 (224) | 17000 | 36000 (224) | | | | |
| 1,4-Dichlorobenzene (2.5% SOM | 150 | 150 | 37 | 10000 (540) | 17000 | 36000 (540) | | | | |
| 1,4-Dichlorobenzene (6% SOM) | 350 | 350 | 88 | 25000 (1280) | 17000 | 36000 (1280) | | | | |
| 1,2,3-Trichlorobenzene (1% SOI | 1.5 | 1.5 | 4.7 | 102 | 1800 | 770 (134) | | | | |
| 1,2,3-Trichlorobenzene (2.5% S( | 3.6 | 3.7 | 12 | 250 | 1800 | 110 (330) | | | | |
| 1,2,3-Trichlorobenzene (6% SOI | 8.6 | 8.8 | 28 | 590 | 1800 | 1600 (789) | | | | |
| 1,2,4-Trichlorobenzene (1% SOI | 2.6 | 2.6 | 55 | 220 | 15000 | 1700 (318) | | | | |
| 1,2,4-Trichlorobenzene (2.5% S( | 6.4 | 6.4 | 140 | 530 | 17000 | 2600 (786) | | | | |
| 1,2,4-Trichlorobenzene (6% SOI | 15 | 15 | 320 | 1300 | 19000 | 400 (1880) | | | | |
| 1,3,5-Trichlorobenzene (1% SOI | 0.33 | 0.33 | 4.7 | 23 | 1700 | 380 (36.7) | | | | |
| 1,3,5-Trichlorobenzene (2.5% S( | 0.81 | 0.81 | 12 | 55 | 1700 | 580 (90.8) | | | | |
| 1,3,5-Trichlorobenzene (6% SOI | 1.9 | 1.9 | 28 | 130 | 1800 | 860 (217) | | | | |
| 1,2,3,4-Tetrachlorobenzene (1% | 15 | 24 | 4.4 | 1700 (122) | 830 | 1500 (122) | | | | |
| 1,2,3,4-Tetrachlorobenzene (2.5 | 36 | 56 | 11 | 3080 (304) | 830 | 1600 | | | | |
| 1,2,3,4-Tetrachlorobenzene (6% | 78 | 120 | 26 | 4400 (728) | 830 | 1600 | | | | |
| 1,2,3,5-Tetrachlorobenzene (1% | 0.66 | 0.75 | 0.38 | 49 (39.4) | 78 | 110 (39) | | | | |
| 1,2,3,5-Tetrachlorobenzene (2.5 | 1.6 | 1.9 | 0.90 | 120 (98.1) | 79 | 120 | | | | |
| 1,2,3,5-Tetrachlorobenzene (6% | 3.7 | 4.3 | 2.2 | 240 (235) | 79 | 130 | | | | |
| 1,2,4,5-Tetrachlorobenzene (1% | 0.33 | 0.73 | 0.06 | 42 (19.7) | 13 | 25 | | | | |
| 1,2,4,5-Tetrachlorobenzene (2.5 | 0.77 | 1.7 | 0.16 | 72 (49.1) | 13 | 26 | | | | |
| 1,2,4,5-Tetrachlorobenzene (6% | 1.6 | 3.5 | 0.37 | 96 | 13 | 26 | | | | |
| Pentachlorobenzene (1% SOM) | 5.8 | 19 | 1.2 | 640 (43.0) | 100 | 190 | | | | |
| Pentachlorobenzene (2.5% SOM | 12 | 30 | 3.1 | 770 (107) | 100 | 190 | | | | |
| Pentachlorobenzene (6% SOM) | 22 | 38 | 7.0 | 830 | 100 | 190 | | | | |
| Hexachlorobenzene (1% SOM) | 1.8 (0.20) | 4.1 (0.20) | 0.47 | 110 (0.20) | 16 | 30 | | | | |
| Hexachlorobenzene (2.5% SOM) | 3.3 (0.50) | 5.7 (0.50) | 1.1 | 120 | 16 | 30 | | | | |
| Hexachlorobenzene (6% SOM) | 4.9 | 6.7 (1.2) | 2.5 | 120 | 16 | 30 | | | | |
| 1,2,4-Trimethylbenzene (1% SOM) | | | | | | | 0.35 | 0.41 | 0.38 | 42 |
| 1,2,4-Trimethylbenzene (2.5% SOM) | | | | | | | 0.85 | 0.99 | 0.93 | 99 |
| 1,2,4-Trimethylbenzene (6% SOM) | | | | | | | 2 | 2.3 | 2.2 | 220 |
| Isopropyl benzene (1% SOM) | | | | | | | 11 | 12 | 32 | 1400 |
| Isopropyl benzene (2.5% SOM) | | | | | | | 27 | 28 | 79 | 3300 |
| Isopropyl benzene (6% SOM) | | | | | | | 64 | 67 | 190 | 7700 |
| Propylbenzene (1% SOM) | | | | | | | 34 | 40 | 34 | 4100 |
| Propylbenzene (2.5% SOM) | | | | | | | 82 | 97 | 83 | 9700 |
| Propylbenzene (6% SOM) | | | | | | | 190 | 230 | 200 | 21000 |
| Styrene (1% SOM) | | | | | | | 8.1 | 35 | 1.6 | 3300 |
| Styrene (2.5% SOM) | | | | | | | 19 | 78 | 3.7 | 6500 |
| Styrene (6% SOM) | | | | | | | 43 | 170 | 8.7 | 11000 |

## PHENOLS AND CHLOROPHENOLS

**Based on sandy loam soil as defined in SR3 (Environment Agency, 2009) and 1%, 2.5% and 6% soil organic matter (SOM)**
**Generic assessment criteria will vary according to SOM for all land values**
**Values are expressed in mg/kg**
**GACs assume that free phase contamination is not present**
**GACs are based on sub-surface soil to indoor air correction factor of 1**

| | LQM/CIEH | | | | | | EA SGV | | | EIC/AGS/CL:AIRE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Compound** | **Residential with home grown produce** | **Residential without home grown produce** | **Allotment** | **Commercial** | **POSresi** | **POSpark** | **Residential** | **Allotment** | **Commercial** | **Residential with consumption of homegrown produce** | **Residential without consumption of homegrown produce** | **otm** | **Commercial** |
| Phenol (1% SOM) | 120 | 440 (460) | 23 | 440 (26000) | 440 (10000) | 440 (7600) | | | | | | | |
| Phenol (2.5% SOM) | 200 | 690 | 42 | 690 (30000) | 690 (10000) | 690 (8300) | | | | | | | |
| Phenol (6% SOM) | 380 | 1200 | 83 | 1300 (34000) | 1300 (10000) | 1300 (9300) | 420 | 280 | 3200 (38000) | | | | |
| Chlorophenol (1% SOM) | 0.87 | 94 | 0.13 | 3500 | 620 | 1100 | | | | | | | |
| Chlorophenol (2.5% SOM) | 2.0 | 150 | 0.30 | 4000 | 620 | 1100 | | | | | | | |
| Chlorophenol (6% SOM) | 4.5 | 210 | 0.70 | 4300 | 620 | 1100 | | | | | | | |
| Pentachlorophenol (1% SOM) | 0.22 | 27 (16.7) | 0.03 | 400 | 60 | 110 | | | | | | | |
| Pentachlorophenol (2.5% SOM) | 0.52 | 29 | 0.08 | 400 | 60 | 120 | | | | | | | |
| Pentachlorophenol (6% SOM) | 1.2 | 31 | 0.19 | 400 | 60 | 120 | | | | | | | |
| 2,4-Dimethylphenol (1% SOM) | | | | | | | | | | 19 | 210 | 3 | 16000 |
| 2,4-Dimethylphenol (2.5% SOM) | | | | | | | | | | 43 | 410 | 7 | 24000 |
| 2,4-Dimethylphenol (6%SOM) | | | | | | | | | | 97 | 730 | 17 | 30000 |
| Total Cresols (2-Methylphenol, 3-methylphenol, 4-methylphenol) (1%SOM) | | | | | | | | | | 80 | 3700 | 12 | 160000 |
| Total Cresols (2-Methylphenol, 3-methylphenol, 4-methylphenol) (2.5%SOM) | | | | | | | | | | 180 | 5400 | 27 | 180000 |
| Total Cresols (2-Methylphenol, 3-methylphenol, 4-methylphenol) (6%SOM) | | | | | | | | | | 400 | 6900 | 63 | 180000 |

## PHTHALATES

**Based on sandy loam soil as defined in SR3 (Environment Agency, 2009) and 1%, 2.5% and 6% soil organic matter (SOM)**
**Generic assessment criteria will vary according to SOM for all land values**
**Values are expressed in mg/kg**
**GACs assume that free phase contamination is not present**
**GACs are based on sub-surface soil to indoor air correction factor of 1**

| | EIC/AGS/CL:AIRE | | | |
|---|---|---|---|---|
| **Compound** | **Residential with consumption of homegrown produce** | **Residential without consumption of homegrown produce** | **Allotment** | **Commercial** |
| Bis (2-ethylhexyl) phthalate (1% | 280 | 2700 | 47 | 85000 |
| Bis (2-ethylhexyl) phthalate (2.5 | 610 | 2800 | 120 | 86000 |
| Bis (2-ethylhexyl) phthalate (6% | 1100 | 2800 | 280 | 86000 |
| Butyl benzyl phthalate (1% SOM | 1400 | 42000 | 220 | 940000 |
| Butyl benzyl phthalate (2.5% SO | 3300 | 44000 | 550 | 940000 |
| Butyl benzyl phthalate (6% SOM | 7200 | 44000 | 1300 | 950000 |
| Diethyl Phthalate (1% SOM) | 120 | 1800 | 19 | 1500000 |
| Diethyl Phthalate (2.5% SOM) | 260 | 3500 | 41 | 220000 |
| Diethyl Phthalate (6% SOM) | 570 | 6300 | 94 | 290000 |
| Di-*n*-butyl phthalate (1% SOM) | 13 | 450 | 2 | 15000 |
| Di-*n*-butyl phthalate (2.5% SOM | 31 | 450 | 5 | 15000 |
| Di-*n*-butyl phthalate (6% SOM) | 67 | 450 | 12 | 15000 |
| Di-*n*-octyl phthalate (1% SOM) | 2300 | 3400 | 940 | 89000 |
| Di-*n*-octyl phthalate (2.5% SOM | 2800 | 3400 | 2100 | 89000 |
| Di-*n*-octyl phthalate (6% SOM) | 3100 | 3400 | 3900 | 89000 |

# OTHER ORGANICS

**Based on sandy loam soil as defined in SR3 (Environment Agency, 2009) and 1%, 2.5% and 6% soil organic matter (SOM)**
**Generic assessment criteria will vary according to SOM for all land values**
**Values are expressed in mg/kg**
**GACs assume that free phase contamination is not present**
**GACs are based on sub-surface soil to indoor air correction factor of 1**

| | S4UL | | | | | | EIC/AGS/CL:AIRE | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Compound** | **Residential with home grown produce** | **Residential without home grown produce** | **Allotment** | **Commercial** | **POSresi** | **POSpark** | **Residential with consumption of homegrown produce** | **Residential without consumption of homegrown produce** | **Allotment** | **Commercial** |
| Carbon disulphide (1% SOM) | 0.14 | 0.14 | 4.8 | 11 | 11000 | 1300 | | | | |
| Carbon disulphide (2.5% SOM) | 0.29 | 0.29 | 10 | 22 | 11000 | 1900 | | | | |
| Carbon disulphide (6% SOM) | 0.62 | 0.62 | 23 | 47 | 12000 | 2700 | | | | |
| Hexachloro-1,3-butadiene (1% S | 0.29 | 0.32 | 0.25 | 31 | 25 | 48 | | | | |
| Hexachloro-1,3-butadiene (2.5% | 0.70 | 0.78 | 0.61 | 66 | 25 | 50 | | | | |
| Hexachloro-1,3-butadiene (6% S | 1.6 | 1.8 | 1.4 | 120 | 25 | 51 | | | | |
| Tributyl tin oxide (1% SOM) | | | | | | | 0.25 | 1.4 | 0.042 | 130 |
| Tributyl tin oxide (2.5% SOM) | | | | | | | 0.59 | 3.1 | 0.1 | 180 |
| Tributyl tin oxide (6% SOM) | | | | | | | 1.3 | 5.7 | 0.24 | 200 |
| Biphenyl (1% SOM) | | | | | | | 66 | 220 | 14 | 18000 |
| Biphenyl (2.5% SOM) | | | | | | | 160 | 500 | 35 | 33000 |
| Biphenyl (6% SOM) | | | | | | | 360 | 980 | 83 | 48000 |
| 2,4-Dinitrotoluene (1% SOM) | | | | | | | 1.5 | 170 | 0.22 | 3700 |
| 2,4-Dinitrotoluene (2.5% SOM) | | | | | | | 3.2 | 170 | 0.49 | 3700 |
| 2,4-Dinitrotoluene (6% SOM) | | | | | | | 7.2 | 170 | 1.1 | 3800 |
| 2,6-Dintrotoluene (1% SOM) | | | | | | | 0.78 | 78 | 0.12 | 1900 |
| 2,6-Dintrotoluene (2.5% SOM) | | | | | | | 1.7 | 84 | 0.27 | 1900 |
| 2,6-Dintrotoluene (6% SOM) | | | | | | | 3.9 | 87 | 0.61 | 1900 |
| Bromoform (1% SOM) | | | | | | | 2.8 | 5.2 | 0.95 | 760 |
| Bromoform (2.5% SOM) | | | | | | | 5.9 | 11 | 2.1 | 1500 |
| Bromoform (6% SOM) | | | | | | | 13 | 23 | 4.6 | 3100 |

## 6. GEOENVIRONMENTAL RISK ASSESSMENT

6.1 **Potential Hazard Sources.** Ground contamination can occur through several causes, particularly from historical use of the site and is often linked to the processes of waste disposal, underground storage, open storage, process pipework, leaks, spillages, tanks, site filling and various other reasons. The contamination can either arise from site sources or be the result of migration from other sources off site.

6.2 **Potential Migratory Pathways.** The primary pathways are considered to be laterally or vertically downward through underlying strata or upward to the ground surface. Such pathways also provide the potential for contaminants to migrate towards local watercourses and groundwater.

6.3 **Potential Targets At Risk.** Potential environmental liabilities related to current legislation associated with contaminated land with regard to existing ownership and redevelopment are summarised.

The probability of a hazard, linked with its consequences, can be used to assess risk in accordance with the tables below for use in decision making.

**Consequence of Pollution Linkage**

| | |
|---|---|
| **Severe** | Damage to human health.<br>Substantial pollution of controlled waters.<br>Significant change in ecosystem population.<br>Irreparable damage to property. |
| **Moderate** | Non-permanent damage to human health.<br>Minor pollution of controlled waters.<br>Change in ecosystem.<br>Damage to property. |
| **Mild** | Short term health effects.<br>Slight pollution of controlled waters.<br>Slight effect on ecosystem.<br>Minor repairable damage to property. |
| **Near Zero** | No noticeable effect on human health.<br>No significant pollution to controlled waters.<br>No measurable effect on ecosystem densities.<br>Non-structural cosmetic damage to property. |

**Decision Making**

| **Probability of a hazard and an associated linkage** | **Consequences of a pollution linkage (hazard-pathway-target)** | | | |
|---|---|---|---|---|
| | Severe | Moderate | Mild | Near Zero |
| High | High | High | Medium/low | Negligible |
| Medium | High | Medium | Low | Negligible |
| Low | High/medium | Medium/low | Low | Negligible |
| Unlikely | High/medium/low | Medium/low | Low | Negligible |

Final overall risk is based on an assessment of probability of a hazard and its consequences. Risk categories are shown shaded in the table above and defined below.

| **Risk** | **Description** |
|---|---|
| High | Site probably or certainly unsuitable for present use or environmental setting. Contamination probably or certainly present and likely to have an unacceptable impact on key targets. Urgent action needed. |
| Medium/ Moderate | Site may not be suitable for present use or environmental setting. Contamination may be present, and likely to have unacceptable impact on key targets. Action may be needed on the medium term. |
| Low | Site considered suitable for present use and environmental setting. Contamination may be present but unlikely to have unacceptable impacts on key targets. Action unlikely to be needed in present use. |
| Negligible | Site considered suitable for present use and environmental setting. Contamination may be present but unlikely to have unacceptable impacts on key targets. No action needed while site remains in present use. |

The review of the information from the exploratory investigation may be such that a decision is made that there is no need for further investigation. Alternatively, it may be necessary to carry out a further main investigation.

The Environment Agency has set out guidance as to the classification of waste arising from construction sites in its document "The Definition of Waste" dated April 2006. This document outlines how waste is to be handled

The following activities are not regarded as a waste management activity requiring licencing.

1) Construction activities carried out for the purpose of producing a suitably engineered soil e.g. lime stabilisation, vibro-replacement and piling.

2) Uncontaminated materials produced on site (including excavated soils and materials from demolition) which can be reused without further treatment. Examples include site regrading and footing excavations.

   These must be done in accordance with the Planning Permission. Demolition material must be used in accordance with the quality protocols for the production of aggregates from inert waste, subject to appropriate testing and the lack of any harmful constituents. Uses include pipe bedding, backfill and sub-base.

3) Contaminated soils can be moved on-site providing they do not require treatment or containment. There should be no risk to the environment i.e. non-leachable and in accordance with Planning Permission. Relevant activities can include site regarding and use of materials below clean cover systems, capping, buildings and hardstanding.

Where contaminated materials have to be placed in an engineered cell to prevent pollution, then this would be classed as landfilling and require PPC permits. Any material taken off site is considered to be waste. However, this is under review. If material is waste, then there is a duty of care including ensuring material is transported by a registered carrier. The destination of material leaving the site should be regularly checked and Waste Transfer Notes kept.

**Clean Cover Systems**

According to the Environment Agency's Remediation Position Statements of May 2006, the placement of a cover system using "clean" material is not treatment of waste. Consequently, no licensing/permitting position statements are applicable to this type of remediation. If the cover system uses 'waste materials' in its construction, waste management licensing exemption paragraph 9A may be applicable to its installation. If the installation of the proposed cover system does not meet the criteria for registration of this exemption, the activity may be regulated through a waste management site license.

## 7. WASTE ACCEPTANCE CRITERIA (WAC)

The main objective of the Landfill Directive is to prevent or reduce as far as possible the negative effects of landfilling waste on the environment and on human health. It is intended to reduce the disposal of waste materials to landfills and to encourage more sustainable approaches to dealing with wastes. It bans the landfill of liquids and certain solid wastes, introduces requirements for the treatment of wastes prior to landfill and provides for the classification of landfills as sites for inert, hazardous or non-hazardous waste and prohibits co-disposal.

It sets out procedures for waste acceptance at landfills and the types of waste for each class of landfill as specified by Waste Acceptance Criteria (WAC). The WAC are predominantly lists of "limit values" for certain parameters obtained from standard leaching tests of wastes going to landfills. WAC are set out in the Landfill Directive itself. Full details can be found in the Environment Agency document "Waste Classification – Guidance on the classification and Assessment of Waste " Technical Guidance WM3 - 2015

## 8. MAIN REFERENCES


| | |
|---|---|
| British Standards | BS3882: 2015 British Standard Specification for Topsoil<br>BS5930: 2015+A1:2020 British Standard Code of Practice for Site Investigations<br>BS8485: 2015 British Standard Code of Practice for the design and protective measures from methane and carbon dioxide ground gases for new buildings<br>BS10175: 2011+A2:2017 British Standard Code of Practice for the Investigation of Potentially Contaminated Sites |
| BRE | Radon: Guidance on protective measures for new dwellings, BR211, 2015<br>Protective measures for housing on gas-contaminated land, BR414, 2015<br>Cover systems for land regeneration, 2004<br>Concrete in aggressive ground. Special Digest SD1, 3rd Edition, 2005<br>Soakaway Design (DG365) |
| CIEH | The LQM / CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd Edition) |
| CIRIA | Assessing risks posed by hazardous ground gases to buildings, CIRIA C665<br>Asbestos in Soil and Made Ground: a guide to understanding and managing risks, CIRIAC733, 2014<br>Good Practice on the testing and verification of protection systems for buildings against hazardous ground gases. C735:2014 |
| CL:AIRE | Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination, SP1010, 2013 |
| DEFRA | Contaminated Land Report CLR 11, 2002 (7-10 withdrawn)<br>R & D Publications TOX 1 – 12, 14, 16 – 25<br>R & D Publications SGV 1, 3, 4, 5, 7, 8, 9, 10, 15 and 16 (withdrawn)<br>Improvements to Contaminated Land Guidance - "Outcome of the "Way Forward", 2008<br>Exercise on Soil Guideline Values. July 2008<br>Guidance on the Legal Definition of Contaminated Land. July 2008<br>Simplification of the Contaminated Land Regime Impact Assessment No: Defra 1133 |
| DETR | Circular 02/2000. Contaminated Land, 2000<br>Guidelines for Environmental Risk Assessment and Management, 2000 |
| Environment Agency | Guidance for the Safe Development of Housing on Land Affected by Contamination, 2000<br><br>Protective measures for housing on gas-contaminated land<br>Remediation Position Statements, May 2006<br>Guidance and monitoring of landfill leachate, groundwater and surface water<br>Human health toxicological assessment of contaminants in soil (Science Report SC050021/SR2) 2008<br>Updated technical background in the CLEA model (Science Report SC0520021/SR3)<br>Waste Classification – Guidance on the classification and Assessment of Waste - Technical Guidance WM3 (2015)<br>Contaminated Land Risk Management (2021) |
| HMSO | Part 2A of the Environmental Protection Act<br>Part 2A Statutory Guidance – April 2012<br>Contaminated Land (England) Regulations 2006<br>The Contaminated Land (England) (Amendment) Regulations 2012<br>The Water Act 2003 (Commencement No. 11) Order 2012 |
| Institution of Civil Engineers | Contaminated Land: Investigation, Assessment and Remediation, 2nd Edition |
| NHBC | Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present, 2007 |


This list is not intended to be exhaustive.