



ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

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16012-TRE-BRY-XXX-RP-EN-000005

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FINAL

Prepared for:

Wilmott Dixon on behalf of Transport
for Greater Manchester

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ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No : 16012-TRE-BRY-XXX-RP-EN-000005
Page No : i of i
Engineer: Stuart Milne
Date: 06/06/2025

CONTENTS

1.	INTRODUCTION.....	1
1.1.	Proposed Development	1
1.2.	Previous Reports	1
1.3.	Objectives	2
1.4.	Assumptions.....	2
2.	SITE DETAILS AND DESCRIPTION	4
3.	CONCEPTUAL MODEL AND QUALITATIVE RISK ASSESSMENT OF POLLUTANT LINKAGES	5
4.	ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT	7
4.1.	Objectives and Approach	7
4.2.	Asbestos Quantification Testing	7
4.3.	Concentration of Asbestos in Soils and Potential Fibre Release.....	7
4.4.	Exposure Scenario for the Critical Receptor	9
4.5.	Cumulative Exposure for the Described Worst Case Exposure Scenario.....	10
5.	UPDATED CONCEPTUAL MODEL AND QUALITATIVE RISK ASSESSMENT OF POLLUTANT LINKAGES	11
6.	REGULATORY APPROVALS	12
7.	REFERENCES	13
8.	GLOSSARY OF TERMS	14

TABLES

Table 2.1 Current Site Overview.	4
Table 3.1 Assessment of Pollutant Linkages.	6

FIGURES

Figure 2.1 Recent Aerial Photograph from Groundsure	4
Figure 4.1 Variations in the Normalised Airborne Respirable Fibre Concentrations (f ml-1/mg m-3) in Relation to Bulk Asbestos Content (Sand Soils) Reproduced from Figure 7 Addison et al (1988).	8

APPENDICES

Appendix A - Drawings	
Appendix B - Definitions of Terms Used in Qualitative and Quantitative Risk Assessments	
Appendix C - Complying With Control of Asbestos Regulations 2012	
Appendix D - Sobra Calculation Sheet For Risk From Cumulative Exposure To Asbestos In Air Output	



ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No : 16012-TRE-BRY-XXX-RP-EN-000005
Page No : 1 of 15
Engineer: Stuart Milne
Date: 06/06/2025

1. INTRODUCTION

Tier Environmental was commissioned by Willmott Dixon on behalf of Transport for Greater Manchester to undertake an Asbestos Detailed Quantitative Risk Assessment (DQRA) report for an area of land referred to as Bury Interchange, Bury, BL9 0AY (the "site").

The title of this report is in accordance with that described in the Land Contamination Risk Management guidance (available at <https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm>) which has superseded CLR 11:

Stage 1:

- LCRM Tier 3 Detailed Quantitative Risk Assessment Report

1.1. Proposed Development

Under current proposals the development will comprise the construction of a new Transport Interchange in Bury Town Centre. The Bury Interchange project comprises two phases:

- Southern Access - construction of a new pedestrian footbridge with access between Union Square, the existing Metrolink platform and Pyramid Park to enable Bury Tram Stop to continue operating during Phase 2 works. This phase of work also includes refurbishing the existing Metrolink platforms including replacement of the existing platform canopy and enhanced passenger amenities/facilities.
- 2. Bury Interchange - demolition and replacement of the existing Interchange Building.

A planning application for the second phase comprising the interchange is to be prepared for an anticipated submission in early-to-mid 2026.

As such, in accordance with the 'Updated technical background to the CLEA model' (Environment Agency, 2009) and 'Suitable 4 Use Levels' (LQM / CIEH 2015) the proposed generic land use for this development is commercial, acknowledging the proposed development as a new walkway for station access. In this context, for the purposes of assessing *chemical* contaminants of concern we considered the use of commercial land use GACs to be a reasonable and appropriately conservative default scenario, especially when the actual exposure frequency and duration for public users will be less than that assumed for the default commercial worker.

Given the unknown extent of both proposed earthworks and intended areas of soft landscaping, we had previously undertaken an additional step of conducting sensitivity analysis by comparing the reported *chemical* concentrations against Public Open Space (POS) Park GACs.

It is considered; however, that the primary human health receptor with respect to asbestos at the site is likely to be future landscape maintenance workers as the assumptions built into the modelling will assume a more conservative situation of exposure via more aggressive disturbance of the soils via digging activities and also assess risks over a longer duration (49 years) than would be applicable for POS land users. In doing so, it is considered that these assumptions would be protective of all human health receptors identified for the site.

1.2. Previous Reports

A Detailed UXO Desk Study was completed by EOD Contracts Ltd (Ref: EOD/24/24140/DTS, dated November 2024) for the combined Phase 1 and Phase 2 site boundaries, this is contained within Appendix I.

The following third part reports were provided for review:



ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No :	16012-TRE-BRY-XXX-RP-EN-000005
Page No :	2 of 15
Engineer:	Stuart Milne
Date:	06/06/2025

- A Factual Report on Site Investigation for Land at Townside Fields, Bury, by Dunelm Geotechnical and Environmental on behalf of Campbell Reith (Ref: M1062/01, dated April 2022)
- A Geoenvironmental Appraisal of land at Bury Market, for Bury Council, by ID Geoenvironmental Ltd (Ref: 5237-G-R001 Rev A, dated August 2022).
- A Factual Report for Pyramid Park, Bury, by Geotechnics on behalf of Campbell Reith (Ref: PN234595, dated February 2024)

The above factual reports for Townside Fields/Pyramid Park are collated in the following produced by Campbell Reith, which were available on the Bury Council planning portal:

- A Geotechnical and Geoenvironmental Desk Study Report, by Campbell Reith (Ref: 13819-CRG-XX-XX-RP-LQ-0001, dated March 2022).
- A Phase 2 Interpretive Report (Contamination), by Campbell Reith (Ref: 13819-CRG-XX-XX-RP-LQ-0002, dated July 2022).
- A Land Quality Statement by Campbell Reith (Ref: 14111-CRH-XX-XX-RP-LQ-0001, dated April 2024)
- A Remediation Strategy and Quality Statement by Campbell Reith (Ref: 14111-CRH-XX-XX-RP-LQ-0001-P02, dated November 2024)

Tier Environmental reviewed the above as part of a Preliminary Risk Assessment Report for the Phase 1 Area (Ref: 16012-TRE-BRY-XXX-RP-EN-000001 Rev. P02, dated April 2025). A subsequent Ground Investigation Report (Ref: 16012-TRE-BRY-XXX-RP-EN-000004 REV.P02, dated May 2025) was completed for the Pyramid park and Union Square area.

1.3. Objectives

Taking into account the proposed development of the Site, the objectives of this appraisal were:

- To reproduce the Revised Conceptual Site Model developed during the Tier Environmental LCRM Tier 1 & 2 Ground Investigation Report;
- To conduct a asbestos detailed risk assessment in accordance with CIRIA C733 in order to determine whether any residual risk remains for future land users;
- To assess whether the conclusions of this risk assessment eliminate the remediation requirements for a clean cover system;
- Update the Conceptual Site Model based on the conclusions of the asbestos detailed quantitative risk assessment.

1.4. Assumptions

The following assumptions are made in this report:

- It is assumed that ground levels will not change significantly from those described in this report or as shown on proposed development drawings. If this is not the case, then amendments to the recommendations made in this report may be required.
- The ground investigation has been designed with due consideration of known or suspected constraints (including underground services and access constraints).
- Any references to observations of suspected asbestos-containing materials are for information only and should be verified by a suitably qualified asbestos specialist and/or confirmed by laboratory analysis.
- The use of the term 'Topsoil' within this report is based on a visual identification only and that these materials have not been classified in accordance with BS3882:2015.
- The use of the terms 'shallow' and 'deep' within this report assume *typically* between ground level to circa 5.00m below ground level (bgl) for 'shallow' and greater than 5.00m bgl regarded as 'deep';



**ASBESTOS DETAILED QUANTITATIVE RISK
ASSESSMENT FOR BURY INTERCHANGE**

Report No : 16012-TRE-BRY-XXX-RP-EN-000005
Page No : 3 of 15
Engineer: Stuart Milne
Date: 06/06/2025

- The comments and opinions presented in this report are based on the findings of the desk study, ground conditions encountered during intrusive investigation works performed by Tier Environmental and the results of tests carried out within one or more laboratories. There may be other conditions prevailing on the Site which have not been revealed by this investigation and which have not been taken into account by this report.
- Responsibility cannot be accepted for any conditions not revealed by this investigation. Any diagram or opinion on the possible configuration of the findings is conjectural and given for guidance only. Confirmation of intermediate ground conditions should be undertaken if deemed necessary.

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ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No : 16012-TRE-BRY-XXX-RP-EN-000005
Page No : 4 of 15
Engineer: Stuart Milne
Date: 06/06/2025

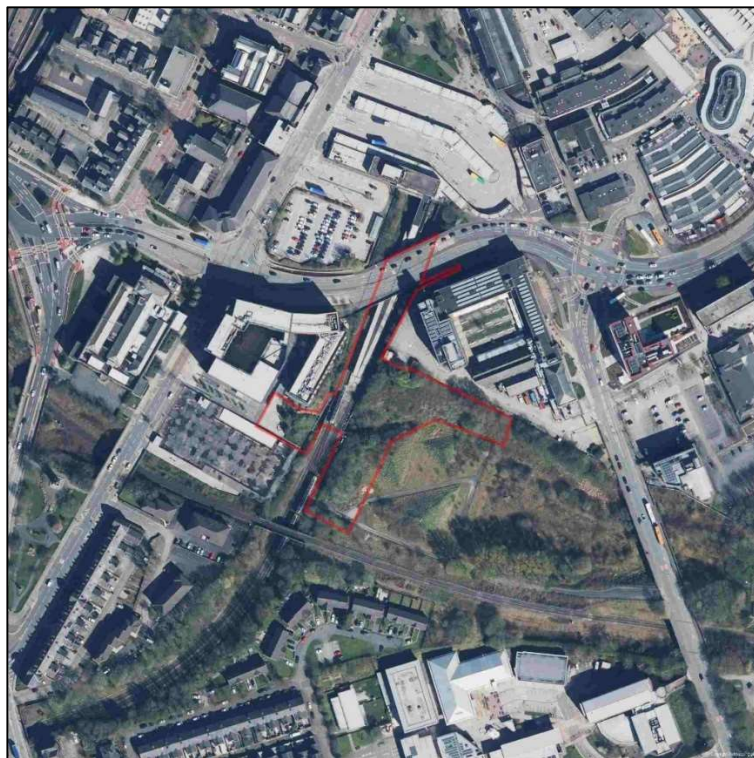
2. SITE DETAILS AND DESCRIPTION

Table 2.1 Current Site Overview.

Site name	Bury Interchange
Site address	Bury Interchange, Bury, BL9 0AY. A site location plan is included as Drawing No. TE1885-TE-00-XX-RP-001-V01 within Appendix A.
National Grid Reference (NGR)	380399 410392
Approximate Site area	0.92 ha
Site shape	The Site is irregular elongate shape.
Current land use on the Site	The site forms part of Bury Interchange station, with station and platform buildings in the north of the site, and railway lines extending south just east of the site boundary. Underground service drawings have not been provided to Tier Environmental; however, there remains a potential for such features to be present beneath the site.
Surrounding land uses	The site is set within a mixed commercial and residential area with the wider Bury Interchange to the north, car parking and commercial buildings including a hotel to the west and Bury College and a disused park to the east.
General topography and ground levels	The track level of the Phase 1 area is at approximately 86m AOD. The site is within a cutting with levels to the west at 91.4m AOD and to the east circa 94m AOD; the overpass is at circa 95m AOD.

An aerial photograph (from the Groundsure report) of the site and site boundary is shown below.

Figure 2.1 Recent Aerial Photograph from Groundsure





ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No :	16012-TRE-BRY-XXX-RP-EN-000005
Page No :	5 of 15
Engineer:	Stuart Milne
Date:	06/06/2025

3. CONCEPTUAL MODEL AND QUALITATIVE RISK ASSESSMENT OF POLLUTANT LINKAGES

The preliminary combined conceptual site model and conceptual exposure model, developed from the desk study information and presented in Section 6 of the Tier Environmental LCRM Tier 1 Preliminary Risk Assessment Report, was revised in light of the ground investigation and the chemical analysis results within the LCRM Tier 2 Ground Investigation Report. This Conceptual Site Model has been reproduced in Table 3.1, below.

A qualitative risk assessment was made of the likelihood of the linkage operating and its potential significance in accordance with CIRIA C552.

This Conceptual Site Model will be updated accordingly upon completion of the Asbestos Detailed Quantitative Risk Assessment included within this report.



ASBESTOS DETAILED QUANTITATIVE RISK
ASSESSMENT FOR BURY INTERCHANGE

Report No : 16012-TRE-BRY-XXX-RP-EN-000005
Page No : 6 of 15
Engineer: Stuart Milne
Date: 06/06/2025

Table 3.1 Assessment of Pollutant Linkages.

Source	Potential Contaminants of Concern	Pathway	Receptor	Consequence	Probability	Qualitative Risk Assessment
Localised asbestos impacts within Made Ground at WS-P2-102 at 0.50-1.00, WS-P2-110 at 0.30-0.50m bgl, WS-P2-106 at 0.70-1.00m bgl, BH-P2-105 at 1.70-2.00 and WS-P2-104 at 1.00-1.50	Asbestos	(Dust migration and) dust inhalation	Future site users (commercial)	Medium	Low Likelihood	Moderate / Low Risk
			Adjacent site users (agricultural)	Medium	Low Likelihood	Moderate / Low Risk
			Adjacent site users (commercial)	Medium	Low Likelihood	Moderate / Low Risk
			Adjacent site users (residential)	Medium	Low Likelihood	Moderate / Low Risk
			Construction, site investigation, demolition and future maintenance workers	Medium	Likely	Moderate Risk

For definition of the terms used in the qualitative risk assessment, please see Appendix B.



ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No : 16012-TRE-BRY-XXX-RP-EN-000005
Page No : 7 of 15
Engineer: Stuart Milne
Date: 06/06/2025

4. ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT

4.1. Objectives and Approach

Taking into account the planned future use of the Site, the objectives of this appraisal were:

- To undertake a site specific human health risk assessment with regard to the concentration of identified asbestos, in line with the principals stated in C733.

As no robust method of producing an asbestos GAC is available or possible at present, quantitative risk assessments for asbestos-related soils need to characterise the nature and extent of asbestos contamination in soils. For this site, this is achieved through a clear evaluation of the future land use, including likely receptors and the type, form, condition and concentrations of asbestos in soils. From the characteristic value, it will be possible to estimate potential airborne fibre concentrations that may arise from such contamination and then use a range of risk assessment techniques which will enable lines of evidence to develop a realistic exposure scenario for the future commercial, and Public Open Space (POS) Park, land use. This exposure scenario will also utilise in-built conservatism and predict likely cumulative exposures for the maximum period of time a typical landscape maintenance worker (the critical receptor due to length of time and exposure through digging activities) is likely to spend at the site. This exposure will finally allow us to evaluate the significance of the associated risks and whether the worst case occurrences of asbestos represent anything other than a minimal risk to the site users.

4.2. Asbestos Quantification Testing

In order to attempt to quantify the percentage of asbestos in any given soil sample, the following method is followed. The whole sample is tipped into a tray, weighed, dried, and weighed again. The sample is inspected under a x40 stereomicroscope, and any visible ACM or clumps of fibres are removed and weighed.

These fibres are inspected under a Polarising Light Microscope to confirm the presence and type of asbestos in the sample (a bulk ID). This will be reported even if only a small number of fibres are found, and then the full quantification method is implemented.

For fibre quantification the residual sample is sieved and the <5mm fraction is dispersed in water for an hour. Replicate aliquots (at least four) are then removed, filtered, and the filters mounted onto microscope slides for counting and measuring using Phase Contrast Optical Microscopy. These results are then converted to a % by weight and added to the % of ACM found in the initial part of the method.

Of the 20 No. of Made Ground samples submitted for asbestos screening, 5 No. were reported to contain asbestos at WS-P2-102 at 0.50-1.00, WS-P2-110 at 0.30-0.50m bgl, WS-P2-106 at 0.70-1.00m bgl, BH-P2-105 at 1.70-2.00 and WS-P2-104 at 1.00-1.50, in the form of chrysotile and locally amosite fibre bundles, all at <0.001% w/w concentration.

4.3. Concentration of Asbestos in Soils and Potential Fibre Release

There have been no direct airborne fibre concentration tests on the affected soils. Instead, the aim of this section of the risk assessment is to predict realistic airborne concentrations from the measured soil concentrations, backed up from published fibre release potential tests. The assessment has taken into account the potential for a future increase in fibre release as ACMs degrade in order to determine whether the measured concentrations are representative of the range of possible weather conditions and activities that could occur. The risk of the aforementioned further physical and



ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No : 16012-TRE-BRY-XXX-RP-EN-000005
Page No : 8 of 15
Engineer: Stuart Milne
Date: 06/06/2025

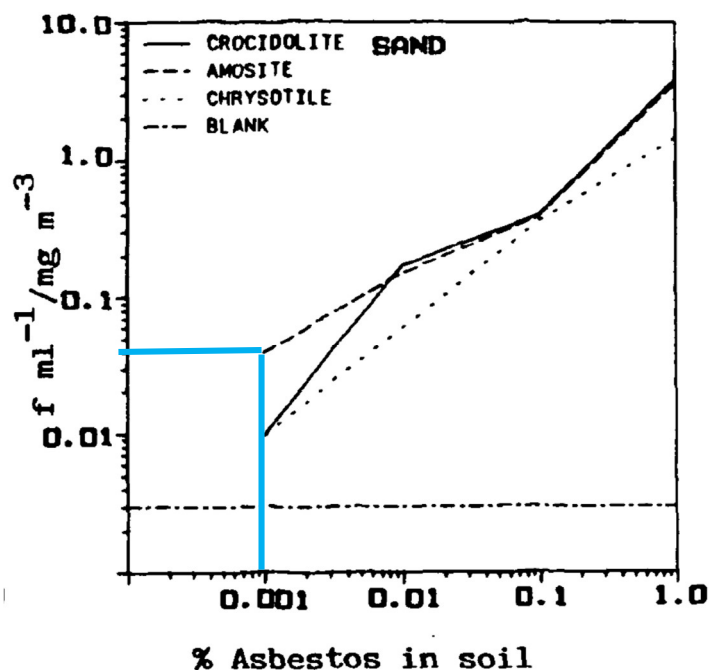
chemical degradation of the chrysotile or amosite fibre bundles is considered to be unlikely; however, the potential for fibre release given the pre-existing nature of the fibres shall be considered.

Current risk models are based on airborne fibre concentrations and, in order to predict the potential fibre release from the soils at the site, information has been taken from the published literature. Addison et al. (1988) measured the release of airborne fibres from 'spiked' dry soils ('sandy', 'intermediate' and 'clay') containing between 0.001, 0.01, 0.1 and 1% free fibrous asbestos (3 types). The experiment used rotating drums to generate dust from dry soils and measured the dust concentrations in mg/m^3 and asbestos fibre concentrations in f/ml . The effects of soil moisture were also assessed. As a precautionary approach, the fibre release prediction has been taken to be sand (conservatively). Further conservatism is built in to these numbers, given that the laboratory experiments were very violent and produced much more dust/airborne fibre than would be expected from normal site activities during future commercial use. When the correlation between normalised fibre concentrations in air and % of asbestos in soil is studied, it appears that the model also over-predicts the concentrations of fibre release at low concentrations (which provides further conservatism in the model).

Taking into account that background urban dust (PM_{10}) is generally taken to be at concentrations of around $20 \mu\text{g}/\text{m}^3$; however, in line with example 13.3 in CIRIA C733, the concentration of soil dust during gardening activities (considered to be consistent with landscape maintenance works that may take place on Site) in dry and dusty conditions was estimated to be $100 \mu\text{g}/\text{m}^3$ ($0.1 \text{ mg}/\text{m}^3$) based on ambient urban dust levels and ART modelling of shovelling of dry powders.

Figure 7 from Addison et al (1988) has been used to estimate the normalised airborne respirable fibre concentration (f/ml) for amosite (blue) (based on the 'worst-case' asbestos type from asbestos screen results) assuming a sand soil type. The maximum reported concentration is $<0.001\%$ w/w.

Figure 4.1 Variations in the Normalised Airborne Respirable Fibre Concentrations ($\text{f ml}^{-1}/\text{mg m}^{-3}$) in Relation to Bulk Asbestos Content (Sand Soils)
Reproduced from Figure 7 Addison et al (1988).





ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No : 16012-TRE-BRY-XXX-RP-EN-000005
Page No : 9 of 15
Engineer: Stuart Milne
Date: 06/06/2025

Taking the maximum reported amosite concentration reported in the soil, which gives the worst case normalised fibre concentrations, the graph gives a normalised fibre concentrations of 0.04 f/ml mg/m³ (shown in blue on Figure 4.1 above).

As such, when the value derived for amosite and the concentration of soil dust is taken into consideration then an airborne fibre concentration during such activities in a dry and dusty conditions has been estimated to be 0.004 f/ml (Ci) and assumed to be insignificant at other times.

The release of airborne asbestos is also strongly influenced by soil moisture content, with the addition of 5% moisture reducing potential airborne asbestos by 80% to 95%, with no fibres being detected at above 15% moisture content (as described on page 64 of CIRIA C733). The average moisture content of the samples obtained across the site was reported as 18.2%. It is not unreasonable to assume as a worst-case scenario that the soils could lose half of their natural moisture content, i.e. the soils drying out to c. 9.1% in the summer months, close to the surface. This has the effect of reducing the potential airborne asbestos (Ci) by a minimum of 80% which would equate to 0.0008 f/ml.

4.4. Exposure Scenario for the Critical Receptor

It has been conservatively assumed that worst case exposure would occur during digging and landscape maintenance activities.

Rochdale weather station (7 miles away) is considered to be a relatively accurate representation of the average amount of days (24h) with precipitation during a month. The number of days when precipitation has surpassed 1mm per day (24h) it is defined as a day with precipitation. The rainfall data from 1991 – 2020 has been used as it accounts for more dry days per year and is taken from a large data set therefore is the more conservative value to use (as opposed to data from last year). Airborne asbestos fibres are only likely to be released when the ground conditions are dry and dusty. The number of dry days per year is used as an indicator for potential fibre release, however, although there was less than 1mm of rain reported on 195 days of the year this does not reflect the soil moisture content. It is estimated based on industry practice, that on 35% of the dry days each year the ground surface may be dry enough to allow fibre release in an outdoor environment therefore, a total of 68 days a year has been calculated for this site.

The primary receptor at the site with respect to the landscaped areas is considered to be a landscape gardener / maintenance worker, as opposed to a member of the public. Justification for this is as follows:

- A member of the public is anticipated to use the space sparingly to access the new walkway and therefore have a much reduced exposure duration versus a landscape maintenance worker;
- A member of the public would not use the site on a consistent basis and therefore would not have the exposure frequency of that of a landscape maintenance worker;
- A landscape maintenance worker would potentially be digging into the ground and this represents the higher risk activity in terms of potential asbestos fibre release from the soils;
- We would assume a worst-case of a landscape maintenance worker working on the site for the period of their entire working lives

It is considered that proceeding the risk assessment for a landscape maintenance worker is therefore also appropriately protective of public open space users.

Landscape maintenance workers are assumed, very conservatively, to conduct activities in landscaped areas under dry and dusty conditions for an average of 1 hour per day for 68 days per year (FitI) consistent with the approach in example 13.3 in CIRIA C733.

In order to obtain a realistic but conservative estimate for the exposure scenario, it has been envisaged that a worst case commercial worker would be working adult with an exposure duration of 49 years.



ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No : 16012-TRE-BRY-XXX-RP-EN-000005
Page No : 10 of 15
Engineer: Stuart Milne
Date: 06/06/2025

Annual exposure is calculated in accordance with CIRIA C733:

$$Ei = Ci \times Fi \times Ti$$

Where Ei is annual exposure, Ci is the estimated concentration (f/ml) for the event, Fi is the frequency of the event per year, Ti is the period of time that the event lasts in hours.

Tier Environmental have at this point applied the SoBRA 'Calculation Sheet for risk from cumulative exposure to asbestos in air' (SoBRA 2021) and a copy of the sheet and the assumptions made is appended to this report.

A worst-case assumption has been made that all available 5 year age tranches have been applied for the number of days and hours and summarised above for a commercial worker from 15 years of age.

4.5. Cumulative Exposure for the Described Worst Case Exposure Scenario

Mesothelioma Risk

The cumulative risk for mesothelioma is calculated as 0.088 per 100,000 over a lifetime of 80 years.

Lung Cancer Risk

The cumulative risk for lung cancer is calculated as 0.0068 per 100,000 over a lifetime of 80 years.

Total Risk and Conclusion

This exposure-risk model can be used to investigate the significance of potential exposures in terms of likely ELCR. The ELCR of 1:100,000 is generally considered the limit of minimal risk; however, uncertainties need to be treated carefully if unrealistically cautious assessments are to be avoided.

The above mesothelioma and lung cancer risk calculations provides a total risk of 0.094 per 100,000 over a lifetime of 80 years with significant conservatism built into the model.

On this basis, it is considered that the reported concentrations of amosite asbestos within the Made Ground materials will present a minimal risk for the proposed primary landscape maintenance worker receptors and is also considered appropriately protective of future Public Open Space users (i.e. people enjoying use of the bridgescape area).



ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No :	16012-TRE-BRY-XXX-RP-EN-000005
Page No :	11 of 15
Engineer:	Stuart Milne
Date:	06/06/2025

5. UPDATED CONCEPTUAL MODEL AND QUALITATIVE RISK ASSESSMENT OF POLLUTANT LINKAGES

The conceptual site model and conceptual exposure model presented in Table 3.1 has been updated upon completion of the Asbestos Detailed Quantitative Risk Assessment and the conclusion reached in Section 4.5, above.

As a result the conclusions reached above, asbestos as a source has been removed from the conceptual site model as the risk has been reduced to minimal.



ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No :	16012-TRE-BRY-XXX-RP-EN-000005
Page No :	12 of 15
Engineer:	Stuart Milne
Date:	06/06/2025

6. REGULATORY APPROVALS

The conclusions and recommendations presented above are considered reasonable based on the conclusions of the Asbestos Detailed Quantitative Risk Assessment. However, these cannot be guaranteed to gain regulatory approval and, therefore, the report should be passed to the appropriate regulatory authorities and/or other organisations for their comment and approval prior to undertaking any works on site.



ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No : 16012-TRE-BRY-XXX-RP-EN-000005
Page No : 13 of 15
Engineer: Stuart Milne
Date: 06/06/2025

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ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No : 16012-TRE-BRY-XXX-RP-EN-000005
Page No : 14 of 15
Engineer: Stuart Milne
Date: 06/06/2025

8. GLOSSARY OF TERMS

ACEC	Aggressive Chemical Environment for Concrete (classification)
aOD	Above Ordnance Datum
bgl	Below ground level
BGS	British Geological Survey
BRE	Building Research Establishment
CBR	California Bearing Ratio (test)
COMAH	Control of Major Accident Hazards (regulations)
Designated location	Site (and the ecosystem on that site) protected under national or international legislation. A potential ecological receptor to be considered as part of the assessment of land contamination. Example designated locations include SSSIs (q.v.), SACs (q.v.), national nature reserves, Ramsar sites and bird special protection areas.
DQA	Data Quality Assessment
DQO	Data Quality Objective
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EQS	Environmental Quality Standard
GAC	Generic Assessment Criterion
GQA	General Quality Assessment (Environment Agency)
GSV	Gas Screening Value
HCV	Health Criteria Value
IPPC	Integrated Pollution Prevention and Control (regulations)
K _{ow}	Octanol-water partition coefficient
LEL	Lower Explosive Limit
LL	Liquid Limit
LoD	Limit of Detection (analytical)
LoQ	Limit of Quantification (analytical)
Mean Value Test	Statistical test (described in the CIEH Guidance) to estimate the mean value of a normally distributed population of data at a given level of confidence. Normally for contaminated land assessment, the 95th percentile (referred to as the 95%UCL or US95) is applied as a reasonable but conservative estimate of the mean concentration for comparison with the relevant assessment criteria.
Maximum Value Test	Statistical test (described in the CIEH Guidance) to identify whether an elevated concentration within a normally distributed data set forms part of the underlying population from which it has been sampled or whether it is an outlier (such as a localised area of contamination) that merits further consideration.
MC	Moisture Content
NGR	National Grid Reference
NIHHS	Notification of Installations Handling Hazardous Substances (regulations)
OS	Ordnance Survey
PI	Plasticity Index
PID	Photoionisation Detector
PL	Plastic Limit
ppm	Parts per million
ppmv	Parts per million by volume
QA	Quality Assurance
QC	Quality Control
SAC	Special Area of Conservation
SOM	Soil Organic Matter

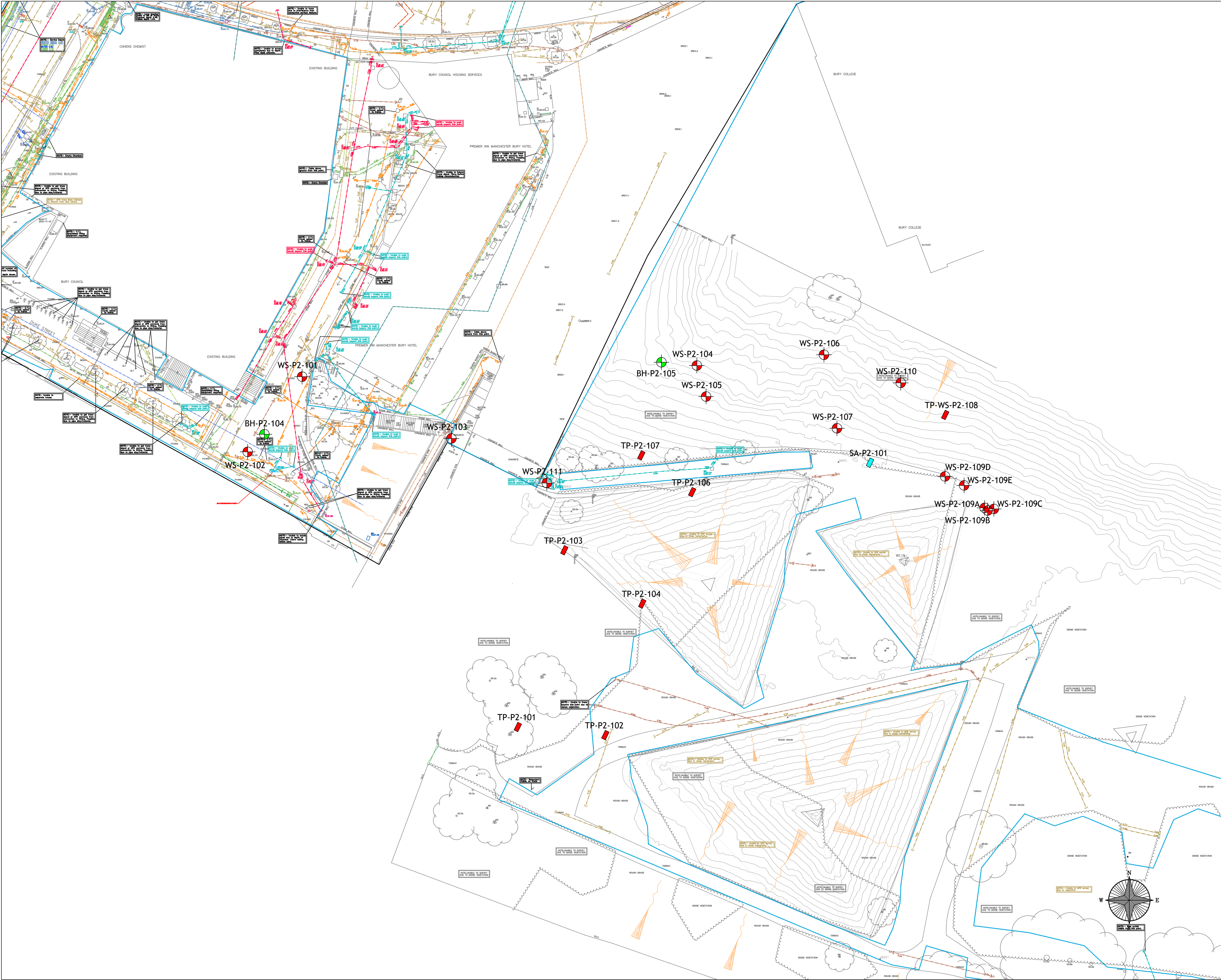


ASBESTOS DETAILED QUANTITATIVE RISK ASSESSMENT FOR BURY INTERCHANGE

Report No : 16012-TRE-BRY-XXX-RP-EN-000005
Page No : 15 of 15
Engineer: Stuart Milne
Date: 06/06/2025

SPT	Standard Penetration Test
SPZ	Source Protection Zone
SSAC	Site-Specific Assessment Criterion
SSSI	Site of Special Scientific Interest
SVOC	Semi-Volatile Organic Compound
TEF	Toxicity Equivalent Factor
TPH	Total Petroleum Hydrocarbons
TWA	Time Weighted Average
US95	95 th percentile estimate of the true mean value of a data population (also known as 95%UCL).
VOC	Volatile Organic Compound

APPENDIX A - DRAWINGS



DO NOT SCALE

TIER

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NOTES

CABLE PERCUSSIVE BORE HOLE WITH ROTARY FOLLOW ON TO DEFINE ROCK QUALITY

WINDOW SAMPLE

TRIAL PITS TO ESTABLISH NATURE OF FOUNDATIONS OF RETAINED STRUCTURES

SOAKAWAY LOCATION

P1	25.03.2025	CS	ISSUED FOR INFORMATION	AR	AR
REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS:

INFORMATION

TIER

CONSULT GROUP

Tier Environmental Ltd.

Unit 5 Office Village

Sandpiper Court

Chester Business Park

Chester | CH4 9QZ

t: 01925 818 388

CLIENT:

WILLMOTT DIXON CONSTRUCTION

PROJECT:

BURY INTERCHANGE

TITLE:

PROPOSED EXPLORATORY HOLE LOCATION PLAN

SCALE	SIZE	CHECKED	APPROVED
CAD FILE	NTS	AR	AR
PROJECT No:	TE1885	DESIGN/DRAWN:	DATE:
DRAWING No:	TE1885-TE-00-XX-DR-GE-006-V02	REV:	25.03.2025

PROJECT No:	TE1885	DRAWING No:	TE1885-TE-00-XX-DR-GE-006-V02	REV:	p2
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APPENDIX B - DEFINITIONS OF TERMS USED IN QUALITATIVE AND QUANTITATIVE RISK ASSESSMENTS

CIRIA C552 Terminology

For the qualitative and quantitative assessment of risks posed by potential pollutant linkages have been undertaken using the risk matrix adapted from CIRIA C552 and outlined in the table below.

	Category	Definition
Potential severity	Severe	Acute (short term) risk to human health, Major pollution of sensitive controlled waters, ecosystems or habitat. Catastrophic damage to buildings or property or crops.
	Medium	Chronic (Medium / long term) risk to human health Pollution of sensitive controlled waters, ecosystems or species, Significant damage to crops, buildings or structures
	Mild	Easily preventable permanent health effects on humans. Pollution of non-sensitive controlled waters. Minor damage to buildings or structures.
	Minor	Easily preventable non-permanent health effects on humans, or no effects. Minor, low level and localised contamination of on-site soil. Easily repairable damage to buildings or structures.
Probability of risk	High Likelihood	Pollutant linkage may be present, and the risk is almost certain to occur , or there is evidence of harm already occurring.
	Likely	Pollutant linkage may be present, and it is probable that the risk will occur over the long term.
	Low Likelihood	Pollutant linkages may be present and there is a possibility of the risk occurring, although there is no certainty that it will do so.
	Unlikely	Pollutant linkage may be present but the circumstances under which harm would occur are improbable.

		Potential Severity			
		Severe	Medium	Mild	Minor
Probability of risk	High Likelihood	Very high risk	High risk	Moderate risk	Moderate / low risk
	Likely	High risk	Moderate risk	Moderate / low risk	Low risk
	Low Likelihood	Moderate risk	Moderate / low risk	Low risk	Very low risk
	Unlikely	Moderate / low risk	Low risk	very low risk	Very low risk

APPENDIX C - COMPLYING WITH CONTROL OF ASBESTOS REGULATIONS 2012

Complying with Control of Asbestos Regulations (CAR): Risk Assessments, Licensing and Training

This appendix outlines CAR risk assessments and where they should be applied in relation to assessing and remediating brownfield sites. The information below details the different classifications of work with asbestos under CAR, summarises the legal requirements for asbestos awareness training for all involved in the investigation and management of asbestos containing soil (ACS), and details the potential requirements for suitable proficiency training relating specifically to ACS.

CAR RISK ASSESSMENTS

A CAR Risk Assessment is required for any work which may expose employees to asbestos. It is recommended that a precautionary approach is adopted if there is any doubt about risks associated with asbestos.

There are three main activities for potential asbestos exposure during work on brownfield sites:

- Site reconnaissance visits;
- Site investigation works; and
- Site remediation.

CAR risk assessments are needed at each stage but may be incorporated during the site investigation stage into the overarching health and safety risk assessments.

The CAR risk assessment must:

- Identify the type of asbestos to which employees are liable to be exposed, where possible, or assume it is present in different forms;
- Determine the type and extent of exposures to asbestos that may occur during the work
- Identify the steps to be taken to prevent exposure or reduce it to the lowest level reasonably practicable; and,
- Consider the effects of control measures that have been or will be taken.

The CAR risk assessment should include any information used to inform the risk assessment such as asbestos reports or desk study information. In the event that this information is not available, the assessor should be assumed that all forms of asbestos may be present on Site.

For all investigation and remediation of ACSs, a detailed written work plan should be produced and followed as detailed on the HSE website and in the CAR.

The CAR risk assessments for specific investigations or remediation projects, will determine whether or not work is 'licensable work' (LW), notifiable non-licensable work' (NNLW) or 'non-licensed work' (NLW). In addition, training requirements are also defined by the CAR risk assessment.

Some examples of control measures that apply during site reconnaissance, site investigation works, and site remediation are given below and should be applied depending on the asbestos risks identified for the Site at each stage of investigation:

- Avoiding stirring up dust;
- Cleaning footwear after site works;
- Removing and bagging any overalls for disposal/laundry;
- Respirators and hygiene facilities for high risk sites;
- Segregated welfare units;
- Wetting ground
- Minimising soil disturbances;
- Implementation or retention of capping/break layers;
- Implementation of awareness training;
- Air monitoring;
- Managing stockpiles;
- Area segregation;
- Wheel washing
- Road washing/cleaning

It is important to note that during Site reconnaissance visits, Site investigation works and Site remediation that asbestos should not be considered in isolation and control measures are likely to form part of a wider health and safety precautions.

Respiratory protective equipment (RPE)

RPE is the last line of defence and its requirement would be defined by the CAR risk assessment. HSE (2013b) advises that RPE should have an assigned protection factor of 20 or more for all work with asbestos. In certain instances, full face-piece, positive pressure respirators with a protection factor of 40 are necessary (to EN 12942:1998, TM3).

Suitable types of RPE for most **short** duration non-licensed asbestos work:

- Disposable respirator to standards EN149 (type FFP3) or EN1827 (type FMP3)
- Half mask respirator (to standard EN140) with P3 filter
- Semi-disposable respirator (to EN405) with P3 filter

These filters are not suitable for people with beards/stubble or for long or continuous use.

LICENSING

CAR defined certain types of activities involving asbestos as 'licensable work' (LW) or as 'notifiable non-licensable work' (NNLW). All other work would be 'non-licensable work' (NLW).

LW is defined as:

- work where exposure is not 'sporadic and low intensity'
- work where the risk assessment cannot demonstrate that the control limits (four hour and 10 minute limits) will not be exceeded
- work on asbestos coating
- work on AIB or insulation where risk assessment is either of first two points above or not of short duration (where short duration is defined for any work liable to disturb asbestos as taking less than two hours per week (including ancillary work) and no one person carries out that work for more than one hour').

NNLW includes work with:

- AIB or asbestos insulation of short duration that is not licensable
- fire-damaged asbestos cement or asbestos cement damaged so as to create significant dust and debris
- asbestos ropes, yarns, woven cloths in poor condition or handling cutting or breaking up the materials
- asbestos papers, felts and cardboard in poor condition, unencapsulated or not bound into another material.

Work with weathered asbestos cement, air monitoring and collecting samples of ACM in buildings would not normally be notifiable.

It is impossible to specify definitively what activities will and will not be licensable. This decision should be made as part of the CAR risk assessment. CAR is not primarily aimed at work with ACSs and there is little published information on airborne asbestos concentrations during work with ACSs. Nevertheless, CAR will require some remediation projects, and occasionally site investigations, to be LW. Investigations on other sites may involve NNLW. The decision as to whether work is LW or NNLW should be made during the CAR risk assessment by those in charge of the brownfield site investigations and remediation projects.

TRAINING REQUIREMENTS

Asbestos health and safety courses are offered by a number of providers in the UK. Training courses that include the problem of identifying ACMs in soil should be undertaken at regular intervals by those involved in the investigation, assessment and management of sites where ACs are known or suspected. It is the role of the employer to identify the level of training required for an employee based on their role, experience and duties. Reference to Regulation 10 of CAR should be referred to for more information on training requirements.

Recognising asbestos within soils is challenging due to the heterogeneity of such soils and the discolouration of asbestos by smeared soil. Specific training for ground workers should include understanding fibre release potential, potential control measures in the field, how to take representative ACSs safely, sample labelling and what analytical tests are available and when they should be implemented.

Health and safety training required under CAR includes asbestos awareness, non-licensable work (including notifiable non-licensable work) and licensable work with asbestos.

In addition to health and safety training, some staff involved in the technical identification on site of ACMs, sampling and analysis may require technical proficiency training (competency training).

Training vs. Competence

HSE (2005) identifies that 'training alone does not make people competent. Training must be consolidated by practical experience so that the person becomes confident, skilful and knowledgeable in practice on the job'. It is critical that ACS surveyors demonstrate competency with details of relevant field experience alongside training and examples of previous works/references.

**APPENDIX D - SOBRA CALCULATION SHEET FOR RISK FROM CUMULATIVE
EXPOSURE TO ASBESTOS IN AIR OUTPUT**

Calculation Sheet for risk from cumulative exposure to asbestos in air

Based on The quantitative risks of mesothelioma and lung cancer in relation to asbestos exposure, John T. Hodgson and Andrew Darnton, Ann Occup Hyg (2000) 44 (8): 565-601, and personal communication with Andrew Darnton and should be read in conjunction with SoBRA's Discussion Paper on Guidelines for Airborne Concentrations of Asbestos Fibres in Ambient Air: Implications for Quantitative Risk Assessment (SoBRA, 2021)
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Default parameters

Asbestos type	Amosite
Mesothelioma model	Linear
Lung cancer model	Non-Linear
Lung cancer base risk population	All - population average
Receptor expected lifetime	Lifetime 80 years
Lung cancer age adjustment	Age adjustment based on Latency

Concentration in air

Assumes exposure to constant average asbestos exposure

Concentration in air	f/ml	Amosite 8.00E-04
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Exposure over five year tranches

Age	Concentration in air f/ml	Exposure Days per year	Hours per day	Years (Actual)	Exposure time hrs per year hrs/year	Exposure over each 5 year tranche (includes adjustment to occupational years (equal to 2000hrs of exposure per year)) f/ml.yr	X - Cumulative exposure in f/ml.yr ~Concentration in air x Exposure time hrs per year x Time period / 2000 (hrs in an occupational year) to top of age group X - Cumulative exposure in f/ml.yr
0							
1	0-5	8.00E-04			0.00E+00	0.00E+00	0.00E+00
2	5-10	8.00E-04			0.00E+00	0.00E+00	0.00E+00
3	10-15	8.00E-04			0.00E+00	0.00E+00	0.00E+00
4	15-20	8.00E-04	68	5	6.80E+01	1.36E-04	1.36E-04
5	20-25	8.00E-04	68	5	6.80E+01	1.36E-04	2.72E-04
6	25-30	8.00E-04	68	5	6.80E+01	1.36E-04	4.08E-04
7	30-35	8.00E-04	68	5	6.80E+01	1.36E-04	5.44E-04
8	35-40	8.00E-04	68	5	6.80E+01	1.36E-04	6.80E-04
9	40-45	8.00E-04	68	5	6.80E+01	1.36E-04	8.16E-04
10	45-50	8.00E-04	68	5	6.80E+01	1.36E-04	9.52E-04
11	50-55	8.00E-04	68	5	6.80E+01	1.36E-04	1.09E-03
12	55-60	8.00E-04	68	5	6.80E+01	1.36E-04	1.22E-03

Mesothelioma Risk

$$P_M = A_{pr}X^r + A_{pt}X^t$$

P_M Percent excess mortality from Mesothelioma (in percent)

A_{pr} Constant of proportionality for Pleural risk

A_{pt} Constant of proportionality for peritoneal risk

X Cumulative exposure in f/ml.yr

r Pleural slope of exposure response (on a log-log scale)

t Peritoneal slope of exposure response (on a log-log scale)

$$\dot{O}_M = \frac{(A_{pr}X^r + A_{pt}X^t)E_{adj}}{100}$$

O_M the observed meso deaths

E_{adj} the expected mortality from all causes adjusted to an age at start of exposure of 30.

Risk estimate based on a 30 year old worker exposed for a five year period with cumulative exposure above.

Reference: Developing risk estimates consistent with Table 11 for extended exposures, Hodgson and Darnton 2000

Best Estimate	Amosite	Reference
Asbestos type		
A_{pr}	0.1	H&D 2000 Table 1 Mesothelioma risk expressed as percentage total expected mortality per f/ml.yr - Adjusted for age at first exposure.
r_{meso}	1	Linear model
A_{pt}	0.0006	H&D 2000 Table 8 Best estimate slope (i=0.75, t=0.1)
t	2.1	H&D 2000 Table 8 Best estimate slope (i=0.75, t=0.1)
Expected mortality from all causes adjusted to an age at start of exposure of 30	0.7	H&D 2000 p. 584 "Absolute risk estimates can therefore be derived from the PM value for a given exposure by multiplying by a factor of 0.7."

Age	Age adjustment Factor for mesothelioma risk Lifetime 80 years	Reference	P_M (%)*	Risk	Risk age adjusted assuming Lifetime 80 years
0					
1	0-5		0.0E+00	0.0E+00	0.0E+00
2	5-10		0.0E+00	0.0E+00	0.0E+00
3	10-15		0.0E+00	0.0E+00	0.0E+00
4	15-20		1.4E-05	9.5E-08	2.9E-07
5	20-25		1.4E-05	9.5E-08	2.0E-07
6	25-30		1.4E-05	9.5E-08	1.4E-07
7	30-35		1.4E-05	9.5E-08	9.5E-08
8	35-40		1.4E-05	9.5E-08	5.7E-08
9	40-45		1.4E-05	9.5E-08	3.8E-08
10	45-50		1.4E-05	9.5E-08	2.9E-08
11	50-55		1.4E-05	9.5E-08	1.9E-08
12	55-60		1.4E-05	9.5E-08	9.5E-09

* To get the contribution to the risk for the second period alone the risk due to the cumulative dose from the first period is subtracted... and so on.
Developing risk estimates consistent with Table 11 for extended periods, Hodgson and Darnton 2000

Cumulative risk	Amosite	Lifetime 80 years 8.8E-07
-----------------	---------	------------------------------

Lung Cancer

$$P_L = A_L X^r$$

P_L Percentage excess of expected lung cancer mortality

A_L Constant of proportionality for lung cancer risk

r Lung cancer slope of exposure response (on a log-log scale)

X Cumulative exposure in f/ml.yr

$$\text{Predicted excess risk} = O_L - E_L = \frac{A_L X^r E_L}{100}$$

E_L Proportion of the specific population that will die of lung cancer between age 40-79

Risk estimate based on a 30 year old worker exposed for a five year period with cumulative exposure above.
Reference: Developing risk estimates consistent with Table 11 for extended exposures, Hodgson and Darnton 2000

Best Estimate	Amosite	Reference
A_L	1.6	H&D 2000 Table 10 Best (n=1.3)
r_{lung}	1.3	H&D 2000 Table 10 Best (n=1.3)
Proportion of the specific population that will die of lung cancer between age 40-79	0.033	Based on Average 2016-2018 populations statistics

Age	Age adjustment	Age adjustment reference	P_L (%)	Risk (age adjusted)
0				
1	0-5	1	0.0E+00	0.0E+00
2	5-10	1	0.0E+00	0.0E+00
3	10-15	1	0.0E+00	0.0E+00
4	15-20	1	1.5E-05	4.9E-09
5	20-25	1	2.2E-05	7.2E-09
6	25-30	1	2.6E-05	8.4E-09
7	30-35	1	2.8E-05	9.3E-09
8	35-40	1	3.1E-05	1.0E-08
9	40-45	1	3.3E-05	1.1E-08
10	45-50	0.75	3.4E-05	8.4E-09
11	50-55	0.5	3.6E-05	5.9E-09
12	55-60	0.25	3.7E-05	3.0E-09
Cumulative risk		Amosite	6.8E-08	

Cumulative lifetime Risk Estimate

Asbestos type	Amosite		
Risk from Mesothelioma	Lifetime 80 years	Linear	8.8E-07
Risk from Lung Cancer	All - population average	Non-Linear	6.8E-08
TOTAL			9.4E-07

Limitations

This spreadsheet is offered as a free available resource by SoBRA to improve the consistency in, and adoption of, the use of the Hodgson and Darnton algorithms for estimating lifetime cancer risk for low level environmental exposures to airborne asbestos fibres. It has been developed by members of the SoBRA Asbestos-in-soil sub-group acting in a voluntary capacity, and constitutes the work of the individual authors, not those of their employers. Users of this spreadsheet must satisfy themselves that the content is appropriate for the intended use and no guarantee of suitability is made.

Feedback on this spreadsheet is welcome and should be sent to info@sobra.org.uk