CD6/1/B

RE: APPEAL BY FCC RECYCLING (UK) LTD PURSUANT TO REGULATION 31 OF THE ENVIRONMENTAL PERMITTING (ENGLAND AND WALES) REGULATIONS 2016 REGARDING DANESHILL SOIL TREATMENT FACILITY AT DANESHILL LANDFILL SITE AND 3C WASTE LIMITED PURSUANT TO REGULATION 31 OF THE ENVIRONMENTAL PERMITTING (ENGLAND AND WALES) REGULATIONS 2016 REGARDING MAW GREEN SOIL TREATMENT FACILITY AT MAW GREEN LANDFILL SITE

APPEAL REFERENCE APP/EPR/636 AND APP/EPR/651 (DANESHILL)

APPEAL REFERENCE APP/EPR/652 (MAW GREEN)

ENVIRONMENTAL PERMIT REFERENCE EPR/NP3538MF (DANESHILL)

ENVIRONMENTAL PERMIT REFERENCE EPR/BS7722ID (MAW GREEN)

PROOF OF EVIDENCE OF SIMON JAMES COLE

Report Reference: 28480-HYD-XX-XX-RP-GE-0001

February 2024

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1. Introduction

1.1 Terms of reference

1.1.1 I am instructed by FCC Recycling (UK) Ltd (FCC) as of the 18 April 2023 to provide evidence with respect to the potential fugitive emission of airborne asbestos fibres and associated health risk relating to the proposed treatment of asbestos contaminated soils at the Daneshill Landfill Site. This treatment of asbestos contaminated soils forms part of FCC's proposed Soil Treatment Facility (STF) that is subject to Environmental Permit (reference EPR/NP3538MF/V009) issued by the Environment Agency on 02 December 2022.

1.1.2 I am also instructed by 3C Waste Limited as of the 14 November 2023 to provide similar evidence relating to the Maw Green Soil Treatment Facility that is subject to Environmental Permit (reference EPR/BS7722ID/V010) issued by the Environment Agency on 05 October 2023.

1.1.3 I have specifically been instructed to consider the following:

a. The potential emission of airborne asbestos fibres during the proposed soil treatment;

b. The presence of loose, free asbestos fibres in processed soil and the associated potential health hazard;

c. The potential for material processing to increase the quantity of loose, free asbestos fibres in the treated soil; and

d. The potential off-site dispersion of airborne asbestos fibres and the associated potential health risk to off-site receptors.

1.2 Factual evidence drawn upon

1.2.1 The evidence which I have prepared and set out in this PoE is based on published information, air dispersion modelling carried out by Matt Stoaling of Isopleth Limited

[CD/6/4], and on measurement and monitoring data that has been collected by, or on behalf of, Provectus Soils Management Limited (Provectus). Published information is cross-referenced in the text and detailed in the list of references provided at the end of this PoE. The measurement and monitoring data provided by Provectus relates to the Maw Green and Edwin Richards Quarry (ERQ) STFs that Provectus operates on behalf of FCC. This data is primarily soil acceptance and validation data, and activity-based air monitoring data. The air monitoring data for ERQ has been provided to the Environment Agency as part of Provectus' quarterly reports submitted in accordance with the ERQ installation permit requirement. The mobile treatment licence deployments for Maw Green did not require the reporting of air monitoring data to the Environment Agency, and therefore the Environment Agency will not have been in receipt of this data during the deployment periods. There was no requirement to submit soil reception or post-treatment soil validation data to the Environment Agency. All data would have been available to Environment Agency officers during site permit inspections and I am instructed that that officers have reviewed this data during site visits.

1.2.2 The amount of data provided to me by Provectus is extensive, and is far in excess of that required under the site permits. For example, activity-based air monitoring at the two operational STFs, Edwin Richards Quarry (ERQ) and Maw Green (MG) includes daily near-source air monitoring using high volume sampling and low limit of detection scanning electron microscopy (SEM) analysis. This compares to the permit requirement for monthly (i.e 1 day a month) monitoring using lower volume, higher limit of detection, non-fibre discriminatory phase contrast optical microscopy (PCOM). I have set out a factual summary of the data provided to me in Appendix F.

1.3 Qualifications and experience

1.3.1 My name is Simon James Cole and I am the Practice Lead for Geoenvironment within Hydrock's Geo Division. Hydrock is an engineering design, energy and sustainability consultancy with offices across the UK.

1.3.2 I have a BEng (Hons) degree in Environmental Engineering from Cardiff University, awarded in 1995. I also have a PhD in Environmental Engineering from Cardiff University, awarded in 1998. I am a chartered member of the Chartered Institution of Water and Environmental Management (CIWEM), a Chartered Environmentalist (CEnv) under the Society of the Environment, and an accredited risk assessor (ASoBRA) under the Society of Brownfield Risk Assessment (SoBRA) accreditation scheme for human health, permanent gases, and soil vapour.

1.3.3 I have 25 years of environmental consultancy experience, primarily focused on land contamination risk assessment. I have served as technical advisor to the Environment Agency, the UK Government, and Natural Resources Wales, was the Environmental Industries Commission nominated representative on Defra's Expert Panel on Part 2A of EPA 1990, and invited member of the Welsh Government's land contamination advisory group. I supported the UK Health Protection Agency (HPA) in the EC-funded HPA-led Risk ASSETS programme in 2010 and was a BSI Committee member for the associated CEN standard (CEN/TC 416) BS EN 16736:2015 on Health Risk Assessment of Chemicals.

1.3.4 I am a former chair of the Society of Brownfield Risk Assessment and have been on the executive committee of the Society for five years between 2018 and 2023. Prior to that I founded and chaired SoBRA's asbestos in soil working group and have been an integral member of the Joint Industry Working Group (JIWG) on Asbestos in Soil since its inception in 2013, including co-authorship of the Decision Support Tools that support the CAR-SOIL^{TM} guidance. I chaired the Network for Industrially Contaminated Land in Europe (NICOLE)'s working group on asbestos in soil and was lead author of a NICOLE publication on the approaches to risk-based management of asbestos in Europe that was published in 2021. I have been a lead author of SoBRA's various guidance on asbestos in soil since 2015. I also sit on the Sustainable Remediation Forum (SuRF) UK Steering Group and on the Energy Institute's Soil Groundwater and Waste Group.

1.3.5 A copy of my curriculum vitae is provided as Appendix A.

1.4 Statement of truth

The evidence which I have prepared and provide for this appeal in this Evidence is true and has been prepared and is given in accordance with the guidance of my professional institutions and I confirm that the opinions expressed are my professional opinions unless otherwise attributed.

2. Context

2.1.1 The aspects of the appeal that I have been instructed to consider, as identified in paragraph 1.1.3 above, relate to the following parts of the Appellant's Grounds of Appeal and Statement of Case as follows:

Table 2.1: Signposting my evidence to relevant sections of the Grounds of Appeal and Statement of Case

a. The potential emission of airborne asbestos fibres during the proposed soil treatment	
Ground One	6.6 relating to evidence, or otherwise, of the Proposed Activity resulting in increased amounts of fibres being released to the environment. 6.7 relating to evidence for potential emission sources which arise from the Proposed Activity.
Statement of Case - 7.1-7.17 and 7.25-7.29	Evidence for, and critical factors in, asbestos emissions from material processing.
b. The presence of loose, free asbestos fibres in processed soil and the associated potential health hazard;	
Ground One	6.38 relating to the definition of hazardous waste in the context of asbestos contaminated soils and evidence of the amount of bonded asbestos which is expected to be processed by Provectus at the STF, based on the operation of existing facilities.
Statement of Case - 7.18-7.20	Evidence for, and the potential for, the presence of, and hazard from, loose asbestos fibres in processed soil.

c. The potential for material processing to increase the quantity of loose, free asbestos fibres in the treated soil;	
Ground One	6.6 relating to evidence, or otherwise, of the Proposed Activity resulting in increased amounts of fibres being released to the environment.
Statement of Case – 7.21-7.24	Evidence for, and the potential for, material processing to increase loose, free fibre concentrations in processed soil.
d. The potential off-site dispersion of airborne asbestos fibres and the associated potential health risk to off-site receptors.	
Ground Three – 6.37	6.37 relating to evidence as to whether the Proposed Activity will result in significant pollution. 6.40 relating to the review of the location of relevant sensitive receptors and their location to the STF and to the Site, and evidence as to what level of risk the Proposed Activity poses to the environment and human health, assessed over its full life cycle, 6.41 relating to evidence as to whether the dispersion of emissions would further lower the potential risks of exposure in the event of a release of asbestos fibres from the Proposed Activity.
Statement of Case – 7.30-7.40	Evidence for, and the potential for, off-site dispersion of airborne asbestos fibres and the estimate of associated health risk using published risk estimation approaches.

3. Relevant guidance

3.1.1 There are a number of published guidance documents that I reference in my Evidence that either relate to good practice in air monitoring for 'asbestos in soil' activities, or relate to the assessment of fibre release from soil containing asbestos. To assist in understanding the context of my use of these references as part of my evidence I have briefly summarised the guidance below.

3.1.2 The Environment Agency's guidance on monitoring particulate matter in ambient air around waste facilities (M17) (EA, 2013) [CD1/N] is the guidance referenced by the Environment Agency in the permits for Daneshill, ERQ and Maw Green, and provides guidance in section 7.4 that largely draws on the HSE's MDHS 87 (now subsumed into HSG248 [CD1/O]). The focus in M17 is on the use of Phase Contrast Optical Microscopy (PCOM) analysis to a limit of quantification (LOQ) of 0.01 f/ml (albeit recognising that this LOQ can be improved for measuring ambient environmental levels by increasing the sample volume). Electron microscopy (EM) is mentioned and is advocated when there are significant levels of non-asbestos fibres in the air. The authors additionally report that EM-visible fibres are reported to be in the range of 40-100 f/m^3 in remote areas and up to 2400 f/m^3 in urban air (source(s) of these quoted values are not provided). Overall, the guidance in M17 advocates the use of PCOM analysis of samples using 480 litre samples (at sampling rates of either at 8l/min for one hour or 2l/min for 4 hours). This gives an LOQ of 0.01f/ml. If interferences in PCOM analysis are encountered, EM is recommended, with a practicable approach being to divide exposed filter papers in half, analysing one half by PCOM and sending the other half for EM analysis. M17 makes no comment on the appropriateness of the LOQ for ambient environmental monitoring. Section 7.4.3 of M17 does identify that "*no safe level can be proposed for asbestos because a threshold is not known to exist*[1]...[therefore] *exposure should be kept to as low as possible and asbestos should not be found above background levels at site boundaries*". It is my understanding that the Environment Agency's permitting team(s) commonly reference the M17 requirements in permit conditions (i.e., monitoring to 0.01f/ml using PCOM). There is reference in Section 7.4.1 of M17 to unpublished EA/HSE trials to support the development of guidance for asbestos in soil, and reference to industry bodies working together to develop 'practical and robust non-statutory industry guidance'. This guidance has now been published in the form of CAR-SOIL™ [CD1/Q] (see paragraph 3.1.8). Since the last revision to M17 in 2013 the HSE has also issued a revised version of HSG248 in 2021.

3.1.3 HSE's second edition of HSG248 published in 2021 (HSE, 2021) [CD1/O] provides recommended sampling parameters for different applications in Table 5.2 of Part 2

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[1] Cross-reference in M17 text to WHO Regional Office for Europe, 2000. Air Quality Guidelines for Europe (WHO Regional Publications. European Series). 2nd Edition from which the often quoted 500 f/m^3 'guideline' is sourced.

Chapter 5. The applicable types of static sampling in this context are defined in Table 5.1 of HSG 248. The relevant guidance in Tables 5.1 and 5.2 is summarised below:

Table 3.1: Summary of Tables 5.1 and 5.2 in HSG248

Application	Background sampling	Near-source static sampling	Far-source/perimeter sampling
Purpose	To establish the prevailing fibre concentration. This is often carried out before an activity which may lead to airborne asbestos contamination. Background sampling gives a useful baseline with which other samples can be compared	To assess the release and spread of asbestos fibre concentrations near sources (e.g. inside enclosures, work without an enclosure, near simulated disturbance activities in unoccupied areas, buildings and enclosures to represent typical release scenarios for normal occupation or maintenance activities, disturbance of asbestos in soil and made ground, or mineral processing etc)	Conducted around the perimeter of the site where there may be other workers, public access or residential and commercial buildings
Sampling rate (litres/minute)	0.5-16	0.5-16	0.5-16
Minimum volume to be sampled onto 25mm diameter filter (litres)	480	480	960[2]
Calculated airborne concentration at the LOQ (20 fibres counted) (f/ml)	0.01	0.01	0.005[3]

3.1.4 In s.7.21 of HSG248 it is stated, based on evidence published by SoBRA in the UK and RIVM (National Institute for Public Health and the Environment) in The Netherlands, that the PCOM LOQ of 0.01f/ml is 'rarely exceeded' during soil disturbance, and that worker

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[2] In low-dust environments samples of up to 2400 litres can be collected (assuming a ~380 mm^2 exposed filter area) which will give an LOQ of 0.002 f/ml based on 200 graticule areas examined.

[3] The rationale for why this LOQ is desirable/required/appropriate is not given.

exposure during such activities will likely be below the LOQ when carried out under controlled conditions. The authors do note in s.7.22 that more energetic process such as power screening may give rise to elevated fibre concentrations, especially if the material is dry, and that soil should be kept damp if 'significant fine unbound asbestos fibres are present'.

3.1.5 It is stated in Appendix 8 paragraph A8.6 of HSG248 that in the HSE's view in most circumstances the extent of dilution in the environment will be sufficient to discount significant exposure to people over 100m from the emission source. Furthermore, in paragraph A8.7 it is stated that average exposure is the only relevant measure for boundary samples and that boundary sampling periods should be as long as feasible (over 1-week periods or longer with an example given of 8-hr days of continuous sampling at a rate of 1l/min).

3.1.6 Guidance specifically relating to asbestos in soil activities is given in two CIRIA guidance documents (C733 (CIRIA, 2014) and C765 (CIRIA, 2016) [CD1/P]). Note that both these documents were published prior to the release of the second edition of HSG248, and draw heavily on earlier guidance published by RIVM in The Netherlands in 2003 [CD1/R]. In terms of advice on air monitoring strategies, C733 Chapter 12 states that an air monitoring strategy should be proportionate to risk. It identifies that background air concentrations can be <0.0001f/ml and that sampling methods for ambient monitoring may need to achieve detection limits of 0.00001f/ml or less. A detection limit of 0.0001f/ml for activity-based environmental monitoring is stated as being “acceptable”. For ambient air monitoring it is advised that sampling periods of up to 1 week may be necessary to pick up a change in ambient concentrations, with monitoring designed to represent long-term average conditions (i.e. over 12 months) to allow for weather and activity variations – although the authors note that this is rarely practicable. Several weeks of sampling during dry weather may suffice. For activity-based sampling no further guidance is given on monitoring frequency, duration or detection limit. C765 cross-references to C733, specifically in relation to ensuring that sampling is sufficiently sensitive to discriminate background (i.e. LOD of 0.00001f/ml or less), but I would note that there is no UKAS accredited method that can achieve this LOD to my knowledge. The authors also note that dust and activity-based sampling can provide assurance of dust suppression.

3.1.7 RIVM published guidance on the assessment of the risks of asbestos contamination with asbestos in 2003 (RIVM, 2003) [CD1/R], and this has formed the basis for not only the regulatory approach to asbestos in The Netherlands but has strongly influenced regulatory guidance in other countries, including Belgium and Australia, as well as being heavily referenced in industry guidance such as CIRIA's. The guidance proposes a three-tiered methodology for the assessment of risks of soil contamination with asbestos, and significantly also provides details and interpretation of extensive laboratory and field trials focused on the better understanding of the factors that influence the release of asbestos fibres from soil and the consequent airborne concentrations to support the proposed methodology. It is these laboratory and field studies that I particularly refer to in my Evidence.

3.1.8 CAR-SOIL™ [CD1/Q] was developed prior to the publication on the second edition of HSG248, and consequently there is some overlap between CAR-SOIL™ and the guidance in HSG248 relating to asbestos in soil. CAR-SOIL™ was specifically developed by members of the Joint Industry Working Group on Asbestos in Soil, and Construction & Demolition Materials (JIWG) to provide an interpretation of the Control of Asbestos Regulations 2012 (CAR2012) specific to work with asbestos in soil as opposed to work with asbestos in buildings. It draws on the guidance published by CIRIA and RIVM noted in paragraphs 3.1.6 and 3.1.7 above, as well as other guidance such as that by the Institute of Occupational Medicine (IOM) that I reference later in my evidence. Of relevance in the guidance is (1) recognition that asbestos contamination can be found at brownfield sites, and within recycled aggregates created from crushed construction and demolition (C&D) materials, and (2) '*the nature and degree of potential risk from exposure to asbestos fibres when working with asbestos contaminated soil or C&D materials in the external environment is significantly lower than that which might be expected when working with ACMs internally in buildings.*' The guidance also provides a qualitative framework for deciding on the licenced status of proposed occupational work which is supported by two decision support tools (DST) that use a series of qualitative and semi-quantitative factors to help determine the relative hazard and risk of the proposed work activity. These DST largely focus on the potential for airborne fibre release from soil, and importantly include considerations on asbestos material type, form, and amount, and on the degree of material degradation and deterioration.

4. Airborne asbestos fibre emission from soil during mechanical processing

4.1.1 The disturbance of asbestos-containing soils has the potential to release asbestos fibres into the air. This is a well-established issue that has been addressed by UK and international guidance (both from a regulatory and an industry perspective). There are a number of factors that have been shown to influence the emission of asbestos fibres from soil, and the actual release of asbestos fibres from soil at a site-specific level is a complex function of these factors.

4.1.2 Critical factors in asbestos fibre release include the soil moisture content, the degree of soil disturbance/agitation, physical soil characteristics (such as particle size distribution), the type and form of the asbestos, and the concentration of the asbestos in the soil.

4.1.3 The CAR-SOIL™ relates the potential release of airborne fibres from soil disturbance/agitation to both the degree of degradation of the asbestos of the asbestos material (is it intact in its original state, or is it weathered and has lost some of its structural integrity), and to the degree of potential deterioration that might be caused by the material handling methods. 'Low intensity' work is described as work that will not cause further deterioration of the asbestos materials and thereby where there is a reduced likelihood of airborne fibres being released by the activity. Mechanical excavation of soil is included in this category. Mechanical crushing, grading and/or screening of C&D materials by contrast are given as examples of 'high intensity' work, i.e. work activities that are expected to cause deterioration of the asbestos materials and thereby where there is an increased likelihood of airborne fibres being released.

4.1.4 The guidance in CAR-SOIL™ does not expand further on the differentiation between low intensity and high intensity activities and the distinction between the two is subjective. In considering whether the mechanical screening at the STFs is a 'high intensity' activity as defined by the CAR-SOIL™ guidance it is relevant to consider the range of activities captured by the general term 'mechanical screening, grading and crushing'. A useful way to consider the activity is to consider the nature of the equipment being used (i.e. the way in which it handles the material), and the processing rate. The 3-way screener used at the Maw Green STF is a Keestrack K3 which uses vibrating beds to sieve the feed material using gravity. An alternative screening technique is to use a rotating drum (a Trommel Screen). Given the material in this type of equipment is tossed within a large cylindrical drum it might be expected that the degree of agitation and therefore potential for asbestos material deterioration is higher for a Trommel than it is for a vibrating screener such as the K3. The physical crushing of C&D material using an aggregate crusher is at the highest end of the work intensity range. By contrast, the use of a vibrating screener sits at the lower end of the work intensity range.

4.1.5 The K3 has a maximum operating material processing rate of 250 tonnes per hour. Provectus has operated the screener at Maw Green at processing rates ranging from approximately 100-500 tonnes per day depending on daily processing requirement (approximately 20-80 tonnes per hour if a daily operational time of 6 hours is assumed).

The revised permits for Daneshill and Maw Green limit the soil processing rate to 100 tonnes per day (less than 20 tonnes per hour). This reduced rate is under appeal. For context, the K3 is the smallest screener manufactured by Keestrack – the largest (the K8) has a maximum processing rate of 1200 tonnes per hour. This is similar to the product range of other manufacturers. The higher the process rate the machine is operated at, the greater the likely soil/material disturbance as the machine is operating faster and the material is moving through the machine quicker. I have included relevant screener manufacturer information in Appendix I. The processing rate used by Provectus is therefore at the low end of the likely range for soil/aggregate screening activities. Further detail on the operation of the mechanical screener by Provectus is provided in Leslie Heasman's evidence [CD6/2]. Overall, and having seen the soil processing in operation at Maw Green, it is not apparent that the soil disturbance in the screener is significantly different to soil disturbance occurring from the loading and unloading of the haulage trucks used to deliver the soil, or from the stockpile management using a mechanical excavator and dumper.

4.1.6 Mechanical screening is used as a process in the remediation and reclamation of Brownfield sites, and is not unique to Provectus. Three examples of the use of the mechanical screening of asbestos-contaminated soil are included in the NICOLE asbestos in soil publication (2021) [CD1/2] whereby a Trommel screen was used as part of the remediation scheme for a new school in Birmingham, a 3-way screener was used as part of the remediation scheme for a new business park in Ipswich, and mechanical screening was undertaken as part of the remediation and redevelopment of a former car part manufacturing facility in the UK. It is advocated in the NICOLE publication that mechanical screening and physical segregation of asbestos-contaminated soil can be part of a sustainable approach that minimises overall environmental impact and delivers the greatest cost-benefit when dealing with asbestos-contaminated soil, and the above examples would have been completed under mobile treatment permits issued by the Environment Agency. Further examples of the use of mechanical screening of asbestos-contaminated soils as part of Brownfield site remediation can be found in industry articles and remediation contractor promotional material.

4.1.7 Whilst the hazard of potential asbestos fibre emission to air is associated with the presence of asbestos in soil, the risk of airborne fibre emission can vary greatly dependent on the site-specific conditions. Published approaches for the estimation of airborne fibre release from soil and the calculation of the associated health risk from human exposure to airborne asbestos fibres in non-occupational scenarios are summarised in the Society of Brownfield Risk Assessment (SoBRA)'s Asbestos in Soil Human Health Risk Assessment Toolbox (SoBRA, 2021a) [CD1/2].

4.1.8 An initial screening of STF activities can be made using the US EPA AP-42 guidance (US EPA, 2006) [CD1/2]. The air pollutant emission factors developed in this guidance are generic but can be modified by a number of site-specific activity parameters. The activities envisaged at the STF are: (1) haulage of waste soil to the STF by 20 tonne tipper trucks, (2) stockpile management of pre- and post-processed soil by 360 excavator, bulldozer, and 25 tonne dumper truck, (3) mechanical screening of soil, (4) transfer to belt picker and hand picking of soil, (5) haulage of processed material away from STF. Emission factors for particulate matter less than 10 microns in size (PM10), in lieu of emission factors for asbestos fibres, have been calculated along with estimates of air concentrations assuming the emissions are generated within a theoretical air box. The PM10 emission calculations provide a useful guide to the relevant strength of the various dust generating activities.

4.1.9 The US EPA AP-42 calculations are provided as Appendix B. They are only designed to be a screening assessment to evaluate which activity(s) might generate greater emissions and should not be taken as predictions of actual emissions. The AP-42 emission calculations indicate that the emission activities most likely to contribute to measured ambient air concentrations are likely to be vehicle movement on the concrete slab, followed by surface wind erosion from exposed concrete pad. Other emission activities (such as the screener, material transfer, and the picking station) are likely to be insignificant by comparison. Material transfer might become more significant (and greater than vehicle movement emissions) if the material is exceptionally dry (<2%), however, screener and conveyor emissions remain insignificant in comparison. I refer later to the underlying moisture content of soils processed to date at Maw Green and ERQ that shows that processed soils are rarely this dry. A separate surface wind erosion calculation for exposed stockpiles indicates that the maximum wind speed would need to approximate gale-force before the threshold frictional velocity for 'overburden' soils is exceeded. This indicates that for the majority of the time, wind erosion is not expected to contribute to air emissions relative to the operational activities noted above.

4.1.10 Manual (handheld) dust monitoring and static continuous dust monitoring has been undertaken at the Maw Green STF operated by Provectus. Provectus installed a 'PurpleAir Flex' air quality monitor[4] to the exterior of the picking station in July 2023 and I have been provided with the data from this instrument for the period 12 July-06 September 2023. This three-month period of monitoring provides context to the 'dustiness' or otherwise of the STF operation. The 6-hourly monitoring data is shown in Figure 4.1 alongside the site's weather station data for temperature and rainfall.

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[4] PurpleAir Flex Air Quality Monitor / PA-II-FLEX | PurpleAir

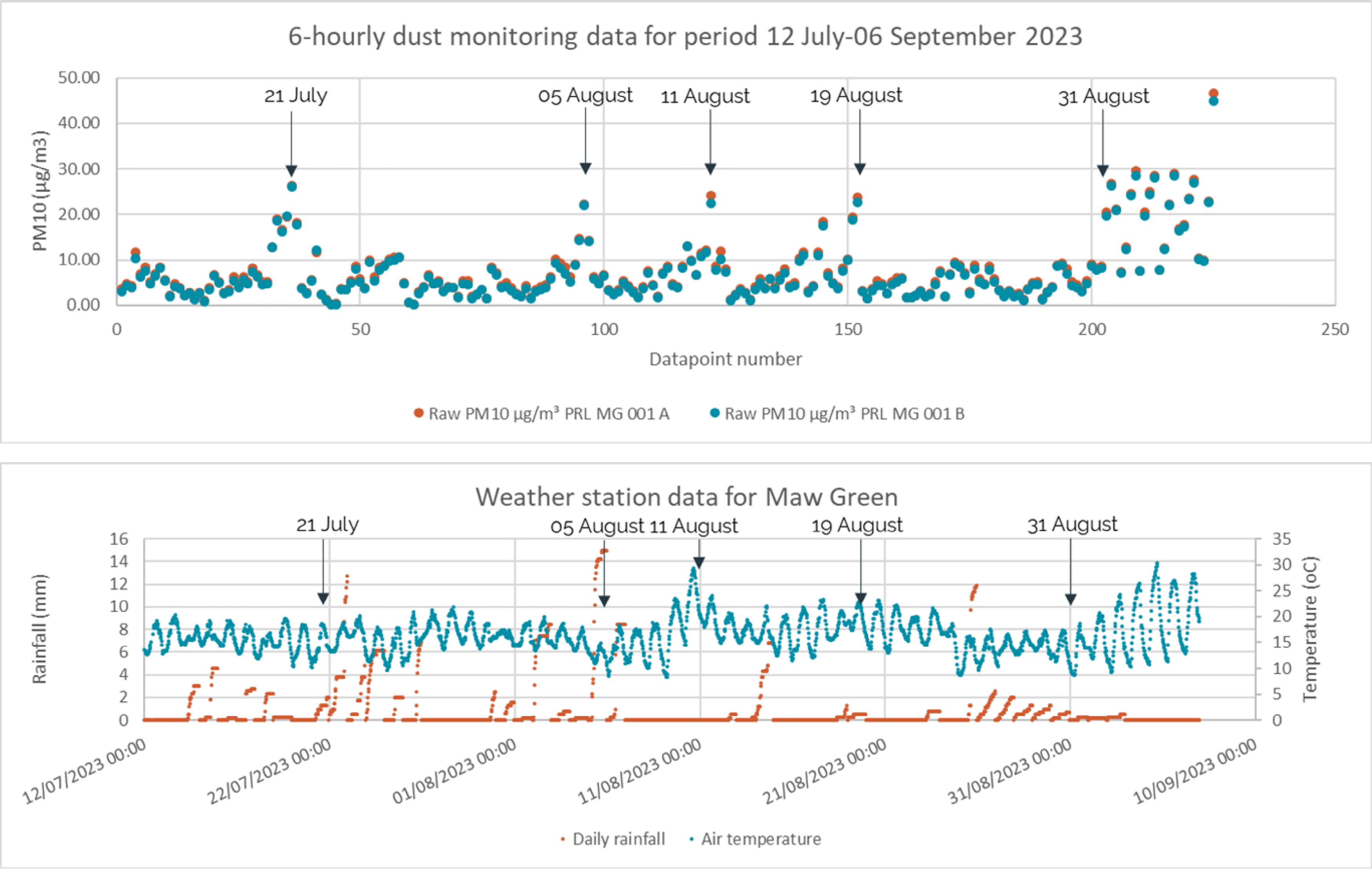

Figure 4.1: Dust monitoring and weather station data for the Maw Green STF

4.1.11 The period of more elevated (relative) PM10 concentration measurements in the first week of September coincides with a period of hot weather in the UK created by a high-pressure weather system drawing hot air from north Africa and southern Europe. It also coincides with four days of handheld dust monitoring carried out at the Maw Green STF by Hydrock.

4.1.12 Weather news reports for early September note the presence of a Saharan dust plume over Western Europe (including the UK) and it is reasonable to conclude that this is a contributing factor to the higher dust concentrations reported for the first week in September.

4.1.13 The Hydrock monitoring was carried out between 04-07 September 2023, and used a TSI DustTrak DRZ Aerosol Monitor 8534[5]. The details of the site monitoring activities are provided in Hydrock Technical Note 28480-HYD-XX-XX-TN-GE-0003 dated 06 November 2023 (included in Appendix F) and the dust monitoring results are provided as Appendix C. It is evident from the data that dust concentrations vary relatively rapidly with time and that there are short (transient) periods when dust concentrations are elevated (relative). These transient increases in dust concentrations were observed on-site to be typically caused by gusts of wind and plant movements on the treatment pad (specifically the 20-tonne dumper truck used to move processed material to the storage stockpile). Background (upwind) monitoring during the morning and afternoon of 06 September 2023 suggests that 'background' PM10 dust concentrations at the time of monitoring ranged from 10-32 µg/m^3 with an average over the 5-10 minute monitoring periods of 13-24 µg/m^3. The PurpleAir monitoring data shown in Figure 4.1 suggests PM10 dust concentrations within this range for the majority of the time.

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[5] https://tsi.com/products/aerosol-and-dust-monitors/aerosol-and-dust-monitors/dusttrak%e2%84%a2-drx-aerosol-monitor-8534/

4.1.14 A higher resolution (10-minute measurement frequency) dataset from the PurpleAir monitor for the period 03-08 September 2023 can be compared to the 'near-source' DustTrak data detailed in Appendix C. The monitoring locations are not identical but both are reasonably close. The data comparison is shown in Figure 4.2 and Table 4.1 below. The brackets underneath the data in Figure 4.2 identify the daily operational time of the STF.

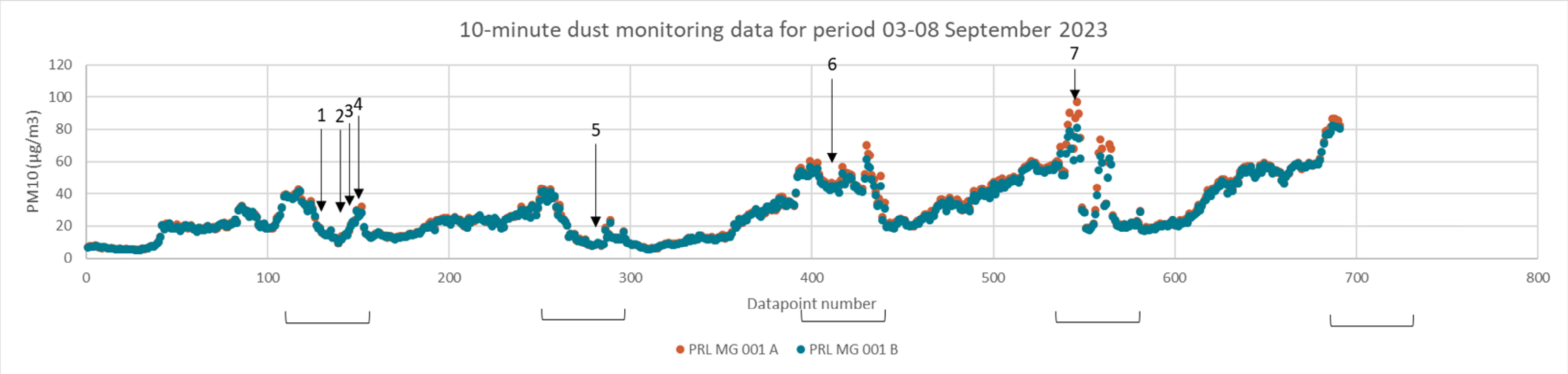

Figure 4.2: PurpleAir dust monitoring data for the Maw Green STF for the comparable time period of Hydrock dust monitoring

Table 4.1: TSI DustTrak summary concentrations for the 5-10 minute handheld monitoring data periods

Arrow marker	1	2	3	4	5	6	7
Time/date	04/09/2023 12:02:41	04/09/2023 13:43:23	04/09/2023 14:49:40	04/09/2023 15:20:56	05/09/2023 12:48:11	06/09/2023 10:58:23	07/09/2023 09:19:31
PM10 Average [mg/m³]	0.033	0.053	0.032	0.04	0.031	0.061	0.219
PM10 Minimum [mg/m³]	0.018	0.012	0.023	0.021	-0.017	0.05	0.045
PM10 Maximum [mg/m³]	0.075	0.641	0.101	0.341	1.33	0.252	0.637

4.1.15 The DustTrak and PurpleAir results are not identical but are similar, noting the different sampling location, instrument, and monitoring timing. This provides some reassurance that the data are reasonably representative of airborne dust concentrations close to the STF operations at the time of monitoring.

4.1.16 The data shown in Figure 4.2 indicates that ambient dust levels drop when site operations cease late afternoon, and then start to increase as the night progresses and this continues into early morning. It is evident that these early morning pre-site operation commencement dust concentrations steadily increased as the week progressed.

4.1.17 The data shown in Figure 4.2 also indicates that the process contribution (i.e. the increase in measured concentrations compared to those before operations start and after operations cease for the day) to near-source airborne dust concentrations during the four-day monitoring period might be between 20-40 $\mu g/m^3$.

4.1.18 It is reasonable to assume that airborne asbestos fibre emission might follow a similar, if not identical, temporal pattern to that for PM10 dust. It would be expected that there will be some differences, due to the very different aerodynamic shape of asbestos fibres compared to PM10 soil dust, material density, and hydrophobic/hydrophilic nature (i.e. ability to repel or absorb water), however, Matt Stoaling, in his evidence [CD6/4], notes that dust dispersion models can be used to model asbestos fibres.

4.1.19 The methods for the estimation of airborne asbestos fibre release published by SoBRA (SoBRA, 2021a) [CD1/2] include the use of airborne dust estimates, such as those above, and soil test results for the asbestos fibre content in the PM10 soil fraction. Provectus and Hydrock commissioned laboratory analysis of the pre- and post-processed soil and the dust settled on the concrete pad at the Maw Green STF for the period leading up to and including the time of the air monitoring detailed above. The testing results from 37 samples taken by Provectus between 14-25 August 2023 provided asbestos fibre counts in the PM10 fraction of the samples of between 5110 and 58700 fibres per milligram. Similar sampling was undertaken by Hydrock for the period 04-07 September 2023. This reported asbestos fibre counts between 5110 and 38300 fibres per milligram. If simplifying assumptions are made that long-term average background PM10 concentrations are at least 10 µg/m^3, and that average dust concentrations during soil processing activity are approximately 40 µg/m^3, this gives a process contribution of 30 µg/m^3 PM10. Multiplying 30 µg/m^3 with the ranges in reported asbestos fibres per gram PM10 gives an estimated range of airborne asbestos fibre concentrations of 150-1800 f/m^3 as measured by scanning electron microscope. This estimation method is evaluated further in Section 6.

4.1.20 There are inherent uncertainties in the indirect estimation of airborne asbestos fibre emissions from soil disturbance activities, and activity-based sampling (ABS) can provide valuable direct evidence of asbestos fibre release. Provectus has undertaken daily air monitoring of its asbestos containing soil processing activities at two similar soil treatment facilities, at FCC's landfill site at Maw Green (MG) in Crewe, and at FCC's Edwin Richards Quarry (ERQ) landfill site at Rowley Regis near Wolverhampton. The Maw Green STF is situated in the open air, whereas the Edwin Richards Quarry STF is situated in a building. The two STFs therefore provide a contrast in STF set-up.

4.1.21 The equipment and material processing rates at both sites are similar. There will be heterogeneity in the received soil being treated; this will be the case for both inter- and intra-site comparison. The air conditions at the two sites will be different, with one being outside (MG) and one being inside (ERQ). It is a reasonable expectation based on the design of the building at ERQ that air flow in the building will be less than that experienced outside, and therefore dust generated by processing activities inside the building will not disperse as readily as it would if those activities were located outdoors. This needs to be balanced against reduced wind erosion of the surface of uncovered stockpiled material indoors in the ERQ building as opposed to when stockpiles are uncovered outdoors at MG to enable material to be processed. As a general rule, dust and fibre release resulting from material agitation and movement will be greater than that resulting from surface wind erosion, and therefore I would expect the asbestos (and fine dust (PM10 and PM2.5) airborne concentrations to remain higher in the ERQ building than they would outside at MG. The data is therefore comparable with respect to monitoring method, and comparable with respect to processing operations being monitored. The expectation is that the monitoring data for ERQ would overestimate (to an undefined extent) equivalent airborne asbestos concentrations if the activities were undertaken outdoors.

4.1.22 In addition to permit-compliance air monitoring using a 'standard' air monitoring method[6] that utilises phase contrast optical microscopy (PCOM) (this cannot differentiate between asbestos fibres and non-asbestos fibres), Provectus has also undertaken air monitoring to a lower limit of quantification and utilised an analytical technique (scanning electron microscopy (SEM)) that is capable of fibre discrimination (i..e. between asbestos and non-asbestos fibres, and between serpentine (e.g. chrysotile) and amphibole (e.g. amosite) asbestos). It is this UKAS-accredited SEM data that I have focused on because of its superior detection limit and fibre discrimination.

4.1.23 The additional activity-based sampling was designed to monitor source emissions during the soil processing operation, and has generally comprised the positioning of a high-volume air sampling pump close to the material processing operation. Further information on the available ABS data is provided in Appendix F which provides a summary of the factual data provided to me.

4.1.24 The substantial amount of ABS data available for the Maw Green Soil Treatment Facility (STF) comprises 395 single point daily air samples taken across the period 15 August 2022

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[6] Phase contrast microscopy methods are advocated by the HSE in HSG248 and by the Environment Agency in M17.

to 15 September 2023 that have been taken close (i.e. within 5m) to the 3-way mechanical screener used to segregate the 'as received' soil into three size fractions prior to further treatment of the 'mid-size' fraction via a manned picking belt. This compares to much lower amounts of data collected at other permitted sites as summarised in Table 4 of Leslie Heasman's evidence [CD6/2].

4.1.25 I have been informed by Provectus (see Appendix H) that the location of the near-source SEM sampling pump does not vary much from day to day but that it is moved such that the sampler is located downwind of the mechanical screener shaker decks each day.

4.1.26 The on-site sampling at Maw Green has been undertaken by a UKAS accredited company (Thames Laboratories) and the analysis undertaken by a UKAS accredited laboratory (Institute of Occupational Medicine (IOM)) with fibre counting to ISO 14966:2019. The samples are typically 100 minutes in duration, with a resultant air sample volume of 1440 litres. This has enabled a limit of quantification (LoQ) of 0.0005 f/ml (500 f/m^3). This LoQ is significantly lower than that ordinarily associated with conventional monitoring used for asbestos-related activities (0.04f/ml for personal monitoring and 0.01f/ml for static sampling using the methodology set out in HSG248); than the BAT-associated emissions levels (AELs) required by environmental permits for waste facilities (understood to typically be set as 0.1f/ml at the emission source, and 0.01f/ml at the boundary); and than the LOD of 0.01f/ml for the 'preferred' method stated in M17 (section 7.4.2) There is no relevant MCERTS performance standard or MCERTS accredited test methods for ambient air monitoring for asbestos[7].

4.1.27 It is also noted that SEM analysis is generally capable of detecting smaller fibres than that detected using PCOM. The effect of this on the comparison of data from different

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[7] https://www.gov.uk/government/collections/monitoring-emissions-to-air-land-and-water-mcerts#ambient-air-monitoring-performance-standards

analytical methods is discussed in a SoBRA paper on air monitoring (SoBRA, 2021b) [CD1/2]. The World Health Organisation used the assumption of a two-fold difference between PCOM and SEM results in its evaluation of asbestos air quality guidelines (WHO, 2000) [CD1/2].

4.1.28 I have been informed that dust suppression at the STFs was not employed during the air sampling due to the potential for interference with sampling filters from water spray but would have been in operation as per Provectus' operating procedure before the air sampling commenced. The air sampling data is therefore indicative of reasonable worst case in each instance (i.e. fibre release without ongoing dust suppression).

4.1.29 Detectable asbestos fibres were reported in 14% of Maw Green air samples of which quantifiable concentrations of asbestos (i.e. equal to or greater than 500f/m^3) have been detected in 8 samples (2% of total samples taken). The highest reported concentration was 0.0015f/ml (1500f/m^3), and the 95th percentile fibre count is 1 fibre (i.e. <500f/m^3). Because 98% of the data is less than the limit of quantification of 0.0005f/ml (500f/m^3), further detailed statistical analysis of the data is not justified from a statistical perspective.

4.1.30 The substantial air monitoring data available for the ERQ STF comprises 809 daily samples taken across the period 14 January 2022 and 29 September 2023, predominantly within the processing building during processing activities, and also on occasion within the external storage pad. The monitoring approach and methodology are the same as that employed at the MG STF with the exception that monitoring up to 26 January 2023 was carried out at 4 monitoring locations rather than one. The data is therefore comparable in the context of sampling air within the operational area of the STF.

4.1.31 As per the Maw Green monitoring, sampling is reported to have been undertaken with dust suppression methods temporarily halted.

4.1.32 Quantifiable levels of airborne asbestos fibres (i.e. equal to or greater than 500 f/m³) were detected at ERQ on 26 occasions (3% of ABS samples). Asbestos fibres were not detected at all in 76% of ABS samples. The maximum reported airborne asbestos fibre concentration was 0.001f/ml (1000f/m³). Because 97% of the data is less than the limit of quantification of 0.0005f/ml (500f/m³), further detailed statistical analysis of the data is not justified.

4.1.33 The operation of the STF at ERQ has varied over the monitoring period. This has varied from the use of an uncovered mechanical screener and a covered manned picking station, to the mechanical screener being covered and fitted with a HEPA filter, to the screening operation not being used and only the manned picking station being in operation. The data sets for each operational period, if treated at face value appear to indicate a reduction in measured airborne fibre counts when the screener was covered and a HEPA filter fitted, and when the screening operation was not used. A summary of the data sets is shown in Table 4.2 below.

Table 4.2: Summary of operational air monitoring datasets for ERQ

Parameter	Screener in operation and uncovered	Screener in operation and covered + HEPA filter	No screening operation
Total number of air samples	88	128	593
Number of samples with zero fibres reported	49	95	472
Number of samples with countable fibres present	39	33	121
Percent of samples with countable fibres	44	26	20
95th percentile fibre count	3	2	2
99th percentile fibre count	5.5	3	4
Maximum fibre count	5.5	4	6.5
Maximum concentration (all asbestos)	0.0009 f/ml	0.0007 f/ml	0.001 f/ml
Maximum concentration (chrysotile)	0.0009 f/ml	0.0007 f/ml	0.0007 f/ml

Maximum concentration (amosite)	0.0005 f/ml	< 0.0005 f/ml	0.0007 f/ml
Percent of sample concentrations >LOQ	6%	1%	4%

4.1.34 Noting my comment in paragraphs 4.1.29 and 4.1.32, caution needs to be applied to any comparison of the summary data above because most of the data is below the limit of quantification for the analysis. At face value the data suggests that the highest fibre release occurred when all processing activities were being undertaken, and logically this makes sense. Lower levels of detectable airborne fibres were recorded when the screener was covered and when the screener was not in operation. However, the differences observed are unlikely to be statistically significant due to the measurement uncertainty inherent in the reported results. The analytical method limit of quantification is set at three detectable fibres on the basis that if no fibres are detected during the SEM examination, the upper 95 percent confidence limit is 2.99 fibres (ISO 14966, 2019). The lower- and upper-95 percent confidence limits for low fibre counts based solely on random counting errors are given in Table 4 of ISO 14966 and are reproduced below in Table 4.3. These error bounds do not consider sampling error (spatial and temporal variability in airborne concentrations, and sampling equipment error such as pump calibration and flow variability). Individual data points therefore should be interpreted with caution. Overall, there is no strong evidence from this data that mechanical screening increases detectable levels of fibre concentrations.

Table 4.3: Upper- and lower-95 percent confidence limits for fibre counts (reproduced from Table 4 of ISO 14966)

Fibre count	Lower 95 CL	Upper 95 CL
0	0	2.99
1	0.025	4.674
2	0.242	7.225
3	0.619	8.006
5	1.624	11.669

7	2.914	14.423
9	4.115	17.085

4.1.35 For comparison, the Environment Agency permit requirements for the installation permit at ERQ requires an emission limit of <0.01f/ml (10,000 f/m^3) at all sampling locations whereas for MG the permit requires an emission limit of 0.1f/ml (100,000 f/m^3) at the Environment Agency proposed HEPA filter on a future treatment building and an asbestos limit of 0.01f/ml (10,000 f/m^3) at ambient monitoring locations identified in the permit.

4.1.36 The Control Limit and Short-Term Exposure Level set by the Control of Asbestos Regulations (CAR) 2012 [CD1/F] are 0.1f/ml and 0.6f/ml respectively. The HSE advocates a monitoring LoQ of 0.002-0.005f/ml for perimeter monitoring (HSG248, 2013. Appendix 8, Table 5.2), and Environment Agency guidance for monitoring at waste facilities (M17) (EA, 2013) [CD1/N] advocates that asbestos should not be found above background levels (reportedly in the range of 0.0004-0.001 f/ml in remote areas and up to 0.0024 f/ml in urban air for electron-microscope-visible fibres according to M17). It is evident that the measured 'near-source' airborne fibre concentrations are typically below these background levels quoted in M17.

4.1.37 Notwithstanding the above it is also stated in M17 that the 'preferred' method for monitoring will usually be a 480-litre air sample followed by PCOM fibre-counting in accordance with HSG248 (which would give an LoQ of 0.01f/ml). This LoQ is higher than the background levels intimated in M17, and higher than the LoQs for perimeter monitoring advocated in HSG248. Using this method, all results would be simply 'non-detect'.

4.1.38 In summary, reported near-source air concentrations are consistently very low. Very few airborne fibres are detected, and quantifiable concentrations are infrequent. Factors affecting measurement results will likely include the asbestos content of the soil being processed, the process activities taking place, and the weather conditions, at the time of monitoring.

4.1.39 All reported concentrations are significantly below the criterion of 0.01f/ml (expressed as PCMe[8] concentrations) referenced in Environment Agency Environmental Permit requirements. Near-source monitoring is all below the perimeter/boundary LoQ of 0.002-0.005f/ml (PCMe) advocated by HSE in HSG248. The expectation is that dispersion from near-source to boundary will be significant, further reducing site boundary and potential off-site concentrations (see Section 7 for further details on this point).

4.1.40 In its interpretation of soil investigation results for assessing the risk specifically to workers, the HSE states in its latest guidance (HSG248, 2023) [CD1/O] that airborne fibre concentrations are unlikely to exceed 0.01f/ml (PCMe) where the asbestos in soil is mostly bound/bonded and at concentrations <0.1% wt/wt (section 7.21 of HSG 248). It goes on to state in section 7.22 that more energetic processes (including power screening) may give rise to elevated fibre levels, especially if the material is dry, however, when the soil is damp or wet, it states that airborne emissions of asbestos will be suppressed and wind dilution and dispersion of emissions will reduce worker and bystander exposures. The source(s) of information used by the HSE to inform their guidance is not given, however, it seems likely that the primary source is the guidance published by RIVM (2003) [CD1/R]. Personal communications during JIWG meetings may also have influenced this view, and the air monitoring results for one of the case studies detailed in NICOLE (2021) [CD1/2] are consistent with this.

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[8] PCMe denotes a PCOM-equivalent concentration. Using the approach taken by WHO, a SEM concentration can be expressed as a PCMe concentration by dividing the result by a factor of 2.

4.1.41 The RIVM[9] guidance published in 2003 [CD1/R] has yet to be superseded in terms of its content, and has been used to form the basis of regulatory guidance in other countries, such as that in Australia. RIVM included an analysis of over 1000 measurements of airborne asbestos at asbestos-contaminated soil sites in The Netherlands, and concluded that the disturbance of soil containing less than 1% wt/wt (10,000mg/kg) 'bound' asbestos did not generate detectable concentrations of asbestos fibres, and the disturbance of soil containing less than 0.01% wt/wt (100mg/kg) of 'unbound' asbestos did not generate airborne asbestos fibre concentrations greater than 10,000 f/m^3 (as measured by transmission electron microscopy (TEM))[10]. It also concluded that a soil moisture content of 5-10% reduced the re-suspension of asbestos fibres in air compared to dry soil by a factor of 100.

4.1.42 The monitoring at MG STF and ERQ STF supports the HSE's view that near-source airborne fibre concentrations are unlikely to exceed 0.01f/ml (PCMe), and indicates that in practice airborne concentrations are likely to be substantially lower than 0.01f/ml even when more energetic processes such as power screening are in operation.

4.1.43 Although there are some uncertainties in the data sets (something that is common in most datasets), the air monitoring datasets from the MG and ERQ STFs are substantial in terms of the number and the timespan of the data. The uncertainties principally centre around the operating and weather conditions at the time of sampling. Site activities, soil concentrations, and weather conditions will vary with time during the day, and the sampling typically covers 90 minutes. Therefore, it is theoretically possible that the sampling could miss transient (short-term) peaks in airborne fibre concentrations during each day.

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[9] Dutch National Institute for Public Health and the Environment

[10] The PCMe concentration will be <5000 f/m^3 (<0.005f/ml).

4.1.44 Given that such a high proportion of the sample results are less than the limit of quantification and less than the limit of detection, it remains reasonable to conclude that that long-term near-source average concentrations are unlikely to be significantly greater than the maximum concentrations detected.

4.1.45 To further develop the interpretation of the monitoring dataset, Hydrock undertook four days of more extensive ABS at the MG STF during a period of hot dry weather between 04-07 September 2023. The primary purpose of the monitoring was to provide an alternative monitoring dataset to that provided by the Provectus monitoring using more sensitive monitoring techniques, thereby enabling a comparison of the differing monitoring approaches. The details of this monitoring are provided in Hydrock Technical Note 28480-HYD-XX-XX-TN-GE-0003 dated 06 November 2023 which is included in Appendix F.

4.1.46 The monitoring included three days of near-source air sampling carried out by Lucion Services (a UKAS-accredited asbestos surveying and testing company) close to the location of the daily sampling undertaken by Thames Laboratories for Provectus, but with a longer sampling period (240 minutes versus the 90 minutes for the Thames sampling) and with a higher sample volume (3720 litres versus 1440 litres) to achieve a lower limit of detection and limit of quantification. Thames Laboratories undertook the monitoring on the fourth day to the same sampling method. This lower LoQ analytical method is not UKAS-accredited, however, I do not consider that this compromises the data. The sampling and testing has been undertaken by UKAS-accredited companies and the only difference to the accredited methods is the sampling of a greater air volume, and the counting of more image fields on the SEM. The benefit of a lower detection limit in my view outweighs the loss of method accreditation in this context.

4.1.47 A comparison of the longer sampling period, lower LoQ data with the ‘standard’ daily near-source sampling is provided in Table 4.4 below.

Table 4.4: Summary of near-source airborne asbestos air monitoring for 04-07 September 2023

Date	Thames Laboratories' 'standard' monitoring	Lucion/Thames lower LoQ monitoring
04 September 2023	1 chrysotile asbestos fibre detected (<0.0005f/ml)	No asbestos fibres detected (<0.00005f/ml)
05 September 2023	No asbestos detected (<0.0005f/ml)	No asbestos fibres detected (<0.00004f/ml)
06 September 2023	No asbestos detected (<0.0005f/ml)	No asbestos fibres detected (<0.00004f/ml)
07 September 2023	No asbestos detected (<0.0005f/ml)	No asbestos fibres detected (<0.00005f/ml)

4.1.48 Although the four days of sampling is a relatively short snapshot in time when considering STF operation over a number of years, it does indicate that under reasonably worst-case conditions (hot, dry weather, albeit with relatively light winds), a longer sampling period and lower limits of detection and quantification did not provide conflicting data to that provided by the shorter 'standard' daily sampling carried out by Thames. It also indicates that the frequently reported results that are <0.0005f/ml (<500 f/m^3) in the Provectus/Thames/IOM dataset could represent air concentrations significantly less than 500 f/m^3 (i.e. <50 f/m^3).

4.1.49 Overall, the additional data reported by Hydrock supports the data provided by Provectus, with both sets of data indicating that near-source airborne fibre concentrations measured within the STF operational areas are consistently significantly lower than the operational limits set out in the environmental permits).

5. Presence of loose asbestos fibres in post-processed soil and associated hazard potential

5.1.1 Provectus' acceptance criteria for asbestos-containing soils are:

- <0.1% wt/wt chrysotile
- <0.01%wt/wt amphibole

Where reception (acceptance) soil sample data based on gravimetric laboratory testing exceeds these thresholds, I have been verbally informed that Provectus will either reject the soil, further inspect the received soil, and/or submit the soil sample for further loose, free fibre laboratory testing, with the aim of confirming whether or not the soil is non-compliant. The intention of FCC/Provectus, and the associated material acceptance criteria they have set for the STFs, is to only accept soil material containing fragments of bound asbestos-type materials (i.e. bonded asbestos-containing materials that predominantly contain chrysotile asbestos and not amphibole asbestos). The potency (a function of fibre size and asbestos type) of chrysotile asbestos in these materials is such that it poses a considerably lower health risk than amphibole asbestos. The release of fibres from bonded asbestos is also comparatively low. These two factors combined indicate a low potential for chrysotile fibre release as a result of processing fragments of bonded chrysotile asbestos materials compared to that for more friable amphibole asbestos materials.

5.1.2 For reference, the hazardous waste criteria for soils containing asbestos are set out in Environment Agency waste classification guidance (WM3) (EA, 2021) [[CD1/X] as follows:

'If the waste contains fibres that are free and dispersed then the waste will be hazardous if the waste as a whole contains 0.1% or more asbestos…. Where the waste contains identifiable pieces of asbestos containing material (i.e. any particle of a size that can be identified as potentially being asbestos by a competent person if examined by the naked eye), then these pieces must be assessed separately. The waste is hazardous if the concentration of asbestos in the piece of asbestos containing material is 0.1% or more.'

The waste classification takes no additional account of the asbestos type or asbestos form.

5.1.3 The simple identification of the presence of asbestos in soil tells you very little about the likely release of airborne fibres from that soil and the associated potential health hazard, and this is considered further in this section of my evidence.

5.1.4 Validation soil sample data provided by Provectus for the material processed at the Maw Green and ERQ STFs between 24 September 2019 and 19 October 2023 has been reviewed. According to Provectus Soil Treatment Centre (STC) Work Instruction (WI) 006, revision 5 dated 14/12/2022, (included in Appendix G) validation soil samples are taken 'using a grid formation sampling plan', with one composite sample being taken for every 500 tonnes of material 'as a general rule'. Soil reception acceptance samples are taken on a similar frequency or for each consignment, whichever requires the greatest sample number (Appendix G WI 002 and WI 003). Data from 89 soil samples is available from Maw Green and 253 samples from ERQ, and represents treated soil that originated from approximately 300 different sites across the UK. The data, whilst not representing future processed soil, provides a good indication of the type of material being generated at remediation sites in the UK and being accepted by FCC/Provectus over this four-year period. This is soil data for material after it has been processed at the STFs. Corresponding soil acceptance test results (i.e. pre-processing) have been made available to me, however, I have initially focused on the post-processed data as it will better represent the fibre-release hazard of the material. I comment on the difference (if any) with the pre-processed (i.e. as received) soil in Section 6. Larger pieces of asbestos containing materials (such as visible fragments of bonded asbestos material) that are picked out and separated as part of the processing will not significantly contribute to the airborne fibre release hazard. The smaller, more degraded fragments and fibre bundles, either pre-existing in the material, or generated as part of the material processing will, and it is these that will represent the post-processed soil concentrations that have been reported. It has already been established that the fibre loss from the soil from airborne release is likely to be low based on the evidence presented in Section 4, and this is evaluated in more detail in Section 6.

5.1.5 The soil data is either from the finer separated soil fraction post screening or from the finer fraction of unscreened, picked material dependent on the processing operations in use at the time of sampling. Post-processing, this material is less likely to contain visible[11] fragments of ACM and is more likely to contain the loose fibre bundles and loose fibres that were present in the originally received material (if present originally). All laboratory test results are UKAS accredited.

5.1.6 For the Maw Green data, asbestos fibres were not detected above 'trace' (defined in HSG248 as 3 or more fibres) in 48% of the soil samples. For the 52% of samples where loose fibres, fibre bundles or small ACM fragments were detected, 16 samples (37%) contained levels of asbestos below the LOQ. Of the 27 samples with quantifiable levels of asbestos (30% of all samples), the highest reported concentration was 0.024%wt/wt (240mg/kg). The 90th percentile soil concentration for all soil samples is approximately 0.009%wt/wt (90mg/kg) and the upper quartile 0.001%wt/wt (10mg/kg). Percentiles are subject to assumptions on the statistical treatment of <LOQ data. 38 samples from December 2022 onwards were specifically tested for loose individual fibres (as opposed to the ACM fragments and fibre bundles detectable by gravimetric analysis). All reported results are <LOQ (i.e. <0.001%wt/wt). For reference, the highest reported gravimetric result for these 38 samples was 0.018%wt/wt.

5.1.7 For the ERQ soil validation data a similar pattern emerges. Asbestos fibres were not detected above 'trace' (defined in HSG248 as 3 or more fibres) in 74% of the soil samples. For the 26% of samples where loose fibres, fibre bundles or small ACM fragments were

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[11] Visible to the naked eye as opposed to visible under a microscope

detected, 33 samples (46%) contained levels of asbestos below the LOQ. Of the 38 samples with quantifiable levels of asbestos (14% of all samples), the highest reported concentration was 0.089%wt/wt (890mg/kg). The 90th percentile soil concentration for all soil samples is approximately 0.002%wt/wt (20mg/kg) and the upper quartile <0.001%wt/wt (<10mg/kg).

5.1.8 Overall, the data indicates that approximately 30% of processed soil at Maw Green has an asbestos concentration greater than the LOQ. For ERQ it is lower, at less than 15%. Where higher concentrations are reported, other samples for the processed material from the same site of origin report lower concentrations. The data does not therefore provide compelling evidence of continuously elevated soil concentrations in processed material following soil screening.

5.1.9 The reported loose free fibre concentrations in samples of processed soil at Maw Green are less than the LOQ of 0.001%wt/wt (10mg/kg). The Joint Industry Working Group for Asbestos in Soil and Construction & Demolition Materials (JIWG) Decision Support Tool (DST) for work categories (CL:AIRE, 2017a) [CD1/2] classifies the fibre release hazard from soil with loose fibre concentrations less than 0.001% as 'negligible'.

5.1.10 The hazard from 'very low' quantities (<0.01%wt/wt) of loose fibres/fibre bundles (closest DST description to the detected 'fibre bundles/clumps' reported in the gravimetric analysis test results for soil validation samples) is described as 'medium' in the JIWG DST. As the DST does not distinguish between fibre bundles and individual loose fibres, and loose free fibres have been reported to be <0.001%wt/wt, the 'medium' DST hazard designation will be an overestimation. An overall hazard ranking of 'low' to 'very low' is more appropriate (i.e. greater than 'negligible' and less than 'medium').

5.1.11 The Control of Asbestos Regulations and associated HSE guidance does not differentiate between asbestos type when it comes to airborne fibre concentrations. The Control Limit, Short-term Exposure Limit and Clearance Indicator Level are all defined as a non-differentiated fibre concentrations in air, and the standard analytical technique of Phase Contrast Optical Microscopy (PCOM or PCM) for analysing air samples does not discriminate between asbestos and non-asbestos fibres, let alone between different asbestos fibre types. There is however good scientific evidence to differentiate between asbestos type and between fibre size, and this has been taken into account in robust guidance published on the assessment of environmental exposures to asbestos (as opposed to occupational exposure). A summary of published evaluations of fibre potency by the likes of the Dutch National Institute of Public Health and the Environment (RIVM), and the US Environmental Protection Agency (US EPA) is published in SoBRA (2021b) [CD1/2]. That summary is reproduced in part here:

'Hodgson and Darnton (2000)[12] *suggested a potency difference based on asbestos type of 1:100:500 for mesothelioma for chrysotile:amosite:crocidolite. This however is only relevant to the range of occupational exposures measured in the occupational cohorts. The ratio is more like 1:10:100 at lower environmental exposure levels.*

RIVM (2003)[13] *evaluated potency based on fibre asbestos type and fibre dimension as follows:*

Chrysotile	*Fibre length >5um*	*1*
Amphiboles	*Fibre length >5um*	*10*
Chrysotile	*Fibre length <5um*	*0.1*
Amphiboles	*Fibre length <5um*	*1*

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[12] *Hodgson, J.T. and Darnton A. The quantitative risks of mesothelioma and lung cancer in relation to asbestos exposure. Annals of Occ. Hyg., Volume 44, No 8, pages 565-601*

[13] *Assessment of the risks of soil contamination with asbestos, F.A Swartjes, P.C Tromp, J.M Wezenbeek, RIVM report 711701034/2003*

The Health Council of the Netherlands in 2010[14] re-evaluated the epidemiological data and provided a revised analysis of potency differences. It concluded on a potency ratio of 1:2:10 for chrysotile:mixed fibres:amphiboles.

ATSDR (2001)[15] concluded that mineral type and fibre size were of prime importance to health risk, and that long fibres were more carcinogenic than short ones [without providing a quantitative risk differentiation].

US EPA (1986)[16] concluded that crocidolite was 2-4 times more potent than chrysotile for mesothelioma but that the difference may be overstated by differences in fibre size distribution in the exposures received by the occupational cohorts.

The World Health Organisation (1986)[17] and US EPA (1986) chose not to distinguish between fibre potency when developing guideline values and unit risks for air concentrations and as a result these values can be taken to be associated with amphibole exposure.

Berman & Crump (2008)[18] looked more closely at accounting for fibre mixtures and fibre size distributions in the historic occupational cohort data. In doing so they produce very different exposure-risk coefficients to those based solely on the reported air concentration. They suggest a potency ratio of at least 1:200 for chrysotile:amphibole mesothelioma risk.

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[14] *Asbestos: Risks of environmental and occupational exposure, Health Council of the Netherlands, The Hague, Publication no. 2010/10E, June 2010*

[15] *Toxicological Profile for Asbestos, US Agency for Toxic Substances and Disease Registry, September 2001*

[16] *Airborne asbestos health assessment update. Research Triangle Park, NC: Environmental Criteria and Assessment Office; EPA 600/8-84/003F, US Environmental Protection Agency, 1986.*

[17] *Asbestos and other natural mineral fibres, Environmental Health Criteria No.53, World Health Organisation, 1986*

[18] *Berman DW, Crump KS. Final draft: technical support document for a protocol to assess asbestos related risk. Prepared for office of solid waste and emergency response. Washington DC: US Environmental Protection Agency; 2003*

Although focus can sometimes be on mesothelioma, lung cancer risk can be an important factor at low concentrations. CIRIA (2014)[19] provides a summary of the different potencies for mesothelioma and lung cancer based on the HEI and H&D models:

Mesothelioma	*HEI*	*1:3.2*
	H&D	*1:100*
Lung cancer	*HEI*	*1:4*
	H&D	*1:10-50*

Ratios expressed as chrysotile:amphiboles

The results of SoBRA's modelling using the HEI and H&D models, accounting for the summation of mesothelioma and lung cancer risk suggests the following:

Berman & Crump (2008) analysis taking into account fibre size distribution and fibre mixture of original occupational exposure (adjusted coefficients)	*1:185*
HCN (use of unadjusted cohort coefficients and UK mortality data)	*1:35*
Hodgson & Darnton (non-linear) (best estimates)	*1:80 (residential scenario)*
Hodgson & Darnton (linear) (best estimates)	*1:75 (residential scenario)*

Potency ratio expressed as chrysotile:amphibole'

5.1.12 As can be seen in the SoBRA summary above, there is a majority consensus that chrysotile fibres pose a lower carcinogenic risk to humans than amphibole asbestos. The variability in the published quantification of that difference in potency partly reflective of the scientific uncertainty in the interpretation of the epidemiological evidence, and partly

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[19] *Nathanail, C.P, Jones, A, Ogden, R, Robertson, A, Asbestos in soil and made ground: a guide to understanding and managing risks, C733, CIRIA, London, 2014.*

reflective of a change/strengthening in scientific opinion over time. The publications that don't make a differentiation in potency are those by the US EPA and WHO, both published in the 1980's. The text used by the US EPA in its IRIS evaluation published in 1988 (US EPA, 1988) [CD1/2] for example is '*There is some evidence which suggests that the different types of asbestos fibers vary in carcinogenic potency relative to one another and site specificity. It appears, for example, that the risk of mesothelioma is greater with exposure to crocidolite than with amosite or chrysotile exposure alone. This evidence is limited by the lack of information on fiber exposure by mineral type. Other data indicates that differences in fiber size distribution and other process differences may contribute at least as much to the observed variation in risk as does the fiber type itself'.*

5.1.13 Asbestos fibre type is considered in the Joint Industry Working Group for Asbestos in Soil and Construction & Demolition Materials (JIWG) Decision Support Tool (DST) for receptor ranking (CL:AIRE, 2017b) [CD1/2]. The DST classifies the fibre release hazard from soil containing loose fibres and fibre bundles as 'low' if the fibres are chrysotile asbestos, and as 'medium' if the fibres are 'mainly amosite'. The DST takes no account of fibre concentration at this step in the DST. The soil validation data noted above suggests that soil asbestos content is mixed, with chrysotile-only asbestos identified in 16% of samples from ERQ and 29% of samples from MG. Amosite and/or combinations of chrysotile and amosite Is identified in 5% of ERG samples and 22% of MG samples. Based on this data the detectable levels of asbestos in processed soil are predominantly chrysotile but amosite is also present.

5.1.14 Earlier this year, a reassessment of the Hodgson & Darnton (2000) was published by one of the original authors (Darnton, 2023) [CD1/2]. It is worth recognising that this work was funded by the UK Health and Safety Executive. The authors of the original paper in 2000 concluded that much of the variation in the mesothelioma risk per unit exposure seen across the cohort studies could be explained by fibre mineral type alone with amosite and crocidolite fibres conferring a risk 100 and 500 times that of chrysotile respectively (i.e. 1:100:500 for chrysotile : amosite : crocidolite risk). The effect of mineral type on lung cancer risk was less certain, with a suggestion that risk estimates were between a factor of 10 and 50 times higher in amphiboles (such as amosite) compared with chrysotile. The reassessment suggests the ratios for mesothelioma risk remain the same when considering pure chrysotile, but that the ratios may be an order of magnitude lower (1:10:50) if the chrysotile contains small amounts of amphibole asbestos (due to natural co-occurrence and/or cross-contamination during processing and manufacturing). The latter ratios are more consistent with those advocated by Dutch authorities.

5.1.15 In summary, the type of asbestos present in the soil being processed (for example chrysotile or amosite) makes a significant difference to the potential exposure risk.

5.1.16 RIVM (2003) [CD1/R] also looked at the risk differentiation between bound (bonded) and unbound asbestos when disturbed in the context of soil containing asbestos. It is the leading guidance published on the subject. Laboratory and field experiments, resulting in a database of over 1000 measured data, were used by the authors to conclude that for soils contaminated with less than 1% bound asbestos, no airborne fibres were detected. For field measurements with soil containing friable asbestos, air concentrations were found to be less than 100 f/m^3 (0.0001 f/ml) at soil concentrations below 100 mg/kg (0.01%wt/wt). The field experiments are noted to be from daily practice activities described as driving on contaminated roads and digging, dumping and sifting of humid soil. As the authors describe the soil as ‘humid’ it is reasonable to assume that the soil was neither wet nor bone dry. It would appear that the soil was made damp as part of the safety precautions for the experiments. The field experiments involved soils containing chrysotile and amphibole asbestos and the reported air concentrations notably did not differentiate between asbestos type. However, the authors do note that the fraction of respirable fibres in the soil is likely to be a function of the form of the asbestos material and the type of asbestos present in that material. From a database comprising 10 years of soil asbestos test results the authors concluded that the respirable fibre content for soils containing asbestos cement is less than 0.1% of the total reported soil asbestos content, even for weathered (degraded) material. For unbound (friable) asbestos materials containing amphibole asbestos, such as loose fibre insulation lagging, the fraction of respirable fibres in the soil ranged from approximately 5% to 25% of the total reported soil concentration dependent on the asbestos material present.

5.1.17 Whilst it is recognised that these experimental results are only loosely described in the RIVM guidance, and that the results will be dependent on the analytical method (the analytical method used in the experiments is likely to be different to that adopted in the UK), the underlying principles remain relevant – i.e. that the respirable fibre content in bonded asbestos containing soils is likely to be low and be a small percentage of the total asbestos in soil concentration.

5.1.18 This is not to say that asbestos cement does not contain respirable fibres. Whilst the Dutch authors did conclude that respirable fibres from asbestos cement in soil are “nil” an investigation undertaken by the HSL and published in 2006 on chrysotile fibres in asbestos cement (HSL, 2006) [CD1/2] demonstrated that respirable fibres can be released from asbestos cement when that material is broken up using a hammer under test conditions. Previously reported monitoring of work on asbestos cement roofs included in Annex 1 of the HSL report also includes measured fibre concentrations by PCM in excess of 0.01f/ml. The HSL report author also notes that weathered asbestos cement has the potential to release more fibres from its surface than unweathered cement. The conclusion of the Dutch authors is therefore likely to be limited by the analytical limit of detection used when testing the soil samples.

5.1.19 It is expected that soils containing unbound, more friable amphibole asbestos materials will likely contain a relatively higher proportion of respirable fibres. This is important in the context of the typical analytical methods used by UK laboratories to report asbestos in soil concentrations. What is commonly described as Stage 2 Gravimetric Analysis by UK laboratories involves the weighing of small fragments of asbestos containing materials (ACM) and fibre bundles. The weight of the fibre bundles is taken as 100% asbestos. The weight of the small ACM fragments is corrected for asbestos content using prescribed asbestos contents for different materials. Both approaches do not therefore equate to a concentration of releasable respirable fibres. A correction for reported gravimetric results along the lines of the respirable fractions reported in the Dutch guidance is therefore valid when interpreting gravimetric data, and it is likely that gravimetric results will be an overestimate of releasable respirable fibre content. This is especially relevant when looking to predict the release of respirable asbestos fibres from soil using experiments that have been based on soils containing loose free fibres, such as that published by IOM in 1988 [CD1/2].

5.1.20 The research on asbestos fibre release from soil by Addison et al published by IOM in 1988 [CD1/2] is referenced in the RIVM guidance, and the Dutch authors comment that the Addison et al experiments indicate '*…that fibres are released more easily from amphibole asbestos types, especially amosite, than from chrysotile asbestos. On average two to five times higher concentrations in the air are measured in experiments with amphibole asbestos than in experiments with chrysotile asbestos.*' It is apparent from the Addison et al data that loose amosite fibres are more readily released from soil compared to comparable conditions with loose chrysotile fibres. This may explain why amosite fibres are more frequently detected in the minority of air samples from both Maw Green and ERQ in which detectable fibres were reported (14% of Maw Green samples and 24% of ERQ samples). At Maw Green, 88% of these air samples containing detectable fibres contained amosite fibres, whereas only 18% contained chrysotile fibres. The percentages for the ERQ data are 76% and 42% respectively. However, given that the material accepted for treatment at the STFs is understood to predominantly contain chrysotile based asbestos cement (and/or similar bonded asbestos materials), and that the majority of the air samples contained no detectable asbestos fibres, the air monitoring data indicates that chrysotile fibre release from these fragments of bonded ACMs during material processing is comparatively low and unlikely to be significantly contributing to airborne fibre emissions.

5.1.21 The Addison et al research also identifies that fibre release may vary as a result of soil type – the experiments were conducted with 'sand', 'clay', and 'intermediate' soils - and with soil moisture levels. Based on the research of Addison et al and similar research carried out in The Netherlands, the authors of the Dutch guidance conclude that different soil types show different 'immobilising capacities', with clay soils exhibiting the strongest immobilisation of asbestos fibres and sandy soils exhibiting the weakest immobilisation. Soil moisture, however, has the greatest influence on the release of asbestos fibres.

5.1.22 Soil moisture content is a key factor in asbestos fibre release from soil, and scientific studies published in the UK and in The Netherlands have established the significance of this. The laboratory studies reported by IOM (1988) indicate that a soil moisture content of 10% reduced measured airborne fibres by a factor of 10. Similar studies by TNO and reported by RIVM (2003) [CD1/R] indicated that a soil moisture content of 5-10% reduced the re-suspension of asbestos fibres in air by a factor of 100. The difference in the results between the experiments published by IOM and RIVM are plausibly due to the differing experimental designs used.

5.1.23 The relationship between fibre release and moisture content appears to be inversely exponential, and the experiments also appear to indicate that moisture content has the greatest influence on the release of fibres from sandy soil, with the Dutch authors commenting that *'…a small percentage of water contributes heavily to increasing adhesion force and reducing fibre emission'*. This is directly relevant to the consideration of dust suppression mitigation effectiveness, as damping down would appear to be most effective for sandy soils (i.e. the soil type identified to have the weakest asbestos immobilisation).

5.1.24 The principal assumption made by the authors in a study of farm tracks containing asbestos cement production waste in South Cambridgeshire (IOM, 2005) [CD1/2] on the effects of weather on fibre release was that the airborne fibre concentration on wet days would be 'small, probably negligible' compared to that on dry days. Furthermore, in Appendix 8 of HSG248 (HSE, 2021) [CD1/O] it is stated (A8.4) that if the soil surface is damp, almost no release of asbestos fibres to air will occur.

5.1.25 Excavated soil received at the STFs is unlikely to have zero moisture content, and the Provectus operating procedure is for the material to be stockpiled under sheeting before being processed, thus reducing the potential for stored soil to dry out prior to being processed. Laboratory moisture testing of pre- and post-processed soil at Maw Green and ERQ confirms this, with reported soil sample moisture contents typically above 5% (range 0.62%- 52%, 5th percentiles 5%-8%). The lowest reported values are associated with material batches for which additional samples have higher reported moisture contents. Some heterogeneity in moisture content is expected and therefore a more relevant soil moisture content when looking at long-term average emissions and exposure is a low percentile of the datasets rather than the minimum value. The lowest moisture contents tend to be reported for ERQ samples and this may reflect the storage of the material inside a building as opposed to outside, as is the case at Maw Green. A summary of the post-processed soil datasets for the two STFs, focusing on the lower percentiles, is provided below for reference.

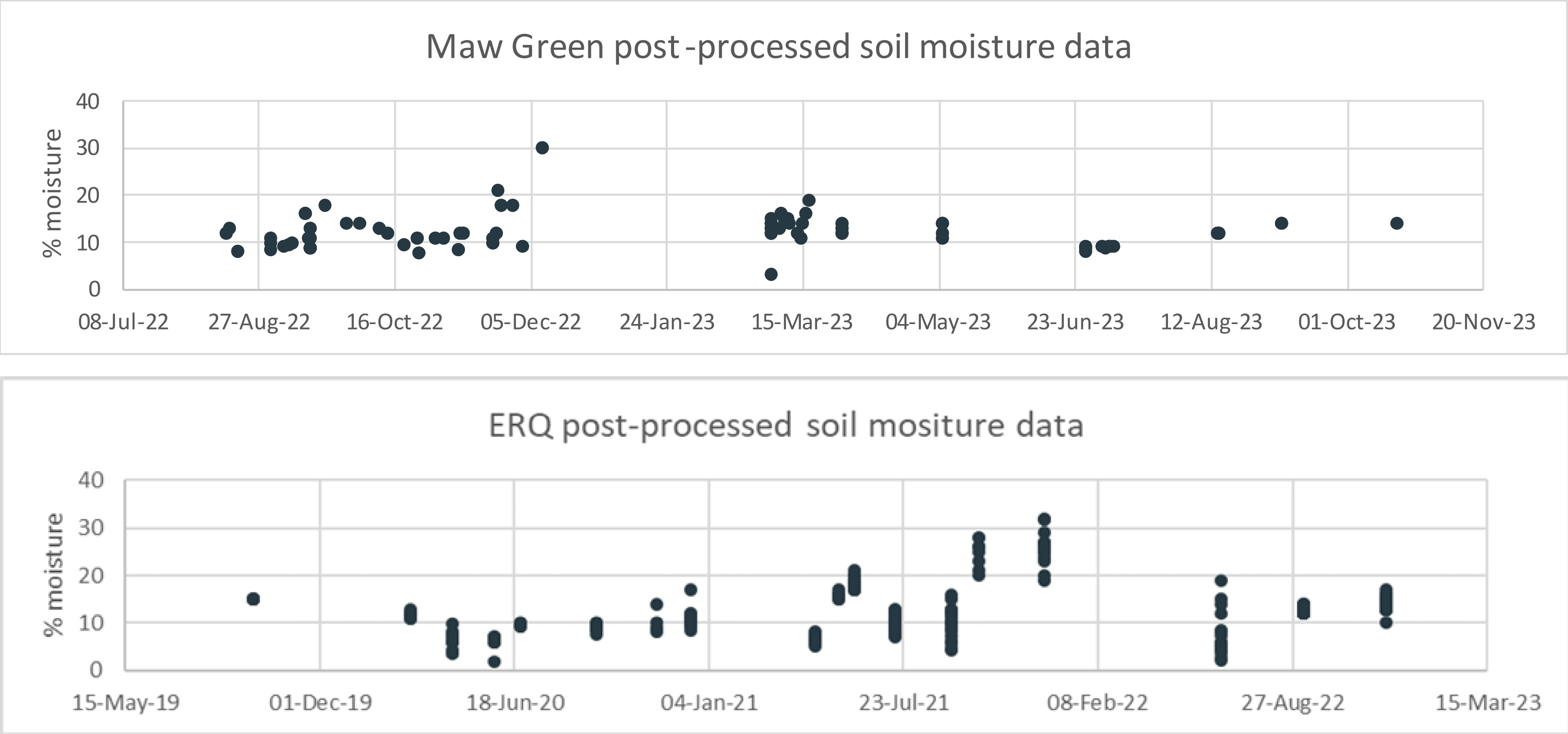


Figure 5.1: Post-processed soil validation sample moisture contents

Table 5.1: Summary of post-processed soil validation sample moisture contents

Parameter	Maw Green	ERQ
Total number of soil sample test results	89	253
Time period covered by data	15 August 2022 – 19 October 2023	24 September 2019 – 01 December 2022
Minimum	3.3%	2%
Maximum	30%	32%
5th percentile	8%	5%
Lower quartile	10%	9%

5.1.26 The data is similar for the pre-processing soil data.

Table 5.2: Summary of pre-processed soil reception (acceptance) sample moisture contents

Parameter	Maw Green	ERQ
Total number of soil sample test results	118	769
Time period covered by data	15 August 2022 – 06 October 2023	02 August 2019 – 12 October 2022
Minimum	4.3%	0.62%
Maximum	30%	52%
5th percentile	7.7%	6.1%
Lower quartile	9.4%	10%

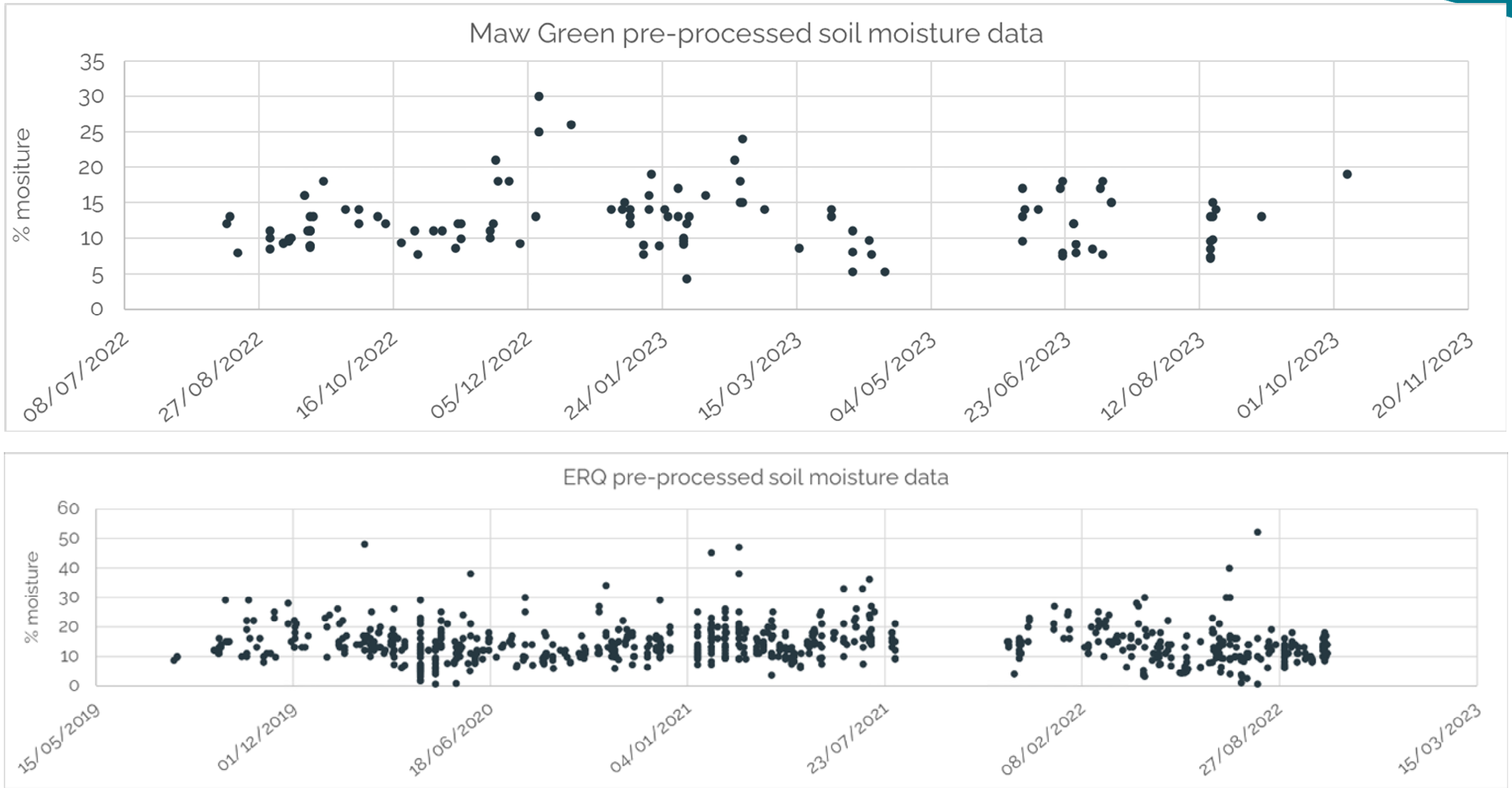


Figure 5.2: Pre-processed soil reception (acceptance) sample moisture contents

6. Potential for material processing to increase loose, free fibres concentrations in the soil

6.1.1 The revised permit conditions for both Daneshill and Maw Green stipulate that the processing should not increase the amount of loose asbestos fibres present in the treated soil (termed ‘asbestos fibre load’ in the permits – Schedule 1 Table S1.1 AR3A for Daneshill and Schedule 1 Table S1.1 AR7 for Maw Green) . The available pre- and post-processed soil acceptance/validation data for both Maw Green and ERQ that is based on UKAS-accredited analytical methods for the reporting of asbestos identification and gravimetric quantification cannot answer the question of whether or not the processing increases the respirable fibre concentration of the material as a high proportion of the reported soil acceptance and soil validation concentrations are less than the limit of quantification for current commercially available UKAS-accredited test methods and therefore any attempt to distinguish between pre- and post- processed data would be subject to the uncertainties associated with attempting to compare datasets with a high proportion of non-detect results. In addition, the gravimetric analysis results are not reported as a respirable fibre concentration but rather a total asbestos concentration based on generic published asbestos content for fragments of asbestos containing materials and the total weight of bundles or clumps of fibres picked out of the sample. “Any increase” is therefore not a practicable measure. A summary of the asbestos identification and gravimetric quantitative laboratory results for pre- and post- processed acceptance validation data is provided in Appendix F.

6.1.2 Those pre- and post- processing soil datasets for ERQ and Maw Green summarised in Appendix F are compared in Table 6.1 and Table 6.2 below. The data for Maw Green spans the period August 2022-October 2023, and the data for ERQ spans the period during which the mechanical screener was in operation (September 2019 - September 2022).

Table 6.1: Comparison of Maw Green pre- and post- processing soil samples

Parameter	Pre-processed soil samples	Post-processed soil samples
Total number of soil samples	118	89
Number of samples with no asbestos detected	69 (58%)	43 (48%)
Number of samples with detectable asbestos present	49 (42%)	46 (52%)
Number of samples with asbestos concentration > LOQ	40 (34%)	27 (30%)
Median concentration	<0.001%wt/wt (<LOQ)	<0.001%wt/wt (<LOQ)
Upper quartile	0.002%wt/wt	0.001%wt/wt
90th percentile concentration	0.008%wt/wt	0.008%wt/wt
95th percentile concentration	0.019%wt/wt	0.021%wt/wt
Maximum concentration	0.5%wt/wt (repeat sample 0.018%wt/wt)	0.075%wt/wt

Table 6.2: Comparison of ERQ pre- and post- processing soil samples

Parameter	Pre-processed soil samples	Post-processed soil samples
Total number of soil samples	769	278
Number of samples with no asbestos detected	589 (77%)	207 (74%)
Number of samples with detectable asbestos present	179 (23%)	71 (26%)
Number of samples with asbestos concentration > LOQ	134 (17%)	38 (14%)
Median concentration	<0.001%wt/wt (<LOQ)	<0.001%wt/wt (<LOQ)
Upper quartile	<0.001%wt/wt (<LOQ)	<0.001%wt/wt (<LOQ)
90th percentile concentration	0.003%wt/wt	0.002%wt/wt
95th percentile concentration	0.009%wt/wt	0.007%wt/wt
Maximum concentration	4.7%wt/wt (chrysotile cement)	0.09%wt/wt

6.1.3 Noting the caveats expressed in paragraph 6.1.1 above, the comparison of Maw Green samples provides a mixed picture, with a higher number of post-processed samples containing detectable asbestos but the number of samples with quantifiable asbestos is lower in the post-processed samples. The comparison of ERQ samples (a much larger dataset) suggests a potential reduction in asbestos content in the post-processed soil for all parameters.

6.1.4 As noted in paragraph 5.1.6, Provectus retrospectively re-tested validation soil samples from Maw Green for loose, free fibre content. 38 samples from December 2022 onwards were re-tested for loose individual fibres (as opposed to the ACM fragments and fibre bundles detectable by gravimetric analysis). All reported results are <LOQ (i.e. <0.001%wt/wt). For reference, the highest reported gravimetric result for these 38 samples was 0.018%wt/wt.

6.1.5 It is theoretically plausible that material agitation could cause ACM deterioration that could result in the release of individual fibres into the soil. As noted in paragraph 5.1.18, an investigation undertaken by the HSL and published in 2006 on chrysotile fibres in asbestos cement (HSL, 2006) demonstrated that respirable fibres can be released from asbestos cement when that material is broken up using a hammer under test conditions. Critical to this is the degree to which this might occur under less extreme conditions such as soil processing involving a soil screener.

6.1.6 The potential for material deterioration during work activities was considered by the authors of the CAR-SOIL guidance (CL:AIRE, 2016) [CD1/Q] and I've considered this in Section 4.

6.1.7 Activity-based sampling published by the Dutch Institute of Public Health and the Environment (RIVM, 2003) [CD1/R] indicates that disturbance of soil containing less than 1%wt/wt 'bound' asbestos (e.g. asbestos cement) did not create detectable concentrations of asbestos fibres in air (in this case the detection limit was 0.001f/ml (1000 f/m^3) by transmission electron microscope). This conclusion was based on a reported dataset of over 1000 measurements. The authors of the same Dutch guidance also concluded that the respirable fibre concentration in soil containing fragments of bound asbestos is 'nil' (less than 0.1% of the total asbestos soil concentration). This conclusion was based on 10 years of soil test data.

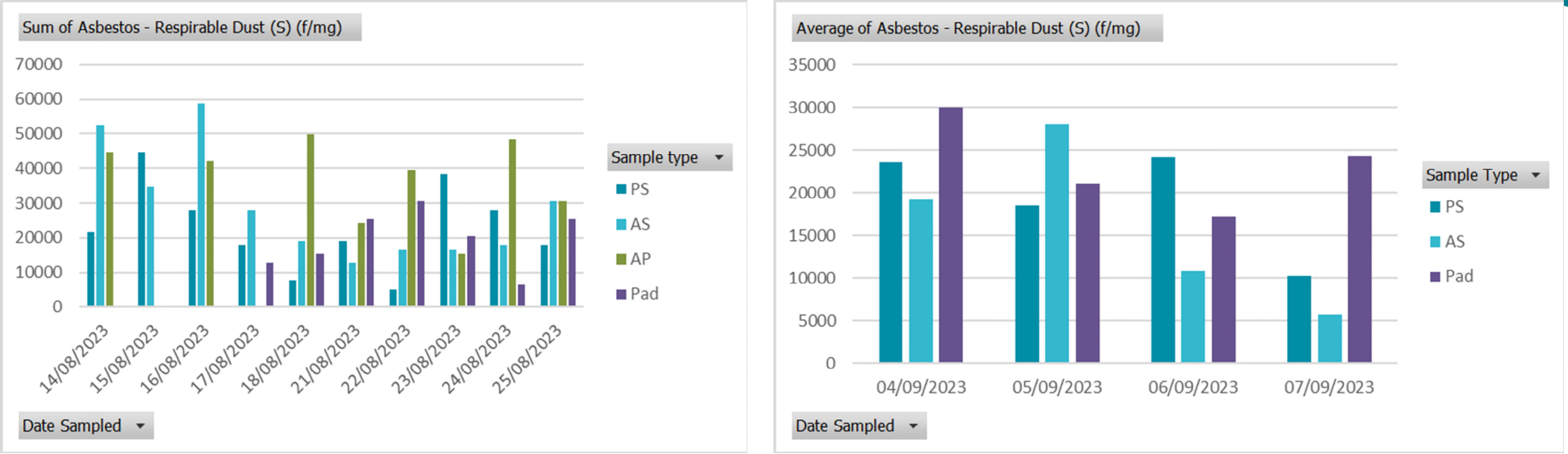
6.1.8 The Institute of Occupational Medicine conducted an assessment of fibre release from farm tracks in South Cambridgeshire made with asbestos cement waste (IOM, 2005) [CD1/2]. The calculated average weekly airborne fibre concentrations resulting from pedestrian and vehicular use of these farm tracks were <0.00001 – 0.0007 f/ml (<10-700 f/m^3). Vehicular traffic was described by the authors to be one to two vehicles per hour.

6.1.9 Overall, it is expected that respirable fibre release from weathered/damaged bound asbestos will be very low compared to the potential release from unbound, more friable asbestos containing materials. The stated material acceptance criteria for the proposed Daneshill STF precludes unbound friable asbestos materials (notwithstanding the potential for undetected low levels of such materials). The same acceptance criteria apply to the Maw Green and ERQ STFs, and the very low (relative) fibre release from bound asbestos appears to be reflected in the air monitoring data and the post-processed soil data that has been reviewed from Maw Green and ERQ.

6.1.10 To better understand the potential impact of soil processing on loose fibre concentrations in soil, Provectus and Hydrock separately commissioned more detailed soil laboratory testing for soil samples taken from the Maw Green STF during August and September 2023. The sampling protocol used by Hydrock is set out in Hydrock's Technical Note 28480-HYD-XX-XX-TN-GE-0003 included in Appendix F and I have been informed that Provectus also followed Hydrock's sampling protocol. Samples were variously taken of stockpiled soil to be processed, the finer fraction of screened soil, and the middle fraction of screened soil after it had passed through the picking station. Samples were also taken of the sedimented dust on the concrete treatment pad. The analytical test commissioned specifically counts the loose asbestos fibres present in the PM10 size fraction of the soil (i.e. the fraction most likely to constitute any soil-derived airborne dust).

6.1.11 The laboratory testing was undertaken by Derwentside Environmental Testing Services (DETS). DETS is a UKAS accredited laboratory and first designed this specific test in 2017. Unlike the 'standard' UKAS accredited three-stage asbestos in soil testing that DETS and other commercial soil testing laboratories in the UK offer, this specific test method is not UKAS-accredited. However, I do not consider that this compromises the associated data. The method has been developed by a UKAS accredited laboratory, and provides the level of analytical sensitivity required to quantify potential differences in loose fibre concentrations at levels that are at or below the limit of detection of 'standard' UKAS-accredited methods. No UKAS-accredited method of this type is commercially available in the UK or similarly accredited in Europe to my knowledge.

6.1.12 The fibre counting results are shown in Figure 6.1 below. The sample type abbreviations are 'PS' pre-screener, 'AS' after screener, 'AP' after picking, and 'Pad' concrete treatment pad.



(a) (b)

Figure 6.1: Detailed fibre counting soil analysis for samples from Maw Green STF (a) Provectus, (b) Hydrock

Figure 6.1 (a) shows the results from individual samples taken by Provectus for each day sampling was undertaken. Figure 6.1 (b) shows the average of two samples for each sample type taken by Hydrock for each day sampling was undertaken.

6.1.13 The data shown in Figure 6.1 above is mixed. It shows a potential increase in loose asbestos fibres in the PM10 fraction of the post-screened fine-size soil fraction in six out of the ten sample sets taken by Provectus, and in all seven of the post-screened + picked mid-size soil fraction (noting that the PM10 soil fraction in this mid-size material will likely be a very small fraction of the overall material). The Hydrock data shows a potential increase in post-screened fine-size soil fraction in just one of the four sample sets. The variability in the dataset is likely to be a function of the heterogeneity in the soil being treated. Taking the 14 samples as a combined dataset, there is a measured decrease in loose fibres in the PM10 soil fraction in post-screened soil in 50% of the samples and a measured increase in the remaining 50%. It is therefore possible that the processing of the soil by mechanical screener does increase measurable loose fibres in the soil dust fraction, however, this is not consistently the case. It is relevant to note that these differences in loose fibre counts are all at soil concentrations that are lower than the 'standard' UKAS-accredited asbestos in soil test method LoQ of 0.001%wt/wt (10 mg/kg).

6.1.14 The percentage change in reported fibre counts between pre- and post-screener samples varies from -55% to +225%, with an average percent change of +38%. This variability is shown graphically in Figure 6.2 below.

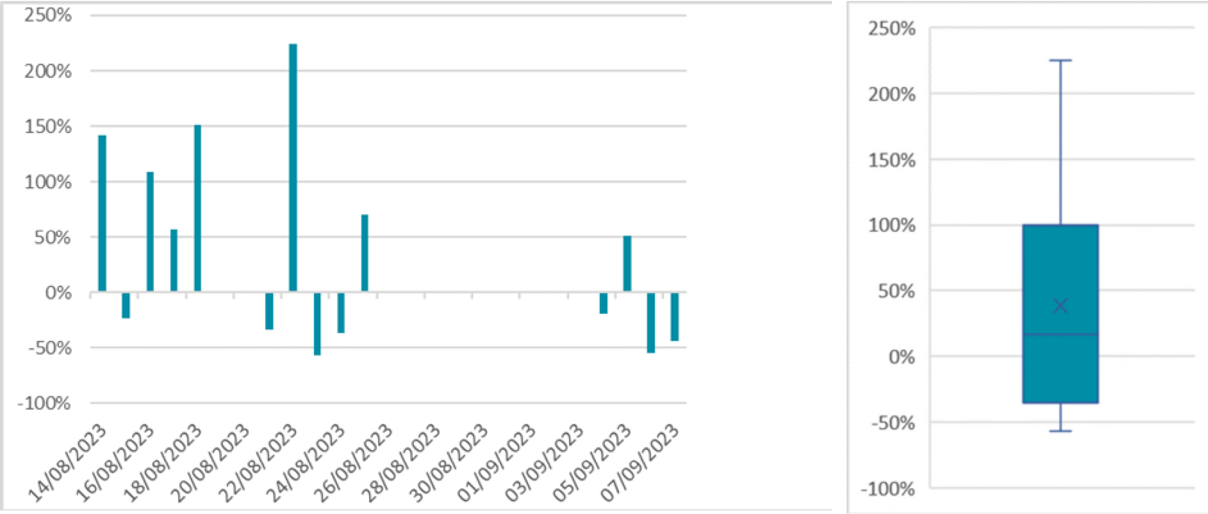


Figure 6.2: Variability in the percent change in fibre count results for pre- and post- screener soil samples

6.1.15 The percentage difference between the average fibre counts for the pre-screener dataset (27288 f/mg) and the post- screener dataset (29651 f/mg) is lower at +9%.

6.1.16 Caution should be exercised in the interpretation of the fibre count data detailed above as it is a relatively small dataset.

6.1.17 It is possible to estimate what the possible airborne fibre concentration in air might be if the soil PM10 fibre count is known and the soil-derived airborne PM10 concentration can be estimated or measured. This is a modified approach to that published by the Nevada Division of Environmental Protection (NDEP, 2015) [CD1/2], and is included as an assessment option in the SoBRA AiSHHRA Toolbox (SoBRA, 2021a) [CD1/2]. The calculations for this are presented as Appendix D.

6.1.18 The calculation of %wt/wt concentration equivalent values for the average PM10 fibre count value of approximately 30,000 f/mg also provided in Appendix D produces a wide range of concentrations between the approach taken by the developers of the DETS method and the approach taken by the authors of the RIVM guidance, with estimated equivalent %wt/wt concentrations ranging from 0.000075% to 0.16% wt/wt depending on the assumptions made on fibre dimensions and density. It is important to note that the fibre concentration reported as f/mg is for the PM10 fraction for the soil – which typically is a very small percentage of the overall soil mass. This is relevant as the standard methods for asbestos in soil analysis (typically based on the now withdrawn Standing Committee of Analysts 'Blue Book Method') report results for the sample as received, thereby reflecting a much larger proportion of the soil as a whole. I discuss this in more detail in paragraph 6.1.22.

6.1.19 There is a simple calculation that can be made using the PM10 fibre count data to estimate the potential airborne asbestos fibre concentration using an estimated or measured PM10 dust concentration. If an average process contribution to airborne PM10 dust concentration of 30 µg/m^3 is assumed based on the dust monitoring data for Maw Green STF presented in Section 4, and an average PM10 soil fraction fibre count of 30,000 f/mg is assumed, the expected airborne respirable fibre concentration would be 900 f/m^3 (0.0009f/ml). As this is based on PCOM soil analysis we might expect the equivalent SEM air analysis result to be higher (0.0018f/ml or 1800 f/m^3) if the correction factor used by WHO is adopted. The near-source air monitoring at Maw Green for the corresponding soil processing times did not typically detect air concentrations this high, the highest was 1500f/m^3, but the average is <500f/m^3. This suggests that either the process contribution to measured PM10 airborne dust concentrations is less than thought, and/or that the release of PM10 soil-derived dust particles and respirable asbestos fibres is not equal (i.e. proportionally less fibres emitted from the soil compared to PM10 dust particles).

6.1.20 If a 'standard' UK soil laboratory test method is used (i.e. one based on a three-stage analysis akin to that described in the now withdrawn Standing Committee of Analysts (SCA) 'Blue Book' method or the more recently presented (and similar) method in Appendix 7 of HSG248 (2021) it is unlikely that any change in free fibre concentration will be detected. To better understand the potential impact of soil processing on loose fibre concentrations in soil, Provectus commissioned more detailed soil laboratory testing for soil samples taken from the Maw Green STF during August 2023. Samples were variously taken of stockpiled soil to be processed, the finer fraction of screened soil, and the middle fraction of screened soil after it had passed through the picking station. Samples were also taken of the sedimented dust on the concrete treatment pad. The samples were submitted to Eurofins Chemtest for testing using a UKAS-accredited three-stage asbestos in soil quantification method. The results for those samples are shown in Table 6.3 for comparison.

Table 6.3: Pre-, and post- screening and picking soil sample data from Maw Green

Sample ID	Asbestos Identification (Stage 1)	Asbestos by Gravimetry (Stage 2)	Asbestos By Fibre Counting (Stage 3)
ASB 12/PS14/08	Fibres/Clumps, Chrysotile	0.001	<0.001
ASB 12/AS14/08	Fibres/Clumps, Chrysotile	0.003 ↑	<0.001
ASB 12/AP14/08	No Asbestos Detected	- ↓	-
ASB 12/PS15/08	No Asbestos Detected	-	-
ASB 12/AS15/08	No Asbestos Detected	- →	-
ASB 12/AP15/08	Fibres/Clumps, Chrysotile	<0.001 ↑	<0.001
ASB 12/PS16/08	Insulation, Amosite, Chrysotile	0.008	<0.001
ASB 12/AS16/08	No Asbestos Detected	- ↓	-
ASB 12/AP16/08	Fibres/Clumps, Amosite	<0.001 ↓	<0.001
ASB 12/PS21/08	Fibres/Clumps, Board, Amosite, Chrysotile	0.005	<0.001
ASB 12/AS21/08	Fibres/Clumps, Chrysotile	0.002 ↓	<0.001
ASB 12/AP21/08	Fibres/Clumps, Chrysotile	<0.001 ↓	<0.001
ASB 12/PS22/08	Fibres/Clumps, Chrysotile	0.001	<0.001
ASB 12/AS22/08	Fibres/Clumps, Chrysotile	0.001 →	<0.001
ASB 12/AP22/08	Fibres/Clumps, Chrysotile	0.002 ↑	<0.001
ASB 12/PS23/08	Fibres/Clumps, Amosite, Chrysotile	0.002	<0.001
ASB 12/AS23/08	Fibres/Clumps, Chrysotile	<0.001 ↓	<0.001
ASB 12/AP23/08	Fibres/Clumps, Chrysotile	0.002 →	<0.001

ASB 12/PS24/08	Fibres/Clumps Chrysotile	<0.001	<0.001
ASB 12/AS24/08	Fibres/Clumps Chrysotile	0.001 ↑	<0.001
ASB 12/AP24/08	Fibres/Clumps Amosite	0.003 ↑	<0.001
ASB 12/PS25/08	- No Asbestos Detected	-	-
ASB 12/AS25/08	Fibres/Clumps Chrysotile	0.002 ↑	<0.001
ASB 12/AP25/08	Fibres/Clumps Amosite	0.001 ↑	<0.001

Table notes:

All values quoted as %wt/wt (equivalent to mg/kg).

Sample ID codes are: ASB12 = soil treatment batch number; PS = soil input pre-screening; AS = fines fraction after screening; AP = mid-size fraction after picking; xx/xx = day/month of sample date.

The arrows indicate whether the reported sample concentration after screening or after picking is higher, lower or the same as that reported for the pre-screening sample.

6.1.21 The gravimetric (Stage 2) results give a tally of seven higher results (44%), three results that are the same value (19%), and six lower results (37%) for post screening or picking results compared to the pre-screening sample result. The loose/free fibre concentrations in the soil samples (Stage 3) are all reported to be below the method limit of quantification such that no measurable change in loose/free fibre soil concentration can be ascertained.

6.1.22 Given that the standard Stage 3 test results are all reported as less than the limit of quantification of 0.001%wt/wt, yet the DETS results report detectable fibres it is appropriate to compare the two methods in more detail. There is no simple equivalence between the two test methods as the analytical results reported for both methods are calculated on the basis of the dimensions of the individual fibres identified in the samples, and relate to different size fractions of the sampled soil. However, a result of 0.001%wt/wt for the 'standard' method is equivalent to approximately 500 chrysotile fibres per mg soil (assuming consistent fibre dimensions of 1μm diameter and 10 μm length)). Note that whilst the f/mg results are equated to the dust fraction of the soil only, the 'standard' testing results are equated to the 'as received' soil sample. The DETS method concentrates respirable fibres into the PM10 size fraction and therefore the results need to be corrected for that before any comparison of method results is made. The PM10 size fraction of Maw Green soil samples submitted to DETS by Hydrock ranged from 0.001-0.006% (based on an original sub-sample size of approximately 8-10g and a PM10 filtrate sub-sample that was analysed of between 0.0001-0.0005g). The conversion factor for converting the reported fibre count results to an equivalent concentration for the soil sample as a whole is therefore approximately x0.00001-0.00006 on this basis. A reported fibre count of 10,000 f/mg for the PM10 size fraction for example equates to a maximum concentration of 0.6 f/mg for the soil sample as a whole (i.e. approximately equivalent to 0.000001%wt/wt assuming the fibre dimensions of 1µm diameter and 10 µm length). The detection limit for the DETS method is approximately 2500 f/mg based on the counting of one fibre in 200 microscope fields analysed across the filter and a sub-sample filtrate mass of 0.1 mg. 2500 f/mg would equate to an equivalent whole soil sample concentration of less than 0.000001%wt/wt. This demonstrates just how more sensitive the DETS method is compared to the standard UKAS accredited methods of analysis that has a reporting limit of 0.001%wt/wt. A brief summary of the sample preparation for the two analytical methods is provided in Table 6.4 below:

Table 6.4: Asbestos in soil laboratory method comparison

	SCA Blue Book / HSG 248 App 7 method	**DETS fibres per mg dust method**
Sub-sample	20-50g for gravimetric Stage 2 analysis 1-5g for Stage 3 free/dispersed fibre analysis	8-12 g
Sub-sample prep	Oven dried for Stage 2 For Stage 3, 1-5 g sub-sample is mixed with water to a ratio of 1:200	Mixed with 1 litre water Filtered through 10-micron filter
Mass basis for reported concentration	Sum of both ACM fragments & visible fibre bundles, and loose free fibres reported as the % content of the original sample on a dry weight basis. If large (oversized) material was removed from the sample prior to sub-sampling, the calculated asbestos concentration in the sub-sample is corrected for the mass of removed larger material before reporting.	Mass of dust passing 10-micron filter.

6.1.23 Overall, the available data does not provide compelling evidence that loose fibre concentrations in the soil change substantially during processing even when looking at this issue using a more sensitive sample analytical method (DETS fibre count data).

7. Potential off-site dispersion of airborne asbestos fibres and the associated potential health risk to off-site receptors

7.1.1 The first and most precautionary approach to evaluating the potential health risk from exposure to airborne respirable asbestos fibres is to consider the potential risk associated with measured near-source concentration. The health risk from low environmental levels of exposure (as opposed to high occupational exposure – for example that associated with former asbestos processing and manufacturing facilities, or with building construction, demolition, maintenance and refurbishment activities involving asbestos-based materials) is calculated on the basis on long-term cumulative exposure. A measurement used to express this cumulative exposure is f/ml.yr which is the cumulative dose over a year expressed as the average air concentration multiplied by the exposure time as a proportion of a year.

7.1.2 Measured near-source air concentrations at the Maw Green and ERQ STFs range from less than the LoQ (<500f/m^3) to a maximum of 1500f/m^3. The 95th percentiles are <LoQ and 600 f/ml respectively, and the long-term average will be <500f/m^3. Because such a high proportion of the monitoring data is <LoQ it is not known just how low the actual long-term average concentration at these sites is. If the starting point is 500f/m^3 as measured by SEM, this is half the value of 1000 f/m^3 (500 f/m^3 PCMe) that the WHO used to articulate its risk estimates (WHO, 2000) [CD1/2]. WHO equated long term continuous exposure at this concentration to potential excess lifetime cancer risk (ELCR) of between 1 in 10,000 and 1 in 100,000. Although WHO did not set 1000 f/m^3 (by EM) as an air quality guideline (AQG) on the basis that 'a [safe] threshold is not known to exist', this is similar to WHO's approach for other carcinogenic substances such as arsenic. benzene, and

benzo(a)pyrene, and is therefore not unique to asbestos. For context, although WHO avoids setting AQGs based on ELCR, it does use ELCR thresholds for setting drinking water guidelines – most commonly adopting an ELCR of 1 in 100,000. There is no published UK or EU AQG for asbestos.

7.1.3 Other jurisdictions have adopted air quality guidelines (as opposed to occupational limits) for airborne asbestos fibres. Those that I am aware of are summarised in Table 7.1 below.

Table 7.1: Published air quality guidelines for airborne asbestos fibres used in relation to soil contamination

Source	Value	Further information
The Netherlands (RIVM, 2003 and Swartjes & Tromp, 2008)	1000 f/m^3	Termed 'negligible risk level'. As measured using transmission electron microscopy
Australia (WA, 2021)	1000 f/m^3	Adopted from the guidance from The Netherlands above. Used to derive soil guidelines rather than a AQG in its own right
US EPA[20] (US EPA, 2021)	Approx. 10-1000 f/m^3 (range dependent on choice of target risk level (10^{-6} – 10^{-4})	These are defined as example 'levels of concern' for baseline residential exposure at Superfund sites as opposed to general air quality guidelines. Values applicable to measurements using PCOM.
Ontario, Canada (MECP, 2020)	0.04 f/cm^3 (40,000 f/m^3)	No further detail provided

7.1.4 Published epidemiological evaluations of airborne asbestos fibre exposure vary due primarily to uncertainties in the underlying cohort data. The variation in published risk-based AQG is summarised in the discussion paper published by SoBRA (SoBRA, 2021b) [CD1/2], and assumptions on the potency of asbestos type (refer to Section 5 for more detail on fibre potency) play a significant part in the risk estimates that underpin the AQG.

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[20] The US EPA is currently reviewing its approach to asbestos Risk Evaluation for Asbestos | US EPA

The AQG summarised by SoBRA vary from 30-10,000 f/m^3, with the lowest value applicable to amphiboles (e.g. amosite) and the highest value attributable to chrysotile.

7.1.5 The air monitoring data from the Maw Green and ERQ STFs suggests that airborne fibres detected in near-source air samples include both chrysotile and amosite fibres. The majority of detected airborne asbestos fibres at Maw Green were amosite (amosite detected in 49 samples compared to chrysotile detected in 10 samples; total number of samples 395).

7.1.6 The majority of detected airborne asbestos fibres at ERQ were also amosite but the contrast between the two asbestos types is not as pronounced as at MG (amosite detected in 146 samples compared to chrysotile detected in 81 samples; total number of samples 809).

7.1.7 The prevalence of airborne amosite fibres compared to chrysotile fibres could be attributable to the greater ease with which amosite fibres appear to become airborne, as noted in the IOM research (IOM, 1988) and commented on by the RIVM authors (RIVM, 2003) overriding the greater gravimetric content of chrysotile asbestos in the treated soil.

7.1.8 It is plausible that long-term average near-source air concentrations could exceed published AQG at the lower end of the reported range in AQG reported by SoBRA (SoBRA, 2021b)., noting the uncertainty in how low the likely long-term site average is. It is more certain (relative) that the near-source concentrations at the STF do not exceed either the HSE Control Limit of 0.1f/ml PCMe, or the permit boundary threshold of 0.01f/ml PCMe (equivalent to approximately 20,000 f/m^3 as measured by SEM).

7.1.9 It is noted that the EU has agreed a revised occupational exposure limit (OEL) for asbestos[21] (EU, 2023) [CD1/2]. The UK Control Limit of 0.1f/ml is the same value as the

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[21] https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3557

current occupational exposure limit set by EU Directive. The proposal of the European Commission that has been agreed by the European Parliament, is for a ten-fold reduction in the OEL to 0.01f/ml during a transition period. After the transition period, a 'dual model' is proposed whereby member states can choose between adopting a limit value equal to 0.01f/ml that requires the counting of thinner asbestos fibres in addition to existing 'countable fibres', or a limit value equal to 0.002f/ml that does not include the requirement to count thinner asbestos fibres. The reference to thinner fibres is connected to the shift in the EU to analysing air samples using electron microscopy rather that the current technique of phase contrast optical microscopy (PCOM). The near-source air monitoring data for Maw Green and ERQ would be in compliance with the revised EU OEL.

7.1.10 The four-day monitoring exercise carried out by Hydrock at the Maw Green STF in September 2023 included ambient air monitoring both upwind of STF operational area, and at downwind locations at 50m and 100m distance from the operational area, as well as near-source monitoring. As all the results from all locations came back as <LoQ, it is not possible to evaluate the impact of downwind air dispersion on airborne asbestos concentrations using this data. However, airborne asbestos fibre concentrations will be subject to air dispersion, and this will have an impact on associated air concentrations at distances away from the STF operational area.

7.1.11 Off-site air quality impact will be a function of primary and secondary emissions of airborne asbestos fibres. Primary emission is the release of fibres from either specific short-term soil disturbance activities and/or continuous emission from wind erosion of the soil surface. Emissions from soil disturbance activity is principally determined by the bonding of the asbestos material (including the age, brittleness and weathering of the ACM), the nature of the disturbance activity (i.e. the degree of soil disturbance and energy/force applied), and the dampness of the material. The contribution from wind erosion is considered to be low by comparison (RIVM, 2003) [CD1/R].

7.1.12 Secondary emission is the resuspension of asbestos fibres that have already been previously released and sedimented. Resuspension increases with the speed of air movement, but if measurements are taken very close to the surface the asbestos concentration in air is highest when the wind speed is lowest (i.e. a slight wind movement is sufficient to release fibres but not sufficient to ensure atmospheric dispersion) (RIVM, 2003).

7.1.13 This is relevant to the interpretation of air measurements taken inside buildings compared to similar measurements outdoors, as the lighter (relative) air movement inside a building is expected to hinder fibre dispersal in air and therefore result in higher near source measured concentrations.

7.1.14 In the context of the STFs, the primary emissions are (1) the movement of the soil during processing (specifically the dropping of the material on to and off the screener belts and picking belts, and (2) wind erosion from material stockpiles. Secondary emission from resuspension of fibres is most likely to be associated with dust generation from vehicle movements on the STF concrete pad as a result of vehicle tyre disturbance of deposited dust and soil fines from stockpiled material. This secondary emission was evident during my site orientation visit to Maw Green on the 2nd June 2023. From site observation this secondary emission has the potential to be a potentially significant (relative) emission source of dust and asbestos fibres. The emission duration will however be short and periodic as the heavy plant machinery (two 360 excavators and one dumper truck) only move on the concrete pad during site mobilisation in the morning, site demobilisation at the end of the day, when receiving new material to be processed, and when moving stockpiles of processed material. This contrasts with the mechanical screener and picking station that are operational all day.

7.1.15 The potential for air dispersion of asbestos fibres is covered in Matt Stoaling's evidence [CD6/4]. I have provided brief commentary in the following paragraphs to provide context to my later risk estimation calculations. Three key factors are wind speed, precipitation (e.g. rainfall), and the distance to the receptor.

7.1.16 Asbestos fibres are likely to have a smaller aerodynamic diameter compared to soil particles and therefore require greater wind speeds than soil particles in order to become airborne (RIVM, 2003).

7.1.17 Laboratory experiments by TNO (and reported in RIVM, 2003) that studied the resuspension of loose fibres from soil using air flow generated by fans indicate an exponential relationship between soil surface disturbance (i.e. wind speed) and fibre release. For wind speeds between Beaufort Scale 1-4 very few fibres were released. At a soil concentration of 0.007% wt/wt (70mg/kg) resuspended fibre concentrations remained below 1000f/m^3 (0.001f/ml) as measured by Transmission Electron microscopy (TEM) at these wind speeds. For greater air speeds (comparable with a wind force of 8-10 on the Beaufort scale) a clear increase in fibre emission was observed, with concentrations of 10,000 to 100,000 f/m^3. These experimental results relate to dry soil. The expectation is that wind speeds would need to increase to achieve the same effect for damp/wet soil.

7.1.18 IAQM guidance for mineral sites identifies that high wind speeds will increase the likelihood of dust being emitted from sites; that dry materials are more easily emitted; and that rainfall acts as a natural dust suppressant. The authors of the guidance therefore conclude that the high-risk meteorological conditions are '*when the wind is coming from the direction of the dust source at a sufficient strength, during periods of little or no rainfall (often taken as <0.2 mm per day) especially during periods when evaporation exceeds rainfall and drying conditions prevail. The threshold wind speeds for initiation of wind blow can range from 2.4 m/s (Force 2, "light breeze") up to gale force, depending on the particle size and the condition of the surface but moderate breeze, 5.5 m/s and above, is sometimes used as a general threshold.*'

7.1.19 Matt Stoaling in his evidence [CD/6/4] notes that the wind speed required to re-suspend particles is highly variable and references research that indicates that wind speeds below 7m/s did not show 'significant resuspension' of particles and that resuspension only starts becoming significant at wind speeds >10m/s.

7.1.20 The significance of this is the frequency of winds at this strength occurring at Daneshill and Maw Green. Local interpolated meteorological data[22] for Daneshill for the 12-month period of June 2022-June 2023 reports a maximum daily average wind speed of 59.4 kph (16.5m/s), with a peak gust of 78.7kph. Average daily wind speeds at and above Beaufort Scale 5 (>9m/s and described as a 'fresh breeze') were reported for 68 days during this period (19% of the time) and gusts above 17m/s (Beaufort Scale 8 'Gale') were reported on 8 days of these days (2% of the time). Given the relatively sheltered location of the proposed STF at Daneshill it might be reasonable to conclude that the STF will experience lower wind speeds than those reported for the general area.

7.1.21 For Maw Green, local interpolated meteorological data[23] for the same 12-month period of June 2022-June 2023 reports a maximum daily average wind speed of 48.3 kph (13.4m/s), with a peak gust of 73.1kph. Average daily wind speeds at and above Beaufort Scale 5 were reported for 26 days during this period (7% of the time) and gusts above 17m/s were reported on 3 days of these days (1% of the time).

7.1.22 Matt Stoaling in his evidence [CD6/4] notes that in the 5 years (2018-2022) of hourly sequential Met Office meteorological data for the nearest Met Office station for Daneshill (Doncaster Sheffield Airport) only 2.78% of the recorded wind speeds were >10m/s, and only 0.15% recorded >14m/s ('Near gale' Beaufort Scale 7). 2.78% equates to approximately 10 days per year. For Maw Green, Matt Stoaling in his evidence [CD6/4]

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[22] https://www.visualcrossing.com/weather-history/retford/metric
[23] https://www.visualcrossing.com/weather-history/maw green

reports that in 5 years (2018-2022) of hourly sequential NWP meteorological data only 1.62% of the recorded wind speeds were >10m/s, and only 0.05% recorded >14m/s. 1.62% equates to approximately 6 days per year.

7.1.23 Rainfall (if it occurs on the same day as the higher wind) will further reduce the likely frequency of significant wind-blown dust resuspension/surface wind erosion events. For the 68 days noted above for Daneshill with average daily wind speeds above Force 5, 57 days also recorded rainfall too (i.e. there were 11 days in this 12-month period when higher winds were linked to dry days). For the 8 days where wind gusts were Force 8 or above, rainfall was recorded for all 8 days. For Maw Green, of the 26 days noted with average daily wind speeds above Force 5, 23 days also recorded rainfall too (i.e. there were 3 days in this 12-month period when higher winds were linked to dry days). For the 3 days where wind gusts were Force 8 or above, rainfall was recorded for all 3 days.

7.1.24 The distance to which airborne asbestos fibre might travel has also been considered in published literature. Air measurements of outdoor soil disturbance (110 measurements of various activities soils containing bound and unbound (friable) asbestos are reported to show non-detectable levels of airborne concentrations up to 100m from the emission activity where the soil concentration was less than 10,000mg/kg (1%wt/wt) (RIVM, 2003). The LoQ was typically 1000f/m^3 by TEM.

7.1.25 IOM theorised in its assessment of asbestos fibre release from vehicular use of asbestos cement farm tracks in South Cambridgeshire (IOM, 2005) [CD1/2] that airborne fibre concentrations ought to diminish approximately linearly with distance from a line source (such as a track). Concentrations 10 m away were therefore expected to be less than a tenth of those detected less than 1m from the edge of the tracks. The authors note that this is consistent with the observations of an earlier similar study by the Health and Safety Laboratory in 2001.

7.1.26 In HSG248 (Appendix 8) it is stated (A8.6) that 'in most circumstances' the extent of dilution in the environment (i.e. air) will be sufficient to discount any significant exposure to people over 100 metres from the emission source.

7.1.27 Relevant off-site receptor distances for the proposed Daneshill STF have been clarified in the Appellant Comments on EA Rule 6 and are reproduced below.

Table 7.2: Confirmed off-site receptor distances that are relevant in relation to potential offsite air dispersion impacts for Daneshill STF

Receptor	Distances from the closest point on the STF boundary (m)
Travellers Site to the south	167.2-169.3
Daneshill Cottages to the south west	430.5
Loundfield Farm to the east	470.6-566.9
Tudorstone Building Materials to the south	288.1
Tomlinson Family Settlement to the south	393.9

Further information on the receptor locations for Daneshill is provided in Matt Stoaling's evidence [CD6/4].

7.1.28 The site setting and more detailed location of the proposed Daneshill STF is indicated in Figure 7.1 and Figure 7.2 below for context. The proposed area for the STF is shaded blue.

Figure 7.1: Google Earth image of Daneshill STF site setting

Figure 7.2: Google Earth image of proposed location of Daneshill STF

7.1.29 The modelled receptors for the Maw Green STF in Matt Stoaling's evidence [CD6/4] are as follows:

Table 7.3: : Off-site receptor distances that are relevant in relation to potential offsite air dispersion impacts for Maw Green STF

Receptor	Approximate distances from the closest point on the STF boundary (m)
Brook House Farm and Barns to the east	289
Meadow Croft Cottage to the south east	205
New housing development to the south east	193
Existing housing development to the south of Maw Green Road	249
Windy Nook to the south west	363
Shandon Barn to the west	430

Further information on the receptor locations for Maw Green is provided in Matt Stoaling's evidence [CD6/4].

7.1.30 The site setting and more detailed location of the Maw Green STF is indicated in Figure 7.3 and Figure 7.4 below for context. The proposed area for the STF is shaded blue.

Figure 7.3: Google Earth image of Maw Green STF site setting

Figure 7.4: Google Earth image of location of Maw Green STF

7.1.31 The evidence for dust and asbestos fibre dispersion from soil disturbance activity-related emission is limited and mixed. HSL and IOM experimental results suggest a linear reduction in asbestos concentrations with distance. This would provide an approximate x170 reduction in on-site concentrations at the nearest receptor for Daneshill, and approximate x280 reduction for Maw Green. RIVM and HSE essentially discount exposure beyond distances of 100m from the emission source. Wind direction, wind speed, and rainfall are expected to be critical factors in off-site air dispersion, as is the source emission scale (size and rate). These factors are not detailed in the references noted above.

7.1.32 As well as the characteristics of the soil processing activities that influence the dust (and fibre) emission rate, other key factors on dust dispersion are the topography and vegetation that characterise the distance between the site and the relevant off-site receptors, wind pattern, and rainfall pattern. The proposed location of the Daneshill STF appears to be a slight topographic depression, with the land directly to the east in particular rising relatively steeply. Land to the east, south and west comprises mature woodland. Both these features might be mitigating factors in off-site dust dispersion. Matt Stoaling in his evidence [CD6/4] states that elevated terrain off-site has the effect of reducing the dust plume centreline distance to an off-site ground level receptor location, but increasing air turbulence and mixing which has the effect of decreasing off-site concentrations. The surrounding topography to the east and south for Maw Green is flatter and with sparser tree cover by comparison.

7.1.33 Off-site air concentrations will also be related to the rate of dust deposition, and this is potentially an area of greater uncertainty as the potentially lower aerodynamic diameter of asbestos fibres might result in lower levels of deposition compared to PM10 dust particles. This would be expected to result in more asbestos fibres remaining airborne, but, if travelling greater distances, also being subject to greater dispersion and dilution compared to PM10. The effect of this would be to lower expected airborne asbestos fibre concentrations compared to that predicted for PM10.

7.1.34 Matt Stoaling in his evidence [CD6/4] presents AERMOD air dispersion modelling for a theoretical dust emission source located at the Daneshill and Maw Green STFs that is designed to estimate the potential dispersion effects (dilution) at the closest relevant off-site receptors to the STFs.

7.1.35 For the Daneshill site the AERMOD modelling indicates that the most sensitive (relative) off-site receptor is the Travellers Site located to the south of the proposed STF when looking at minimum daily dispersion, and annual average dispersion. The dispersion estimates take into account the frequency of wind speed and direction on any given day in conjunction with the location of the designated receptor.

7.1.36 The relative sensitivity of other close receptors can be expressed as the difference in the minimum dispersion factors calculated for each receptor location compared to those for the Travellers Site. These are detailed in below:

Table 7.4: Dispersion factor differences for off-site receptors relative to the Daneshill Travellers Site

Receptor	**Difference in magnitude of minimum dispersion factors**	
	Daily minimum	Annual average
Daneshill Cottages	x7.9 higher	x10 higher
Loundfield Farm	x6.9 higher	x4.6 higher
Tudorstone Building Materials	x1.9 higher	x2.4 higher
Tomlinson Family Settlement	x4.2 higher	x6.2 higher

7.1.37 It is evident from this that although Loundfield Farm is more (but not directly) downwind of the prevailing wind direction (South-westerly) compared to the Travellers Site, it is also further distant from the proposed STF and therefore is predicted to benefit from greater air dispersion (i.e. dilution) effects.

7.1.38 For the Maw Green site, the AERMOD modelling indicates that the most sensitive (relative) off-site receptor is the new housing development located to the southeast of the STF when looking at minimum daily dispersion, and annual average dispersion. The dispersion estimates take into account the frequency of wind speed and direction on any given day in conjunction with the location of the designated receptor. There is only a marginal difference between the sensitivity of the new housing development and Meadow Croft Cottage.

7.1.39 The relative sensitivity of other close receptors can be expressed as the difference in the minimum dispersion factors calculated for each receptor location compared to those for new housing development. These are detailed in below:

Table 7.5: Dispersion factor differences for off-site receptors relative to the new housing development

Receptor	Difference in magnitude of minimum dispersion factors	
	Daily minimum	Annual average
Brook House Farm and Barns to the east	x3.3 higher	x2.4 higher
Meadow Croft Cottage to the south east	x1.0 higher	x1.1 higher
Existing housing development to the south of Maw Green Road	x2.3 higher	x3.5 higher
Windy Nook to the south west	x4.6 higher	x6.2 higher
Shandon Barn to the west	x4.3 higher	x6.7 higher

7.1.40 It is evident from this that although Brook House Farm is more (but not directly) downwind of the prevailing wind direction (South-westerly) compared to the new housing development and Meadow Croft Cottage, it is also further distant from the STF and therefore is predicted to benefit from greater air dispersion (i.e. dilution) effects.

7.1.41 Off-site receptor sensitivity is a function of land-use and associated human exposure patterns, and the anticipated daily and annual air dispersion noted above. The frequency and duration of exposure at the receptor location dictates the cumulative exposure when coupled to the expected air concentration. The distance and orientation to the STF dictates the expected air dispersion and therefore the receptor air concentration at any point in time as fugitive fibre emissions from the STF will only reach the receptor if the wind is blowing in the right direction, and the distance, coupled to the wind speed and other climatic conditions such as rainfall, will dictate the attenuation (reduction) in airborne fibre concentration from the emission source.

7.1.42 Based on the available data, there are two options to estimating potential cumulative airborne asbestos fibre exposure at a receptor location. The first is to use a daily minimum estimate of air dispersion and factor this with the likely frequency that climatic conditions will result in air dispersion in the direction of the receptor. The second option is to use an annual average estimate of air dispersion which already takes into account the frequency of climatic conditions resulting in air dispersion in the direction of the receptor. To understand the sensitivity of this choice, both options have been adopted and are detailed below.

7.1.43 For the Daneshill STF, local interpolated meteorological data for the 12 months from June 2022 to June 2023 indicates that the wind direction was only from the north (i.e. blowing from the site to the Travellers Site) for 11 days (3% of the time). If conservatively the days for wind direction from the NNW and NNE is included, this equates to 51 days (14% of the time). Average wind speeds above Beaufort Scale 5 (9m/s) were only recorded for one of these 51 days.

7.1.44 The same meteorological data recorded 120 days of no rain during those 12 months (33% of the time). Of these only 18 days had a recorded wind direction of NNW, N or NNE.

7.1.45 For the Maw Green STF, local interpolated meteorological data for the 12 months from June 2022 to June 2023 indicates that the wind direction was only from the northwest (i.e. blowing from the site to the new housing development for 32 days (9% of the time). If conservatively the days for wind direction from the NNW and WNW is included, this equates to 83 days (23% of the time). Average wind speeds above Beaufort Scale 5 (9m/s) were not recorded for any of these 83 days.

7.1.46 The same meteorological data recorded 89 days of no rain during those 12 months (24% of the time). Of these only 27 days had a recorded wind direction of WNW, NW or NNW.

7.1.47 The SoBRA AiSHHRA Toolbox provides a structured way of assessing the potential health risk from exposure to fugitive airborne asbestos fibres resulting from the disturbance of asbestos in soil. The estimation of health risk can be calculated using the SoBRA Excel-based spreadsheet that was developed to support SoBRA's discussion paper on guidelines for airborne concentrations of asbestos in ambient air (SoBRA, 2021b) [CD1/2].

This calculation tool requires the exposure point air concentration, and the exposure frequency and duration for 5-year time periods. The health risk from asbestos exposure is related to the cumulative exposure dose (air concentration x duration) and the age of first exposure.

7.1.48 The most precautionary approach is to model exposure for a newborn child. The planned operational timescale for the Daneshill STF is 10 years, therefore the appropriate exposure duration is 10 years. With reference to paragraph 7.1.43, the reasonable worst-case exposure frequency is 51 days per year. This assumes that northerly winds are all associated with periods of prolonged dry weather. It has already been noted that this will not be the case. The exposure time is a maximum of 8 hours per day (the daily operational time for the STF). Processing operations are not expected outside of this time period. Stockpiles of pre -treated soils will be sheeted outside of operational hours. Surface wind erosion of uncovered processed stockpiles outside of working hours ought to be mitigated if damping down measures are implemented at the end of working days as dictated by weather conditions. It is plausible that surface wind erosion could increase over a hot, dry weekend where further damping down does not take place and the weather conditions are such that the surface of the soil dries out, however, it has already been established that resuspension via wind action is unlikely when considering wind direction, wind speed, and rainfall patterns.

7.1.49 For the Maw Green STF, the planned operational timescale is 6 years (operational from 2022 and with operations required to cease by 31 December 2027 in accordance with Planning Decision 19/1376N issued by Cheshire East Borough Council), therefore the appropriate exposure duration is 6 years. With reference to paragraph 7.1.45, the reasonable worst-case exposure frequency is 83 days per year. This assumes that north-westerly winds are all associated with periods of prolonged dry weather. It has already been noted that this will not be the case. The exposure time is a maximum of 8 hours per day (the daily operational time for the STF).

7.1.50 The near source activity-based sampling at Maw Green and ERQ has shown that the majority of reported airborne asbestos fibre concentration are less than the method LOQ (0.0005f/ml). Reported concentrations above the LOQ are infrequent and average concentrations are <0.0005f/ml. It is not reasonable to assume that off-site concentrations will be at the LOQ (i.e. 0.0005f/ml). The AERMOD dispersion modelling conducted by Matt Stoaling [CD6/4] gives a minimum dispersion factor for the closest Daneshill receptor (Travellers Site) that suggests air dilution of approximately x4000. It is therefore reasonable to assume on a precautionary basis that daily average exposure concentrations at that closest receptor are unlikely to exceed a thousandth of the on-site near-source concentrations (i.e. <0.0000005f/ml (<0.5f/m^3)). Similarly, for Maw Green, the AERMOD dispersion modelling gives a minimum dispersion factor for off-site receptors that suggests air dilution of approximately x3000. It is therefore reasonable to assume on a precautionary basis that daily average exposure concentrations at those receptors are similarly unlikely to exceed a thousandth of the on-site near-source concentrations (i.e. <0.0000005f/ml (<0.5f/m^3)).

7.1.51 The estimated lifetime risk of mesothelioma and lung cancer from the above exposure scenario for the Daneshill site is approximately 1 in 230 million if all the fibres are assumed to be amosite. It will be lower if some of the fibres are chrysotile. For the Maw Green site, the risk is very similar, at approximately 1 in 210 million if all the fibres are assumed to be amosite. These levels of risk are so low as to be of negligible consequence (i.e. insignificant).

7.1.52 If the AERMOD annual dispersion factors are used, the modelling assumptions outlined above are the same, except for the exposure frequency, which is increased to 365 days a year to reflect the use of an annual average receptor exposure concentration. For the

Daneshill site, the annual average receptor exposure concentration is expected to be at least 10,000 times lower than the on-site near-source concentrations, based on the AERMOD minimum dispersion factor for the Travellers Site of approximately 75000. This equates to a receptor exposure concentration of <0.00000005f/ml (<0.05f/m^3)). Similarly, for the Maw Green site, the annual average receptor exposure concentration is expected to be at least 10,000 times lower than the on-site near-source concentrations, based on the AERMOD minimum dispersion factor for off-site receptors of approximately 50000. This similarly equates to a receptor exposure concentration of <0.00000005f/ml (<0.05f/m^3)).

7.1.53 The estimated lifetime risk of mesothelioma and lung cancer from the above exposure scenario for the Daneshill site is approximately 1 in 320 million if all the fibres are assumed to be amosite. For the Maw Green site, the risk is lower, at approximately 1 in 480 million if all the fibres are assumed to be amosite. These levels of risk is lower than those calculated using the minimum dispersion factors and the local meteorological data for June 2022-June 2023 (albeit the same order of magnitude, noting the precautionary assumptions on the number of dry days with wind in the direction of the receptors used in that approach), and is similarly so low as to be of negligible consequence. The risk will be lower if some of the fibres are chrysotile.

7.1.54 The SoBRA Excel spreadsheet calculations are provided as Appendix E.

7.1.55 To place the calculated receptor exposure risks in context a risk of 1 in a million is defined by prevailing contaminated land risk assessment guidance as ‘minimal’ (EA, 2009) [CD1/2], and a risk of 1 in 50,000 as ‘low’ (CL:AIRE, 2014) [CD1/2]. Both risk levels are used to define ‘acceptable’ levels of soil contaminants. International soil, air, and water standards for carcinogenic substances tend to be set based on ELCR of 1 in 10,000 to 1 in a million.

7.1.56 Off-site dispersion would need to be at least two orders of magnitude lower than that predicted before off-site exposure risk potentially reached the most stringent of the 'minimal' risk thresholds noted in paragraph 7.1.55.

7.1.57 'Significant' off-site airborne concentrations and associated exposure risk would normally be associated with a predicted or measured airborne concentration or risk that is in excess of health-based guidelines (i.e. air guidelines or risk thresholds), taking into account any uncertainty in those predictions or measurements. There is no hard and fast rule as to how much a predicted concentration or exposure risk has to exceed a threshold before it becomes 'significant' as this depends on the context (namely the relevant regulatory regime, the nature of the potential harm, and the sensitivity of the receptor). Whilst the statutory guidance for Part 2A of the Environmental Protection Act 1990 goes some way to define 'significant' (SG 3.29), the final decision on 'significance' is a subjective judgement. It was acknowledged in the UK Government's approach to the Soil Investigation at Grenfell Tower (HMG, 2019) [CD1/2] that the range in the exceedance of a generic screening value before exposure might be considered to be potentially significant varied from '*a few times higher to orders of magnitude higher*'. Under the Planning Regime, risks from contaminated land should (as a minimum) not be such that the land could be determined as contaminated land under Part 2A of EPA1990. Under the Environmental Permitting Regime, emissions not resulting in an exceedance of an Environmental Assessment Level (or equivalent) at a designated monitoring point are deemed 'insignificant'. The Industrial Emissions Directive (IED) (Directive 2010/75/EU) [CD1/A], although not directly stated, can be read to equate 'significant' to a breach of permit conditions and certainly where that breach of those conditions poses an immediate danger to human health or threatens to cause an immediate significant adverse effect upon the environment (Article 8 paragraph 2). There is no direct definition of 'significant' in the IED text in relation to emissions or pollution, with 'pollution' defined as the '*…introduction… of substances… [etc] into air, water or* *land which might be harmful to human health or the quality of the environment, result in damage to material property, or impair or interfere with amenities and other legitimate uses of the environment.*' The inference is that if pollution is capable of the harm, damage or impairment/interference noted in the definition then it is 'significant'. Under The Environmental Damage (Prevention and Remediation)(England) Regulations 2015, "environmental damage" is defined as damage that either lowers the status of a surface water or groundwater body, results in a significant risk of adverse effects on human health, or has a significant adverse effect on reaching or maintaining the favourable status of a protected species or natural habitat. 'Damage', by its definition is 'significant', and of note, the definition of damage relating to human health is aligned to the definition of significant risk in Part 2A of the Environmental Protection Act 1990.

7.1.58 On the basis of the above I would expect 'significant' exposure to ambient airborne asbestos to be prolonged and repeated exposure that is associated with a risk greater than at least 1 in 10,000.

7.1.59 Refinement of the risk estimation based on factoring for potential sampling and analytical error, and for more detailed consideration of weather conditions is not expected to fundamentally alter the risk conclusion that off-site exposure is associated with an extremely low risk to health, given how low the risk estimates are. Consequently, both the on-site monitoring data from Maw Green and ERQ, and the predicted off-site air concentrations at Maw Green and Daneshill are not considered 'significant' in the context of paragraph 7.1.57 above.

7.1.60 The Environment Agency in their Rule 6 response (paragraph 179) states that the risk profiles of temporary remediation undertaken by mobile treatment plant (such as the examples in paragraph 5.1.6 of my Evidence), and treatment undertaken at a fixed treatment installation (such as a soil treatment facility) are entirely different. The risk profile of both a temporary remediation activity (maximum duration of 12 months) and a fixed installation will be a function of the same factors, such as activity duration, asbestos type, form, and concentration, volume of soil treated, the rate at which it is treated, the nature of the soil (moisture, particle size), and the control measures in place to prevent and minimise asbestos fibre release and subsequent human exposure. It is plausible that a short-term activity could result in higher cumulative exposure than that associated with a longer-term activity if the factors (other than duration) indicated a greater potential for fugitive airborne fibre emissions over a shorter duration, noting that the health risk from exposure to asbestos is a function of cumulative exposure (i.e. concentration x duration).

7.1.61 The difference between temporary remediation and fixed installations seems to be a moot point if the estimated exposure risk from a fixed installation is negligible.

8. Conclusions

8.1.1 An assessment of the airborne asbestos fibre emission from soil during mechanical processing has shown that:

a. US EPA AP-42 calculations predict that the more likely significant emission sources for PM10 are transient vehicle movement on the concrete slab, followed by surface wind erosion from exposed concrete pad. Other emission activities (such as the screener, material transfer, and the picking station) are likely to be insignificant by comparison. Material transfer might become more significant (and greater than vehicle movement emissions) if the material is exceptionally dry (<2%), however, screener and conveyor emissions remain insignificant in comparison. Later more detailed consideration of particle resuspension and the significance of weather patterns on this suggests that particle resuspension is not a significant off-site mechanism.

b. Dust monitoring at the open-air Maw Green STF between July and September 2023, and four days of dust monitoring at the same STF by Hydrock during a spell of hot dry weather in early September 2023 indicates a potential process contribution to near-source PM10 dust concentrations within the operational area of the STF of approximately 20-40 µg/m^3. with transient maxima an order of magnitude higher.

c. Loose fibre counts for the PM10 dust fraction of processed soil and sedimented dust on the STF concrete pad are of the order of 10,000 fibres per milligram. Multiplying this by the estimated range of process-contribution airborne dust gives an estimate of near-source airborne fibre concentrations of 150-1800 f/m^3.

d. Activity-based air monitoring at the Maw Green and Edwin Richards Quarry STFs operated by Provectus indicates that near-source airborne asbestos fibre concentrations are likely to range between <500-1500 f/m^3. This dataset comprises over 1,200 daily sample measurements taken between 2022 and 2023.

e. The same activity-based data did not show a quantifiable change in near-source air concentrations at the ERQ STF during a trial using a cover and HEPA filter, or when mechanical screening ceased and only manual picking continued.

f. Measured near-source concentrations are at least an order of magnitude lower than boundary concentrations required under the environmental permits issued for the two sites.

g. These results appear to be consistent with conclusions published by UK (HSE) and Dutch (RIVM) authorities.

h. The data from four days of activity-based air monitoring at Maw Green using a sampling and analytical approach that reduced the limit of quantification by an order of magnitude indicates that concentrations reported as <500 f/m^3 could be at least an order of magnitude lower (i.e. <50f/m^3.)

8.1.2 An assessment of the presence of loose asbestos fibres in post-processed soil and the associated hazard potential has shown that:

a. Asbestos fibres above 'trace' were not detected in over 50% of post-processed soil validation samples taken from soil processed at Maw Green and ERQ. The data set comprises 342 samples representing soil processed from approximately 300 source sites across the UK.

b. Quantifiable quantities of asbestos (i.e. greater than the LoQ of 0.001%wt/wt (10mg/kg) were detected in between 15% and 30% of the samples.

c. The post-processed soil dataset suggests that the asbestos hazard is 'low' according to the Joint Industry Working Group Decision Support Tool for work categories based on reported concentrations. The hazard is 'medium' according to the JIWG DST for receptor ranking based on the presence of amosite fibres in addition to chrysotile fibres.

d. The health risk from exposure to a mixture of amosite and chrysotile fibres is expected to be approximately an order of magnitude higher than that from the same concentration of chrysotile-only fibres.

e. Based on published research, the fibre release from soil containing fragments of bonded asbestos is expected to be negligible. The respirable fibre content of soil containing bonded asbestos is also expected to be negligible. This appears to be borne out by the soil datasets reviewed.

f. Published research indicates that fibre release from soil is significantly reduced by soil moisture levels >5%. Laboratory moisture testing of post-processed soil at Maw Green and ERQ suggests that soil sample moisture contents were typically above 5% (range 0.62%- 52%, 5th percentiles 5%-8%).

8.1.3 An assessment of the potential for material processing at an STF to increase loose, free fibres concentrations in the soil has shown that:

a. It is plausible that soil agitation could cause the deterioration of fragments of asbestos containing material within that soil. It is expected that the release of respirable fibres as a result of that agitation will be very low for bound/bonded asbestos materials compared to that for unbound/friable asbestos materials. The latter are precluded in the STF acceptance criteria, notwithstanding the potential for undetected low levels of such materials in the received soils.

b. Comparison of soil testing of pre- and post- processed soils at Maw Green and ERQ did not provide consistent evidence of increased quantifiable asbestos concentrations in the post-processed soils. This comparison is constrained by the analytical method limit of quantification.

8.1.4 An assessment of potential off-site dispersion of airborne asbestos fibres and the associated potential health risk to off-site receptors has drawn on the air dispersion modelling evidence of Matt Stoaling [CD6/4], and has shown that:

a. The location of the proposed STF at Daneshill and its environs (specifically topography and vegetation cover) is likely to reduce off-site airborne dust and asbestos fibre dispersion.

b. Airborne asbestos fibres detected in air samples from Maw Green and ERQ have been identified to be a mix of amosite and chrysotile.

c. Daily and long-term near-source air concentrations are likely to be at least an order of magnitude lower than the limit set in the environmental permit. Boundary concentrations would be expected to be lower still.

d. On-site emission and off-site dispersion of airborne dust and asbestos fibres is highly dependent on factors such as wind speed, wind direction, and rainfall.

Meteorological data indicates that worst-case conditions of no rain, right wind direction, and sufficient wind speed will be relatively rare events.

e. The AERMOD modelling detailed in Matt Stoaling's evidence [CD6/4] identifies the Travellers Site to the south of the Daneshill site, and Meadow croft Cottage and the new housing development to the southeast of the Maw Green site, as the most sensitive receptors. The dilution effect of air dispersion from the STF to these receptors is predicted to result in a reduction in near-source airborne asbestos fibre concentrations of at least x1000.

f. Exposure risk estimates based on precautionary exposure assumptions indicate that the mortality risk from off-site asbestos exposure is likely to be less than be 1 in 200 million. This compares with risk thresholds used in the setting of soil, air and water quality guidelines and standards that range from 1 in 10,000 to 1 in a million. The predicted level of risk for both sites is so low as to be of negligible consequence.

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