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Grenfell Investigation into Potential Land Contamination Impacts

Stage 2 Investigation
Tier 2 and Tier 3 Risk Assessment

Royal Borough of Kensington and Chelsea

Project number: 60632092
LORP0001

11 June 2021

Quality information

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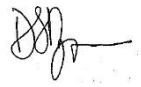	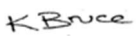		
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Revision	Revision date	Details	Authorized	Name	Position
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The methodology adopted and the sources of information used by AECOM in providing its services are outlined in this Report. The work described in this Report was undertaken between **25th May 2020** and **19th March 2021** and is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances. AECOM disclaim any undertaking or obligation to advise any person of any change in any matter affecting the Report, which may come or be brought to AECOM's attention after the date of the Report.

The exploratory holes carried out during the fieldwork, which investigate only a small volume of the ground in relation to the size of the investigation area, can only provide a general indication of conditions within that investigation area. The comments made and recommendations given in this Report are based on the ground conditions apparent at the locations of the exploratory holes. There may be exceptional ground conditions elsewhere in the investigation area which have not been disclosed by this investigation and which have therefore not been taken into account in this Report.

The opinions expressed in this Report concerning any contamination found and the risks arising there from are based on current good practice assessment and comparison with available soil guideline values, generic assessment criteria and other guidance values.

It should be noted that the effects of ground and water borne contamination on the environment are constantly under review, and authoritative guidance values are potentially subject to change. The conclusions presented herein are based on the guidance and guideline values available at the time this Report was prepared, however, no liability by AECOM can be accepted for the retrospective effects of any changes or amendments to guidance or guideline values. Unless otherwise stated in this Report, the assessments made assume that the sampling areas will continue to be used for their current purpose without significant changes.

Reference to historical Ordnance Survey (OS) maps and/or data provides invaluable information regarding the land use history in the investigation area. However, it should be noted that historical evidence will be incomplete for the period pre-dating the first edition and between the release of successive maps and/or data.

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Acronyms and Abbreviations

ACM	Asbestos containing material
AGS	Association of Geotechnical and Geoenvironmental Specialists
AIB	Asbestos insulating board
ATSDR	US Agency for Toxic Substances and Disease Registry
BaA	Benzo(a)anthracene
BAF	Bioaccessible Fraction
BaP	Benzo(a)pyrene
BDE	Brominated Diphenyl Ethers
BFR	Brominated Fire Retardants
bgl	Below ground level
BGS	British Geological Survey
BS	British Standard
BSI	British Standards Institution
CF	Concentration Factor
CI	Confidence Interval
CIRIA	Construction Industry Research and Information Association
CKG	Community Kitchen Garden
CLs	Contaminant Linkages
CLEA	Contaminated Land Exposure Assessment
COC	UK Department of Health Committee on Carcinogenicity
COPC	Chemicals of Potential Concern
COT	Committee on Toxicity
CSM	Conceptual Site Model
C4SL	Category 4 Screening Level
DahA	Dibenzo(a,h)anthracene
Defra	Department for Environment, Food & Rural Affairs
DIV	Dutch Intervention Value
DQRA	Detailed Quantitative Risk Assessment
DVSR	Data Validation Summary Report
EA	Environment Agency
EFSA	European Food Safety Authority
EIC	Environmental Industries Commission
ELCR	Excess Lifetime Cancer Risk
FSA	UK Food Standards Agency
GAC	Generic Assessment Criteria
G-BASE	Geochemical Baseline Survey of the Environment
GSC	Generic Screening Criteria
GQRA	Generic Quantitative Risk Assessment
HCV	Health Criteria Value
HP	Homegrown Produce
HSE	Health and Safety Executive
HSL	Health and Safety Laboratory
IEUBK	Integrated Exposure Uptake Biokinetic

IPPC	Integrated Pollution Prevention and Controls
ISO	International Organization for Standardization
KAA	Kensington Aldridge Academy
LA	Local Authority
LBB	London Borough of Brent
LBHF	London Borough of Hammersmith & Fulham
LCRM	Land Contamination Risk Management
LLTC	Low Level of Toxicological Concern
LQM	Land Quality Management Ltd
MAP	Multi-Agency Partnership
MDL	Method Detection Limit
mg/kg	Milligrams per kilogram
µg/kg	Micrograms per kilogram
µg/dl	Micrograms per decilitre
MHCLG	Ministry of Housing, Communities and Local Government
MMMF	Man-made mineral fibres
NBC	Normal Background Concentration
ng/kg	Nanograms per kilogram
NMQS	National Quality Mark Scheme
PAHs	Polycyclic Aromatic Hydrocarbons
Part 2A	Part 2A of the Environmental Protection Act, 1990 (the 'Contaminated Land regime')
PBBs	Poly-brominated Biphenyls
PBDEs	Poly-brominated Diphenyl Ethers
PCBs	Polychlorinated Biphenyls
PCLs	Potential Contaminant Linkages
PHE	Public Health England
POSpark	Public Open Space in a parkland setting
POSresi	Public Open Space in a residential setting
POSH	Possibility of Significant Harm
PRA	Preliminary risk assessment
QA	Quality Assurance
RBA	Relative Bioavailability
RBKC	Royal Borough of Kensington and Chelsea
Resi+HP	Residential land-use with homegrown produce consumption
Resi-HP	Residential land-use without homegrown produce consumption
RIVM	Dutch National Institute for Public Health and the Environment
RPD	Relative Percent Difference
RSLs	Regional Screening Levels
SSAC	Site Specific Assessment Criteria
SAG	Science Advisory Group
SCL	Significant Contaminant Linkage
SGV	Soil Guideline Values
SIR	Soil Ingestion Rate
SoBRA	Society of Brownfield Risk Assessment
SOM	Soil Organic Matter
SPOSH	Significant Possibility of Significant Harm

SQP	Suitably Qualified Person
SRM	Standard Reference Material
Statutory Guidance	2012 Statutory Guidance to Part 2A of the Environmental Protection Act, 1990
SVFs	Synthetic Vitreous Fibres
SVOCs	Semi-Volatile Organic Compounds
S4UL	Suitable 4 Use Level
TDI	Tolerable daily intake
TDSI	Tolerable daily soil intake
TEF	Toxic Equivalency Factor
TICs	Tentatively Identified Compounds
TN	Technical Notes
TOC	Total organic carbon
TWI	Tolerable weekly intake
UKAS	United Kingdom Accreditation Service
UKSHS	UK Soil and Herbage Survey
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
VROM	Dutch Ministry of Housing, Spatial Planning and the Environment
WHO	World Health Organisation

Executive Summary

AECOM has undertaken Stage 2 of the soil investigation into potential land contamination caused by the Grenfell Tower fire. This work has been undertaken during the period May 2020 to March 2021, with the sampling of soil and crops taking place in October to November 2020. The investigation has been carried out under Part 2A of the Environmental Protection Act 1990 and in accordance with the statutory guidance for Part 2A, and has been subject to review by the Multi-Agency Partnership, Scientific Advisory Group, and independent Suitably Qualified Person. The objectives of the investigation were to determine the geographical extent of any significant contamination caused by the fire; establish whether there are unacceptable risks to human health; provide recommendations in relation to the Part 2A classification of all potential significant contaminant linkages; and provide recommendations for whether or not any land appears to meet the definition of contaminated land, under Part 2A.

Stage 2 followed on from the Stage 1 investigation, which was reported in 2019 and had involved exploratory sampling, completion of a preliminary risk assessment, and production of a draft design for Stage 2. The Stage 2 scope of work included:

- Review and refinement of the draft design in consultation with residents and the Multi-Agency Partnership and Science Advisory Group.
- An investigation area that broadly covered land within a 1km radius from the Tower in a north-westerly direction consistent with the prevailing wind direction at the time of the fire. A small number of land areas were investigated beyond the 1km distance (up to a maximum distance of 4.5 km).
- Collection and laboratory analysis of 35 samples of homegrown fruit and vegetables from 12 different allotment or community kitchen garden (CKG) areas.
- Collection and analysis of 475 soil samples from 39 different areas (a combination of allotment, community kitchen gardens, parks and public open space surrounding residential housing).
- Laboratory chemical testing of homegrown produce and soil samples for lead, polycyclic aromatic hydrocarbons and asbestos in all samples. A sub-set of soil samples was tested for antimony, dioxins, furans & dioxin-like PCBs and a separate targeted sub-set of soil samples was tested for the full broader range of potential fire effluent chemicals tested during the Stage 1 exploratory sampling. Soil samples were also tested to assess the bioaccessibility of lead and polycyclic aromatic hydrocarbons.
- The spatial assessment of the chemical dataset (using the combined Stage 1 and Stage 2 datasets) to look at data patterns with lateral distance and direction from Grenfell Tower, with vertical depth in the soil, with overlying ground cover (bare soil or grass), and with soils from ground level or raised beds.
- A comparison with expected normal background concentrations to evaluate whether there was any evidence of the identified concentrations having been caused directly by the Grenfell Tower fire.
- Assessment and interpretation of the Stage 1 and Stage 2 laboratory testing data in accordance with the UK's tiered risk assessment process. This included initial screening of data using generic screening criteria, with subsequent chemical exposure modelling to calculate site-specific assessment criteria.
- Evaluation of the level of risk to human health in accordance with the decision framework set out in the Statutory Guidance for Part 2A.

The spatial review of chemical testing data did not identify consistent patterns that might indicate aerial deposition of chemicals from debris, soot and ash effluent from the Grenfell Tower fire that could be distinguished from normal pre-fire background variation. The assessment concluded that any undiscernible contribution from the fire would not in itself result in a risk to health above the 'no to low risk' Part 2A definition of Category 4 land. The chemical concentrations appear to fall within expected ranges of normal urban background and localised variation was interpreted to be mainly a result of local land-use development history.

On this basis, the Stage 2 investigation did not identify evidence – in the form of concentrations of chemicals in soil – of significant contamination caused by the fire.

The sampling results from individual sampling areas were also assessed to determine the risk to health caused by underlying pre-fire contamination.

The soil results from each of the forty-five Stage 1 and Stage 2 sampling areas were assessed in line with the objective to identify potential contamination arising from the Grenfell Tower fire. The results were also assessed for risk to human health taking into account the concentrations of potentially fire-related chemicals that could be

present in soil from sources not related to the Grenfell Tower fire. The risk assessment has not considered potential soil contaminants not directly associated with the fire that might also be present in soil as a result of historic land-use activities.

The risk assessment in accordance with Part 2A concluded that all land investigated directly as part of the Stage 1 and Stage 2 investigations falls into Category 4 (indicating at most a low risk to health) with the exception of:

- **Treadgold House (communal garden to south and west of residential building)** – soil concentrations of lead (considered to be from historic pre-fire sources) exceed the threshold for 'low' risk; therefore the land does not meet the definition of Category 4 based on the current data. Uncertainty associated with the range of reported soil concentrations and the manner in which residents may use the area is sufficient to justify a recommendation to undertake further assessment in this area. That further assessment should be designed to confirm whether the land meets the definition of Category 2, or Category 3 by reducing the uncertainty associated with average soil concentrations and attempting to define an improved understanding of how the land is typically used by residents.
- **Avondale Park Gardens** – high uncertainty associated with average soil concentrations of lead (considered to be from historic pre-fire sources) and how regularly the area is used by residents meant that a decision on the category of land could not be made. Additional sampling to reduce uncertainty is recommended to allow a decision between Category 2, Category 3 and Category 4 to be made.

The combination of the assessment of fire-related contamination and the health risk assessments of individual areas indicates that if any small amounts of fire-related contaminants are present in the investigation area (including those areas that have not been sampled) then they are indistinguishable from urban background levels and / or are lower than screening criteria that are designed to fall into Category 4 land (i.e. low or no risk to health). Hence the condition of any land surrounding Grenfell Tower should not have been materially affected by any impact from the Grenfell Tower fire and the pre-existing inspection strategy for land within the investigation area does not need to be altered as a result.

1. Introduction

This report presents the summary of the findings of Stage 2 of the Grenfell Investigation into the Potential Land Contamination Impacts. Stage 2 includes works completed to undertake a "Detailed Inspection Comprising Tier 2 and Tier 3 Risk Assessment into Potential Contaminated Land around Grenfell Tower" in accordance with Part 2A of the Environmental Protection Act 1990.

A plan showing the location of Grenfell Tower (hereafter referred to as 'the Tower') is shown on **Figure A1** reported in **Appendix A**.

AECOM Limited (AECOM) was appointed to undertake these works on behalf of the Multi-Agency Partnership (MAP), which was established by the UK Government to oversee and advise on the further environmental checks for the Grenfell site that were announced by the UK Government on October 26th 2018.

The work that AECOM has undertaken has been overseen and reviewed by the Multi-Agency Partnership, the Science Advisory Group (SAG), and the National Quality Mark Scheme (NQMS) Suitably Qualified Person (SQP) Paul Nathanail.

The investigation into potential land contamination impacts is being carried out under Part 2A (Crown, 1990) and the associated Statutory Guidance (Defra, 2012). This statutory guidance sets out specific requirements on how the investigation should be undertaken and how the results from that investigation should be interpreted.

The objective of Part 2A is to provide a means of dealing with unacceptable risks to human health and the environment posed by land contamination. This is achieved through the identification of land that poses an unacceptable risk, making that land suitable for use by removing that risk, and doing so in such a way that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and compatible with the principles of sustainable development.

The primary focus of this investigation is on the risk to human health, and therefore the Part 2A definition of unacceptable risk to human health is of direct relevance. This definition is that "significant harm" is occurring, or there is "a significant possibility of significant harm" (SPOSH). The statutory guidance for Part 2A additionally defines four categories of land when considering if there is a SPOSH being caused by reason of substances in, on or under the land:

- Category 1 – Paragraph 4.19 of the Part 2A Statutory guidance states that *"The local authority should assume that a significant possibility of significant harm exists in any case where it considers there is an unacceptably high probability, supported by robust science-based evidence, that significant harm would occur if no action is taken to stop it."* Land placed in Category 1 meets the legal definition of Contaminated Land.
- Category 2 – Paragraph 4.25(a) of the Part 2A Statutory guidance states that *"Land should be placed into Category 2 if the authority concludes, on the basis that there is a strong case for considering that the risks from the land are of sufficient concern, that the land poses a significant possibility of significant harm, with all that this might involve and having regard to Section 1. Category 2 may include land where there is little or no direct evidence that similar land, situations or levels of exposure have caused harm before, but nonetheless the authority considers on the basis of the available evidence, including expert opinion, that there is a strong case for taking action under Part 2A on a precautionary basis.".* Land placed in Category 2 meets the legal definition of Contaminated Land.
- Category 3 – Paragraph 4.25(b) of the Part 2A Statutory guidance states that *"Land should be placed into Category 3 if the authority concludes that the strong case described in 4.25(a) does not exist, and therefore the legal test for significant possibility of significant harm is not met. Category 3 may include land where the risks are not low, but nonetheless the authority considers that regulatory intervention under Part 2A is not warranted. This recognises that placing land in Category 3 would not stop others, such as the owner or occupier of the land, from taking action to reduce risks outside of the Part 2A regime if they choose. The authority should consider making available the results of its inspection and risk assessment to the owners/ occupiers of Category 3 land.".* Land placed in Category 3 does not meet the legal definition of Contaminated Land.
- Category 4 – Paragraph 4.20 of the Part 2A Statutory guidance states that *"The local authority should not assume that land poses a significant possibility of significant harm if it considers that there is no risk or that the level of risk posed is low. For the purposes of this Guidance, such land is referred to as a "Category 4: Human Health" case".*. Land placed in Category 4 does not meet the legal definition of Contaminated Land. This includes land where:

- no contaminant linkage has been identified.
- only normal levels of contaminants in soil are present.
- soil concentrations do not exceed relevant generic assessment criteria (GAC).
- estimated levels of exposure from soil are likely to form only a small proportion of exposure from other sources.

Further detail in relation to Part 2A, the 2012 Statutory Guidance, and the process of risk assessment within the Part 2A regime is provided in Appendix A of the Environment Agency "Analysis and Interpretation Methodology for the Soil Investigation at Grenfell Tower" (EA, PHE, 2019).

1.1 Project Background

The investigation has taking a phased approach and comprised two stages:

Stage 1 – the collation of relevant background information to be able to design Stage 2.

Stage 2 – the main stage of investigation and assessment.

Further information on the programme for the environmental checks can be found online at https://www.gov.uk/guidance/soil-and-environmental-checks.

In 2019 AECOM completed Stage 1 of the Grenfell Investigation into Potential Land Contamination Impacts (Stage 1) (AECOM, 2019b). Stage 1 resulted in the completion of a Preliminary Risk Assessment (PRA) in accordance with Part 2A of the Environmental Protection Act (EPA) (Crown, 1990) (hereafter referred to as "Part 2A"), the associated Statutory Guidance (DEFRA, 2012), Environment Agency (EA) land contamination guidance (CLR11 (Environment Agency, 2004) and LCRM (Environment Agency, 2020)) and the MAP "Analysis and Interpretation Methodology for the Soil Investigation at Grenfell Tower (v8_2)" (EA, PHE, 2019). A pilot study to evaluate more detailed assessment was also completed for Stage 1. Based on the PRA and the pilot study a draft detailed design for Stage 2 investigation was prepared. All reporting of the Stage 1 work and findings was published on the gov.uk/ website at https://www.gov.uk/guidance/grenfell-environmental-checks-stage-1-report#report-documents (Ministry of Housing, Communities and Local Government, 2019).

This report presents the findings of the Stage 2 investigations.

1.2 Objectives

The primary aim of Stage 2 was to undertake targeted investigation works within key areas identified during the Stage 1, to identify significant contamination in the soil resulting from the fire. Specific objectives of Stage 2 were:

- Determine so far as possible the geographical extent of any significant contamination caused by the fire whilst recognising the potential for underlying (pre-fire) contamination.
- Carry out generic and detailed quantitative human health risk assessments required under Part 2A to establish whether there are unacceptable risks to human health.
- Provide recommendations in relation to the classification of all potential significant contaminant linkages investigated as Category 1-4 in accordance with the Statutory Guidance.
- Provide recommendations to the regulatory authority for whether or not land appears to meet the definition of contaminated land, under Part 2A.

1.3 Outline Scope of Work

The scope of work presented in this report, was designed to achieve the objectives stated in **Section 1.2** above. It was developed based on the findings of the Stage 1 assessment and in accordance with the approach described in the EA's LCRM guidance (Environment Agency, 2020), and comprised the following tasks:

- Review of Stage 1 information alongside other relevant additional information to identify potential data-gaps in the draft Stage 2 detailed design as it was presented in TN18 (AECOM, 2019e).
- Summary of initial Conceptual Site Model.
- Site walkovers, to identify suitable sampling locations, potential constraints and logistical requirements for the Stage 2 soil sampling activities.

- Preparation of an updated detailed design for the Stage 2 investigation taking into account information from the data-gaps assessment and site walkovers.
- Implementation of sampling investigation, including laboratory analysis of soil samples.
- Data assessment and reporting, including conclusions and recommendations consistent with the framework and requirements of Part 2A, to include:
  - Summary of final agreed Stage 2 detailed design, including changes from the draft design presented in TN18 (AECOM, 2019e), and justification for the changes.
  - Presentation of spatial distribution of chemicals of potential concern (COPC) in soil and comparison with available background data.
  - Generic quantitative risk assessment (GQRA), comprising comparison of soil concentrations against GAC in order to screen out COPC that immediately fall into Category 4.
  - Detailed quantitative risk assessment (DQRA), to develop site specific assessment criteria (SSAC) to provide greater understanding of the level of risk posed to human health.
  - Risk Evaluation, taking into account remaining data-gaps and uncertainty, considers which land Category the degree of health risk identified through the DQRA falls under.

2. Review of Stage 1 and Data-gaps Assessment

2.1 Scope of Review

AECOM completed a review of the draft Stage 2 Detailed Design based on additional information available since completion of the Stage 1 investigation. The additional information provided by MAP that was reviewed and considered included:

- Stage 1 Report – Phase 1 Desk Study and Phase 2 Shallow Soil Investigation Report. Edward Woods Estate, Hammersmith, London (RPS, 2019).
- Combustion Related Fire Products: A Review. (Hadden & Switzer, 2020).
- Comments provided by Robert Tyler (of RBKC) related to proposed Stage 2 Scope of Work.
- Additional technical questions[1] related to the draft Stage 2 scope that were raised and discussed by MAP following the commencement of the Stage 2 contract.
- Questions arising from the first Stage 2 community engagement event and question and answer session held on Teams Live on Monday 20th July 2020.

In addition:

- AECOM has completed a Landmark Envirocheck search covering the proposed Stage 2 sampling areas and including a buffer of at least 50m around each area to provide information on current and historical land use.
- For each of the Stage 2 sampling areas, AECOM has completed a review of Planning application and Planning permission information available on the RBKC, London Borough of Hammersmith and Fulham (LBHF) and London Borough of Brent (LBB) online portals.
- AECOM has made Environmental Information Requests to RBKC, LBHF and LBB.

Further to the above information review, AECOM has also considered questions raised at the first community engagement Q&A event and recent communication with Kensington Aldridge Academy (KAA).

2.2 Findings of Review

The findings of the review were presented to MAP in a memorandum, along with recommendations for potential changes to the proposed Stage 2 scope detailed in TN18 (AECOM, 2019e) to address the findings and potential data-gaps. This memorandum is included in **Appendix C.**

2.3 Scope Adjustments

Based on the findings of the Stage 1 Review and Data-gaps assessment, and following agreement by MAP, the following adjustments presented in Table 1 below were made to the proposed Stage 2 investigation scope which were presented in TN18 (AECOM, 2019e).

Table 1. Scope Adjustments following Data-gap Assessment

Change No.	Details of Change
1	The Tower cordon was not originally included in the Stage 2 Detailed Design, however, following the data-gap assessment it was agreed that soil samples would be taken from 10 locations within the Tower Cordon area.
2	Three additional sampling areas were added to the Stage 2 sampling scope, including Stonebridge Recreation Ground, Wormwood Scrubs and St. Quintin's Family Centre, due to their proximity to the centre line of the modelled indicative plume extent. For each area the scope included a background review (Envirocheck, Planning portal review, LA Environmental Information Request), site walkover, collection of 10 shallow soil samples, and laboratory analysis of soil samples for the standard Stage 2 analytical test suite.
3	Completion of a detailed review of the Semi Volatile Organic Compounds (SVOC) TICs: benzo(e)pyrene, perylene, indene, biphenyl, benzonitrile and pyridine to determine whether there would be any benefit in their inclusion in the Stage 2 analytical suite following their identification in the academic fire effluent chemistry review. The scope of the review included a review of the compound toxicity to determine suitability for inclusion the benzo(a)pyrene (BaP) surrogate marker approach, search for alternative compound specific generic screening criteria (GSC), search for available toxic equivalency factors (TEFs), spatial review of

[1] Contained with email from Sean Kenny (MHCLG) to David Dyson (AECOM) dated 20 July 2020. Subject: [EXTERNAL] FW: Stage 2 Grenfell environmental checks next steps

Change No.	Details of Change
	where these TICs detected, and overall polycyclic aromatic hydrocarbon (PAH) proportional composition in these samples to assess likelihood of being a fire effluent marker.
4	Sampling of crops and paired soil samples was brought forwards in the project programme to before the main soil sampling works to ensure that sufficient viable produce was available for sampling and testing. It was also agreed that the analysis of some crop samples would be of value to the risk assessment and risk communication process regardless of the concentrations of chemicals of potential concern (COPC) found in soils and therefore analysis of crop samples was also brought forward in the project programme. The scope adjustment included the analysis of 35 crop and soil pair samples for lead and PAHs.
5	Antimony was added to the Stage 2 analytical testing suite for two samples in each sampling area due to its identification as a COPC in the academic fire effluent chemistry review. In addition, and also due to its identification in the academic fire effluent chemistry review, the Stage 1 Volatile Organic Compound (VOC) analyses were re-evaluated in order to report carbon disulphide quantitatively. Deca-bromo diphenyl ether (deca-BDE) was added to the poly-BDE analytical suite for those sampling areas to be tested for the broader Stage 1 suite of analysis (Longstone Avenue allotments, Stonebridge Recreation Ground and Tower Cordon)
6	It was agreed that AECOM would extract laboratory data from four identified site investigation reports that might be suitable for use as local background and baseline data, including (where available) information on depth of samples, soil descriptions, sampling method and laboratory techniques) to inform the data comparison. The reports were from works conducted at Avondale Primary School, Avondale Park, St. Quintins Family Centre, and multiple public open space areas sampled by RBKC as part of its Part 2A response strategy. After a data request submitted to LBB, a fifth report covering a site investigation at Longstone Avenue allotments was added to this task for data extraction.
7	The full Stage 1 analytical testing suite, which was originally only included in the Stage 2 design for Longstone Avenue allotments, was also applied to four of the ten locations within the new Tower Cordon sampling area (see change no. 1 above). The allowance for the Stage 1 suite testing originally planned for Longstone Avenue allotments was agreed to be split between Longstone Avenue allotments and Stonebridge Recreation Ground). For the poly-brominated biphenyls (PBBs) in the analytical suite, testing was changed from Element to Fera to achieve a limit of detection lower than the GSC that was identified during the Stage 1 work.
8	The sampling method for samples planned to be analysed for volatile organic compounds (VOCs) was adjusted to be consistent with methanol preservation sampling method described in British Standard BS10176:2020 (BSI, 2020). This BS was published in May 2020 after preparation of the draft detailed design during Stage 1. To allow a comparison between Stage 1 and Stage 2 data, it was agreed that all samples requiring VOC analysis would be tested using the previous method used for Stage 1 as well as the updated BS10176 method.
9	It was agreed that the sampling depth interval for the majority of shallow soil samples would be adjusted to 0cm - 2cm. Exceptions to this included where the soil surface was considered likely to have been disturbed to greater depth, and the original proposed depth of 0cm - 5cm was retained. No changes were made to the proposed sampling depths in community kitchen gardens (0cm - 20cm) or where deep soil sampling was proposed (50cm - 60cm).

2.4 Target PAH and SVOC Review

Following the recommendations of the data-gap assessment, AECOM completed a review of the target polycyclic aromatic hydrocarbon (PAH) compounds and semi volatile organic compounds (SVOC) compounds from the Stage 1 data that had been identified in the combustion related fire products review (Hadden & Switzer, 2020) as COPC from fire effluents. The review is provided in full in **Appendix C** and it concluded that it was not necessary to add any of the additional PAHs / SVOCs to the existing PAH compound target list either because they were not detected during the Stage 1 sampling to an extent to cause concern, or it was considered that their toxic effects could be adequately assessed through the use of benzo(a)pyrene as a surrogate marker for carcinogenic PAHs.

As a result, no further changes to the analytical testing suite for the Stage 2 works were recommended.

2.5 Desk Study – Additional Sampling Areas

Following the recommendation to include three additional areas (Stonebridge Recreation Ground, St. Quintin's Family Centre and Wormwood Scrubs) for Stage 2 sampling, a background desk study review of these areas was completed using the same method as for all other areas, including:

- Landmark Envirocheck search covering the proposed additional sampling areas with a buffer of at least 50m around each area to provide information on current and historical land use.
- a review of Planning application and Planning permission information available on the RBKC, LBHF and LBB online portals.

- Environmental Information Request to LBHF and LBB covering Stonebridge Recreation Ground and Wormwood Scrubs (the additional area within RBKC jurisdiction, St. Quintin's Family Centre, were covered by the original Environmental Information Request).

The findings of the desk study review for each of the three additional areas is included in **Appendix C** and the Envirocheck reports covering these areas is included in **Appendix L**.

3. Site Setting

In this section, Grenfell Tower and the area within the current security cordon are referred to as 'the Site'. The extent of the security cordon at the time that this report was prepared is shown in **Figure A1** reported in **Appendix A**. The extent of this security cordon has not changed since the Stage 1 investigation. The area investigated as part of the Stage 2 investigation extends beyond the boundary of the Site to a maximum distance of approximately 5km to the north-west of Grenfell Tower. This area, indicated in **Figure A2**, is referred to as the "investigation area" throughout this report. This does not imply that all land within the investigation has been actively sampled and assessed in detail; rather that the investigation area boundary delimits the area within which individual sampling areas were chosen based on the criteria defined in the Stage 2 Detailed Design (AECOM, 2020).

The Site setting was described as part of the Stage 1 investigation in TN16: Preliminary Risk Assessment (AECOM, 2019d). The site setting is not reproduced in detail here; however, since the extent of the area being investigated has changed with the addition of further sampling areas for the Stage 2 investigation, the key elements of the site setting are summarised below with any notable additions related to the expanded Stage 2 investigation area.

3.1 Site Location and Description

Grenfell Tower is located off Station Walk in the Notting Hill area of London, approximately 145m from Latimer Road Tube Station (grid reference: 523910, 180960).

The area surrounding the Site is a densely populated predominantly residential urban area with a mixture of terraced residential housing and blocks of flats of various heights and ages.

Typical commercial and amenity facilities exist in the area including grassed public open spaces, parks, shops, community centres, schools, and leisure/sports centres. The large Westfield shopping complex is located approximately 600m south west of the Site.

The Hammersmith and City London Underground line runs roughly south west/north east 75m to the north west of the Site, with the nearest station (Latimer Road) located approximately 125m south west of the Tower.

3.2 Current and Historic Land Uses

Technical Note TN10/12 (AECOM, 2019h) produced as part of the Stage 1 assessment identified a range of existing land uses within 250m of the Tower that could be potential sources of contamination, including garage services, furniture manufacturers, fabric and clothes manufacturers, pharmaceutical manufacturers and petrol / fuel stations. As part of the expanded review of the Stage 2 investigation area, four Envirocheck® reports (Envirocheck Report 244506740 (Landmark Information Group, 2020a) covering the area around Grenfell Tower, Envirocheck Report 244510776 (Landmark Information Group, 2020b) covering the area around Longstone Avenue allotments, Envirocheck Report 259484194 (Landmark Information Group, 2020c) covering the area around Wormwood Scrubs, and Envirocheck Report 259487084 (Landmark Information Group, 2020d) covering the area around Stonebridge Recreation Ground) were acquired to provide up to date coverage of the full area of investigation. The review of contemporary trade directory entries for the full investigation area identified thirty-six contemporary trade directory entries listed within 250m of the Site, eight within 250m of the Longstone Avenue Site and fourteen within 250m of the Stonebridge Recreation Ground.

Historic land uses for the Site and its surroundings to a distance of 1km from the Tower were reviewed and summarised as part of the Stage 1 assessment and were presented in TN10/12. This historic land use review has been expanded for the Stage 2 assessment to cover all proposed sampling areas; the historic land-use summary is described in the data-gap review in **Appendix C** and **Figure A3** in **Appendix A** shows a combined map of all proposed Stage 2 sampling areas with identified historic contaminative land uses overlaid.

The Site was shown as open land from 1867 to 1895 when residential properties are shown on Blechynden Street. The Site was cleared in the early 1970's and Grenfell Tower was built between 1972 and 1975. In the early nineteenth century, prior to the earliest historical mapping available during the production of this report, the area around Notting Hill was famed for its potteries and piggeries, both of which are considered to be potential sources of land contamination caused by the brick kilns and slum conditions in the area. Several historical potentially contaminative land uses including; railway land, brickfields, ironworks, breweries, dye works, printing works, engineering works, cleaning works, motor repair works, joiners, electricity substations and metal works have been identified within a 1km radius of the Site over the years. A number of areas have been redeveloped on one or more

occasions raising the potential for made ground containing historic demolition rubble and building materials to be present in the ground. In relation to the proposed specific Stage 2 sampling areas, potential contaminative land uses are summarised in **Appendix C, Data Gap Analysis Table C1 and Appendix C Table 1**.

3.3 Geology, Hydrogeology and Hydrology

The geological sequence beneath the Site was summarised in the Stage 1 PRA (TN16) (AECOM, 2019d) and comprised made ground, overlying Langley Silt, overlying Kempton Park Gravel, overlying London Clay. Surrounding the Site, the Langley Silt and underlying gravel are absent to the north and east of the Tower beyond a distance of approximately 50m, with the London Clay bedrock immediately underlying this area as far as the furthest sampling areas of Longstone Avenue allotments and Stonebridge Recreation Ground.

The presence of variable thickness and composition of made ground in the area is likely to result in variable concentrations of constituents (including some of the COPC) in the surface soils and shallow soils.

The Langley Silt and London Clay are classified as Unproductive Strata, whilst the Kempton Park Gravel is classified as a Secondary-A aquifer.

The nearest surface water feature to the Tower is recorded in the Envirocheck report to be 242m south west of the site, but this has not been designated and not identified by any other documentary evidence reviewed by AECOM and its existence is uncertain. A small watercourse is indicated to be present at 680m north west, this appears to be a small drain along the side of a railway line and is likely to be fed by surface water drainage and have no continuity with groundwater. The nearest significant water feature is the Grand Union Canal located approximately 1.4km north of the site.

3.4 Mining and Mineral Extraction

3.4.1 BGS Recorded Mineral Sites

Envirocheck Report 209140267 (Landmark Information Group, 2019b) identified ten BGS Mineral sites recorded between 76m and 467m south east of the Tower. These are associated with the former Notting Hill Brick Field and Potteries Field Clay Pit, all of which were former opencast working, all now recorded to have ceased. To the west and south west of the Site, a further 19 mineral sites are recorded at distances of between 494m and 995m from the Site. These sites were associated with the former Eynham (Farm), Woodlane Farm and Norham Brick Fields, and the Cowley Brick Works.

Envirocheck Report 244506740 (Landmark Information Group, 2020a) identified twenty-six BGS Mineral sites recorded between 50m and 950m south, south-west and west of the Tower. These are associated with former opencast working, all now recorded to have ceased.

Envirocheck Report 244510776 (Landmark Information Group, 2020b) identified no BGS Mineral sites recorded within 500m of the Longstone Avenue Site.

Envirocheck Report 259484194 (Landmark Information Group, 2020c) identified three BGS Mineral sites recorded between 973m west and 1000m south of the Wormwood Scrubs Site (Landmark Information Group, 2020c). These are associated with former recycling working and opencast working, all now recorded to have ceased.

Envirocheck Report 259487084 (Landmark Information Group, 2020d) identified eight BGS recorded Mineral sites recorded between 286m south west and 991m west of the Stonebridge Recreation Ground Site. These are associated with former opencast working, all now recorded to have ceased.

Former mineral extraction sites are frequently associated with later filling and hence represent potential sources of contamination from waste materials used as fill.

3.5 Regulated Activities

3.5.1 Licensed Waste Management Facilities

There are no active landfill Sites, waste treatment, transfer or disposal Sites within 500m of the study Tower (Landmark Information Group, 2019b).

Envirocheck Report 244506740 (Landmark Information Group, 2020a) identified no active landfill Sites, waste treatment, transfer or disposal Sites within 500m of the Tower.

Envirocheck Report 244510776 (Landmark Information Group, 2020b) identified no active landfill Sites, waste treatment, transfer or disposal Sites within 500m of the Longstone Avenue Site.

Envirocheck Report 259484194 (Landmark Information Group, 2020c) identified two waste transfer sites within 361m north east and 391m north east of the Wormwood Scrubs Site, and no active landfill Sites, waste treatment or disposal Sites within 500m of the Wormwood Scrubs Site (Landmark Information Group, 2020c).

Envirocheck Report 259487084 (Landmark Information Group, 2020d) identified no active landfill Sites, waste treatment, transfer or disposal Sites within 500m of the Stonebridge Recreation Ground Site.

3.5.2 Pollution Prevention and Control

Based on the Envirocheck Report 209140267 (Landmark Information Group, 2019b), there are no active Integrated Pollution Prevention and Controls (IPPC) within 250m of the Tower, the nearest IPPC is 487m west which denotes a surrendered permit for organic chemicals and oxygen containing compounds (e.g. alcohols). A Local Authority Pollution Prevention and Control is recorded 248m south west associated with the respraying of road vehicles, it is noted that this site is now closed, another nearby permit listed at the same address is for coatings manufacturing, this application is withdrawn. There are no other Local Authority Pollution Prevention and Controls within 250m of the site.

Based on the Envirocheck Report 244506740 (Landmark Information Group, 2020a), there is no active Integrated Pollution Prevention and Controls (IPPC) within 250m of the Tower, the nearest IPPC is 450m west which denotes a surrendered permit for organic chemicals and oxygen containing compounds (e.g. alcohols).

Based on the Envirocheck Report 244510776 (Landmark Information Group, 2020b), there is no active Integrated Pollution Prevention and Controls (IPPC) within 250m of the Longstone Avenue Site, the nearest IPPC is 876m west which denotes an effective permit for combustion. Three Local Authority Pollution Prevention and Control are recorded at 163m south west, associated to PG1/1waste oil burners, 211m south, associated to PG1/1Water oil burners and 215m north east, associated to PG6/46 Dry cleaning. There are no Local Authority Pollution Prevention and Controls within 250m of the site.

Based on the Envirocheck Report 259484194 (Landmark Information Group, 2020c), there is no active Integrated Pollution Prevention and Controls (IPPC) within 250m of the Wormwood Scrubs Site, the nearest IPPC is 415m north east which denotes an effective permit for disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day involving physico-chemical treatment, for the temporary storage of hazardous waste and for the recovery or a mix of recovery and disposal of >50 T/D non-hazardous waste involving treatment in shredders of metal waste. There are no Local Authority Pollution Prevention and Controls within 250m of the site.

Based on the Envirocheck Report 259487084 (Landmark Information Group, 2020d), there is no active Integrated Pollution Prevention and Controls (IPPC) within 250m of the Stonebridge Recreation Ground Site, the nearest IPPC is 381m south of the site which denotes an effective permit for treating vegetable raw materials for food. There are no Local Authority Pollution Prevention and Controls within 250m of the site.

3.5.3 Registered Radioactive Substances

Based on the Envirocheck Report 209140267 (Landmark Information Group, 2019b), no registered radioactive substances are recorded within 500m of the Tower. There is one record of a radioactive substance at 949m north; the status of this record indicates authorisation has been revoked or cancelled.

Based on the Envirocheck Report 244506740 (Landmark Information Group, 2020a), no registered radioactive substances are recorded within 500m of the Tower. There is one associated with St Charles Hospital, 800m north of the Tower and a further are sixty-two records of a radioactive substance on Du Cane Road associated with Hammersmith hospital and Imperial College from 1.5km north west of the Tower; the status of these records indicates authorisations have been revoked or cancelled, superseded by a substantial or non-substantial variation or replaced, authorised and any conditions apply to the operator or determined by the EA.

Based on the Envirocheck Report 244510776 (Landmark Information Group, 2020b), no registered radioactive substances are recorded within 500m of the Longstone Avenue Site.

Based on the Envirocheck Report 259484194 (Landmark Information Group, 2020c), there are fifty records of a radioactive substance between 419m south east and 478m south east of the Wormwood Scrubs Site; the status of these records indicate authorisations have been revoked or cancelled, superseded by a substantial or non-

substantial variation or replaced, authorised and any conditions apply to the operator, determined by the EA or replaced.

Based on the Envirocheck Report 259487084 (Landmark Information Group, 2020d), no registered radioactive substances are recorded within 500m of the Stonebridge Recreation Ground Site.

3.5.4 Hazardous Substances (COMAH) Facilities

Envirocheck Report 209140267 (Landmark Information Group, 2019b), indicated no records of COMAH facilities within 1km of the Tower.

Envirocheck Report 244506740 (Landmark Information Group, 2020a), indicated three records of COMAH facilities approximately 1.4km north of the Tower.

Envirocheck Report 244510776 (Landmark Information Group, 2020b), Envirocheck Report 259484194 (Landmark Information Group, 2020c) and Envirocheck Report 259487084 (Landmark Information Group, 2020d) indicated no records of COMAH facilities within 1km of the Longstone Avenue Site, the Wormwood Scrubs Site and the Stonebridge Recreation Ground Site.

3.6 Spillages, Accidents, Emergency Responses

Envirocheck Report 209140267 (Landmark Information Group, 2019b), Envirocheck Report 244506740 (Landmark Information Group, 2020a), Envirocheck Report 244510776 (Landmark Information Group, 2020b), Envirocheck Report 259484194 (Landmark Information Group, 2020c) and Envirocheck Report 259487084 (Landmark Information Group, 2020d) commissioned by AECOM indicate no records of spillages accidents or emergency responses within 1km of the Tower, the Longstone Avenue Site, the Wormwood Scrubs Site and the Stonebridge Recreation Ground Site.

3.7 Regulatory Actions

No land determined as contaminated under Section 78B of the Environmental Protection Act 1990 has been identified within 1km of the Tower, the Longstone Avenue Site and the Wormwood Scrubs Site based on the information provided in Envirocheck Report 209140267 (Landmark Information Group, 2019b), Envirocheck Report 244506740 (Landmark Information Group, 2020a), Envirocheck Report 244510776 (Landmark Information Group, 2020b) and Envirocheck Report 259487084 (Landmark Information Group, 2020d).

Seven areas of land determined as contaminated under Section 78B of the Environmental Protection Act 1990 have been identified within 1km of the Stonebridge Recreation Ground area based on the information provided in Envirocheck Report 259487084 (Landmark Information Group, 2020d).

Information provided to AECOM by RBKC indicates that there is not any land that has been determined as Contaminated Land within RBKC's boundary that lies within 500m of the Tower.

3.8 Previous Ground Investigations

As part of the background data review, a large number of historic site investigations were identified surrounding the site and the proposed Stage 2 sampling areas. A summary of the identified site investigations where testing for contamination was carried out was initially produced during Stage 1 in Technical Note TN10/12 (AECOM, 2019h). This summary was updated as part of the Stage 1 Review and data-gaps assessment to cover all proposed Stage 2 sampling areas, with the additional information covering all Stage 2 sampling areas included in **Tables B1** and **B2** in **Appendix B**.

During the review and summary process, analytical data from five site investigations completed in the investigation area were considered to be of particular use for comparison with analytical data collected during the Stage 1 and Stage 2 sampling. These areas included investigations at:

- Longstone Avenue allotments.
- St. Quintin's Family Centre.
- Avondale Park Primary School.
- Avondale Park.

- Multiple public open spaces within RBKC sampled by RBKC to provide a baseline for its Part 2A Inspection Strategy.

The data (for lead, PAHs and asbestos) and sample description information from these investigations are presented in **Table B1** and **Table B2** in **Appendix B**.

Although a much larger number of site investigations have been completed in the area surrounding the Tower, it was considered that detailed extraction of data for comparison with Stage 1 and Stage 2 sampling results would not be beneficial since the majority of site investigations tend to collect samples from deeper horizons than the primary target depth in the Grenfell Tower fire investigations. A high level review of additional site investigations around Grenfell Tower was completed as part of the Stage 1 reporting and was supplemented in the additional desk study described in **Section 2.5**.

3.8.1 RBKC Sampling in KALC Area, January 2021

Between 18th January 2021 and 18th February 2021 Curtins Consulting collected 109 soil samples from 55 sampling locations around the Kensington Academy and Leisure Centre (KALC) on behalf of RBKC in order to support the discharge of Planning conditions associated with the development of the KALC area. Samples were collected from depths ranging between 0.02m and 1.6m with the majority from the shallower end of this range, including 41 samples collected at depths of either 0.02m or 0.05m depth. Samples were analysed for a range of COPC including sulphate, total cyanide, total phenols, metals, chlorinated and brominated dioxins and furans, PCBs, asbestos, PAHs, total petroleum hydrocarbons (TPH), BTEX (benzene, toluene, ethylbenzene, xylenes) and MTBE. Formal reporting by Curtins for the completed investigation was still pending at the time of completion of this Stage 2 investigation report.

AECOM has reviewed the laboratory results from the sampling, which have been provided to AECOM by RBKC in the interim. A summary of the data is included in **Table B8** in **Appendix B**. Although the data have not been incorporated into the main assessments presented in **Section 6** and **Section 7**, AECOM has reviewed the data to determine whether it appears to be consistent with the data collected in the same areas (Tower cordon and Lancaster Green from Stage 1 and Stage 2 investigations) and therefore whether it is likely to be consistent with the conclusions drawn in this report.

Table B8 in **Appendix B** compares summaries of the Curtins data alongside similar summaries of the AECOM Stage 1 and Stage 2 data. The comparison shows that the concentration ranges and average concentrations for the COPC are very similar in the two data-sets and there is nothing in the Curtins data that would be expected to change any of the interpretation presented in this report. The greatest variability is for the brominated dioxins and furans data, with concentrations in the Curtins dataset appearing to be one to two orders of magnitude higher than the concentrations in the AECOM Stage 1 and Stage 2 dataset. It is not evident from the data alone why this might be. However, when evaluated using the dioxins, furans and dioxin-like PCB hazard index approach the higher concentrations reported by Curtins are of negligible significant in terms of health risk, with the highest Hazard Index (HI) for all Curtins samples being 0.09 compared to the target HI of 1.0 for a residential land-use scenario. On this basis it is considered that the conclusions drawn in this report are consistent with the data collected by Curtins.

3.9 Background Soil Chemistry

The Landmark Envirocheck reports for the Grenfell Tower (included in Stage 1 TN10/12 (AECOM, 2019h)and **Appendix L** of this report) provide an overview of the background urban soil chemistry for a small number of metal elements, including arsenic, cadmium, chromium, lead and nickel. The data presented in these maps is taken from British Geological Survey (BGS) Geochemical Baseline Survey of the Environment (G-BASE) and London Earth soil chemistry surveys (British Geological Survey, 2010). The BGS GBASE / London Earth sampling project only includes analysis of metals and hence there is no data-set for the other COPC from this source.

As part of the Stage 1 assessment, AECOM produced two technical notes related to urban soil pollution ('TN9: Published Data on National and Regional Urban Background Soil Concentrations' (AECOM, 2019c) and 'TN13: Potential Source Contributions to Urban Soil Pollution' (AECOM, 2019a)). TN9 identified a number of useful datasets for helping to define background soil concentrations, including the UK Soil and Herbage Survey (SHS) (Environment Agency, 2007a) (for metals, PAHs, dioxins and Polychlorinated Biphenyls (PCBs)), London Earth (British Geological Survey, 2010) (for metals, part of the BGS G-BASE survey as noted above), (Vane, et al., 2014) in the Greater London area (for PAHs and PCBs) and (Drage, et al., 2016) (for PBDEs and emerging flame retardants).

As part of the Stage 2 assessment, AECOM has purchased the licence for the BGS London Earth datasets in the area around Grenfell Tower and the background data for lead has been collated. The London Earth project is part of a nationwide project to determine the distribution of chemical elements in the surface environment, namely the Geochemical Baseline Survey of the Environment (G-BASE). Soil samples were collected at a density of four samples from every square kilometre and from a standard depth in the soil profile, 5cm – 20cm. Data for the other metals has not been used since the other metals were not identified as COPC during the Stage 1 assessment. The available lead background data has been plotted by AECOM and is presented on **Figure G46** in **Appendix G** encompassing the full investigation area.

For the UKSHS dataset the two nearest sample locations are Hyde Park and Richmond Park. Data from the Vane et al. paper are summarised in TN9 (AECOM, 2019c) but have not been plotted on AECOM figures for the Stage 2 assessment as the sample locations are within an area of East London at some distance from Grenfell Tower. However, the general characteristics of the (Vane, et al., 2014) dataset are considered to be useful for risk evaluation purposes.

The normal background concentrations (NBCs) (Johnson, et al., 2012) described in TN9 (AECOM, 2019c) are intended to be utilised in accordance with the Part 2A Statutory Guidance, which states that "*Normal levels of contaminants in soil should not be considered to cause land to qualify as contaminated land, unless there is a particular reason to consider otherwise."* The NBCs were derived by the BGS in associated with Defra with the explicit objective *"to give guidance on what are normal levels of contaminants in English soils in support of the Part 2A Contaminated Land Statutory Guidance"*. it is noted that the values are intended to be used on a 'national to regional scale' and they are derived mainly using the G-BASE (including London Earth) and SHS datasets described above for which AECOM has identified the specific samples local to Grenfell Tower. The NBCs have been calculated as the 95% upper confidence limit of the 95th percentile for each dataset and are therefore considered to be reasonable upper bounds on what can be considered a background level in soil.

The literature review reported in TN9 did not identify any sources of information for background soil concentrations of asbestos. Since completion of the Stage 1 assessment, SoBRA has published a paper 'The Distribution of Asbestos in Soil – what can the data mining of sample results held by UK laboratories tell us?' (SoBRA, 2020) and a paper 'Asbestos Contamination on Brownfield Development Sites in the UK' (Hellawell & Hughes, 2021)' has been published in Environmental Research.

(SoBRA, 2020) focused on gaps related to the risk management of asbestos in soil, such as the lack of a collective understanding on the typical background concentrations of asbestos in soil across the UK. As part of the work, anonymised data from five UK laboratories was reviewed.

The anonymised data collated from the five laboratories as part of the study indicated that:

- Asbestos is not detected in the majority of samples.
- The majority of asbestos that is detected is chrysotile.
- The majority of the reported concentrations of free fibres detected in soils are below the method reporting limit of 0.001%wt/wt.
- Anecdotal information from the industry suggests that asbestos is detected at the majority of brownfield sites that are investigated. This data suggests that, on average, asbestos is detected in a small (but nevertheless potentially significant) proportion of samples from those sites.

(Hellawell & Hughes, 2021) focuses on site investigations that included the collection of soil samples for asbestos contamination analysis. This project analysed the resource of brownfield asbestos data dated 2001-2019, using site investigation data from over 100 reports submitted to a local Borough Council, in Surrey, UK, focusing over 100 site investigation reports. Despite a high proportion of asbestos-containing samples containing more carcinogenic amphibole type, the results showed the asbestos concentrations to be very low, with 74% of samples having concentrations below the limit of detection of the laboratory and were predominantly of fibrous form. Most of the asbestos was found in the top 1m of made ground soil. Former gasworks were shown to have the highest asbestos detection rates.

3.10 RBKC Records of Soil Changes in Community Kitchen Gardens

RBKC provided information to AECOM regarding records of soil changes in the community kitchen gardens and in the parks. This information has been used for choosing appropriate sampling locations and for interpreting data where samples may have been collected from areas where soil changes have taken place.

Information for the community kitchen gardens included:

- Lancaster West, 2019: The soil located in the beds was completely replaced. Information subsequently provided by RKBC housing management (refer further below in this section) indicated that soil was not replaced in the beds that were sampled during Stage 2.
- St Charles Wellbeing Centre, 2019: The soil located in the beds was replaced to a depth of 8-10 inches.
- Whitstable House (Silchester East), 2019: The soil was completely replaced.
- Nottingwood House, 2019: The soil located in the beds was topped up as part of the regular programme.

Information for parks included:

- Avondale Park, December 2018: Wildflower soil was added at the park. Moreover, the soil in the Pottery Lane Planters (located adjacent to Avondale Park) was replaced due its poor soil quality.
- Kensington Green (Lancaster Green), December 2017-Spring 2021: New plants to be installed in the raised brick bed located at corner of Lancaster West adjacent to Bomore Road. Moreover, improvement works to be executed in the park, such as:
    - To add new bulbs to the existing borders, shrubs to the boundary planting, turf along the pathway of the park (0.6m width), and wildflower seeds.
    - To redefine the border edge of the park.
    - To cut some of the saplings.
- Kensington Memorial Park, Winter 2018 to September 2019: The soil quality of the football pitch was improved by bringing new sand and new soil. Moreover, a new drainage system was installed.

Information from RBKC housing management (updated October 2019 plans) included:

- Testerton, Barandon and Hurstway Walkways: The soil located in a number of beds has been replaced, however the sampling locations as part of Stage 2 were not located in these areas (six samples were from beneath areas of turf, and 4no. were from raised vegetable beds in which the soil had not been replaced since the Grenfell Tower fire).
- Talbot Grove House: The soil located in a number of beds has been replaced, however the Stage 2 sampling locations were not located in beds where the soil had been replaced (two samples were from beneath areas of turf, and four were from raised brick/vegetable beds in which the soil had not been replaced since the Grenfell Tower fire).
- Morland House: Information was provided indicating that the soil in a number of beds has been replaced, however these were not in areas which were sampled as part of the Stage 1 or Stage 2 investigation.

4. Conceptual Site Model

4.1 Introduction

The Conceptual Site Model (CSM) identifies the current source-pathway-receptor potential Contaminant Linkages (CLs) based on information about the Site's history, its environmental setting, evidence from previous ground investigations and the findings of the Stage 1 investigation. In this section the CSM covers the Tower itself, as well as the surrounding area that could potentially have been affected by the fire. It is intended to provide the basis for designing the quantitative stages of risk assessment, which evaluate each potential CL further to allow an assessment of the linkage significance with respect to the regulatory tests of "suitability for use" and "significant possibility of significant harm". The development of the CSM was primarily completed as part of the Stage 1 assessment in TN16: Preliminary Risk Assessment and the full development of the CSM has not been reproduced in this report.

The CSM was developed in the Stage 1 PRA to identify CLs that are considered to result in a reasonable possibility of a significant contaminant linkage (SCL). In accordance with the Statutory Guidance (Defra, 2012), an SCL is defined as a contaminant linkage which gives rise to a level of risk sufficient to justify a piece of land being determined as contaminated land.

The CSM developed as part of the Stage 1 PRA, and which identifies the CLs to be investigated further during the Stage 2 assessment, is summarised in **Table 2** below.

4.2 Summary Conceptual Site Model

Following completion of the PRA, a number of CLs were identified for which it was considered that there remains a reasonable possibility of a significant CL to human health. This indicates that further assessment should be considered in order to more reliably assess the potential significance of these linkages.

These linkages are summarised in Table 2 below and identify the potential SCLs that have been taken forwards for further assessment as part of the Stage 2 investigation. The PRA considered COPC that could have had their source as the Grenfell Tower fire and did not consider any other COPC that might be present in individual sampling areas caused by the land-use histories in individual sampling areas. This assessment therefore focusses on risks based on information from the Stage 1 and Stage 2 investigations and has not considered potential soil contaminants not directly associated with the fire that might also be present in soil as a result of historic land-use activities. However, the potential SCLs identified include COPC that may be fire-related but may also be related to other non-fire sources of contamination. The potential SCLs have been addressed in this report regardless of the source of the COPC in soil.

Table 2. Summary of Contaminant Linkages Investigated at Stage 2

Sources		Pathways		Receptors	
S1	Lead	P1	Ingestion of soil and indoor dust*	R1	Residents
		P2†	Inhalation of soil derived dust (indoor and outdoor) †	*R2*	*Visitors to the area*
		P3†	Dermal contact with soil (outdoor) †	*R5*	*Allotment holders*
		P4†	Dermal contact with soil derived dust (indoor) †		
		P5	Consumption of produce and attached soil		
S2	Genotoxic Polycyclic Aromatic Hydrocarbons (PAHs) and associated SVOCs (represented by BaP as a surrogate marker)	P1	Ingestion of soil and indoor dust*	R1	Residents
		P2†	Inhalation of soil derived dust (indoor and outdoor) †	*R2*	*Visitors to the area*
		P3	Dermal contact with soil (outdoor)	*R5*	*Allotment holders*
		P4	Dermal contact with soil derived dust (indoor)*		
		P5	Consumption of produce and attached soil		
S8	Asbestos	P2	Inhalation of soil derived dust (indoor and outdoor)*	R1	Residents
				R2	*Visitors to the area*
				R5	*Allotment holders*

† pathway included for completeness although not expected to be a significant pathway for risks to health as noted at Stage 1

[Those linkages that are greyed out are included on the basis of reducing uncertainty as opposed to the reasonable possibility of a SCL]

Those receptors in italics (R2 and R5) were not included in the final CSM in TN16 but have been added in to the CSM for Stage 2 on the basis that public areas have been selected for sampling as well as one allotments site. Note that the R2 – Visitors receptor group is expected to be at lower risk than R1 – Residents and the assessment of R2 is therefore covered by the assessment of R1 going forwards.

* in the context of a Part 2A contaminated land assessment indoor dust refers to dust generated by the tracking back of soil into a building rather than dust blown directly from Grenfell Tower during and after the fire. Outdoor dust is that derived from wind-blown soil rather than dust blown directly from Grenfell Tower.

In addition to the contaminant linkages identified in **Table 2**, linkages associated with the following COPC have been investigated to a lesser degree for the purposes noted below:

- Dioxins, furans and dioxin-like PCBs were included in the Stage 2 sampling scope as they were considered to provide a better potential marker of fire-related impact compared to lead and PAHs.

- Antimony was included in the Stage 2 sampling scope as it was identified as a COPC in the independent academic fire effluent literature review (Hadden & Switzer, 2020) the University of Edinburgh and University of Strathclyde review into fire effluent related contaminants.
- The full suite of COPC tested during the Stage 1 preliminary sampling was included in the Stage 2 scope at a small, specific group of sampling locations (Tower cordon, Longstone Avenue allotments and Stonebridge recreation ground) to close potential data-gaps associated with assessment of more distant transport from the Tower in the smoke plume and the more limited suite of COPC that had been tested in the samples collected within the Tower cordon as part of the Stage 1 investigation.

5. Stage 2 Sampling Investigation

This section sets out the details of the Stage 2 soil and crop sampling exercise, which was carried out in accordance with the final agreed detailed design for the Stage 2 assessment (AECOM, 2020).

5.1 Site Walkover

David Dyson and Katie Bruce of AECOM completed a walkover of the proposed sampling areas between the 18th and 26th August, and on the 7th September 2020, to identify potential problems with sampling in the proposed areas, plan logistics for the sampling event, and select specific sampling locations within each area.

The AECOM staff were accompanied by a representative from MHCLG. The project Suitably Qualified Person also visited and observed sampling activities on 24th August, when some of the walkover was also filmed by a member of the MHCLG team.

Relevant observations from the site walkover were included in the Stage 2 Detailed Design (AECOM, 2020), with the key observations that resulted in material changes to the design summarised in **Table 3** below.

Table 3. Site walkover observations

Sampling Area	Observation and Implication
Barlby Primary	Large section of the school site is cordoned off as a construction site, sampling to be carried out in the remaining Primary School area.
Silchester East	Additional Community kitchen garden area identified to the west of Whitstable House, beds heavily used. Location planned for some sampling.
Equal People	Informed of additional growing area used by Equal People at the St Charles Centre for Health and Wellbeing. Sampling to be carried out at both sites.
Darfield Way	No community kitchen garden, switched to play areas.
Robinson House	Full soil change in raised beds. Raised beds therefore excluded from sampling plan.
Wesley Square	Residents identified a small private garden, in direct line from Tower where soil unchanged, area added for sampling.

5.2 Sampling Areas and Locations

5.2.1 Location Rationale for Stage 2 Sampling

The 39 Stage 2 soil sampling areas identified on **Figure A2** in **Appendix A** (this figure also shows the Stage 1 sampling areas) were chosen by considering a number of factors described in the Stage 2 Detailed Design (AECOM, 2020). The areas include a combination of schools and nurseries, community kitchen gardens, allotments and public open spaces and that meet a combination of one or more of the following criteria:

- Land-uses of concern raised by residents and community representatives, particularly local schools and community kitchen gardens/allotments.
- Areas within the geographical extent that debris has been reported to have fallen during the fire.
- Areas within the Met Office modelled indicative smoke particle deposition plume, including the areas modelled with the highest particle deposition rates.
- Areas across a large enough geographical extent to evaluate any potential variation in soil concentrations correlated with distance from the Tower.

During the site walkover a number of the sites were identified as having crops which could potentially be viable for sampling and analysis.

The 39 areas chosen for soil sampling, and those identified on the walkover as being potentially suitable for crop sampling, are listed in **Table 4** below.

Table 4. Sample Areas

Area Type	Area Name (with potential crop availability)
Schools and Nurseries	**Latimer Alternative Provision Academy**
	Burlington Danes School
	Bassett House School (St Helen's Church)
	Thomas Jones Primary School
	All Saints Catholic College
	Barlby Primary School
	St. Francis Primary School - *Various fruit trees available*
	St. Anne's and Avondale Primary School and Nursery
	Oxford Gardens Primary School
	Golborne and Maxilla Children's Centre Forest School
	Grenfell Creche Under 3s' Centre / Grenfell Nursery
	New Studio pre-school
	St Quintin Children and Family centre
Community Kitchen Gardens and Allotments	**Longstone Avenue allotments** - *Various fruits and vegetables available*
	St Quintin Gardens - *Various fruits and vegetables available*
	St Charles Centre for Health and Wellbeing - *Various fruits and vegetables available*
	Equal People - *Various fruits and vegetables available*
	Portland Road and Nottingwood House - *Various fruits and vegetables available*
	The Grove *– no produce growing at time of visit. Beds reportedly not used so far during this growing season due to pandemic restrictions*
Combined Community Kitchen Gardens and Public Open Space	**Eynham Road Railway Land** - *Various fruits and vegetables available*
	Hurstway, Grenfell, Testerton and Barandon Walks (Lancaster Walkways) - *Various fruits and vegetables available*
	Henry Dickens Court - *Various fruits and vegetables available (however, crops could not be sampled due to access constraints at that time)*
	Silchester East - *Various fruits and vegetables available*
	Allom House and Barlow House - *Various fruits and vegetables available*
	Morland House and Talbot Grove House - *Various fruits and vegetables available*
	Bramley House - *Various fruits and vegetables available*
	Kensington Memorial Park *– no evidence of recent produce cultivation in beds and likely insufficient for sampling. Some small chard but possibly self seeded from previous year.*
	Treadgold House – *growing beds viewed from a distance therefore specific produce not identified. Use of beds appears to be relatively limited at the time of the site visit.*
Public Open Space	**Verity Close**
	Little Wormwood Scrubs Including Adventure Playground
	Darfield Way
	Lancaster Green
	Robinson House - *Various fruits and vegetables available, however it was reported by a local resident during the site walkover that there had been a full soil change since the fire. Therefore no plans to test produce from this location*
	Wesley Square
	Silchester West (North and North West area)
	Maxilla Walk - Maxilla Hall / Maxilla Green
	Stonebridge Recreation Ground

Area Type	Area Name (with potential crop availability)
	Wormwood Scrubs
Currently inaccessible public open space	**Tower cordon**

5.2.2 Selection of Sample Locations Within Each Area

In accordance with the Stage 2 Detailed Design (AECOM, 2020), ten individual soil sampling locations were chosen from each of the 39 sampling areas listed above. The only exceptions to this being Kensington Memorial Park, St Charles Centre for Health and Wellbeing, and Equal People. At Kensington Memorial Park 20 individual soil samples were collected; as this had originally been considered as two separate sites, which were then combined. St Charles Centre for Health and Wellbeing and Equal People are effectively one site utilised by the same group from Equal People, hence five samples were collected at each.

The precise sampling locations within each area were decided following the site walkover. The chosen locations avoided any hardstanding (paths, playground surfacing etc.), positions very close to trees (due to the possibility of tree roots near to surface), unsafe sampling positions (from heavy foot traffic), potentially intrusive or obstructive locations (such as directly outside windows/doors). The locations depended on the available space and the nature of usage. For some areas the locations were spread across the whole area to give general coverage, others were spread out within the available non hardstanding space. Some key areas such as vegetable beds were pinpointed due to their particular sensitivity.

The sampling locations within each area generally avoided individual private garden spaces, opting instead for the communal garden areas within residential areas. The only exceptions to this were within kitchen gardens and Longstone Avenue allotments where plots are rented to individuals, and in Wesley Square where one private garden was chosen for sampling due to its position directly in line and relatively close to the Tower.

The rationale for selecting each sample location are presented in Table 3 and Table 6 of the Stage 2 Detailed Design (AECOM, 2020). Any minor changes to the locations that were made for the final sampling location compared to the Detailed Design are listed in **Table B3** in **Appendix B**.

The sample depth was dependent on the observed ground surface, as detailed below:

- for turf and undisturbed ground, samples taken from 0m - 0.02m below ground level (bgl).
- for disturbed ground, samples taken from 0m - 0.05m bgl.
- for crop or vegetable growing areas, samples taken from 0m -0.2m bgl.

Samples from the raised beds at Bramley House were collected from slightly deeper to ensure that soil present in 2017 was sampled, following residents' information regarding the addition of soil on top.

At five areas a number of deeper samples were taken. For each deeper location a set of three samples were collected as follows:

- 0m - 0.02m (or 0m – 0.05m depending on ground cover as above).
- 0m - 0.2m.
- 0.5m - 0.6m.

Where the total depth was not achievable due to obstructions (Lancaster Walkways), water ingress (Longstone Avenue allotments) or reaching underlying hardstanding (St Quintin Community Kitchen Gardens), the sample was taken as close to the above depths as possible.

The selection of crop samples was based on the availability, permission being granted to harvest from the owner, the quantity available and the desire to obtain as many different crop types[2] as possible within each area. The root zone soil samples were collected wherever a crop sample had been harvested. The soil was collected from 0-0.2m bgl, as close to the plant as possible (without causing unnecessary damage to the roots).

[2] For the purposes of contaminated land assessment and the uptake of contaminants from soil, there are six different crop types with distinct contaminant uptake characteristics. These are: root vegetables, tuber vegetables, green vegetables, herbaceous fruit, shrub fruit, and tree fruit.

5.2.3 Sample Identification

The sample location IDs were prefixed 'GTCS 2' (Grenfell Tower Contamination, Soil – Stage 2) in accordance with the Detail Design (AECOM, 2020).

Each sample was then provided with a letter/word to signify the type of sample and a unique three digit identifying number. For each soil sample taken (not including root zone soil samples), a full additional set were collected for long-term storage.

The identification was as follows:

- GTCS2-S001a - for primary soil samples.
- GTCS2-S001b - for long term storage soil samples.
- GTCS2-P001 – for plant or crop samples.
- GTCS2-P001_soil - for the root zone soil sample from the crop sample of the same number.

The blind duplicate samples followed a similar pattern:

- GTCS2-Dup01a - for blind duplicate primary soil samples.
- GTCS2-Dup01b - for blind duplicate long-term storage soil samples.

The full listing for the soil samples collected giving their area, sample IDs, type, scheduled analysis, ground cover, rationale, and any changes from the Detailed Design (AECOM, 2020) are given in **Table B3** in **Appendix B**. The equivalent information for the crop and soil root zone samples are provided in **Table B4** in **Appendix B**. The locations of all Stage 1 and Stage 2 soil and crop samples are shown on **Figures E1 to E45** in **Appendix E**.

5.3 Stage 2 Sampling Dates and Personnel

5.3.1 Stage 2 Crop and Root Zone Soil Sampling

The crop and soil root zone sampling works were undertaken between the 24th and 30th September 2020. While this sampling had originally been intended to be part of the wider soil sampling exercise, the decision was made to move the crop and root zone sampling forwards by a month, to ensure that crops would still be available, before the end of the growing season.

The AECOM sampling team comprised Katie Bruce, Christopher Arkwright and Fraser Keith. The AECOM staff were accompanied by Lisa James from MHCLG.

5.3.2 Stage 2 Soil Sampling

The exploratory soil sampling works were undertaken between the 22nd October and 19th of November 2020.

The AECOM sampling team comprised Katie Bruce, David Dyson, Fraser Keith, Emma Toms, Giacomo Ciavatti, Beverly Okeke, Ian Muir, Jamie Charles and Mary Tsiropoulou.

MHCLG representatives were in attendance during the sampling. The project Suitably Qualified Person visited and observed sampling activities on 28th and 30th October and the 4th November 2020. An independent expert engaged by the Lancaster West Residents' Association on behalf of local residents, attended and observed the sampling works on 4th November 2020.

5.4 Summary of Crop and Root Zone Soil Sampling

A total of 59 crop samples were collected from fruit trees, vegetable growing beds and pots. The crop samples were collected from the areas listed below:

- St. Francis Primary School.
- Longstone Avenue allotments.
- St Quintin Kitchen Gardens.
- St Charles Centre for Health and Wellbeing.
- Equal People.

- Portland Road.
- Nottingwood House.
- Eynham Road Railway Land.
- Hurstway, Grenfell, Testerton and Barandon Walks (Lancaster Walkways).
- Silchester East.
- Allom House and Barlow House.
- Morland House.
- Talbot Grove House.
- Bramley House.

Samples were collected in the manner in which they would be expected to be collected for consumption at home i.e. the edible portion of the plant.

Immediately after harvesting each individual crop for analysis, a corresponding root zone soil sample was collected from a depth of 20cm bgl. For the purposes of contaminated land assessment and the uptake of contaminants from soil, there are six different crop types with distinct contaminant uptake characteristics. These are:

- Green Vegetables.
- Root Vegetables.
- Tuber Vegetables.
- Herbaceous Fruit (non wooded stems).
- Shrub Fruit (perennial woody).
- Tree Fruit.

During sampling the team endeavoured to collect as many different types of crop as possible from each of the sampling areas. Selected crop samples were then scheduled for laboratory analysis, along with the corresponding root zone sample. Details of the sample analyses are presented in **Section 5.7**. Scans of the signed Chains of Custody are presented in **Appendix K**.

Table B4 in **Appendix B** presents a summary of the crop and root zone soil samples taken, where they were taken from, sample ID code, crop species collected, crop type, sample weight, whether the sample was scheduled for analysis and any variations from the Stage 2 Detailed Design (AECOM, 2020).

Photographic logs and typed up sampling notes are presented in **Appendix F**.

5.5 Summary of Stage 2 Soil Sampling

Stage 2 Soil Sampling involved the collection of soil samples from the 39 Stage 2 sites listed in **Table 4** above. The samples were collected from a variety of different ground surface types, such as turf, disturbed bare soil, undisturbed bare soil, raised vegetable growing beds, and flower beds. The samples were collected from depths of between 0m - 0.02m bgl and 0.5m - 0.6m bgl, with the majority being from the shallower horizon. A total of 440 samples were collected for laboratory analysis along with 31 duplicate samples.

Table B2 in **Appendix B** presents a summary of the exploratory soil sampling for the 39 Stage 2 sites. The table provides details of the sample identification, duplicate samples, scheduled analysis, ground cover, rationale for that location, and any variations from the Detailed Design.

A photographic record of the sampling process, the soil logs and observations at each location is included in **Appendix F**.

5.6 Sampling Methodology

The sampling method was in accordance with the AECOM ‘Grenfell Stage 2 Soil Sampling Protocol’, the AECOM field procedure ‘Soil Sampling for volatile organic compounds (VOC) Analysis Using Methanol Preservation’ and the ‘Grenfell Stage 2: Crop Sampling Procedure’. The three documents are included in **Appendix D**.

Two full sets of sampleware were collected for each soil sample, with the sample ID on one set of sampleware appended with an 'a', and the sample ID on the second set of sampleware appended with a 'b'. This was undertaken in order to provide a complete sample (the containers appended 'b') for long-term storage at the laboratory.

During the sampling activities, a supply of cool packs was kept in a dedicated project freezer at the Grenfell Tower site office. Each morning, empty sample containers were stored in cool boxes along with frozen cool packs. Prior to sending samples to the laboratory using the laboratory organised overnight courier, fresh frozen cool packs were placed in the cool boxes to maintain a low temperature during transport. For any soil or crop samples gathered after the daily courier pick up, these were kept overnight in a dedicated project fridge at the Grenfell Tower site office. These samples were then sent by courier to the laboratory the following day, with further fresh frozen cool packs placed in the cool box immediately prior to the courier collection. Scans of the signed Chains of Custody are presented in **Appendix K**.

5.7 Analytical Testing

The soil samples collected as part of the Stage 2 sampling were scheduled for a range of predetermined analytical suites, detailed below.

Suite 1: PAHs; lead; asbestos (+ asbestos quantification where fibres are detected).

Suite 2: PAHs; lead; asbestos (+ asbestos quantification where fibres are detected); antimony; chlorinated dioxins & furans; brominated dioxins & furans; dioxin-like polychlorinated biphenyls (PCBs); total organic carbon (TOC).

Suite 3: Metals; volatile organic compounds (VOCs) + tentatively identified compounds (TICs), semi-volatile organic compounds (SVOCs) + TICs, PAHs, SVOC forensic scan, PCBs ('Dutch 7' congeners), chlorinated dioxins and furans, brominated dioxins and furans, dioxin-like PCBs ('WHO-12 congeners'), organophosphorous flame retardants; poly-brominated diphenyl ethers (PBDEs); poly-brominated biphenyls (PBBs); tetrabromobisphenol A; hexabromocyclododecane (1,2,5,6,9,10-); isocyanates; cyanides; TOC; asbestos (+ asbestos quantification where fibres are detected); synthetic vitreous fibres (SVF) / man-made mineral fibres (MMMF).

For Suite 3, the VOC sampling and analysis was carried out using two different methods. Following publication of the British Standard *BS10176 Taking soil samples for determination of volatile organic compounds (VOCs). Specification* in May 2020 (BSI, 2020), the sampling and analysis method that had been used for the Stage 1 sampling was supplemented with the updated method recommended in BS10176, which utilises a methanol preservative at the point of sampling to minimise volatile losses up to the point of analysis. For any samples requiring VOC analysis both methods were used so as to be compliant with the new British Standard but to also provide a comparison with the method used for the Stage 1 sampling.

Crop samples and their paired root zone soil samples were scheduled for analysis of PAHs and lead. The crop samples were prepared for analysis by the laboratory in the same manner that they would typically be prepared for home consumption.

Following initial review of the soil analytical data, a number of soil samples were additionally scheduled for bioaccessibility testing. Fifty soil samples (plus two duplicates) were analysed for lead bioaccessibility at Element using the BS ISO 17924:2018 method (BSI, 2018) (with minor adjustments to achieve stable pH). Ten soil samples were scheduled for PAH bioaccessibility testing using the FOREhST analytical method (Cave, et al., 2010).

Full details of the analytical methods, detection limits and laboratory accreditation are given in the Stage 2 Detailed Design (AECOM, 2020).

A summary of the total number of samples, broken down by depth intervals, scheduled for each of the analytical testing suites is provided in **Table 5** below.

Table 5. Sample quantities for each analytical suite

Analytical Suites	Sample Quantity and total from each depth in mbgl.
Soil Samples	
Suite 1	299 samples (*199 from 0m - 0.02m; 18 from 0m - 0.05m; 64 from 0m - 0.2m; 16 from 0.5m - 0.6m; 1 from 0.3m - 0.4m; and 1 from 0.15m - 0.34m);* plus 18 duplicates

Analytical Suites	Sample Quantity and total from each depth in mbgl.
	(11 from 0m - 0.02m; 1 from 0m - 0.05m; 4 from 0m - 0.2m; and 2 from 0.5m - 0.6m)
Suite 1 + TOC	37 samples *(30 from 0m - 0.02m; 2 from 0m - 0.05m; and 5 from 0m - 0.2m);* plus 1 duplicate *(1 from 0m - 0.2m)*
Suite 2	86 samples *(56 from 0m - 0.02m; 4 from 0m - 0.05m; 19 from 0m - 0.2m; 1 from 0.35m - 0.44m; 1 from 0.4m - 0.6m; and 5 from 0.5m - 0.6m);* plus 8 duplicates *(3 from 0m - 0.02m; 1 from 0m - 0.05m; 2 from 0m - 0.2m; 1 from 0.4m - 0.6m; and 1 from 0.5m - 0.6m)*
Suite 3	18 samples *(9 from 0m - 0.02m; 1 from 0m - 0.05m; 6 from 0m - 0.2m; 1 from 0.5m - 0.6m; and 1 from 0.5m);* plus 1 duplicate *(2 from 0m - 0.2m)*
Lead Bioaccessibility	50 samples (31 *from 0m - 0.02m; 4 from 0m - 0.05m; 13 from 0m - 0.2m; and 2 from 0.5m - 0.6m);* plus 2 duplicates *(1 from 0m - 0.02m and 1 from 0.5m - 0.6m)*
PAH Bioaccessibility	11 samples (5 *from 0m - 0.02m; 3 from 0m - 0.2m; and 3 from 0.5m - 0.6m);* plus 1 duplicate (*1 from 0.5m - 0.6m)*
Crop and Root Zone Samples	
PAHs and lead	35* crop samples 35 root zone soil samples – all collected at 0m - 0.2m depth

*35 of the 59 crop samples collected were selected for analysis to provide an appropriate number of different crop types and geographical spread around the investigation area to be able to meet the objectives of the health risk assessment. Remaining crop samples were retained at the laboratory for future use if necessary

The full list of samples and their associated analytical testing is included in **Tables B3** and **Table B4** in **Appendix B**.

5.7.1 Duplicates

A total of 31 blind duplicate samples were collected from 24 different areas during Stage 2 soil sampling as per the Detailed Design (AECOM, 2020).

The duplicate samples were scheduled for the same analytical suite as their corresponding primary soil sample in all cases except for GTCS2-Dup 25, which was scheduled for VOC analysis only.

The sample locations where the blind duplicates were collected, and their corresponding soil samples are summarised in **Table B5** in **Appendix B**.

5.7.2 Quality Assurance

The review and checking process for the Field Records was performed as per AECOM Field Procedure 'FP26 - Field Sampling and Laboratory Quality Assurance and Quality Control Procedures'.

The completed field records were checked by the originators on the day of the field work.

Review of field notes was completed as soon as possible for all locations by the sampling manager Katie Bruce. The review included performing a detailed check of field data sheets for completeness and accuracy.

5.8 Summary of Ground Conditions

Table B6 in **Appendix B** presents a summary of the soil descriptions and observations for Stage 2 sampling. The table separates out the different types of surface cover encountered, such as raised beds, vegetable growing beds,

turf, roughly vegetated ground and flower beds and bare soil, and the soil encountered within each surface cover type is summarised.

The full description and sampling notes for each sampling location and a photographic log is presented in **Appendix F**.

Table 6 presents a summary of the visual observations of potential sources of COPC (such as ash, coal, clinker and potential cladding) for the Stage 2 Soil Sampling. Only observations of potential sources that might be related to the Stage 2 COPC (metals, PAHs, dioxins and furans, and asbestos have been included).

Table 6 Visual Observations of Potential Sources of COPC

Sample Location Area	Figure Ref.	Sample location	Depth (m)	Observed Potential Sources of COPC
Area 1: Latimer Alternative Provision	E1	GTCS2 S004	0 - 0.02	Rare charcoal
		GTCS2 S005	0 - 0.05	Charcoal
Area 3: Bassett House School	E3	GTCS2 S024	0 - 0.02	Occasional charcoal
Area 11: Grenfell Nursery	E11	GTCS2 S104	0 - 0.02	Occasional tarmac
		GTCS2 S105	0 - 0.02	Occasional fine gravel possibly charcoal
		GTCS2 S110	0 - 0.02	Occasional tarmac
Area 13: St Quintin Children and Family Centre	E13	GTCS2 S129	0 - 0.02	1cm potential ash fragment (black)
Area 14: Longstone Allotments	E14	GTCS2 P007 soil	0.2	Possible ACM
		GTCS2 P009 soil	0.2	Ash fragments
		GTCS2 S138	0 - 0.6	Occasional charcoal
Area 15: St Quintin Kitchen Garden	E15	GTCS2 S142	0.3 - 0.4	One piece bituminous coal
		GTCS2 S146	0.4 – 0.5	Rare charcoal
Area 18: Portland Road	E18b	GTCS2 P030 soil	0.2	Possible clinker
Area 19: The Grove	E19	GTCS2 S177	0.2	Ash and clinker
		GTCS2 S180	0 – 0.2	Clinker
Area 20: Eynham Road Railway Land	E20	GTCS2 S182	0 – 0.6	Anthracite and charcoal
		GTCS2 S184	0 – 0.2	Coal fragments
		GTCS2 S186	0.5 – 0.6	Occasional charcoal
Area 21: Hurstway, Grenfell, Testerton and Barandon Walks (Lancaster Walkways)	E21	GTCS2 P042 soil	0.2	Coal fragment
		GTCS2 S195	0.5 - 0.6	Occasional charcoal

Sample Location Area	Figure Ref.	Sample location	Depth (m)	Observed Potential Sources of COPC
		GTCS2 S199	0 - 0.2	Burnt / bubbly / kiln brick
Area 24: Allom House and Barlow House	E24	GTCS2 S222	0 - 0.02	Occasional charcoal
		GTCS2 S226	0 - 0.2	Occasional charcoal
		GTCS2 S227	0 - 0.2	Occasional charcoal
		GTCS2 S228	0 - 0.2	One piece charcoal
Area 25: Morland House and Talbot Grove House	E25a and E25b	GTCS2 P061	0.2	Coal / charcoal
		GTCS2 S233	0 - 0.2	One fragment charcoal
		GTCS2 S236	0 - 0.2	Occasional tarmac
		GTCS2 S239	0 - 0.02	Occasional charcoal fragments
Area 27: Kensington Memorial Park	E27	GTCS2 S253	0 - 0.02	Clinker
		GTCS2 S261	0 - 0.02	Tarmac
Area 31: Darfield Way	E31	GTCS2 S308	0 - 0.02	Tarmac fragments
Area 32: Lancaster Green	E32	GTCS2 S311	0 - 0.02	Occasional charcoal
		GTCS2 S313	0 - 0.02	Rare charcoal
			0 – 0.2	Four ‘kiln baked / charred’ bricks
		GTCS2 S314	0 - 0.02	Occasional charcoal
		GTCS2 S317	0 - 0.2	Charcoal and burnt wood
		GTCS2 S319	0 - 0.02	Occasional charcoal
		GTCS2 S320	0 - 0.02	Occasional charcoal
Area 33: Robinson House	E33	GTCS2 S322	0 - 0.02	Occasional charcoal
Area 34: Wesley Square	E34	GTCS2 S331	0 - 0.2	Two pieces of ash (honeycomb texture) orange and black
		GTCS2 S333	0 - 0.2	Metal rod (10cm)
		GTCS2 S334	0 - 0.02	Piece of black ash (~ 3cm)
		GTCS2 S335	0 - 0.05	Possible ash (~1cm) red fragment with honeycomb texture
		GTCS2 S336	0 - 0.02	Possible ash fragments (up to 1cm) dark grey / black
		GTCS2 S339	0 - 0.02	Possible piece of grey ash (~3cm) with honeycomb texture

Sample Location Area	Figure Ref.	Sample location	Depth (m)	Observed Potential Sources of COPC
		GTCS2 S340	0 - 0.02	Potential dark grey ash fragments (~ 0.5 - 1cm)
Area 37: Stonebridge Recreation Ground	E37	GTCS2 S370	0 - 0.02	Occasional charcoal
Area 39: Tower Cordon	E39	GTCS2 S381	0.5 - 0.6	One kiln brick
		GTCS2 S382	0 - 0.02	Occasional charcoal fragments
		GTCS2 S383	0 - 0.02	Melted metal fragments
		GTCS2 S384	0 - 0.02	Piece of metal (probable cladding) and charcoal
		GTCS2 S385	0 - 0.1	Metal fragments up to 6cm
		GTCS2 S386	0 - 0.02	Metal fragments at surface (1 – 7cm) (probable cladding /debris)
		GTCS2 S387	0 - 0.02	Metal fragments (thin, bent, melted) at surface (1 – 5cm) (probable cladding /debris)
		GTCS2 S388	0 - 0.02	Two pieces thin metal (2cm)

5.9 Laboratory Analysis Results

The laboratory results are presented in the analytical test certificates included in **Appendix K**.

Test methods and the accreditation status of each analysis were as per the Detailed Design (AECOM, 2020) and are also included within the laboratory analytical certificates presented in **Appendix K**.

The primary analytical laboratories were:

- For all crop and selected soil: Fera Science Limited (Fera), National Agri-Food Innovation Campus, Sand Hutton, York, YO41 1LZ. UKAS Accreditation No. 1642.
- For majority of soil: Element Materials Technology (Element), Unit 3 Deeside Point, Zone 3 Deeside Industrial Park, Deeside, CH5 2UA, UKAS Accreditation No. 4225.

Analyses sub-contracted by Element were completed by two additional laboratories:

- Marchwood Scientific Services Ltd - 371 Millbrook Rd W, Southampton SO15 0HW, UKAS Accreditation No. 1668.

  Chlorinated dioxins and furans and dioxin-like PCBs.

  Brominated dioxins and furans.
- RPS Mountainheath Limited – 13 St. Martins Way, Bedford, Bedfordshire, MK42 0LF, UKAS Accreditation No. 1663.

  organophosphorous flame retardants.

  Poly-brominated diphenyl ethers (PBDEs)

  poly brominated biphenyls (PBBs).

  Tetrabromobisphenol A.

  hexabromocyclododecane (1,2,5,6,9,10-).

5.9.1 QA/QC

A Data Validation Summary Report (DVSR) has been completed in accordance with the AECOM standard procedures. The completed DVSR is included in **Appendix K** and concludes that the analytical data received for the exploratory samples is suitable for interpretation, with the following minor comment:

- Initial QA/QC assessment of the data identified 33 samples recorded a surrogate recovery with a 'variation of >30% or being outside of the lab LCL or UCL calibration range'. No samples were identified below the requirement for a manual data check of 30% recovery and all were above the unacceptable data range of <10% recovery.
- Of the 33 samples the majority of entries related to Surrogate Recovery percentage with eight associated with the percentage recovery for 4-Bromofluorobenzene, and one entry each associated with Toluene-d8 and p-Terphenyl-d14. In the case of 4-Bromofluorobenzene these entries related to testing method 'TM15'[3], with each sample having a secondary 4-Bromofluorobenzene entry under the 'TM152'[4] method which was within the acceptable range. The p-Terphenyl-d14 entry was reported at >100%, suggesting potential over-reporting of concentrations rather than under-reporting. This indicates improved recovery of the surrogate compounds using the methanol preservative VOC analytical method.

The surrogate recovery results are associated with a small number of VOC analyses and would normally indicate that some additional care be taken when quantitatively evaluating the results. However since the surrogate recoveries do not fail the unacceptability limits, the data are considered to be suitable for interpretation. In addition, as VOCs were very rarely detected in samples – and where they were all concentrations were lower than the GSC (refer to **Section 6** and **Section 7**) – the slight variability in concentrations indicated by variability in a small number of surrogate recoveries is not considered to be significant.

The analysis of metals is usually completed by first drying and crushing the sample before extraction for analysis. However, when asbestos is identified in the 'as received' sample, the laboratory does not dry and crush the sample as part of the preparation method to avoid the potential for exposure the laboratory analysts to asbestos fibres. This means that the sample is not prepared in the manner consistent with the laboratory accredited method; however the analytical method is the same as that used for the accredited analysis and undergoes the same internal laboratory QA/QC checks including process blanks, calibration checks and detection limit checks. The data are therefore considered suitable for interpretation.

5.9.2 Duplicates

The evaluation of the data quality results is determined using duplicate samples submitted to the lab. The results from duplicate samples are used to calculate the Relative Percent Difference (RPD), which is defined as:

$$RPD = 200\frac{(x_1 - x_2)}{(x_1 + x_2)}$$

- where x_1 and x_2 are the values of the concentration obtained for an analyte x in duplicate samples, and $(x_1 - x_2)$ is the absolute difference of x_1 and x_2.
- Of the 31 duplicate samples collected, 28 were analysed. The laboratory was not informed of the location from which the duplicate samples were taken. The RPD 'limits' adopted in this investigation were:
- If the value is <10x the laboratory method reporting limit, then the RPD should be <80%.
- If the concentration is between 10 and 20x the laboratory method reporting limit, then the RPD should be <50%.
- If the concentration is >20x the laboratory method reporting limit, then the RPD should be <30%.

Based on this, the RPDs for the analysed duplicate samples were considered. The duplicate sample assessment is presented in **Table B7** in **Appendix B**. It was identified that for the main COPC (lead, benzo(a)pyrene) the RPDs were all acceptable except for 2 samples for lead (GTCS2-S139A/DUP08A and GTCS2-S313A/DUP19A) and 3 samples for benzo(a)pyrene (GTCS2-S139A/DUP08A, GTCS2-S249A/DUP15A and GTCS2-S366A/DUP22A).

[3] Modified USEPA 8260B v2:1996. Quantitative Determination of Volatile Organic Compounds (VOCs) by Headspace GC-MS.
[4] Modified USEPA 8260B v2:1996. Quantitative determination of Volatile Organic Compounds (VOCs) by Headspace GC-MS on methanol preserved samples

GTCS2-S139A (DUP08A), GTCS2-S249A (DUP15A) and GTCS2-S366A (DUP22A) all had 13 compounds for which the RPD was considered 'high', however considering the number of samples analysed, this is a low proportion of the total, and therefore the data is considered acceptable for interpretation.

In total there were 9 of 22 duplicate samples for which the RPD for occasional individual chemicals was considered 'high'. For the majority of the high RPDs identified, these were isolated occurrences, suggesting that the analytical methods do not have any systematic, repeated variability. This includes:

- There was one sample (GTCS2-S313) for which there was a high RPD noted for asbestos, however this is not considered significant, as asbestos fibres present may have been distributed differently throughout the sample (both the original and duplicate sample noted the presence of asbestos).
- There were six samples for which there was a high RPD for a single PAH compound and one sample for which there was a high RPD for three PAH compounds – the specific PAH compounds varied between these samples (e.g. naphthalene, chrysene, phenanthrene and fluoranthene).
- Lead – only two samples out of 28 had a high RPD for lead. In sample GTCS2-S313, metal fragments are noted in the description, therefore it is likely that the heterogeneity of the sample implied by the presence of visible fragments of anthropogenic material is responsible for the varying concentrations.
- Antimony – there was one sample (GTCS-S001) for which there was a high RPD for antimony.

For four of the samples which have 9 or more high RPDs for the PAH compounds, these correspond to samples which have high total PAH concentrations (i.e. higher than 15mg/kg).

Across the samples, there is no single compound which consistently reports high RPDs, therefore the high RPDs observed appear most likely to correspond to natural variation within the samples, and not a systematic issue with the laboratory testing. Therefore, the data is considered to be suitable for use for interpretation.

5.9.3 VOC Analysis Methods

During the investigation, two different methods of analysing for VOCs were used. The two different methods were the 'Standard' VOC method, and the BS10176 method (BSI, 2020) VOC which uses methanol preservation of the samples in the field. Samples from 18 sample locations were analysed using both of these methods, and the results obtained were compared. The observations are discussed below.

It was identified that the Standard VOC method has a lower laboratory detection limit than the methanol preservation method for the majority of VOC compounds. This means that in some instances, VOC compounds were detected using the Standard method, but not using the methanol preservation method. For example:

- Chloromethane was detected in samples GTCS2-S131A, GTCS2-S133A, GTCS2-S135A, GTCS2-S137A (at concentrations of 7, 7, 9 and 4µg/kg respectively) when using standard VOC method. However, these concentrations would have been too low for the methanol preservation method to detect this compound (as the methanol preservation method limit of detection is <50µg/kg).

Therefore, the standard method which has been used throughout Stage 1 and Stage 2 of the investigation could be considered advantageous, as it would report lower levels of the contaminants than the methanol preservation method. On this basis the results presented in **Tables J1 to J46** in **Appendix J** are based on the standard method rather than the methanol preservative method.

There were a couple of instances where compounds were detected using the methanol preservation method, but not using the standard method, for example:

- Naphthalene in samples GTCS2-S133A and GTCS2-S137A were reported as 133µg/kg and 71µg/kg respectively using methanol preservation method, but this compound was not detected in the same samples tested using the standard method (<27µg/kg).

However, as the concentrations detected are 2 or more orders of magnitude lower than the screening criteria values (13mg/kg and 24mg/kg), then this is not considered to be significant to interpretation of the data.

5.9.3.1 Surrogate Recovery – comparison of the two different VOC methods

It was identified that the surrogate recovery of Toluene & 4-Bromofluorobenzene was typically higher for the methanol preservation method than for the standard method, which could suggest a more accurate result is obtained using the methanol preservation method. However, all surrogate recovery values for both methods are considered acceptable for the interpretation of this data.

5.9.4 Fera analysis QA/QC

For the samples analysed by Fera Science Ltd, a reference material was used to determine the uncertainty in the results. Samples submitted to Fera for analysis included crop (fruit and vegetable) samples and associated soil samples.

The reference material used was Standard Reference Material (SRM) 1944 for the soil samples analysed for PAHs and lead. For the crop (fruit and vegetable) samples, the reference material used was T0658 Cocoa butter.

Fera Science Ltd (Fera) reported variability in the reported concentrations of PAHs in fruit and vegetables as less than 10% of the Batch Reference Material Value. This is within an acceptable level of variation in accordance with Fera's QA/QC protocols. For PAHs in soils, the variability was found to be less than 10% of the SRM value except for three compounds (benzo(b)fluoranthene, benzo(j)fluoranthene and dibenzo(ah)anthracene). The PAH uncertainty data are provided in **Appendix K.**

The soil results from samples analysed by Fera were compared to nearby samples analysed by Element: the results were found to be similar and within the expected range of variability for separate samples collected from similar soils. Two examples are included in **Appendix K** to illustrate this.

For PBBs in soil, as advised by Fera, the results for PBB-15 have been treated as indicative due to its low extraction from samples caused by its higher (than the other PBB compounds) volatility. Two of the 18 results for PBB-209 could not be reported due to analytical failures. Taken alongside the availability of data that passes the Fera QA/QC process for four other PBB compounds in all 18 samples, the limitations in the data for PBB-15 and PBB-209 are not considered to affect the data interpretation for this report, noting that where PBB concentrations were detected above the laboratory detection limit, the reported concentrations were between two and four orders of magnitude lower that the health risk-based screening criteria.

5.9.5 Lead Analysis – GTCS2-P012

When analysed for lead, the sample GTCS2-P012 returned a result of 14,200mg/kg. This appeared to be anomalous, therefore the lab was asked to re-test the same sample for lead. The result of the re-test was 184mg/kg.

The result from the re-test is more consistent when compared with the other samples analysed from this site, for example the next nearest soil sample collected from this area was GTCS2-S137, which reported a lead concentration of 216mg/kg. The maximum concentration amongst the other soil samples collected from the same sampling area was reported as 589mg/kg (in GTCS2-S134A at 0-0.2m bgl).

However, the laboratory could not identify any specific analytical problems or concerns with the original reported concentration of 14,200mg/kg and both concentrations have been considered where appropriate in the data interpretation.

6. Assessment of Potential Evidence for Fire-related Contamination

One of the key objectives of the Stage 2 investigation was to determine so far as possible the geographical extent of any significant contamination caused by the fire whilst recognising the potential for underlying (pre-fire) contamination from other sources.

The approach to this has been to:

1. Review the Stage 1 and Stage 2 datasets to identify the presence or absence of potential fire-related COPC;
2. Compare Stage 2 COPC concentrations detected in soil samples based on differing depth, differing ground cover (i.e. turf vs. bare soil) and the split between raised bed planter and ground level soils, to identify patterns that could match with the conceptual model of aerial deposition of debris, soot and ash;
3. Plot Stage 2 COPC concentrations on maps to ascertain spatial distribution patterns that could match with the deposition of debris, soot and ash;
4. Plot Stage 2 COPC concentrations on a graph to show variations in concentrations with increasing distance from the Tower;
5. Compare Stage 2 COPC concentrations with available background ranges, using maps, graphs and dataset statistics; and
6. Compare Stage 2 COPC concentrations with published criteria associated with health protection.

The information presented in this way has been evaluated taking into account potential sources of historic contamination, baseline data from site investigations carried out in the area under investigation before the Grenfell Tower fire, and generic screening criteria (GSC) that represent soil concentrations that define a level of health risk that would cause land to meet the definition of Category 4 (i.e. low to no risk). Full details of the GSC are presented in **Section 7**.

6.1 Presence of Fire-related COPC

The full Stage 1 and Stage 2 analytical results are presented in **Table J46** of **Appendix J**. **Table 7** below summarises the results in terms of the main COPC groups and their presence or absence in soil in the areas sampled.

Table 7. Detections of COPC

COPC Group	Discussion
Metals	Metals were detected in all soil samples. However, the analysed metals would be expected to be present in urban soils either as naturally occurring mineral species or from historic anthropogenic sources. Further evaluation is required to identify any potential evidence of metals impact from the fire and since lead and antimony were specifically identified as potential fire effluents and were analysed as part of the Stage 2 sample testing these two metals have been taken forward for further assessment of potential fire related impact.
PAHs	PAHs were detected in all soil samples and are an expected fire-effluent. However, PAH compounds would also be expected to be present in urban soils either from diffuse urban air pollution or from historic anthropogenic sources. Further evaluation is required to identify any potential evidence of PAH impact from the fire.
SVOCs (other than PAHs)	Phenolic compounds were reported in 7 of 86 samples tested and phthalates were reported in 63 of the 86 samples. These compounds have been picked up as part of the standard SVOC suite analysis but were not specifically identified as potential fire effluents in the Stage 1 review or by the independent fire chemistry review. They are most likely to be related to historic land-uses and have not been prioritised for assessment potential fire related impacts. Phthalates are present in commonly used plastics and therefore their presence in soil could be associated with presence of discarded plastics in the urban environment. Phenolic compounds are large group of compounds associated with both man-made chemicals and with their ubiquitous (natural) presence in plant tissue. The presence of low levels of phenolic compounds in organic soil is therefore expected. A range of other SVOCs were reported sporadically in soil samples, with the large majority of these either related to the PAH group of compounds or other hydrocarbon compounds and most likely associated with impacts from historic

COPC Group	Discussion
	land uses. The evidence for these compounds being widespread fire effluents is therefore weak and does not warrant further assessment.
VOCs	Of the VOC suite of compounds, only benzene was identified at Stage 1 as a potential COPC from fire effluents. Benzene was identified in one of 86 samples and is also encountered occasionally in urban soils from historic land uses and other current sources (e.g. petrol). Therefore there is no evidence from Stage 1 that it is a COPC related to the Grenfell Tower fire that has remained in soil. Further assessment is therefore not warranted.
Chlorinated dioxins, furans and dioxin-like PCBs	This group of compounds is an expected fire effluent and was reported in all soil samples. However, these compounds are also expected to be present in urban soils from historic anthropogenic sources. Further evaluation is required to identify any potential evidence of dioxins, furans and dioxin-like PCB impact from the fire.
Non dioxin-like PCBs	These compounds were detected in 11 of 82 samples, although all samples were located within Waynflete Square. Since dioxin-like PCBs were not identified as a main fire effluent COPC at Stage 1 or by the independent review, and given the clustered nature of the detections in a single sampling area, it is likely that their presence is related to historic non-fire sources. Further assessment of these compounds as fire effluents is not warranted.
Brominated dioxins and furans	These compounds were detected in 132 of 163 samples. They have been identified as potential fire effluents but are also expected to be present to some extent in urban soils associated with historic contamination and diffuse urban pollution in a similar manner to the chlorinated dioxins and furans. However there is a much more limited dataset for understanding the background levels of the brominated dioxins and furans in urban soils and therefore the chlorinated dioxins and furans have been prioritised ahead of the brominated compounds to further evaluate the potential for release of these types of compounds from the Grenfell Tower fire.
Organophosphorous flame retardants Triphenylphosphate Tris(1-chloro-2-propyl)phosphate Tris(2-ethylhexyl) phosphate	Organophosphorous flame retardants were identified in 8 of 86 samples, from sampling areas Portland Road CKG, Silchester East, Bramley House and the Tower cordon (4 of 18 sampling locations). The limited detections of these compounds and the sporadic nature of these detections suggests that the fire has not caused increased soil concentrations of these compounds, since there are sampling areas close by to these areas where these compounds were not detected (e.g. Lancaster West Walkways and Treadgold House close to Tower cordon, and Waynflete Square close to Bramley House). In addition, Portland Road CKG is to the southeast of the Tower and in an area that might be expected to be least affected (of all the sampled areas) by the fire. Because the detected concentrations are far lower than the GSC (refer to **Section 6.7**), further assessment of these compounds as fire effluents is not warranted.
Brominated flame retardants poly brominated diphenyl ethers (PBDEs) poly-brominated biphenyls (PBBs) tetrabromobisphenol A hexabromocyclododecane (1,2,5,6,9,10-)	PBDEs, tetrabromobisphenol A and hexabromocyclododecane (1,2,5,6,9,10-) were not detected in any of the 82 samples analysed. Of the PBBs, PBB-15 was detected in 12 of 82 samples. All 12 detections were from Longstone Avenue allotments and Stonebridge Recreation Ground; however, only these two areas plus the Tower cordon were tested at the lower detection limit. All detections were lower than the higher detection limit used during Stage 1. This significant restriction in the dataset coupled with the fact that the detected concentrations are lower than the GSC (refer to **Section 6.7**) means that PBBs have not been prioritised as a COPC for further assessment of potential fire related impacts.
Isocyanates	Isocyanates were not detected in any of the 82 samples tested for this group of compounds. There is no evidence from the sampling of fire-related impacts from this group of compounds, and further assessment of this group of compounds is not warranted.
Cyanides	Cyanide compounds were detected in 33 of 82 samples, although free cyanide was only detected in one sample from Morland House. Thiocyanate was reported in 50 of 82 samples. Although cyanide compounds were identified as potential fire effluent related COPC, they are also often encountered in urban soils related to contamination from historic land-uses. Compared to metals, PAHs and chlorinated dioxins, furans and dioxin-like PCBs, there is not a good background or baseline dataset for cyanides in urban soils. The detected concentrations in soil might (in part) be associated with the release of HCN during the fire but because the detected concentrations are far lower than the GSC (refer to **Section 6.7**) these compounds have not been prioritised for further assessment of fire-related impact.
Asbestos	Asbestos has been detected above the HSE definition of trace (i.e. more than two fibres detected based on a qualitative inspection of the soil sample) in 42 of the 502 samples screened for the presence of asbestos across both the Stage 1 and Stage 2 sampling. However, asbestos is also expected to be present in urban

COPC Group	Discussion
	soils from historic anthropogenic sources. Further evaluation is required to identify potential evidence of asbestos impact from the fire.
Synthetic vitreous fibres (SVF) / man-made mineral fibres (MMMF).	SVFs were detected in 18 of 64 samples analysed. The laboratory testing capability for SVFs is a presence / absence screen only and the sporadic nature of the unquantified detections from Stage 1 sampling does not provide a good dataset for further evaluation of the potential for fire-related impact. Although there is little information related to the background presence of SVFs in urban soils, it is expected that they would be present in much the same way that asbestos is present given the use of these fibres in building and construction materials.

Based on the discussion above, the following COPC are addressed in more detail below to evaluate the potential for evidence of fire-related impact.

- Metals: lead and antimony;
- PAHs: using BaP as a marker compound;
- Chlorinated dioxins and furans;
- Dioxin-like PCBs; and
- Asbestos.

6.2 Comparison of Sub-sets of Stage 2 COPC Data

To compare data sub-sets against each other and against either health risk based or background criteria, AECOM has considered the use of the recent CL:AIRE 2020 statistical guidance (Marriott, 2020) as this is the most recent UK-based guidance designed for comparing soil concentrations with critical concentrations. This guidance requires the soil dataset being investigated to satisfy a number of conditions for the use of this statistical assessment to be strictly valid. Overall, the full dataset collected as part of the Stage 2 investigation does not meet the conditions for explicit use of the guidance on the basis that:

- Sample locations have not been chosen using simple random, stratified random or stratified systematic sampling patterns due to the targeted nature of the sampling areas;
- Samples are highly clustered within sampling areas;
- Statistical testing using Rosner's and Dixon's outlier tests suggest the possible presence of outliers;
- Samples are from varying depths and may not be from the same material (e.g. ground level soils versus raised beds); and
- Spatial trends and patterns in the data are likely to exist either due to fire-related deposition patterns, or if no fire-related deposition patterns are identified, due to varied historic land uses in the different sampling areas.

Given the above, this guidance is not strictly applicable for the full dataset and so a simpler approach to the statistical comparison of the datasets has been taken. The first task has been to split the data so that samples from the same depths are grouped together and samples from the same soil types are grouped together. This has been done as follows:

- **Sample depth**: soil samples have been predominantly collected at 0-2cm, 0-5cm, 0-20cm, 10-15cm, 50-60cm. Due to restrictions caused by localised ground conditions, a small number of samples were collected from slightly different depth ranges including 15-35cm, 30-40cm, 35-44cm, 40-50cm and 40-60cm. The sample depths chosen as sub-sets for assessment were 0-2cm, 0-5cm, both 0-2cm and 0-5cm combined, all 0-20cm samples; and all 50-60cm (plus 40-50cm and 40-60cm sample) samples. The 10-15cm samples were not assessed as they all came from a single area – Waynflete Square – which was evaluated as part of Stage 1. The other intermediate depth samples (15-35cm, 30-40cm and 35-44cm) were excluded from the analysis due to being a small number of isolated occurrences.
- **Ground cover**: samples were collected either from beneath grassed areas, or from bare soil areas. The bare soil areas were categorised as either disturbed or undisturbed with disturbed soil being either from crop growing beds or flower beds that were likely to be routinely turned over for planting annuals. The data split adopted was to separate the samples collected from turfed/grassed areas from those located on bare soils on the basis of a potentially significant difference in COPC being entrained within the soil where debris, soot

or ash fell onto grass or turf compared to where it fell directly onto bare soil. Only samples from 0-2cm and 0-5cm was used for this assessment as these were considered the most likely to be affected by the aerial deposition.

- **Raised beds**: samples were either collected from ground level soils or from raised beds designed specifically for cultivating homegrown produce in community kitchen gardens. Soil replenishment is expected to be more likely in the raised beds giving rise to different soil origin and time in-situ. The data split adopted was to separate those samples collected from raised beds from those samples collected from ground level soil on the basis that there may be significant differences in the source of the soils in raised beds e.g. they could be imported from specialist supply sources.

The basis for placing each sample into one of these categories is the observations and best judgement made by the team at the time of the sampling. This information is presented in **Appendix F**.

Splitting the data using these characteristics was considered most likely to provide information related to potential fire-related impact with higher concentrations in shallower samples a potential indicator of aerial deposition, higher concentrations in bare soil potentially indicating an aerial deposition source, and differences in ground level samples compared to raised beds a potential indicator that non-fire related impact is the more dominant control on soil concentrations.

Although breaking the data down in this way helps to resolve some of the limitations on using the CL:AIRE 2020 statistical guidance, there are still a number of factors that mean the guidance is limited in its use here.

Normality testing has indicated that all evaluated datasets were unlikely to be normally distributed, (with a less than 5% probability that the underlying population is normally distributed). In addition, potential outliers have been identified in all datasets using Rosner's or Dixon's outlier tests. Without a detailed interrogation of each of the higher concentrations that could be potential outliers (or could be part of the same data population), a commonly adopted method to easily compare right-skewed datasets is to compare the median (50th percentile) rather than the arithmetic mean; the median is less affected by the most extreme high concentrations in the right-skewed dataset. Datasets with a large difference between the mean and median are likely to be more right-skewed that those with similar values for the mean and median.

Therefore AECOM has taken a simplified approach to the comparison of datasets by presenting a selection of basic statistical parameters for each of the datasets. These include the minimum, maximum, arithmetic mean and median concentrations. In addition a 95% confidence interval (CI) for the mean has been calculated using a non-parametric BCA Bootstrap method. Given the limitations described above for assessing the data statistically, the CI has been used only to provide a general indication of the level of uncertainty associated with the calculated arithmetic mean. The mean, median and CI have not been used for any precise comparisons with health based or background assessment criteria without acknowledging the uncertainty and limitations in the approach.

Tabular summaries of the dataset statistics are presented in **Tables 8 to 12 below.** Summary statistics for the same sub-divisions of the data are shown in box and whiskers plots (using the Microsoft Excel function) in **Graphs 1 to 5**. These box and whiskers plots are reproduced as **Figures A9a to A9e** in **Appendix A** at larger scale for clarity. The box and whiskers plots plot individual sample concentrations (filled circles), the minimum value (lower whisker – excludes outliers[5]), the maximum value (upper whisker – excludes outliers[5]), 25th and 75th percentiles (lower and upper boundaries of the box), median (horizontal line through box), and arithmetic mean (cross). These plots provide a simple way to visually compare different datasets to help identify differences in the different datasets and demonstrate the right skewed nature of the datasets.

[5] The **Excel** box and whisker plot function considers any data value to be an "**outlier**" if it is 1.5 times the inter-quartile range (IQR) larger than the third quartile or 1.5 times the IQR smaller than the first quartile.

6.2.1 Chlorinated Dioxins and Furans

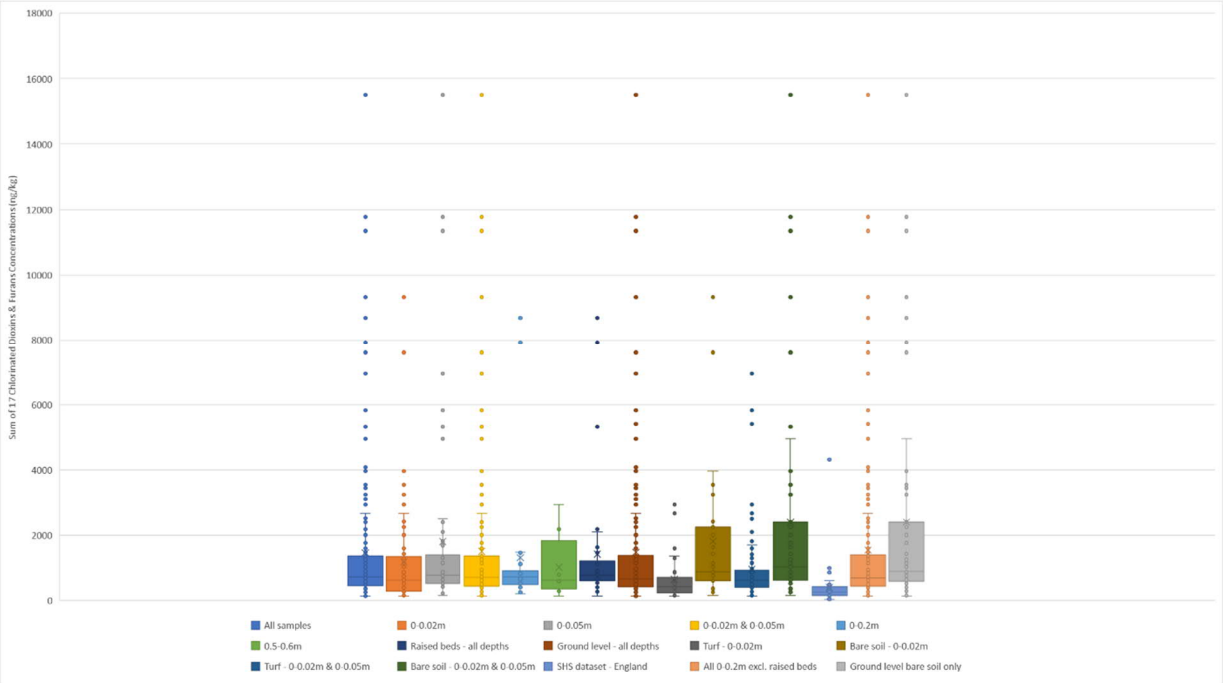
Table 8 and **Graph 1** below show the summary data-set statistics for chlorinated dioxins and furans. Discussion of the data is provided after the table and graph.

Table 8. Chlorinated dioxins and furans summary statistics – units of ng/kg

Dataset	Number of samples	Minimum conc	Maximum conc	Mean conc	Median Conc	95% CI of the mean
All Stage 1 and Stage 2 samples	167	128	15507	1466	717	1150 – 1802
All samples at 0-0.02m depth	60	128	9317	1173	623	789 – 1573
All samples at 0-0.05m depth	64	154	15507	1808	767	1157 – 2501
All samples at 0-0.02m & 0-0.05m depth	124	128	15507	1500	705	1116 – 1912
All samples at precisely 0-0.2m depth	25	195	8688	1311	717	630 – 2173
All samples at precisely 0.5-0.6m depth	8	135	2936	1020	625	451 – 1664
All samples in raised beds	21	271	5322	1139	820	751 – 1596
All samples at locations commencing at ground level	146	128	15507	1513	680	1159 – 1887
All samples on bare soil at locations commencing at ground level	54	135	15507	2406	896	1564 – 3268
All sample within 0-0.2m range – excluding raised bed samples	140	128	15507	1543	686	1180 – 1935
All samples from beneath turf - 0-0.02m depth	33	128	2944	644	424	438 – 865
All samples from bare soil - 0-0.02m depth	27	151	9317	1818	869	1084 – 2610
All samples from beneath turf - 0-0.02m and 0-0.05m depth	77	128	6949	955	619	715 – 1216
All samples from bare soil - 0-0.02m and 0-0.05m depth	47	151	15507	2393	1022	1522 – 3326

CI = confidence interval; conc = concentration

Graph 1 Box and whisker plots of chlorinated dioxins and furans summary statistics



The key observations from the simple statistics presented for chlorinated dioxins and furans concentrations in **Table 8** and **Graph 1** above include:

- **Depth variation:** Average (both mean and median) concentrations appear to be slightly lower in the deep soil dataset (0.5-0.6m) than the shallower datasets (0-0.2m exc. Raised beds, 0-0.02m and 0-0.05m), which could indicate an aerial deposition source for the chlorinated dioxins and furans detected at shallow depth. However, concentrations in the 0-0.05m depth samples appear higher than the 0-0.02m depth samples Although this is not consistent with the initial expectation that highest concentrations might be expected in the very shallowest samples (i.e. 0-0.02m depth), it is possible (but unknown) that a proportion of the dioxins and furans could have been washed down in the soil from the surface causing the higher concentrations in the 0-0.05m depth samples. However, the significant overlap in the ranges of concentrations reported at each sampling depth means there is high uncertainty associated with pattern and any potential explanation.
- **Raised beds vs. ground level:** The differences between the raised beds and ground level (all samples) datasets are mixed, with the mean concentration higher for ground level samples but the median higher for raised bed samples. Given the difference between turf and bare soil locations noted in the next bullet point, ground level samples collected from bare soil only were also separately compared against the raised beds data. In this comparison the concentrations in soils at ground level are notably higher than those in raised beds. The higher concentrations in ground level exposed soils compared to raised beds could be explained by the ground level soils having been present in-situ for a longer duration than soil in raised beds and therefore exposed to a longer period of aerial deposition from long-term historic sources. The Grenfell Tower fire cannot be discounted as one of those contributory aerial deposition sources (based on this evidence alone) as concentrations could potentially be lower in raised beds due to soil replacement, greater soil mixing and / or addition of compost since the fire.
- **Turf vs. bare soil ground cover:** Samples collected on bare soil appear to have higher concentrations than those collected on turf locations, with no overlap of the 95% CIs for these datasets. The reason for this is uncertain; it may be that aerial deposition of dioxins and furans is more readily mixed and incorporated into soils without grass cover, or it could also be that aerial deposition onto turf areas results in the soot particles being trapped in the root zone of the grass - from which it is more difficult to extract the soil from when sampling. These explanations could indicate an aerial deposition source for the chlorinated dioxins and furans, although this is unlikely to be only attributable to the Grenfell Tower fire. Alternatively, whilst the soil in border areas may be soil that was originally present prior to the first development of the land or have been present in that location for a considerable period of time, the turf could have been imported and hence the soil associated with turf areas may not have originated locally and therefore has not been subject to local historical contamination.

6.2.2 Lead

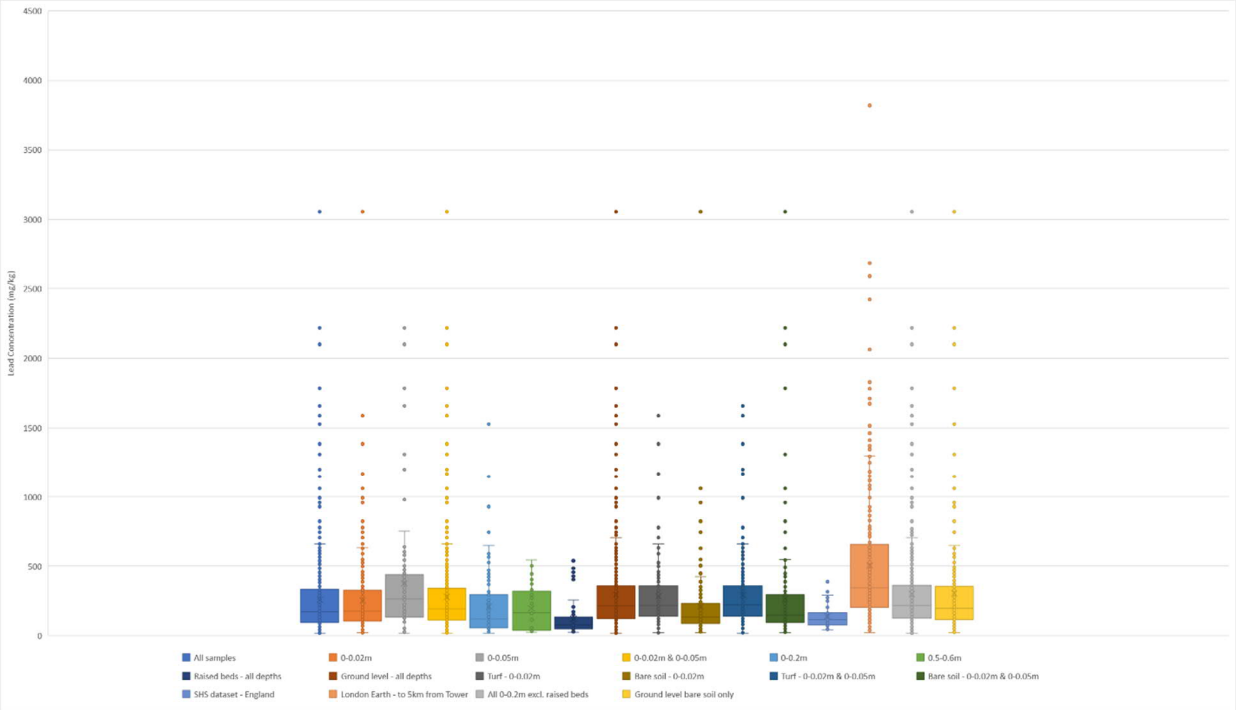
Table 9 and **Graph 2** below show the summary data-set statistics for lead. Discussion of the data is provided after the table and graph.

Table 9. Lead summary statistics – units of mg/kg

Dataset	Number of samples	Minimum conc	Maximum conc	Mean conc	Median Conc	95% CI of the mean
All Stage 1 and Stage 2 samples	543	17	3056	258	172	234 - 281
All samples at 0-0.02m depth	294	19	3056	252	176	223 - 283
All samples at 0-0.05m depth	84	17	2216	375	263	289 - 461
All samples at 0-0.02m & 0-0.05m depth	378	17	3056	279	191	248 - 310
All samples at precisely 0-0.2m depth	129	18	1527	207	119	169 - 246
All samples at precisely 0.5-0.6m depth	24	25	544	195	163	135 - 258
All samples in raised beds	114	25	547	122	78	100 - 145
All samples at locations commencing at ground level	429	17	3056	294	214	265 - 322
All samples on bare soil at locations commencing at ground level	199	20	3056	303	197	254 - 353
All sample within 0-0.2m range – excluding raised bed samples	411	17	3056	298	215	268 - 328

Dataset	Number of samples	Minimum conc	Maximum conc	Mean conc	Median Conc	95% CI of the mean
All samples from beneath turf - 0-0.02m depth	167	19	1588	282	215	248 - 316
All samples from bare soil - 0-0.02m depth	127	20	3056	212	131	165 - 265
All samples from beneath turf - 0-0.02m and 0-0.05m depth	211	17	1657	291	219	258 - 323
All samples from bare soil - 0-0.02m and 0-0.05m depth	167	20	3056	264	146	210 - 322

Graph 2 Box and whisker plots of lead summary statistics



The key observations from the simple statistics presented for lead concentrations in **Table 9** and **Graph 2** above include:

- **Depth variation:** Median concentrations appear to be slightly lower with increasing depth (0.5-0.6m lower than 0-0.2m lower than combined 0-0.02 & 0-0.05m) although the difference between 0-0.2m and 0.5-0.6m is slight. Reported concentrations in the 0-0.05m depth samples appear higher than the 0-0.02m depth samples. This does not provide consistent evidence for any significant impact caused by an aerial deposition scenario, where highest concentrations might be expected in the very shallowest samples (i.e. 0-0.02cm depth). It is possible (but unknown) that a proportion of the lead could have been washed down in the soil from the surface but the significant overlap in the ranges of concentrations reported at each sampling depth means there is high uncertainty associated with pattern and any potential explanation.
- **Raised beds vs. ground level:** There is a noticeable difference between the range of reported concentrations in the raised beds compared to ground level samples, with concentrations in raised beds considerably lower. This may be explained by the soils in raised beds having a different original source to the ground level soil (i.e. imported from a supplier intended to provide high quality soil for growing produce). Equally it could be explained by replacement and topping up of soils since the fire. **Section 3.10** identified a number of locations where soil replacements are reported to have occurred since the fire. This list does not include Treadgold House and lead concentrations in the raised beds at Treadgold House are significantly lower than the ground level soil, suggesting a possible different original source of the soil. However, unreported soil replacement or topping up completed by residents cannot be ruled out and could have an effect in reducing concentrations potentially caused by the fire. The uncertainty and potentially differing interpretations for the differences mean that this line of evidence alone cannot be used to identify fire-related impact.
- **Turf vs. bare soil ground cover:** Samples collected on bare soil appear to have slightly lower lead concentrations than those collected on turf locations, although there is considerable overlap of the 95% CIs.

This is the opposite pattern to that for dioxins and furans which had notably higher concentrations on bare soil locations. This indicates the potential for differing sources for the dioxins and furans compared to lead in soil and does not suggest that they are necessarily linked to the same aerial deposition source.

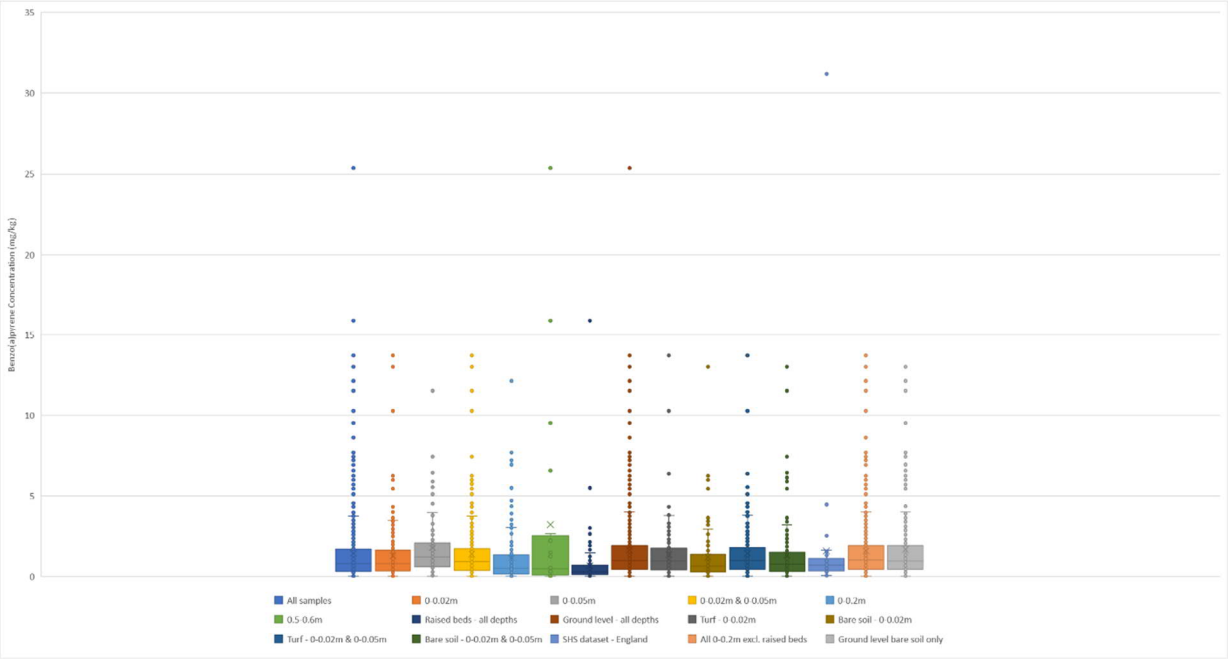
6.2.3 Benzo(a)pyrene

Table 10 and **Graph 3** below show the summary data-set statistics for BaP. Discussion of the data is provided after the table and graph.

Table 10. BaP summary statistics – units of mg/kg

Dataset	Number of samples	Minimum conc	Maximum conc	Mean conc	Median Conc	95% CI of the mean
All Stage 1 and Stage 2 samples	543	0.04	25.36	1.45	0.79	1.28 - 1.62
All samples at 0-0.02m depth	294	0.04	13.71	1.30	0.79	1.12 - 1.47
All samples at 0-0.05m depth	84	0.04	11.52	1.75	1.17	1.37 - 2.14
All samples at 0-0.02m & 0-0.05m depth	378	0.04	13.71	1.40	0.92	1.23 - 1.57
All samples at precisely 0-0.2m depth	129	0.04	12.13	1.16	0.52	0.87 - 1.46
All samples at precisely 0.5-0.6m depth	24	0.04	25.36	3.23	0.50	1.13 - 5.65
All samples in raised beds	114	0.04	15.93	0.67	0.29	0.43 - 0.97
All samples at locations commencing at ground level	429	0.04	25.36	1.65	1.01	1.45 - 1.86
All samples on bare soil at locations commencing at ground level	199	0.04	13.01	1.69	0.98	1.41 – 1.97
All sample within 0-0.2m range – excluding raised bed samples	411	0.04	13.71	1.59	1.02	1.41 - 1.76
All samples from beneath turf - 0-0.02m depth	167	0.04	13.71	1.37	0.98	1.15 - 1.61
All samples from bare soil - 0-0.02m depth	127	0.04	13.01	1.20	0.66	0.94 - 1.49
All samples from beneath turf - 0-0.02m and 0-0.05m depth	211	0.04	13.71	1.44	1.00	1.24 - 1.66
All samples from bare soil - 0-0.02m and 0-0.05m depth	167	0.04	13.01	1.34	0.76	1.08 - 1.62

Graph 3 Box and whisker plots of BaP summary statistics



The key observations from the simple statistics presented for BaP concentrations in **Table 10** and **Graph 3** above include:

- **Depth variation:** There does not appear to be noticeable variation in concentrations with depth, with the higher uncertainty (defined by the larger 95% CI range) in the dataset for the deeper soils (0.5-0.6m) linked to the smaller number of samples and a few higher concentrations in that dataset. The 0-0.05m depth samples have slightly higher average (both mean and median) concentrations compared to the 0-0.02m depth, although an explanation for this is not obvious and there remains some overlap in the 95% CIs for both datasets.
- **Raised beds vs. ground level:** There is a noticeable difference between the range of concentrations in the raised beds compared to ground level samples, with concentrations in raised beds considerably lower.
- **Turf vs. bare soil ground cover:** There is little difference between the average concentrations for turf and bare soil areas, this pattern is more akin to the data for lead than the data for chlorinated dioxins and furans.

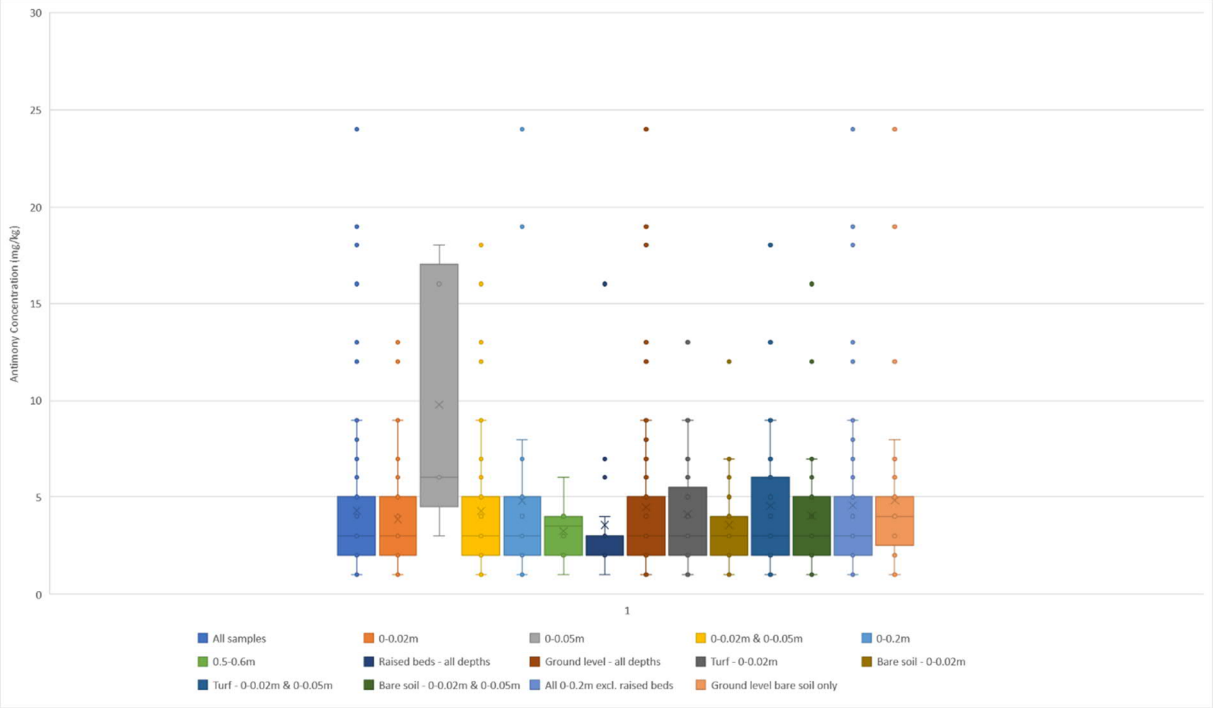
6.2.4 Antimony

Table 11 and **Graph 4** below show the summary data-set statistics for antimony. Discussion of the data is provided after the table and graph.

Table 11. Antimony summary statistics – units of mg/kg

Dataset	Number of samples	Minimum conc	Maximum conc	Mean conc	Median Conc	95% CI of the mean
All Stage 1 and Stage 2 samples	103	1	24	4.3	3	3.6 - 5
All samples at 0-0.02m depth	64	1	13	3.8	3	3.3 - 4.4
All samples at 0-0.05m depth	5	3	18	9.8	6	4.2 - 15
All samples at 0-0.02m & 0-0.05m depth	69	1	18	4.3	3	3.6 - 5
All samples at precisely 0-0.2m depth	25	1	24	4.8	3	3 - 6.8
All samples at precisely 0.5-0.6m depth	8	1	6	3.3	3.5	2.1 - 4.1
All samples in raised beds	20	1	16	3.6	3	2.4 - 5
All samples at locations commencing at ground level	83	1	24	4.5	3	3.7 - 5.3
All samples on bare soil at locations commencing at ground level	41	1	24	4.8	4	3.6 – 6.2
All sample within 0-0.2m range – excluding raised bed samples	77	1	24	4.56	3	3.8 - 5.5
All samples from beneath turf - 0-0.02m depth	33	1	13	4.1	3	3.3 - 5.0
All samples from bare soil - 0-0.02m depth	31	1	12	3.5	3	2.8 - 4.3
All samples from beneath turf - 0-0.02m and 0-0.05m depth	34	1	18	4.5	3	3.5 - 5.6
All samples from bare soil - 0-0.02m and 0-0.05m depth	35	1	16	4	3	3.1 - 5.0

Graph 4 Box and whisker plots of antimony summary statistics



The key observations from the simple statistics presented for antimony concentrations in **Table 11** and **Graph 4** above include:

- **Depth variation:** There does not appear to be any noticeable variations in concentrations associated with different depths with the higher average concentrations in the 0-0.05m dataset likely to be an artifact of the small number of samples at this depth.
- **Raised beds vs. ground level:** There is not any noticeable difference between the concentrations reported in ground level soil and those reported in raised beds.
- **Turf vs. bare soil ground cover:** There is not any noticeable difference between the average concentrations when split between turf and bare soil.

The generally consistent datasets for antimony tend to indicate that reported concentrations may be associated with natural background, suggesting that there is not a significant effect caused by aerial deposition, differences in redevelopment history, or variations in imported soils.

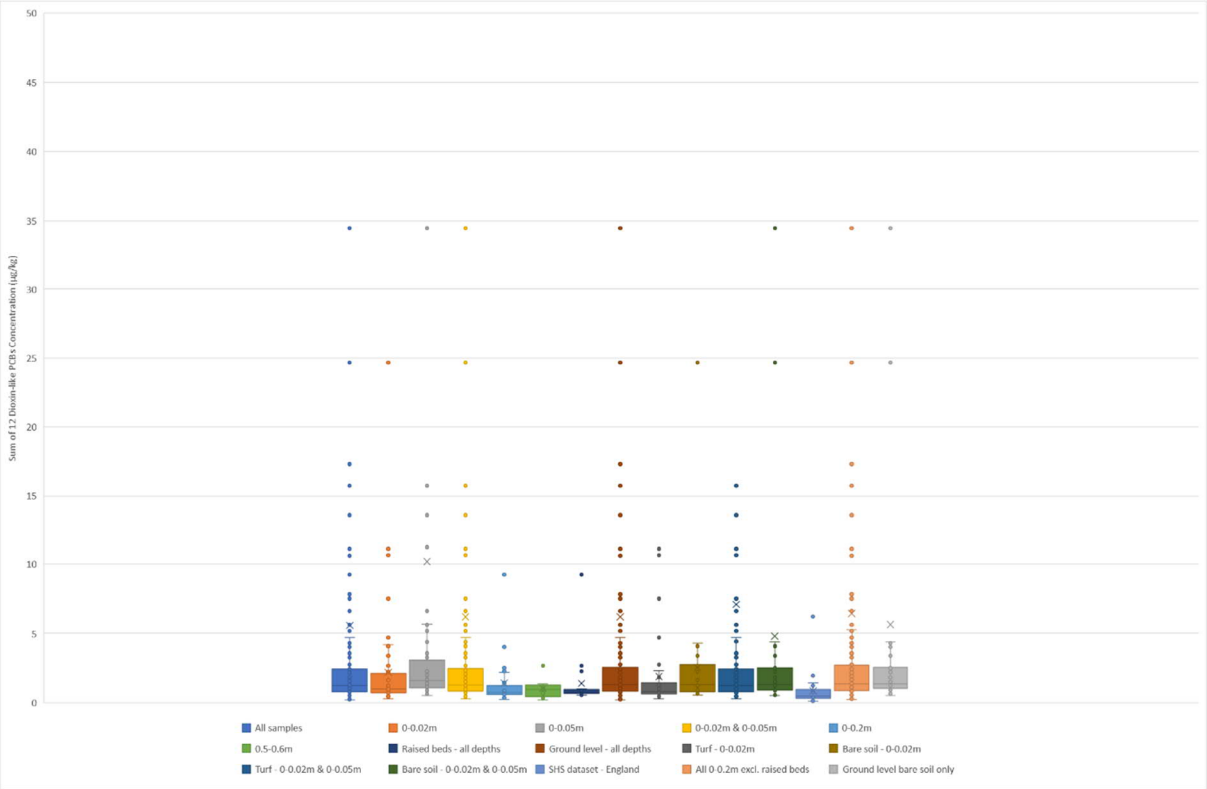
6.2.5 Dioxin-like PCBs

Table 12 and **Graph 5** below show the summary data-set statistics for dioxin-like PCBs. Discussion of the data is provided after the table and graph.

Table 12. Dioxin-like PCB summary statistics – units of µg/kg

Dataset	Number of samples	Minimum conc	Maximum conc	Mean conc	Median Conc	95% CI of the mean
All Stage 1 and Stage 2 samples	163	0.21	278	5.57	1.23	2.65 - 9.33
All samples at 0-0.02m depth	60	0.29	24.7	2.19	1	1.40 - 3.11
All samples at 0-0.05m depth	60	0.51	278	10.2	1.59	2.81 - 20.1
All samples at 0-0.02m & 0-0.05m depth	120	0.29	278	6.19	1.29	2.43 - 11.1
All samples at precisely 0-0.2m depth	25	0.25	9.25	1.41	0.76	0.83 - 2.11
All samples at precisely 0.5-0.6m depth	8	0.21	2.66	1.03	0.97	0.59 - 1.53
All samples in raised beds	21	0.55	9.25	1.38	0.71	0.78 - 2.21
All samples at locations commencing at ground level	142	0.21	278	6.19	1.3	2.77 - 10.4
All samples on bare soil at locations commencing at ground level	54	0.51	94.5	5.64	1.34	1.92 – 9.96
All sample within 0-0.2m range – excluding raised bed samples	136	0.25	278	6.43	1.34	2.89 - 11.1
All samples from beneath turf - 0-0.02m depth	33	0.29	11.1	1.89	0.81	1.07 - 2.80
All samples from bare soil - 0-0.02m depth	27	0.55	24.7	2.56	1.29	1.32 - 4.29
All samples from beneath turf - 0-0.02m and 0-0.05m depth	73	0.29	278	7.09	1.25	2.05 - 14.7
All samples from bare soil - 0-0.02m and 0-0.05m depth	47	0.51	94.5	4.79	1.31	1.55 - 8.82

Graph 5 Box and whisker plots of dioxin-like PCB summary statistics



The key observations from the simple statistics presented for dioxin-like PCBs concentrations in **Table 12** and **Graph 5** above include:

- **Depth variation:** There is some indication that samples in the upper 0.2m depth have higher concentrations than those at 0.5-0.6m depth, although the shallow soil datasets are heavily skewed by outliers. In particular if the maximum concentration of 278mg/kg is removed from the datasets, the mean concentrations of the 0-0.05m dataset and the 0-0.02 and 0-0.05m dataset approximately halve. In such a scenario the median concentration may be a more appropriate average value to consider and there is much less difference between the median concentration in shallow soils compared to the deeper soils than when looking at the mean.
- **Raised beds vs. ground level:** The concentrations in raised beds appear to be noticeably lower than those in ground level samples, although the degree of difference is uncertain due to the highly right-skewed dataset for the ground level samples.
- **Turf vs. bare soil ground cover:** There is no consistent difference between the average concentrations for turf and bare soil. For the 0-0.02m depth samples the bare soil concentrations are slightly higher than the turf samples; whereas for the combined 0-0.02m and 0-0.05m dataset the concentrations in samples below turf may be higher than those on bare soil.

6.2.6 Summary

In comparing the sample concentrations between different depth intervals, between raised bed and ground level, and between different types of ground cover, the following main observations have been made:

- For chlorinated dioxins and furans, and to a lesser extent lead and dioxin-like PCBs, the data indicates potentially decreasing concentrations with depth in the soil. This is not the case for BaP or antimony. This could indicate a potential aerial deposition source as the dominant source for chlorinated dioxins and furans, lead and dioxin-like PCBs in the upper 0.6m of the soil profile, with BaP and antimony concentrations potentially dominated by other sources. However, the potential for an aerial deposition source does not necessarily mean that this source was the Grenfell Tower fire and these COPC are known to have other historic and ongoing aerial deposition sources such as motor vehicle exhausts and other general industrial and commercial sources of combustion. It is noted that it is also the case that BaP is likely to have an aerial deposition source from historic and current burning of wood and fossil fuels.
- Concentrations of all COPC except antimony were notably lower in raised beds than in ground level soils. This may be explained by a different original pre-fire source of the soils in the raised beds, with material likely to have been imported specifically to supply good quality soil for growing produce. Equally some locations have had soil replacement since the fire (refer to **Section 3.10**) and there is some potential for those that have not had recorded soil replacement (e.g. Treadgold House) to have had ad hoc topping up with compost and mixing by residents, which could 'dilute' potential impacts from the fire. Given the alternative explanations this line of evidence does not provide by itself an indication of whether or not there has been impact caused by the Grenfell Tower fire.
- A noticeable pattern of higher concentrations in samples from bare soil compared to those from beneath turf was observed for dioxins and furans, with a possible similar but much less pronounced patter for dioxin-like PCBs. For lead and BaP the data suggest potential lower concentrations on bare soil, and for antimony there was no obvious difference between the two. Consistent with the potential for higher dioxins and furans concentrations in shallower samples, higher concentrations on bare soil could be indicative of an aerial deposition source, although this does not mean that the aerial deposition source was the Grenfell Tower fire, since these COPC have long-term aerial deposition sources in the urban environment (Stage 1 TN13: Sources of Urban Soil Pollution).

The review of these datasets tends to suggest that the dioxin and furans and dioxin-like PCB concentrations could have an aerial deposition source as a significant contributing source of these COPC in soils between ground level and 0.6m depth. This is less likely for the other COPC, although this does not mean that lead and BaP do not have any input from aerial deposition, just that any aerial deposition input does not seem to be discernible from other sources contributing to the soil concentrations.

6.3 Spatial Distribution Plots

Maps showing the average concentrations of lead, antimony, benzo(a)pyrene, chlorinated dioxins & furans, and dioxin-like PCBs at each sampling area are shown in **Figure G46** (for lead), **Figure H46** (for BaP), **Figure A4** (for antimony)**, Figure A5** (for dioxin-like PCBs) and **Figure A6a** (for chlorinated dioxins and furans). The average

values used are the arithmetic means of the reported concentrations within each sampling area. For these maps, only shallow sample results from ground level soil have been used i.e. those between ground level and 0.02m and those between ground level and 0.05m. Samples from raised beds have been excluded. The map for chlorinated dioxins and furans is reproduced below as **Figure 1** as an example. For chlorinated dioxins and furans, a map has also been created to show individual sample concentrations across the investigation area (**Figure A7a**). This has been reproduced below as **Figure 2** for illustration. Alternative versions of Figures A6a and A7a have also been prepared using only those samples collected in areas of bare soil ground cover. These are included in **Appendix A** as **Figure A6b** and **Figure A7b**.

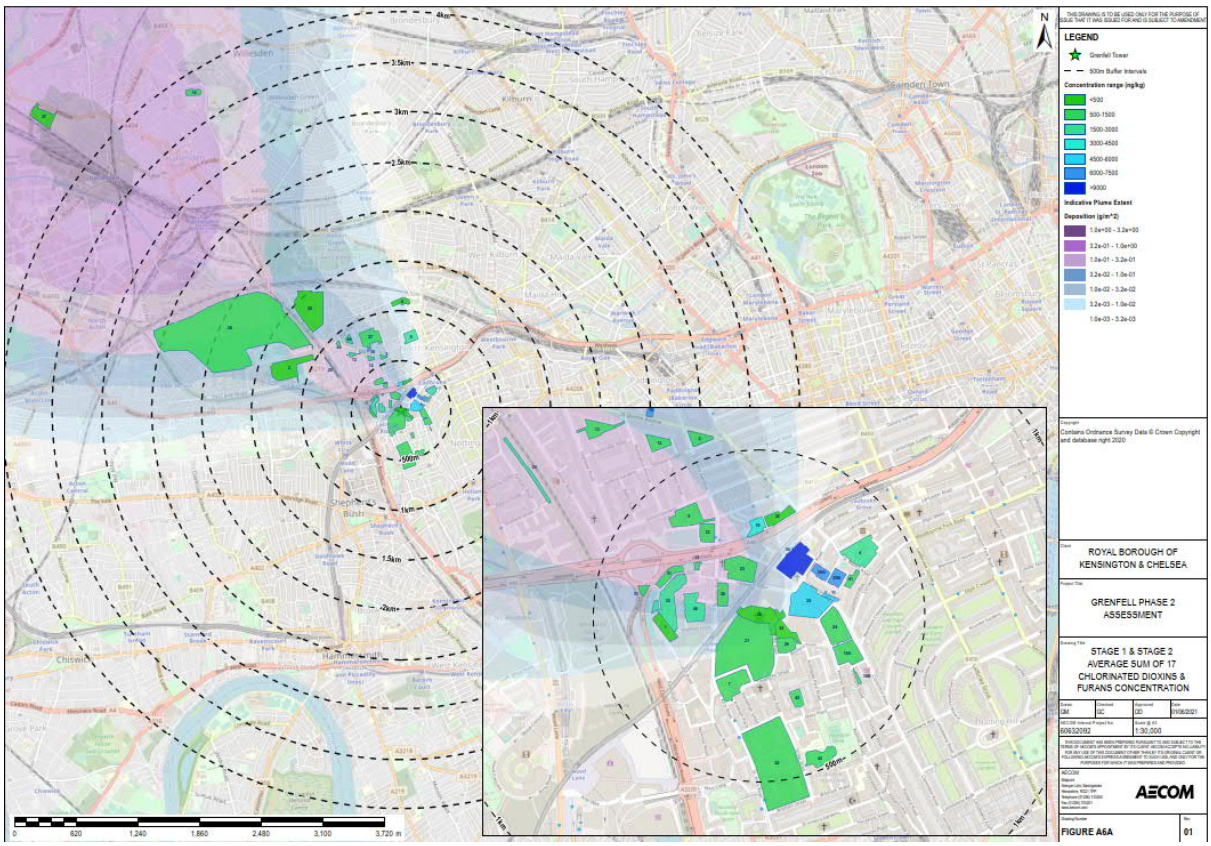


Figure 1 Chlorinated Dioxins and Furans Concentrations Averaged by Sampling Area (also presented as Figure A6a in Appendix A)

Figure 2 Chlorinated Dioxins and Furans Concentrations in Individual Samples (also presented as Figure A7a in Appendix A)

The maps do not indicate a consistent spatial pattern of concentrations that would appear to match with the indicative plume extent and the expected radius of debris deposition. For dioxins & furans, some of the sampling areas that might be expected to have the highest impact from larger debris and ash deposition (such as the Tower cordon, Bramley House, Silchester East, Darfield Way and Robinson House) have concentrations that are similar to or lower than sampling areas where fire-related impacts would be expected to be much lower (e.g. Wesley Square, All Saints Catholic College, Avondale Park). Equally, at distances from the Tower where larger debris deposition would not have occurred (at Stonebridge Recreation Ground and Longstone Avenue allotments), the dioxins and furans concentration in soil was lower at Stonebridge Recreation Ground than it was at Longstone Avenue allotments, despite a higher relative particulate deposition being modelled at Stonebridge Recreation Ground.

Similarly, the equivalent figures for lead, antimony, BaP and dioxin-like PCBs do not indicate fire-related impact.

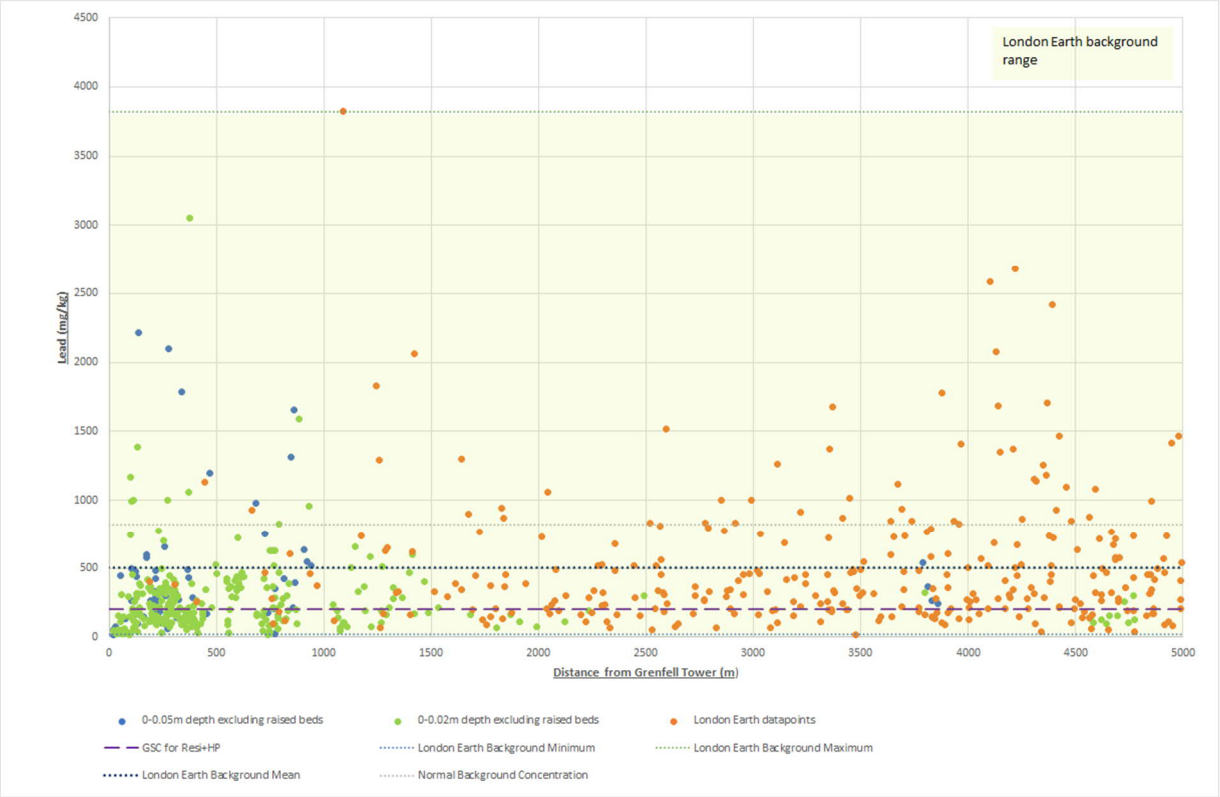
The map showing reported concentrations of chlorinated dioxins and furans in individual samples (**Figure 2**) indicates that the highest concentrations seems to be clustered within 300m to the northeast of the Tower (Wesley Square, Morland House, Verity Close, Grenfell Nursery) with another cluster located approximately 250m to the west of the Tower at Waynflete Square and Silchester East. A single notably higher concentration is located at St. Quintin's CKG approximately 700m northwest of the Tower. In all of these areas the high concentrations are also interspersed with lower concentrations and the cluster to the north east does not match the main direction of the indicative modelled plume extent, which was to the northwest. The lower concentrations to the south of the Tower, as well as the lower concentrations in the area between and close to Waynflete Square and Verity Close (e.g. Bramley House, Silchester East, Darfield Way, Robinson House, Tower cordon, Lancaster Green) do not fit with a relatively even aerial deposition scenario, either associated with debris or soot and ash fall-out at closer distances to the Tower (e.g. up to 500m). Whilst some more heterogeneous deposition cannot be ruled out, the available evidence does not provide an indication of consistent and widespread impact from the Grenfell Tower fire.

6.4 Distance from Tower

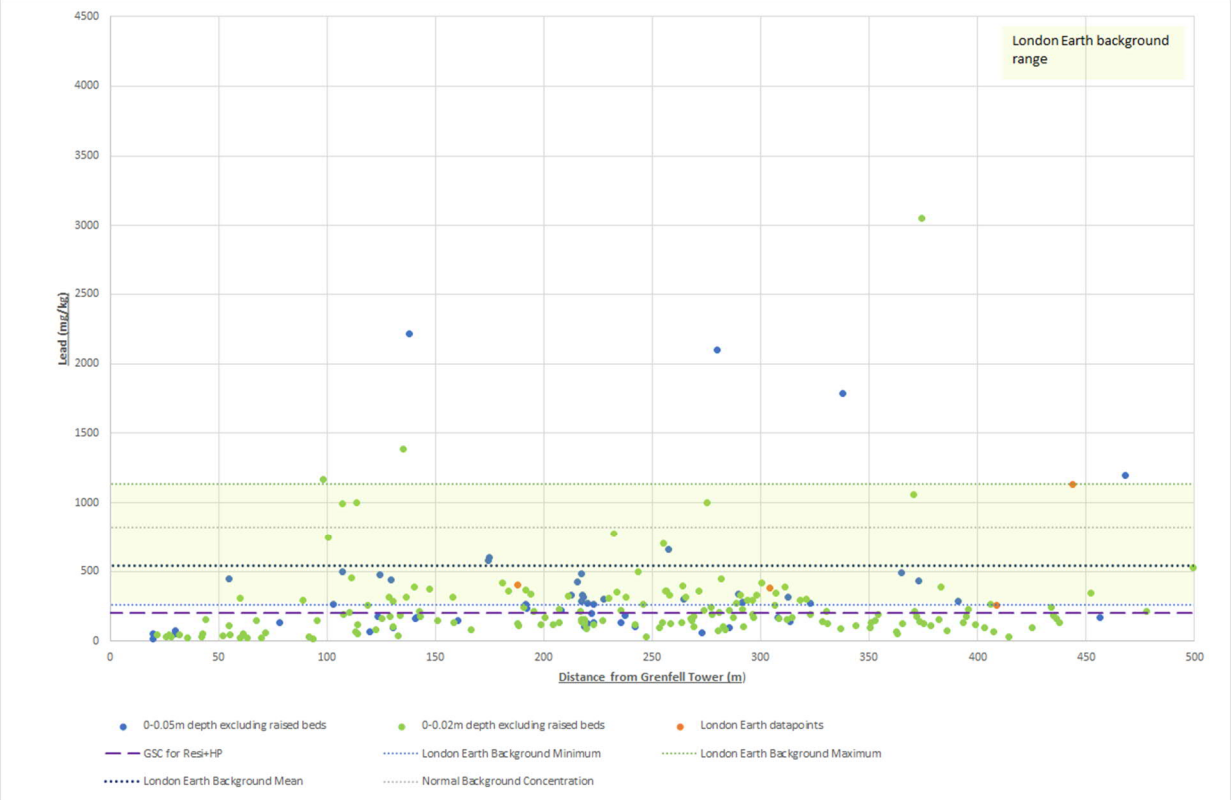
Graphs 6 to 9 show the reported concentrations of lead and chlorinated dioxins and furans in individual samples compared to the sample location distance from Grenfell Tower. These graphs are also presented in **Appendix A** alongside equivalent graphs for antimony, BaP and dioxin-like PCBs as **Figures A8a to A8j** in **Appendix A**.

Estimates of background concentrations and generic screening criteria (GSC) are also marked on these figures and these are discussed in **Sections 6.5 and 6.7** respectively.

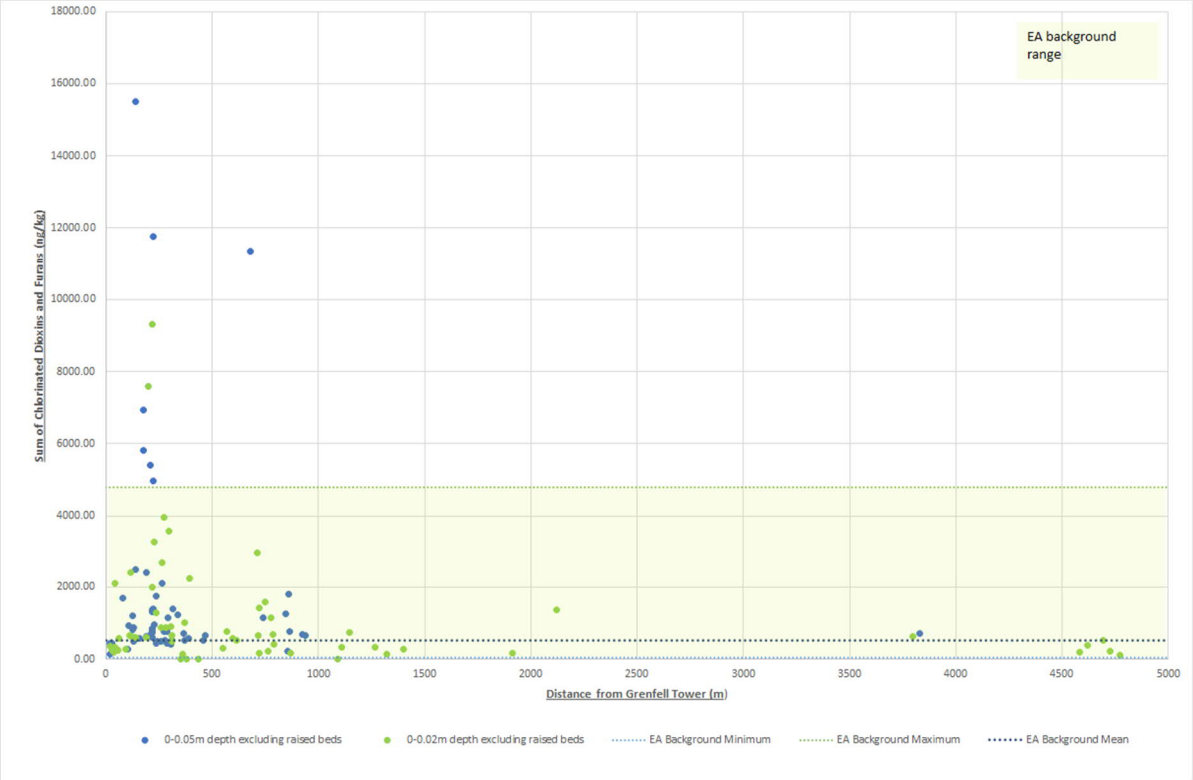
Graph 6 Lead concentrations comparison with GSC and background data - Shallow samples, up to 5km radius from Grenfell Tower



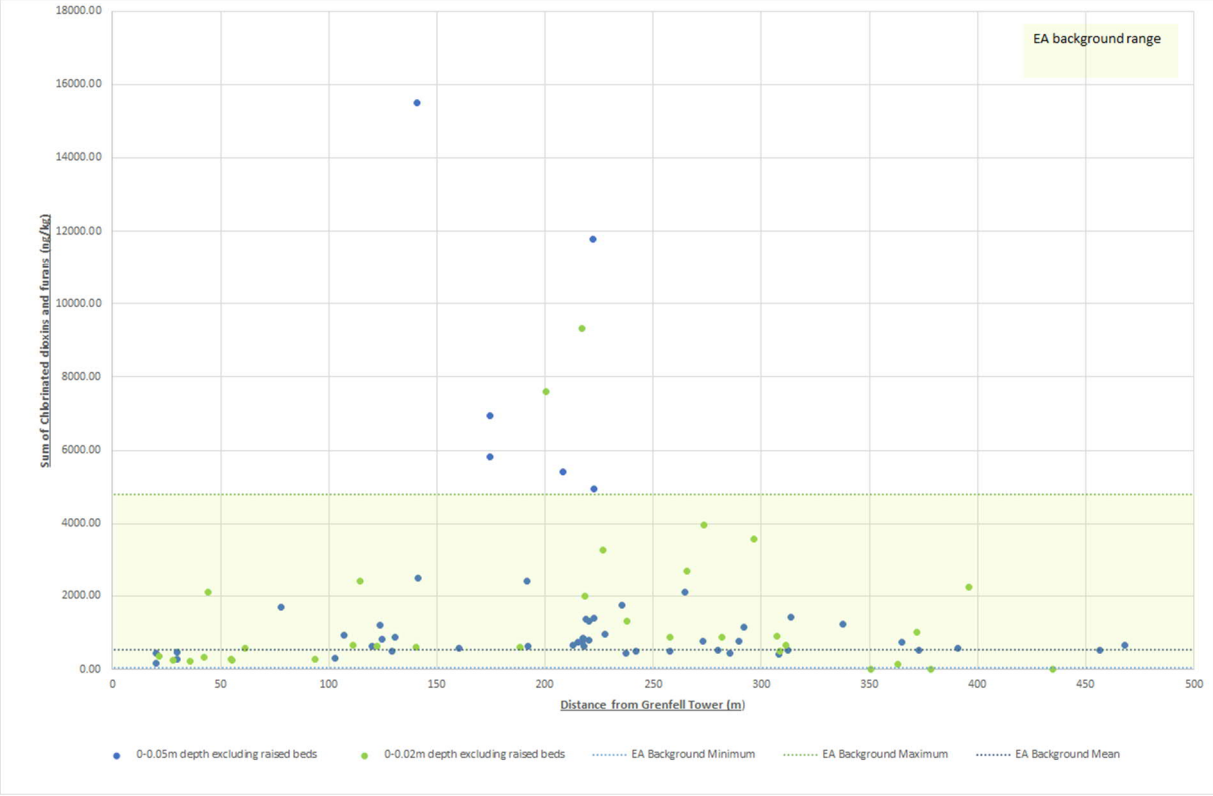
Graph 7. Lead concentrations comparison with GSC and background data - Shallow samples, up to 500m radius from Grenfell Tower



Graph 8. Chlorinated dioxins and furans concentrations comparison background data - Shallow samples, up to 5km radius from Grenfell Tower



Graph 9. Chlorinated dioxins and furans concentrations comparison background data - Shallow samples, up to 500m radius from Grenfell Tower



For antimony and BaP, the general range and pattern of soil concentrations do not appear to show any variability with distance from Grenfell Tower.

For lead, **Graph 6** which shows samples to a distance of 5km suggests a decrease in soil concentrations with increasing distance from Grenfell Tower. However **Graph 7**, which shows samples to a distance of 500m from the Tower does not indicate any pattern of variation linked to sample distance from the Tower. The lower lead concentrations detected at distances further from the Tower shown on **Graph 6** are considered to be explained by the smaller number of sampling areas at greater distance from the Tower, coupled with these areas (particularly those beyond 1km from the Tower) typically being parks such as Little Wormwood Scrubs, Wormwood Scrubs, Stonebridge Recreation Ground and Longstone Avenue allotments with less history of urban and industrial redevelopment (i.e. would be expected to have lower soil lead concentrations pre-fire).

For chlorinated dioxins & furans, **Graph 8** and **Figure A8g** suggest potential decreasing soil concentrations as the distance from Grenfell Tower increases. As described above for lead, the generally lower concentrations at distances of more than 1km from the Tower are expected to be related to the parkland type nature of those sampling areas compared to the more heavily redeveloped land closer to Grenfell Tower.

For the chlorinated dioxins and furans soil concentrations shown on **Graph 9** and **Figure A8h** extending to 500m distance from the Tower, the apparent pattern of higher concentrations closer to the Tower is primarily associated with a group of samples located between 140m and 300m from the Tower. Of the 23 samples identified in this distance range with a concentration above 2,000ng/kg, 10 were from Waynflete Square. These 10 samples were collected from five of the 17 individual locations within Waynflete Square, with both samples at the two depth intervals (0-0.05m and 0.1-0.15m) at these locations exceeding 2,000ng/kg. The highly localised nature of these higher concentrations – both in terms of being concentrated within a single sampling area as well as being localised within that area – suggests that the cause of the higher dioxins and furans at this distance from the Tower is unlikely to be related to deposition from the fire but is more likely to be associated with historic pre-fire sources. Historically Waynflete Square has undergone substantial post-war redevelopment (demolition and construction) and the made ground encountered at relatively shallow depth when sampling in this area indicates the potential for anthropogenic materials in the soils that could be the source of the elevated dioxins and furans concentrations.

Similarly, although dioxins and furans concentrations above 2,000ng/kg were identified in more than one sample at Verity Close (potentially previously occupied by commercial/industrial buildings) and Wesley Square (previously occupied by an iron works, engineering works and transport depot) there are other sampling areas at similar distance from the Tower and in similar directions where reported concentrations did not appear in the cluster above 2,000ng/kg. In particular, the maximum concentration at Silchester East was 820ng/kg. Silchester East also has the potential for historic contamination (bootmakers and commercial / industrial buildings) but impacts from this type of historic source would be expected to be more localised.

Within 500m of the Tower, nine samples (0-0.02m and 0-0.05m depths) reported chlorinated dioxins and furans at concentrations exceeding the maximum value from the EA SHS dataset urban background range (4,312ng/kg, see **Section 6.5** below). Four of these were located at Waynflete Square, two at Morland House, and one at each of Grenfell Nursery, Verity Close and Wesley Square. Three of the four at Waynflete Square were located on turf, with all others located on bare soil. As discussed above these areas have either had historic industrial land uses (the maximum concentration in the EA SHS dataset for industrial land is 79,367ng/kg) or have undergone significant urban residential redevelopment and the clustering in these areas, combined with the lack of the more elevated concentrations in other sampling areas at similar distances and similar directions from Grenfell Tower, suggests that there has not been widespread consistent aerial deposition that could have been caused by the fire (noting the potential for localised heterogeneous deposition, which cannot be evaluated by looking at spatial patterns).

The localised nature of the higher dioxins and furans concentrations coupled with the presence of notably lower concentrations in and around the same areas is more indicative of impact from varied historic contamination sources rather than a pattern consistent with impact from fire-related deposition.

A similar (though less pronounced) pattern to that observed for chlorinated dioxins and furans was observed for dioxin-like PCBs. As shown on **Graph 13**, four samples were identified at concentrations notably higher than the majority of results within 200m and 250m of Grenfell Tower. All four of these were from Waynflete Square, with two from turfed locations and two from bare soil locations. The clustering of these four higher samples in a single sampling area is not indicative of an aerial deposition source from the Grenfell Tower fire or from other diffuse urban sources of aerial deposition.

6.5 Comparison with Background

The reported concentrations of lead, BaP, chlorinated dioxins and furans, and dioxin-like PCBs have been compared with available background datasets to assist in determining whether there is any evidence that soil concentrations reported as part of the Stage 1 and Stage 2 investigations might be related to effluent (debris, soot and ash) from the Grenfell Tower fire.

In addition, the comparison with background concentrations is relevant to the Part 2A assessment of risk to human health. The Part 2A Statutory Guidance (paragraph 3.22) states that "…*normal levels of contaminants in soil should not be considered to cause land to qualify as contaminated land, unless there is a particular reason to consider otherwise*. *Therefore, if it is established that land is at or close to normal levels of particular contaminants, it should usually not be considered further in relation to the Part 2A regime…*".

The background data used for this assessment have come from the following sources:

- NBCs, which are based on the BGS study (Johnson, et al., 2012) to determine the 'normal' levels of contaminant concentrations in English soils. For lead, the NBC in urban soils has been defined as 820mg/kg. For BaP the NBC in urban soils has been defined as 3.6mg/kg. NBCs are not available for chlorinated dioxins and furans, and dioxin-like PCBs.
- London Earth study (British Geological Survey, 2010), which is part of the nationwide project to determine the distribution of chemical elements in the surface environment, namely the Geochemical Baseline Survey of the Environment (G-BASE). The soil samples were collected using a 15cm auger flight after removing surface vegetation and the surface litter and rootlet zone. This thickness of removed material is reported as 'usually <5cm' and therefore the sample depth range can be assumed to be anywhere from 0-15cm to 5-20cm and is intended to be targeted at topsoil. Each reported concentration is from a single sample composited from five sub-samples collected within a 20m x 20m square area using a hand auger. Although the sampling method is slightly different to the approach taken for collecting the Stage 1 and Stage 2 samples, it is considered reasonable to compare these datasets for a high level comparison. Reported lead concentrations in soil taken from this study within a 5km radius of Grenfell Tower range from 20mg/kg to 10,000mg/kg. After the maximum reported value of 10,000mg/kg (sample location approximately 3km south west of the Tower), the next highest reported background concentration in topsoil within this 5km radius was 3821.3mg/kg.
- Environment Agency – UK Soil and Herbage Pollutant Survey (UK SHS) (Environment Agency, 2007a), data for PAHs, dioxins and furans, and dioxin-like PCBs in soil samples from urban areas in the UK. The data for lead included in this survey has not been used as the London Earth dataset is considered to be more comprehensive and suitable for comparison. The range of the background BaP data presented for all samples within urban areas in England is between 0.06mg/kg and 31.2mg/kg, with a mean concentration of 1.59mg/kg. For dioxins and furans the range was between 45.54ng/kg to 4,803.67ng/kg. For dioxin-like PCBs the range was between 0.12µg/kg to 6.21µg/kg. The UK SHS dataset comprises three samples from each separate sampling area. The three samples are all collected from a depth of 0-5cm within a 20m x 20m area and each one comprises a composite of three sub-samples. The UK SHS urban data from London was collected in two locations: Hyde Park and Richmond Park. These areas are historic parkland and have not undergone the same kind of urban re-development of industrial legacy land-uses that is common in the residential areas surrounding Grenfell Tower. The most similar Stage 2 sampling areas for comparison are likely to be Little Wormwood Scrubs and Wormwood Scrubs. As the data in this study pertaining to London is so limited for these compounds, the comparison to Stage 1 and Stage 2 data is made on the basis of background urban concentrations typical for the UK as a whole and not specifically to London (as is the case for the London Earth data for lead).
- (Vane, et al., 2014). This study reported PAH data for topsoil samples collected in 2009 from the Abbey Wood, Thamesmead, Erith, Belvedere and Jenningtree Point areas of London. Summary statistics for the data were included in the Stage 1 Technical Note 9: Published Data on National and Regional Urban Background Soil Concentrations. The data for BaP are discussed in **Section 6.5.2** below.
- Data from site investigation reports carried out in the vicinity of Grenfell Tower prior to the fire. A summary of the investigations and the data used for comparison is presented in **Section 3.8**.

The Stage 1 and Stage 2 data were collected in clusters of samples within specific sampling areas. Sample locations were also restricted by available access to soft ground giving a targeted element to the sampling strategy. This is different to the London Earth data which were collected on a more regular grid pattern. Whilst the clustered and targeted nature of the Stage 1 and Stage 2 samples does not lend itself to a detailed statistical comparison

with the London Earth dataset (e.g. 2-sample hypothesis tests), it is considered that there remains some benefit in high level comparison of simple statistical measures of these datasets.

6.5.1 Lead

6.5.1.1 National and regional background

The data comparisons detailed below are based on the entire Stage 1 and Stage 2 sample dataset for lead. **Graph 6, Graph 7 and Graph 10** summarize the comparison between the lead concentrations in the depth range between ground level and 0.2m bgl, excluding the data for samples collected from raised beds, and the background data. Although there are slight differences in the depth horizons sampled, the data comparisons summarised in **Section 6.2** do not indicate variations in concentrations that would make the general comparisons intended here inappropriate. The combined Stage 1 and Stage 2 dataset does comprise clustered data that is not consistent with the BGS and EA datasets. This difference in sample pattern is unavoidable.

Graph 10 and Table 13 below compares the samples collected during the Stage 1 & Stage 2 investigations and the London Earth background data.

Graph 10 Box and Whisker plot per depth – Lead concentrations Stage 1 & Stage 2 compared to London Earth background data - Shallow samples

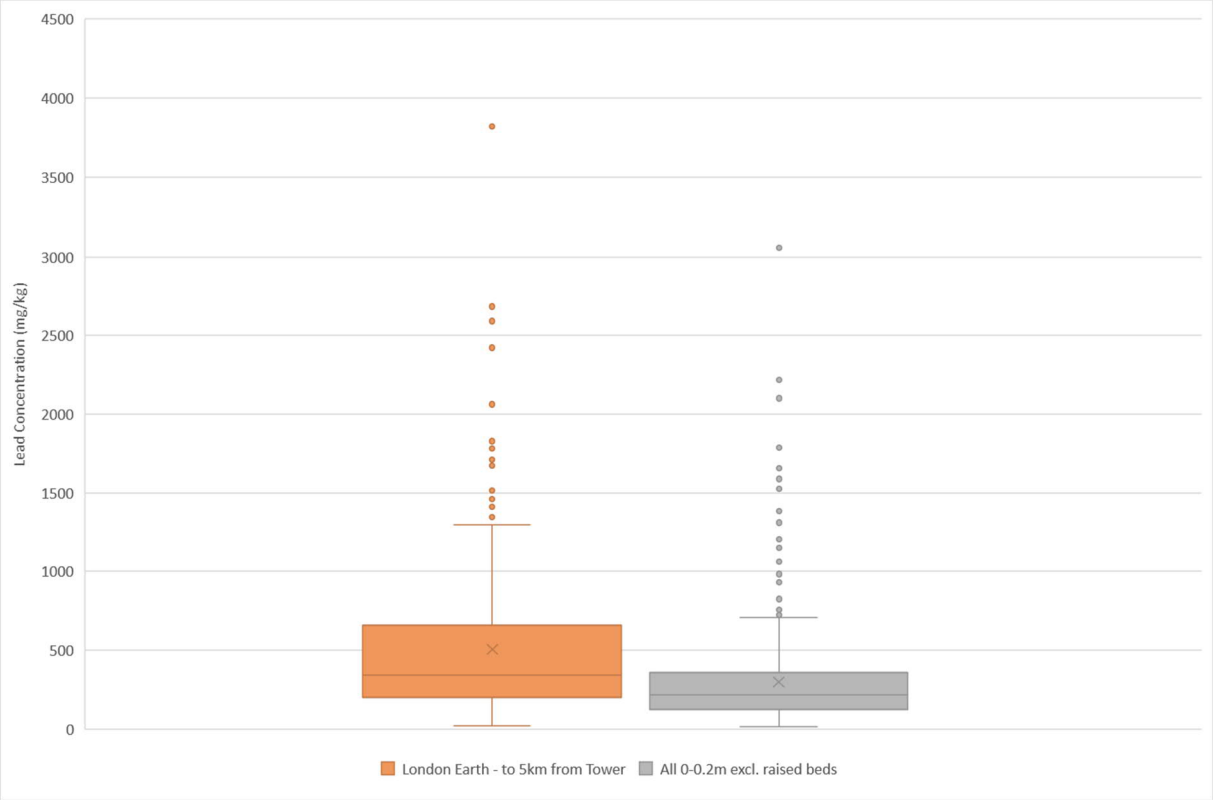


Table 13. Lead concentrations comparison with London Earth data - All samples in 0-20cm depth range from ground level soils
All units mg/kg unless stated otherwise

Method	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval for the Mean
London Earth Background Data (500m radius from the Tower)	4	261	1132	544	392	156 - 933
Stage 1 & Stage 2 Grenfell Tower Sampling (500m radius from the Tower)	250	18	3056	290	195	250 - 332
London Earth Background Data (5km radius from the Tower)	310	20	3821	504	345	455 - 557
Stage 1 & Stage 2 Grenfell Tower Sampling 5km radius from the Tower)	411	17	3056	298	215	269 - 328

Graph 6, Graph 7, Graph 10 and **Table 13** all show that the Stage 1 and Stage 2 sample concentrations appear to fall within (and on the whole at the lower end of) typical background levels in terms of the range of concentrations reported. The reported average concentrations for the Stage 1 and Stage 2 sample dataset are typically lower than those reported for the London Earth dataset for the same area. The 95th percentile of the Stage 1 and Stage 2 dataset was calculated as 767mg/kg. Combined with the evidence from **Graphs 7 to 9** and **Table 13**, this 95th percentile is sufficiently below the NBC of 820mg/kg to indicate that the Stage 1 and Stage 2 data do not appear to represent conditions different to normal urban background. This provides reasonable evidence that the lead content of topsoil around Grenfell Tower is not likely to have changed substantially since the fire compared with reported background concentrations before the fire.

Figure G46 in **Appendix G** also shows the mean lead concentration at each of the sampled areas along with the London Earth background concentrations within that area. The variations in concentrations shown on **Figure G46** do not indicate any particular pattern that might be linked to the sample area location relative to the Met Office indicative modelled plume deposition map.

6.5.1.2 Localised background within specific sampling areas

This section presents an indicative comparison of Stage 1 and Stage 2 sampling with background data from historic investigations in certain sampling areas. The historic data used for comparison are described in **Section 3.8**.

The Stage 1 data collected from Avondale Park (two samples collected, with no further samples collected during Stage 2) reported lead concentrations of 168mg/kg and 1,200mg/kg (both collected at 0cm - 5cm bgl). Historical data (see **Tables B1** and **B2** in **Appendix B**) have been collected from Avondale Park as part of three separate site investigations associated with development planning, verification of topsoil, and a wider assessment of potential land contamination completed between November 2013 and March 2014. 18 samples were collected in soils of 20cm depth or shallower (i.e. targeting topsoil, and most suitable for comparing with Stage 1 and Stage 2 data) and excluding those samples (labelled “V”) that were collected as part of the verification of recently imported soil. The range of lead concentrations in these 18 samples was 41mg/kg to 710mg/kg, with a mean concentration of 318mg/kg. Although the maximum lead concentration of 1,200mg/kg from the Stage 1 sampling exceeds the maximum shallow soil sample concentration from the historical investigations, the historical investigation reported a lead concentration of 1,976mgk/g at a depth of 0.5m at one location. The maximum concentration of 4,445mg/kg from the historical investigation was reported at a depth of 1m bgl and the report concluded that the nearby presence of a historical clay pit (now backfilled) was a likely cause of the high lead concentrations. The concentration of 1,200mg/kg from the Stage 1 sampling is not considered unusual given the findings of the historical investigations suggesting that the fire has not caused increased concentrations in soils, particularly given that the concentration in the second Stage 1 sample was 168mg/kg and towards the low end of the range encountered in the pre-fire sampling investigations.

Also, as part of an investigation linked to development works, historical samples have been collected from Avondale Park Primary School, which is adjacent to Avondale Park, from February 2015 to October 2016. Lead concentrations between 29mg/kg and 500mg/kg were reported in six samples collected between 10cm and 20cm bgl. This compared to the Stage 2 sampling concentrations, which ranged between 32mg/kg and 244mg/kg, with a single Stage 2 sample having a notable higher concentration of 3,056mg/kg. Excluding the maximum of

3,056mg/kg, there does not appear to be an obvious difference between the historical sample results and the Stage 2 results suggesting that the fire has not caused increased concentrations in soils that might have been caused by the fire. The cause of the higher maximum concentration from the Stage 2 sampling is not known; however, one possibility is that it could also be related to the historical clay pit and backfilling activities in this area as noted above for the Avondale Park historical sampling.

Historical data (see **Tables B1** and **B2** in **Appendix B**) have been collected from St Quintin's Family Centre between November 2007 to July 2011 as part of development works at the site and validation of imported topsoil. Lead concentrations in the range 0.7mg/kg to 359mg/kg (mean of 181mg/kg) were reported from 22 samples collected at depths of 0cm - 20cm. This compares to the Stage 2 sampling concentration range of 20mg/kg to 366mg/kg with a mean of 108mg/kg. Hence the Stage 2 sampling data do not indicate any evident increase in concentrations compared to the historic pre-fire dataset; this suggests that the fire has not caused increased concentrations in these soils.

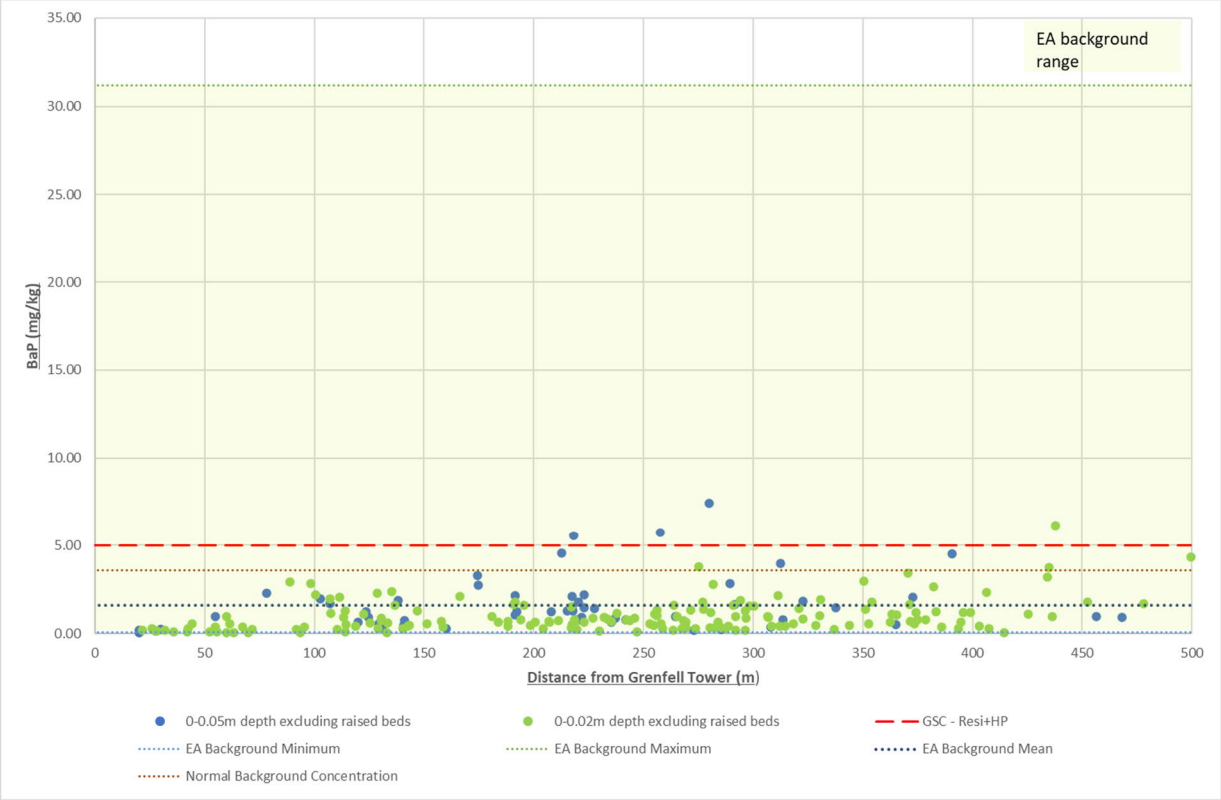
Historical data (thirty-five samples, within a depth range of 10cm - 30cm, 10cm - 40cm, 20cm - 40cm, 20cm - 50cm) have been collected from the Longstone Avenue allotments site in September 2006 as part of an investigation into the potential for contamination (see **Tables B1** and **B2** in **Appendix B**). Lead concentrations were reported ranging between 90mg/kg and 816mg/kg, with a mean of 285mg/kg. The Stage 2 sampling results reported lead concentrations ranging between 36mg/kg and 589mg/kg, with a mean of 296mg/kg. The range and mean of lead concentrations are similar for the historic and Stage 2 sampling datasets; this suggests that the fire has not caused increased concentrations in these soils..

6.5.2 Benzo(a)pyrene

6.5.2.1 National and regional background

Graph 11, **Graph 12** and **Table 14** summarize the comparison between the BaP concentrations reported within each area in the depth range between GL and 0.2m bgl and the background data. The graph also includes the residential C4SL of 5mg/kg (i.e. protective of residential land use including homegrown produce).

Graph 11. BaP concentrations comparison with GSC and background data - Shallow samples, 500m radius from Grenfell Tower



Graph 12. BaP concentrations comparison with GSC and background data - Shallow samples, 5km radius from Grenfell Tower

Table 14. BaP concentrations comparison background data - Shallow samples (0-2cm and 0-5cm) All units mg/kg unless stated otherwise

Method	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval
EA Background Data	42	0.06	31.2	1.59	0.71	1.59 ± 1.44
Vane et al (2014)	76	0.33	6.98	1.90	1.47	Not available
Stage 1 & Stage 2 Grenfell Tower Sampling (0-2cm depth)	294	0.04	13.7	1.30	0.79	1.13 – 1.48
Stage 1 & Stage 2 Grenfell Tower Sampling (0-5cm depth)	84	0.04	11.5	1.75	1.17	1.37 – 2.15

As shown on **Graph 11** and **Graph 12** there does not appear to be any pattern of variation in concentrations linked to sample distance from Grenfell Tower. **Figure H46**, presented in **Appendix H**, also indicates that average BaP concentrations in each sampling area do not appear to be related to distance from Tower or location relative to the modelled plume deposition extent.

Graph 11, Graph 12 and **Table 14** all show that the Stage 1 and Stage 2 sample concentrations appear to fall within typical background levels in terms of range of concentrations, and the reported average concentrations for the Stage 1 and Stage 2 sample datasets are similar to the EA urban background dataset.

The urban NBC for BaP of 3.6mg/kg is higher than both the mean and median Stage 1 and Stage 2 dataset concentrations and the EA dataset concentrations, however, NBCs are defined as 95% upper confidence limits (UCLs) of the 95th percentile of the dataset from which it is derived. The 95th percentile of the Stage 1 and Stage 2 datasets for the 0-2cm samples and the 0-5cm samples are 3.7mg/kg and 5.7mg/kg respectively. Although these values exceed the NBC of 3.6mg/kg, the calculation of 95th percentiles is sensitive to outliers from a normal distribution. Whilst the Stage 1 and Stage 2 dataset does indicate the potential for BaP soil concentrations to be slightly higher than those reported in the EA SHS urban dataset, this does not automatically imply impact from the

Grenfell Tower fire. Similar to the discussion in **Section 6.5.3** for dioxins and furans, the EA SHS dataset is unlikely to be entirely comparable to the data collected from the Stage 1 and Stage 2 investigations.

The Vane et al (2014) background dataset has a slightly higher mean and notably higher median concentration than the EA SHS background dataset and both metrics were higher than the equivalent average concentrations for the Stage 1 and Stage 2 data presented in **Table 14**. It is also worth noting that Vane et al (2014) calculated a local (East London) NBC for BaP of 6.9mg/kg; indicating that background BaP concentrations in dense urban parts of London may be higher than those indicated by the national urban NBC of 3.6mg/kg.

Equally, the comparison with background concentrations from pre-fire site investigations described in **Section 6.5.2.2** has not identified any obvious increases since the fire, and these comparisons are more representative of the soils collected during the Stage 1 and Stage 2 Grenfell investigations from spatial proximity to the Tower and land use type perspectives (the London data in the EA SHS dataset were collected from Richmond Park and Hyde Park, more comparable to Wormwood Scrubs).

6.5.2.2 Localised background within specific sampling areas

This section presents a comparison of Stage 1 and Stage 2 sampling with background data from historic investigations in certain sampling areas. The historic data used for comparison are described in **Section 3.8**.

The Stage 1 data collected from Avondale Park reported BaP concentrations of 0.9mg/kg and 0.95mg/kg (both collected at 0-5cm bgl). Historical data (**Table B1** and **B2** in **Appendix B**) have been collected from Avondale Park between November 2013 and March 2014. Eighteen samples were collected from depths of between 4cm and 20cm with BaP concentrations ranging between 0.35mg/kg and 93mg/kg with a mean concentration of 13.6mg/kg. The two samples from the Stage 1 sampling are at the bottom end of this historic range of concentrations and therefore suggest that the fire has not caused increased concentrations in these soils.

Historical samples have been collected from Avondale Park Primary School from February 2015 to October 2016. Ten samples were collected from a depth range between 10cm and 50cm bgl reporting a BaP concentration between 0.1mg/kg and 98mg/kg. BaP concentrations were reported between 0.04mg/kg and 6.14mg/kg in the ten Stage 2 samples and although the historical samples are slightly deeper, the comparison provides evidence that the surface soils most likely to be impacted by deposition from the fire do not have evidently different concentrations from the general topsoil and subsoil to a depth of 50cm in this area.

Historical data (see **Tables B1** and **B2** in **Appendix B**) have been collected from St Quintin's Family Centre between November 2007 to July 2011. BaP concentrations in the range 0.44mg/kg to 7.34mg/kg (mean of 1.9mg/kg) were reported from 22 samples collected at depths of 0cm - 20cm. The BaP concentration range (0.04mg/kg to 1.49mg/kg) and mean (0.46mg/kg) reported from the Stage 2 sampling were lower than from the historical sampling, suggesting that the fire has not caused increased concentrations in these soils.

Historical data (thirty-five samples, within a depth range of 10-30cm, 10-40cm, 20-40cm, 20-50cm) have been collected from the Longstone Avenue allotments site in September 2006 (see **Tables B1** and **B2** in **Appendix B**), reporting a BaP concentration ranging between 0.58mg/kg and 14.17mg/kg, with a mean of 5.92mg/kg. BaP concentrations from the Stage 2 sampling (all samples including depths of 0-2cm, 0-5cm, 0-20cm and 50-60cm) were reported between 0.1mg/kg and 12.13mg/kg, with a mean concentration of 3.6mg/kg. The historical concentrations appear to be higher than the Stage 2 dataset and therefore this suggests that the fire has not caused increased concentrations in these soils.

6.5.3 Dioxins and Furans

Graph 8, Graph 9 and **Table 15** summarize the comparison between the chlorinated dioxins and furans concentrations (sum of 17 compounds) reported within the Stage 1 and Stage 2 samples and the EA UK SHS background data.

Table 15. Dioxins and furans concentrations comparison with EA background data - Shallow samples All units ng/kg unless stated otherwise

Method	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval
EA Background Data	42	28.6	4312	396	257	198 - 593
Stage 1 & Stage 2 Grenfell Tower Sampling (0-2cm)	60	128	9317	1173	623	789 - 1573
Stage 1 & Stage 2 Grenfell Tower Sampling (0-5cm)	64	154	15507	1808	767	1157 - 2501

Method	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval
Stage 1 & Stage 2 Grenfell Tower Sampling (0-2cm and 0-5cm in parks*)	15	128	1361	477	272	294 - 682

*includes Stonebridge Recreation Ground, Wormwood Scrubs, Little Wormwood Scrubs and Kensington Memorial Park. Avondale Park not included due to documented contaminative historic land use (though relatively low concentrations of 650ng/kg and 520ng/kg were reported).

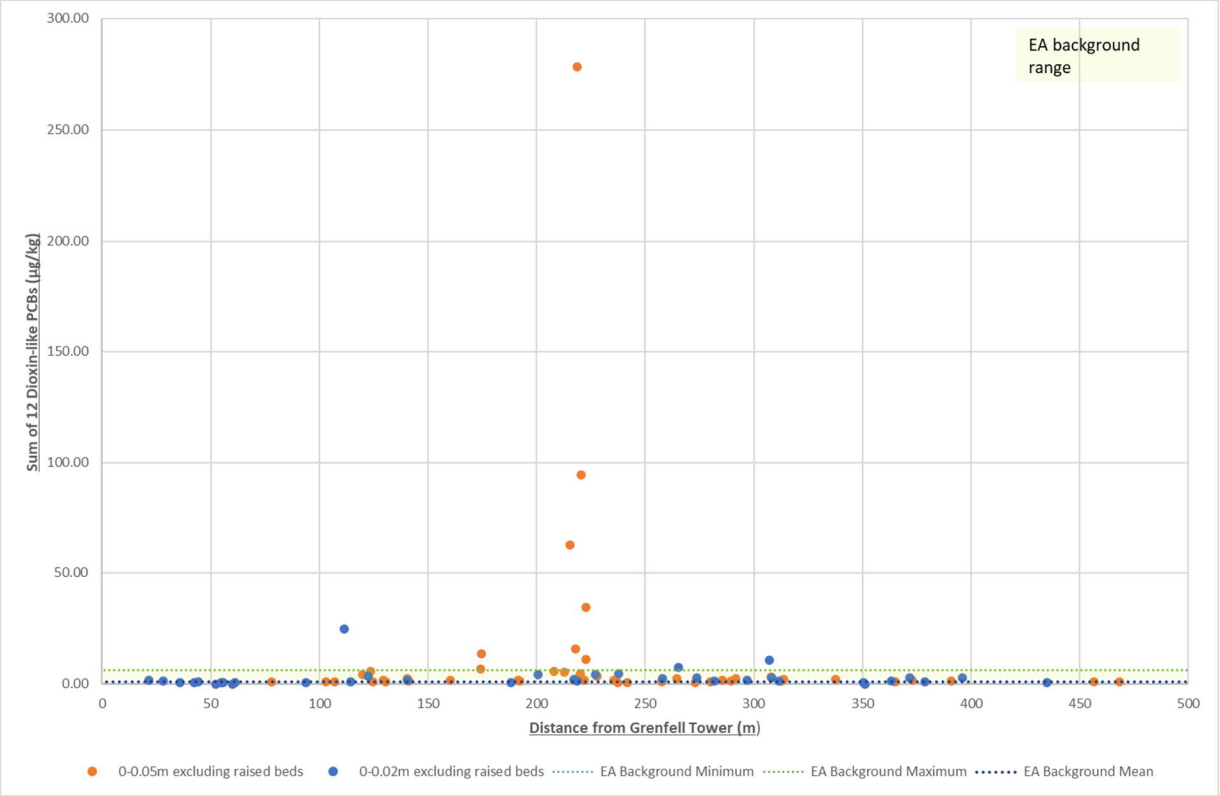
Graph 9 indicates that a number of samples between approximately 140m and 300m from Grenfell Tower have dioxins and furans concentrations higher than the range of EA background concentrations from the urban UKSHS dataset. A discussion of potential reasons for the higher concentrations in these samples was presented in **Section 6.4**. The potentially contaminative historic industrial land uses at these sampling locations is not consistent with the types of sites generally sampled for the EA UKSHS background dataset, which included Hyde Park and Richmond Park in the London area.

Although **Table 15** shows that the estimated average concentrations of the Stage 1 and Stage 2 data (0-2cm and 0-5cm) across all sampling locations are higher than the EA background dataset, when the EA UKSHS dataset is compared to Stage 1 and Stage 2 data collected from park areas similar to Richmond Park and Hyde Park, the ranges and average concentrations are much more similar and this suggests that the Stage 1 and Stage 2 data from parks are similar to the EA UKSHS background dataset. Therefore, there is no evidence of impact from soot and ash deposition from the Grenfell Tower fire at these locations.

6.5.4 Poly-chlorinated Biphenyls

Graph 13, Graph 14 and **Table 16** below summarize the comparison between the dioxin-like PCB concentrations (sum of 12 compounds) reported in the 0-2cm and 0-5cm depth ranges and the EA UKSHS background data.

Graph 13. Dioxin-like PCB concentrations comparison with EA background data - Shallow samples up to 500m from Tower



Graph 14. Dioxin-like PCB concentrations comparison with EA background data - Shallow samples up to 5km from Tower

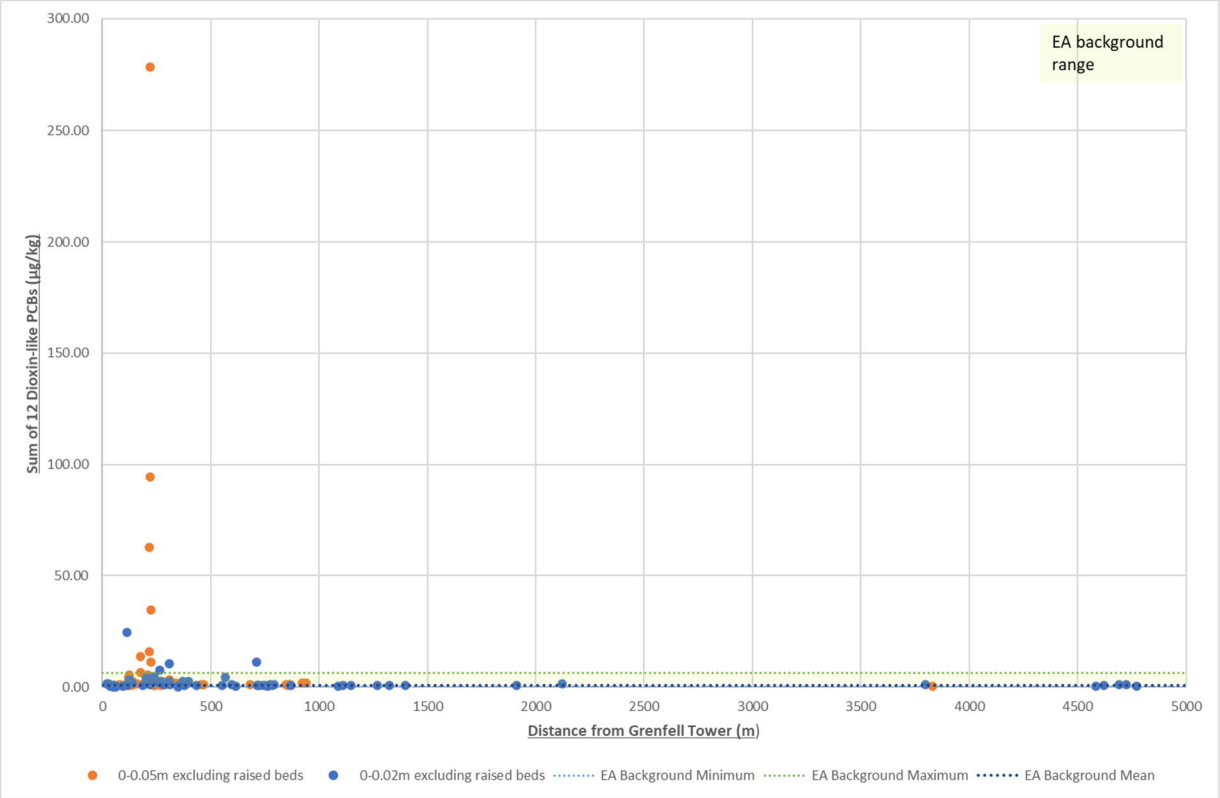


Table 16. Sum of 12 Dioxin-like PCB concentrations comparison with EA SHS background data - Shallow samples

All units µg/kg unless stated otherwise

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval
EA Background Data	42	0.12	6.21	0.87	0.47	0.56 - 1.18
Stage 1 & Stage 2 Grenfell Tower Sampling (0-2cm)	60	0.29	24.7	2.19	1.00	1.40 – 3.09
Stage 1 & Stage 2 Grenfell Tower Sampling (0-5cm)	60	0.51	278	10.2	1.59	2.86 – 20.0
Stage 1 & Stage 2 Grenfell Tower Sampling (0-2cm and 0-5cm in parks*)	15	0.29	1.40	0.87	0.81	0.73 – 1.02

*includes Stonebridge Recreation Ground, Wormwood Scrubs, Little Wormwood Scrubs and Kensington Memorial Park. Avondale Park not included due to documented contaminative historic land use (though relatively low concentrations of 1.12µg/kg and 1.07µg/kg were reported).

In a similar pattern to the dioxins and furans data, **Graph 13** indicates that a number of samples between approximately 140m and 300m from Grenfell Tower have dioxin-like PCB concentrations higher than the range of EA background concentrations from the urban UK SHS dataset. This is also indicated in **Table 16** with the estimated average concentrations of the Stage 1 and Stage 2 samples being higher than the EA SHS background dataset. However, when the Stage 1 and Stage 2 data from the park areas are compared to the UK SHS dataset, there is a much closer match between the mean concentrations.

Similar to the interpretation for chlorinated dioxins and furans, the sampling areas in parks more distant from Grenfell Tower which are nevertheless located on parts of the modelled plume map with higher rates of deposition (Wormwood Scrubs, Stonebridge Recreation Ground, Little Wormwood Scrubs, Kensington Memorial Park) have

reported dioxin-like PCB concentrations more closely matching the EA urban dataset with no evidence of increased concentrations that might be caused by soot and ash deposition from the smoke plume in these areas.

6.6 Asbestos

Asbestos has been detected above the HSE definition of trace (i.e. more than two fibres detected based on a qualitative inspection of the soil sample) in 42 of the 502 samples screened for the presence of asbestos across both the Stage 1 and Stage 2 sampling. **Figures I1** to **I21** in **Appendix I** show the locations where asbestos was encountered, and the reported concentration at each location. The laboratory results for these samples are summarised in **Table 17** below. The asbestos testing comprises three analytical stages or steps, a qualitative inspection that identifies asbestos above "trace" (Testing Step 1), a gravimetric analysis (Testing Step 2) and a fibre counting stage (Testing Step 3).

Table 17. Asbestos detections during Stage 1 & Stage 2 soil sampling

Sample Area	Sample ID	Sampling Location	Qualitative Description (Testing Step 1)	Gravimetric Result (Testing Step 2)	Fibre Counting (Testing Step 3)
2. Burlington Danes School	GTCS2-S017, 0-2cm	Beneath turf in area of grassed open space	Amosite fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS2-S020, 0-2cm	Beneath turf in area of grassed open space	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
4. Thomas Jones Primary School	GTCS2-S035 0-2cm	Beneath turf in area of grassed open space	Chrysotile fibre bundles	**0.005%wt/wt**	<0.001%wt/wt
	GTCS2-S040 0-2cm	Bare soil in accessible landscaped area	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
9. Oxford Gardens Primary School	GTCS2-S084 0-2cm	Bare soil in accessible soil borders	Amosite fibre bundles	<0.001%wt/wt	<0.001%wt/wt
10. Golborne & Maxilla Children's Centre	GTCS2-S096 0-2cm	Bare soil in accessible soft ground	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
11. Grenfell Nursery	GTCS2-S102 0-2cm	Bare soil in outside play area	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
15. St. Quintins Community Kitchen Garden	GTCS1-29 0-5cm	Bare soil in raised growing bed	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS1-30 0-5cm	Bare soil in raised growing bed	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS2-S149 0-20cm	Bare soil in raised growing bed reportedly not used since the fire	Amosite fibre bundles	<0.001%wt/wt	<0.001%wt/wt
17. Equal People	GTCS2-S158 0-20cm	Bare soil within raised growing bed	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
18. Portland Road Community Kitchen Garden and Nottingwood House	GTCS1-18 0-5cm	Bare soil in raised growing bed	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS2-S166 0-20cm	Bare soil within ground level growing bed	Chrysotile and crocidolite fibre bundles	**0.009%wt/wt**	<0.001%wt/wt
21. Lancaster West Walkways	GTCS1-05 0-5cm	Beneath turf in area of grassed open space	Amosite fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS2-S191 50-60cm	Bare soil in raised growing bed	Chrysotile and crocidolite fibre bundles	<0.001%wt/wt	**0.002%wt/wt**
	GTCS2-S193 50-60cm	Bare soil in raised growing bed	Amosite fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS2-S195 0-20cm	Bare soil in raised growing bed	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS2-S197 0-20cm	Beneath turf in area of grassed open space	Amosite fibre bundles	**0.001%wt/wt**	<0.001%wt/wt

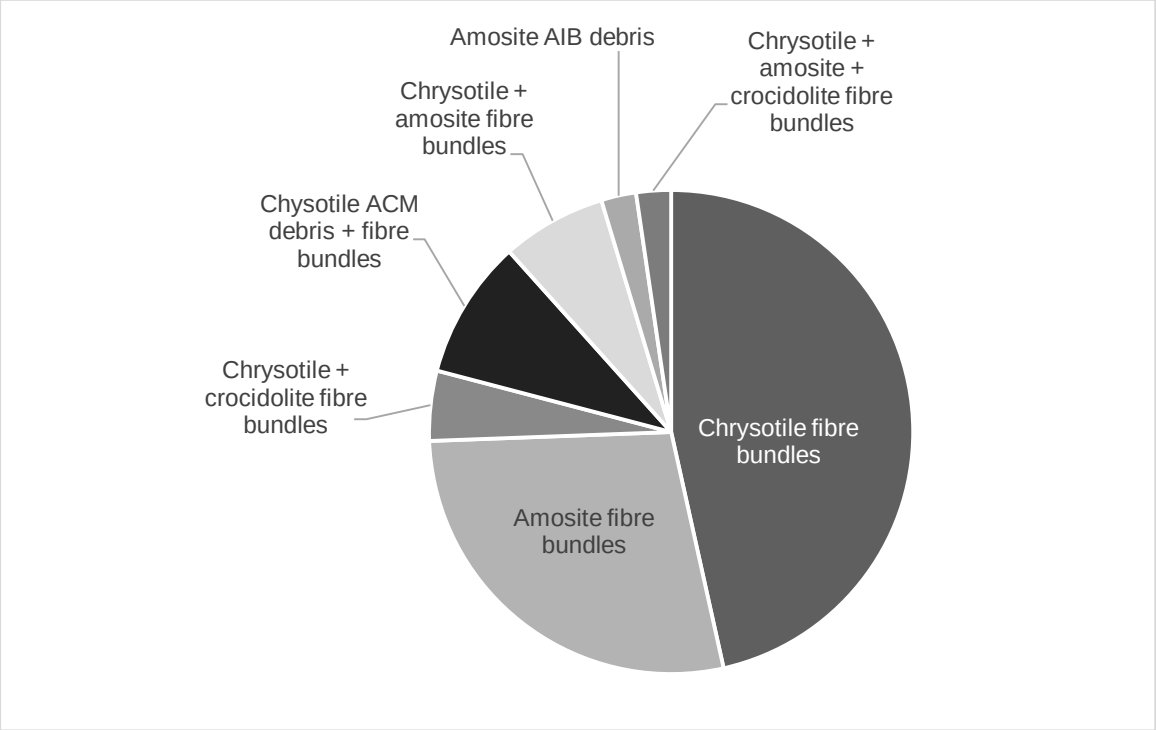
Sample Area	Sample ID	Sampling Location	Qualitative Description (Testing Step 1)	Gravimetric Result (Testing Step 2)	Fibre Counting (Testing Step 3)
	GTCS2-S199 50-60cm	Beneath turf in area of grassed open space	Chrysotile fibre bundles	**0.004%wt/wt**	<0.001%wt/wt
26. Bramley House	GTCS2-S249 40-60cm	Bare soil in raised growing bed	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
28. Treadgold House	GTCS2-S280 0-5cm	Bare soil in ground level planting bed	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
31. Darfield Way	GTCS2-S305, 0-2cm	Beneath turf in area of grassed open space	Amosite fibre bundles	**0.001%wt/wt**	<0.001%wt/wt
32. Lancaster Green	GTCS2-S313 50-60cm	Bare soil in ground level planting bed	Chrysotile ACM debris and fibre bundles	**0.003%wt/wt**	<0.001%wt/wt
33. Robinson House	GTCS1-36 0-5cm	Beneath turf in area of grassed open space	Amosite fibre bundles	<0.001%wt/wt	<0.001%wt/wt
34. Wesley Square	GTCS2-S332 0-20cm	Bare soil within herb growing beds	Chrysotile ACM debris	<0.001%wt/wt	<0.001%wt/wt
	GTCS2-S333 0-20cm	Bare soil within herb growing beds	Chrysotile and amosite fibre bundles	<0.001%wt/wt	<0.001%wt/wt
35. Silchester West (North and North West area)	GTCS2-S349 0-2cm	Beneath turf in area of grassed open space	Amosite AIB debris	**0.151%wt/wt**	**0.002%wt/wt**
36. Maxilla Walk - Maxilla Hall | Maxilla Green	GTCS2-S352 0-2cm	Beneath turf in area of grassed open space	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
39. Tower Cordon	GTCS1-03 0-5cm	Bare soil in accessible soft ground	Chrysotile fibre bundles	-	-
	GTCS2-S381 50-60cm	Beneath turf in area of grassed open space	Chrysotile fibre bundles	**0.115%wt/wt**	<0.001%wt/wt
	GTCS2-S386 0-2cm	Bare soil in area of overgrown vegetation	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
40. Waynflete Square	GTCS1-43 0-5cm	Beneath turf in area of grassed open space	Amosite fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS1-43 10-15cm	Beneath turf in area of grassed open space	Chrysotile and amosite fibre bundles	**0.001%wt/wt**	<0.001%wt/wt
	GTCS1-46 10-15cm	Beneath turf in area of grassed open space	Chrysotile and amosite fibre bundles	**0.002%wt/wt**	<0.001%wt/wt
	GTCS1-47 0-5cm	Bare soil in accessible soft ground	Amosite fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS1-49 0-5cm	Beneath turf in area of grassed open space	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS1-49 10-15cm	Beneath turf in area of grassed open space	Chrysotile, amosite and crocidolite fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS1-50 10-15cm	Beneath turf in area of grassed open space	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS1-51 10-15cm	Beneath turf in area of grassed open space	Amosite fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS1-52 0-5cm	Beneath turf in area of grassed open space	Amosite fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS1-55 0-5cm	Beneath turf in area of grassed open space	Chrysotile fibre bundles	<0.001%wt/wt	<0.001%wt/wt
	GTCS1-59 0-5cm	Beneath turf in area of grassed open space	Chrysotile ACM debris and fibre bundles	**0.083%wt/wt**	<0.001%wt/wt
44. West London Bowling Club	GTCS1-39 0-5cm	Bare soil in accessible soft ground	Chrysotile ACM debris and fibre bundles	<0.001%wt/wt	<0.001%wt/wt

The relevant observations from this data are:

- Asbestos has been detected in 20 sample areas out of a total of 45 sample areas (44%).
- Asbestos has been detected in 43 of the 502 soil samples taken across the Stage 1 and Stage 2 investigations (<9%).
- With the exception of the sampling areas of Waynflete Square and Lancaster Walkways, asbestos has been identified in a minority of soil samples in each area (typically 1-3 samples out of the 10 samples taken per area). Where asbestos is found it does not therefore appear to be widespread when considering the spatial scale of the sampling in each area.
- The spatial distribution of soil samples identified to contain asbestos does not conform to an evident pattern across the investigation area.
- Of the 43 detections, 21 were reported in soils beneath turf ground cover. Asbestos detections below turf included amosite AIB debris and chrysotile ACM debris. Fragments of debris, if deposited on the surface, are less likely to penetrate turf surfaces than individual fibres or small bundles of fibres, suggesting that at least some of the identified asbestos is more likely to be associated with historic pre-fire contamination.
- Asbestos has been detected at or above the reporting limit for quantification (0.001%wt/wt) in eleven samples (GTCS1-43, GTCS1-46, GTCS1-59, GTCS2-S035, GTCS2-S166, GTCS2-S197, GTCS2-S199, GTCS2-S305, 0-2cm, GTCS2-S313, GTCS2-S349, GTCS2-S381) at analytical Step 2 and in two samples (GTCS2-S191 and GTCS2-S349) in Step 3.

The detected asbestos forms and types can be summarised using the pie chart, **Graph 15** below.

Graph 15. Proportions of asbestos types and forms identified in soil samples across the sampling areas



There are some published studies on the occurrence of asbestos in soil in the UK, but these studies do not match the scale of the BGS studies for other contaminants such as lead and benzo(a)pyrene. Defra commissioned a study led by the University of Reading into background concentrations of asbestos in soil in public open space areas in England and Wales in 2015 (Collins, et al., 2019). The study findings were published in 2019 and showed that of the 272 soil samples taken across England and Wales on a 40km grid pattern, asbestos was only detected in two samples. The concentration of asbestos in these two samples was extremely low (<0.0002% by weight).

The Society of Brownfield Risk Assessment (SoBRA) published an open access discussion paper in 2020 (SoBRA, 2020) that summarised the results of a survey of UK commercial soil analytical laboratories designed to collate soil

test data for asbestos. The detection rate of asbestos in soil samples varied from 1.4% to 20% across the laboratories, with the majority of reported concentrations <0.001% by weight.

A recent study (Hellawell & Hughes, 2021) of reported asbestos soil concentrations at brownfield redevelopment sites in Surrey found that asbestos was detected on average in 22% of samples tested between 2016-2019. The majority of samples had concentrations <0.001% by weight.

It is therefore expected that asbestos could be detected in a minority of samples in land that has been subject to repeated development, such as in London. The locations and concentrations of this asbestos are expected to be variable and unpredictable in most cases.

Whilst it cannot be discounted that some of the detected asbestos might be the result of debris and particulate deposition from the fire, the variable spatial presence of asbestos in soil samples and the variable concentrations appears to be consistent with what might be expected in an urban environment with a history of redevelopment. This suggests that the fire has not caused the presence of asbestos in soil over and above what might be expected at background levels in the urban environment around Grenfell Tower.

6.7 Health Risk from Potential Fire-related Impact

All Stage 1 and Stage 2 data have been compared against generic screening criteria (GSC) for residential land-use. The data compared against the residential screening criteria are presented in **Table J46** in **Appendix J**. The purpose of this is to screen out COPC that do not need to be considered any further in the context of potential impact from the fire. Further assessment of health risks from non-fire related sources that have been identified as a consequence of the investigation is presented in **Section 7**. The approach and methodology for assessing risks to health due to the presence of contaminants in soil is presented in full in **Section 7**.

For the large majority of potential fire effluent COPC, none of the reported soil concentrations exceeded the GSC. For those COPC that were not detected above the laboratory detection limit, the GSC was confirmed as being higher than the detection limit (hence any low level presence of the COPC below the limit of detection would fit into Category 4 (i.e. low to no risk)). These COPC are summarised in **Table 18**:

Table 18. Potential fire-effluent COPC without GSC exceedances

COPC Group	Discussion
Metals, excluding arsenic, barium, beryllium, cadmium and lead	Aluminium, boron, chromium, copper, mercury, selenium, vanadium and zinc were all analysed and detected in soils. However, none of the reported concentrations exceeded the GSC, which were available for all of these metals.
PAHs	The non-carcinogenic PAHs including naphthalene, phenanthrene, fluoranthene, pyrene, acenaphthylene, fluorene, acenaphthene, and anthracene were detected in the large majority of samples. However, none of the reported concentrations exceeded the GSC, which were available for all of these PAHs.
SVOCs (other than PAHs or other compounds assessed using the BaP surrogate marker approach)	Phenol was detected above the laboratory MDL in 7 samples, and biphenyl was detected above the laboratory MDL in 1 sample. The reported concentrations were lower than the GSC.
VOCs	Benzene was identified in one of 86 samples and the reported concentration was lower than the GSC. Styrene and carbon disulphide were not reported above the laboratory MDL in any sample tested for VOCs. The GSC for these compounds are higher than the detection limits and are therefore protective of potential trace levels of these compounds that cannot be detected by the laboratory.
Brominated and chlorinated dioxins and furans and dioxin-like PCBs	The assessment presented in **Sections 6.1 to 6.5** did not identify multiple corroborating lines of evidence of these compounds being present in soil as a result of the Grenfell Tower fire, although there were indications of an aerial deposition source based on the assessment of chlorinated dioxins and furans and dioxin-like PCBs. These COPC are present in urban background soil and it cannot be ruled out that some small proportion of the concentrations measured in soil is a result of deposition from the Grenfell Tower fire. However, even the total concentrations reported in soil did not exceed the GSC for residential land use and therefore any indistinguishable minor contribution to those concentrations that might be a result of the fire must also be present in quantities that would result in the land meeting the Category 4 definition.
Organophosphorous flame retardants Triphenylphosphate Tris(1-chloro-2-propyl)phosphate	Triphenylphosphate was not detected above the laboratory detection limit in any sample and although a GSC was not identified for this compound, the lack of any detectable presence of this compound indicates that it is of low priority for further assessment.

COPC Group	Discussion
Tris(2-ethylhexyl) phosphate	Tris(1-chloro-2-propyl)phosphate and tris(2-ethylhexyl) phosphate were detected above the laboratory detection limit in three and five of 82 samples respectively, with the maximum reported concentrations between two and three orders of magnitude lower than the GSC. The lack of evidence for any fire-related impact and the limited number of identified concentrations being substantially lower than the GSC indicates that human health CLs from these compounds would meet the definition of Category 4 land.
Brominated flame retardants poly brominated diphenyl ethers (PBDEs) poly-brominated biphenyls (PBBs) tetrabromobisphenol A hexabromocyclododecane (1,2,5,6,9,10-)	PBDEs, tetrabromobisphenol A and hexabromocyclododecane (1,2,5,6,9,10-) were not detected in any of the 82 samples analysed. GSC were identified for three of the individual PBDE compounds with the GSC at least 63 times higher than the laboratory detection limit. Although GSC were not identified for the other PBDEs, tetrabromobisphenol A or hexabromocyclododecane (1,2,5,6,9,10-), they are considered to be of low priority for human health risk assessment given that the review suggests that the Grenfell Tower fire has not caused detectable concentrations of these COPC in soils. PBBs were detected in a number of samples when analysed using the lower detection limit during Stage 2 sampling. However, the maximum reported concentrations for individual compounds were between 2 and 4 orders of magnitude lower than the GSC.
Isocyanates	These is no evidence of isocyanate impact to soils from the Grenfell Tower fire since none of the compounds were identified above the laboratory detection limit. The GSC for toluene diisocyanate (which was identified as a potential fire effluent by the independent review) was between one and two orders of magnitude above the detection limit. Even if these compounds were present at trace levels not detectable with the laboratory methods used they would not exceed the GSC used to define 'low to no risk'.
Cyanides	Cyanide compounds were detected in 33 of 82 samples, however the maximum reported concentration of 10.5mg/kg did not exceed the GSC of 23mg/kg. Since evidence for fire-related impacts to soil has not been identified for the compounds discussed in **Sections 6.1 to 6.5** there is also a very low likelihood that the reported total cyanide concentrations are related to fire effluent from the Grenfell Tower fire. Free cyanide was reported above the laboratory detection limit in one sample with the reported concentration 33 times lower than the GSC. Thiocyanate was identified in 50 samples; however the maximum concentration of 4.1mg/kg was five times lower than the GSC. Combined with the very low likelihood that the presence of these compounds is related to fire effluents from the Grenfell Tower, human health CLs from cyanides in soil related to the Grenfell Tower fire would meet the definition of Category 4 land.

The COPC with one or more samples at concentrations exceeding the residential GSC are summarised in **Table 19** below.

Table 19. Comparison with Residential GSC

COPC Group	Discussion
Metals	
Arsenic	Concentrations in three of 86 samples exceeded the GSC by up to a factor of 2.5, with these samples located at Portland Road CKG, St. Quintin's CKG and Waynflete Square. The isolated nature of these exceedances and conclusion from **Sections 6.1 to 6.5** that the Grenfell Tower fire has not caused noticeable increases in metals concentrations indicates that the higher concentrations in these samples are associated with historic land uses and are not caused by fire related impact. As a result, human health CLs (if any) associated with arsenic from the Grenfell Tower fire would meet the definition of Category 4 land.
Barium	Concentrations in four and 15 of 86 samples – for barium and beryllium respectively – exceeded the GSC by up to a factor of 2.4, The 4 barium exceedances were spread across 4 different sampling areas and the 15 beryllium exceedances across eight different sampling areas. Neither barium or beryllium were identified as a potential COPC from fire effluent by the independent review (Hadden & Switzer, 2020). Coupled with the isolated nature of these exceedances and conclusion from **Sections 6.1 to 6.5** that the Grenfell Tower fire has not caused noticeable increases in metals concentrations this indicates that the higher concentrations in these samples are associated with historic land uses and are not caused by fire related impact. As a result, human health CLs (if any) associated with barium and beryllium from the Grenfell Tower fire would meet the definition of Category 4 land.
Beryllium	

COPC Group	Discussion
Cadmium	Concentrations in two of 86 samples exceeded the GSC by up to a factor of 2.1. Both samples were located at Waynflete Square in deeper samples (10-15cm) rather than the shallowest samples (0-5cm). these deeper samples were observed to contain a notably greater proportion of anthropogenic materials than the shallowest topsoil samples. The very isolated nature of the two exceedances and the presence in slightly deeper made ground soil likely to be affected by historic land-uses indicates human health CLs (if any) associated with cadmium from the Grenfell Tower fire would meet the definition of Category 4 land.
Lead	The lead concentration in 239 of 543 samples exceeded the GSC , with the mean concentration of all samples (258mg/kg) also exceeding the GSC of 200mg/kg. However, a detailed assessment of whether reported lead concentrations could have been caused by the fire is presented in **Sections 6.1 to 6.5** and the evidence indicates that the presence of lead in soil is not related to the Grenfell Tower fire, but is related to historic pre-fire contamination. The average concentration reported across all samples, regardless of how the data are split, is also considerably lower than the NBC of 820mg/kg and lower than the average lead concentrations reported in the London Earth background dataset across the investigation area. The presence of concentrations lower than typical urban background combined with the conclusion from **Sections 6.1 to 6.5** that the Grenfell Tower fire has not caused noticeable increases in lead concentrations indicates that human health CLs (if any) associated with lead from the Grenfell Tower fire would meet the definition of Category 4 land.
PAHs	
BaP (as a surrogate marker)	The BaP concentration in 28 of 543 samples exceeded the GSC), although the mean concentration of all samples (1.4mg/kg) was lower than the GSC. The detailed assessment of whether reported BaP concentrations could have been caused by the fire is presented in **Sections 6.1 to 6.5** and the evidence indicates that the presence of BaP in soil is not related to the Grenfell Tower fire, but is primarily related to pre-fire historic contamination. The average concentration reported across all samples is also considerably lower than the NBC of 3.6mg/kg. The presence of concentrations lower than the urban NBC, combined with the conclusion that the Grenfell Tower fire has not caused noticeable increases in BaP concentrations indicates that human health CLs (if any) associated with BaP (and other compounds evaluated by the BaP surrogate marker approach) from the Grenfell Tower fire would meet the definition of Category 4 land.
Non dioxin-like PCBs	Concentrations in one of 82 samples (located at Waynflete Square) exceeded the GSC by a factor of 2. Non-dioxin like PCBs were not identified as a group of potential COPC from fire effluent by the independent review (Hadden & Switzer, 2020). Coupled with the isolated nature of a single exceedance and the conclusion from **Sections 6.1 to 6.5** that the Grenfell Tower fire has not caused noticeable increases in COPC concentrations this indicates that this concentration exceeding the GSC is associated with historic land uses and was not caused by fire related impact. As a result human health CLs (if any) associated with non-dioxin-like PCBs from the Grenfell Tower fire would meet the definition of Category 4 land.
Asbestos	Discussed separately below.
Synthetic vitreous fibres (SVF) / man-made mineral fibres (MMMF)	Synthetic Vitreous Fibres (SVFs) do not have published GSC. An occupational exposure limit for SVFs has been set by the Health and Safety Executive (HSE) of 2f/cm^3. The HSE Control Limit for asbestos fibres by comparison is 0.1f/cm^3, suggesting that from an occupational health perspective, asbestos fibres are of more concern than SVFs. There is emerging evidence that exposure to very high levels of airborne SVFs might be a causal factor in adverse respiratory health effects noted in people affected by the World Trade Center collapse (Lippmann, et al., 2015), but such high exposures are not consistent with the substantially lower exposure levels that might be associated with low levels of SVFs in soil. No information has been found on typical background levels of SVFs in soil; however, SVFs are commonly used in building insulation and would therefore be expected to be present in the urban environment, particularly in areas of multiple phases of demolition and development, such as the areas around Grenfell Tower. The occupational exposure limit for SVFs appears to be associated with short-term reversible irritation to skin, eyes, nose, throat and lungs (therefore unlikely to meet the definition of significant harm), rather than chronic long-term adverse health effects. No commercially available laboratory method for reliably quantifying the number of synthetic vitreous (or machine-made mineral) fibres has been found and therefore a quantitative assessment of the SVF identified in soil is not possible at this time. Given the conclusion from **Sections 6.1 to 6.5** that the Grenfell Tower fire has not caused noticeable increases in COPC concentrations and the high likelihood that SVFs will be present at background levels in the urban environment, it is

COPC Group	Discussion
	concluded that it is very likely that human health CLs (if any) associated with SVFs from the Grenfell Tower fire would meet the definition of Category 4 land.

All detected asbestos concentrations pass the GSC described in **Section 7**, with the exception of those listed in **Table 20** below:

Table 20. Individual Sample Results Equal to or Greater Than Adopted GSC

Sample Area	Sample ID	Analytical Result	Comment
Lancaster West Walkways	GTCS2-S191	Chrysotile and crocidolite fibre bundles 0.002%wt/wt	Fibre bundles detected under the microscope at the method reporting limit and equal to the GSC in S197 when the reported concentration is multiplied by 10 to account for the presence of amosite. This sample was taken from under turf. Fibre bundles detected under the microscope above the GSC in S191 if the reported concentration is multiplied by 10 to account for the presence of crocidolite fibres. This sample was taken from one of the raised growing beds. The laboratory testing does not differentiate the quantities of chrysotile and crocidolite in the sample. If the dominant asbestos present is chrysotile the GSC would not be exceeded. Asbestos detected in 3 other samples (out of 12 in total) – all with reported concentrations less than the DIV Tier 1 value (the GSC adopted for this assessment, refer to **Table 26**). It is considered very unlikely that the average concentration of asbestos in soil in this area exceeds the GSC (noting the limitations of accurately calculating averages in datasets dominated by non-detects). In the raised bed from which sample S197 was taken, asbestos was not detected in the other samples taken from this bed at the same location at the different depths of 0-0.02m and 0.5-0.6m.
	GTCS2-S197 (0-0.2m)	Amosite fibre bundles 0.001%wt/wt	
Darfield Way	GTCS2-S305	Amosite fibre bundles 0.001%wt/wt	Fibre bundles detected under the microscope at the method reporting limit and equal to the GSC. S305 taken from beneath turf. Asbestos not detected in other 11 samples taken from this area. It is considered very unlikely that the average concentration of asbestos in soil in this area exceeds the GSC (noting the limitations of accurately calculating averages in datasets dominated by non-detects).
Portland Road CKG	GTCS2-S166	Chrysotile and crocidolite fibre bundles 0.009%wt/wt	Fibre bundles detected under the microscope in one of 12 samples taken in this area. The reported concentration in S166 exceeds the GSC if the concentration is multiplied by 10 to account for the presence of crocidolite fibres. The laboratory testing does not differentiate the quantities of chrysotile and crocidolite in the sample. If the dominant asbestos present is chrysotile the GSC would not be exceeded. No asbestos was detected in the three samples taken from raised beds. Of the four samples taken from ground level soils one other sample, GTCS1-18, was reported to contain chrysotile fibres bundles at a concentration below the method reporting limit of 0.001%wt/wt. It is considered very unlikely that the average concentration of asbestos in soil in this area exceeds the GSC (noting the limitations of accurately calculating averages in datasets dominated by non-detects).
Silchester West	GTCS2-S349	Amosite asbestos insulation board (AIB) fragment 0.151%wt/wt with associated 0.002%wt/wt concentration of loose fibres also detected	One AIB fragment detected under the microscope in one sample. Sample taken from beneath turf. No asbestos detected in the other 11 samples taken from this area. The data is not suggestive of widespread presence of AIB fragments in the soil, although the sporadic presence of other fragments across the sampling area cannot be ruled out. It is considered unlikely that the average concentration of asbestos exceeds the GSC (recognising that the concentration in this one sample is 153x higher than the GSC and noting the limitations of accurately calculating averages in datasets dominated by non-detects and a singular elevated concentration).

Sample Area	Sample ID	Analytical Result	Comment
Tower Cordon	GTCS2-S381	Chrysotile fibre bundles 0.115%wt/wt	A relatively high (11.5x higher than the GSC) concentration of fibre bundles (likely to be associated with the disaggregation of a fragment of asbestos containing material) identified under the microscope in a sample taken from a depth of 50-60cm. Asbestos not detected in the shallower samples taken at this location and area is turfed. The presence of asbestos in this deeper sample is therefore likely to be a result of historical land-use (including potential historical importation of soil). Asbestos detected in two other shallow samples in this area (out of 14 samples in total). It is considered very unlikely that average soil concentrations exceed the GSC (noting the limitation of accurately calculating averages in datasets dominated by non-detects and a singular elevated concentration).
Waynflete Square	GTCS1-43	Chrysotile and amosite fibre bundles 0.001%wt/wt	Out of the 26 soil samples tested, asbestos was not detected in 15 samples. In 8 samples it was detected below the quantification limit of 0.001%wt/wt and detected above the method reporting limit in 3 samples. All three samples were taken beneath turf. Fibre bundles detected under the microscope in GTCS1-43 at the method reporting limit and equal to the GSC if the concentration is multiplied by 10 to account for the presence of amosite fibres. Chrysotile and amosite fibre bundles were detected below the method reporting limit (i.e. <0.001%wt/wt) in the shallower sample taken at this location. Fibre bundles detected under the microscope in GTCS1-46 and the reported concentration exceeds the GSC if the concentration is multiplied by 10 to account for the presence of amosite fibres. The laboratory testing does not differentiate the quantities of chrysotile and amosite in these two samples. If the dominant asbestos present is chrysotile the GSC would not be exceeded. ACM debris and associated chrysotile. Asbestos was not detected in the shallower sample taken at this location. Chrysotile ACM debris and fibre bundles detected under the microscope in GTCS1-59. At a reported concentration of 0.083%wt/wt this is 8.3x the GSC. With asbestos concentrations exceeding the GSC in only 2 samples out of 26 it is considered very unlikely that average soil concentrations exceed the GSC (noting the limitation of accurately calculating averages in datasets dominated by non-detects).
	GTCS1-46	Chrysotile and amosite fibre bundles 0.002%wt/wt	
	GTCS1-59	ACM debris and chrysotile fibre bundles 0.083%wt/wt	

In all cases it is considered unlikely that average fibre in soil concentrations exceed the GSC for asbestos (taking into account that the DIV is relevant to the average soil concentration within an area up to 1,000m^2 when used in accordance with the Dutch assessment framework). The health risk from exposure to asbestos in soil at concentrations below the GSC is minimal. The majority of the samples noted in **Table 20** are currently located under turf which reduces the risk compared to bare soil. To support this conclusion that the risk appears to be low, a supporting line of evidence in the form of a risk estimation based on the methodology described in CIRIA C733 (Nathanail, et al., 2014) is provided in **Appendix J**.

Bearing in mind that the evidence suggests that the Grenfell Tower fire has not caused asbestos impact that could be distinguished from what might be expected in urban background (based on evidence from (Hellawell & Hughes, 2021) summarised in **Section 3.9** and reported expectations for urban soils in CIRIA C733 (Nathanail, et al., 2014)), and the assessment of health risk from the asbestos that has been detected as low, it is considered that human health CLs (if any) associated with asbestos from the Grenfell Tower fire would meet the definition of Category 4 land.

6.8 Summary of Potential Fire-related Impacts

Section 6 has assessed the available evidence to determine whether there is any indication of significant contamination caused by the Grenfell Tower fire. For the purposes of the assessment this has comprised looking for patterns in the spatial distribution of the concentrations of COPC, and comparison with pre-fire background levels, to determine whether potential impacts from the fire have resulted in concentrations in soil that exceed GSC that define health risk consistent with Category 4 land (i.e. no to low risk).

Specific assessments included:

- **Section 6.1:** Evidence of the presence of fire-related COPC in soils within the investigation area;
- **Section 6.2:** Comparison of a variety of sub-sets of the soil results (differing depths, differing ground cover, raised beds vs. ground level) to identify potential consistent differences in concentrations that could be attributed to fire-related impact.
- **Section 6.3:** Comparison of soil concentrations with spatial position from the Tower to determine whether there were any noticeable patterns that could be attributed to the fire.
- **Section 6.4:** Comparison of soil concentrations with distance from the Tower to determine whether there were any noticeable patterns that could be attributed to the fire.
- **Section 6.5:** Comparison of soil concentrations with pre-fire background concentrations to determine whether there were any noticeable increases above the background levels that could be attributed to the fire; and
- **Section 6.7:** Comparison of soil concentrations with GSC designed to indicate levels below which risks to health meet the definition of Category 4 (i.e. no to low risk.

(The evidence from asbestos has been treated separately in **Section 6.6**).

When evaluating each line of evidence, it is important to note that individual patterns of COPC that have the potential to indicate fire-related impact must be corroborated by other lines of evidence. Furthermore, evidence of potential aerial deposition sources do not necessarily imply impact from the Grenfell Tower fire, but could also be caused by long-term historic deposition from diffuse urban air pollution.

An integrated summary of the lines of evidence for the key COPC is presented below, with asbestos dealt with in **Section 6.6** above.

6.8.1 Chlorinated Dioxins and Furans

The assessment of different depth samples and ground cover type indicated that chlorinated dioxins and furans in ground level soils (i.e. those excluding raised beds for growing produce) could have an aerial deposition source. The comparison of concentrations with distance from the Tower and with indicative background levels from the EA UKSHS urban dataset also suggested the potential for higher concentrations above background closer to Grenfell Tower. However, a more detailed review of the precise locations of the higher concentrations relative to the tower location did not identify any pattern consistent with radial debris deposition or the indicative plume extent to the northwest. The comparison with GSC concluded that chlorinated dioxins and furans concentrations would cause the associated CL to fall into the definition of Category 4 land (i.e. no to low risk) and therefore any potential minor contribution from the Grenfell Tower fire – which has not been discernible by the multiple lines of evidence but which cannot be entirely ruled at if present at very low amounts that are inseparable from the underlying background – would also fall into the definition of Category 4 land.

6.8.2 Lead

The assessment of different depth samples, raised beds vs. ground level soil, and ground cover type, suggested a possible aerial deposition source, although there is considered to be relatively high uncertainty with this interpretation. Lead concentrations in ground level soil were generally higher than in raised beds indicating the possibility of pre-fire historic contamination in ground level soils that is not present in raised beds. Equally, the comparison of concentrations with distance from the Tower, with pre-fire background levels and with spatial position relative to the Tower did not identify any patterns consistent with a source from the Grenfell Tower fire. Since the assessment suggested that the Grenfell Tower fire had not caused discernible increases in lead soil concentrations, there could not be considered to be a potential CL for lead associated with the Grenfell Tower fire (hence no evidence of a risk from the Grenfell Tower fire) and as such any risk to health from lead in soil was associated with pre-fire historic contamination. This has been addressed separately in **Section 7** of this report onwards.

6.8.3 Benzo(a)pyrene

The assessment of different depth samples, raised beds vs. ground level soil, and ground cover type did not identify any particular pattern of data that would indicate an aerial deposition source, either historic or recent. BaP concentrations in ground level soil were generally higher than in raised beds indicating the possibility of pre-fire historic contamination in ground level soils that is not present in raised beds. Equally, the comparison of concentrations with distance from the Tower, with pre-fire background levels and with spatial position relative to the Tower did not identify any patterns consistent with a source from the Grenfell Tower fire. Since the assessment

suggested that the Grenfell Tower fire had not caused discernible increases in BaP soil concentrations, there could not be considered to be a potential CL for BaP associated with the Grenfell Tower fire (hence no evidence of a risk from the Grenfell Tower fire) and as such any risk to health from BaP in soil was associated with pre-fire historic contamination. This has been addressed separately in **Section 7** of this report onwards.

6.8.4 Antimony

The assessment of different depth samples, raised beds vs. ground level soil, and ground cover type did not identify any particular pattern of data that would indicate an aerial deposition source, either historic or recent. There was also little different in concentrations of antimony in ground level soils compared to raised beds, indicating that antimony concentrations in ground level soils may be mainly controlled by its natural occurrence rather than any historic or ongoing anthropogenic urban pollution. Equally, the comparison of concentrations with distance from the Tower, with pre-fire background levels and with spatial position relative to the Tower did not identify any patterns consistent with a source from the Grenfell Tower fire. Since the assessment suggested that the Grenfell Tower fire had not caused discernible increases in antimony soil concentrations, there could not be considered to be a potential CL for antimony associated with the Grenfell Tower fire. Equally, the concentrations encountered (and considered to be unrelated to the Grenfell Tower fire) would result in a risk to health falling into the definition of Category 4 land (i.e. no to low risk).

6.8.5 Dioxin-like PCBs

The assessment of different depth samples, and ground cover type indicated the potential for an aerial deposition source, although there is considered to be relatively high uncertainty with this interpretation. The comparison of concentrations with distance from the Tower and with indicative background levels from the EA UKSHS urban dataset also suggested the potential for higher concentrations above background closer to Grenfell Tower, though not to the same extent as for chlorinated dioxins and furans. However, a more detailed review of the precise locations of the higher concentrations relative to the tower location did not identify any pattern consistent with radial debris deposition or the indicative plume extent to the northwest. The comparison with GSC concluded that dioxin-like PCB concentrations would cause the associated CL to fall into the definition of Category 4 land (i.e. no to low risk) and therefore any potential minor contribution from the Grenfell Tower fire – which has not been discernible by the multiple lines of evidence but which cannot be entirely ruled at if present at very low amounts that are inseparable from the underlying background – would also fall into the definition of Category 4 land.

7. Generic Quantitative Risk Assessment

Risk assessment is an iterative and tiered process, with the process normally continuing under Part 2A until it is possible to decide whether or not the land meets the definition of Contaminated Land, or that there is insufficient evidence to justify further inspection and assessment. This is underpinned by the Part 2A starting assumption that land is not contaminated, and the burden of proof is required to demonstrate that it is. The purpose of Generic Quantitative Risk Assessment (GQRA) as defined in the Part 2A Statutory Guidance is to use generic assessment criteria (GAC) to help decide when land can be excluded from the need for further inspection and assessment, or when further work may be warranted. For Part 2A, one of the primary objectives of the GQRA is to determine whether land can be immediately placed into Category 4. For land where a contaminant linkage (CL) has been identified, the Statutory guidance states that this land should be placed into Category 4 where:

1. The land has only normal levels of contaminants in soils;
2. Contaminant levels do not exceed relevant GAC; or
3. Land where the estimated intake from soil represents only a small proportion of that from other sources (such as diet).

In UK guidance, the term GAC has typically come to be used to refer to assessment criteria derived in accordance with UK guidance and based on tolerable or minimal risk levels. Therefore for this GQRA, the term generic screening criteria (GSC) has been used to refer to a broader range of criteria including those derived by national organisations outside the UK as well as UK derived criteria that are based on low levels of toxicological concern (LLTCs), namely the Category 4 Screening Levels (C4SLs) published by Defra (Department for Environment, Food and Rural Affairs (Defra), 2012a).

To address normal levels of contaminants in soils, the GQRA uses the background data information (particularly the NBCs) presented in **Section 6.5** to screen out – to the extent appropriate – concentrations of contaminants that do not exceed normal levels. In accordance with Paragraph 3.22 of the Part 2A Statutory Guidance *"Normal levels of contaminants in soil should not be considered to cause land to qualify as contaminated land, unless there is a particular reason to consider otherwise. Therefore, if it is established that land is at or close to normal levels of particular contaminants, it should usually not be considered further in relation to the Part 2A regime…".* The NBCs derived by Defra were explicitly intended to meet the definition of "normal levels" as described by the Part 2A Statutory Guidance, and it includes both the natural and diffuse anthropogenic contribution to the concentration of a contaminant in soil.

The laboratory testing data used for this GQRA represents the concentrations of COPC in soil irrespective of the source. **Section 6** concluded that there was not any impact from the Tower fire that would result in risks to health above the 'low to no risk' range for Category 4 land. However, the concentrations of some COPC identified as likely resulting from pre-fire historic land uses required further risk assessment, and this additional risk assessment for individual sampling areas predominantly deals with the underlying pre-fire contamination that has been encountered.

The soil data collected for each sampling area was based on the Stage 2 objectives to identify potential contamination arising from the Grenfell Tower fire. As a result, the COPC tested, the number of samples, sample depths and sampling locations chosen, were designed to answer questions about fire-related contamination and have not been explicitly designed to undertake a Part 2A assessment of each sampling area. This risk assessment therefore focusses on risks based on data collected during Stage 1 and Stage 2, but may be an incomplete assessment of all potential risks associated with potential historic pre-fire contamination within each sampling area.

7.1 Conceptual Exposure Scenarios

For this GQRA, laboratory soil test results have been compared against a range GSC published by authoritative national or international bodies or developed in accordance with methodologies set out by these bodies. Similar GSC relevant to the assessment of land contamination are not available for the assessment of crop samples. The crop testing data described in **Section 5** has been used to calculate soil to plant concentration factors (CF) as part of the detailed quantitative risk assessment presented in **Section 8**.

It is necessary for the adopted GSC to be appropriate and suitable for the conceptual exposure at the Site. GSC for use in the UK are typically available for six land use types based on the Contaminated Land Exposure Assessment (CLEA) (Environment Agency, 2009) and Category 4 Screening Level (C4SL) (DEFRA, 2012) guidance, including:

- Residential with private gardens where homegrown produce may be cultivated and consumed (hereafter referred to as “Resi+HP”).
- Residential without private gardens where no homegrown produce is assumed (hereafter referred to as “Resi-HP”).
- Commercial and industrial settings (hereafter referred to as ”Comm/Ind”).
- Public open spaces comprising parkland (hereafter referred to as “POSpark”).
- Public open spaces in close proximity to residential property (hereafter referred to as “POSresi”).
- Allotments.

The relevant exposure pathways and assumptions for each of these land-uses are summarised in **Table 21** below in order to determine which are initially sufficiently precautionary and relevant for use to assess the land-uses around Grenfell Tower.

Table 21. Exposure pathways and assumptions for generic land use scenarios

Pathway	Resi+HP	Resi-HP	POSpark	POSresi	Comm/Ind	Allotments
Soil and dust ingestion	Y	Y	Y	Y	Y	Y
Dust inhalation - indoor and outdoor	Y	Y	Y (outdoor only[1])	Y	Y	Y (outdoor only[1])
Dermal contact - indoor and outdoor	Y	Y	Y (outdoor only[1])	Y	Y	Y (outdoor only[1])
Consumption of homegrown produce	Y	N	N	N	N	Y
Inhalation of vapours - indoor and outdoor	Y	Y	Y (outdoor only[1])	Y (outdoor only[1])	Y	Y (outdoor only[1])
Critical receptor	0-<6 years female child	0-<6 years female child	0-<6 years female child	3-<9 years female child	16-65 years female worker	0-<6 years female child
Exposure duration	6 years	6 years	6 years	6 years	49 years	6 years
Occupation period – indoor	0-<4yrs – 23hrs 4-<6yrs – 19hrs	0-<4yrs – 23hrs 4-<6yrs – 19hrs	0hrs	3-<4yrs – 23hrs 4-<9yrs – 19hrs	8.3	0hrs
Occupation period - outdoor	1hr	1hr	2hrs	1hr	0.7hrs	3hrs
Exposure frequency	365 days	365 days	170 days	365 days (170 days outside)	230 days	365 days (consumption)up to 130 days (on site)
Fruit/veg plot size	19.9m^2	n/a	n/a	n/a	n/a	132.9m^2

[1] No tracked back soil into home pathway

For assessing the potential health risks caused by potential fire-related impact, the most sensitive land-use within the investigation area has been considered. This is the Resi+HP scenario and the full Stage 1 and Stage 2 dataset has been compared to GSC protective of this scenario. This comparison is discussed earlier in **Section 6**.

Since the conclusion drawn from **Section 6** was that there was no significant fire-related contamination that would cause land to meet anything other than the definition of Category 4 land, the localised assessment for individual sampling areas has taken the approach of comparing data from these individual areas with GSC derived specifically for each sampling area’s land-use on the basis that the contamination identified in that sampling area is specific to that area.

With this in mind and noting that 13 of the 45 sampling areas were schools or nurseries, GSC protective of a schools scenario have been derived for the main Stage 2 COPC - lead and benzo(a)pyrene. Although dioxins, furans & dioxin-like PCBs were also tested more widely as part of the Stage 2 investigation, a schools GSC was not derived for these COPC since the Hazard Index calculated for the Resi+HP scenario screening undertaken and reported in **Section 6** did not exceed 1.0 (i.e. the risk to public health from these compounds is negligible regardless of land-use). The derivation of additional school GSC was therefore not necessary. The derivation and justification for the schools land-use scenario and the resulting GSC are presented in **Appendix J.**

For this assessment, the conceptual exposure for any given sampling area will vary dependent on the specific land-use for that sampled area. The sampled areas fall into four main categories:

- Schools and nurseries;
- Communal or public areas within a residential setting;
- Public parks; and
- Community kitchen gardens.
- In addition, one area – Longstone Avenue allotments – is a full-size allotments.

The CKGs fall into two differing scenarios. There are those that are standalone areas separated from nearby residential occupancy, and there are others that are embedded in residential estates and are openly accessible within the communal gardens which might be either restricted access to residents, or accessible by the general public.

The land-use for the standalone CKGs is likely to be similar to the standard POSpark land use in terms of the active exposure pathways, but with an added consumption of homegrown produce pathway. The consumption of homegrown produce pathway is expected to be of significantly lesser importance that the allotments land use and more closely aligned to (though still less than) consumption of produce in the Resi+HP scenario. Exposure in these areas is also affected by the evidence identified in **Section 6** that there is a noticeable difference in soil quality between the ground level soils and the soils in the raised beds for some COPC. At two of these sites (Portland Road and Henry Dickens Court), the cultivation of produce is not restricted to the raised beds, with some tree fruit and shrub fruits grown in ground level soil.

For the CKGs or growing areas embedded within the residential communal garden areas usage of these CKGs is most likely to be similar to the POSresi land-use with an additional consumption of homegrown produce pathway. One caveat to this is for Eynham Road and Treadgold House, where there may be an element of the use of these areas that is more akin to a private residential scenario (discussed in more detail in **Table 22**).

Different approaches are taken on an area specific basis as described in **Table 22** below, which provides a summary of the land-use in each of the 45 sampling areas and indicates which of the GSC land-use scenarios – or combination of scenarios – best fits each sampling area.

Table 22. Sampling Area Land-use Scenario Selection

Area Name	Discussion
Latimer Alternative Provision Academy	Latimer Alternative Provision Academy is a school for vulnerable and challenging young people. It has a single main school building with grounds around the building comprising hard paved play areas, grasses areas and raised beds built into the perimeter wall for decorative planting. There are currently two small unused raised wooden planters. The schools GSC described in Appendix J is considered suitable for this area.
Burlington Danes School	Burlington Danes School is a combined primary and secondary school with a mixture of hard paved areas, soft landscaping and grass playing fields. No raised beds with any potential for growing produce were observed during the site walkover. The schools GSC described in Appendix J is considered suitable for this area.
Bassett House School (St Helen's Church)	The main Bassett House School locations do not have any unpaved outside space and were therefore not suitable for soil sampling. The school uses outside space at St. Helen's Church for some breaktimes and lessons with a small woodland area which is partly covered in artificial grass with soil borders. Raised beds for growing produce were present but they were reported to have been installed after the fire. The schools GSC described in Appendix J is considered suitable for this area, although is likely to be overly conservative.
Thomas Jones Primary School	Thomas Jones Primary School is a primary school with a single storey school building surrounded by grounds which include hard paved play areas, soft landscaped areas of

Area Name	Discussion
	grass and soil borders, areas of less managed grass and bare soil for woodland type play and learning, and raised beds with the potential for growing produce. The schools GSC described in Appendix J is considered suitable for this area.
All Saints Catholic College	All Saints Catholic College is a secondary school with one main school building surrounded by grounds comprising a combination of hard paved and soft landscaping. Some raised beds were present in one area. The schools GSC described in Appendix J is considered suitable for this area.
Barlby Primary School	Barlby Primary School was undergoing redevelopment with a new school building being constructed in the eastern part of the area. The existing school comprises a main single storey building with some temporary buildings in the grounds. The grounds comprised mainly hard paving or artificial grass with some areas of landscaping, bare earth and a less managed grass/soil area. The schools GSC described in Appendix J is considered suitable for this area.
St. Francis Primary School	St. Francis Primary School comprises one main school building with two smaller ancillary buildings. Construction works were ongoing in the northeast of the area with this part currently inaccessible to pupils. The majority of the outside space comprised hard paving or artificial grass with some soil borders and one 'woodland' garden area. Growing beds and some small fruit trees were present in the west of the area although they had reportedly not been used since the fire. The schools GSC described in Appendix J is considered suitable for this area.
St. Anne's and Avondale Primary School and Nursery	St. Anne's and Avondale Primary School and Nursery is a combined primary and nursery school with two main school buildings. The outside space was primarily hard paved play areas with some managed soil borders, some raised beds and a small bare earth 'woodland' type area. The schools GSC described in Appendix J is considered suitable for this area.
Oxford Gardens Primary School	Oxford Gardens Primary School has three main school buildings with the outside space almost entirely hard paved with the exception of managed vegetated soil borders and some raised decorative beds. The schools GSC described in Appendix J is considered suitable for this area.
Golborne and Maxilla Children's Centre Forest School	The Forest School is an area of open space used for play and woodland style learning that is not adjacent to the main Golborne and Maxilla Children's Centre, which is located approximately 750m northeast of the Forest School. The schools GSC described in Appendix J is considered suitable for this area, although it is likely to be overly conservative as the Forest School is not used as frequently as an onsite outdoor play area and the distance from the main building means that tracked back dust exposure will be relatively lower.
Grenfell Creche Under 3s' Centre / Grenfell Nursery	Grenfell Creche Under 3s' Centre / Grenfell Nursery is a small nursery with an outdoor play area comprising a mixture of hard paving, artificial grass and some bare soil areas around the edge. A slightly raised area of bare soil with brick edging is present although it is not used for growing edible produce. An area of currently unused land in the eastern part of the sampling area is inaccessible to the children and has mixed ground cover of cobbled paving, bare soil and light vegetation. The schools GSC described in Appendix J is considered suitable for this area.
New Studio pre-school	New Studio pre-school is a nursery with a single indoor area and a large grassed outdoor play area. There is also a woodland play area used for 'forest school' type learning. The schools GSC described in Appendix J is considered suitable for this area.
St Quintin Children and Family centre	St Quintin Children and Family centre is a multi-use centre primarily for disabled people, children and their families and also hosts a nursery. There is a single main building with much of the surrounding grounds being hard paved with some landscaped areas and soil borders. The schools GSC described in Appendix J is considered suitable for this area.
Longstone Avenue allotments	Longstone Avenue allotments is a typical allotments site. Based on a growing plot map provided to AECOM showing the 2020 layout the largest single growing plot is approximately 250m^2. This is slightly smaller than the typical allotment size of 300m^2 referred to in the CLEA guidance. The allotments land-use scenario is considered suitable for this area.
St. Quintin's CKG	This area is sited on an old tennis court, with the raised beds placed on the tarmac surface. A very narrow strip of unpaved ground runs along the southern, eastern and northern edges of the area but access to this area is limited and not part of the day to day use of the site. Growing within this area is primarily in raised beds although there is some limited fruit tree and shrub fruit cultivation in ground level soil. The ground around the raised beds is a combination of gravelled paths and bare earth. St. Quintin's CKG is a growing site situated on its own and is not linked to any specific residential properties. Hence any users of this site are most likely to travel to it from the

Area Name	Discussion
	nearby area in a similar way that people use allotments or public parks. Therefore the exposure pathways consistent with allotments and parks are considered most appropriate. The outdoor occupation period of 170 days and the exposure duration of 2 hours for POSpark seems reasonably precautionary for this CKG given that the standard allotments scenario includes 130 days exposure frequency and 3 hrs exposure duration for the same critical receptor (0-6 year old female child). It is expected that considerably less work is required to maintain a CKG compared to an allotment, so the POSpark assumptions have been adopted as reasonable given the similarity to allotment exposure frequency. The alternative POSresi generic land-use is not considered to best match likely exposure as exposure frequency for this scenario is 365 days per year and includes tracked back soil into homes (something not assumed for allotments or parks). Produce consumption from the CKG is likely to be more consistent with (but still likely to be lower than) the Resi+HP scenario than the allotments scenario. Evidence identified in Section 6 also indicated that there is a noticeable difference in soil quality between the ground level soils and the soils in the raised beds for some COPC. Soils at St Quintin's CKG have been assessed against POSpark GSC for ground level soils and against Resi+HP GSC for raised beds where produce is grown.
St. Charles Centre for Health and Wellbeing	All growing is within raised beds with the majority of the ground surrounding the beds being hard paved. There are some ground level soil borders around the perimeter of the area with some fruit trees planted. All soil results have been compared against the Resi+HP GSC due to the presence of the homegrown produce consumption pathway.
Equal People	All growing is carried out in raised planters that are located on hard tarmac surfacing. There is no exposed ground level soil in the area. All soil results have been compared against the Resi+HP GSC due to the presence of the homegrown produce consumption pathway.
Portland Road CKG	Growing within this area is primarily in raised beds although there is some limited fruit tree and shrub fruit cultivation in ground level soil. The ground around the raised beds is a combination of gravelled paths and bare earth. Portland Road CKG is a growing site situated on its own and is not linked to any specific residential properties. Hence any users of this site are most likely to travel to it from the nearby area in a similar way that people use allotments or public parks. Therefore the exposure pathways consistent with allotments and parks are considered most appropriate. The outdoor occupation period of 170 days and the exposure duration of 2 hours for POSpark seems reasonably precautionary for this CKG given that the standard allotments scenario includes 130 days exposure frequency and 3 hrs exposure duration for the same critical receptor (0-6 year old female child). It is expected that considerably less work is required to maintain a CKG compared to an allotment, so the POSpark assumptions have been adopted as reasonable given the similarity to allotment exposure frequency. The alternative POSresi generic land-use has not been adopted as it includes tracked back soil into homes to the degree assumed for residential gardens (something not assumed for allotments or parks), assumes less time is spent at the land (1hr as opposed to 2hrs) and assumes an older critical receptor (3-9 year old female child). Produce consumption from the CKG is likely to be more consistent with (but still likely to be lower than) the Resi+HP scenario than the allotments scenario. Evidence identified in Section 6 also indicated that there is a noticeable difference in soil quality between the ground level soils and the soils in the raised beds for some COPC. The cultivation of produce is not restricted to the raised beds, with some tree fruit and shrub fruits grown in ground level soil. As a precautionary approach for the GQRA, all soil data have been compared with the Resi+HP exposure scenario with ground level soils also compared against POSpark GSC to be representative of the ground level soils where produce is not cultivated.
Nottingwood House	The raised beds at Nottingwood House are located in the main communal garden area and are sited on hard paved ground, although the grassed part of the communal area is close by. Soils in raised beds have been compared against the Resi+HP GSC due to the presence of the homegrown produce consumption pathway. No samples were collected from the main communal garden area at Nottingwood House although one sample was collected from a brick construction raised bed that appeared to be for decorative growing rather than cultivating produce. This sample was also compared against POSresi GSC.
The Grove	All growing is carried out in soil beds installed on the roof terrace of the building. Hence there is no ground level soil in the sampling area. Initially as a precautionary approach due to the existence of the consumption of produce, soil data have been compared against the Resi+HP GSC.
Eynham Road railway land	At Eynham Road, the area of land investigated comprises a strip of communal land behind the private residential gardens of a row of terraced houses. This strip of land was formerly part of the adjacent railway land but has been adopted by the residents of Eynham Road (with Network Rail approval) as additional land for their recreational use. The strip of land is walled off from the private gardens with access through gates in these

Area Name	Discussion
	walls at the back of the private gardens. The sampled area is communally accessible along its full length and therefore any one resident has the potential to be exposed to any part of the land. Some of the residents use small areas of this land for growing fruit and vegetables, although the observed area for growing for any individual resident appeared to be limited to areas of up to two or three metres square (i.e. 5-10m^2). Given the communal nature of the land and its separation from the private gardens by a wall it is considered that use of the railway land could be similar to the POSresi scenario, although the cultivation of some produce also contains elements of the Resi+HP scenario. For the GQRA, the railway land at Eynham Road has been compared against both the Resi+HP and POSresi GSC given the uncertainty with the precise land use.
Hurstway, Grenfell, Testerton and Barandon Walks (Lancaster Walkways)	Lancaster Walkways has communal gardens that are publicly accessible with a mixture of grass and landscaping and a children's play area. Cultivation of produce is carried out in raised beds and some ground level beds that have been adapted for growing. A small number of fruit trees are grown in ground level soils which do not appear specifically adapted as growing beds. RBKC records indicate that soil in the sampled beds was not changed after the fire. The general use of Lancaster Walkways fits into the POSresi land use scenario and all non-growing area soils have been compared against the POSresi GSC. For soils in raised beds and at ground level where cultivation of produce is possible, the results have been compared against the Resi+HP GSC.
Henry Dickens Court	The communal gardens are publicly accessible with a mixture of grass and landscaping. One area has been planted as an orchard. Soil results from this part of the Henry Dickens estate have been compared against the POSresi land-use GSC. A CKG is located in the north-eastern part of the Henry Dickens estate but is not directly linked to the estate – it is a CKG site for the wider community. Growing is primarily in raised beds although soil borders at ground level around the perimeter are used for vines and some shrub fruit. In and around the raised beds, the ground is a combination of gravel paths, bare earth and grass. Soil results from the CKG area have been compared to the Resi+HP land-use GSC due to the presence of the homegrown produce pathway.
Silchester East	The communal gardens are publicly accessible with a mixture of grass and landscaping and this appears consistent with the POSresi land use scenario. For soils at ground level, results have been compared against the POSresi land use GSC. There were two distinct areas of raised beds for growing: one area within a freely accessible plot of public open space and one area behind a locked gate and clearly signposted as an RBKC community kitchen garden site. Both areas are in close proximity to Whitstable House. Ground level soil in both areas was exposed but there was no evidence of crop cultivation at ground level. RBKC records indicate that soil at the Silchester East CKG was completely replaced after the fire, although there is no indication of which area of raised beds this referred to. Soil results from the CKG area have been compared to the Resi+HP land-use GSC due to the presence of the homegrown produce pathway.
Allom House and Barlow House	The communal gardens that samples have been collected from are accessible to residents of Allom House and Barlow House, with a mixture of grass and landscaping. Flats with ground floor doors do not lead directly out onto the communal garden area. This situation appears consistent with the POSresi land use scenario and therefore for soils at ground level, results have been compared against the POSresi land use GSC. The raised beds are located in the middle of the communal garden between Allom House and Barlow House. All crop cultivation is in the raised beds and the ground around the raised beds is a mixture of hard paved path and grass. Soil results from the raised beds have been compared to the Resi+HP land-use GSC due to the presence of the homegrown produce pathway.
Morland House and Talbot Grove House	**Morland House** The communal gardens are publicly accessible with a mixture of hard paving, grass and landscaping which appears reasonably consistent with the POSresi land use scenario. A small CKG area is located at the northern end of the communal garden with the majority of growing in raised beds, although a fig tree was growing at ground level. Soils in the CKG growing beds have been compared against the Resi+HP land-use GSC due to the presence of the homegrown produce pathway. Ground level soils and soil in one slightly raised brick bordered soil bed that was not used or intended for homegrown produce were compared against the POSresi land-use GSC. **Talbot Grove House** The communal gardens comprise a mixture of hard paving, grass and landscaped soil borders. The communal area is not publicly accessible but there are also no doors from flats in Talbot Grove House leading directly onto the communal area. This scenario is reasonably consistent with the POSresi land-use scenario and ground level soils have been compared to the POSresi GSC. A small CKG area is located in the middle of the communal garden with the majority of growing in raised beds, although a small amount of produce (callaloo) was being grown in

Area Name	Discussion
	the lower brick bordered raised beds that are part of the decorative landscaping. Soils in these brick bordered beds were also compared against Resi+HP GSC.
Bramley House	The communal gardens are accessible to residents of Bramley House, but not to the general public and are composed of a mixture of grass, vegetated soil borders and artificial grass. The raised beds at Bramley House are located in the main communal garden area and are sited on hard paved ground. The land use of the main communal garden area seems to be consistent with the POSresi scenario and all ground level soils have been compared against the GSC for this land use. Soils in raised beds have been compared against the Resi+HP land-use GSC due to the presence of the homegrown produce pathway.
Kensington Memorial Park	Kensington Memorial park is a multi-use park with a play area, tennis courts, sports pitches, a café, decorative gardens and a CKG area. There is a mixture of artificial play area surface, hard paving, bare soil and grass across the park. A single strip of raised beds is located at the end of a small grassed area planted with some fruit trees. Samples collected at ground level around the park have been compared against the POSpark land-use GSC. Soils collected from the raised beds in the CKG area were compared against the Resi+HP land-use GSC due to the presence of the homegrown produce pathway.
Treadgold House	The communal gardens are only accessible to residents of Treadgold House, with a mixture of grass and landscaping comprising vegetated soil borders and beds. The communal garden in the north of the area is accessible to residents through the car park and the land use in this area is reasonably consistent with the POSresi scenario – hence samples from this area have been compared against POSresi GSC. The communal gardens to the south and west of the building contain some small raised planters for growing produce. Soils collected from these raised planters have been compared against the Resi+HP land-use GSC due to the presence of the homegrown produce pathway. The communal area to the south of the residential building has some doors to individual residential flats that open directly onto the communal garden. There is some evidence from the site walkover that this area is used by these residents in a similar manner to a residential garden as garden chairs and a barbecue were observed during the walkover on the small areas of paving outside the doors. This area to the south of the residential building is continuous with the communal garden to the west of the building and therefore the ground level samples collected in this area have been compared against both the Resi+HP land use GSC and the POSresi land use GSC. The raised beds at Treadgold House are located in the communal garden area to the south and west of the building. This communal garden area has some direct access from ground floor flats. The ground around the raised beds is primarily grass and there is no evidence of crop cultivation in ground level soil borders around the perimeter of the communal garden.
Verity Close	The open spaces and play area are publicly accessible with a mixture of hard paving, grass and landscaping in bare soil borders. Some communal gardens to the rear of the residential blocks in which samples were collected are accessible only to residents of those blocks, with some ground level flats opening directly onto the gardens. There is some potential for residents in these flats to use these communal gardens in a similar manner to a private residential garden albeit without the opportunity for homegrown produce. There are residential houses in Verity Close with private garden areas, although none of these were sampled during the Stage 2 investigation. All samples have been compared against Resi+HP GSC due to the presence of private gardens at Verity Close. For the samples collected around Verity Close in publicly accessible area the results have been compared to the POSresi GSC. For the samples collected in communal gardens only accessible to residents and with direct access at ground level, the results have been compared to Resi-HP land-use GSC.
Little Wormwood Scrubs	This area includes parkland of trees, shrubbery and grassland with smaller areas of decorative planting, an outdoor gym, a children's play centre and a children's play area. The land use is generally consistent with the POSpark land use scenario and all samples collected from this area have been compared to the POSpark GSC.
Darfield Way	Darfield Way comprises a decorative garden park with grass and planted soil borders as well as two children's play areas. The presence of the easily accessible play areas close to residential properties indicates some potential for the area to be used by nearby residents more frequently than the assumptions for the POSpark scenario. On this basis soil results from Darfield Way have been compared against the POSresi land use GSC.
Lancaster Green	Lancaster Green is a publicly accessible green space with grass and landscaped soil borders. The area is likely to be a daily thoroughfare for a number of local residents and therefore because of this high potential exposure frequency the results from Lancaster Green have been compared against the POSresi land-use GSC.

Area Name	Discussion
Robinson House	The communal gardens are accessible to residents of Robinson House, with a mixture of grass and landscaping and a small children's play area. The land-use appears to be consistent with the POSresi scenario. Although some ground floor flats do have external doors they do not lead directly onto the communal garden, there is a small front yard space fenced off from the communal garden which acts as a buffer against using the communal garden in the manner of a private residential garden. Samples at Robinson House were not taken in the CKG raised beds after residents reported that all the soil have been changed in them after the fire. Given the above the soil results at Robinson House have been compared against the POSresi land use GSC.
Wesley Square	The communal gardens are publicly accessible with a mixture of grass and landscaping. The CKG area was reportedly constructed with new soil after the fire and therefore was not sampled. Some herb bushes are grown in ground level soil in the communal garden. A small number of houses on Wesley Square have private gardens and one of these was sampled during the Stage 2 investigation. Samples at Wesley Square have been compared against both Resi+HP and POSresi to cover the private garden scenario as well as the communal gardens.
Silchester West (North and North West area)	This area has communal space that is publicly accessible, including a play area. The communal space is mainly grassed with some soil borders. There are also some communal gardens that are accessible only to residents of certain residential blocks and cannot be accessed by the wider public. three samples were collected in these communal gardens that do not have general public access but they are managed landscaped areas and any ground level doors from properties do not lead directly onto the garden as there are boundary fences forming a buffer between the doors of the property and the communal garden. The POSresi land use scenario is considered to be appropriate for all parts of Silchester West and all samples have been compared to the POSresi GSC.
Maxilla Green	Maxilla Green is a small park area with multiple open entrances predominantly surfaced with grass and occasional areas of soil borders. Its usage appears to be a mixture of a through route for local residents as well as a location for local god exercise and socialising. As a precautionary approach the POSresi land use has been adopted for the GQRA although the assume exposure frequency and duration are likely to be conservative for this area. Soil results from Maxilla Green have been compared against the POSresi GSC.
Stonebridge Recreation Ground	A local park almost entirely surfaced with grass with a hard paved perimeter path and some areas of bare soil with shrub planting. Its usage is local dog exercise and other activities typical of an urban park. Soil results from Stonebridge recreation ground have been compared against the POSpark land-use GSC.
Wormwood Scrubs	A large area of parkland mainly consisting of grass, trees and shrubs with sports pitches on the grassed areas. Its usage appears to be consistent with the POSpark land use exposure assumptions and hence soil results have been compared against the POSpark GSC.
Tower cordon	The tower cordon is currently inaccessible due to restrictions around Grenfell Tower – although the outer part of the cordon to the west of the Tower is opened for through access to the Kensington Aldridge Academy school. Prior to the fire, the area had a children's play area and was an extension of Lancaster Green located immediately to the east. Although the future use is currently unknown and is likely to undergo transformation through the Planning regime, the soil results collected in this area have been compared against POSresi GSC which is the land use most consistent with its former use and the daily access through the area for school children.
Waynflete Square	Waynflete Square is a publicly accessible space in the middle of low-rise residential housing that includes grassed areas, a children's play area and decorative planted borders. Its usage appears typical of the POSresi scenario and soil results from this area have been compared against the POSresi GSC.
Camelford Walk	The sampled area at Camelford Walk is on a grassed area within a public space surrounded by residential buildings. The grassed areas are not readily accessible as they are behind railings that discourage access. Generally the area fits the POSresi scenario although the railings that obstruct access to the grass area are likely to mean that the POSresi assumptions are conservative for this sampling area. Nevertheless sample results at Camelford Walk have been compared against the POSresi GSC.
Avondale Park	Avondale Park is a multi-use park including play area, grassed amenity space, a café area, and decorative planting in soil beds. The park appears to be typical of the POSpark land use scenario and the samples from Avondale park – both collected in the grass amenity space with one close to the children's play area – have been compared against the POSpark GSC.

Area Name	Discussion
Avondale Park Gardens	This area is a fenced communal garden in the middle of a residential square. It comprises a grassed area with soil borders planted with trees and shrubs. General the area fits the POSresi land-use scenario although the railings around the entire area with a single gate, and the fact that the residential square is not a through route for anyone, means that the exposure frequency and duration assumptions of the POSresi scenario are likely to be conservative for Avondale Park Gardens. Nonetheless sample results have been compared against the POSresi GSC.
West London Bowling Club	West London Bowling Club is a private sports club and does not easily fit into any of the standard land use scenarios. The layout of the sampling area includes a clubhouse, a car park and well maintained grass bowling greens, with an area of landscaping comprising a grassed area and vegetated soil borders. Of the standard land-uses, the POSresi land use most closely fits the expectation of leisure activities in a mainly grassed space with tracked back dust into the clubhouse. Soil results have initially been compared against the POSresi GSC. However, the POSresi land-use assumes soil ingestion for 365 days per year which is likely to be an overestimate for a bowling club. The POSpark scenario assumes soil ingestion for 170 days per year, 2 hours per day, which seems a more reasonable assumption for exposure at a Bowling Club since bowls is not typically played through the winter months. One key difference for the POSpark scenario is that it does not include indoor exposure pathways, whereas there may be some indoor pathways at the Bowling Club due to the presence of the clubhouse. However, in the case of lead for the POSresi scenario, indoor dust inhalation, vapour inhalation and dermal contact make up only 0.4% of exposure (direct soil ingestion is 99.6%). These indoor pathways are therefore of negligible significance. For the soil ingestion pathway, the POSpark scenario uses a reduced soil ingestion rate of 50mg/day (for a child receptor) to account for the lack of exposure to indoor dust. This value of 50mg/day is the same as the standard (i.e. including indoor pathways) soil ingestion rate used for adult receptors and since adult receptors are likely to be the main receptor group at a Bowling Club, this lower ingestion rate in the POSpark scenario is considered to be reasonable. Therefore as a secondary approach the results have been compared against both the POSresi GSC and the POSpark GSC for risk evaluation purposes.
St. Quintin's Roundabout	This sampling area is a small area of public open space in the middle of a roundabout junction which is surfaced with grass and planted soil beds. The area is intended for occasional local access such as dog walking but its location and layout is not suitable for daily play by children as assumed for the POSresi land use. Therefore the results have been compared against the POSpark land-use GSC which is likely to be most similar to the usage of this area, though still expected to be conservative as the exposure duration is expected to be low compared to any of the standard land uses for this sampling area.

The selected land-use exposure scenarios for each of the 45 sampled areas are summarised in **Table 23** below.

Table 23. Generic Conceptual Exposure Scenarios

Area Name	Schools	Resi+HP	Resi-HP	POSpark	POSresi	Allotments
Latimer Alternative Provision Academy	Y					
Burlington Danes School	Y					
Bassett House School (St Helen's Church)	Y					
Thomas Jones Primary School	Y					
All Saints Catholic College	Y					
Barlby Primary School	Y					
St. Francis Primary School	Y					
St. Anne's and Avondale Primary School and Nursery	Y					
Oxford Gardens Primary School	Y					
Golborne and Maxilla Children's Centre Forest School	Y					

Area Name	Schools	Resi+HP	Resi-HP	POSpark	POSresi	Allotments
Grenfell Creche Under 3s' Centre / Grenfell Nursery	Y					
New Studio pre-school	Y					
St Quintin Children and Family centre	Y					
Longstone Avenue allotments						Y
St Quintin Gardens CKG		Y (raised beds)		Y (ground level)		
St Charles Centre for Health and Wellbeing		Y				
Equal People		Y				
Portland Road CKG		Y (raised beds and ground level soil)		Y (ground level)		
Nottingwood House		Y (raised beds)			Y (decorative border bed)	
The Grove		Y				
Eynham Road railway land		Y			Y	
Hurstway, Grenfell, Testerton and Barandon Walks (Lancaster Walkways)		Y (raised beds and ground level soil where produce grown)			Y (ground level soil with no produce)	
Henry Dickens Court		Y (all samples in CKG area)			Y (all samples in main residential area)	
Silchester East		Y (raised beds)			Y (ground level)	
Allom House and Barlow House		Y (raised beds)			Y (ground level)	
Morland House and Talbot Grove House		Y (raised beds)			Y (ground level)	
Bramley House		Y (raised beds)			Y (ground level)	
Kensington Memorial Park		Y (raised beds)		Y (ground level)		
Treadgold House		Y (all samples south and west of building)			Y (all samples northeast of building)	
Verity Close		Y	Y (communal gardens with direct access)		Y (publicly accessible communal areas)	
Little Wormwood Scrubs Including EPIC CIC Adventure Playground				Y		
Darfield Way					Y	
Lancaster Green					Y	
Robinson House					Y	
Wesley Square		Y			Y	
Silchester West (North and North West area)					Y	

Area Name	Schools	Resi+HP	Resi-HP	POSpark	POSresi	Allotments
Maxilla Walk - Maxilla Hall / Maxilla Green					Y	
Stonebridge Recreation Ground				Y		
Wormwood Scrubs				Y		
Tower cordon					Y	
Camelford Walk					Y	
Avondale Park				Y		
Avondale Park Gardens					Y	
West London Bowling Club				Y	Y	
St. Quintin's Roundabout				Y		
Waynflete Square					Y	

7.2 Selection of GSC

7.2.1 Sources of GSC

The assumptions and parameters described in **Section 7.1** are applicable to GSC derived in accordance with the UK CLEA (Environment Agency, 2009) and Category 4 Screening Level (C4SL) methodologies (DEFRA, 2012) and may not be applicable for GSC published by other bodies such as the USEPA and the Dutch RIVM (see bullet list below). Where non-UK criteria are used, the assumptions are checked on a case by case basis to confirm that the criteria are sufficiently protective of the land use around Grenfell Tower (the Dutch IVs and US EPA RSLs do not take into account exposure at allotments, for example).

Health-based GSC are published by a number of authoritative organisations, including in the UK Defra and the Environment Agency, and internationally, the US Environmental Protection Agency (EPA) and the Dutch public health bodies (VROM and RIVM). The derivation of these criteria by these organisations is different – the organisations have each developed technical guidance and methodologies that are slightly different (aligned to their own regulatory frameworks and scientific judgements). The purpose of the criteria however is the same – to define concentrations in soil that do not warrant further action.

The screening criteria used in this assessment (in order of preference are):

- Category 4 screening levels (C4SLs) (DEFRA, 2012).
- Suitable for use levels (S4ULs) (Nathanail, et al., 2015).
- Environment Agency Soil Guideline Values (SGV) – specifically for dioxins (Environment Agency, 2009).
- Generic assessment criteria (CL:AIRE/AGS/EIC, 2010).
- Dutch Intervention values (DIV) (Dutch Ministry of Infrastructure and the Environment, 2013).
- Regional screening levels (RSLs) (November 2020) (USEPA, 2020).

The definitions and relevance of these screening criteria to UK guidance and Part 2A are summarised in **Table 24** below. More detailed definitions can be found in the reference documents for these criteria. Where non-UK criteria have been used to screen COPC, further discussion of the suitability in the context of UK guidance is provided in **Section 7.4.2**.

Table 24. Basis and applicability of chosen screening criteria

Screening Criteria	Basis	Applicability to Part 2A
C4SLs	Levels in soil that pose a low risk to human health. Values are derived using the Environment Agency's CLEA model with updated generic land use exposure assumptions and toxicological criteria termed "Low Levels of Toxicological Concern (LLTC).	Intended as "relevant technical tools" to help decide when land falls within Category 4 (no to low risk) for human health. Not intended to define Significant possibility of Significant Harm (SPOSH).

Screening Criteria	Basis	Applicability to Part 2A
S4ULs	Levels in soil that pose minimal or no appreciable risk to human health. Values are derived using the Environment Agency's CLEA model with updated generic land use exposure assumptions defined by SP1010. Toxicological criteria remain as health criteria values (HCV) (i.e. TDI or Index Doses as defined for SGVs) as recommended by Environment Agency SR2 guidance. The S4ULs do not use the 'Top 2' homegrown produce assumption that was introduced by the C4SL project.	Similar in purpose to SGVs below. Signify concentrations that fall within Category 4 and represent no appreciable or minimal risk to health. Do not define SPOSH.
SGV	Guidelines on the level of long-term human exposure to individual chemicals in soil that, unless stated otherwise, are tolerable or pose a minimal risk to health. Values are calculated using the Environment Agency's CLEA model using precautionary generic land use exposure assumptions and health criteria values that represent a tolerable or minimal risk to health.	Guidelines not specifically derived for the purposes of Part 2A but which indicate concentrations and levels of risk that are firmly within Category 4. Do not define SPOSH. Widely seen as out of date and superseded apart from dioxins, furans and dioxin like PCBs.
EIC GAC	Intended to compliment SGVs and derived using the CLEA methodology and CLEA model. The EIC GAC were derived using the more precautionary exposure assumptions used for deriving the SGV (compared to the more recent updated exposure assumptions used for C4SL derivation).	As per S4ULs and SGV above. Widely considered to be out of date and superseded.
DIV	Designed to support the Dutch Soil Protection Act 2005 and Soil Quality Decree 2007. DIVs define cases of "severe contamination" if the average concentration of at least one substance exceeds the IV in at least 25m^3 of soil. DIVs are derived using the CSOIL methodology and are defined for the multi-purpose use of soil (human and ecological). Human health risk requiring intervention is defined as a situation where acute or chronic adverse health effects may occur, or the contamination presents a demonstrable nuisance. The toxicological criteria for threshold substances (those that are not genotoxic carcinogens) are set on the same general basis as the TDI for SGV etc. A different approach is taken for genotoxic carcinogens whereby linear extrapolation methods are used to define soil concentrations that might be associated with an excess lifetime cancer risk (ELCR) of 1 in 10,000 for the exposed population. This ELCR is 10x higher than that typically adopted by the World Health Organisation (WHO) in the derivation of drinking water guidelines, and 100x higher than that used by the US EPA (see below). Extrapolation is not endorsed by the UK Department of Health or the UK Committee on Carcinogenicity but it is a widely adopted approach internationally and has not been shown to underestimate risk relative to the Index Dose approach adopted in the UK.	The exposure assumptions for the multi-use land-use are slightly different to those used in the UK, but the intent is the same – protection of human health from adverse health effects. The values define concentrations in soil that do not pose a risk to humans where intervention would be required and are designed to be used as the first screening stage in a risk assessment process. They are therefore compatible with the use of similar GSC in identifying land that meets the definition of Category 4 (particularly for threshold substances).
RSLs	Designed to support the US EPA Superfund regime and based on the US EPA RAGS technical guidance. The RSLs are risk-based concentrations derived from standardised exposure equations and toxicological guidelines and intended to screen out land that does not warrant further action under the Superfund regime. They are based on reasonable maximum exposure assumptions for different land uses combined with references doses and reference concentrations that represent exposure estimates that are likely to be without an appreciable risk of deleterious health effects during a lifetime. For genotoxic carcinogens the US EPA adopts linear extrapolation and sets an ELCR limit of 1 in 1,000,000 (100x lower than the Dutch and 10x lower than the WHO. Extrapolation is not endorsed by the UK Department of Health or the UK Committee on Carcinogenicity but it is a widely adopted approach internationally and has not been shown to	The exposure assumptions for land-uses are slightly different to those used in the UK (for example the absence of indoor vapour intrusion and consumption of homegrown produce), but the equations are closely aligned to those adopted in the CLEA methodology and in some cases the US EPA oral reference doses have been reviewed and adopted in the derivation of SGVs, S4ULs and EIC GAC. As per DIVs they are therefore compatible with the Part 2A definition of Category 4 whereby land poses a low risk to human health.

Screening Criteria	Basis	Applicability to Part 2A
	underestimate risk relative to the Index Dose approach adopted in the UK.	

Where no screening criteria have been identified, substances have been initially considered on the basis of their detection, the family of substances they belong to, and their reported concentration relative to other substances.

Where screening criteria are presented for a range of different soil organic matter (SOM) contents, the use of values associated with the closest reported SOM have been used. The range of SOM values reported for all of the Stage 1 and Stage 2 soil samples is 2.1% to 45% with a geometric mean of 8.6% and an arithmetic mean of 9.7%. Screening criteria have been chosen based on a SOM of 6% for UK criteria which are typically reported for either 1%, 2.5% or 6% SOM. For the 45 sampling areas, the average SOM content was lower than 6% in 3 areas: Tower Cordon (4.7%), Barlby Primary School (4.7%) and Camelford Walk (4.6%). These average SOM are closer to 6% than the lower SOM of 2.5% and therefore the GSC derived using SOM of 6% are considered likely to be sufficiently protective in these areas, given the generally conservative approaches adopted for derivation of GSC.

7.2.2 Additional Considerations for Specific Contaminant Groups

7.2.2.1 Chloromethane

In response to the exceedances of the GSC for chloromethane identified as part of Stage 1, AECOM derived an updated Resi+HP GSC for chloromethane. This GSC was derived using the physico-chemical parameters used in the CL:AIRE/EIC/AGS GAC Report (refer to **Section 7.2.1** above), the most recent US EPA Health Criteria Values that supersede those used for the original derivation of the CL:AIRE/EIC/AGS GAC, and the most recent version of the Environment Agency's CLEA model. The CLEA model input and output reports for the derivation of the updated chloromethane GSC are presented in **Appendix J**.

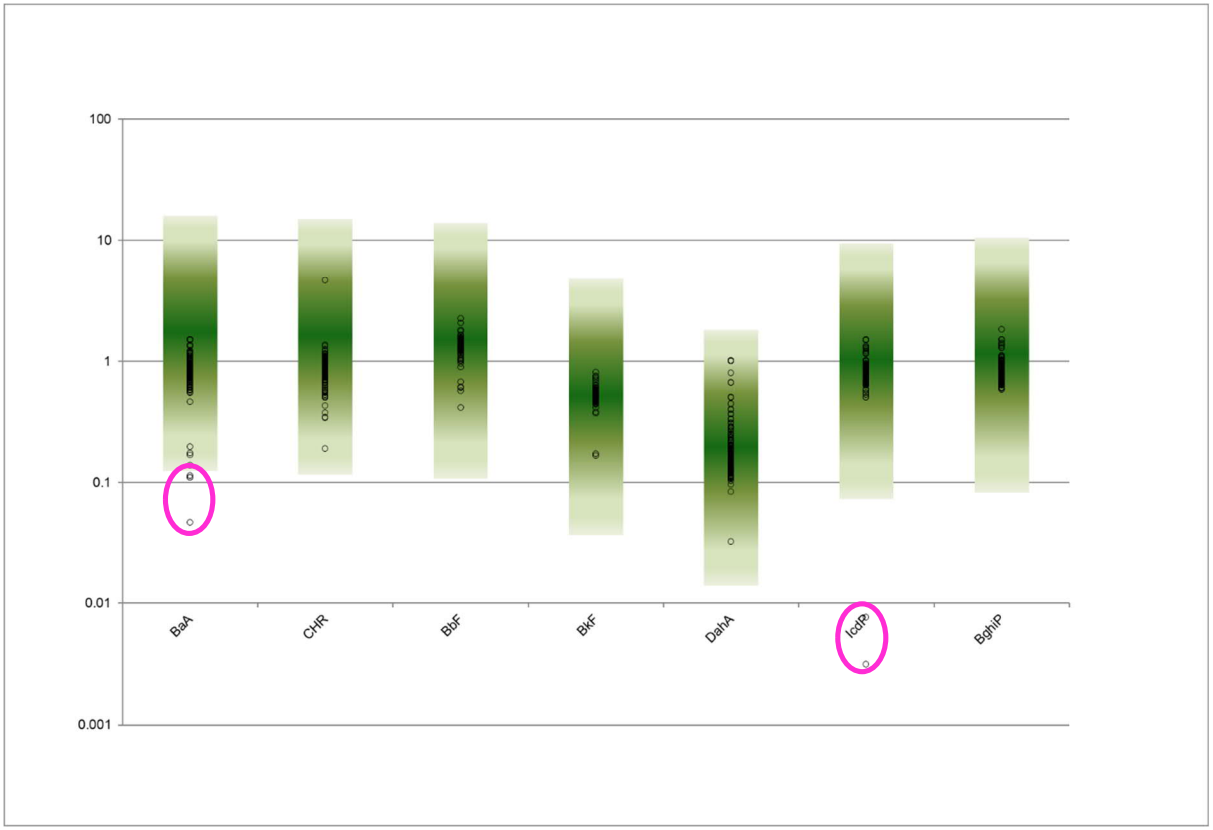
7.2.2.2 PAHs

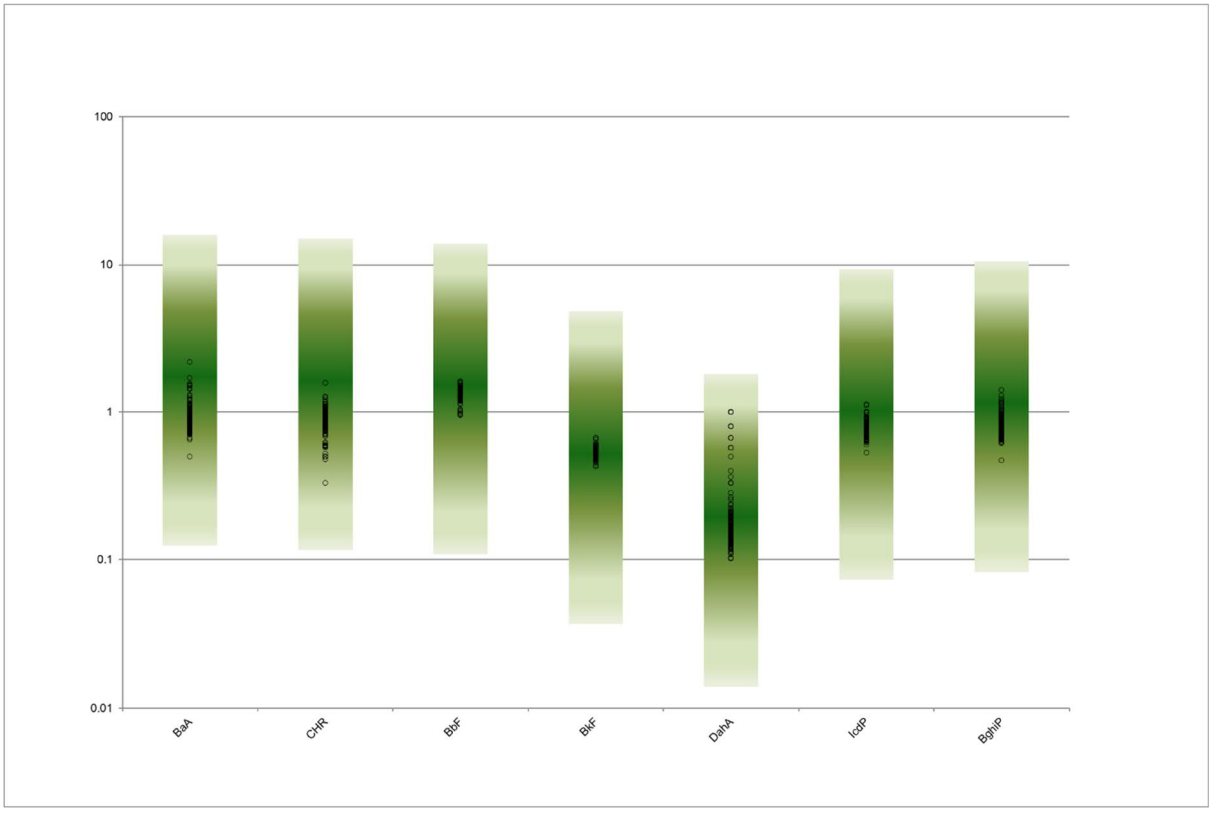
The C4SL for benzo(a)pyrene was derived using toxicological studies based on coal tar toxicity from a study by Culp et al., and it is intended to act as a GSC for the additive toxic effects of carcinogenic PAHs. Public Health England (PHE) (Public Health England, 2017) has endorsed this surrogate marker approach for assessing PAH toxicity on the assumption that the PAHs ratios in the samples being assessed are similar to those in the coal tars used for the toxicological studies. The PHE report defines 'similar' as where the ratios of each PAH relative to BaP are within an order of magnitude of the ratios from the test material (in this case the coal tar from Culp et al toxicological study used to derive the C4SL).

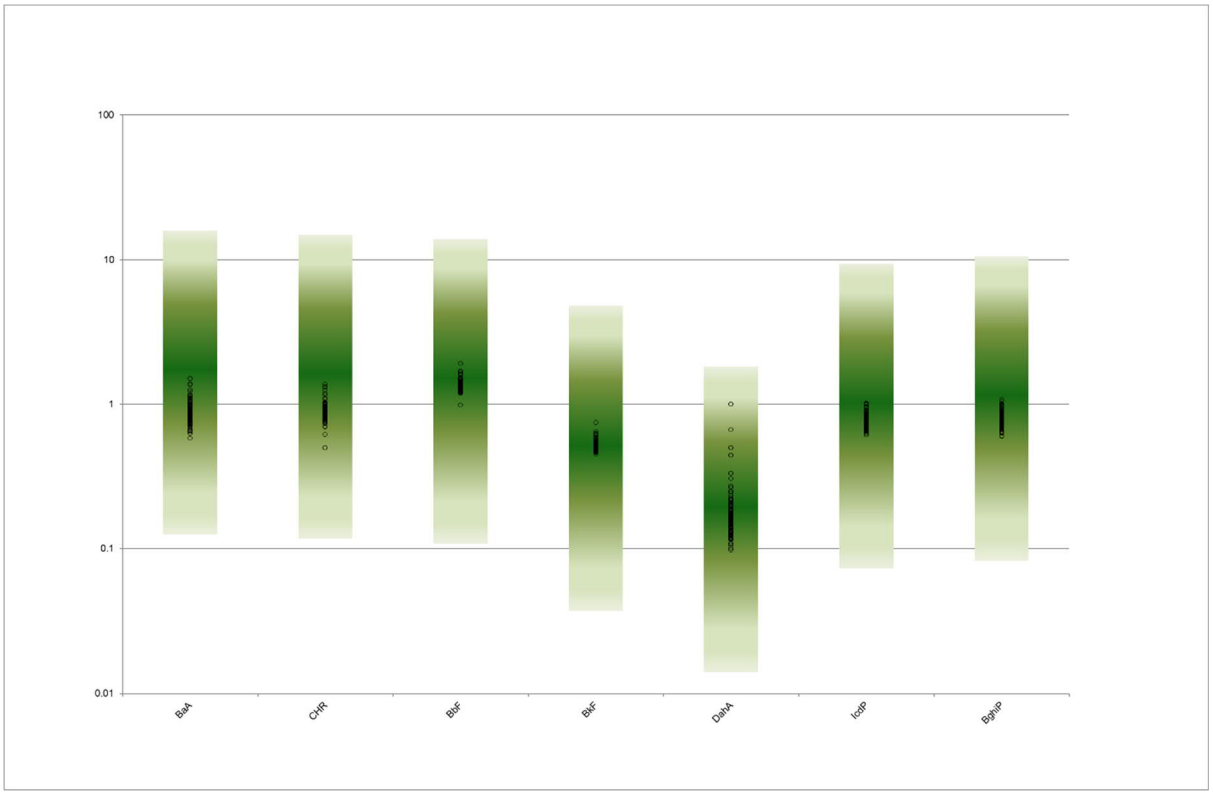
The PAH ratios for all samples collected as part of the Stage 1 and Stage 2 Grenfell Tower investigation have been plotted in accordance with the (Public Health England, 2017) approach. This is shown on the four separate plots[6] of **Graph 16** below. Graph 16 also shows in green the order of magnitude ranges used to decide where the PAH ratios are 'similar' to the ratio for the Culp et al toxicological study. For the analysis, the concentration of PAH samples below detection limit were assigned the value of the detection limit.

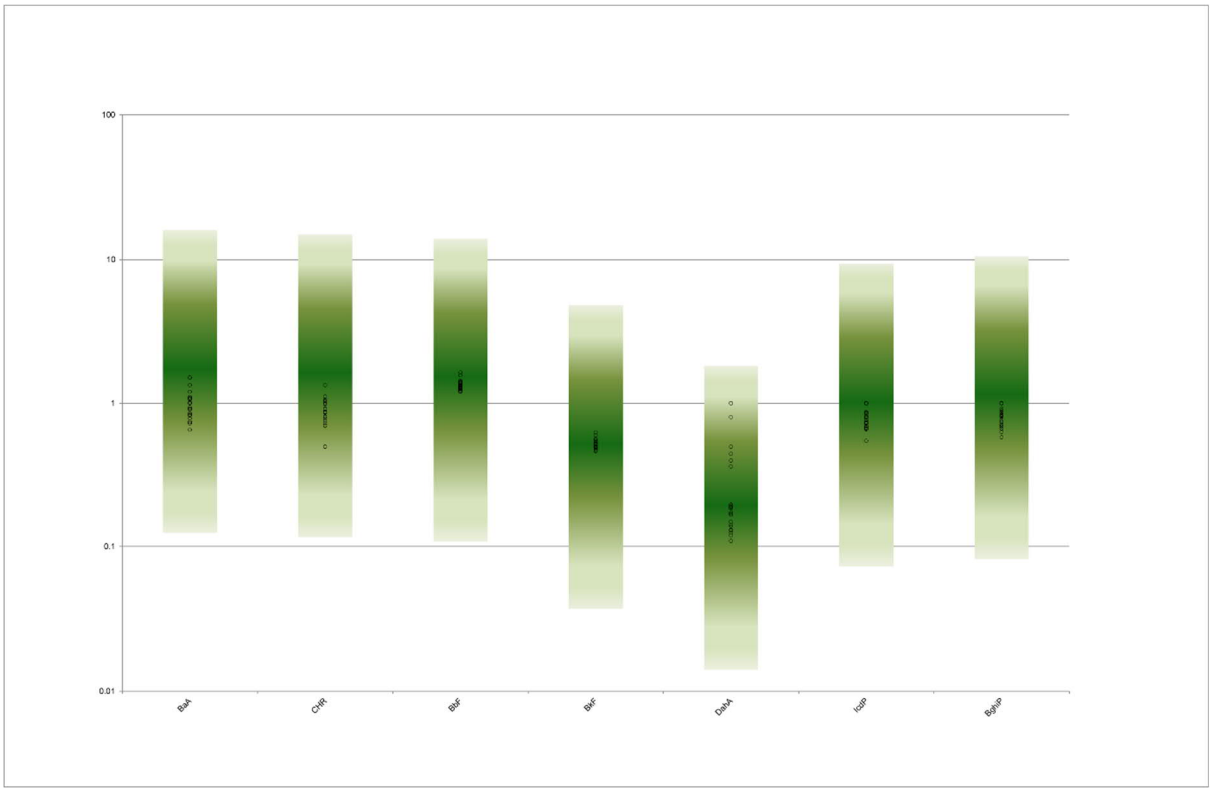
[6] Data limits on the spreadsheet mean not all data can fit on to one graph.

Graph 16. PAH ratio plots for soil sample PAH compositions against Culp et al ratios – Plot 1 to 4









Of the four plots shown in **Graph 16**, there are 4 samples outside the order of magnitude range for the BaA:BaP ratio and two samples outside the order of magnitude range in the I123cdP:BaP ratio. These samples are:

- BaA:BaP ratio. GTCS2-P031_Soil, GTCS2-P007_Soil, GTCS2-P008_Soil, GTCS2-P010_Soil.
- I123cdP:BaP ratio. GTCS2-P031_Soil and GTCS2-P033_Soil.

This indicates that for the majority of samples (only 5 samples of 546 – less than 1% - are outside the ranges) the BaP surrogate marker approach is considered to be appropriate for evaluation of additive risk from carcinogenic PAHs.

For the five samples with BaA:BaP and I123cdP:BaP ratios outside the ranges, three were collected from Eynham Road during the crop sampling and two were collected from Longstone Avenue allotments during the crop sampling. Additional soil samples were collected and tested for PAHs from these areas during the main soil sampling event and all PAH ratios were within the ranges for these other samples. The very small number of samples with ratios beyond the ranges are therefore not considered to be representative of average soil conditions in these specific areas or of other areas in the investigation area for which the surrogate marker approach might not be appropriate.

For the five samples with ratios outside the ranges, the low ratios are caused by isolated atypically low concentrations of a single PAH for four of the samples, and both BaA and I123cdP for one of the samples. Since the other PAHs are within the normal ranges, it is considered that overall the BaP surrogate marker approach will be suitable for the assessment, although as a precautionary measure each of these samples has also been compared to the 2015 S4ULs which provide GSC for the individual PAHs as an alternative to relying on the BaP surrogate marker approach.

7.2.2.3 Dioxins, Furans and Dioxin-like PCBs

Soil concentrations for the individual chlorinated dioxins, furans and biphenyls have been summed and compared to the residential land-use SGV published by the Environment Agency in 2009 of 8700ng/kg. Because the SGV is only applicable to soil PCDD/F and PCB12 concentrations where the composition is very similar to the median UKSHS urban soil composition used in the SGV calculation, and because (COT, 2010) has recommended that the WHO TEFs are also applicable to brominated dioxins and furans, hazard indices (HI) have been calculated for each sample based on the unique mixture of brominated and chlorinated congeners detected in each sample. The HI assessment is considered to supersede the more simplistic SGV approach.

A calculated HI of 1.0 would indicate that exposure is expected to be at 50% of the tolerable daily intake chosen by the EA, since the hazard indices and SGV are based on a tolerable daily soil intake (TDSI) which has been set at 50% of the TDI due to people's background exposure to dioxins and furans in their diet.

It is noted in Stage 1 Technical Note 8 (AECOM, 2019g) that the European Food Safety Authority (EFSA) produced a revised toxicological assessment of dioxins in 2019, in which the tolerable daily intake was reduced from 2picograms per kilogram bodyweight per day (pg/kgBW/day) to a tolerable weekly intake (TWI) of 2pg/kgBW/week; a seven-fold decrease. The adoption of revised health-based guideline value would reduce the SGV to 1200ng/kg, but the UK Food Standards Agency (FSA) has advised against this on the basis of the recommendation of EFSA to review the TEFs (though driven mainly by the dominance of PCB-126). Furthermore, the FSA also advised that it is premature to apply the TWI of 2pg/kgBW/week as COT has not yet provided advice and has not fully assessed the health impacts.

7.2.2.4 Asbestos

There is no UK regulatory guidance on the assessment of asbestos in soil. Dutch authorities developed a risk assessment methodology that has been adopted/amended for use in other countries and is considered relevant for use here in the absence of UK regulatory guidance. The CIRIA C733 report 'Asbestos in Made Ground' guidance (Nathanail, et al., 2014) identifies six factors to consider in the use of non-UK guidelines for asbestos. These six factors are considered in **Table 25** below, and is a copy of Table TN17-06 that was included in Technical Note 17 (AECOM, 2019f) for the Stage 1 investigation:

Table 25. Consideration of applicability of Dutch asbestos methodology for Part 2A

Factor identified in CIRIA C733	Comment
Differences in national policy, guidance and assumptions to soil risk assessment.	No different to UK in so much that the intent is to identify land that poses a level of risk to human health that triggers regulatory intervention.
Differences in asbestos risk modelling and toxicological approaches.	The UK does not have a risk modelling approach for asbestos in soil. The UK toxicological approach to asbestos is set out by the HSE and the preferred risk model is that developed by Hodgson & Darnton (described in CIRIA C733 guidance (Nathanail, et al., 2014). This model continues to be refined by the authors, as does the risk model used by the Dutch. The most recent review of the toxicology by the Health Council of the Netherlands has not been adopted as policy and illustrates the variability in the interpretation of the epidemiological data that has to be accepted in the risk assessment process.
Differences in potency of the different asbestos types.	The Dutch methodology assumes that amphiboles are 10x more potent than chrysotile. The HSE does not differentiate between asbestos type in setting the control limit for

Factor identified in CIRIA C733	Comment
	occupational exposure. The Hodgson & Darnton model assumes a potency ratio of 1:100:500 for chrysotile, amosite and crocidolite. Of note, the Dutch methodology is based on airborne fibre concentrations not exceeding 100f/m^3 for amphiboles (amosite and crocidolite), and 1000f/m^3 for chrysotile. This is consistent the WHO air quality guideline value for all asbestos of 1000f/m^3 (all values as measured by transmission electron microscopy).
Differences in climate.	The climate of the Netherlands and the UK is similar.
Appropriateness and applicability of thresholds or toxicological benchmarks.	See above for the air guideline values adopted by the Dutch methodology. Unlike the IV for other substances, the IV for asbestos is based on an asbestos fibre concentration in air associated with a 1 in 1,000,000 excess lifetime cancer risk, not the higher 1 in 10,000 risk normally used. Defra concluded in the development of the C4SLs that an ELCR of 1 in 100,000 should constitute minimal risk and an ELCR of 1 in 50,000 could be specified as “low risk” and be used as a generic level for all human genotoxic carcinogens.

Table TN8-20 that was included in Technical Note 8 (AECOM, 2019g) for the Stage 1 investigation describes the tiered assessment approach published by the Dutch Ministry of Housing, Spatial Planning and the Environment (VROM). A summary of the criteria is presented in **Table 26** below. The two relevant criteria are 0.1%wt/wt for non-friable asbestos (relevant to the ACM debris identified in sample GTCS2-S313 from Lancaster Green, GTCS2-S332 from Wesley Square, GTCS1-039 from the West London Bowling Club, and GTCS1-59 from Waynflete Square) and 0.01%wt/wt for friable asbestos (relevant to the chrysotile and amosite fibre bundles detected in the majority of samples where asbestos was identified, and GTCS2-S349 from Silchester West where asbestos insulating board (AIB) debris was identified). The additional requirement of the Dutch guidance is that the DIV is applied to the average soil concentration in an area up to 1000m^2.

Table 26. Dutch Asbestos in Soil Criteria

Criterion	Assessment Stage	Applicability
0.01% by weight	Tier 1	To be compared to the total concentration of serpentine asbestos (chrysotile) + 10 x concentration of amphibole asbestos (amosite and crocidolite) as an average concentration across an area up to 1000m^2. Designed to be protective of human health under all normal land-uses.
0.1%	Tier 2	To be compared to the concentration of serpentine asbestos (chrysotile) + 10 x concentration of amphibole asbestos (amosite and crocidolite) for non-friable asbestos e.g. fragments of asbestos cement
0.01% by weight	Tier 2	As above but for friable asbestos e.g. asbestos insulation materials, fibre bundles.
0.001% by weight	Tier 3	To be compared to counted respirable asbestos fibres only, and to be compared to the concentration of serpentine asbestos (chrysotile) + 10 x concentration of amphibole asbestos (amosite and crocidolite)

Source: VROM Soil Remediation Circular, 2013

7.3 Data Comparison with GSC

7.3.1 All Areas

Section 6.7 provides a summary of the data comparison with GSC for the Resi+HP land-use dataset across the investigation area in relation to the potential significance of impact that might be related to the Grenfell Tower fire.

This section focusses on the comparison of the dataset within each individual sampling area to GSC applicable to the specific land-use. The discussion includes screening of the combined Stage 1 and Stage 2 dataset. Stage 1 data are also presented alongside Stage 2 data in the GSC screening tables presented in **Appendix J** as **Tables J1 to J45**.

A summary of the exceedances within individual sampling areas is presented in Table 27**.**

Table 27. GSC Exceedances for Individual Sampling Areas

Area Name	Summary of Exceedances
Latimer Alternative Provision Academy	No GSC exceedances
Burlington Danes School	No GSC exceedances
Bassett House School (St Helen's Church)	No GSC exceedances
Thomas Jones Primary School	No GSC exceedances
All Saints Catholic College	No GSC exceedances
Barlby Primary School	No GSC exceedances
St. Francis Primary School	No GSC exceedances
St. Anne's and Avondale Primary School and Nursery	One exceedance of the Schools GSC for lead, maximum value of 3,056mg/kg. Maximum also exceeds NBC.
Oxford Gardens Primary School	One exceedance of the Schools GSC for lead, maximum value of 1,059mg/kg. Maximum also exceeds NBC.
Golborne and Maxilla Children's Centre Forest School	No GSC exceedances
Grenfell Creche Under 3s' Centre / Grenfell Nursery	No GSC exceedances
New Studio pre-school	No GSC exceedances
St Quintin Children and Family centre	No GSC exceedances
Longstone Avenue allotments	7 (of 7) exceedances of barium GSC 25 (of 26) exceedances of lead GSC. No samples exceed lead NBC. 7 (of 26) exceedances of BaP GSC. 7 also exceed the BaP NBC.
St Quintin Gardens CKG	No GSC exceedances
St Charles Centre for Health and Wellbeing	No GSC exceedances
Equal People	No GSC exceedances
Portland Road CKG	No GSC exceedances in raised beds **4 ground level samples** All exceed Resi+HP GSC for lead, two exceed POSpark for lead 1 of 2 analysed exceed Resi+HP GSC for arsenic, barium and beryllium but do not exceed POSpark GSC 2 samples exceed the lead NBC 1 sample exceeds asbestos GSC
Nottingwood House	1 exceedance of BaP Resi+HP GSC in raised growing bed. Does not exceed POSresi or allotments GSC 1 exceedance of lead Resi+HP GSC in raised bed (elevated brick bed, currently decorative use). Does not exceed POSresi GSC No exceedances of lead NBC, one exceedance of BaP NBC.
The Grove	3 of 10 samples exceed lead Resi+HP GSC. No exceedances of NBC for lead
Eynham Road railway land	20 (of 24) exceedances of Resi+HP GSC for lead Of these, 10 samples also exceed POSresi GSC and 5 samples exceed the NBC.
Hurstway, Grenfell, Testerton and Barandon Walks (Lancaster Walkways)	Resi+HP lead GSC exceedances in 7 ground level samples (non-growing areas), none exceed POSresi GSC. Resi+HP lead GSC exceedances in 8 growing bed samples (3 ground level, 5 raised), none exceed POSresi GSC. No exceedances of the lead NBC 4 exceedances of BaP GSC for Resi+HP (one ground level growing bed, one raised bed, two ground level (non-growing area). Two of these exceed POSresi GSC (one ground level growing bed, one ground level (non-growing) 5 exceedances of NBC for BaP Asbestos GSC exceeded for 1 sample

Area Name	Summary of Exceedances
Henry Dickens Court	1 exceedance of lead GSC for Resi+HP in ground level growing bed within the CKG area, does not exceed NBC
Silchester East	No GSC exceedances
Allom House and Barlow House	Exceedance of POSresi GSC for lead in one of nine raised ground level samples, does not exceed NBC.
Morland House and Talbot Grove House	Morland House Exceedance of Resi+HP GSC and POSresi GSC for lead in one ground level growing bed (fig tree root zone), also exceeds NBC Talbot Grove House Exceedance in 3 of 5 raised growing beds for Resi+HP GSC for lead. One ground level sample exceeds POSresi GSC and also exceeds lead NBC
Bramley House	No GSC exceedances
Kensington Memorial Park	No GSC exceedances
Treadgold House	2 (of 2) exceedances of Resi+HP GSC for beryllium, neither exceed the POSresi GSC 9 (of 9) exceedances of Resi+HP GSC for lead; 6 of which also exceed POSresi GSC and five exceed the NBC.
Verity Close	4 of 12 exceed lead Resi+HP GSC, none exceed POSresi GSC or NBC. None of the four samples in the private access communal gardens exceed the Resi-HP GSC.
Little Wormwood Scrubs Including EPIC CIC Adventure Playground	No GSC exceedances
Darfield Way	Asbestos GSC exceeded for 1 sample
Lancaster Green	No GSC exceedances
Robinson House	No GSC exceedances
Wesley Square	3 (of 3) ground level growing bed samples exceed Resi+HP GSC for lead. None exceed POSresi GSC or NBC
Silchester West (North and North West area)	Asbestos GSC exceeded for 1 sample
Maxilla Walk - Maxilla Hall / Maxilla Green	No GSC exceedances
Stonebridge Recreation Ground	No GSC exceedances
Wormwood Scrubs	No GSC exceedances
Tower cordon	Asbestos GSC exceeded for 1 sample
Camelford Walk	No GSC exceedances
Avondale Park	No GSC exceedances
Avondale Park Gardens	2 (of 2) samples exceed POSresi GSC for lead, one of these exceeds the NBC
West London Bowling Club	1 (of 2) samples exceed POSresi GSC for lead, sample also exceeds the NBC
St. Quintin's Roundabout	No GSC exceedances
Waynflete Square	1 (of 26) exceedances of POSresi GSC for lead, this sample does not exceed the NBC. 1 (of 26) exceedances of Residential GSC for non-dioxin like PCBs. Asbestos GSC exceeded in 2 samples

Each of the sampling areas with any GSC exceedances summarised in **Table 27** above is discussed in more detail in the sections below.

7.3.2 Areas With One or More Reported Concentration Greater Than GSC

Each of the sampling areas with one or more COPC concentrations exceeding the GSC is discussed in greater detail below. Relevant datasets for each area are presented with simple statistical parameters (as described in **Section 6.2** presented for each dataset to aid discussion. Where appropriate simple outlier tests of the datasets

have been completed using either the Rosner or Dixon outlier test (dependent on dataset size). The Part 2A Statutory Guidance indicates that Part 2A decision making should be made 'on the balance of probabilities' and therefore the simplest approach is to compare the estimated mean concentration with the GSC. Confidence intervals for the mean concentration are used to provide an impression of the level of certainty that might be associated with a mean concentration exceeding (or being below) a threshold. The confidence intervals (CIs) presented below are based on the non-parametric BCA bootstrap method (using 10,000 iterations), which are more robust to heavily right-skewed datasets (as many of those presented are) than the parametric tests which assume a normal distribution. For right skewed datasets it could also be more appropriate to use the median as the statistical measure of the average soil concentration across an exposure averaging area for comparing with GSC. Using the mean will initially be more precautionary for right-skewed datasets but where appropriate a discussion of the median concentration compared to the GSC has also been considered.

7.3.2.1 St. Anne's and Avondale Primary School

A summary of the datasets for COPC exceeding GSC at St. Anne's and Avondale Primary School is presented in **Table 28.**

Table 28. St. Anne's and Avondale Primary School GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead	10	32	3056	418	123	93 - 1000	820	1,050

Although the maximum concentration of 3,056mg/kg exceeds the GSC (1,050mg/kg) and NBC (820mg/kg), the mean, median and upper limit of the 95% CI on the mean are all lower than the GSC. The maximum concentration was reported at location S072 and soil conditions did not appear different at this location that might explain the higher concentration. S072 lies only 5 to 6 metres away from sampling location S073 within the same relatively small area of landscaping adjacent to the hard-paved playground. The much lower reported lead concentration of 115mg/kg at S073 suggests that the maximum concentration of 3,056mg/kg at S072 does not represent a wider area of higher soil lead concentrations within the school area as a whole and the calculated average values (that are inclusive of the maximum value) are reasonable to use for exposure assessment purposes.

On this basis, the average lead concentrations in soil at St. Anne's and Avondale Primary School are considered to result in CLs that would meet the definition of Category 4 land since they are lower than the GSC, the urban NBC and the average concentrations from the London Earth dataset summarised in **Table 13.**

7.3.2.2 Oxford Gardens Primary School

A summary of the datasets for COPC exceeding GSC at Oxford Gardens Primary School is presented in **Table 29.**

Table 29. Oxford Primary School GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead	10	55	1059	237	130	103 - 422	820	1,050

Although the maximum concentration of 1,059mg/kg exceeds the GSC and NBC, the mean, median and upper limit of the 95% CI on the mean are all lower than the GSC and NBC. The outlier test suggests that 1,059mg/kg is an outlier value, with the next highest concentration being 387mg/kg. The maximum concentration was reported at location S083 and soil conditions did not appear different at this location that might explain the higher concentration. S083 lies only 5 to 6 metres away from sampling location S084 which has a lead concentration of 176mg/kg. Both of these samples are from undisturbed ground level bare soil in small areas of landscaping not designed for access or play. This suggests that the maximum concentration of 1,059mg/kg at S083 does not represent a wider area of higher lead concentrations within the school area as a whole and the calculated average values (that are inclusive of the maximum value) are reasonable to use for exposure assessment purposes.

On this basis, the average lead concentrations in soil at Oxford Gardens Primary School are considered to result in CLs that would meet the definition of Category 4 land since they are lower than the GSC, the urban NBC (820mg/kg) and the average concentrations from the London Earth dataset summarised in **Table 13**.

7.3.2.3 Longstone Avenue Allotments

A summary of the datasets for COPC exceeding GSC at Longstone Avenue allotments is presented in **Table 30.**

Table 30. Longstone Avenue Allotments GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Barium	7	116	239	176	179	151 - 199	n/a*	102
Lead – all samples	26	36	589	296	262	248 - 346	820	80
Lead (inc. 14,200mg/kg)	26	36	14200	835	268	249 - 1906	820	80
Lead (single result from multi-depth locations)	16	149	589	318	268	260 - 382	820	80
BaP – all samples	26	0.1	12.13	3.73	2.39	2.59 - 4.87	3.6	5.7
BaP (single result from multi-depth locations)	16	1.18	12.13	3.96	2.85	2.65 - 5.32	3.6	5.7

* No specific NBC derived however mean and median concentrations from London Earth dataset were 403mg/kg and 380mg/kg respectively

The barium concentration in all samples exceeds the GSC, with the reported mean and median concentrations both exceeding the GSC by 1.7 times. Barium is included in the London Earth topsoil dataset, and of the 6,487 samples in the London Earth dataset, the minimum, maximum, mean and median concentrations were 144mg/kg, 3,475mg/kg, 403mg/kg and 380mg/kg (i.e. all above the GSC). The barium concentrations at Longstone Avenue allotments are well within this background range and in the context of Part 2A this suggests that barium concentrations in this sampling area are associated with CLs that would meet the definition of Category 4 land. Of additional note, the EIC/AGS/CL:AIRE consortium that developed the GAC for barium did not publish final values for barium for allotments or for residential land use with homegrown produce because of the degree of uncertainty in plant uptake of barium. AECOM has used the plant uptake factors that were recorded in the substance proformas published in support of the EIC/AGS/CL:AIRE work to derive the missing GAC. In doing so it is recognised that there is greater uncertainty in these GAC compared to other published GAC (and in this case the GAC being lower than the minimum value reported in regional soil).

Three datasets are presented for lead for this area. The datasets with 26 samples include all results from the locations where multiple depths were sampled, whereas the dataset with 16 samples includes only one result (the maximum) from those multi-depth locations. Generally the selected concentration was from one of the shallower depths (0-5cm or 0-20cm) rather than the deeper sample (50-60cm) as the deeper samples typically had notably lower concentrations. The dataset with 26 samples has been presented twice; once with the unusually high concentration of 14,200mg/kg and once with the lower concentration of 182mg/kg which was reported following re-analysis of the same sample.

The maximum reported concentration of 14,200mg/kg was indicated as a likely outlier by the statistical analysis, whereas no outliers were indicated when this was replaced with the re-sample concentration. Given that the concentration of 14,200mg/kg could not be replicated with re-testing of the sample and that the next highest concentration reported at the site was 589mg/kg, it appears that the maximum concentration is not representative of typical concentrations at the site and there is no evidence that it represents a wider area of higher lead concentrations (rather it is more likely that a small fragment of lead metal or similar was present in the sub-sample tested by the laboratory). On this basis the average concentrations with 14,200mg/kg excluded are considered reasonable for assessing exposure risk in this sampling area. Although the mean and median lead concentrations exceed the GSC by between a factor of 4 and 5, the values are approximately 2.5 to 3 times lower than the urban NBC and are approximately half of the average concentrations reported in the London Earth background dataset in **Table 13**. In the context of Part 2A this suggests that lead concentrations in this sampling area are associated with CLs that would meet the definition of Category 4 land.

Although the allotments site is located in an urban area there is an argument to say that allotment holders have a right to expect that the soils should be assessed based on a slightly higher standard than urban background, since they are effectively being used as agricultural soils and might be expected to be of a more suitable quality for crop growth than (for example) soils in a patch of landscaping adjacent to a busy urban road. For reassurance, lead in soil at Longstone Avenue allotments has been taken forward to the DQRA stage of assessment where the site-specific bioaccessibility and plant uptake of lead has been taken into account.

For BaP the outlier testing did not identify outliers when the maximum concentrations are used for the locations with multi-depth sampling. With all samples included in the dataset a single outlier is indicated – location S136 with a reported concentration of 12.13mg/kg. There was no evidence from observations during sampling that the soil at S136 was noticeably different to soil across the rest of the sampling area that would indicate a reason for this being a significant outlier representative of a hotspot area. However, the historic site investigation carried out at Longstone Avenue allotments (refer to **Section 3.8**) included three samples located in a similar part of the area to S136. The sampling locations were WS29, WS30 and WS35 and the BaP concentrations in shallow soil at these three locations were reported to be 8.1mg/kg, 12.4mg/kg and 14.2mg/kg respectively. This indicates the potential for an area of the allotments site to have notably higher concentrations than other areas, and for this area with higher concentrations to potentially extend across three or four separate growing plots. Outside this area of potentially higher concentrations, BaP concentrations in soil are considered to result in CLs that would meet the definition of Category 4 land given that the average concentration including S136 is lower than the GSC.

However, since allotments sites are made up of a number of separate averaging areas related to individual plots, the presence of an area covering more than one individual plot which could have concentrations exceeding the GSC means that BaP at Longstone Avenue allotments has been taken forwards to the DQRA stage of assessment.

7.3.2.4 Portland Road CKG

A summary of the datasets for COPC exceeding GSC at Portland Road CKG is presented in **Table 31.**

Table 31. Portland Road CKG GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead (ground level soil)	4	325	1,785	1,032	1,010	367 – 1,592	820	200 | 1,300
Lead (raised beds)	5	30	83	49	48	35 - 66	820	200

The data presented in **Table 31** demonstrates a notable difference between the lead concentrations in the raised beds and the lead concentrations in ground level soil. In the raised beds, all sample lead concentrations are lower than the Resi+HP GSC indicating that the health risk associated with exposure to lead in soil in the raised beds would meet the definition of Category 4 (no to low risk).

A wide range of lead concentrations was reported in the ground level soils, with all concentrations exceeding the Resi+HP GSC and two also exceeding the POSpark scenario. The relatively small number of samples and the large range in reported concentrations means that the estimate of the mean has high uncertainty although with the data available it seems more likely than not that the average ground level soil concentration is less than the POSpark GSC of 1,300mg/kg.

The use of the POSpark scenario here is complicated by the fact that the two highest soil concentrations at ground level were located in areas where produce may be grown for consumption and the POSpark scenario does not take this exposure pathway into account. Although it is likely that the pathway would be of low significance (the produce growing in these areas were tree and shrub fruit which typically make up a low proportion of exposure from homegrown produce (HP) consumption) the uncertainty associated with this pathway as well as the high uncertainty associated with the soil concentrations in this area means that lead in soil at Portland Road CKG has been taken forwards to the DQRA stage of assessment.

Asbestos in the form of chrysotile and crocidolite fibre bundles were reported at a concentration of 0.009%wt/wt in sample S166. This concentration exceeds the GSC if the concentration is multiplied by 10 to account for the presence of crocidolite fibres. The laboratory testing does not differentiate the quantities of chrysotile and crocidolite in the sample. If the dominant asbestos present is chrysotile the GSC would not be exceeded. No asbestos was detected in the three samples taken from raised beds. Of the four samples taken from ground level soils one other sample, GTCS1-18, was reported to contain chrysotile fibres bundles at a concentration below the method reporting limit of 0.001%wt/wt. It is considered very unlikely that the average concentration of asbestos in soil in this area exceeds the GSC (noting the limitations of accurately calculating averages in datasets dominated by non-detects). On this basis, linkages associated with asbestos in soil would meet the definition of Category 4 land. To support this conclusion that the risk appears to be low, a supporting line of evidence in the form of a risk estimation based on the methodology described in CIRIA C733 (Nathanail, et al., 2014) is provided in **Appendix J**.

7.3.2.5 Nottingwood House CKG

The reported concentration of lead in one raised bed sample (S165, 455mg/kg) exceeded the Resi+HP GSC; however, none of the reported concentrations exceed the NBC (820mg/kg). Lead concentrations in the other raised beds ranged between 49mg/kg and 68mg/kg, considerably lower than the maximum concentration.

The BaP concentration (5.5mg/kg) also exceeded the Resi+HP GSC in the same sample and in this case exceeded the NBC of 3.6mg/kg, with a similar pattern emerging to lead, where the BaP concentrations in the other five samples were noticeably lower (0.11mg/kg to 0.17mg/kg). The sample at S165 was not part of the formal CKG growing beds constructed of wooden sleepers like the other samples collected at Nottingwood House, it was from a raised bed around the periphery of the communal garden with a raised brick border. This was the only sample taken from this setting and therefore the uncertainty associated with average concentrations in this area is high. At the time of the sampling it was not being used for growing produce and appears more likely to be used for decorative planting – it is not part of the CKG setup and therefore growing produce for consumption in this bed would not be an authorised use of the landscaped part of Nottingwood House. In this situation the POSresi scenario is likely to be more appropriate for assessing this sample, with the lead concentration not exceeding the POSresi GSC of 630mg/kg and the BaP concentration not exceeding the POSresi GSC of 10mg/kg.

On this basis it is considered that lead and BaP CLs at Nottingwood House would meet the definition of Category 4 land.

7.3.2.6 The Grove

A summary of the datasets for COPC exceeding GSC at The Grove is presented in **Table 32.**

Table 32. The Grove GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead	10	112	539	247	149	156 - 348	820	200

The reported concentrations for lead in 3 of the 10 samples exceed the GSC for the Resi+HP land-use, which has initially been selected due to the presence of the homegrown produce exposure pathway. The three concentrations exceeding the GSC were indicated as potential outliers; however, no differences were identified in the sampling observations for these three samples compared to the other seven samples to suggest they are indicative of a hotspot. The average concentrations are similar to the GSC (mean slightly higher, median slightly lower) and all sample concentrations are below the NBC.

The Resi+HP exposure scenario is overly precautionary for The Grove, since it is a learning disability community centre for adults with the rooftop garden and growing beds used by the staff and visitors. Exposure to soils excluding the homegrown produce pathway is likely to be closer to the POSresi or comm/ind scenarios and all sample concentrations are lower than the GSC for these scenarios. Reported concentrations are also considerably lower than the Schools GSC of 1,050mg/kg. The homegrown produce pathway accounts for 36% of lead exposure in the Resi+HP scenario and consumption of any produce grown at The Grove by any one individual will be significantly lower than the Resi+HP scenario since the garden is used by multiple individuals and its use is more for teaching and wellbeing as opposed to providing any meaningful contribution to diet.

Given the average concentrations close to the GSC, the overly conservative nature of the Resi+HP scenario for The Grove, and all concentrations being lower than the NBC, it is considered that the health risk from CLs at The Grove would meet the definition of Category 4 land.

7.3.2.7 Eynham Road Railway Land

A summary of the datasets for COPC exceeding GSC at Eynham Road is presented in **Table 33.**

Table 33. Eynham Road GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead - all samples	24	31	1657	564	430	412 - 724	820	200 | 630
Lead – excluding deep samples	19	310	1657	679	631	525 - 848	820	200 | 630

The average reported lead concentrations at Eynham Road generally exceed the Resi+HP GSC and when the deeper samples are excluded from the dataset, the average concentrations also exceed the POSresi GSC. Five individual samples also exceeded the NBC. Since the deeper samples (50-60cm) have notably lower concentrations than the samples in the top 20cm, they are likely to represent a negligible proportion of exposure with the few exceptions where a resident may double-dig a growing plot. Given the small size and limited use of the growing plots observed during sampling this activity is not likely to be frequent.

With the deep samples excluded, the outlier testing indicates that the two maximum concentrations (1,588mg/kg at S183, 0-0.02m and 1,657mg/kg at S184, 0-0.05m) could be outliers. Although these two locations are adjacent to one another, the sampling observations did not identify any obvious differences in the soil condition in this area that might indicate a hotspot of locally higher concentrations. Equally a second sample was collected at location S184 at a depth of 0-0.2m with a reported concentration of 310mg/kg. This suggests that the concentration of 1,657mg/kg was caused by a very localised source that could not be repeated in slightly deeper (but still topsoil) material within the same sampling location. Further evidence of this comes from sample P035_Soil (0-0.2m) which was located less than 10m from location S184 with a reported concentration of 437mg/kg. Taking a precautionary view, it is noted that the two samples with the highest concentrations of 1,588mg/kg and 1,657mg/kg were both from depths of 0-5cm whereas the samples in the same area with low concentrations were 0-20cm. It remains possible that the two samples from 0-5cm could indicate that the upper few centimetres of topsoil in this area have a higher average concentration than the average soil concentration in the area as a whole.

The average concentrations for the shallow samples (inclusive of the highest reported concentrations) do not exceed the NBC; however, they do exceed the average lead concentrations from the London Earth background dataset reported in **Table 13**. In addition, five individual samples exceed the NBC. Given that the average concentrations also exceed the Resi+HP GSC and the POSresi GSC, and that there is some potential for an area of higher concentrations in a sub-area of the sampling area (around S183 and S184), the Eynham Road Railway Land sampling area has been taken forwards to the DQRA stage.

7.3.2.8 Hurstway, Grenfell, Testerton and Barandon Walks (Lancaster Walkways)

A summary of the datasets for COPC exceeding GSC in the Lancaster West Walkways area is presented in **Table 34.**

Table 34. Lancaster Walkways GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead - all samples	26	62	610	275	260	215 - 337	820	200 | 630
Lead - raised beds and ground level growing beds	11	62	610	274	206	167 - 385	820	200
Lead - ground level (exc. deep 0.5-0.6m samples)	13	82	610	263	226	184 - 343	820	200 | 630
Lead - ground level (exc. deep samples and growing beds)	10	82	428	214	185	149 - 279	820	630
BaP – all samples	26	0.34	25.36	3.39	1.20	1.49 – 5.48	3.6	5 | 10
BaP – excluding deep (0.5-0.6m) samples	21	0.34	7.21	1.58	0.98	0.95 – 2.29	3.6	10
BaP – growing beds samples	14	0.34	15.93	2.58	0.78	0.71 – 4.89	3.6	5

The data in **Table 34** indicate that for the soil concentrations generally (and excluding potential produce consumption exposure from the CKG), are lower than the POSresi GSC and the NBC. Hence for the majority of residents that do not use the CKG facilities, the health risk from CLs associated with lead in soil is expected to meet the definition of Category 4 land.

For the soils in which produce is grown, the mean and median concentrations of 274mg/kg and 206mg/kg slightly exceed the Resi+HP GSC but are comfortably below the NBC and the average concentrations for lead from the London Earth dataset reported in **Table 13**. The Resi+HP scenario is overly precautionary for residents using the

CKG beds because the small growing plots in the CKG are much smaller than the growing area of 20m^2 assumed for a residential garden in the Resi+HP scenario.

If a GSC were derived for the POSresi scenario with a consumption of homegrown produce pathway added, the value would be closer to the value to the POSresi GSC (630mg/kg) than the Resi+HP GSC (200mg/kg) because the soil ingestion exposure pathway would be the dominant route of exposure. Hence the average concentrations of 274mg/kg and 206mg/kg would not exceed a GSC predominantly based on the POSresi scenario with an added homegrown produce pathway representative of the CKG. This is demonstrated in **Section 8** where the POSresi+HP SSAC derived for Eynham Road Railway Land (692mg/kg) was only slightly lower than the POSresi SSAC of 710mg/kg derived for Treadgold House.

Taking the above into account the health risk from CLs associated with lead in soil at Lancaster West Walkways is expected to meet the definition of Category 4 land.

For BaP, none of the samples collected from shallow soils (i.e. those not at 0.5-0.6m depth) exceeded the POSresi GSC. As a result, the health risk from CLs associated with BaP in soil for residents that do not use the CKG facilities is expected to meet the definition of Category 4 land.

For those residents using the CKG facilities, two samples were reported at concentrations exceeding the Resi+HP GSC. Both of these samples were from depths of 0.5 – 0.6m, with considerably lower concentrations reported in the overlying soils at 0-0.05m and 0-0.2m depth. At both locations concrete was observed only in the deeper samples indicating a possible change of soil type at this depth. This slight but consistent difference in soil description and the noticeably higher concentrations in the deeper samples suggest that there has been limited mixing of the soils at 0.5-0.6m depth during the use of the CKG area. This seems reasonable given that 0.6m is typically considered to be the maximum mixing depth for double digging at a full-scale allotments site: digging in raised beds and small ground level beds is much less likely to achieve mixing to this depth. If the samples from 0.5-0.6m depth are excluded from the dataset then no concentrations exceed the GSC. If the concentrations from the three samples at different depths at locations S191 and S193 are averaged as a crude indicator of longer term soil mixing (3.9mg/kg at S191 and 5.8mg/kg at S193), then only the average at S193 slightly exceeds the Resi+HP GSC. Bearing in mind that the Resi+HP GSC is overly precautionary for the CKG scenario, that the shallow samples have concentrations below the GSC and that mixing to depths of 0.5-0.6m is unlikely in a small CKG area, this single exceedance is not considered to be significant and the health risk from CLs associated with BaP in soil is expected to meet the definition of Category 4 land for residents using the CKG facilities.

One sample exceeded the GSC for asbestos. At location S197 amosite fibre bundles at a reported concentration of 0.001%wt/wt were detected under the microscope at the method reporting limit and equal to the GSC. Asbestos was also detected in five other samples from the 22 samples analysed, but at concentrations lower than the GSC. Combined with the fact that the sample at S197 was from a depth of 0-0.2m, and the samples from 0-0.02m and 0.5-0.6m at the same location did not have asbestos identified, this indicates that the exceedance is isolated and is not representative of average concentrations in soil. It is considered unlikely that the average concentration of asbestos in soil exceeds the GSC and the health risk from CLs associated with asbestos in soil is expected to meet the definition of Category 4 land at Lancaster West Walkways. To support this risk evaluation an alternative risk estimation approach is presented in **Appendix J** based on the methodology described in CIRIA C733 (Nathanail, et al., 2014).

7.3.2.9 Henry Dickens Court

A summary of the datasets for COPC exceeding GSC in the Community Kitchen Garden at Henry Dickens Court is presented in **Table 35.**

Table 35. Henry Dickens Court GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead	5	68	273	142	115	83 - 205	820	200

The maximum concentration of 273mg/kg exceeded the Resi+HP GSC; however, the mean and median concentrations do not exceed the GSC and the outlier testing did not identify any outliers. All individual concentrations as well as the average concentrations are also lower than the NBC and therefore the health risk from CLs associated with lead in soil at Henry Dickens Court is expected to meet the definition of Category 4 land.

7.3.2.10 Allom House and Barlow House

A summary of the datasets for COPC exceeding GSC at Allom and Barlow House is presented in **Table 36**.

Table 36. Allom and Barlow House GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead (ground level soil only, not raised growing beds)	9	94	705	217	157	129 - 334	820	630

The maximum lead concentration in ground level soil at Allom and Barlow House exceeds the GSC; however, the mean and median concentrations of nine samples are lower than the GSC. None of the reported concentrations exceed the NBC. Whilst the maximum concentration is indicated to be a likely outlier, there is no specific evidence from the sampling observations to suggest that the soil at the location is substantially different from the other samples and it is therefore unlikely to represent a hotspot. The average concentrations are therefore considered to be reasonable for assessing exposure risk.

On this basis the health risk from CLs associated with lead in soil at Allom House and Barlow House is expected to meet the definition of Category 4 land.

7.3.2.11 Morland House and Talbot Grove House

A summary of the datasets for COPC exceeding GSC at Morland House is presented in **Table 37.**

Table 37. Morland House GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead (ground level soil only, not raised beds) – GTCS1-11, GTCS1-12, P064, S231	4	131	1148	431	223	148 - 699	820	630
Lead (raised beds) - P065, S232, S233, S234	4	35	257	95	44	35 - 154	820	200

In each of the two datasets summarised in **Table 37**, one of four samples exceeds the applicable GSC. Although in both datasets the maximum value is indicated as a potential outlier by the outlier test, there is no evidence from the sampling observations that these samples are representative of noticeably different soil types, and the spatial proximity of the samples with the maximum concentrations to other samples with much lower concentrations means that they cannot be representative of significant portions of the area. On this basis the average concentrations are considered reasonable for assessing exposure risk and since these are comfortably below both the GSC and NBC the health risk from CLs associated with lead in soil at Morland House is expected to meet the definition of Category 4 land.

A summary of the datasets for COPC exceeding GSC at Talbot Grove House is presented in **Table 38.**

Table 38. Talbot Grove House GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead (ground level soil only, not raised beds) – S235, S240	2	358	997	678	678	358 - 997	820	630
Lead (raised beds) – S236 to S239, P002	5	29	428	264	407	107 - 420	820	200

Only two samples were collected from ground level soil at Talbot Grove House, with the maximum exceeding the GSC and the NBC, and the lower concentration being below both. In the raised beds dataset, the concentrations of two samples are notably lower than the other three (29mg/kg and 33mg/kg vs. 407mg/kg, 421mg/kg and

428mg/kg). The samples with the lower concentrations are located in the raised beds constructed from wooden sleepers in the centre of the communal garden (S237 and S238), whereas the three higher concentrations are located in older brick construction beds around the edge of the garden (S236, S239 and P062). Sample descriptions of the two locations in the wooden sleeper beds describe a sandy soil, whereas the majority of the other samples in the area are described as clayey soils. Hence there is some justification to think that the samples in the older raised brick beds are more similar to the ground level soil, although they may have undergone some alteration if they have been topped up with compost or other topsoil for cultivation purposes.. If they are added to the ground level soil dataset, the mean and median concentrations drop to 522mg/kg and 421mg/kg, both below the GSC and the NBC.

The concentrations of lead in the samples from the wooden sleeper raised beds are lower than the GSC.

Whilst there is some produce grown in the brick construction raised beds, the concentrations of lead in the soil are lower than both the NBC and the mean concentration from the London Earth dataset reported in **Table 13** in these areas. In addition, consumption of produce from these areas alone is expected to be considerably lower for any one individual than the Resi+HP land-use scenario assumes.

Given the above the health risk from CLs associated with lead in soil at Talbot Grove House is expected to meet the definition of Category 4 land.

7.3.2.12 Treadgold House

A summary of the datasets for COPC exceeding GSC at Treadgold House is presented in **Table 39.**

Table 39. Treadgold House GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead – all samples	12	28	2216	755	622	431 - 1093	820	200 | 630
Lead – raised beds	3	28	65	42	32	28 - 54	820	200
Lead – ground level soils	9	454	2216	992	992	672 - 1336	820	310 | 630
Lead – ground level outliers, mainly in west and south	6	744	2216	1250	1083	928 - 1629	820	310 | 630

Reported lead concentrations in soil in the raised beds were noticeably lower than the ground level soils. As all raised bed sample concentrations were lower than the Resi+HP GSC the health risk from CLs associated with lead in soil in the raised beds at Treadgold House is expected to meet the definition of Category 4 land.

For ground level soils all reported lead concentrations exceed the Resi+HP GSC as well as the Resi-HP GSC and six of the nine concentrations in ground level soils also exceed the POSresi GSC.

From the ground level soils dataset, the outlier testing indicates six potential outliers, with most of these six sampling locations being in the west and south of the sampling area. When either all nine ground level samples, or just the six higher outlier concentrations are evaluated the average concentrations exceed the POSresi GSC, the NBC, and the average London Earth background concentrations reported in **Table 13.**

Given the above, lead in soil at Treadgold House has been assessed further at the DQRA stage.

7.3.2.13 Verity Close

A summary of the datasets for COPC exceeding GSC at Verity Close is presented in **Table 40.**

Table 40. Verity Close GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead	12	100	415	200	173	151 - 252	820	200 | 630

Of the 12 samples collected at Verity Close, the lead concentration exceeds the Resi+HP GSC in 4 of them. The outlier testing indicates good evidence for two potential outliers, with both of these samples (S281 and S282) located in the same small strip of landscaping in public open space. The mean and median concentrations in the full dataset are equal to and slightly below the Resi+HP GSC and well below the POSresi GSC and the NBC.

Of the 4 samples collected in the restricted access communal gardens (S284, S285, S287 and S288), none of the reported concentrations (118mg/kg to 258mg/kg) exceeded the Resi-HP GSC (310mg/kg) and all are comfortably lower than the NBC.

Given the above, the health risk from CLs associated with lead in soil at Verity Close is expected to meet the definition of Category 4 land.

7.3.2.14 Darfield Way

Amosite fibre bundles were detected under the microscope in sample GTCS2-S305 at the method reporting limit (0.001%wt/wt) and equal to the GSC. Asbestos was not detected in the other 11 samples collected from this area and the isolated presence of asbestos in the soil samples appears to be consistent with what might be expected in an urban environment with a history of redevelopment.

It is considered unlikely that the average concentration of asbestos exceeds the GSC. The health risk from exposure to asbestos in soil at concentrations below the GSC is minimal and the presence of the amosite fibre bundles below turf reduces this risk further. To support this conclusion that the risk appears to be low, a supporting line of evidence in the form of a risk estimation based on the methodology described in CIRIA C733 (Nathanail, et al., 2014) is provided in **Appendix J**.

Given the above, the health risk from CLs associated with asbestos in soil at Darfield Way is expected to meet the definition of Category 4 land.

7.3.2.15 Wesley Square

A summary of the datasets for COPC exceeding GSC at Wesley Square is presented in **Table 41.**

Table 41. Wesley Square GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead	10	133	369	278	298	237 - 316	820	200 | 630

Of the ten samples, the reported lead concentrations exceed the Resi+HP GSC in nine, but do not exceed the POSresi GSC or the NBC in any sample. The outlier testing did not identify any outliers in the dataset and therefore the average concentrations are considered to be reasonable for assessing exposure risk across this area.

The most representative land-use scenario is POSresi; however, Resi+HP was also considered on the basis that herbs are grown in some of the ground level soils and some of the properties have small private gardens. Two samples were collected from one of these gardens, with reported concentrations of 133mg/kg and 313mg/kg. Consumption of produce at Wesley Square will be significantly less than that in the standard Resi+HP land-use. The sampled private garden has an area of approximately 30m^2 and would require two-thirds of the garden to be given over to produce consumption to meet the standard Resi+HP scenario assumption of a 20m^2 plot for growing. The current garden was more than half hard paved with soil exposed soil borders. It is also noted that the Resi+HP GSC is conservative, illustrated by the fact that an SSAC of 335mg/kg was derived for the Resi+HP scenario for Eynham Road Railway Land in **Section 8**. The mean, median and upper bound of the 95% CI are all lower than this SSAC at Wesley Square.

The main CKG area in Wesley Square was constructed with fresh imported soil after the Grenfell Tower fire and was not sampled as part of the Stage 2 investigation, and the herbs grown in the soil would provide a negligible proportion of exposure for the produce consumption pathway.

Since the average lead concentrations only slightly exceed the conservative Resi+HP GSC, the POSresi GSC and the NBC – with all individual sample concentrations also substantially lower than the NBC average concentrations from the local London Earth dataset (**Table 13**), the health risk from CLs associated with lead in soil at Wesley Square is expected to meet the definition of Category 4 land.

7.3.2.16 Silchester West

One asbestos insulation board (AIB) fragment was detected under the microscope in one sample (GTCS2-S349). The AIB fragment concentration in soil was reported as 0.151%wt/wt with an associated 0.002%wt/wt concentration of loose fibres also detected. No asbestos was detected in the other 11 samples taken from this area.

The data are not suggestive of widespread presence of AIB fragments in the soil and the isolated presence of asbestos in the soil samples appears to be consistent with what might be expected in an urban environment with a history of redevelopment. The presence of the AIB fragment in a sample beneath turf also suggests its presence from historic redevelopment.

it is considered unlikely that the average concentration of asbestos exceeds the GSC. The health risk from exposure to asbestos in soil at concentrations below the GSC is minimal and the presence of the AIB below turf reduces this risk further. To support this conclusion that the risk appears to be low, a supporting line of evidence in the form of a risk estimation based on the methodology described in CIRIA C733 (Nathanail, et al., 2014) is provided in **Appendix J**.

Given the above, the health risk from CLs associated with asbestos in soil at Silchester West is expected to meet the definition of Category 4 land.

7.3.2.17 Tower Cordon

A relatively high (11.5 times higher than the GSC) concentration of chrysotile fibre bundles (0.115% by weight – likely to be associated with the disaggregation of a fragment of asbestos containing material) was identified under the microscope in a sample taken from a depth of 50-60cm. Asbestos was not detected in the shallower samples collected at this location. The presence of asbestos in this deeper sample is therefore likely to be a result of historical land-use (including potential historical importation of soil).

Asbestos was detected in two shallow samples in this area (out of 14 samples in total) but at concentrations at or below the GSC. it is considered unlikely that average soil concentrations exceed the GSC. The health risk from exposure to asbestos in soil at concentrations below the GSC is minimal and the presence of the asbestos below turf (which is the case for the sample exceeding the GSC – though not for the shallow samples below the GSC) reduces this risk further. To support this conclusion that the risk appears to be low, a supporting line of evidence in the form of a risk estimation based on the methodology described in CIRIA C733 (Nathanail, et al., 2014) is provided in **Appendix J**.

Given the above, the health risk from CLs associated with asbestos in soil at the Tower Cordon is expected to meet the definition of Category 4 land.

7.3.2.18 Avondale Park Gardens

Two samples were collected at Avondale Park Gardens during the Stage 1 sampling. The lead concentrations reported in both samples, 659mg/kg and 2,099mg/kg, exceeded the POSresi GSC. Two samples are insufficient for any reliable statistical summaries and therefore the uncertainty associated with the average lead concentrations in this sampling area is too high if this data is not considered in conjunction with historical sampling data for this area.

Both sample concentrations fall within the range of concentrations reported in the London Earth background dataset; however the high uncertainty means that it is unknown whether the true average concentrations exceed both the average concentrations from London Earth reported in **Table 13** and the NBC; it is possible that they could if the concentrations of 659mg/kg and 2,099mg/kg were found to be representative of the area.

Given the high uncertainty associated with the assessment of Avondale Park Gardens, a POSresi scenario suitable for representing Avondale Park Gardens has been taken forwards to the DQRA stage of assessment.

7.3.2.19 West London Bowling Club

Two samples were collected at the West London Bowling Club during the Stage 1 sampling. The lead concentration in sample GTCS1-40, 1,311mg/kg, exceeded the POSresi GSC. The lead concentration in the other sample, 398mg/kg, was lower than this GSC. The higher concentration also exceeds the NBC (820mg/kg) whilst the lower concentration is below the NBC. Two samples are insufficient for any reliable statistical summaries and therefore the uncertainty associated with the average lead concentrations in this sampling area is high.

Both sample concentrations fall within the range of concentrations reported in the London Earth background dataset; however the high uncertainty means that it is unknown whether the true average concentrations exceed both the average concentrations from London Earth reported in **Table 13.** Lead concentrations comparison with

London Earth data - All samples in 0-20cm depth range from ground level soils and the NBC; it is possible that they could do if the concentrations of 398mg/kg and 1,311mg/kg were found to be representative of the area.

The POSresi scenario is likely to be highly precautionary for this sampling area, since it assumes a child receptor using the site for 365 days per year. Since the pathway contribution for lead in most land-use scenarios (i.e. those not including significant homegrown produce) is overwhelmingly dominated by soil ingestion, a more appropriate scenario might be the POSpark land-use, further discussion associated with the suitability of the POSpark land-use, particularly for lead, is provided in **Table 22**. The maximum concentration of 1,311mg/kg marginally exceeds the POSpark GSC of 1,300mg/kg but the lower concentration of 389mg/kg is comfortably lower than this GSC. It is also noted that as part of the DQRA in Section 8, a Step 1 SSAC was derived for Portland Road CKG using the POSpark scenario as the starting point and with an added homegrown produce pathway. The Step 1 SSAC of 1,400mg/kg derived for Portland Road CKG is higher than both sample results from the West London Bowling Club. This Step 1 SSAC is also likely to be precautionary for West London Bowling Club since it is based on a 0-6 year old child receptor, whereas the most likely receptor at the bowling club is expected to be an adult.

On the basis that the relevant exposure assumptions for the Bowling Club are likely to be similar to the POSpark land use scenario, that the reported concentrations are lower than the Step 1 SSAC of 1,400mg/kg noted above, and that the reported concentrations fall within the range of concentrations in the London Earth background dataset, the health risk from CLs associated with lead in soil at West London Bowling Club is expected to meet the definition of Category 4 land.

7.3.2.20 Waynflete Square

A summary of the datasets for COPC exceeding GSC at Waynflete Square is presented in **Table 42.**

Table 42. Waynflete Square GSC Exceedances

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	NBC mg/kg	GSC mg/kg
Lead	26	102	757	316	293	258 - 377	820	630
Sum of 7 PCB congeners	26	<35	407	nc	nc	nc	n/a	200

nc – not calculated as 17 of 26 samples not detected above laboratory detection limit

Of the 26 samples collected at Waynflete Square, one reported lead concentration exceeded the GSC but did not exceed the NBC.

The outlier testing did not identify any outliers and therefore the average concentrations are considered to be reasonable for the exposure risk assessment. Both the mean and median concentrations are lower than the GSC and are lower than the average lead concentrations from the London Earth dataset reported in **Table 13.**

On this basis the health risk from CLs associated with lead in soil at Waynflete Square is expected to meet the definition of Category 4 land.

The reported concentration of the sum (∑) of 7 PCB congeners in one sample exceeded the adopted GSC (the adjusted Dutch Intervention Value (DIV) of 200µg/kg). The reported concentration for GTCS1-58 (0-5cm) is 407µg/kg. This sample is part of the cluster of samples centred around GTCS1-51. The reported soil concentrations in the adjacent samples (GTCS1-51 and GTCS1-59) are <35µg/kg and 111µg/kg respectively, indicating that the elevated concentration reported at GTCS1-58 is not likely to be representative of average soil concentrations in the area. This means that the requirement within the Dutch guidance for the exceedance of the DIV to be representative of a soil volume of at least 25m^3 of soil has not been met and the exceedance of this single sample would not be considered to require further assessment. An additionally relevant consideration is the derivation and adjustment of the DIV. The published DIV is 1000µg/kg, and this has been adjusted based on soil organic matter content from 10% to 2% due to the lower SOM content reported in some of the pilot study soil samples (including GTCS1-58). The DIV adjustment for SOM is a generic adjustment set out in the Dutch guidance for all organic compounds, and is most relevant for compounds where vapour intrusion or plant uptake pathways are significant. It is much less relevant for compounds where the dominant exposure pathway is direct contact (especially ingestion). The highest reported concentrations for the individual congeners in sample GTCS1-58 are for PCB 52, 101 and 126. The exposure modelling reported in (Environment Agency, 2009) suggests that exposure for these congeners will be dominated by soil ingestion and dermal contact (>98% exposure pathway contribution), and hence the generic SOM adjustment to the DIV is not warranted.

(Vane, et al., 2014) investigated PCB concentrations in a 19km^2 area of east London and reported a range of ∑7 PCB concentrations of 0.6-750µg/kg, with a mean of 21µg/kg and a calculated NBC of 180µg/kg. (Environment Agency, 2007b) reported a range of ∑7 PCB urban soil concentrations across England of 0.5-30.2µg/kg with a mean of 3.2µg/kg. Some of the detected concentrations in Waynflete Square are therefore potentially higher than most concentrations that typify urban soil quality.

The reported concentrations of the sum of 7 PCB congeners did not exceed the GSC (re-adjusted DIV of 1,000µg/kg) in any samples analysed but typical urban background concentrations are likely to be lower than the higher concentrations detected at Waynflete Square.

Because the sum of 7 PCB congeners concentrations in soil at Waynflete Square do not exceed the GSC, the health risk from CLs associated with PCBs in soil at Waynflete Square is expected to meet the definition of Category 4 land.

Out of the 26 soil samples tested at Waynflete Square, asbestos was not detected in 15 samples. In eight samples it was detected below the quantification limit of 0.001%wt/wt and it was detected above the method reporting limit in three samples. All three samples were taken beneath turf. Fibre bundles were detected under the microscope in GTCS1-43 at the method reporting limit and equal to the GSC if the concentration is multiplied by 10 to account for the presence of amosite fibres. Chrysotile and amosite fibre bundles were detected below the method reporting limit (i.e. <0.001%wt/wt) in the shallower sample taken at this location. Fibre bundles were detected under the microscope in GTCS1-46 and the reported concentration exceeds the GSC if the concentration is multiplied by 10 to account for the presence of amosite fibres. The laboratory testing does not differentiate the quantities of chrysotile and amosite in these two samples. If the dominant asbestos present is chrysotile the GSC would not be exceeded. Asbestos was not detected in the shallower sample taken at this location. Chrysotile ACM debris and fibre bundles were detected under the microscope in GTCS1-59. At a reported concentration of 0.083%wt/wt this is 8.3 times higher than the GSC. With asbestos concentrations exceeding the GSC in only two samples out of 26 it is considered very unlikely that average soil concentrations exceed the GSC (noting the limitation of accurately calculating averages in datasets dominated by non-detects). On this basis, linkages associated with asbestos in soil would meet the definition of Category 4 land. To support this conclusion that the risk appears to be low, a supporting line of evidence in the form of a risk estimation based on the methodology described in CIRIA C733 (Nathanail, et al., 2014) is provided in **Appendix J**.

7.3.3 Summary

Based on the GSC screening and discussion above, a summary of the areas that fall into Category 4 and hence do no require further assessment, and those requiring further investigation as part of the DQRA, is presented in **Table 43** below.

Table 43. Summary of GSC Screening Results

Area Type	Area Name	Category 4 ('Low or no risk') after GQRA screening using GSC
Schools and Nurseries	Latimer Alternative Provision Academy	Y
	Burlington Danes School	Y
	Bassett House School (St Helen's Church)	Y
	Thomas Jones Primary School	Y
	All Saints Catholic College	Y
	Barlby Primary School	Y
	St. Francis Primary School	Y
	St. Anne's and Avondale Primary School and Nursery	Y
	Oxford Gardens Primary School	Y
	Golborne and Maxilla Children's Centre Forest School	Y
	Grenfell Creche Under 3s' Centre / Grenfell Nursery	Y
	New Studio pre-school	Y
	St Quintin Children and Family centre	Y

Area Type	Area Name	Category 4 ('Low or no risk') after GQRA screening using GSC
Community Kitchen Gardens and Allotments	Longstone Avenue allotments	N COPC: Lead and BaP
	St Quintin Gardens	Y
	St Charles Centre for Health and Wellbeing	Y
	Equal People	Y
	Portland Road CKG	N COPC: Lead
	Nottingwood House	Y
	The Grove	Y
Combined Community Kitchen Gardens and Public Open Space	Eynham Road railway land	N COPC: Lead
	Hurstway, Grenfell, Testerton and Barandon Walks (Lancaster Walkways)	Y
	Henry Dickens Court	Y
	Silchester East	Y
	Allom House and Barlow House	Y
	Morland House and Talbot Grove House	Y
	Bramley House	Y
	Kensington Memorial Park	Y
	Treadgold House	N COPC: Lead
Public Open Space	Verity Close	Y
	Little Wormwood Scrubs Including Adventure Playground	Y
	Darfield Way	Y
	Lancaster Green	Y
	Robinson House	Y
	Wesley Square	Y
	Silchester West (North and North West area)	Y
	Maxilla Walk - Maxilla Hall / Maxilla Green	Y
	Stonebridge Recreation Ground	Y
	Wormwood Scrubs	Y
	Tower cordon *(not currently accessible to public)*	Y
	Waynflete Square	Y
	Communal Space at Camelford Walk	Y
	Avondale Park *(public park)*	Y
	Avondale Park Gardens *(open space on residential street)*	N COPC: Lead
	West London Bowling Club	Y
	St Quintin's Roundabout	Y

7.4 Other COPC Considerations

7.4.1 Asbestos

Where asbestos has been encountered in soil, the GQRA assessment has concluded that its presence is consistent with Category 4 land (i.e. no to low risk). However, the distribution of asbestos in soil is often less predictable than other chemical COPC and therefore for all areas where more than one sample contained

asbestos a brief discussion of any evidence for clustering which could indicate more substantial asbestos presence in nearby soils is included here:

- **Burlington Danes**: Amosite fibres bundles (<0.001%wt/wt) in sample S017 below turf and chrysotile fibre bundles (<0.001%wt/wt) in sample S020 below turf, both at depths of 0-0.02m. The two samples are approximately 100m apart with different asbestos types and with closer samples (S016 and S014) where asbestos was not identified. There does not appear to be any clustering that might indicate the presence of more substantial asbestos.
- **Thomas Jones Primary School**: Chrysotile fibres bundles (<0.005%wt/wt) in sample S035 below turf and chrysotile fibre bundles (<0.001%wt/wt) in sample S040 on undisturbed bare soil in a landscaped area, both at depths of 0-0.02m. The two samples are approximately 80m apart at opposite ends of the school grounds with closer samples where asbestos was not identified. There does not appear to be any clustering that might indicate the presence of more substantial asbestos.
- **Portland Road CKG**: Two samples from ground level soil at the northern end of the sampling area contained asbestos, with no samples between the two. At S166 (ground level growing bed, bare soil, 0-0.2m) chrysotile and crocidolite fibre bundles were encountered with a reported concentration of 0.009%wt/wt and at GTCS1-18 (ground level bare soil on path, 0-0.05m) chrysotile and amosite fibre bundles were encountered with a reported concentration of <0.001%wt/wt. The fact that these samples are adjacent to one another provides a line of evidence that could suggest asbestos might be more likely to be encountered in the northern part of this area.
- **St Quintin's CKG**: One sample (GTCS1-30) from ground level soil (not a growing area) contained chrysotile and amosite fibres bundles (<0.001%wt/wt) in sample S017. Two samples in raised beds (GTCS1-29 and S149) contained amosite fibre bundles and chrysotile fibre bundles respectively, with the concentrations of both <0.001%wt/wt. The two samples in raised beds were adjacent to one another at the southern end of the sampling area and hence there is some potential that this could indicate soil more likely to contain asbestos in this section of the raised beds (for example a different original source, or topped up with soils sourced differently to any soils used to top up other parts of the raised beds.
- **Lancaster West Walkways**: Asbestos was detected in six of 22 samples, with the samples spread across the sampling area with no pattern of clustering indicative of more substantial asbestos. Five of the six samples contained chrysotile or amosite fibre bundles, with one containing chrysotile and crocidolite fibre bundles. Five of the six samples containing asbestos were collected at locations where samples were taken from multiple depths and at each location asbestos was only identified in one of the three samples. This indicates that the asbestos is most likely to be present sporadically at low concentrations.
- **Wesley Square:** Two of ten samples contained asbestos. Both samples – S332 and S333 – were located in the same landscaped soil bed where some herb bushes were growing with one sample containing chrysotile ACM debris and another containing chrysotile and amosite fibre bundles. Concentrations in both samples were <0.001% wt/wt.
- **Waynflete Square**: Asbestos was encountered in 10 of 26 samples distributed across the sampling area. In nine of the samples, amosite and/or chrysotile fibre bundles were reported, with crocidolite fibre bundles reported in one of these nine samples. Reported concentrations in eight of these nine samples was <0.001%wt/wt, with the ninth sample concentration being 0.002%wt/wt. These low levels distributed around the sampling area are not indicative of localised areas of higher concentrations. At one sample location (GTCS1-59), chrysotile fibre bundles and ACM debris were reported at a concentration of 0.083%wt/wt. Samples GTCS1-52 to 59 are located in a cluster to the south of GTCS1-59 and asbestos was not encountered in 6 of these 8 nearby sampling locations. For the two with asbestos identified the reported concentrations of <0.001%wt/wt are not indicative of an area of more substantial asbestos presence in the vicinity of the ACM debris at GTCS1-59.
- **Tower cordon**: Asbestos was encountered in three of 20 samples distributed across the sampling area. The asbestos at location S381 (chrysotile fibre bundles at 0.115%wt/wt) was encountered in a deeper sample (0.5-0.6m) and asbestos was not identified in the two shallower samples at the same location. The other two samples containing asbestos (GTCS1-03 and S386, 0-0.2m) were from a similar part of the sampling area immediately north of Grenfell Tower. However, a third sample in this area (S385) located closer to GTCS1-03 than S386 did not contain asbestos.

Based on the discussion above the conclusions from the risk assessments of individual areas are considered to remain valid and any CLs associated with asbestos in soil are considered to meet the definition of category 4

land. None of the data is suggestive of specific clustering of asbestos that warrants further investigation under Part 2A.

7.4.2 PAHs

PAHs have primarily been assessed using BaP as a surrogate marker, and this is discussed in more detail in **Section 7.2.2.2**.

However, as was noted in **Section 7.2.2.2**, for five samples the PAH ratios fell outside those used to indicate the suitability of the surrogate marker approach. Three of the five samples were located at Longstone Avenue allotments on bare cultivated soil with depths of 0-0.2m, and two were located at Eynham Road Railway Land in areas where residents were growing produce, again with the sample depth of 0-0.2m. For the samples at Longstone Avenue allotments the reported concentrations of BaP and DahA slightly exceeded the S4ULs in two of the three samples. The maximum BaP concentration of 4.35mg/kg marginally exceeded the allotments S4UL of 3.5mg/kg and the maximum DahA concentration of 0.8mg/kg exceeded the allotments S4UL of 0.43mg/kg by a factor of 1.9. For the samples at Eynham Road the reported concentration of BaP in one of the two samples (4.01mg/kg) slightly exceeded the Resi+HP S4UL of 3mg/kg but did not exceed the POSresi S4UL of 5.7mg/kg. The reported concentration of DahA in both samples at Eynham Road Railway Land (0.34mg/kg and 0.33mg/kg) marginally exceeded the Resi+HP S4UL of 0.3mg/kg but did not exceed the POSresi S4UL of 0.58mg/kg.

These minor exceedances are not considered to result in CLs that would represent a level of risk and greater than the C4SLs (i.e. Category 4 'low to no risk') since the S4UL is based on a toxicological threshold equivalent to a 1 in 100,000 excess lifetime cancer risk, whereas the C4SL is based on an LLTC which is based on a 1 in 50,000 excess lifetime cancer risk. Adopting a 1 in 50,000 ELCR using the S4UL TEF method would result in all BaP and DahA concentrations below the GSC.

7.4.3 Non-UK Criteria

Dibenzo(a,e)pyrene and dibenzo(j)fluoranthene were reported in a small number of samples at concentrations exceeding the USEPA RSL for residential land use. Whilst these compounds are expected to be covered by the BaP surrogate marker approach they do exceed the RSL in samples with outlying PAH ratios from the coal tar composition (refer to **Section 7.2.2.2**). The RSLs are based on an excess lifetime cancer risk of 1 in 1,000,000, which is 20 times lower than the basis of the C4SL for BaP as a surrogate marker. If the RSLs for these compounds are increased by a factor of 20 (i.e. to be equivalent to the C4SL level of risk) then none of the reported concentrations would exceed the GSC. It is noted that the RSLs do not include the vapour intrusion or homegrown produce pathways but these pathways are not expected to be significant enough for these compounds to make a material difference to the assessment due to the relatively low volatility and low plant uptake of such compounds in soil.

Other compounds which have been assessed using USEPA RSLs include aluminium, 2,4,6-tribromophenol, 2-methylnaphthalene, 9,10-anthracenedione, dibenzonfuran and 1,1-sulfonylbis4-chlorobenzene). The reported concentrations of all of these compounds are below the USEPA RSLs for a residential land-use and although the USEPA RSLs do not include homegrown produce or vapour intrusion pathways they are considered reasonable for screening these COPC since none are particularly volatile and (with the exception of aluminium) they have only been detected rarely in soil samples. In addition, 2-methylnaphthalene and dibenzofuran are likely to be covered by the BaP surrogate marker approach as both are present in coal tars. Aluminium, the only compounds detected in all samples, is a naturally abundant element in soil and the concentrations detected are considered to be consistent with normal soil conditions.

Detected concentrations of free cyanide, thiocyanate and the 'Dutch 7' suite of PCBs were assessed using Dutch Intervention Values. The Dutch criteria are considered to be suitable for assessing the most sensitive residential scenario as they are designed to protect 'multifunctionality of soils' i.e. they cover the most sensitive land use. The only soil concentrations to exceed a DIV were the PCB concentrations in a single sample in Waynflete Square – this was discussed in **Section 7.3.2.20**.

7.4.4 Consideration of COPC without Screening Criteria

7.4.4.1 Semi-Volatile Organic Compounds (SVOC)

Consistent with the Stage 1 assessment, a number of combustion-related semi-volatile organic compounds (SVOCs) have been quantified or tentatively identified by the laboratory analysis in Stage 2 samples. These include carbazole, non-target PAHs (i.e. those not listed in the US EPA 16) and alkyl PAHs. The majority of these tentatively

identified compounds (TICs) have been detected in a very small proportion of samples and at concentrations generally similar to those encountered in the Stage 1 samples.

Without undertaking a detailed review of the likely presence of these alkyl PAHs and other SVOCs in coal tar, it is considered reasonable at this stage of assessment to assume that the toxicological approach used in the derivation of the C4SL for benzo(a)pyrene, using benzo(a)pyrene as a surrogate marker for PAHs in coal tar, accounts for exposure to the wider range of unidentified coal tar constituents that may or may not include those detected in this study. This approach was taken for the Stage 1 assessment of SVOC TICs and is considered reasonable to extend to the Stage 2 samples.

The PAH ratios for all Stage 2 samples were plotted as **Graph 16** in **Section 7.2.2.2** in accordance with the assessment published by (Public Health England, 2017). The assessment indicates that the PAH compositions in the soil samples are within the limits for the approach to be valid. Hence the tentatively identified alkyl PAHs and combustion related SVOCs are considered to be satisfactorily assessed through the use of benzo(a)pyrene as a surrogate marker for PAHs in coal tar.

7.5 Potential significance of CLs and prioritisation of further assessment

The Part 2A statutory guidance includes two tests of significance with respect to the assessment of contaminant linkages associated with human health. Paragraph 2.13 of the guidance states that *"if at any stage the local authority considers, on the basis of the information obtained from inspection activities, that there is no longer a reasonable possibility that a significant contaminant linkage exists on the land, the authority should not carry out any further inspection in relation to that linkage"*. Paragraphs 4.4-4.27 of the guidance define significant harm and significant possibility of significant harm and four categories of land - Categories 1-4. Category 4 is associated with a range of risk from none to low. Category 3 is associated with a range of risk from "not low" to "not unacceptable". Categories 1 and 2 are associated with an unacceptable risk. These categories can be placed in a matrix that assists in prioritising which contaminant linkages could be defined as significant contaminant linkages (SCL) in accordance with the statutory guidance and should be assessed further. This matrix is illustrated in **Table 44** below:

Table 44. Prioritisation Matrix

Possibility of SCL being present	Risk	Possible land category	Priority
High possibility	Unacceptable	1	Highest
More than reasonable possibility	Unacceptable (on a precautionary basis)	2	
Reasonable possibility	Not Low or potentially unacceptable (on a precautionary basis)	3 or 2	
Less than reasonable possibility	Low	4	
Less than reasonable possibility	None (e.g. no CL)	4	Lowest

Factors that can be used to assess the possibility of the presence of an SCL include:

- Frequency and spatial distribution of COPC detection in soil samples.
- Proportion of COPC concentrations that exceed GSC.
- The degree to which COPC concentrations exceed GSC[7].
- Comparison of reported COPC soil concentrations with local, regional and national background levels.

[7] Footnote 2 of paragraph 3.29 of the statutory guidance states that the level of risk posed by land contamination will depend on more than simply the amount of contaminant in the soil; it will also depend on what form the contaminants take, where they are in the soil, the efficiency of the pathway by which receptors may be exposed, the sensitivity of receptors, the likely degree and duration of exposure, and the dose-response relationship of that contaminant. These factors will vary from case to case, sometimes very substantially. Footnote 3 goes on to state that GSC (because of the variability in how they are derived) can be exceeded by a substantial degree (sometimes by orders of magnitude) but in other cases there may be a considerably smaller margin and in some cases it may be that GSC are only exceeded by a few times for land to fall outside of Category 4.

- The level of confidence in the available data (what uncertainties or data gaps remain).

These factors can be translated into the prioritisation matrix in **Table 44** above as shown in **Table 45** below, which is taken directly from the EA/PHE Analysis and Interpretation Methodology for the Soil Investigation at Grenfell Tower.

Table 45. Contaminant linkage prioritisation using soil data*

Detection and spatial distribution of COPC in soil		Proportion of COPC concentrations above GSC		Comparison with normal levels in urban soils	Linkage Ranking
Most if not all results less than suitable method detection limits (MDL) and/or sample depth and location inconsistent with potential exposure pathways		N/A		N/A	No further investigation required (evidence suggests that there is no reasonable possibility of a significant contaminant linkage)
Most results above MDL and sample depth and location consistent with potential exposure pathways, but no indication of spatial patterns or hot spot consistent with fire emissions		All results at or below a relevant GSC		All results considered to be within typical background levels	Low priority for further investigation (evidence suggests that there is unlikely to be a reasonable possibility of a significant contaminant linkage)
Most results above MDL and sample depth and location consistent with potential exposure pathways, but no indication of spatial patterns or hot spot consistent with fire emissions	And	Some results well-above a relevant GSC	And	Some results above typical background levels	Medium priority for targeted further investigation (evidence suggests there could be a reasonable possibility of a significant contaminant linkage)
Results above MDL and sample depth and location consistent with potential exposure pathways. Results indicate a strong spatial pattern and/or hot spot(s) that are consistent with fire emissions		Majority of results above relevant GSC and many results well-above a relevant GSC		Majority of results above typical background levels	High priority for further investigation (evidence suggests there could be a reasonable possibility of a significant contaminant linkage)
Results above MDL and sample depth and location consistent with potential exposure pathways. Results indicate of a strong spatial pattern or hot spot that is consistent with fire emissions		Majority of results well-above a relevant GSC		Majority of results well-above typical background levels	Highest priority for further investigation (evidence suggests there is a reasonable possibility of a significant contaminant linkage)

* Not shown in the above matrix is the assessment of uncertainty and the identification of information gaps for each contaminant linkage. If confidence in the assessment of a contaminant linkage is low, this may indicate the need for further investigation.

Following completion of the GQRA, the potentially significant contaminant linkages identified as part of the PRA, and which are summarised in **Section 4**, have been updated and categorised based on the above matrix.

The CLs evaluated were specifically related to questions about fire-related contamination and do not necessarily include all CLs that would be relevant to a full site-specific Part 2A assessment of each sampling area since other non-fire-related soil contamination could be present as the result of historical land-use and release to ground of different (and untested) contaminative chemicals. The conclusions from **Section 6** were that the Grenfell Tower fire did not cause impacts to soil that would result in a risk to health above the Category 4 'low to no risk' and hence fire-related linkages would be no higher than low priority for further assessment. Because the CLs that have been assessed are based on total COPC concentrations identified during Stage 1 and Stage 2 sampling and are not limited to the additional contribution to those concentrations that might have been a result of the Grenfell Tower fire, any CLs identified with a priority higher than "low" are considered to be associated with pre-fire historic sources of contamination. The revised contaminant linkages are provided in **Table 46** below.

Table 46. Contaminant linkage prioritisation for further assessment

COPC Group		Detection and spatial distribution of COPC in soil	Proportion of COPC concentrations above GSC	Comparison with normal levels in urban soils	Linkage Ranking	Uncertainty
Lead		Detected in all soil samples	238 of 543 samples exceed the residential C4SL of 200mg/kg. Some sample results well above this GSC, particularly where the allotments C4SL applies, and in a small number of specific sampling areas where typical concentrations are at the higher end of the detected range	Some concentrations of individual samples higher than NBC of 820mg/kg, though wider comparison of data with London Earth background dataset suggests that all data are within the range and distribution of background lead concentrations in West London	Low to High	Stage 2 sampling has provided a reasonable level of certainty in terms of typical representative exposure concentrations. Higher uncertainty in localised areas
	Longstone Avenue allotments	Detected in all soil samples	All but one of 26 samples exceed the allotments GSC of 80mg/kg, with maximum of 565mg/kg 7 times higher.	Mean concentrations slightly lower than London Earth background range.	Medium	Reasonable level of certainty across the site as a whole with no obvious outliers. However, insufficient data for characterisation of individual growing plots.
	Eynham Road railway land		All shallow samples exceed Resi+HP GSC of 200mg/kg. 9 of 19 samples exceed the POSresi GSC	Five sample concentrations above NBC and average concentrations above mean concentration from London Earth dataset	Medium	Reasonable level of certainty. Two higher possible outlier value at adjacent sampling locations indicating possible localised area of higher concentrations.
	Treadgold House		All raised bed sample concentrations less than Resi+HP GSC. All ground level samples exceed Resi+HP GSC and 6 of 9 also exceed POSresi GSC, with maximum exceeding the Resi+HP GSC by a factor of 11.	Mean and median concentrations of ground level soils exceed the NBC and the average concentrations in the London Earth dataset, though they are within the range of the London Earth dataset.	High	Possible higher lead concentrations in the south and west of the sampling area is not well defined therefore relatively high uncertainty associated with average exposure concentrations for residents whose properties open onto the south and west part of the site.
	Portland Road CKG		All raised bed sample concentrations less than Resi+HP GSC. All ground level samples exceed Resi+HP GSC and 2 of 4 also exceed POSpark GSC. Maximum ground level sample concentration exceeds Resi+HP GSC by factor of 9 and POSpark GSC by factor of 1.5	Of four ground level samples, the reported concentration in two are more than double the NBC, though remain within the range of London Earth data. Mean and median concentrations are above the averages for the London Earth dataset	Medium	Only 4 samples in ground level soils with wide range of reported concentrations – two well above the NBC and two well below the NBC. Therefore relatively high uncertainty associated with average concentrations in ground level soils

COPC Group	Detection and spatial distribution of COPC in soil	Proportion of COPC concentrations above GSC	Comparison with normal levels in urban soils	Linkage Ranking	Uncertainty
Avondale Park Gardens		Both sample concentrations exceed the POSresi GSC, with the maximum concentration 3.3 times higher	One sample exceeds the NBC and one is below the NBC. Although both samples are within the range of the London Earth dataset, both concentrations are higher than the mean and median of the London Earth dataset	Medium	Very high uncertainty with average concentrations as only two samples available from Stage 1 sampling.
Antimony	Detected in all 103 soil samples	None. Maximum reported concentration of 24mg/kg lower than GSC of 198mg/kg	Background data not reviewed due to concentrations reported substantially below the GSC and antimony not anticipated to be a key marker of potential fire effluent	Low	Concentrations consistent across 103 samples, therefore considered to be low uncertainty.
PAHs **BaP (as surrogate marker for carcinogenic PAHs)**	Detected in 532 of 546 soil samples	The reported concentrations in 30 of 546 samples exceeded the residential C4SL of 5mg/kg. The exceedances ranged up to five times higher than this GSC. Highest concentrations often in deeper soils (e.g. Lancaster West Walkways) where exposure to residents likely to be very limited.	Some concentrations higher than NBC of 3.6mg/kg although comparison with wider background urban dataset for England suggests reported concentrations within typical urban range and average concentrations consistent with urban background range.	Low to Medium	Stage 2 sampling has provided a reasonable level of certainty in terms of typical representative exposure concentrations. Uncertainty in averaging area concentrations in one sampling area
Longstone Avenue allotments	Detected in all 26 soil samples	BaP concentrations exceed the allotments GSC at 4 of 16 sampling locations, with the maximum exceeding the GSC by a factor of 2.1	The mean concentration slightly exceeds the NBC, with the median slightly lower than the NBC. Average concentrations also slightly exceed the equivalent averages from the EA SHS urban dataset. The maximum BaP concentration (a possible outlier) exceeds the NBC by a factor of 3.3.	Medium	Reasonable level of certainty across the site as a whole, though with one potential outlier. High uncertainty associated with BaP concentration in the plot with the maximum possible outlier concentration.
Dioxins, furans and dioxin-like PCBs	Detected in all soil samples	None (based on WHO 2005 TEQ approach and hazard index calculation)	High uncertainty with what normal ranges in urban soils such as those that surround Grenfell Tower might be. Some evidence that Stage 1 and Stage 2 soil results are higher than urban background based on the limited background datasets available (typically collected from city parks such as Richmond Park and Hyde Park); however, there are no background data available for heavily urbanised areas with areas of heavy historic industry and multiple phases of re-development such as North Kensington	Low	Stage 2 sampling has provided a reasonable level of certainty in terms of typical representative exposure concentrations.

COPC Group	Detection and spatial distribution of COPC in soil	Proportion of COPC concentrations above GSC	Comparison with normal levels in urban soils	Linkage Ranking	Uncertainty
Asbestos	Detected in 42 of 502 samples	4 individual samples exceed the GSV (Dutch Tier 2 screening values) However, the Dutch Tier 2 values relate to average soil concentrations and risk assessment in **Section 6.7** indicates that the nine individual sample exceedances do not indicate a risk to health that is likely to exceed the 'no to low risk' consistent with Category 4 land.	Considered likely to be within expected urban range.	Low	The presence of asbestos in urban soils and made ground is typically known to be sporadic and unpredictable, and this is consistent with the asbestos identified in the Stage 2 assessment. Given the unpredictable nature of encountering asbestos, the uncertainty associated with its presence in any given area remains relatively high, but the Stage 2 investigation has shown that it does not appear to be any higher than expected in a typical urban area, and there is not any evidence for potential clusters of ACM and asbestos presence that might be expected to increase the potential health risk above that discussed in the GQRA..

Table 46 above indicates that lead and PAHs have sufficient linkage ranking priority for further assessment to be required, taking the form of detailed quantitative risk assessment. A summary of the potentially significant contaminant linkages to be addressed further as part of the DQRA is presented in **Table 47** below. As discussed in **Section 6**, these CLs are not considered to be caused by fire-related contamination and are believed to be caused by pre-fire historic contamination sources.

Table 47. Potentially significant contaminant linkages to be addressed further in DQRA

Sources	Pathways	Receptors
Lead in soil at Eynham Road railway land	Ingestion of soil and indoor dust Dermal contact with soil (outdoor) Dermal contact with soil derived dust (indoor) Consumption of produce and attached soil Inhalation of dust (indoor and outdoor)	Residents of private properties along Eynham Road that use the communal land beyond the end of the private garden as an extension to their gardens.
Lead in soil at Treadgold House	Ingestion of soil and indoor dust Dermal contact with soil (outdoor) Dermal contact with soil derived dust (indoor) Consumption of produce and attached soil *(likely to be negligible due to small scale of raised beds and much lower lead concentrations in soil in raised beds)* Inhalation of dust (indoor and outdoor)	Residents of Treadgold House
Lead in soil at Portland Road CKG	Ingestion of soil Dermal contact with soil (outdoor) Consumption of produce and attached soil *(likely to be negligible due to small scale of raised beds and much lower lead concentrations in soil in raised beds. Produce growing at ground level are fruit trees and shrubs, therefore also expected to be a low level of exposure)* Inhalation of dust (outdoor)	Users of the Community Kitchen Garden
Lead in soil at Avondale Park Gardens	Ingestion of soil and indoor dust Dermal contact with soil (outdoor) Dermal contact with soil derived dust (indoor) Inhalation of dust (indoor and outdoor)	Residents of Avondale Park Gardens and their visitors. *Although theoretically open to the public, Avondale Park Gardens is a 'square' and therefore not a through route for the public. Avondale Park is also close by and more likely to be used as a recreation location for the public. Therefore general members of the public are much less likely to be a receptor of concern.*
Lead in soil at Longstone Avenue allotments Genotoxic Polycyclic Aromatic Hydrocarbons and associated SVOCs (represented by BaP as a surrogate marker) in soil at Longstone Avenue allotments	Ingestion of soil Dermal contact with soil (outdoor) Consumption of produce and attached soil Inhalation of dust (outdoor)	Allotments users at Longstone Avenue allotments

Note: in the context of a Part 2A contaminated land assessment indoor dust refers to dust generated by the tracking back of soil into a building rather than dust blown directly from Grenfell Tower during and after the fire. Outdoor dust is that derived from wind-blown soil rather than dust blown directly from Grenfell Tower.

8. Detailed Quantitative Risk Assessment

In accordance with the tiered approach to land contamination risk management prescribed in UK guidance, the next stage of assessment following completion of the GQRA described in **Section 7** is the detailed quantitative risk assessment (DQRA).

The objective of the DQRA is to quantify the estimated level of health risk based on the adoption of site-specific exposure parameters and the review and adjustment (if appropriate) of the toxicological criteria used to define the level of health risk. A key part of the DQRA process is the adoption of more appropriate exposure assumptions which can estimate the more likely level of risk.

A number of specific sampling areas were identified as needing further assessment following the GQRA and have been assessed further, including:

- Longstone Avenue allotments;
- Eynham Road railway land;
- Treadgold House;
- Portland Road CKG; and
- Avondale Park Gardens.

The approach to this DQRA has been to calculate site-specific assessment criteria (SSAC) using the same methods used to derive the C4SLs, but making adjustments to exposure assumptions and parameters based on site specific information, as well as adjusting exposure assumptions based on evolving evidence that has been published since the CLEA guidance and C4SL reports. The DQRA has been completed in two steps:

- Step 1 comprises the calculation of SSAC where site specific information is used to refine the exposure assessment whilst retaining a low level of risk consistent with Category 4 land (i.e. the precautionary nature of the exposure and toxicological assumptions remains largely unchanged). Step 1 also involves adjustment of the soil ingestion rated based on guidance published by the US EPA in 2017 (US EPA, 2017). This constitutes a refinement based on the update of the original documentation reviewed when the Environment Agency and CL:AIRE/Defra selected an appropriate soil ingestion rate for the original CLEA guidance and C4SL derivation.

  In the context of this report, the Step 1 SSAC define a level of risk that is closer to the Category 4 / Category 3 boundary such that soil concentrations equal to or below the Step 1 SSAC would fall into Category 4, but soil concentrations exceeding the Step 1 SSAC would be less likely to fall into Category 4.

- Where soil concentrations in a sampling area exceed these Step 1 SSAC, these sampling areas are taken forwards to Step 2 which involves the calculation of SSAC that are associated with a higher (i.e. not low) level of risk, This may involve the adoption of alternative exposure assumptions and/or alternative toxicological values.

  In the context of this report, the Step 2 SSAC define a level of risk approaching that that could be considered to pose a significant possibility of significant harm. They are intended to provide an indication of where the threshold between Category 2 and Category 3 could be, although this decision must also be weighed against the strength of the evidence, remaining uncertainty and other considerations to be made by the local authority, as described in Paragraphs 4.24 to 4.29 of the Part 2A Statutory Guidance.

The COPC include lead for all five areas, and BaP for Longstone Avenue allotments. As part of a precautionary approach and because it is relatively simple to do so, SSAC have been calculated for BaP for all fives sampling areas at Step 1.

8.1 Step 1 SSAC Derivation

The exposure parameter adjustments used for the calculation of SSAC in each of these scenarios are based on a combination of changes to the following parameters:

- site-specific plant concentration factors taken from the results of the Stage 2 crop/soil sample pairs.
- the site-specific soil bioaccessibility testing data.

- soil ingestion rate.
- homegrown produce diet fraction.

Other key exposure parameters have been maintained as the default values used in the C4SL and CLEA guidance. Although the CKG scenario considered in this report does not have a standard CLEA or C4SL scenario, the exposure assumptions adopted (other than those adjusted as noted in the bullet list above) are based on the C4SL POSpark scenario.

A summary of the crop/root zone soil data, the bioaccessibility data-sets and the selection of representative modelling input parameters for ingestion rate, exposure durations occupancy periods and exposure periods, and homegrown produce diet fraction is presented in the following report sections below.

8.2 Paired crop and root zone soil sampling

The crop and paired root zone soil testing was completed as part of the Stage 2 investigation on the basis that they would be an informative line of evidence in any DQRA that might be required, noting that the key exposure pathways for health risks caused by lead and PAHs are soil ingestion and consumption of homegrown fruit and vegetables.

The crop and root zone soil sampling and laboratory analysis scope of work and method are described in **Section 5**. The results provided by the laboratories are presented in appended **Appendix K** and have been summarised in the tables below and used to derive soil to plant correction factors (CFs). The soil to plant CF describes the fraction of the COPC that is present in soil that is taken up into the edible part of the plant. CFs are simply calculated by dividing the concentration in the crop by the concentration in the soil from the root zone of the crop.

8.2.1 Lead

The lead concentrations identified within the individual crop and root zone soil samples are provided in **Table 48** below. Presented alongside these concentrations are the resulting soil to plant concentration factor (CF) and the default CF used in the C4SL CLEA model for the derivation of the GSC.

Table 48. Lead Crop and Root Zone Soil Data

Sampling Area	Sample ID	Sample Type	Crop Group	Crop lead concentration mg/kg (as received)	Lead in root zone soil mg/kg (dry weight)	Soil to plant CF	Equivalent CLEA default CF
St. Francis Primary School	GTCS2-P002	Apple	Tree fruit	0.001	276	3.6E-06	2.29E-04
Longstone Ave allotments	GTCS2-P007	Potato	Tuber vegetable	0.017	256	6.6E-05	7.31E-03
	GTCS2-P008	Horseradish	Root vegetable	0.167	430	3.9E-04	4.02E-03
	GTCS2-P009	Butternut squash	Herbaceous fruit	0.008	395	2.0E-05	7.49E-04
	GTCS2-P010	Marrow	Herbaceous fruit	0.006	218	2.8E-05	7.49E-04
	GTCS2-P011	Raspberry	Shrub fruit	0.009	252	3.6E-05	2.05E-04
	GTCS2-P012	Rhubarb	Root vegetable	0.195	14,200 | 184	1.37E-05 | 1.1E-03	4.02E-03
St Quintin's Community Kitchen Garden	GTCS2-P013	Grapes	Shrub fruit	0.005	47	1.1E-04	2.05E-04
	GTCS2-P014	Horseradish	Root vegetable	0.005	37	1.4E-04	4.02E-03
	GTCS2-P017	Beans	Green vegetable	0.001	36	2.8E-05	4.19E-03
Equal People	GTCS2-P019	Kale	Green vegetable	0.036	88	4.1E-04	4.19E-03

Sampling Area	Sample ID	Sample Type	Crop Group	Crop lead concentration mg/kg (as received)	Lead in root zone soil mg/kg (dry weight)	Soil to plant CF	Equivalent CLEA default CF
St Charles Centre for Health and Wellbeing	GTCS2-P022	Rhubarb	Root vegetable	0.039	42	9.3E-04	4.02E-03
	GTCS2-P023	Runner beans	Green vegetable	0.001	48	2.1E-05	4.19E-03
Portland Road Community Kitchen Garden and Nottingwood House	GTCS2-P025	Plum tomato	Herbaceous fruit	<0.001	68	1.5E-05	7.49E-04
	GTCS2-P029	French beans	Green vegetable	0.002	48	4.2E-05	4.19E-03
	GTCS2-P030	Ruby Chard	Green vegetable	0.23	50	**4.6E-03**	4.19E-03
Eynham Road railway land	GTCS2-P031	Pears	Tree fruit	0.004	928	4.3E-06	2.29E-04
	GTCS2-P033	Horseradish	Root vegetable	0.447	743	6.0E-04	7.49E-04
	GTCS2-P035	Apples	Tree fruit	0.002	437	4.6E-06	2.29E-04
	GTCS2-P036	Beetroot	Root vegetable	0.311	525	5.9E-04	4.02E-03
Lancaster West Walkways	GTCS2-P037	Spinach	Green vegetable	0.075	87	8.6E-04	4.19E-03
	GTCS2-P038	Potatoes	Tuber vegetable	0.022	65	3.4E-04	7.31E-03
	GTCS2-P041	Cabbage	Green vegetable	0.031	62	5.0E-04	4.19E-03
	GTCS2-P042	Rhubarb	Root vegetable	0.114	226	5.0E-04	4.02E-03
Silchester East	GTCS2-P049	Cavolo Nero Kale	Green vegetable	0.016	86	1.9E-04	4.19E-03
	GTCS2-P050	Turnip	Root vegetable	0.006	149	4.0E-05	4.02E-03
	GTCS2-P053	Potatoes	Tuber vegetable	0.009	78	1.2E-04	7.31E-03
Allom and Barlow House	GTCS2-P055	Runner Beans	Green vegetable	0.003	119	2.5E-05	4.19E-03
	GTCS2-P057	Potatoes	Tuber vegetable	0.031	137	2.3E-04	7.31E-03
Morland and Talbot Grove	GTCS2-P062	Callaloo	Green vegetable	0.116	428	2.7E-04	4.19E-03
	GTCS2-P064	Figs	Tree fruit	0.005	1148	4.4E-06	2.29E-04
	GTCS2-P065	Potatoes	Tuber vegetable	0.007	35	2.0E-04	7.31E-03
Bramley House	GTCS2-P068	Pumpkin	Herbaceous fruit	0.002	61	3.3E-05	7.49E-04
	GTCS2-P069	New Potatoes	Tuber vegetable	0.005	117	4.3E-05	7.31E-03
	GTCS2-P072	Olives	Tree fruit	0.007	61	1.1E-04	2.29E-04

Blue cell shading indicates site-specific CF higher than CLEA default value.

A statistical summary of the above dataset is presented in **Table 49** below.

Table 49. Summary of Lead Soil to Plant Concentration Factors

		Soil to Plant Concentration Factor				
Crop Type	No. of samples	Minimum	Maximum	Mean	Geometric mean	CLEA default
Green vegetable	10	2.1E-05	4.6E-03	6.9E-04	1.7E-04	4.19E-03
Tree fruit	5	3.6E-06	1.1E-04	2.6E-05	8.1E-06	2.29E-04
Tuber vegetable	6	4.3E-05	3.4E-04	1.6E-04	1.3E-04	7.31E-03
Shrub fruit	2	3.6E-05	1.1E-04	7.1E-05	6.2E-05	2.05E-04
Root vegetable	8	4.0E-05	1.1E-03	5.3E-04	3.7E-04	4.02E-03
Herbaceous fruit	4	1.5E-05	3.3E-05	2.4E-05	2.3E-05	7.49E-04

Table 48 shows that the site-specific plant concentration factors are lower than the CLEA default values for all samples with the exception of one – ruby chard grown at Portland Road community kitchen garden in a raised bed. The CF calculated from this sample was very similar to the default value (4.6E-03 compared to 4.19E-03), whereas all other CFs calculated in the green vegetables category ranged from 8.6E-04 to 2.1E-05. This includes french beans grown in soil with a very similar lead concentration at the same site (Portland Road), for which a CF of 4.2E-05 was calculated. This demonstrates that this maximum value is unlikely to be representative of the CFs locally within a single sampling area or across the investigation area and could be associated with a specifically higher uptake of lead that is unique to ruby chard. Given this evidence, it is considered appropriate to reduce the CFs used as part of the DQRA modelling.

The initial approach is to take the mean CF for each crop type as the parameter for DQRA modelling. The adopted values are shown in **Table 56**. Taking the mean rather than median or geometric mean avoids preferentially skewing the adopted value towards the lower values in the range and results in an adopted CF that is within a factor of between 1.4 and 6.6 of the maximum site-specific CF for each crop type. These mean values are between 3 and 44 times lower than the default CLEA values. The same soil to plant CFs have been applied to each of the land-use scenarios for which homegrown produce is a relevant pathway, including:

- Longstone Avenue allotments;
- Eynham Road railway land; and
- Portland Road CKG.

For the sampling areas where the risk assessment is likely to be most sensitive to plant uptake and consumption of produce – Eynham Road railway land and Longstone Avenue allotments – the adopted mean CFs are either lower than, or very similar to (maximum of 1.2 times higher than), the CFs calculated in those particular areas.

8.2.2 Benzo(a)pyrene

The derivation of the C4SL for BaP as a surrogate marker assumes that the physico-chemical properties of BaP are considered sufficiently similar to the other genotoxic PAHs to assume that the prediction of exposure to BaP will be a good surrogate for prediction of exposure to the other genotoxic PAHs. Soil to plant concentration factors used for the C4SL derivation were based on the geometric mean of relatively small unpublished Environment Agency empirical datasets for BaP. The BaP crop and root zone soil data is summarised below in **Table 50** with the calculated soil to plant CF shown for each sample pair.

Table 50. BaP Crop and Root Zone Soil Data

Sampling Area	Sample ID	Sample Type	Crop Group	Crop BaP concentration µg/kg (as received)	BaP in root zone soil µg/kg (dry weight)	Soil to plant CF	CLEA default CF
St. Francis Primary School	GTCS2-P002	Apple	Tree fruit	<0.1	670	1.5E-04	4.7E-05
Longstone Ave allotments	GTCS2-P007	Potato	Tuber vegetable	0.14	3920	3.6E-05	8.9E-04

Sampling Area	Sample ID	Sample Type	Crop Group	Crop BaP concentration µg/kg (as received)	BaP in root zone soil µg/kg (dry weight)	Soil to plant CF	CLEA default CF
	GTCS2-P008	Horseradish	Root vegetable	0.93	4350	2.1E-04	1.8E-03
	GTCS2-P009	Butternut squash	Herbaceous fruit	<0.1	1840	5.4E-05	5.1E-04
	GTCS2-P010	Marrow	Herbaceous fruit	<0.1	2660	3.8E-05	5.1E-04
	GTCS2-P011	Raspberry	Shrub fruit	<0.1	1810	5.5E-05	5.6E-06
	GTCS2-P012	Rhubarb	Root vegetable	<0.1	1180	8.5E-05	1.8E-03
St Quintin's Community Kitchen Garden	GTCS2-P013	Grapes	Shrub fruit	<0.1	90	1.1E-03	5.6E-06
	GTCS2-P014	Horseradish	Root vegetable	<0.1	70	1.4E-03	1.8E-03
	GTCS2-P017	Beans	Green vegetable	<0.1	90	1.1E-03	4.1E-04
Equal People	GTCS2-P019	Kale	Green vegetable	0.14	210	6.7E-04	4.1E-04
St Charles Centre for Health and Wellbeing	GTCS2-P022	Rhubarb	Root vegetable	<0.1	100	1.0E-03	1.8E-03
	GTCS2-P023	Runner beans	Green vegetable	<0.1	170	5.9E-04	4.1E-04
Portland Road Community Kitchen Garden and Nottingwood House	GTCS2-P025	Plum tomato	Herbaceous fruit	<0.1	150	6.7E-04	5.1E-04
	GTCS2-P029	French beans	Green vegetable	<0.1	220	4.5E-04	4.1E-04
	GTCS2-P030	Ruby Chard	Green vegetable	0.31	160	1.9E-03	4.1E-04
Eynham Road railway land	GTCS2-P031	Pears	Tree fruit	<0.1	4010	2.5E-05	4.7E-05
	GTCS2-P033	Horseradish	Root vegetable	0.67	1720	3.9E-04	1.8E-03
	GTCS2-P035	Apples	Tree fruit	<0.1	3120	3.2E-05	4.7E-05
	GTCS2-P036	Beetroot	Root vegetable	0.1	3230	3.1E-05	1.8E-03
Lancaster West Walkways	GTCS2-P037	Spinach	Green vegetable	0.22	640	3.4E-04	4.1E-04
	GTCS2-P038	Potatoes	Tuber vegetable	0.14	430	3.3E-04	8.9E-04
	GTCS2-P041	Cabbage	Green vegetable	<0.1	450	2.2E-04	4.1E-04
	GTCS2-P042	Rhubarb	Root vegetable	<0.1	440	2.3E-04	1.8E-03
Silchester East	GTCS2-P049	Cavolo Nero Kale	Green vegetable	0.1	290	3.4E-04	4.1E-04
	GTCS2-P050	Turnip	Root vegetable	<0.1	770	1.3E-04	1.8E-03
	GTCS2-P053	Potatoes	Tuber vegetable	<0.1	1260	7.9E-05	8.9E-04
Allom and Barlow House	GTCS2-P055	Runner Beans	Green vegetable	<0.1	790	1.3E-04	4.1E-04

Sampling Area	Sample ID	Sample Type	Crop Group	Crop BaP concentration µg/kg (as received)	BaP in root zone soil µg/kg (dry weight)	Soil to plant CF	CLEA default CF
Morland and Talbot Grove	GTCS2-P057	Potatoes	Tuber vegetable	0.12	930	1.3E-04	8.9E-04
	GTCS2-P062	Callaloo	Green vegetable	0.43	880	4.9E-04	4.1E-04
	GTCS2-P064	Figs	Tree fruit	<0.1	540	1.9E-04	4.7E-05
	GTCS2-P065	Potatoes	Tuber vegetable	<0.1	110	9.1E-04	8.9E-04
Bramley House	GTCS2-P068	Pumpkin	Herbaceous fruit	<0.1	470	2.1E-04	5.1E-04
	GTCS2-P069	New Potatoes	Tuber vegetable	0.5	410	1.2E-03	8.9E-04
	GTCS2-P072	Olives	Tree fruit	<0.1	520	1.9E-04	4.7E-05

Blue cell shading indicates site-specific value higher than CLEA default
Grey text indicates site-specific value based on non-detect concentration in plant, therefore conservative.

A statistical summary of the above dataset is presented in **Table 51** below, with average values calculated by substituting the laboratory detection limit as the plant concentration where results were reported as being below detection.

Table 51. Summary of BaP Soil to Plant Concentration Factors

		Soil to Plant Concentration Factor				
Crop Type	No. of samples	Minimum	Maximum	Mean	Geometric mean	CLEA default
Green vegetable	10	1.3E-04	1.9E-03	6.3E-04	4.8E-04	4.12E-04
Tree fruit	5	2.5E-05	1.9E-04	1.2E-04	8.4E-05	4.69E-05
Tuber vegetable	6	3.6E-05	1.2E-03	4.5E-04	2.3E-04	8.89E-04
Shrub fruit	2	5.5E-05	1.1E-03	5.8E-04	2.5E-04	5.63E-06
Root vegetable	8	3.1E-05	1.4E-03	4.4E-04	2.3E-04	1.78E-03
Herbaceous fruit	4	3.8E-05	6.7E-04	2.4E-04	1.3E-04	5.08E-04

Of the 35 crop samples, 14 are indicated to have concentration factors higher than the CLEA default value, although of these 14, ten are based on non-detect values in the crop sample and are therefore an over-estimation of the CF. All six crop types have one or more samples for which the plant did not have BaP detected above the detection limit and for all three types of fruit none of the samples detected BaP in the plants. The values reported for fruit crop types are therefore considered to be overestimated to an unquantifiable degree and it is reasonable to revert to the C4SL default values for tree fruit, shrub fruit and herbaceous fruit.

For vegetable crops, with non-detects replaced with the detection limit (i.e. **Table 51** above), the mean of the site-specific CFs are 150% (green veg), 50% (tuber veg) and 25% (root veg) of the C4SL default values. If CFs calculated using non-detect values are removed from the dataset entirely, the mean values increase marginally for green and tuber vegetables, and decrease slightly for root vegetables.

As an initial approach, the site-specific CFs for green, tuber and root vegetables based on the mean of detected samples have been adopted, with the adopted CFs for the DQRA listed in **Table 52** below (also presented in **Table 56**).

Table 52. Adopted soil to plant CFs for BaP

Crop Type	Adopted soil to plant CF	Rationale
Green vegetable	7.6E-04	Site specific average for BaP, 4 samples
Tree fruit	4.69E-05	BaP C4SL default
Tuber vegetable	4.3E-04	Site specific average for BaP, 4 samples
Shrub fruit	5.63E-06	BaP C4SL default
Root vegetable	2.1E-04	Site specific average for BaP, 3 samples
Herbaceous fruit	5.08E-04	BaP C4SL default

A sensitivity check has been completed to ascertain whether it is reasonable to assume that the physico-chemical properties of BaP are considered sufficiently similar to the other genotoxic PAHs to assume that the prediction of exposure to BaP will be a good surrogate for prediction of exposure to the other genotoxic PAHs.

Soil to plant concentration factors were calculated for all 8 genotoxic PAHs present in the USEPA 16 suite of priority PAHs to understand whether any of them might have significantly higher uptake into crops than BaP. The maximum of the average soil to plant CF for each crop type are summarised in **Table 53** below.

Table 53. Highest Soil to Plant Concentration Factors for other PAHs

Crop Type	PAH	Toxic Equivalency Factor (relative to BaP)	CF
Green vegetable	Chrysene	0.1	2.3E-03
Tree fruit	BaP C4SL default	1	4.69E-05
Tuber vegetable	Dibenzo(ah)anthracene	1	1.25E-03
Shrub fruit	Benzo(a)anthracene	0.1	1.83E-03
Root vegetable	Benzo(a)anthracene	0.1	1.91E-03
Herbaceous fruit	Benzo(b)fluoranthene	0.1	2.36E-04

The CFs presented in **Table 53** have been used as part of the sensitivity assessment described in **Section 8.9.3**.

8.3 Soil bioaccessibility testing

The scope of work and method for the soil bioaccessibility laboratory analysis are described in **Section 5**. The bioaccessibility testing provides an estimate of the proportion of the COPC present in the soil that would be available to be absorbed by the digestive system if it were ingested. The results provided by the laboratory are presented in **Appendix K** and have been summarised in the report sections below.

8.3.1 Lead

A summary of the lead bioaccessibility test results, grouped by sampling area, is presented in **Table 54** below.

Table 54. Soil Bioaccessibility Data Summary for Lead

Sampling Area	Number of samples	Total Pb range (mg/kg)	Bioaccessible fraction (BAF) range (%)	BAF mean (%)
1. Latimer Alternative Provision Academy	1	104	56	n/a
2. Burlington Danes School	3	641 - 772	69 - 80	74
3. Bassett House School (St Helen's Church)	2	436 - 475	61 - 67	64
5. All Saints Catholic College	3	444 - 653	63 - 76	69
6. Barlby Primary School	1	861	66	n/a

Sampling Area	Number of samples	Total Pb range (mg/kg)	Bioaccessible fraction (BAF) range (%)	BAF mean (%)
8. St. Anne's and Avondale Primary School and Nursery	1	1179	61	n/a
9. Oxford Gardens Primary School	1	539	81	n/a
11. Grenfell Creche Under 3s Centre | Grenfell Nursery	2	545 - 860	65 - 71	68
12. New Studio pre-school	2	495 - 804	55 - 58	56.5
14. Longstone Avenue allotments	4	220 - 643	64 - 73	69
18. Portland Road Community Kitchen Garden and Nottingwood House	2	548 - 2553	61 – 66	63.5
19. The Grove	2	178 - 546	56 – 71	63.5
20. Eynham Road railway land	6	350 - 2695	55 – 72	65
21. Lancaster West Walkways	3	202 - 709	58 – 75	65
22. Henry Dickens Court	2	449 - 480	60 – 72	66
24. Allom House and Barlow House	1	717	73	n/a
25. Morland House and Talbot Grove House	2	452 - 499	62 – 74	68
27. Kensington Memorial Park	1	187	51	n/a
28. Treadgold House	3	1296 - 1989	57 – 62	60
29. Verity Close	1	493	64	n/a
30. Little Wormwood Scrubs	2	493 - 575	58 – 63	60.5
32. Lancaster Green	2	537 - 889	79 – 85	82
33. Robinson House	1	584	68	n/a
34. Wesley Square	1	491	70	n/a
35. Silchester West (North and North West area)	1	412	67	n/a
All samples	50	104 - 2695	51 – 85	66

The bioaccessible fractions (BAF) reported in the table above are based on the highest value taken from either the gastric phase or gastric + intestinal extraction phases of the analysis. The gastric phase of the test is run using an approach simulating a fasted biological state with the lowest expected stomach pH values. Lower pH results in higher extraction of lead (its solubility increases with decreasing pH), hence the approach is precautionary and likely to overestimate longer term time-weighted bioaccessibility where a proportion of lead extraction in the stomach will occur during periods of higher pH after people have eaten.

The average (mean) BAF of all samples summarised in the table above is 66%, which is slightly higher than the BAF of 60% adopted for the oral exposure pathways in the derivation of the C4SLs. It is worth noting that the average BAF for the gastric+intestinal extraction phase (higher pH) for all samples was 21%, more than three times lower than the stomach phase. If even a part of this much lower bioaccessibility at higher pH values is factored into the overall long term bioaccessibility then it would likely be reasonable to reduce the expected bioaccessibility somewhere below 60%. However, the initial precautionary site-specific approach to deriving SSAC adopts the mean value of 66% as a reasonable representative of average bioaccessibility across the investigation area.

Only two of the individual sampling areas where more than one sample was collected have average BAF values greater than 70%. For Lancaster Green (with two samples at 79% and 85% BAF) the two samples were collected from deeper soils (0m - 0.2m and 0.5m - 0.6m) where the soil description indicated the presence of more granular anthropogenic made ground and these materials are unlikely to be representative of the topsoil that residents are likely to come into contact with most frequently. For Burlington Danes school a mean BAF of 74% was calculated based on three samples. This value has been used for sensitivity analysis described in **Section 8.9.3**. The average value of 66% is therefore considered to be sufficiently protective in the areas where individual samples have higher reported BAFs, particularly given the retained conservatism in the adopted value described above.

Calculation of SSAC in the CLEA model requires input of the relative bioavailability (RBA), which is not necessarily the same as the BAF. The RBA is the ratio of the bioavailability of the contaminant in soil to the bioavailability of the contaminant in the critical study used to derive the health criteria (i.e. in this case the LLTC). To estimate the RBA from soil BAF data accurately, some knowledge of the BAF from the diet using the same test method would be needed. Since this information is not available, a more general approach to selecting the RBA to be used for deriving the SSAC is required. The C4SL project presented data from a study which used the UBM method (effectively the same test as the bioaccessibility test method used for this investigation) to test BAF in urban soils in the UK. It was noted that if the dietary RBA estimated using the UBM method was 100% then the results from the UK urban soils study would be similar to the RBA of 60% assumed in the IEUBK model and which was adopted for derivation of the C4SL. Since the C4SL Research Project considered that average soil BAFs of 68% from samples collected in London were consistent with the use of a default RBA of 60% for calculating the C4SLs, then it is considered reasonable and precautionary to use the mean value of 66% BAF from this site-specific study as the input for the RBA. The selected RBA value of 66% for lead is included in **Table 56**.

8.3.2 Polycyclic Aromatic Hydrocarbons

The results provided by the laboratory have been summarised in **Table 55** below.

Table 55. Soil Bioaccessibility Data Summary for BaP

		BAF (%)		
Carcinogenic PAHs	**Number of samples**	**min**	**max**	**mean**
Benzo(a)anthracene	10	37.3	84.1	57.2
Chrysene	10	29	67.7	45.6
Benzo(bk)fluoranthene	10	25.5	53.9	40.6
Benzo(a)pyrene	10	21.5	48	34.3
Indeno(123cd)pyrene	10	15.5	40	29.3
Dibenzo(ah)anthracene	10	28.3	95.9	56.9
Benzo(ghi)perylene	10	22	53.6	37.6

The seven PAHs listed in **Table 55** above comprise the compounds from the USEPA list of 16 priority PAHs that are generally considered to be, or potentially be, genotoxic carcinogens. It is these PAHs that are accounted for when using the BaP surrogate marker approach to assess the carcinogenic risk from reported US EPA 16 PAHs.

Reported bioaccessible fractions of the individual PAHs range between 15.5% and 95.9%, although the mean BAF (averaged for individual compounds across the 10 tested samples) ranges from 29.3% to 57.2%. When the average is calculated as an average of the BAFs of the 7 carcinogenic PAHs within a single sample, a similar mean range of 27.8% to 60.4% is calculated.

BaP is used as a surrogate marker for assessing the risks posed to human health by the carcinogenic PAHs that are found in coal tar. The differences in bioaccessibility between the different PAHs could influence their internal dose, however this uncertainty is built into the surrogate marker approach and so the bioaccessibility of BaP has been adopted to be representative of the bioaccessibility of the carcinogenic PAHs. Given the relatively high range of reported BAFs from the laboratory testing, the maximum BAF for BaP of 48% has been adopted for the calculation of the Step 1 SSAC. The selected RBA value of 48% for BaP is included in **Table 56.**

The C4SL project noted that bioavailability of BaP in the toxicological study used to derive the LLTC was likely to be significantly higher than that of BaP in aged contaminated soils. The toxicological study used coal tar in acetone, with this mixture intended to make the contaminants have the highest possible bioaccessibility. As a result it is considered reasonable to assume that the bioaccessibility of the coal tar / acetone mixture was close to 100% and the BAF reported for soils in the Grenfell Stage 1 and Stage 2 samples can be used directly as the RBA value. The C4SL sensitivity analysis concluded that the adopted RBA of 100% for the C4SL was likely to overestimate risk (and underestimate the value of the C4SL) by at least a factor of two (i.e. the expected RBA of BaP in aged soils is 50% or lower). The assumption made that the measured bioaccessible fraction is the same as the relative bioaccessibility required by the CLEA model is consistent with the assumption made by the authors of the CL:AIRE Research Bulletin 15 (CL:AIRE, 2011).

8.4 Soil Ingestion Rate

The soil ingestion rate (SIR) for children of 100mg/day that was adopted in the UK CLEA guidance and also used for the derivation of C4SLs was based on the central tendency estimate (CTE) from the US EPA 2011 Exposure Factors Handbook guidance. Subsequent to the publication of the CLEA guidance and C4SL reports, the US EPA guidance was updated in 2017 (US EPA, 2017) and the recommended CTE for soil ingestion for children aged 1 to <6 was reduced to 80mg/day. It is considered appropriate to adjust the SIR for children in the calculation of the Step 1 SSAC to 80mg/day on the basis that this is a refinement of a parameter based on new research from reference sources used in the original CLEA and C4SL methodologies. The US EPA 2017 update also published lower CTE estimates for soil ingestion rates for infants aged 0-6months (40mg/day), infants aged 6-12months (70mg/day) and children aged 6 to <12 years (60mg/day). However to maintain conservatism at Step 1 these lower SIR have not been adopted and the value of 80mg/day has been used across all children's age groups.

For the POSresi land-use, the SIR has been adjusted following the same logic as developed in the C4SL report (mid-way between the residential SIR and 50% of it, assumed for indoor soil derived dust only), resulting in a revised SIR of 60mg/day.

For the allotments scenario, the SIR of 80mg/day has been adopted on the basis that the C4SL report used the 100mg/day value for its allotments scenario i.e. the same as the value used for the residential C4SL.

For the CKG scenario at Portland Road which was equated to a POSpark scenario in the GQRA, the SIR adopted for POSpark in the C4SL guidance was adopted, which is half of the 80mg/day used for the residential land uses on the basis that indoor soil-derived dust ingestion accounts for approximately 50% of the combined land use ingestion pathway. Hence a value of 40mg/day has been adopted for this scenario.

The SIR adopted for derivation of the Step 1 SSAC are included in **Table 56**.

8.5 Exposure Frequency, Occupancy Period and Exposure Duration

For the residential with private gardens (Resi+HP and Resi-HP), the allotments, and the POSresi land uses, the exposure frequencies, occupancy periods and exposure durations adopted are based on the default values used for derivation of the C4SL (which are taken unchanged from the CLEA methodology). These are summarised in **Table 56**.

For the CKG land-uses not tied to the communal gardens of residential estates, the standard POSpark exposure assumptions from the C4SL reports have been adopted, with a homegrown produce exposure frequency of 365 days/year. The homegrown produce diet fraction has been adopted as described in **Section 8.6** below.

8.6 Homegrown Produce Diet Fraction

For the CKG scenario which is not linked to a residential estate, the fraction of homegrown produce in the total diet has been reduced by a factor of five from the values used for the standard CLEA residential with homegrown produce land use. This is on the basis that during the site walkovers and sampling activities observations indicated that a typical plot for growing produce in a community kitchen garden is at least 5 times smaller than the growing area assumed for the standard residential with homegrown produce scenario (19.9m^2). This is considered to retain a sufficient level of conservatism since during the site walkovers the typical growing space for any one resident appeared to be in the order of 2 to 4m^2. Although it is possible that multiple growing beds could be merged by a single user to form a larger plot, this was not observed in any of the direct discussions with plot holders and growing beds in all active CKGs appeared to be well used. There is no particular reason to believe that demand for space in the CKGs will decrease to allow fewer individuals more space; however the effect of a doubling of this assumed plot size of 4m^2 to 8m^2 has been considered in the sensitivity analysis. Even if residents share produce from adjacent plots the homegrown produce diet fraction is unlikely to exceed the CLEA default.

For the POSresi+HP scenario adopted as one of the land-use options for Eynham Road railway land, homegrown produce diet fraction from the Resi+HP land-use scenario has been adopted since there is the potential for a growing area of approximately 20m^2 in the part of the sampling area directly behind each private garden.

Based on the discussion in **Section 8.2** to **Section 8.6** above, the following exposure assumptions and parameters listed in **Table 56** have been adopted for the five site-specific scenarios assessed as part of the DQRA.

Table 56. Summary of Exposure Pathways and Assumptions

	Longstone Avenue allotments	Eynham Road Railway Land		Treadgold House		Portland Road CKG	Avondale Park Gardens
	Allotments	POSresi+HP	Resi+HP	POSresi	Resi-HP	POSpark+HP	POSresi
Soil and dust ingestion	Y	Y	Y	Y	Y	Y	Y
Dust inhalation - indoor and outdoor	Y (outdoor only)	Y	Y	Y	Y	Y	Y
Dermal contact - indoor and outdoor	Y (outdoor only)	Y	Y	Y	Y	Y	Y
Consumption of homegrown produce	Y	Y	Y	Y	Y	Y	Y
Inhalation of vapours - indoor and outdoor	Y (outdoor only)	Y (outdoor only)	Y	Y	Y	Y	Y
Critical receptor	0-<6 yrs female child	3-<9 yrs female child	0-<6 yrs female child	3-<9 yrs female child	0-<6 yrs female child	0-<6 yrs female child	3-<9 yrs female child
Exposure duration	6 years	6 years	6 years	6 years	6 years	6 years	6 years
Occupation period	3hrs	20 - 24 hrs	24hrs	20 - 24 hrs	24hrs	2hrs	20 - 24 hrs
Exposure frequency	365 days (consumption of produce) Up to 130 days (present on site)	365 days	365 days	365 days	365 days	365 days (consumption of produce) Up to 170 days (present on site)	365 days
Soil ingestion rate	80mg/day	60mg/day	80mg/day	60mg/day	80mg/day	40mg/day	80mg/day
Fruit/veg plot size	132.9m^2	19.9m^2	19.9m^2	n/a	n/a	4m^2	n/a
Soil to plant concentration factors	**Pb** / **BaP**	**Pb** / **BaP**	**Pb** / **BaP**			**Pb** / **BaP**	
green veg	6.94E-04 / 7.60E-04	6.94E-04 / 7.60E-04	6.94E-04 / 7.60E-04			6.94E-04 / 7.60E-04	
tuber veg	1.65E-04 / 4.30E-04	1.65E-04 / 4.30E-04	1.65E-04 / 4.30E-04			1.65E-04 / 4.30E-04	
root veg	5.31E-04 / 2.10E-04	5.31E-04 / 2.10E-04	5.31E-04 / 2.10E-04			5.31E-04 / 2.10E-04	
herb fruit	2.38E-05 / 5.08E-04	2.38E-05 / 5.08E-04	2.38E-05 / 5.08E-04	n/a	n/a	2.38E-05 / 5.08E-04	n/a

	Longstone Avenue allotments		Eynham Road Railway Land				Treadgold House		Portland Road CKG		Avondale Park Gardens
	Allotments		POSresi+HP		Resi+HP		POSresi	Resi-HP	POSpark+HP		POSresi
shrub fruit	7.10E-05	5.63E-06	7.10E-05	5.63E-06	7.10E-05	5.63E-06			7.10E-05	5.63E-06	
tree fruit	2.63E-05	4.69E-05	2.63E-05	4.69E-05	2.63E-05	4.69E-05			2.63E-05	4.69E-05	
Gardener Type	**High end**		**Average**		**Average**				**Average**		
Fraction of diet											
green veg	0.33		0.05		0.05				0.01		
tuber veg	0.13		0.02		0.02				0.004		
root veg	0.4		0.06		0.06				0.012		
herb fruit	0.4		0.06		0.06				0.012		
shrub fruit	0.6		0.09		0.09				0.018		
tree fruit	0.27		0.04		0.04		n/a	n/a	0.008		n/a
RBA – Pb	0.66		0.66		0.66		0.66	0.66	0.66		0.66
RBA – BaP	0.48		0.48		0.48		0.48	0.48	0.48		0.48

8.7 Toxicological Criteria

Lead and BaP were both addressed as part of the C4SL Research Project (Department for Environment, Food and Rural Affairs (Defra), 2012a), the objective of which was to develop GSC suitable for use within the Part 2A framework and would define a level of exposure risk towards the upper end of the Category 4 definition (i.e. low risk).

The toxicological concept developed for the C4SL Research Project was the Low Level of Toxicological Concern (LLTC), and the values ultimately selected for oral exposure for lead and BaP were:

- Lead (child receptor): LLTC of 1.4 micrograms per kilogram bodyweight per day (µg/kg-bw/day).
- BaP: LLTC of 0.042µg/kg-bw/day.

For lead, the LLTC was defined as the dietary dose that would result in a geomean blood lead level of 3.5µg/dL in young children. This value was chosen by Defra as it was considered to represent a low level of risk in relation to the toxicological effects of lead on neuro-behaviour and the cardiovascular system. It does not represent minimal risk: a lower potential blood lead target level of 1.6µg/dL was considered by Defra to be "too close to minimal risk to support its use in the derivation of the more pragmatic C4SLs". The UK's current public health intervention level for blood lead is set at 10µg/dL, although this is anticipated to change to 5µg/dL in early 2021 (PHE, 2021).

For BaP the LLTC represents a dose which is 5000 times less than that which was shown to give rise to tumours in 10% of experimental animals (BMD_{10}). The C4SL report states that this LLTC could be defined as a notional cancer risk level for humans of 1 in 50,000, a risk level defined in the C4SL guidance as "low".

For inhalation exposure to BaP, the LLTC value used was:

- BaP: variable LLTC dependent on receptor age-group. For Resi+-HP, allotments and POSpark an LLTC of 0.66ng/kg-bw/day was adopted for a female child aged 0-6. For POSresi, an LLTC of 0.52ng/kg-bw/day was adopted for a female child aged 3-<9.

The inhalation LLTC for BaP is not directly based on the same types of toxicological studies as the oral LLTC but is based on the UK air quality standard (Crown, 2010). As a result it has a different (higher) acceptable ELCR of 1 in 10,000. This ELCR is ten times higher than the ELCR of 1 in 100,000 typically used in the UK to derive index doses (defined as the daily dose which is expected to be associated with a minimal excess risk of cancer) in accordance with EA SR2 (EA, 2009).

In accordance with the methodology for deriving the C4SLs, a separate inhalation LLTC is not used for lead since the oral LLTC has been derived based on a blood lead target for multiple exposure routes: the blood lead target has been converted to a daily intake using the IEUBK biokinetic model and this intake is applied to the CLEA model as the oral LLTC described above.

Initially, for the derivation of the SSAC, the LLTC used for the C4SLs have been retained so that the SSAC continue to reflect a low risk to human health. Where reported soil concentrations continue to exceed these SSAC, further consideration of alternative health risk thresholds have been considered in **Section 8.11** in relation to what might be considered to be an "unacceptable risk" under Part 2A.

8.8 Exposure Modelling

The Environment Agency CLEA model v1.071 has been used to calculate SSAC for each of the five sampling areas evaluated as part of the DQRA. These SSAC derived for Step 1 are presented in **Table 57** below. The CLEA model inputs and outputs for the five main scenarios are presented in **Appendix J**.

Table 57. Site-specific Assessment Criteria

	Longstone Ave. allotments		Eynham Road railway land				Treadgold House				Portland Road CKG		Avondale Park Gardens	
			Resi+HP	Resi+HP	POSresi+HP	POSresi+HP	Resi-HP	Resi-HP	POSresi	POSresi				
	Lead	BaP	Lead	BaP	Lead	BaP	Lead	BaP	Lead	BaP	Lead	BaP	Lead	BaP
Step 1 SSAC (mg/kg)	465	10.7	332	11.7	627	20.9	357	12.7	710	23.9	1420	43.9	710	23.9
GSC (mg/kg)	80	5.7	200	5	630	5	310	5.3	630	10	200 | 1,300	5	630	10

These SSAC for lead and BaP have been derived using the LLTCs adopted for derivation of the C4SLs, along with adjustments to modelling assumptions and exposure parameters that are either based on site-specific data or remain reasonably precautionary. As such, they are considered to represent concentrations, for the area around Grenfell Tower, that still represent a low risk to human health. In the context of Part 2A, this may be defined as still within Category 4 but closer to the Category 4/ Category 3 boundary than the C4SLs. Hence where estimated average soil concentrations within a sampling area are at or below these SSAC, then it is considered that associated CL meets the definition of Category 4 land.

8.9 Uncertainty

Uncertainty associated with exposure modelling and derivation of SSAC is predominantly caused by the uncertainties in the toxicological thresholds and the exposure assumptions. The C4SL research project evaluated the expected uncertainty in the derivation of the C4SLs for both lead and BaP, with the following parameters considered to be the most uncertain and most likely to have the potential for substantial over-estimation or under-estimation of risk.

8.9.1 Lead

For lead, the main uncertainties with the adopted LLTC of 1.4µg/kgbw/day were considered by the report authors to be associated with uncertainty in the Lanphear et al. study (Lanphear, et al., 2005) and the BMD modelling that was carried out from the study. The Integrated Exposure Uptake Biokinetic (IEUBK) (USEPA, 2019) modelling process used to convert the LLTC from a blood lead concentration to a dietary intake was also considered to have a moderate level of uncertainty. Overall, the C4SL report concluded that the LLTC is more likely to be underestimated than overestimated (and hence overestimate risk), but only by a relatively small margin up to a factor of two.

For exposure parameters, those with the highest uncertainty were considered to be soil and dust ingestion rate, relative bioavailability (RBA) and soil to plant concentration factors. Produce consumption rates were also considered likely to be overestimates. Overall, the combination of uncertainty was considered to be more likely to overestimate than underestimate exposure.

All of the exposure parameters with the likely greatest uncertainty have been adjusted as part of the SSAC derivation, with the SIR reduced to be consistent with updated guidance (but still based on the same degree of risk as intended by CLEA and the C4SL project), and RBA and CFs adjusted to site-specific values. A sensitivity analysis associated with these parameters has been completed and is presented in **Section 8.9.3** below. In addition, for the residential scenarios involving crop consumption in smaller CKG type plots, a larger assumed plot size has been considered for the sensitivity analysis to assess the significance of the potential for individuals to take over growing produce in more than one.

8.9.2 BaP

For BaP, the main uncertainties identified in the C4SL research project were the choice of a coal tar toxicological study for setting the LLTC (considered to potentially overestimate risk due to possible presence of genotoxic compounds other than PAHs) and the high uncertainty with interspecies variability. Overall, it was considered most likely that the LLTC was slightly underestimated, maintaining a precautionary approach for deriving the C4SL.

For exposure assumptions, the C4SL report identified SIR, RBA and soil to plant CFs as key areas of uncertainty. The use of the BaP surrogate marker approach for assessment of carcinogenic PAHs was also highlighted to introduce uncertainty on the basis that the exposure modelling assumes that the physico-chemical properties of BaP are sufficiently similar to those of the other genotoxic PAHs that the use of RBAs, CFs and dermal absorption factors based on BaP is reasonably representative of those for other PAHs. Overall, the combination of uncertainty was considered to be more likely to overestimate than underestimate exposure.

All of the exposure parameters with the likely greatest uncertainty have been adjusted as part of the SSAC derivation, with the SIR reduced to remove some conservatism, and RBA and CFs adjusted to site-specific values.

8.9.3 Sensitivity Assessment

For the DQRA modelling and derivation of SSAC, single values are selected to be representative of specific exposure assumptions and parameters. A sensitivity analysis has been carried out on the derived SSAC bearing in mind the parameters identified with the highest and most significant uncertainties in **Sections 8.9.1** and **8.9.2**. The parameters adjusted and the justification for the adjustments are shown in **Table 58** below.

Table 58. Adjusted Parameters for Sensitivity Assessment

			Alternative value choice		
Sensitive Parameter	**SSAC Value choice**	**Less precautionary**	**Justification**	**More precautionary**	**Justification**
RBA (%) - Lead	0.66	0.5	Arbitrarily lower to reflect the likely time-weighted nature of the low pH conditions in the stomach, noting that RBA in the stomach + intestinal phase is considerably lower than in the stomach phase alone	0.74	maximum of the mean BAFs for any single sampling area with more than 1 sample - Burlington Danes school
RBA (%) – BaP	0.48	0.34	97.5% UCL of the mean of the site-specific RBAs for dibenzo(ah)anthracene	0.68	mean RBA calculated for BaP from site-specific testing
Soil ingestion rate (mg/day)	80 / 60 / 40*	60 / 45 / 30	based on the lower CTE for children 0-<6 in USEPA 2017	n/a – see GSCs	n/a
Soil to plant CFs - Lead	Mean value	Geomean value	geometric mean of site-specific values rather than the mean. It is noted that the C4SL derivation uses geometric mean	Maximum value	maximum calculated from any site-specific sample
Green vegetable	6.90E-04	1.70E-04		4.60E-03	
Root vegetable	5.30E-04	3.70E-04		1.10E-03	
Tuber vegetable	1.60E-04	1.30E-04		3.40E-04	
Herbaceous fruit	2.40E-05	2.30E-05		3.30E-05	
Shrub fruit	7.10E-05	6.20E-05		1.10E-04	
Tree fruit	2.60E-05	8.10E-06		1.10E-04	
Soil to plant CFs - BaP	Mean value (defaults for fruit)	Geomean value	geometric mean of site-specific values for vegetables rather than the mean. It is noted that the C4SL derivation uses geometric mean	Average for worst-case of any genotoxic PAH (defaults for fruit)	mean of the individual genotoxic PAH with the highest calculated CFs irrespective of toxic equivalence
Green vegetable	7.6E-04	6.0E-04	*no change to CFs for fruits as SSAC derivation uses the C4SL default due to large number of non-detects in crop analysis results.*	2.30E-03	
Root vegetable	2.1E-04	1.4E-04		1.91E-03	
Tuber vegetable	4.3E-04	2.1E-04		1.25E-03	
Herbaceous fruit	5.08E-04	5.08E-04		5.08E-04	
Shrub fruit	5.63E-06	5.63E-06		5.63E-06	
Tree fruit	4.69E-05	4.69E-05		4.69E-05	
Gardener Type	Average	Average		Average	
Fraction of diet – applied to CKG areas only					
green veg	0.01	0.02	Less precautionary choice is based on a resident acquiring two of the plots intended for individual growers within a CKG area.	n/a	-
Root veg	0.012	0.024		n/a	-
tuber veg	0.004	0.008		n/a	-
herb fruit	0.012	0.024		n/a	-
shrub fruit	0.018	0.039		n/a	-
tree fruit	0.008	0.016		n/a	-

** first value is for all scenarios except POSresi and Portland Road CKG, second value for POSresi, third value for Portland Road CKG based on POSpark assumption*

Table 59 below presents the results of the sensitivity assessment. Further discussion is provided below the table.

Table 59. Sensitivity Analysis Results
All values in mg/kg

Parameter		Longstone Ave. allotments		Eynham Road railway land				Treadgold House				Portland Road CKG		Avondale Park Gardens	
				Resi+HP	Resi+HP	POSresi+HP	POSresi+HP	Resi-HP	Resi-HP	POSresi	POSresi	POSpark+HP		POSresi	
		Lead	BaP	Lead	BaP	Lead	BaP	Lead	BaP	Lead	BaP	Lead	BaP	Lead	BaP
RBA	SSAC - High	520	11.5	429	15.3	800	26.5	470	17.0	937	31.3	1840	55.2	937	31.3
	SSAC	465	10.7	332	11.7	627	20.9	357	12.7	710	23.9	1420	43.9	710	23.9
	SSAC - Low	441	9.7	298	8.8	566	16.1	318	9.4	634	17.9	1280	33.9	634	17.9
SIR	SSAC - High	509	11.2	432	13.7	803	25.4	475	16.3	946	30.0	1850	53.1	946	30.0
	SSAC	465	10.7	332	11.7	627	20.9	357	12.7	710	23.9	1420	43.9	710	23.9
	SSAC - Low	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CFs	SSAC - High	705	11.9	344	11.9	670	21.5	n/a	n/a	n/a	n/a	1480	44.6	n/a	n/a
	SSAC	465	10.7	332	11.7	627	20.9	357	12.7	710	23.9	1420	43.9	710	23.9
	SSAC - Low	138	5.2	264	10.0	433	16.6	n/a	n/a	n/a	n/a	1140	37.9	n/a	n/a
Diet Fraction	SSAC - High	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	SSAC	465	10.7	332	11.7	627	20.9	357	12.7	710	23.9	1420	43.9	710	23.9
	SSAC - Low	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1330	41.1	n/a	n/a

The sensitivity analysis indicates that the changes in the soil to plant CFs generally have the least effect on the SSAC with the exception of the allotments scenario, where it has the biggest effect. Excluding the allotments, the changes to CFs result in alternative SSAC values between 69% and 107% of the original SSAC. For the allotments scenario the changes to CFs result in alternative SSAC values between 30% and 152% of the original SSAC.

The changes to RBA have a more consistent effect on the SSAC across the different land use scenarios, with the alternative SSAC ranging between 74% and 134% of the original SSAC, with the effect in the allotment scenario slightly less pronounced, in the range 91% to 112% of the original value.

The change to soil ingestion rate had a similar effect to the RBA changes, with the higher alternative SSAC being between 117% and 133% of the original SSAC for all scenarios except the allotments. For allotments, the effect was less pronounced (as it was for the RBA changes) with alternative SSACs being 109% (lead) and 105% (BaP) of the original. A less precautionary SIR was not adopted for the sensitivity analysis as the SIR adopted for the generic C4SL is considered to be a reasonable upper bound on SIR.

The higher diet fraction used for the Portland Road CKG scenario resulted in a slightly lower SSAC, the SSAC reducing to 94% of the original value used for the Step 1 SSAC for both lead and BaP.

Overall, the soil to plant CFs are the most sensitive parameter for the allotments scenario, whereas the RBA and SIR were more sensitive and had a similar degree of sensitivity for the other scenarios. The site-specific CFs adopted for the derivation of the SSAC were based on mean values of multiple samples and hence were reasonably precautionary since the C4SL report adopts geometric mean values of an unpublished dataset, which are likely to be lower than the mean. The discussion in **Section 8.2.1** indicates that the adopted CFs, whilst based on data from multiple sampling areas, are expected to be representative of conditions at Longstone Avenue allotments as they are similar to or higher than the CFs calculated based on samples from that specific sampling area.

The SIR adopted for the Step 1 SSAC derivation are considered to remain relatively precautionary as they are based on central tendency estimates from (US EPA, 2017), which provided updated recommendations compared to the original guidance adopted by the CLEA methodology and derivation of the C4SLs.

Given the above the uncertainties associated with RBA, SIR and CFs are considered likely to retain a degree of conservatism within the SSAC derivation, primarily due to the SIR that has been adopted. The variations in diet fraction that could result from an individual using up to double the normal allocated space in a CKG are not expected to be significant given the uncertainties associated with other more sensitive parameters.

8.9.4 Intake from Growing Beds with Low Soil Concentrations

The assessment for Treadgold House and Portland Road CKG has excluded the raised beds as a source of COPC on the basis that soil concentrations of lead were considerably lower than in the ground level soils, and were lower than the Resi+HP GSC. Even so, consumption of homegrown produce from these beds will result in a small additional intake not accounted for by the SSAC. To assess the significance of this intake from raised beds with lower concentrations the CLEA model was used to estimate the hazard quotient for the HP pathway assuming the site-specific soil to plant CFs and the 4m^2 growing area used for the derivation of the Step 1 SSAC. The CLEA model inputs and outputs are presented in **Appendix J**.

The mean lead soil concentration for the three raised bed samples at Treadgold House (42mg/kg) was used as the starting soil concentration and the hazard quotient was calculated as 0.2%. This indicates a negligible contribution from the HP pathway in raised bed scenarios where the soil concentrations are below the GSC and much lower than the concentrations in ground level soils.

On this basis the minor contribution from the HP pathway in areas where the raised beds have good quality soil at concentrations below the GSC has not been considered further.

8.10 Comparison of Site Data with Step 1 SSAC

8.10.1 Longstone Avenue allotments

A summary of the datasets for COPC at Longstone Avenue allotments to be compared against the Step 1 SSAC is presented in **Table 60.**

Table 60. Longstone Avenue Allotments Step 1 SSAC Data Comparison

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	SSAC mg/kg
Lead – all samples	26	36	589	296	262	248 - 346	465
Lead (inc. 14,200mg/kg)	26	36	14,200	835	268	249 - 1906	465
Lead (single result from multi-depth locations)	16	149	589	318	268	260 - 382	465
BaP – all samples	26	0.1	12.13	3.73	2.39	2.59 - 4.90	10.7
BaP (single result from multi-depth locations)	16	1.18	12.13	3.96	2.85	2.65 - 5.32	10.7

The average concentrations of all datasets in **Table 60** above are lower than the SSAC. Although the maximum concentration of BaP exceeds the SSAC, the magnitude of the exceedance is only a factor of 1.4 and taking into account the data from across the whole area it is very unlikely that this maximum sample represents a hotspot of equally high (or higher) concentrations that extend across an area as large as a full growing plot.

The maximum concentration of 14,200mg/kg for lead has previously been shown to be anomalous – and very unlikely to be representative of anything more than an extremely small soil volume (e.g. a flake of old lead-based paint). It is not considered to be appropriate to include this result when assessing average exposure.

The maximum concentration of BaP exceeds the Step 1 SSAC and there is evidence from a previous ground investigation that other samples in this area have similar concentrations. Calculating the mean of shallow soil samples at locations S136 (12.13mg/kd), WS30 (12.43mgk/g) and WS35 (14.17mg/kg) gives a BaP concentration of 12.9mg/kg, which slightly exceeds the Step 1 SSAC. S136 and WS30 are both located in the same growing plot (Plot 6a) and WS35 is located in the adjacent growing plot (Plot 6b). Therefore these concentrations exceeding the Step 1 SSAC could potentially be representative of higher concentrations in individual averaging areas (i.e. Plot 6a and Plot 6b). On this basis BaP at Longstone Avenue allotments – particularly with reference to a more localised area around Plots 6a and 6b where S136, WS30 and WS35 are located – has been taken forwards to the Step 2 DQRA.

8.10.2 Eynham Road Railway Land

A summary of the datasets for COPC at Eynham Road railway land to be compared against the Step 1 SSAC is presented in **Table 61.**

Table 61. Eynham Road Railway Land Step 1 SSAC Data Comparison

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	SSAC mg/kg
Lead – excluding deep samples	19	310	1657	679	631	525 - 848	332 Resi+HP 627 POSresi+HP

The average concentrations at Eynham Road railway land exceed both the POSresi+HP land-use SSAC and the Resi+HP land-use SSAC. For the Resi+HP land use there is a relatively high degree of confidence that average concentrations exceed the SSAC as the lower limit of the 95% CI exceeds the SSAC. However for the POSresi+HP scenario, the median concentration (631mg/kg) only slightly exceeds the SSAC of 627mg/kg and therefore there is relatively high uncertainty as to whether the true average soil concentrations exceed the POSresi+HP SSAC.

It is unknown whether the land-use for individual residents at Eynham Road Railway Land more closely resembles the POSresi+HP or the Resi+HP scenario. Given the unusual land-use and the fact that the average concentrations are only slightly lower than the POSresi+HP SSAC it would not take much of a shift in behaviour towards the Resi+HP land-use for the SSAC to fall lower than the average concentrations. It seems less likely that behaviour would be closer to Resi+HP than POSresi+HP since the houses all have further private gardens (in addition to the communal area at the back) that will take up a proportion of the total exposure time for people being outside in

their garden. Although the conditions in these private gardens are unknown, they are not on reclaimed 'former railway land' and there may be some expectation of a lesser presence of COPC..

The two highest concentrations are located adjacent to one another (1657mg/kg at S184, 0-0.05m) and 1588mg/kg at S183, 0-0.02m). There is some potential for these two samples to represent an area of generally higher lead concentrations and if residents focus their use on this area rather than along the full length of the sampling area then this could result in average exposure concentrations that exceed the POSresi+HP SSAC with a much higher degree of confidence.

Since the land-use conditions for individual residents are unknown and may fall somewhere between the Resi+HP and POSresi+HP land use scenarios, and there is some potential for higher average concentrations in the area of S183 and S184, Eynham Road has been considered further as part of the Step 2 DQRA.

8.10.3 Treadgold House

A summary of the datasets for COPC at Treadgold House to be compared against the Step 1 SSAC is presented in **Table 62.**

Table 62. Treadgold House Step 1 SSAC Data Comparison

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	SSAC mg/kg
Lead – ground level soils	9	454	2216	992	992	672 - 1336	357 – Resi-HP 710 – POSresi
Lead – ground level outliers, mainly in west and south	6	744	2216	1250	1083	928 - 1629	357 – Resi-HP 710 – POSresi

The average lead concentrations in soil at Treadgold House exceed the SSAC derived for both the Resi-HP and the POSresi land uses.

The land-use at Treadgold House may fall somewhere in between these two scenarios; however, it is not possible to define exactly where on the spectrum it might be. However, as the average concentrations exceed the SSAC for both scenarios, and all results in the west and south of the area exceed the SSAC for both the Resi-HP and POSresi scenarios, Treadgold House has been considered further in Step 2 of the DQRA.

The raised beds at Treadgold House were excluded from the DQRA assessment on the basis that the soil quality was significantly different to that in ground level soils, and the reported concentrations were well below the Resi+HP GSC. It is acknowledged that although lead concentrations are much lower (typically 20 times lower) in the raised beds, they will still contribute to a small lead intake which will be additive to the intake from ground level soils. The significance of this was discussed in **Section 8.9.4**.

8.10.4 Portland Road CKG

A summary of the datasets for COPC at Portland Road CKG to be compared against the Step 1 SSAC is presented in **Table 63.**

Table 63. Portland Road CKG Step 1 SSAC Data Comparison

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	SSAC mg/kg
Lead (ground level soil)	4	325	1,785	1,032	1,010	367 – 1,592	1420

There is a high level of uncertainty associated with average ground level soil concentrations at Portland Road CKG. However, the average concentrations are lower than the Step 1 SSAC, with the majority of the 95% CI below the SSAC. This suggests that it is more likely than not that the average concentrations are lower than the Step 1 SSAC.

The two highest lead concentrations are located in the northern part of the area and these two sample locations (S166 (1527mg/kg) and GTCS1-18 (1785mg/kg)) are the same as those where asbestos was found at Portland Road CKG. As these two concentrations both exceed the Step 1 SSAC and there is some corroborating evidence from the asbestos data to indicate a possible different soil condition I the northern part of the sampling area, Portland Road CKG has been considered further as part of the Step 2 DQRA to allow further risk evaluation.

8.10.5 Avondale Park Gardens

Two samples were collected at Avondale Park Gardens during the Stage 1 sampling. The reported lead concentrations were 659mg/kg and 2,099mg/kg. The higher concentration exceeds the Step 1 SSAC of 710mg/kg and the lower concentration is below the Step 1 SSAC.

Two samples are insufficient for any meaningful statistical summary and therefore the uncertainty associated with the average lead concentrations in Avondale Park Gardens is high. Given the high uncertainty associated with the average concentrations at Avondale Park Gardens, this sampling area has been considered further in Step 2 of the DQRA.

8.10.6 Outliers and Acute Health Risk

A number of potential outliers in the lead datasets are not consistent with average exposure concentrations across the majority of the sampling areas. It is relevant to consider whether the highest concentrations encountered as part of the sampling investigation have the potential to cause acute adverse health effects if people come into contact with those discrete areas of soil either as one-off exposures or for intermediate durations somewhere between the one-off exposure scenario and the chronic exposure scenario that has been evaluated thus far as part of this DQRA. The maximum reported lead concentration during Stage 1 and Stage 2 sampling was 14,200mg/kg at Longstone Avenue allotments, although there is considerable uncertainty associated with the cause and reproducibility of this high value (refer to **Section 5.9.5**). After this sample, the next highest lead concentration of 3,056mg/kg was reported at St Anne's & Avondale Primary School. For BaP, the maximum concentration was 25.36mg/kg from one of the deep samples (0.5m - 0.6m) in Lancaster West Walkways.

For one-off exposures, organic contaminants such as PAHs are not typically associated with adverse acute health effects. The maximum BaP concentration of 25.36mg/kg is considerably lower than the C4SL used for commercial and industrial land-use settings (C4SL of 76mg/kg) and is close to the C4SL for POSpark land-use of 21mg/kg. Given the acceptability of these similar and higher concentrations in various UK standard land uses for long-term exposure there is not expected to be the potential for health risks above the 'low to no risk' Category 4 land definition associated with one-off acute exposures to PAHs in soils encountered during the Stage 1 and Stage 2 investigations at the concentrations reported.

For lead, acute toxic effects discussed by ATSDR (ATSDR, 2020) and SoBRA (SoBRA, 2020) suggest that one-off exposure to high lead concentrations in soil is not a cause for concern, since acute toxic effects of lead are linked to high blood lead levels, which are unlikely to be affected by a single exposure event. SoBRA did not set an acute GAC for lead due to the uncertainty associated with the effect of a one-off exposure to high lead concentrations in soil on blood lead concentrations. It is considered that such single exposure events would not have the potential to cause acute adverse health effects at the maximum concentrations encountered during Stage 1 and Stage 2 sampling since all but one result was within the range of the London Earth background dataset. The one result outside the London Earth range was the concentration of 14,200mg/kg encountered at Longstone Avenue allotments, which was not reproducible in a follow up laboratory test of the same sample. It is likely that this maximum concentration could have been caused by a flake of old lead-based paint or some other similar point source, which would not cause adverse acute health effects from a one-off ingestion scenario.

The Committee on Toxicity (COT) (Committee on Toxicity, 2013) stated that acute toxicity of lead salts in experimental animals is low. In humans, COT noted that colic is a characteristic early symptom of acute lead poisoning following high exposures – for example, in the workplace. High workplace exposures would typically be more consistent and continuous than one-off exposures to a very localised patch of soil with a high lead concentration. Given the lack of evidence that such one-off exposures have the potential to cause problematic acute toxicity, the risk of acute toxicity from one-off exposures to very localised high concentrations in soils is considered to be low.

For intermediate duration lead exposure which could occur over a period of weeks or months to average soil concentrations in a residential setting, the ATSDR report (ATSDR, 2020) indicates that acute toxicity is generally not observed at blood lead levels less than 30µg/dL but that acute gastrointestinal and neurological toxicity are observed as concentrations increase above 30µg/dL, with severity increasing with blood lead level. The report

notes that lead induced encephalopathy has been reported at blood lead concentrations <100µg/dL but is more commonly associated with blood lead >100µg/dl. ATSDR reported that in a review of 96 cases of death due to acute lead poisoning in children, death occurred at blood lead >100µg/dL. A similar picture of acute lead toxicity being linked to blood lead levels is reported in the SoBRA acute GAC report (SoBRA, 2020). Three cases of lead poisoning in children were reported in the SoBRA GAC report where blood lead levels of 36µg/dl, 22 – 35µg/dl, and 25.6µg/dl.

The available information suggests that acute lead toxicity could start to be observed at blood lead levels around 30µg/dl, with a precautionary range of 20 – 40µg/dL. The Step 1 SSAC that have been derived are based on a target blood lead level of 3.5µg/dl which is 6 times lower than the 20µg/dL value identified as a lower precautionary limit for an approximate level for the onset of acute health effects. Figure 2.3 of the lead C4SL report indicates that blood lead levels do not increase proportionately with dose and for soil and dust ingestion exposure the dose would need to (for example) more than double in order for the blood lead concentration to double. Since exposure to lead in the scenarios evaluated in Step 1 of the DQRA is dominated by soil and dust ingestion, it could be expected that soil concentrations would need to be around 6 to 10 times higher than an SSAC derived based on 3.5µg/dL blood lead before acute health effects might start to appear.

Since the mechanism for the reported acute health effects is the same as for chronic effects (raised blood lead level), any average soil concentrations which do not substantially exceed (i.e. by a factor of 6 to 10) an SSAC based on a blood lead of 3.5µg/dL should not be a concern for acute health effects.

For the sampling areas considered in **Section 8.10.1** to **Section 8.10.5** above, the average soil concentrations (taking the higher of the mean or the median) exceed the lowest of the Step 1 SSAC in four of the five areas by between 1.8 times (Longstone Avenue allotments) and 3.5 times (Treadgold House). These exceedances are all lower than the 6 to 10 times exceedance of the SSAC noted above that could begin to indicate a potential for acute health effects. Hence acute health effects from lead in soil do not need to be considered further in the context of the soil concentrations identified during the Stage 1 and Stage 2 investigations.

8.11 DQRA Step 2 – Potentially Unacceptable Risk Threshold

Step 2 builds on the SSAC derived in Step 1, which were presented in **Table 57**.

The objective of Step 2 is to identify concentrations where the level of risk approaches that that could be considered to pose a significant possibility of significant harm. This means identifying a concentration at which it can be considered that the risk is definitely not low, and that the possibility of significant harm is such that it could be considered significant by the relevant regulatory authority (subject to the tests of the overarching objectives of Part 2A). Since the SSAC derived in Step 1 are based on low levels of toxicological concern, one element of the approach to Step 2 is to adopt an alternative threshold that defines a higher level of risk.

For lead, a toxicological threshold associated with a 5µg/dL blood lead level has been adopted for Step 2. This is in comparison to the blood lead level used to define the LLTC of 3.5µg/dL. 5µg/dL is the US CDC Action Level and is the threshold being adopted by PHE for individual case intervention in England. The HCV calculated as part of the C4SL Research Project as being equivalent to a blood lead level of 5µg/dL was 2.1µg/kg-bw/day and this value has been used as the input for deriving the Step 2 SSAC for lead.

For BaP, the oral LLTC is based on an ELCR of 1 in 50,000 whereas the inhalation LLTC is based on an ELCR of 1 in 10,000. An initial approach to deriving the Step 2 SSAC is to adjust the oral LLTC for BaP so that it also represents an ELCR of 1 in 10,000. The approach to this is to multiply the LLTC by five (equating to the factor of five decrease in ELCR between 1 in 50,000 and 1 in 10,000) to give a health criteria value (HCV) of 0.21µg/kg-bw/day for deriving the Step 2 SSAC.

The second major adjustment adopted to calculate a Step 2 SSAC in residential and public open space scenarios that could represent a level of risk closer to SPOSH is a further reduction of the precautionary approach to the soil ingestion rate. The USEPA 2017 guidance provided a range for the CTEs for SIR based on a variety of studies, and differing SIRs for different child age groups. These are summarised in **Table 64** below.

Table 64 Soil Ingestion Rates from (US EPA, 2017)

Age Group	Soil and dust ingestion general population central tendency (mg/day)
<6 months	40
6 months to <1year	70 (60 – 80)

Age Group	Soil and dust ingestion general population central tendency (mg/day)
1 to <2 years	90
2 to <6 years	60
1 to <6 years	80 (60 – 100)
6 to <12 years	60 (60 – 60)
12 years through adult	30 (4 – 50)

After Table 5-1, USEPA 2017

For the derivation of Step 2 SSAC, AECOM has selected the SIRs presented in **Table 65** below. The Resi+HP, Resi-HP and Allotments values represent the lower end of the estimated ranges for the CTE published by USEPA 2017, and are therefore likely to be closer to defining SPOSH than the middle of these estimates used for the Step 1 SSAC. For the POSresi land-use, the SIR has been adjusted following the same logic as developed in the C4SL report (mid-way between the residential SIR and 50% of it, assumed for indoor soil derived dust only).

For the CKG scenario at Portland Road which was equated to a POSpark scenario in the GQRA, the SIR adopted for POSpark in the C4SL guidance was adopted, which is half of the value used for the residential land uses on the basis that indoor soil-derived dust ingestion accounts for approximately 50% of the combined land use ingestion pathway.

Table 65 Soil Ingestion Rates adopted for Step 2 SSAC

Age Group	CLEA Model SIR Inputs for Step 2 SSAC (mg/day)			
	Allotments (Longstone Avenue allotments)	Resi+HP and Resi-HP (Treadgold House and Eynham Road Railway Land)	POSresi and POSresi+HP (Treadgold House, Eynham Road Railway Land and Avondale Park Gardens)	POSpark+HP (Portland Road CKG)
1	50	50	n/a	25
2	60	60	n/a	30
3	60	60	n/a	30
4	60	60	45	30
5	60	60	45	30
6	60	60	45	30
7	n/a	n/a	45	n/a
8	n/a	n/a	45	n/a
9	n/a	n/a	45	n/a

For BaP, the default assumption for the dermal absorption through skin is 13% - this is based on a study by Wester et al from 1993 which was referenced in USEPA risk assessment guidance and subsequently adopted by the EA for the CLEA model (Environment Agency, 2009) A more recent study by Turkhall et al in 2009 (Turkhall, et al., 2009) suggests that absorption from aged BaP in soil might be half that amount (6.5%). The use of a lower value based on absorption of aged BaP in soil is considered appropriate on the basis that significant fire-related impact has not been identified, and the BaP in soil is likely to be associated with aged historic sources. This reduced dermal absorption factor has been applied to the derivation of Step 2 SSAC for BaP in the Longstone Avenue allotments scenario.

The Environment Agency CLEA model v1.071 has been used to calculate Step 2 SSAC for each of the five sampling areas evaluated as part of the DQRA. The Step 2 SSAC calculated using the adjusted toxicological criteria, soil ingestion rates and dermal absorption factors described above are presented in **Table 66** below.

Table 66. Step 2 SSAC

	Longstone Ave allotments	Eynham Road railway land Resi+HP	Eynham Road railway land POSresi+HP	Treadgold House Resi-HP	Treadgold House POSresi	Portland Road CKG	Avondale Park Gardens
Step 2 SSAC Iteration	**BaP**	**Lead**	**Lead**	**Lead**	**Lead**	**Lead**	**Lead**
Step 2 SSAC (mg/kg) – toxicological criteria adjustments*	53.4	497	940	535	1070	2140	1070
+ SIR reduced as per Table 65 above	56.3	667	1200	737	1420	2870	1420
+ reduced dermal absorption	68.1						

*5µg/dL blood lead target and 1 in 10,000 ELCR for oral HCV for BaP

The Step 2 SSAC presented in **Table 66** above are discussed in the context of the lead data for each of the sampling areas that was progressed beyond the Step 1 DQRA. This included Eynham Road railway land, Treadgold House, Portland Road CKG and Avondale Park Gardens.

8.11.1 Longstone Avenue allotments

The shallow soil sampling data at Longstone Avenue allotments that are most applicable for comparison with the Step 2 SSAC are shown in **Table 67** below.

Table 67. Longstone Avenue Allotments Step 2 SSAC Data Comparison

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	Step 2 SSAC mg/kg
BaP (single result from multi-depth locations)	16	1.18	12.13	3.96	2.85	2.65 - 5.32	53.4 – 68.1
BaP – potential outlier area (WS35, WS30, S136 in Plot 6a/b6)	3	12.13	14.17	12.91	12.43	12.13 – 13.59	53.4 – 68.1

The maximum and average concentrations across the sampling area as a whole and in the potential outlier area are considerably less than the Step 2 SSAC. This indicates that the presence of BaP in soil would not cause SPOSH at Longstone Avenue allotments.

8.11.2 Eynham Road Railway Land

The shallow soil sampling data at Eynham Road railway land that are most applicable for comparison with the Step 2 SSAC are shown in **Table 68** below.

Table 68. Eynham Road Railway Land Step 2 SSAC Data Comparison

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	Step 2 SSAC mg/kg
Lead – excluding deep (0.5-0.6m) samples (includes samples from 0-0.2m depth)	19	310	1657	679	631	525 - 848	497 – 667 Resi+HP 940 – 1,200 POSresi+HP
Lead – 0.02m and 0.05m depth samples only	10	349	1657	821	695.5	571 - 1097	497 – 667 Resi+HP 940 – 1,200 POSresi+HP

The average (both mean and median) soil concentrations at Eynham Road railway land are lower than all of the potential Step 2 SSAC based on the POSresi+HP scenario. For the Resi+HP scenario the mean and median concentrations for both datasets in **Table 68** exceed the lower of the Step 2 SSAC with only the median concentration from the dataset excluding the deepest samples being lower than the higher SSAC.

As discussed in **Section 8.10.2**, the two highest concentrations are in adjacent samples and this provides some indicate that there may be a sub-area within the Eynham Road railway land with higher average concentrations around S183 and S184 (0-0.05m). The concentrations in both these samples exceed the highest of the POSresi SSAC. However, there is uncertainty associated with this on the basis that other samples in this area collected in the depth range 0-0.2m have lower concentrations (S184, 0-0.2m = 310mg/kg and P035 = 437mg/kg): it is unknown whether the difference in reported concentrations is related to the differences in depth horizon sampled or does reflect the true heterogeneity of lead concentrations in the S183 and S184 area that are relevant for direct contact exposure.

The other key uncertainty is the manner in which the land is used by the residents. As discussed in **Section 8.10.2** the use of the land may fall somewhere between the Resi+HP scenario and the POSresi+HP scenario but whether the usage is closer to Resi+HP or POSresi+HP is likely to depend on individual residents. The fact that the communal area is located behind a wall at the bottom of the private gardens, and is accessible along its whole length to any resident, suggests that generically usage may be more similar to POSresi+HP. If this scenario is accepted then average concentrations should be compared against the POSresi+HP SSAC in which case average exposure concentrations are lower than the SSAC and the lead in soil is not likely to cause SPOSH.

Further discussion is presented in **Section 9.**

8.11.3 Treadgold House

The shallow soil sampling data at Treadgold House that are most applicable for comparison with the SSAC are shown in **Table 69** below.

Table 69. Treadgold House Step 2 SSAC Data Comparison

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	SSAC mg/kg
Lead – all ground level soils	9	454	2216	992	992	672 - 1336	535 – 737 Resi-HP
							1,070 – 1,420 POSresi
Lead – ground level to north of residential building	5	454	997	634	500	471 - 796	1,070 – 1,420 POSresi
Lead – ground level in west and south of residential building	4	992	2216	1440	1277	928 - 1629	535 – 737 Resi-HP
							1,070 – 1,420 POSresi

When taken together, the mean and median ground level soil concentrations at Treadgold House exceed the Resi-HP SSAC but are lower than the POSresi SSAC. However, there appear to be two separate averaging areas within Treadgold House and the soil concentrations in each area also appear to be substantially different. The communal garden located to the north of the residential building is accessible across the car park and appears most likely to fit into the POSresi land use scenario. The average lead concentrations in this area (second row of **Table 69**) are lower than the POSresi GSC SSAC (they are also lower than the POSresi GSC) and this area is therefore likely to be consistent with Category 4 land for the human health CL associated with lead in soil.

The communal garden to the south and west of the residential building is directly accessible to a number of residential properties through private doors and there is some evidence (presence of patio chairs and barbecue) that this area is used in a manner similar to a private garden. However, on the basis that it is a communal garden, there are still likely to be some elements of the use of this area that are more consistent with the POSresi scenario. For example the lawn and soil borders are managed by the housing association which could reduce the exposure of residents to soils through gardening activities, and young children are less likely to be left to play in a communal garden for such long durations as they might in an entirely private garden.

The average soil concentrations (based on only 4 samples, so with relatively high uncertainty) in the communal garden to the south and west are higher than the Resi-HP SSAC by a factor of between two and three. Both the mean and median concentrations in this area exceed the lower of the Step 2 SSAC for POSresi, with the mean (1440mg/kg) also fractionally exceeding the higher of the POSresi SSAC (1420mg/kg). The median concentration in this area falls between two alternative Step 2 SSAC for the POSresi scenario.

In addition to the uncertainty associated with the average soil concentrations, the uncertainty associated with SSAC derivation is relevant when comparing single values against one another. For example the BAF of 66% used for the lead SSAC derivation was based on an average of all data across the Grenfell investigation area, not just the data within Treadgold House. For Treadgold House specifically there were there lead BAF results with an average concentration of 60%. If this value were used to calculate the Treadgold House SSAC then the higher Step 2 SSAC would increase from 1420mg/kg to 1560mg/kg and both the mean and median concentrations would fall below this SSAC.

Given the hybrid nature of the use of the land to the south and west of the residential building (somewhere between Resi-HP and POSresi) and the relatively high uncertainty associated with the average soil concentrations, there is considered to be relatively high uncertainty associated with the level of health risk at Treadgold House caused by lead in soil and whether it could cause SPOSH. Further discussion is presented in **Section 9.**

8.11.4 Portland Road CKG

The shallow soil sampling data at Portland Road CKG that are most applicable for comparison with the SSAC are shown in **Table 70** below.

Table 70. Portland Road CKG Step 2 SSAC Data Comparison

Dataset	Number of samples	Minimum	Maximum	Mean	Median	95% Confidence Interval	SSAC mg/kg
Lead (ground level soil)	4	325	1,785	1,032	1,010	367 – 1,592	2140 – 2870

The maximum and average soil concentrations at Portland Road CKG are lower than the lowest derived Step 2 SSAC.

On this basis it is unlikely that lead in soil at Portland Road CKG would cause SPOSH.

8.11.5 Avondale Park Gardens

Two samples were collected at Avondale Park Gardens during the Stage 1 sampling. The lowest concentration of 659mg/kg is lower than the lowest SSAC, whilst the highest concentration of 2,099mg/kg exceeds both the Step 2 SSAC (1070mg/kg and 1420mg/kg)

There is high uncertainty associated with the average soil concentrations at Avondale Park Gardens and the land-use for Avondale Park Gardens could have some similarities with the POSpark scenario compared to the POSresi scenario as the area is a fenced area of decorative gardens in the centre of a residential square. It is not a through route for daily activities and for a child resident a maximum of 170 days accessing the area (POSpark) seems more realistic, even on a precautionary basis, than the 365 days assumed for the POSresi scenario. This would serve to reduce the risk further. However without a more detailed appraisal of the typical usage of the area, and less uncertainty with the average soil concentrations, there is high uncertainty associated with the level of health risk at this sampling area. Further discussion is presented in **Section 9.**

9. Part 2A Risk Evaluation

This Part 2A risk evaluation is based on concentrations of COPC in soil measured during the Stage 1 and Stage 2 investigations. The investigations were designed to assess the potential for contamination associated with the Grenfell Tower fire and therefore the COPC investigated are those that could have been fire-related. On this basis other COPC and associated CLs that might be related to historic contaminative land uses but that would not be captured when considering potential fire effluents have not been considered.

Section 6 of this report concluded that the evidence did not show signs of fire-related impact that could be discerned from background levels of contaminants associated with other pre-fire sources – be that aerial deposition from diffuse urban contaminant sources or more localised contamination from historic industry. As a result, this Part 2A Risk Evaluation deals with contamination caused by historic contamination unrelated to the Grenfell Tower fire.

9.1 Introduction

In accordance with the 2012 Statutory Guidance for Part 2A of the Environmental Protection Act 1990, Local Authorities must consider a range of factors when deciding whether land should be determined as Contaminated Land.

Land which is shown to be causing Significant Harm, as defined by the Statutory Guidance, should be determined as Contaminated Land. For land where there is not any direct evidence of Significant Harm, it may still be determined as Contaminated Land if there is a Significant Possibility of Significant Harm (SPOSH).

When assessing land for SPOSH, initially, it must be shown that a possibility of significant harm (POSH) exists. Beyond that, the Statutory Guidance describes 4 categories of land (refer to **Section 9.1.3**) to be used to assist when deciding whether a POSH is significant or not.

9.1.1 Definitions of Significant Harm and Possibility of Significant Harm

The Part 2A statutory guidance definition of significant harm includes: death; life threatening diseases (e.g. cancers); other diseases likely to have serious impacts on health; serious injury; birth defects; and impairment of reproductive functions. The adverse health effects that can be caused by sufficiently high exposure to lead and PAHs fall within this definition. High enough chronic exposure to carcinogenic PAHs can cause cancer. High enough chronic exposure to lead can cause serious kidney (renal) damage and heart (cardiovascular) effects such as high blood pressure. In children it can adversely affect the development of the brain and nervous system. High enough short to medium term exposure to lead can cause adverse 'acute' health effects such as gastrointestinal and neurological toxicity, encephalopathy, and in extreme cases, death. A more detailed summary of lead and PAH toxicity is provided in Stage 1 Technical Note 8 (AECOM, 2019g).

To demonstrate significant harm, Paragraph 4.4 of the Statutory Guidance states that *"Conditions for determining that land is contaminated land on the basis that significant harm is being caused would exist where: (a) the local authority has carried out an appropriate, scientific and technical assessment of all the relevant and available evidence; and (b) on the basis of that assessment, the authority is satisfied on the balance of probabilities that significant harm is being caused (i.e. that it is more likely than not that such harm is being caused) by a significant contaminant(s)."*

The Statutory Guidance states that the evidence required to decide whether there is a possibility of significant harm (POSH) to human health includes:

- the estimated likelihood that significant harm might occur to an identified receptor, taking account of the current use of the land in question.
- the estimated impact if the significant harm did occur i.e. the nature of the harm, the seriousness of the harm to any person who might suffer it, and (where relevant) the extent of the harm in terms of how many people might suffer it.

To estimate the likelihood that a specific form of significant harm might occur the Statutory Guidance further states that the following information should be considered:

- The estimated probability that the significant harm might occur:
  - if the land continues to be used as it is currently being used; and

  - where relevant, if the land were to be used in a different way (or ways) in the future but within what the land can reasonably be used for without significant redevelopment that would require an application through the Town and Country Planning Act.

- The strength of evidence underlying the risk estimate. It should also consider the key assumptions on which the estimate of likelihood is based, and the level of uncertainty underlying the estimate.
- An estimate of the timescale over which the significant harm might become manifest, to the extent that this is possible and practicable.

The estimated impact (seriousness of harm) is determined by the toxicological endpoint (often defined as a toxicological point of departure (such as a benchmark dose)) and the margin of exposure (how close to or in excess of that dose the exposure is predicted to be). If a POSH is established, the available information must be interpreted to decide whether that possibility is significant i.e. is a significant possibility of significant harm (SPOSH).

9.1.2 Significant Possibility of Significant Harm

The decision on whether the POSH is significant is a regulatory decision to be taken by the relevant local authority. In deciding whether the POSH is significant, the authority is deciding whether the POSH posed by contamination in, on or under the land is sufficiently high that regulatory action should be taken to reduce it, with all that that would entail.

In considering whether a SPOSH exists, the local authority should consider the number of people who might be exposed to the risk in question and/ or the number of people it estimates would be likely to suffer harm. The Statutory Guidance defines four land categories associated with risk to human health, which are intended to assist in the decision making when evaluating the POSH and if required, SPOSH, for any Part 2A assessment.

9.1.3 Four Categories of Land

The Statutory Guidance defines four Categories for land being investigated under Part 2A in the context of SPOSH. **Category 1** describes land where there is an unacceptably high probability, supported by robust science-based evidence, that significant harm would occur if no action is taken to stop it. **Category 4** describes land where there is little evidence for a POSH, there is no risk or that the level of risk posed is low. This includes land where: no contaminant linkage has been identified; only normal levels of contaminants in soil are present; soil concentrations do not exceed relevant GSC; or estimated levels of exposure from soil are likely to form only a small proportion of exposure from other sources.

Categories 2 and 3 occupy the area where a POSH is considered to exist and a decision must be made as to whether the POSH is significant (Category 2, and the Site to be determined as Contaminated Land) or is not significant (Category 3, and the Site is not to be determined as Contaminated Land). The Statutory Guidance indicates that for human health:

- *"Land should be placed into Category 2 if the authority concludes, on the basis that there is a strong case for considering that the risks from the land are of sufficient concern, that the land poses a significant possibility of significant harm. Category 2 may include land where there is little or no direct evidence that similar land, situations or levels of exposure have caused harm before, but nonetheless the authority considers on the basis of the available evidence, including expert opinion, that there is a strong case for taking action under Part 2A on a precautionary basis.*
- *Land should be placed into Category 3 if the authority concludes that a strong case does not exist, and therefore the legal test for significant possibility of significant harm is not met. Category 3 may include land where the risks are not low, but nonetheless the authority considers that regulatory intervention under Part 2A is not warranted. This recognises that placing land in Category 3 would not stop others, such as the owner or occupier of the land, from taking action to reduce risks outside of the Part 2A regime if they choose.*

In making its decision on whether land falls into Category 2 or Category 3, the local authority should first consider its assessment of the possibility of significant harm to human health, including the estimated likelihood of such harm, the estimated impact if it did occur, the timescale over which it might occur, and the levels of certainty attached to these estimates."

If the authority considers that it cannot make a decision in line with the factors noted in the paragraph above, it should consider other factors which it considers are relevant to achieving the overarching objectives of Part 2A. Additional factors for consideration include:
(a) the likely direct and indirect health benefits and impacts of regulatory intervention. This would include benefits of reducing or removing the risk posed by contamination. It would also include any risks from contaminants being

mobilised during remediation (which would in any case have to be considered under other relevant legislation); and any indirect impacts such as stress-related health effects that may be experienced by affected people, particularly local residents. If it is not clear to the authority that the health benefits of remediation would outweigh the health impacts, the authority should presume the land falls into Category 3 unless there is strong reason to consider otherwise.

(b) The authority's initial estimate of what remediation would involve; how long it would take; what benefit it would be likely to bring; whether the benefits would outweigh the financial and economic costs; and any impacts on local society or the environment from taking action that the authority considers to be relevant.

The decision is a positive legal test, meaning that the starting assumption should be that land does not pose a significant possibility of significant harm unless there is reason to consider otherwise.

9.2 Part 2A Evaluation

9.2.1 Significant Harm

The assessment has not identified any conditions for which there is evidence that significant harm is being caused by contaminants in soil.

9.2.2 Low or No Risk – Category 4

Land has been placed in Category 4 where it is considered to pose no more than a low risk to human health, either through screening the COPC concentrations using GSC, or by virtue of the COPC being present at normal levels in soil. The land placed in Category 4 in this way included the following sampling areas listed in **Table 71** below:

Table 71. Sampling Areas defined as Category 4 land

Area Number	Area Name
1	Latimer Alternative Provision Academy
2	Burlington Danes School
3	Bassett House School (St Helen's Church)
4	Thomas Jones Primary School
5	All Saints Catholic College
6	Barlby Primary School
7	St. Francis Primary School
8	St. Anne's and Avondale Primary School and Nursery
9	Oxford Gardens Primary School
10	Golborne and Maxilla Children's Centre Forest School
11	Grenfell Creche Under 3s' Centre / Grenfell Nursery
12	New Studio pre-school
13	St Quintin Children and Family centre
15	St Quintin Gardens CKG
16	St Charles Centre for Health and Wellbeing
17	Equal People
18a	Nottingwood House
19	The Grove
21	Hurstway, Grenfell, Testerton and Barandon Walks (Lancaster Walkways)
22	Henry Dickens Court
23	Silchester East
24	Allom House and Barlow House
25a & 25b	Morland House and Talbot Grove House

Area Number	Area Name
26	Bramley House
27	Kensington Memorial Park
29	Verity Close
30	Little Wormwood Scrubs Including EPIC CIC Adventure Playground
31	Darfield Way
32	Lancaster Green
33	Robinson House
34	Wesley Square
35	Silchester West (North and North West area)
36	Maxilla Walk - Maxilla Hall / Maxilla Green
37	Stonebridge Recreation Ground
38	Wormwood Scrubs
39	Tower cordon
40	Waynflete Square
41	Camelford Walk
42	Avondale Park
44	West London Bowling Club
45	St. Quintin's Roundabout

9.2.3 Significant Possibility of Significant Harm

For those sampling areas not immediately placed into Category 4, the assessment of whether a significant possibility of significant harm exists has been carried out following the Statutory Guidance approach of placing the land into one of the three remaining categories (described in **Section 9.1.3).**

The remaining five sampling areas (Longstone Avenue allotments, Eynham Road railway land, Treadgold House, Portland Road CKG and Avondale Park Gardens) were assessed further using DQRA, with the only remaining COPC following the GQRA being lead (all five areas), and BaP (Longstone Avenue allotments only). The DQRA involved a process of refinement of the assessment criteria initially used as GSC to make them more site specific and progressively less precautionary. Each of the five sampling areas is discussed below in the context of:

- Possibility of Significant Harm – Likelihood, Impact and Timescale;
- Uncertainty; and
- Objectives of the Contaminated Land Regime.

A summary of the conclusions for each of these areas is provided in **Table 72**, with the supporting discussion below the table.

Table 72 Summary of SPOSH Discussion

Area Number	Area Name	Category Comments
14	**Longstone Avenue allotments**	Lead in soil human health CLs: Category 4
		BaP in soil (except area around Plot 6) human health CLs: Category 4
		BaP in soil (area around Plot 6) human health CLs: Category 3/4
18b	**Portland Road CKG**	Lead in soil human health CLs: Category 3/4
20	**Eynham Road railway land**	Single averaging area assumption: Category 4
		Potential hotspot and Resi+HP assumption within hotspot: Cat 2/3/4
28	**Treadgold House**	Communal garden to north of residential building: Category 4

Area Number	Area Name	Category Comments
		Communal garden to south and west of residential building: Category 2/3
43	**Avondale Park Gardens *(open space on residential street)***	Insufficient information.

9.2.3.1 Longstone Avenue allotments

SSAC were derived as part of the DQRA which adopted site-specific parameters and some alternative (though still precautionary) exposure assumptions. The Step 1 SSAC derived in this manner were therefore intended as a reasonable marker of the upper limit of Category 4 (noting that C4SLs are intended to fall within Category 4, so the upper limit of Category 4 must exist at some higher level).

Average lead concentrations across the sampling area were lower than the Step 1 SSAC therefore indicating that lead in soil at Longstone Avenue allotments should fall into Category 4. This is consistent with the average concentrations also being similar to or below normal urban background.

For BaP, the majority of sample results were lower than the Step 1 SSAC indicating no more than a low risk to health. A small part of the allotments was identified as having notably higher concentrations than the rest of area. This area was defined by Stage 2 sample S136 as well as two sample locations from a historic investigation (RPS, 2006), WS30 and WS35. Based on the site map from the RPS November 2006 report, these three samples are located in growing plots 6 and 6A . A more recent 2020 breakdown of the allotments plots provided by LBB suggests that the plots containing these samples may now be called 6A and 6B.

The average concentrations of the three samples in this area slightly exceeded the Step 1 SSAC but were approximately one quarter of the calculated Step 2 SSAC. This indicates that BaP in soils at Longstone Avenue allotments are not associated with a CL that is likely to cause SPOSH. Exposure in the area of notably higher concentrations could result in a risk to health that exceeds the low level required to place land in Category 4; however due to the limited number of samples in each individual plot, there is insufficient information to provide a sufficiently reliable estimate of average concentrations for a decision between Category 3 and Category 4 to be made. However, paragraph 2.13 of the Part 2A Statutory Guidance states that *"If at any stage the local authority considers, on the basis of information obtained from inspection activities, that there is no longer a reasonable possibility that a significant contaminant linkage exists on the land, the authority should not carry out any further inspection in relation to that linkage."* On this basis further investigation is not required under Part 2A.

9.2.3.2 Eynham Road Railway Land

The main uncertainties for Eynham Road railway land are associated with how the land is used by residents and whether there is an area of significantly higher concentrations defined by sample locations S183 and S184. The area investigated is a communal strip of land to the rear of private gardens of terraced houses. Each resident is nominally responsible for the piece of land backing directly onto their private garden and in this sense the area could be viewed as an extension of the private garden and assessed as such. However, the use of the investigated land will be split with the use of the private garden and therefore it is very unlikely to be used entirely in the manner assumed by the standard Resi+HP scenario, which envisages a private residential garden where homegrown produce can be cultivated. Since the investigated land is also further from the houses than the private gardens and is separated from the private garden by a wall with access gates, it is less likely to be used daily by very young children than the private gardens. In this sense the use may be more similar to the standard POSresi scenario (which envisages a publicly accessible area of land very close to residential properties where older children will frequently play), with the added homegrown produce pathway that was included as part of the DQRA.

Since the average (mean and median) concentrations of lead in soil at Eynham Road railway land (all samples except 0.5-0.6m depth) are below the POSresi+HP Step 1 SSAC and are also below the NBC it is considered to be appropriate to place the land in Category 4 if its communal use as a single averaging area is accepted as the most reasonable scenario.

If a more precautionary land-use similar to Resi+HP is considered to be more appropriate where individual residents use certain areas behind their properties almost exclusively, then for the area around S183 and S184, there is insufficient information to determine whether the land could fall into Category 2, Category 3 or Category 4, where an average lead concentration of around 1,500mg/kg could exist if the results at those two locations are representative (but equally an average concentration lower than the NBC could exist if S183 and S184 turned out to be localised and unrepresentative of residential averaging areas).

AECOM's judgement is that the communal use as a single averaging area is the more likely scenario and therefore Eynham Road railway land is most likely to meet the definition of Category 4 land. If this single averaging area assumption is not considered sufficiently precautionary then further sampling and a land use survey could be considered, particularly for the area around sample locations S183 and S184.

9.2.3.3 Treadgold House

For the communal garden to the north of the residential building, average concentrations were lower than the POSresi GSC and NBC. This area therefore meets the definition of Category 4 land.

For the communal garden to the south and west of the residential building, mean and median soil concentrations exceed the Step 1 SSAC and the NBC.

On this basis it is reasonable to conclude that this part of the land at Treadgold House could pose a risk to health that is not low and therefore falls into either Category 1, Category 2 or Category 3..

One of the main uncertainties for the decision-making at Treadgold House is the precise use of the land and how it fits with the standard Resi-HP and POSresi scenarios. For the communal gardens to the south and west of the residential block there is a possibility of this land being used in some respects in a manner similar to a private garden (standard Resi+HP or Resi-HP scenarios) since a number of back doors to private properties open directly onto the garden, which is securely fenced, not accessible to the public, and only directly accessible to a small number of residents. The presence of patio chairs and a barbecue in the area also indicates usage similar to a private garden in some respects. However, the fact that the garden is managed by the housing association and its communal use are likely to reduce exposure to soils compared to a typical private garden as exposure during gardening will be reduced, and young children are less likely to play unattended for such long durations as they would in a private garden.

The average (mean and median) lead concentrations in soil in the southern/western communal garden exceed the Step 2 SSAC for the Resi-HP land-use but the median concentration does not exceed the higher of the two Step 2 SSAC for the POSresi land-use. Given the uncertainty associated with how the land is used, the average soil concentrations (only four samples from ground level soils) and the sensitivity of the assessment to uncertain parameters such as bioaccessibility, it is concluded that the current uncertainty in the assessment is too high to reliably place this area of land in a particular category and it could reasonably fall into either **Category 2** or **Category 3** once the uncertainty in the assessment has been reduced. The area is not considered to meet the definition of Category 1 as the three tests for Category 1 set out in Paragraph 4.19 (a), (b) and (c) have not been met.

The remaining uncertainty over the assessment of land at Treadgold House is associated with what is the representative average soil concentration as well as precisely how the gardens to the south and west are used by residents with direct access. The higher lead concentrations in this area could be caused by historic land-uses (e.g. brickworks formerly occupying this area), redevelopment works such as stripping and discarding of old leaded paint and roofing materials, or the importation of soils used for the redevelopment and landscaping of Treadgold House from unknown contaminated sources, for example. .

In order to reduce the uncertainty in the assessment at Treadgold House some additional sampling in the southern and western area would be beneficial to more reliably determine how the average concentrations fit into the range of Step 2 SSACs. Other assessments that could be considered include additional bioaccessibility testing and a formal survey of how the land is typically used to make an informed decision in terms of the applicability of the Resi-HP or POSresi land use scenarios.

9.2.3.4 Portland Road CKG

The calculated average soil concentrations at Portland Road CKG have a high level of uncertainty due to the wide range of reported concentrations and the relatively small dataset in ground level soils. There is some evidence that soils in the northern part of the sampling area could have higher average concentrations that those in the southern part.

The average concentrations are lower than the Step 1 SSAC used to define a reasonable upper level of Category 4 and the maximum concentration (1,725mg/kg) is only slightly above this Step 1 SSAC (1,420mg/kg). On this basis the level of risk at Portland Road CKG is most likely to be low (i.e. within the definition of Category 4), assuming the estimated averages are reasonably representative of the true mean concentrations in ground level soil.

Given the high uncertainty in the average concentrations, there is some potential that the true mean exceeds the Step 1 SSAC and this could potentially push this area above the upper Category 4 threshold. This is also the case

if the northern part of the area were found to have an average concentration notably higher than the southern area, with the concentrations potentially exceeding the Step 1 SSAC. However, there is no evidence that any individuals use the northern part of the Site as a single averaging area as this area does not contain the managed raised beds and is an area of ground level soils with occasional fruit trees and shrubs.

It is considered that the most likely outcome that the true average concentrations across the whole area would fall below the Step 1 SSAC and therefore the land fall meet the definition of Category 4. It is less likely (but possible) that true average concentrations could exceed the Step 1 SSAC. However in this scenario there is no evidence that the average concentrations would exceed the lowest of the Step 2 SSAC and therefore the land would meet the definition of Category 3.

9.2.3.5 Avondale Park Gardens

Two samples were collected at Avondale Park Gardens during the Stage 1 sampling. The lowest lead concentration of 659mg/kg is lower than the lowest Step 2 SSAC, whilst the highest concentration of 2,099mg/kg exceeds both of the Step 2 SSAC.

Since only two samples were collected resulting in very high uncertainty with average soil concentrations, and there is uncertainty as to whether the use of this sampling area would meet the definition of POSresi, it is considered that there is insufficient information to place this sampling area in a land category.

Further sampling and additional information to guide the expected land-use behaviours in this area would be required before a decision could be made between Category 2, Category 3 or Category 4.

9.3 Updated CSM

Following the Part 2A risk evaluation, the CSM initially presented in **Section 4.2** has been updated and is presented in **Table 73** below.

Table 73. Final CSM following Stage 2 Investigation

Sources	Pathways	Receptors	Discussion
Lead in soil at Treadgold House (communal gardens to south and west of residential building	Ingestion of soil and indoor dust Dermal contact with soil (outdoor) Dermal contact with soil derived dust (indoor) Inhalation of dust (indoor and outdoor)	Residents of Treadgold House	Treadgold House has not been placed into a Category due to the high uncertainty associated with average lead concentrations and uncertainty with the manner that the communal garden is used by residents, and how this relates to standard land use assumptions. The higher concentrations of lead in soil in this area could have arisen from a variety of historic sources, including redevelopment works such as stripping and discarding of leaded paint and old roofing materials, soils being imported from other unknown contaminated sources during redevelopment and landscaping, and nearby historic land-uses such as the brickworks which formerly occupied land now within the southern part of Treadgold House. Although is it considered that there is not currently the strong case for SPOSH required by the Statutory Guidance to place this CL into Category 2, further assessment within this area would be of benefit in order to more reliably conclude on the Part 2A land category and decide whether the land meets the definition of Category 2 or Category 3.
Lead in soil at Avondale Park Gardens	Ingestion of soil and indoor dust Dermal contact with soil (outdoor) Dermal contact with soil derived dust (indoor) Inhalation of dust (indoor and outdoor)	Residents of Avondale Park Gardens and their visitors.	The high uncertainty associated with the assessment at Avondale Park Gardens means that a final decision has not been made for whether the land could cause SPOSH. It is considered that there is still some potential that the land could fall into any of Category 2, Category 3 or Category 4. The higher concentrations of lead in soil in this area could have arisen from a variety of historic sources, including soils being imported from other unknown contaminated sources during redevelopment and landscaping, and nearby historic land-uses such as the brickworks which formerly occupied the land of which now includes Avondale Park Gardens. Limited further assessment within this area would be of benefit in order to more reliably conclude on the Part 2A land category.

Eynham Road railway land has not been included in **Table 73** above as it is considered that there is a plausible reason to place this sampling area in Category 4 (i.e. the area can be assumed to be a single averaging area in which case the average concentrations are lower than the NBC). However there is some uncertainty associated with how individual residents use the area and if a precautionary approach is preferred there could be some benefit to further sampling, particularly in the area of S183 and S184.

9.4 Part 2A Land Category Recommendations

Table 74 below summarises the recommended land categories for each of the 45 sampling areas.

Table 74. Part 2A Land Category Recommendations

Area Type	Area Name	Proposed Category
Schools and Nurseries	**1. Latimer Alternative Provision Academy**	Cat 4
	2. Burlington Danes School	Cat 4
	3. Bassett House School (St Helen's Church)	Cat 4
	4. Thomas Jones Primary School	Cat 4
	5. All Saints Catholic College	Cat 4
	6. Barlby Primary School	Cat 4
	7. St. Francis Primary School	Cat 4
	8. St. Anne's and Avondale Primary School and Nursery	Cat 4
	9. Oxford Gardens Primary School	Cat 4
	10. Golborne and Maxilla Children's Centre Forest School	Cat 4
	11. Grenfell Creche Under 3s' Centre / Grenfell Nursery	Cat 4
	12. New Studio pre-school	Cat 4
	13. St Quintin Children and Family centre	Cat 4
Community Kitchen Gardens and Allotments	**14. Longstone Avenue allotments**	Cat 4*
	15. St Quintin Gardens	Cat 4
	16. St Charles Centre for Health and Wellbeing	Cat 4
	17. Equal People	Cat 4
	18. Portland Road and Nottingwood House	Cat 4
	19. The Grove	Cat 4
Combined Community Kitchen Gardens and Public Open Space	**20. Eynham Road railway land**	Cat 4**
	21. Hurstway, Grenfell, Testerton and Barandon Walks (Lancaster Walkways)	Cat 4
	22. Henry Dickens Court	Cat 4
	23. Silchester East	Cat 4
	24. Allom House and Barlow House	Cat 4
	Morland House and Talbot Grove House	Cat 4
	26. Bramley House	Cat 4
	27. Kensington Memorial Park	Cat 4
	28. Treadgold House (communal garden in north)	Cat 4
	28. Treadgold House (communal garden to south and west)	Uncertain –Cat 2 or Cat 3, further assessment to resolve
Public Open Space	**29. Verity Close**	Cat 4
	30. Little Wormwood Scrubs Including Adventure Playground	Cat 4
	31. Darfield Way	Cat 4
	32. Lancaster Green	Cat 4
	33. Robinson House	Cat 4
	34. Wesley Square	Cat 4
	35. Silchester West (North and North West area)	Cat 4
	36. Maxilla Walk - Maxilla Hall / Maxilla Green	Cat 4
	37. Stonebridge Recreation Ground	Cat 4

Area Type	Area Name	Proposed Category
	38. Wormwood Scrubs	Cat 4
	39. Tower cordon *(not currently accessible to public)*	Cat 4
	40. Waynflete Square	Cat 4
	41. Communal Space at Camelford Walk	Cat 4
	42. Avondale Park *(public park)*	Cat 4
	43. Avondale Park Gardens *(open space on residential street)*	Uncertain (Cat 2/3/4)
	44. West London Bowling Club	Cat 4
	45. St Quintin's Roundabout	Cat 4

* At Longstone Avenue allotments there is a slight possibility of individual plots (around Plot 6) falling into Category 3, though they are more likely than not to be Category 4. If more confidence in this decision was required in the future then some additional limited sampling in this area would be beneficial.

** This category applies to the assumption that land is assumed as a single averaging area and that the use of the land (in terms of exposure frequency and exposure duration) is more similar to POSresi+HP than Resi+HP land-use. If this assumption is not considered sufficiently precautionary then further sampling and a land use survey could be considered, particularly for the area around sample locations S183 and S184

Section 6 of this report evaluated the potential for significant fire-related impact and concluded that the Grenfell Tower fire did not cause impact to soils that would be considered significant in the context of Part 2A of the EPA. Whilst this is an important result in terms of demonstrating that any deposition of COPC from the fire has not caused any discernible increase in health risk from soil contamination over and above what might have already been present on the land, this does not allow an overall land category to be assigned to the investigation area as a whole. In terms of Part 2A land categories on land within the investigation area that has not been directly sampled, it can be concluded that the condition of that land should not have been materially affected by any impact from the Grenfell Tower fire and the pre-existing inspection strategy for land within the investigation area does not need to be altered as a result of the Grenfell Tower fire.

10. Conclusions and Recommendations

Stage 2 of the Grenfell Investigation into Potential Land Contamination Impact was completed with the objectives to:

- Determine so far as possible the geographical extent of any significant contamination caused by the fire whilst recognising the potential for underlying (pre-fire) contamination.
- Carry out generic and detailed quantitative human health risk assessments required under Part 2A to establish whether there are unacceptable risks to human health.
- Provide recommendations in relation to the classification of all potential significant contaminant linkages investigated as Category 1-4 in accordance with the Statutory Guidance.
- Provide recommendations for whether or not any land appears to meet the definition of contaminated land, under Part 2A.

Conclusions for each of these objectives in turn are summarised as follows:

Determine so far as possible the geographical extent of any significant contamination caused by the fire whilst recognising the potential for underlying (pre-fire) contamination.

Section 6 of the report evaluates and discusses the evidence for any significant contamination caused by the fire. The review of the reported concentrations of COPC in terms of sample depth, ground level vs. raised beds, turf vs. bare soil ground cover identified a possible aerial deposition source for chlorinated dioxins and furans and to a lesser extent dioxin-like PCBs and lead. In addition for chlorinated dioxins and furans and dioxin-like PCBs, there higher concentrations were encountered at a distance of 150m to 300m from the Tower. However, the other lines of evidence which included spatial position relative to the Tower and comparison with background levels suggested that these higher concentrations were not likely to have been caused by aerial deposition from the Grenfell Tower fire.

Where the higher concentrations of dioxins, furans and dioxin-like PCBs were encountered, the evidence suggested that this was more likely to be linked to historic contaminative land-uses and longer-term pre-fire urban development, and the comparison of the reported concentrations with GSC concluded that these COPC would cause the associated CL to fall into the definition of Category 4 land (i.e. no to low risk). Therefore any potential minor contribution to soil concentrations from the Grenfell Tower fire – which has not been discernible by the multiple lines of evidence but which cannot be entirely ruled out if present at very low amounts that are inseparable from the underlying background – would also fall into the definition of Category 4 land.

For lead, there was some indication (though with high uncertainty) of a potential aerial deposition source but no corroborating evidence to indicate that it could be a result of the Grenfell Tower fire. The comparison of lead concentrations with GSC concluded that in some areas the lead concentrations in soil could exceed levels defining Category 4 land, but that this was not associated with impact from the Grenfell Tower fire.

For BaP the assessment did not identify an aerial deposition source either from Grenfell Tower fire or other urban pollution sources. The comparison of BaP concentrations with GSC concluded that in some areas the BaP concentrations in soil could exceed levels defining Category 4 land, but that this was not associated with impact from the Grenfell Tower fire.

Given the above, it was concluded that the Stage 2 investigation has not identified any significant contamination caused by the fire. The recommendation following this conclusion is that no further work is required with respect to the investigation in terms of whether the Grenfell Tower fire caused significant long-term soil contamination.

Carry out generic and detailed quantitative human health risk assessments required under Part 2A to establish whether there are unacceptable risks to human health.

The soil results from each of the forty-five Stage 1 and Stage 2 sampling areas were assessed in line with the objective to identify potential contamination arising from the Grenfell Tower fire. The results were also assessed for risk to human health taking into account the concentrations of potentially fire-related chemicals that could be present in soil from sources not related to the Grenfell Tower fire. The risk assessment has not considered potential soil contaminants not directly associated with the fire that might also be present in soil as a result of historic land-use activities.

Sections 7 and 8 respectively present the Part 2A-compliant generic and detailed quantitative risk assessments and these did not identify any contaminant linkages definitely associated with unacceptable risks (i.e. Category 1 or Category 2 land) to human health.

For two areas there was considered to be insufficient information to make a final decision with respect to unacceptable risk: these areas were Treadgold House and Avondale Park Gardens.

It is recommended that further work is completed in these areas to reduce the uncertainty associated with average soil concentrations and to gather more precise information from residents to determine how the land is used.

Provide recommendations in relation to the classification of all potential significant contaminant linkages investigated as Category 1-4 in accordance with the Statutory Guidance.

All areas of land (and their associated potential significant contaminant linkages) evaluated as part of the Grenfell Investigation into Potential Land Contamination Impact fall into Category 4, with the following exceptions:

- **Treadgold House**: The available evidence indicates that the risk to health from lead in soil is likely to exceed the 'low' threshold (i.e. it is not Category 4) for the communal gardens to the south and west of the residential building and that this area could meet either the definition of Category 2 or Category 3 land, dependent on resolving ongoing uncertainties.. Due to high uncertainty with the average soil concentrations in the south and west of the Site, and uncertainty over how this area is used by residents, further assessment is recommended if a more reliable conclusion about the level of health risk and the categorisation of the land (south and west communal garden only) in to either Category 2 or 3 is warranted.
- **Avondale Park Gardens**: Due to the high uncertainty associated with average soil concentrations and how frequently the area is used by residents, this area is could fall into Category 2, Category 3 or Category 4.. Further sampling in this area and improved understanding the land use could resolve this uncertainty and allow a final decision to be made.

Provide recommendations for whether or not any land appears to meet the definition of contaminated land, under Part 2A.

The Part 2A risk evaluation did not identify any land that definitely appears to meet the definition of contaminated land under Part 2A.

Further work is required at Treadgold House and Avondale Park Gardens to reduce the uncertainty in the assessment and allow a final decision to made for these sampling areas.

11. References

Addison, J., Davies, L. S., Robertson, A. & Willey, R. J., 1988. *The release of dispersed asbestos fibres from soils, Historical Research Report TM/88/14,* Edinburgh: Institute of Occupational Medicine.
AECOM, 2019a. *Grenfell Investigation into Potential Land Contaminatino Impacts. Technical Note 13: Potential Source Contributions to Urban Soil Pollution,* Croydon: AECOM Limited.
AECOM, 2019b. *Grenfell Investigation into Potential Land Contamination Impacts. Technical Note 01: Final Specification for the Stage 1 Investigation,* Croydon: AECOM Limited.
AECOM, 2019c. *Grenfell Investigation into Potential Land Contamination Impacts. Technical Note 09: Urban Background Concentrations,* Croydon: AECOM Limited.
AECOM, 2019d. *Grenfell Investigation into Potential Land Contamination Impacts. Technical Note 16: Preliminary Risk Assessment,* Croydon: AECOM Limited.
AECOM, 2019e. *Grenfell Investigation into Potential Land Contamination Impacts. Technical Note 18: Stage 2 Design,* Croydon: AECOM LImited.
AECOM, 2019f. *Grenfell Investigation into Potential Land Contamination Impacts. Technical Note 17: Pilot Study Part 2A Risk Assessment,* Croydon: AECOM Limited.
AECOM, 2019g. *Grenfell Investigation into Potential Land Contamination Impacts. Technical Note 8: COPC Toxicity,* Croydon: AECOM Limited.
AECOM, 2019h. *Technical Note 10/12: Potentially Contaminative Land Uses and Local Background Soil Concentrations,* Croydon: AECOM Limited.
AECOM, 2020. *Grenfell Investigation into Potential Land Contamination Impacts. Stage 2 Detailed Design,* Croydon: AECOM Limited.
ATSDR, 2020. *Toxicological Profile for Lead,* Washington D.C.: US Department of Health and Human Services.
British Geological Survey, 2010. *London Earth BGS Datasets,* London: BGS.
BSI, 2018. *BS ISO 17924:2018. Soil quality — Assessment of human exposure from ingestion of soil and soil material - Procedure for the estimation of the human bioaccessibility/bioavailability of metals in soil,* London: British Standards Limited.
BSI, 2020. *BS10176:2020. Taking soil samples for determination of volatile organic compounds (VOCs) - Specification,* UK: BSI Standards Limited.
Cave, M. R., Wragg, J., Harrison, I. & Vane, C., 2010. A comparison of batch mode and dynamic physiologically based bioaccessibility tests for PAHs in soil samples.. *Environ Sci Technol.,* 7(44), pp. 2654-60.
CL:AIRE/AGS/EIC, 2010. *Soil Generic Assessment Criteria for Human Health Risk Assessment,* London: CL:AIRE.
CL:AIRE, 2011. *Generic Human-Health Assessment Criteria for Benzo(a)Pyrene at Former Coking Works Sites, Research Bulletin 17,* London: CL:AIRE.
Cole, S. J., Hay, S. & Mitcheson, B., 2021. *Discussion paper on guidelines for airborne concentrations of asbestos fibres in ambient air: implications for quantitative risk assessment,* London: SoBRA.
Collins, C. et al., 2019. *Determination of typical background concentrations of asbestos in near-surface soils of selected public open space areas of England and Wales to define representative concentrations in areas not expected to be subject to significant contamination.,* London: Defra.
Committee on Toxicity, 2013. *Statement on the potential risks from lead in the infant diet,* London: COMMITTEE ON TOXICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT.
Committee on Toxicity, 2016. *Addendum to the 2013 COT statement on potential risks from lead in the infant diet,* London: COMMITTEE ON TOXICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT.
COT, 2010. *COT statement on occurrence of mixed halogenated dioxins and biphenyls in UK food, COT Statement 2010/02,* London: Committee on Toxicity in Food, Consumers Products and the Environment.
Creaser, C. et al., 2007b. *UKSHS Report No. 9: Environmental concentrations of polycyclic aromatic hydrocarbons in UK soil and herbage,* Bristol: Environment Agency.
Crown, 1990. *Environmental Protection Act,* London: UK Stationery Office.
Crown, 2010. *The Air Quality Standards Regulations 2010.* London: The Stationery Office Ltd.
Defra, 2012. *Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance.* London: Department of Environment Food and Rural Affairs.
DEFRA, 2012. *Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance.* London: DEFRA.
DEFRA, 2012. *SP1010: Development of Category 4 Screening Levels for assessment of land affected by contamination - Policy Companion Document,* London: Defra.
Department for Environment, Food and Rural Affairs (Defra), 2012a. *Development of Category 4 Screening Levels for assessment of land affected by contamination - SP1010,* London: DEFRA.

Drage, D. et al., 2016. Concentrations of legacy and emerging flame retardants in air and soil on a transect in the UK West Midland. *Chemosphere, vol. 148 ,* pp. 195-203.
Dutch Ministry of Infrastructure and the Environment, 2013. *Soil Remediation Circular,* Bilthoven: RIVM.
EA, PHE, 2019. *Analysis and Interpretation Methodology for the Soil Investigation at Grenfell Tower,* London: Environment Agency.
EA, 2009. *Human health toxicological assessment of contaminants in soil. Science Report – Final SC050021/SR2.,* Bristol: EA.
Entwistle, J. A. et al., 2019. An apple a day? Assessing gardeners' lead exposure in urban agriculture sites to improve the derivation of soil assessment criteria. *Environment International,* Volume 122, pp. 130-141.
Environment Agency, 2004. *CLR11, Model Procedures for the Management of Land Contamination,* Bristol: Environment Agency.
Environment Agency, 2007a. *Science project: SC000027. UK Soil & Herbage Pollutant Survey (reports 1-10),* Bristol: Environment Agency.
Environment Agency, 2007b. *UK Soil and Herbage Pollutant Survey, UKSHS Report No.10. Environmental concentrations of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans in UK soil and herbage,* Bristol: Environment Agency.
Environment Agency, 2009. *Soil Guideline Values for dioxins, furans, and dioxin-like PCBs in soil, Science Reprot SC050021/Dioxins SGV,* Bristol: Environment Agency.
Environment Agency, 2009. *Updated technical background to the CLEA model. Science Report: SC050021/SR3,* Bristol: Environment Agency.
Environment Agency, 2020. *Guidance. Land contamination risk management (LCRM). How to assess and manage the risks from land contamination..* [Online]
Available at: https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm
Hadden, R. & Switzer, C., 2020. *Combustion Related Fire Products: A Review,* s.l.: University of Edinburgh and University of Strathclyde.
Hellawell, E. E. & Hughes, S. J., 2021. Asbestos contamination on brownfield development sites in the UK. *Environmental Research,* p. in press.
Jeffries, J. &. M. I., 2009. *Updated technical background to the CLEA model. Science report: SC050021/SR3,* Bristol: Environment Agency.
Johnson, C. C., Ander, E. L., Cave, M. R. & Palumbo-Roe, B., 2012. *Normal background concentrations (NBCs) of contaminants in English soils: Final project report,* London: British Geological Survey.
Keppler, F. et al., 2005. New insight into the atmospheric chloromethane budget gained using stable carbon isotope ratios. *Atmospheric Chemistry and Physics, 5,* pp. 2403-2411.
Landmark Information Group, 2019b. *Datasheet and Site Sensitivity Report. Order number: 209140267_1_1,* Reading: Landmark Information Group.
Landmark Information Group, 2020a. *Datasheet and Site Sentivity Report. Order number: 244506740_1_1.,* Reading: Landmark Information Group.
Landmark Information Group, 2020b. *Datasheet and Site Sentivity Report. Order number: 244510776_1_1,* Reading: Landmark Information Group.
Landmark Information Group, 2020c. *Datasheet and Site Sentivity Report. Order number: 259484194_1_1.,* Reading: Landmark Information Group.
Landmark Information Group, 2020d. *Datasheet and Site Sentivity Report. Order number: 259487084_1_1,* Reading: Landmark Information Group.
Lanphear, B. P. et al., 2005. Low-level environmental lead exposure and and children's intellectual function: an international pooled analysis. *Environ Health Perspect,* 113(7), pp. 894-9.
Lippmann, M., Cohen, M. & Chen, L.-C., 2015. Health Effects of World Trade Center (WTC) Dust: An unprecented disaster with inadequate risk management. *Critical Reviews in Toxicology, 45 (6),* pp. 492-530.
Marriott, N., 2020. *Professional Guidance. Comparing Soil Concentrations with a Critical Concentration.,* London: CL:AIRE.
Ministry of Housing, Communities and Local Government, 2019. *Guidance. Grenfell environmental checks: stage 1 report.* [Online]
Available at: https://www.gov.uk/guidance/grenfell-environmental-checks-stage-1-report#report-documents
Nathanail, C., McCaffrey, C., Gillett, A. & Ogden, R. &. N. J., 2015. *The LQM/CIEH S4ULs for Human Health Risk Assessment,* Nottingham: Land Quality Press, Nottingham.
Nathanail, P., Jones, A., Ogden, R. & Robertson, A., 2014. *CIRIA C733. Asbestos in soil and made ground: a guide to understanding and managing risks,* London: CIRIA.
Nathanail, P. et al., 2009. *The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition),* Nottingham: Land Quality Press.
PHE, 2021. *Lead Exposure in Children Surveillance System (LEICSS) annual report, 2019 Health Protection Report Volume 15 Number 5,* London: PHE.

Public Health England, 2017. *Contaminated Land Information Sheet: Risk Assessment Approaches for Polycyclic Aromatic Hydrocarbons (PAHs),* Didcot: PHE.
RPS, 2006. *Investigation and Semi-Quantitative Risk Assessment at Longstone Avenue Allotment,* Chepstow: RPS Group.
RPS, 2019. *Stage 1 Report – Phase 1 Desk Study and Phase 2 Shallow Soil Investigation Report. Edward Woods Estate, Hammersmith, London,* Abindgon: RPS.
SoBRA, 2020. *Development of Acute Generic Assessment Criteria for Assessing Risks to Human Health from Contaminants in Soil,* London: SoBRA.
SoBRA, 2020. *The Distribution of Asbestos in Soil – what can the data mining of sample results held by UK laboratories tell us?,* London: SoBRA.
Stanek, E., Calabrese, E. & Xu, B., 2011. eta-Analysis of Mass-Balance Studies of Soil Ingestion in Children. *Risk analysis : an official publication of the Society for Risk Analysis,* 32(-), pp. 433-447.
Swartjes, F. A. & Tromp, P. C., 2008. A Tiered Approach for the Assessment of the Human Health Risks of Asbestos in Soil. *Soil & Sediment Contamination,* Volume 17, pp. 137-149.
Turkhall, R. M., Skowronski, G. A. & Abdel-Rahmann, M. S., 2009. Effects of soil matrix and aging on the dermal bioavailability of polycyclic aromatic hydrocarbons in the soil. *International Journal of Soil, Sediment and Water,* 2(4), pp. -.
US EPA, 2017. *Update for Chapter 5 of the Exposure Factors Handbook. Soil and Dust Ingestion,* Washington: US Environment Protection Agency.
USEPA, 2019. *Lead at Superfund Sites: Software and Users' Manuals.* [Online]
Available at: https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals
[Accessed 1 February 2021].
USEPA, 2020. *Regional Screening Levels - Generic Tables.* [Online]
Available at: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables
Vane, C. et al., 2014. Polycyclic aromatic hydrocarbons (PAH) and polychlorinated biphenyls (PCB) in urban soils of Greater London, UK. *Applied Geochemistry,* Volume 51, pp. 303-314.
Vane, C. et al., 2014. Polycyclic aromatic hydrocarbons (PAH) and polychlorinated biphenyls (PCB) in urban soils of Greater London, UK. *Applied Geochemistry,* Volume 51, p. 303.
Wilson R., J.-O. H. P. S. M. I. B. Y. W. D. R. M., 2013. Revisiting Dust and Soil Ingestion Rates Based on Hand-to-Mouth Transfer. *Human and Ecological Risk Assessment: An International Journal,* 19(1), pp. 158-188.

Appendix A – Figures

A1 - Grenfell Tower Site Location Map

A2 - Grenfell Tower Sampling Areas for Stages 1 and 2

A3 - Sampling Areas for Stages 1 and 2 with Historical Potentially Contaminative Land Uses

A4 - Average Antimony Concentrations

A5 - Average Dioxin-like PCB Concentrations

A6a - Average Chlorinated Dioxins and Furans Concentrations – Shallow samples on Grass/Turf and Bare Soil

A6b - Average Chlorinated Dioxins and Furans Concentrations – Shallow samples on Bare Soil only

A7a - Individual Chlorinated Dioxins and Furans Concentrations – Shallow samples on Grass/Turf and Bare Soil

A7b - Individual Chlorinated Dioxins and Furans Concentrations – Shallow samples on Bare Soil only

A8a - Lead Concentrations with GSC and Background Data – Shallow samples up to 5km

A8b - Lead Concentrations with GSC and Background Data – Shallow samples up to 500m

A8c - Chlorinated Dioxins and Furans Concentrations – Shallow samples up to 5km

A8d - Chlorinated Dioxins and Furans Concentrations – Shallow samples up to 500m

A8e - BaP Concentrations with GSC and Background Data – Shallow samples up to 5km

A8f - BaP Concentrations with GSC and Background Data – Shallow samples up to 500m

A8g - Dioxin-like PCB Concentrations with GSC and Background Data – Shallow samples up to 5km

A8h - Dioxin-like PCB Concentrations with GSC and Background Data – Shallow samples up to 500m

A8i - Antimony Concentrations with GSC and Background Data – Shallow samples up to 5km

A8j - Antimony Concentrations with GSC and Background Data – Shallow samples up to 500m

A9a - Box and whisker plots of chlorinated dioxins and furans summary statistics

A9b - Box and whisker plots of lead summary statistics

A9c - Box and whisker plots of benzo(a)pyrene summary statistics

A9d - Box and whisker plots of antimony summary statistics

A9e - Box and whisker plots of dioxin-like PCB summary statistics

Appendix B – Tables

B1 - Summary of Historical Reports

B2 - Summary of Historical Data

B3 - Detailed Soil Sample Information

B4 - Detailed Crop Sample Information

B5 - Duplicate Sample Information

B6 - Soil Type Summary According to Surface Cover

B7 - Duplicate Sample RPD Analysis

B8 - Curtins KALC Site Investigation Data Summary Comparison

Appendix C – Data-gap Assessments

- Data Gap Analysis memorandum
- Target PAH and SVOC memorandum
- Table C1 Potentially Contaminative Historical Land Uses (Includes Historical Information Search for Stonebridge Recreation Ground, Wormwood Scrubs and St Quintin's Children and Family Centre)

Appendix D - Sampling Procedures

- Soil Sampling Procedure
- VOC Sampling Procedure
- Crop Sampling Procedure

Appendix E – Sample Location Figures

E1 - Latimer Alternative Provision Academy
E2 - Burlington Danes School
E3 - Bassett House School (St Helen's Church)
E4 - Thomas Jones Primary School
E5 - All Saints Catholic College
E6 - Barlby Primary School
E7 - St. Francis Primary School
E8 - St. Anne's and Avondale Primary School and Nursery
E9 - Oxford Gardens Primary School
E10 - Golborne and Maxilla Children's Centre Forest School
E11 - Grenfell Creche Under 3s' Centre / Grenfell Nursery
E12 - New Studio pre-school
E13 - St Quintin Children and Family centre
E14 - Longstone Avenue allotments
E15 - St Quintin Community Kitchen Garden
E16 - St Charles Centre for Health and Wellbeing
E17 - Equal People
E18a - Nottingwood House
E18b - Portland Road Community Kitchen Garden
E19 - The Grove
E20 - Eynham Road railway land
E21 - Hurstway, Grenfell, Testerton and Barandon Walks (Lancaster Walkways)
E22 - Henry Dickens Court
E23 - Silchester East
E24 - Allom House and Barlow House
E25a - Morland House
E25b - Talbot Grove House
E26 - Bramley House
E27 - Kensington Memorial Park
E28 - Treadgold House
E29 - Verity Close
E30 - Little Wormwood Scrubs Including Adventure Playground
E31 - Darfield Way
E32 - Lancaster Green
E33 - Robinson House
E34 - Wesley Square
E35 - Silchester West (North and North-West area)
E36 - Maxilla Walk - Maxilla Hall / Maxilla Green
E37 - Stonebridge Recreation Ground
E38 - Wormwood Scrubs
E39 - Tower Cordon
E40 - Waynflete Square
E41 - Communal Open Space at Camelford Walk
E42 - Avondale Park
E43 - Communal Space at Avondale Park
E44 - West London Bowling Club
E45 - St Quintins Roundabout

Appendix F – Field Sampling Notes and Photologs

- Sampling Notes and Photo Records - Crop and Root Zone Soil
- Sampling Notes and Photo Records - Soil Sampling

Appendix G – Lead Concentration in Soil Figures

G1 - Latimer Alternative Provision Academy
G2 - Burlington Danes School
G3 - Bassett House School (St Helen's Church)
G4 - Thomas Jones Primary School
G5 - All Saints Catholic College
G6 - Barlby Primary School
G7 - St. Francis Primary School
G8 - St. Anne's and Avondale Primary School and Nursery
G9 - Oxford Gardens Primary School
G10 - Golborne and Maxilla Children's Centre Forest School
G11 - Grenfell Creche Under 3s' Centre / Grenfell Nursery
G12 - New Studio pre-school
G13 - St Quintin Children and Family centre
G14 - Longstone Avenue allotments
G15 - St Quintin Community Kitchen Garden
G16 - St Charles Centre for Health and Wellbeing
G17 - Equal People
G18a - Nottingwood House
G18b - Portland Road Community Kitchen Garden
G19 - The Grove
G20 - Eynham Road railway land
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G22 - Henry Dickens Court
G23 - Silchester East
G24 - Allom House and Barlow House
G25a - Morland House
G25b - Talbot Grove House
G26 - Bramley House
G27 - Kensington Memorial Park
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G29 - Verity Close
G30 - Little Wormwood Scrubs Including Adventure Playground
G31 - Darfield Way
G32 - Lancaster Green
G33 - Robinson House
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G35 - Silchester West (North and North-West area)
G36 - Maxilla Walk - Maxilla Hall / Maxilla Green
G37 - Stonebridge Recreation Ground
G38 - Wormwood Scrubs
G39 - Tower Cordon
G40 - Waynflete Square
G41 - Communal Open Space at Camelford Walk
G42 - Avondale Park
G43 - Communal Space at Avondale Park
G44 - West London Bowling Club
G45 - St Quintins Roundabout
G46 - Stage 1 & 2 Average Lead Concentrations with London Earth background data
G47 - Stage 1 & 2 Average Lead Concentrations with Indicative Plume Extent

Appendix H – Benzo(a)pyrene Concentration in Soil Figures

H1 - Latimer Alternative Provision Academy
H2 - Burlington Danes School
H3 - Bassett House School (St Helen's Church)
H4 - Thomas Jones Primary School
H5 - All Saints Catholic College
H6 - Barlby Primary School
H7 - St. Francis Primary School
H8 - St. Anne's and Avondale Primary School and Nursery
H9 - Oxford Gardens Primary School
H10 - Golborne and Maxilla Children's Centre Forest School
H11 - Grenfell Creche Under 3s' Centre / Grenfell Nursery
H12 - New Studio pre-school
H13 - St Quintin Children and Family centre
H14 - Longstone Avenue allotments
H15 - St Quintin Community Kitchen Garden
H16 - St Charles Centre for Health and Wellbeing
H17 - Equal People
H18a - Nottingwood House
H18b - Portland Road Community Kitchen Garden
H19 - The Grove
H20 - Eynham Road railway land
H21 - Hurstway, Grenfell, Testerton and Barandon Walks (Lancaster Walkways)
H22 - Henry Dickens Court
H23 - Silchester East
H24 - Allom House and Barlow House
H25a - Morland House
H25b - Talbot Grove House
H26 - Bramley House
H27 - Kensington Memorial Park
H28 - Treadgold House
H29 - Verity Close
H30 - Little Wormwood Scrubs Including Adventure Playground
H31 - Darfield Way
H32 - Lancaster Green
H33 - Robinson House
H34 - Wesley Square
H35 - Silchester West (North and North-West area)
H36 - Maxilla Walk - Maxilla Hall / Maxilla Green
H37 - Stonebridge Recreation Ground
H38 - Wormwood Scrubs
H39 - Tower Cordon
H40 - Waynflete Square
H41 - Communal Open Space at Camelford Walk
H42 - Avondale Park
H43 - Communal Space at Avondale Park
H44 - West London Bowling Club
H45 - St Quintins Roundabout
H46 - Stage 1 & 2 Average Benzo(a)pyrene Concentrations Indicative Plume Extent

Appendix I – Asbestos Identification in Soil Figures

I1 - Burlington Danes School
I2 - Thomas Jones Primary School
I3 - Oxford Gardens Primary School
I4 - Golborne and Maxilla Children's Centre Forest School
I5 - Grenfell Creche Under 3s' Centre / Grenfell Nursery
I6 - St Quintin Gardens
I7 - Equal People
I8 - Portland Road
I9 - Hurstway, Grenfell, Testerton and Barandon Walks (Lancaster Walkways)
I10 - Bramley House
I11 - Treadgold House
I12 - Darfield Way
I13 - Lancaster Green
I14 - Robinson House
I15 - Wesley Square
I16 - Silchester West (North and North-West area)
I17 - Maxilla Walk - Maxilla Hall / Maxilla Green
I18 - Tower Cordon
I19 - Waynflete Square
I20 - West London Bowling Club
I21 - Sampling Areas where Asbestos Detected with Indicative Plume Extent

Appendix J – Quantitative Risk Assessment

Table J1 to J45. GQRA Data Screening Tables – Individual Sampling Areas

Table J46. GQRA Data Screening Table – All Stage 1 and Stage 2 Data

- Asbestos Assessment
- Chloromethane GSC Derivation CLEA Model
- Schools Land-use Scenario and CLEA Model GSC Derivation
- CLEA Models for SSAC Derivations

Appendix K – Laboratory Information

- Sampling Chains of Custody (Fera and Element)
- Fera PAH Uncertainty Data (provided by Fera)
- Comparison of Fera and Element Data
- Laboratory Certificates
  - Fera certificates
  - Element Stage 1 re-issued data including carbon disulphide
  - Element lead in root zone soil certificates
  - Element soil certificates batches 1 – 21
  - Element bioaccessibility certificates
- Data Validation Summary Report

Appendix L – Envirocheck Reports

- Envirocheck 259484194
- Envirocheck 259487084

- *Envirocheck 244506740 is in Appendix C Data Gap Analysis memorandum*
- *Envirocheck 244510776 is in Appendix C Data Gap Analysis memorandum*