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Grenfell Investigation into Potential Land Contamination Impacts

Technical Note 13: Potential Source Contributions to Urban Soil Pollution

Royal Borough of Kensington and Chelsea

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1. Introduction

This technical note presents the scope, methodology, results and conclusions of the desk-based Evidence Review (ER) of the potential contributing sources of identified contaminants of potential concern (COPC) in urban soils in support of the assessment of potential sources of COPC in soils in the area around Grenfell Tower, London, UK.

2. Methodology

The ER was completed in accordance with the Quick Scoping Review (QSR) approach described in AECOM's technical note (TN) presenting the protocol for the ER (TN2: Protocol for evidence reviews). The protocol for the QSR of potential sources of COPC in urban soils is reproduced below as **Table TN13-01**.

Table TN13-01. ER Protocol for QSR of sources of urban soil pollution

Protocol Element	Protocol Adopted
Background rationale:	Requirement to understand the potential contributing sources to reported concentrations of fire effluent chemicals in urban soils.
Objective:	Identify the potential contributing sources for urban soil pollution for the priority chemicals identified by the fire chemistry evidence review.
Scope:	Focus on identification of common sources of urban soil pollution, including air pollution. Limited to English language only. Limited to studies from year 2000 onwards.
Method: Search keywords	Urban, soil, pollutant, contaminant, concentration, background, air.
Method: Search strategy	Published reports from UK government organisations and other institutions: Defra, Environment Agency, Health Protection Agency (HPA)/Public Health England (PHE), and United Nations Environment Programme (UNEP). Google Scholar search using Boolean search terms constructed from the keywords above. PubMed search as per Google Scholar search. Research Gate search as per above.
Method: Inclusion and exclusion criteria	Exclude data before 2000.
Method: Information extraction	Initial extraction from abstract only. Selection of full papers had been based on the results of the first phase screening. Information had been recorded as per the evidence template.
Information synthesis	Included: Descriptive characteristics of evidence identified. A narrative synthesis of the evidence.

Whilst drafting this TN the following changes were made to the initial ER protocol presented in Table 1:

- Additional search terms were added based on the results of the fire products review and initial search results for this QSR.
- If too many irrelevant search results were produced, or the search keywords listed above gave no results, extra search keywords were added, or Boolean search terms and advanced search features of search engines were used to aid the search. Search terms and results are presented in **Appendix TN13-A**.

- The Natural Environment Research Council's document on-line publication database (NERC Open Research Archive (NORA)) was added to the list of search tools. The same search method was used for this portal as for other search locations.
- In some searches on GOV.UK the results were filtered to only display results from relevant organisations (Environment Agency, Defra and PHE).
- The original format of **Appendix TN13-B** was modified to indicate if a reference was taken forward to more detailed review. If not, a reason was given in an adjacent column in this table.
- Preference was given to existing review articles or publications that collated or summarised other sources.

3. Review Questions

The primary question to be answered by this ER was:

- What are the likely or common sources of the reported soil concentrations in London or UK soils for the COPCs identified by the fire chemistry evidence review?

Whilst the primary question references 'concentrations of COPC in London and UK soils', the review presented in this TN (TN13: Potential source contributions to urban soil pollution) has focused on source identification. The review of evidence of measured concentrations of COPC in London and UK soils is presented in TN9 (Published data on national and regional urban background soil concentrations).

The review presented in TN13 is closely related to, and supported by, the ER presented in TN9, TN7 (COPC fate & transport in the environment), TN10 (Local baseline data on soil concentrations of COPC) and TN12 (Spatial mapping of historic and current land uses). Whilst reference is made to these documents in the following sections, the reader should consult these TN for more details.

4. Results

The search of published UK surveys, open source data from UK government organisations and on-line databases identified 80 individual references for further screening. These searches are listed in **Appendix TN13-A**, appended to this technical note. The individual references are presented in **Appendix TN13-B**.

The selected search results were then reviewed in more detail to obtain a summary or overview of the information presented on potential sources of COPC in urban soil. The results of this second level of screening are presented in **Appendix TN13-B**, appended. Based on review of these summaries of search results, 19 individual references were selected for more detailed review.

Each of the selected search results were then reviewed to assess if it contained relevant information to answer the primary question of this ER. The pertinent information from this third level of screening is presented in **Appendix TN13-C**, appended to this technical note. Key data on sources of urban soil pollution were taken from these sources and are summarised below.

4.1 Types of Potential COPC Sources

Discussion of potential sources of COPC identified in TN04 (Fire Chemistry and Identification of COPC) are presented in the following sections. To aid this, an overall framework for describing sources of urban soil pollutants was sought.

(Mirsal, 2008), describes three potential sources of urban soil pollutants: power/energy generation, transportation; and waste disposal. However, it is noted that this discussion focused on sources or activities associated with urban environments and that the point of release of pollutants to soils may not necessarily be within the urban area, e.g. disposal of waste at landfills or incineration sites outside the urban areas where waste is produced.

(Meuser, 2010), identifies a series of pollutant sources in an urban environment that could affect soils:

- Natural sources:
  - Diffuse, extensive sources associated with parent geological materials;
- Anthropogenic sources:
  - Diffuse, extensive sources associated with dust deposition from industrial emissions plus combustion of fuels;
  - Diffuse linear sources associated with road or rail transportation, flooding or utility networks;
  - Point sources associated with contaminated land due to past or current land use;
  - Point sources associated with management of vegetated areas.

Potential for diffuse contamination due to parent geological materials, or dust deposition, are reviewed in relation to specific groups of COPC in the text, below.

Of the linear, diffuse sources listed above, transportation is considered a more likely potential source for the current study than flooding or utility networks, given the presence of roads such as the A40 Westway or A3220 West Cross Route, plus railways, within the area of interest[1]. Contaminant sources related to road transportation include emissions from vehicle exhausts, plus tyre abrasion, followed by deposition of atmospheric particulates, plus release of fuel, lubricants or de-icing salts to ground (Mirsal, 2008) (Meuser, 2010).

The site is located in a medium to high risk zone for surface water flooding[2]; however, there are currently no known, reported occurrences of flooding from surface water, sewers or drains. The site is located within a zone with low probability of fluvial flooding[3] with the nearest area of higher risk located over 1 km to the southwest. Overall, floods are not expected to have led to extensive deposit of COPC on soils within the area of interest compared to what might be anticipated from road or rail transportation. Inputs from utility networks are of more concern as a source of dissolved-phase contamination to underlying soils.

The potential for the point sources to pollute urban soils should be assessed based on the specific environmental setting and history of the area, including the location, and type of current or historical industrial sites and on the history of land in-filling or levelling of ground using waste materials. Point sources associated with contaminated land due to past or current land use have been reviewed in TN10 (Local baseline data on soil concentrations of COPC) and TN12 (Spatial mapping of historic and current land uses) and these TN should be reviewed in conjunction with TN13.

Pollutants associated with management of vegetated areas could include pesticides and fertilizers (Meuser, 2010). These are not identified COPC (see **Section 4.9** for further details). Areas of public open space and private gardens are present within the study area.

4.2 Metals

The UK Soil and Herbage Survey (UKSHS) (Ross, et al., 2007) found that in the UK, there were significant differences between metal concentrations detected in rural[4], urban[5] and industrial[6] soils, with mean values for many metals in urban/industrial soils up to three times those to in rural soils. Overall, the UKSHS results suggest that urban areas may be a notable source of metals in soils. Background concentrations of trace and major elements in urban soils (including metals) are summarised in Table TN09-02 of TN9 (Published data on national and regional urban background soil concentrations).

[1] Area of interest is located within 500 m radius of the site.
[2] https://flood-warning-information.service.gov.uk/long-term-flood-risk/map, accessed 02 July 2019 (surface water).
[3] https://flood-map-for-planning.service.gov.uk/confirm-location?easting=523870&northing=180890, accessed 16 May 2019. (Also: Flood map for Rivers and Seas); Landmark Datasheet, Order Number: 209140267_1_1 Date: 27-Jun-2019 (groundwater, sea, rivers,);
[4] All other areas not categorised as industrial, urban, semi-urban (areas that abut urban centres and/or are 25 % urbanised/built up; normally up to 3 km outside the urban core) or semi-rural (area within a small town or village; a small town is assumed to be 3–20 km^2 in area and a village < 3 km^2 in area). Rural areas are considered to be predominantly agricultural land or undeveloped countryside.
[5] An area which is ≥90 % urbanised/built up. A conurbation may be formed when a large town and city merge. Urban areas include large towns (20–50 km^2 in area) and cities (> 50 km^2 in area).
[6] A site dominated by some form of industry.

Anthropogenic sources of the UKSHS metals to the environment noted by (Ross, et al., 2007) vary for specific metals but commonly included burning of wood and fossil fuels, industrial processes such as metal smelting and processing, sewage sludge disposal to land, plus waste incineration and disposal to land. However, distinct urban sources of the metals detected in soils were not discussed in the UKSHS report.

Assessment of natural inputs requires consideration of what metals might be associated with a particular parent material and whether this would be evident when compared to inputs from anthropogenic sources. For example, the mean lead concentration in urban soils in the UKSHS data was higher than in rural soils (110 mg/kg compared to 52.6 mg/kg) (Ross, et al., 2007). However, the range for urban soils was smaller than the range for rural soils (8.6-387 mg/kg compared to 2.6-713 mg/kg).The greater maximum levels reported in rural soils are due to the presence of underlying, parent geological material which contain elevated levels of metals.

Metals from anthropogenic sources are discussed below.

Sources of air pollution and dust deposition across urban areas include industry and burning of fossil fuels (Meuser, 2010). This evidence discusses how a rural to urban gradient of increasing metal concentrations in soil with increasing proximity to the centre of urban areas may be observed, due to greater proximity to multiple pollution sources. However, the urban overall ‘signature’ described by this evidence is interpreted as the combination of inputs from various sources that include those such as industry or transportation, which are discussed in more detail below.

Review of evidence collated during this QSR identified the following in relation to metals in urban soils resulting from road transportation:

- (Meuser, 2010) notes that the concentration of heavy metals in soil decreases with increasing distance from traffic (road) and with increasing soil depth. This source states that emissions, like car exhaust, from main traffic arteries may be assumed to cause soil contamination at adjacent sites up to a distance of 100 m;
- (Ross, et al., 2007) state that although studies show that the bulk of soil lead contamination from vehicle emissions does not extend significantly further than 30 m from a road, elevated soil background lead levels indicate that at least a proportion of lead aerosols emitted from vehicles can be carried over much longer distances;
- Lead contamination of roadside soils also persists in spite of the lead reduction in petrol, since lead is relatively immobile and consequently it can remain in topsoil over decades (Mirsal, 2008). The transport and fate of lead to and within soil is assessed further in TN7 (COPC fate & transport in the environment);
- (Ross, et al., 2007) also note that since the reduction in use of lead in petrol, atmospheric lead levels have decreased, but soil concentrations are still high in places where traffic has been heavy in the past; and
- Soil samples taken from major cities in Norway, namely Oslo, Bergen and Trondheim showed accumulation of mercury, lead and zinc in soils near main roads. (Meuser, 2010)

Railway land may also act as a linear source of soil pollution. For the area of concern, this possible source has been assessed in the accompanying TN10 (Local baseline data on soil concentrations of COPC) and TN12 (Spatial mapping of historic and current land uses).

Potential point sources for metals associated with historical land use in the area of concern have been assessed in the accompanying TN10 and TN12. They include railway land, iron works (220 m north-east and 320 m south-west of the Grenfell Tower Site), dye works (350 m south-west of the Site), printing works (250 m south-west of the Site), engineering works (120 m north-east and 300 m north-west), and motor repair works (250 m north-west) and metal works (250 m north-west), plus fill materials.

4.3 Polycyclic Aromatic Hydrocarbons (PAH)

These compounds are present in the environment as by-products of incomplete combustion processes. This may be due to natural events, such as forest fires, or anthropogenic activities, such as vehicle emissions or waste incineration (Earl, et al., 2003) Although there are measurable emissions of PAHs from natural sources, the majority of the PAHs released to the environment arise from anthropogenic sources; in addition emissions of PAHs to the environment during their manufacture are considered to be negligible relative to combustion sources (Earl, et al., 2003).

(Creaser, et al., 2007a), estimated that around 2000, the main anthropogenic PAH sources in the UK were:

- Combustion in energy production;
- Combustion at commercial and residential properties;
- Combustion at industrial sites;
- Non-ferrous metal processing (primarily aluminium production);
- Solvent use; and
- Road transport.

This evidence also reported that the emissions from combustion at commercial and residential properties and road transport represented over 80% of total UK PAH emissions to the environment (air, water and soil). PAH sources associated with road transport are primarily vehicle exhaust emissions, particularly from diesel engines (Meuser, 2010).

(CL:AIRE, 2014) report potential sources of PAHs in UK soils to include:

- Atmospheric deposition of combustion particles;
- Fuel oil (diesel, heating or lube oil);
- Ash and clinker fill from industrial processes;
- Coal tar from gasworks;
- Industrial processing of oil and coal tar derivatives; and
- Asphalt.

Most transfer of atmospheric PAH to soils occurs through aerial deposition, either through dry deposition of gas or particles direct to the ground surface, or wet deposition via wash out of entrained gas and particles (Creaser, et al., 2007a). The transport and fate of PAHs to and within soil is assessed further in TN7 (COPC fate & transport in the environment).

The UKSHS assessment of PAHs in UK soils identified that median concentrations of PAHs detected in urban and industrial soils were up to eight times greater than those in rural soils (Creaser, et al., 2007a) indicating urban and industrial areas to be significant sources of PAHs. However, the proportion of individual PAHs did not differ significantly between urban and rural soils suggesting that the actual sources may not differ greatly even if quantities do. Apportioning concentrations from specific sources based on profiles of PAHs in soils was complicated by changes in relative proportions of PAHs between emission source and deposition into soil due to differences in chemical properties, rates of atmospheric reactions or advective mixing. The difficulties in source apportionment may make it problematic to assign PAHs to the framework of diffuse and point sources identified by (Meuser, 2010) and referenced in the preceding section on types of pollutant source.

Whilst apportioning PAH in soils to specific sources may be difficult, variations in the presence of specific, individual PAHs between different types of emissions may help to assess sources. This includes:

- Motor vehicle traffic. Diesel-fuelled vehicles emit naphthalene and acenaphthene and petrol-fuelled vehicles emit predominantly fluoranthene and pyrene (Earl, et al., 2003);
- (Creaser, et al., 2007a) suggest that if road traffic and domestic/commercial fuel combustion do constitute approximately 80% of PAH emissions in the UK, this should be reflected in significant proportions of acenapthylene, acenaphthene, fluorene, phenanthrene and benzo(ghi)perylene in emissions;
- Combustion of wood or coal for residential heating and cooking. The main PAHs released are phenanthrene, fluoranthene, pyrene and chrysene (Earl, et al., 2003);

- Aluminium, iron and steel production in plants and foundries. Although little actual data are available on emissions from these facilities, their high energy demands mean that significant emissions of PAHs may be from associated energy production such as burning of coal or oil (Earl, et al., 2003). The review of potentially contaminated land use presented in TN10/TN12 reported historical iron works 220 m north-east and 320 m south-west of the Grenfell Tower Site.

(Vane, et al., 2014) considered source apportionment for the PAHs detected in London soils between petrogenic[7] or pyrogenic[8] processes. This was based on both proportions of specific PAHs and also on PAH isomeric ratios. This evidence source noted that:

- Overall, the soils were dominated by four to six ring PAHs which were considered to indicate production by burning fossil fuels. This was based on higher detected concentrations PAHs such as fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenzo[a,h]anthracene and benzo[g,h,i]perylene, which suggest a pyrogenic origin;
- Low concentrations of alkylated PAHs (e.g. 1-methylnaphthalene (1-MN), 2-methylnaphthalene (2-MN)) relative to other PAH suggested that non-combusted petroleum fuels were not a likely source of the detected PAHs, with petrogenic sources expected to give greater ratios of alkylated PAHs relative to parent compounds. In comparison, incomplete combustion of pyrogenic sources such as coal tar and creosote would be expected to yield parent PAH in greater proportions than their alkylated equivalents;
- Use of isomeric plots comparing ratios of phenanthrene/anthracene to fluroanthene/pyrene, plus benzo[a]anthracene/(benzo[a]anthracene + chrysene) to fluoranthene /(fluoranthene + pyrene) suggested a pyrogenic or a coal/gas/wood combustion source of the PAHs detected in soils. However, comparison of benzo[g,h,i]perylene to benzo[a]pyrene did not provide evidence of ratios greater than 3.14, the threshold indicative of vehicle exhaust emissions previously proposed by (Creaser, et al., 2007a).
- Low concentrations of 1-MN and 2-MN relative to other PAH suggests that non-combusted petroleum sources (e.g. fugitive diesel spills) are an unlikely source (Vane, et al., 2014). However, weathering processes such as leaching (solubilisation), evaporation/volatilisation and biodegradation can modify PAH distribution. For example, it has been shown that parent PAH and low molecular weight PAHs are more susceptible to microbial degradation than alkylated PAH and high molecular weight compounds (Vane, et al., 2014).

The discussion above identifies burning of fossil fuels (coal or gas) for heating or road transportation to be the principal sources of PAHs. This suggests PAHs to be associated with extensive diffuse sources, or linear diffuse sources. Background concentrations of PAHs in urban soils are summarised in Table TN09-03 of TN9 (Published data on national and regional urban background soil concentrations).

PAHs might also result from specific current and historical industrial land use, or in-filling of ground. Potential point sources of PAHs in the area of interest are identified in the accompanying TN10 (Local baseline data on soil concentrations of COPC) and TN12 (Spatial mapping of historic and current land uses). Potential point sources for PAHs associated with historical land use in the area of concern include railway land, breweries (280 m to the east and 250 m south-west) of the Grenfell Tower Site, engineering works (120 m north-east and 300 m north-west), and motor repair works (250 m north-west) and metal works (250 m north-west), plus fill materials.

4.4 Dioxins and Furans

Dioxins and furans are by-products of certain industrial, chemical processes involving chlorine or chlorinated compounds or of combustion processes (Creaser, et al., 2007b). They are not manufactured intentionally other than for research purposes.

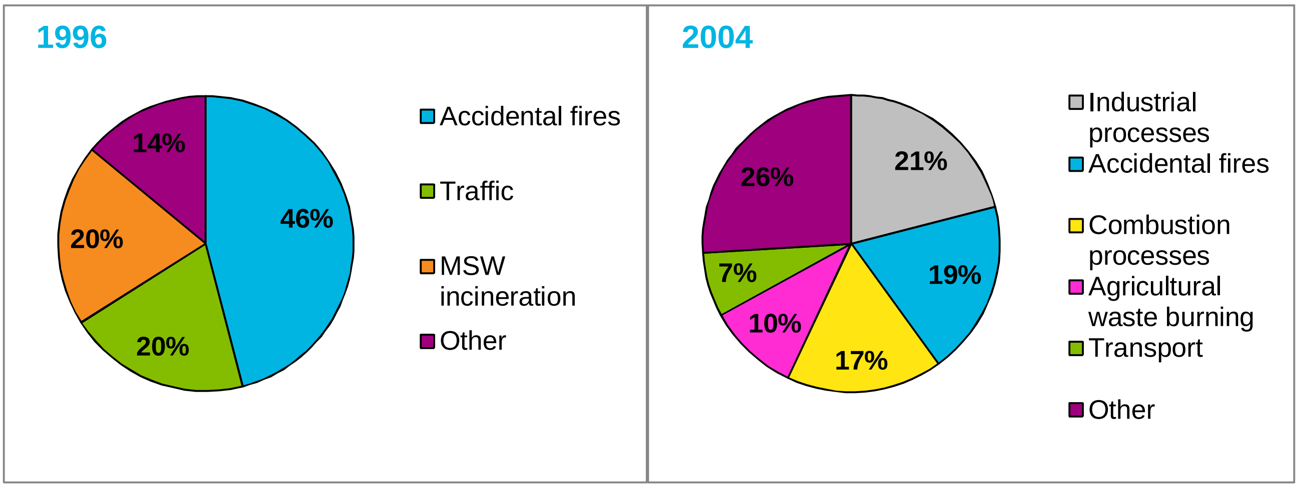
In reporting the UKSHS results, the authors considered their soil results to integrate inputs during at least the last 10–30 years (Creaser, et al., 2007b). Over this period, land use was identified as the key factor influencing dioxin levels in UK soils. Median concentrations in urban and industrial soils measured by the UKSHS were up to three times those in rural soil, implying greater historical sources

[7] PAHs present naturally in crude oil and coal
[8] PAHs formed by incomplete combustion or heating of organic materials, including fossil fuels

of dioxins in urban and industrial areas. However, dioxin reduction initiatives and removal of point sources from urban areas were thought to have since decreased inputs such that current inputs to urban soils will be lower than historical levels.

The main sources of dioxin emission identified in inventories of UK emissions in 1996 and 2004 are presented in **Figure TN13-01** (Creaser, et al., 2007b). Total emissions of dioxins to atmosphere are reported to have decreased by over 70% during the 1990s before stabilising in the 2000's.

Figure TN13-01. Dioxin Sources



MSW: municipal solid waste

Of the sources identified in **Figure TN13-01**, traffic/transport is likely to have been the most relevant to the area of concern at the time these inventories were compiled.

Congener/homologue profiles observed in the UKSHS data were broadly similar across rural, urban and industrial sites suggesting that source congener signatures were lost relatively quickly following emission due to atmospheric weathering and the mixing in air masses over the UK (Creaser, et al., 2007b). The UKSHS found that Hepta-CDD/Fs and OCDD/F dominate the soil profiles (Creaser, et al., 2007b). Background concentrations of dioxins and furans in urban soils are summarised in Table TN09-05 of TN9 (Published data on national and regional urban background soil concentrations). The transport and fate of dioxins and furans to and within soil is assessed further in TN7 (COPC fate & transport in the environment).

Whilst the UKSHS provides an overall range of dioxins in urban soils in the UK, it notes that point sources were historically the key contributors to total emissions, but the numbers of these have decreased (Creaser, et al., 2007b). However, based on the diffuse and point sources framework proposed by (Meuser, 2010) sources in urban soils could be classed as diffuse (traffic, or widespread aerial deposition from a point sources such as waste incineration or extensive fossil fuel combustion) as well as more specific, localised point sources (accidental fires, industrial process). For the latter source type, TN10 (Local baseline data on soil concentrations of COPC) and TN12 (Spatial mapping of historic and current land uses) identifies industrial processes related to former joinery/woodworking sites (300 m west of the site) as a potential source of dioxins and furans in the area of interest.

4.5 Isocyanates

No information describing potential sources of isocyanates in urban soils has been identified using the adopted search methodology.

The transport and fate of isocyanates to and within soil is assessed in TN7 (COPC fate & transport in the environment).

4.6 Synthetic Vitreous Fibres

No information describing potential sources of synthetic vitreous fibres (SVF) in urban soils has been identified using the adopted search methodology. SVF, specifically glass and rock wool, are used for thermal and acoustic insulation and fire protection in buildings, machinery and electrical installations and can also be used as a growing media or for soil conditioning and as anti-vibration insulation mats for railways and tram tracks (International Agency for Research on Cancer, 2002).

4.7 Asbestos

No information concerning potential sources of asbestos in urban soils was identified using the agreed search methodology. However, there is an unpublished research project to establish typical background levels of dispersed asbestos fibres in urban and rural soils funded by DEFRA. No results from this project have been reported up to this date (Department for Environment Food and Rural Affairs, 2015).

TN10 (Local baseline data on soil concentrations of COPC) and TN12 (Spatial mapping of historic and current land uses) identified asbestos as a potential contaminant associated with the majority of historical land uses found in the area of interest. (Nathanail, et al., 2014) reported that Historical waste management and demolition practice has resulted in asbestos-containing materials (ACMs) being potentially present in the soil or made ground at any brownfield site. ACMs may have been buried on site intact, broken up and mixed with other demolition wastes, and also potentially imported on site as a contaminant in recycled aggregates/made ground materials. Asbestos cement wastes were also used to improve paths and farm tracks on otherwise greenfield sites. Given the widespread historic use of asbestos in buildings and many household and commercial/industrial products in the UK until it was banned in 1999, its presence in the ground can also be the result of the weathering of asbestos products used on the external fabric of buildings, debris created by the refurbishment of buildings, and the everyday use of products such as car brake linings (Virta, 2002) (PHE, 2017) (WHO IPCS, 1986).

4.8 Volatile Organic Compounds

The volatile organic compounds (VOCs) encompass a wide range of halogenated and non-halogenated, aliphatic and mono-aromatic compounds. The accompanying TN on fire chemistry (TN4) identified benzene as a component of fire effluents and as an indicator compound for VOCs.

Benzene can occur naturally in crude oil and be generated from forest fires. (Earl, et al., 2003), although releases from natural sources are stated to be limited compared to anthropogenic inputs (Environment Agency, 2009). It is found collectively in petroleum and petroleum products such as gasoline and individually as feedstocks in chemicals, paint and pharmaceuticals production (Earl, et al., 2003). Historically, benzene was used widely as a solvent in manufacturing processes and also in consumer products (Environment Agency, 2009).

Benzene is often assessed collectively with toluene, ethyl benzene and xylenes due to contemporaneous release to, and co-occurrence in the environment (Earl, et al., 2003). These four analytes are commonly referred to as the BTEX compounds.

The presence of benzene (and other BTEX) in soils is attributed to anthropogenic releases. This can be due to point source pollution such as oil spills or diffuse contamination such as car exhaust (Earl, et al., 2003). Vehicle exhaust, particularly from diesel engines, contains benzene (Meuser, 2010). As such, benzene might be considered similar to the PAHs, for which the importance of road vehicle exhaust emission as a potential diffuse contaminant source is noted in the above sections on PAHs. The transport and fate of benzene to and within soil is assessed further in TN7 (COPC fate & transport in the environment).

The accompanying TN10 (Local baseline data on soil concentrations of COPC) and TN12 (Spatial mapping of historic and current land uses) identified potential point sources for BTEX compounds associated with historical land use, including railway land, dye works (350 m south-west of the of the Grenfell Tower Site), printing works (250 m south west of the Site), engineering works (120 m north-east and 300 m north-west), and motor repair works (250 m north-west).

4.9 Phosphorus Compounds

Phosphorus compounds, specifically organophosphorus compounds (OPs) were identified as COPC by TN04 (Fire Chemistry and Identification of COPC).

The individual OPs identified as COPC in TN04 are:

- 2-Propanol, 1-chloro-,2,2',2"-phosphate (TCIPP, previously known as TCPP);
- Phosphoric acid triphenyl ester (TPHP);
- Ethanol, 2-butoxy-,1,1',1"-phosphate (TBOEP, previously known as TBEP);
- Phosphoric acid tris(methylphenyl) ester (TMPP, previously known as TCP); and
- Phosphoric acid triethyl ester (TEP).

Sources of OPs may include (Wei, et al., 2014):

- Halogenated OPs are frequently used as fire retardants (FR), whilst non-halogenated OPs are primarily used as plasticisers;
- OPs are used as stabilisers for anti-foaming and as additives to lubricants, lacquers, floor polishes, as an antifoaming agent in concrete or as additives in hydraulic fluids, lubricants and motor oils;
- In addition, OPs are commonly found in building materials, soft foams, paints and wallpapers, acoustic ceiling coatings, polyurethane mattresses, electrical goods, curtains, electrical outlets, insulation boards wallpaper and building materials.

Use of OPs is noted to be increasing with the restriction and removal of brominated flame retardants and polychlorinated biphenyls (PCBs) (Wei, et al., 2014).

Of the OPs identified in TN04, TMPP (TCP) is used as a flame retardant in poly-vinyl chloride (PVC), various cellulose coatings and rubber products, plus as an additive in hydraulic fluids (Brooke, et al., 2009a).

TPHP is used as a flame retardant or plasticiser in various coatings, thermoplastics, rigid urethane foam and acetate films in materials such as computer casings, printed circuit boards and photo film, and also as a high pressure additive in lubricants and hydraulic fluids (Brooke, et al., 2009b).

Based on assessments of the emission potentials of OPs in different consumer products, releases of OPs from materials, from vehicles and from e-waste recycling activities have been identified as the dominant sources of OPs in indoor and external environments (Wei, et al., 2014).

There are limited data describing the occurrence of OPs in soil (Wei, et al., 2014). However, this evidence concluded that, based on the available studies, severe contamination of soils by OPs was explained by point source emissions whereas lower concentrations of OPs in soils resulted from atmospheric deposition. TMPP (tricresyl phosphate) was identified as the most common OP from point sources in soil in these studies (linked to hydraulic fluids and plastic film), along with TPHP (triphenyl phosphate; from hydraulic fluids) whereas the atmospheric pollutants identified were TCIPP (tris(2-chloroisopropyl) phosphate), TCEP (tris(2-chloroethyl) phosphate), plus TPHP.

Concentrations of OPs in outdoor air have been noted to be greater in urban areas than in rural areas (Wei, et al., 2014). Road traffic and vehicle exhaust gases were reported as significant sources of OPs in outdoor air in studies referenced by this evidence, and this may be due to the use of OPs in engine oil. The most commonly detected OPs in the studies of outdoor air in urban areas cited in this evidence were TBOEP (tris(2-butoxyethyl) phosphate), TCIPP and TDCPP (tris(1,3-dichloro- 2-propyl) phosphate).

(Brooke, et al., 2009a) and (Brooke, et al., 2009b) provide values for release of TMPP and TPHP to the environment (air, water and soil compartments), however, these are based on estimates at local, regional or continental scales rather than measurement in the environment (although the evidence does not define these scales). The estimates presented in these studies assume that loss of particulates from plastic materials to be the main mechanism for release of TMPP and TPHP to soil. The transport and fate of selected OPs to and within soil is assessed further in TN7 (COPC fate & transport in the environment).

The sources of OPs outlined above indicate that they could be widespread in the modern urban environment and are associated with diffuse sources including road transportation. The accompanying TN10 (Local baseline data on soil concentrations of COPC) and TN12 (Spatial mapping of historic and current land uses) did not identify OPs as potential contaminants associated with specific historical land uses. However, based on the evidence reviewed above, localised, elevated concentrations of OPs in soil might be expected with point sources where high levels of OP emissions have taken place, e.g. use or disposal of hydraulic oil, lubricants or engine oil.

Whilst organophosphate pesticides could be present in vegetated areas (e.g. gardens, public open space), they have not been considered in TN13 as they were not identified as a COPC in TN04 (Fire Chemistry and Identification of COPC).

4.10 Hydrogen Cyanide and Cyanides

Sources of cyanide in air, that could affect soils, include (Jaszczak, et al., 2017):

- Combustion of fuels in vehicle engines as a result of catalytic reduction of nitrogen oxides;
- Chemical manufacturing and metal processing;
- Municipal solid waste incinerators;
- Fires at domestic and industrial properties;
- Combustion of polyurethanes, acrylonitrile, and polyamide plastics, and combustion of wool and silk;
- Volatilization from cyanide wastes disposed of in landfills and waste ponds; and
- Production of coke or other coal carbonization procedures.

The reviewed evidence did not provide data on likely deposition of aerial cyanides to soil. However, some of the sources listed above might be widespread and diffuse in urban environments including combustion of fuels by vehicles and, historically, combustion or fires at domestic and industrial properties. The transport and fate of hydrogen cyanide to, and within soil is assessed further in TN7 (COPC fate & transport in the environment).

The accompanying TN10 (Local baseline data on soil concentrations of COPC) and TN12 (Spatial mapping of historic and current land uses) identified historical ironworks (220 m north-east and 320 m south-west of the Grenfell Tower Site) as a potential point source of cyanides.

4.11 Brominated Fire Retardants

Polybrominated diphenyl ethers (or PBDE) and hexabromocyclododecane (HBCDD) are anthropogenic substances that are added to building materials, automotive parts, plastics, textiles, foam furnishings and electronic equipment as flame retardants (Muresan, et al., 2010). Penta- and octa-BDE consumer products were banned in Europe in 2003, and globally under the UNEP Stockholm Convention (SC) in 2009. Furthermore, significant restrictions have been put on deca-BDE consumer products since 2008 (Drage, et al., 2016).

In soil samples collected in the Paris area by (Muresan, et al., 2010), BDE-209 was predominant in superficial soils followed by BDE-47 and BDE-99. A significant increase of the concentration of BDE-209 was observed in urban areas compared to surrounding rural or forested areas, whereas BDE-47 and BDE-99 concentrations remained relatively stable. This suggested that the different PBDE congeners either originated from different urban sources or exhibited different geochemical behaviours such as trapping and mobilisation. (Muresan, et al., 2010) also noted that particulates[9] accounted for the majority of the atmospheric PBDEs and dry deposition of these (the direct impact of gas and particles on plant and soil surfaces) was identified as the principal pathway for PBDEs to transfer from the atmosphere to soils.

(Drage, et al., 2016) reported a distinct urban signature in PBDEs in soils collected along a transect through the Birmingham conurbation at locations with differing levels of urbanisation. Those sites closest to the city centre displayed the highest concentrations of PBDEs, compared to those in outlying areas, consistent with the results of PBDE air quality monitoring at the same locations. BDE-209 was the principal PBDE detected in soils, along with lower levels of BDE-47 and BDE-99. This was thought to reflect history of use and atmospheric degradation of different congeners.

[9] Particles collected by (Muresan, et al., 2010) are assumed to be < 0.7 µm due to reported filter pore size in this Evidence.

The collected evidence suggests an urban, diffuse source for brominated fire retardants. Background concentrations of selected PBDEs in urban soils are summarised in Table TN09-06 of TN9 (Published data on national and regional urban background soil concentrations).

The accompanying TN10 (Local baseline data on soil concentrations of COPC) and TN12 (Spatial mapping of historic and current land uses) has not identified these substances as potential pollutants from the historical land uses present in the area of interest. The transport of brominated fire retardants to, and fate within soil is assessed further in TN7 (COPC fate & transport in the environment).

5. Conclusions

The likely or common anthropogenic sources of the COPCs identified by the fire chemistry evidence review in London or UK soils for are summarised in **Table TN13-02**. This has used the framework to describe urban soil contamination source proposed by (Meuser, 2010). The results of this QSR show that many of the overall classes of COPC are likely to be ubiquitous in the urban environment. However, the occurrence and proportion of specific compounds and congeners may be used to assess inputs from possible sources.

This evidence review was not able to locate relevant information for the other priority chemicals identified in the fire chemistry evidence review: isocyanates and synthetic vitreous fibres.

Table TN13-02. Potential contributing sources of urban soil pollution for identified COPC

	Metals	PAHs	Dioxins and furans	Isocyanates	Synthetic vitreous fibres	Asbestos	VOCs	Organo-phosphorus compounds	Cyanides	Brominated fire retardants
Diffuse, extensive Aerial deposition associated with urban land use, including industrial emissions and combustion of fuels	✓	✓	✓	-	-	✓	X	✓	✓	✓
Diffuse, linear Transportation, specifically exhaust from road traffic	✓	✓	✓	-	-	-	✓	✓	✓	X
Point source Contaminated land due to past or current land use or in-filling of ground*	✓	✓	✓	-	-	✓	✓	-	✓	-
Point source Management of vegetated areas	X	X	X	-	-	X	X	X	X	X

✓: ER indicates a potential contributing source

X: ER indicates not a potential contributing source

-: No evidence found by ER

*: Further details provided in TN10 (Local baseline data on soil concentrations of COPC) and TN12 (Spatial mapping of historic and current land uses).

6. Reference List

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Appendix TN13-A. Evidence Record - Search Summaries

A. Evidence Record - Search Summaries

Search number	Keyword(s) / word string	Date of Search	Search tool / origin or other tracing information	Hyperlink to origin (URL)	Number of search hits	Number of hits screened	Number of hits taken forward to review (Table B)
1	urban soil concentration	24.04.2019	GOV.UK	https://www.gov.uk/search?q=urban+soil+concentration	11131	100	0
2	"soil contamination"	24.04.2019	GOV.UK	https://www.gov.uk/search?q=%22soil+contamination%22	13	13	0
3	soil contamination (Organization = EA)	24.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=soil+contamination+&level_one_taxon=&manual=&organisations%5B%5D=environment-agency&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	309	100	3
4	background concentration	24.04.2019	GOV.UK	https://www.gov.uk/search?q=background+concentration	19523	100	0
5	urban AND soil AND pollutant AND contaminant AND concentration AND background	24.04.2019	GOV.UK	https://www.gov.uk/search/all?keywords=urban+AND+soil+AND+pollutant+AND+contaminant+AND+concentration+AND+background+&order=relevance&page=4&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=	28427	100	0
6	"air pollution"	24.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=%22air+pollution%22&level_one_taxon=&manual=&organisations%5B%5D=environment-agency&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	29	29	1
7	pollution source	24.04.2019	GOV.UK	https://www.gov.uk/search/all?keywords=Pollution+source&order=relevance&page=5&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=	22817	100	0
8	atmospheric "soil"	24.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=%22atomospheric%22+AND+%22soil%22&level_one_taxon=&manual=&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	3438	100	0
9	"atmospheric" (Organization = DEFRA)	24.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=%22Atmospheric%22+&level_one_taxon=&manual=&organisations%5B%5D=department-for-environment-food-rural-affairs&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	51	51	4
10	"atmospheric" (Organization = EA)	24.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=%22atmospheric%22&level_one_taxon=&manual=&organisations%5B%5D=environment-agency&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	34	34	0
11	"deposition" (Organization = EA)	24.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=%22deposition%22&level_one_taxon=&manual=&organisations%5B%5D=environment-agency&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	105	105	0
12	pollution source (Organization = EA)	24.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=pollution+source&level_one_taxon=&manual=&organisations%5B%5D=environment-agency&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	2520	100	0

A. Evidence Record - Search Summaries

Search number	Keyword(s) / word string	Date of Search	Search tool / origin or other tracing information	Hyperlink to origin (URL)	Number of search hits	Number of hits screened	Number of hits taken forward to review (Table B)
13	pollution source (Organization = DERFA)	24.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=pollution+source&level_one_taxon=&manual=&organisations%5B%5D=department-for-environment-food-rural-affairs&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	1083	100	3
14	atmospheric (Organization = PHE)	24.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=atmospheric&level_one_taxon=&manual=&organisations%5B%5D=public-health-england&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	33	33	1
15	"soil" "urban" (Organization = PHE)	24.04.2019	GOV.UK	https://www.gov.uk/search/all?keywords=%22soil%22+%22urban%22&order=relevance&organisations%5B%5D=public-health-england&page=2&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=	143	100	0
16	"pollution" (Organization = PHE)	24.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=%22pollution%22&level_one_taxon=&manual=&organisations%5B%5D=public-health-england&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	55	55	0
17	"contamination" (Organization = PHE)	24.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=%22contamination%22&level_one_taxon=&manual=&organisations%5B%5D=public-health-england&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	174	100	0
18	Dioxin source soil	24.04.2019	GOV.UK	https://www.gov.uk/search/all?keywords=Dioxin+source+soil&order=relevance	18012	100	0
19	dioxin	25.04.2019	GOV.UK	https://www.gov.uk/search/all?keywords=dioxin&order=relevance	21	21	1
20	furan	25.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=furan&level_one_taxon=&manual=&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	8	8	0
21	PAH	25.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=PAH&level_one_taxon=&manual=&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	16	16	2
22	Benzene	25.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=Benzene&level_one_taxon=&manual=&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	33	33	1
23	Isocyanate	25.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=Isocyanate&level_one_taxon=&manual=&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	7	7	0

A. Evidence Record - Search Summaries

Search number	Keyword(s) / word string	Date of Search	Search tool / origin or other tracing information	Hyperlink to origin (URL)	Number of search hits	Number of hits screened	Number of hits taken forward to review (Table B)
24	"hydrogen cyanide"	26.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=Hydrogen+cyanide&level_one_taxon=3cf97f69-84de-41ae-bc7b-7e2cc238fa58&level_two_taxon=&manual=&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	2	2	0
25	asbestos	26.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=Asbestos&level_one_taxon=3cf97f69-84de-41ae-bc7b-7e2cc238fa58&level_two_taxon=&manual=&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	59	59	0
26	"Synthetic vitreous fibre"	26.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=%22Synthetic+vitreous+fibre%22&level_one_taxon=3cf97f69-84de-41ae-bc7b-7e2cc238fa58&level_two_taxon=&manual=&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	0	0	0
27	"Phosphate"	26.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=%22Phosphate%22&level_one_taxon=3cf97f69-84de-41ae-bc7b-7e2cc238fa58&level_two_taxon=&manual=&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	36	36	1
28	Organochlorine pesticide	26.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=%22Organochlorine+pesticide%22&level_one_taxon=3cf97f69-84de-41ae-bc7b-7e2cc238fa58&level_two_taxon=&manual=&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	3	3	0
29	Aldehyde	26.04.2019	GOV.UK	https://www.gov.uk/search/all?parent=&keywords=%22Aldehyde%22&level_one_taxon=3cf97f69-84de-41ae-bc7b-7e2cc238fa58&level_two_taxon=&manual=&public_timestamp%5Bfrom%5D=&public_timestamp%5Bto%5D=&order=relevance	1	1	0
30	atmospheric pollution Region: Europe	24.04.2019	UNEP	https://www.unenvironment.org/search/node?keys=atmospheric+pollution	5	5	0
31	air pollution "urban" "London" "soil"	24.04.2019	Google Scholar	https://scholar.google.co.uk/scholar?q=%22air+pollution%22+%22urban%22+%22London%22+%22soil%22&hl=en&lr=&as_sdt=0%2C5&as_ylo=2000&as_yhi=	52800	140	6
32	contaminant AND "urban" AND "source" AND "united kingdom" AND "soil"	24.04.2019	Google Scholar	https://scholar.google.co.uk/scholar?hl=en&lr=&as_sdt=0%2C5&as_ylo=2000&q=%22contaminant%22+AND+%22urban%22+AND+%22source%22+AND+%22united+kingdom%22+AND+%22soil%22&btnG=	14100	100	5
33	"contaminant source" "urban" "soil" "UK"	24.04.2019	Google Scholar	https://scholar.google.co.uk/scholar?hl=en&lr=&as_sdt=0%2C5&as_ylo=2000&q=%22contaminant+source%22+%22urban%22++%22soil%22+%22UK%22&btnG=	972	100	2

A. Evidence Record - Search Summaries

Search number	Keyword(s) / word string	Date of Search	Search tool / origin or other tracing information	Hyperlink to origin (URL)	Number of search hits	Number of hits screened	Number of hits taken forward to review (Table B)
34	contamination source "soil" "Urban"	24.04.2019	Google Scholar	https://scholar.google.co.uk/scholar?hl=en&as_sdt=0%2C5&q=%22contamination+source%22+%22soil%22+%22Urban%22&btnG=	4460	100	7
35	dioxin AND "contamination source" "soil" "Urban"	24.04.2019	Google Scholar	https://scholar.google.co.uk/scholar?hl=en&as_sdt=0%2C5&q=%22dioxin%22+AND+%22contamination+source%22+%22soil%22+%22Urban%22&btnG=	351	100	1
36	benzene AND "contamination source" "soil" "Urban"	24.04.2019	Google Scholar	https://scholar.google.co.uk/scholar?start=40&q=%22Benzene%22+AND+%22contamination+source%22+%22soil%22+%22Urban%22&hl=en&as_sdt=0,5	734	100	2
37	Isocyanate AND "contamination" "soil" "Urban" "source"	24.04.2019	Google Scholar	https://scholar.google.co.uk/scholar?start=100&q=%22Isocyanate%22+AND+%22contamination%22+%22soil%22+%22Urban%22+%22source%22&hl=en&as_sdt=0,5	1210	100	2
38	Hydrogen cyanide AND "contamination" AND "soil" AND"Urban"AND "source" post 2000	24.04.2019	Google Scholar	https://scholar.google.co.uk/scholar?hl=en&as_sdt=0%2C5&q=%22Hydrogen+cyanide%22+AND+%22contamination%22+AND+%22soil%22+AND%22Urban%22AND+%22source%22&btnG=	2380	100	3
39	asbestos AND "contamination" AND "soil" AND "Urban "AND "source"	25.04.2019	Google Scholar	https://scholar.google.co.uk/scholar?hl=en&as_sdt=0%2C5&as_ylo=2000&q=%22asbestos%22+AND+%22contamination%22+AND+%22soil%22+AND%22Urban%22AND+%22source%22&btnG=	9650	100	2
40	"Synthetic vitreous fibres" AND "contamination" AND "soil" AND"Urban"AND "source"	25.04.2019	Google Scholar	https://scholar.google.co.uk/scholar?hl=en&as_sdt=0%2C5&as_ylo=2000&q=%22Synthetic+vitreous+fibres%22+AND+%22contamination%22+AND+%22soil%22+AND%22Urban%22AND+%22source%22&btnG=	14	14	0
41	Phosphate AND "contamination" AND "soil" AND"Urban"AND "source" AND "diffuse"	25.04.2019	Google Scholar	https://scholar.google.co.uk/scholar?hl=en&as_sdt=0%2C5&as_ylo=2000&q=%22Phosphate%22+AND+%22contamination%22+AND+%22soil%22+AND%22Urban%22AND+%22source%22+AND+%22diffuse%22&btnG=	15100	100	5
42	Organochlorine pesticide AND "contamination" AND "soil" AND "Urban" AND "source" AND "diffuse"	25.04.2019	Google Scholar	https://scholar.google.co.uk/scholar?hl=en&as_sdt=0%2C5&as_ylo=2000&q=%22Organochlorine+pesticide%22+AND+%22contamination%22+AND+%22soil%22+AND%22Urban%22AND+%22source%22+AND+%22diffuse%22&btnG=	653	100	1
43	Aldehydes AND "contamination" AND "soil" AND "Urban" AND "source" AND "diffuse"	25.04.2019	Google Scholar	https://scholar.google.co.uk/scholar?hl=en&as_sdt=0%2C5&as_ylo=2000&q=%22Aldehydes%22+AND+%22contamination%22+AND+%22soil%22+AND%22Urban%22AND+%22source%22+AND+%22diffuse%22&btnG=	1990	100	3

A. Evidence Record - Search Summaries

Search number	Keyword(s) / word string	Date of Search	Search tool / origin or other tracing information	Hyperlink to origin (URL)	Number of search hits	Number of hits screened	Number of hits taken forward to review (Table B)
44	urban AND soil AND pollutant AND contaminant AND concentration AND background (All)	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=urban+AND+soil+AND+pollutant+AND+contaminant+AND+concentration+AND+background+&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle&_action_search=Search	0	0	0
45	pollution source	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=pollution+source&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	15	15	4

A. Evidence Record - Search Summaries

Search number	Keyword(s) / word string	Date of Search	Search tool / origin or other tracing information	Hyperlink to origin (URL)	Number of search hits	Number of hits screened	Number of hits taken forward to review (Table B)
46	Dioxin soil source (All)	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=Dioxin+soil+source&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	0	0	0
47	Dioxin soil	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=dioxin+soil&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	0	0	0
48	soil contamination	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=soil+contamination&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	3	3	0

A. Evidence Record - Search Summaries

Search number	Keyword(s) / word string	Date of Search	Search tool / origin or other tracing information	Hyperlink to origin (URL)	Number of search hits	Number of hits screened	Number of hits taken forward to review (Table B)
49	diffuse pollution	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=diffuse+pollution&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	28	28	5
50	Benzene AND soil	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=benzene+AND+soil+&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	0	0	0
51	PAH AND soil	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=PAH+AND+soil+&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	9	9	1

A. Evidence Record - Search Summaries

Search number	Keyword(s) / word string	Date of Search	Search tool / origin or other tracing information	Hyperlink to origin (URL)	Number of search hits	Number of hits screened	Number of hits taken forward to review (Table B)
52	Dioxin and soil	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=Dioxin+AND+soil+&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	0	0	0
53	Furan AND soil	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=furan+AND+soil+&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	0	0	0
54	Isocyanate	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/facet/archive/simple2?screen=XapianSearch&dataset=archive&order=&q=isocyanate	11	11	0

A. Evidence Record - Search Summaries

Search number	Keyword(s) / word string	Date of Search	Search tool / origin or other tracing information	Hyperlink to origin (URL)	Number of search hits	Number of hits screened	Number of hits taken forward to review (Table B)
55	Hydrogen cyanide	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ANY&title=Hydrogen+cyanide&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	15	15	0
56	Asbestos AND soil AND urban (in abstract)	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=Asbestos+AND+soil+AND+urban&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	1	1	1

A. Evidence Record - Search Summaries

Search number	Keyword(s) / word string	Date of Search	Search tool / origin or other tracing information	Hyperlink to origin (URL)	Number of search hits	Number of hits screened	Number of hits taken forward to review (Table B)
57	Synthetic vitreous fibres AND soil (in abstract)	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=Synthetic+vitreous+fibres+AND+soil&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	0	0	0
58	Phosphate AND soil AND urban (in abstract)	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=Phosphate+AND+soil+AND+urban&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	3	3	0

A. Evidence Record - Search Summaries

Search number	Keyword(s) / word string	Date of Search	Search tool / origin or other tracing information	Hyperlink to origin (URL)	Number of search hits	Number of hits screened	Number of hits taken forward to review (Table B)
59	Organochlorine pesticide (in abstract)	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=Organochlorine+pesticide&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle&_action_search=Search	27	27	0
60	Title matches "soil" AND Abstract/Summary matches "aldehyde"	25.04.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&_action_search=Search&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=&date=&id_number=&publication_merge=ALL&publication=soil&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=aldehyde&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle	0	0	0
61	source AND soil AND contamination AND urban	25.04.2019	WHO	https://apps.who.int/iris/discover?scope=%2F&query=source+AND+soil+AND+contamination+AND+urban&submit=&filtertype_0=subject&filter_relational_operator_0=equals&filter_0=Environmental+exposure	174	100	3
62	(((source) AND contaminant) AND urban) AND soil	24.04.2019	PubMed	https://www.ncbi.nlm.nih.gov/pubmed?term=(((source)%20AND%20contaminant)%20AND%20urban)%20AND%20soil	27	27	1
63	((((source) AND atmospheric) AND contamination) AND soil) AND UK	24.04.2019	PubMed	https://www.ncbi.nlm.nih.gov/pubmed?term=((((source)%20AND%20atmospheric)%20AND%20contamination)%20AND%20soil)%20AND%20UK	11	11	0
64	((((particle) AND air) AND urban) AND soil) AND contamination	24.04.2019	PubMed	https://www.ncbi.nlm.nih.gov/pubmed?term=((((particle)%20AND%20air)%20AND%20urban)%20AND%20soil)%20AND%20contamination	21	21	3

A. Evidence Record - Search Summaries

Search number	Keyword(s) / word string	Date of Search	Search tool / origin or other tracing information	Hyperlink to origin (URL)	Number of search hits	Number of hits screened	Number of hits taken forward to review (Table B)
65	"contaminant source" "urban" "soil" "UK" "diffuse"	25.04.2019	ResearchGate	https://www.researchgate.net/search.Search.html?type=publication&query= "contaminant source" "urban" "soil" "UK" "diffuse"&subfilter[publication Type]=article	?	100	0
66	diffuse pollution "urban" "soil"	25.04.2019	ResearchGate	https://www.researchgate.net/search.Search.html?type=publication&query="diffuse pollution" "urban" "soil"	?	100	0
67	pollution source atmospheric soil	25.04.2019	ResearchGate	https://www.researchgate.net/search.Search.html?type=publication&query=pollution source atmospheric soil	?	100	1
68	"Isocyanate" AND "soil"	13.05.2019	PubMed	https://www.ncbi.nlm.nih.gov/pubmed/?term=%22Isocyanate%22+AND+%22soil%22	14	14	0
69	"Isocyanate" AND "soil"	13.05.2019	ResearchGate	https://www.researchgate.net/search.Search.html?type=publication&query=%22isocyanate%22%20AND%20%22soil%22%20&subfilter[publicationType]=article	42	42	0
70	organophospho	01.07.2019	GOV.UK	https://www.gov.uk/search/all?keywords=organophospho&order=relevance	0	0	0
71	organophosphate AND "contamination" AND "soil" AND"Urban"AND "source" AND "diffuse"	01.07.2019	Google Scholar	https://scholar.google.co.uk/scholar?hl=en&as_sdt=0,5&q=organophosphate+AND+%22contamination%22+AND+%22soil%22+AND%22Urban%22AND+%22source%22+AND+%22diffuse%22	2760	100	9
72	"Organophosphate AND soil AND urban (in abstract)	02.07.2019	NERC	http://nora.nerc.ac.uk/cgi/search/archive/advanced?screen=Search&dataset=archive&creators_editors_merge=ALL&creators_editors=&creators_name_merge=ALL&creators_name=&title_merge=ALL&title=&date=&id_number=&publication_merge=ALL&publication=&series_merge=ALL&series=&divisions_merge=ANY&refereed=EITHER&documents_merge=ALL&documents=&keywords_merge=ALL&keywords=&abstract_merge=ALL&abstract=Organophosphate+AND+soil+AND+urban&subjects_merge=ANY&rod_collaborations_merge=ANY&affiliations_merge=ALL&affiliations=&sections_merge=ANY&grant_nos_merge=ALL&grant_nos=&projects_merge=ALL&projects=&programmes_merge=ANY&gtr_progs_merge=ANY&res_grps_merge=ANY&department_merge=ALL&department=&lastmod=&datestamp=&satisfyall=ALL&order=-date%2Fcreators_name%2Ftitle&_action_search=Search	0	0	0

Appendix TN13-B. Evidence Record - Summary of Evidence Identified

B. Evidence Record - Summary of Evidence Identified

Evidence Number	Evidence Reference	Evidence hyperlink (if available)	Evidence Type	Corresponding search number	Taken forward	Reason for rejection	Brief summary of evidence available from source number
1	Earl, N. et al., 2003. Review of the Fate and Transport, s.l.: Environmental Agency.	https://www.gov.uk/government/publications/review-of-the-fate-and-transport-of-selected-contaminants-in-the-soil-environment	Publication	3,8	Yes		A critical review of the available data on the fate and transport behaviour of a number of contaminants.
2	Environment Agency, 2007, Soil and Herbage Survey	https://www.gov.uk/government/publications/uk-soil-and-herbage-pollutant-survey	Publication	3	Yes		Series of reports presents the first national survey of soil quality. Includes volumes about heavy metals, PAHs, PCBs, dioxins and furans.
3	Environment Agency, 2005, Indicators for land contamination	https://www.gov.uk/government/publications/indicators-for-land-contamination	Publication	3,19	No	Only Methodology	This report describes the work undertaken to populate indicators for chemical and radiological land contamination for England and Wales.
4	Environment Agency,2006, UK air pollutants: key facts and monitoring data	https://www.gov.uk/government/publications/uk-air-pollutants-key-facts-and-monitoring-data	Publication	6	No	No mention of soil contamination, report is exclusively on small fine particulates in air	Digest of ambient air-quality monitoring data in the UK for 143 pollutants, with other key information for the 51 most important pollutants.
5	DEFRA, 2013, Air quality and emissions statistics	https://www.gov.uk/government/collections/air-quality-and-emissions-statistics	Publication	9,13	No	No mention of soil contamination, report is exclusively on small fine particulates in air	Series contains National Statistics on the emission and concentrations of major air pollutants such as power stations, road transport, household heating, agriculture and industrial processes.
6	DEFRA, 2012, Emissions of air pollutants	https://www.gov.uk/government/statistics/emissions-of-air-pollutants	Publication	9,13	No	No mention of soil contamination, report is exclusively on small fine particulates in air	This publication covers UK emissions of sulphur dioxide, nitrogen oxides, non-methane volatile organic compounds, ammonia and particulate matter.
7	DEFRA, 2012, Fine particulate matter (PM2.5) in the UK	https://www.gov.uk/government/publications/fine-particulate-matter-pm2-5-in-the-uk	Publication	9,13	No	No mention of soil contamination, report is exclusively on small fine particulates in air	This report gives an overview of the evidence base for PM2.5 in the UK. The report challenges the robustness of the evidence for making future policy decisions in respect of PM2.5 in the UK context. There is an analysis of the evidence concerning key relevant aspects including PM2.5 measurement and the composition and current concentrations of PM2.5 across the UK, as well as source emissions and receptor modelling for PM2.5. Finally, AQEG evaluates the methods for modelling PM2.5 and what can be said about future concentrations.
8	DEFRA,2009, UK emissions of Air Pollutants: 2009 results	https://www.gov.uk/government/news/uk-emissions-of-air-pollutants-2009-results	Publication	9	No	Indirect relevance: Air pollution rather than soil	National Statistics contains 2009 results from the National Atmospheric Emissions Inventory (NAEI) for UK emissions.
9	PHE,2018, Health matters: air pollution	https://www.gov.uk/government/publications/health-matters-air-pollution	Publication	14	No	Not soil and focused on human health	Guidance focuses on air pollution and discusses how local authorities, supported by national policies, have an important role in assessing and improving local air quality - and how the cumulative effects of local action can be significant.
10	UNE, 2017, Revealed: Every Londoner is exposed to dangerous toxic air particles	https://www.unenvironment.org/news-and-stories/press-release/revealed-every-londoner-exposed-dangerous-toxic-air-particles#_ftn1	Press release	38	No	One page press release to the public, no scientific information	The research, based on the latest updated London Atmospheric Emissions Inventory, also shows that 7.9 million Londoners – nearly 95 per cent of the capital's population – live in areas of London that exceed the guidelines by 50 per cent or more.
11	Kukkonen,2005, Analysis and evaluation of selected local-scale PM10 air pollution episodes in four European cities: Helsinki, London, Milan and Oslo	https://www.sciencedirect.com/science/article/pii/S1352231005001615	Publication	31	No	Focuses on meteorological effects on air pollution	Research analysed in detail four episodes involving high concentrations of PM10 that occurred in Oslo on 4–10 January 2003, in Helsinki on 3–14 April 2002, in London on 18–27 February 2003 and in Milan on 14–19 December 1998 and utilised a more extensive dataset containing relevant information regarding 21 episodes from seven cities in six countries.
12	Crilley,2017, Source apportionment of fine and coarse particles at a roadside and urban background site in London during the 2012 summer ClrfLo campaign	https://www.sciencedirect.com/science/article/pii/S0269749116304833	Publication	31	No	No mention of soil contamination, report is exclusively on small fine particulates in air.	Analysed trace elemental composition of the fine and coarse fraction at hourly time resolution at urban background (North Kensington, NK) and roadside (Marylebone Road, MR) sites within central London. Current study focuses on measurements during the summer providing a snapshot of contributing sources, utilising the high time resolution to improve source identification. Conclusion: roadside enrichment was observed for a large number of elements associated with traffic emissions (Al, S, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, As, Rb and Zr).Elements from more regional sources (e.g. Na, Cl, S and K) were not found to have an appreciable increment.

B. Evidence Record - Summary of Evidence Identified

Evidence Number	Evidence Reference	Evidence hyperlink (if available)	Evidence Type	Corresponding search number	Taken forward	Reason for rejection	Brief summary of evidence available from source number
13	Rimmer,2006, Metal contamination of urban soils in the vicinity of a municipal waste incinerator: One source among many	https://www.sciencedirect.com/science/article/pii/S0048969705002329	Publication	31	No	Sufficient information about dioxins and furans is available from other sources	Concern from local residents about possible contamination with metals and PCDD/F (dioxins and furans) from fugitive and stack emissions from the Byker municipal solid waste incinerator in Newcastle upon Tyne led the City Council to initiate a study of the concentration of these pollutants in soils for the metals and arsenic.
14	Yang,2009, Decline in atmospheric mercury deposition in London	https://pubs.rsc.org/en/content/articlelanding/2009/em/b904952e/unauth#!divAbstract	Publication	31	No	Only air pollution and lead	Bulk atmospheric deposition samples were continuously collected using a standard IVL-type mercury (Hg) bulk deposition collector from January 1999 to December 2005 in order to monitor Hg deposition in London.
15	Harrad, Concentrations of polybrominated diphenyl ethers in air and soil on a rural− urban transect across a major UK conurbation	https://pubs.acs.org/doi/abs/10.1021/es0606879	Publication	31	No	No sources mentioned in abstract	Polybrominated diphenyl ethers (PBDEs) were measured in air (using PUF disk passive samplers) and soil samples taken at approximately monthly intervals over 1 year at 10 locations on a transect across the West Midlands of the UK.
16	Nwachukwu, 2008,Contaminant source as factor of soil heavy metal toxicity and bioavailability to plants	https://www.researchgate.net/profile/Olayinka_Nwachukwu/publication/325404999_Contaminant_source_as_factor_of_soil_heavy_metal_toxicity_and_bioavailability_to_plants/links/5b0c83da4585157f871cb650/Contaminant-source-as-factor-of-soil-heavy-metal-toxicity-and-bioavailability-to-plants.pdf	Publication	32	No	Botanical study, not relevant for sources of soil pollution	Mine waste and sewage sludge treated soil were used as contaminants in a greenhouse pot experiment and the effect of the contaminants on ryegrass growth, soil metal levels and plant metal uptake was evaluated over a period of 16 weeks. Soils were amended with bone meal, compost, peat, coir or lime phosphate and amendments led to immobilization of Pb, Cu and Zn.
17	Drage, 2016, Concentrations of legacy and emerging flame retardants in air and soil on a transect in the UK West Midlands	https://www.sciencedirect.com/science/article/pii/S0045653516300339	Publication	32	Yes		Passive air samples were collected for 6 months from 8 sites along a transect of Birmingham, United Kingdom between June 2012 and January 2013. Soil samples were collected once at each site. Includes values from average concentrations of BDE-209, ΣPBDEs17and ΣPBDEs.
18	Godri,2011, Increased oxidative burden associated with traffic component of ambient particulate matter at roadside and urban background schools sites in London	https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0021961	Publication	32	No	Only dust particulates no mention of soil	Passive air samples were collected monthly for 6 months from 8 sites along a transect of Birmingham, United Kingdom between June 2012 and January 2013. Soil samples were collected once at Each site. Average concentrations of BDE-209, ΣPBDEs17:183 and ΣPBDEs in ambient air were 150, 49, and 180 pg m−3, respectively.
19	Johnson, 2012,Mapping the chemical environment of London, UK: an important contribution to understanding national levels of normal background contaminant concentrations	http://nora.nerc.ac.uk/id/eprint/18818/	Poster	32	No	Poster, 'source' is not mentioned in the abstract	London Earth study: Results demonstrate a strong geological control on element distributions with significant anthropogenic modifications in many areas for some elements. The urban baseline information generated to determine normal background concentrations of contaminants in soil.
20	Baker and Hites, 2000, Is Combustion the Major Source of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans to the Environment? A Mass Balance Investigation	https://pubs.acs.org/doi/abs/10.1021/es9912325	Publication	32	No	This source refers to a global review and mass balance of PCDD/F rather than on specific processes in urban soils	Summarises some of the significant work characterizing polychlorinated dibenzo-p-dioxin and dibenzofuran (PCDD/F) sources and sinks to and from the atmosphere. Research focused on estimating emissions from combustion sources and comparing those estimates to atmospheric deposition measurements.
21	Mellor,2001, Lead and zinc in the Wallsend Burn, an urban catchment in Tyneside, UK	https://www.sciencedirect.com/science/article/pii/S0048969700008111	Publication	33	No	Only Pb, Zn, other papers provide broader overview.	This paper examines lead and zinc concentrations in topsoil's and stream sediments of public access areas in an urban catchment in Tyneside, UK. It examines the extent and severity of metal contamination, explores spatial patterns in relation to urban and industrial development, and makes inferences about potential metal mobility.
22	Fordyce, 2003,Urban soils geochemistry and GIS-aided interpretation: a case study from Stoke-on-Trent	http://nora.nerc.ac.uk/id/eprint/7018/	Publication	33	No	Focused only on Stoke-on-Trent	Case study from Stoke-on-Trent: The presentation of urban geochemical data, both within the urban area and in relation to rural geochemical data and the possible controls on soil geochemistry and distributions of chemical elements in the area

B. Evidence Record - Summary of Evidence Identified

Evidence Number	Evidence Reference	Evidence hyperlink (if available)	Evidence Type	Corresponding search number	Taken forward	Reason for rejection	Brief summary of evidence available from source number
23	Prevedouros, 2004, Modelling the atmospheric fate and seasonality of polycyclic aromatic hydrocarbons in the UK	https://www.ncbi.nlm.nih.gov/pubmed/15172593	Publication	62	No	Focuses on seasonal trend not sources of contamination	This paper presents the results from an exercise in atmospheric contaminant fate modelling, which had three main objectives : to investigate the balance between estimated national atmospheric emissions of six selected PAHs and observed ambient measurements for the UK; to investigate the potential influence of seasonally dependent environmental fate processes on the observed seasonality of air concentrations; and make inferences about the likely magnitude of seasonal differences in sources. The study also suggests that the contributions of inefficient, diffusive combustion processes (e.g. domestic coal/wood burning) may be underestimated as a source of the toxicologically significant higher molecular weight species in the winter.
24	Mazzei, 2008, Characterization of particulate matter sources in an urban environment	https://www.ncbi.nlm.nih.gov/pubmed/18486189	Publication	23,39	No	Foreign study (i.e. study area not considered similar to UK urban environments) but discusses contribution of specific sources of particulate matter concentration in the atmosphere	Study presents study results for the urban area of Genoa (Italy) based on several hundred of PM10, PM2.5 and PM1 daily samples collected in sites with different geo-morphological and **urbanization characteristics** ,sampled at different sites and obtained the average and stable values for the tracers of specific sources, in particular traffic (Cu, Zn, Pb) and heavy oil combustion (V, Ni). Study identifies and quotes the contamination of anthropogenic PM in "natural" sources (sea, soil dust).
25	Dordevic, 2014, Trace elements in size-segregated urban aerosol in relation to the anthropogenic emission sources and the resuspension.	https://www.ncbi.nlm.nih.gov/pubmed/24859696	Publication	64	No	These elements are not part of chemicals identified in the fire chemistry review.	PCA analysis has shown that main contribution is of resuspension followed by traffic that are together contributing around 50 % of elements in the investigated urban aerosol. The EF model shows that major origin of Cd, K, V, Ni, Cu, Pb, Zn, and As in the fine mode is from the anthropogenic sources while increase of their contents in the coarse particles indicates their deposition from the atmosphere and soil contamination.
26	Muresan et al., 2010, Fate and spatial variations of polybrominated diphenyl ethers in the deposition within a heavily urbanized area case of Paris (France).	https://www.ncbi.nlm.nih.gov/pubmed/20729584	Publication	64	Yes	Foreign study (i.e. study area not considered similar to UK urban environments), but assess the influence of different pollution sources resulting in changes in the composition of soil samples	Study present the first results on the geochemical cycle of Polybrominated Diphenyl Ethers (or PBDE) in the Paris Region (France). It provides information about the distribution and mobility of eight PBDE congeners by determining the level of contamination of different environmental compartments: i.e. atmosphere, soils and waters. Atmospheric PBDE deposition was estimated from a site located in the centre of Paris. Surface soils (0-10 cm) were collected from multiple wooded, rural and urban locations through the Paris Region (12,000 km²). Gained results showed that in the superficial soils the highest concentrations of highly brominated congeners were measured in the vicinity of the most urbanized areas whereas less brominated congeners were widespread in the whole Paris Region.
27	Weiss,2006, Distribution of lead in urban roadway grit and its association with elevated steel structures.	https://www.ncbi.nlm.nih.gov/pubmed/16793117	Publication	64	No	Foreign study (i.e. study area not considered similar to UK urban environments) and focused on urban roadway grit, not soil	Study investigated the concentration of lead in roadway grit along major thoroughfares in New York City and in certain areas under elevated steel structures supporting elevated rails. It revealed the presence of high concentrations of lead in roadway grit under elevated steel structures. The differences in the concentration of lead in roadway grit under steel structures in comparison to areas in NYC not near elevated rails was statistically significant.
28	Szynkowska,2009, Toxic Metal Distribution in Rural and Urban Soil Samples Affected by Industry and Traffic	http://www.pjoes.com/Toxic-Metal-Distribution-in-Rural-and-Urban-Soil-r-nSamples-Affected-by-Industry,88338,0,2.html	Publication	34,41	No	Foreign study (i.e. study area not considered similar to UK urban environments) assessing the influence of different pollution sources resulting in changes in the composition of soil samples	This study was undertaken to determine the impact of industrial activities and traffic emissions on metal concentrations in soil samples and the waste products. The major goal of the work was to assess the influence of different pollution sources resulting in changes in the composition of soil samples collected from Łódź city (central Poland, urban area) and the outskirts of Gdansk city (northern Poland, rural area affected by industry).
29	Douay,2007, Contamination of Urban Soils in an Area of Northern France Polluted by Dust Emissions of Two Smelters	https://link.springer.com/article/10.1007/s11270-007-9541-7	Publication	34	No	Foreign and too specialised setting	The contamination of 27 urban topsoil's has been assessed around two lead and zinc smelters (Metaleurop Nord and Unicode) in the North of France. The comparison of the studied element concentrations in urban soils with nearby local agricultural values shows that the dust emission originating from the Metaleurop and Unicode smelters were not the only source of contamination. Thus a large contamination of the studied urban soils by Sb and In could be explained by domestic combustion of coal for heating.
30	Ma,2018, Contamination source apportionment and health risk assessment of heavy metals in soil around municipal solid waste incinerator: A case study in North China	https://www.sciencedirect.com/science/article/pii/S0048969718307678	Publication	34	No	Foreign study (i.e. study area not considered similar to UK urban environments) and too specialised (incinerator)	In this study, 8 elements (Cr, Pb, Cu, Ni, Zn, Cd, Hg, and As) in fly ash, soil samples from different functional areas and vegetables collected surrounding the MSWI in North China were determined...The source apportionment results showed that MSWI, natural source, industrial discharges and coal combustion were the four major potential sources for heavy metals in the soils, with the contributions of 36.08%, 29.57%, 10.07%, and 4.55%, respectively.

B. Evidence Record - Summary of Evidence Identified

Evidence Number	Evidence Reference	Evidence hyperlink (if available)	Evidence Type	Corresponding search number	Taken forward	Reason for rejection	Brief summary of evidence available from source number
31	Luo, 2008, Distribution and availability of arsenic in soils from the industrialized urban area Agency of Beijing, China	https://www.sciencedirect.com/science/article/pii/S0045653508003287	Publication	34	No	Foreign study (i.e. study area not considered similar to UK urban environments) and only industrial urban area	Concentrations of arsenic (As) were determined in soils of 5 industrial sites in an urban area of Beijing, China. Fifty seven typical surface soils were sampled to determine total concentrations of metals, pH and dissolved organic carbon (DOC).
32	Meuser, 2010, Causes of Soil Contamination in the Urban Environment	https://link.springer.com/chapter/10.1007/978-90-481-9328-8_3	Book chapter	34	Yes		This chapter gives information about all kinds of contaminant sources for soils in urban environments. The description is mainly focused on heavy metals but also a number of organic pollutants, e.g. petroleum hydrocarbons, PAH and PCB, are of concern. Urban-to-rural gradients, depth gradients and relations to urban and industrial land uses are discussed in association with dust deposition.
33	Sun, 2012, Polycyclic Aromatic Hydrocarbon (PAH) Contamination in the Urban Topsoil's of Shenyang, China	https://www.tandfonline.com/doi/abs/10.1080/15320383.2012.697937	Publication	34	No	Foreign study (i.e. study area not considered similar to UK urban environments) and there is sufficient information available about coal combustion/petroleum	Study of PAH concentrations in Tiexi. PAHs ratios indicated that the pollutants probably originated primarily from coal combustion and petroleum sources.
34	Qiao, 2010, Characterization of PAHs Contamination in Soils from Metropolitan Region of Northern China	https://link.springer.com/article/10.1007/s00128-010-0083-0	Publication	34	No	Foreign study (i.e. study area not considered similar to UK urban environments) but PAHs source: incomplete combustion of coal, biomass and petroleum	The study characterized the distribution, sources as well as carcinogenic potency of PAHs in surface soil from metropolitan region of northern China. Source analysis revealed that pyrogenic sources played a major role at the locations and pyrogenic PAHs were mainly from incomplete combustion of coal, biomass and petroleum.
35	Stogiannidis, 2014, Source Characterization of Polycyclic Aromatic Hydrocarbons by Using Their Molecular Indices: An Overview of Possibilities	https://link.springer.com/chapter/10.1007/978-3-319-10638-0_2	Publication	36	No	By source they mean molecular source not environmental	The Polycyclic Aromatic Hydrocarbons (PAHs or Polyaromatic hydrocarbons) have been extensively studied to understand their distribution, fate and effects in the environment .Our study deals with the parent compounds (without alkyl groups and/or heteroatoms), the alkyl PAHs (denoted as PAHn, with n referring to the number of methyl groups; see footnotes in Table 1), and certain heterocyclic sulphur PAHs (dibenzothiophenes).
36	Griffith, 2014, Contamination from Industrial Toxicants	https://link.springer.com/content/pdf/10.1007/978-3-642-41609-5_11-1.pdf	Book Chapter	37	No	Focuses on food receptor not soil	This chapter will focus on a few of the industrial pollutants commonly found in the world's food supply and the mechanisms associated with their transport throughout the various environmental compartments. In addition, this chapter intends to touch upon toxicological effects in humans and the detection of these contaminants in food and the environment, which include: heavy metals, radionuclides, polycyclic aromatic hydrocarbons (PAHs), chlorinated solvents, polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxin (PCDDs), polychlorinated dibenzofurans (PCDFs), and brominated flame retardants.
37	Fishbein, 1990, Sources, Nature and Levels of Air Pollutants	https://link.springer.com/chapter/10.1007/978-3-642-75906-2_2	Publication	37	No	Foreign study (i.e. study area not considered similar to UK urban environments) and abstract is too vague/ cannot tell if its relevant without purchasing the paper.	Describes data base compilation, around 2,800 atmospheric compounds were identified of which +300 have been bioassayed. Contains discussion about the introduction of toxicants into the atmosphere may be direct via the inadvertent or deliberate release from a particular mobile or stationary source, or indirectly by water or soil. Hazardous pollutants may be accidentally released into ambient air or via escape of raw materials or finished products at their manufacturing site (e.g., release of methyl isocyanate in Bohpal, India), or by a chemical spill resulting from a transportation mishap such as a truck, cargo train derailment and/or barge spillage or collision.
38	Mirsal, 2008, Sources of Soil Pollution	https://link.springer.com/chapter/10.1007%2F978-3-540-70777-6_7	Book chapter	38	Yes		General text about soil pollution sources that might be discrete point sources, or diffuse sources, and the pollution processes such as deliberate, or following an accident. Figure 7.1 summarises the main sources of soil pollution.
39	Simeonova and Fishbein, 2004, Hydrogen Cyanide and Cyanides: Human Health aspects	https://apps.who.int/iris/bitstream/handle/10665/42942/9241530618.pdf	Chapter in publication	38	No	Only includes short section on contamination sources, Jaszczak is used instead.	Hydrogen cyanide sources of human and environmental exposure

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40	Jaszczak, Polkowska, Narkowicz & Namiesnik, 2017. Cyanides in the environment—analysis—problems and challenges. Environmental Science and Pollution Research, 24(19), pp. 15929-15948.	https://link.springer.com/article/10.1007/s11356-017-9081-7	Publication	41	Yes		The aim of this paper is to review the current state of knowledge on the behaviour of cyanide in the environment and its impact on human health.
41	Diamond, 2007, Urban contaminant dynamics: from source to effect	https://pubs.acs.org/doi/pdf/10.1021/es072542n	Publication: Article	41	No	General text about contamination, Mirsal (38) used instead	Review the array of contaminants produced, retained and/ or released in urban areas in industrialised countries and their fate in the relation to the urban environment.
42	Testa, 2004, Sources of chromium contamination in soil and groundwater	https://books.google.co.uk/books?hl=en&lr=&id=DVdCqL9NbOcC&oi=fnd&pg=PA143&dq=%22asbestos%22+AND+%22contamination%22+AND+%22soil%22+AND%22Urban%22AND+%22source%22&ots=eiB0IPin0-&sig=z-YNfjUvdPaMDF98CUdrXJIdwoc#v=onepage&q&f=false	Book chapter	41	No	General text about Chromium sources, UKSHS (2) and 38 used instead	Chapter on Anthropogenic Sources of Chromium
43	Ferrier,2007 DIFFUSE POLLUTION - WHAT IS THE NATURE OF THE PROBLEM?	https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1747-6593.2005.tb00574.x	Publication	41	No	Abstract doesn't suggest its urban environment.	This paper considers recent developments in the understanding of diffuse pollution, its generation, transport and impacts. The relative importance of diffuse sources to total pollutant loading must be identified in order to develop appropriate strategies for management.
44	Meijer,2001, Polychlorinated naphthalene in UK soils: time trends, markers of source, and equilibrium status	https://pubs.acs.org/doi/abs/10.1021/es010071d	Publication	42	No	Not a chemical identified in the fire chemistry review	Significant ($p < 0.05$) increasing trends were observed for several congeners associated with combustion sources (CN-29, -51, -52/60, -54, and -66/67) suggesting that combustion related sources are more important now than they were in the past.
45	Charlesworth et al.,2018, Insights and Issues of Trace Elements Found in Streets and Road Dust	https://books.google.co.uk/books?hl=en&lr=&id=w3JyDwAAQBAJ&oi=fnd&pg=PA91&dq=%22Aldehydes%22+AND+%22contamination%22+AND+%22soil%22+AND%22Urban%22AND+%22source%22+AND+%22diffuse%22&ots=aguyf88VZm&sig=lyqWmJpGH9YPGCkUU9C_t-kzPpo#v=onepage&q&f=false	Book chapter	35	No	Road dust and trace elements are not the main aim of the study	Chapter considers sources, pathways, deposits and hazards associated with street and road dust.
46	Donner et al., 2009, Identifying and classifying the sources and uses of xenobiotics in urban environments	https://link.springer.com/chapter/10.1007/978-90-481-3509-7_2	Book chapter	35	No	Book title suggests it not soil but urban water cycle	Chapter provides a general introduction to the topic of substance source and use identification, highlighting the key differences between different types of sources (e.g. processes vs. commodities; natural vs. anthropogenic etc.) and different types of uses (e.g. active vs. passive; dispersive vs. non-dispersive, etc.). Examples of relevant classification systems and their applications are also given, and the diversity of potential xenobiotic sources and uses is clearly demonstrated through the description of a series of 'archetypes' (i.e. model examples).
47	Fenger, 2009, Urban air pollution	https://books.google.co.uk/books?hl=en&lr=&id=2_lSPQtBBPsC&oi=fnd&pg=PA243&dq=%22Aldehydes%22+AND+%22contamination%22+AND+%22soil%22+AND%22Urban%22AND+%22source%22+AND+%22diffuse%22&ots=XTsvTh7YuK&sig=p7pVbT8gtQvHuAK3a4BRlofFWG8#v=onepage&q&f=false	Publication	35	No	Possibly Africa, Sub Sahara environment	Book chapter about, urban contaminants, pollutants and sources
48	Giandon,2015, Soil Contamination by Diffuse Inputs	https://www.researchgate.net/publication/283876776_Soil_Contamination_by_Diffuse_Inputs	Publication	36	No	Abstract doesn't suggest its urban environment	The interaction of diffuse inputs with the soil and water systems and with their uses and functions has many uncertain aspects but it is certainly a potential source of soil contamination. The two main pathways for diffuse contaminant accumulation in soil are atmospheric deposition and agricultural practices. Two key issues can be defined: Diffuse contamination by heavy metals and by persistent organic pollutants.

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49	Khan,2018, Polluted Soils	https://www.researchgate.net/publication/324913264_Polluted_Soils	Publication	67	No	Cannot identify the focus/ data/ region from abstract. Other evidence covers this material.	General summary of pollution sources: soils can be polluted with several organic and inorganic pollutants. Organic pollutants such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), polychlorinated naphthalene's (PCNs), polychlorinated dibenzodioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and other persistent organic substances. Inorganic pollutants mainly include heavy metals such as lead (Pb), cadmium (Cd), mercury (Hg), zinc (Zn), copper (Cu) and nickel (Ni), metalloid arsenic (As), and radioactive substances or radionuclides. The sources of soil pollutants are mainly anthropogenic. Point sources include municipal wastes, industrial wastes, medical wastes, agricultural wastes, composts and sludges, agrochemicals, domestic wastes and nuclear wastes. Organic and inorganic soil pollutants can be toxic to soil organisms, plants and animals.
50	Cave, 2016, Identification of the geochemical signatures of diffuse pollution in the Tellus Border soil data set, using source apportionment	http://nora.nerc.ac.uk/id/eprint/515926/	Publication	45,49	No	Focused on bog and peat hence no relevance to urban environment	Describes statistics used in Tellus Border, Ireland geochemical survey for peat bogs
51	Fordyce,2012, A case study to identify urban diffuse pollution in the Light Burn Catchment, Glasgow, UK. Stage 3 contribution to: Wade, R et al. (2013) A critical review Of urban diffuse pollution control: methodologies to identify sources, pathways and mitigation measures with multiple benefits. CRW2012/	http://nora.nerc.ac.uk/id/eprint/502913	Publication	45,49	No	Stream catchment in Glasgow	This report is the BGS contribution to Stage 3 of the CRW2012/1 Project 'A critical review of urban diffuse pollution control: Includes methodologies to identify sources, pathways and mitigation measures with multiple benefits'. A case study of a typical Scottish urban environment is presented. The report documents work to identify and characterise urban diffuse pollution sources and pathways in a case study stream catchment in Glasgow based on existing information. The findings of this report have been used to support the required research outputs for stages 1, 2 and 3 of the CREW project CRW2012/1.
52	Marchant,2011, The assessment of point-source and diffuse soil metal pollution in Swansea (Wales, UK) using robust geostatistical methods : a case study in Swansea (Wales, UK).	http://nora.nerc.ac.uk/id/eprint/14343/	Publication	45,49	No	Only 4 metals and in Swansea so may not be that applicable	Study analysed a survey of soil arsenic, copper, lead, and tin at 372 locations around Swansea (Wales, UK) to determine the natural metal concentrations in contaminated regions from the iron content.
53	Cave et al., 2012, Assessing the effect of urbanisation on diffuse pollution in English soils	http://nora.nerc.ac.uk/id/eprint/18906/	Unpublished conference paper	49	No	A page long Unpublished conference paper - little detail	Summary of G-BASE London Earth study: Including determining urban pollution pattern. Thy tested for As and Pb concentrations in topsoils from urban and rural samples from the BGS G-BASE project and the National Soils Inventory (XRFS) data set and Benzo [a] pyrene (BaP) from the English UKSHS. For As, no observable trend in the As concentration between the rural and urban UI distributions were found. This suggests that, As in soils in England has a minimal contribution from diffuse pollution compared to natural sources. Lead shows a trend of increasing concentrations from the rural to urban categories. Concludes Pb content of soils has a significant diffuse pollution contribution. For BaP the data distributions show similar trends to Pb Suggesting that BaP is mostly derived from anthropogenic inputs and its concentration in soils is controlled by diffuse pollution.
54	Rawlins, 2005, The assessment of point and diffuse metal pollution of soils from an urban geochemical survey of Sheffield, England	http://nora.nerc.ac.uk/id/eprint/15839/	Publication	49	No	Only Cr, Ni and Pb in Sheffield. These chemicals are included in other papers.	A model of soil variability as a continuous background process with superimposed point contamination was applied to 569 measurements of metal concentrations (Cr, Ni and Pb) in the topsoils of Sheffield, England
55	Vane, 2014, Polycyclic aromatic hydrocarbons (PAH) and polychlorinated biphenyls (PCB) in urban soils of Greater London, UK	http://nora.nerc.ac.uk/id/eprint/508789/	Publication	51	Yes		Surface soils from a 19 km2 area in East London, UK were analysed for polycyclic aromatic hydrocarbons (PAH) and polychlorinated biphenyls (PCB).
56	Johnson, 2012, Normal background concentrations (NBCs) of contaminants in English soils : final project report.	http://nora.nerc.ac.uk/id/eprint/19946/	Publication	56	No	No sources mentioned in abstract	Description of soil study method in UK: The two principal data sets used in this work are the BGS Geochemical Baseline Survey of the Environment (G-BASE) rural and urban topsoil's (37,269 samples) and the English NSI (National Soil Inventory) topsoil's (4,864 samples) reanalysed at the BGS laboratories by X-ray fluorescence spectrometry (XRFS)/

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57	Faroon, 2003, Polychlorinated biphenyls : health aspects	https://apps.who.int/iris/handle/10665/42640?search-result=true&query=source+AND+soil+AND+contamination+AND+urban&scope=%2F&filtertype_0=subject&filter_relational_operator_0=equals&filter_0=Environmental+exposure&rpp=10&sort_by=score&order=desc&page=7	Publication	61	Yes	Chemistry paper about molecular distribution of PCBs. It's not an environmental study.	Chemical assessment report on Polychlorinated biphenyls: 1. toxicity 2.Risk assessment 3.Environmental exposure 4.Occupational exposure I. International Programme on Chemical Safety
58	Howe, 2001, Chlorinated naphthalenes	https://apps.who.int/iris/handle/10665/42403?search-result=true&query=source+AND+soil+AND+contamination+AND+urban&scope=%2F&filtertype_0=subject&filter_relational_operator_0=equals&filter_0=Environmental+exposure&rpp=10&sort_by=score&order=desc&page=8	Publication	61	No	Studies chemical is not identified in the fire chemistry review.	Chemical assessment report on chlorinated naphthalenes: 1. toxicity 2.Risk assessment 3.Environmental exposure 4.Occupational exposure I. International Programme on Chemical Safety
59	Esch, 2000, Flame retardants : tris(2-butoxyethyl) phosphate, tris(2-ethylhexyl) phosphate, tetrakis(hydroxymethyl) phosphonium salts	https://apps.who.int/iris/handle/10665/42248?search-result=true&query=source+AND+soil+AND+contamination+AND+urban&scope=%2F&filtertype_0=subject&filter_relational_operator_0=equals&filter_0=Environmental+exposure&rpp=10&sort_by=score&order=desc&page=14	Publication	61	Yes		Environmental transport, distribution and transformation of flame retardants
60	Environment Agency, 2005, PCB and PAH Releases from Incineration and Power Generation Processes	https://www.gov.uk/government/publications/polychlorinated-biphenyls-pcb-and-polycyclic-aromatic-hydrocarbons-pah-releases-from-inceneration-and-power-generation-processes	Publication	21	Yes		Environmental levels and human exposure of PAH released from Incinerator and Power Generation Processes
61	Environment Agency, 2009, Environmental risk evaluation reports	https://www.gov.uk/government/publications/environmental-risk-evaluation-reports	Publication	65	Yes		Overview of potential environmental risks for aryl phosphate esters. Includes examples for sources.
62	Manseva, 2002, Polycyclic aromatic hydrocarbons in the environment	http://www.en.msceast.org/reports/9_2002.pdf	Publication	Referenced in UKSHS (Evidence ref 2)	No	Relevant information is presented in UKSHS (Evidence number = 2) paper. Access restrictions cannot be determined.	The work was aimed at an analytical review of main emission sources, measurement data and physical-chemical properties of 4 indicator PAH.
63	DEFRA, 2015, Establishment of typical background levels of dispersed asbestos fibres in urban and rural soils in England and Wales - SP1014	http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=19295	Announcement	Provided by internal reviewer	Yes		Evidence of ongoing research
64	Wei et al., Organophosphorus flame retardants and plasticizers: Sources, occurrence, toxicity and human exposure, 2014	https://www.sciencedirect.com/science/article/pii/S0269749114003923	Publication	Provided by internal reviewer	Yes		Information about organophosphorus in the environment including sediment.
65	Mihajlovic, 2012. Dry and wet deposition processes as a source of organophosphate flame retardants (OFR) in soils	https://repositorium.ub.uni-osnabrueck.de/bitstream/urn:nbn:de:gbv:700-2012070610196/2/thesis_mihajlovic.pdf	Dissertation	71	No	Appears to have been published in peer-reviewed journal as Evidence Number 68.	This is a Doctoral thesis presenting the results of an assessment of selected organic flame retardants (OFR) in urban, semi-urban and rural soils in Germany following periods of differing atmospheric conditions (snow, rain and dry) in 2010/2011. Snow melt and rain water were also analysed for OFR. The study concludes that snow was a more efficient source of OFR than rain. During dry weather, concentrations of OFR of interest were thought to result mainly from source emission strength and atmospheric photochemcial degradation.

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66	Diamond et al., 2010. Estimation of PCB Stocks, Emissions, and Urban Fate: Will our Policies Reduce Concentrations and Exposure?	https://pubs.acs.org/doi/abs/10.1021/es9012036	Publication	71	No	Study in based on data for Toronto and Canada, rather than UK. QRS has already identified evidence with data on PCB sources for the UK.	This study provides an estimate of PCB stocks in Toronto, Canada to assess why PCB trends are stabilising and if regulatory policies may further reduce concentrations and potential environmental exposure. A Multimedia Urban Model as used to estimate city-wide emissions, which equated up to approximately 0.3% of the total stock.
67	Khelfi, 2018, Sources of Soil Pollution	https://www.igi-global.com/chapter/sources-of-soil-pollution/206531	Chapter in publication	71	No	Focus on agricultural soils	Overview of soil pollutants by contamination groups (PAH< PCB, Pesticides, Heavy metals and radionuclides) and their sources. This review appears to focus on agricultural soils across the globe.
68	Mihajlovic and Fries 2012. Atmospheric deposition of chlorinated organophosphate flame retardants (OFR) onto soils	https://www.sciencedirect.com/science/article/pii/S1352231012002956	Publication	71	No	Study is focused on environmental fate and transport	This article presents the results of an assessment of selected chlorinated organophosphate flame retardants in soil following periods of differing atmospheric conditions (snow, rain and dry) in 2010/2011. Snow melt and rain water were also analysed. The study concludes that snow was a more efficient scavenger and transport medium of OFR than rain. During dry weather, concentrations of OFR in soils appeared to result mainly be due to concentrations in air, with these controlled by source emission strength and atmospheric photochemcial degradation.
69	Donner et al., 2009. Identifying and Classifying the Sources and Uses of Xenobiotics in Urban Environments	https://link.springer.com/chapter/10.1007/978-90-481-3509-7_2	Chapter in publication	71	No	General text about contamination, Mirsal (38) used instead	This chapter provides a review of methods of classifying sources of xenobiotic substances in urban environments.
70	Westerdahl et al., 2012. Emission inventories of different source categories for selected organic substances	http://www.chemitecs.se/download/18.439d807113f821c98c5abe/1373283899495/Chemitecs%20P5-D1%20SFA_final.pdf	Report	71	No	Only considers one COPC (TPP) in relation to one potential source (LCD screens).	Evidence presents case studies for selected organic chemicals to estimate emissions of these substances from specific articles in relation to other emission categories and pathways. The selected substances include organophosphate triphenyl phosphate (TPP) in relation to emissions from LCD screens.
71	Csiszar, et al., 2014. The Magnitude an Spatial Range of Current-Use Urban PCB and PBDE Emissions Estimated Using A Coupled Multimedia and Air Transport Model	https://pubs.acs.org/doi/abs/10.1021/es403080t	Publication	71	No	Appears to be focused on atmospheric deposition to surface waters, not soils	This publication presents results of atmospheric modelling of PCB emissions in Toronto, Canada and estimated loading of PCBs to Lake Ontario.
72	Rivett et al., 2010, Measuring the water and soil environments	https://books.google.co.uk/books?hl=en&lr=lang_en&id=EknOBQAAQBAJ&oi=fnd&pg=PA119&dq=organophosphate+AND+%22contamination%22+AND+%22soil%22+AND%22Urban%22AND+%22source%22+AND+%22diffuse%22&ots=gzmxWFEz1N&sig=-vl1FKHCnqfPAd_ji4HrsoJJBL4#v=onepage&q&f=false	Chapter in publication	71	No	Focus is not methods of measurement	Overview of water and soil environments and their measuring methods.
73	Hodge and Diamond, 2010. Sources, fate and effects of contaminant emissions in urban areas	https://books.google.co.uk/books?hl=en&lr=lang_en&id=6rro9sZSy_4C&oi=fnd&pg=PA171&dq=organophosphate+AND+%22contamination%22+AND+%22soil%22+AND%22Urban%22AND+%22source%22+AND+%22diffuse%22&ots=_YmzAw890P&sig=UsyOzifsbtF-YNyoSkaxsyJmSjY#v=onepage&q=organophosphate%20AND%20%22contamination%22%20AND%20%22soil%22%20AND%22Urban%22AND%20%22source%22%20AND%20%22diffuse%22&f=false	Chapter in publication	71	No	General overview - similar has been used.	Overview of widespread environmental pollutants with a focus on currently listed POPs that are still of major concern (e.g. polychlorinated biphenyls - PCBs), as well as new and emerging POPs that have been the subject of an explosion of scientific interest in the last decade, i.e. brominated flame retardants (BFRs) and perfluorinated chemicals (PFCs).
74	Environment Agency. 2009. Soil Guideline Values for benzene in soil	https://webarchive.nationalarchives.gov.uk/20140328153731/http://www.environment-agency.gov.uk/static/documents/Research/SCHO0309BPQI-e-e.pdf	Report	n/a - provided by TN reveiwer	Yes		Summary of environmental fate and transport of benzene. Includes summary of potential sources of benzene in UK soils.
75	Environment Agency. (2009). Soil Guideline Values for dioxins, furans and dioxin-like PCBs in soil. Bristol: Environment Agency.	https://webarchive.nationalarchives.gov.uk/20140328153735/http://www.environment-agency.gov.uk/static/documents/Research/SCHO0909BQYQ-e-e.pdf	Report	n/a - provided by TN reveiwer	No	Repetition of information in Evidence 34.	Summary of environmental fate and transport of dioxins & furans. Includes summary of potential sources of dioxins & furans in UK soils.

B. Evidence Record - Summary of Evidence Identified

Evidence Number	Evidence Reference	Evidence hyperlink (if available)	Evidence Type	Corresponding search number	Taken forward	Reason for rejection	Brief summary of evidence available from source number
76	SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Appendix D: Provisional C4SLs for Benzene	http://randd.defra.gov.uk/Document.aspx?Document=12347_SP1010AppendixD-Benzene.pdf	Report	n/a - provided by TN reveiwer	No	Repetition of information in Evidence 1 and 74.	Presents screening levels to assess risks to human health from benzene in soils. Includes summary of potential sources of benzene in UK soils.
77	SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Appendix E: Provisional C4SLs for Benzo(a)pyrene as a Surrogate Marker for PAHs	http://randd.defra.gov.uk/Document.aspx?Document=12348_SP1010AppendixE-BaP.pdf	Report	n/a - provided by TN reveiwer	Yes		Presents screening levels to assess risks to human health from benzo(a)pyrene in soils. Includes summary of PAHs in UK soils.
78	SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Appendix H: Provisional C4SLs for Lead	http://randd.defra.gov.uk/Document.aspx?Document=12351_SP1010AppendixH-Lead.pdf	Report	n/a - provided by TN reveiwer	No	Repetition of information in Evidence 2 and 324.	Presents screening levels to assess risks to human health from lead in soils. Includes summary of potential sources of lead in UK soils.
79	CIRIA. 2014. Asbestos in soil and made ground: a guide to understanding and managing risks	-		Provided by internal reviewer	Yes		Risk assessment and management of sites that contain soils or made ground potentially contaminated with asbestos.
80	IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, No. 81.	https://www.ncbi.nlm.nih.gov/books/NBK396450/	Report	n/a - provided by TN reveiwer	Yes		Provides background information on the sources or uses of synthetic vitreous fibres.

Appendix TN13-C. Evidence Record Template - Evidence Extraction

C. Evidence Record Template - Evidence Extraction

Evidence Number	Evidence Reference	Summary of evidence
1	Earl, N. et al., 2003. Review of the Fate and Transport, s.l.: Environmental Agency.	Polycyclic aromatic hydrocarbons (PAHs): review of the available data on the fate, transport, behaviour and sources of PAHs. - Cited in this this QSR
2	Creaser, M.D., W., Alcock, R. & Copplestone, D., 2007a,b,c. UKSHS Report No. 9, 10 : Environmental concentrations of polycyclic aromatic hydrocarbons and polychlorinated dibenzo-p-dioxins s.l.: Environment Agency.	This series of reports presents the first national survey of soil quality. Each chemical-specific report presents information about possible sources of a group of COPC in soil (dioxins, PAHs and trace metals) - Cited in this QSR
17	Drage, 2016, Concentrations of legacy and emerging flame retardants in air and soil on a transect in the UK West Midlands	This study describes emerging flame retardant (EFR) concentrations in air and soil samples collected in Birmingham. Describes how congener ratios of bromated fire retardants show urban pollution signatures. - Cited in this QSR
26	Muresan et al., 2010, Fate and spatial variations of polybrominated diphenyl ethers in the deposition within a heavily urbanized area case of Paris (France).	This study presents the first results on the geochemical cycle of Polybrominated Diphenyl Ethers (or PBDE) in the Paris Region (France). The papers provides details of sources of PBDE and hexabromocyclododecane (HBCDD), the distribution and mobility of eight PBDE congeners. Furthermore, it describes the chemical signature for urban environments displayed by congener ratios of bromated fire retardants. - Cited in this QSR
32	Meuser, 2010. Causes of Soil Contamination in the Urban Environment. In: Contaminated Urban Soils. s.l. Springer, pp. 29-94.	Summary of anthropogenic contaminants and their sources. Provides a list of contaminants along road sides. - Cited in this QSR
38	Mirsal, I., 2008. Sources of Soil Pollution. In: Soil Pollution. s.l. Springer, pp. 137-173.	Summary of anthropogenic contaminants and their sources. Including a list of heavy metals and their potential sources in the urban environment. - Cited in this QSR
40	Jaszczak, Polkowska, Narkowicz & Namiesnik, 2017. Cyanides in the environment—analysis—problems and challenges. Environmental Science and Pollution Research, 24(19), pp. 15929-15948.	This document reviewed the current knowledge on the behaviour of cyanide in the environment and its impact on human health. It lists the major sources of cyanide released to air. - Cited in this QSR
55	Vane, C. et al., 2014. Polycyclic aromatic hydrocarbons (PAH) and polychlorinated biphenyls. Applied Geochemistry, Volume 51, pp. 304-314.	This study describes the urban signature of PAHs and PCBs in London: PAH congeners and their sources such as pyrogenic, diesel fuel wood smoke, traffic exhaust, spills. - Cited in this QSR
57	Faroon, et al., 2003. Polychlorinated biphenyls : human health aspects. [Online] Available at: http://www.who.int/iris/handle/10665/42640 [Accessed 30 04 2019].	Describes PCB pollution sources such as incineration of municipal waste and their concentrations. - Not cited in this QSR as PCBs were not identified as a COPC in the Fire Products Review.
59	Esch, D. G. v. & Bilthoven, 2000. Flame retardants : tris(2-butoxyethyl) phosphate, tris(2-ethylhexyl) phosphate, tetrakis(hydroxymethyl) phosphonium salts, Geneva: World Health Organization.	Discusses sources of Tris(2-butoxyethyl) phosphate (TBEP), Tris(2-ethylhexyl) phosphate (TEHP), Tetrakis(hydroxymethyl) phosphonium salts (THP salts)). - Not cited in this QSR as limited data on occurrence in soil.
60	Dyke, P.H., 2005. PCB and PAH Releases from Incineration and Power Generation Processes	Study is focused on emissions from power stations and wate incineration to atmosphere. Although some information on potential emissions from different sources are presented, these are for national inventories and date from the 1990s. - Not cited in this QSR as limited data on occurrence emissions to urban areas or to soil.

C. Evidence Record Template - Evidence Extraction

Evidence Number	Evidence Reference	Summary of evidence
61	Brooke, D.N., Crookes, M.J., Quarterman, P. and Burns, J., 2009. Environmental risk evaluation report: Tricresyl phosphate. Environment Agency	This report presents an environmental risk assessment based on data available at the time of reporting (2009) and methods from a European Technical Guidance document. the study was completed in accordance with the Notification of New Substances (NONS) Regulations. The evidence provides a summary of uses, and therefore potential sources, of this substance and then reviews its potential fate and transport in the environment. Model estimates for releases of this substance to the environment (air, water and agricultural soil) are also presented. - Cited in the QSR.
61	Brooke, D.N., Crookes, M.J., Quarterman, P. and Burns, J., 2009. Environmental risk evaluation report: Triphenyl phosphate. Environment Agency	This report presents an environmental risk assessment based on data available at the time of reporting (2009) and methods from a European Technical Guidance document. the study was completed in accordance with the Notification of New Substances (NONS) Regulations. The evidence provides a summary of uses, and therefore potential sources, of this substance and then reviews its potential fate and transport in the environment. Model estimates for releases of this substance to the environment (air, water and agricultural soil) are also presented. - Cited in the QSR.
63	Department for Environment Food and Rural Affairs, 2015. Defra.go.uk. [Online] Available at: http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=19295 [Accessed 13 05 2019].	Describes on-going research on background levels of dispersed asbestos fibres in urban and rural soils in England and Wales. - Cited in this QSR
64	Wei, G.-L.et al., 2014. Organophosphorus flame retardants and plasticizers: Sources, occurrence, toxicity and human exposure. Environmental Pollution, Volume 196, pp. 29-46.	Organophosphorus flame retardants and plasticizers: includes information on sources such as consumer products and production, plus occurrence in the environment. - Cited in this QSR
74	Environment Agency. 2009. Soil Guideline Values for benzene in soil. Bristol: Environment Agency.	Provides information on the potential sources of benezene in soils. - Cited in this QSR
77	Contaminated Land: Applications in Real Environments (CL:AIRE). 2014. SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Appendix E: Provisional C4SLs for Benzo(a)pyrene as a Surrogate Marker for PAHs	Provides information on the potential sources of PAHS in UK soils. - Cited in this QSR
79	Nathanail, C., Jones, A., Ogden, R., & Robertson, A. (2014). Asbestos in soil and made ground: a guide to understanding and managing risks, C733. CIRIA	Risk assessment and management of sites that contain soils or made ground potentially contaminated with asbestos.
80	IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, No. 81. IARC Working Group on the Evaluation of Carcinogenic Risk to Humans. Lyon (FR): International Agency for Research on Cancer; 2002.	Provides background information on the sources or uses of synthetic vitreous fibres.