

A REMEDIATION STRATEGY REPORT FOR PEELER'S YARD AT GOULDEN STREET, MANCHESTER

REVISION: B
REPORT REFERENCE: SS0034R

17/02/2023

Client: Cert Property



DOCUMENT CONTROL

Project No. :	SS0034R	SoilSafe Ltd
Report Status:	FINAL	54 Oak Street
Issue No.:	b	Manchester
Project	James Blyth	M4 5JA
Engineer:		
Date of Issue:	17/02/2023	

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Revision No.	Description of Issue / Revision	Date of Issue	Reviewed By	Author
a	Final	25/07/22	CH	JB
B	Removal of clean cover system contingency details following comments from LA	17/02/2023	IB	JB



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1 INTRODUCTION

SoilSafe was commissioned by Cert Property to undertake a Remediation Strategy for a site referred to as Peeler's Yard, Goulden Street, Manchester (the "Site").

This report has been produced in order to provide a detailed remediation scheme/strategy and method statement for the remediation works so that the site can be made suitable for its intended use by removing any unacceptable risks to human health. A previous remediation strategy for the site has previously devised by E3P Ltd; however, the results of the remedial options appraisal suggested that the most suitable option to break the identified pollutant linkages was to remove all Made Ground soils at the site. It should be noted that a listed Chimney structure is present at the site, around which no excavations can take place in order to maintain the stability of the historically important feature. As such, the wholesale removal of Made Ground soils is not considered technically feasible at this site.

This report includes details on the anticipated works and provides method statements for these works in order to achieve the proposed remedial objectives/criteria presented through the report. Details of site management procedures including environmental monitoring and mitigation and the contractor responsibilities are given, as well as details of what should be included as part of the required verification report to verify the remedial works outlined in this document. As a result of the above objectives being achieved, this report is satisfactory to discharge Condition 5 of Planning Consent 125678/FO/2019.

It is understood that the proposed development comprises the erection of an 8 No. storey residential development with commercial units on the ground floor and associated hardstanding and soft landscaping. It is understood that the proposed development includes the required retention of a protected chimney structure located within the south eastern area of the site. Care must be maintained at all times not to undermine the foundations of this structure or otherwise detrimentally impact it as a result of excavation works.

It was identified within the Phase 2 Ground Investigation Report produced by E3P (Ref: 12-728-R2-2) that the measured concentrations of potential chemical contaminants of concern, including PAHs, heavy metals, TPH bans C16-21 present a potential risk to human health, along with low level concentrations of asbestos reported in 2 No. soils samples in the southwestern and southeastern parts of the Site that may present a potential risk to human health for the proposed land use. The results of a controlled waters risk assessment with due regard to the conceptual site model and sensitivity of the water environment has been undertaken that has demonstrated no significant risk to the wider environment. Based on the results from ground gas monitoring undertaken by E3P, it is considered that ground gas the site should be designated as Character Situation 1, for which ground protection measures are not required.

The comments and opinions presented in this report are based on the desk study and ground conditions encountered during an intrusive investigation performed by E3P Ltd and the laboratory determined chemical test results reported. There may be other conditions prevailing on the Site which have not been revealed by this investigation and which have not been taken into account by this report. Responsibility cannot be accepted for any conditions not revealed by this investigation. Any diagram or opinion on the possible configuration of the findings is conjectural and given for guidance only. Confirmation of intermediate ground conditions should be undertaken if deemed necessary.

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2 SITE DETAILS AND DESCRIPTION

Table 2-1 Current Site Overview.

Site name	Goulden Street
Site address	Goulden Street, Manchester M4 5EH
National Grid Reference	384710, 398890
Location description	The Site is located to the north of Oldham Road (A62) in the Northern Quarter of Manchester City Centre, between Goulden Street, Cross Keys Street and Chadderton Street.
Approximate Site area	Approximately 0.13 ha
Site shape	The site is rectangular in shape.
Current land use	The site is currently disused.
General Topography	The site is relatively flat lying with a stockpile of material present at the western boundary.
Below ground structures	Numerous concrete and brick obstructions were encountered within the Made Ground soils at the site, interpreted to represent relict foundations from pre-existing buildings.
Invasive plant species	None recorded by E3P.



3 REVIEW OF HUMAN HEALTH RISK ASSESSMENT IN RELATION TO SEMI VOLATILE ORGANIC COMPOUNDS AND MERCURY

The E3P remediation strategy report identifies a risk from SVOCs (namely, naphthalene) and mercury (elemental) to end users via the exposure to indoor air. This has resulted in an unsustainable, expensive and unworkable remediation strategy including the wholesale removal of all Made Ground soils at the site. In producing this remediation strategy, SoilSafe have placed this assessment under further scrutiny.

It should be noted that the building only covers the western half of the site and in relation to this, all exploratory holes which fall outside of the building have been removed from the pollutant linkage. This includes the mercury in TP105 and, as such, elemental mercury will no longer be considered to pose a risk to indoor air. SoilSafe have also removed from the dataset any samples for SVOCs and VOCs which do not lie underneath building as they do not pose a risk to end users of the building through exposure to volatile compounds in indoor air.

It should be noted at this point that the sample results show a significant difference between those from the standard speciated PAHs analysis and those from the SVOC analysis. This casts some doubt on the accuracy of the laboratory test results.

In terms of the source of the SVOCs, and the analysis of the Made Ground dataset as a whole, it is noted that the SVOC impacts from TP101 are likely to be due to hydrocarbon impacts. A sheen was noted on a "water strike" at 0.6m bgl and, a sample taken from 0.6m bgl and tested. It should be noted that no water shown in trial pit photograph. It is therefore considered that these hydrocarbon impacted soils are not representative of the SVOC contamination of the Made Ground as a whole and should be regarded as a hotspot.

SoilSafe have also undertaken a PAH Double ratio plot, which suggests that the results are in the *combustion products* range, as opposed to *petroleum derived products*. It is therefore considered likely that the SVOCs within TP101 and other sample results are due to very small amounts of coal tar fragments within in the samples. Coal tar pitch contains a large number of substances. It is solid at room temperature and consists of a complex mixture of numerous polycyclic aromatic hydrocarbons (PAHs), their methyl and polymethyl derivatives, and heterocyclics, and shows a broad softening range instead of a defined melting temperature.

Statistical analysis of the remaining 7 No. samples suggests that the sample from TP101 at 0.50m bgl (120 mg/kg) is a statistical outlier. It is considered that this does not for part of the same overall population of the soils as a whole and therefore can be regarded as a hotspot. Upon removal of this sample, there are no more samples which are in exceedance of the GACs and, as such, once the hotspots of naphthalene are removed from TP101 and TP102, the soils beneath the building are considered not to pose a risk to the end users through exposure to semi volatile organic compounds.



4 REMEDIATION STRATEGY

4.1 REVISED CONCEPTUAL MODEL

A revised conceptual site model was presented within the E3P Phase 2 Geoenvironmental Site Assessment (Ref: 12-728-R2-2) outlines the source-pathway-receptor linkages identified for the site. Using this, the below conceptual site model was produced.

4.1.1 General Understanding of Ground Model

- Made Ground has been identified across the Site at every intrusive locations during the previous site investigation works undertaken by E3P, from Ground Level to depths of between 1.00 and 4.60m bgl, with depths generally between 1.20 and 3.00m bgl. Made Ground soils were observed to generally comprise reworked cohesive soils with relict foundations and rubble comprising brick and concrete from pre-existing structures. Made Ground soils were not bottomed out at locations TP101, TT101A, TT101B or TT102C due to continuous collapse of the excavations. As such, it may be that Made Ground soils extend to greater depths within these areas.
- Where Made Ground soils were penetrated, drift deposits comprising firm to stiff reddish brown gravelly clays with gravel of sandstone with localised lenses of fine to medium sand were encountered. Soft black silty clay was identified local to WS101 directly underlying Made Ground soils from between 3.0m and 3.2m bgl.
- Numerous concrete and brick obstructions were encountered within the Made Ground soils at the site, interpreted to represent relict foundations from pre-existing buildings.
- A design sulphate class of DS-1 and AEC Class of AC-1s is required for future concrete structures.
- Groundwater strikes encountered at the site indicated the presence of several inconsistent perched groundwater bodies to be present at the site, largely either within or at the interface of the Made Ground soils with the underlying cohesive drift deposits, with strike depths varying widely from between 0.60m and 3.50m bgl. Monitoring of installation wells reported groundwater to be between 0.78m (Ws105) and 4.20m bgl (CP101), further indicating groundwater at the site to be laterally discontinuous.
- With respect to ground gas risk assessment, a worst-case GSV of 0.00208l/hr has been calculated using the maximum reported CO₂ concentration (0.7% v/v) and the maximum reported peak flow rate (0.52l/hr) which places the Site in a Characteristic Situation 1 – Very Low Risk scenario on the basis of the GSV.
- The results of the various human health risk assessments have demonstrated that the measured concentrations of potential chemical contaminants of concern, including two hotspots of naphthalene, PAHs, TPH (C16-21) and heavy metals, including mercury and low level asbestos present a potential risk to human health for the proposed end use.
- An assessment of leachate and groundwater data obtained for the Site has determined that the reported concentrations do not present a risk to the controlled waters environment given the absence of any nearby significant surface water bodies, the significant thickness of the underlying low permeability Glacial Till that offers protection to the underlying Principal Aquifer, the absence of a Source Protection Zone and nearby water abstraction licences, the discontinuous nature of the shallow groundwater body and the cohesive low permeability Made Ground beneath the Site reducing potential for lateral migration.

4.1.2 Sources

- Human Health: Presence of heavy metals, PAHs, TPH and low level asbestos within Made Ground soils.
- 2 No. hotspots of naphthalene beneath the proposed building area.

4.1.3 Pathways

- Dermal contact, ingestion and inhalation of contaminants including contaminated dust migration during construction.
- Inhalation of SVOC in indoor air

4.1.4 Receptors

- Future and adjacent users of the Site.
- Site investigation, demolition and construction staff and future underground service maintenance workers from hazardous short-term exposure.



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Table 4-1 **Pollutant linkages**

	Source	Pathway(s)	Receptor(s)	Qualitative risk assessment
1	Human Health: Presence of PAHs (non-volatile), heavy metals (non-volatile), TPH (C16-21) and asbestos within Made Ground soils.	Dermal contact, ingestion and inhalation of contaminants including contaminated dust migration during construction.	Current site users (site visitors) Adjacent site users (commercial/residential) Construction, site investigation, demolition and future maintenance workers Future site users	Medium x Very Low Likelihood = Low Risk Medium x Very Low Likelihood = Low Risk Medium x Low Likelihood = Moderate/Low Risk Medium x Very Low Likelihood = Low Risk
2	Human Health: Presence of "hotspots" of volatile naphthalene and within Made Ground soils.	Vapour inhalation	Current site users (site visitors) Construction, site investigation, demolition and future maintenance workers Future site users	Mild x Very Low Likelihood = Negligible Risk Medium x Low Likelihood = Moderate/Low Risk Medium x Very Low Likelihood = Low Risk

4.2 REMEDIAL OPTIONS APPRAISAL

Multiple options have been assessed in order to break the various potential Source-Pathway-Receptor pollutant linkage at the site:

Non-volatile S-P-R Pollutant Linkage

- 1) The removal of **widespread** contamination sources, including PAHs (non-volatile), heavy metals (non-volatile), TPH (C16-21) and asbestos would involve excavating Made Ground soils in the vicinity of the proposed soft landscaped area and removing to landfill. Given the costs and sustainability issues, this option is not considered the most appropriate.
- 2) The removal of the human health pathways associated with the identified asbestos contamination would involve impacted Made Ground soils to remain beneath buildings and hardstanding (there are no landscaped areas proposed) and is considered to be the most viable option.

Semi Volatile S-P-R Pollutant Linkage

- 1) Under current development plans it is anticipated that there will be a net cut as a result of the removal of underlying relict foundations and shallow Made Ground soils. Considering the localised and shallow depths from which elevated concentrations of naphthalene were encountered and the likelihood that they would be removed from site anyway, it is considered that their planned and verified removal from site in all areas underlying building footprints would be the most appropriate method of breaking the S-P-R pollutant linkage for the proposed end use.

Although there is no additional human health risk, it will be required that all soils to be removed from site undergo a WM-3 waste classification prior to disposal in order to inform the appropriate landfill designation and selection. Materials should undergo assessment and segregation during the earthworks in order to prevent mixing hazardous wastes with other non hazardous materials.



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4.3 ANTICIPATED REMEDIAL WORKS

Based upon the findings of the site investigation by E3P and the proposed development plans, the following Remediation Strategy has been devised in order to make the site safe and suitable for redevelopment.

With respect to the current development plans, it is anticipated that the site surface will be entirely covered by building footprint.

In this case, it is anticipated that the S-P-R pollutant linkages will be broken for all volatile and non-volatile contaminants:

- General site clearance of structures and hardstanding;
- Removal of below ground relict structures and foundations.
- Earthworks to bring site to proposed levels, including removal of surplus soils, including those Made Ground containing volatiles, to landfill.
- Verification testing following excavation to confirm removal of volatile source materials, with additional excavation and removal as required.
- Backfill of any excavations with suitable material, if applicable.
- The deeper Made Ground soils will be remain under either building footprints of hardstanding surfaces, with no viable pathway remaining.



5 NAPHTHALENE HOTSPOT REMOVAL

As indicated in the Remedial Options Appraisal, the SVOC impacted soils within the north western corner of the site (within the vicinity of TP101 and TP102) will need to be removed from site under controlled conditions. This is to prevent impacted material from being spread around the site or being illegally mixed with other waste during demolition and construction works.

5.1.1 Anticipated Volumes of Hydrocarbon Impacted Soil

From an assessment of the historical mapping, the conditions noted on site and the spatial locations showing impacted soils, it has been estimated by that the impacted soils may have a volume in the region of 20m³, based upon 2 No. areas of around 3m x 3m and an anticipated average thickness of 1m. This is a best estimate based upon the encountered ground conditions and is subject to change, depending upon the findings during the actual remediation works.

5.1.2 Impacted Soils Removal

Impacted soils should be considered to be soils which have significant visual and/or olfactory evidence of SVOC contamination. Impacted soils should be disposed of to a suitably licensed landfill site. As such, methods of removing these soils are also highlighted below.

The excavation of Made Ground soils in these areas will begin with those immediately within the affected trial pits (the GPS coordinates of these boreholes are presented on the logs), extending to the soils outwards. The grossly impacted soils will be "chased out" incrementally, based upon directions given by the Supervising Engineer (SE). The SE will cease excavation when they are satisfied that all grossly contaminated soils have been removed. Any disposal of contaminated materials shall take place by the direct placement onto a bunded polythene layer whilst chemical analysis is undertaken. This soil will also be covered in a layer of polythene to prevent leaching to the surrounding soils. Following WAC and soils analysis, the soil will be placed into a road haulage truck and subsequent disposal at a suitable landfill site. On site precautions will be required to prevent the spreading of contaminated soils around the site or to adjacent land.

In the event that visual or olfactory evidence of contamination in perched groundwater is encountered during the excavation works, it will be removed by vacuum tanker and disposed of at a suitably licensed facility. Waste transfer notes for any contaminated perched groundwaters removed from site shall be retained and presented to the relevant authorities as part of the final verification report.

5.1.3 Remedial Targets

Soil samples will be taken from the base and sides of the 'chased out' excavations and sent to a laboratory for speciated PAH soils analysis. The results of the total soils analysis will be screened against the human health criteria for a residential land use without plant uptake, as per the Phase 2 report for this site.



6 WASTE SOILS REMOVAL AND DISPOSAL

If materials are disposed off-site, then material exported from site to landfill shall be hauled by a registered waste carrier in accordance with Duty of Care Regulations, 1991 and the Hazardous Waste Regulations, 2005.

It should be maintained throughout all excavation works for the purposes of removal that a protected chimney structure is present within the south eastern area of the site which must be retained. Care must be maintained at all times not to undermine the foundations of this structure or otherwise detrimentally impact it as a result of excavation works.

It will be necessary to register the site in advance of the intended reclamation works with the Environment Agency before disposal to landfill can take place. There will be the requirement for the waste producer to provide additional Waste Acceptance Criteria (WAC) testing of the soils for disposal, to ensure that the soils are appropriately classified and that the landfill is licensed to receive such soils. A consignment note shall be completed, signed and retained by all parties involved. The consignment note shall state the volume of waste, a physical description of the material and statement of its chemical composition. The waste consignment notes shall be kept by the contractor for a period of at least two years. Final categorisation is the responsibility of the producer or holder of the waste. Additionally, liaison with the intended landfill operator may be required to confirm the receipt of the waste

It is proposed that if any hotspots of material containing hazardous waste are encountered then this material will be excavated and disposed off-site (to a hazardous landfill). This will prevent cross contamination of other non-hazardous and inert material during earthworks. Before undertaking the removal works the following salient points should be considered:

- The removal works will involve locating the start position then grubbing any hardstanding from the surface and stockpiling separately away from the removal works.
- None of the underlying natural material should be excavated as part of the removal.

Following removal, a suitably qualified geoenvironmental consultant shall be present to obtain verification samples from the sides and the base of the excavation on an approximate 5.00m grid basis to verify the effective removal of the hazardous materials. The results of the verification samples will be assessed to determine the soil waste classification and waste disposal route determination. The excavation will be extended until such time that all hazardous waste materials have been removed.

On the basis of the information obtained to date and the assessment of the soils within this report, it is considered that the following measures will be put in place to reduce the volume of material being sent to hazardous landfill sites in order to provide a more sustainable solution to the excavation works:

- The hazardous material will be segregated on site under the part time supervision by a SoilSafe Geoenvironmental Engineer;
- The geoenvironmental engineer will liaise with the haulier or landfill operator to ensure that they know that the material can be accepted at their treatment facility or landfill site;
- The remaining soils which have been shown to be non-hazardous can be excavated throughout this process to ensure that wagons can be kept moving, thus ensuring that the development program is maintained;

SoilSafe will then provide a verification document which will be submitted to the client to ensure that the soils have been treated in accordance with this statement.

6.1.1 Waste soils segregation, materials management and the role of the supervising engineer

The Supervising Engineer (SE) will supervise, control and advise on all relevant matters. The responsibilities of the SE shall include, but not be limited to the following:

- Part time supervision and quality control of the soil segregation works;
- Supervision and recording of the segregation of any previously unidentified areas of contamination and the liaison between the Principal Contractor, sub contractors and the regulatory bodies;
- Advise upon the correct handling of materials and conditions encountered;
- Record materials movements, approximate excavation locations / dimensions and volumes of material removed from site (including destination and copies of waste transfer notes);
- Liaison with statutory bodies as required.

Any hazardous waste hotspot removal will be summarised in a letter report that details the waste classification of the material that has been removed and the results of verification testing around the margins of the excavation.



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7 IMPORTED MATERIALS

As there is a net cut at the site, it is not envisaged that any soils will be imported to site. It is anticipated that piling mat materials are likely to be site won, created from the large amount of obstructions and oversize materials during the grubbing up process.

If imported materials are required, however, a desk study should be provided with details of the source of the cover material. It should be demonstrated that the material is free from contamination by supplying results of analytical tests. Justification for the analytical suite used should be included. Sampling densities should be justified and based on the findings of a desk study. It would be expected that as an absolute minimum sampling would consist of at least three samples for each source used. One sample for every 200m³ of imported material will be provided, in line with Manchester City Council's guidelines for imported soils (Table 3).

Fill material imported onto site should be stored in a designated area, which is clearly identified on an appropriate scale plan. Stockpile management protocols consistent with best practice apply.

Off-site validation of fill material (whether this is top-soil, sub-soil or other substrate) is not acceptable, as this often results in chemical testing of different material to that actually imported to site. It is therefore difficult to prove the exact chemical nature of the material eventually imported, as off-site validation tends to involve composite samples taken from a 'typical batch' of the material intended for import. As such, validation testing of imported fill materials should be carried out in-situ, after materials have been imported to site.

An exception will be made if samples can be taken at source from a stockpile which has already been allocated to the site in question and this can be proven in the validation report.



8 EARTHWORKS PHASE ENVIRONMENTAL MONITORING AND MITIGATION

In order to mitigate the environmental impacts of the works on nearby residents and sensitive areas, a programme of measures should be implemented during the remediation works.

8.1.1 Dust Mitigation

Appropriate measures shall be implemented at all times during the remediation works, to minimise dust emissions. Soils should be dampened down, as necessary, and activity should be minimised in extremely windy conditions to prevent dust nuisance. An adequate supply of water shall be maintained on site at all times to allow for dust suppression activities to be carried out at short notice.

When dusty material is being loaded onto trucks, extra care should be taken to ensure that the drop height is minimised. Trucks should be suitably covered when leaving the site with contaminated material to prevent dust migration.

The amount of disturbed surfaces left exposed for significant time periods should be minimised. Stockpiles of fine or loose materials should be tamped down or covered to reduce the production of dust. Traffic both entering and working on the site shall obey a maximum speed limit of 5mph.

8.1.2 Vapour and Odours

Based upon the absence of any observations of recorded olfactory evidence of contamination during the site investigation works, excavations across much of the site are not considered likely to give rise to significant odour problems. During any remedial works, the Supervising Engineer should monitor the atmosphere and, in the case of excessive vapours being detected at the site boundary, should instruct the contractor to cover the excavation face releasing the vapours with soil or sand (some suitable material should be required to be kept of site as a contingency) and any stockpiles should be located away from residential properties.

8.1.3 Noise

The requirements of BS 5228:1997 "Noise and Vibration Control on Construction Sites" shall be adhered to at all times. All machinery shall be fitted with effective silencers and shall be serviced at regular intervals. No plant shall be operated with engine covers raised.

8.1.4 Run-off into Drains

All potential drainage on site and any discharge points should be identified, including land drains, foul sewers, surface water drains and any combined drains. These should be marked, as appropriate, for easy identification. Works should be minimised during periods of heavy rainfall to reduce the likelihood of contaminated run-off. Temporary containment and cover measures or tamping down of stockpiles to reduce run-off shall be used where necessary.

8.2 CONTRACTORS RESPONSIBILITIES

The following regulations, guidance and legislation relating to the works shall be complied with at all times:

- The Health and Safety Executive "Protection of Workers and the General Public During Redevelopment of Contaminated Land", HS(G)66, HMSO 1991;
- The Construction (Design and Management) Regulations 1994;
- The Control of Substances Hazardous to Health Regulations 1994.
- The Control of Asbestos Regulations 2012.
- The Contractor shall detail in his method statement how any hazardous materials and / or situations are to be handled / managed.
- The Contractor shall also be responsible for the following:
 - The provision of health and welfare facilities;
 - Obtaining the relevant consents / approvals;
 - Mitigation measures;
 - Stability of works.

8.2.1 Health and Safety

Contaminated materials are present on site. During the reclamation and construction phases of site development, it will be necessary to protect the health and safety of the personnel. General guidance on these matters is given in the Health and Safety Executive (HSE) document "Protection of Workers and the General Public during the



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Redevelopment of Contaminated Land" (HS(G)66). In summary, the following measures are suggested as a minimum level of protection:

- All ground workers should be issued with protective clothing, hard hats, footwear and gloves. Personnel should be instructed as to how they are to be used;
- All personnel shall wear hard hats, high visibility clothing and protective footwear at all times;
- Hand washing and boot cleaning facilities shall be provided;
- No smoking except in designated areas;
- Good practices relating to personal hygiene shall be adopted.

Before site operations are commenced, the necessary COSHH Assessments, Method Statements and Health and Safety Plans should be completed and issued by the Principal Contractor in Accordance with the CDM regulations.

All visitors to site must enter and register at the main site office, subject to the relevant terms and conditions of entry. All site personnel shall undergo a site specific health and safety induction prior to commencement of works on site.

Suitable precautions will be implemented to prevent dust and odour emissions during all reclamation work activities. The contractor shall provide details of emergency procedures.

8.3 ASBESTOS RISK TO CONSTRUCTION WORKERS

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

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

8.3.2 CAR Risk Assessments

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

CAR risk assessments are needed at remediation stage but may be incorporated into the overarching health and safety risk assessments for the site. The CAR risk assessment must:

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

The CAR risk assessment should include any information used to inform the risk assessment such as asbestos reports or desk study information. In the event that this information is not available, the assessor should be assumed that all forms of asbestos may be present on Site. For all investigation and remediation of ACSs, a detailed written work plan should be produced and followed as detailed on the HSE website and in the CAR. The CAR risk assessments for specific investigations or remediation projects, will determine whether or not work is 'licensable work' (LW), notifiable non-licensable work' (NNLW) or 'non-licensed work' (NLW). In addition, training requirements are also defined by the CAR risk assessment.

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

- Avoiding stirring up dust;
- Cleaning footwear after site works;
- Removing and bagging any overalls for disposal/laundrying;
- Respirators and hygiene facilities for high risk sites;



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- Segregated welfare units;
- Wetting ground
- Minimising soil disturbances;
- Implementation or retention of capping/break layers;
- Implementation of awareness training;
- Air monitoring;
- Managing stockpiles;
- Area segregation;
- Wheel washing
- Road washing/cleaning

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

8.3.3 Respiratory Protective Equipment (RPE)

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

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

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

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

8.3.4 Licensing

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

LW is defined as:

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

NNLW includes work with:

- AIB or asbestos insulation of short duration that is not licensable
- fire-damaged asbestos cement or asbestos cement damaged so as to create significant dust and debris
- asbestos ropes, yarns, woven cloths in poor condition or handling cutting or breaking up the materials
- asbestos papers, felts and cardboard in poor condition, unencapsulated or not bound into another material.
- Work with weathered asbestos cement, air monitoring and collecting samples of ACM in buildings would not normally be notifiable.



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

8.3.5 Training Requirements

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

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

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

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

8.3.6 Training vs. Competence

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



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9 CONTINGENCY FOR ANY UNKNOWNNS

Whilst relatively uniform ground conditions have been encountered across the site during the investigations, a small risk exists of the presence of localised unidentified contamination of Made Ground soils. Should any suspicious material be encountered during the redevelopment works, works shall be ceased within this part of the site and the area should then be investigated further by a suitably qualified geo-environmental engineer and sampled as necessary. The Environmental Health or Contaminated Land Officer at the local authority should also be notified immediately. Samples will be forwarded to a UKAS/MCERTS accredited laboratory for a suite of analytical testing deemed appropriate based upon an appraisal of the material identified. Once the results of the analysis are known and have been interpreted, the required remedial action (if any) will be determined and approved with the relevant regulatory authorities.



10 MATERIALS MANAGEMENT AND LEGISLATIVE COMPLIANCE

A U1 Exemption will be registered for the site, which allows the reuse of up to 5000 T of prescribed material within construction, with up to 25,000 T of material permissible to be reused in the construction of roads. It should be noted that only 1000 T of material described as sand, stones or clay soil classified as waste can be reused with a U1.

A T5 Exemption, allowing for the screening and recovery of up to 5000 T of permissible material for subsequent reuse in construction will also be registered.

All materials that are recovered under the WRAP protocol, U1 or T5 exemptions must be analysed to demonstrate that they are both chemically and structurally suitable for use within the context of the development.

The relevant LAPC, U1, T5 and WRAP licences, exemptions and protocols provide the legislative framework for material compliance during the site enabling works to be completed by the specialist contractor under the supervision of their geoenvironmental consultant /engineer.

Where necessary, operations as outlined within the enabling works rationale summarised in this report may be subject to regulation using the appropriate environmental permit, standard rules exemption and materials management plan, to be created in accordance with version 2 of the CL:AIRE Definition of Waste: Code of Practice (DoW CoP).

It is noted that if material is to be imported utilising the CL:AIRE DoW CoP from an alternative development site, then only chemically certified, clean, naturally occurring material can be transferred.

If required, the MMP will be created with due consideration of all proposed enabling works operations prescribed within this document and will be undertaken by a qualified person with a signed declaration submitted to the EA prior to reuse of materials on the site.



11 FINAL VERIFICATION REPORT

The site engineer should ensure that the requirements of the strategy are complied with. On satisfactory completion of all remedial works, a verification report should be produced. This report will comprise all relevant site records and act as certification that the remedial preparation works have been carried out in accordance with this Remediation Strategy.

11.1.1 Verification Report

The reporting of verification activities will be in general accordance with the Model Procedures (Environment Agency, 2004) and other relevant guidance (Environment Agency, 2010a and b). The reporting requirements will reflect the type and level of verification activity (if deemed to be required by the verifier) carried out at this site.

The final report will inform all the relevant stakeholders (regulators, site owners, funders, the local community etc) of the verification activities/integrity testing undertaken and will provide a logical framework to demonstrate confidence in the remediation measures.

The SE will maintain records of the works to include the following:

- Site details and reasons for carrying out remediation;
- Details of the various parties involved in the project, i.e. client, consultant, contractor;
- A summary of the original site conditions and contaminated land risk assessment carried out;
- The CSM for remediation identifying each pollutant linkage to be addressed by remedial activities, and the lines of evidence to test whether the linkages are broken;
- A description of the remediation measures put in place, with reference to detailed design drawings;
- A clear description of this remediation strategy, including the methods used for data collection and interpretation;
- A description of the inspection regime (who carried out the inspections, their competence to do so, over what period, at what frequency and supported by a written record, e.g. completed pro formas and captioned photographs presented in the appendices);
- Presentation of the manufacturer's material(s) specifications(s) for all elements of the remediation system, including warranty information;
- A summary of progress data, such as completed pro formas and monitoring results;
- Details of all communications held with regulatory bodies during implementation;
- A clear statement, based on the presentation of 'lines of evidence' and review of the CSM, of the extent to which the remedial objectives and criteria have been achieved and the presence, extent and nature of any residual hazards;



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12 REGULATORY APPROVALS

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

This report has outlined a detailed remediation scheme/strategy and method statement for the remediation works so that the site can be made suitable for its intended use by removing any unacceptable risks to human health and the natural environment such as controlled waters. This report includes details on the anticipated works and provides method statements for these works in order to achieve the proposed remedial objectives/criteria presented through the report. Details of site management procedures including environmental monitoring and mitigation and the contractor responsibilities are given, as well as details of what should be included as part of the required verification report to verify the remedial works outlined in this document. As such, this report is satisfactory to discharge Condition 5 and Condition 6.



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APPENDIX A – GLOSSARY OF TERMS

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

APPENDIX B – QUALITATIVE AND QUANTITATIVE RISK ASSESSMENTS

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

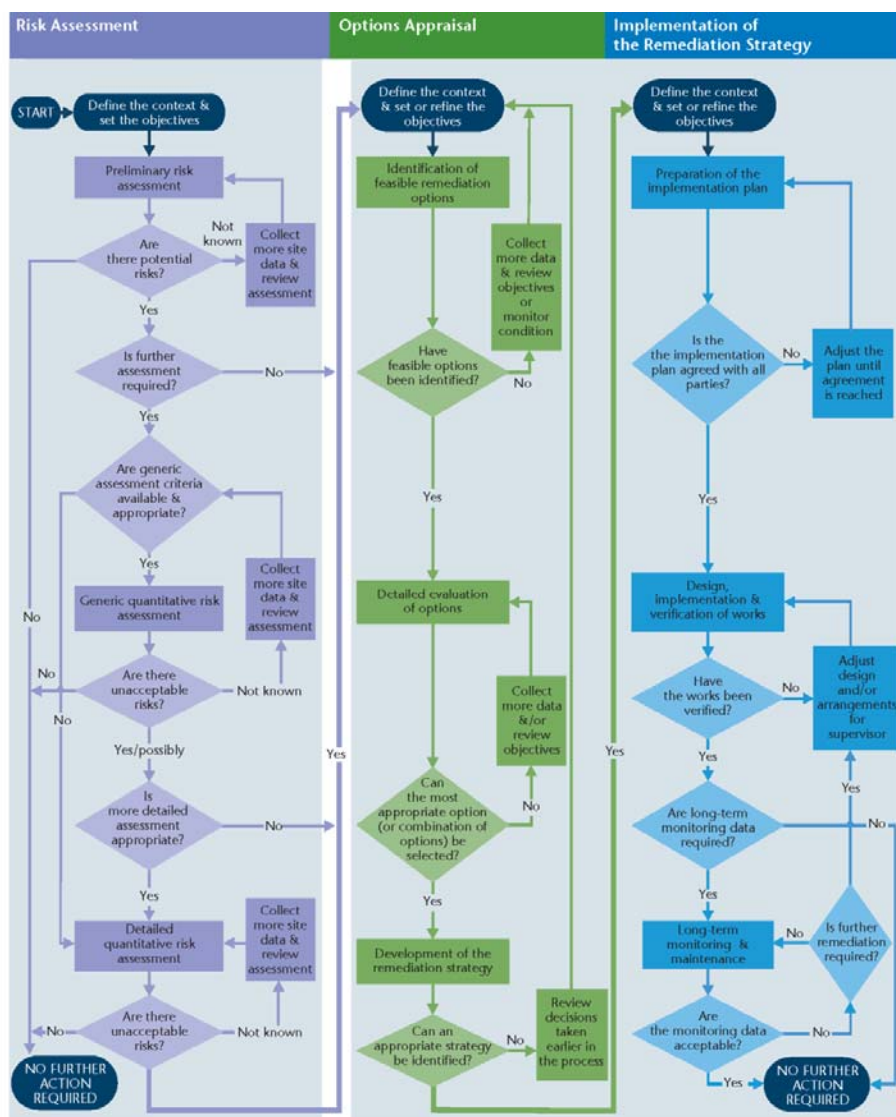
	Category	Definition
Potential severity	Severe	Acute (short term) risk to human health, Major pollution of sensitive controlled waters, ecosystems or habitat. Catastrophic damage to buildings or property or crops.
	Medium	Chronic (Medium / long term) risk to human health Pollution of sensitive controlled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

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

APPENDIX C – HUMAN HEALTH RISK ASSESSMENTS

Contaminated Land is defined under law through Part IIA of the Environmental Protection Act 1990, implemented through Section 57 of the Environment Act 1995 and associated guidance (“Part IIA”). These specify that a “suitable for use” approach is to be applied in the assessment of potentially contaminated land, implemented through a phased programme of site investigation and risk assessment appropriate to the site under consideration.

The assessment of potential risks posed by contaminated land is based upon the assessment of plausible contaminant source - pathway - receptor linkages (“pollutant linkages”) for the current and/or proposed future use of the site. The process for the assessment of contaminated land adopted in this report is in line with guidance issued by DEFRA and Environment Agency (EA) 2004: “Model Procedures for the Management of Contaminated Land (CLR11)”. The overall process for the management of land contamination is shown Figure 1 of CLR11 and reproduced below:



Note: The process may apply to one or more pollutant linkages each of which may follow a different route. For some linkages, it may be possible to stop at an early stage – others will progress all the way through the process. The level of complexity of each stage may also vary and in some cases may be very simple.

The risk assessment and subsequent investigation, remediation and verification must address all potential sources of pollutants that may be present on the site (the “hazards”), all receptors that may be harmed by these (e.g. human health, controlled waters, ecological receptors) and the pathways by which the contamination may be transported from the contaminant source(s) to the receptor(s). This is defined within the conceptual model for the site, which represents the characteristics of the site in a form that shows the possible pollutant linkages. As further information becomes available (for example, through site investigation), so the conceptual model will be refined.

Remedial action can be specified at any phase within this assessment process to break the identified pollutant linkage. In determining whether or not to undertake further assessment or to undertake remediation, the potential

A different approach to the statistical appraisal of data is required depending on whether the assessment is being undertaken to assess land as Contaminated Land in accordance with the regulations or whether the assessment is to assess whether the site is suitable for new development in accordance with the Planning regime. The statistical approach to assessment is discussed further in CL:AIRE:2009 “Guidance on Comparing Data with a Critical Concentration”.

Generic Assessment Criteria for Human Health Risk Assessment

- “Using Soil Guideline Values”; SC050021/SGV Introductions, EA,2009;
- “Human Health toxicology assessment of contaminants in soil”; SC050021/SR2, EA, 2009;
- “Update technical background to the CLEA model”; SC050021/SR3, EA, 2009;
- CLEA Software (Version) Handbook; SC050021/SR4; EA, 2008;
- Compilation of Data for priority Organic Contaminants for Derivation of Soil Guideline Values; Science Report SC050021/SR7, 2008; and,
- Guidance on Comparing Data with a Critical Concentration: CL:AIRE. 2009.

The diagram illustrates various exposure pathways for contaminants in food and the environment. It is divided into two main sections: indoor (left) and outdoor (right).

Indoor Section:

- Ingesting dust:** A person is shown sitting at a table, eating contaminated vegetables and soil adhering to vegetables.
- Inhaling indoor dusts and vapours:** A person is shown standing, inhaling indoor dusts and vapours.
- Rising vapours:** A wavy arrow indicates rising vapours from the ground into the indoor space.
- Tracking back of soil/dust from garden into home:** A wavy arrow indicates the migration of contamination from the outdoor garden into the indoor space.
- Skin contact with dust:** A person is shown standing, with a dot indicating skin contact with dust.
- Skin contact with soil:** A dog is shown lying on the ground, with a dot indicating skin contact with soil.

Outdoor Section:

- Ingesting soil:** A person is shown standing, ingesting soil.
- Inhaling outdoor dusts and vapours:** A person is shown standing, inhaling outdoor dusts and vapours.
- Rising vapours:** A wavy arrow indicates rising vapours from the ground into the outdoor space.
- Wind-blown dust:** A wavy arrow indicates wind-blown dust from the garden into the outdoor space.
- Plant uptake:** A wavy arrow indicates plant uptake of contaminants from the ground.

Legend:

- Exposure Pathways:** Represented by a solid line with a dot.
- Migration of contamination:** Represented by a wavy arrow.

- **Ingestion**
 - Outdoor soil;
 - Indoor dust;
 - Home grown produce;
 - Soil attached to home grown produce.
- **Dermal Contact**
 - Outdoor soil;
 - Indoor dust.
- **Inhalation**
 - Outdoor dust;
 - Indoor dust;
 - Outdoor vapour;
 - Indoor vapour.

It should be noted that the CLEA model does not include an exhaustive list of potential exposure pathways, e.g. certain compounds can pass through plastic water pipes into drinking water supply.

The potential significance of each of the exposure pathways is dependant upon the type of land use and the nature of the contaminant being considered. The CLEA model considers principal 'default' land use scenarios and makes a series of assumptions with regards to building type (where applicable), identification of the critical human receptor group, exposure frequency and duration. The definitions of the principal land use types given in SR3 (EA, 2009) are:

- **Residential land use:**

A typical residential property consisting of a two story terraced house built on a ground-bearing slab of 0.15m thickness with a private garden consisting of lawn, flowerbeds, and a small fruit and vegetable patch. The occupants are assumed to be parents with young children, who make regular use of the garden. The critical receptor is a 0 – 6 year old female.

Active exposure pathway are: ingestion of outdoor soil, ingestion of indoor dust, ingestion of home grown produce and soil adhering to home grown produce; direct dermal contact with outdoor soil and indoor dust; inhalation of outdoor dust and vapour and indoor dust and vapour.

- **Allotments**

A plot of open space commonly made available by the Local Authority to tenants to grow fruit and vegetables for their own consumption. There are usually several plots to a site and the overall site area may cover more than one hectare. The tenants are assumed to be the parents or grandparents and that young children make occasional accompanied visits to the plots. The critical receptor is a 0 – 6 year old female and there is no building present on Site.

Active exposure pathways are ingestion of outdoor soil, ingestion of home grown produce and soil adhering to home grown produce; direct dermal contact with outdoor soil; inhalation of outdoor vapour.

- **Commercial and industrial land use.**

A typical commercial or light industrial property consisting of a three-story office building (pre-1970) with a ground bearing floor slab at which employees spend most time indoors and are involved in office based or related light physical work. The critical receptor is a working female adult aged 16 – 65 years.

Active exposure pathway are ingestion of outdoor soil, ingestion of indoor dust; direct dermal contact with outdoor soil and indoor dust; inhalation of outdoor dust and vapour and inhalation of indoor dust and vapour.

Soil Guideline Values

Based on the assumption of each land use type, the EA and DEFRA developed and published Soil Guideline Value (SGV) using the CLEA model for a number of principal contaminants and 'default' end-use scenarios of residential, allotments and commercial/industrial use. The primary purpose of the SGVs are as trigger value for the tolerable daily intake (TDI), below which it can be assumed that the soil does not pose an unacceptable risk to the identified receptor. Where soils contamination is present above this level further assessment may be required. SGVs were developed for the following contaminants:

- Heavy metals and other inorganic compounds: arsenic, cadmium, chromium, cyanide, lead (now withdrawn), mercury, nickel and selenium;
- Benzene, ethylbenzene, toluene and xylenes;
- Phenol;
- Dioxins and dioxin-like polychlorinated biphenyls (PCBs)
- Polycyclic aromatic hydrocarbons (PAHs) – 11 substances

LQM/CIEH Generic Assessment Criteria of Human Health Risk Assessment

In addition, in 2009 CIEH through LQM and EIC published generic assessment criteria (GACs) for 82 substances including metals, petroleum hydrocarbons, PAHs and explosive substances for a variety of soil types and the three 'default' land uses – (residential, allotments and commercial end-uses) as described in SR3 (EA, 2009). These have been superseded as described below.

Category 4 Screening Values

In 2013 "SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination" (CL:AIRE 2013) was issued which detailed findings of a research project undertaken by CL:AIRE to set out the framework by which potential Category 4 Screening Levels (pC4SL) may be derived. This was supplemented in 2014 by "SP1010: Development of Category 4 Screening Levels for the Assessment of Land Affected by Contamination –

Policy Companion Document” (DEFRA, 2014). SP1010 proposed several updated toxicology information relating to contaminant behaviour updated assumptions relating to the modelling of human exposure to soil contaminants, derivation of separate C4SLs for residential with the consumption of home grown produce, residential without the consumption of home grown produce, and two new land uses: public open spaces near residential housing (POS resi) and public parks (POS park).

- **Public Open Space: Residential**

For public open space in close proximity to residential housing and the central green area around which houses are located, as on many housing estates from the 1930s to 1970s. It is also applicable for smaller areas commonly incorporated in newer developments as informal grassed areas or more formal landscaped areas with a mixture of open space and covered soil with planting. It is considered to be a generally grassed area up to 0.5ha with up to 50% bare soil. The land use is an important resource for children and the area is near the homes. The critical receptor is a female child age >3 - <9 years old (CLEA age class 4 – 9) as younger children are unlikely to play outdoors unsupervised.

Active exposure pathways are: ingestion of outdoor soil, ingestion of indoor dust; direct dermal contact with outdoor soil and indoor soil derived dust; inhalation of outdoor and indoor dust and inhalation of outdoor vapour.

- **Public Open Space: Park**

A public park is defined as an area of open space provided for recreational use and usually owned and maintained by the Local Authority. It is anticipated the park could be used for a wide range of activities, including the following:

- o Family visits and picnics;
- o Children's play area;
- o Sporting activities such as football on an informal basis (i.e no a dedicated sports pitch); and
- o Dog walking.

The park is modelled as an area >0.5 ha of predominantly grasses open space with no more than 25% of exposed soil.

The critical receptor is a female child with CLEA age classes 1 – 6.

Active exposure pathway are: ingestion of outdoor soil; direct dermal contact with outdoor soil; inhalation of outdoor dust and inhalation of outdoor vapour.

Furthermore the C4SLs are based on a different toxicological benchmark, the 'low level of toxicological concern' (LLTC). This difference in approach was adopted because the C4SLs were primarily intended for use under Part 2A of the EPA 1990 to quickly screen out Category 4 sites where there is “*no risk or that the level of risk posed is low*”. SGVs and LQM GACs are based on the more conservative 'minimal or tolerable level of risk' as defined in SR2 (EA, 2009) and were derived for assessment of contamination for the Planning process.

Lead

The SGV for lead was withdrawn in 2011 and is not used in this report. The C4SL for lead provides a technically robust and conservative assessment tool using significantly updated toxicological modelling than the withdrawn SGV and derived in line with current science of lead toxicology.

LQM/CIEH Suitable 4 Use Levels (S4ULs)

The publication of the C4SLs resulted in considerable and inconclusive debate about the applicability of the lower level of protection of the C4SL, which are underlain by the LLTC, outside of the Part 2A context for which they were derived. In 2014 LQM/CIEH presented a Suitable 4 Use Levels (S4ULs), which incorporate the updated assumption exposure derived for the production of the C4SLs but within the context of deriving screening criteria above which further assessment of the risks or remedial action may be needed. The S4ULs replace the 82 substances, species and fractions and congeners contained in the previous LQM/CIEH GACs issued in 2009. Additionally, following changes and new land uses proposed in the C4SL research project, S4ULs have also been derived for the majority of substances for which the EA derived SGVs in 2009.

The GAC values adopted in this report are summarised in Table 1, below.

Parameter	Residential <u>with</u> homegrown produce			Residential <u>without</u> homegrown produce			Allotment			Commercial / Industrial			Public Open Space near Residential			Public Open Space - Park			Source
	(mg/kg, unless otherwise stated)			(mg/kg, unless otherwise stated)			(mg/kg, unless otherwise stated)			(mg/kg, unless otherwise stated)			(mg/kg, unless otherwise stated)			(mg/kg, unless otherwise stated)			
SOM	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	
Metals/metalloids																			
Arsenic	37			40			43			640			79			170			LQM (2014)
Beryllium	1.7			1.7			35			12			2.2			63			LQM (2014)
Boron	290			11000			45			240000			21000			46000			LQM (2014)
Cadmium	11			85			1.9			190			120			532			LQM (2014)
Chromium III	910			910			18000			8600			1500			33000			LQM (2014)
Chromium VI	6			6			1.8			33			7.7			220			LQM (2014)
Copper	2400			7100			520			68000			12000			44000			LQM (2014)
Lead	200			310			80			2330			630			1300			C4SL
Mercury (elemental)	1.2			1.2			21			58 (25.8)			16			30 (25.8)			LQM (2014)
Mercury (Inorganic)	40			56			19			1100			120			240			LQM (2014)
Methylmercury	11			15			6			320			40			68			LQM (2014)
Nickel	180			180			230			980			230			3400			LQM (2014)
Selenium	250			430			88			12000			1100			1800			LQM (2014)
Vanadium	410			1200			91			9000			2000			5000			LQM (2014)
Zinc	3700			40000			620			730000			81000			170000			LQM (2014)
Other																			
Total Sulphate	2,400			2,400			2,400			2,400			2,400			2,400			BRE (2005)
Water Soluble Sulphate (g/l)	0.5			0.5			0.5			0.5			0.5			0.5			BRE (2005)
PAHs																			
Acenaphthene	210	510	1100	3000 (57)	4700(141)	6000 (336)	34	85	200	84000 (57)	97000 (141)	100000	15000	15000	15000	29000	30000	300 00	LQM (2014)
Acenaphthylene	170	420	920	2900 (86.1)	4600 (212)	6000 (506)	28	69	160	8300 (86.1)	97000 (212)	100000	15000	15000	15000	29000	30000	300 00	LQM (2014)
Anthracene	2400	5400	11000	31000 (1.17)	35000	37000	380	950	2200	520000	540000	540000	74000	74000	74000	150000	150000	150 000	LQM (2014)

Benzo(a)anthracene	7.2	11	13	11	14	15	2.9	6.5	13	170	170	180	29	29	29	49	56	62	LQM (2014)
Benzo(a)pyrene	2.2	2.7	3	3.2	3.2	3.2	0.97	2	3.5	35	35	36	5.7	5.7	5.7	11	12	13	LQM (2014)
Benzo(b)fluoranthene	2.6	3.3	3.7	3.9	4	4	0.99	2.1	3.9	44	44	45	7.1	7.1	7.1	13	15	16	LQM (2014)
Benzo(g,h,i)perylene	320	340	350	360	360	360	290	470	640	3900	4000	4000	640	640	640	1400	1500	1600	LQM (2014)
Benzo(k)fluoranthene	77	93	100	110	110	110	37	75	130	1200	1200	1200	190	190	190	370	410	440	LQM (2014)
Chrysene	15	22	27	30	31	32	4.1	9.4	19	350	350	350	57	57	57	93	110	120	LQM (2014)
Dibenz(a,h)anthracene	0.24	0.28	0.3	0.31	0.32	0.32	0.14	0.27	0.61	3.5	3.6	3.6	0.57	0.57	0.58	1.1	1.3	1.4	LQM (2014)
Fluoranthene	280	560	890	1500	1600	1600	52	130	290	23000	23000	23000	3100	3100	3100	63	6300	6400	LQM (2014)
Fluorene	170	400	860	2800 (30.9)	3800 (76.5)	4500 (183)	27	67	160	63000 (30.9)	68000	71000	9900	9900	9900	20000	20000	20000	LQM (2014)
Indeno(1,2,3-cd)pyrene	27	36	41	45	46	46	9.5	21	39	500	510	510	82	82	82	150	170	180	LQM (2014)
Naphthalene	2.3	5.6	13	2.3	5.6	13	4.1	10	24	190 (76.4)	460 (183)	1100 (432)	4900	4900	4900	1200 (76.4)	1900 (183)	3000	LQM (2014)
Phenanthrene	95	220	440	1300 (36)	1500	1500	15	38	90	22000	22000	23000	3100	3100	3100	6200	6200	6300	LQM (2014)
Pyrene	620	1200	2000	3700	3800	3800	110	270	620	54000	54000	54000	7400	7400	7400	15000	15000	15000	LQM (2014)
Coal Tar (BaP as surrogate marker)	0.79	0.98	1.1	1.2	1.2	1.2	0.32	0.67	1.2	15	15	15	2.2	2.2	2.2	4.4	4.7	4.8	LQM (2014)
BTEX and TPH																			
Benzene	0.087	0.17	0.37	0.38	0.7	1.4	0.017	0.034	0.075	27	47	90	72	72	73	90	100	110	LQM (2014)
Toluene	130	290	660	880 vap (869)	1900	3900	22	51	120	56000 vap (869)	110000 vap (1920)	180000 vap (4360)	56000	56000	56000	87000 vap (869)	95000 vap (1920)	100000 vap (4360)	LQM (2014)

Ethylbenzene	47	110	260	83	190	440	16	39	91	5700 vap (518)	13000 vap (1220)	27000 vap (2840)	24000	24000	25000	17000 vap (518)	22000 vap (1220)	270 00 vap (284 0)	LQM (2014)
Xylene - o	60	140	330	88	210	480	28	67	160	6600 (478)	15000 (1120)	33000 (2620)	41000	42000	43000	17000 (478)	24000 (1120)	330 00 (262 0)	LQM (2014)
Xylene - m	59	140	320	82	190	450	31	74	170	6200 (625)	14000 (1470)	31000 (3460)	41000	42000	43000	17000 (625)	24000 (1470)	320 00 (346 0)	LQM (2014)
Xylene - p	56	130	310	79	180	430	29	69	160	5900 (576)	14000 (1350)	30000 (3170)	41000	42000	43000	17000 (576)	23000 (1350)	310 00 (317 0)	LQM (2014)
Aliphatic EC 5-6	42	78	160	42	78	160	730	1700	3900	3200 (304)	5900 (558)	12000 (1150)	570000 (304)	590000	600000	95000 (304)	130000 (558)	180 000 (115 0)	LQM (2014)
Aliphatic EC >6-8	100	230	530	100	230	530	2300	5600	13000	7800 (144)	17000 (322)	40000 (736)	600000	610000	620000	150000 (144)	220000 (322)	320 000 (736)	LQM (2014)
Aliphatic EC >8-10	27	65	150	27	65	150	320	770	1700	2000 (78)	4800 (190)	11000 (451)	13000	13000	13000	14000 (78)	18000 (190)	210 00 (451)	LQM (2014)
Aliphatic EC >10-12	130 (48)	330 (118)	760 (283)	130 (48)	330 (118)	760 (283)	2200	4400	7300	9700 (48)	23000 (118)	47000 (283)	13000	13000	13000	21000 (48)	23000 (118)	240 00(2 83)	LQM (2014)
Aliphatic EC >12-16	1100 (24)	2400 (59)	4300 (142)	1100 (24)	2400 (59)	4300 (142)	11000	13000	13000	59000 (24)	82000 (59)	90000 (142)	13000	13000	13000	25000 (24)	25000 (59)	260 00 (142)	LQM (2014)
Aliphatic EC >16-35	65000 (8.48)	92000 (21)	110000	65000 (8.48)	92000 (21)	110000	260000	270000	270000	160000 0	1700000	1800000	250000	250000	250000	450000	480000	490 000	LQM (2014)
Aliphatic EC >35-44	65000 (8.48)	92000 (21)	110000	65000 (8.48)	92000 (21)	110000	260000	270000	270000	160000 0	1700000	1800000	250000	250000	250000	450000	480000	490 000	LQM (2014)
Aromatic EC 5-7	70	140	300	370	690	1400	13	27	57	26000 (1220)	46000 (2260)	86000 (4710)	56000	56000	56000	76000 (1220)	84000 (2260)	920 00 (471 0)	LQM (2014)
Aromatic EC >7-8	130	290	660	860	1800	3900	22	51	120	56000 (869)	110000 (1920)	180000 (4360)	56000	56000	56000	87000 (869)	95000 (1920)	100 000 (436 0)	LQM (2014)
Aromatic EC >8-10	34	83	190	47	110	270	8.6	21	51	3500 (613)	8100 (1500)	17000 (3580)	5000	5000	5000	7200 (613)	8500 (1500)	930 0 (358 0)	LQM (2014)
Aromatic EC >10-12	74	180	380	250	590	1200	13	31	74	16000 (364)	28000 (899)	34000 (2150)	5000	5000	5000	9200 (364)	9700 (899)	100 00	LQM (2014)

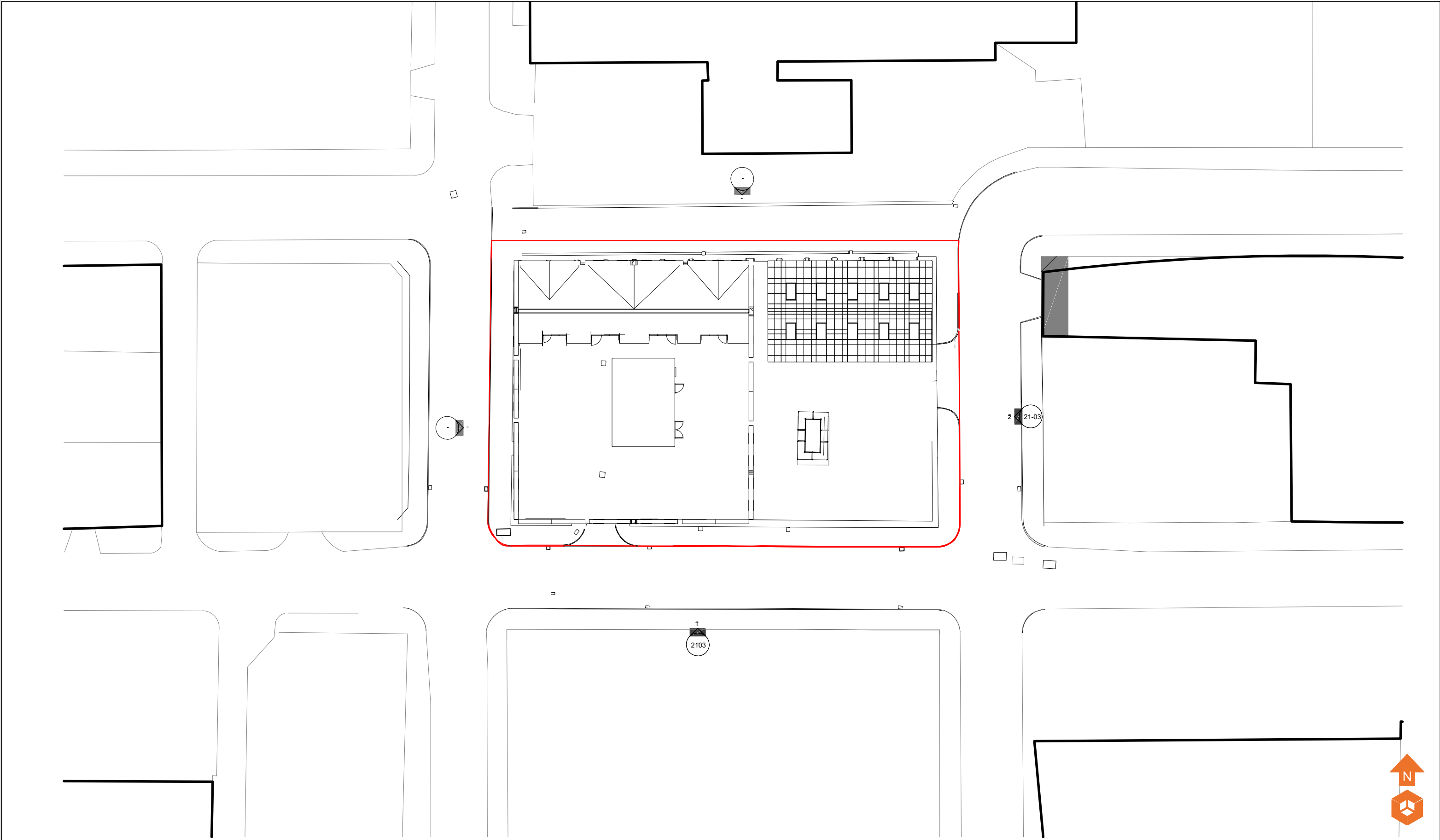
Aromatic EC >16-16	140	330	660	1800	2300 (419)	2500	23	27	130	36000 (169)	37000	38000	5100	5100	5000	10000	10000	10000	LQM (2014)
Aromatic EC >16-21	260	540	930	1900	1900	1900	46	110	260	28000	28000	28000	3800	3800	3800	7600	7700	7800	LQM (2014)
Aromatic EC >21-35	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	LQM (2014)
Aromatic EC >35-44	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	LQM (2014)
Aromatic EC >44-75	1600	1800	1900	1900	1900	1900	1200	2100	3000	28000	28000	28000	3800	3800	3800	7800	7800	7900	LQM (2014)
VOCs																			
1,2-dichloroethane (1,2-DCA)	0.0071	0.011	0.019	0.0092	0.013	0.023	0.0046	0.0083	0.016	0.67	0.97	1.7	29	29	29	21	24	28	LQM (2014)
1,1,1-trichloroethane	8.8	18	39	9	18	40	48	110	240	660	1300	3000	140000	140000	140000	57000 (1425)	76000 (2915)	100000 (6392)	LQM (2014)
1,1,2,2-tetrachloroethane	1.6	3.4	7.5	3.9	8	17	0.41	0.89	2	270	550	1100	1400	1400	1400	1800	2100	2300	LQM (2014)
tetrachloroethene	0.18	0.39	0.9	0.18	0.4	0.92	0.65	1.5	3.6	19	45	95	1400	1400	1400	810 (424)	1100 (951)	1500	LQM (2014)
tetrachloromethane (Carbon tetrachloride)	0.026	0.056	0.13	0.026	0.056	0.13	0.45	1	2.4	2.9	6.3	14	890	920	950	190	270	400	LQM (2014)
Trichloroethene	0.016	0.034	0.075	0.017	0.036	0.08	0.041	0.091	0.21	1.2	2.6	5.7	120	120	120	70	91	120	LQM (2014)
Trichloromethane (chloroform)	0.91	1.7	3.4	1.2	2.1	4.2	0.42	0.83	1.7	99	170	350	2500	2500	2500	2600	2800	3100	LQM (2014)
Chloroethene (Vinyl chloride)	0.00064	0.00087	0.0014	0.00077	0.001	0.0015	0.00055	0.001	0.0018	0.059	0.077	0.12	3.5	3.5	3.5	4.8	5	5.4	LQM (2014)
2,4,6 Trinitrotoluene (TNT)	1.6	3.7	8.1	65	66	66	0.24	0.58	1.4	1000	1000	1000	130	130	130	260	270	270	LQM (2014)

RDX	120	250	540	13000	13000	13000	17	38	85	210000	210000	210000	26000	26000	27000	49000 (18.7)	51000	530 00	LQM (2014)
HMX	5.7	13	26	6700	6700	6700	0.86	1.9	3.9	110000	110000	110000	13000	13000	13000	23000 (0.35)	23000 (0.39)	240 00 (0.4 8)	LQM (2014)
Aldrin	5.7	6.6	7.1	7.3	7.4	7.5	3.2	6.1	9.6	170	170	170	18	18	18	30	31	31	LQM (2014)
Dieldrin	0.97	2	3.5	7	7.3	7.4	0.17	0.41	0.96	170	170	170	18	18	18	30	30	31	LQM (2014)
Atrazine	3.3	7.6	17.4	610	620	620	0.5	1.2	2.7	9300	9400	9400	1200	1200	1200	2300	2400	240 0	LQM (2014)
Dichlovos	0.032	0.066	0.014	6.4	6.5	6.6	0.0049	0.01	0.022	140	140	140	16	16	16	26	26	27	LQM (2014)
Alpha-Endosulfan	7.4	18	41	160 (0.003)	280 (0.007)	410 (0.016)	1.2	2.9	6.8	5600 (0.003)	7400 (0.007)	8400 (0.016)	1200	1200	1200	2400	2400	250 0	LQM (2014)
alpha-Hexachlorocyclohexane	0.23	0.55	1.2	6.9	9.2	11	0.035	0.087	0.21	170	180	180	24	24	24	47	48	48	LQM (2014)
beta-hexachlorocyclohexanes	0.085	0.2	0.46	3.7	3.8	3.8	0.013	0.032	0.077	65	65	65	8.1	8.1	8.1	15	15	16	LQM (2014)
gamma-hexachlorocyclohexanes	0.06	0.14	0.33	2.9	3.3	3.5	0.0092	0.023	0.054	67	69	70	8.2	8.2	8.2	14	15	15	LQM (2014)
Chlorobenzene	0.46	1	2.4	0.46	1	2.4	5.9	14	32	56	130	290	11000	13000	14000	1300 (675)	2000 (1520)	290 0	LQM (2014)
1,2-Dichlorobenzene	23	55	130	24	57	130	94	230	540	2000 (571)	4800 (1370)	11000 (3240)	90000	95000	98000	24000 (571)	36000 (1370)	510 00 (324 0)	LQM (2014)
1,3-Dichlorobenzene	0.4	1	2.3	0.44	1.1	2.5	0.25	0.6	1.5	30	73	170	300	300	300	390	440	470	LQM (2014)
1,4-Dichlorobenzene	61	150	350	61	150	350	15	37	88	4400 (224)	10000 (540)	25000 (1280)	17000	17000	17000	36000 (224)	36000 (540)	360 00 (128 0)	LQM (2014)
VOCs Continued																			
1,2,3-Trichlorobenzene	1.5	3.6	8.6	1.5	3.7	8.8	4.7	12	28	102	250	590	1800	1800	1800	770 (134)	1100 (330)	160 0 (789)	LQM (2014)

1,2,4-Trichlorobenzene	2.6	6.4	15	2.6	6.4	15	55	140	320	220	530	1300	15000	17000	19000	1700 (318)	2600 (786)	4000 (1880)	LQM (2014)
1,3,5-Trichlorobenzene	0.33	0.81	1.9	0.33	0.81	1.9	4.7	12	28	23	55	130	1700	1700	1800	380 (36.7)	580 (90.8)	860 (217)	LQM (2014)
1,2,3,4-Tetrachlorobenzene	15	36	78	24	56	120	4.4	11	26	1700 (122)	3080 (304)	4400 (728)	830	830	830	1500 (122)	1600	1600	LQM (2014)
1,2,3,5-Tetrachlorobenzene	0.66	1.6	3.7	0.75	1.9	4.3	0.38	0.9	2.2	49 (39.4)	120 (98.1)	240 (235)	78	79	79	110 (39)	120	130	LQM (2014)
1,2,4,5-Tetrachlorobenzene	0.33	0.77	1.6	0.73	1.7	3.5	0.06	0.16	0.37	42 (19.7)	72 (49.1)	96	13	13	13	25	26	26	LQM (2014)
Pentachlorobenzenes	5.8	12	22	19	30	38	1.2	3.1	7	640 (43)	770 (107)	830	100	100	100	190	190	190	LQM (2014)
Hexachlorobenzene	1.8 (0.2)	3.3 (0.5)	4.9	4.1 (0.2)	5.7 (0.5)	6.7 (1.2)	0.47	1.1	2.5	110 (0.2)	120	120	16	16	16	30	30	30	LQM (2014)
Phenol	280	550	1100	750	1300	2300	66	140	280	760 _{dir} (31000)	1500 _{dir} (35000)	3200 _{dir} (37000)	760 _{dir} (31000)	1500 _{dir} (35000)	3200 _{dir} (37000)	760 _{dir} (31000)	1500 _{dir} (35000)	3200 _{dir} (37000)	LQM (2014)
Chlorophenols (excluding pentachlorophenol)	0.87 (g)	2	4.5	94	150	210	0.13 (g)	0.3	0.7	3500	4000	4300	620	620	620	1100	1100	1100	LQM (2014)
Pentachlorophenol	0.22	0.52	1.2	27 (16.4)	29	31	0.03	0.08	0.19	400	400	400	60	60	60	110	120	120	LQM (2014)
Carbon Disulphide	0.14	0.29	0.62	0.14	0.29	0.62	4.8	10	23	11	22	47	11000	11000	12000	1300	1900	2700	LQM (2014)
Hexachlorobutadiene	0.29	0.7	1.6	0.32	0.78	1.8	0.25	0.61	1.4	31	66	120	25	25	25	48	50	51	LQM (2014)

(g) derived based on 2,3,4,6-tetrachlorophenol; dir - based on a threshold protective of direct skin contact with phenol (guideline in brackets based on health effects following long term exposure provided for illustration only); (vap) calculated for vapour phase only. SOM – Soil Organic Matter; (4.5) solubility.

APPENDIX D: DRAWINGS



	Notes:					Client: Scott Hughes Design	Job No:	12-728	Date:	06.11.2020	 Environmental Engineering Partnership Ltd Taylor Road, Trafford Park Urmston, Manchester, M41 7JQ Tel: 0161 707 9612 E-mail: info@e3p.co.uk Website: www.e3p.co.uk
							Drawing No:	002	Scale:	NTS	
						Job Title: Goulden Street	Drawing Title: Proposed Development Plan		The client must not amend any drawing, design or other intellectual property produced by E3P Ltd without permission in writing from E3P Ltd in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, E3P Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or intellectual property.		
	P1	REVA	06.11.2020	LM	NS						
					Phase	Issue	Date	Drawn	Checked		