Borough Council of
King's Lynn &
West Norfolk

Contaminated Land
Inspection Report Review

GAS WORKS At
SANDY LANE,
HILGAY,
NORFOLK

January 2018

Reference no. s115100001852

Written by

Alex Grimmer
Senior Environmental Protection Officer

Reviewed by

Fabia Pollard
Scientific Officer

Approved by

Dave Robson
Environmental Health Manager

Please Note:

Borough Council of King's Lynn and West Norfolk
King's Court
Chapel Street
King's Lynn
Norfolk
PE30 1EX
Tel: 01553 616200
Email: environmentalquality@west-norfolk.gov.uk

Contents

Executive Summary

The Borough Council of King's Lynn and West Norfolk (BCKLWN) has a statutory duty to inspect its district for potentially contaminated land under Part 2A of the Environmental Protection Act 1990. The Borough Council's Part 2A inspection strategy identified Gas House, Hilgay (the site) as being of high priority due to the presence of a former country house gas works and potentially sensitive receptors.

Given the former site usage, an assessment of the site has been undertaken to assess the potential for harm to human health, property, ground/surface water and designated environmental receptors under Part 2A.

To gather information of the site's history a preliminary risk assessment and desk study were carried out by the Environmental Quality Team. From the evidence gathered during the desk study of the site history and a site walkover, the following can be stated: The site was historically a gas works associated with Wood Hall and took place during late 1900s. The site's present use is a residential property. During the desk study a plausible linkage was identified for the risk to human health. No plausible linkage was identified for property, controlled waters or the environment.

The site has been subject to a previous investigation under Part 2A of the Environmental Protection Act. During the site investigation elevated levels of organic and inorganic contamination were detected. After a detailed quantitative risk assessment it was determined that the site did not pose a significant risk to human health.

Following recent changes to the toxicological data for some of the contaminants of concern encountered a review of the earlier risk assessment has been undertaken. This report comprises that review.

The previous site investigation reported elevated levels of lead, arsenic and some polycyclic aromatic hydrocarbons. A reassessment of the recorded levels has been carried out using the revised risk assessment model CLEA v1.071 to calculate site specific assessment criteria. One result from one soil sample recorded levels of lead which were potentially a risk to human health. This sample was from 0.5 to 0.6 m below ground level. This is not considered to be a plausible exposure pathway via ingestion or inhalation. However, for completeness the risk assessment model was adjusted to take account of the sample depth. The recalculated site specific assessment criteria indicated that the levels of lead present at 0.5 - 0.6m do not pose a significant risk to human health.

Therefore a low risk to human health has been assigned to the site for its present usage. If the circumstances to the site change a further assessment of the risk posed to human health would be required.

Plausible source pathway receptor linkages were identified from the contaminated land risk assessment. A LOW risk to human health was assessed from contamination. As the risk posed is low, the site would be classified as Category 4 as set out in the Statutory Guidance. Therefore the site is not considered to be contaminated land under Part 2A of the Environmental Protection Act 1990.

1 Introduction

This report details a review of information and risk summary about land at Gas House, Sandy Lane Hilgay and provides a conclusion on the risk to human health, property, groundwater and the wider environment.

The Contaminated Land Statutory Guidance (DEFRA, 2012) suggests that where the authority has ceased its inspection and assessment of land as there is little or no evidence to suggest that it is contaminated land the authority should issue a written statement to that effect.

2 Desk Study Information

Location

The site's location is shown in Appendix B. The grid reference for the centre of the site is 562763, 297620. The nearest postcode is PE38 0JY.

Previous investigation

The site has been subject to a number of investigations which should be read in conjunction with this report. Table 1 below lists the reports used in compiling this written statement.

Table 1 Documents used in this report

Reference	Date	Author	Title
s115100001852	December 2012	A J Grimmer	Preliminary Site Assessment
s115100001852DQRA	May 2013	A J Grimmer	Detailed Risk Assessment of a Former Country House Gas Works

Overview of the previous investigations

The site is a tied cottage which is part of Wood Hall Farm and was used as a country house gas works. The gas works operated from approximately the late 19th century until some point before 1945. The Country House Gas Works was a small scale installation, which was located in the garden of a residential dwelling (Gas House), which is rented to adult workers. The Preliminary Site Assessment concluded that a site investigation would be required to assess the potential for contamination to be present on the site from the identified pollution linkage (Human Health).

A site investigation was undertaken with the permission of the site owner on 27th February 2013. The site investigation included the excavation of four boreholes, one in the centre of the former gasometer and three around its perimeter. The soils excavated from the boreholes was logged and representative soil samples were taken and dispatched to a UKAS accredited laboratory for analysis for analytes which are associated with gas works as described in the Preliminary Site Assessment.

The chemical analysis recorded elevated values of Arsenic, Lead and some species of PAHs when compared to Generic Assessment Criteria. A detailed quantitative risk assessment (DQRA) of the above contaminants of concern was undertaken using CLEA v1.06 and the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK). The DQRA returned results which indicated that no significant risk existed to the human health.

Revision to the Toxicological Data

Since 2013 new toxicological data has been released, which has changed some of the risk factors associated with undertaking DQRAs. The documents which detail the revisions to the risk assessment are the LQM/CIEH S4ULs for Human Health Risk Assessment developed by Land Quality Management and the Chartered Institute of Environmental Health and the C4SLs presented in the SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination developed by Contaminated Land: Applications in Real Environments.

The chemical data from the site investigation has been compared to Generic Assessment Criteria (GAC) within the S4ULs and C4Sls. The analytes which exceeded the relevant GACs has been presented in tables 1 and 2 below.

Table 2 Metal Exceedances

Analyte	GAC mg/kg	Min/Max recorded	No. of exceedances
Arsenic	37_1	13/47	1/5
Lead	200_1	270/1,700	5/5
1). C4SLs selected as the most appropriate level for assessing significant risk.			

Table 3 Polycyclic Aromatic Hydrocarbon Exceedances

Analyte	GAC mg/kg	Min/Max recorded	No. of exceedances
Benzo(a)anthracene	7.2_2	0.45/11	1/5
Benzo(b)fluoranthene	2.6_2	0.85/8.8	2/5
Benzo(a)pyrene	5_1	0.87/8.2	1/5
Dibenzo(a, h)anthrocene	0.24_2	<0.1/1.6	3/5
1). C4SLs selected as the most appropriate level for assessing significant risk. 2) S4ULs selected as values do not exist in the C4SL.			

Following the assessment of the chemical data against the GACs several exceedances were noted. Therefore a Detailed Quantitative Risk Assessment was undertaken to further assess the risk posed by the identified contamination. The risk assessment package CLEA v1.071 was considered to be the most appropriate risk assessment package to be used as this is the contains the most up to date toxicological data

Input parameters for CLEA v1.071.
Contact was made with the site owner who provided information regarding the situation on site, i.e. the number of people who are living on the site, their age and sex etc. Therefore the following parameters have been adopted for this assessment.

- The occupants are all male.
- They are over the age of 16.
- The garden is not used for growing vegetables.

Results of the CLEA risk assessment model
An initial risk assessment was undertaken using the above receptor information. The results are presented below compared against the derived site specific assessment criteria (SSAC). Risk assessment output is presented in Appendix A.

Table 4 Metal Exceedances

Analyte	SSAC mg/kg	Min/Max recorded	No. of exceedances
Arsenic	237_1	13/47	0/5
Lead	864_1	270/1,700	1/5
1). CLEA v 1.071			

Table 5 Polycyclic Aromatic Hydrocarbon Exceedances

Analyte	SSAC mg/kg	Min/Max recorded	No. of exceedances
Benzo(a)anthracene	107_1	0.45/11	0/5
Benzo(b)fluoranthene	26.9_1	0.85/8.8	0/5
Benzo(a)pyrene	28.9_1	0.87/8.2	0/5
Dibenzo(a, h)anthrocene	$2.14._1$	<0.1/1.6	0/5
1). CLEA v 1.071			

One result of the chemical analysis indicated an exceedance of the calculated SSAC. This related to one value of lead which was from a sample taken from between 0.3 to 0.5m below ground level (bgl). As the sample was from between 0.3 and 0.5m bgl it is considered that the inhalation and ingestion pathways are not applicable to this sample and do not represent a risk to human health. A revised site specific assessment criteria was calculated to reflect the assumption that ingestion and inhalation are not relevant exposure pathways. Risk assessment output is presented in Appendix B.

Table 6 Metal Exceedances

Analyte	SSAC mg/kg	Min/Max recorded	No. of exceedances
Lead	$209{,}000_1$	270/1,700	0/5
1). CLEA v 1.071			

The revised site specific assessment criteria indicate that the levels of contamination encountered on site do not pose a significant risk to human health.

5 Outcome of Revised Detailed Quantitative Risk Assessment

Conclusion

A plausible source pathway receptor linkage was identified in the previous reports for human health and was initially assessed during the Detailed Quantitative Risk Assessment which concluded that no significant risk was present.

This risk assessment revised the detailed quantitative risk assessment (DQRA) in light of recent revisions in toxicological data for the identified contaminants of concern. The outcome of the DQRA was that there was no significant risk to the only identified potential linkage (human health). As the risk posed is low, the site would be classified as Category 4 for human health as set out in the Statutory Guidance (Appendix C contains categorisations)

Part 2A status

Statutory Guidance states that 'If the authority considers there is little reason to consider that the land might pose an unacceptable risk, inspection activities should stop at that point.' In such cases the authority should issue a written statement to that effect. This report forms that written statement.

On the basis of its assessment, the authority has concluded that the land does not meet the definition of contaminated land under Part 2A and is not considered contaminated land.

Further Action

This assessment is based on the site's current use and is valid providing no changes are made to the soil or vegetation cover material, to surface water conditions or to the site's use.

No further assessment of the site is considered necessary under Part 2A unless additional information is discovered or if changes are made to the site.

Appendices

Appendix A: CLEA Risk Assessment model for the Revised Detailed Quantitative Risk Assessment (With inhalation and ingestion)

CLEA Software Version 1.071

Report generated 10-Nov-17

Report title Hilgay Country House Gas Works

Created by Alex Grimmer at BCKLWN

Environment Agency

RESULTS

Environment Agency

		Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?		Top Two applied?	Apply Top 2 Approach to Produce Group						
		oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal		Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
1	Arsenic (C4SL adult)	2.37E+02	8.08E+02	NR	1.00	0.29	NR	NR	No	No	Yes	Yes	No	No	No	No	Yes
2	Lead (C4SL adult)	8.64E+02	NR	NR	1.00	NR	NR	NR	No	No	Yes	Yes	No	Yes	No	No	No
3	Benz[a]anthracene	1.07E+02	2.62E+02	NR	1.00	0.41	NR	1.03E+01 (sol)	No	No	Yes	No	No	No	No	No	No
4	Benzo[b]fluoranthene	2.69E+01	7.99E+01	NR	1.00	0.34	NR	7.29E+00 (sol)	No	No	Yes	No	No	No	No	No	No
5	Benzo[a]pyrene (C4SL adult)	2.89E+01	6.33E+01	NR	1.00	0.46	NR	5.46E+00 (vap)	No	No	Yes	No	Yes	Yes	No	No	No
6	Dibenz[ah]anthracene	2.14E+00	6.27E+00	NR	1.00	0.34	NR	2.36E-02 (vap)	No	No	Yes	No	No	No	No	No	No
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

Environment Agency

	Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?		Top Two applied?	Apply Top 2 Approach to Produce Group					
	oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal		Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
21																
22																
23																
24																
25																
26																
27																
28																
29																
30																

Environment Agency

		Soil Distribution				Media Concentrations													
		Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.6m	Outdoor dust at 1.4m	Indoor Vapour	Outdoor Vapour at 0.6m	Outdoor Vapour at 1.4m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
		%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
1	Arsenic (C4SL adult)	99.9	0.1	0.0	100.0	2.37E+02	NR	1.19E+02	1.01E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	NA	NA	NA	NA
2	Lead (C4SL adult)	100.0	0.0	0.0	100.0	8.64E+02	NR	4.32E+02	3.68E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	NA	NA	NA	NA
3	Benz[a]anthracene	100.0	0.0	0.0	100.0	1.07E+02	1.25E-03	5.35E+01	4.55E-08	0.00E+00	5.98E-07	1.61E-07	0.00E+00	NA	NA	NA	NA	NA	NA
4	Benzo[b]fluoranthene	100.0	0.0	0.0	100.0	2.69E+01	1.51E-05	1.35E+01	1.15E-08	0.00E+00	8.48E-09	3.30E-08	0.00E+00	NA	NA	NA	NA	NA	NA
5	Benzo[a]pyrene (C4SL adult)	100.0	0.0	0.0	100.0	2.69E+01	1.13E-05	1.44E+01	1.23E-08	0.00E+00	6.50E-09	3.21E-08	0.00E+00	NA	NA	NA	NA	NA	NA
6	Dibenz[ah]anthracene	100.0	0.0	0.0	100.0	2.14E+00	1.78E-06	1.07E+00	9.11E-10	0.00E+00	9.52E-10	1.91E-09	0.00E+00	NA	NA	NA	NA	NA	NA
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			

Environment Agency

	Soil Distribution				Media Concentrations													
	Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.5m	Outdoor dust at 1.4m	Indoor Vapour	Outdoor vapour at 0.5m	Outdoor vapour at 1.4m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
	%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
21																		
22																		
23																		
24																		
25																		
26																		
27																		
28																		
29																		
30																		

Environment Agency

		Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
		Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Backgrnd (ing)	Backgrnd (inhalation)	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Backgrnd (ing)	Backgrnd (inhalation)
1	Arsenic (C4SL adult)	2.87E-04	0.00E+00	1.30E-05	1.11E-06	0.00E+00	0.00E+00	0.00E+00	95.65	0.00	4.35	0.00	0.00	0.00	0.00	0.00
2	Lead (C4SL adult)	6.27E-04	0.00E+00	0.00E+00	2.60E-06	0.00E+00	0.00E+00	0.00E+00	99.59	0.00	0.00	0.41	0.00	0.00	0.00	0.00
3	Benz[a]anthracene	1.30E-04	0.00E+00	2.55E-05	5.03E-07	1.10E-07	7.24E-07	1.33E-07	83.55	0.00	16.45	0.00	0.00	0.00	0.00	0.00
4	Benzo[b]fluoranthene	3.26E-05	0.00E+00	6.42E-06	1.27E-07	1.57E-09	1.33E-06	1.57E-07	83.55	0.00	16.45	0.00	0.00	0.00	0.00	0.00
5	Benzo[a]pyrene (C4SL adult)	3.50E-05	0.00E+00	6.89E-06	1.36E-07	1.21E-09	0.00E+00	0.00E+00	83.28	0.00	16.40	0.32	0.00	0.00	0.00	0.00
6	Dibenz[ah]anthracene	2.59E-06	0.00E+00	5.10E-07	1.01E-08	1.76E-10	4.83E-07	3.98E-07	83.55	0.00	16.45	0.00	0.00	0.00	0.00	0.00
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Environment Agency

	Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produce	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															

Environment Agency

		Oral Health Criteria Value (µg kg^{-1} BW day^{-1})		Inhalation Health Criteria Value (µg kg^{-1} BW day^{-1})		Oral Mean Daily Intake (µg day^{-1})	Inhalation Mean Daily Intake (µg day^{-1})	Air-water partition coefficient (K_{aw}) (cm^3 cm^{-3})	Coefficient of Diffusion in Air (m^2 s^{-1})	Coefficient of Diffusion in Water (m^2 s^{-1})	log K_{oc} (cm^3 g^{-1})	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor (g g^{-1} DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
1	Arsenic (C4SL adult)	ID	0.3	ID	0.0035	NR	NR	NR	NR	NR	NR	NR	0.03	0.5	1	1	1
2	Lead (C4SL adult)	ID	0.63	NR	0	NR	NR	NR	NR	NR	NR	NR	0	0.5	1	0.6	0.64
3	Benz[a]anthracene	ID	0.155	ID	0.0015	0.06	0.011	3.16E-05	4.60E-06	3.80E-10	4.89	5.91	0.13	0.5	1	1	1
4	Benzo[b]fluoranthene	ID	0.039	ID	0.00038	0.11	0.013	2.05E-05	4.36E-06	3.62E-10	5.02	6.06	0.13	0.5	1	1	1
5	Benzo[a]pyrene (C4SL adult)	ID	0.042	ID	0.0003	NR	NR	1.76E-05	4.38E-06	3.67E-10	5.11	6.18	0.13	0.5	1	1	1
6	Dibenz[ah]anthracene	ID	0.0031	ID	0.00003	0.04	0.033	5.40E-06	4.08E-06	3.40E-10	5.27	6.38	0.13	0.5	1	1	1
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

Environment Agency

	Oral Health Criteria Value (µg kg^{-1} BW day^{-1})		Inhalation Health Criteria Value (µg kg^{-1} BW day^{-1})		Oral Mean Daily Intake (µg day^{-1})	Inhalation Mean Daily Intake (µg day^{-1})	Air-water partition coefficient (K_{aw}) (cm^3 cm^{-3})	Coefficient of Diffusion in Air (m^2 s^{-1})	Coefficient of Diffusion in Water (m^2 s^{-1})	log K_{oc} (cm^3 g^{-1})	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor (g g^{-1} DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
21																
22																
23																
24																
25																
26																
27																
28																
29																
30																

Environment Agency

		Soil-to-water partition coefficient ($cm^3 g^{-1}$)	Vapour pressure (Pa)	Water solubility ($mg L^{-1}$)	Soil-to-plant concentration factor for green vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for root vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for fruiting vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tree fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)
1	Arsenic (C4SL adult)	5.00E+02	NR	1.25E+06	0.00043 fw	0.0004 fw	0.00023 fw	0.00033 fw	0.0002 fw	0.0011 fw
2	Lead (C4SL adult)	1.00E+03	NR	2.96E+05	0.00419 fw	0.00402 fw	0.00731 fw	0.0074 fw	0.00020 fw	0.00022 fw
3	Benz[a]anthracene	2.70E+03	1.24E-06	3.80E-03	model	model	model	model	model	model
4	Benzo[b]fluoranthene	3.64E+03	6.34E-06	2.00E-03	model	model	model	model	model	model
5	Benzo[a]pyrene (C4SL adult)	4.48E+03	2.00E-06	3.80E-03	0.00041 fw	0.00178 fw	0.00055 fw	0.00050 fw	0.00000 fw	0.00004 fw
6	Dibenz[ah]anthracene	6.48E+03	1.66E-10	6.00E-04	model	model	model	model	model	model
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Environment Agency

	Soil-to-water partition coefficient ($cm^3 g^{-1}$)	Vapour pressure (Pa)	Water solubility ($mg L^{-1}$)	Soil-to-plant concentration factor for green vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for root vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tuber vegetables ((mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for non-woody fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for shrub fruit ((mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for trees fruit ((mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

Appendix B: CLEA Risk Assessment model for the Revised Detailed Quantitative Risk Assessment (Without ingestion and inhalation)

CLEA Software Version 1.071

Report generated 10-Nov-17

Report title Hilgay Country House Gas Works

Created by Alex Grimmer at BCKLWN

Environment Agency

RESULTS

CLEA Software Version 1.071 Report generated 10-Nov-17 Page 2 of 11

Environment Agency

		Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?		Top Two applied?	Apply Top 2 Approach to Produce Group					
		oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal		Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
1	Lead (C4SL adult)	2.09E+05	NR	NR	1.00	NR	NR	NR	No	No	Yes	Yes	No	Yes	No	No	No
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

Environment Agency

	Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?		Top Two applied?	Apply Top 2 Approach to Produce Group						
	oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal		Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit	
21																	
22																	
23																	
24																	
25																	
26																	
27																	
28																	
29																	
30																	

Environment Agency

		Soil Distribution				Media Concentrations													
		Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.0m	Outdoor dust at 1.4m	Indoor Vapour	Outdoor Vapour at 0.0m	Outdoor Vapour at 1.4m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
		%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
1	Lead (C4SL adult)	100.0	0.0	0.0	100.0	2.09E+05	NR	1.05E+05	5.91E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	NA	NA	NA	NA
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			

Environment Agency

	Soil Distribution				Media Concentrations													
	Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.5m	Outdoor dust at 1.5m	Indoor Vapour	Outdoor vapour at 0.5m	Outdoor vapour at 1.5m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
	%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
21																		
22																		
23																		
24																		
25																		
26																		
27																		
28																		
29																		
30																		

Environment Agency

		Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
		Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
1	Lead (C4SL adult)	0.00E+00	0.00E+00	0.00E+00	6.30E-04	0.00E+00	0.00E+00	0.00E+00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Environment Agency

	Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produce	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															

Environment Agency

		Oral Health Criteria Value (µg kg^{-1} BW day^{-1})	Inhalation Health Criteria Value (µg kg^{-1} BW day^{-1})	Oral Mean Daily Intake (µg day^{-1})	Inhalation Mean Daily Intake (µg day^{-1})	Air-water partition coefficient (K_{aw}) (cm^3 cm^{-3})	Coefficient of Diffusion in Air (m^2 s^{-1})	Coefficient of Diffusion in Water (m^2 s^{-1})	log K_{oc} (cm^3 g^{-1})	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor (g g^{-1} DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
1	Lead (C4SL adult)	ID	0.63	NR	0	NR	NR	NR	NR	NR	NR	0	0.5	1	0.6	0.64
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Environment Agency

	Oral Health Criteria Value (µg kg^{-1} BW day^{-1})		Inhalation Health Criteria Value (µg kg^{-1} BW day^{-1})		Oral Mean Daily Intake (µg day^{-1})	Inhalation Mean Daily Intake (µg day^{-1})	Air-water partition coefficient (K_{aw}) (cm^3 cm^{-3})	Coefficient of Diffusion in Air (cm^2 s^{-1})	Coefficient of Diffusion in Water (cm^2 s^{-1})	log K_{oc} (cm^3 g^{-1})	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor (g g^{-1} DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
21																
22																
23																
24																
25																
26																
27																
28																
29																
30																

CLEA Software Version 1.071 Report generated 10-Nov-17 Page 10 of 11

Environment Agency

		Soil-to-water partition coefficient ($cm^3 g^{-1}$)	Vapour pressure (Pa)	Water solubility (mg L^{-1})	Soil-to-plant concentration factor for green vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for root vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tree fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)
1	Lead (C4SL adult)	1.00E+03	NR	2.96E+05	0.00419 fw	0.00402 fw	0.00731 fw	0.00074 fw	0.00020 fw	0.00022 fw
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Environment Agency

	Soil-to-water partition coefficient ($cm^3 g^{-1}$)	Vapour pressure (Pa)	Water solubility ($mg L^{-1}$)	Soil-to-plant concentration factor for green vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for root vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g^{-1} plant DW or FWbasis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g^{-1} plant DW or FWbasis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tree fruit (mg g^{-1} plant DW or FWbasis over mg g^{-1} DW soil)
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

Appendix C: Risk Assessment Methodology

The Model Procedures for the Management of Land Contamination (CLR11[1]) provide the technical framework for applying a risk management process when dealing with contaminated land.

The Borough Council's Contaminated Land Strategy has identified priority sites based on mapping and documentary information. The Contaminated Land Inspection Report collates all the existing information on the site and develops a conceptual site model to identify and assess potential pollutant linkages and to estimate risk.

The risk assessment process focuses on whether there is an unacceptable risk, which will depend on the circumstances of the site and the context of the decision. The Council has used a process adapted from CIRIA C552, Contaminated Land Risk Assessment, a guide to good practice[2] to produce the conceptual site model and estimate the risk of harm to defined receptors. This involves the consideration of the probability, nature and extent of exposure and the severity and extent of the effects of the contamination hazard should exposure occur.

The probability of an event can be classified as follows:

- Highly likely: The event appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution;
- Likely: It is probable that an event will occur, or circumstances are such that the event is not inevitable, but possible in the short term and likely over the long term;
- Low likelihood: Circumstances are possible under which an event could occur, but it is not certain even in the long term that an event would occur and it is less likely in the short term;
- Unlikely: Circumstances are such that it is improbable the event would occur even in the long term.

The severity of the hazard can be classified as follows:

- High: Short term (acute) risk to human health likely to result in 'significant harm' as defined by the Environment Protection Act 1990, Part IIA. Short term risk of pollution of sensitive water resources. Catastrophic damage to buildings or property. Short term risk to an ecosystem or organism forming part of that ecosystem (note definition of ecosystem in 'Contaminated Land Statutory Guidance, April 2012');
- Medium: Chronic damage to human health ('significant harm' as defined in 'Contaminated Land Statutory Guidance, April 2012'), pollution of sensitive water resources, significant change in an ecosystem or organism forming part of that ecosystem (note definition of ecosystem in 'Contaminated Land Statutory Guidance, April 2012');

[1] https://www.gov.uk/guidance/land-contamination-risk-management
[2] https://www.brebookshop.com/samples/142102.pdf

- Low: Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ('significant harm' as defined in 'Contaminated Land Statutory Guidance, April 2012'). Damage to sensitive buildings, structures or the environment.

Once the probability of an event occurring and hazard severity has been classified, a risk category can be assigned from the table below:

		Hazard		
		High	Medium	Low
Probability	High Probability	Very High Risk	High Risk	Moderate Risk
	Likely	High Risk	Moderate Risk	Moderate/Low Risk
	Low Probability	Moderate risk	Moderate/Low Risk	Low Risk
	Unlikely	Moderate/Low Risk	Low Risk	Very Low Risk

Very High Risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) if required to clarify the risk and to determine the potential liability. Some remedial work may be required in the longer term.
Moderate risk	It's possible that harm could arise to a designated receptor from an identified hazard. However, it is relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that harm would be relatively mild.
Moderate/Low risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, if any harm were to occur it is more likely that harm would be relatively mild.
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is unlikely to be severe.

Determination of contaminated land
Contaminated Land Statutory Guidance, April 2012

Human Health

Category	
1	The local authority should assume that a significant possibility of significant harm exists in any case where it considers there is an unacceptably high probability, supported by robust science-based evidence that significant harm would occur if no action is taken to stop it. For the purposes of this Guidance, these are referred to as "Category 1: Human Health" cases. Land should be deemed to be a Category 1: Human Health case where: (a) The authority is aware that similar land or situations are known, or are strongly suspected on the basis of robust evidence, to have caused such harm before in the United Kingdom or elsewhere; or (b) The authority is aware that similar degrees of exposure (via any medium) to the contaminant(s) in question are known, or strongly suspected on the basis of robust evidence, to have caused such harm before in the United Kingdom or elsewhere; (c) The authority considers that significant harm may already have been caused by contaminants in, on or under the land, and that there is an unacceptable risk that it might continue or occur again if no action is taken. Among other things, the authority may decide to determine the land on these grounds if it considers that it is likely that significant harm is being caused, but it considers either: (i) that there is insufficient evidence to be sure of meeting the "balance of probability" test for demonstrating that significant harm is being caused; or (ii) that the time needed to demonstrate such a level of probability would cause unreasonable delay, cost, or disruption and stress to affected people particularly in cases involving residential properties.
2	Land should be placed into Category 2 if the authority concludes, on the basis that there is a strong case for considering that the risks from the land are of sufficient concern, that the land poses a significant possibility of significant harm, with all that this might involve and having regard to Section 1. Category 2 may include land where there is little or no direct evidence that similar land, situations or levels of exposure have caused harm before, but nonetheless the authority considers on the basis of the available evidence, including expert opinion, that there is a strong case for taking action under Part 2A on a precautionary basis.
3	Land should be placed into Category 3 if the authority concludes that the strong case described in 4.25(a) does not exist, and therefore the legal test for significant possibility of significant harm is not met. Category 3 may include land where the risks are not low, but nonetheless the authority considers that regulatory intervention under Part 2A is not warranted. This recognises that placing land in Category 3 would not stop others, such as the owner or occupier of the land, from taking action to reduce risks outside of the Part 2A regime if they choose. The authority should consider making available the results of its inspection and risk assessment to the owners/occupiers of Category 3 land.

Human Health

Category	
4	The local authority should consider that the following types of land should be placed into Category 4: Human Health: (a) Land where no relevant contaminant linkage has been established. (b) Land where there are only normal levels of contaminants in soil, as explained in Section 3 of this Guidance. (c) Land that has been excluded from the need for further inspection and assessment because contaminant levels do not exceed relevant generic assessment criteria in accordance with Section 3 of this Guidance, or relevant technical tools or advice that may be developed in accordance with paragraph 3.30 of this Guidance. (d) Land where estimated levels of exposure to contaminants in soil are likely to form only a small proportion of what a receptor might be exposed to anyway through other sources of environmental exposure (e.g. in relation to average estimated national levels of exposure to substances commonly found in the environment, to which receptors are likely to be exposed in the normal course of their lives).