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LONDON BOROUGH OF SOUTHWARK

PHASE TWO LAND QUALITY ASSESSMENT: CAMBERWELL OLD CEMETERY

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EXECUTIVE SUMMARY

In August 2008 Enviros Consulting Ltd was commissioned by the London Borough of Southwark to undertake an investigation at the site of placed material in the north of Camberwell Old Cemetery. Further investigation was completed in February 2009. Key factual information is summarised in the table below.

Aspect	Description
Current Site Activities	The placed material is located in the north of the site in a mound off one of the main routes through the cemetery. The placed material is thicker further away from the access road at the northern end of the mound and shallower at the southern end.
Surrounding Land Uses	North – Ryedale road, with residential properties and Peckham Rye Park beyond; East – Underhill Road with residential properties beyond; West – Forest Hill Road and Woodvale road with Camberwell New Cemetery and railway line beyond; and South – residential properties.
Site sensitivity	The closest BGS borehole log indicates the aquifer (Woolwich and Reading Beds) to be protected by approximately 12m of London Clay. Site not located within a groundwater Source Protection Zone. No known watercourses located within 500m of the site and little potential for baseflow. Surface water drains are present in the wider cemetery, details of where these discharge to are not known. Ecological sensitivity is assessed as very low. No ecological sensitive areas have been identified within 1km of the site.
Ground Investigation	The initial ground investigation comprised a total of 9 trial pits and 10 window sample boreholes between the 26th and 27th August 2008. The additional investigation comprised a further 18 window sample boreholes between the 18th and 20th February 2009. The trial pits were excavated to a maximum depth of 2.9m bgl and the window sample holes to a maximum depth of 7m bgl.
Ground Conditions	The material in the mound generally comprised a brown sandy clay with frequent gravels of flint and chalk, brick fragments, ash, concrete and occasional wood. The made ground ranged in thickness from 0.7m in the most southern part of the mound, to 5m towards the north of the mound. Black sandy clay was identified around TP101 and EWS1 containing plastic, wood, metal, concrete, brick, wire and paper and a degrading waste odour. Black made ground was also present at WS101, EWS3, EWS5, EWS9 EWS11, EWS12, and EWS15 – EWS18. The natural strata was present under the Made Ground and generally comprised a light brown/orange to grey soft clay.
Chemical analysis	Eighty two samples were analysed (eighty from Made Ground and two from natural strata) for a combination of the following: heavy metals, pH and sulphate, total cyanide, asbestos screen, speciated Total Petroleum Hydrocarbons, Extractable Petroleum Hydrocarbons, speciated polyaromatic hydrocarbons (PAH), total phenols and total organic carbon. In addition a total of 8 samples were analysed for Waste Acceptance Criteria (WAC).

Aspect	Description
Conceptual model of the site	As the material has been placed on site over a period of time there may be physically distinct materials deriving from specific loads brought onto site from different sources, leading to localised areas of contamination. The following sources of contamination have been identified from the comparison of analytical data for soils with generic assessment criteria: ♦ Isolated occurrence of chrysotile (white) asbestos in one window sample hole (WS104); ♦ Hotspot area(s) within the made ground containing localised significantly elevated PAHs, TPH and cyanide; and ♦ Remaining made ground containing widespread slightly elevated benzo(a)pyrene. The receptors relevant to the site and possible pathways are: ♦ Current and future site users (direct contact, inhalation or accidental ingestion); and ♦ Grave diggers (direct contact, inhalation or accidental ingestion).

Conclusions

The material in the mound has been derived from a number of sites and discarded at the cemetery and is therefore waste. Currently there is no Environmental Permit or WML exemption in place for the site and prior to any use of the material the permitting situation will need to be resolved with the Environment Agency.

Risks associated with continuation of existing use - For continued current use it has been assessed that current site users are at a moderate/low risk from localised significantly elevated PAHs and TPH in the made ground. This is due to the particularly elevated concentrations, but also the lack of open access and the vegetation cover at the site. Current site users are also considered to be at a low risk from asbestos in the vicinity of WS104, as asbestos is only known to be present in one location and there is limited use of the site.

Risks associated with redesign and future use as a cemetery - If the placed material were to be stabilised and landscaped so the area could be used as part of the cemetery, potential high and moderate risks exist from localised significantly elevated PAHs and TPH to grave diggers and future site users. This is due to the particularly elevated nature of PAHs and the potential for regular short-term exposure. These risks would require mitigation in order to reduce them to an acceptable level before the site could be used.

Grave diggers and future site users would be at a moderate and moderate/ low risk from exposure to asbestos respectively. Potential moderate and moderate/low risks also exists from widespread slightly elevated benzo(a)pyrene.

Recommendations

Option 1: Continued current use

- The area should be fenced to prevent public access and complete vegetation cover should be maintained;
- The area of identified asbestos contaminated soil should be clearly marked as an area not be disturbed, or excavated and disposed off site; and

- The Environment Agency should be contacted to seek advice on obtaining an Environmental Permit.

Option 2: Future use as a cemetery

In addition to the recommendations above, the following are recommended actions if the area is to be used for a cemetery:

- The volume of material which comprises the hotspot(s) should either be excavated and disposed off site or treated and replaced, subject to agreement from the Environment Agency. Appropriate risk management procedures should be implemented to control potential exposure, especially of site workers during excavation works;
- A detailed quantitative risk assessment (DQRA) should be completed to assess whether the widespread slightly elevated PAHs are at concentration which pose a risk to future site users;
- Subject to the results of the DQRA, the Environment Agency should be contacted to seek advice on obtaining an Environmental Permit or exemption to enable the non-hazardous material to remain on-site; and
- The proposed use of the site should be discussed with the planning officer to determine if Planning Permission is required for change of use / waste permitting / materials movement in the area.

In terms of mitigation measures to make the site suitable for use, a number of options exist, these include:

- Removal of asbestos, PAH and TPH hotspot materials, and subject to the results of the DQRA demonstrating that the remaining material is suitable for use on site, this remaining material could be re-profiled and left on site;
- Installation of full depth cap to ensure that all future grave excavations are within clean materials; or
- Installation of partial depth cap to prevent exposure of site users and appropriate long term management of H&S and waste issues at the site.

All of the above options will require a feasibility study to be carried out with input from cemetery designers to ensure solution is practical for the design and management of the cemetery. The first option (partial removal) may allow the remaining material to be either exempted from WML requirements or re-profiled as non–waste materials under the CLAIRE Code of Practice as part of the development, providing remaining material is considered suitable for use. The third option (installation of a partial cap) would also require long-term management to ensure that graves are being constructed in a manner that minimises exposure to both site users and groundworkers.

1. INTRODUCTION

In August 2008 Enviros Consulting Ltd was commissioned by the London Borough of Southwark to undertake an investigation at the site of placed material in the north of Camberwell Old Cemetery.

The objectives of the Enviros work were to:

- provide information on the nature of the placed material;
- to assess the implication of any land quality risks and liabilities associated with the continued current use of the site; and
- to identify any works and actions required to clarify, manage and mitigate any unacceptable risks.

Further investigation was completed in February 2009. The objectives were to:

- to provide further information on the nature of the tipped material, across the mound as a whole but also in the vicinity of TP101, TP108, WS104 and WS109;
- undertake chemical analysis to assist in the assessment of risks from the material; and
- provide a detailed report summarising the characteristics of the material and information on the options for management or disposal of material.

Assessment of the stability of the material is beyond the scope of this site investigation.

1.1 Scope of Work

The scope of work for each investigation included the following activities:

- review of geological, hydrogeological and hydrological information to establish environmental sensitivities at the site and its environs;
- site walkover and intrusive investigation including collection of soil samples for chemical analysis;
- recording of visual/olfactory observations of contamination and logging the composition of the placed material; and
- preparation a report, including a qualitative risk assessment and outlining the findings and recommendations including requirements for any further work and likely waste classifications.

A more detailed account of the methodology of the work is given in Appendix 1. This report presents the information supplied to us by third party sources together with our own observations during the environmental site investigation. Our conclusions and opinions have been based upon all of this information. However, the third party data has been accepted at face value and has not been independently verified by Enviros. Enviros therefore can give no warranty, representation or assurance as to the accuracy or completeness of such information.

1.2 Framework for Contaminated Land Assessment

Contaminated land risk assessment is based on development of a conceptual model for the site. This model is a representation of the relationship between contaminant sources, pathways and receptors developed on the basis of hazard identification. Risk assessment is the process of collating known information on a hazard or set of hazards in order to estimate actual or potential risks to receptors. The guiding principle behind this approach is an attempt to establish connecting links between a hazardous source, via an exposure pathway to a potential receptor, referred to as a 'pollutant linkage'. If there is no pollutant linkage, then there is no risk. Therefore, only where a viable pollutant linkage is established does this assessment go on to consider the level of risk.

This approach is in accordance with the Department for the Environment, Food and Rural Affairs (DEFRA) Statutory Guidance on Contaminated Land (Ref. 1) and the DEFRA/ Environment Agency (EA) Model Procedures (CLR11) (Ref. 2). The risk assessment undertaken in this document comprises 'generic quantitative risk assessment' as defined in CLR11.

Analysis for waste assessment is in line with the conceptual model for the site and is based upon the technical guidance WM2 on the interpretation of the definition and classification of hazardous waste published by the Environment Agency.

2. SITE PROFILE

Address: Camberwell Old Cemetery, Forest Hill Road, Camberwell, London, SE22 0QP	**Local Authority**: London Borough of Southwark
GR: 534666, 174190	**Site Area**: approx. 0.3 hectare

2.1 Site Location

The placed material is located within Camberwell Old Cemetery (Figure 1). The following land uses border the cemetery:

- North – Ryedale road, with residential properties and Peckham Rye Park beyond;
- East – Underhill Road with residential properties beyond;
- West – Forest Hill Road and Woodvale road with Camberwell New Cemetery and railway line beyond; and
- South – residential properties.

2.2 Site Description

The placed material is located in the north of Camberwell Old Cemetery and is accessed off one of the main road routes through the cemetery. The material is level with the ground level of the main cemetery and forms a plateau extending northwards as adjacent ground levels drop. The placed material is thicker further away from the access road at the northern end of the mound and shallower at the southern end. The mound is located close to residential properties on Ryedale.

2.3 Surface Cover

The material is un-surfaced and has vegetation cover present across the majority of the site. Visible brick is present on the surface of the mound.

2.4 Environmental Setting

The site is located at approximately 50m above Ordnance Datum (Ref. 3). The topography of the area is generally flat but the original ground level, beneath placed material, slopes downwards to the north.

2.4.1 Geology

The geological map (Ref. 4) indicates that the site area is underlain by the London Clay. The London Clay is the area is underlain by the Blackheath Beds (where present), and then the Woolwich and Reading Beds and then the Upper Chalk.

A log provided by BGS for a borehole located approximately 400m south-east of the site indicates the presence of 12m of brown silty clay. This is underlain by a further 41m of grey silty clay with pockets of fine sand.

The borehole log indicates that water was struck at 39m below ground level within the Woolwich and Reading Beds. The log indicates the absence of the Blackheath Beds in this area.

The thicknesses and composition of the geology beneath the site are summarised in the table below.

Table 1 Summary of Site Geology & Hydrogeology

Unit	Composition	Thickness	Presence of Groundwater?	Aquifer Type
London Clay	Clay	Approx 12m	No	Non-Aquifer
Woolwich and Reading Beds	Sands and clays	~ 41m	Yes	Minor aquifer
Upper Chalk	Chalk	+ 60m	Yes	Major

2.4.2 Hydrogeology

The site lies directly on the London Clay, classified as a non-aquifer by the Environment Agency (Ref 5).

The Woolwich and Reading Beds are classified as a minor aquifer. Below this unit, the deposits of Upper Chalk are classified as a major aquifer. The water abstracted from the Chalk is used for a variety of uses including for potable supplies. The presence and thickness of the London Clay will serve to protect the Chalk from the downward migration of any contamination.

The site is not located within a groundwater Source Protection Zone. The nearest groundwater abstraction is located approximately 1.1km north-east of the site.

2.4.3 Hydrology

There are no known surface water bodies within 500m of the site. Surface water drains are present in the wider cemetery, details of where these discharge to are not known.

2.4.4 Ecology

There are no areas of high (e.g. Ramsar sites, Special Areas of Conservation, Special Protection Areas, Sites of Special Scientific Interest, National Nature Reserves and Marine Nature Reserves) or medium ecological importance (e.g. Local Nature Reserves) within 1km of the site.

2.4.5 Site Sensitivity

The sensitivity of the site with respect to groundwater, surface water and ecological receptors is classified as follows:

Groundwater sensitivity*: Low*

The closest BGS borehole log indicates the aquifer to be protected by approximately 12m of London Clay. The site is not located within Groundwater Protection Zone.

Surface water sensitivity: Moderate / *Low*

No known watercourses located within 500m of the site, and there is little pot for baseflow. Surface water drains are present in the wider cemetery, deta where these discharge to are not known.

Ecological sensitivity: *Very Low*

No ecological sensitive areas have been identified within 1km of the site

3. METHODOLOGY OF THE ENVIROS INVESTIGATIONS

3.1 Objectives

The objective of the site investigations was to provide environmental information and waste classification on the material present for Southwark Council.

3.2 Sampling Strategy

All sampling was carried out with due regard to existing standards and guidelines including the British Standard Code of Practise for Investigation of Potentially Contaminated Sites: BS10175 (Ref. 6) and standard protocols developed on site investigation works for our own in-house purposes.

The intrusive site investigations were carried out between on the 26th and 27th August 2008 and 18th to 29th February 2009. The further investigation was designed to provide further information on the nature of the tipped material, across the mound as a whole but also in the vicinity of TP101, TP108, WS104 and WS109 where elevated concentrations wer eidneitfed in the August investigation.

All works were carried out under full time supervision of Enviros consultants. Enviros completed the collection and chemical scheduling of soil samples. A plan of the exploratory investigation locations is presented as Figure 2.

3.2.1 Intrusive work

The intrusive work comprised a total of 9 trial pits and 28 window sample boreholes. The trial pits were excavated to a maximum depth of 2.9m below ground level (bgl) and the window sample boreholes to a maximum depth of 7m bgl. Arisings were logged in general accordance with BS5930.

3.2.2 Soil Sampling

The soil samples were placed in clean plastic tubs or glass amber jars provided by the accredited laboratory. All sample containers were appropriately labelled with their location and depth. All samples were packed into cold cool boxes as appropriate with chain of custody documentation and sent by courier from site directly to laboratory at the end of each day of intrusive work.

3.2.3 Analytical suite

The chemical analysis was carried out by ALcontrol Laboratories. All the soil parameters were analysed using ISO 17025 accredited methods with the exception of asbestos screening. When available, analytical methods with MCERTS accreditation have been used (as denoted in the laboratory analysis results). MCERTS accreditation is associated with soil type.

3.2.4 Soil Inorganics

In total thirty nine samples were analysed (thirty seven from Made Ground and two from natural strata) during the August 2008 site investigation. Forty three further samples were analysed from the February 2009 investigation. The samples were analysed for the following inorganic suite to assess the placed material across the site. This suite was selected based on visual observations and experience of potential contaminants of such material.

- Heavy metals (arsenic, cadmium, chromium, copper, nickel, lead, mercury, zinc, selenium, water soluble boron and vanadium) (all samples);

- pH and sulphate (all samples);

- Total cyanide (all samples); and

- Asbestos screen (all samples).

3.2.5 Soil Organics

The same eighty two samples from the Made Ground and natural strata were analysed for the following organic determinands:

- Speciated Total Petroleum Hydrocarbons (60 samples);

- Extractable Petroleum Hydrocarbons (19 samples);

- Speciated polyaromatic hydrocarbons (PAH) (all samples);

- Total phenols (all samples); and

- Total Organic Carbon (20 samples).

In addition a total of 8 samples were analysed for Waste Acceptance Criteria (WAC).

4. INTERPRETATION OF FIELD DATA

This chapter collates all the factual information from this investigation and provides a summary of the placed materials. The trial pit and window sample logs for these investigations are included in Appendix 2.

4.1 Geology

4.1.1 Made Ground

The material in the mound generally comprised a brown sandy clay with frequent gravels of flint and chalk, brick fragments, ash, concrete and occasional wood. The Made Ground was present at a thickness ranging from 0.7m in the most southern part of the mound, to 5m towards the north of the mound.

Black sandy clay was identified around TP101 and WS101 (located adjacent to each other) at a depth of 1.5-2.0m bgl. The material contained plastic, wood, metal, concrete, brick, wire and paper and a degrading waste odour was noted in both locations. Nearby EWS1 contained three horizons of black clayey sand and sandy gravel from 0.65m to 3.5m, including black clayey sand with brick flint, metal, ash and a slight fuel odour. EWS9 contained black ashy clay with plastic, wood and occasional concrete from 1.6m bgl to 2.7m bgl. Thinner black horizons were present in EWS2, EWS3, EWS5, EWS11, EWS12, and EWS15 – EWS18.

4.1.2 Natural Strata

The natural strata present under the Made Ground generally comprised a light brown/orange to grey soft clay. The natural strata appeared to slope down from the entrance to the mound at the southern point to the edges of the mound in the northern most point following natural ground levels.

4.2 Groundwater

No perched water was encountered in the placed material during the investigation. The investigation focused on the raised material and did not advance to depth in the natural strata.

4.3 Flame Ionisation Detector (FID) Screening Results

FID screening, which indicates the presence of volatile organic compounds, was completed during the August 2008 investigation but did not record elevated readings in the majority soil samples. The samples which recorded FID results over 20ppm are shown in Table 2 below. As none of these are significantly elevated, FID screening was not completed in the February investigation..

Table 2 FID results over 20 ppm

Sample location and depth	FID reading (ppm)	Soil Type	Odour
TP101 (1.7m)	65	Black sandy clay with plastic, wood, metal, concrete and brick.	Degrading waste odour
TP104 (0.3m)	25	Brown sandy clay with brick, concrete, wood, glass and	No odour

Sample location and depth	FID reading (ppm)	Soil Type	Odour
		ash.	
TP104 (0.8m)	100	Stiff light brown sandy clay.	No odour
WS101 (1.6m)	40	Black sandy gravels with frequent ash and bricks.	No odour
WS101 (2.1m)	30	Black ashy sand with concrete, wood, plastic and brick.	No odour
WS108 (3.2m)	40	Grey sandy clay with wood, flints, bricks and ash.	No odour

5. INTERPRETATION OF CHEMICAL ANALYSIS DATA

5.1 Chemical Analysis

Eighty two soil samples obtained during the Enviros investigation were scheduled for analysis for a range of determinands. A full copy of the results is included in Appendix 3.

5.2 Division of data

As the material has been placed on site over a period of time there may be physically distinct materials deriving from specific loads brought onto site from different sources (e.g. material containing metals and PAHs associated with ash or metals in construction rubble). This may lead to localised areas of contamination related to specific loads placed on the site or areas where physically distinct material has been spread.

In the initial review of the data, only the data from the underlying natural ground was separated from the placed material. However, there appeared to be some distinction within the placed material by colour during the investigation (namely “black made ground” and “brown made ground”), and these horizons were often found at the same location with different layers of black and brown made ground. Assessment of the material by these soil types did not reveal a significant chemical distinction in the data.

Further spatial division of the data with elevated contaminants has been considered and this has indicated that some spatial patterns may occur, and is discussed in Section 5.5.

5.3 Assessment Criteria

In order to put the analytical results into context, the data has in the first instance been assessed in relation to several sets of guidelines. This is a Tier 1 assessment with data interpreted against generic assessment criteria, which have been derived and published by an authoritative body and are designed to be protective in a range of conditions. This is discussed in more detail in Appendix 4.

5.4 Chronic Hazards to Human Health

Derivation of Soil Screening Thresholds

The data have been assessed against values equivalent to Soil Guideline Values (SGVs) called Enviros Screening Values (ESVs). Between August 2008 and January 2009 the Environment Agency made the following changes to the way we determine whether contaminant concentrations in soil are a risk to health:

- withdrew all the SGV reports;
- issued draft and final new versions of the CLEA methodology (SR3), formerly called CLR10, and the CLEA model;
- issued draft and final versions of the methodology used to calculate the toxicity data entered into the model (SR2), formerly called CLR9; and

- stated that the current TOX reports will be replaced by new ones by March 2009 (old reports to be withdrawn as each new one is issued).

In the absence of any current SGV reports Enviros has calculated screening thresholds (ESVs) for the standard CLEA land uses using the current CLEA methodology and model (version 1.04).

For contaminants where a TOX report has been published, toxicity values from the relevant TOX report have been applied. For all other contaminants we have completed a literature review in line with the methodology set out in SR2. Physical properties data have been taken from Environment Agency report SR7 where possible, and for contaminants not listed in SR7 a literature search for appropriate data has been undertaken in accordance with SR2.

A detailed description of the methodology used to derive ESVs is provided in Appendix 4, together with model output and references.

The chemical results have been compared to residential end use with no vegetable uptake. This is to enable the data to be put into context and to establish whether any risks to site users onto the site exist. The residential end use with no vegetable uptake scenario, considers daily exposure to children in a residential setting including activities such as digging. This is considered most appropriate as a Tier 1 screening value for the public open space use of the site. However, it is likely to be conservative for adult grave diggers, and extremely conservative for the public who are unlikely to spend significant periods on site.

Soil Organic Matter

The mobility of organic contaminants can be strongly influenced by the organic content of the soil. This particularly affects the exposure pathways involving absorption by plants and inhalation for soil vapours as well as the leachability of these organics. The soil organic matter was ascertained by measuring the total organic carbon and applying a correction factor as set out in BS1377.

In the Made Ground the average soil organic matter (SOM) was 3% and within the natural material the SOM was 4.3%. ESVs based on 2.5% have therefore been used for the assessment of organic contaminants for both soil types. As organic content increases the mobility of organic contaminants decreases. Basing the ESV on a lower organic content is therefore a conservative assumption.

5.5 Hydrocarbon analysis

Some hydrocarbon mixtures can pose a carcinogenic risk to human health primarily due to the presence of carcinogenic PAHs in the mixture. In addition, the mixtures as a whole may pose a general non-cancer risk to human health. In order to assess the first aspect of the toxicology of hydrocarbons, assessment has been made of the carcinogenic PAHs to assess that risk to human health.

In addition, the total petroleum hydrocarbons (TPH) are evaluated to assess the non-cancer risk. Hydrocarbons are known to have an additive effect. This means that even if each individual hydrocarbon is not at a level to pose a risk, the combined effect may pose a risk. The mixture specific thresholds derived by Enviros consider the concentration of each individual hydrocarbon group and also the effect of each group being combined in a sample, thus the thresholds vary for each individual sample with the concentrations and also the mix of hydrocarbons present. The assessment is in accordance with the guidance from the Total Petroleum Hydrocarbon Criteria Working Group Series (Ref. 8). The calculated screening values are shown in Appendix 5.

A summary of the chemical analysis for organic determinands identified at the site is presented in Table 3 below.

Table 3 Organic Determinands

Determinand	Analyses	SGV2-residential use without vegetable consumption (Exceeded)[1]	Min[2]	Max[2]	Location of Max	US_{95}[3] (excluding outliers)	Outliers	US_{95} (i
All Made Ground Samples								
Naphthalene	80	3920 (10)	9	490000	EWS1 (1.75m)	5340	490000 ppb in EWS1 (1.75m); 440000 ppb in EWS1 (3.35m)	
Benzo(a)pyrene	80	1027 (49)	15	300000	TP101 (0.35m)*	27000		
Benzo(b)fluoranthene	80	10190 (12)	15	330000	TP101 (0.35m)*	28200		
Benzo(k)fluoranthene	80	10292 (8)	14	170000	TP101 (0.35m)*	13200		
Chrysene	80	9736 (10)	10	300000	TP101 (0.35m)*	25600		
Dibenzo(ah)anthracene	80	1010 (16)	9	54000	TP101 (0.35m)*	4380		
Indeno(123cd)pyrene	80	10140 (8)	18	170000	TP101 (0.35m)*	14000		
Benzene	62	32.6 (3)	10	130	EWS1 (3.35m)*	10.7	68 ppb in EWS1 (1.75m); 130 ppb in EWS1 (3.35m); 72 ppb in TP101 (1.7m)	
Toluene	62	6698 (0)	10	220	EWS1 (1.75m)	10	220 ppb in EWS1 (1.75m); 130 ppb in EWS1 (3.35m); 130 ppb in TP101 (1.7m)	
TPH	62	Mixture specific 930-	1200	12,000,000	EWS1 (1.75)			
Phenol	80	37183 (0)	0.15	11	EWS1 (1.75m)	0.155	11 ppb in EWS1 (1.75m); 6.8 ppb in EWS1 (3.35m)	
Natural strata								
Naphthalene	2	3920 (0)	340	390	TP105 (1.2m)*	523		
Benzo(a)pyrene	2	1027 (1)	470	4000	TP104 (0.8m)	13400		
Benzo(b)fluoranthene	2	10190 (0)	650	4400	TP104 (0.8m)	14400		
Benzo(k)fluoranthene	2	10292 (0)	290	2800	TP104 (0.8m)	9470		
Chrysene	2	9736 (0)	460	3200	TP104 (0.8m)	10500		
Dibenzo(ah)anthracene	2	1010 (0)	86	1000	TP104 (0.8m)	3430		
Indeno(123cd)pyrene	2	10140 (0)	280	3000	TP104 (0.8m)	10200		
Benzene	1	32.6 (0)	<10	<10	TP104 (0.8m)	0		
Toluene	1	6698 (0)	<10	<10	TP104 (0.8m)	0		
Phenol	2	37183 (0)	<0.15	<0.15	TP104 (0.8m)*	0.15		
TPH	1	Mixture specific (0)		190,000		-	-	

Notes:

1. Number of samples with concentrations above the ESV given in brackets

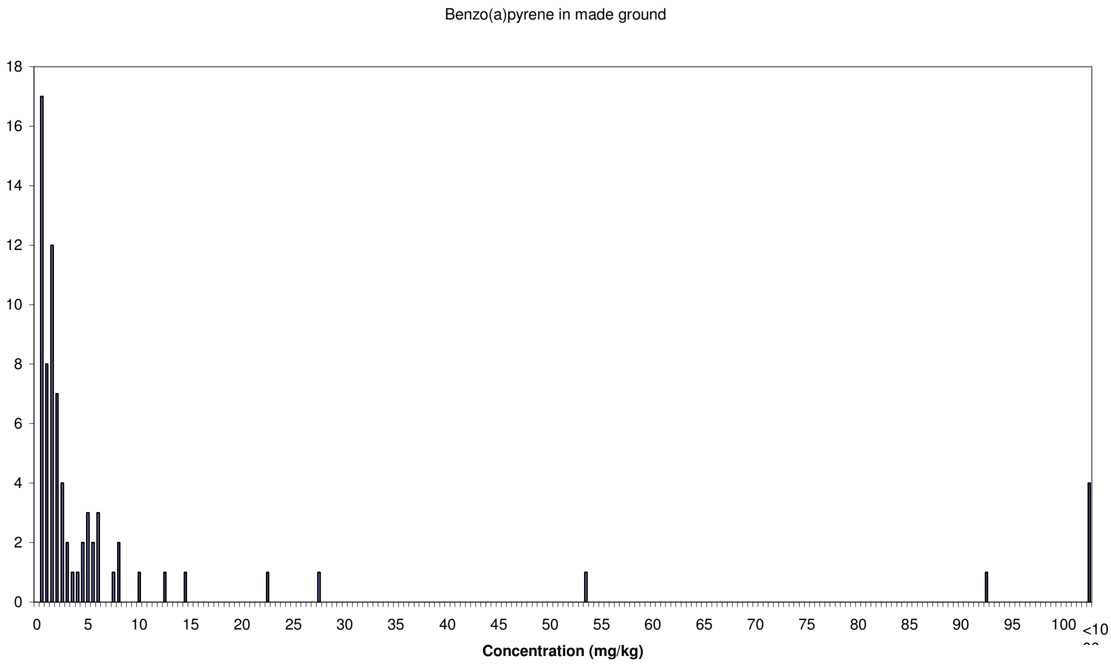
All Units µg/kg .

US95 (excluding outliers) and outliers only calculated where maximum exceeds SGV

Denotes ESV

The maximum values for all determinands tested in the natural material were below the relevant ESV, except for the benzo(a)pyrene from TP104. One sample from natural material was analysed for total petroleum hydrocarbons, and the result was below the calculated mixture specific thresholds for residential end use without vegetable consumption or inhalation into buildings.

Analysis of the hydrocarbon data in made ground, particularly that for PAHs indicates a wide range in the data as shown in the chart below. With the PAHs, benzo(a)pyrene has been used as a marker, due to its prevalence and higher toxicity.



A plot of the data has indicated that the more elevated benzo(a)pyrene concentrations are clustered in the east of the site in TP101, EWS1, EWS2 and TP109 and also in the centre of the site at TP108 and EWS5. Due to the paucity of data in between these locations it is unclear if these are linked.

Another line of evidence adding weight to the conceptual model that there may be localised areas of contamination is a double ratio plot of the data. This is used to establish "signatures" of PAHs associated with specific sources. Data clustered on a double ratio plot is likely to have a similar source. The data from EWS1, EWS1 and TP101 all plot is a similar location. The TP108 and EWS5 also are in a similar location. [Interpretation clustering in not definitive but in general it is noted the higher concentration have a higher ratio of benzo(a)anthracene to pyrene which is often associated with coal or coal tar rather than coal ash.]

Samples of the black made ground from TP101 and adjacent EWS1 had concentrations between 160,000 µg/kg and 300,000 µg/kg. Other nearby locations had concentrations up to 53,000 µg/kg. The area of the hotspot is partially constrained to the east and north by samples with significantly lower concentrations at ESW3, WS101, EWS11, EWS12. However, it is not well constrained to the northwest.

In the centre of the site a sample of coal containing brown made ground from EWS5 had a concentration of 92,000 µg/kg, with a concentration of up to 53,000µg/kg in adjacent TP108. The coal containing brown made ground at EWS5 is visually different to other made ground materials and can be considered a hotspot. However, the incidence of other elevated benzo(a)pyrene concentrations close to EWS5 suggest that this may be an area of different material.

Data from these locations appears to be different to other material found at the site and the data has therefore been reconsidered with these samples and adjacent elevated samples separated from the reminder of the made ground. The adjacent samples typically show concentrations between the significant exceedances and the remainder of the made ground.

Table 4 Organic Determinands in Made Ground with hotspot data divided from remaining samples

Determinand	Analyses	SGV2-residential use without vegetable consumption (Exceeded)[1]	Min[2]	Max[2]	Location of Max	US_{95}[3] (excluding outliers)	Outliers	US (e
Hotspot samples								
Naphthalene	9	3920 (7)	560	490000	EWS1 (1.75m)	245000		
Benzo(a)pyrene	9	1027 (9)	14000	300000	TP101 (0.35m)*	202000		
Benzo(b)fluoranthene	9	10190 (9)	11000	330000	TP101 (0.35m)*	208000		
Benzo(k)fluoranthene	9	10292 (8)	7000	170000	TP101 (0.35m)*	98300		
Chrysene	9	9736 (9)	14000	300000	TP101 (0.35m)*	191000		
Dibenzo(ah)anthracene	9	1010 (9)	1900	54000	TP101 (0.35m)*	32800		
Indeno(123cd)pyrene	9	10140 (8)	7100	170000	TP101 (0.35m)*	104000		
Benzene	8	32.6 (3)	10	130	EWS1 (3.35m)*	70.4		
Toluene	8	6698 (0)	10	220	EWS1 (1.75m)	121		
TPH	8	Mixture specific (3)	640,000	12,000,000	EWS1 (1.75)			
Phenol	9	37183 (0)	0.15	11	EWS1 (1.75m)	4.58		
Remaining Made Ground samples								
Naphthalene	71	3920 (3)	9	6500	TP107 (2m)*	987		
Benzo(a)pyrene	71	1027 (40)	15	12000	WS108 (0.8m)*	2650		
Benzo(b)fluoranthene	71	10190 (3)	15	15000	WS108 (0.8m)*	3110		
Benzo(k)fluoranthene	71	10292 (0)	14	6300	WS108 (0.8m)*	1360		
Chrysene	71	9736 (1)	10	11000	WS108 (0.8m)*	2390		
Dibenzo(ah)anthracene	71	1010 (7)	9	2100	WS108 (0.8m)*	442		
Indeno(123cd)pyrene	71	10140 (0)	18	7000	WS108 (0.8m)*	1550		
Benzene	54	32.6 (0)	10	18	EWS5 (0.75m)*	10	18 ppm in EWS5 (0.75m); 17 ppm in WS101 (1.6m); 17 ppm in WS101 (2.1m)	
Toluene	54	6698 (0)	10	10	EWS1 (0.35m)*	10		
TPH	54	Mixture specific (0)	1200	1,300,000	EWS16 (2.55m)			
Phenol	71	37183 (0)	0.15	0.27	WS108 (0.8m)*	0.15	0.27 ppm in WS108 (0.8m)	

Notes:

1. Number of samples with concentrations above the ESV given in brackets
All Units ug/kg .
US95 (excluding outliers) and outliers only calculated where maximum exceeds SGV
Denotes ESV

In the hotspot data most or all of the concentrations of PAHs exceeded the ESV and the US95s exceed the ESVs by up to three order of magnitude.

Three samples had benzene concentrations which exceeded the ESV, although these were not outliers and the US95 was below the ESV. No concentrations of phenol or toluene exceeded the ESVs.

Eight samples from the hotspot areas were analysed for total petroleum hydrocarbons, three of the results exceeded the calculated mixture specific thresholds for residential end use without vegetable consumption or inhalation into buildings. The three samples, from TP101 at 0.35m and 1.7m, and EWS5 were from the samples with highest PAH concentrations.

In the remaining made ground samples, 40 of the 71 samples exceeded the ESV for benzo(a)pyrene and the US95 exceeded the ESV by a factor of approximately 2.5. Further quantitative risk assessment considering site specific factors needs to be carried out to confirm the threshold to be applied although risk assessments on similar sites nearby have indicated that concentrations in this range are unlikely to be of concern for this type of land use. A number of the concentrations of other PAHs exceeded the ESV, particularly from WS108 which may be at the edge of the hotspot. However, the US95s were below the ESVs. No concentrations of phenol, benzene or toluene exceeded the ESVs.

Fifty four samples from the remaining made ground were analysed for total petroleum hydrocarbons, none of the results exceeded the calculated mixture specific thresholds for residential end use without vegetable consumption or inhalation into buildings.

5.6 Results of Inorganic Analysis on Soils

A summary of the chemical analysis for inorganic determinands identified at the site is presented in Table 5 below. With the exception of chromium, lead and cyanide, there were no exceedances of the relevant ESVs for any of the inorganic determinands within either the made ground or the natural ground.

There were twenty three exceedances of chromium, six exceedances of lead and one exceedence of cyanide within the made ground materials.

For chromium, twenty three of the eighty made ground samples marginally exceed the initial screening value. The data showed no clear spatial pattern and the 95th percentile upper estimate of average of the data of 31.3mg/kg is below the screening value. It is also noted that this screening value assumes that the any inhaled chromium is in the form of chromium (VI) which is less stable than the less toxic chromium III form. The inhalation of tracked back dust is significant when considering a residential garden as 50% of the indoor dust is assumed to derive from the garden. The amount of tracked back dust into houses is likely to be significantly smaller for the cemetery than for gardens at residential properties.

For lead, six samples marginally exceeded the initial screening value. The data showed no clear spatial pattern and the 95th percentile upper estimate of average of the data of 135mg/kg is below the screening value. The average is based on logged data for lead as the effects from lead tend to vary on a logarithmic scale.

For cyanide outliers were identified corresponding to the hotspot areas identified above (TP101, EWS1), and once these were removed the US95 values were below the ESVs.

Both of the natural ground samples exceeded the relevant ESVs for chromium, however no other determinads within the natural material (clay) exceeded the ESVs.

Table 5 Inorganic contaminants

Determinand	Analyses	SGV2-residential use without vegetable consumption (Exceeded)[1]	Min[2]	Max[2]	Location of Max (depth)	US_{95}[3] (excluding outliers)	Outliers	US_{95}[3] (inclu outlie
Made Ground								
Arsenic	80	25 (0)	3	19	EWS4 (0.75m)*	9.21		
Cadmium	80	30 (0)	0.2	0.8	EWS16 (2.55m)*	0.303	0.8 ppm in EWS16 (2.55m)	
Chromium	80	38 (23)	6.7	50	EWS4 (4.70m)*	31.3		
Lead	80	450 (6)	14	890	TP102 (0.6m)*	135		
Mercury	80	21 (0)	0.4	5.7	TP101 (0.35m)*	0.581	5.7 ppm in TP101 (0.35m); 3.0 ppm in EWS3 (1.35m); 2.8 ppm in TP106 (2.4m)	
Nickel	80	110 (0)	5.6	51	EWS4 (4.70m)*	28.4		
Selenium	80	334 (0)	3	3	EWS1 (1.75m)*	3		
Vanadium	80	230 (0)	13	99	EWS13 (2.65m)*	55.2		
Tot Cyanide	80	17 (1)	1	27	TP101 (0.35m)*	1.26	10 ppm in EWS1 (1.75m); 10 ppm in EWS1 (3.35m); 27 ppm in TP101 (0.35m); 9 ppm in TP101 (1.7m)	
pH	80	-	7.48	8.88	WS109 (2.6m)*	8.01	8.88 ppm in WS109 (2.6m)	
Natural Strata								
Arsenic	2	25 (0)	6	8	TP104 (0.8m)	13.3		
Cadmium	2	30 (0)	0.3	0.4	TP105 (1.2m)*	0.666		
Chromium	2	38 (2)	51	51	TP104 (0.8m)*	51		
Lead	2	450 (0)	46	97	TP105 (1.2m)*	704		
Mercury	2	15 (0)	<0.4	0.4	TP104 (0.8m)*	0.4		
Nickel	2	110 (0)	43	47	TP104 (0.8m)	57.6		
Selenium	2	335 (0)	<3	<3	TP104 (0.8m)*	3		
Vanadium[4]	2	230 (0)	89	92	TP105 (1.2m)*	100		
Cyanide (total)[5]	2	17 (0)	<1	<1	TP104 (0.8m)*	1		
pH	2	-	7.92	8.01	TP104 (0.8m)	8.25		

Notes:

1. Number of samples with concentrations above the ESV given in brackets
All Units mg/kg.
US95 (excluding outliers) only calculated where maximum exceeds SGV.
Denotes ESV
ESV based on free cyanide as posing an acute risk

5.7 Asbestos

In total, eighty samples from the made ground and two from the natural ground were analysed for asbestos.

Asbestos fibres were identified by the laboratory in one sample and this was from WS104 at 0.7m. The report indicated the fibres were chrysotile (white) asbestos. This sample was from an area not physically distinct from other Made Ground in the north of the mound.

Inhalation of asbestos fibres can lead to asbestosis and lung cancer. There is therefore potential for acute exposure to asbestos if excavations are carried out in this area.

5.8 Hazards to plants

Copper, zinc and boron are common contaminants of soil but are primarily considered due to their toxicity to plants rather than humans. The concentrations have been compared with Dutch Intervention Values (DIV) for ecotoxicological risk rather than human health (there is no relevant published threshold value for boron). A comparison of soil concentrations for made ground, clay and chalk is presented in Table 6.

Table 6 Phytotoxic metals

Determinand	Analyses	DIV (Exceeded)[1]	Min[2]	Max[2]	Location of Max (depth)	US_{95}[3] (excluding outliers)	Outliers	US_{95}[3] (including outli
Made Ground								
Boron	80	-	3.5	6	WS104 (2.8m)*	3.56	5 ppm in TP106 (2.4m); 4.7 ppm in WS103 (1.5m); 6 ppm in WS104 (2.8m)	
Copper	80	190 (0)	6	140	EWS7 (1.85m)*	38.6		
Zinc	80	720 (0)	25	480	EWS12 (0.75m)*	148		
Natural Ground								
Boron	2	-	<3.5	<3.5	TP104 (0.8m)*	3.5		
Copper	2	190 (0)	32	35	TP105 (1.2m)*	43		
Zinc	2	720 (0)	120	170	TP105 (1.2m)*	303		

All Units mg/kg.
Bold = DIV exceeded
Number in brackets indicates number of samples with concentrations exceeding the screening value.

None of the soil samples recorded concentrations of copper or zinc in excess of the assessment criteria. Concentrations of Boron were low.

5.9 Waste Classification

5.9.1 Justification of Analysis

A consideration of the conceptual model including current site uses is required when determining the analytical suite, to provide a robust set of analytical data for consideration. For this site the analytical suite as detailed in Chapter 3 takes into account the placed material.

5.9.2 Hazardous Waste Assessment

In order to determine how the material should be classified (i.e. inert, non hazardous or hazardous), the concentrations for each chemical parameter (inorganic and organic) analysed have been compared with our in-house threshold for hazardous waste. These thresholds have been derived following technical guidance WM2 on the interpretation of the definition and classification of hazardous waste published by the Environment Agency. The thresholds are based on risk phrases which are obtained from the Health and Safety Commission Approved Supply List (Eighth Edition) specific to each potential contaminant. The data was initially screened by considering the maximum values from all samples in the assessment. The results of the assessment are reproduced in Appendix 6.

The maximum values for all determinands, except asbestos and TPH within the hotspot areas, are under the hazardous waste thresholds, meaning that where asbestos and significantly elevated TPH are not present the material would be classified as non-hazardous waste. Subject to sufficient sample remaining, tests for oily waste will be scheduled to confirm this assessment for the TPH data is awaited.

5.9.3 Asbestos

Eighty two samples were analysed for asbestos. One sample tested positive for asbestos fibres. For disposal purposes, any material containing asbestos would be classified as hazardous waste, although it could be accepted at a non hazardous landfill with a cell for receive stabilised non reactive hazardous waste.

5.9.4 Waste Acceptance Criteria

Leachate analysis has been undertaken to determine whether the material could further be classified as inert waste. The results indicate that the material can be disposed as non-hazardous waste but cannot be disposed of as inert due to elevated leachate concentrations. Table 7 is a summary of the samples analysed for Waste Acceptance Criteria (WAC) for inert waste.

Table 7 Summary of WAC Testing

Sample ID	Depth (m bgl)	Classification	Reason for not inert waste	Material
TP102	0.6	Non-Hazardous	Leachable Sulphate	Light brown sandy clay with concrete, pipes, glass, brick and wood.
TP104	0.3	Non-Hazardous	Leachable Antimony and Sulphate	Brown sandy clay with brick, concrete, wood, glass and ash.
TP106	2.4	Non-Hazardous	Leachable Sulphate	Brown to black sandy clay with ash, brick and wood.

Sample ID	Depth (m bgl)	Classification	Reason for not inert waste	Material
			TDS	
TP108	1.3	Non-Hazardous	Leachable Fluoride and Sulphate	Brown sandy clay with tarmac and blue to green sheeting.
WS101	2.1	Non-Hazardous	Leachable Antimony TOC over 3%	Black ashy sand with concrete, wood, plastic and brick.
WS105	0.3	Inert (Although the presence of wood is likely to lead to a non hazardous classification)	-	Light brown slightly sandy clay with bricks, wood and glass..
WS107	2.7	Non-Hazardous	Leachable Antimony	Light brown slightly sandy clay with bricks and plastic.
WS108	3.2	Non-Hazardous	Leachable Antimony	Grey sandy clay with wood, flints, bricks and ash.

5.10 Summary

The following is a summary of the soil data at the site:

- Asbestos was identified in one of the eighty made ground samples. The asbestos was identified in WS104 0.7m depth and was identified as white asbestos fibres.

- Analysis of the hydrocarbon data in made ground, particularly that for PAHs, indicates that a spatial pattern to their distribution. Samples of the black made ground from TP101 and adjacent EWS1 had significantly elevated concentrations of benzo(a)pyrene and other PAHs. In addition, in the centre of the site, a sample of coal containing brown made ground from EWS5 had elevated concentration of PAHs. Data from these locations appears to be different to other materials found at the site and these have been considered as hotspots.

- In the hotspot data most or all of the concentrations of PAHs exceeded the ESV and the US95s exceed the ESVs by up to three order of magnitude. Three of the highest PAH samples from the hotspots also contained concentrations of total petroleum hydrocarbons which exceeded the calculated mixture specific thresholds for residential end use without vegetable consumption or inhalation into buildings.

- In the remaining made ground samples, 40 of the 71 samples exceeded the ESV for benzo(a)pyrene and the US95 exceeded the ESV by a factor of approximately 2.5. A number of the concentrations of other PAHs exceeded the ESV, however the US95s were below the ESVs.

- In the made ground and natural ground, the maximum concentrations of inorganic contaminants were all below SGVs for residential end use without plant uptake with the exception of chromium, lead and cyanide. None of the lead and chromium exceedence samples were outliers and the US_{95} "average" concentrations were below the respective ESVs for residential end use without plant uptake. For cyanide outliers were identified corresponding to the hotspot areas, and once these were removed the US95 values were below the ESVs.

- Material on site, with the exception of identified asbestos and TPH hotspot areas, is likely to be would be classified as non-hazardous waste. Subject to sufficient sample remaining further testing for oily waste to confirm this assessment for the TPH data will be scheduled.

- Material containing asbestos would be classified as hazardous waste.

6. CONCEPTUAL MODEL & EVALUATION OF POTENTIALLY UNACCEPTABLE RISKS

This chapter presents the conceptual model of the site based on the site investigation data and further evaluates the potentially unacceptable risks identified.

6.1 Conceptual Site Model

The conceptual model of the site has been developed to include the results obtained from the intrusive investigation. Identified sources, pathways and receptors are listed below and presented diagrammatically in Figure 3.

Sources of Contamination

The following sources of contamination have been identified from the comparison of analytical data for soils with generic assessment criteria:

- An isolated occurrence of chrysotile (white) asbestos fibres in WS104. It is likely that there is asbestos in the soil in the area around WS104 if this soil has come from a single contaminated source (see below);
- Possible asbestos contamination - the material present on site was tipped over an extended period of time and was from numerous sources, including what appear to be demolition wastes. We do not have any details regarding these sources but it is possible that there is asbestos contamination in some areas. Due to the nature of demolition, the placement of the wastes and the difficulty of sampling to prove a negative, there is the potential for asbestos to be present;
- Hotspots of Made Ground with significantly elevated PAHs, cyanide and TPH present in two areas; TP101, EWS1, EWS2 and potentially TP109, also at EWS5 and TP108; and
- Remainder of Made Ground containing widespread benzo(a)pyrene that is slightly elevated above the generic assessment criteria.

Pathways & Receptors

Receptors relevant to the site and possible pathways are summarised as follows:

Human Health

- Current and future site users (direct contact, inhalation or accidental ingestion); and
- Grave diggers (direct contact, inhalation or accidental ingestion).

Other Receptors

Controlled waters have not been considered as a receptor due to the presence of a non-aquifer beneath the site and the lack of surface water bodies within 500m.

Environmental Permitting

The site does not currently hold an Environmental Permit for the storage of waste materials on site and is therefore in breach of waste management regulations.

6.2 Evaluation of Potentially Unacceptable Risks

The potentially unacceptable risks associated with the sources, pathways and receptors identified above are further evaluated in this section. Potential pollutant linkages are evaluated by considering where viable pathways between sources and receptors exist. Risk is based on a consideration of both:

- the likelihood of an event (probability) [takes into account both the presence of the hazard and receptor and the integrity of the pathway];
- the severity of the potential consequence [takes into account both the potential severity of the hazard and the sensitivity of the receptor].

In accordance with the guidance, the following categorisation of risk has been developed to assist in qualitative assessment of potentially unacceptable risks:

Table 8 Categorisation of Risk

Term	Description
Very high risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
High risk	Harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
Moderate risk	It is possible that without appropriate remedial action harm could arise to a designated receptor. It is relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely that such harm would be relatively mild.
Low risk	It is possible that harm could arise to a designated receptor from an identified hazard. It is likely that, at worst if any harm was realised any effects would be mild.
Very Low risk	The presence of an identified hazard does not give rise to the potential to cause harm to a designated receptor.

The method of dealing with identified risks and the level of significance of those risks will be a function of site use. The following matrix summarises potential risks associated with current and future land uses. Further information on the risk assessment methodology used is given in Appendix 1. The method of dealing with identified risks and the level of significance of those risks will be a function of site use. The risks associated with each potential pollutant linkage under current and future use are considered in the following table.

Table 9 **Qualitative Risk Assessment for Current and Future Site Use**

Source	Pollutant	Receptors	Pathways to Receptor	Associated Hazard [Potential severity]	Likelihood of Occurrence	Risk
Continued Current Use						
Made Ground	Identified asbestos in area around WS104 and potential in soils not sampled	Site Users	Inhalation	Health risk [Medium]	Unlikely: Asbestos only found in one sample out of 80. Asbestos at 0.7m and identified as white asbestos fibres which could result in possible accidental exposure. Surrounding samples indicate absence of widespread asbestos so source may be limited to a discrete area, although further areas may be present. Site is not currently used but is fenced off. Contact unlikely during current site activities due to nature of the area (well vegetated).	**Low Risk [maintaining curr level of vegetatio**
	Localised hotpsots with PAHs, TPH, and cyanide	Site Users	Direct contact, inhalation; accidental ingestion	Health risk [Severe]	Unlikely: Highest concentrations of PAHs and elevated concentrations of cyanide and TPH present in two localised areas. Considered to relate to import of different material to remainder of mound. Contact unlikely during current site activities as well established vegetation is present, the area is infrequently visited, the contaminated areas are small, and the site is fenced off.	**Moderate/Low Ri [maintaining curr level of vegetatio**
	Widespead slightly elevated PAHs	Site Users	Direct contact, inhalation; accidental ingestion	Health risk [Medium]	Unlikely: Slightly elevated benzo(a)pyrene in remaining Made Ground, but across whole site. Contact unlikely during current site activities as well established vegetation is present, the area is infrequently visited, and site fenced off.	**Low Risk [maintaining curr level of vegetatio**
Future use as a cemetery						
Made Ground	Identified asbestos in area around WS104	Grave diggers	Inhalation	Health risk [Medium]	Likely: Asbestos found in one sample out of 80 at 0.7m. Surrounding samples indicate absence of widespread asbestos so source may be limited to a discrete area, although further areas may be present. The sample indicated fibres in soil which could result in possible accidental exposure. Grave diggers will be in regular contact with the soil.	**Moderate Risk**

Source	Pollutant	Receptors	Pathways to Receptor	Associated Hazard [Potential severity]	Likelihood of Occurrence	Risk
		Future site users	Inhalation	Health risk [Medium]	Low Likelihood: Asbestos found in one sample out of 80. Surrounding samples indicate absence of widespread asbestos so source may be limited to a discrete area, although further areas may be present. Site users may be exposed to arisings from grave digging, but exposure times will be of very limited duration..	**Moderate/Low R**
	Potential presence of asbestos in parts of the site not sampled	Grave diggers	Inhalation	Health risk [Medium]	Low Likelihood: No asbestos found in soil samples away from WS104, but based on nature and extent of wastes there is potential (albeit low) for asbestos fibres to be present in the soil which grave diggers may be exposed to.	**Moderate/Low R**
		Future site users	Inhalation	Health risk [Medium]	Unlikely: No asbestos found in soil samples away from WS104, but based on nature and extent of wastes there is potential (albeit low) for asbestos fibres to be present in the soil. Site users may be exposed to arisings from grave digging, but exposure times will be of very limited duration.	**Low Risk**
	Localised hotpsots with PAHs, TPH, and cyanide	Grave diggers	Direct contact, inhalation; accidental ingestion	Health risk [Severe]	Likely Highest concentrations of PAHs and elevated concentrations of cyanide and TPH present in two areas Grave diggers would have regular contact with soil. Grave diggers unlikely to be aware of contact and not have appropriate PPE. Exposure may be short-term but frequent	**High Risk**
		Future site users	Direct contact, inhalation; accidental ingestion	Health risk [Severe]	Low likelihood. Highest concentrations of PAHs and elevated concentrations of cyanide and TPH present in two areas. Prolonged contact with soil unlikely during future site use, although site users may be exposed to arising from grave digging. Site visitors may include children and regular walkers.	**Moderate Risk**
	Widespread slightly elevated PAHs	Grave diggers	Direct contact, inhalation; accidental	Health risk [Medium]	Likely Slightly elevated benzo(a)pyrene in remaining Made Ground. Grave diggers would have regular contact with soil and elevated PAHs are	**Moderate Risk**

Source	Pollutant	Receptors	Pathways to Receptor	Associated Hazard [Potential severity]	Likelihood of Occurrence	Risk
			ingestion		present throughout the Made Ground. Grave diggers unlikely to be aware of contact and not have appropriate PPE. Exposure may be short-term but frequent	
		Future site users	Direct contact, inhalation; accidental ingestion	Health risk [Medium]	Low likelihood. Slightly elevated benzo(a)pyrene in remaining Made Ground. Prolonged contact with soil unlikely during future site use, although site users may be exposed to arising from grave digging. Site visitors may include children and regular walkers.	**Moderate/Low Ri**

7. CONCLUSIONS AND RECOMMENDATIONS

Two options are being considered for the site:

- Continuation of existing use; and
- Landscaping of the material and use as part of the cemetery.

The implications for these options are considered in this chapter. Background information on the legislative framework for contaminated land, including Part 2A of the Environmental Protection Act 1990 is given in Appendix 7.

7.1 Conclusions

The material in the mound has been discarded and is therefore waste. Currently there is no Environmental Permit in place for the site and prior to any use of the material the permitting situation will need to be resolved. Key conclusions for each of the two options listed above are as follows:

7.1.1 Continuation of existing use

For continued current use it has been assessed that current site users are at a moderate/ low risk from localised significantly elevated PAHs and TPH in the made ground. This is due to the particularly elevated concentrations, but also the lack of open access and the vegetation cover at the site.

For continued current use it has been assessed that current site users are at a low risk from asbestos. This is due to the known asbestos only being present in one location at a depth of 0.7m and the very limited use of the site.

The site is suitable for continued current use provided that the risks are mitigated as described in the recommendations below.

7.1.2 Redesign and future use as a cemetery

If the area of placed material were to be stabilised and landscaped so the area could be used as part of the cemetery potential high and moderate risks exist from localised significantly elevated PAHs and TPH to grave diggers and future site users. This is due to the particularly elevated nature of PAHs and the potential for regular direct short-term exposure and indirect longer term exposure via tracked back dust. These risks would require mitigation in order to reduce them to an acceptable level before the site could be used as a cemtry.

Potential moderate and moderate / low risks exist from the widespread slightly elevated PAHs in the made ground to grave diggers and future site users in the future use as a cemetery. These risks would require further assessment and/or mitigation in order to reduce them to an acceptable level before the site could be used. The further assessment could include a detailed quantitative risk assessment (DQRA) for the site.

It has been assessed that grave diggers would be at a moderate risk from asbestos in the future use as a cemetery. This is due to the identified presence of asbestos within one location coupled with the regular contact grave diggers will have with the soil. Risks from the identified asbestos could be managed by ensuring the area is not disturbed or by removal.

The risk to future site users from asbestos fibres has been assessed as a moderate/ low risk. This is due to the identified presence of asbestos fibres within WS104 however; the risk from the asbestos is limited as it has only been identified at one location. Risks from the identified asbestos could be managed by ensuring the area is not disturbed or by removal.

7.2 Recommendations

Two options have been assessed to manage the materials at the site. The recommendations for implementing each of these options are outlined below.

7.2.1 Option 1: Continued current use

For continued use as infrequently used open space, it is recommended that the following take place:

- The area should be fenced to prevent public access and complete vegetation cover should be maintained across the area to minimise the potential for contact with PAHs and for dust generation from asbestos;

- The area of identified asbestos contaminated soil should be clearly marked as an area not be disturbed, or it should be excavated and disposed off site as hazardous (stabilised non reactive) waste; and

- The Environment Agency should be contacted to seek advice on obtaining an Environmental Permit or exemption to enable the non-hazardous material to remain on-site.

London Borough of Southwark should note that the exemptions to Environmental Permitting are in the process of being reviewed and it is likely that in mid to late 2009 a new exemption regime will be in place with fewer options for exemptions.

7.2.2 Option 2: Future use as a cemetery

If it is decided that the material is to remain in-situ (and an appropriate regulatory position can be agreed), and the area is to be used as a cemetery, the following are recommended to ensure that the site does not pose a risk to future site users:

- Until mitigation measures can be implemented the area should be fenced to prevent public access and complete vegetation cover should be maintained across the area to minimise the potential for contact with PAHs and for dust generation;

- The area of identified asbestos contaminated soil should be clearly marked as an area not be disturbed, or it should be excavated and disposed off site as hazardous (stabilised non reactive) waste;

- The volume of material which comprises the hotspot should be either excavated and disposed off site, or treated and replaced. Agreement should be sought with the EHO over the on-going management of potential asbestos (and other localised contaminants) within the mound and the widespread elevated PAHs across the site. Appropriate risk management procedures should be implemented to control potential exposure, especially of site workers during excavation works;

- A detailed quantitative risk assessment (DQRA) should be completed to assess whether the widespread slightly elevated PAHs are at concentrations which pose a risk to future site users. Agreement should be sought with the EHO over the results of this assessment;

- Subject to the results of the DQRA, the Environment Agency should be contacted to seek advice on obtaining an Environmental Permit or exemption to enable the non-hazardous material to remain on-site; and

- The proposed use of the site should be discussed with the planning officer to determine if Planning Permission is required for the area, either as part of waste regulation or change of use.

In terms of mitigation measures to make the site suitable for use, a number of options exist, these include:

- Removal of asbestos and hotspot materials, and subject to the results of the DQRA, the remaining material could be re-profiled and left on site;

- Installation of full depth cap to ensure that all future grave excavations are within clean material and therefore neither site users or grave diggers will be exposed to contact with elevated contaminants and/ or the presence of asbestos. However this would mean importation of material and the raising of site levels;

- Installation of partial depth cap to prevent exposure of site users and appropriate long term management of H&S and waste issues at the site. The capping may include: a geo-textile separator layer to alert grave diggers when they are excavating through potentially contaminated material and to prevent soil mixing with clean cap: and re-instatement of capping after burial to ensure shallow soils are clean and appropriate storage and disposal of contaminated soil.

All of the above options will require a feasibility study to be carried out with input from cemetery designers to ensure solution is practical for the design and management of the cemetery.

The first option (partial removal) may allow the remaining material to be either exempted from WML requirements or re-profiled as non–waste materials under the CLAIRE Code of Practice as part of the development providing remaining material is considered suitable for use. There would be no requirement for long term management. An exemption under paragraph 9 would require the material to be:

a) spread for the purpose of reclamation, restoration or improvement of land which has been subject to industrial or other man-made development, and the use to which that land could be put would be improved by the spreading;

b) spread in accordance with any requirement of or under the Town and Country Planning Act 1990; and

c) the waste is spread to a depth not exceeding 2 metres.

The third option (installation of a partial cap) would also require long-term management to ensure that graves are being constructed in a manner that minimises exposure to both site users and groundworkers, and that any surplus material excavated from the graves is appropriately disposed of. A management plan should be put in place for this including the health and safety procedures to be adopted during the construction and finishing of graves and annual disposal costs allowed within the cemetery running costs.

8. REFERENCES

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8. Total Petroleum Hydrocarbon Criteria Working Group Series. Development of Fraction Specific Doses (RfDs) and Reference Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH), 1997.

FIGURES

Figure 1 Site location plan

Figure 2 Site layout

Figure 3 Conceptual Model

APPENDICES

1. METHODOLOGY

Site sensitivity

The vulnerability of the site with respect to the potential for contamination of the surface and sub-surface aqueous environments was assessed using British Geological Survey (BGS) data and Environment Agency (EA) data on groundwater and surface water sensitivity.

Information, pertaining to the classification of the aquifer, nature and direction of groundwater flow, distance to licensed abstractions, nature of overlying strata and whether the site was located within a groundwater protection zone was sought from EA and available map information from the BGS, in order to determine the hydrogeological sensitivity. The 1:25,000 Ordnance Survey sheet for the area was used to determine the location of surface watercourses, the quality of which were then determined through consultation with EA data. The combination of distance to the watercourse and its quality were used to assess its sensitivity to pollution. Based on all the available information a summary assessment of vulnerability to contamination of surface and sub-surface waters was made.

Qualitative Risk Assessment Methodology

Risk assessment is the process of collating known information on a hazard or set of hazards in order to estimate actual or potential risks to receptors. The receptor may be human health, a water resource, a sensitive local ecosystem or even future construction materials. Receptors can be connected with the hazard under consideration via one or several exposure pathways (e.g. the pathway of direct contact). Risks are generally managed by isolating or removing the hazard, isolating the receptor, or by intercepting the exposure pathway. Without the three essential components of a source (hazard), pathway and receptor, there can be no risk. Thus, the mere presence of a hazard at a site does not mean that there will necessarily be attendant risks. The following risk assessment thus focuses on those parts of the site where hazards or potential hazards have been identified and is not general to the whole site.

Hazards

Potential sources of contamination are identified for the site, based on a review of the current and previous site uses. Not only the nature but also the likely extent of any contamination is considered, e.g. whether such contamination is likely to be localised or widespread.

Receptors

The varying effects of a hazard on individual receptors depend largely on the sensitivity of the target. Receptors include any people, animal or plant population, or natural or economic resources within the range of the source which are connected to the source by the transport pathway. Receptors can, in addition, extend to remediation processes and future construction materials that may be adversely affected by on-site contamination. In general, however, receptors can be divided into a number of groups dependant on the final use of the site.

Pathways

The mere presence of contamination does not infer a risk. The exposure pathway determines the dose delivered to the receptor and the effective dose determines the extent of the adverse effect on the receptor. The pathways which transport the contaminants to the receptor or target generally involves conveyance via soil, water or air.

Exposure Assessment

By considering the source, pathway and receptor, an assessment is made for each contaminant on a receptor by receptor basis with reference to the significance and degree of the risk. In assessing this information, a measure is made of whether the source contamination can reach a receptor, determining whether it is of a major or minor significance. The exposure risks are assessed against the present site conditions.

A qualitative risk assessment has been undertaken for these potential source-pathway-receptor linkages based on DEFRA and CIRIA guidance. This is based on consideration of both:

- The likelihood of an event (probability – takes into account both the presence of the hazard and receptor and the integrity of the pathway);
- The severity of the potential consequence (takes into account both the potential severity of the hazard and the sensitivity of the receptor).

Under such a classification system the following categorisation of risk has been developed and the terminology adopted as follows:

Term	Description
Very high risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
High risk	Harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
Moderate risk	It is possible that without appropriate remedial action harm could arise to a designated receptor but it is relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely that such 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 at worst, that this harm if realised would normally be mild.
Negligible risk	The presence of an identified hazard does not give rise to the potential to cause significant harm to a designated receptor.

2. SOIL LOGS

3. LABORATORY ANALYSIS RESULTS

4. GENERIC CRITERIA FOR ASSESSMENT OF CONTAMINATED LAND

Contaminated Land Exposure Assessment

In March 2002, the Environment Agency published the results of research into the long-term risks to human health posed by contaminated land (Ref. 1). The Contaminated Land Report (CLR) series of documents have been produced to provide relevant, appropriate, authoritative and scientifically based information and advice on the assessment of risks arising from the presence of contamination in soils. This material can be used to support the application of statutory regimes addressing land contamination, particularly Part IIA of the Environmental Protection Act 1990 and development control under the Town and Country Planning Acts, and effectively supersedes the Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) guidance (Ref. 2).

The research uses the CLEA (Contaminated Land Exposure Assessment) model to evaluate the risk to human health from contaminates via different pathways for a range of land use scenarios. The Soil Guideline Values (SGVs) are intended to provide a means of assessing chronic risks to human health, and are dependant on exposure in the context of a specified land use, in accordance with the ‘suitable for use’ approach and do not alter the assessment of risk to other environmental receptors (groundwater, surface water, flora, fauna, etc) or to acute risks to health. To date, guideline values have been set for seven contaminants – arsenic, cadmium, chromium, lead, nickel, mercury, selenium with cyanide, benzo (a) pyrene and phenol soon to follow. Toxicological (TOX) reports have continued to be issued for organic contaminants from which guideline values can be calculated using the CLEA model.

SGVs have currently been derived for the following land uses:

- Residential with or without plant uptake
- Allotments
- Commercial / Industrial

These are also dependent on a number of assumptions (for example, relating to the soil conditions (pH of 7 and organic carbon content of 2%), the particular behaviour and type of pollutants, the existence of pathways, the land use patterns and the availability of receptors. Where the SGVs have been designated for a land use appropriate to the site being assessed, and the distribution of contaminants has been characterised, statistical tests can be used to assist in the assessment. Under the CLEA model, a statistic called the US_{95} is recommended. This statistic is an upper estimate of the mean soil concentration, which the actual mean soil concentration should be below $_{95}$% of the time and should be used for comparison with the SGV.

Enviros Screening Values (ESVs)

Since the publication of the Contaminated Land Exposure Assessment model (Ref 1) and the withdrawal of ICRCL guidance (Ref 2), the Environment Agency has published reports providing toxicological Health Criteria Values for a total of twenty two contaminants (Ref 3). In addition the Environment Agency has published a consultation document on assessment of hydrocarbon fuels (Ref 4).

Soil guideline values have only been published for ten contaminants (Ref 5). These all relate to metals. These soil guideline values provide authoritative guidelines for assessment of soil concentration in a series of standard scenarios:

- Residential areas where vegetables are grown and consumed
- Residential areas where no vegetables are grown and consumed
- Allotments
- Commercial and industrial areas

There is, therefore, a lack of authoritative information to enable assessment of soil concentrations. With this in mind Enviros have decided to develop a set of internal screening values (ESVs) for other contaminants to allow initial assessment of data for standard scenarios. As authoritative soil guideline values are produced these will replace the current interim ESV values.

Selection of the model

The exposure assessment needed to be carried out in a manner that is consistent with the published methodology set out in CLR10 and updated in the briefing notes subsequently published by the Environment Agency.

The Sniffer methodology and associated spreadsheets (Ref 6) have been selected to perform the modelling. This is because the calculations are relatively simply set out and the equations have already been designed to be similar to the CLEA model.

Vapour intrusion

One adjustment has been made to the Sniffer methodology. In the original methodology, the dilution occurring as soil vapours migrate into a building is estimated as a simple dilution ratio of 20 000. The Environment Agency briefing note (Ref 7) for vapour intrusion propose that this dilution is estimated using the Johnson Ettinger model. The model is based on migration of vapour through the crack between the building floor and wall. The model allows the dimensions of the building to be taken into account. For scenarios where vapour intrusion into building is required the Johnson Ettinger equations have been used to generate the dilution ratio for ESVs.

For volatile organics, where this pathway is present, it is the dominant pathway.

A common problem is that the equilibrium partitioning used to calculate the soil vapour shows considerable variability particularly for compounds which have low solubility in water and in general tends to overestimate the soil gas concentration. This is, at least in part, because the concentration in the vapour is based on the Henry's law constant usually estimated from ratio of the saturate vapour pressure to the water solubility. For relatively insoluble compounds, small changes in the solubility lead to large changes in the Henry's law constant. Uncertainty in the measurements of solubility thus lead to large variations in the Henry's law constant calculated. In addition other factors such as whether dissolved organic matter is present in the water, may lead to significant changes in the water solubility. If the water solubility increases, this will tend to decrease the vapour concentration.

In order to overcome this issue and properly assess the pathway, the Enviros methodology will include screening the soils on site to determine if vapours are potentially present in the soil. If there is significant potential for their presence they will be measured by taking samples from appropriately designed gas wells to obtain laboratory measurement of the soil gas concentrations in the shallow soils. The dilution ratio between the soil gas concentration in these soils and the concentration in the building can then be assessed using the Johnson-Ettinger model.

Dermal uptake

The Sniffer methodology recommends carrying out a "dermal check" to determine if the dermal exposure route will be significant. The dermal check implies that for polycyclic aromatic hydrocarbons the dermal uptake pathway route may be significant.

The exposure from the dermal route has thus been assessed for all determinands but has only been found to be significant for PAHs using calculations from the updated CLEA methodology.

Exposure Parameters

The CLEA model as set out in CLR10 provided distributions for a number of exposure parameters:

- Body weight in kg ;
- Total body surface area in m2 as a function of body weight ;
- Respiration rate in m3 h-1 as a function of body weight ;
- Mean daily soil ingestion rate by children aged 1–6 in mg day-1 ;
- Estimated ratio of the concentration of a contaminant in chosen vegetables to the contaminant concentration found in the soil
- Daily vegetable consumption rate in g day-1 as a function of body weight
- Fraction of homegrown garden vegetables as part of daily vegetable consumption rate
- Fraction of exposed skin area in contact with soil

The Sniffer methodology is a deterministic method and thus uses single values rather than a distribution. To allow for comparability the Sniffer methodology proposes the use of the 75th percentile value for these parameters with the exception of body weight where a more conservative 95th percentile is recommended. These default parameters have also been used in the Enviros assessment.

Exposure Pathways

The following table shows the pathways that have been considered under each of the scenarios considered.

Pathway	Direct ingestion of soil and indoor dust	Ingestion of homegrown vegetable and attached soil	Vapour intrusion into buildings	Inhalation of vapour in outdoor air	Inhalation of fugitive dust	Dermal uptake
Residential Scenarios						
Residential with vegetable consumption	✓	✓	✓	✓	×	✓
Residential without plant uptake	✓	×	✓	✓	×	✓
Allotments	✓	✓	✓	✓	×	✓
Commercial /Industrial Scenarios						
Commercial/Industrial	✓	×	✓	✓	×	✓

May be assessed separately for hydrophobic substances with low solubility.
Only significant for Polycyclic aromatic hydrocarbons (PAHs)

Physico-chemical parameters

The chemical data on the parameters have been obtained from Croner's Environmental Hazards Database December 2003. This database includes chemical data from a wide variety of sources. Wherever possible measured values have been used, however this was not always possible. Where estimates have been used this is indicated on the input parameter sheet for that contaminant.

For diffusivity data there is very little published data. Data from ORNL laboratories primarily based on estimated values have thus been used. The diffusivity of the compounds considered show little variation and the results show very low sensitivity with respect to changes in diffusivity.

For the hydrocarbons, the threshold risk has been considered using the approach devised by the TPH criteria working group (ref 10) where the total petroleum hydrocarbons are divided into fractions based on their mobility and toxicity. As part of the work in deriving appropriate fractions, characteristic physicochemical data has been derived for these fractions and this has been used to calculate ESVs.

Soil parameters

The ESVs have been based on a sandy soil using data from briefing note 2 (ref. 7). This is the most conservative soil type. For volatile contaminants the soil air permeability is highest for sand. For non-volatile contaminants or pathways where inhalation of vapour is not considered the soil type has very little effect on the exposure.

The fraction of organic content has a significant effect on the partitioning of organic contaminants. Thus less contaminant is in the vapour form or available for plant uptake in soil with higher organic content. The ESVs have thus been calculated for a series of soil organic contents. Therefore, the choice of ESV to use depends on the organic carbon content of the soil on the site.

Care must be taken not to confuse Soil Organic Matter and Fraction of Organic Matter, as provided by the analytical laboratory. A conversion factor is provided in the Sniffer worksheets that 1% Soil Organic matter is the same as 1.67% total organic carbon.

Toxicological input data

The majority of contaminants being assessed are those for which toxicological data has been published by the Environment Agency. For contaminants where there is not a published TOX report, data has been derived from other source using the hierarchy set out in CLR9. In these cases, justification of the toxicology data is provided with the input parameters.

For the assessment of hydrocarbons a two stage approach is employed. The non-threshold risk is assessed by an assessment of know carcinogenic indicators. These include benzene, and seven non-threshold PAHs (benzo(a)pyrene, chrysene, benz[a]anthracene, benzo[b]fluoranthere, benzo[k]fluoranthere, dibenz[ah]anthracene, indeno[1,2,3 c,d]pyrene) identified in the Environment Agency Consultation Document on Assessment of Petroleum (Ref 4). The relative carcinogenicity of the PAHs has been based on that of benzo(a)pyrene.

The threshold risk is then assessed in accordance with the TPH criteria working group fractions and methodology. The petroleum fraction is assumed to be additive and a spreadsheet has been set up to carry out this additivity calculation. The approach in CLR9 is that additivity should be considered for contaminants where substances may act on the same target organ system. The critical effect for the aliphatic fractions is hepatoxicity (toxicity to the liver). Thresholds for the majority aromatic fractions are not based on this effect, however other studies (such as those detailed in the TOX report for naphthalene) indicate that these fractions may be also affect the liver. Simple additivity is thus included in determining a threshold for hydrocarbons.

Dutch Guideline Values

In the absence of SGVs and calculated internal ESVs being available for particular parameters, guidelines produced by the Dutch Government (Ref. 11) have been used for comparative purposes only. Although this Guidance is specific to conditions in Holland, it is often used elsewhere in Europe, including the U.K as a useful indicator of relative concentrations of contamination. The guideline values have been defined for both soils and groundwater by the Dutch government research agency (RIVM) using a toxicological risk-based approach (i.e. based on determining the maximum tolerable risk from available toxicity and exposure data). The Guidance takes into account the risk to the ecosystem as well as risks to human health. The guidance refers to a standard soil with 25% clay and 10% organic matter. Adjustment to the values are made dependant of the contaminant under consideration. The guidance defines target and intervention values as follows:

- A Target Value – which represents the “background” concentration and can be considered the ultimate level of soil quality which any remediation should seek to achieve;

- An Intervention Value, which if exceeded suggests that there is a potential threat to the environment. In Holland, if measured concentrations exceed the Intervention Value, it is recommended that some form of remediation, or as a minimum, further risk assessment, is undertaken to determine the actual degree of risk.

For UK sites where contamination is present at concentrations above Dutch Intervention Values this would normally indicate that contaminants are present at above "background" levels, and probably at potentially significant concentrations. Therefore, in the absence of UK or site specific threshold values, the comparison of site data with the Dutch Values is an appropriate first step in the determination of the potential significance of ground and groundwater chemistry.

Leachable Metals and Groundwater

By assessing the leachability of metals, an assessment of their availability for uptake by plants and the potential to pollute water resources can be made. A methodology has been developed by the Environment Agency to derive remedial targets for soil and groundwater, to protect water resources (Ref. 12). This outlines the different levels or tiers of assessment that can be undertaken. Although primarily aimed at deriving remedial targets for site remediation, the methodology also predicts the impact on water receptors for a given set of site conditions.

The first stage of the assessment (Tier 1) is carried out by comparing measures or estimates of the concentration of contaminants in the soil pore water (e.g. from leachability tests) with the guidelines acceptable in the target water resources. Further stages consider dilution of infiltrating water in the Aquifer (Tier 2) and then more complex processes such as attenuation or degradation (Tier 3 and 4). The initial Tier 1 assessment is thus used as a screen to determine which if any of the soil contaminants could potentially pose a problem or not.

On this site, as there are no UK standards specifically for groundwater resources, the Drinking Water Standards as set out in the Water Supply (Water Quality) regulations 2001 (Ref. E) have been used for the initial comparison. Where there are no Drinking Water Standards, the Drinking Water Standards 1989 (DWS 1989) (Ref. 13), were used, followed by the Environmental Quality Standards (EQS) for saltwater.

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8. Environment Agency CLEA Briefing Note 3: Update on supporting values and assumptions describing the UK building stock. Version 1.0 (March 2003)

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11. Ministerial Circular Intervention Values for Soil Remediation; Ministry of VROM, 1994 and Ministerial Circular Intervention Values, second and third series; Ministry of VROM, 1997

12. Environment Agency. Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Human Resources. R&D Publication 20. 1999.

13. The Water Supply (Water Quality) Regulations 1998 and 2002.

Soil Gas Guidance

The results of gas monitoring and the subsequent need for remedial works are assessed with respect to guidance given in the following documents:

- CIRIA have produced guidance on the investigation and interpretation of gases in the ground (Ref. A-C).

- Guidance concerning landfill gas control on landfill sites is contained in Waste Management Paper 27 (WMP 27; Ref. D). The Paper provides technical advice on the investigation and monitoring of both closed and active landfill sites. WMP27 proscribes methane and carbon dioxide concentrations above which monitoring is required and it also prescribes monitoring frequencies. This proscriptive approach has been superseded by a risk based approach in recent draft guidance discussed below. WMP27 is used in the absence of specific guidance relating to the presence of methane and carbon dioxide in the ground in areas that are not defined as landfill sites;

- Environment Agency guidance (Ref. E), updates Waste Management Paper 27. The draft guidance states that closed unlicensed landfills which do not have a waste management licence issued under Part 2 of the Environmental Protection Act 1990 may fall within the definition of contaminated land contained in Part 2A, Section 57 of the Environment Act 1995. The statutory guidance on contaminated land uses the concept of a pollution linkage through risk assessment and the development of a conceptual model of the site.

- The Building Regulations 1991 (Schedule 1) require that precautions are taken to "avoid danger to health and safety caused by substances on or in the ground". Methane and carbon dioxide are included in the list of contaminants in Approved Document C (Ref. F).

- Advice on the protection of new buildings from gas in the ground is given in Building Research Establishment (BRE) Report 212: Construction of New

Buildings on Gas Contaminated Land (Ref. G). The guide levels provided in Report 212 is also used for existing buildings as there is no guidance for the protection of existing buildings;

- With respect to the protection of buildings against gas ingress the BRE gives two trigger values for carbon dioxide irrespective of the concentration of methane. At the lower trigger level of 1.5% carbon dioxide gas protection measures should be considered. Above the upper trigger level of 5% such measures are mandatory. In addition to the BRE Guidance, WMP27 gives trigger values for methane / flammable gas and carbon dioxide within buildings of 1% by volume (10,000ppm) and 1.5% respectively above which evacuation and implementation of control measures are required.

- The Partners in Technology Guide for Design (Ref. H) defines the suitability of a number of gas protection measures for various soil gas regimes. The gas regime is comparable to the classes defined by CIRIA (Ref. B). The CIRIA categories have wide bands and it is difficult to fit a measured gas concentration and flow rate into the CIRIA categories. A methodology for the calculation of gas regimes is given in Ref. I.

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5. CALCULATED SCREENING VALUES FOR TPH MIXTURES

6. ASSESSMENT OF HAZARDOUS PROPERTIES OF SOIL FOR WASTE CLASSIFICATION

7. RELEVANT LEGISLATION

This appendix gives an overview of UK environmental legislation relating to land quality issues.

Part 2A EPA 1990 – Contaminated Land Regulations

Outline of the Regime

A new regime for identifying and remediating contaminated land under Part 2A of the Environmental Protection Act 1990 came into force in England on 1 April 2000. 'Contaminated Land' for the purposes of Part 2A is defined as 'any land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that:

- Significant harm is being caused or there is a significant possibility of such harm being caused; or

- Pollution of controlled waters is being, or is likely to be, caused.

Part 2A recognises that harm to health and the environment arises not from the mere presence of contaminating substances in land, but from their movement along a 'pathway' to where they can cause damage to a 'receptor'. This is referred to as a 'significant pollutant linkage'. Risk assessment and the 'suitable for use' approach are therefore fundamental parts of the regime.

The Statutory Guidance on contaminated land places specific duties on local authorities to inspect their areas to identify land falling within this definition and, where they do, to require its remediation in line with the 'suitable for use' approach. The regime also provides detailed rules for assigning liabilities for contaminated land, based on the 'polluter pays' principle. For most sites, any such liability will fall to the person (individual or corporation) who caused or knowingly permitted the presence of the substances causing actual or potential significant harm (Class A Person) or if they cannot be found the owner/ occupier of the site (Class B Person). There are a number of exclusion tests listed within the Statutory Guidance, including 'selling with information' and 'payments made for remediation'.

Local authorities are the main regulators and are required to publish a strategy for inspecting their area. Most have now done so. The EA has specific roles under the new regime. They are responsible for providing site-specific advice to local authorities, dealing with defined 'special sites', and monitoring and reporting on progress made. Both local authorities and the EA record certain prescribed information about their regulatory actions on a public register.

The main focus of the regime is remediation of historically contaminated sites to ensure that they are suitable for current use. The statutory definition covers land which poses unacceptable risks to human health or the environment, in its present condition and circumstances. Not all land affected by contamination will pose such risks, and the majority is expected to remain outside the scope of this regime. In practice most contamination from the past will continue to be dealt with through development, i.e. the planning process. One of the aims of the Part 2A regime is reduce uncertainties about what remediation needs to be done, by whom and to what standards.

Changes to Part 2A - Pollution of Controlled Waters

As stated above, the definition of contaminated land in the Statutory Guidance includes ‘pollution of controlled waters’, although this is not specifically defined. This means that any polluting matter, however small or trivial the amount, entering ‘controlled waters’ could lead to the land involved being formally determined as contaminated land. The Government has indicated its intention of reviewing the wording of the legislation on this aspect and of seeking amendments to the primary legislation. This is now underway with a clause (No. 79) in the new Water Bill introduced into Parliament and published on 20th February 2003. The clause proposes amending the definition of contaminated land under section 78A(2) of Part 2A by introducing the word ‘significant’ to ‘pollution of controlled waters’, and allowing statutory guidance to be issued on as to what water pollution is ‘significant’.

Role of the Regulators

In outline, the role of the regulators under Part 2A is:

- to inspect their areas to identify any contaminated land
- to establish responsibilities for remediation of the land
- to ensure that appropriate remediation takes place
- through agreement with those responsible, or if not possible;
- by serving a remediation notice, or;
- in certain cases, carrying out the work themselves or;
- in certain cases, through other powers.
- to keep a public register detailing the regulatory action which they have taken under the new regime.

In most cases the regulator is the borough or district council. For certain ‘Special sites’ the EA will take over from the local authority as regulator once the site has been formally designated. The criteria for definition of Special Sites are identified in the Statutory Guidance and include specific cases such as acid tar lagoons, military land and water pollution cases, including pollution of potable water supplies.

When land is identified as contaminated, the regulator will contact those they think are responsible, and will normally discuss the case including liability and remediation requirements. If there is no satisfactory outcome, such as voluntary action, a remediation notice may be served to ensure the land is remediated. At least three months must elapse before such a notice is served except in urgent cases. The remediation notice may specify a requirement for further site investigation as well as remediation actions.

Local authorities will take a strategic approach to inspection, finding and dealing with the most pressing and serious problems first and concentrating on areas where contaminated land is most likely to be found. Their published strategies set out their approach to inspection, and the reasoning behind it.

Public registers held by local authorities contain information about regulatory action on contaminated land as it happens. They will record remediation notices as they are served and remediation statements as they are published. Information on the register is not deleted, so that appropriate action can be taken later e.g. if proposals are made to change the use of that land.

Part 2A follows the polluter-pays principle. If a remediation notice has to be served, or if the authority carries out the remediation in an emergency, the cost of remediation will normally lie with the person(s) who caused or knowingly permitted the contamination. If this person(s) cannot be identified the owner or occupier of the land will be responsible (unless the problem is one of water pollution). However, the Statutory Guidance includes a series of cases that would exempt parties, such as ‘selling with information’ or ‘payments made for remediation’.

Planning Regime

Local planning authorities should take account of contamination or the potential for contamination both in preparing development plans, which set out the policies and proposals for future land use and development within their area, and in determining individual applications for planning permission. Planning permission may be granted on condition that the site is remediated to the satisfaction of the local authority. Guidance for planning authorities is currently provided in ‘Planning Policy Guidance: Planning and Pollution Control (PPG 23)’.

Building work is subject to Building Control under the Building Regulations 1991. The approval process is carried out by Building Control bodies which include local authority technical officers or Approved Inspectors. Under Schedule 1 of these Regulations Requirement C2 states that ‘precautions shall be taken to avoid danger to health and safety caused by substances found on or in the ground covered by the building.’ It should be noted that if contaminating substances in the ground have the potential to attack building materials it may lead to a breach of Part A of these Regulations which relate to Structural safety. Approved Document ‘C’ sets out how contamination should be addressed in building control, and is now under review.

Water Resources Act

The Part 2A regime covers the pollution of controlled waters where contaminated land is the cause. In other cases the EA have powers under the Water Resources Act 1991 (WRA) to prevent and remedy the pollution of controlled water.

The WRA is concerned with contamination of controlled waters (both groundwater and surface water) and gives powers to the EA to either deal with/ remedial contamination of such controlled water and also of land where pollution may enter controlled waters. This power may be exercised by means of a Works Notice, issued by the EA requiring the necessary remediation to be carried out or by the EA carrying out the remediation itself and serving a notice to recover the cost. The person liable is the person who caused or knowingly permitted the substances to be present on the land or in the water.

The provisions of the WRA (and the consequent powers of the EA) can apply even when the land is not Statutory Contaminated Land under the terms of Part 2A. The EA have indicated that in general Part 2A will be applied in preference to WRA powers if it is applicable.

Waste Management Licensing

The waste management licensing system (Part 2, EPA 1990) interacts with the contaminated land regime in a number of ways. Anyone who deposits, recovers or disposes of controlled waste must do so either within the conditions of a waste management licence, or within the conditions of an exemption from waste licensing and must not cause pollution of the environment, harm to human health or serious detriment to local amenities. The EA are responsible for operating this licensing system, which can be used to secure remediation of land contamination arising from currently licensed activities or illegal dumping.