Northdown House
Ashford Road
Harrietsham
Maidstone
Kent, ME17 1QW

t: 01622 858545
f: 01622 858544
w: www.cet-uk.com

Frankham Consultancy Group Limited

Irene House

Five Arches Business Park

Maidstone Road

Sidcup

Kent

DA14 5AE.

For the attention of Mr Joshua Wukowic

Geotechnical Department

Our ref: 241002

24 March 2016

Dear Joshua,

RE: CAMBERWELL NEW CEMETERY SITE B – REVIEW OF EXISTING CONTAMINATED LAND ASSESSMENTS

CET Infrastructure (CET) was instructed by Frankham Consultancy Group Ltd (Frankham) to carry out a review of existing site investigation and risk assessment reports relating to Area B of the Camberwell New Cemetery site located within the grounds of the existing Honor Oak Cemetery.

It is understood that Southwark Council are currently exploring various options to increase cemetery capacity for burial. One option under consideration is the use of currently vacant land located within the existing Honor Oak Cemetery. A portion of the cemetery denoted as Area A has been utilised for burials since 2012. This site is now understood to have reached capacity and as such an adjoining area, denoted as Area B, is now under consideration.

Previous ground investigations carried out across the wider cemetery site have identified ground contamination with the potential to pose a significant risk to human receptors including future site visitors and site workers, in particular grave diggers. Prior to use Area A was subjected to supplementary phases of ground investigation, risk assessment and remediation in order to quantify and ultimately ameliorate the identified risks posed to human health. Due to the proximity of Site B to Site A, and the similar history of both study areas, is considered highly likely that comparable remediation measures will be required prior

to its use as a cemetery. The aim of the data review detailed herein is therefore to extract information specifically relevant to Site B from the numerous ground investigation reports supplied by Frankham and recommend any additional works likely to be required to support the preparation of a remediation strategy.

REPORT ON GROUND CONTAMINATION AND SUGGESTED REMEDIAL WORK (DOBSON & POOLE, JUNE 1996)

The first supplied report concerning land contamination involved an investigation of the wider Honor Oak Cemetery site including Site B. A total of thirty seven window sample boreholes were formed to depths of up to 4.0m across an area of 5.7Ha. Made Ground, described as sandy clays with flint, ash, brick and concrete, was identified to depths of between 0.5m and 2.3m below ground level (bgl). The underlying natural soils comprised London Clay Formation.

Twenty eight samples of Made Ground and the underlying London Clay were recovered from the window sample boreholes and tested for a suite of determinands including metals and toluene extractable matter (TEM). The results of this testing were compared to a series of generic screening criteria that were relevant at the time of reporting. These included ICRCL thresholds and Dutch Intervention Values.

The report concluded that the soils beneath the study area could pose a significant risk to human health as the concentrations of arsenic, copper, zinc and TEM exceeded the threshold criteria that considered both domestic gardens and public open spaces. In terms of remediation the report suggested that there was “little alternative available to the Council than clear away the contaminated made up ground and to import fresh top soil”.

When assessing the 1996 investigation in a current regulatory context we would comment that the suite of contaminants analysed are now not suitable with which to conduct an appropriate risk assessment. Assessment of the risks posed by organic contaminants including petroleum hydrocarbons and poly aromatic hydrocarbons (PAHs) is now based on detailed speciated data. The TEM method of solvent extraction adopted by Dobson & Poole provides total concentrations of all organic compounds and as such these results cannot be compared to current guideline criteria. It should also be noted that both the ICRCL and Dutch guideline values have now been withdrawn and are not deemed suitable with which to ascertain the risks posed to human health.

Based on the time elapsed since the Dobson & Poole investigation, the type of determinands tested and the assessment criteria to which the results have been compared it is judged that the 1996 report provides little relevant information with which to further develop a remediation strategy for Site B.

DETAILED QUANTITATIVE RISK ASSESSMENT (DQRA) FOR BENZO[A]PYRENE (ENVIROS, OCTOBER 2008)

In order to more accurately assess the potential risks posed to human health Enviros conducted a DQRA, the purpose of which was to determine site specific assessment criteria with which to compare the recorded concentrations of the PAH compound benzo(a)pyrene.

Enviros considered grave diggers and future site visitors as two distinct receptors and tailored the parameters used to populate the CLEA v1.03b model to reflect the varying potential for both groups to be exposed to contaminated soils. Unfortunately the version of the CLEA risk assessment model and much of the data used to populate it have both now been superseded and therefore the established assessment criteria are not deemed to be suitable for use in the current regulatory context.

ENVIRONMENTAL AUDIT FOR GROUNDWATER PROTECTION (CDS, 2008)

The CDS report comprised a desk based, qualitative assessment of the potential risks posed to controlled water receptors in the event the that site was redeveloped as a cemetery.

The report identified the site as being located within an Environment Agency groundwater Source Protection Zone II (SPZ II) Outer Protection Zone. An SPZ II is designated at comprising either 25% of the source area or a 400 day travel time to the groundwater source, whichever is greater. However, as some 25m of relatively impermeable London Clay was mapped beneath the study site the report concluded that the use of the site as a cemetery would not result in a significant risk being posed to the sensitive aquifer present at depth.

HONOR OAK CEMETERY FURTHER INVESTIGATION (SKM ENVIROS, May 2011)

The most recent and relevant phase of assessment supplied for review, comprising the formation of a series of exploratory holes across the portions of the site now denoted as Areas A, B and C, was carried out SKM Enviros in 2011. Of the twelve supplementary window samples formed only five, WS03 to WS07, were located within Area B. With regards to laboratory testing a total of eight samples, comprising seven of Made Ground and one of London Clay, were relevant to the study area. The suites of testing

Supplementary Generic Risk Assessment

In order to ascertain the significance of the results specifically relevant to Area B the data was extracted from the SKM Enviros report and subjected to a Generic Risk Assessment. Based on the proposed end use of the study area, and that future users to the cemetery are likely visit the site relatively infrequently and for short time periods only, the initial screen of the chemical data was made against available Suitable 4 Use Levels (S4ULs) and Category 4 Screening Levels (C4SLs) that considered a

'public park' land use. The guidance describes such sites as those utilised for "recreational uses including family visit and picnics, informal sporting activities and dog walking". It should be noted that these criteria are not judged to be applicable for grave diggers as this receptor is far more likely to come into contact with contaminated soils via the direct contact, ingestion and dust inhalation exposure pathways.

A comparison of the metals recorded by the analysis with the corresponding generic screening criteria is presented in the following table:

Contaminant	Samples		S4UL* (POS_{PARK})	
	Maximum Conc. (mg/kg)	Location	S4UL (mg/kg)	No. Samples exceeding assessment criteria
Arsenic	22	WS07 @ 0.4m	170	0
Cadmium	0.52	WS06 @ 0.6m	532	0
Chromium III	60	WS03 @ 1.0m	33 000	0
Mercury	1.3	WS07 @ 0.4m	240	0
Lead#	210	WS03 @ 0.5m	1300	0
Nickel	40	WS05 @ 0.5m	3400	0
Copper	47	WS04 @ 0.9m	44 000	0
Selenium	<0.2	N/A	1800	0
Zinc	430	WS07 @ 0.4m	170 000	0
Notes to Table				
*	*Most appropriate supplied S4ULs are based on a 'public park' end use, a sandy loam soil type, pH of 7 and a soil organic matter (SOM) of 6%.*			
#	*Category 4 Screening Level (2014) used in absence of suitable S4UL.*			

As the above table indicates the concentrations the concentrations of metals recorded by the analysis did not exceed the corresponding threshold criteria in any instance and are therefore not judged to have the potential to pose a significant risk to future site users via the direct contact, ingestion and dust inhalation exposure pathways.

Asbestos was not detected in any of the samples screened by the laboratory.

A summary of the PAH compounds recorded by the analysis is included in the following table:

Contaminant	Samples		S4UL* (POS_{PARK})	
	Maximum Conc. (mg/kg)	Location	S4UL (mg/kg)	No. Samples exceeding assessment criteria
Naphthalene	3.1	WS04 @ 0.9m	3000	0
Acenaphthylene	3.5	WS04 @ 0.55m	30 000	0
Acenaphthene	3.9	WS04 @ 0.9m	30 000	0
Fluorene	8.2	WS04 @ 0.9m	20 000	0
Phenanthrene	52	WS04 @ 0.9m	6300	0
Anthracene	12	WS04 @ 0.9m	150 000	0
Fluoranthene	81	WS04 @ 0.9m	6400	0
Pyrene	61	WS04 @ 0.9m	15 000	0
B(a)A	34	WS04 @ 0.9m	62	0
Chrysene	38	WS04 @ 0.9m	120	0
B(b)F	**40**	WS04 @ 0.55m	16	**2**
B(k)F	29	WS04 @ 0.55m	440	0
B(a)P	**38**	WS04 @ 0.55m	13	**2**
I(123-cd)P	26	WS04 @ 0.55m	180	0
D(ah)A	6.2	WS04 @ 0.9m	1.4	**2**
B(ghi)P	25	WS04 @ 0.55m	1600	0
Notes to Table				
*	*Most appropriate supplied S4ULs are based on a 'public park' end use, a sandy loam soil type, pH of 7 and a soil organic matter (SOM) of 6%.*			

As the above table indicates, potentially significant concentrations in excess of the corresponding S4ULs were detected in the two samples of Made Ground recovered from WS04. Reference to the corresponding exploratory hole log identifies the tested soils to contain inclusions of black sand and gravel, tarmac and clinker, all of which are known to represent potential sources of PAH contamination.

With regards to petroleum hydrocarbons the recorded total concentrations in the seven tested samples were found to range from <10mg/kg to 1100mg/kg in WS04 at 0.55m. Unfortunately only one sample, recovered from WS04 at 0.9m, was tested for speciated petroleum hydrocarbons and can therefore be assessed in accordance with current best practice. In this instance the petroleum compounds detected predominately comprised aromatic hydrocarbons from the heavier aromatic C21 to C35 carbon range. Such hydrocarbons are not considered to be indicative of a recent fuel escape and are far more likely to be present as a result of inclusions of materials such as ash and clinker in the Made Ground.

Notwithstanding the above, assuming a worst case scenario that the encountered hydrocarbons exclusively comprised the most potentially hazardous species of aromatic C16 to C21 hydrocarbons, the total concentrations recorded by the analysis would not exceed the corresponding S4ULs and are therefore unlikely to pose a risk to future site users.

The SKM Enviros report concluded that the concentrations of PAHs across the wider study site could have the potential to pose a risk to human receptors and as such some form of remediation was likely to be required. However, prior to formulating a Remediation Plan they also suggested that "the collection of additional shallow soil samples for PAH analysis to increase the size of the data base and therefore confidence in the soil quality".

REMEDIATION STRATEGY AND METHOD STATEMENT (SKM ENVIROS, November 2011)

This phase of assessment exclusively concerned Area A and involved the recovery of additional samples to enable the formulation of a Remediation Strategy.

Of the thirteen supplementary tested samples two recorded concentrations of the PAH compound B(a)P in excess of the adopted assessment criteria. The impacted material within this area was described as being "visually distinct and comprised a black gravelly clay, the gravel comprised brick, concrete and rare clinker". This layer appears to be similar to that encountered on Site B that was also found to contain elevated concentrations of PAHs.

In response to the supplementary risk assessment the SKM Enviros Remediation Strategy was developed to comprise the following works:

- Excavation and off site disposal of the black gravelly soils found to be impacted by PAHs and validation of the exposed formations;
- Implementation of a "reactive strategy" so that any potentially contaminated soils identified during the excavation of graves can be assessed and remediated if required;
- Development of appropriate health and hygiene practices to ensure that grave diggers take appropriate precautionary measures when exposed to on site soils;
- The use of control measures to ensure that any excess spoil is appropriately handled and removed from site; and
- Provision of a final Verification Report detailing the successful completion of the remediation works.

Following the successful implantation of the above measures SKM Enviros stated that "the remaining soil would be considered suitable for use at the site and the elevated concentrations of PAHs within this material would not be considered to present a significant risk to the identified receptors". However, it should be noted that at the time of reporting CET were not supplied with a copy of the Verification Report or any correspondence from the Local Authority confirming that they were in acceptance of the proposed Remediation Strategy.

SUMMARY & CONCLUSIONS

Based upon the findings of the supplied reports relating to Area B of Camberwell New Cemetery it is considered that the study area is relatively unlikely to be subject to significant and widespread ground contamination. However, localised deposits of black sand and gravel of ash, clinker and asphalt as identified in exploratory excavation WS04 have been found to contain significantly elevated concentrations of PAHs that could impact future visitors to the cemetery site.

As the ground contamination identified within Area B appears to be relatively consistent to that identified in Area A it is considered that a similar remediation strategy is likely to be applicable. However, prior to the development of any such strategy it would necessary to carry out a further phase of investigation to increase the size of the relevant dataset and more accurately delineate the PAH impacted ashy soils.

If the results obtained by this additional investigation are consistent with those obtained to date on both Site A and Site B we would be able to recommend the excavation of localised 'hot spots' while leaving the majority of the remaining Made Ground soils in situ. When finalising this strategy it would be prudent for us to obtain and review any correspondence with the Local Authority relating to the remediation of Site A so that any pertinent comments of recommendations can be incorporated into this phase of works.

We trust that the above meets your requirements. However, please do not hesitate to contact us with any additional questions or queries.

Kind regards,

James Appleby BSc MSc CSci MIEnvSc
Principal Environmental Scientist
For and on behalf of CET Infrastructure