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WESTMINSTER KINGSWAY COLLEGE SIDMOUTH STREET, LONDON

SUPPLEMENTARY GEOENVIRONMENTAL & QUANTITATIVE RISK ASSESSMENT REPORT

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SUMMARY AND CONCLUSIONS

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Figure 1: Site Location Plan Figure 2: Exploratory Hole Location Plan

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Appendix A: **Cable Tool Borchole Logs**

Windowless Sample Borehole Logs Appendix B:

Results of Gas and Groundwater Monitoring Appendix C:

Results of Chemical Analysis – Soils Appendix D:

Results of Chemical Analysis – Water Appendix E:

Results of Chemical Analysis - Waste Classification Appendix F:

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1.

EXECUTIVE SUMMARY

<u>General</u>

This report presents the factual information from a supplementary ground investigation and details the findings of a supplementary quantitative risk assessment undertaken for the proposed redevelopment of the Westminster Kingsway College site on Sidmouth Street, London.

Through previous desk study and investigation undertaken by others no previous on site contaminating activities have been identified. However, the desk study did identify that a filling station operated on adjoining land off site to the southeast and that the site suffered direct hit bomb damage.

This supplementary investigation by MLM EL was prescribed by consultants, Sinclair Knight Mertz, to determine if contamination from the filling station off site to the southeast has migrated onto the site, to fully characterise the Made Ground and gas regime across the site and undertake a Quantitative Risk Assessment to confirm site remediation requirements.

The investigation has revealed broadly similar ground conditions to those encountered in previous investigation, that is 0.4 - 3.1m of Made Ground over London Clay.

The results of testing on soil samples confirm the presence of arsenic, lead and PAH contamination that present risks to residential occupants in the west of the site should contaminated soil be exposed in areas of landscaping.

There are no risks through exposure to contaminated soils beneath the eastern side of the college site due to the cover of buildings and landscaping, which is to be contained within raised planters.

Levels of PAH and TPH present a risk to on site water supply pipes.

Groundwater contamination was not present.

Gas/vapour contamination was not present.

Recommendations

Clean soil capping is required in landscaped areas in the west of the site, which is planned for residential use.

Site workers involved in construction or future services maintenance should observe a good standard of site hygiene and appropriate PPE and health and safety procedures used.

Protected services are required for water supply pipework and run in clean corridors to reduce risks to future services maintenance workers.

Off site disposal of hydrocarbon contaminated soil what sat non hydro contaminated will mainly qualify mainly as non-hazardous waste. Locally, hydrocarbon contaminated soils are present that qualify for hazardous waste disposal.

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Non-hydrocarbon contaminated made ground will qualify as non-hazardous waste. Natural soils for off site disposal, such as the London Clay, will qualify as inert waste. If construction commences after October 2007, all materials except inert waste will require pre-treatment prior to off site disposal.

The interpretation and findings provided in this report are intended for guidance only. It is recommended that the findings of this report be reviewed as part of the design process and incorporated into the final Remediation Strategy Document.

LIMITATIONS AND EXCEPTIONS

- 1. This report and its findings should be considered in relation to the terms and conditions proposed and scope of works agreed between MLM Environmental Limited and the client.
- 2. The Executive Summary, Conclusions and Recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon until considered in the context of the whole report.
- 3. The assessment and interpretation of contamination and associated risks are based on the scope of work agreed with the client and the report may not be sufficient to fully address contaminations or to allow detailed remediation design to proceed without further investigation and analysis.
- 4. Any assessments made in this report are based on the ground conditions as revealed by the exploratory holes and pits, together with the results of any field or laboratory testing undertaken and, where appropriate, other relevant data which may have been obtained for the sites including previous site investigation reports. There may be special conditions appertaining to the site, however, which have not been revealed by the investigation and which have not, therefore, been taken into account in the report. The assessment may be subject to amendment in the light of additional information becoming available.
- 5. Interpretations and recommendations contained in the report represent our professional opinions, which were arrived at in accordance with currently accepted industry practices at the time of reporting and based on current legislation in force at that time.
- 6. Where the data available from previous site investigation reports, supplied by the Client, have been used, it has been assumed that the information is correct. No responsibility can be accepted by MLM Environmental Limited for inaccuracies within the data supplied.
- 7. Whilst the report may express an opinion of possible configuration of strata between or beyond exploratory hole or pit locations, or on the possible presence of features based on either visual, verbal or published evidence, this is for guidance only and no liability can be accepted for the accuracy.
- 8. Comments on groundwater conditions are based on observations made at the time of the investigation unless otherwise stated. It should be noted, however, that groundwater levels vary due to seasonal or other effects.
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10. This report is prepared and written in the context of the proposals stated in the introduction to this report and should not be used in a differing context. Furthermore, new information, improved practices and legislation may necessitate an alteration to the report in whole or in part after its submission. Therefore, with any change in circumstances or after the expiry of one year from the date of the report, the report should be referred to us for re-assessment and, if necessary, re-appraisal.

1. INTRODUCTION

1.1. General

The report has been prepared by MLM Environmental Limited (MLM EL) for Kier London Limited (Kier), who are redeveloping the existing Westminster Kingsway College site on Sidmouth Street. London on behalf of Westminster Kingsway College.

This further investigation has been undertaken in accordance with the brief prescribed by Sinclair Knight Mertz (SKM) in their email to Mr Andrew Vittery of Kier on 30 November 2006 (ref. Westminster Kingsway College: Agreed Supplementary Site Investigation). The requirements of the agreed supplementary site investigation were as follows:

- Establish if the former garage on Gray's Inn Road offsite to the southeast has resulted in contamination of the site.
- Further investigate the character of Made Ground beneath the site.
- Further investigate the ground gas regime beneath the site.
- Undertake Quantitative Risk Assessment (QRA) for human health.
- Confirm the remedial measures needed to support the development of the site.

This report presents the findings of a site investigation, laboratory analysis, monitoring and contamination assessment undertaken at the site during January and February 2007. For the sake of completeness, this report also incorporates, where relevant, the factual data obtained from previous investigations.

The extent of this investigation and analysis undertaken as part of this study is considered sufficient to identify potential sources of contamination, pathways and targets, with comparison of sample analysis against guideline values for the purpose of addressing the aforementioned outstanding issues raised by the local authority and SKM.

1.2. Terms of Reference

The terms of reference for the work were set out in a written proposal by MLM EL, ref. SJO/DMB/721543/002/DMB, dated 4 December 2006.

The proposals for this supplementary investigation included for the following scope of work:

- Construction of 6 No. trial pits or windowless sample boreholes
- Construction of 2 No. cable tool boreholes to 10m depth
- Gas and groundwater monitoring in existing and proposed wells
- Chemical analysis of soil and groundwater samples
- Waste classification testing.

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This original scope of work was later varied on 12 December 2006 to include:

• Quantitative Risk Assessment of contamination and guidance on remediation

1.3. Report Structure

This report is divided into a number of sections, which contain:

- A description of the issues that the investigation is to address
- A brief description of the site
- A summary of the findings from a previous intrusive investigation
- Description of the supplementary intrusive investigations, monitoring and analysis undertaken
- Description of the ground and groundwater conditions encountered
- Quantitative Risk Assessment of Contamination and potential remediation requirements
- Factual Data from the investigations.

2. THE SITE

2.1. Location and Description

• Location

The site is known as the King's Cross Centre of Westminster Kingsway College and is located on Sidmouth Street, London WC1H 8JB.

The location plan for the site is presented as Figure 1.

• Description

The subrectangular shaped site is presently developed with college buildings, areas of hardstanding and a limited amount of landscaping.

Site boundaries are formed by Sidmouth Street to the north, Gray's Inn Road to the east, Heathcote Road to the south and a park (St. George's Gardens) to the west.

The surrounding area comprises mixed residential, commercial, retail and academic land uses and a park.

For a full description of the site and the local area including site history, reference should be made to the SKM report entitled, Westminster Kingsway College, Contaminated Site Investigation draft report (ref. 110110, July 2005).

2.2. Previous Investigation Findings

<u>SKM draft report - Westminster Kingsway College, Contaminated Site Investigation</u> (ref. 110110, July 2005)

The desk study element of the report identified no previous development on site with the potential to cause significant contamination of soil or groundwater. However, a garage was located on adjoining land to the southeast on Gray's Inn Road.

The site is reported to have suffered bomb damage during World War II. This has been substantiated by MLM EL through reference to the London Bomb Damage Maps (ref. 1).

Made Ground was found across the site overlying London Clay strata to depths of between 1.7m and 3.1m below ground level (bgl). Made Ground comprised mainly clayey sand and gravel and cobbles of brick and concrete. The gravel component was of glass, clinker and metal fragments.

The underlying London Clay geology is classed a non aquifer.

Groundwater was found to be localised and perched at a level of 0.5m bgl. Following drilling, groundwater levels varied from 5.2m to 15.9m bgl.

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Based on the generic guideline criteria adopted in the SKM report, contamination of soil was identified in the form of lead, barium, copper, zinc and polyaromatic hydrocarbons.

Metals contamination was also identified in samples of groundwater and soil leach test elute.

2.3. Proposed Development

The eastern two thirds of the site are to be developed almost entirely with a new, 4storey college building. At ground floor level, the building is to contain a theatre, studios, workshops, offices and meeting rooms, stores and WC. A basement is also indicated.

The layout development, current at the time of writing, is as set out in the Brian Bond Architects Drawing, ref. 04-019 (07)002 T4, dated 02.05.06.

In the west of the site, residential apartments and soft landscaping are planned. However, no plans were available to show the development for this area.

3. GEOENVIRONMENTAL INVESTIGATIONS

3.1. General

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Supplementary fieldwork was carried out at the site on 10 and 11 January 2007 comprising the construction of cable tool boreholes, windowless sampling and groundwater and gas monitoring.

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The locations of all exploratory holes were positioned by a MLM EL engineer as prescribed in an unreferenced SKM sketch plan contained at Appendix A. These were varied on site taking into account observed features, existing building layout and services.

Features, structures or certain ground conditions may be present between exploratory hole locations, which are different to that encountered during the investigation and which developers should take into account during construction.

Locations of all exploratory holes are presented as Figure 2.

All boreholes were logged by a Geoenvironmental Engineer in accordance with BS 5930: 1999 (ref. 2).

3.2. Cable Tool Borcholes

A total of 2 No. Cable Tool Boreholes (ref BH1A – BH2A) were constructed using percussive drilling techniques to a maximum depth of 10.0m below ground level.

These boreholes were constructed for the specific purpose of installing gas and groundwater monitoring wells.

Engineer's cable tool borehole logs are presented in Appendix A for this supplementary phase of investigation.

During the previous investigation by SKM, a total of 7 No. cable tool boreholes were constructed to depths of 3.0m - 30.0m bgl.

3.3. Windowless Sample Boreholes

A total of 6 No. windowless sample boreholes (refs. WS1 - WS6) were constructed across the site using 1 No. Archway Dart Windowless Sampling Rig to depths of 0.8m - 4.0 bgl. Boreholes were advanced from the surface following coring of the ground slab.

Continuous soil cores in clear plastic liners were recovered during boring to prevent cross contamination and aid sample recovery.

The windowless sample boreholes were backfilled with arisings upon completion and made safe.

Engineer's windowless sample borehole logs are presented in Appendix B.

3.4. Monitoring Well Installations

Combined groundwater and gas/vapour monitoring wells were installed in boreholes BH1A and BH2A.

The installations comprised 50mm plain casing from ground level to 0.50m bgl with the resulting annulus sealed with bentonite pellets. From 0.5m bgl to the base of the hole, the casing was slotted with the resulting backfilled with a pea gravel filter.

The installations were completed at the surface beneath a flush mounted inspection cover and gas taps monitoring installed.

The full well installation details are presented on the relevant engineer's logs.

3.5. Gas and Groundwater Monitoring

A total of 6 No. monitoring visits were undertaken following site work completion on 15 and 22 January and 6, 15, 22 and 27 February 2007. These were conducted to carry out gas monitoring, to obtain groundwater samples (initial visit only) for chemical laboratory testing and to measure depths to groundwater in the wells.

Carbon dioxide (CO_2) , methane (CH_4) , oxygen, flow rates and barometric pressure were recorded using a Geotechnical Instruments GA 2000 gas analyser. Levels of hydrocarbon vapour were obtained during drilling using a Phocheck 3000 PID.

Results of groundwater and gas monitoring undertaken are presented in Appendix C for this supplementary investigation.

3.6. Sampling

Disturbed soil samples were recovered in tubs and amber glass jars from the windowless sample liners appropriate for the type of analysis and determinants tested.

Where present, groundwater samples were recovered from each well during the initial monitoring visit, using dedicated disposable bailers. Samples were decanted into plastic bottles or amber glass Winchester bottles appropriate for the type of analysis and determinants tested.

Samples for chemical laboratory analysis were couriered to the laboratory the day following recovery.

Sample types and depths are recorded on exploratory hole records.

3.7. Laboratory Analysis

Chemical Analysis

The following analytical tests were scheduled on samples recovered from the investigation and monitoring.

These were selected according to the criteria set out by SKM and were undertaken on samples as follows:

Contaminant	Made Ground	London Clay	Groundwater	
Metals (arsenic, cadmium, chromium, mercury, nickel, lead, selenium)	10 (19)	3 (3)	1 (2)	
Metals (copper, nickel, zinc)	10 (19)	3 (3)	i (2)	
Total petroleum hydrocarbons (TPH) C10-C35	7	3	1	
TPH, carbon banded (C6-C40)	(7)	(1)	(2)	
TPH, TPHCWG carbon banded (AA-splits)	-	-	1	
Speciated polyaromatic hydrocarbons (PAH)	2	-	-	
Total PAH	2 (19)	(3)	-	
VOC (including BTEX)	(4)	-	1 (2)	
SVOC (including speciated PAH)	(4)	-	1 (2)	
Waste classification tests	7	1	-	
Asbestos fibre identification	2 (7)		-	
pН	(19)	(3)		

Table 3.1Summary of chemical testing

(n) Number of tests carried out in a previous phase of investigation by SKM

The other determinants tested for, which included pesticides, formaldehyde, phenol, cyanides, asbestos, were at or below their respective limits of detection and are therefore excluded from this assessment.

It is noted that a solvent extract was also performed previously by SKM on samples however it is considered this has limited benefit since it is a measure of anything soluble in a solvent such as dichloromethane. This could include a range of SVOC's and VOC's (including PAH's and BTEX compounds) and TPH. Since solvent extract is sometimes used as an indicator to PAH or TPH content the resulting assessment is likely to be overly conservative and is also excluding from this assessment for this reason.

Current chemical analysis was undertaken by Chemtest Limited at their UKAS and MCERTS accredited laboratory in Newmarket, Suffolk.

The full results of chemical laboratory testing are presented in Appendices D (soil), E (groundwater) and F (waste classification).

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4. GROUND AND GROUNDWATER CONDITIONS

4.1. General

The ground conditions encountered across the site during this supplementary investigation generally confirmed the findings of the previous SKM investigation and comprised of the following general strata sequence:

Table 4.1 Generalised strata sequence

Strata	Depth Range (m bgl)	Thickness Range (m)
Made Ground	GL	0.4 - 3.1
London Clay	0.4 - 3.1	28.3+

+ base of stratum not proved

4.2. Made Ground

Made Ground was encountered in all the exploratory holes below a surface cover of either topsoil (0.1 - 0.2m), concrete (0.05 - 0.2m) or tarmacadam (0.1 - 0.2m).

Made Ground extended to depths of between 0.4m bgl in WS4 and a maximum of 3.1m bgl in WS2 and BH01.

Made Ground was generally of a clayey, sand and gravel with cobbles and gravel of brick and concrete and a subordinate content of flint, ash, clinker, ceramic, roadstone, glass, iron, charcoal and some organic matter.

4.3. London Clay

Underlying the Made Ground was a firm to stiff, brown mottled grey, occasionally sandy CLAY. The London Clay is locally very stiff, fissured and with sand partings.

4.4. Groundwater

Groundwater strikes were generally not encountered within the boreholes during drilling with the exception of seepage at 0.5m bgl in BH03 in April 2005 and at 1.0m in BH1A in January 2007; both in Made Ground.

During subsequent monitoring of wells installed during previous investigations, the depths to groundwater elevations were as follows:

Location	Depth to Groundwater (m bgl)		
	Apr-05	Jan/Feb-07	
BH01	5.24 - 5.99	2.82	
BH06	7.11 - 7.38	8.41	
BH07	9.34 - 9.52	6.28	
BHIA	*	0.70 - 1.20	
BH2A	-	Dry	

 Table 4.2.
 Summary of groundwater level data

It should be recognised that groundwater levels can fluctuate seasonally and, therefore, may be encountered at higher or lower elevations than indicated from the site investigation.

4.5. Contamination Observations

Other than the presence of Made Ground, there was no visual or olfactory evidence for contamination during this or previous phases of investigation.

4.6. Ground Gas/Vapour Conditions

The presence of Made Ground indicated the potential for ground gas to be present.

After the fieldwork, during subsequent monitoring, the range of gas levels were as follows:

Date	Methane, %	Carbon dioxide, %	Oxygen, %	Flow Rate, I hr ⁻¹	Barometric Pressure, mb
15-Jan-07	<0.1	<0.1	19.3 - 19.2	< 0.3	1004 - 1005
22-Jan-07	<0.1	<0,1	19.8 - 19.9	< 0.3	1017
6- Feb-07	<0.1	<0.1	17.6 - 18.5	< 0.3	1006
15- Feb-07	<0.1	<0.1	17.6 - 19.2	<0.3	1020
21-Feb-07	<0.1	<0.1	18.0 - 18.8	< 0.3	1017
27-Feb-07	<0.1	< 0.1	19.1 - 19.2	< 0.3	1002
Previous Investigation					
Apr-05	<0.1	0.2 - 1.1	19.7 - 21.1	<0.1	1011 - 1019

 Table 4.3.
 Summary of ground gas conditions during monitoring

5. DISCUSSION OF SOIL TEST RESULTS

5.1. Contaminant Trigger Levels and Reference Criteria

Human Health

In assessing the levels of compounds in soil at the site in terms of the potential for harm to human health, quantitative risk assessment has been carried out and Site Specific Assessment Criteria (SSAC) have been developed using the Contaminated Land Exposure Assessment model (CLEA) developed by Defra and the EA (ref. 3).

SSAC have been calculated using the Environmental Agency's CLEA Beta Version 2005 Excel spreadsheet (ref. clea_vl_0.xl).

Further guidance was issued by Defra in November 2006 in the form of Contaminated Land Advice Note 6/06 (ref. 4). CLAN 6/06 is intended as an additional tool to assist in the assessment process.

CLAN 6/06 allows the practitioner to review the assessment process over a series of 'judgement points' in four key areas (Zones A, B, C and D). Zone A concerns toxicology and health effects; Zone B concerns exposure pathways; Zone C concerns practical and policy considerations; and Zone D concerns decisions on individual sites.

Zone B (changes to exposure of pathways) of CLAN 6/06 sets out a number of enhancements that can be adopted in assessments for the derivation of appropriate CLEA SGV'S using CLEA 2005 software with immediate effect from November 2006. The most important change under Zone B was the decision made by Environment Agency to move away from modelling maximum exposed individuals (or sub-groups) to modelling more realistic worst-case scenarios.

The enhancement adopted in this assessment is as follows:

 Removal of the probabilistic function in calculating soil ingestion for children (0-6 years) and fixing the rate at 100mg day⁻¹.

Phytotoxicity

Risks from phytotoxicity have been assessed through the British Standard PAS 100 (ref. 5) 100:2002. This sets out the minimum quality standards for composted materials, which may be used as a planting media.

Water Supply

Risks to water supply pipes and services are assessed through the Water Regulations Advisory Scheme guidance note 9-04-03 (WRAS) (ref. 6).

The WRAS guidance note provides threshold concentrations above which permeation by organic compounds can occur through polymer supply pipes to taint or affect the quality of potable water.

Waste Classification

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Wastes for off site disposal at landfill must be classified as either inert, non-hazardous or hazardous waste according to Waste Acceptance Criteria (WAC) (ref. 7).

5.2. Reference Criteria vs. Proposed Land Use

The proposed development is to comprise an almost complete cover of college buildings in the east and residential apartments in the west. Some areas of soft landscaping are likely to be proposed. Private gardens are not included in the development plans for the site.

Appropriate SSAC are developed, therefore, according to land use as follows:

• Residential use <u>without</u> plant uptake in the west of the site

AND

• College use in the cast of the site modelled using the commercial office with basement function in CLEA 2005.

5.3. Soil Dependent Factors

Based upon statistical analysis, SSAC have been determined using the following soil dependent factors:

Soil dependent factor	Range	No. of determinations	Mean	Median
pH	7.7 – 10.4	19	8.7	9.1
OMC	Not tested	Assume 5%		
Soil type	Clay - gravel	Assume sandy soils throughout		

 Table 5.1.
 Statistical analysis of soil dependent factors (Made Ground only)

The number of pH determinations made is considered to be representative and the mean value is therefore adopted.

5.4. Human Health Site Specific Assessment Criteria

The following table presents a summary of test results for metals compared with the calculated SSAC. Sample numbers are based on those obtained during both phases of investigation.

The exploratory locations included in the assessment for the western area to be developed as residential without gardens include BH6 and BH7 of the SKM investigation and WS5 and WS6 of this investigation.

The exploratory locations included in the assessment for the eastern area to be developed as college premises include BH1 - BH5 of the SKM investigation and WS1 - WS4 and BH1 - BH2 of this investigation.