HERTS & ESSEX SITE INVESTIGATIONS

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GEOTECHNICAL ASSESSMENTS – ENVIRONMENTAL ASSESSMENT - DESKTOP STUDY – CONTAMINATED LAND

Report For :

Ward Williams Associates

Phase III REMEDIATION REPORT

Site location :

24-28 Warner Street,
London
EC1R 5EX

July 2012
Report No. 10847

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INDEX

DOCUMENT INFORMATION AND CONTROL SHEET

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Regulatory Body :

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Application Number 2012/2587/P

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Document Status and Approval Schedule

Issue No	Status	Date	***Prepared by :*** Chris Gray Signature / Date	***Technical review by :*** Rebecca Chamberlain Martyn Smith Signature / Date	***Checked By :*** Rebecca Chamberlain Chris Gray Signature / Date
1	Final				

REPORT ISSUE RECORD

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Controlled copies of this report have been issued according to the following schedule :-

	Issue No	Recipient	Type	No. of copies	Date
1	1	HESI, (File Copy)	Paper	1	July 2012
2	1	Ward Williams Associates	Paper	1	July 2012
3	1	Ward Williams Associates	PDF	1	July 2012
4					
5					
6					
7					
8					

Definitions

Hard Landscaping – This is defined as areas of external hard landscaping and includes paved areas, and landscaping to include shingle, mulch and decking areas. Due to the nature of these finished surfaces, it is possible that future residents could removed these features to place grassed landscaping in their place.

1 Introduction

1.1 Aims and objectives

At the request of Ward Williams Associates, Herts & Essex Site Investigations have been asked to further assess and consider the site for the preparation of this Site Remediation Strategy Report to define the way forward for the site in light of all previous site investigation works undertaken. A location plan of the site is provided as Appendix 2, Sheet 1.

The principal aim of this report is to provide a source document for regulatory authorities and other interested parties to review, in particular the Environment Agency, the Local Authority Department, (Environmental Health Department), Ward Williams Associates and their representatives. Agreement from regulatory authorities will be required in order to satisfy planning conditions and to ensure that the site does not present a significant risk to potentially vulnerable receptors including future site users, controlled waters and the environment.

The main objectives of this Remediation Method Statement are as follows:

- To comply with the requirements of the Regulatory Authority requirements;
- To provide a summary of the remedial works, and specific methodology for removal of metal based pollutants that have impacted on soils; and,
- To provide details of good working practices during site remediation works, in accordance with current legislation and guidance.

This document should be read in conjunction with the Phase I carried out by Herts & Essex Site Investigations undertaken in May 2012 and Phase II report compiled by Herts & Essex Site Investigations in June 2012.

1.2 Current Planning Status

After a review of the Camden Council Website, we can confirm that there is an application in place. (2012/2587/P)

1.3 Remediation Requirements

The preparation of this remediation strategy and verification plan is to ensure the site is suitable for future use when completed and habitable. The proposals laid out in this report have been proposed based on the initial risk assessments completed within the site investigation works undertaken and are in place to mitigate against future risk being in place.

This remediation strategy is based upon the findings of all previous reporting and assessments which have been completed by Herts & Essex Site Investigations. As such, any and all reviewing undertaken should be read in conjunction with the following reports :-

- HESI, (May 2012), Preliminary Risk Assessment, (Phase I Desk Top Study – CSG/10847);
- HESI, (June 2012), Secondary Site Investigation, (Phase II Environmental Assessment – CSG/10847).

The remediation strategy and verification plan have been developed for the site in accordance with guidance documents :-

- Defra & Environment Agency, (2004), CLR 11 Model Procedures for Management of Land Contamination;
- Environment Agency, (2010) GPLC1 Guidance Principles for Land Contamination;
- PPS23 Pollution and Planning, (ODPM 2004)
- Environment Agency, (2010) Science Report SC030114/R1 Verification of Remediation of Land Contamination;
- CL:AIRE, (2010) Framework for Assessing the Sustainability of Soil and Groundwater Remediation;
- CL:AIRE, (2008) The definition of Waste; Development Industry Code of Practice.

2 Background and Environmental Settings

2.1 Site Details

The site is located within a commercial area of London, the details of which are summarised in Table 1 with the location plan of the site shown in Appendix 2, Sheet 1.

Table 1 Site Detail

Site Address	24-28 Warner Street, London EC1R 5EX
Site assessed under	Planning
Current use of land	Warehouse building
Previous use of site, (if known)	Timber Merchants
Grid Reference	NGR 531150, 182170
Site Area	Approximate area – 0.04 Hectares
Local Authority	Camden Council
Gradient of the site	The site is recorded as level area of land
Proximity of Controlled Waters, (if known)	671 meters to the north east of the site - Ornamental pond

2.2 Site Description

The site is recorded as an existing commercial building which covers the majority of the site with a small courtyard area to the rear of the site. The site incorporates a heavy concrete floor covering the entire building footprint. The site forms a level area of land and is accessed from the main road directly onto the site from the main road through roller shutter doors.

2.3 Brief Site History

The site area is recorded as having buildings in place pre 1877, one of which was recorded as a public house until 1853. From 1982 there is a warehouse recorded in place within the site area and this remains in place to date, until recently it was used by a timber merchant, the site is currently vacant.

Surrounding the site area there have always been buildings in place, and the majority of these are recorded as commercial units.

2.4 Desk Top Study Conclusions

Considering the assessment of the site to incorporate the walk over survey, historical mapping and environmental searches undertaken, we can confirm that risks identified in place form :-

On Site

- Warehouse, (Timber Works).

Off Site

- Commercial Buildings, (including printers).

2.5 Scope of site investigation Works completed

The scope of works completed within the site investigation are recorded in the Phase II Environmental Report and can be reviewed within this report. This confirms the following source data :-

- Trial Pits, (Three trial pits have been sunk to a depth of 1.00-2.60 meters);

- Deep borehole, (sunk to a depth of 25 meters).
- Initial Gas Testing Data

2.6 Ground Conditions

From the information gained, it is recorded that the geology within the site is formed by depths of made ground overlying Clay with a granular soil was recorded below this. The geology within the site is as follows :-

- ***Made Ground*** was present to the close of all trial pits with trial pit one recorded a concrete basement floor which halted process and to a depth of 4.00 meters within borehole one.
- ***London Clay*** This was seen to overlie a peaty Clay to 4.50 meters where lay was present to 21 meters;
- ***Sand and Gravel*** below the clay there is a dense sand and gravel in place to the base of the excavation at 25m
- ***Groundwater*** was not recorded in place as part of the site investigation works. This is currently based on short term observations.

The scope of works has been undertaken in May 2012 which has been undertaken by Herts & Essex Site Investigations. The scope of the works has been undertaken over a period of two days. Long term monitoring has been completed.

2.6.1 Made ground

Made ground within the site is recorded as present to an increased depth upto 4.00m. The fill material is recorded as a hardcore fill with, metal ash and clinker recorded in some locations. The makeup of the made ground may promote contamination to be in place.

2.6.2 Superficial Geology

By examination of the lower natural subsoil, no obvious contamination has been identified visually. No testing of the underlying natural soils has been undertaken, although, visual examination of these soils confirm risks are likely to be low.

The presence of Peat within the lower clays may promote an increased land gas risk due to the degradation of this stratum.

2.6.3 Groundwater

Based on the initial assessments of the site, no groundwater has been recorded in place. Long term monitoring is ongoing and initial results show groundwater strikes at depths of between 4.21-4.28 m

2.6.4 Contamination Observations

Based on the information gained from the site inspection, the hardcore fill material within the site area was seen to form a possible been affected by the previous uses of the site and by contained contamination. Chemical testing was carried out and elevated levels of arsenic, Lead and Mercury were recorded. No Asbestos product was noted within the hardcore materials in place.

Non visual on site risks have been confirmed as potential land gas risks from Peat within the lower subsoil within the clay stratum. This may promote land gas and as such, on site land gas assessments have been completed and are enclosed in appendix three of this report. The gas assessment completed confirms that the site should be classed as a Gas Characteristic Situation 2.

2.7 Conceptual Site Model

In order to assess he potential risks posed to human health and the surrounding environment from the site condition, a Generic Quantitative Risk Assessment has been used to consider whether risk is in place. This uses Source Pathway Receptor risk assessment methodology in accordance with CLR11.

The summary conceptual site model developed within the ground investigation reports has been re created below :-

Table 2 **Risk Assessment A**

Source	*Receptors*	*Pathway*	*Mitigation / Discussion*
Arsenic	Site Users, (current and future); Construction Workers; Adjacent Site Users, Fauna.	Direct contact	Risk is in place.
		Ingestion dust and soil	
		Ingestion of soils attached to vegetation	
		Inhalation of asbestos fibers	Not Applicable
		Inhalation of vapours, (gas and organic)	No vapour risk from Arsenic contamination identified
		Explosive risk from Land Gas	Not Applicable
		Ingestion of contaminated water through water main pipework	No risk in place from Arsenic contamination identified
		Inhalation of vapours through contaminated ground waters	No groundwater receptors within the general site area and surface water are some distance away. Risk is considered low.
		Direct contact with contaminated ground waters	
	Surface Water.	Lateral migration of shallow groundwater to a target receptor.	
	Ground Water; Abstraction Well.	Migration through fissures / cracks which may migrate to a groundwater receptor.	
	Plants; Vegetation.	Plant uptake; Direct contact.	Plant Risks are considered Low based on assessments with ICRCL old exposure levels. No specific plant risk assessment criteria in place
	Buildings; Construction Materials.	Direct contact with contaminated soils;	Arsenic poses a low risk to the built environment.
		Direct contact with contaminated groundwater	No groundwater contamination is anticipated based on site assessments.

Table 3 **Risk Assessment B**

Source	*Receptors*	*Pathway*	*Mitigation / Discussion*
Lead	Site Users, (current and future); Construction Workers; Adjacent Site Users, Fauna.	Direct contact	Risk is in place.
		Ingestion dust and soil	
		Ingestion of soils attached to vegetation	
		Inhalation of asbestos fibers	Not Applicable
		Inhalation of vapours, (gas and organic)	No vapour risk from Lead contamination identified.
		Explosive risk from Land Gas	Not Applicable
		Ingestion of contaminated water through water main pipework	No risk in place from Lead contamination identified
		Inhalation of vapours through contaminated ground waters	No groundwater receptors within the general site area and surface water are some distance away. Risk is considered low.
		Direct contact with contaminated ground waters	
	Surface Water.	Lateral migration of shallow groundwater to a target receptor.	
	Ground Water; Abstraction Well.	Migration through fissures / cracks which may migrate to a groundwater receptor.	
	Plants; Vegetation.	Plant uptake; Direct contact.	Plant Risks are considered Low based on assessments with ICRCL old exposure levels. No specific plant risk assessment criteria in place
	Buildings; Construction Materials.	Direct contact with contaminated soils;	Lead poses a low risk to the built environment.
		Direct contact with contaminated groundwater	No groundwater contamination is anticipated based on site assessments.

Table 4 **Risk Assessment C**

Source	*Receptors*	*Pathway*	*Mitigation / Discussion*
Mercury	Site Users, (current and future); Construction Workers; Adjacent Site Users, Fauna.	Direct contact	Risk is in place.
		Ingestion dust and soil	
		Ingestion of soils attached to vegetation	
		Inhalation of asbestos fibers	Not Applicable
		Inhalation of vapours, (gas and organic)	If the Mercury Contamination forms Elemental or Methyl Mercury, vapour risk is potentially in place. Additional testing would be required.
		Explosive risk from Land Gas	Not Applicable
		Ingestion of contaminated water through water main pipework	No risk in place from Mercury contamination identified
		Inhalation of vapours through contaminated ground waters	No groundwater receptors within the general site area and surface water are some distance away. Risk is considered low.
		Direct contact with contaminated ground waters	
	Surface Water.	Lateral migration of shallow groundwater to a target receptor.	
	Ground Water; Abstraction Well.	Migration through fissures / cracks which may migrate to a groundwater receptor.	
	Plants; Vegetation.	Plant uptake; Direct contact.	Plant Risks are considered Low based on assessments with ICRCL old exposure levels. No specific plant risk assessment criteria in place
	Buildings; Construction Materials.	Direct contact with contaminated soils;	Mercury poses a low risk to the built environment.
		Direct contact with contaminated groundwater	No groundwater contamination is anticipated based on site assessments.

Table 5 **Risk Assessment D**

Source	*Receptors*	*Pathway*	*Mitigation / Discussion*
Land Gas	Site Users, (current and future); Construction Workers; Adjacent Site Users, Fauna.	Direct contact	
		Ingestion dust and soil	No risk is in place through these pathways
		Ingestion of soils attached to vegetation	
		Inhalation of asbestos fibers	
		Inhalation of vapours, (gas and organic)	Install Land Gas Mitigation Measures, (Assume Gas Characteristic Situation 2)
		Explosive risk from Land Gas	
		Ingestion of contaminated water through water main pipework	
		Inhalation of vapours through contaminated ground waters	
		Direct contact with contaminated ground waters	
	Surface Water.	Lateral migration of shallow groundwater to a target receptor.	No risk is in place through these pathways
	Ground Water; Abstraction Well.	Migration through fissures / cracks which may migrate to a groundwater receptor.	
	Plants; Vegetation.	Plant uptake; Direct contact.	
	Buildings; Construction Materials.	Direct contact with contaminated soils;	
		Direct contact with contaminated groundwater	
		Explosive risk from Land Gas	Install Land Gas Mitigation Measures, (Assume Gas Characteristic Situation 2)

3 Remedial Strategy

3.1 Remediation Strategy

The conceptual site model developed for the site confirms that Source Pathway Receptor links are in place within the site which may require mitigation or remediation works in order to develop a suitable development. The methods of control or reducing the unacceptable risks are defined as follows :-

- Remove the contamination at source;
- Remove the pathway in which contamination can impact on a receptor;
- Remove the receptor from the environment.

Considering the extent of contamination in place, it is not viable to remove the pathway or receptor and as such, likely remediation options will incorporate the removal of any source risk. As such, this forms the desired remediation option.

Based on the above, the soils remediation process will comprise the following:

3.2 Proposed Remediation Options

General Contamination Risks Brought Forward

- The site has been classed as contaminated by Metals and Land Gas Risk across all areas of the site based on the assessments made;
- The contamination assessment of the site to date confirms that source – pathway – receptor risk is in place and as such, likely remedial measures are required where these complete pollution links exist. This will incorporate primarily soft landscaped areas where soils will be exposed to human interaction through dermal contact, ingestion and inhalation, although, land gas risk will be in place within areas proposed to be developed as structures;
- Contamination is present to in increased depths based on all assessments of the site undertaken to date;
- Should contamination extend under buildings and hard landscaping contamination will effectively be capped and therefore, could potentially remain in place, although, this will need documentation to confirm the contamination status below any buildings.
- Land Gas risk has been assumed to be in place although, all data to date confirms no risk. This forms a cautious approach, although, in the absence of long term monitoring, gas risk has been classified as a Gas Characteristic Situation 2 and therefore mitigation measure will remove risk associated with this classification.

Human Health Risk

Areas below soft and hard landscaped areas – Remediation Cells, (See Remediation Plans) Where contamination extends to depth :-

- Remediation cells will be formed through excavation and disposal of appropriate depths of soil. As considered within the below 'Cover Systems' assessment, we would suggest that a minimum depth of 0.60 meters of surface soils are removed to depths below the finished ground level. If the current ground levels are 'Low' the proposed capping layer only need to remove sufficient soils to provide 0.60 meters of the capping layer.

Where contamination is recorded as shallow :-

- In areas of the site where contamination is only present to a shallow depth, excavation and removal of the soils can be undertaken to confirm that the stratum is removed. This may not remove the proposed full depth of capping and as such, validation sampling should be completed across the base of the excavation to confirm that any soils which remain in place are clean and fit for the proposed land use which lie within this proposed capping depth;

- To re-iterate, the remediation of the site does not need to automatically remove 0.60 meters of soil regardless of what the material is and only needs to remove the contamination present with appropriate validation. (e.g. If the contaminated stratum only extends to 0.20 meters, only 020 meters of soil need removal) Validation sampling will be required to confirm that the soils are acceptable.

Construction Features

- ***Water Main*** By examination of the current chemical assessment undertaken, we can confirm that in accordance with UKWIR, (UK Water Industry Research – Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites), no risk is in place to water main pipework.

Below Buildings –Land Gas Risk

- Land Gas Risks are recorded as low, however, a cautious approach has been adopted for the site and the site classed as a Gas Characteristic Situation 2.
- The mitigation measures associated with the Gas Characteristic Situation 2 are as follows :-
    - The development should be constructed using a suspended floor construction which will provide passive ventilation for below floor ventilation;
    - All brickwork construction should incorporate the installation of a Carbon Dioxide DPC across the cavity wall construction and also incorporate cavity trays to protect against the migration of vapours into the proposed structure. This should be left lapping into the building;
    - A Carbon Dioxide Barrier should be placed across the structure and lapped over the DPC which should be taped and sealed to prevent vapour ingress into the building;
    - Any and all entry and egress points for services or tears in the barrier should be sealed using appropriate tape to prevent vapour ingress;
    - Increased airbricks should be installed around the property at increased intervals. These should be placed at 2 meter centres to increase below floor ventilation.

Whilst this is the case, a basement construction is proposed within the structure and as such, the above mitigation measure is unlikely to be sufficient. As such, we have included the solution score sheet in this report, see appendix 3, to design appropriate remediation measures in lieu of the gas risks. A solution score of 3 must be achieved in light of the Gas Characteristic Situation for the site.

Photographs

We can confirm that photographs will be required of any excavation cells, (where appropriate) which should be included within a validation report

Cover Systems – NHBC – Soft Landscaping Areas

The remedial measures are likely to include one of the following cover systems for the site :-

Engineered cover systems – designed to provide the complete separation of the receptor from the hazard and to perform a number of functions including limiting upward migration of contaminants due to capillary rise and controlling the downward infiltration of water.

Simple cover systems – to provide a reduction of the hazard to human health and to provide a suitable medium for plant growth.

Consultation within NHBC guidance documents, (Cover Systems for Land Regeneration), confirm that maximum depths of cover will be required for residential sites and overcome the inherent issues with earthworm activity, burrowing animals, effects of trees and plants, digging during garden activities and intermixing of leaf fall. Justification of this is included within the NHBC guidance document.

It is also recorded that as part of the review, a questionnaire was sent out to various Developers, Consultants and Regulators who all confirmed variable degrees of cover system based on the level of contamination which ranged from 0.30 meters to 3.00 meters, although, the report by NHBC removes these as conservative and the suggestion of a 0.60 meter cover system adopted by the report as a maximum depth of cover required to be sufficient.

It should be noted that these cover systems do not overcome the risks from soil gases, hydrocarbons, highly elevated Mercury or Arsenic, the groundwater or any controlled waters, significant

contamination, deep excavations, services, slopes or areas where rabbit or badger populations are significant. These are not present within the site. We can confirm that at an appropriate time, we will be instructed to visit the site and recover photographic evidence from the excavation cells.

Validation of Imported Soils

- Upon importing of subsoil, (if any), and topsoil, samples will be required for chemical analysis. It should be noted that soils which are placed in the site are recommended for pre-validation such that confirmation that these soils will form clean and acceptable materials based on the validation criteria shown within this report. It is often the case that soils are manufactured in landfill sites or waste management facilities which still promote an unacceptable risk based on an end use of residential land uses. This should be noted within the importing status of any soils to the site.
- We can suggest that Ward Williams Associates operates a sampling system for topsoil which confirm that one sample should be recovered per 15m³ of imported soils which is proposed to be adopted for this site.

3.3 Proposed Excavation Areas

The proposed areas of zoned source removal requiring excavation / remediation are summarised in Table 4 below. This is an estimate of the likely removal volumes and cannot be guaranteed and should only be used as a guide when considering remediation costs.

Table 4 Areas of Zoned Source Removal

Remediation Area	**SI Location**	**Depth of Contamination**	**Area of Impact (m^2)**	**Maximum Depth of Impact (m)**	**Excavation Volume (m^3)**
Existing site levels are unknown and as such, no comments can be made in relation to volumes of soil.					
				TOTAL	m^3

The above volumes do not take into account a bulking up factor of as excavated soil which could be considered as 30% as an indicator

3.4 Process of Remediation

The development of the site is anticipated to incorporate the following phases :-

- Demolition of any and all features within the site;
- Site Strip in preparation for the development of the site;
- Excavations for basement within two areas of the site;
- Foundation Construction;
- Main development;
- Landscaping.

4 Implementation Process

4.1 Remediation Team

This report confirms the required level of remediation needed to remediate the site to a suitable and fit for purposes standard. We can confirm that at this time, the following parties are involved in the remediation proposals at this site :-

The Client: *the client will ultimately be responsible for the remediation of the site and appointing appropriate personnel to provide lines of evidence that remediation works have been undertaken and that validation works have been completed sufficiently to provide the relevant authority, with documentary evidence that works have been completed to a suitable standard.*
Consultant *: the consultant will undertake validation that the remediation works have been undertaken to a suitable standard although, will require instruction from 'the client' as and when appropriate levels of remediation have been achieved.*
Principle Contractor: *The principle contractor will likely undertake initial site works which will remove contamination from the site as part of the initial site development. It is possible that these works may remove the depths of made ground, (contamination), to remove any and all risk within the site.*

4.2 Discovery Strategy

We can confirm that as a result of the majority of remediation being undertaken through the development of the site, stringent procedures must be adopted for the site to ensure that the remediation of the site through the development of the site and any unsuspected contamination which provides appropriate action for any of the site soils through soils assessments. This is as follows :-

The contamination within the site is recorded as from Metals and Land Gas. This may manifest itself in the form of hardcore fill . This is therefore easy to identify within the site and could therefore be viewed by a competent laymen. Whilst this is the case, we can confirm that a watching brief should be made by a senior site agent with a number of years experience or through consultation with Herts & Essex Site Investigations. Whilst the above should be maintained as a watching brief, (which is detailed below in bullet points), we can confirm that Herts & Essex Site Investigations should be consulted should any abnormal materials be encountered. We would additionally require Herts & Essex Site Investigations to make visits at appropriate stages of the development of the site.

The discovery strategy is recorded as follows :-

- Herts & Essex Site Investigations must be consulted as follows :-
    - To confirm that full contamination removal has taken place within the site and that no risk is in place;
    - To recover photographic evidence of these cells to assess any malicious materials;
    - Confirm that should areas of the site be encountered or recorded that would form a questionable material over and above that identified within this report, consultation with ourselves should be made in order to classify the risk.

Should the extent of all validation works and testing confirm that risks are reduced, a validation report must be completed to document that all excavations works have been undertaken in line with the proposed recommendations of this report. This will incorporate validation of any imported soils brought onto the site.

4.3 Verification Required.

In order to provide lines of evidence that the remediation process has been achieved and the remediation criteria has been met, the verification process must be followed. This verification process should incorporate all site test data, measurements and management records from the development of the site including muck away certificates and details of any variations to the remediation works undertaken.

No permanent monitoring proposals are in place in relation to the site.

Should soils be proposed for re-use within the site, any and all soils should be tested and confirmed that they are suitable for re use against the human health risk criteria as set out within Table 5 below.

Soils which fail the human health criteria will not be permitted to be re-used within the site development. Any soils which fail this criteria should be removed from the site with appropriate waste tickets retained.

The following forms the verification requirements that will be needed in order to prepare and complete a Verification Report for the site and as such, where 'the client' does not provide suitable evidence, further testing may be required.

On Site Verification – During Remediation

- Photos of the 0.60m reduced dig within areas of soft landscaping.
- or, Validation to the base of the excavation should the full 0.6 meters of soil not be removed;
- Scaled photographs should be taken of the reduced dig to confirm the depth of clean capping.

General Verification – Post Remediation

- Volumes of soils disposed off site;
- Results of topsoil analysis of any subsoil/topsoil/capping to the site;
- Plans showing verification sample locations;
- Documentation of variations and unforeseen conditions;
- Records of off site disposal of soil and groundwater;
- Consents, permits and approvals gained,
- 'As built' drawings;
- Other records, (e.g. correspondence, photographs etc).

It should be noted that this list may vary dependant upon conditions met on site and therefore is not complete.

Upon completion of any and all remediation works which comply with this strategy and a risk assessment and site conceptual model can be completed to confirm no risk is in place to the future user or environment, a site verification report should be completed for submission to the Local Authority and any other interested parties to confirm the site status.

Should the quality of remediation data not be completed in accordance with this report, reasonable attempts to confirm that the works have been undertaken retrospectively should be made. This may involve further more detailed site assessments and testing, monitoring and evidence.

Table 5 **Validation Criteria**

Pollutant	Allowable Level (mg/kg^{-1})
Electrical Conductivity	<200µS cm^{-1}, (as an indicator)
Arsenic	32
Cadmium	3
Chromium, (III)	3000
Chromium, (VI)	4.3
Copper	2330
Lead	276
Mercury	1
Nickel	130
Selenium	350
Vanadium	75
Zinc	3750
Boron	3
Sulfate, (2:1 water soluble)	1.2
TPH, (Total)	>20 required Speciated assessment
Benzo(g,h,i)perylene	44

Pollutant	Allowable Level (mg/kg^{-1})
Phenols	420
Naphthalene	1.5
Acenapthylene	170
Acenapthene	210
Flourene	160
Phenanthrene	92
Anthracene	2330
Flouranthene	260
Pyrene	560
Benzo(a)anthracene	3.1
Chrysene	6
Benzo(b)flouranthene	5.6
Benzo(k)flouranthene	8.5
Benzo(a)pyrene	0.83
Dibenzo(ah)anthracene	0.76
Indeno(1,2,3-cd)pyrene	3.2

Table 6 *Site Agents Summary Sheet*

Remediation and Validation Work Required at:- Land Adjacent to 24-28 Warner Street, London EC1R 5EX		Site Reference - 10847 Date updated: 18th July 2012 Revision Number -	
		ACTION REQUIRED	COMPLETED
Working Brief			
1	All personnel should be informed of the site status in relation to contaminated land.	The site is contaminated in all locations. The contamination has been assessed as widespread. Upon inducting members of site staff, the site agent must confirm that the site forms a contaminated land site and that remediation works are required. The site should be confirmed as contaminated by Metals and at risk from Land Gas.	
2	Should suspicious or unexpected soil, contamination or nuisance odours be encountered within any site works, HESI should be contacted so that the appropriate action or reporting can be undertaken where necessary.	Site notes to be kept by any and all staff involved in these remediation works.	
General			
3	If as part of the demolition work or initial site set up, site scrape or reduced dig for piling mat and or basment etc, works on site reduce the levels of the site HESI should be contacted to review this reduced dig.	Call HESI who can make an informed choice as to whether a site visit would be appropriate to validate or offer assistance in the remediation of the site.	
All Soft landscaping - Private Garden, Soft Landscaping, Grassed Areas and Hard Landscaping			
4	Excavate contaminated soils within the areas shown on the attached plan to a maximum depth of 0.60m. Excavate contaminated soils until clean soils are encountered to a maximum depth of 0.60m	A depth of cover is required and should form a maximum depth dig of 0.60 meters of clean soil placed in remediated soft landscaped areas - see sections attached. Should visually clean soils be recorded at a shallow depth within the 0.60m, the remediation should STOP and validation works completed through consultation with HESI.	
5	Validation samples to be taken from sides and base of excavations	Validation samples should be taken from the sides and base of the excavation where the full depth of contamination has not been removed.	
6	Photos of reduced dig	Contact HESI when the area of fill within soft landscaping is going to be removed so we can attend site. (photos can be taken)	

Continued.....

7	Import clean soils to backfill reduced area and to provide 0.60m capping layer. (see attached Table 5 Validation criteria which any imported soils must comply to)	See attached Table 5 Validation criteria which any imported soils must comply to.	
8	Validation of any imported topsoil/subsoil within the site area individually.	War Williams Associates should adopt an in house policy which incorporates a single sample of imported topsoil per 15m³ tested to confirm soils imported into the site are acceptable.	
9	Photos of capping layer installed -	Call HESI when soils have been imported and being installed with the site area for photographs to be recovered.	
10	A record of any material removed from the site should be kept.	Send a copy of any muck away tickets to HESI	
Under Permanent Hard Standing			
11	Demarcation barrier to be installed below hard standing	No risk is in place.	
Under Buildings			
12	Vapour / Gas Risk Assessment	A full gas proof membrane should be incorporated in the design of the site, (See section 3.1)	
Service			
13	Water Main Pipework	No risk is in place to water main pipework based on assessments against UKWIR.	

APPENDIX ONE

CONCEPTUAL MODEL

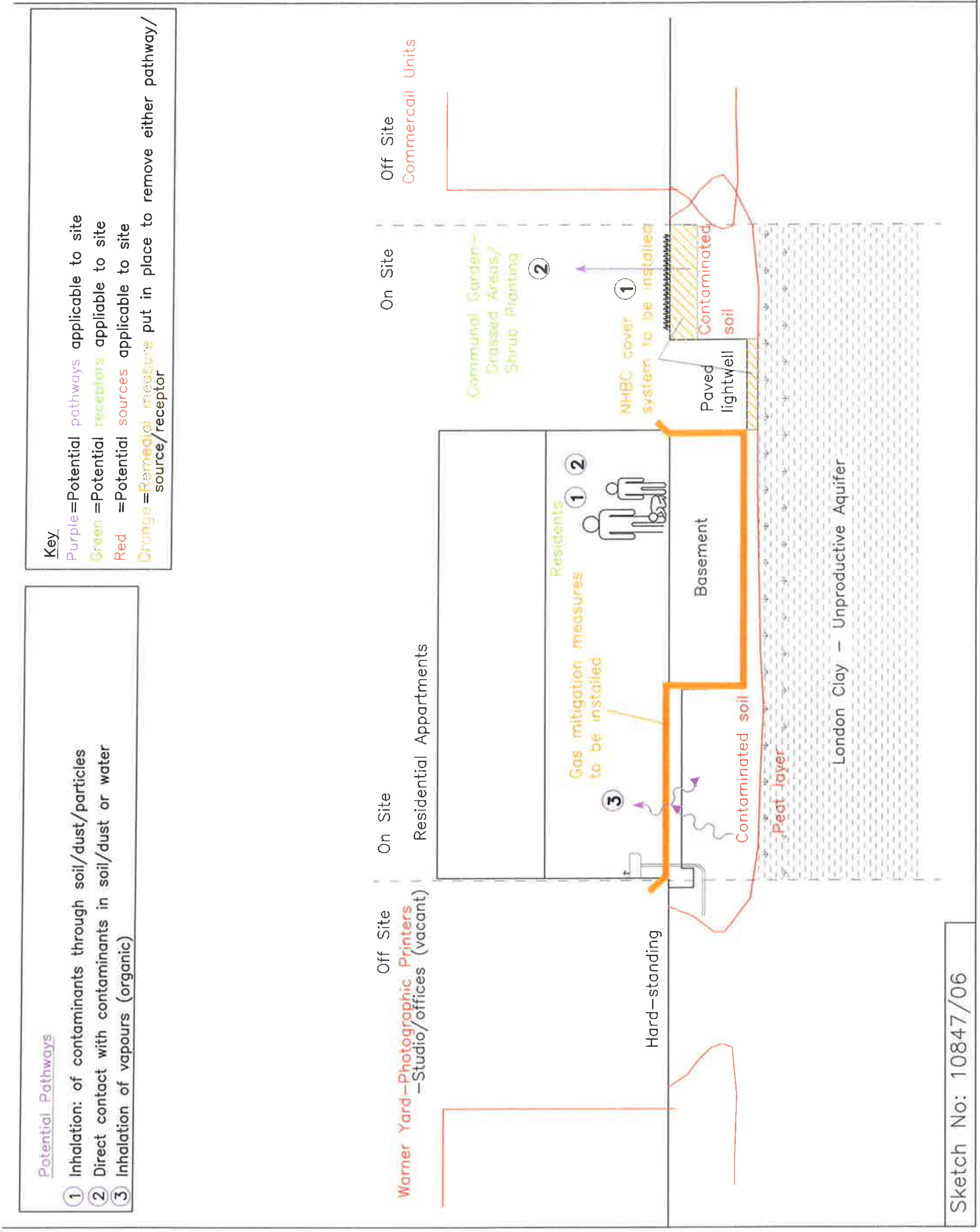
HERTS & ESSEX SITE INVESTIGATIONS

The Old Post Office, Wellpond Green, Standon, Ware, Herts SG11 1NJ
Telephone: Ware (01920) 822233
Fax: Ware (01920) 822200

Appendix No.	1
Sheet No.	1
Job No.	10847
Date	July 2012

4–28 Warner Street, London EC1R 5EX

Proposed Source–Pathway–Receptor – Post Remediation Report



APPENDIX TWO

SITE PLANS

HERTS & ESSEX SITE INVESTIGATIONS

The Old Post Office, Wellpond Green, Standon, Ware, Herts SG11 1NJ
Telephone: Ware (01920) 822233
Fax: Ware (01920) 822200

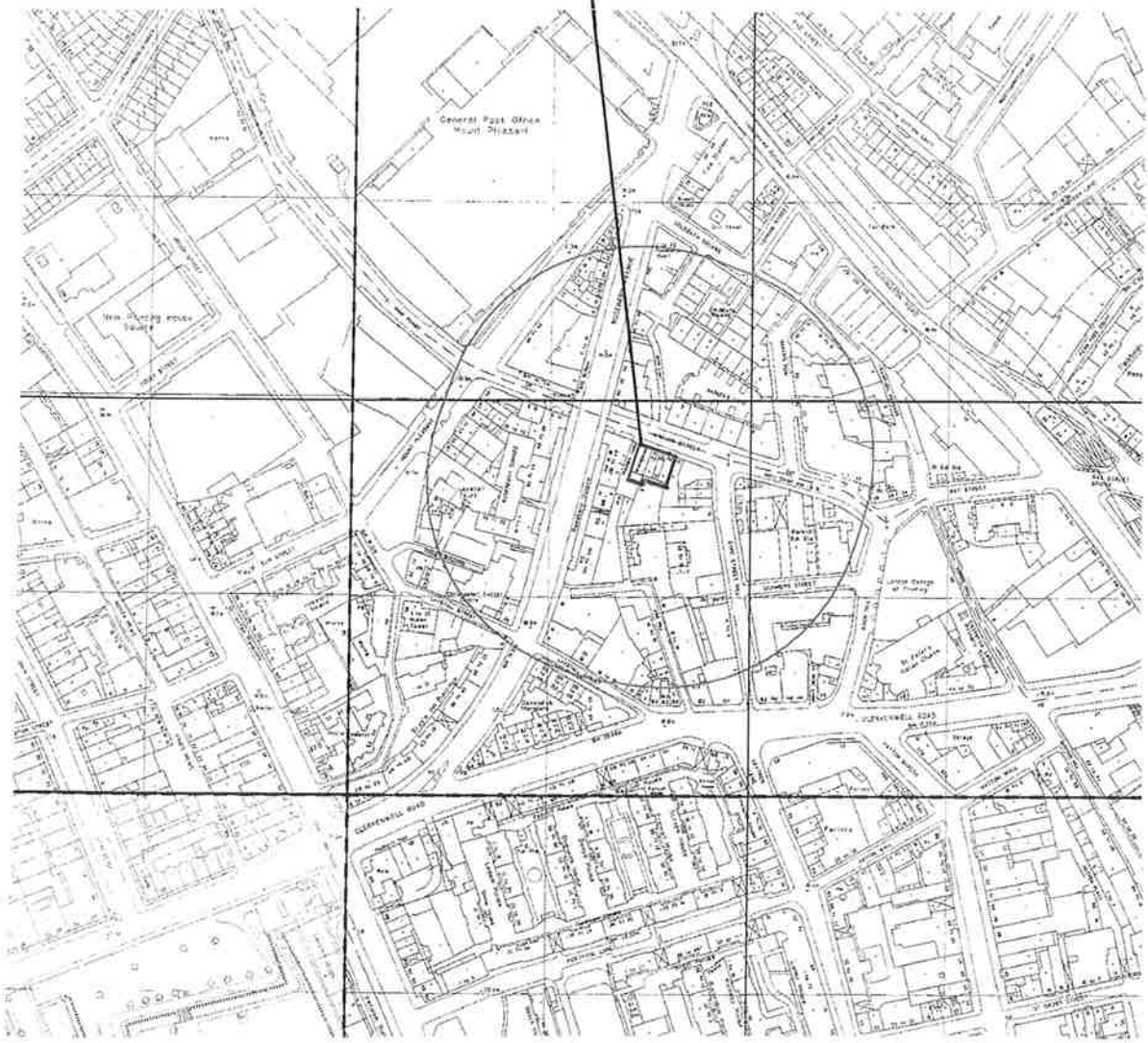
Appendix No.	2
Sheet No.	1
Job No.	10847
Date	May 2012

24–28 Warner Street, London EC1R 5EX

Location Plan

N

The Site



Not To Scale
Sketch No: 10847/02

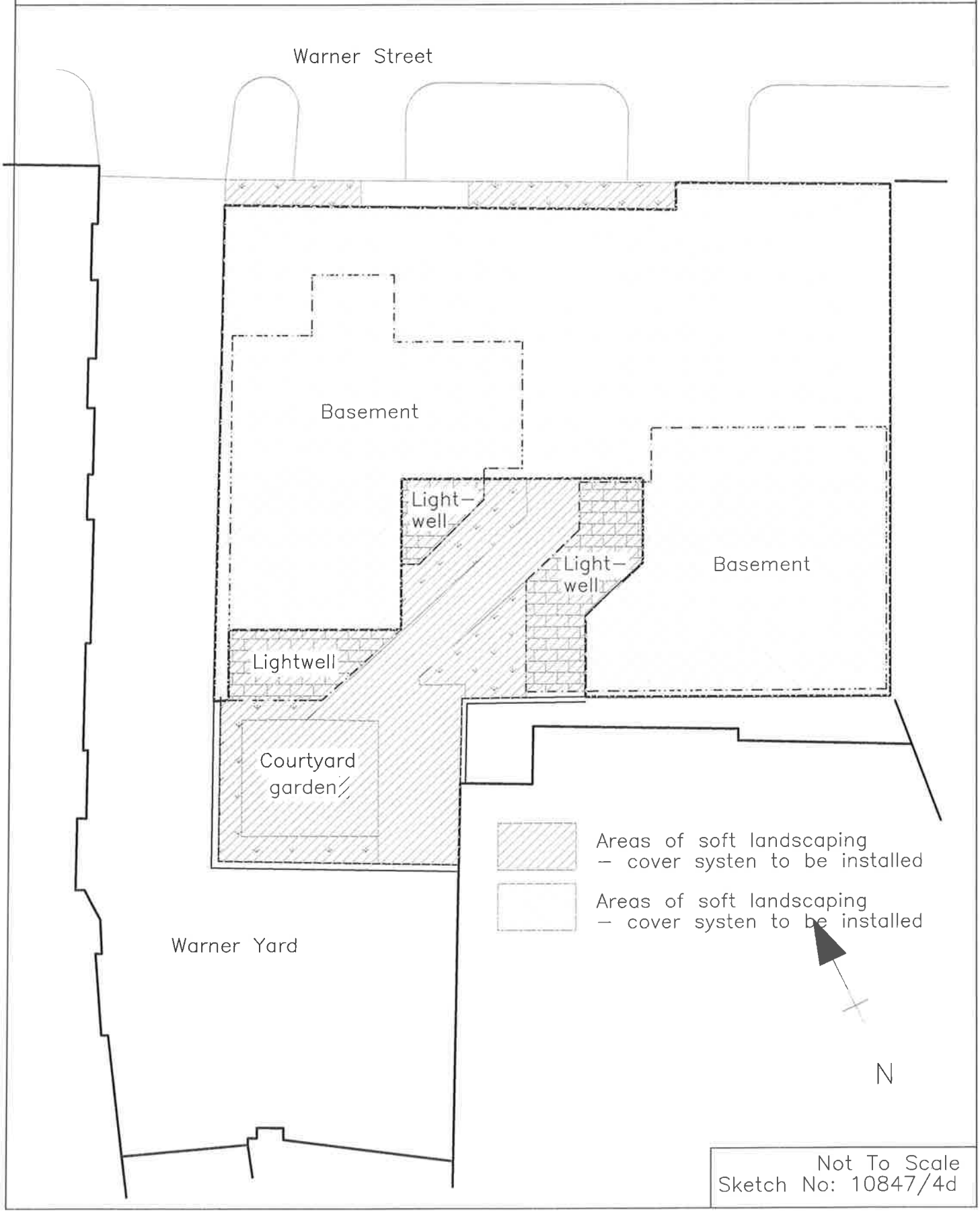
HERTS & ESSEX SITE INVESTIGATIONS

The Old Post Office, Wellpond Green, Standon, Ware, Herts SG11 1NJ
Telephone: Ware (01920) 822233
Fax: Ware (01920) 822200

Appendix No.	2
Sheet No.	2
Job No.	10847
Date	July 2012

24–28 Warner Street, London EC1R 5EX

Remediation Plan



Not To Scale
Sketch No: 10847/4d

HERTS & ESSEX SITE INVESTIGATIONS

The Old Post Office, Wellpond Green, Standon, Ware, SG11 1NJ
Telephone: Ware (01920) 822233
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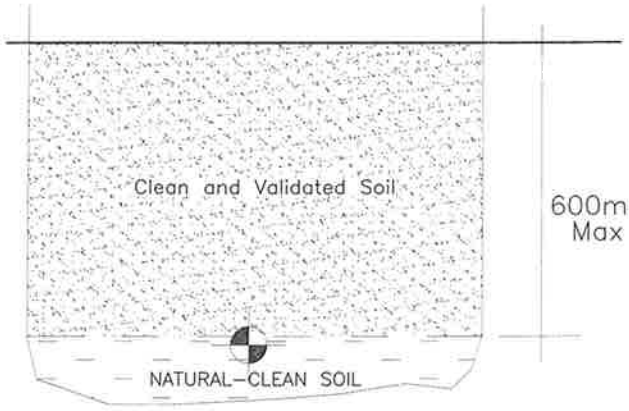
Appendix No.	2
Sheet No.	3
Job No.	10847
Date	July 2012

Typical Section for Remediation of Soft Landscapings

Scale 1:25

Soft landscaping
Where fill does not exceed 0.60m

1.



This is the finished Ground Level

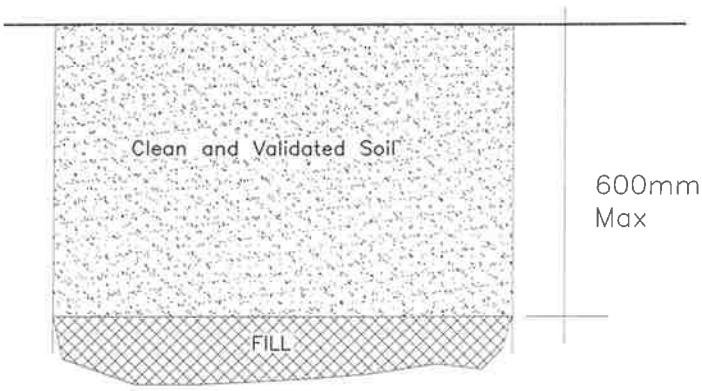
600mm Max

Where contaminated soils are shallow (less than 0.60m) only the contaminated soil needs to be removed

Validation testing needs completing Call HESI
A visual validation can initially be done by site agent

Soft landscaping
Where fill exceeds 0.60m

2.



This is the finished Ground Level

600mm Max

This is depth of clean (certificated or validated) soil required to be in place

Photos of the base required – Call HESI

APPENDIX THREE

BS 8485 : 2007
Gas Risk
Assessment

HERTS & ESSEX SITE INVESTIGATIONS

'THE OLD POST OFFICE', WELLPOND GREEN,
STANDON, WARE, HERTS, SG11 1NJ

TELEPHONE 01920 822233
FAX 01920 822200

GEOTECHNICAL ASSESSMENTS – ENVIRONMETAL ASSESSMENTS - DESKTOP STUDY – CONTAMINATED LAND

18th July 2012

Our ref : CSG/10792

Ward Williams Associates
91 - 93 Baker St
London
W1U 6QQ

For the attention of J.Truscott Esq.

Dear Sir,

Re: Site at 24-28 Warner Street, London EC1R 5EX : Gas Investigation Report

Further to your recent instructions, we have visited the above site to asses the extent of land gas risk.

The purpose of this visit was to establish whether reasonable assessments and investigative works could be undertaken within the proposed site works to confirm the extent and nature of gas risk and any mitigation measures could or would need to be implemented.

Gas monitoring installations were then installed within the site within a single borehole, (installed to a depth of 6 meters). Method statements and sampling strategies are enclosed within this report.

Considering the results of the gas testing and taking into account he worst case readings from the gas testing undertaken, it remains the case that no flow rates were recorded within the site and as such, the site and surrounding area is not degrading at a fast rate.

Whilst this is the case, increased levels of Carbon Dioxide have been recorded at slightly increased atmospheric pressures and as such, the possible scenario is that with a rapidly falling atmospheric pressure, increased flow rates and Carbon Dioxide may be in place.

As such, a cautious approach should be adopted for the site which should incorporate mitigation measures in line with a Gas Characteristic Situation 2. When considering remediation measures, we can confirm that in accordance with BS 8485 :2007, (Code of Practice for the Characterization and remediation from ground affected in gas developments), a Gas Solution Score of 3 will be required.

Considering the basement construction, we enclose an extract from this document, (Table 3 – Solution Scores), which dictates the extent of remedial works possible sufficient to achieve a solution score of 3.

As such, gas generation within the site area is minimal and would return a Gas Screening Value in line with CIRIA C665, CLR11 and BS8485:2007 of GSV = 2.

I hope the foregoing is sufficient for your requirements, although, please do not hesitate to contact me should you require any additional information or assistance.

Yours faithfully

C.S.Gray, M.Sc
Contract Engineer

Table 1 ***Gas Monitoring Data Sheet***

Site : 24-28 Warner Street, London EC1R 5EX Project No :10847 Date : 24th May 2012

Monitoring Point Reference	Flow Range, (litres / hr)	Atmospheric Pressure Range, (Pascal's)	Methane, (% v / v)		Methane, (% LEL)		Carbon Dioxide, (% v / v)		Oxygen, (%v / v)		Water Level, (m.b.g.l)	Depth of Well, (m)	Vol of gas in well, (m^3)	Other Gases.	Notes
			Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady					
BH1	0.0	1005 Start 1005 End	0.0	0.0	0.0	0.0	4.8	4.3	16.7	16.1	4.25	6m	0.012	None	

After CIRIA C665 – Table A3

Table 1 ***Gas Monitoring Data Sheet***

Site : 24-28 Warner Street, London EC1R 5EX Project No :10847 Date : 2nd July 2012

Monitoring Point Reference	Flow Range, (litres / hr)	Atmospheric Pressure Range, (Pascal's)	Methane, (% v / v)		Methane, (% LEL)		Carbon Dioxide, (% v / v)		Oxygen, (%v / v)		Water Level, (m.b.g.l)	Depth of Well, (m)	Vol of gas in well, (m^3)	Other Gases.	Notes
			Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady					
BH1	0.0	1005 Start 1005 End	0.0	0.0	0.0	0.0	6.9	5.1	14.3	14.2	4.21	6m	0.012	None	

After CIRIA C665 – Table A3

Table 1 ***Gas Monitoring Data Sheet***

Site : 24-28 Warner Street, London EC1R 5EX Project No :10847 Date : 17th July 2012

Monitoring Point Reference	Flow Range, (litres / hr)	Atmospheric Pressure Range, (Pascal's)	Methane, (% v / v)		Methane, (% LEL)		Carbon Dioxide, (% v / v)		Oxygen, (%v / v)		Water Level, (m.b.g.l)	Depth of Well, (m)	Vol of gas in well, (m^3)	Other Gases.	Notes
			Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady					
BH1	0.0	1005 Start 1005 End	0.0	0.0	0.0	0.0	7.1	6.8	14.5	13.2	4.28	6m	0.012	None	

After CIRIA C665 – Table A3

Soil Gas Monitoring Sheet

Site Reference No :	10847
Client :	Ward Williams
Site Address :	24-28 Warner Street, London EC1R 5EX
National Grid Reference:	NGR 531150, 182170
Date / Time of Monitoring :	24th May 2012 at 3.00 pm
Monitoring Personnel :	Rob Ward
Instrument Type :	Gas Data GFM 430
Serial Number :	10253
Barometric Pressure (Including any trend in rise or fall of pressure), (uncorrected) :	Start 1005 – Finish 1005
Air Temperature, (^{0}C) :	14^{0}C
Recent Weather, (eg precipitation and wind speed) :	Very slight breeze, no rain, overcast
Ground Conditions, (including vegetation stress visual contamination):	No obvious signs of contamination near surface – Brick Infill

After CIRIA C665 – Table A3

Soil Gas Monitoring Sheet

Site Reference No :	10847
Client :	Ward Williams
Site Address :	24-28 Warner Street, London EC1R 5EX
National Grid Reference:	NGR 531150, 182170
Date / Time of Monitoring :	2nd July 2012 at 11.00 pm
Monitoring Personnel :	Chris Gray
Instrument Type :	Gas Data GFM 430
Serial Number :	10253
Barometric Pressure (Including any trend in rise or fall of pressure), (uncorrected) :	Start 1003 – Finish 1002
Air Temperature, (^{0}C) :	14^{0}C
Recent Weather, (eg precipitation and wind speed) :	Very slight breeze, no rain, overcast
Ground Conditions, (including vegetation stress visual contamination):	No obvious signs of contamination near surface – Brick Infill

After CIRIA C665 – Table A3

Soil Gas Monitoring Sheet

Site Reference No :	10847
Client :	Ward Williams
Site Address :	24-28 Warner Street, London EC1R 5EX
National Grid Reference:	NGR 531150, 182170
Date / Time of Monitoring :	17th July 2012 at 12.00 pm
Monitoring Personnel :	Rob Ward
Instrument Type :	Gas Data GFM 430
Serial Number :	10253
Barometric Pressure (Including any trend in rise or fall of pressure), (uncorrected) :	Start 1001 – Finish 1001
Air Temperature, (^{0}C) :	14^{0}C
Recent Weather, (eg precipitation and wind speed) :	Very slight breeze, no rain, overcast
Ground Conditions, (including vegetation stress visual contamination):	No obvious signs of contamination near surface – Brick Infill

After CIRIA C665 – Table A3

Method Statement – Borehole Location

1. The location of the boreholes should be relevant to the designed site conceptual model taking into account historical and current information along with a walk over inspection of the site area. More detailed information may be required on sites where gas generation is considered to potentially be high;
2. The implications of the anticipated site conditions should take into account the proposed land use of the site. This must take into account the potential hazards and risks, (including health and safety risks), which could arise from the site conditions;
3. The investigation should be designed such that you are able to establish the nature and extent of current soil gas and / or vapour regime within the site;
4. The investigation should be designed such that the geological and hydrogeological conditions that may affect the soil gas regime are recorded and understood;
5. The investigation should identify the need and potential scope for further assessments and investigations;
6. Ultimately, the investigation should establish the need, where appropriate, for remedial works to take place and the extent of those works along with the likely costs;
7. The location of the boreholes should be located and installed relevant to the likely gas generation sources in place within the site;
8. The depth of the response zones within the site should be located such that the investigation targets the source of the ground gas and attains a suitable depth at which the source is considered located;
9. A minimum of three monitoring locations are required for a site under assessment from ground gases or vapours.

Table 1 ***Spacing of Gas Monitoring Wells for development sites, (Wilson et al, 2005)***

Gas Hazard	*Typical Examples*	*Sensitivity of end use*	*Initial nominal spacing of gas monitoring wells*[1, 2]
High	Domestic landfill sites	High[3]	Very close, (<25m)
		Moderate	Close, (25-50m)
		Low	Close, (25-50m)
Moderate	Older domestic landfills, disused shallow mine workings[4]	High	Close / Very close, (<25-50m)
		Moderate	Close, (25-50m)
		Low	Close/Wide, (25-75m)
Low	Made ground within limited degradable material, organic clays of limited thickness	High	Close, (25-50m)
		Moderate	Wide, (50-75m)
		Low	Wide / Very Wide, (50->75m)

1 The initial spacing may need to the reduced if, "initial" investigations suggest this is necessary to give a robust indication of the gas regime below a site. To prove the absence of gas closer spacing may also be required

2 The spacing assumes relatively uniform ground conditions and the gas source present below a site. The spacing will need to be reduced if ground conditions are variable or if the investigation is an attempt to assess migration patterns from off site;

3 Placing high sensitivity end use on a high gas hazard site is not normally acceptable unless source is removed or treated to reduced gassing potential

4 petrol stations and other sources of vapours are most likely to be classified as gas hazard " Moderate", however site specific assessments would be required.

Method Statement – Borehole Installation

1. Monitoring standpipes should be constructed in un plasticised polyvinylchloride, (uPVC) or HDPE, (high density polyethylene). HDPE should be used as the preferred material as it is more resistant to attack by aggressive chemicals commonly encountered on contaminated sites;
2. Subject to site specific considerations, standpipes of 50 mm diameter will be used to allow consistency and interpretation of data;
3. Perforations within the slotted sections of pipework will not exceed 5mm within the slots in place within the pipework;
4. Each length of pipework will be joined by a screw thread fitting;
5. No glues or adhesives will be used within the development of standpipe installations;
6. In fine grained soils, the slotted section of any pipework should the taped into a geotextile sock to prevent the fine grained soils from entering the well and clogging;
7. Gas taps with a rubber bung, screw on gas taps or push on caps with gas taps should be used;
8. Each installation should be finished with a protective lockable cover, (on operational sites it is recommended that all covers are flush with the ground to avoid damage to both the well and vehicles using the site);

The response zone refers to the perforated length of standpipe which allows gas in the unsaturated zone to enter the standpipe and collect in the upper un perforated length of pipework. Most common installations will comprise of a un perforated length, (usually not less than 0.50m and no more that 1.0m) near the ground surface and a perforated section below. Different lengths of un perforated and perforated pipework can be used to dictate the soil horizon from which the has is monitored, although, this will be site specific and based on the derived conceptual model.

9. The installation of the slotted and solid pipework will be installed into the excavations made to the required depths, (generally the base of the excavation), allowing the appropriate depth of solid pipework at the surface and enabling the response zone to be assessed within the gas assessment;
10. A gravel pack surround will be installed within the surround of the monitoring well, (granular size to be 10mm shingle) and placed within the excavation to a depth not encroaching on the solid pipework;
11. A Bentonite pellet will be installed surrounding the standpipe to ground level to provide a seal to the gas monitoring well and compacted in place;
12. A rubber bung will be placed over the standpipe and hammered in to place such that a tight seal is recorded as in place. No gaps or void should be recorded within the seal such that an air tight seal is in place;
13. A gas tap valve should be placed within rubber bung, (in a pre formed hole), and an air tight seal recorded in place. The gas tap should be closed;
14. As a result of any gases generated within the monitoring well mixing and potentially diluting with atmospheric pressures, it is recommended that any newly installed monitoring wells are left for a period of 24 hours to allow the soil gas to reach equilibrium. It should be noted that some soil gas regimes could take considerably longer to reach equilibrium, (up to seven days).

Method Statement - Gas Testing.

1. Monitoring of gases has been reported in CIRIA C665, (Assessing Risks Posed By Hazardous Ground Gases To Buildings). This confirms that 'Monitoring, should, as far as practical, be undertaken during times of falling atmospheric pressure and various weather/site specific conditions, (rainfall, frost and tidal influences) to ensure data is acquired during "worst case" conditions;
2. Record daily, (and if appropriate hourly), atmospheric pressure readings during period before the monitoring visit;
3. Calibrate the instrument before the monitoring visit;
4. Before starting the monitoring, turn on the monitoring equipment, attach the tubing and run through clean air and ensure that all readings are zero. This should be done well away from any sources of gases and / or vapours such as vehicles and monitoring locations;
5. The monitoring equipment must be kept switched on at all times between monitoring of boreholes to prevent re-zeroing the monitoring device before the next monitoring well. This will also purge any residual gas readings from the previous monitoring well;
6. Record the atmospheric pressure reading from the monitoring equipment. Additional features to record form the weather, air temperature and ground conditions at the site as this information may influence the gas results;
7. Switch on the flow meter and attach the inlet tube to the gas tap and open. Record the range of pressures and flow readings on the gas monitoring proforma, making sure "positive" or "negative" is recorded;
8. Close the gas tap. Attach the gas flow meter monitoring equipment tubing to the gas tap and open and record the ***peak and steady*** reading for methane, (% v / v), methane (% LEL), carbon dioxide, (% v / v) and oxygen, (%v / v). It is recommended that the time taken to record a steady state reading should be noted;
9. If the gas concentrations have not reached steady state values after three minutes, record the concentrations and the direction of rate of change in concentration, (That is steadily increasing or decreasing). Where the concentrations are decreasing, always record the peak concentration.
10. Once data is recorded, remove the tuning from the gas tap and close the gas tap. Purge the monitoring equipment in clean air, (away from the borehole / and other sources of gas), until the methane and carbon dioxide concentrations return to zero and that the oxygen reading is reading normal atmospheric conditions;
11. Record the water level using a dip meter usually obtained by removing the gas tap or cover from the borehole. Water level readings are usually recorded from the top of the borehole or from ground level or both, (but this must be consistent), to the top of the water. After obtaining a reading, record on the proforma and replace the gas tap and / or cover ensuring that the gas tap is closed and the cover locked;
12. Make a note of any defects to the boreholes and perform maintenance, if appropriate;
13. Repeat for all boreholes and record an atmospheric pressure reading once all monitoring has ceased and record on the proforma. Note any trend in atmospheric pressure in the lead up to and during the monitoring visit;

Personnel

14. All monitoring will be undertaken by Chris Gray of Herts & Essex Site Investigations. I have undertaken a Post Graduate Diploma, Post Graduate Certificate and Masters Degree in Geotechnical Engineering which incorporated Environmental Science modules. Additionally, I have been instructed on the mechanical workings of the Gas Data GFM 430 by Shaw City upon purchase of the equipment which enables me to competently use the device.

Presentation of data

1. As a minimum, presentation of gas data in reports should include the following :-

    - Site Plan, (Showing monitoring locations, identifying site zones, source areas etc);
    - Raw data, (usually set out in proformas), See attached Sheet 1;
    - Summarised data, (set out in tables / charts).
    - Gas Composition;
    - Gas flow rate;
    - Water level;
    - Atmospheric pressure.

Soil Gas Monitoring Sheet

Site Reference No : _____

Client : _____

Site Address : _____

National Grid Reference: _____

Date / Time of Monitoring : _____

Monitoring Personnel : _____

Instrument Type : _____

Serial Number : _____

Barometric Pressure
(Including any trend in rise or fall of
pressure), (uncorrected) : _____

Air Temperature, (^{0}C) : _____

Recent Weather, (eg precipitation
and wind speed) : _____

Ground Conditions, (including
vegetation stress visual contamination): _____

After CIRIA C665 – Table A3

Table 2 Gas Monitoring Data Sheet

Site :

Project No :

Date :

Monitoring Point Reference	Flow Range, (litres / hr)	Atmospheric Pressure Range, (Pascal's)	Methane, (% v / v)		Methane, (% LEL)		Carbon Dioxide, (% v / v)		Oxygen, (%v / v)		Water Level, (m.b.g.l)	Depth of Well, (m)	Vol of gas in well, (m^3)	Other Gases.	Notes
			Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady					

LEL – Lower Explosive Limit

Initial

After CIRIA C665 – Table A3

BS 8485 : 2007

CODE OF PRACTICE FOR THE CHARACTERIZATION AND REMEDIATION FROM GROUND GAS IN AFFECTED DEVELOPMENTS

TABLE 3 SOLUTION SCORE

Table 3 **Solutions scores**

PROTECTION ELEMENT/SYSTEM		SCORE	COMMENTS
a) Venting/dilution (see Annex A)			
Passive sub floor ventilation (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.) [A]	Very good performance	2.5	*Ventilation performance in accordance with Annex A.* *If passive ventilation is poor this is generally unacceptable and some form of active system will be required.*
	Good performance	1	
Subfloor ventilation with active abstraction/pressurization (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.) [A]		2.5	*There have to be robust management systems in place to ensure the continued maintenance of any ventilation system.* *Active ventilation can always be designed to meet good performance.* *Mechanically assisted systems come in two main forms: extraction and positive pressurization.*
Ventilated car park (basement or undercroft)		4	*Assumes car park is vented to deal with car exhaust fumes, designed to Building Regulations Document F [5] and IStructE guidance [6].*
b) Barriers			
Floor slabs			
Block and beam floor slab		0	*It is good practice to install ventilation in all foundation systems to effect pressure relief as a minimum.* *Breaches in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances.*
Reinforced concrete ground bearing floor slab		0.5	
Reinforced concrete ground bearing foundation raft with limited service penetrations that are cast into slab		1.5	
Reinforced concrete cast in situ suspended slab with minimal service penetrations and water bars around all slab penetrations and at joints		1.5	
Fully tanked basement		2	
c) Membranes			
Taped and sealed membrane to reasonable levels of workmanship/in line with current good practice with validation [B], [C]		0.5	*The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation, and the integrity of joints.*
Proprietary gas resistant membrane to reasonable levels of workmanship/in line with current good practice under independent inspection (CQA) [B], [C]		1	
Proprietary gas resistant membrane installed to reasonable levels of workmanship/in line with current good practice under CQA with integrity testing and independent validation		2	
d) Monitoring and detection (not applicable to non-managed property, or in isolation)			
Intermittent monitoring using hand held equipment		0.5	*Where fitted, permanent monitoring systems ought to be installed in the underfloor venting/dilution system in the first instance but can also be provided within the occupied space as a fail safe.*
Permanent monitoring and alarm system [A]	Installed in the underfloor venting/ dilution system	2	
	Installed in the building	1	
e) Pathway intervention			
Pathway intervention		—	*This can consist of site protection measures for off-site or on-site sources (see Annex A).*

NOTE In practice the choice of materials might well rely on factors such as construction method and the risk of damage after installation. It is important to ensure that the chosen combination gives an appropriate level of protection

[A] It is possible to test ventilation systems by installing monitoring probes for post installation validation.

[B] If a 1 200 g DPM material is to function as a gas barrier it should be installed according to BRE 212 [8]/BRE 414 [9], being taped and sealed to all penetrations.

[C] Polymeric Materials >1 200 g can be used to improve confidence in the barrier. Remember that their gas resistance is little more than the standard 1 200 g (proportional to thickness) but their physical properties mean that they are more robust and resistant to site damage.