Land Quality Management Ltd

For

Welwyn Hatfield Borough Council

REVIEW OF LAND CONTAMINATION REPORTS RELATING TO A SITE AT CHEQUERSFIELD, WELWYN GARDEN CITY

LQM Report Number: **1474-0/1**

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LQM obtained, reviewed and evaluated information from the Client and other sources as detailed in the report. LQM's conclusions, opinions and recommendations are based solely on this information.

The conclusions and recommendations contained in this report represent our professional opinions. These opinions were arrived at in accordance with accepted industry practices at this time and location and as such are not a guarantee that the Site is free from hazardous materials or conditions.

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1 INTRODUCTION

1.1 Terms of Reference

(1) In January 2020, Welwyn Hatfield Borough Council (WHBC) commissioned Land Quality Management Ltd. (LQM) to undertake work in relation to the aim and objectives listed below. A signed Order Confirmation letter was received on the 9th Jan 2020.

1.2 The Site

(2) The site is a roughly triangular area of derelict land located to the southwest of Welwyn Garden City, Hertfordshire at National Grid reference 523619, 211325.

(3) Soiltechnics summarise its history as follows: "The site formed part of a field until 1937-1939 when a gravel pit encroaches the north eastern corner of the site. The site appeared to be quarried until 1960 where the gravel pit is infilled. In 1965-1990 a playing field cut across the north of the site from when the site remains unchanged relatively unchanged until 2018 where a track is recorded running through the centre of the site from east to west". LQM understand that the infilled pit is locally known as the 'Chequersfield landfill'. Records suggest that waste was imported from at least 1965 to after 1993.

(4) The former landfill lies immediately to the north of the Site, and it is understood that the toe of the landfill may extend under some parts of the Site. The landfill itself is an undeveloped open area of grass and shrubs. To the west is a further undeveloped area leading to a large electricity substation or similar installation and a railway line running north-south beyond that. A gravel track cuts through the centre of the Site, which is assumed to provide access to this infrastructure.

(5) Chequersfield road forms the southern and eastern boundary of the Site. To the south of Chequersfield road lies a residential development, constructed in ~2006, that is protected by a gas trench or Virtual Gas Curtain (VGC).

1.3 Background

(6) LQM understand that the reports reviewed were submitted in relation to discharging land contamination conditions applied to an approved planning application (6/2018/1519/MAJ) for residential development (30 units) in the vicinity of a former gravel pit that has been infilled with wastes: the Chequersfield landfill. LQM understand that the development involves blocks of flats and/ or maisonettes rather than individual owner-occupied houses. Further details are presented in Section 1.7.

(7) The proposed development is located to the west of the A1000 off Chequersfield, Welwyn Garden City, Hertfordshire, Welwyn Garden City AL7 4SX (the "Site"). LQM understand that the proposed development is next to (and partially overlies) a 'virtual gas curtain'; presumably installed to mitigate landfill gas migration from the former landfill. Previous reports, submitted to WHBC in support of application 6/2019/2130/COND, did not mention the 'virtual gas curtain'. LQM understand that the revised reports listed below have been submitted in support of a new application (6/2019/3113/COND) to discharge the relevant parts of Condition 1. It is these revised reports that WHBC commissioned LQM to review.

(8) LQM also understand that WHBC intends to purchase the residential development once completed.

1.4 Materials for review

(9) The following documents have been provided to LQM:

- Soiltechnics (2019a), "Ground Investigation Report – Proposed development land at Chequersfield, Welwyn Garden City". Report Ref STM3370A-G02. Dated June 2019 – Revision 03 – Bookmarked and searchable PDF (139 pages, Main text 92 pages)[1]
- Soiltechnics (2019b), "Remediation Strategy Report – Residential development land at Chequersfield, Welwyn Garden City". Report Ref STM3370A-RS01. Dated November 2019 – Revision 01 – Bookmarked and searchable PDF (60 pages, Main text 16 pages)

1.5 Aim

(10) The aim of this work was to provide an opinion as to whether the updated reports are technically robust and sufficient to support a decision regarding the discharge the relevant parts of Condition 1.

1.6 Objectives

(11) The following objectives will be needed to meet the aim:

- Review the Ground Investigation Report (Soiltechnics, 2019a) and establish:

[1] During the review it became clear that the GI Report, as provided, was incomplete and only included appendices A-E2. Appendices F1-L (95 pages) and the majority of Appendix N (29 pages) were subsequently provided. However, Appendix M, which includes correspondence with WHBC Environmental Health, remains missing.

  - The technical robustness of the investigation and risk assessment undertaken to date given the wording of Condition 1a;
  - The nature and distribution of the contaminants of concern; and
  - The nature of any ground gas risks at the Site.

- Review the Remediation Strategy Report (Soiltechnics, 2019b) to establish its appropriateness given the above and the wording of Condition 1b.

1.7 Legal Context

(12) We have conducted our review in the context of the English planning system, primarily focussed on the requirements of the NPPF with respect to ground conditions and pollution.

(13) Planning application 6/2018/1519/MAJ, submitted in June 2018, was approved with conditions in December 2018. Revised versions of the National Planning Policy Framework (NPPF) were published in July 2018 (MHCLG, 2018) and February 2019 (MHCLG, 2019) however, the requirements with respect to land contamination issues and site investigation information have changed only slightly since the original NPPF published in 2010. The NPPF (MHCLG, 2019) requires that, in order to demonstrate that the site is suitable for its proposed use, adequate site investigation information is required that:

- Includes "a risk assessment of land potentially affected by contamination, or ground stability and slope stability reports, as appropriate."
- Should be prepared by a 'competent person', to prepare site investigation information, defined as "A person with a recognised relevant qualification, sufficient experience in dealing with the type(s) of pollution or land instability, and membership of a relevant professional organisation."
- "All investigations of land potentially affected by contamination should be carried out in accordance with established procedures (such as BS10175 Code of Practice for the Investigation of Potentially Contaminated Sites)."

1.7.1 Relevant Planning conditions

(14) Condition 1 (a-e) attached to planning permission (6/2018/1519/MAJ) relates to potential land contamination issues. These conditions are presented in Box 1.

Box 1: Condition 1 (a-e) attached to planning application 6/2018/1519/MAJ

1.No development other than that required to be carried out as part of an approved scheme of remediation must commence until conditions A to D have been complied with. If unexpected contamination is found after development has begun, development must be halted on that part of the site affected by the unexpected contamination to the extent specified by the Local Planning Authority in writing until condition D has been complied with in relation to that contamination.

(a) Site Characterisation

An investigation and risk assessment, in addition to any assessment provided with the planning application, must be completed in accordance with a scheme to assess the nature and extent of any contamination on the site, whether or not it originates on the site. The investigation and risk assessment must be undertaken by competent persons and a written report of the findings must be produced. The contents of the scheme and the written report are subject to the approval in writing of the Local Planning Authority. The report of the findings must include:

(i) a survey of the extent, scale and nature of contamination

(ii) an assessment of the potential risks to:

- human health
- property (existing or proposed) including buildings, crops, livestock, pets,
- woodland and service lines and pipes
- adjoining land
- groundwaters and surface waters
- ecological systems
- archaeological sites and ancient monuments

(iii) an appraisal of remedial options, and proposal of the preferred option(s).

This must be conducted in accordance with DEFRA and the Environment Agency's 'Model Procedures for the Management of Land Contamination, CLR 11'.

(b) Submission of Remediation Scheme

A detailed remediation scheme to bring the site to a condition suitable for the intended use by removing unacceptable risks to human health, buildings and other property and the natural and historical environment must be prepared, and is subject to the approval in writing of the Local Planning Authority. The scheme must include all works to be undertaken, proposed remediation objectives and remediation criteria, timetable of works and site management procedures. The scheme must ensure that the site will not qualify as contaminated land under Part 2A of the Environmental Protection Act 1990 in relation to the intended use of the land after remediation.

(c) Implementation of Approved Remediation Scheme

The approved remediation scheme must be carried out in accordance with its terms prior to the commencement of development other than that required to carry out remediation. The Local Planning Authority must be given two weeks written notification of commencement of the remediation scheme works. Following completion of measures identified in the approved remediation scheme, a verification report that demonstrates the effectiveness of the remediation carried out must be produced, and is subject to the approval in writing of the Local Planning Authority.

(d) Reporting of Unexpected Contamination

In the event that contamination is found at any time when carrying out the approved development that was not previously identified it must be reported in writing immediately to the Local Planning Authority. An investigation and risk assessment must be undertaken in accordance with the requirements of condition 1, and where remediation is necessary a remediation scheme must be prepared in accordance with the requirements of condition 2, which is subject to the approval in writing of the Local Planning Authority.

Following completion of measures identified in the approved remediation scheme a verification report must be prepared, which is subject to the approval in writing of the Local Planning Authority in accordance with condition C.

(e) Long Term Monitoring and Maintenance

Where indicated in the approved remediation scheme, a monitoring and maintenance scheme to include, monitoring the long-term effectiveness of the proposed remediation over the agreed period of five years, and the provision of reports on the same must be prepared, both of which are subject to the approval in writing of the Local Planning Authority. Following completion of the measures identified in that scheme and when the remediation objectives have been achieved, reports that demonstrate the effectiveness of the monitoring and maintenance carried out must be produced, and submitted to the Local Planning Authority. This must be conducted in accordance with DEFRA and the Environment Agency's 'Model Procedures for the Management of Land Contamination, CLR 11'.

REASON: To ensure that risks from land contamination to the future users of the land and neighbouring land are minimised, together with those to controlled waters, property and ecological systems, and to ensure that the development can be carried out safely without unacceptable risks to workers, neighbours and others offsite in accordance with Policies R2 and R7 of the Welwyn Hatfield District Plan 2005.

2 GROUND INVESTIGATION REPORT

(15) The Ground Investigation (GI) Report (Soiltechnics 2019a) is a combined geotechnical and geoenvironmental report which "*integrates both contamination and geotechnical aspects*". In line with our remit, LQM have not reviewed in detail the geotechnical elements of the report.

(16) The GI report states that its objectives were:

- "*to establish ground conditions at the site*" sufficiently to identify and design foundation solutions;
- To evaluate "potential chemical and gaseous contamination of the Site" including "the production of a risk assessment in relation to contamination";
- To "support a planning application by satisfying National Planning Policy Framework sections 120 and 121."[2]

(17) With respect to the geoenvironmental elements of the GI report, the authors (Soiltechnics 2019a) state that it was produced following "*the principles of "BS10175: 2011 'Investigation of potentially Contaminated Sites – Code of Practice"*". It should be noted that two revised versions of this guidance have been published prior to 2019, the most recent of which is BS10175:2011+A2:2017 (BSI, 2017). This is the standard against which we have compared the report.

(18) The report combines several of the elements defined in BS10175 into a single report, namely

- Phase I – Preliminary investigation (desk study and site reconnaissance); and
- Phase II – Exploratory and main (intrusive) investigations; and
- Quantitative risk assessments of chemical and gas contamination (using generic assessment criteria).

2.1 Desk study and site observations

(19) The extent and result of the preliminary investigation are reported in Section 3 of the GI Report (Soiltechnics 2019a). It is unclear whether this included a site reconnaissance, as required by BS10175.

[2] Although the exact version of the NPPF is not stated, LQM infer that this relates to the original 2012 version (DCLG, 2012), as Sections 120 and 121 of both subsequent versions relate to do not relate to "Making effective use of land" and not to pollution and land instability".

(20) The desk study is primarily based on an Envirocheck report supplied in April 2018 and other published documents, the GI Report states that "*the study did not extend to research of meteorological information or consultation with other interested parties such as English Heritage (ancient monuments), Ordnance Survey (survey control points), Planning Authorities or Archaeological Units*". This could suggest that the potential consequences of climate change have not been considered.

(21) The GI Report appears to provide an adequate synthesis of the history of the Site (including the former sand/gravel quarry and landfill to the north that impinges on parts of the Site), the underlying geology and hydrogeology etc. This synthesis has informed the sources, pathways and receptors identified within Section 8 of the GI report.

(22) However, LQM understand that, as the WHBC Environmental Health Officers were not consulted, versions 1 and 2 of the GI Report failed to identify the presence of a "*virtual gas curtain along the northern boundary of the residential development to the south of the subject site, with monitoring boreholes along the landfill site*". Following a review of these earlier versions by Environmental Health[3], version 3 was amended to include paragraphs 3.10.2-3, which acknowledge and describe these features. The curtain and monitoring boreholes strongly suggest that a significant gas risk was identified during the construction of the residential properties to the south. However, Soiltechnics do not report further details of the nature, construction or justification for these measures. There is a need for an assessment of the gas risk to the new proposed residential development and of any possible change on the risks to the existing development due to changes in the gas regime and/or impacts on the virtual curtain.

2.2 Exploratory and main investigations – fieldwork and laboratory testing

(23) The fieldwork undertaken is partially described in Section 4 of the GI Report (Soiltechnics 2019a). It is clear from the GI Report (Soiltechnics 2019a) that several phases of investigation have been conducted. From Drawing 02 and Section 2.2, LQM assume that at least 3 phases of site work were undertaken prior to Jan 2016, to May 2018 and to Feb 2019. However, the exact dates of the site work and details of exactly what was undertaken and by whom are not clear.

(24) In total, it appears that:

- Five hand dug pits (TP101-105) were excavated to a maximum depth of 1 mbgl, to the south of the gravel driveway, primarily on the embankment.

[3] In the absence of Appendix N, LQM have been unable to review these comments and correspondence

- Three light cable percussive boreholes (BH101, 102 and 201) were excavated to a maximum depth of 27 mbgl to the north of the gravel driveway. Standpipes were installed in BH101, screened between 1 and 15mbgl (through layers of made ground and glacial deposits (clay and gravel)), and in BH201, screened between 22-27mbgl (through the chalk).

- Five driven tube sampling boreholes (DTS101-105) were excavated to a maximum depth of 5mbgl to the north of the gravel driveway. Standpipes were installed in DTS101, screened between 1 and 4mbgl (in layers of made ground and glacial deposits (mainly sand)), and in DTS104, screened between 1-4mbgl (in layers of made ground).

- Dynamic cone penetration tests were conducted at three locations for geotechnical purposes.

(25) The report provides no justification for the sampling and analytical strategies adopted by Soiltechnics as required by BS10175. However, LQM note that the majority of sampling locations are to the north of the gravel driveway, but that much of this area is proposed as car parking area. Only shallow trial pit data is available south of the gravel driveway where the majority of the housing will be located. However, we also note that the proposed development layout presented in Drawing 03 in the GI Report (Soiltechnics 2019a), suggests that there will be substantial earthworks and changes in level prior to construction. It is, therefore, questionable whether the soil samples collected by Soiltechnics were from materials that will ultimately be at the Site surface. For these reasons, we find the statement in Section 8.8.3.1 that "*In our opinion, the quantity and scope of analysis undertaken to date is adequate to characterise soils at the site in relation to chemical contamination*" is not supported by the evidence in the report but is also inconsistent with the statement that "*a confirmed site layout will be required in order to produce a full remediation strategy*".

(26) The ground conditions encountered are described in Section 6 and a geological model is presented as Table 7.3.1. In general, the profile consisted of Made Ground (~4 mbgl) overlying natural fine grained (~12.5-19.5mbgl) and coarse-grained (~14.5-22mbgl) Glacial Deposits with White Chalk at depth (~27mbgl). Ground water, encountered at several depths in various locations, seemed to be associated with either sand and gravel horizons within the Glacial Deposits or the Chalk. The Chalk is classified as a Principal aquifer. The Glacial Deposits are understood to be the Kesgrave Catchment Subgroup, designated a Secondary A aquifer.

(27) According to Table 5.2.1, 22 samples were submitted to Chemtest for chemical testing; 1 sample of groundwater from the Chalk and 21 soil samples. The soil samples were from depths of between 0.3-19.5 mbgl (10 sample ≤1.0 mbgl) and consist of made ground (15 samples), glacial deposits (5 samples) and chalk (1 sample). Some samples were only submitted for leachate analysis. The actual testing suite varied from sample to sample and it is difficult for LQM to follow the types of

materials and depths submitted for each type of test. Due to the lack of clarity regarding the analytical strategy (i.e. how many and which samples were tested for which determinands), and as no plots showing the resulting data, including those for the remaining contaminants of concern (i.e. lead, mercury and PAHs) have been provided, LQM are unsure if the testing is sufficient to provide a robust characterisation of potential contamination in the subsurface at the Site.

(28) No details of the sample storage, transport or preservation measures undertaken by Soiltechnics are reported. However, from the Certificates of Analysis, LQM note that five of the samples submitted to the laboratory on the 14th May 2018 had been sampled on the 3rd May 2018 and that this exceeded the relevant stability times for some of the analytes, and that three samples were submitted in an inappropriate sample container for some or all of the testing scheduled on that sample. This is not acknowledged within the report. The data affected by these deviations should be regarded as unreliable but it is unclear to LQM exactly which data is affected.

2.3 Risk assessment – chemical contamination

(29) The chemical data is evaluated in Section 8 of the GI Report (Soiltechnics 2019a). Although this section of the report states that "*the investigations were carried out to determine if there are any liabilities with respect to Part IIA of the Environmental Protection Act*", this is at odds with the overall objective of supporting a planning application under the overall National Planning Policy Framework rather than Part 2A. In fact, the report presents assessments with respect to both the current use (under Part IIA) and the future use (under the planning regime). Below we have limited our comments to the assessment relevant to the proposed residents of the development that forms the current planning application.

(30) Soiltechnics evaluated potential contaminant sources relating to historical land uses on and near the site and the underlying geology and ranked them. Sources considered likely to impact the Site included:

- The infilled gravel pit/landfill (partly onsite) and other nearby landfills could result in metals, TPH, PAHs, Volatile Organic Compounds (VOCs) and Semivolatile Organic Compounds (SVOCs) and asbestos contamination
- Made ground (onsite) – observations of odour and suspected asbestos-containing materials (ACMs) during field work could result in metals, TPH, PAHs, VOCs, SVOCs and asbestos contamination
- Glacial deposits (onsite) – localised hydrocarbon odour and staining observed during field work could indicate secondary TPH contamination of these materials.

(31) The chemical testing suite undertaken seems reasonable given the potential sources identified, but it is unclear how many and which samples were tested for each determinand. More details of the analytical strategy should be presented.

(32) In addition to these potential contaminants, Soiltechnics also identified a number of:

- Receptors, including:
    - Humans (end users and construction operatives)
    - Vegetation (incl. retained trees)
    - Controlled waters (groundwater and nearby stream)
    - Building materials
- Pathways:
    - Human: Ingestion, inhalation and skin adsorption
    - Vegetation: root uptake, gaseous and particulate deposition
    - Controlled waters: percolation, runoff, flooding

(33) A tabulated preliminary risk assessment was presented in Appendix I of the GI Report (Soiltechnics 2019a) but is described as an initial conceptual site model (CSM). Below we have limited our comments to the assessments in relation to human health of proposed residents and to controlled waters.

(34) Soiltechnics (2019a) also present outline assessments in relation to construction workers and vegetation and, in Section 10, a more detailed assessment of the effects of ground conditions on building materials. LQM have not provided detailed comments on these aspects of the report. While there are technical queries in relation to these assessments, we would generally agree with Soiltechnics' conclusions.

2.3.1 Human health risk assessment

(35) Soiltechnics have presented mean and 95th upper confidence limits (UCLs) for the various contaminants without providing suitable evidence of the appropriateness of using such statistical approaches on datasets acknowledged as resulting primarily from targeted sampling and analysis. However, these statistics do not appear to have influenced their conclusions and so we have not commented further on this aspect.

(36) Soiltechnics (2019a) have adopted human-health generic assessment criteria from a range of appropriate and authoritative sources, including LQM/CIEH S4ULs, C4SLs, SGVs and Atkins SSVs. The assessment criteria adopted are those for the "residential with homegrown produce' land use[4] and, for organics, a soil organic matter of 1% has been assumed; both are cautious and protective approaches. We note that for mercury the criteria for elemental mercury has cautiously been applied but we are unclear about the validity of the criteria selected for lead of 270 mg/kg, which appears to be described as the lower bound range for the C4SL. The C4SL for Lead is 200 mg/kg (Defra, 2014) in a residential with homegrown produce scenario. Contaminant concentrations have been compared with these values within Appendix H.

(37) Above we reported that 21 soil samples were sent for analysis but that all samples were not tested for all determinands. Of 10 samples tested, only that from DTS105@0.5mbgl exceeded the assessment criteria for lead, mercury and PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluanthene and dibenzo[ah]anthracene). Of 5 samples tested, only that from DTS101@3.8m exceeded the assessment criteria for petroleum hydrocarbons (aliphatic EC8-10 & 10-12, and aromatic EC10-12, 12-16, 16-21 & 21-35). Soiltechnics observed that both these locations correspond to where the toe of the adjacent landfill may impinge onto Site. Of the six samples tested for asbestos, asbestos cement (chrysotile) was identified at DTS105 at both 0.5 and 1.0 mbgl.

(38) Two samples were also tested for VOCs and SVOCs. No VOCs were detected. However, in addition to PAHs, one of these samples (DTS101@0.4mbgl) contained detectable levels of dibenzofuran; a heterocyclic compound similar to, and usually found in association with, polyaromatic hydrocarbons (PAHs). In trying to assess the risks from this substance, Soiltechnics have used as a screening value the Soil Guideline Value for dioxins, **furans** and dioxin-like polychlorinated biphenyls, or PCBs (Environment Agency, 2009), which relate to the structurally-related but toxicologically distinct polychlorinated dibenzofurans (PCDFs). Although likely to be highly cautious, this suggests a fundamental misunderstanding of contaminant chemistry and a lack of familiarity with the guidance underpinning this SGV.

(39) On the basis of the potential risks to residents from lead, mercury and PAHs, the GI report concludes that "the Made Ground at the site potentially poses a risk to all human receptors and thus requires further consideration and potentially remedial action". LQM would tend to agree with this conclusion but are concerned that the statements relating to remediation in relation to the toe of the landfill within Section 8.8.3.1 do not account for the potential vapour risks associated with potential landfill leachate (see below).

[4] LQM are unaware of the details of the application but it is possible that the 'residential **without** homegrown produce' landuse would be adequate.

2.3.2 Controlled waters risk assessment

(40) Based on the certificates of analysis, leachate analysis (metals, PAHs and petroleum hydrocarbons) was conducted on three samples; BH102 (2.0mbgl, Glacial deposits), DTS101 (2.3 mbgl Made Ground) and DTS104 (3.3 mbgl Made Ground)[5]. However, Appendix H of the GI Report also presents data for DTS103(0.5 mbgl, made ground) and DTS105 (0.2 mbgl, made ground). LQM have been unable to locate the associated Certificates of Analysis for this data.

(41) Soiltechnics (2019a) have assessed potential risks to controlled waters using range of generic criteria including "*Environmental Quality Standards (EQS) and UK Drinking Water Standards (UKDWS)*", but the full references for the dates and sources of these criteria are not provided. However, references within Appendix H to "salmonid", "List II substances" and the correction of EQS values for hardness suggest that the criteria are outdated and so not appropriate. Current, EQS are specified within "The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015. The most recent UK drinking water standards are given within The Water Supply (Water Quality) Regulations 2018.

(42) Based on their selected assessment criteria, Soiltechnics identify exceedances for PAHs (benzo[a]pyrene in DTS103) and hydrocarbons (DTS101)

(43) In addition to the above, three samples (including BH102 and DTS101) were tested for VOCs and SVOCs in leachate. It should be noted that due to the nature of VOCs, leachate analysis is unlikely to produce reliable data. Detectable levels of several VOCs were reported in DTS101, these included chlorinated solvents and dichlorobenzenes, which Soiltechnics rightly identify as potential landfill leachate components.

(44) On the basis of this assessment, the GI report concludes that "the near surface soils at the site potentially pose a risk to water resources and thus requires further consideration and potentially remedial action" and recommends that "Analysis of groundwater samples is required to further assess risks to controlled waters".

(45) Despite its limitations, it is likely that this assessment is sufficient, particularly given that the adjacent former landfill is likely to pose much more serious risks to any underlying groundwater.

2.4 Risk assessment – ground gases

(46) A gas conceptual model (gCSM) identifying the relevant sources, pathways and receptors is fundamental in order to correctly interpret and assess any gas risks (BSI, 2019). Within the GI report,

[5] DTS104 was not tested for hydrocarbons.

Soiltechnics identify the nearby landfills and made ground with a high proportion of organic matter as potential sources of ground gases at the Site and the made ground as a potential migration pathway. However, they do not consider the likelihood that the former land fill (previously a sand and gravel quarry) will be in continuity with sand and gravel horizons within the underlying Glacial Deposits (Kesgrave Group), which could facilitate significant and rapid advective flows from the landfill. Such a scenario is presented in Figure 4b within BS8485. The failure to identify this potential pathway, is a result of the lack of a geological cross section within the gCSM, as recommended in BS8485.

(47) In-situ gas monitoring data is presented in Appendix J of the GI Report. This shows that ground gas monitoring was undertaken from 1 or 2 standpipes on 9 separate days between Dec 2015 and July 2018[6]. But this contrasts with Section 9.7.2 that states "*We have returned to site on four occasions to obtain measurements of landfill type gases*". The monitoring also appears unsystematic with most visits only involving monitoring of a single borehole, thus potentially missing spatial variation in the data. It is normal good practice to monitor all wells on all visits. The reason for consistently not doing so is not stated.

(48) During the monitoring, data was apparently gathered from DTS104 (3m response zone in made ground) on 6 occasions, DTS101 (3m response zone in made ground and top of glacial deposits) on 1 occasion and BH101 (14m response zone in 3m made ground and 11m glacial deposits) on 5 occasions. This contrasts with Section 4.6.1 that suggests that only BH101 was monitored for landfill-type gases. Furthermore, Section 9.7.1 states that "*Two standpipes were installed during the previous investigation, however an additional standpipe was installed to give further coverage of the site*" but LQM are unaware which standpipes this refers to. It should also be noted that all standpipes were combined gas and water monitoring wells. Such dual purpose wells can generate erroneous and misleading data. However, the wells were found to be dry on most occasions although water levels up to 3.8 mbgl were also recorded. It is also unclear to what extent the locations and construction of the wells provides adequate information in relation to the potential migration of gases. For example, did any of the installations target the sand and gravel strata and provide robust data on any potential advective flow within them.

(49) The monitoring identified low gas flow rates (-0.6 to 0.1 L/hr), low methane concentrations (0.0%-0.2%) but moderate carbon dioxide concentrations (1.1%-9.3%. Oxygen concentrations were also generally substantially below 20%.

(50) The GI report states that the monitoring spanned "*atmospheric conditions in the range of 1005 to 1024*" but it is now well accepted that it is trends in pressure change that are important in driving

[6] Presumably to satisfy the requirements of Ciria C665 (Wilson et al., 2007), for 9 visits over 6 months

gas risks not atmospheric pressures *per se*. Appendix J shows that most data was collected when the atmospheric pressure was "steady" with a small number representing "rising" pressures. Given the potential for advective, pressure-driven flows within the Glacial Deposits, it is therefore of concern that none of the reported gas monitoring was conducted under falling atmospheric pressure as it is these conditions that may facilitate such flows.

(51) We also note that the assessment contains no mention or data of the gas concentrations and flows likely to be present within the adjacent landfill. As this is the principal source of landfill gas identified by Soiltechnics, it is difficult to understand how they can provide a robust assessment of the potential risk from gas migration with no information relating to current conditions within the landfill.

(52) The gas monitoring data has reportedly been assessed in line with BS 8485:2015[7] and the Site classified as "characteristic gas situation 2 and traffic light colour 'Amber 1'". However, due to a single carbon dioxide concentration of almost <10%, Soiltechnics recommend that this either be increased to Amber 2 or additional monitoring is undertaken. LQM understand that the proposed development will consist of flats or apartments and so question the applicability of the NHBC traffic light approach (NHBC, 2007) at this site. This approach was developed for use at "*low-rise housing development with a clear ventilated sub floor void*", NHBC (2007) specifically state that it is not suitable for "*flats/apartments*", for which a revised Wilson and Card assessment is required. Consequently, if the gas risk assessment is deemed robust and sufficient, most appropriate basis for the design of gas protection measures would be Characteristic Gas Situation 2 (CS2).

2.4.1 Virtual gas curtain

(53) Revision 03 of the GI Report makes several references to a Virtual Gas Curtain (VGC) protecting the residential development to the south:

- Section 9.3.2.3 "Monitoring of site boreholes shows that the level of methane produced does not pose a risk to health and is effectively controlled at the landfill site boundary". However, no data is presented within the report to support this statement (not even the location of boundary boreholes and details of when and how frequently they were monitored).

- Section 9.8.3 "Monitoring of ground gas concentrations within the subject site boundary has not encountered any evidence that the virtual gas curtain installed to the south is having an adverse effect on ground gas conditions within the subject site". LQM would not expect the VGC to have any adverse effects but are concerned that the need for a VGC has not prompted a more extensive and rigorous characterisation and assessment of potential gas risks at the new

[7] We note that BS 8485:2015 was amended in March 2019 (BSI, 2019) but recognise that this was only 3 months prior to the GI Report being issued.

development nor have the potential impacts of the new development on the existing development to the south been considered.

- "Our monitoring observations support the Local Authority assessment that ground gases are being controlled at the landfill site boundary". LQM are not aware of any formal gas risk assessment undertaken by WHBC Local Authority. However, we are aware that WHBC hold data that suggest the adjacent land fill may still be actively gassing. This ought to be considered by Soiltechnics in formulating their gCSM and in characterising and assessing the related risks in relation to the proposed development.

2.5 Conclusions

(54) Section 8.10.1 of the GI report states that "On the assumption that further investigations and/or remedial action described above are adequately completed, we have produced a final conceptual model which is presented in Appendix I, **which shows the risks have been reduced** to acceptable levels and the site therefore fit for purpose". This is inaccurate; the final conceptual model suggests that the risk **could be** reduced, if all the required additional assessments have been conducted and the necessary remediation implemented and validated. The conclusion needs to be couched in NPPF terms – namely that the Site would be safe and suitable for its intended use. We believe that this is an important distinction as the current wording is likely to mislead readers and down play the need for further action at the Site.

3 REMEDIATION STRATEGY

(55) The Remediation Strategy (RS) Report (Soiltechnics 2019b) states that its objectives were "to establish areas of the Site requiring remediation and provide a strategic approach to handling the remediation to enable the site to be deemed suitable for its proposed end use as residential flats" and that it was intended to satisfy "parts b), c) and d) of planning condition 1". The proposed development is described as "*the construction of a [sic] three/four storey residential blocks together with grassed amenity areas, planted areas and car parking*".

3.1 Chemical contamination

(56) Section 2 of the RS Report (Soiltechnics 2019b) provides a specification for a capping layer. Figure RS02[8] shows such capping to be restricted to a "*grassed amenity area*" in the east of the Site, which coincides with the toe of the landfill identified in the GI Report. However, elsewhere the RS report refers to capping all landscaped areas. If the need to cap landscaped areas is limited to the 'grassed amenity area' the reason for this should be clearly stated with reference to the findings of the GI report. Capping of 300mm thickness of "*chemically 'clean' soils*" with "*a 'no dig' warning marker membrane placed at the base*" is proposed. In order to maintain current site levels, it is proposed that 300mm of made ground will be removed and disposed of off-site. Soiltechnics propose that the cap consists of either:

- "topsoil to a minimum thickness of 150mm, over subsoil" or;
- "a full thickness of topsoil".

(57) The use of a 300mm cap seems arbitrary and no evidence is presented to justify why Soiltechnics consider that this thickness is sufficient to break the relevant linkages and ensure that the Site is suitable for use.

(58) Soiltechnics specify that:

- "Topsoil shall comprise a material which will allow plants to grow healthily. Topsoil shall be general purpose grade in accordance with BS3882:2015 'Specification for topsoil' unless otherwise specified by the consultant landscape architect for the project. Testing shall be carried out to demonstrate compliance for general purpose topsoil (or other topsoil specified by

[8] The figure numbering is confused throughout the RS Report. This figure is cites in the text as RS03 but no such figure is presented.

others) with test criteria provided in table 2 of BS3882 with at least one sample tested per source".

- "Subsoils shall be granular (sands / gravels) or clays / silts of natural origin, which shall be classified, placed and compacted in accordance with the current Specification for Highway works, Volume 1, 600 series".

(59) Laboratory testing and verification criteria for "imported materials" are also proposed in the RS Report (see Box 2). LQM assume that this should relate to all imported materials (i.e. both top soil and subsoils) whereas Section 3.4.2 only refers to topsoil. Clarification is required.

(60) The RS Report states that the "testing schedule for imported soils will depend on the source/provenance of the soils, though as a minimum, contamination testing should include metals, PAHs and asbestos screening". As Box 2 only contains criteria for metals and PAHs, LQM assume that this means that additional testing may be required on a case-by-case basis but we are uncertain what verification criteria would be adopted or how such criteria would be selected. Furthermore, we note that Box 2 does not seem to contain the criteria to be used for asbestos.

(61) For each source of imported top or subsoil, the RS Report specifies that "*at least 3 representative soil samples have been taken, subject to a minimum rate of at least 1 sample per 250m*^{3}". LQM understand this to mean that a minimum of 3 samples will be tested per source, and that additional samples would be taken if more than 750m^3 were imported from a single source. This would seem reasonable.

(62) The RS Report specifies that the "thickness of the completed cover system will require verification by an independent consultant. This will be undertaken at a frequency of 1 location per 30m^2 with a minimum of 3 locations in total sufficiently spaced across the remedial area". Again this seems reasonable. We would add the requirement for the consultant to take suitable and adequate photographs, as required for the Verification Report.

(63) With respect to unidentified contamination, the RS Report specifies that the procedure in Box 3 would be followed. This seems reasonable, but, as a minimum, LQM would expect all potential unexpected contamination events and any subsequent actions to be noted within the Verification Report. A statement to this effect should be added.

(64) The need for a verification report is specified (Section 3.4), but there is a mismatch between the required contents of this report and the compliance documentation specified in Section 3.3.8. The verification report should also include details of any unexpected contamination, records of communications with WHBC and, if necessary, appropriate validation evidence. However, taken

together, LQM believe that the required details should provide adequate data to verify the remediation undertaken **with respect to chemical contamination**.

Box 2: Validation criteria proposed for capping soils specified in the RS Report (Soiltechnics 2019b)

Table summarising maximum concentration of contaminants in soils used for capping (RESIDENTIAL WITHOUT PLANT UPDAKE MODEL)

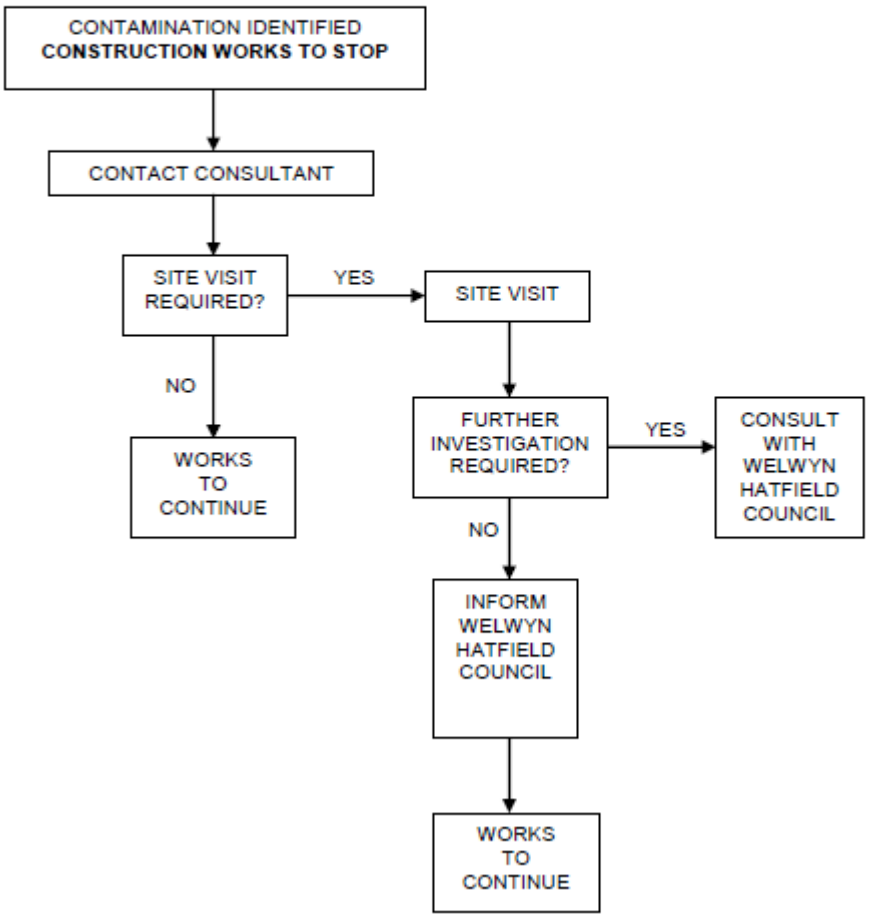
Contaminant	Maximum allowable concentration and test criteria (Human receptors) (Total concentration)		Maximum concentration (µg/l) (leachate concentration)
	C4SL (mg/kg)	S4UL (mg/kg)	
Inorganic contaminants			
Arsenic	-	40	50
Barium	-	-	700
Boron	-	11000	2000
Beryllium	-	1.7	-
Cadmium (pH to 7.4)	-	85	5
Copper	-	7100	1
Chromium	-	910	5
Cyanide (total)	-	34	50
Lead	330*	-	4
Mercury	-	1.2	1
Nickel		180	50
Nitrate	-	-	50000
Selenium	-	430	10
Sulfate	-	-	400000
Sulfide	-	-	0.25
Vanadium	-	1200	20
Organic contaminants			
Acenaphthene	-	3000	
Acenaphthylene	-	2900	
Anthracene	-	31000	
Benzo(a)anthracene	-	11	
Benzo(a)pyrene	-	3.2	
Benzo(b)fluoranthene	-	3.9	
Benzo(g,h,i)perylene	-	360	
Benzo(k)fluoranthene	-	110	
Chrysene	-	30	
Dibenzo(a,h)anthracene	-	0.31	
Fluoranthene	-	1500	
Fluorene	-	2800	
Indeno(1,2,3-cd)pyrene	-	45	
Naphthalene	-	2.3	
Phenanthrene	-	1300	
Phenols	-	750	
Pyrene	-	3700	

Table 3.3.7
*upper limit adopted for lead based on risk analysis and site end use.

Box 3: Procedure specified in the RS Report (Soiltechnics 2019b) in relation to unexpected contamination being encountered

Contractor's procedure for reporting contamination

In the event that, during construction, previously unidentified soil and/or groundwater contamination is discovered, the contractor will be required to halt construction works and **contact** the appointed consultant. The following outline procedure will be followed:



3.2 Ground gases

(65) The RS Report relates solely to the remediation of chemical contamination; no details of the required gas protection measures and their verification are included.

(66) Section 7.4 of BS8485 requires a design report be prepared for any proposed gas protection system, but LQM are not aware of any such document having been produced. LQM do not consider the details presented within the GI Report to constitute a design report.

4 CONCLUSIONS

4.1 Competent person

(67) The NPPF requires all site investigation information to be prepared by a "competent person", defined as "A person with a recognised relevant qualification, sufficient experience in dealing with the type(s) of pollution or land instability, and membership of a relevant professional organisation".

(68) The GI Report (Soiltechnics 2019a) was prepared by "Leanne Carr B.Sc (Hons)", supervised by "Seb Crolla B.Sc, (Hons), MIEnvSc., FGS" and reviewed by "Dr Matthew Hooper B.Sc. (Hons)., M.Sc., Ph.D., MIEnvSc., F.G.S.". The Remediation Strategy (Soiltechnics 2019b) was prepared by "Seb Crolla B.Sc, (Hons), MIEnvSc., FGS". This indicates that the authors may have relevant qualifications and that some are members of a relevant professional organisation but there is little evidence of the sufficiency of their experience. Indeed, as a whole, the errors and weaknesses identified in the information submitted suggests that there is insufficient experience in dealing with pollution.

(69) On the basis of the information reviewed, and in conjunction with the National Brownfield Skills Framework[9], LQM cannot confirm that the site investigation information relating to land contamination has been prepared by a 'competent person' as defined in the NPPF (MHCLG, 2019).

(70) LQM make no comment on the standard of the geotechnical aspects of the report.

4.2 Referencing

(71) LQM have had great difficulty in following the exact guidance and references referred to by Soiltechnics. Although source documents are generally cited, which is welcomed, only the titles are generally presented. Full citations are required (including dates *etc*.) in all cases but in particular for documents that are regularly revised and updated, such as the NPPF and individual British Standards.

4.3 Sampling and analytical strategy

(72) Full details of the sampling and analytical strategy adopted by Soiltechnics should be presented, including justification based on the initial conceptual model, the known uncertainties and the data quality needs of the intended risk assessments.

[9] https://www.silc.org.uk/content/uploads/2011/09/SiLC-NBSF-2016-Version-3.pdf. Accessed 9th Dec 2019

4.4 Chemical contaminant risks

(73) Whilst our review has identified numerous shortcomings in the assessment of chemical contaminants presented by Soiltechnics (see Section 2), the available data does seem to indicate that the made ground associated with the toe of the landfill is the source of contaminant concentrations that could be a concern. The remediation strategy does not propose any specific actions beneath the proposed building in this vicinity, but does propose capping of any proposed landscaping in this vicinity.

(74) However, the potential vapour risks associated with organic contamination within any landfill leachate migrating beneath the Site has not be adequately assessed. If the flux of volatile organics migrating away from the landfill is high, additional protection may need to be incorporated into the design and construction of the proposed apartments. Given the limitations of analysing VOCs within laboratory-derived leachates, any such assessment needs to be based on additional lines of evidence, potentially including on site vapour monitoring or ground water analysis.

4.5 Gas risks

(75) Our major concerns relate to the apparent lack of robust assessment of ground gas risks at the Site. The presence, and extent of, the gas venting trenches (*e.g.* VGC) protecting the circa 2006 development located further away from the landfill suggests that gas migration has previously been shown to pose a substantial risk. Consequently, the report needs to present a robust and comprehensive gas risk assessment and demonstrate why, in 2019, lower standards of protection (*e.g.* ventilated voids and gas membranes) will provide sufficient protection to a proposed development located closer to, and potentially in continuity with, this landfill.

(76) The assessment presented by Soiltechnics does not include:

- Any data relating to the current gas regime (concentrations, flows and generation potential etc.) within the adjacent landfill, and how this may have changed since 2006; or
- Suitable consideration and assessment of potential advective flows between the landfill and the proposed development (including those within natural porous strata and existing and future service runs);

(77) BS8485 (BSI, 2019) states that gas risk assessments should not be based solely on gas monitoring data but also consider the implications of the gCSM in relation to (i) the robustness of the monitoring data, (ii) the relevance of the risk assessment and (iii) the adequacy of any proposed gas protection measures. Consequently, the current gas risk assessment for the proposed development should be reviewed and updated once Soiltechnics have:

- a detailed gCSM (including a geological cross section showing the potential gas source(s) and their relationship to preferential flow pathways, such as porous strata);
- data on the gas regime (concentrations and flow rates *etc.*) within the adjacent landfill; and
- an interpretation of the available gas monitoring data that accounts for both these.

(78) Furthermore, Soiltechnics need to understand, and present:

- an explanation of how the proposed development may affect the ground gas regime experienced on surrounding sites, particularly in relation to the substantial hard surfacing (*e.g.* buildings, roads and car parking) proposed for the Site;
- an assessment of the likely impact(s) of these changes on the risks posed to these surrounding sites.

(79) In particular, this assessment will need to establish whether residents in the properties to the south are still at risk from gas migration and, if so, to show that the proposed development does not increase the risks to these residents nor compromise or exceed the capacity of the existing VGC.

4.6 Remediation strategy

(80) It is likely that the risk assessment discussed above will demonstrate that gas protection measures will be required to protect the proposed development; the current proposals may be sufficient or more substantial measures may be called for. Such gas protection measures need to be specified within a robust design report as required by BS8485. This design report needs to provide detailed specifications for the protection system (including demonstrating the suitability of each of the proposed products and elements) and provide design calculations demonstrating the level of protection provided. Such design reports may need to be produced by a 3rd party.

(81) Should vapour risks be shown to pose no appreciable or minimal risk, the current remedial strategy is likely to be sufficient to mitigate risks posed by chemical soil contamination and proposes appropriate verification measures and criteria. However, it must also acknowledge the critical landfill gas risks and either contain (*e.g.* in an appendix) or explicitly reference an appropriate design report, and present details of the verification requirements required for such a gas protection system. The required verification should be specified in line with CIRIA C735 (Mallett et al., 2014).

(82) If the vapour risk proves to be unacceptable, careful thought should be given to specifying the required mitigation measures as the gas protection measures are unlikely to be sufficient due to the high toxicity of many volatile organics and the permeability of most gas membranes to such

compounds. Guidance on the selection of suitable membranes is available in CIRIA C748 (Wilson et al., 2014).

4.7 Recommendation

(83) Given our comments above, and particularly the inadequate assessment of the landfill gas and vapour risks, LQM are unable to recommend the discharge of any parts of the Planning Condition 1 based on the documents reviewed above.

5 REFERENCES

BSI. (**2017**). *BS10175:2011+A2:2017 - Investigation of potentially contaminated sites - code of practice*. British Standards Institution: London, UK.

BSI. (**2019**). *BS 8485:2015+A1:2019 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*. British Standards Institution: London, UK.

DCLG. (**2012**). *National Planning Policy Framework*. Department for Communities and Local Government: London, UK. Accessed from http://www.communities.gov.uk/documents/planningandbuilding/pdf/2116950.pdf

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Wilson SA, Oliver S, Mallett H, Hutchings H, & Card GB. (**2007**). *C665 - Assessing risks posed by hazardous ground gases to buildings*. CIRIA: London, UK.

5.1 Site-Specific Reports

Soiltechnics (2019a). "Ground Investigation Report – Proposed development land at Chequersfield, Welwyn Garden City". Report Ref STM3370A-G02. Dated June 2019 – Revision 03

Soiltechnics (2019b). "Remediation Strategy Report – Residential development land at Chequersfield, Welwyn Garden City". Report Ref STM3370A-RS01. Dated November 2019 – Revision 01

5.2 Websites

LCRM (2019) "Land contamination: risk management" URL: https://www.gov.uk/guidance/land-contamination-how-to-manage-the-risks. Last updated 23 Dec 2019.