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LAND OFF FARLEIGH HILL

MAIDSTONE

KENT

ME15 6RQ

REMEDIATION STRATEGY & IMPLEMENTATION PLAN

March 2020
Revision 3

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Report Status: FINAL		**Date of Issue: March 2020**
		Signature
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Checked and Approved	**R J Moore**	

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REMEDIATION STRATEGY & IMPLEMENTATION PLAN

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APPENDICES

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REMEDIATION STRATEGY & IMPLEMENTATION PLAN

1. INTRODUCTION

This document has been prepared to provide advice on the management of remediation as part of the redevelopment of the above site.

The site has been the subject of a number of phases of intrusive Site investigation, with associated laboratory testing of representative samples dating back to 2004, with the most recent investigation occurring in December 2019. This document summarises the findings of these investigations and provides a review of information pertaining to this site and the surrounding area and concludes with a Remediation Strategy and Preliminary Implementation Plan. However, it should be noted that several phases of investigation and associated at testing at this site have indicated that it is generally lacking in contamination which would represent a risk to the developer and the end-user and that any remediation should be of a routine nature, i.e. clean cover soils.

The most relevant documents are listed below and are issued as Appendices to this report.

Details of appropriate remedial measures to ensure that, at commencement of development, the site will be suitable for the proposed residential development are proposed in later sections of this report.

Principal References are listed below and issued as attachments with this document (Appendix A) and a brief summary of relevant current environmental and geological information derived from a current Groundsure Report (25th march 2020) for the site is presented overleaf:

1	Tovil Quarry, Site Sub-surface Conditions & Reclamation Method Statement, Liverpool Environmental Engineering Consultants Ltd, May 2006
2	Farleigh Hill, Tovil, Maidstone, supplementary Site Investigation & Review of Site Information, Knapp Hicks & Partners Limited, September 2013
3	Farleigh Hill, Tovil, Maidstone, Interim Report on Remediation Works to July 2017
4	Stockpiles Characterisation Table, 2019
5	Trial Pit & Monitoring information, Tovil Quarry, Farleigh Hill, Maidstone, Letter Reference 27686/L/012A/G/RJM, 20th January 2020
6	Supplementary Ground Gas Monitoring and Groundwater Quality Test Results, to February 2020
7	Tovil Closed Landfill Site, Maidstone, Environmental Monitoring Summary, prepared by Waterman Limited on behalf of Kent County Council Waste Management
8	Earthworks Specification, Knapp Hicks & Partners, 2017
9	Ground Contamination Review, Remediation strategy and Implementation Plan. Land off Dean Street, Burial Ground Lane, Maidstone, for Fenham Homes Limited, Prepared by Land & Environment, September 2013.
10	Topographical Survey, May 2019 (site unchanged since this date) & Isopachyte drawings showing existing vs proposed levels.
11	Former Tovil Quarry, Farleigh Hill, Tovil, Maidstone: Groundsure Report Ref: EMS_602271_805497, 25 March 2020

Review of GroundSure Report Reference EMS-602271-805497, dated 25th March 2020

- No Radon Protection Measures are required.
- 3No potential sources of contamination identified on site. These have been addressed by the above references (substation, tanks and depot).
- Off-site potential sources of contamination identified within a 100m radius included a waste recycling plant, hire depot, and adjacent KCC landfill. None deemed to be critical in terms of proposed site final use.
- Negligible to Low risk of shrink-swell clays and natural ground subsidence.
- Moderate risk of landslides.
- Geology is confirmed as Atherfield Clay and Hythe Formation (See Section 2.3 of this report). The site was quarried for the Ragstone and remnants remain on site along with other re-worked soils.
- The Atherfield Clay and Hythe Formation are classified as Secondary B/ Principal Aquifers respectively (See also Section 2.4 of this report).
- 2No discharges to Controlled waters are denoted onsite (Trade discharges into freshwater -1997)
- The site is recorded as a historical inert landfill site/ refuse tip, with the last recorded noted to be 1983-1985. The KCC landfill is denoted upon the NW boundary of the site.
- There are no groundwater or surface water abstractions, including potable, ones within 500m radius.
- An intermediate Soil Leaching Potential is identified for the site.
- The closest surface water feature is the River Medway 74mNE. The site is located within the catchment of Loose Stream and River Medway.
- The highest risk of groundwater/surface water flooding is denoted as high/>1m in a 30year storm. It Following completion of the proposed site re-profiling, this will be re-evaluated to lower risk classes.
- The site is classified as a Nitrate Vulnerable Zone and a SSSI Impact Risk Zone. A designate Ancient Woodland is denoted within a 50m radius of the site.

Review of Historic Maps (1:1,250,1:2,500, 1:10,000, 1:10,560)

1867, 1868, 1869, 1896, 1897	The majority of the site is shown within an open field in a semi-rural setting. A pit is noted within the N portion of the site along Farleigh Hill. On the 1897 map the existing cottages within the northern portion of the site are now depicted. Tovil itself is starting to develop to the north. By 1896 the site is denoted as an old quarry, two (what appear to be) tanks are located within SE portion of the site.
1907, 1908, 1909	The quarry has now expanded both E & S. An offsite quarry is denoted around 30mN.
1933, 1938	The quarry encompasses the majority of the site and has expanded west into what is now known as the KCC landfill at a later date. A number of small buildings and tanks are denoted across the site. The site located upon the southern boundary now includes a travelling crane and various buildings. The quarry to the north has also expanded and is noted to be a refuse yard.
1957, 1958, 1961, 1962,1966, 1971, 1972, 1978,	The site is now denoted as a refuse tip. By 1978 the northern portion of the site is noted as a ready mix concrete yard. The northwestern to central portions of the site are denoted as a disused tip, and eastern and southern areas as a refuse tip. A small quarry area remains within the southwestern area of the site. The quarry to the north of the site is now denoted as a works On the 1972 map a number of buildings are located upon the southern boundary of the site (Note: this is drawn within the boundary on the highlighted maps). This is associated with the Tovil Paper Mill.
1980, 1986, 1989, 1991	On the 1986 map- The northern portion of the site is denoted as a fuel depot with tanks. By 1991 the site is denoted as a disused workings and in 1993 the tanks remain but the depot appears to be scaled down.
2001	The site is now denoted as Workings and includes the adjacent KCC landfill located upon the western boundary of the site.
2010, 2020	No significant changes are depicted on site.

2. BACKGROUND

2.1 Introduction

The site is located on the southern side of Farleigh Hill, Tovil approximately 2km south west of Maidstone town centre. The centre of the site is at approximate grid reference TQ752541.

The site is roughly 'L' – shaped and 300m by 220m at its largest, the entrance to the site is off Farleigh Hill. There are a number of temporary site buildings located adjacent to the site entrance, along with an area set aside for plant storage and another for car parking. There are no other buildings located on the site.

A proportion of the site area is occupied by stockpiles and these are described in Reference 4 above which includes historical testing. Recent test results for each stockpile are also provided in Reference 5.

2.2 Review of Site History

Dates	Use
1884	Agricultural land.
1897 – 1958	Quarrying for building stone.
1950 – 1976 (approximately)	Backfilling with refuse including ash, domestic refuse and paper pulp.
1980 – late 1990's	Fuel depot on the north western corner.
1992	Tipped soils re-excavated and recycled.
2000	Extensive remodelling, re-excavation and recycling.
2002	Low area on northern eastern side was infilled.
2010- 2014	Overspill of domestic refuse excavated and screened to remove unsuitable deposits.
2017-2018	Installation of gas barrier between subject site and adjacent KCC site.

2.3 Geology

The 1:50,000 Geological Map (Sheet No. 288, Maidstone) indicates the site geology to be Hythe Beds (Sandstone and Limestone) with a band of Atherfield Clay (typically blue grey, plastic silty clays and mudstone with subordinate sandy clays) running south-west to north-east across the centre of the site. No superficial deposits are recorded.

Previous investigations proved Hythe Beds strata overlain by significant depths, in excess of 20m, of Made Ground. The Made Ground was present as two layers comprising landfill waste overlying inert site-derived Quarry Waste Materials (mix of natural ragstone, and hassock - a silty sandy clayey by-product of ragstone quarrying). The underlying Atherfield Clay has been encountered in boreholes and in trial pits (the latter taken out at low points adjacent to the KCC landfill prior to gas barrier construction) as a stiff greenish grey silty CLAY, becoming blue grey with depth.

The Quarry Waste material is generally quite well compacted and Standard Penetration test N Values from previous investigations (See Appendix A) generally indicate that they are medium dense or better.

Further information on the geology and the make-up of the filled ground is provided in References 1 & 2 above.

2.4 Groundwater

The Hythe Beds are classified as a Principal Aquifer with the underlying Atherfield Clay now classified as a Secondary B Aquifer, (albeit this was formerly classified as a non-aquifer, noting that it comprises very predominantly clay/mudstone strata in the area), Groundwater is expected to flow in a northerly direction through Hythe Beds strata towards the River Medway. Based on existing records the site does not lie within a groundwater abstraction zone.

Groundwater has been recorded at various times in a number of boreholes across the site from 25.7mbgl to 36mbgl, generally at levels just above the surface of the low permeability Atherfield Clay Recent groundwater level and quality monitoring and testing is provided in References 5 & 6.

Where the Atherfield Clay was exposed enabling inspection in the deepest excavations in the site, the groundwater was generally located only as a slow seepage at the top of the clay.

2.5 P J Burke (KENT) Ltd Works to 2019

The site is bound to the north by Farleigh Hill, to the east by residential development, to the south by disused industrial land and to the south west by a Kent County Council (KCC) owned historic landfill that is currently occupied by fields used for grazing horses.

Following EA approval of a Reclamation Method Statement prepared by Liverpool Environmental Consultants Ltd (2006), P J Burke (KENT) Ltd (PJB) screened the material on site in accordance with the recommendations in that report.

Since 2010, P J Burke (KENT) Ltd undertook more intensive remediation works in general accordance with the Reclamation Method Statement described above. Waste from the site has been transferred during a period between November 2011 and October 2014 to alternative landfills at the Cory Greatness facility at Sevenoaks (499No loads totalling 9564.73 tonnes) and the Waste Recycling Group landfill at Milton (121 loads totalling 3102.26 tonnes), and a further 711 tonnes was removed in large skips. The relevant waste transfer documentation is available for scrutiny on request. During excavation and removal of the unsuitable waste materials, a proportion of the residual screened soil materials was accumulated on-site as stockpiles.

On the western boundary a near vertical face existed adjacent to the adjoining land. This was approximately 16m high at its maximum and a 1m to 16m height of landfill waste was exposed along the boundary. During 2017, PJ Burkes installed a landfill gas barrier along the length of this boundary, consisting of an engineered earth bund placed against the KCC landfill waste with a continuous gas membrane installed by Butek along the length of the bund and anchored into natural ground at its base and anchored at the top into the upper surface of the earth bund. A rubble filled venting trench was installed to depths of up to 6m to the KCC landfill side of the gas membrane.

The levels across the site vary considerably, however the site generally slopes down from the south and west towards the north and east.

A topographical survey was carried out in 2005 by Survey Solutions and, for comparison, updated topographic surveys have been carried out in 2013, 2017 and 2018. The most recent survey was carried out in 2019. No further works have been carried out since the topographical survey in May 2019 (Ref. 10).

The main changes across the site between surveys may be seen on the attached drawings which include an isopach drawing and sections comparing 2005 with 2017. Other isopach drawings show the difference between 2019 levels (as existing at the present time) and proposed development levels.

2.6 Gas Monitoring at KCC Historic Landfill

KCC continue to monitor a number of gas wells installed in the adjacent landfill. The following information is derived from a recent report (November 2019) on monitoring of the landfill:

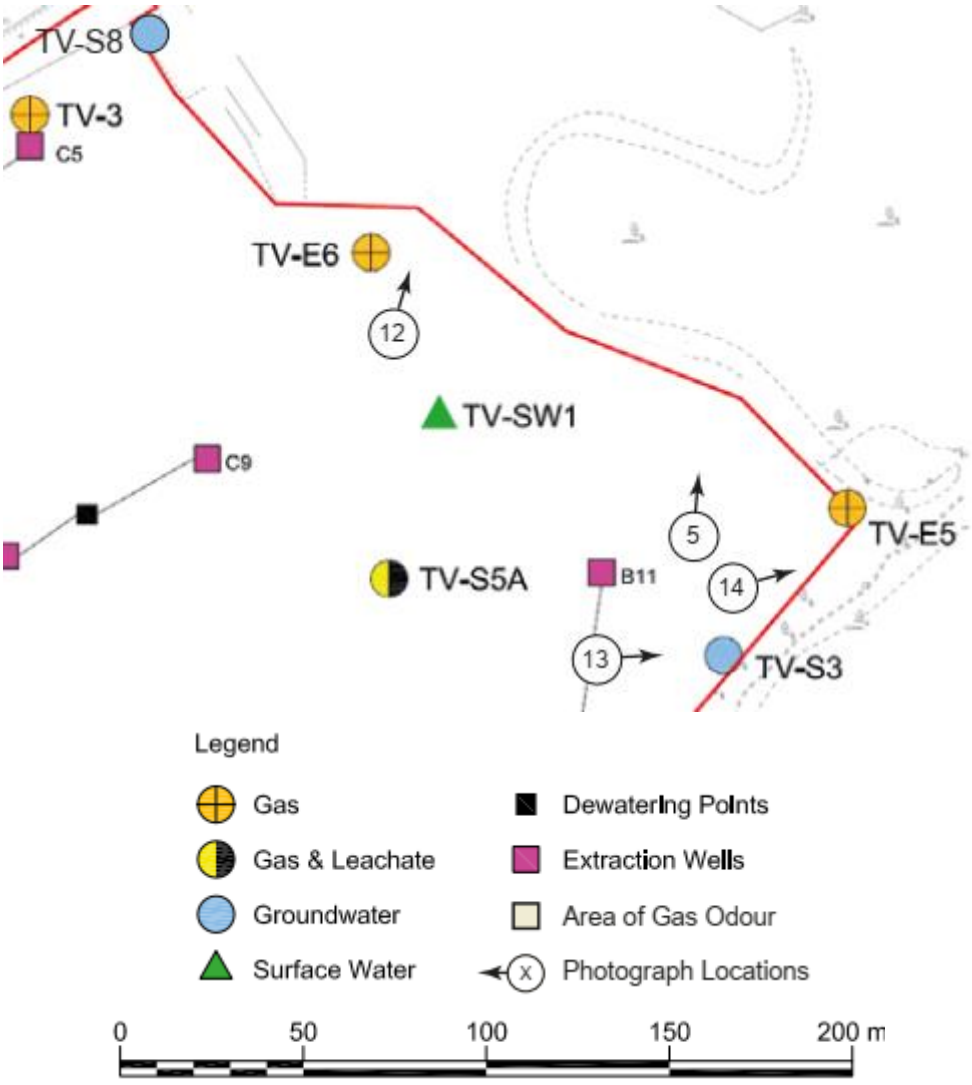
- Two combined ground gas and leachate monitoring wells installed in the waste on the northern Site half (TV-S5A) and southern half (TV-S4A), and one ground gas monitoring borehole (TV-E2) for the purposes of monitoring the ground gas generation of the landfill waste;
- Twelve monitoring wells on the western Site boundary monitoring the landfill gas migration off the western Site boundary (TV-4 – TV-9, TV-S6, TV-S7, TV-E7 – TV-E9).
- Three monitoring wells on the northern Site boundary monitoring the landfill gas migrating off the northern Site border (TV-3, TV-E6, TV-E5).
- Two monitoring wells on the eastern boundary monitoring the landfill gas migrating off the eastern boundary (TV-E3 – TV-E4).
- Two monitoring wells in the south western Site corner monitoring the landfill gas migrating off the southern boundary (TV-E1, TV-2).

Landfill gases are extracted from the Site using a flare on the western boundary which is fed by three lines.

The most relevant of these wells to the PJ Burke site are as follows:

Ground Gas: TV-3, TV-E6 & TV-E5

Groundwater: TV-S3 & TV-S8



The following monitoring information has been provided by KCC:

Borehole	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Comments
Western Boundary				
TV-3 (2m)	<0.1	<0.1 – 1.8	21	Near Atmospheric
Northern Boundary				
TV-E5	0.1 – 0.5	2.4 – 16.4	2.6 – 17.8	Variable
TV-E6	<0.1 – 0.2	<0.1 – 0.7	21 - 22	Near Atmospheric

2.7 KCC Gas Monitoring at adjacent closed landfill site (2019-2020)

KCC (Reference 7) have prepared a risk assessment based upon their ongoing monitoring results and this is reproduced below. It can be seen that their assessment of risk rating to property adjoining their site is generally Low, and this is because there is little evidence of significant lateral migration of ground gas.

Table 6: Conceptual Site Model

Source	Receptor	Potential Transport Pathways	Associated Hazard	Probability	Potential Consequence	Risk Classification	Comments
Landfill Gas	Human health	Lateral migration through the ground and build up in buildings	Asphyxiation Explosion	Unlikely	Severe	Moderate/low	Evidence of significant lateral ground gas migration has not been recorded.
		Vertical migration through landfill capping	Headaches, shortness of breath	Unlikely	Minor	Very low	A SES should be completed during the following EMS period to quantify the risk.
	Flora and fauna on site	Vertical migration through landfill capping	Toxicity	Likely	Minor	Low	
	Property (crops to west of the site)	Lateral migration through the ground	Toxicity	Unlikely	Mild	Very low	Boreholes along western boundary generally do not indicate lateral migration is occurring.
	Property (crops to the east of the site)	Lateral migration through the ground	Toxicity	Low likelihood	Mild	Low	Boreholes along eastern boundary indicate the potential for lateral ground gas migration. The monitoring and assessment of ground gas flow is required to confirm the risk.
	Property (buildings)	Lateral migration through the ground and build up in buildings	Explosion	Unlikely	Mild	Very low	Gas extraction system is effective at controlling lateral landfill gas migration towards the south.
	Global environment	Lateral and vertical migration with release to atmosphere	Greenhouse gas (contribution to global warming)	Likely	Minor	Low	A SES should be completed during the following EMS period to quantify the risk.
Leachate (infiltration through waste and leaching out of base)	Controlled waters (groundwater & River Medway)	Leaching through base of site	Pollution of controlled waters	Likely	Medium	Moderate	Groundwater monitoring point TV-S3 records a significant deterioration in groundwater quality compared to results from TV-S1 and TV-S2 but overall stays within historic ranges.

Following review of gas levels reported on the KCC site, and following discussion with the Local Authority EHO, PJ Burkes have installed 5No gas monitoring wells within the subject site. These are located along the boundary in-between the proposed housing and the installed ground gas barrier. Monitoring is ongoing (See Sections 3.2 and 6.7).

Borehole logs and subsequent monitoring readings are provided in Reference 6.

3 SUMMARY OF SITE INVESTIGATION FINDINGS

3.1 Review of Previous investigations

Reference 1 identified 5 zones, A to E, across the site which are summarised below and remain valid as the basis for understanding the make-up of the site and associated lateral variations:

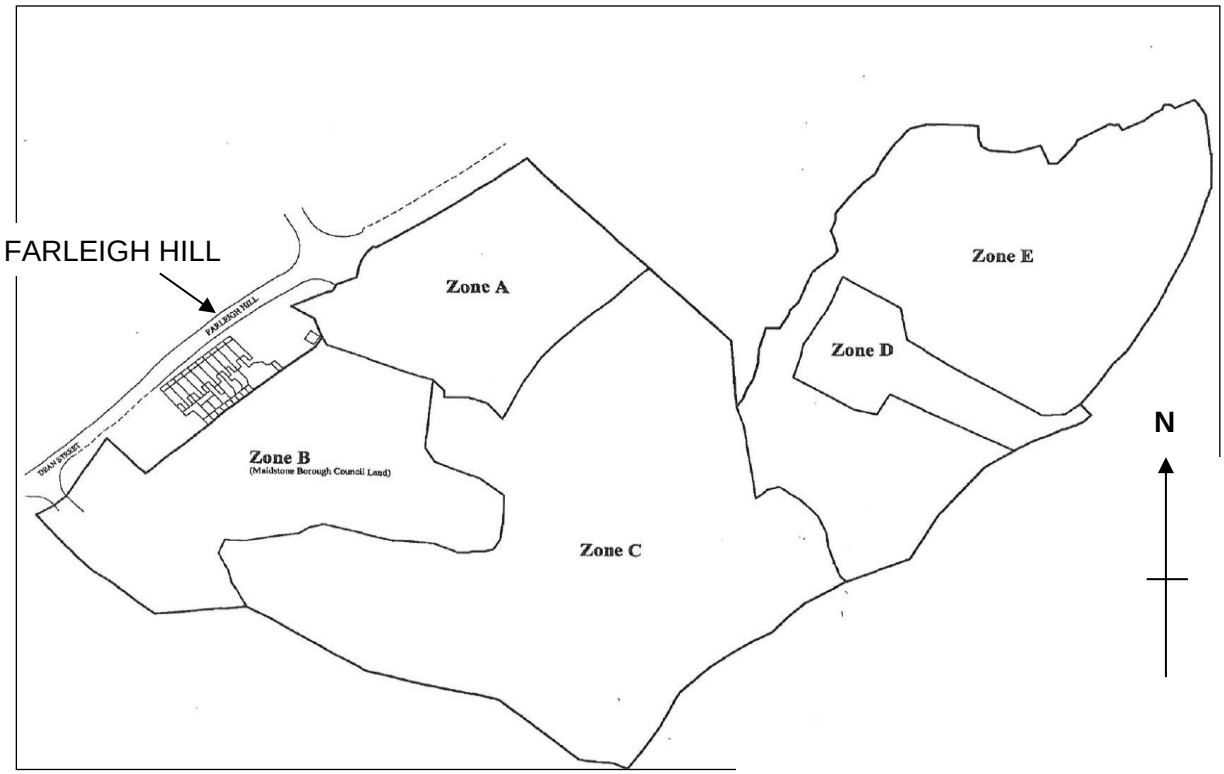


Figure 2.1 Site Plan showing Zones A to E.

Zone	2005-2006 Investigation Findings
A	• Predominantly ash rich (up to 13m) understood to be derived from local paper manufacturing processes. • No elevated landfill gas concentrations • Quarry waste rock encountered at base
B	• Household waste & shredded paper (>5.80m) • Some layers noted to be 'steaming'. • No active gassing recorded. • No boreholes undertaken in this zone.
C	• Sandy clay with shredded paper, paper, ash and brick particles (up to 15.30m). • Some wastes noted as "warm". • High methane (up to 27%) but very low gas pressure heads suggests limited but locally active gassing.

Zone	2005-2006 Investigation Findings
D	• Not investigated as this area of the site was occupied at that time.
E	• Sandy clays overlying quarried rock waste. • No degradable materials. • No elevated levels of landfill gas.

The following table provides some more specific information on what was identified by investigations during the period 2005-2006.

Zone	Southern Testing Limited 2005	Ground Investigation Limited 2005/6	LEEC 2006
A	➢ Elevated CO_2 recorded (up to 10%) ➢ 2No contamination test samples recorded only elevated boron, which was not measurably water leachable. ➢ Fuel staining noted.	➢ No elevated levels of landfill gases. ➢ 9No contamination samples tested (on fill): 2No clean, 7No indicated elevated levels of metals and hydrocarbons, associated with the ashy strata and historic fuel spills. ➢ Water leachability tests indicated slight potential for lead and hydrocarbons to enter the groundwater flow.	➢ No fuel staining or odours noted.
B	➢ Elevated CO_2 recorded (up to 17.2%) ➢ One instance of "steaming" material was recorded. ➢ 3No PCB and TPH tests recorded no elevated levels. ➢ 2No water leachability tests recorded no elevated levels.	➢ Elevated levels of methane (up to 14.8%) and CO_2 (up to 29.8%), but no gas flows recorded. ➢ No "steaming" material noted. ➢ 12No contamination tests (on fill) recorded elevated levels of metals and hydrocarbons. ➢ Slight potential for water leachability.	No further investigation
C	➢ Elevated methane (5.1%) in 1No location (BH8). ➢ Elevated CO_2 in 2No boreholes. ➢ Visible asbestos fragments noted in 2No trial pits ➢ Elevated levels of metals and lubricating oil were recorded in samples from 2 trial pits. ➢ "Steaming" layers noted. **(NOTE (2020): This material has been excavated (2010-2014) and removed from site see Section 2.5 of this report)**	➢ Elevated levels of methane (up to 10.4%), but no gas flows recorded ➢ No elevated CO_2 ➢ No asbestos identified. ➢ 18No contamination tests (on fill): 6No clean, 12No elevated levels of metals and hydrocarbons. ➢ Essentially no leachable contaminants. ➢ No "steaming" layers noted.	No further investigation
D	➢ 1No instance of elevated methane which was not associated with positive gas flow. ➢ 2No contamination tests were uncontaminated.	➢ No elevated levels of landfill gas were recorded, nor any positive flow rates. ➢ 5No contamination tests (from quarry waste); 3No clean, 1No	➢ Groundwater testing on samples indicated clean groundwater.

Zone	Southern Testing Limited 2005	Ground Investigation Limited 2005/6	LEEC 2006
	➢ 1No water leachability test was clean.	elevated nickel, 1No elevated benzo(a)pyrene.	
E	➢ No elevated landfill gas recorded. ➢ 1No sample recorded elevated levels of hydrocarbons within an ash band.	➢ Slightly elevated levels of CO_2, no elevated levels of methane nor a positive gas flow recorded. ➢ 14No contamination tests (from quarry waste): 8No clean, 5No slight elevations of nickel or arsenic, and 1No elevated levels of hydrocarbons and metals.	No further investigation.

3.2 Knapp Hicks Site Investigations 2013 to 2019

Knapp Hicks & Partners have carried out 3 phases of site investigation to obtain representative samples from across this site.

Year	Scope of Investigations	Summary of Findings
2013	40 No machine dug pits 30No Contamination Suites	Rare asbestos fibres (4 samples) Rare slight exceedances of metals (lead, arsenic) in 2 out 30 samples All TPH & BTEX parameters below guidance values Localised exceedances of PAH's
2017	26No Machine Dug Trial Pits 10No Contamination Suites Asbestos Quantifications	Minor exceedances of lead in 2 samples Asbestos fibres in 2 samples. Asbestos quantifications generally relatively low at <0.001% to 0.002%
2019	40No machine dug trial pits from areas where existing ground level will be reduced 36No Contamination Suites 36No Waste Acceptance Criteria (leachate) tests) 5No Ground Gas Wells installed Ground Gas Monitoring Groundwater samples obtained from 4No wells (2No on PJ Burke site, 2 No on adjacent landfill site close to	Contamination testing of representative samples taken from areas to be excavated to provide fill for re-profiling the site have generally found levels of contamination below assessment criteria for residential end use with private gardens. WAC testing identified sulphate levels above the assessment criteria for inert waste and antimony levels were close to the upper level for inert waste. 12 of the 36 samples identified asbestos fibres. Quantification analysis identified that 7 samples had asbestos levels below 0.001%w/w. The remaining 5 samples identified asbestos levels at between 0.002% and 0.007%. Ground gas results are discussed in Section 2.7 above. Groundwater samples did not identify any criteria exceeding drinking water quality standards with the exception of some elevated sulphates in KCC borehole TV-S3 located on the adjacent site to the south.

3.3 Ground & Contamination/Sources

Very few sources of contamination have been identified by the various phases of site investigation on this site, but it is possible that localised hotspots of contamination may remain on site.

A Conceptual Site Model is presented in Section 5 which assesses the potential sources of contamination which may be present on site and the potential pathways and receptors.

This is followed by a Human Health Risk Assessment.

3.4 Groundwater & Controlled Waters

Principal sources of contamination affecting groundwater are addressed in a Conceptual Site Model and Human Health Risk Assessment in Section 5 of this report.

4. REGULATORY CONSULTATIONS

4.1 Environment Agency (EA)

A Waste Recovery Plan is currently under preparation for approval with the Environment Agency. This Remediation Strategy and its Implementation will be reviewed as part of this process and any extra requirements identified through consultation with the EA will be advised in due course.

A meeting with the EA is currently being arranged through the EA charged advice scheme to facilitate this.

4.2 Kent County Council (KCC)

KCC Waste Management have been consulted at various times during the recent gas monitoring and their approval was obtained prior to construction of the ground gas barrier installed by PJ Burkes in-between the subject site and the adjacent closed landfill to the south.

We refer you to the KCC Ground Gas Risk Assessment re-produced in this report in Section 2.7.

4.3 Maidstone Borough Council

The Local Authority EHO has been consulted at intervals over the period 2018-2020 with particular reference to Ground Gas monitoring, risk assessment and protection requirements.

It is understood that Maidstone Borough Council are keen for the proposed 272 dwellings to be delivered. Therefore, as the planning permission expires May 2021 we urgently seek discharge of the planning conditions concerning contamination and gas monitoring.

4.4 Other

It should be noted that reference has been made to the on-line planning documents associated with the adjacent and recently constructed residential site known as `Land off Dean Street`, now known as Farleigh Heights.

These documents refer in detail to the subject site and confirm that the completed housing development was also constructed within an infilled ragstone quarry. The ground conditions and associated risks and proposed solutions are very similar to those prevailing and proposed at the subject site of this report.

The Remediation Strategy for Farleigh Heights was approved by the Environment Agency, Maidstone Borough Council and Kent County Council, and similar remediation measures are proposed for the Land off Farleigh Hill which is the subject of this document.

5. CONCEPTUAL SITE MODEL & RISK ASSESSMENT

For the assessment of contamination, a risk-based approach is utilised in accordance with the Environment Agency's 'Model Procedures for the Management of Land Contamination' (CLR11). In the development of a conceptual site model, consideration is given to potential sources of contamination, potential targets (receptors) and how the sources and targets may be linked (the pathway). Significant risk due to contamination will only be considered to exist where a reasonable linkage from the source to target can be identified. A residential with home grown produce end-use is being considered for this assessment. However, it must be noted that all soils derived from the subject site will be buried underneath a final layer of imported clean materials which is expected to be around 600mm to 750mm thickness.

Potential Sources	Potential Pathways	Potential Receptors
On Site Deposits of Made Ground generated from • Historic quarrying i.e. reject quarried materials. • Landfill activities *Off Site* The site is located in a mixed setting, and the following potential sources of contamination have been identified by this assessment: • Other historical quarries which have been used as landfills (southern boundary) or are part filled with quarry waste materials or engineered fill to facilitate development (to south west to other side of Farleigh Hill) • Electrical substations in the surrounding area are a potential source of contamination	Dermal contact with soil during proposed end use (limited to the communal soft landscaped areas). Inhalation of outdoor and indoor dust and vapours. Dermal contact with and ingestion of soil during site works. Migration of ground gas through strata. Migration via buried services. Groundwater Flow	Human receptors in the proposed redevelopment. Neighbouring residents. Plant growth in landscaped areas. Construction workers during development. Site structures and utilities.

Table 5.1 – Conceptual Site Model

Information gained from the desk study and historic maps is summarised in Section 2.2.

Based on the Conceptual Site Model presented in Table 4.1, and information gained from the earlier investigations, Table 4.2 provides a pre-remediation qualitative risk assessment for the site. Classification of consequence, probability and risk used are adopted from CIRIA C552:2001 'Contaminated Land Risk Assessment – a guide to good practice' and a summary of the process is included in Appendix B.

Source/Contaminants	Pathway	Receptor	Consequence of Occurrence	Probability of Occurrence	Risk
Toxic Metals from superficial made ground	Ingestion, Inhalation, Direct Contact	Humans	Medium	Unlikely	Low
		Underground water supply pipes	Medium	Unlikely	Low
Phytotoxic Metals from the superficial made ground	Uptake by roots	Flora	Medium	Unlikely	Low
Petroleum Hydrocarbons from superficial made ground	Ingestion, Inhalation, Direct Contact	Humans	Medium	Unlikely	Low
	Inhibition of concrete setting	Buildings	Minor	Unlikely	Very Low
	Direct contact	Underground water supply pipes	Medium	Unlikely	Low
Leachable and mobile hydrocarbons from made ground or fuel spillages/leakages (associated with the carpark and adjacent electrical substations) Benzene, toluene, ethyl benzene and xylenes (BTEX), Polychlorinated biphenyl (PCBs), Chlorinated hydrocarbons and polycyclic aromatic hydrocarbons (PAH)	Migration via permeable strata or groundwater	Groundwater	Medium	Unlikely	Low
		Underground water supply pipes	Medium	Unlikely	Low
Soil gasses arising from superficial made ground	Migration via permeable strata	Humans	Severe	Unlikely	Very Low
		Buildings (explosion, fire)	Mild	Unlikely	Very Low
		Flora and Fauna	Minor	Unlikely	Very Low
Soil gasses arising via migration from the adjacent landfill to south	Migration via permeable strata	Humans	Severe	Likely	High * (*See Footnotes)
		Buildings (explosion, fire)	Mild	Low	Low
		Flora and Fauna	Minor	Low	Very Low
Sulphates and Corrosives arising from superficial made ground	Direct contact	Buildings	Mild	Low	Low
		Humans	Mild	Low	Low
Asbestos from buildings / demolition	Ingestion, Inhalation	Humans	Severe	Unlikely	Low
Asbestos from soils	Ingestion, Inhalation	Humans	Severe	Lowe	Moderate ** (**See Footnotes)

Classification of Consequence, Probability and Risk have been defined based on CIRIA C552:2001 guidance (Appendix B). * Risk associated with ACMs is assessed as low based on an assumption that the existing buildings will be surveyed and demolished in accordance with accepted good practice for dealing with ACMs.

* Please note that the risk rating of `high` for soil gas is reduced further by the addition of the ground gas berm and associated venting trench along the full length of the south western site boundary with the KCC landfill. We propose that this reduces the risk rating to moderate/Low. Please also refer to the risk ratings in the Table 6 Conceptual Site Model prepared by KCC under Section 2.7 preceding.

** For asbestos in soils, the `moderate` risk rating may be reduced to `low` on condition that groundworks contractors ensure that their RAMs include an ACM identification procedure and that, during all groundworks, relevant operatives and on-site staff should be asbestos awareness trained and appropriately insured and with procedures to identify evidence of potential fragments of ACMs.

Table 5.2 – Human Health Risk Assessment (Based on laboratory testing and monitoring)

6. REMEDIATION STRATEGY IMPLEMENTATION PLAN

6.1 Earthworks

6.1.1 General Re-profiling & Filling

Details of a proposed engineering methodology for the excavation and re-placement of site won soils to re-profile the site to the proposed landform are available in Reference 8 (2017), prepared by Knapp Hicks & Partners. It is anticipated this will be reviewed and updated as part of the Waste Recovery Plan for the site.

Testing has also indicated that the soils are suitably uncontaminated and that their geotechnical properties are acceptable for use as engineering fill to reprofile the site as suggested above.

It has been calculated that the site won materials are of sufficient quantity (Ref 10) to re-profile the site up to an approximate level of 600mm to 750mm below the proposed finished ground level.

The remaining 600 to 750mm will be made up of hard construction materials (roads, hardstandings, foundations etc) or imported soils for landscaping (See 6.1.2 below).

6.1.2 Gardens & Soft Landscaping

Clean soil comprising 450mm of validated clean subsoil and 150mm topsoil will be required in proposed private gardens and soft landscaped areas as a suitable growing medium. The chemical quality of the clean topsoil and subsoil should meet current acceptance criteria for chemical quality.

Verification sampling and testing to demonstrate compliance with the required acceptance criteria should be undertaken at a frequency of not less than 1 sample per 1000m^3, and a minimum of 3 samples for each source.

Subsoils should be free draining and be in general compliance with the Specification for Subsoils (BS8601). Topsoil should be compliant with BS3882 (Multi-purposes Grade) and/or any specific requirements of the landscape architect, where appropriate.

Detailed records to demonstrate the suitability of imported materials for gardens and soft landscaped areas will be included in a Validation Report, including supporting testing records as necessary.

6.2 Traffic Management

Importation of materials for construction and landscaping will be spread throughout the overall duration of the site re-development works. Careful programming/scheduling of deliveries will be required in conjunction with a robust traffic management plan to minimise congestion impacts on local road infrastructure and moderate the potential impacts on local residents and businesses.

6.3 Air Quality

The following measures should be incorporated to minimise impacts on air quality and to ensure they are managed as far as practicable. This should include but may not be limited to:

- Sympathetic stockpiling of materials and materials management
- Establishment and maintenance of temporary haul routes
- Suitable resources for damping down of the works during periods of dry weather
- Provision of suitable wheel cleaning and an inspection programme
- Installation of static deposition gauges at the boundaries in the immediate vicinity of sensitive receivers (4-6No) to monitor for dust deposition rates
- Provision of suitable screening along sensitive boundaries to intercept fugitive particulates
- Provision of road cleaning as required

Prior to commencement of work on site, it is recommended that surveys be undertaken to establish baseline dust levels, particularly in view of the adjacent highway and nearby municipal waste depot.

6.4 Noise & Vibration

Whilst the proposed remediation works will only involve limited concrete breaking or crushing operation, the filling/construction platform preparations will have the potential to generate increased levels of noise and potentially groundborne vibrations from machine tracking and the application of compaction plant. A suitably robust programme of monitoring of both noise and vibration to establish baseline levels prior to commencement of work should be undertaken by the earthworks contractor.

The earthworks contractor should also make sufficient allowance to undertake monitoring during the course of the works, to reassure residents and other property owners in the vicinity of the site that any groundborne vibrations do not have potential to result in structural damage. The results of this monitoring should be made available for review by the Local Authority Environmental Health Officer as required.

It is anticipated that strict adherence to agreed site working hours, maintenance of a robust monitoring programme and maintaining ongoing constructive dialogue with local residents/businesses should be sufficient to address these issues during the course of the project.

6.5 Surface Water / Drainage

There are no sensitive water courses within the immediate vicinity of the site or residential properties with gardens that would be considered vulnerable to run-off due to the proposed profile of the site. During the course of the earthworks it will be necessary to ensure the working platform is carefully maintained and profiled to ensure no deterioration of the surface from an engineering perspective, and to ensure run-off is intercepted and managed in a controlled manner. It is acknowledged that the nearest down gradient receptor is the houses to the north west of the site (Passmore Way), which could be considered a potential sensitive receptor if drainage is not controlled due to the significant height difference between the site and Passmore Way.

6.6 Mud & Debris

Due to the large number of vehicle movements required to import construction materials, there is potential for mud and debris to be trafficked on to the public highway. Consideration will need to be given to the installation and maintenance of temporary haul roads, and robust wheel cleaning facilities. The contractor will likely require full time gateman to assist vehicles accessing/leaving the site and to inspect vehicles before they return to the public highway. A road sweeper will also likely be required periodically to ensure the public highway is free of mud/debris.

6.7 Ground Gas Protection Measures

The proposed reprofiling of the site and associated earthworks engineering will facilitate the use of piled foundations which is identified as the optimum foundation solution for much of this site, particularly the southern portion.

6.7.1 Ground Gas Risk Assessment

The following assessment is based on the following equation which is taken from BS 8485:2015, *Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*. In addition, reference was made to CIRIA Report C735, 2014, *Good Practice on the testing and verification of protection systems for buildings against hazardous ground gases*.

Ground gas monitoring has been undertaken on 4No occasions at five representative locations within the subject site and located alongside the installed bund at a range of barometric pressure from 986mb to 1021mb.

Boreholes hazardous gas flow rates (Q_{hg}) have been calculated for assessment of methane and carbon dioxide at the site. These are derived from the measured flow rate of combined gases from the monitoring standpipe (litres/hour) and the measured hazardous gas concentration in percentage volume/volume.

Q_{hg} (l/hr) = q (C_{hg}/100)

Qhg - Borehole hazardous gas flow rate

q - Measured flow rates (in litres per hour) of combined gases from the monitoring standpipe

C_{hg} - Measured hazardous gas concentration (in percentage volume/volume)

The gas monitoring was carried out using a Gas Data GFM 436, which is acceptable industry standard equipment for routine ground gas monitoring work. The limit of detection of gas flow is 50ml/minute (i.e. 3 l/hr) and the limit of detection for methane and carbon dioxide levels below 5%v/v is 0.5%. Therefore, where gas flow rates are reported as 0 litres/hour we revert to the limit of flow detection or where gas levels below the limit of detection are reported, i.e. <0.5%, we adopt the limit of detection as a more conservative approach.

BS8485:2015 advises that Qhg may be used as the Gas Screening Value (GSV) upon which decisions about ground gas protection measures will be made. This is regarded as an appropriate methodology on condition that the site is close to the potential gas source. However, if the site is located further away from the source then this method can be conservative.

In this instance, we propose to assume the Qhg value as our GSV but to modify the model to take account of more of the sites specific characteristics if the result seems overly conservative.

6.7.2 Monitoring Visits

Four gas monitoring visits have taken place on 3rd December 2019, 12th December 2019, 10th January 2020, and 11th February 2020.

6.7.3 Methane Assessment

The peak Methane during the visits was recorded as 3.4%v/v. The flow was noted to be high during the first three visits (not untypical for fresh installations), but was recorded at 4.1l/hr during visit 4 and 1.0l/hr in other boreholes during this visit. Therefore, the 4.1l/hr value is used for the following analysis.

Q_{hg} CH_4 = 4.1 x (3.4/100) = 0.1394

By reference to BS 8485:2015, Table 2, if the above Qhg value is adopted as the GSV, the above equation calculates a **Low** hazard potential (0.07 to <0.7l/h) for methane (CS2).

6.7.4 Carbon Dioxide Assessment

The peak Carbon Dioxide during the visits was recorded as 4.3%.v/v. The flow was noted to be high during the first three visits, (not untypical for fresh installations), but was recorded at 4.1l/hr during visit 4 and 1.0l/hr in other boreholes during this visit. Therefore the 4.1l/hr value is used for the following analysis.

Q_{hg} CO_2 = 4.1 x (4.3/100) = 0.1763

By reference to BS 8485:2015, Table 2, if the above Qhg value is adopted as the GSV, the above equation calculates a **Low** hazard potential (0.07 to <0.7l/h) for carbon dioxide (CS2).

6.7.5 Groundwater Levels

The groundwater levels were also monitored during the visits. No groundwater was encountered within any of the newly installed boreholes which were installed to depths of 6.82 to 7.00mbgl (G1, G2, G3 & G5) and 14.10mbgl (G4). Further details are found on the gas monitoring record sheets in Reference 6.

6.7.6 Ground Gas Conclusions

Four monitoring visits have been completed at both high and low barometric pressure. Based on the monitoring data obtained from our visits the site is representative of Characteristic Gas Situation CS2 due to the low concentrations of ground gases encountered (GSV 0.07 to <0.7 (l/h)). **This means that the site has a Low Hazard Potential (BS 8485:2015, Table 2).**

Therefore, some gas protection measures are required to be incorporated in the proposed development at the site as the gas protection score is **3.5** (Table 4 BS 8485:2015). We advise a gas protection membrane is incorporated in the ground floor construction, which has a minimum thickness of 0.4mm. This would give a score of **2**. The remaining **1.5** would be created by the use of a passive sub floor dispersal layer 1.5-2.5 score. This is because the structural barrier for piled properties is likely to be a beam and block floor which give a 0 score. Please refer to Table 5 & BS 8485:2015.

Appropriate void spaces and exact gas protection details should be specified by the structural engineer appointed to design foundations.

6.8 Clean Cover Systems

Clean cover soil comprising minimum depth of 450mm of validated subsoil and 150mm topsoil will be required in proposed private gardens and soft landscaped areas as growing medium – See Section 6.1.2.

6.9 Environmental Permitting/Waste Management

A Waste Recovery Plan is currently under preparation by RPS Consulting Engineers and is the subject of separate ongoing discussion with the Environment Agency. Following the relevant Environment Agency scrutiny and approvals procedures, the WRP will be issued to the Local Authority.

7. VALIDATION & REPORTING

All validation sampling and testing should be undertaken by an appropriately qualified subcontractor/specialist UKAS accredited testing company.

Following the proposed re-profiling of the site, the attainment of the required formation levels across the site is to be verified by a topographical survey. This must be carried out before the placement of any imported soils to raise the re-profiled ground level to proposed final ground levels.

Within areas to be occupied by buildings or landscaping, a 200mm protective capping layer of 6F2-compliant recycled secondary aggregate is to be placed on top of the formation level. A tolerance of +/-50mm is considered appropriate.

Within areas to be provided with communal or private soft landscaping, a clean cover system is to be provided as described in Section 6.1.2 of this report i.e. make ground level up to proposed final level with validated clean imported subsoils and topsoils.

A daily site diary of the backfilling and related operations shall be maintained. The following information should be recorded:

- Date.
- Prevailing weather conditions including detail of when any earthworks operations were suspended due to inclement weather.
- Records of Materials imported and stockpiled, including details of provenance and chemical testing and any non-compliant materials received
- Details of any unacceptable/unsuitable materials encountered during the earthworks/reprofiling including records for their appropriate disposal.
- Details of all samples dispatched for laboratory testing.
- Volume of material placed compacted and record keeping to demonstrate that adequate compaction has been achieved.
- Daily records of plant operating to carry out the earthworks, and any changes of equipment used, e.g. compaction plant
- Details of field testing including co-ordinates and levels.
- Stockpiles management and details of approvals based on Material Classification Tests.
- Details of any test failures and remedial works completed.

This information shall be collated and presented together with all the results of geotechnical field and laboratory testing, in addition to any contamination or other classification sampling undertaken in the form of a Validation Report.

The results of all environmental monitoring undertaken shall also be included. Further gas monitoring at a range of barometric pressures is recommended for at least another three months (March, April and May 2020) while the site remains in its existing condition.

A further six-month period of monthly ground gas monitoring at a range of barometric pressures is recommended upon completion of the re-profiling to proposed formation levels.

Our assessment of appropriate ground gas protection measures based on the monitoring results collected to date is included in Section 6.7 of this report. These recommendations should be reviewed as further data is collected.

Further supplementary Validation Reports will be required in due course which should include (a) Construction Quality Assurance (CQA) inspection Reports and associated site photographs to validate the workmanship associated with gas protection measure installation, and (b) Details of all sources of imported subsoil and topsoil, inspection records and laboratory certificates for all verification sampling and testing to confirm the imported soils are suitable for their proposed end-use.

FIGURES

APPROVED DEVELOPMENT PLAN

GROUND MODEL

SITE INVESTIGATION LOCATIONS

HISTORIC MAPS

APPENDIX A

REFERENCES

1	Tovil Quarry, Site Sub-surface Conditions & Reclamation Method Statement, Liverpool Environmental Engineering Consultants Ltd, May 2006
2	Farleigh Hill, Tovil, Maidstone, supplementary Site Investigation & Review of Site Information, Knapp Hicks & Partners Limited, September 2013
3	Farleigh Hill, Tovil, Maidstone, Interim Report on Remediation Works to July 2017
4	Stockpiles Characterisation Table, 2019
5	Trial Pit & Monitoring information, Tovil Quarry, Farleigh Hill, Maidstone, Letter Reference 27686/L/012A/G/RJM, 20th January 2020
6	Supplementary Ground Gas Monitoring and Groundwater Quality Test Results, to February 2020
7	Tovil Closed Landfill Site, Maidstone, Environmental Monitoring Summary, prepared by Waterman Limited on behalf of Kent County Council Waste Management
8	Earthworks Specification, Knapp Hicks & Partners, 2017
9	Ground Contamination Review, Remediation strategy and Implementation Plan. Land off Dean Street, Burial Ground Lane, Maidstone, for Fenham Homes Limited, Prepared by Land & Environment, September 2013.
10	Topographical Survey, May 2019 (site unchanged since this date) & Isopachyte drawings existing vs proposed levels.

APPENDIX B

Summary of Classification of consequence, probability and risk adopted from CIRIA C552:2001 'Contaminated Land Risk Assessment – a guide to good practice