Our Ref: JMW/BC/J14372

06 March 2020

Southern Testing
Environmental & Geotechnical

Southern Testing Laboratories Ltd
Keeble House, Stuart Way
East Grinstead, West Sussex RH19 4QA

t 01342 333100 f 01342 410321
e info@southerntesting.co.uk w southerntesting.co.uk



KD Attwood & Partners
Down Court Farm
Down Court Road
Doddington
Sittingbourne
Kent - ME9 0AT

**For the attention of Mr K Attwood**
(by email: kda@downcourt.co.uk)

Dear Sirs,

**Re: Preliminary Land Gas Monitoring at: Land off Shawstead Road, Hale, Kent, ME5**

**This is an updated report that supersedes our land gas monitoring letter report, dated 11th June 2019. (STL ref: J13752 – Preliminary Land Gas Monitoring).**

We have pleasure in enclosing the results of 20 No. land gas monitoring visits carried out at the above site.

## 1 Background information

It is proposed to develop the subject site area of 48ha, currently comprising open agricultural land, with residential housing, schools and associated infrastructure.

The site has been the subject of a Desk Study & Preliminary Site Investigation report produced by Southern Testing (STL J13752, dated October 2018). The site investigation identified the site to be underlain by chalk bedrock, locally overlain with Clay-with-flints and Chalk Head superficial deposits.

The desk study identified a former landfill on land immediately to the east of the site. Reference with historical mapping and aerial imagery has suggested the landfill was operational for much of the twentieth century, before closure and incorporation into the nearby Capstone Country Park.

A preliminary programme of twelve land gas monitoring visits were undertaken at approximately fortnightly intervals between December 2018 and May 2019 to assess the potential for gas migration from this landfill source onto the subject site. The findings of this monitoring programme were summarised within our original Preliminary Land Gas Monitoring report, dated June 2019. Recommendations were made within this report for additional monitoring visits in order to comply with current guidance and to obtain the 'worst case' land gas scenarios, commonly experienced during periods of lower atmospheric pressure, typical of the winter months.

## 2 Risk Assessment

As identified in previous reporting, the source of potential gas generating ground that may impact the subject site is as follows:

- An adjacent former landfill site, in operation during the latter half of the twentieth century.

Five land gas monitoring wells (WLS1-WLS5) were installed on site during the preliminary site investigation (ref: STL J13752 Desk Study & Preliminary Site Investigation Report, October 2018) at regular intervals along part of the site's boundary with the former landfill. The number and spacing of these monitoring wells was specified by the client prior to the start of this initial investigation. The location of these monitoring wells can be found in Figures 2 & 3 in Appendix A.

In accordance with current guidance set out in BS8485:2015[1], twelve land gas monitoring visits were scheduled to be carried out over a period of six months, assuming a High development sensitivity of the site (residential with gardens) and Moderate land gas generation potential of the adjacent landfill source.

Southern Testing initially conducted a series of eight land gas monitoring visits over a period of four months. Based on the concentrations of land gases recorded within the wells during these visits, it was recommended that additional wells be installed and monitored during the remaining four scheduled monitoring visits.

An additional ten land gas monitoring wells were installed on site in April 2019 (WLS6 to WLS15). The additional well locations were selected with the aim to delineate areas of the site where concentrations of land gases may pose a potential hazard to the development, based on gas concentrations recorded during the initial eight monitoring visits.

Following completion of the initial monitoring period, it was recommended that a further eight land gas monitoring visits be carried out to allow for a total of twelve monitoring visits to be conducted on the most recently installed monitoring wells.

## 3 Results

A total of twenty land gas monitoring visits have been carried out for installations WLS1 to WLS5, with twelve in total for WLS6 to WLS15.

Monitoring visits were conducted over the end of winter and spring/ early summer months (December 2018 – May 2019) and late autumn/ winter (October 2019 – January 2020). Visits were conducted during periods of low and high atmospheric pressure.

The results of the programme of gas monitoring are summarised below. Full results of this monitoring programme can be found in Appendix B.

| | Borehole Gas Monitoring Results Summary | | | | |
|---|---|---|---|---|---|
| **Monitoring Well** | **WLS1** | **WLS2** | **WLS3** | **WLS4** | **WLS5** |
| **Monitoring Period** | 12/2018 to 05/2019 & | 12/2018 to 05/2019 & | 12/2018 to 05/2019 & | 12/2018 to 05/2019 & | 12/2018 to 05/2019 & |

| | Borehole Gas Monitoring Results Summary | | | | |
|---|---|---|---|---|---|
| | 10/2019 to 01/2020 | 10/2019 to 01/2020 | 10/2019 to 01/2020 2020 | 10/2019 to 01/2020 2020 | 10/2019 to 01/2020 2020 |
| **Response Zone/Stratum** | Chalk | Chalk | Chalk | Chalk | Chalk |
| **Evidence of contamination** | None | None | None | None | None |
| **No. of monitoring events** | 20 | 20 | 20 | 20 | 20 |
| **Methane % range** | 0 | 0-2.2 | 0 | 0-11.6 | 0 |
| **Carbon Dioxide % range** | 0.1-3.6 | 1.0-2.5 | 0-4.1 | 0-12.2 | 1.9-5.1 |
| **Oxygen % range** | 16.4-20.0 | 2.7-20.0 | 15.7-18.1 | 0-20.3 | 16.2-19.3 |
| **Flow rate l/hr range** | -0.9-2.4 | -4.5-2.1 | -3.0-2.0 | -3.7-80.7 | -1.3-3.4 |
| **BH Pressure range mb** | 0-6 | 0-5 | -13-0 | -15-23 | -6-6 |
| **Water level mbgl** | Dry | Dry | Dry | Dry | Dry |
| **Atmospheric pressure during monitoring mb** | 982-1023mb | 984-1022mb | 983-1023mb | 982-1022mb | 982-1023mb |

| | Borehole Gas Monitoring Results Summary | | | | |
|---|---|---|---|---|---|
| **Monitoring Well** | **WLS6** | **WLS7** | **WLS8** | **WLS9** | **WLS10** |
| **Monitoring Period** | 04/2019 to 05/2019 & 10/2019 to 01/2020 | 04/2019 to 05/2019 & 10/2019 to 01/2020 | 04/2019 to 05/2019 & 10/2019 to 01/2020 | 04/2019 to 05/2019 & 10/2019 to 01/2020 | 04/2019 to 05/2019 & 10/2019 to 01/2020 |
| **Response Zone/Stratum** | Chalk | Chalk | Chalk | Chalk | Chalk |
| **Evidence of contamination** | None | None | None | None | None |
| **No. of monitoring events** | 12 | 12 | 12 | 12 | 12 |
| **Methane % range** | 0-7.9 | 0 | 0 | 0 | 0 |

| | Borehole Gas Monitoring Results Summary | | | | |
|---|---|---|---|---|---|
| **Carbon Dioxide % range** | 0.7-5.1 | 0.9-2.8 | 0.7-4.5 | 0.5-2.5 | 0.3-3.7 |
| **Oxygen % range** | 2.1-20.5 | 17.3-20.8 | 8.0-19.8 | 17.1-20.2 | 15.1-20.0 |
| **Flow rate l/hr range** | 0-24.8 | 0-3.6 | 0-2 | 0-3.4 | 0-3.1 |
| **BH Pressure range mb** | 0-10 | 0-5 | 0-2 | 0-6 | 0-4 |
| **Water level mbgl** | Dry | Dry | Dry | Dry | Dry |
| **Atmospheric pressure during monitoring mb** | 984-1017mb | 985-1015mb | 985-1019mb | 985-1015mb | 985-1016mb |

| | Borehole Gas Monitoring Results Summary | | | | |
|---|---|---|---|---|---|
| **Monitoring Well** | **WLS11** | **WLS12** | **WLS13** | **WLS14** | **WLS15** |
| **Monitoring Period** | 04/2019 to 05/2019 & 10/2019 to 01/2020 | 04/2019 to 05/2019 & 10/2019 to 01/2020 | 04/2019 to 05/2019 & 10/2019 to 01/2020 | 04/2019 to 05/2019 & 10/2019 to 01/2020 | 04/2019 to 05/2019 & 10/2019 to 01/2020 |
| **Response Zone/Stratum** | Chalk | Chalk | Chalk | Chalk | Chalk |
| **Evidence of contamination** | None | None | None | None | None |
| **No. of monitoring events** | 12 | 12 | 12 | 12 | 12 |
| **Methane % range** | 0 | 0 | 0 | 0 | 0 |
| **Carbon Dioxide % range** | 0.5-3.4 | 0.5-2.8 | 0.6-4.3 | 0.3-2.7 | 0.1-2.8 |
| **Oxygen % range** | 18.0-20.1 | 2.7-20.4 | 16.0-20.2 | 17.6-20.2 | 16.4-20.4 |
| **Flow rate l/hr range** | 0-1.6 | -0.3-0 | -0.7-3.3 | -5.0-4.8 | 0-3.0 |
| **BH Pressure range mb** | 0-5 | -1-3 | -2-1.1 | -10-6 | -2-6 |
| **Water level mbgl** | Dry | Dry | Dry | Dry | Dry |
| **Atmospheric pressure during monitoring mb** | 985-1017mb | 985-1018mb | 984-1017mb | 984-1015mb | 984-1019mb |

A recording of 0% or 0l/hr indicates that the gas concentration/ flow rate is below the limit of detection of the gas analyser (<0.1% or l/hr).

## 4 Identified Gas Regime

A total of between 12 and 20 monitoring visits have been carried out within the monitoring wells on the site, during periods of both high and low atmospheric pressures. Elevated concentrations of methane and carbon dioxide have been recorded within four monitoring wells (WLS2, 4, 5 & 6) during the programme of land gas monitoring carried out to date. In the absence of identified sources of land gases on site, these recordings suggest that land gases are migrating onto site from an off-site source, likely from the adjacent landfill.

With one exception, monitoring wells where elevated concentrations of methane and carbon dioxide land gases have been recorded (WLS2, 4. 5 & 6) are situated in close proximity to one another adjacent to the sites eastern boundary with the landfill, to the south of Shawstead Road. WLS2, where a single slightly elevated methane concentration was recorded, is situated adjacent to the eastern boundary with the landfill on the northern side of Shawstead Road. Elevated concentrations of land gases have not been recorded within other wells on site, including within all wells located adjacent to the sites boundary with the landfill to the north of Shawstead Road, with the exception of WLS2.

Notably, elevated gas concentrations have not been recorded within the site, on the 'inner' line of wells (WLS7, 9, 10, 11, 13 & 14).

## 5 Discussion of monitoring results

Significantly elevated concentrations of methane (11.6%) and carbon dioxide (12.2%) were recorded within one monitoring well (WLS4) during a single monitoring event (06/03/2019). The flow rate within this well during this visit was recorded below the limit of instrument detection (<0.1 l/hr). This reading was recorded during the lowest atmospheric pressure conditions recorded during the monitoring programme (982mb). Concentrations of carbon dioxide recorded within WLS4 could be considered as slightly elevated during the majority of monitoring visits, when compared to concentrations recorded within other wells on site. Methane concentrations were recorded as slightly elevated during one other visit (2.4%), but were below the limit of instrument detection (<0.1%) during the other eighteen visits. Flow rates were generally recorded as negative or below the limit of detection, with the exception of one visit where a flow rate of 1.6 l/hr was recorded (28/01/2020) and one visit (02/01/2020) where a significantly elevated flow rate was recorded (see paragraph below but one).

Elevated methane (7.9%) and carbon dioxide (5.1%) concentrations were also recorded within WLS6 (04/04/2019), situated adjacent to WLS4, during a period of low pressure (987mb). A flow rate of 2.5 l/hr was also recorded during this visit. A flow rate of 0.8 l/hr was recorded during one visit (28/01/2020), whilst the remainder of the visits recorded flow rates below the limit of detection (<0.1 l/hr), with the exception of the recording of a significantly elevated flow rate during one visit (02/01/2020), as within WLS4 (see paragraph below). In light of the above, whilst a number of elevated gas concentrations have been recorded that indicate greater concentrations of gas may be migrating in the area of these wells, the absence of positive flow rates, with a few exceptions, indicates only localised gas migration within the area of these wells. This may not be representative of the site as a whole, based on the low gas concentrations recorded within the other monitoring wells on the site.

Significantly elevated flow rates were recorded within two wells (WLS4 - 80.7 l/hr & WLS6 – 24.8 l/hr) during one monitoring visit (02/01/2020). The recorded flow rates were significantly above those recorded within all other wells during this monitoring visit, where a mean flow rate of 0.6l/hr was recorded, excluding the two wells exhibiting significantly elevated readings. Additionally, flow rates were significantly above those recorded within WLS4 and WLS6 during all other monitoring visits, where mean flow rates of 0.2 l/hr in WLS4 and 0.4 l/hr WLS6 were recorded, again excluding the aforementioned elevated flow rates.

The monitoring visit on the 2nd January 2020 was conducted during a period of relatively high atmospheric pressure (1015mb). Whilst a slight drop in atmospheric pressure was noted in the three days preceding the monitoring visit, no significant atmospheric pressure fluctuations were noted around this time based on historic atmospheric pressure data available online[1]. This suggests that external factors, such as a rapid drop in atmospheric pressure, possibly creating the conditions for significant pressure differential, is unlikely to account for this discrepancy. Additionally, during monitoring visits carried out during periods of similar atmospheric pressure conditions, flow rates within these two wells were recorded below the limit of detection.

The conduction of the monitoring visits over many months, including during periods of high and low atmospheric pressures and with temperature variations has produced a comprehensive dataset that includes wide temporal variation. It is therefore considered reasonable to suggest that the two isolated elevated flow readings are unrepresentative of on-site conditions. Their use in calculating a 'worst case' gas screening value (GSV) would result in a disproportionally high gas hazard prediction.

## 6 GSV calculation

A hazardous gas flow rate has been calculated for each monitoring location and monitoring event, using peak values for methane and steady state values for carbon dioxide concentrations. This data has been tabulated and may be found in Table 1 in Appendix B of this report, together with the gas monitoring results.

Excepting the elevated flow recordings given the reasons set out in Section 4 of this report, the maximum calculated GSV's for both methane and carbon dioxide for individual well gas concentrations and flow rates during each monitoring event have been calculated:

The highest calculated GSV for Methane is: 7.9% (0.079) x maximum recorded flow rate (2.5 l/hr) = 0.20 l/hr (recorded within WLS6 – 04/04/2019).

The highest calculated GSV for Carbon Dioxide is: 5.1% (0.051%) x maximum recorded flow rate (2.5 l/hr) = 0.13 /hr (recorded within WLS6 – 04/04/2019).

'Worst case' gas screening values have also been calculated based on the highest recorded gas concentrations and flow rates taken from all wells across the entire monitoring period. A maximum flow rate of 4.8 l/hr has been used given the two significantly elevated flow rates discussed in Section 4 are considered unrepresentative. A maximum methane concentration of 11.6% and carbon dioxide concentration of 12.2% were recorded during the monitoring period.

Based on the results of monitoring carried out to date, the 'worst case' Gas Screening Value (GSV) for Methane is: 11.6% (0.116) x maximum recorded flow rate (4.8 l/hr) = 0.56 l/hr.

[1] Website: Weather Underground, Southend-On-Sea, England, United Kingdom Weather History. Accessed 27/02/2020. URL: https://www.wunderground.com/history/daily/gb/southend-on-sea/EGMC/date/2019-12-31

The 'worst case' Gas Screening Value (GSV) for Carbon Dioxide is: 12.2% (0.122%) x maximum recorded flow rate (4.8 l/hr) = 0.59 /hr.

Both the maximum calculated GSV's from each monitoring well/ event and the 'worst case' GSV's fall within the threshold for Characteristic Gas Situation (CS) 2 (GSV 0.07-<0.7 l/hr). When applied under the NHBC 'traffic light' system, whist falling within the 'Amber 1' category for methane and 'Green' category for carbon dioxide based on the calculated GSV's, significantly elevated concentrations of both methane (11.6%) and carbon dioxide (12.2%) recorded within one monitoring visit categorise the site as 'Amber 2', under the 'Typical Maximum Concentration' bounds. On balance, given that these two concentrations are considered outliers as discussed in Section 4, categorisation as 'Amber 1' is, on balance, considered appropriate for this site, based on the results of this monitoring programme.

Subsequently, based on the monitoring carried out to date, land gas protection measures will apply in the proposed development. In accordance with BS8485:2015[2], and assuming a 'Type A' building (P21, Table 3), the scope of gas protection measures should be such that the measures employed total a combined score of at least 3.5. The reader is referred to P23 of this document, which details common protective measures. If areas of the site are to be solely developed with other building types, the combined score may be revised as appropriate which may alter the scope of gas protection measures required.

## 7 Recommendations

The results of this monitoring programme suggest elevated concentrations of land gases migrating onto site from the landfill source are localised to areas of the site close to the boundary with the landfill. A reduction in concentrations recorded within wells set away from the boundary with the landfill indicates generated flow rates are insufficient to disperse gases as far as the wells set away from the landfill source. The absence of any elevated gas concentrations or flow rates recorded within the monitoring wells set away from the boundary with the landfill may allow for the 'zoning' of land gas protection measures on this site. The area where the incorporation of land gas protection measures in housing is recommended is shown in Figure 3 in Appendix A.

It is apparent from the proposed site layout plan provided to us for this investigation that a 'buffer' zone is proposed to be developed along the eastern site boundary. This buffer zone roughly corresponds with the area where the incorporation of land gas protection measures is recommended. If the proposed layout plan is to be altered and plots are to be constructed within the 'buffer' zone, the incorporation of land gas protection measures as detailed in Section 5 will be necessary. Additionally, the current proposed site layout plan indicates that the area of the site close to the southern end of the sites eastern boundary with the landfill appears to be intended to be open space. Should the proposed layout plan change and plots are to be constructed within this area, we would recommend further monitoring be carried out, given the slightly elevated concentrations/ positive flow rates recorded in this area, which may include the installation of additional monitoring wells to determine the distance onto site that land gases are migrating from the landfill source in this area.

We would note the importance of preventing additional migration pathways being established within the 'buffer' zone to limit the potential for migration from the landfill source onto site, for example, via the construction of gravel-filled soakaways or service corridors in this area. Notwithstanding the above, we would also advise that all properties on the site be provided with well ventilated floor slabs, as a minimum.

[2] The British Standards Institution BS8485:2015. Code of practise for the design of protective measures for methane and carbon dioxide ground gases for new buildings, June 2015

If you have any queries or we can be of further assistance, please do not hesitate to contact us.

Yours faithfully,

**J M Whibberley BSc MSc FGS**
For and on behalf of
Southern Testing Laboratories Limited
Email: jwhibberley@southerntesting.co.uk

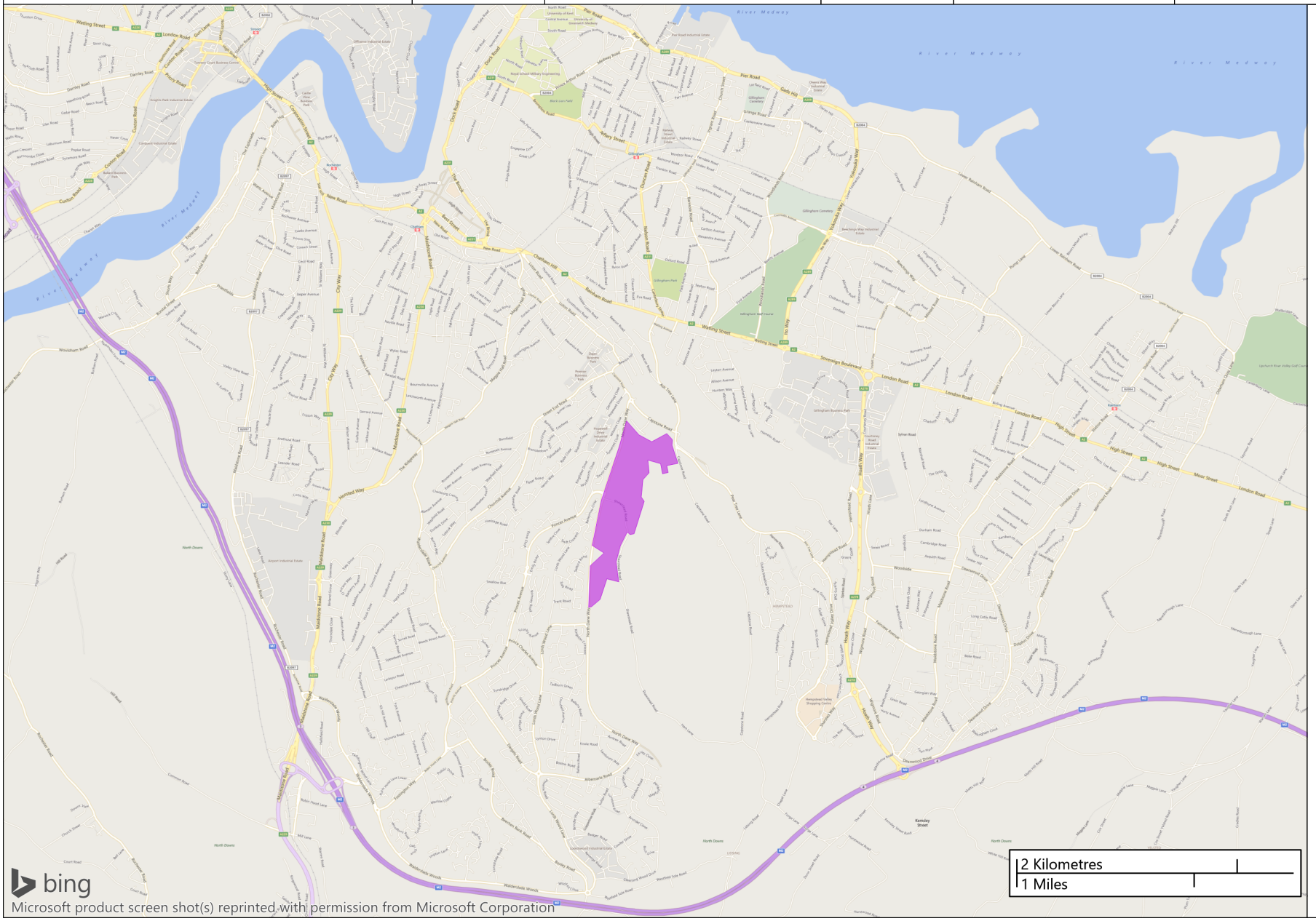
encs

# APPENDIX A

Site Plans and Exploratory Hole Logs

Southern Testing ST Consult

| | | | | |
|---|---|---|---|---|
| **Project Name:** | Land off Shawstead Road | **Project ID:** | J13752 | Site Plan Figure 1 |
| **Location:** | Hale, Kent | **Engineer:** | JMW | |
| **Client:** | KD Attwood & Partners | **Scale:** | 1:50000 | |




Legend Key

Project Bounds - Project Bounds