Total TPH was detected marginally above the withdrawn screening criteria of 10 µg/l in BH101 shallow and deep (ranging between 79.3 to 357 µg/l). The TPH fractions were at concentrations below published WHO TPH guidance values. Given that the groundwater in the eastern half of the site is mapped as an unproductive aquifer, a non-aqueous phase liquid (NAPL) was not identified and exceedances of WHO TPH guidance values were not reported petroleum hydrocarbons reported in BH101S/D are not considered to pose a significant risk to groundwater receptors.

Xylene was detected at concentrations above the published UK Minimum Reporting Value (MRV) of 3µg/l in BH101D and BH101S, higher concentrations were reported in the deeper monitoring well (BH101D) with concentrations ranging from 72.4 to 75.3 µg/l compared to 28 µg/l in BH101S.

BH101 is located beneath a former firewater runoff storage reservoir and to the north of a diesel storage area that has been remediated by others. The exploratory holes excavated by LEAP at BH101 and to the north, west and south of the location (TP145-TP146) did not describe the presence of NAPL, malodours or significantly discoloured soils that may be a source of the xylene present in groundwater at BH101D/S. MRV are used for the protection of groundwater as a long term drinking water resource, the eastern half of the site is highly unlikely to be used for potable water supply.

On the basis of the above, the xylene concentrations reported in BH101D/S are not considered to pose a significant risk to groundwater receptors on the basis that an ongoing source is unlikely to be present, the aquifer is of low sensitivity (mapped as an unproductive aquifer), and the absence of potable water abstractions / source protection zones in the vicinity of the site and the other deep monitoring wells did not detect xylene.

Benzo(a)pyrene was detected at analytical detection limit (0.01 µg/l) in BH101D/S. The low concentration of this polycyclic aromatic hydrocarbon is not considered to pose a risk to groundwater receptors.

In summary, a soil source of nickel, PHC, xylene or benzo(a)pyrene was not identified in the locations where exceedances of groundwater Tier 1 screening criteria were identified. Although present in groundwater the risk is not considered significant to offsite groundwater receptors and groundwater remediation is not proposed.

We note that there are no published UKDWS for phenol, however phenol was reported at elevated concentrations in BH101D in all three monitoring rounds. It was not detected in shallow groundwater at BH101S. An onsite source of the phenol was not identified during this investigation and the risk to groundwater is not considered significant.

33.2.2 Surface Water

The CSM did not identify plausible groundwater contaminant source pathway linkage to offsite surface water receptors, with the exception of a possible preferential pathway via surface water drains that extend through the eastern half of the site and connect to the Horsham Pond ~800m to the southwest of the site.

An assessment of the connectivity between shallow groundwater and the surface water drains is beyond the scope of this assessment. The presence of significant surface water drainage and historic drainage channels taking upstream waters across site and towards the pond should be the subject of further investigation, firstly to ensure the continued integrity of the system and also to assess whether leakages are contributing to the groundwater issues noted in the east of the site.

33.3 Land Gases

Adopting the methods described in 29.3, Gas Screening Values (GSV) per monitoring well location have been derived, using the highest gas concentration and flow readings. Negative flow readings have not been considered, as they are judged unrepresentative of a worst case, on the basis that the highest inflows were short duration and recorded in flooded wells during periodic monitoring events and as such are considered likely to be an artifact of pressure change when the gas valve was opened rather than of land gas generation.

Where negative flows or no flow have been measured the instrument detection limit (0.1 l/hr) has been used, where no methane is detected a concentration of 0.1% is assumed (the detection limit of the equipment used by LEAP.

Table 26: Preliminary Gas Screening Values

Location	Maximum reported values			Gas Screening Value L/hr	
	Carbon dioxide %	Methane %	Peak Flow L/hr	Carbon dioxide	Methane
WS102	1.1	0.1	0.3	0.0033	0.0003
WS103	0.8	0.1	13.7^^	0.1096	0.0137
WS105	8.6	0.1	0.1	0.0086	0.0001
WS106	1.7	0.5	3.8	0.0646	0.019
WS108	3	0.1	4.1^^	0.123	0.0041
WS109	0.5	0.3	0.1	0.0005	0.0003
WS111	0.1	0.2	0.4	0.0004	0.0008
WS113	0.1	0.2	0.8	0.0008	0.0016
WS115	0.1	0.2	17.1^^	0.0171	0.0342
WS116	0.7	0.2	0.1	0.0007	0.0002
WS118	3.6	0.2	66.6^^	2.3976	0.1332
BH101S	0.1	0.2	0.3	0.0003	0.0006
BH103S	1.2	0.2	0.1	0.0012	0.0002
BH106	13.6	0.1	104	14.144	0.104

^^ from a flooded well; green shading is GSV <0.07 (CS1 very low risk or green NHBC); orange shading GSV >0.07 to <0.7 (CS2 low risk or Amber 1 NHBC); dark orange shading >0.7 to <3.5 (CS3 moderate risk or Amber 2); red shading >3.5 to <15 (CS4 moderate to high risk or red NHBC)

The land gas readings from the majority of the monitoring locations are classified as CS1 very low risk or green under NHBC. WS103, WS108 and WS118 have been classified as CS2 or CS3 on the basis of the high flow rates recorded in the monitoring wells, these high flows were measured from flooded wells.

BH106 is classified as CS4 moderate to high risk or red under NHBC based on the high flow rates and elevated carbon dioxide initially reported in January 2021, prior to the planned gas monitoring rounds.

Section 6.3.6 of BS8485:2015 +A1:2019 states that where water is above the top of the response zone any peak flow is likely to be due to a build-up of pressure caused by rising water trapping the gas within the solid section of the pipe and the initial peak is not representative of the rate of gas generation within the ground. On this basis, we have re-assessed the GSV using steady-state flows or peak flows recorded when the response zone was not flooded for WS103, WS108, WS118.

The revised GSVs WS103, WS108 and WS118 are provided in Table 27, below:

Table 27: Revised Gas Screening Values for WS103, WS108 and WS118 only

Location	Maximum reported values			Gas Screening Value L/hr	
	Carbon dioxide %	Methane %	Peak Flow L/hr	Carbon dioxide	Methane
WS103	0.8	0.1	0.6^	0.0048	0.0006
WS108	3.0	0.1	0.1$$	0.003	0.001
WS118	3.6	0.2	0.1$$	0.0036	0.002

^ from an unflooded monitoring round;$$ steady state; green shading is GSV <0.07 (CS1 very low risk or green NHBC); orange shading GSV >0.07 to <0.7 (CS2 low risk or Amber 1 NHBC); dark orange shading >0.7 to <3.5 (CS3 moderate risk or Amber 2); red shading >3.5 to <15 (CS4 moderate to high risk or red NHBC).

With the exception of BH106 the land gas classification for the site is CS1 very low risk or green following NHBC. This classification is consistent with the findings of the ground investigation in that no significant on site land gas generating sources were identified such as deleterious material, paper etc. Some areas of made ground deeper than 2.0 m were identified across the site, but these locations largely comprised demolition rubble, which is not typically associated with having a high land gas generation potential. Carbon dioxide peaks shown in WS105, WS108 and WS118 are likely related to microbial respiration of organic matter in soil, which typically have low to zero methane concentrations and flow.

BH101S is the closest onsite monitoring well to historical infilled clay pits, which are within 60 m of the well. BH101S is also located in an area of deep made ground. Carbon dioxide and methane were not detected at concentrations that would indicate a significant land gas risk from the deep made ground at the location or from the backfilled historical clay pits to the south.

With respect to the offsite sources (railway lines / commercial land to the east) BH101S, BH103S and WS116 did not identify elevated concentrations of land gases that would pose a risk to the proposed development.

With respect to BH106, high gas flow rates (104 l/hr) and 13.6% carbon dioxide were recorded in January 2021 soon after the well was installed. At the time of this initial reading gases were visible around the anulus of the standpipe i.e. gas bubbling through standing water within the headworks. Subsequent gas monitoring rounds at BH106 recorded steady state flow rates between 2.8 to 7.2 l/hr with a peak flow rate of 52l/hr noted on the last monitoring round. During planned monitoring events carbon dioxide has periodically been detected at concentrations between 0.1% to 8.1%. Methane has not been detected above threshold concentrations in BH106. Carbon monoxide of 32 ppm was detected on one occasion.

The response zone for BH106 is installed from ~11 m to ~20 m below ground level in the Tunbridge Well Sand Formation. No land gas sources for the BH106 have been identified on site that would account for the flow rates reported in January 2021. LEAP has discounted the shallow made ground in the vicinity of BH106 as being a significant land gas generation source on the basis that shallow monitoring wells installed at WS106, WS103 and WS105, within, 2 m, 35 m and 30 m respectively did not record flow rates or carbon dioxide concentrations in the same range as BH106. Made ground thicknesses at these locations ranged from 0.40 m (WS105) to 1.70 m (WS103) and was described largely as demolition rubble with brick, concrete and clinker fragments i.e. typically low land gas generation potential. No visual signs of large amounts of deleterious organic material are reported in or around these locations. From ~2.0 m below ground level the bedrock of the Tunbridge Well Sand Formation is present.

Offsite, approximately 28 m north of BH106 a 225 mm diameter foul sewer is present aligned east to west along Parsonage Road. LEAP consider it unlikely that accidental leakages from the sewer could have percolated through the bedrock to 11-20 m depths, and degraded to cause a trapped pocket of land gases resulting in flows of 104 l/hr. Further, during monitoring rounds hydrogen sulphide and methane (which are typical components of sewer gases) were not detected. No odours, sheens or significantly discoloured water was observed during water sampling at this position.

During drilling no voids or below ground service strikes were recorded that may account for the flow rates and carbon dioxide, although we cannot discount that a ruptured compressed air line is present at depth, noting that these were used at part of the pharmaceutical works infrastructure. The initial very high flow rates were noted following a period of heavy rainfall and it was initially supposed that the flows may be generated as an artifact of water flow through the permeable made ground layer creating flows. However, significantly reduced, but still elevated flow rates have been recorded in the subsequent monitoring visits during periods of dry weather.

It is possible that BH106 has punctured a localised a pocket of gas generated from degradation of organic material at depth in the sandstone layer (lignite noted on log at ~10 m bgl), although the flow rates would also be considered unusual for this type of source. The peak flows noted in January may have been the trapped source degassing with force and as pressures equalised the flows have reduced. Once the initial source has been depleted it is not expected to pose an ongoing risk, as microbial degradation of this material will not generate high flows or gas concentrations in the timeframe that properties will be present.

Notwithstanding the above, further investigation and land gas assessment is recommended at BH106 to determine the risk to the proposed development.

34 Geo-Environmental Conclusions

On the basis of the non-targeted ground investigate, made ground was found to generally extend up to 1-2 m in thickness, with deeper areas up to 4m in the east, and is locally impacted with asbestos, arsenic, lead, nickel and benzo(a)pyrene. This is similar to the findings of the previous ground investigations that targeted potential sources of contamination. Made ground soils pose a potential risk to future land users from direct contact and ingestion pathways i.e. in soft landscaped areas.

Access to areas to the north and south of the retained building were limited due to below ground services. The desk study highlighted the potential for a groundwater interceptor to be present to the immediate south of Building 3/36 and fuel tanks to the southwest (anecdotally reported to have been decommissioned).

Xylene was recorded in deep groundwater and shallow groundwater in BH101 at concentrations above published MRVs for groundwater. In the areas investigated by LEAP a potential hydrocarbon source was not identified. Xylene was not considered to pose a significant risk to groundwater receptors, that warrants remediation. Phenol was detected in the deep monitoring well at BH101 during all monitoring rounds and in BH105 in the last round. Phenol does not pose a risk to offsite groundwater receptors for the reasons highlighted for xylene in section 33.2.1.

However, a preferential pathway may exist via the existing surface water drains and historical ditches that extend through the site. A 2018 CCTV found sections of the surface water drains potentially damaged.

An assessment of the potential risk to the Horsham Pond from the surface water drains that extend through the site was beyond the scope of our appointment but should be the subject of further investigation, including inspection of the integrity of the drains as well as laboratory testing of the water quality within the drains as they enter and exit the site.

Based on gas monitoring undertaken to this date, the site gas regime is currently assessed as CS1 for the majority of the site, with the exception of elevated gas flows and carbon dioxide emanating from BH106. Areas identified as potential land gas sources (deep made ground / infilled clay pits) a land gas risk was not identified.

It is recommended to extend the gas monitoring within locations which detected the elevated concentrations of carbon dioxide and carbon monoxide (BH106, WS103, WS105 and WS106) via the means of continuous monitoring and chemical gas bulk sample analysis. This would provide more information on the true nature and the potential source of the released gases at BH106 and hence the residual risks, if any, to the proposed properties in this part of the site.

35 Waste Disposal

It is anticipated that the proposed development will generate waste soils and materials will need to be removed from site as part of the construction process.

Where soils are to be disposed off-site, it is the duty of the waste producer, in this case the developer, to ensure that all waste is disposed of appropriately and that any that is sent to landfill is sent to an appropriately licensed one. All waste sent to landfill must be classified and must be pre-treated. There are various forms of pre-treatment that are acceptable. In this case it could include "reduction in volume", which could be achieved by segregating the Made Ground and re-using part of it on site.

Where made ground soil is to be re-used on site then it is recommended that this is carried out under the CL:AIRE Definition of Waste Industry Code of Practice (DoWCoP) for re-use of soils[31].

Sixty-six soil samples were preliminarily assessed for waste classification purposes using HazWasteOnline© screening tool and the results are presented in Appendix J. It is considered that the made ground soils would be classified mainly as non-hazardous for waste disposal purposes, but localised areas hazardous material due to heavy metals, TPH and benzo(a)pyrene cannot be discounted. The non-hazardous threshold for TPH (1000mg/kg) was exceeded in the made ground sample at WS102 0.2m and TP112 at 0.1 m. We note that benzo(a)pyrene:TPH ratio is <1000:1 in WS102 at 0.2 m. Hazardous waste concentrations for

31 The Definition of Waste: Development Industry Code of Practice. Version 2 2011. CL:AIRE

TPH and benzo(a)pyrene levels were also encountered in the made ground at WS105 0.25m. The heavy metal threshold was exceeded in made ground fill sample encountered below the blacktop and concrete hardstanding at TP112 0.35m. Where asbestos fragments are identified they would be classed as hazardous waste. Twelve soil samples were recorded as hazardous waste due to pH concentrations reported above 11.5 pH units. This may be due to concrete in the sample producing an alkaline test result and not a true reflection of the soil pH.

Eight samples were tested for waste acceptance criteria to indicate whether it will be accepted at landfill. This indicates the waste would be accepted mainly as non-hazardous with potential inert acceptance of segregated natural and reworked natural soils. However, it is recommended that this is confirmed with the haulier and the receiving waste management site.

Further testing and inspection of soils will be required to confirm waste classification of material leaving the site. A watching brief ensuring previously unencountered asbestos is not removed as non-hazardous waste is recommended.

It is strongly advised that detailed discussions be held with remediation/groundworks contractors and that receiving landfill sites are identified in advance of commencing any waste removal.

36 Recommendations for Remediation

The risk driver for remediation is exposure of future site users to heavy metals, benzo(a)pyrene as well as remaining potential for asbestos to be encountered within the made ground. The pathway for impact to future users is direct exposure to the outlined contaminants.

Where soft landscaping is proposed in areas of made ground then remedial works will be required to prevent potential risks to future land users. Where hardstanding is proposed this will break contaminant linkages and remedial measures will not be required.

In private garden areas, where made ground is present a capping solution comprising 600mm of verified clean cover material, including a minimum of 150mm topsoil, and clean corridors for service runs would act to break the pathway of exposure and render the material suitable to be reused on the site. Depending on the final development levels, this may require material to be removed and disposed off-site. Given the potential presence of asbestos, it is recommended that the formation level is inspected to confirm ground conditions prior to placement of capping layer. A visible marker layer (geotextile membrane) should be considered where made ground remains at formation level. Where asbestos containing materials are suspected at formation level further excavation may be required and/or the placement of a 150 mm hard to dig barrier in addition to the geotextile membrane. In public open space / commercial soft landscaped areas the thickness of capping material may be reduced to 300 mm thick. Clean cover thicknesses should be extended to 900 mm depths if new trees are proposed or to 450 mm where shrub planting is proposed. Clean cover systems should be made with reference to CIRIA Special Publication 124:1996 *Barriers, liners and cover systems for containment and control of land contamination.*

Remedial measures for proposed soft landscaping use are not required where natural soils are present.

Surveying and sampling of the surface water drains along the north-eastern boundary (where they enter the site) and along the southern boundary (where they exit the site) should be undertaken to confirm the integrity of the drainage system and the quality of water discharging through the site drains.

Access into the areas north and south of the retained building and along of the southern boundary from the centre towards the south east corner was restricted due to present limited space, proximity to the railway lines, hardstanding and services. It is recommended that once hardstanding has been removed and it is safe to dig without risk of damage to services, formation inspections by a competent environmental engineer with possible further intrusive investigations are undertaken within these locations.

The presence of asbestos within the made ground has been detected in this and previous investigations. Groundworks should be carried out following suitable health and safety protocols, for example, dust suppression measures and reassurance monitoring, as required.

The works should be planned with reference to the Joint Industry Working Group Asbestos in Soil and Construction & Demolition (C&D) Materials guidance titled "Control of Asbestos Regulations 2012: Interpretation for Managing and Working with Asbestos in Soil and Construction & Demolition materials: Industry Guidance (CAR-SOIL^{tm}).

37 Validation of Remediation

A final remediation method statement will be required to be prepared once the final site designs are complete. This method statement should be submitted to the appropriate regulatory authorities. It is advised that the local authority are advised of the intended build programme in order that they can phase the sign off of planning conditions as required.

The remediation strategy will require the importation of clean topsoil, and possibly subsoil. Imported soils should be tested at source by the supplier. The validation engineers should then make spot checks as and when necessary once material has been imported.

Provision should also be made for dealing with further localised hotspots of contamination which may come to light during construction. Any such soils should be inspected by the validation engineers and appropriate remedial action taken as necessary.