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CONSULTING

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<i>Plan Reference</i>	<i>Revision</i>	<i>Title</i>
GRO-21459-P01	-	Project Location Plan
GRO-21459-P02	-	Excavation Progress Plan
345/30/09/22	B	As Built Topographical Survey

1.0 INTRODUCTION

1.1 Objectives

This verification report has been produced by Groundtech Consulting on behalf of Urban Regen and relates to the general physical preparation of area in accordance with the outline Remedial strategy produced by Smith Grant LLP and the suitability of the underlying soils in Phase 1B with regard to hazardous ground gases.

1.2 Proposed Works

Phase 1B is to be developed by a different housebuilder for the same residential end use, it is intended to handover with the pre-construction remediation measures already completed and ready to commence construction. A developable platform levels plan is presented in the table below.



1.3 Previous work

Smith Grant LLP have previously produced a Supplementary Site Investigation Report referenced R2174c-R02 dated June 2020 which should be read in conjunction with this verification report.

2.0 OVERVIEW OF PREVIOUS WORK

A Supplementary Site Investigation Report has been carried out by Smith Grant LLP for Phase 1B, referenced R2174c-R02, dated June 2020.

Methodology

Post remediation vapour and gas monitoring was undertaken at the site to better characterise the ground gas and Volatile Organic Compound (VOC) vapour regime due to limitations within the previous investigation including the density of the monitoring wells and duration of the monitoring period.

Five windowless sample boreholes (WS306, WS313, WS314, WS315a and WS316) were installed to 5.0m bgl (or refusal) within Phase 1B, details regarding the well construction are presented in the below table:

Monitoring Installation	Response Zone Range (m bgl)	Response Zone Target Strata
WS306	1.0 – 4.0	Granular Made Ground / Superficial Cohesive Till
WS313	1.0 – 4.0	Superficial Cohesive Till
WS314	1.0 – 2.0	Granular Made Ground
WS315a	1.0 – 3.0	Cohesive Made Ground / Superficial Cohesive Till
WS316	1.0 – 2.0	Granular Made Ground

Results

All of the monitoring wells has no detectable flows or changes in pressures relative to atmospheric pressure over the course of all the monitoring visits undertaken. Relatively high negative relative pressures and flows were recorded within WS306.

Methane was recorded at a maximum concentration of 16.7% in WS316, with lower maximum concentrations of 5.2% in WS306. The remaining monitoring installations were recorded at concentrations less than 1%.

Carbon dioxide was more widespread across the area and was recorded in most installations at maximum concentrations of between 1%v/v and 8%v/v.

CIRIA C665 Characteristic Situations and NHBC “Traffic Light” classification systems were used to assess the methane and carbon dioxide concentrations of the monitoring standpipes installed across the Phase 1B. A summary of the permanent ground gas results is presented in the below table:

Monitoring Installation	No. Visits	Max CH ₄ (%)	Max CO ₂ (%)	Max Flow (l/hr)	CH ₄ GSV (l/hr)	CO ₂ GSV (l/hr)	CIRIA Characteristic Situation	NHBC Traffic Light
WS306	9	5.2	0.5	<0.1	<0.07	<0.07	CS2	Amber 2
WS313	10	0.3	8.0	<0.1	<0.07	<0.07	CS2	Amber 1
WS314	10	<0.1	2.0	<0.1	<0.07	<0.07	CS1	Green
WS315a	7	<0.1	0.2	<0.1	<0.07	<0.07	CS1	Green
WS316	10	16.7	5.9	<0.1	<0.07	<0.07	CS2	Red

Due to the previous historic use of the site and pockets of Made Ground present across the site as a whole Amber 1 gas precautions are to be installed in all of the plots as standard. However, the elevated carbon dioxide and methane concentrations recorded within WS306 and WS316 exceeded the typical maximum concentrations permitted for CS2/Amber 1 conditions and NHBC Amber 2/NHBC “Red” conditions prevailed in the areas respectively. Further risk assessment or remediation was required in respect to the Amber 2 and Red Conditions.

Conclusions

Based on the generally low risks indicated by the depths of Made Ground and lack of indicators of degradable organic materials, the completed monitoring programme of 6 to 10 visits, including reasonable worst-case atmospheric conditions is deemed sufficient to assess such risks. The data indicates that gas protection measures designed to comply with CIRIA Characteristic Situation 2 or the NHBC Amber 1 classification are appropriate for the majority of Phase 1B.

The exception to this is in the vicinity of WS306 and WS316 where more elevated methane concentrations required further investigation, assessment or remediation to determine the appropriate level of gas protection.

Hydrocarbon VOC vapours were present in all monitoring wells at concentrations below conservative screening criteria used to indicate potential risk.

The selective excavation of soil sources at identified hotspots (including any others encountered during the works) and provision of a soil cover system and ground gas/vapour protection measures will adequately manage risks to the health of future residents of the area, although further assessment of risks from methane were required in the area of WS306/WS316.

Recommendations

The below recommendations were presented to progress the project onto the construction phase with regards to hazardous ground gases in Phase 1:

- *The area in the car park associated with the elevated methane readings in WS306 & WS316 will undergo excavation to natural strata to investigate the source of the high concentrations. Potential sources will be examined and classified with respect to the proportions of degradable organic matter and laboratory tests for total organic matter undertaken. It is envisaged that a process of segregation and screening of materials will be used to remove the gas source, and that depending on the level of confidence achieved with respect to source removal, further post remediation gas monitoring will be carried out in this area to confirm conditions prior to construction.*
- *The observations and testing results from these exercises and the general inspections of the preparatory earthworks within Phase 1B will be compiled into an enabling remediation earthworks verification report for issue to the regulators for approval. This will confirm the construction-stage mitigation measures required to manage residual risks to human health.*
- *All areas outside the those requiring VOC resistant membrane (and the area of WS316/WS306 which is to be confirmed) will require CS2 / NHBC Amber 1 gas protection measures as a precaution based on the gas monitoring undertaken. When combined with the high performance open sub-floor void, these will also supply a suitable degree of protection from the low-level VOCs detected outside the VOC impacted areas. All Gas / VOC membranes across Phase 1 are to be verified in accordance with a verification plan, with integrity testing for the VOC membrane only, in accordance with the provisions of CIRIA C735: "Good Practice on the testing and Verification of Protection Systems for Buildings Against hazardous ground gases".*
- *Details of the design, specification and verification plan for the gas protection measures for the gas protection should be finalised following completion of the Phase 1 preparatory earthworks and interpretation of the validation data for the hydrocarbon hotspot removal and the assessment of the car park methane sources and provided to BMC for approval in advance of construction.*

- *Outside Phase 1, in the higher risk parts of the site, additional investigations based on the same principals as those described in this report are required, in addition to the comprehensive groundwater monitoring programme and controlled waters risk assessment. These will be completed as demolition and enabling works progress but the presence of residual sources outside of Phase 1 is not considered sufficient to constrain preparation of this area, or commencement of development.*

3.0 VERIFICATION

3.1 Remediation Objectives

The objective of this document is to verify that the remedial recommendations set out in *R2174-R01-v2* have been adhered to with respect to the removal of any potential sources of permanent ground gases and provisions of the outline remedial specification including a 600mm soil cover in future gardens, asbestos screening of surface aggregate layer, inspections of uncharacterised sources and the removal of any potential obstructions. This Remedial Verification Report is based on the results of the validation visits between 14th February 2022 and 22nd April 2022.

3.2 Validation Works

Groundtech Consulting visited site on thirteen separate occasions between 14th February 2022 and 22nd April 2022 to observe the removal of the Made Ground and natural soils as part of the reduced level dig and ensure the removal of any potentially hazardous soils with respect to permanent ground gases (Methane/Carbon Dioxide).

Potential sources of ground gas were observed in both the Made Ground and underlying natural soils, the most prominent source comprised the old reservoir bed which had moderate organic content and occasional wood fragments, details of the remedial works undertaken and the soil populations removed are presented in the subsequent sections. The dates and areas where the reduced level dig was progressed is presented on the Groundtech *Excavation Progress Plan - GRO-21459-P02*.

3.2.1 Verification Visit on 14th February 2022

Groundtech Consulting visited site to observe the beginning of the reduced level dig. Stockpile removal and vegetation clearance was observed pre-commencement of the works starting.



Photograph 1 – Western extent of reduced level dig.

The topsoil and spoil heaps were removed to Phase 2 prior to the reduced level dig and stockpiled for reuse as part of the residential development onsite.



Photograph 2 – Stockpile/vegetation clearance at former car park area.

3.2.2 Verification Visit on 16th February 2022

The following visit was undertaken to observe the initial excavations at the western extent of site for any sources of permanent ground gases. Natural soils were encountered with no evidence of organic contamination at this position.



Photograph 3 – Stockpile/vegetation clearance at former car park area.

3.2.3 Verification Visit on 21st February 2022

The reduced level dig was progressed from the previous visit and excavation into the natural cohesive soils at the western end of site was undertaken.



Photograph 4 – Excavation of overlying vegetation at western site boundary.

All soils excavated from the ground were inspected for evidence of a ground gas source, no evidence of a was noted at the extreme western end of site within the Made Ground or reworked clay to formation level (circa 4m bgl).



Photograph 5 – Excavation into reworked clay at western extent.

Several trial pits were undertaken to determine the source of contamination and a potential source was noted within the Made Ground in the form of slightly clayey silty slightly gravelly sand with minor constituents of wood and a mild organic odour.



Photograph 6 – Possible evidence of source of methane located within Made Ground.

All soils which contained putrescible or organic material and posed a potential source of ground gas generation were segregated, removed from Phase 1 and stockpiled at a secure position in the Phase 2 area separate to the 'clean' material identified for reuse within the earthworks exercise, as agreed with Urban Regen. Site personnel were made aware of the material to be removed and additional visits were arranged to ensure the correct material is being removed and for any further evidence of a ground gas source.

3.2.4 Verification Visit on 24th February 2022

Groundtech Consulting visited site on 24th February 2022 to inspect the progress of the reduced level dig and the below was noted.



Photograph 7 – Progress of reduced level dig.

The majority of the western area had been excavated down almost to formation level as shown in the photograph above, reworked clay is present at this depth with no evidence of organic materials/silt present. Visual and olfactory evidence of possible permanent ground gas sources were noted within the Made Ground in the form of high organic content and a mild organic odour. These soils were stockpiled separately in Phase 2 for evaluation on reuse dependant on the results of additional geo environmental testing.



Photograph 8 – Cross profile from existing level to formation.

The reduced level dig is set to continue with Groundtech Consulting undertaking frequent visits to monitor the progress and observe the underlying soils for potential sources of ground gas.



Photograph 9 – Excavation at western extent.

Thin bands of organic material show near the surface bands of organic material (photograph 9) which was removed from Phase 1B and stockpiled in Phase 2 as the reduced level dig was progressed down to formation level.

3.2.5 Verification Visit on 3rd March 2022

The following visit was carried out to observe the progress of the reduced level dig.



Photograph 10 – Excavation of reworked clay and reduced level dig progress west.

No evidence of sources of ground gases such as silt/organic material was identified as part of the excavation with the exception of some evidence of relict topsoil present at circa 2m bgl within the Made Ground likely to be associated with the former reservoir. The areas of relict topsoil were observed across centre west of site near the position of WS316 which has been previously classified as CS2/Red. The soils containing the organic material were removed from Phase 1B and stockpiled separately in Phase 2 alongside the other soils which contained potential sources of ground gas generation. The above is presented spatially on the Groundtech Excavation Progress Plan which outlined the postulated extent of the former reservoir and locations of the previously installed Gas monitoring wells.



Photograph 11 – Evidence of possible sources of methane contamination.

Additional evidence of organic containing material was observed within the deeper areas of Made Ground and is presented in *Photograph 11* above which was taken prior to stockpiling the material in Phase 2. The organic material is considered to be a source of ground gases associated with the former reservoir and the subsequent backfill prior to the development of the car park.



Photograph 12 – Reduced level dig progress.

3.2.6 Verification Visit on 9th March 2022

During this visit, the reduced progress of the reduced level dig was observed further.



Photograph 13 – Northern extent of reduced level dig including area of hydrocarbon contamination.

An area of possible hydrocarbon contamination has been identified in the northern extent of the reduced level dig area and is a possible source of methane. When excavated all soils which contained either visual or olfactory evidence of hydrocarbon contamination were removed and stockpiled separately from the soils which were identified on being a potential gas source based on organic content. The hydrocarbon impacted material was stockpiled in the soil quarantine/treatment visqueen bunded area in Phase.

Evidence of an oily sheen was present within areas of perched Made Ground at formation level at this position in the vicinity of WS306 which was classified as CS2/Amber.

The locations where hydrocarbon contamination was encountered is presented on Groundtech *Excavation progress Plan GRO-2149-P02*. No wells are indicated to directly overlie the area of hydrocarbon contamination however WS306, WS316 and WS315a are all situated very close to the affected areas and did not indicate elevated VOCs implying non-volatile fractions.



Photograph 14 – Natural clay present at formation level (possibly reworked).

The majority of soils had been excavated laterally from the western boundary near to the east, however formation depths vary across the Phase 1B, and some minor areas of further excavation were still required. Furthermore, areas with deeper Made Ground have been excavated and removed to Phase 2 to ensure natural strata is present at the formation depth. In areas where this is not possible, the remaining in-situ Made Ground is reworked Clay with no evidence of organic contamination.



Photograph 15 – Western site boundary with soils at near proposed formation level, some small areas of Made Ground still present at surface level.

3.2.7 Verification Visit on 16th March 2022

The purpose of this visit was to observe the reduced level dig and excavation of soils to formation level.



Photograph 16 – Northern extent of reduced level dig.

The reduced level dig has progressed further to the north since the previous visit, no additional evidence of ground gas sources had been recorded at the site within the natural Clay. Some evidence of silt bands and relict topsoil have been observed beneath the reworked Clay, these soils have been removed and stockpiled separately to the clean material as discussed with Urban Regen.



Photograph 17 – Evidence of hydrocarbon contamination.

Made Ground has been identified at areas of formation level including in the area of hydrocarbon contamination which may have migrated into the underlying natural Clay. Trimming of this area was undertaken to ensure natural ground with no organic content/silt is present at the proposed formation level due to its proximity to WS306 which has recorded high methane levels during previous ground gas monitoring.



Photograph 18 – Possible sources of methane stockpile.

3.2.8 Verification Visit on 22nd March 2022

Groundtech Consulting site on 22nd March to observe the progress of the reduced level dig and investigate the soils at the proposed formation level.



Photograph 19 – Pocket of deeper Made Ground.

Instances of Made Ground and silt were identified at the proposed formation level. This visit included removing any remaining areas of silt or deeper Made Ground/reworked ground to natural soils.



Photograph 20 – Pocket of deeper Made ground & northern area (background) still to be excavated.

3.2.9 Verification Visit on 31st March 2022

The purpose of this visit was to remove any areas of Made Ground or silts at proposed formation level.



Photograph 21 – Natural (possibly reworked) clay beneath containing some bands of silt (black material)

Areas across the site were excavated to a maximum depth of 0.25m bgl and all suitably clean material was stockpiled separately for reuse. The silt bands and organic Made Ground encountered in close proximity to the historic monitoring wells with high methane levels (WS306 & WS316) were placed within the potentially organic stockpile in Phase 2 and the areas with significant hydrocarbon odour were placed within the hydrocarbon stockpile also in Phase 2.

ToC testing is required to confirm the suitability of this material for reuse as part of the development on the site at Phase 2 and additional testing at the hydrocarbon stockpile is required when treated.



Photograph 22 – Made Ground present at proposed formation level.

No evidence of organic contamination was noted during the trimming of Made Ground to formation level. This material was chased out in the deepest area to determine the depth and influence on the high methane levels recorded by the previous Ground Investigation. The remaining silt bands/relict soil layers are thin and not considered to be the identified gas source or a viable gas source. CS2/Amber 1 gas precaution measures present as part of the development will be sufficient to mitigate the low risk.



Photograph 23 – Reworked clay and some areas of silt indicated at formation level.

3.2.10 Verification Visit on 12th April 2022

Groundtech Consulting visited site on 12th April 2022 to observe the trial pits undertaken by Curtins Consulting in Phase 1B to advise on geotechnical parameters for the proposed residential development.

Eight trial pits were undertaken across the area to depths of between 3.0m and 4.0m bgl and any evidence of potential organic/silt contamination was excavated from Phase 1 and stockpiled in Phase 2.



Photograph 24 – Trial Pit at western extent of site, no evidence of organic contamination recorded.

Evidence of potential ground gas sources was observed at shallow depths beneath the current site level in the form of a circa 200mm silt band which thins out to the east and west. This band is present below (circa 4.5m) the previous ground level prior to the reduced level dig and was not noted during the original visits. This material was excavated and stockpiled in Phase 2 with the previously excavated organic material.

The previous monitoring wells recording elevated concentrations are not present within the vicinity of the silt band and therefore it is not considered to be the likely source of methane production recorded in the monitoring wells.



Photograph 25 – Band of silt beneath reworked clay at centre of site.

Excavation of the remaining area of Made Ground was undertaken, specifically at the northern area. The Made Ground was generally inorganic with the exception of the centre section of site whereby large volumes of silt and wood were present accompanied by a moderate organic odour which thins out towards the centre of site where the 200mm band is present.

Deep Made Ground was also indicated in the eastern section of site at the position of the former pile foundations for the historic building, however a lack of organic material was observed in this area and no source of ground gas generation was identified.



Photograph 26 – Area of deep Made Ground in northern extent of site (to be excavated to formation level)

3.2.11 Verification Visit on 20th April 2022

This visit was carried out on 20th April 2022 to excavate the remaining areas of deep Made Ground, specifically the central western section comprising evidence of hydrocarbon and organic sources of contamination. The final extent of the hydrocarbon contamination was identified and a trench was undertaken to excavate the remaining hydrocarbon contaminated soils to remove the potential source of permanent ground gases. All soils excavated were transported and stockpiled in Phase 2. This excavation was targeted at the north western area of site which is located near WS306 where high methane levels were recorded and therefore is considered to be the source.



Photograph 27 – Area of deep Made Ground comprising hydrocarbon contaminated soils at northern extent.

Organic contamination present immediately south of the hydrocarbon soils were excavated and removed to Phase 2, with thin sporadic bands of silt still present in-situ at shallow depths. As discussed previously, the remaining silt bands/relict soil layers are not considered to be a viable gas source, CS2/Amber 1 gas precaution measures will be sufficient to mitigate the low risk.



Photograph 28 – Area of deep Made Ground comprising hydrocarbon contaminated soils at northern extent.

The small amount of silt recorded is at depths just below formation level in this area, the thickest extent of silt has been removed to Phase 2 and the remaining thin bands are not considered to be a significant source of methane. Furthermore, the silt in this area is not present within close proximity to the two monitoring wells (WS306 & WS316) which recorded high methane levels and therefore is not considered to be a major source of ground gas.



Photograph 29 – Deeper Made Ground with organic properties at the northern area of site – silt band thins out southwards.

3.2.12 Verification Visit on 21st April 2022

The purpose of this visit was to obtain samples of the potential sources of organic contamination present within the reduced level dig for soil reuse purposes as part of the development in Phase 2.



Photograph 30 – No evidence of organic material in pit to west.

Four trial pits were excavated within the centre of site spanning from the western boundary to the former pile foundations to the east. No evidence of possible organic contamination was indicated within the pits at the east and west, however localised areas of silt (circa 400mm to 600mm bgl) were indicated at the trial pits to the centre, and thins near the area of WS316 where high methane levels were recorded. The silt bands were excavated and removed during this exercise to the stockpile of organic material in Phase 2.



Photograph 31 – Trial pit to centre with limited silt detected.

The trial pit photographed above (*Photograph 31*) was excavated overlying the position WS316 where the highest methane concentrations were recorded, no direct source of organic contamination was recorded in the natural soils in this area, indicated that the likely source of the Ground gas was the overlying Made Ground (removed to Phase 2), the hydrocarbon impacted Made Ground to the south (removed to Phase 2) and the thicker silt band to the northeast (removed to Phase 2).



Photograph 32 – Rare sections of organic content present within reworked clay.

The underlying reworked clay has small inclusions of organic content, these are typically small in scale and highly localised, due to the above the reworked clay is not considered to be a relevant contributing factor to ground gas generation in Phase 1B.

3.2.13 Verification Visit on 22nd April 2022

This visit was undertaken to excavate and remove any remaining areas of hydrocarbons contamination and organic contamination in the northern area of site to Phase 2.



Photograph 33 – Pockets of silt/organic content within reworked clay.

Some organic material was recorded along the northern extent of the area in the form of silt pockets alongside organic material and is assumed to be associated with the backfill of the historic reservoir, this material is located circa 0.1 to 0.3m below current formation level and not considered to be the source of ground gas. Any material which was considered to be a significant source of ground gas generation based on composition and thickness was excavated and removed to the stockpile in Phase 2.



Photograph 34 – Small silt band chased out towards centre of site.

The remaining hydrocarbon contamination was excavated and placed with the hydrocarbon stockpile at Phase 2 and the organic material was stockpiled separately in Phase 2. Further evidence of a significant ground gas source was not observed with the only the localised smaller bands of silt beneath the reworked clay at the centre section of site being observed, these soils were largely removed but some small pockets may remain in-situ underlying the reworked clay in this area, as discussed the thin bands of Silt are not considered to be the source of ground gas and CS2/Amber 1 site wide precautions will mitigate the low risk.



Photograph 35 – Deeper Made Ground removed from ground along the northern boundary.

3.2.14 Verification Visit on 23rd September 2022

Groundtech Consulting visited site on 23rd September 2022 to observe the installation of the piling mat and roadway in Phase 1B. The levels at the site were excavated to formation and 'clean' natural soils were present at the surface, no evidence of Made Ground or organic soils remained with the exception of localised areas of thin silt bands present at the surface. These circa 100mm to 400mm silt bands have been mostly excavated and only small bands remain immediately beneath the surface. These are not considered to be a generating ground gas source.



Photograph 36 – Roadway at centre of site and imported 6F2 material (piling mat) beneath.

The photograph above illustrates the site formation level on completion of the excavation of the Made Ground and organic deposits. It can be seen that the piling mats have been constructed beneath the position of the plots and the central roadway has been civilised. No evidence of organic/hydrocarbon contamination is present, the ground gas sources have been removed and natural cohesive soils are at the surface of the site.



Photograph 37 – Eastern end of Phase 1B.

The eastern section of Phase 1B has yet to be completed to formation and the crushing of onsite 6F2 is ongoing for this position. It should be noted that no evidence of organic materials or Made Ground is visible including silt bands in this area.

3.2.15 Verification Visit on 24th November 2022

The final visit was carried out to observe the final level changes prior to the commencement of the build phase. The photographs below display the current level post excavation of the soils in the eastern area which have reduced the level to formation. Approximately 1060m³ of 6F2 material has been crushed onsite and placed at the position of the proposed plots and roadways.



Photograph 38 – Eastern section of Phase 1B.



Photograph 39 – Formation level.

3.3 Surface Aggregate Layer

Groundtech Consulting visited site on 4th May 2022 to undertake sampling of the recently generated 6F2 material in Phase 2 for asbestos screening purposes, associated with the development of a surface aggregate layer at formation level following the completion of the earthworks. Approximately 1060m³ of generated 6F2 material has been used as part of the piling mat and road capping, which has been tested at a minimum frequency of 'one sample per 500m³'. This is detailed in outline remedial specification carried out by Smith Grant LLP referenced R2174-R01-v2 and dated May 2019.

Asbestos testing was undertaken on six samples of the site generated 6F2 and asbestos was not detected in any of the samples screened. Therefore, the 6F2 material is considered suitable in accordance with the remedial specification. The result of the asbestos testing is presented in *Appendix 2*.

An As Built Topographical Survey plan of the Phase 1B area is presented in Drawing No. 345/30/09/22 Rev-B.

4.0 GAS ASSESSMENT

To date, Phase 1B has been reduced to formation levels with roadways and piling mats in position. Prior to the installation of the piling mats/roadways, the existing surface area largely comprised 'clean' reworked or natural Clay with no organic material present with the exception of areas of circa 100mm to 300mm thick silt bands immediately beneath the surface, which are not considered to be the ground gas source.

The records of the reduced level dig and removal of potential gas generating material outlined in the previous section meets the required remediation criteria for the below remedial exercise specified in the Smith Grant LLP Supplementary Site Investigation Report:

- The area in the car park associated with the elevated methane readings in WS306 & WS316 will undergo excavation to natural strata to investigate the source of the high concentrations. Potential sources will be examined and classified with respect to the proportions of degradable organic matter and laboratory tests for total organic matter undertaken. It is envisaged that a process of segregation and screening of materials will be used to remove the gas source, and that depending on the level of confidence achieved with respect to source removal, further post remediation gas monitoring will be carried out in this area to confirm conditions prior to construction.*
- The observations and testing results from these exercises and the general inspections of the preparatory earthworks within Phase 1B will be compiled into an enabling remediation earthworks verification report for issue to the regulators for approval. This will confirm the construction-stage mitigation measures required to manage residual risks to human health.*
- All areas outside the those requiring VOC resistant membrane (and the area of WS316/WS306 which is to be confirmed) will require CS2/NHBC Amber 1 gas protection measures as a precaution based on the gas monitoring undertaken. When combined with the high performance open sub-floor void, these will also supply a suitable degree of protection from the low-level VOCs detected outside the VOC impacted areas. All Gas/VOC membranes across Phase 1 are to be verified in accordance with a verification plan, with integrity testing for the VOC membrane only, in accordance with the provisions of CIRIA C735: "Good Practice on the testing and Verification of Protection Systems for Buildings Against hazardous ground gases".*

Testing results for the organic material stockpile and hydrocarbon stockpile has been undertaken, however these have no impact on the remediation of Phase 1B as the material will only be used as part of the earthworks exercise in Phase 2 if the organic content is deemed suitable, otherwise it will likely be incorporated into near surface POS areas.

Based on the reduced level dig exercise undertaken and Groundtech Consulting's observation of the works it is considered that the gas regime of the area can be reassessed as the sources of the ground gas responsible for the high gas readings in the previous supplementary investigation's monitoring wells have now been removed, additionally it is considered that the chosen remedial methodology of source removal was appropriate.

Gas Assessment and Justification

The monitoring results and subsequent assessment of the previous investigation recorded no exceedances over the GSVs for a residential property with suspended floor slab in accordance with the Boyle and Witherington 2006 method of assessment. In accordance with CIRIA C665 (Situation B – Low-rise housing with a ventilated underfloor void (min 150mm) and Table 8.7 – NHBC Traffic light system for 150mm void) it was determined that the GSV values both for carbon dioxide and methane were below the assessment GSV of <0.78l/hr and 0.16l/h respectively and the Phase 1B area fell within the Green traffic light zone. Based on the data from the previous

monitoring the greatest hazardous flow rate for methane was 0.0167l/hr which was recorded in WS316, while the carbon dioxide rate was 0.0085l/hr. Both of the worst case rates hazardous flow rates are well below the associated GSVs for both carbon dioxide and methane.

The classifications in the previous assessment were determined from the maximum typical concentrations being exceeded, the lack of any elevated GSVs was largely due to the absence of any flow rates being recorded in the monitoring wells. Although some isolated high gas concentrations were recorded, the lack of flow indicates that the source has a slow gas generating potential or the gas source is present in pockets.

A combined NHBC table and Modified Wilson and Card Classification table is presented below.

Characteristic Situation (Wilson and Card)	Traffic Light Classification (NHBC)	Methane				Carbon Dioxide			
		NHBC		Wilson and Card		NHBC		Wilson and Card	
		Gas Screening Value (l/hr)	Typical Maximum Concentration (%v/v)	Gas Screening Value (l/hr)	Typical Maximum Concentration (%v/v)	Gas Screening Value (l/hr)	Typical Maximum Concentration (%v/v)	Gas Screening Value (l/hr)	Typical Maximum Concentration (%v/v)
1	Green	0.16	1	<0.07	<1	0.78	5	<0.07	<5
2	Amber 1			<0.7	Borehole flow rate not greater than 70l/hr			<0.7	Borehole flow rate not greater than 70l/hr
3		Amber 2	0.63	5	<3.5		1.56	10	<3.5
4	<15				Quantitative Risk Assessment Required	<15			Quantitative Risk Assessment Required
5	Red	1.56	20	<70		3.10	30	<70	
6				>70				>70	

Based on the reduced level dig undertaken and supervised by Groundtech Consulting discussed in Section 3.0. It has been demonstrated that likely source of the gas concentrations recorded in the previous monitoring exercise was the pockets of organic material, localised hydrocarbon contamination with the Made Ground soils and the underlying residual topsoil/pockets of silt within the natural material.

The response zones for the two monitoring wells with the highest concentrations of ground gas (WS306 and WS316) were situated within the Made Ground soils, indicated that this material has the highest impact on the gas generation in the areas. All of the Made Ground soils which were determined to be a potential source of ground gas have been removed from Phase 1B, and as such the major source of gas generation has been removed.

Although the natural and reworked soils are not considered to be the main source of the ground gas generation some potential sources were identified during the excavation. These sources comprised a thin layer of relic topsoil, some sporadic wood inclusions, and a silt layer. These sources potentially contributed to the methane concentrations recorded in WS306 which had a response zone in both the Made Ground and natural soils, and

was likely responsible for the carbon dioxide concentrations recorded in WS313. Where any organic material was encountered within the natural and 'clean' reworked soils it was removed. Some small pockets of material remain at the formation level surface, as discussed earlier the gas generation potential of the material is considered to be very minor and it will not pose a gas generation risk which will exceed the proposed Amber 1 gas precautions to be installed in all of the residential properties. Groundtech believes that that source removal objective has been completed with a high level of confidence and no additional supplementary monitoring is required to reassess the gas risks.

Based on the reduced level dig removing the gas generating Made Ground soils and the vast majority of the organic material within the underlying reworked 'clean' Clay and natural Clay - the gas generating potential of the remaining soils in the Phase 1B area is considered to be low, and the proposed Amber 1/CS2 gas precautions would be suitable for this area as proposed site wide.

All of the relevant information is shown spatially on Groundtech Plan GRO-21459-P02.

Gas Mitigation Measures

The below remedial measures were required relating to the installation and verification of the gas precautions to be installed in Phase 1B:

- *Details of the design, specification and verification plan for the gas protection measures for the gas protection should be finalised following completion of the Phase 1 preparatory earthworks and interpretation of the validation data for the hydrocarbon hotspot removal and the assessment of the car park methane sources and provided to BMC for approval in advance of construction.*

All the plots within the area are to have Amber 1 gas precautions installed which will comprise:

- *Suspended beam and block floor which should have enough passive ventilation to facilitate a minimum of one complete volume change per 24 hours.*
- *Appropriate ground gas membrane fitted by a competent contractor.*

The above gas precautions will require validation by an independent contractor and the production of a Gas Precautions Verification Report summarising the validation works and determining that the precautions have been installed correctly in accordance with CIRIA C735.

5.0 PHASE 1B BUILD REMEDIATION STRATEGY

A standalone construction stage Remediation Strategy for each phase once the earthworks stage verification is complete. The remedial requirements specific to Phase 1B are summarised below and discussed in more detail below:

- | | | | |
|----|--------------|---|---|
| 1. | Ground Gas | - | Site wide Amber 1 Level Precautions. |
| 2. | Cover System | - | Site wide 600mm with demarcation layer. |

Ground Gas

The additional ground gas assessment discussed in the previous sections has confirmed that the Amber 1 level of precautions recommended site wide is applicable to Phase 1B.

Cover System

No elevated concentrations of Contaminants of Concern (CoC) were recorded in the soils underlying this area when compared to residential with plant uptake screening levels, additionally the vast majority of the Made Ground soils have been removed with only natural Clay and reworked 'clean' cohesive soils remaining further reducing the risk from contaminated soils from a human health perspective. As no contamination was recorded and the area is underlain by impermeable Clay, there is additionally no risk to Controlled Waters in Phase 1B.

The cover system is a Build Phase requirement for Phase 1B which is proposed site wide and should be placed in the front and rear residential gardens of the properties. The cover system should comprise a total of 600mm clean material (minimum 150mm topsoil) and a demarcation membrane. The use of a hard dig layer is not required in this area as the likelihood of asbestos fibres being present within the underling reworked Clay and natural Till is negligible.

Any areas of soft landscaping outside of the residential gardens (verges, POS etc.) should have a 450mm clean material (minimum 150mm topsoil) cover system with a demarcation membrane.

Testing of imported soils to be placed as part of the cover system should be undertaken to confirm they are suitable for use prior to import, testing of the material should also be undertaken on site to confirm the suitability. Depth validation of the installed cover system should be undertaken for both front and rear gardens at a frequency of every one in every three plots. The findings of these verification exercises should be detailed in a cover system verification report produced by a suitably qualified engineer.

The requirements of the cover system has been determined based off the now withdrawn BRE 465 Guidance document and should be verified in accordance with YALPAG Verification Requirements for Cover Systems document.

APPENDIX 1 - Plans



GROUNDTECH
CONSULTING



CLIENT

URBAN REGEN

PROJECT TITLE

TETROSYL BEVIS GREEN WORKS, BURY

PLAN TITLE

EXCAVATION PROGRESS PLAN

DATE

APRIL 2022

SCALE

NTS

PLAN NUMBER

GRO-21459-P02

Rev.	Details	Date

Status

Preliminary

Draft

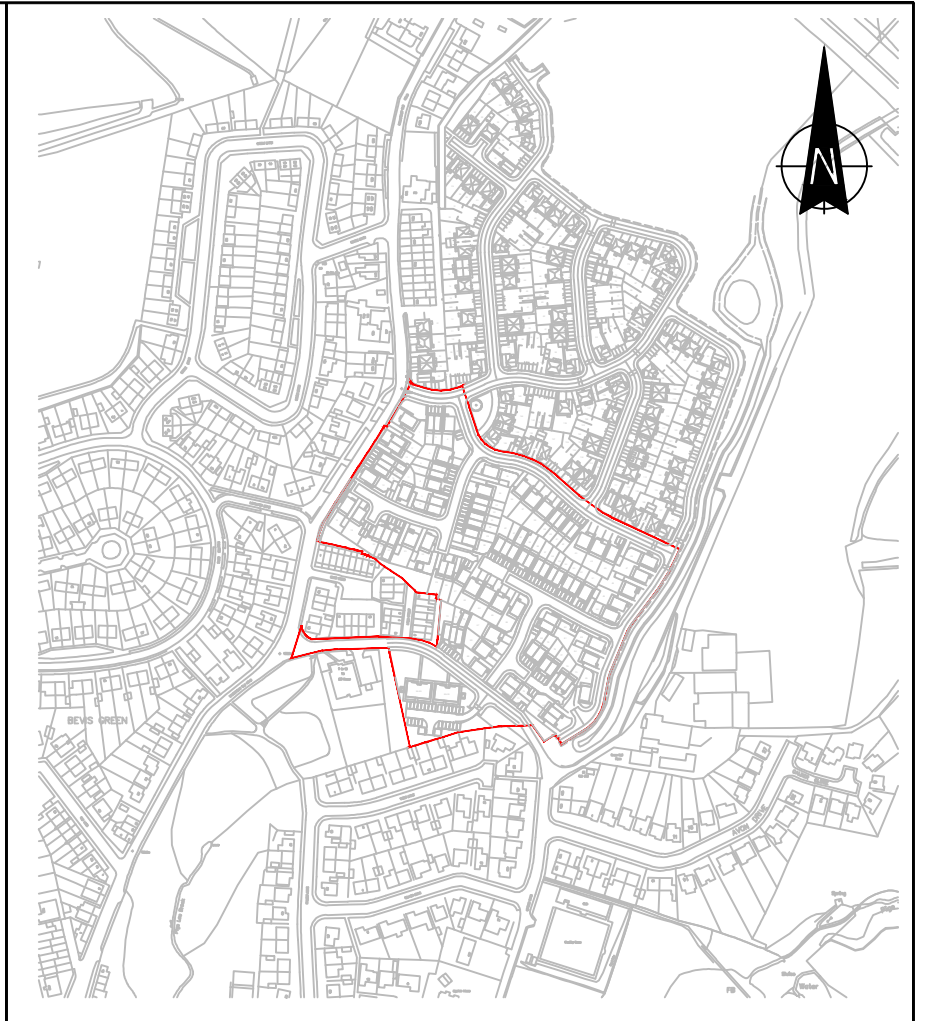
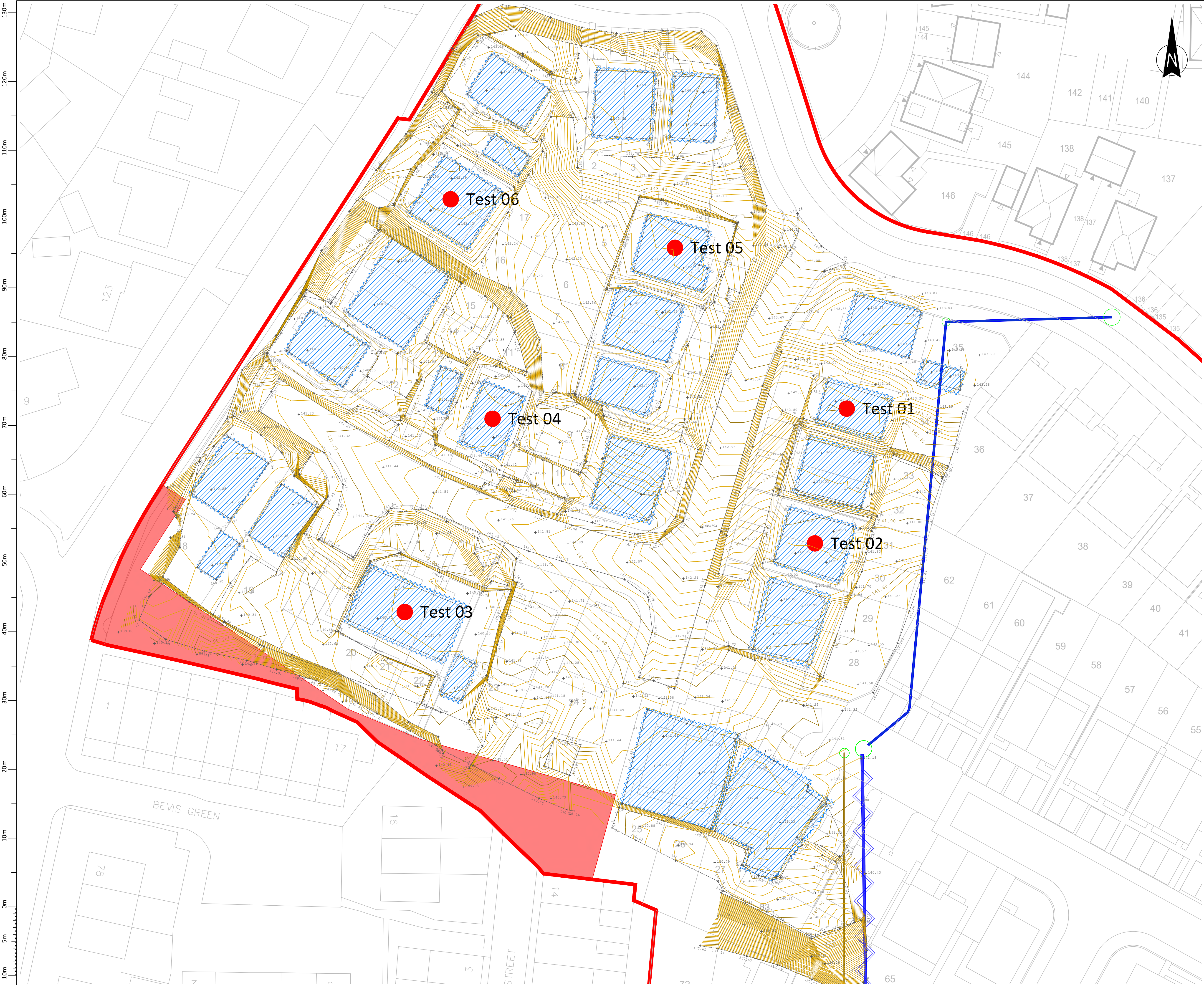
Issued

For Comment

Approved

Notes





Location Plan

Scale 1:5000

Notes:

Site boundary

Major contour

Minor contour

Spot Level

Bottom/Top of bank

CBR Location (Report Number MRN4332/67)

Crushed Areas (Approximate Location Only)

Foul Diversion

Surface Water Diversion

Chamber Location

Revised Development Platform

Notes

1. This plan is to be read in conjunction with the associated Completion Report.

2. The residential layout depicted on this plan is extracted from drawing '491-ED-08' supplied digitally by Barrat Homes Manchester and 'DL01 Revision F' supplied digitally by ANWYL.

3. Due to potential live services and issues associated with withdrawal of support; remediation works have been carried out to within circa 1m of the site boundary unless otherwise detailed.

4. All CBR tests were carried out by Murray Rix.

Survey Information:

Co-ord System:

OSGB36(15)

Co-ord Type:

Grid

Primary Survey Control:

Leica SmartNet

Secondary Survey Control:

Site

Rev

Date

Amendment

Drawn

Checked



Urban Regen

ESTABLISHED 2001

Client:

Barratts Homes Manchester
ANWYL

Project:

Walmersley Old Road
Bury

Title:

As Built Topographical Survey

Scale:

1:250

First Issue:

30/09/2022

Drawn:

G.Bailey

Checked:

A. Smith

Drawing No:

345/30/09/22

Revision:

B

APPENDIX 2 - Laboratory Testing Results

Groundtech Consulting Limited
PO Box 499
Manchester
M28 8EE



Attention : Luke Harrison
Date : 13th May, 2022
Your reference :
Our reference : Test Report 22/7432 Batch 1
Location : Tetrosyl
Date samples received : 7th May, 2022
Status : Final Report
Issue : 1

Six samples were received for analysis on 7th May, 2022 of which six were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.

All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Authorised By:



Liza Klebe

Project Co-ordinator

Please include all sections of this report if it is reproduced

Note:

The LOQ of the Asbestos Quantification is 0.001% dry fibre of dry mass of sample.

Where the sample is not taken by a Element Materials Technology consultant, Element Materials Technology cannot be responsible for inaccurate or unrepresentative sampling.

QF-PM 3.1.15 v10

Client Name: Groundtech Consulting Limited

Reference:

Location: Tetrosyl

Contact: Luke Harrison

[illegible]

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating. Only analyses which are accredited are recorded as deviating if set criteria are not met.

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 22/7432

SOILS and ASH

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. Asbestos samples are retained for 6 months.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C. Ash samples are dried at 37°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overestimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

STACK EMISSIONS

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation for Dioxins and Furans and Dioxin like PCBs has been performed on XAD-2 Resin, only samples which use this resin will be within our MCERTS scope.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.

Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

Laboratory records are kept for a period of no less than 6 years.

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

Customer Provided Information

Sample ID and depth is information provided by the customer.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above calibration range, the result should be considered the minimum value. The actual result could be significantly higher.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

HWOL ACRONYMS AND OPERATORS USED

HS	Headspace Analysis.
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent.
CU	Clean-up - e.g. by florisil, silica gel.
1D	GC - Single coil gas chromatography.
Total	Aliphatics & Aromatics.
AL	Aliphatics only.
AR	Aromatics only.
2D	GC-GC - Double coil gas chromatography.
#1	EH_Total but with humics mathematically subtracted
#2	EU_Total but with fatty acids mathematically subtracted
_	Operator - underscore to separate acronyms (exception for +).
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total
MS	Mass Spectrometry.

EMT Job No: 22/7432

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM65	Asbestos Bulk Identification method based on HSG 248 Second edition (2021)	PM42	Modified SCA Blue Book V.12 draft 2017 and WM3 1st Edition v1.1:2018. Solid samples undergo a thorough visual inspection for asbestos fibres prior to asbestos identification using TM065.	Yes		AR	

APPENDIX 3 - Limitations

Limitations

This report (Report) forms part of the Services and if applicable Additional Services undertaken by Groundtech Consulting Ltd pursuant to a written contract (Agreement) which contains detailed provisions including express limitations of the liability of Groundtech Consulting Ltd.

This Report was prepared using reasonable skill and care as stated in the Agreement for the purpose including intended end use stated by the Client (Purpose) and the liability of Groundtech Consulting Ltd in respect of the form and content of this Report is no greater than its liability under the Agreement. All records, measurements notes, or any other data (Data) obtained by or for the benefit of the Consultant were obtained at a specific point in time and it may not be assumed by the Client or any person relying on this Report that the Data will remain unaffected by the passage of time, the seasons, weather conditions, changes in the water table or the carrying out and completion of works at the Site.

Unless otherwise agreed this Report has been prepared exclusively for the use and reliance of the Client and may not be relied upon, by any other party except as provided for in the Agreement. A third party who relies on this Report, does so at their own and sole risk and Groundtech Consulting Ltd has no liability to such parties.

Groundtech Consulting Ltd that this Report is to be used for the Purpose. The Purpose was instrumental in determining the scope and of the Services provided. If the Purpose should change, the Client may not be able to rely on the Report without the separate agreement of Groundtech Consulting Ltd.

Since the Report was written, later changes in legislation, statutory requirements and industry best practices have not been considered and this should be allowed for. Ground conditions can also change (see below) and should be investigated if there is any significant delay in acting on the findings of this Report. The period of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the Report inaccurate or unreliable. The information and conclusions in this Report should not be relied upon in the future without written confirmation from Groundtech Consulting Ltd that it is safe to do so.

The observations and conclusions outlined in this Report are based exclusively on the services that were provided as set out in the agreement between the client and Groundtech Consulting Ltd.

Groundtech Consulting Ltd is not liable for the existence of any condition, the discovery of which would require additional investigation outside the agreed scope of works or core competency. The Report is based upon Groundtech Consulting Ltd's observations of existing physical conditions at the Site gained from site reconnaissance together with interpretation of information including documentation, obtained from third parties and from the Client on the history and usage of the Site. The findings and recommendations contained in this Report are based in part upon information provided by third parties, and Groundtech Consulting Ltd have relied upon such information assuming it to be correct.

Groundtech Consulting Ltd accepts no responsibility for errors or inaccuracies in third party information presented in this Report. Groundtech Consulting Ltd was not authorised to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services or Additional Services. Groundtech Consulting Ltd is not liable for any inaccurate information, misrepresentation of data or conclusions, which may inform the scope of investigation undertaken by Groundtech Consulting Ltd and forms the contract with the client.

Where field investigations have been carried out these have been restricted to a level of detail required to achieve the stated objectives of the work. Ground conditions may also vary due to the ground's heterogeneous properties

and because investigation exploratory locations only allow examination of the ground at discrete locations. The potential exists for ground conditions to be encountered which are different to those considered in this Report, particularly between exploratory holes. The extent of the limited area depends on the soil and groundwater conditions, together with other constraints such as the position of any existing structures and underground utilities. If so stipulated in the Agreement, geo-environmental testing was carried out for a limited number of parameters based on an understanding of the available operational and historical information, and it should not be inferred that other chemical species are not present.

Any groundwater conditions entered on the exploratory hole records are those observed at the time of investigation. The groundwater level often has not had time to reach equilibrium and a monitoring period is required. Furthermore, groundwater levels are subject to seasonal variation or changes in local drainage conditions and groundwater levels may occur at other times of the year which are higher than were recorded during this investigation.

Any site drawings provided in this Report are preliminary and used to present the general relative locations of features on, and surrounding, the Site.

