STAGE 2 GEO-ENVIRONMENTAL REPORT

AT

LAND AT ST LUKES

BIERLEY MARSH

EAST BIERLEY

ON BEHALF OF

OWENS DEVELOPMENTS LTD

ARP GEOTECHNICAL LTD

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1.0 EXECUTIVE SUMMARY

The pertinent conclusions of the report are tabulated below. However, the information below is not exhaustive, and it is recommended the report is read in its entirety.

Proposed Development	Residential dwellings with private gardens.
Existing Site Description	The site is an irregular shaped parcel of rough grassland where vegetation clearance had recently been undertaken across the site.
Site History	Site has remained largely undeveloped. Several unspecified small structures were once present, between 1920s and 1950s. Planted with crops later.
Geology Maps	The geological maps show the site to be underlain by an unnamed sandstone unit of the Lower Coal Measures with no superficial deposits indicated to be present.
Coal Mining	Borehole investigation has confirmed there are no shallow coal workings affecting the site. There is a slight possibility of unrecorded mine entries - a watching brief should be maintained by the contractors during the site strip and groundworks.
Hazardous Gases	No radon protection measures required. Landfill gas monitoring is ongoing and will be reported separately on completion.
Ground Conditions	Up to 0.4m of topsoil with localised made ground (WS6 only) to 0.5m, overlying natural clays to between 0.9m and 3.95m depth. Bedrock below, of mainly siltstone, localised mudstone, and sandstone.
Contamination	Elevated arsenic (240mg/kg) in the made ground at WS6. Topsoil has widespread slightly elevated benzo[b]fluoranthene (5.5mg/kg) and benzo[a]pyrene (5.3mg.kg), as a result of the presence of coal fragments. One outlier location (WS3) was also shown to have elevated arsenic (59mg/kg) and lead (2,000mg/kg).

Remediation Strategy	Made ground at WS6: Either remove from site, or leave on site, provided 0.6m cover of clean cohesive soils is provided in soft areas. Topsoil: Either remove all the topsoil from site, or carry out further sampling on a closer grid with a view to keeping it on site, if results and statistical analysis is favourable.
Foundations	Strip/trench fill foundations. Tree survey required due to presence of clays.
Excavations	Likely to remain stable during excavation. Significant groundwater ingress is unlikely, but any encountered should be controllable by pumping. Excavations into intact bedrock (found as shallow as 1.4m on the site) are likely to require a hydraulic breaker. Slight possibility of encountering buried foundations.
Concrete	GEN1 designation for unreinforced buried concrete. For any reinforced concrete, other design-specific mixes will apply.
Soakaways	The disposal of surface water using soakaways is unlikely to be practical on the site due to the presence of low permeability strata.
Road Pavement	A design CBR value of 3% is considered applicable on the natural clay.

2.0 TERMS OF REFERENCE

2.1 Owens Developments Ltd is considering developing the site at St. Luke's, Bierley Marsh, East Bierley with residential properties. It was considered appropriate to provide information to aid viability assessment and design of any subsequent development.

2.2 ARP was provided with a copy of a Phase I Geo Environmental Appraisal (H19166B), dated December 2019, and a copy of a Coal Mining Risk Assessment (H19166B CMRA), dated December 2019, both authored by Patrick Parsons on behalf of Planned Contracts Ltd, to which the Client had, or would be, obtaining reliance. The Phase 1 Geo Environmental Appraisal comprised an assessment of the geological and coal mining aspects, Ordnance Survey archive maps, radon gas, indicative flood risk, hydrogeology, landfill, and other environmental issues. In addition to comments on a range of environmental and geotechnical issues, the report also recommended intrusive investigation and assessment.

2.3 ARP Geotechnical Ltd was subsequently appointed by Owens Developments Ltd to undertake the site investigation, with the intrusive investigation comprising windowless sample boreholes to assess the ground conditions.

2.4 The investigation was implemented generally in accordance with BS 5930:2015 +A1:2020 "Code of practice for site investigations", NHBC Standard Chapter 4.1 "Land quality - managing ground conditions", Environment Agency LCRM "Land Contamination Risk Management" and BS10175 : 2011 + A2 : 2017 "Investigation of potentially contaminated sites - Code of practice". This report is limited to the data obtained as part of this investigation. It should be noted that there is a possibility of variation in ground conditions between test locations and interpretation of strata is given for guidance only. No liability is accepted for changes to site conditions, including groundwater levels, after the preparation of this report.

2.5 The findings or contents of the Stage 1 Desk Study Report are not reproduced here in full, and it is recommended that this report is read in conjunction with the Stage 1 Report.

2.6 The general observation and assessment of the ground surface, and the identification/classification of vegetation is made in general terms only. It would be prudent for a specialist to undertake a more detailed survey, including for any invasive/harmful weeds.

2.7 The assessment of any topsoil is carried out in terms of potential chemical effects on human health only, and no account is taken of aesthetic or horticultural properties. Such considerations should be referred to a horticulturist or landscape architect.

2.8 The report has been prepared for the use and reliance of the Client only. The report shall not be relied upon or transferred to any other parties without the written agreement of ARP Geotechnical Ltd. For the avoidance of any doubt, where ARP Geotechnical Ltd enters into a letter of reliance for the benefit of a third party, that third party will be permitted to rely on the report. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party without ARP Geotechnical Ltd.'s consent.

2.9 Attention is drawn to the requirements of the Construction Design and Management Regulations 2015, and in particular the duties and obligation of the Client.

2.10 The report refers to, and includes, a copy of an indicative proposed layout. This is only for the purposes of generating a conceptual site model for the contamination risk assessment. Unless the proposed layout changes significantly, such that the conceptual model and risk assessment is affected, there is no requirement to re-issue this report when the layout is revised.

3.0 THE SITE

Site Location

3.1 The site, which is centred on Ordnance Survey Grid Reference 419870,429223, is located on the eastern side of the road named Bierley Marsh, approximately 20m southeast of its junction with South View Road, in East Bierley near Bradford.

3.2 A site location plan, aerial photograph and indicative proposed site layout, are presented in Appendix A. A site walkover survey was carried out on 2nd July 2024. Photographs taken during the walkover are presented in Appendix B.

Site Description

3.3 The site comprises an irregularly shaped parcel of rough grass land. At the time of the site walkover, vegetation clearance had recently been undertaken across the site. Access to the site is through a gate off Bierly Marsh in the southwestern corner of the site. Numerous mature trees and hedges are present along the boundaries of the site. The site is bounded to the northwest by St Luke's Church and a war memorial, to the west by Bierley Marsh, and to the east, northeast and south by residential properties.

Site History

3.4 The third party desk study indicates that the site has largely been undeveloped until the 1920s. Several small unidentified structures were stated to be present across the site between the 1920s and the 1950s. The structures were cleared by 1956 and no evidence of the buildings was visible during the site walkover. An assessment of Google Earth images by ARP shows that the site has been planted with crops during the period between 2002 and possibly 2015.

4.0 ENVIRONMENTAL SETTING

4.1 The environmental setting for the site was established by the Stage 1 Geoenvironmental Appraisal undertaken by Patrick Parsons under reference H19166B and dated December 2019. The findings of the Desk Study Report, updated and amended where deemed appropriate, are summarised below.

Geology

4.2 The geological maps show the site to be underlain by an unnamed sandstone unit of the Lower Coal Measures. No superficial deposits are indicated to be present. Made ground of probable colliery spoil is indicated to be present 56m southeast of the site. There are no faults shown to affect the site.

Coal Mining

4.3 ARP was provided with a copy of a Coal Mining Risk Assessment by Patrick Parsons under reference H19166B CMRA, dated December 2019. The report concludes the site to be at risk from potential historic shallow mining. A rotary borehole investigation was recommended. ARP subsequently carried out the investigation (reported in letter ODL/01/L2/JP dated 17th September 2024) and this confirmed the site not to be at risk from underground coal mining. There is a residual slight risk from unrecorded mine entries. Details are provided and discussed within this report, as well as the aforementioned letter report.

Hydrogeology

4.4 The Bedrock Aquifer Designation is "Secondary A" and there are no groundwater abstractions within 1km of the site.

4.5 The site is not within a groundwater Source Protection Zone.

Hydrology

4.6 There are no watercourses on or adjacent to the site. The nearest watercourse downslope is Lodge Beck, at 550m to the southeast. Any surface water run-off, which is not intercepted by drainage, is likely to eventually reach the Beck. The site is not in an area at risk from river flooding.

4.7 There are no surface water abstractions within 1km of the site.

Other Relevant Environmental Data

4.8 There is one EA/NRW historic landfill site within 250m of the site at approximately 210m to the northeast (Tong Moor railway cutting).

4.9 No radon protective measures are stated to be necessary for new dwellings or extensions on the site.

Potential Contamination Sources

4.10 The following potential sources of contamination were identified in the Stage 1 Geoenvironmental Appraisal and amended as appropriate, within the judgment of ARP *(ARP's comments/additions are in italics*).

4.10.1 Possible made ground from former site use (numerous small historical structures) – *metals, inorganics, total petroleum hydrocarbons (TPH), polyaromatic hydrocarbons (PAH) and phenol.*

4.10.2 Asbestos containing materials (ACM) within made ground from former site use (numerous small historical structures).

4.10.3 Off-site sources of contamination: made ground from nearby textile works *(90m south)*, refuse tip *(80m north)* and coal tip *(25m southwest)*. *ARP considers the risk of contaminant migration other than ground gas to be unlikely from these sources.*

4.10.4 Ground gas associated with on-site made ground, *possible coal*/mine workings, historic refuse tip *(80m north*), and *coal spoil heap* landfill *(25m southwest):-methane, carbon dioxide.*

5.0 SITE INVESTIGATION

5.1 A site investigation was undertaken by ARP Geotechnical Ltd on 2nd July 2024. The purpose of the investigation was to produce an assessment of the site in accordance with BS10175 : 2011 + A2 : 2017 "Investigation of potentially contaminated sites - Code of practice", and to provide geotechnical information to aid design of the development.

5.2 Windowless sample boreholes were sampled on an approximate 15m grid spacing. Six boreholes (WS1 to WS6) were formed, to depths of between 1.41m and 4.25m. The trial pits and boreholes were organised, supervised and logged by an Engineer from ARP Geotechnical Ltd. Justifications for the trial pit locations are given below.

LOCATION	REASON
WS1	Part of grid, installation of gas well to check for potential ground gas from refuse tip 80m north, and contamination sampling.
WS2 to WS4	Part of grid and contamination sampling.
WS5 & WS6	Part of grid, installation of gas well to check for potential ground gas from coal tip 25m southwest, and contamination sampling.

5.3 Three gas monitoring wells were installed, in WS1, WS5 and WS6, and subsequently monitored by ARP Geotechnical Ltd. The wells were installed to between 1.0m and 4.0m depth, with the bottom 0.5m to 4.0m comprising slotted pipe with gravel surround, and the upper 0.5m to 1.0m comprising plain pipe with bentonite seal and lockable flush cover.

5.4 Three rotary boreholes (BH1 to BH3) were drilled, by Demolition and Geotechnical Ltd, on 14th August 2024, to depths of between 27m and 30.0m, to check for the presence of any coal seams and associated coal workings. The boreholes were organised and supervised by an Engineer from ARP Geotechnical Ltd, and logged by the foreman driller and the Engineer.

5.5 The borehole location plan and logs are included in Appendix C.

5.6 Chemical analysis of six soil samples, for metals, inorganics, speciated PAH, TPH, phenols, and asbestos, was undertaken by the UKAS accredited Eurofins Chemtest Laboratory in Newmarket. The test certificates are included in Appendix D.

5.7 Analysis for Atterberg Limits and moisture content was undertaken by the UKAS accredited Professional Soils Laboratory (PSL) in Doncaster. Geochemical testing comprising pH and water-soluble sulphate was undertaken by Eurofins Chemtest. The test certificates are included in Appendix D.

6.0 SUMMARY OF GROUND CONDITIONS

Strata and Groundwater

6.1 The ground investigation encountered a covering of topsoil across the majority of the site to depths of between 0.3m and 0.4m. In WS6, made ground topsoil was encountered to 0.35m depth, over granular made ground containing brick, clinker and sandstone to 0.5m. No made ground was encountered elsewhere on site.

6.2 The topsoil or made ground was underlain by firm to stiff cohesive residual soils to depths of between 0.9m and 3.95m. This was found to be underlain by intact bedrock comprising usually siltstone (WS1 to WS4), with sandstone at WS5 only, and mudstone at WS6 only. SPT refusals occurred at depths of between 1.41m and 4.25m, concluded to be solid rock.

6.3 No groundwater was encountered during the site investigation.

Gas Monitoring

6.4 Gas monitoring is currently being undertaken in accordance with BS 8576: 2013 "Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)". The findings will be reported separately on completion of the monitoring.

Coal Mining

6.5 The rotary borehole investigation (reported separately under reference ODL/01/L2/JP) was carried out by ARP to assess the potential presence of shallow underground workings (see Patrick Parsons Coal Mining Risk Assessment, reference H19166B CMRA, dated December 2019). The rotary boreholes revealed rock head to be present at depths of between 1.0m (BH2) and 2.0m (BH1), overlying sequences of mudstone and sandstone.

6.6 A 0.1m thick intact coal seam was encountered in BH1, BH2 and BH3 at 4.5m depth, with no indication of any workings. No further seams (or any workings) were encountered in any of the boreholes, to the maximum drilled depth of 30m (BH2 and BH3).

6.7 The 0.1m thick coal seam encountered at depth between 4.5m and 4.6m is considered at negligible risk of being worked and no further action is considered to be required in relation to ground stability. There is a slight risk of unrecorded mine shafts (accessing deeper seams below 30m), which can be dealt with by ensuring that groundworkers are vigilant for any unusual ground conditions, such as patches of differently coloured ground that could represent backfill to a shaft.

7.0 CONTAMINATION ANALYSIS

Screening Values - Soils

7.1 In March 2014, DEFRA published Category 4 Screening Levels (C4SLs) for six contaminants: arsenic, benzene, benzo(a)pyrene, cadmium, chromium VI and lead for soils which should be used in contamination assessment for proposed development. Two further C4SLs for naphthalene and inorganic mercury were added in 2024. The values are based on the toxicological benchmark of a "low level of toxicological concern" (LLTC) rather than the previous regulatory approach of "minimal or tolerable level of risk". As the C4SLs are less protective of health than the previous approach, the Chartered Institute of Environmental Health (CIEH) has advocated an alternative approach based on minimal risk, but with some adjustment of exposure parameters to more realistic scenarios than those previously used. To this end, the CIEH has collaborated with Land Quality Management to publish "Suitable 4 Use Levels" (S4Uls) "The LQM/CIEH S4Uls for Human Health Risk Assessment", November 2014 (LQM/CIEH). However, DEFRA has reiterated its intention that the C4SLs should be used in generic risk assessment for proposed development, and there is indication that other parties will collaborate, in the near future, to extend the range of C4SL determinands beyond the eight published so far.

7.2 Soil contamination test results in this report have been compared first against the more conservative S4UL, and where a C4SL exists for the same determinand, consideration given to the use of the C4SL for any exceedances of the S4UL, within the site-specific context (including the use of benzo(a)pyrene as a surrogate marker for genotoxic PAH compounds, where appropriate). Where no S4UL exists for a determinand, for example lead, the C4SL has been used. The LQM/CIEH screening values have been calculated for soil organic matter contents of 1% and 2.5%, as well as 6%, and the appropriate screening value is used for the organic matter content of the soil. All the C4SL values published are for a soil organic matter content of 6%.

7.3 A table showing the screening values utilised is included in Appendix D.

Soils Analysis

7.4 Six soil samples were issued to Eurofins Chemtest for the suite of testing (As, Cd, Cr (VI), Cr(III), Cu, Hg, Ni, Pb, Se, Zn, Total Sulphate, Water Soluble Sulphate, pH, Phenol-monohydric, Speciated PAH, Total TPH, Asbestos, and Organic Matter). The testing comprised:

- Four samples of topsoil from WS1, WS2, WS3 and WS4
- One sample of made ground from WS6
- One sample of natural clay from WS5

7.5 Within the topsoil, any determinands with exceedances of screening values were subjected to statistical analysis to determine the 95% Upper Confidence Level (UCL). Statistical analysis of the made ground results was not possible given the small number of samples obtained, although appropriate for the site circumstances.

Topsoil

7.6 A results summary table for determinands within the topsoil found to be above screening values is given below. BbF refers to benzo(b)fluoranthene and BaP refers to benzo(a)pyrene.

Sample Reference	Depth (m)	Arsenic	Lead	BbF	BaP
WS1	0.20	30	110	2.2	1.9
WS2	0.30	33	140	5.5	5.4
WS3	0.20	59	2000	4.3	3.8
WS4	0.30	29	93	1.6	1.3
Screening Value at 6% SOM*		37	200	3.7	5.0
95% UCL		54.5#	1695.2#	5.5	5.3

Artificially high due to the outliers

Exceedance

Outlier Exceedance

Acceptable*

7.8 It can be seen from the table that the 95% UCL concentrations of benzo[b]fluoranthene and benzo[a]pyrene are above the screening values, with no outliers, meaning the 95% UCL

concentrations are statistically applicable to all the topsoil sampled. The PAH ratio plots (presented in Appendix D) show the PAH to be from the presence of coal fragments. Arsenic and lead are elevated in WS3 only, both as outliers, meaning that these elevations are applicable only to WS3 (the rest of the samples having no exceedances for arsenic and lead).

Made Ground

7.7 One sample of made ground was taken from WS6, which showed all values to be below screening levels apart from an elevation of Arsenic (240mg/kg, above the screening value of 37mg/kg).

Natural Ground (Clay)

7.8 One sample of the natural clay was taken from WS5, which showed all values to be below screening levels, and therefore no risk posed to human health.

Updated Risk Assessment and Conceptual Model

7.9 The categorisations of risk adopted in this report are adapted from CIRIA Report C552 (Contaminated Land Risk Assessment: A Guide to Good Practice, 2001). This approach assesses the potential severity of any pollution event and the probability of the event occurring, to arrive at a risk category, for the various potential source - pathway - receptor linkages. The relevant tables used, with the definitions, are presented in Appendix E.

7.10 The updated source – pathway – receptor matrix is presented below, taking into account the findings of the investigation. Any pathways in italics are deemed not to be viable and the reason given.

Viable Source - Pathway - Receptor Matrix (Finished Development)

Contamination Sources	Pathways	Receptors	Severity of Consequence	Probability of Event	Risk
Topsoil - widespread BbF, BaP, localised (WS3 only) arsenic and lead Made ground (only found at WS6): - Arsenic	• Inhalation, ingestion and dermal contact with soil and dust	**Humans:-** • Future occupants • Maintenance workers • Adjacent residents and general public	**Medium**	**Low Likelihood**	**Moderate/ Low**
	• Fruit and vegetable intake, with soil	**Humans (as above)**	**Medium**	**Low Likelihood**	**Moderate/ Low**
	• *Vapour inhalation outdoor (negligible volatility)*	***Humans (as above)***	***Pathway Not Applicable***		
	• *Vapour inhalation indoor (negligible volatility)*	***Humans (as above)***	***Pathway Not Applicable***		
	• Migration in surface water	• Surface water (nearest downslope is 550m to the southeast. There are no abstractions within 1km.	**Mild**	**Unlikely**	**Very Low**
	• Migration in groundwater	• Groundwater (Secondary A Aquifer, no abstractions within 1km)	**Mild**	**Unlikely**	**Very Low**
	• Root uptake	**Vegetation:-** • Landscape areas • Private gardens	**Medium**	**Low Likelihood**	**Moderate/ Low**
	• Migration	**Services/Utilities:-** • Potable water supply	**Medium**	**Low Likelihood**	**Moderate/ Low**
Refuse tip 80m north, coal tip 25m southwest:- methane and carbon dioxide	• Asphyxiation • Explosive risk	• Construction/de-molition workers • Future occupants • Buildings	**Severe**	**Low Likelihood**	**Moderate**

7.11 It can be seen from the above matrix that several pathways to receptors are operative, and this may affect users of the finished development, with a moderate risk applicable. Some form of remedial action is, therefore, considered necessary to allow residential development without excess risk.

Risk Based Assessment of Remedial Options

Landfill Gases

7.12 To address the potential risk from landfill gases, monitoring of borehole wells is in progress. This will determine whether or not protection measures are likely to be necessary. This will be confirmed by separate letter report on completion of the monitoring.

Topsoil Across the Site - Ingestion, Dust Inhalation, Dermal Contact, Root Uptake, and Fruit and Vegetable Intake with Soil

7.13 Based on the existing topsoil contamination test results, the topsoil is not suitable for re-use on the site. As topsoil is a poor engineering material and cannot be placed under a cover system due to the potential for gas generation, the only economical option would probably be the removal of the topsoil from site. It is possible that further sampling of the topsoil on a closer grid, and testing for arsenic, lead and speciated PAH, may provide a more accurate representative concentration for these determinands, either allowing the material to be proved suitable for retention on site, or minimising the amount to be removed. However, this is not certain. The existing WS3 location could also be resampled, to determine if the elevated results may be due to an atypical fragment being randomly included within the tested sub sample at the laboratory.

Made Ground (WS6 Only) - Ingestion, Dust Inhalation, Dermal Contact, Root Uptake, and Fruit and Vegetable Intake, with Soil

7.14 This pathway is automatically blocked where buildings or hardstanding are present above the material. However, in garden areas, provision of a cover system of a minimum 0.6m thickness will be required, to reduce the risk to future users of the site to acceptable levels from these pathways. This assumes a worst case double dig scenario (i.e. 2 x spade depths).

7.15 Risks to groundwater and surface water are considered very low but can be reduced further by ensuring the cover system includes at least 0.45m thickness of material with at least 35% silt/clay content (at least 35% passing a 63 micron sieve), for example clay, sandy clay, or gravelly clay. If cohesive cover systems are used, external levels and surface water drainage will need to be carefully designed to avoid localised surface water ponding.

Migration to Utilities

7.16 Any migration to utilities is unlikely to be significant. However, the local water company are likely to require details of the contaminants present on the site, to make a judgment on any requirement for protection of buried water supply pipes from chemical attack/ingress.

Risks During Construction Period

7.17 It is also necessary to consider the effects of the contamination present on the site in relation to the risks to adjacent residents, construction workers and the general public during construction. This is assessed in the following matrix.

Source	Pathway	Potential risk	Risk after employing suitable Health and Safety plan.
Existing topsoil and made ground	Inhalation	Low	Damping down of the site during dry periods and timely placement of the existing made ground below barriers/removal of topsoil from site should block this pathway and reduce the risk to negligible.
Existing topsoil and made ground	Ingestion	Low	Site fencing will exclude access to members of the public. Existing made ground will be contained within the site boundary, and placed below barriers as soon as possible, and contaminated topsoil moved off site. Washing facilities and a clean mess room should be provided. These measures should block this pathway and reduce the risk to negligible.
Existing topsoil and made ground	Contact	Low	Education of workers to use adequate hygiene and PPE should block this pathway and reduce the risk to negligible.
Existing topsoil and made ground	Surface water	Low	Preventing surface water run off by minimising open exposure times of the existing made ground, and using bunds or cut off trenches as necessary should block this pathway and reduce the risk to negligible.

7.18 Provision of all the above measures will ensure that all the identified pathways for the contamination will be blocked.

Summary of Contamination Assessment and Remedial Options

7.19 At all locations except WS6, a surface covering of natural topsoil was present, between 0.3m and 0.4m thick. In WS6, made ground topsoil was encountered to 0.35m depth, over granular made ground containing brick, clinker and sandstone to 0.5m depth. Below the topsoil and made ground, natural clays were present to depths of between 0.9m and 3.95m, onto intact bedrock (mainly siltstone, locally mudstone and sandstone). The made ground at WS6 was shown to have elevated arsenic (240mg/kg), and the topsoil was shown to have widespread (95% UCL and no outliers) slightly elevated benzo[b]fluoranthene (5.5mg/kg) and benzo[a]pyrene (5.3mg.kg), as a result of the presence of coal fragments. One outlier location (WS3) was also shown to have elevated arsenic (59mg/kg) and lead (2,000mg/kg).

7.20 The contamination risk assessment, and assessment of remedial options, has indicated that, provided that the following remedial measures are adopted then the risks to the identified receptors are deemed acceptable for the proposed development of residential properties with private gardens.

7.21 Either all the existing topsoil should be removed from the site, or additional sampling should be undertaken on a closer grid (including resampling of WS3), with testing for arsenic, lead and speciated PAH, to provide more accurate representative concentrations for these determinands. If results are favourable, this could either prove the material to be suitable for retention on site, or at least minimise the amount to be removed. The receiving tip may require Waste Acceptance Criteria testing and asbestos quantification. If topsoil needs to be removed, then independent validation inspection will be required, to verify removal of all the affected topsoil.

7.22 The made ground at WS6 only could either be removed from site, or retained below hard areas, or below 0.6m cover of clean cohesive soils in garden/landscape areas.

7.23 For any soils removed from site, the disposal/transfer documents should be retained for inclusion in the Validation Report. Any imported soils used within the clean soil cover system will need to be verified as suitable by inspection and testing, in accordance with guidance supplied in the document produced by the Yorkshire and Lincolnshire Pollution Advisory Group (YALPAG): "Guidance on the Verification Requirements for Cover Systems".

7.24 The local water company are likely to require details of the contaminants present on the site, to make a judgment on any requirement for protection of buried water supply pipes from chemical attack/ingress

7.25 A Contamination Remediation Statement is included in Appendix F.

8.0 GEOTECHNICAL TESTING

8.1 Selected samples of the natural strata were delivered to PSL in Doncaster for testing with regard to plasticity indices and moisture content. Test certificates are presented in Appendix D and a summary of the results, including Modified Plasticity Indices, is given below.

Location	Depth (m)	MC	LL	PL	PI	<425µm	I'p
WS1	0.80	25	47	24	23	100	23.0
WS4	0.70	24	45	25	20	100	20.0
WS6	1.60	16	39	20	19	97	18.4
	Number of results	3	3	3	3	3	3
	Minimum	16	39	20	19	97	18.4
	Maximum	25	47	25	23	100	23.0

I'p	VCP
>40%	High
20% - <40%	Medium
10% - <20%	Low

MC = Moisture Content (%)	LL = Liquid Limit (%)	PL = Plastic Limit (%)
PI = Plasticity Index (%)	I'p = Modified PI (%)	VCP = NHBC Standard Chapter 4.2 Volume Change Potential

8.2 The plasticity test data shows clays of intermediate plasticity, in accordance with BS 5930:2015 +A1:2020 "Code of Practice for Site Investigations". When the percentage retained on the 425 micron BS sieve is considered, the Modified Plasticity Index, in accordance with NHBC Standard Chapter 4.2 "Building Near Trees" is a maximum of 23.0. In accordance with the Standard, this equates to Medium Volume Change Potential.

8.3 Geochemical testing (water soluble sulphate and pH) was undertaken on selected samples by Eurofins Chemtest, comprising four samples of natural strata and one sample of made ground. In accordance with the BRE Special Digest 1 "Concrete in aggressive ground", the characteristic values for the two materials are given below:

Characteristic Values

Material	pH	SO_4
Made Ground	7.6	32
Natural Strata	7.2	230

SO_4 = Sulphate content in mg/l on a 2:1 water : soil extract pH = Acidity

8.4 The geochemical analyses show the natural strata to have low water-soluble sulphate content and near neutral pH. The Aggressive Chemical Environment for Concrete (ACEC) class is AC-1. Therefore, the use of GEN1 designated concrete will be satisfactory for unreinforced buried concrete. For any reinforced buried concrete, other design-specific mixes will apply.

9.0 GEOTECHNICAL ASSESSMENT

Coal Mining and Coal Recovery

9.1 The rotary borehole investigation confirms there are no shallow coal workings affecting the site and no further action is required in relation to stabilisation of workings.

9.2 There is a slight possibility of unrecorded mine entries. A watching brief should be maintained by the contractors during the site strip and groundworks, and if any suspect features are identified, then a Geotechnical Engineer should be contacted for advice.

9.3 There should be no significant arisings of coal during proposed development works, and it will not be possible to win any coal from the site before development.

Foundations

9.4 The made ground on the site is not considered suitable for support of foundation loads. The underlying natural firm to stiff clay is considered suitable, for the use of strip/trench fill foundations. An allowable bearing pressure of 100kN/m^2 is considered applicable.

9.5 The clays were shown to be of medium volume change potential. Therefore, in accordance with NHBC Standard Chapter 4.2 "Building Near trees", in the absence of trees, a minimum foundation depth of 1.0m below existing or proposed ground level is applicable, whichever is the lower. However, in the presence of any proposed, existing or removed trees, the foundation may need to be deepened, depending on the type of tree and its distance from the face of the foundation. If not already available, a tree survey may be required to enable a foundation schedule to be prepared. The tree survey will also need to consider trees on third party properties.

9.6 The foundation should be taken below the depth of any existing foundations or obstructions, onto natural ground. The whole plan area of the foundation should be placed on similar natural material.

9.7 If bedrock is encountered on part of a foundation excavation, the rest of the plot should be deepened to ensure founding on similar material. However, if rock is not encountered by 2.5m depth on the remainder of the plot, then the Engineer should be contacted for further advice.

Excavations

9.8 It is likely that excavations into the natural strata will remain stable in the short term, requiring minimal trench support, in accordance with the prevailing statutory guidance.

9.9 No groundwater was encountered during the investigation. However, should any groundwater be encountered, it should be controllable by pumping from an artificial sump.

9.10 Excavations within the natural clays should be readily achieved using conventional hydraulic plant. However, excavations into intact bedrock (found as shallow as 1.4m on the site) are likely to require a hydraulic breaker. There is also a slight possibility of encountering buried foundations from the former small structures shown to once be present on the site, on archive mapping.

Chemical Precautions

9.11 The Aggressive Chemical Environment for Concrete (ACEC) class is AC-1 for both the natural strata and made ground. Therefore, the use of GEN1 designated concrete will be satisfactory for unreinforced buried concrete, in accordance with BS 8500-1:2015+A2:2019. For any reinforced buried concrete, other design-specific mixes will apply.

Road Pavement Construction

9.12 For any areas of road pavement, including parking areas, the formation will be the natural clay (cohesive residual soils). Based on the observed characteristics of the material, and the results of the plasticity testing a design California Bearing Ratio (CBR) value of 3% is considered applicable, below any obvious soft spots, and at equilibrium moisture content. If considered necessary, this should be confirmed by testing at proposed subgrade level before construction. Formation of roads on the existing made ground will not be acceptable.

Flooding and Soakaways

9.13 The site is not at risk from river flooding. The risks of flooding from other causes such as adverse topography or insufficient surface water drainage, are not considered here. If such risk needs to be quantified, a separate specialist Flood Risk and Drainage Report should be commissioned, if not already available.

9.14 The disposal of surface water using soakaways is unlikely to be practical on the site due to the presence of low permeability strata.

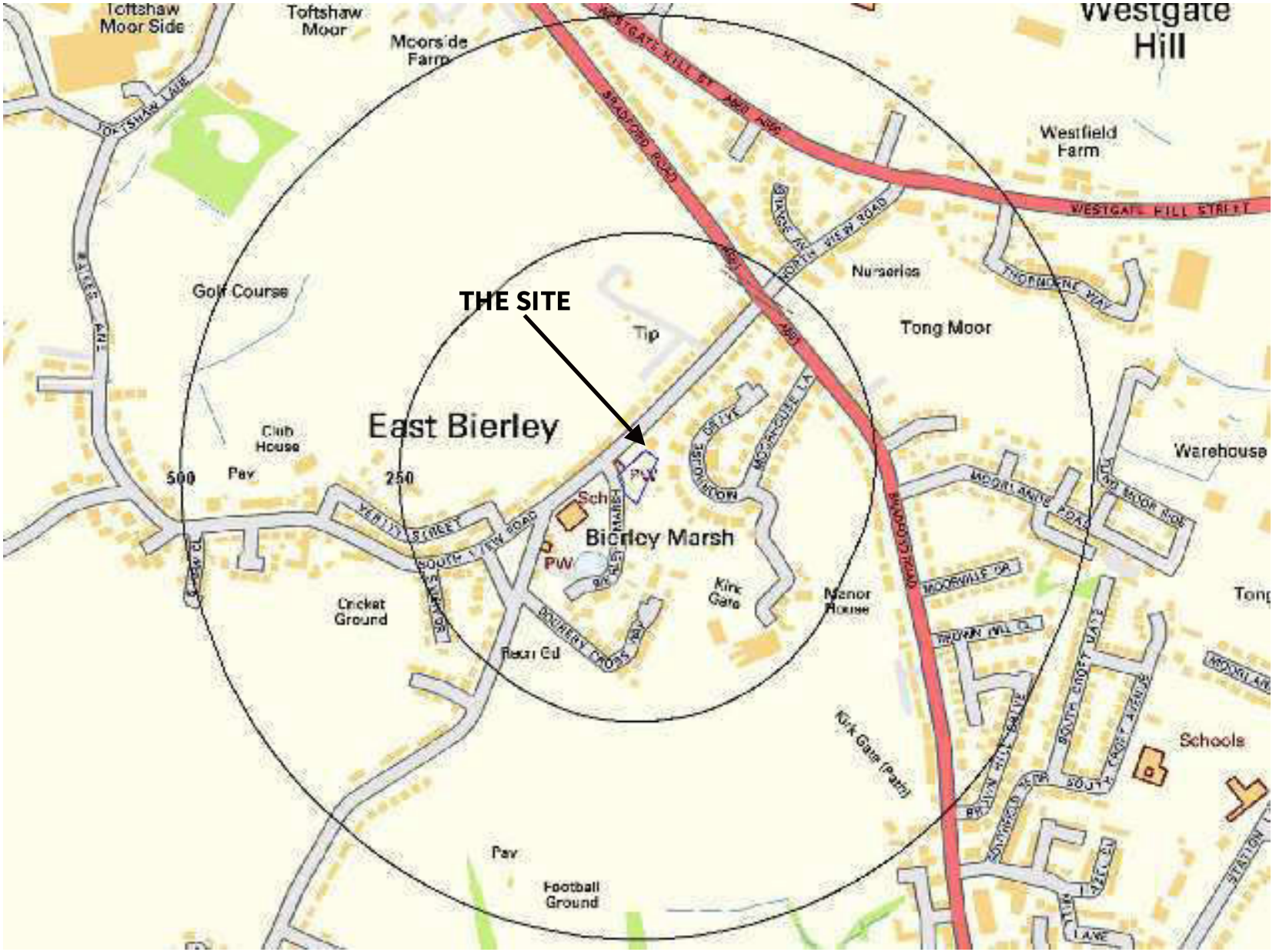
Gas Protection

9.15 No radon protective measures are stated to be necessary for new dwellings or extensions on the site.

9.16 There is one EA/NRW historic landfill site within 250m of the site at approximately 210m to the northeast (Tong Moor railway cutting) and a refuse tip marked on archive maps 80m north. In addition, there is a spoil heap from a coal pit 25m southwest. Gas monitoring is ongoing, and will be reported separately on completion.

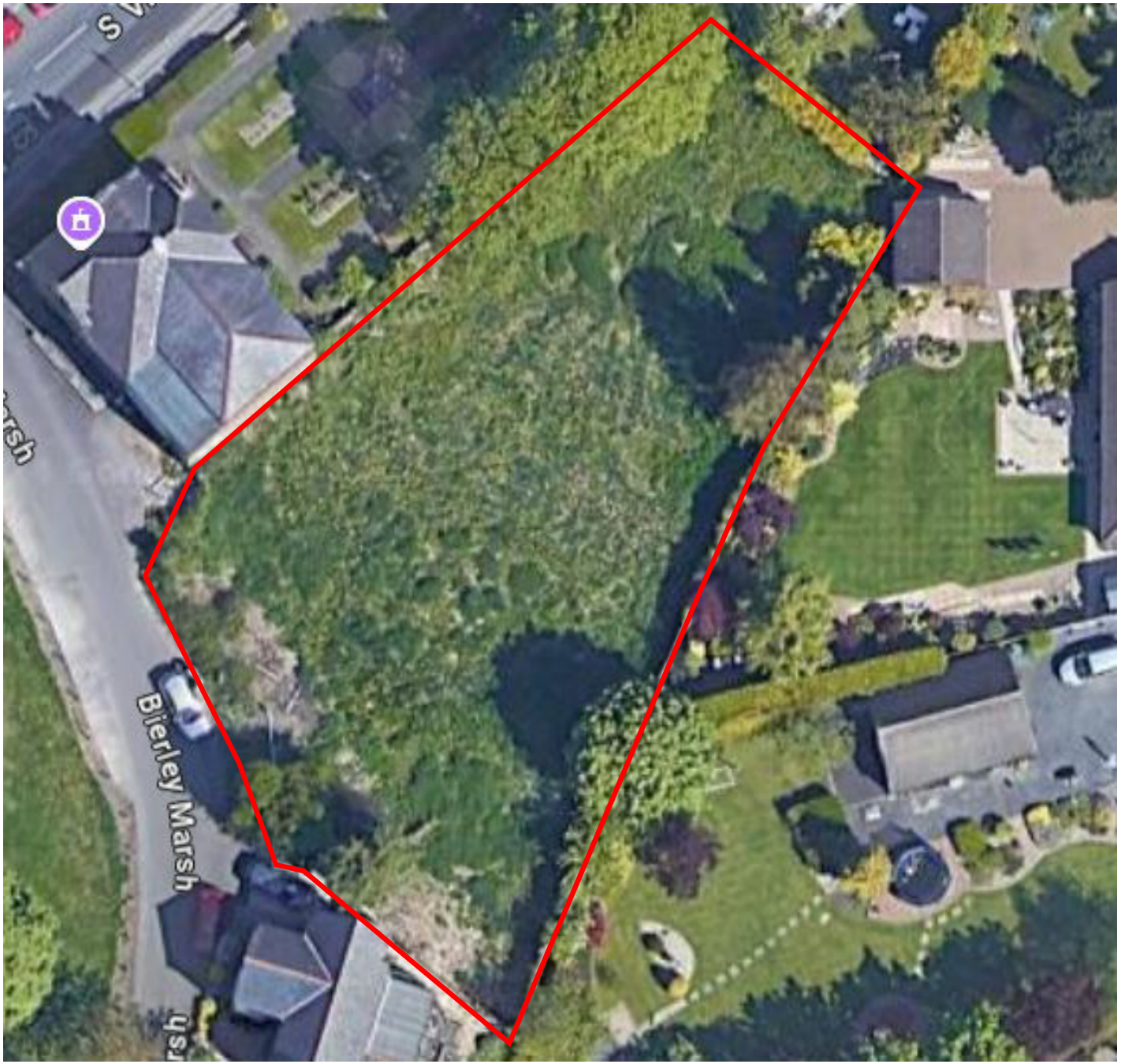
A P P E N D I X A

SITE LOCATION PLAN, AERIEL PHOTOGRAPH AND PROPOSED LAYOUT PLAN



ARP GEOTECHNICAL LTD
CHARTERED CONSULTING ENGINEERS
Northwest House 5-6 Northwest Business Park Servia Hill · Leeds LS6 2QH
Telephone : 0113 245 8498 Fax : 0113 244 3864 E-Mail : leeds@arpassociates.co.uk

Project	LAND AT ST LUKES BIERLEY MARSH
Client	OWENS DEVELOPMENTS LTD
Title	SITE LOCATION PLAN
Date	JULY 2024
Drawn	WW
Scale	AS SHOWN
Job No.	**ODL/01**

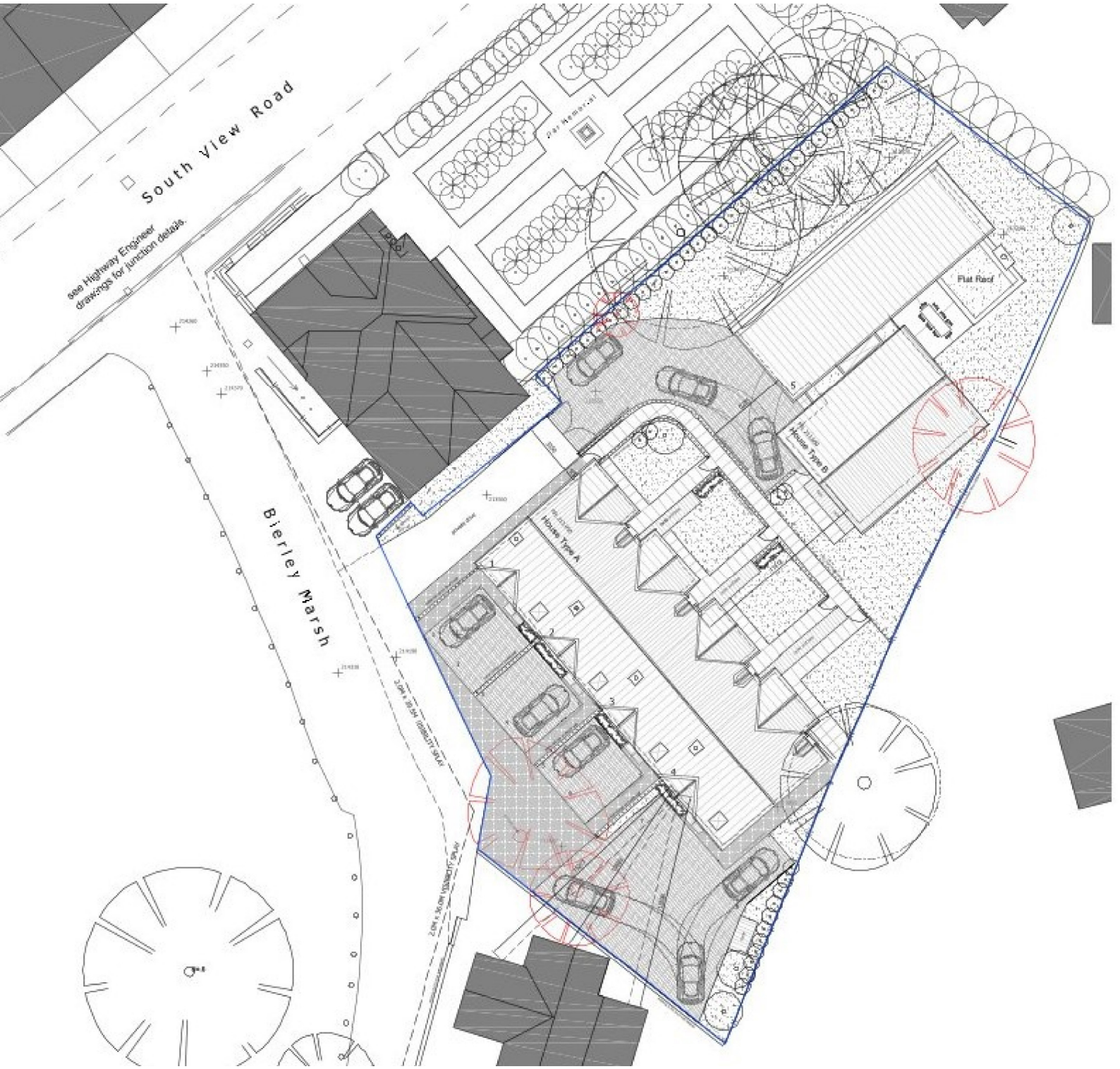


0m 20m

Approximate Scale

ARP GEOTECHNICAL LTD
CHARTERED CONSULTING ENGINEERS
Northwest House 5-6 Northwest Business Park Servia Hill · Leeds LS6 2QH
Telephone : 0113 245 8498 Fax : 0113 244 3864 E-Mail : leeds@arpassociates.co.uk

Project	LAND AT ST LUKES BIERLEY MARSH
Client	OWENS DEVELOPMENTS LTD
Title	AERIAL PHOTOGRAPH
Date	JULY 2024
Drawn	WW
Scale	AS SHOWN
Job No.	**ODL/01**


South View Road
see Highway Engineer drawings for junction details.
Bierley Marsh
House Type A
House Type B
Flat Roof

APPENDIX B

SITE WALKOVER PHOTOGRAPHS

Photograph 1: St Luke's church at the junction of Bierley Marsh and South View Road beyond northwestern corner of the site.

Photograph 2: Site entrance off Bierley Marsh at southwestern corner of the site, facing southeast.

Photograph 3: Site entrance, facing west.

Photograph 4: Looking at the southwestern corner of the site, facing west towards the site entrance.

Photograph 5: Northwestern boundary of the site, facing northwest towards a war memorial beyond the site boundary.

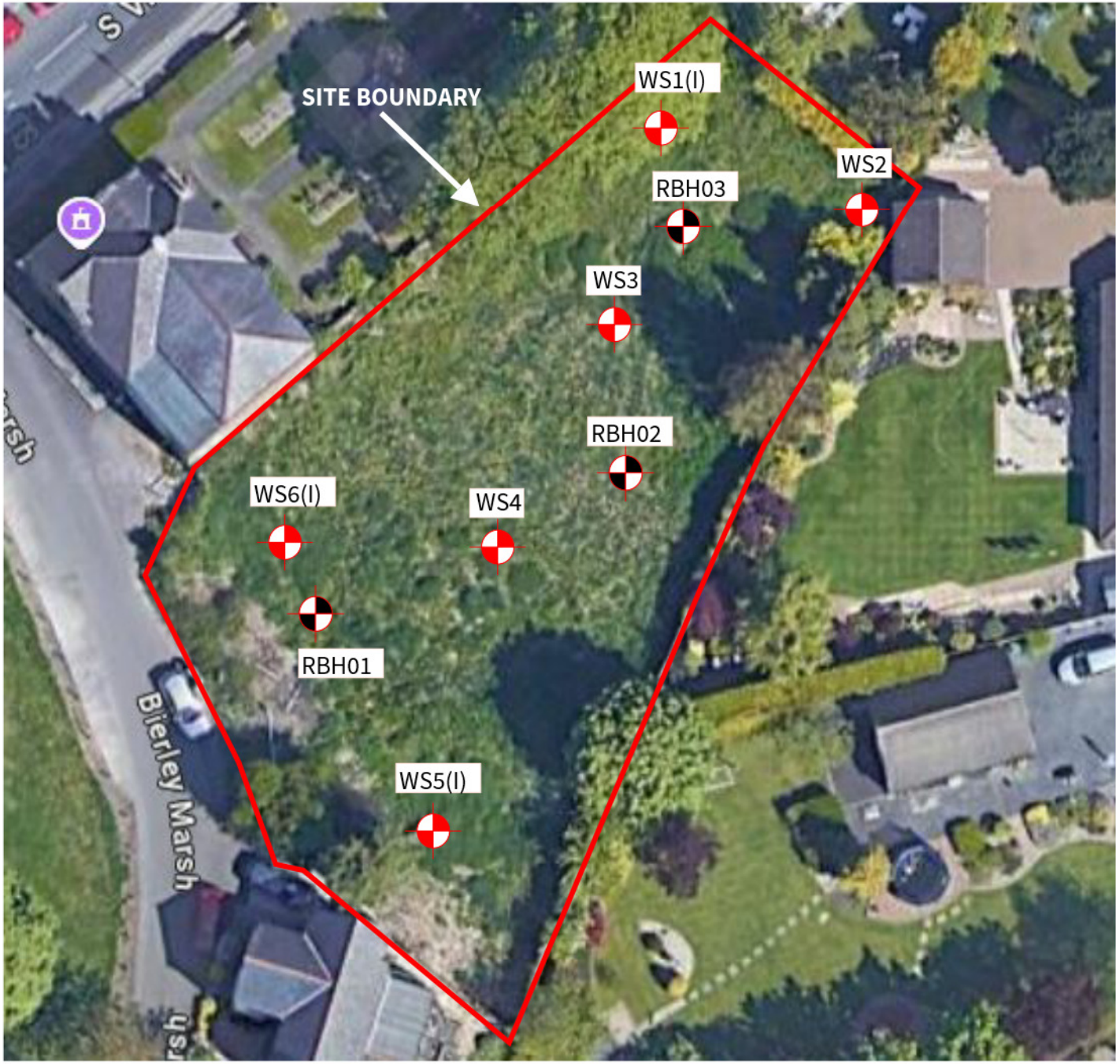
Photograph 6: Northeastern corner of the site, facing northeast.

Photograph 7: Looking at the northern corner of the site, facing north.

Photograph 8: Looking at the centre of the site, facing west towards the site entrance.

A P P E N D I X C

BOREHOLE PLAN & LOGS



0m 15m

Approximate Scale

ARP Window Sample Borehole

(I) - Monitoring installation

ARP Rotary Borehole

ARP GEOTECHNICAL LTD
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Northwest House 5-6 Northwest Business Park Servia Hill · Leeds LS6 2QH
Telephone : 0113 245 8498 Fax : 0113 244 3864 E-Mail : leeds@arpassociates.co.uk

Project
LAND AT ST LUKES
BIERLEY MARSH

Client
OWENS DEVELOPMENTS LTD

Title
SITE INVESTIGATION PLAN

Date
JULY 2024

Drawn	Scale
WW	AS SHOWN

Job No.
ODL/01

ARP GEOTECHNICAL LTD
CHARTERED CONSULTING ENGINEERS

Site	Number
Land at St Lukes, Bierley Marsh	WS1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Dando Terrier Window Sampler Rig.			Owens Developments Ltd	ODL/01
	Location	**Dates** 02/07/2024	**Engineer** WW	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.30)	Brownish grey slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine. Gravel is fine subrounded of sandstone. Frequent rootlets.			
0.20-0.20	D				0.30				
					(0.70)	Firm brownish grey mottled brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is fine subangular of siltstone. Occasional rootlets.			
0.80-0.80	D								
1.00-1.45	SPT N=23		1,2/2,5,7,9		1.00				
					(0.55)	Stiff, high strength, brownish grey mottled brown slightly sandy gravelly CLAY. Sand is fine. Gravel is fine to coarse subangular of siltstone.			
					1.55				
1.60-2.01	SPT 50*/140 25/270		25,25/25		1.60 (0.23)	Extremely weak thinly laminated grey slightly sandy SILTSTONE. SPT test no recovery.			
					1.83	Complete at 1.83m			

Remarks
Ground checked for services with CAT prior to drilling. No groundwater encountered.
Borehole finished due to SPT refusal at 1.83m on siltstone.
Monitoring well installed to 1.6m - slotted from base to 0.6m, with gravel surround, plain above, with bentonite seal. Bung, tap and locking cover provided.

Scale (approx)	Logged By
1:25	W.W

Figure No. GAR/03.WS1

ARP GEOTECHNICAL LTD
CHARTERED CONSULTING ENGINEERS

Site Land at St Lukes, Bierley Marsh			**Number** WS2
Excavation Method Dando Terrier Window Sampler Rig.	**Dimensions**	**Ground Level (mOD)**	**Client** Owens Developments Ltd	**Job Number** ODL/01
	Location	**Dates** 02/07/2024	**Engineer** WW	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40)	Brownish grey slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine. Gravel is fine subrounded of sandstone. Frequent rootlets.		
0.30-0.30	D				0.40			
					(0.60)	Firm brownish grey mottled brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is fine subangular of siltstone. Occasional rootlets.		
1.00-1.45	SPT N=11		2,2/2,3,3,3		1.00			
					(0.90)	Firm, medium strength, brownish grey mottled brown slightly sandy gravelly CLAY. Sand is fine. Gravel is fine to coarse subangular of siltstone.		
					1.90			
					(0.10)	Extremely weak thinly laminated slightly sandy SILTSTONE.		
2.00-2.37	SPT 25*/130 50/240		12,13/35,15		2.00	SPT test no recovery.		
					(0.30)			
					2.30	Complete at 2.30m		

Remarks
Ground checked for services with CAT prior to drilling. No groundwater encountered.
Borehole finished due to SPT refusal at 2.3m on siltstone.
Borehole backfilled with arisings.

Scale (approx)	Logged By
1:25	W.W

Figure No. ODL/01.WS2

ARP GEOTECHNICAL LTD
CHARTERED CONSULTING ENGINEERS

Site	Number
Land at St Lukes, Bierley Marsh	WS3

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Dando Terrier Window Sampler Rig.			Owens Developments Ltd	ODL/01
	Location	**Dates** 02/07/2024	**Engineer** WW	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.20-0.20	D				(0.30) 0.30	Brownish grey slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine. Gravel is fine subrounded of sandstone. Frequent rootlets.		
					(0.70) 1.00	Firm brownish grey mottled brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is fine subangular of siltstone. Occasional rootlets.		
1.00-1.45	SPT N=14		5,4/4,3,3,4		(0.65) 1.65	Firm, medium strength, brownish grey mottled brown slightly sandy gravelly CLAY. Sand is fine. Gravel is fine to coarse subangular of siltstone.		
1.70-2.15	SPT 10/295		25,50/10		1.70 (0.23) 1.93	Extremely weak thinly laminated grey slightly sandy SILTSTONE. SPT test no recovery.		
						Complete at 1.93m		

Remarks
Ground checked for services with CAT prior to drilling. No groundwater encountered.
Borehole finished due to SPT refusal at 1.93m on siltstone.
Borehole backfilled with arisings.

Scale (approx)	Logged By
1:25	W.W

Figure No. ODL/01.WS3

ARP GEOTECHNICAL LTD
CHARTERED CONSULTING ENGINEERS

Site	Number
Land at St Lukes, Bierley Marsh	WS4

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Dando Terrier Window Sampler Rig.			Owens Developments Ltd	ODL/01
	Location	**Dates** 02/07/2024	**Engineer** WW	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40)	Brownish grey slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine. Gravel is fine subrounded of sandstone. Frequent rootlets.		
0.30-0.30	D				0.40	Firm brownish grey mottled brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is fine subangular of siltstone. Occasional rootlets.		
0.70-0.70	D				(0.60)			
1.00-1.45	SPT N=12		3,2/4,3,3,2		1.00	Firm, medium strength, brownish grey mottled brown slightly sandy gravelly CLAY. Sand is fine. Gravel is fine to coarse subangular of siltstone.		
					(0.80)			
2.00-2.45	SPT N=30		4,6/9,7,7,7		1.80	Firm, medium strength, brownish grey mottled brown slightly sandy very gravelly CLAY. Sand is fine. Gravel is fine to coarse subangular of siltstone. From 2.0m: Becomes high strength.		
					(0.90)			
					2.70 (0.10) 2.80	Extremely weak thinly laminated grey slightly sandy SILTSTONE.		
2.80-3.11	SPT 25*/80 50/230		19,6/20,21,9		(0.28)	SPT test no recovery.		
					3.08	Complete at 3.08m		

Remarks
Ground checked for services with CAT prior to drilling. No groundwater encountered.
Borehole finished due to SPT refusal at 2.08m on siltstone.
Borehole backfilled with arisings.

Scale (approx)	Logged By
1:25	W.W

Figure No. GAR/03.WS4

ARP GEOTECHNICAL LTD
CHARTERED CONSULTING ENGINEERS

Site Land at St Lukes, Bierley Marsh			**Number** WS5
Excavation Method Dando Terrier Window Sampler Rig.	**Dimensions**	**Ground Level (mOD)**	**Client** Owens Developments Ltd	**Job Number** ODL/01
	Location	**Dates** 02/07/2024	**Engineer** WW	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.40)	Brownish grey slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine. Gravel is fine subrounded of sandstone. Frequent rootlets.			
0.30-0.30	D				0.40	Firm brownish grey mottled brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is fine subangular of silty sandstone. Occasional rootlets.			
0.60-0.60	D				(0.50)				
					0.90				
					(0.10)	Extremely weak thinly laminated yelllowish brown fine silty SANDSTONE.			
1.00-1.41	SPT 50/255		10,13/12,18,17,3		1.00	SPT test no recovery.			
					(0.41)				
					1.41	Complete at 1.41m			

Remarks
Ground checked for services with CAT prior to drilling. No groundwater encountered.
Borehole finished due to SPT refusal at 1.41m on sandstone.
Monitoring well installed to 1.0m - slotted from base to 0.5m, with gravel surround, plain above, with bentonite seal. Bung, tap and locking cover provided.

Scale (approx)	Logged By
1:25	W.W

Figure No. ODL/01.WS5

ARP GEOTECHNICAL LTD
CHARTERED CONSULTING ENGINEERS

Site	Number
Land at St Lukes, Bierley Marsh	WS6

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Dando Terrier Window Sampler Rig.			Owens Developments Ltd	ODL/01
	Location	**Dates** 02/07/2024	**Engineer** WW	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.35)	MADE GROUND: Brownish grey sandy gravelly clayey TOPSOIL. Sand is fine. Gravel is fine subrounded of sandstone. Frequent rootlets.			
0.40-0.40	D				0.35 (0.15) 0.50	MADEGROUND: Dark reddish brown sandy clayey fine subangular GRAVEL of brick clinker and sandstone.			
					(0.50)	Firm brownish grey mottled brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is fine subangular of siltstone. Occasional rootlets.			
1.00-1.45	SPT N=14		1,2/2,5,4,3		1.00 (1.00)	Firm, medium strength, brownish grey mottled brown slightly sandy gravelly CLAY. Sand is fine. Gravel is fine to coarse subangular of siltstone.			
1.60-1.60	D								
2.00-2.45	SPT N=19		3,3/4,4,5,6		2.00 (1.00)	Stiff, high strength, brownish grey mottled brown slightly sandy very gravelly CLAY. Sand is fine. Gravel is fine to coarse subangular of siltstone.			
3.00-3.45	SPT N=22		4,5/5,5,5,7		3.00 (0.95)	Stiff, high strength, dark grey very gravelly CLAY. Gravel is medium to coarse shaley mudstone.			
3.60-3.60	D								
4.00-4.45	SPT 50/295		8,10/20,30		3.95 4.00 (0.25) 4.25	Extremely weak thinly laminated grey silty MUDSTONE. SPT test no recovery. Complete at 4.25m			

Remarks
Ground checked for services with CAT prior to drilling. No groundwater encountered.
Borehole finished due to SPT refusal at 4.25m on mudstone.
Monitoring well installed to 4.0m - slotted from base to 1.0m, with gravel surround, plain above, with bentonite seal. Bung, tap and locking cover provided.

Scale (approx)	Logged By
1:25	W.W

Figure No. GAR/03.WS6

APPENDIX D

LAB TESTS & SCREENING

ARP GEOTECHNICAL LIMITED
IMPORTED SOIL CONTAMINANT SCREENING VALUES
RESIDENTIAL WITH HOME-GROWN PRODUCE

Determinand	S4UL (unless stated otherwise) (mg/kg)			C4SL (mg/kg)		
Arsenic	37			37		
Cadmium	11			22		
Chromium (trivalent) (MAFF)	400					
Chromium (hexavalent)	6			21		
Copper (MAFF)	80#					
Lead				200		
Inorganic Mercury	40			200		
Nickel (MAFF)	50#					
Selenium	250					
Zinc (MAFF)	200#					
Acidity (pH)	*Should be Greater Than 5			*Should be Greater Than 5		
	1% SOM	**2.5% SOM**	**6% SOM**	**1% SOM**	**2.5% SOM**	**6% SOM**
Naphthalene	2.3	5.6	13	15	36	85
Acenaphthylene	170	420	920			
Acenaphthene	210	510	1,100			
Fluorene	170	400	860			
Phenanthrene	95	220	440			
Anthracene	2,400	5,400	11,000			
Fluoranthene	280	560	890			
Pyrene	620	1,200	2,000			
Benzo(a)anthracene	7.2	11	13			
Chrysene	15	22	27			
Benzo(b)fluoranthene	2.6	3.3	3.7			
Benzo(k)fluoranthene	77	93	100			
Benzo(a)pyrene	2.2	2.7	3			5
Indeno(1,2,3-cd)pyrene	27	36	41			
Dibenzo(a,h)anthracene	0.24	0.28	0.30			
Benzo(g,h,I)perylene	320	340	350			
Phenols	120	200	380			
Total TPH	*Above 500, speciate and compare with values below:					
C5 to C6 Aliphatic	42	78	160			
C6 to C8 Aliphatic	100	230	530			
C8 to C10 Aliphatic	27	65	150			
C10 to C12 Aliphatic	130	330	760			
C12 to C16 Aliphatic	1100	2,400	4,300			
C16 to C35 Aliphatic	65,000	92,000	110,000			
C35 TO C44 Aliphatic	65,000	92,000	110,000			
C5 to C7 Aromatic (Benzene)	70	140	300			
C7 to C8 Aromatic (Toluene)	130	290	660			
C8 to C10 Aromatic	34	83	190			
C10 to C12 Aromatic	74	180	380			
C12 to C16 Aromatic	140	330	660			
C16 to C21 Aromatic	260	540	930			
C21 TO C35 Aromatic	1100	1,500	1,700			
C35 TO C44 Aromatic	1100	1,500	1,700			
Asbestos	*Should be None Detected			*Should be None Detected		

* In House Value/Approach S4UL = Suitable 4 Use Level, CIEH/LQM 2014 C4SL = Cat 4 Screening Level, DEFRA, 2014

Blank cell indicates no published value or in-house value. Some values presented are above saturation limits.

MAFF: Ministry of Agriculture, Fisheries and Food - "Code of Good Agricultural Practice for the Protection of Soil

#pH dependent. If exceeded, to be compared against appropriate MAFF value for the pH

eurofins | Chemtest
Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.:	24-22847-1
Initial Date of Issue:	28-Jul-2024
Re-Issue Details:	
Client	ARP Geotechnical Ltd
Client Address:	5/6 Northwest Business Park Servia Hill Leeds Yorkshire LS6 2QH
Contact(s):	William Watkins
Project	GAR/03 Land At St Lukes Bierley Marsh

Quotation No.:	Q24-33517	**Date Received:**	18-Jul-2024
Order No.:	GAR/03	**Date Instructed:**	18-Jul-2024
No. of Samples:	9		
Turnaround (Wkdays):	5	**Results Due:**	24-Jul-2024
Date Approved:	28-Jul-2024		

Approved By:

Details: David Smith, Technical Director

For details about application of accreditation to specific matrix types, please refer to the Table at the back of this report

Results - Soil

Project: GAR/03 Land At St Lukes Bierley Marsh

Client: ARP Geotechnical Ltd				**Chemtest Job No.:**		24-22847	24-22847	24-22847	24-22847	24-22847	24-22847	24-22847	24-22847
Quotation No.: Q24-33517				**Chemtest Sample ID.:**		1837507	1837508	1837509	1837510	1837511	1837512	1837513	1837514
				Sample Location:		WS1	WS2	WS3	WS4	WS5	WS6	WS1	WS4
				Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):		0.20	0.30	0.20	0.30	0.60	0.40	0.80	0.70
				Bottom Depth (m):		0.20	0.30	0.20	0.30	0.60	0.40	0.80	0.70
				Date Sampled:		02-Jul-2024	02-Jul-2024	02-Jul-2024	02-Jul-2024	02-Jul-2024	02-Jul-2024	02-Jul-2024	02-Jul-2024
				Asbestos Lab:		DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM		
Determinand	**HWOL Code**	**Accred.**	**SOP**	**Units**	**LOD**								
ACM Type		U	2192		N/A	-	-	-	-	-	-		
Asbestos Identification		U	2192		N/A	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected		
Moisture		N	2030	%	0.020	16	20	23	22	13	23	19	19
Soil Colour		N	2040		N/A	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown
Other Material		N	2040		N/A	Stones, Roots and Glass	Stones and Roots	Stones and Roots	Stones and Roots	Stones	Stones and Roots	Stones and Roots	Stones and Roots
Soil Texture		N	2040		N/A	Clay	Loam	Clay	Clay	Clay	Loam	Clay	Sand
pH at 20C		M	2010		4.0	9.8	7.4	7.4	7.4	7.2	7.6	7.6	8.3
Sulphate (2:1 Water Soluble) as SO4		M	2120	g/l	0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.032	< 0.010	0.014
Sulphate (Total)		U	2430	mg/kg	100	< 100	1400	2500	1300	< 100	3800		
Arsenic		M	2455	mg/kg	0.5	30	33	59	29	8.0	240		
Cadmium		M	2455	mg/kg	0.10	0.76	0.55	2.1	1.3	< 0.10	0.14		
Chromium		M	2455	mg/kg	0.5	87	44	160	110	21	20		
Copper		M	2455	mg/kg	0.50	81	68	180	100	22	520		
Mercury		M	2455	mg/kg	0.05	0.24	0.30	0.55	0.34	< 0.05	0.07		
Nickel		M	2455	mg/kg	0.50	14	19	28	16	21	54		
Lead		M	2455	mg/kg	0.50	110	140	2000	93	33	130		
Selenium		M	2455	mg/kg	0.25	0.44	0.67	0.79	0.39	< 0.25	1.2		
Zinc		M	2455	mg/kg	0.50	180	240	340	200	71	97		
Chromium (Trivalent)		N	2490	mg/kg	1.0	87	44	160	110	21	20		
Chromium (Hexavalent)		N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50		
Organic Matter		M	2625	%	0.40	5.7	11	8.4	20	< 0.40	20		
Total TPH >C6-C40	EH_1D_Total	M	2670	mg/kg	10	[B] 150	[B] 180	[B] 240	[B] 120	[B] < 10	[B] 150		
Naphthalene		M	2800	mg/kg	0.10	< 0.10	0.32	1.1	< 0.10	< 0.10	0.31		
Acenaphthylene		N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Acenaphthene		M	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluorene		M	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Phenanthrene		M	2800	mg/kg	0.10	1.5	3.2	4.6	1.2	< 0.10	0.81		
Anthracene		M	2800	mg/kg	0.10	0.34	0.59	1.0	0.27	< 0.10	0.18		
Fluoranthene		M	2800	mg/kg	0.10	3.1	6.2	7.1	2.6	< 0.10	1.3		
Pyrene		M	2800	mg/kg	0.10	2.8	5.6	5.7	2.2	< 0.10	1.2		
Benzo[a]anthracene		M	2800	mg/kg	0.10	1.5	3.2	3.3	1.0	< 0.10	0.63		
Chrysene		M	2800	mg/kg	0.10	1.7	3.4	3.4	1.0	< 0.10	0.65		
Benzo[b]fluoranthene		M	2800	mg/kg	0.10	2.2	5.5	4.3	1.6	< 0.10	0.97		
Benzo[k]fluoranthene		M	2800	mg/kg	0.10	0.75	1.9	1.8	0.58	< 0.10	0.35		
Benzo[a]pyrene		M	2800	mg/kg	0.10	1.9	5.4	3.8	1.3	< 0.10	0.94		
Indeno(1,2,3-c,d)Pyrene		M	2800	mg/kg	0.10	1.2	3.2	2.3	0.78	< 0.10	< 0.10		

Results - Soil

Project: GAR/03 Land At St Lukes Bierley Marsh

Client: ARP Geotechnical Ltd				**Chemtest Job No.:**		24-22847	24-22847	24-22847	24-22847	24-22847	24-22847	24-22847	24-22847
Quotation No.: Q24-33517				**Chemtest Sample ID.:**		1837507	1837508	1837509	1837510	1837511	1837512	1837513	1837514
				Sample Location:		WS1	WS2	WS3	WS4	WS5	WS6	WS1	WS4
				Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):		0.20	0.30	0.20	0.30	0.60	0.40	0.80	0.70
				Bottom Depth (m):		0.20	0.30	0.20	0.30	0.60	0.40	0.80	0.70
				Date Sampled:		02-Jul-2024	02-Jul-2024	02-Jul-2024	02-Jul-2024	02-Jul-2024	02-Jul-2024	02-Jul-2024	02-Jul-2024
				Asbestos Lab:		DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM		
Determinand	**HWOL Code**	**Accred.**	**SOP**	**Units**	**LOD**								
Dibenz(a,h)Anthracene		N	2800	mg/kg	0.10	0.24	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[g,h,i]perylene		M	2800	mg/kg	0.10	1.0	2.7	2.0	0.91	< 0.10	< 0.10		
Total Of 16 PAH's		N	2800	mg/kg	2.0	18	41	40	13	< 2.0	7.3		
Total Phenols		M	2920	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		

Results - Soil

Project: GAR/03 Land At St Lukes Bierley Marsh

Client: ARP Geotechnical Ltd				**Chemtest Job No.:**		24-22847
Quotation No.: Q24-33517				**Chemtest Sample ID.:**		1837515
				Sample Location:		WS6
				Sample Type:		SOIL
				Top Depth (m):		1.60
				Bottom Depth (m):		1.60
				Date Sampled:		02-Jul-2024
				Asbestos Lab:		
Determinand	**HWOL Code**	**Accred.**	**SOP**	**Units**	**LOD**	
ACM Type		U	2192		N/A	
Asbestos Identification		U	2192		N/A	
Moisture		N	2030	%	0.020	10
Soil Colour		N	2040		N/A	Brown
Other Material		N	2040		N/A	Stones
Soil Texture		N	2040		N/A	Clay
pH at 20C		M	2010		4.0	7.3
Sulphate (2:1 Water Soluble) as SO4		M	2120	g/l	0.010	0.23
Sulphate (Total)		U	2430	mg/kg	100	
Arsenic		M	2455	mg/kg	0.5	
Cadmium		M	2455	mg/kg	0.10	
Chromium		M	2455	mg/kg	0.5	
Copper		M	2455	mg/kg	0.50	
Mercury		M	2455	mg/kg	0.05	
Nickel		M	2455	mg/kg	0.50	
Lead		M	2455	mg/kg	0.50	
Selenium		M	2455	mg/kg	0.25	
Zinc		M	2455	mg/kg	0.50	
Chromium (Trivalent)		N	2490	mg/kg	1.0	
Chromium (Hexavalent)		N	2490	mg/kg	0.50	
Organic Matter		M	2625	%	0.40	
Total TPH >C6-C40	EH_1D_Total	M	2670	mg/kg	10	
Naphthalene		M	2800	mg/kg	0.10	
Acenaphthylene		N	2800	mg/kg	0.10	
Acenaphthene		M	2800	mg/kg	0.10	
Fluorene		M	2800	mg/kg	0.10	
Phenanthrene		M	2800	mg/kg	0.10	
Anthracene		M	2800	mg/kg	0.10	
Fluoranthene		M	2800	mg/kg	0.10	
Pyrene		M	2800	mg/kg	0.10	
Benzo[a]anthracene		M	2800	mg/kg	0.10	
Chrysene		M	2800	mg/kg	0.10	
Benzo[b]fluoranthene		M	2800	mg/kg	0.10	
Benzo[k]fluoranthene		M	2800	mg/kg	0.10	
Benzo[a]pyrene		M	2800	mg/kg	0.10	
Indeno(1,2,3-c,d)Pyrene		M	2800	mg/kg	0.10	

Results - Soil

Project: GAR/03 Land At St Lukes Bierley Marsh

Client: ARP Geotechnical Ltd				**Chemtest Job No.:**		24-22847
Quotation No.: Q24-33517				**Chemtest Sample ID.:**		1837515
				Sample Location:		WS6
				Sample Type:		SOIL
				Top Depth (m):		1.60
				Bottom Depth (m):		1.60
				Date Sampled:		02-Jul-2024
				Asbestos Lab:		
Determinand	**HWOL Code**	**Accred.**	**SOP**	**Units**	**LOD**	
Dibenz(a,h)Anthracene		N	2800	mg/kg	0.10	
Benzo[g,h,i]perylene		M	2800	mg/kg	0.10	
Total Of 16 PAH's		N	2800	mg/kg	2.0	
Total Phenols		M	2920	mg/kg	0.10	

Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63. Chemtest have a procedure to ensure 'upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s)'. This policy and the respective holding times applied, can be supplied upon request.The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERTs accredited but the results may be compromised.

Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
1837507			WS1	02-Jul-2024	B	Amber Glass 250ml
1837507			WS1	02-Jul-2024	B	Amber Glass 60ml
1837507			WS1	02-Jul-2024	B	Plastic Tub 500g
1837508			WS2	02-Jul-2024	B	Amber Glass 250ml
1837508			WS2	02-Jul-2024	B	Amber Glass 60ml
1837508			WS2	02-Jul-2024	B	Plastic Tub 500g
1837509			WS3	02-Jul-2024	B	Amber Glass 250ml
1837509			WS3	02-Jul-2024	B	Amber Glass 60ml
1837509			WS3	02-Jul-2024	B	Plastic Tub 500g
1837510			WS4	02-Jul-2024	B	Amber Glass 250ml
1837510			WS4	02-Jul-2024	B	Amber Glass 60ml
1837510			WS4	02-Jul-2024	B	Plastic Tub 500g
1837511			WS5	02-Jul-2024	B	Amber Glass 250ml
1837511			WS5	02-Jul-2024	B	Amber Glass 60ml
1837511			WS5	02-Jul-2024	B	Plastic Tub 500g
1837512			WS6	02-Jul-2024	B	Amber Glass 250ml
1837512			WS6	02-Jul-2024	B	Amber Glass 60ml

Test Methods

SOP	Title	Parameters included	Method summary	Water Accred.
2010	pH Value of Soils	pH at 20°C	pH Meter	
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <30°C.	
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930	
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES	
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry	
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.	
2455	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.	
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.	
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.	
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID	
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenz[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS	
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.	

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

This report shall not be reproduced except in full, and only with the prior approval of the laboratory.
Any comments or interpretations are outside the scope of UKAS accreditation.
The Laboratory is not accredited for any sampling activities and reported results relate to the samples 'as received' at the laboratory.
Uncertainty of measurement for the determinands tested are available upon request .
None of the results in this report have been recovery corrected.
All results are expressed on a dry weight basis.

The following tests were analysed on samples 'as received' and the results subsequently corrected to a dry weight basis EPH, VPH, TPH, BTEX, VOCs, SVOCs, PCBs, Phenols.

For all other tests the samples were dried at ≤ 30°C prior to analysis.
All Asbestos testing is performed at the indicated laboratory .
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1.

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt.
All water samples will be retained for 14 days from the date of receipt.
Charges may apply to extended sample storage.

Water Sample Category Key for Accreditation

DW - Drinking Water
GW - Ground Water
LE - Land Leachate
NA - Not Applicable

Report Information

PL - Prepared Leachate
PW - Processed Water
RE - Recreational Water
SA - Saline Water
SW - Surface Water
TE - Treated Effluent
TS - Treated Sewage
UL - Unspecified Liquid

Clean Up Codes

NC - No Clean Up
MC - Mathematical Clean Up
FC - Florisil Clean Up

HWOL Acronym System

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 - Aromatic only
2D - GC-GC – Double coil gas chromatography
#1 - EH_2D_Total but with humics mathematically subtracted
#2 - EH_2D_Total but with fatty acids mathematically subtracted
+ - Operator to indicate cumulative e.g. EH+EH_Total or EH_CU+HS_Total

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

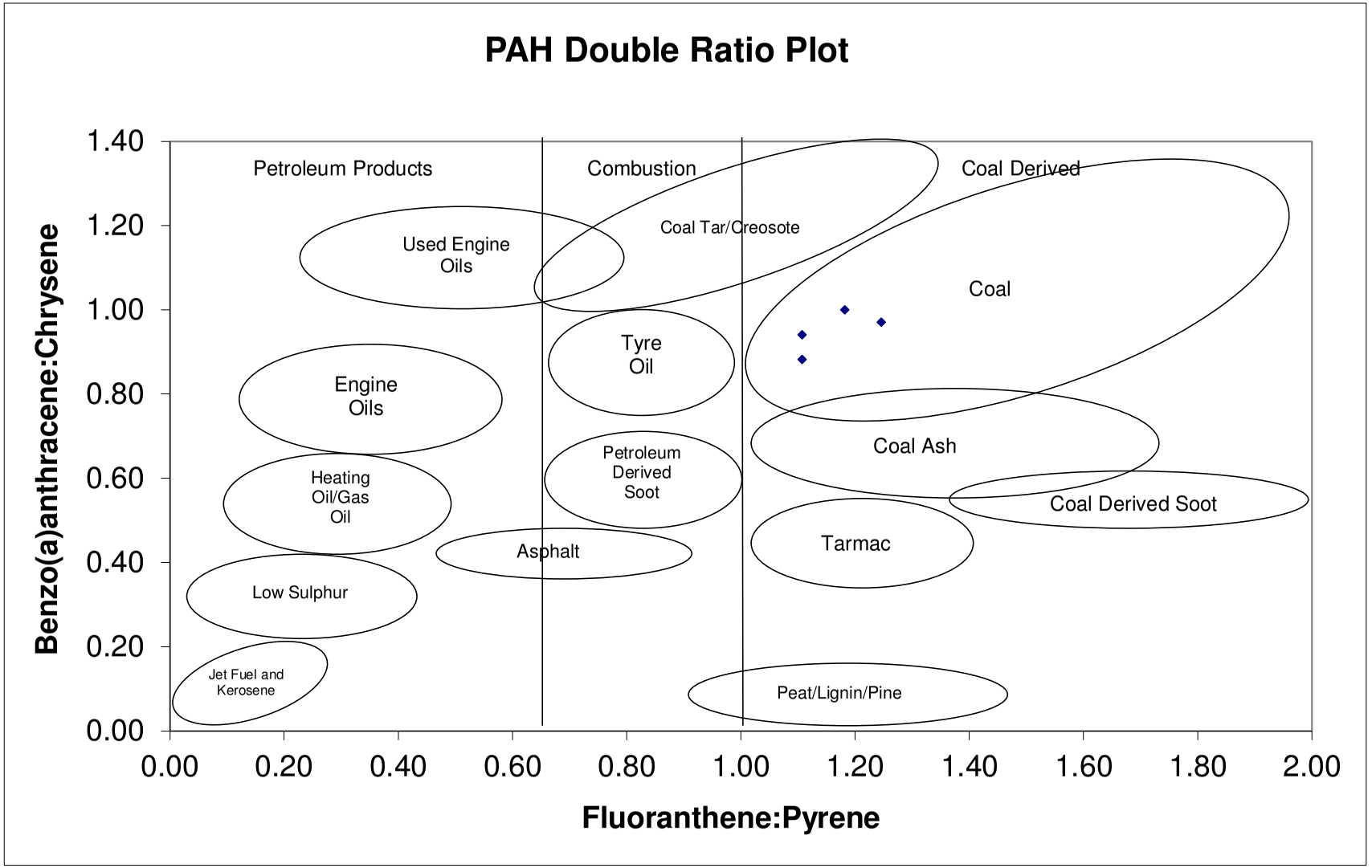
ARP GEOTECHNICAL LIMITED

PAH DOUBLE PLOT RATIOS TO DETERMINE PAH ORIGINS

Material: Topsoil

Site: Land at St. Lukes, Bierley Marsh **Job No: ODY/01**

Sample	Fluoranthene	Pyrene	Ratio Fl:Py	BAP Conc.	Benzo(a) anthracene	Chysene	Ratio B:Ch
WS1	3.10	2.80	**1.11**		1.50	1.70	**0.88**
WS2	6.20	5.60	**1.11**		3.20	3.40	**0.94**
WS3	7.10	5.70	**1.25**		3.30	3.40	**0.97**
WS4	2.60	2.20	**1.18**		1.00	1.00	**1.00**


PAH Double Ratio Plot
Benzo(a)anthracene:Chrysene
Fluoranthene:Pyrene
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Petroleum Products
Combustion
Coal Derived
Used Engine Oils
Coal Tar/Creosote
Coal
Tyre Oil
Engine Oils
Petroleum Derived Soot
Coal Ash
Heating Oil/Gas Oil
Coal Derived Soot
Asphalt
Tarmac
Low Sulphur
Jet Fuel and Kerosene
Peat/Lignin/Pine

LABORATORY REPORT

Contract Number: PSL24/5288

Report Date: 07 August 2024

Client's Reference: GAR/03

Client Name: ARP Geotechnical Ltd
Northwest House
5/6 Northwest Business Park
Servia Hill
Leeds
LS6 2QH

For the attention of: William Watkins

Contract Title: Land at St Lukes Brierley Marsh

Date Received: 24/7/2024
Date Commenced: 24/7/2024
Date Completed: 7/8/2024

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

A Watkins
(Managing Director)

R Berriman
(Associate Director)

S Royle
(Laboratory Manager)

L Knight
(Assistant Laboratory Manager)

D Nicholson
(Senior Technician)

T Watkins
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Doncaster,
DN4 0AR
Tel: 01302 768098
Email: rberriman@prosoils.co.uk
awatkins@prosoils.co.uk

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
WS1	1	D	0.80		Brown mottled grey slightly sandy very silty CLAY.
WS4	1	D	0.70		Brown mottled grey slightly sandy very silty CLAY.
WS6	1	D	1.60		Brown mottled grey slightly gravelly sandy very silty CLAY.

UKAS TESTING 4043

PSL PROFESSIONAL SOILS LABORATORY A PHENNA GROUP COMPANY

Land at St Lukes Bierley Marsh

Contract No: PSL24/5288

Client Ref: GAR/03

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Linear Shrinkage % Clause 6.5	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
WS1	1	D	0.80		25			47	24	23	100	Intermediate Plasticity CI
WS4	1	D	0.70		24			45	25	20	100	Intermediate Plasticity CI
WS6	1	D	1.60		16			39	20	19	97	Intermediate Plasticity CI

SYMBOLS : **NP : Non Plastic** *** : Liquid Limit and Plastic Limit Wet Sieved.**

UKAS TESTING 4043

PSL PROFESSIONAL SOILS LABORATORY A PHENNA GROUP COMPANY

Land at St Lukes Bierley Marsh

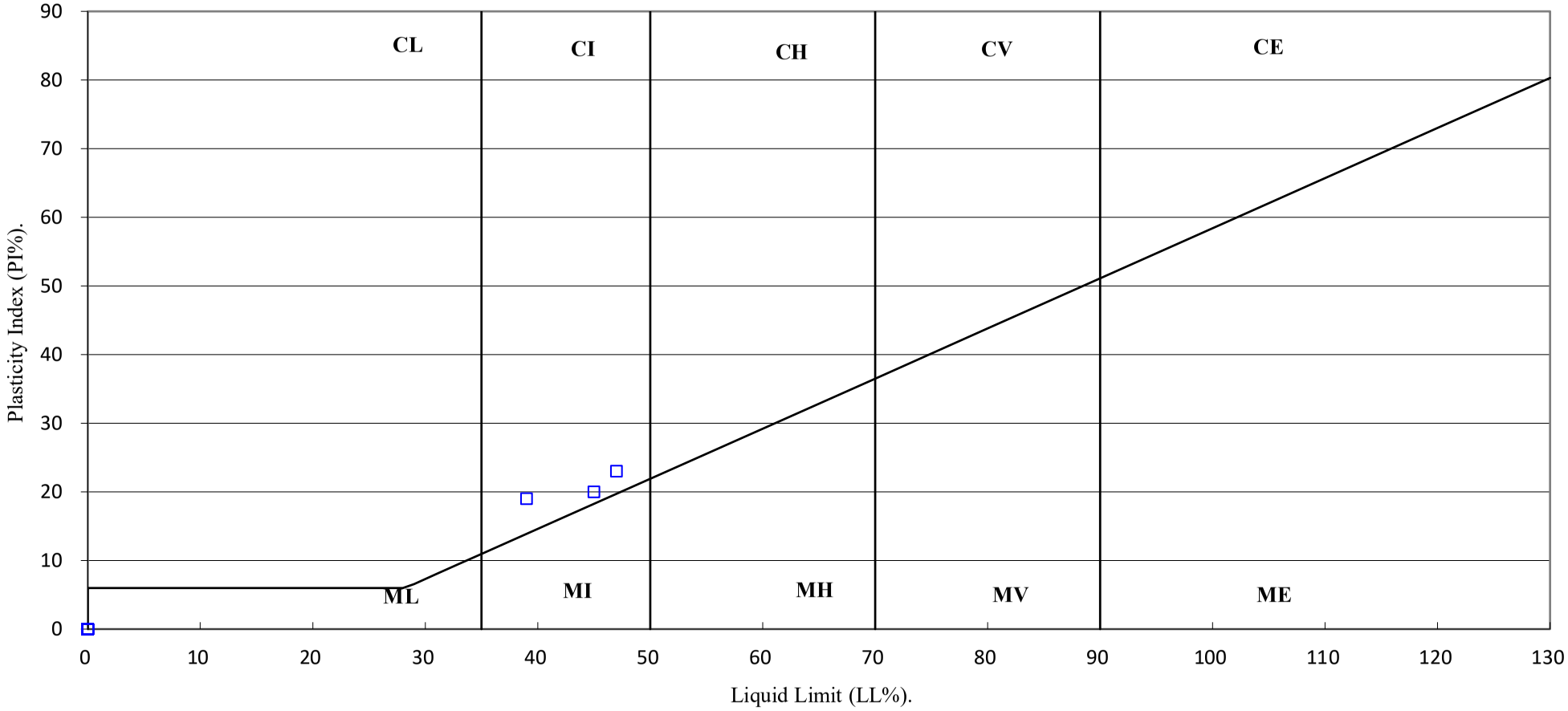
Contract No:

PSL24/5288

Client Ref:

GAR/03

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



UKAS TESTING 4043	PSL PROFESSIONAL SOILS LABORATORY A PHENNA GROUP COMPANY	**Land at St Lukes Bierley Marsh**	**Contract No:**
			PSL24/5288
			Client Ref:
			GAR/03

APPENDIX E

RISK CATEGORISATION TABLES

Severity of Consequence

Severe	Short term (acute) risks to human health, likely to result in significant harm. Major pollution of (watercourses or groundwater)
Medium	Long-term (Chronic) damage (significant harm) to human health. Pollution of sensitive water resources.
Mild	Pollution of non-sensitive water resources.
Minor	Non-permanent health effects easily prevented by use of personal protective equipment during site works.

Probability of Risk Event Occurring

High Likelihood	There is a pollutant linkage and an event that either appears very likely in the short term, almost inevitable in the long term, or there is evidence of harm or pollution at the receptor.
Likely	There is a pollution linkage and all the elements are present and in the right place, so that a risk event is possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible under which a risk event could occur. However, it is not certain that such an event would take place even over a longer period, and even less likely in the short term.
unlikely	There is a pollution linkage, but circumstances are such that it is improbable that an event would occur even in the very long term.

Comparison of Probability Against Severity of Consequence

		Severity of Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**High Likelihood**	**Very High Risk**	**High Risk**	**Moderate Risk**	**Moderate/ Low Risk**
	Likely	**High Risk**	**Moderate Risk**	**Moderate/ Low Risk**	**Low Risk**
	Low Likelihood	**Moderate Risk**	**Moderate/ Low Risk**	**Low Risk**	**Very Low Risk**
	Unlikely	**Moderate/ Low Risk**	**Low Risk**	**Very Low Risk**	**Very Low Risk**

Risk Categories - Definitions

Very High Risk	High probability that severe harm could arise to a receptor, or there is evidence that severe harm is already occurring. Urgent investigation is required and urgent remediation is likely to be required.
High Risk	Harm is likely to arise to a receptor. Urgent investigation is required and remediation may be necessary in the short term and likely over the longer term.
Moderate Risk	Possible that harm could arise to a receptor, but low likelihood that such harm would be severe. Harm is likely to be mild. Investigation normally required to clarify risk. Some remedial works may be required in the long-term.
Moderate/ Low Risk	Possible that harm could arise to a receptor, but where a combination of likelihood and consequence results in a risk that is above low, but is not of sufficient concern to be classified as mild. Limited further investigation may be required to clarify the risk. If necessary, remediation works are likely to be limited in extent.
Low Risk	Possible that harm could arise to a receptor. Such harm, at worst, would normally be mild.
Very Low Risk	Low possibility that harm could arise to a receptor. Such harm is unlikely to be any worse than mild.

APPENDIX F

REMEDIATION STRATEGY

CONTAMINATION REMEDIATION STATEMENT

AT

LAND AT ST LUKES

BIERLEY MARSH

EAST BIERLEY

ON BEHALF OF

OWENS DEVELOPMENTS LTD

ARP GEOTECHNICAL LTD

CHARTERED CONSULTING ENGINEERS

Northwest House 5/6 Northwest Business Park Servia Hill Leeds LS6 2QH

0113 245 8498 leeds@arpgeotechnical.co.uk www.arpconsultingengineers.co.uk

CLIENT:	OWENS DEVELOPMENTS LTD
JOB NUMBER:	ODL/01
PROJECT:	LAND AT ST LUKE'S, BIERLEY MARSH, EAST BIERLEY
REPORT TYPE:	CONTAMINATION REMEDIATION STATEMENT
REPORT REFERENCE:	ODL/01rem1

	Name	**Signature**
Prepared By:	J Pemberton BSc	
Reviewed By:	J Race BSc CGeol FGS EurGeol	
Authorised BY:	Mike Harper BSc(Hons) MSc CEnv	

ISSUE	**DATE**	**STATUS**
1	16TH SEPTEMBER 2024	V1 FINAL

1.0 Introduction

1.1 This document has been prepared to provide information for the Client and other interested parties, such as the regulatory authorities, outlining how contamination encountered on the site will be managed to ensure that the site is environmentally suitable for the intended residential use. The document should be agreed, prior to implementation, with the relevant regulatory authorities, usually the local planning authority and building control provider.

2.0 The Site

2.1 The ARP Geotechnical Ltd Stage 2 Geo-environmental Report, dated September 2024, under reference ODL/01r1, makes an assessment of contamination, along with other aspects.

2.2 The conceptual site model is for a residential development with private gardens.

2.3 At the time of the investigation, the site comprised an irregular shaped parcel of rough grassland. Vegetation clearance had recently been undertaken across the site. Access to the site is through a gate off Bierley Marsh in the southwestern corner of the site. Numerous mature trees and hedges are present along the boundaries of the site.

2.4 The geological maps show the site to be underlain by an unnamed sandstone unit of the Lower Coal Measures. No superficial deposits are indicated to be present.

2.5 The Bedrock Aquifer Designation is "Secondary A". There are no groundwater abstractions within 1km of the site.

2.6 There are no watercourses on or adjacent to the site. The nearest watercourse downslope is Lodge Beck, at 550m to the southeast. There are no surface water abstractions within 1km of the site.

2.7 No radon protective measures are stated to be necessary for new dwellings or extensions on the site. Due to the presence of potential landfill gas sources within 250m of the site, gas monitoring is ongoing and will be reported separately upon completion.

2.8 The third-party desk study indicates that the site has largely been undeveloped until the 1920s. Several small unidentified structures were stated to be present across the site between the 1920s and the 1950s. The structures were cleared by 1956 and no evidence of the buildings was visible during the site walkover. An assessment of Google Earth images by ARP shows that the site has been planted with crops during the period between 2002 and possibly 2015.

2.9 At all locations except WS6, a surface covering of natural topsoil was present, between 0.3m and 0.4m thick. In WS6, made ground topsoil was encountered to 0.35m depth, over granular made ground containing brick, clinker and sandstone to 0.5m depth. Below the topsoil and made ground, natural clays were present to depths of between 0.9m and 3.95m, onto intact bedrock (mainly siltstone, locally mudstone and sandstone).

2.10 Contamination testing showed the made ground at WS6 to have elevated arsenic (240mg/kg), and the topsoil was shown to have widespread (95% UCL and no outliers) slightly elevated benzo[b]fluoranthene (5.5mg/kg) and benzo[a]pyrene (5.3mg.kg), as a result of the presence of coal fragments. One outlier location (WS3) was also shown to have elevated arsenic (59mg/kg) and lead (2,000mg/kg).

3.0 Remediation Strategy

Topsoil

3.1 Based on existing laboratory test results, all the existing topsoil is unsuitable for re-use on the proposed residential development. However, it is recommended that additional sampling is undertaken on a closer grid (including resampling of WS3), with testing for arsenic, lead and speciated PAH, to provide more accurate representative concentrations for these determinands. If results are favourable, this could either prove the material to be suitable for retention on site, or at least minimise the amount to be removed.

3.2 The receiving tip for any removed topsoil may require Waste Acceptance Criteria testing. If topsoil is removed, then validation inspection will be required by the Geo-environmental Engineer, to verify its removal.

Made Ground (Found at WS6 Only)

3.3 Where any proposed garden or landscape areas overlie the existing made ground at WS6, a minimum 0.6m thickness of uncontaminated soils (topsoil and subsoil) should be provided. The proposed profile is provided on the table below. In areas of hardstanding or building footprints, the cover system is not required. system

Proposed cover profile in proposed gardens/landscaping areas

Layer	Thickness (m)	Description
A	Minimum 0.1*	Topsoil
B	Minimum 0.45*	Subsoil with a minimum 35% silt/clay content (at least 35% passing a 63 micron sieve), for example clay, sandy clay, or gravelly clay

* Individual layer minimum shown, but the combined thickness of Layer A and Layer B must be 0.6m.

3.4 Should the made ground be moved in its entirety, the cover system is not required. The receiving tip may require Waste Acceptance Criteria testing. If the made ground is removed, then validation inspection will be required by the Geo-environmental Engineer, to verify its removal.

3.5 Any soils used in the cover system, whether imported or site-won, will need to be verified as suitable by inspection and testing, in accordance with guidance supplied in the document produced by the Yorkshire and Lincolnshire Pollution Advisory Group (YALPAG): "Guidance on the Verification Requirements for Cover Systems". The measures described below will be required to ensure compliance with the document.

4.0 Validation

4.1 If contaminated made ground or topsoil is removed from site, then the resulting excavation base and faces will need to be inspected by an Engineer and sampled and tested on a 25m spacing to confirm its contamination status. The area will be photographed, and all the details included within a Validation Letter Report. The disposal/transfer documents should be retained for inclusion in the Validation Report.

4.2 If the made ground is retained on site below a clean soil cover system, then following placement of the cover soils in residential garden areas and public open spaces, it will be necessary to confirm the required 0.6m cover of uncontaminated soil has been placed, by excavating trial pits to 0.6m depth across these areas on the basis of one pit per every two plots (all excavated in rear gardens, but with an additional pit in a front garden for one in two of the rear garden pits) and pits on a maximum 25m spacing on public open space. The trial pits will be photographed, to include a reference scale, and the photographs included within any report to enable the location on site to be identified.

4.3 If the contaminated topsoil/made ground is removed from site to form an uncontaminated area or site, then the surface will need to be inspected by an Engineer and sampled and tested on a maximum 25m spacing to confirm its uncontaminated status. The area will be photographed, and all the details included within a Validation Letter Report. The disposal/transfer documents should be retained for inclusion in the Validation Report.

5.0 Laboratory Testing

5.1 For any imported subsoil and topsoil used, or any site-won uncontaminated topsoil and subsoil to be re-used on the site, the source will need to be confirmed, and the material tested for the attached suite of contaminants, to comply with the maximum screening values listed. The frequency of testing is given on the table below. Any samples already tested in the site investigation carried out to date can be considered part of the overall total required.

Material Type	**Number of Samples**
Topsoil or subsoil from greenfield / manufactured source	Minimum 3No. or 1 per 250m^3 (whichever is greater)
Topsoil or subsoil from brownfield / screened source.	Minimum 6No. or 1 per 100m^3 (whichever is greater)

5.2 When a potential source of soil is identified, the Client may provide ARP Geotechnical Ltd with supplier certificates, and we will comment on the apparent acceptability of the material. If no certificates are available, the Client may wish us to sample the material at source prior to import, or sample an example load delivered to site, to minimise potential for any problems later. The test results will be available approximately one week, or slightly more, after the site visit.

5.3 Provided the results of the above are acceptable, there are two options for validation:-

A. Import a stockpile of material to site sufficient to complete the required areas and invite ARP to take sufficient further samples of the stockpile for testing to fully approve it as a source. The stockpile should be isolated from any other materials on the site (becoming a

"Quarantined Stockpile"), fenced off to avoid any cross contamination, and must not be added to without further testing. The test results will be available approximately one week, or slightly more, after the site visit.

OR:

B. Import and place the material as and when required and invite ARP to sample the material when in place, during the inspection pits noted in Section 4. The samples will issued to the laboratory for contamination testing to confirm acceptability. The test results will be available approximately one week, or slightly more, after the site visit. Our letter report will be available a day or two later. Therefore, Clients should allow, for receiving the final letter report, two weeks after the site visit.

5.4 Any cross contamination of materials should be avoided, and further testing carried out where any cross contamination is suspected to have occurred.

5.5 The results of all the laboratory analysis, excavation logs, plans, photographs, and import documents will form part of the Remediation Validation Report for the group of plots.

6.0 Timescales for Remediation and Validation

6.1 It is anticipated that the clean soil cover systems will be placed progressively around a group of plots as their construction is nearing completion (usually following removal of scaffolding) and not sooner. This is to ensure that the soils will not be subjected to trafficking or cross contamination by construction activities once placed.

6.2 As soon as the soils are in place around a group of plots, validation can take place via inspection pits, as per Section 4 above.

6.3 Soils in any landscaped areas can be placed as soon as those areas are safe from any further construction trafficking.

6.4 If imported soils are to be used on the site then these can be imported at any time, for future use as quarantined stockpiles, provided there is sufficient space for storage.

6.5 The very latest a Validation Report for a group of plots should be issued is a week before the programmed Council of Mortgage Lenders "Finalling", and preferably before. The Planning Condition relating to contamination remediation validation cannot normally be discharged for a site until all the validation reports have been issued to the local authority, on completion of the development, or a combined Validation Report for the whole site is issued.

7.0 Unexpected Contamination

7.1 Any unexpected contamination uncovered during the works shall be inspected, sampled and analysed in laboratory for the suite of determinands appended to this Remediation Statement, and compared to the maximum concentration levels listed on the enclosure. Works on the affected materials shall cease until the appraisal is complete and, if necessary, a revised Remediation

Statement is to be prepared and approved by the Planning Authority before work is recommenced.

8.0 Protection of Workers and the Public During Development Works

8.1 Damping down of the contaminated made ground must be implemented during dry periods, and timely placement of the contaminated material below barriers.

8.2 Washing facilities and a clean mess room should be provided.

8.3 Site fencing will be provided to exclude access to members of the public, and contaminated material will be contained within the site boundary and placed below barriers as soon as possible.

8.4 Workers will be educated to use adequate hygiene and PPE.

8.5 Movement of contamination off site on vehicle wheels shall be minimised by cleaning of vehicle wheels and/or use of road sweeper, as required.

ARP GEOTECHNICAL LIMITED
IMPORTED SOIL CONTAMINANT SCREENING VALUES
RESIDENTIAL WITH HOME-GROWN PRODUCE

Determinand	S4UL (unless stated otherwise) (mg/kg)			C4SL (mg/kg)		
Arsenic	37			37		
Cadmium	11			22		
Chromium (trivalent) (MAFF)	400					
Chromium (hexavalent)	6			21		
Copper (MAFF)	80#					
Lead				200		
Inorganic Mercury	40			200		
Nickel (MAFF)	50#					
Selenium	250					
Zinc (MAFF)	200#					
Acidity (pH)	*Should be Greater Than 5			*Should be Greater Than 5		
	1% SOM	**2.5% SOM**	**6% SOM**	**1% SOM**	**2.5% SOM**	**6% SOM**
Naphthalene	2.3	5.6	13	15	36	85
Acenaphthylene	170	420	920			
Acenaphthene	210	510	1,100			
Fluorene	170	400	860			
Phenanthrene	95	220	440			
Anthracene	2,400	5,400	11,000			
Fluoranthene	280	560	890			
Pyrene	620	1,200	2,000			
Benzo(a)anthracene	7.2	11	13			
Chrysene	15	22	27			
Benzo(b)fluoranthene	2.6	3.3	3.7			
Benzo(k)fluoranthene	77	93	100			
Benzo(a)pyrene	2.2	2.7	3			5
Indeno(1,2,3-cd)pyrene	27	36	41			
Dibenzo(a,h)anthracene	0.24	0.28	0.30			
Benzo(g,h,I)perylene	320	340	350			
Phenols	120	200	380			
Total TPH	*Above 500, speciate and compare with values below:					
C5 to C6 Aliphatic	42	78	160			
C6 to C8 Aliphatic	100	230	530			
C8 to C10 Aliphatic	27	65	150			
C10 to C12 Aliphatic	130	330	760			
C12 to C16 Aliphatic	1100	2,400	4,300			
C16 to C35 Aliphatic	65,000	92,000	110,000			
C35 TO C44 Aliphatic	65,000	92,000	110,000			
C5 to C7 Aromatic (Benzene)	70	140	300			
C7 to C8 Aromatic (Toluene)	130	290	660			
C8 to C10 Aromatic	34	83	190			
C10 to C12 Aromatic	74	180	380			
C12 to C16 Aromatic	140	330	660			
C16 to C21 Aromatic	260	540	930			
C21 TO C35 Aromatic	1100	1,500	1,700			
C35 TO C44 Aromatic	1100	1,500	1,700			
Asbestos	*Should be None Detected			*Should be None Detected		

* In House Value/Approach S4UL = Suitable 4 Use Level, CIEH/LQM 2014 C4SL = Cat 4 Screening Level, DEFRA, 2014

Blank cell indicates no published value or in-house value. Some values presented are above saturation limits.

MAFF: Ministry of Agriculture, Fisheries and Food - "Code of Good Agricultural Practice for the Protection of Soil

#pH dependent. If exceeded, to be compared against appropriate MAFF value for the pH