



CALA HOMES Ltd

West End Lane Nursery, Angmering

Post-remediation validation report – Phase 1A

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RSK GENERAL NOTES

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Title: Post-remediation validation report - Phase 1A

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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.

This work has been undertaken in accordance with the quality management system of RSK Environment Ltd.

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1 INTRODUCTION

RSK Environment Limited (RSK) was commissioned by CALA Homes Limited, hereafter known as the client, to produce a post remediation works validation report for Phase 1A (Plots 1-64) of the land at the former West End Lane Nursery, Angmering, BN16 4AX.

This report is subject to the RSK service constraints given in **Appendix A**.

1.1 Background

This report details remedial and validation works carried out within the Phase 1A development area, as well as across the wider site.

Validation of the soft landscaping and garden areas within Phase 1A (Plots 1 -64) is still ongoing, the results of which will be reported to the National House Building Council (NHBC) and the Local Authority.

Several preceding phases of site investigation and associated risk assessments have been completed for the site by RSK. These are outlined in the following reports:

- RSK, 2015a. Geo-environmental Site Investigation, report ref: 27621 R01 (02), dated September 2015;
- RSK, 2015b. Additional Geo-environmental Site Investigation and Remediation, report ref: 27621 R02 (00), dated June 2015;
- RSK, 2016a. Remedial Strategy, report ref: 27621 R03 (01), dated January 2016;
- RSK, 2016b. Supplementary Geo-environmental Site Assessment, report ref: 27621 R04 (01), dated June 2016;
- RSK 2016c. Tank Validation, report ref: 27621 L01/ad, dated August 2016;
- RSK 2016d. Bund Validation Works, report ref: 27621 L02, dated October 2016;
- RSK 2016e. Asbestos Delineation Works Phase 1A – Plots 1 to 19, report ref: 27621 L04, dated October 2016; and
- RSK, 2017. Asbestos Delineation Works Phase 1A – Plots 18 and 20 to 64, report ref: 27621 L05, dated February 2017.

Further to the above, Keltbray Remediation, carried out the first phase of remedial works at the site in accordance with recommendations contained within the RSK Remedial Strategy (report ref: 27621 R03 (01), January 2016). RSK attended site on an ad hoc basis during Keltbrays first phase of works to provide advice on delineation, waste disposal and to carry out validation when required. The remedial works undertaken by Keltbray were documented in a Completion Report, (report ref: 6033.CR.LH.08072016V3, dated August 2016). It is understood that this report has already be submitted to the Local Authority and therefore has not been appended to this report.

The salient findings of all the aforementioned works are included within the following report. However the report should be read in conjunction with the previous reports listed above, some of which are included in **Appendix B**.

1.2 Objectives

The objective of the remediation is to produce a site that is suitable for its intended purposes (residential (housing and flats) end use with private gardens and communal soft landscaping) whilst providing a safe working environment with respect to site workers and adjacent users. This will involve the following measures:

- The placement of a suitable clean cover layer within any private gardens and proposed communal soft landscaped areas, locally deepened (to the requirements of the Landscape Architect) in the proximity of any proposed deep root-balled shrubs and/or trees: In order to break potential contamination pathways with respect to the underlying made ground.
- Following decommissioning and demolition of the CHP building, nitric acid store, substations and above ground storage tanks (ASTs), in the event that any visually impacted materials are observed, an Environmental Engineer be contacted so that appropriate sampling can be implemented to determine any additional remedial and validation requirements;
- Regrading of bund materials (where required) to form site levels, in accordance with the approved development plan; and to facilitate placement of a 'clean' cover layer across the remaining bund materials. Where possible material won as part of the re-grading exercise will be re-used on site in accordance with a materials management plan following the CL:AIRE Code of Practice.
- Incorporation of gas protection measures within the proposed buildings: structural barrier comprising suspended or ground bearing floor slab with appropriate ventilation and a gas resistant membrane, sealed at all joints and penetrations.
- Compliance with CAR 2012, through the adoption of safe working procedures with respect to the potential presence of asbestos containing materials (ACM) and notification to the HSE.

The objective this report is to demonstrate that the remedial objectives listed above have been achieved for Phase 1A and that this area of the site is suitable for its intended purposes by:

- Providing a record of validation sampling undertaken post demolition/site clearance, confirming suitability of remaining materials in Phase 1A for the proposed end use (residential).
- Production of a post remediation validation report recording all actions taken to implement the remedial works carried out to date: To confirm that remediation goals set out in the remedial strategy report (RSK ref: 27621 R03 (01), January 2016) have been achieved in Phase 1A and identify further works, if necessary.

1.3 Existing Conditions

The site is situated off Roundstone Lane, Angmering, BN16 4AX. The National Grid reference for the site is 507640, 103520 as shown on **Figure 1**. The site covers approximately 11 ha at an elevation of approximately 11 m above Ordnance Datum (AOD) with the exception that along some boundaries, there are bunds that rise up above general site levels.

The site is currently an active construction site, with the area known as Phase 1A containing Plots Nos. 1 to 64 near to completion.

Historically the site was arable land up until the construction of West End Nursery circa 1943. The nursery was extended during the 1970's towards the eastern part of the site with the construction of greenhouses.

Redevelopment of the site occurred from the 1990's, with the addition of smaller greenhouse's to the south. Also present from the 1990s were ASTs, a gas governor and laboratory in the south west of the site and a drainage pond in the south east. The laboratory was no longer present on mapping data between 2012 and 2014.

It is understood that the site is being redeveloped with 244 residential plots comprising a mixture of housing and flats, with private and communal gardens and some areas of communal soft landscaping. The development plan for Phase 1A is shown within **Figure 3**.

1.4 Regulatory Correspondence

As part of regulatory consultation process, the client forwarded all reports pertaining to the site to the relevant regulators for review and comment.

Subsequently the remedial strategy for the site was agreed with the Pollution Officer at Arun District Council.

Since agreement of the remedial strategy the following items, which deviate from the agreed remedial strategy or, are additional to the remedial strategy have been discussed and agreed as specified with the Council:

- A cover layer validation sampling frequency of one sample per 250 m³ in public open space areas has been agreed rather than one sample per 50 m³.
- Prevention of public access to south west bund B by fencing and planting of prickly vegetation to deter trespassers has been agreed. Photographic evidence confirming these measures have been incorporated shall be included in the verification report for this area of the site.
- A hotspot of ACM of similar composition to materials encountered in other areas of the site was identified in Phase 1B. In accordance with the remedial strategy CALA informed Keltbray and RSK of the discovery. Keltbray subsequently removed the impacted materials in accordance with their previously agreed method statements and existing Health and Safety Executive (HSE) licence. The materials were temporarily stored in their designated treatment area in the centre of the site. RSK discussed the discovery with the Pollution Officer at Arun District Council 12th April 2017. Following verbal agreement from the Local Authority, RSK attended site on the 12th April 2017 to screen the removed materials for volatiles using a photo-ionisation detector (PID) prior to placement in the central public open space (POS) area, please refer to **Section 2.2.7** for further details.
- Following queries raised by the NHBC regarding the gas membrane design submitted for the site, further gas assessment in regards to Phase 1A is in the process of being discussed with the NHBC and Local Authority. Options being considered at this time include subfloor void monitoring within 10 % of the plots across Phase 1A (this is the preferred option) or the installation of gas monitoring wells to allow 6 spot monitoring visits to be undertaken over a three week period. The gas membrane design drawings for the remainder of the site are in the process of being updated and shall be agreed with the NHBC prior to installation commencing across the remainder of the site.

Email correspondence between RSK and Arun District Council in regards to bullet points 1 and 2 above is presented in **Appendix C**.

1.5 Method Statement for Remediation of Contaminated Ground

The strategy proposed for the remedial works was based upon previous site investigations findings. Previous investigations found evidence for asbestos containing materials (ACM) in trial pits TP1-9 (all excavated through the bund materials) and within boreholes BH1, BH4, BH12 and BH15 during the initial ground investigation. Elevated concentrations of hydrocarbons and metals were also identified within bund materials. On this basis, a potentially complete pollutant linkage was identified to human health (construction workers and future residents) from asbestos in soil and elevated concentrations of hydrocarbons and metals.

Upon the basis of the original findings, the RMS outlined the following actions:

1.5.1 Implementation

The overall remediation strategy was divided into the enabling and demolition phase, i.e. those works required to produce a suitable development platform, and the subsequent construction phase.

The sequence of works required under both phases is outlined in the following sections relating to the proposed demolition sequence and the subsequent construction works.

- Before commencing demolition works of the remaining buildings, an asbestos survey suitable for demolition purposes should be undertaken to confirm the presence or absence of ACM within all structures. Where ACM are encountered removal an appropriately licensed contractor should undertake works before commencing demolition works. The demolition works were the responsibility of the vendor prior to handover of the site to our client. As such, no further details are available in regards to whether or not this was completed prior to demolition of the buildings.
- With regards to the removal of the ASTs and substations, live services to these features would need to be isolated/disconnected before removal. In addition the contents of any ASTs and associated pipework should be purged of their liquid contents. The liquid shall be tankered off-site for appropriate disposal by a licensed waste disposal contractor.
- The existing ASTs, substations and associated pipework, underlying concrete and brick, should be removed under the supervision of a suitably geo-environmental engineer and disposed off-site. Validation of the soils underlying these features, in relation to potential contamination, should be completed at the discretion of the geo-environmental engineer. Validation of the underlying soils is likely to include some or all of the following:
 - logging of the underlying materials to BS5930 (2015);
 - in-situ screening by a photo-ionisation device;
 - any materials suspected to be contaminated based on visual/olfactory observations and/or in-situ screening should be stockpiled in areas of impermeable surfacing (hard-standing/on impermeable geo-membrane material).

Soil sample(s) should be collected from the stockpiled material and submitted for laboratory analysis to verify its suitability for re-use on-site or off-site disposal; and

- Any remaining drains or service ducts associated with these features, which have the potential to provide a pathway for contaminant migration should be removed or sealed.
- In accordance with the proposed development plan, sections of the bunds were proposed to be regraded with the removal of the top 1.3 m (approximately). Following agreement from the Local Authority, the excavated materials were to be re-used beneath a clean capping layer in the central POS area. A capping layer to a minimum depth of 600 mm was subsequently required across the re-graded bunds and POS area. The capping materials were proposed to be sourced from natural subsoil won from the central POS area and imported topsoil, underlain by a geo-marker layer.
- It was recommended that material movements across the site be controlled through the implementation of a CL:AIRE Code of Practice Material Management Plan to demonstrate compliance of the four factors set out therein.

1.5.2 Construction Phase

1.5.2.1 Placement of clean cover soils

In order to break the identified pollutant linkages, within proposed areas of private gardens and communal soft landscaping the placement of a suitable clean cover layer was required. To address potential risks posed from the impacts identified in a sustainable manner, a zoned approach was to be adopted in relation to the thickness of the clean cover layer as detailed below:

- 600mm in areas of identified impact (remaining bund materials, pesticide hotspot, and made ground containing asbestos), un-investigated areas considered to potentially impacted (i.e. made ground extending to the south of the sites buildings considered to potentially contain asbestos and soils in the vicinity of the fuel tanks and nitric acid store) and in the central POS area; and
- 450mm in lower risk areas (i.e. no impacts identified during the previous phases of works, no significant un-investigated potential sources identified and distribution of exploratory locations considered appropriate for 'low risk' to be concluded. This zone primarily relates to the footprint of the green house.
- Soils were to be placed over a geomarker in high risk garden and soft risk landscape areas as indicated in **Figure 3**.

1.5.2.2 Installation of gas protection membranes

It was recommended that a detailed gas membrane installation design and implementation plan be completed in accordance with the recent updates in UK guidance (BS8485).

Following queries raised by the NHBC regarding the gas membrane design submitted for the site which incorporated a 1200 gauge membrane (prepared following advice from Opus Engineering Limited), further validation gas assessment in regards to Phase 1A is

in the process of being discussed with the NHBC and Local Authority. To date 1200 gauge membranes have been installed across Phase 1A.

Options being considered at this time in relation to further validation gas assessment include subfloor void monitoring within 10 % of the plots across Phase 1A (this is the preferred option) or the installation of gas monitoring wells to allow 6 spot monitoring visits to be undertaken over a 3 week period.

In the event that the validation monitoring does not demonstrate sufficiently low concentrations, integrity testing shall need to be undertaken to demonstrate retrospectively the integrity of the gas membranes in Phase 1A and if necessary based on the results retrospective mitigation measures may be required.

The gas membrane design drawings for the remainder of the site are in the process of being updated and shall be agreed with the NHBC and Local Authority prior to installation commencing across the remainder of the site.

1.5.3 Verification

1.5.3.1 Validation of clean cover soils

In accordance with the remedial strategy report, validation is required in regards to the thickness and chemical quality of the clean capping layer placed in gardens and areas of communal soft landscaping.

To verify the thickness of the cover layer, it will be necessary to dig through the cover layer at selected locations to verify the required thickness of topsoil, subsoil and presence of the marker layer where required.

In addition, validation samples are to be collected on a 1 in 50 m³ frequency for garden areas and a 1 on 250 m³ frequency in areas of communal soft landscaping as agreed with the Local Authority.

All chemical testing for validation purposes is required to be carried out by an MCERTS and UKAS accredited laboratory and the results compared to the relevant validation assessment criteria as set out in the remedial strategy report (RSK report ref: 27621 R03 (01), January 2016) and **Appendix D**.

1.5.3.2 Validation of gas protection measures

The gas installation and design plan was to provide details of verification requirements. However, it was recommended that as a minimum, validation certificates should be provided for the gas membrane installation along with supporting photographs, demonstrating that the membranes cover the entire building footprint and that all joints and penetrations have been suitably sealed in accordance with the manufacturer's guidelines.

2 REMEDIAL WORKS

The remedial works have been carried out in a phased approach as development has progressed at the site. The remedial works conducted at the site to date are summarised in the subsequent subsections. Laboratory certificates presenting the validation sampling results conducted to date are presented in **Appendix F**.

2.1 Keltbray Remediation Works

Keltbray Remediation (Keltbray) were instructed by the client to carry out a 1st phase of remediation works at the site between the 20th of April and 29th June 2016. The scope of works aimed to provide a record of works carried out in accordance with the RSK remedial strategy (report ref: 27621- R03 (01), January 2016), Environment Agency (EA) and Arun District Council (ADC).

The scope of Keltbray's 1st Phase of works was as follows:

- Excavation of ACM soils across the western perimeter (north west bund);
- A cut to 600 mm below existing ground level to facilitate the development of a new access road;
- Excavation of ACM soils to 600 mm below existing ground levels surrounding the existing residential property near the south west bund;
- Excavation of made ground within the proposed central POS, until natural soils were encountered and removal of visible ACM from arisings for off-site disposal;
- Over dig natural soils to provide suitable site won materials for bund capping subsoil layer;
- Utilise the void space created within the proposed central POS to accommodate the treated made ground (i.e. visible ACM removed); and
- Capping of bunds (north west, north east and south west) with geo-marker layer and 600mm of site won subsoil/imported topsoil.

Further to the above Keltbray completed a Materials Management Plan (MMP) for the site, in which all arisings were managed and re-used. Due to the large volume of soil requiring treatment over the course of the remediation works a mobile treatment permit was deployed.

Further details regarding the Keltbray works are provided in the Keltbray Completion Report (report ref: 6033.CR.LH.08072016v3. It is understood that this report has already been submitted to Arun District Council and as such has not be appended to this report.

2.2 Verification Works

Throughout the remedial works RSK has been attending site on an ad hoc basis to verify the works carried out. The verification works carried out thus far are summarised below:

2.2.1 Pesticide Validation Works (April 2016)

RSK carried out validation works on the 28th April 2016 within the vicinity of HA5, in which elevated concentrations of pesticides were previously recorded.

A series of hand excavated trial pits were considered the most appropriate methodology to delineate the pesticide hotspot previously identified in HA5.

Four samples (labelled HA5 V1-HA5 V4) were sent for validation laboratory testing. All samples were reported to be below laboratory detection limits for pesticides, therefore no further delineation works or remediation was deemed necessary in this area in relation to pesticides, other than the 450 mm capping layer proposed in lower risk garden and communal soft landscaped areas. The laboratory certificates for HA5 V1-HA5 V4 are presented in **Appendix F**.

2.2.2 Tank Validation Works (January & March 2016)

RSK carried out validation works on 25th January and 8th March 2016 in the vicinity of former above ground fuel storage tanks. The works undertaken are detailed in RSK letter report ref: 27621 L01 / ad, dated August 2016 (presented in **Appendix B**) and summarised below.

A series of mechanically excavated trial pits were considered to be the most appropriate investigation technique to provide suitable recovery of soils and inspection of potential contamination beneath the former tanks. A breaker was required to penetrate the concrete hardstanding that formed the base of the historic tanks.

The following site work was carried out:

- Trial pits V1-V4 – 25th January 2016; and
- Trial pits V5-V10 – 8th March 2016.

The locations of the above are shown in **Figure 2** and **Figure 2a**.

The general ground conditions encountered are summarised in **Table 1** below.

Table 1: Ground conditions encountered during tank validation works

Strata	Exploratory encountered holes	Depth to top of stratum m bgl	Thickness (m)
Topsoil	V9	0.00	0.10
Made Ground	All	0.00-0.10	>1.10
River Terrace Deposits	V5, V6, V7, V8, V9, V10	0.70-1.20	>0.70

Hydrocarbon odours were noted at V2, V3, V4, V6, V8 and V10. An oily product was noted to be seeping into trial pit V2 at 0.3m depth.

All soil samples were submitted for chemical laboratory testing comprising speciated total Petroleum Hydrocarbons (TPH-CWG). Additionally, soil sample V10 collected from the centre of the historic nitric acid store was tested for pH.

None of the validation samples collected were found to exceed the validation assessment criteria and pH was not found to be acidic in the sample tested from V10.

However, a total TPH concentration of 1,420mg/kg in the sample from V2 at 0.3m depth would classify this material as hazardous waste.

Evidence for an oil seepage in the ground as previously mentioned was identified at V2, around 0.3m depth. No other positions showed signs of oil seepage. It was recommended that the vicinity of V2 be further investigated by a suitably qualified geo-environmental consultant to identify the extent of oil contamination in this area of the site, with a view to excavating visually impacted soils from this location under the supervision of a suitably qualified geo-environmental engineer, for disposal as hazardous waste or treatment and re-use on site.

Further validation works by a geo-environmental consultant are planned to be undertaken in this area in accordance with the next phase of works commencing; **Phase 1B**. The remaining localised impacts in this area are not considered to pose a risk to the future residents of Phase 1A, neighbouring residents or construction works (subject to standard PPE requirements and good working practices as outlined in the remedial strategy).

2.2.3 Bund and POS Validation Works (April 2016)

2.2.3.1 *Validation of proposed natural materials for re-use as subsoil*

Prior to implementation of remedial works by Keltbray, RSK undertook a series of mechanically excavated trial pits on the 27th April 2016 in the central POS area to obtain representative soil samples to demonstrate that natural subsoil was suitable for use as a subsoil capping material. The works undertaken are detailed in RSK letter report ref: RSK 27621 L02, dated October 2016 (presented in **Appendix B**) and summarised below.

Five trial pits were mechanically excavated to depths up to 3.2m bgl designated TP POS1 to TP POS5. Made ground was identified from surface level to depths of 0.50 m to 1.25 m bgl and comprised grey brown sandy gravelly clay with variable proportions of brick, asphalt and glass fragments. Natural soils were encountered beneath the made ground, generally comprising brown to orange brown sandy, slightly gravelly clay or clayey, sandy flint gravel.

Suspected ACM (fragments of cement bound asbestos) were identified at surface level in the vicinity of each trial pit location. No suspected ACM were encountered within the trial pits.

Samples of natural soils beneath the made ground were submitted for laboratory testing of TPH CWG, polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene, xylenes (BTEX), methyl-tert butyl ether (MTBE), metals and pH at a range of depths between 1.0 m and 2.0 m. None of the measured determinants were in excess of the validation assessment criteria and as such the natural materials were deemed suitable for use as 'clean' subsoil.

2.2.3.2 *Validation of POS and bund capping layers*

RSK attended site on 9th and 23rd June 2016, and 7th and 25th July 2016 to undertake validation works of the capping layer placed on the re-graded bunds and central POS area.

In these areas, a series of hand excavated validation trial pits were undertaken to allow inspection of the capping layer and recovery of representative soils for laboratory testing in accordance with the testing suite outlined in the remedial strategy report (RSK report ref: 27621 R03 (01), January 2016). Trial pits were excavated to the base of the capping layer (i.e. when the bright orange 'geo-marker' geotextile was encountered) or up to a maximum of 600mm depth whereby the geo-marker layer was observed being placed during construction. Validation locations were targeted to give a good spread across the areas subject to remedial works, whilst working to a sampling ratio of 1 in 250 m³ for communal soft landscaping, as agreed with Arun District Council.

The following validation pits were carried out:

- NWB V1-8 - 9th June 2016;
- SWB V1-4 - 23rd June 2016;
- POS V1-12 - 7th July 2016;
- NEB V1-4 - 25th July 2016; and
- Additional inspection pits POS V13-16, POS V2A-D, POS V12-A-D - 22nd August 2016.

The locations of the above are presented on **Figure 2**.

Following the initial validation, ACM were found at surface level in selected areas of the north west bund, north east bund, south west bund A and central POS area. Laboratory testing confirmed presence of chrysotile cement from surface samples obtained from the north west bund and POS. Asbestos was also identified in soil samples obtained from POSV2 and POSV12.

A recommendation for hand picking of visible fragments of asbestos from the surface of the bunds was made by RSK and completed by Keltbray, as summarised in the Keltbray Completion Report. Additional delineation and soil sampling works were recommended in the vicinity of POSV2 and POSV12.

Following the identification of ACM in several areas across the site (as detailed above) on the surface of bunds and within two soil samples (POSV2 and POSV12), Keltbray carried out a series of hand-picking exercises across these areas. RSK re-inspected these areas after Keltbray had completed the hand-picking exercise and were satisfied that visually identifiable asbestos fragments had been removed for the surface across these areas.

Additional validation trial pits were excavated by RSK on 2nd August 2016 to confirm the extent of asbestos materials in the vicinity of POSV2 and POSV12. Representative soils samples were obtained from the validation pits (refer to as POSV12A-D and POSV2A-D) and submitted for laboratory testing to screen for the presence of asbestos fibres. None of the additional soil samples were found to contain asbestos fibres.

It is noted that topsoil had not been placed across the bunds or POS area prior to the validation sampling visits detailed above. It was therefore recommended that additional validation works be completed following placement of topsoil with respect to the north west bund and south west bund A, whereby the subsoil capping layer thickness was observed to be less than 600 mm thick.

It was also noted that works had yet to be completed in relation to the south east bund and the part of the south west bund outside of the hoarding during the initial phase of remedial works.

The north west bund has subsequently been re-validated as detailed in **Section 2.2.6**.

In accordance re-profiling of the north western bund and additional works in Phase 1B and 2, a 2nd phase of remedial works has been completed by Keltbray at the site. A completion report for this phase of works is in progress by Keltbray, as well as supplementary validation works by RSK including revalidation of the central POS area.

2.2.4 Asbestos Delineation Works Phase 1A – Plots 1 to 19 (August & September 2016)

To delineate asbestos impacts observed within Phase 1A, RSK carried out intrusive investigation works across Plots 1-19 between 31st August and 7th September 2016. The works undertaken are detailed in RSK letter report ref: RSK 27621 L04, dated October 2016 (presented in **Appendix B**) and summarised below.

The objective of the works was to characterise made ground and identify the potential presence of ACM and/or asbestos fibres in soil at each plot, to inform cover layer thickness requirements.

The investigation works comprised testing under each house and rear garden area across Plots 1-14, and testing within the rear gardens only at Plots 15-17, and 19. It was not possible to investigate Plot 18 due to access constraints. However, Plot 18 was investigated further during subsequent delineation works, please refer to **Section 2.2.5**.

The locations of the intrusive investigations are shown on **Figure 3**.

The exploratory holes revealed that this area of the site is underlain by a variable thickness of made ground over River Terrace Deposits encountered at depth. The general succession of strata is summarised in **Table 2** below:

Table 2: Ground conditions encountered during asbestos delineation works-Plots 1-19

Strata	Exploratory holes encountered	Depth to top of stratum m bgl	Thickness (m)
Made Ground	All	Ground level	0.15 – 1.10
River Terrace Deposits	All, except TPP14H and TPP19G	0.70 – 1.20	Proven to 1.05

Fragments of suspected cement bound asbestos were noted within made ground in TPP13G, TPP13H, TPP14G, TPP15G and TPP19G.

Soil samples were submitted for laboratory analysis to screen for asbestos in soils. The results from the laboratory testing indicated that the soils obtained from TPP12G at 0.10 m to 0.20 m and TPP17G at 0.20 m to 0.30 m tested positive for loose chrysotile fibres, and from TPP17G at 0.40 m to 0.50 m tested positive for loose amosite fibres.

Based on the results it was recommended that a 600 mm capping layer underlain by a geo-marker membrane be installed in garden areas within Plots 1-19, Plots 12 to 15, 17 and 19. All other plots were deemed suitable for the installation of a 450 mm capping layer.

2.2.5 Asbestos Delineation Works Phase 1A – Plots 18 & 20 to 64 (October 2016)

To delineate asbestos impacts observed within Phase 1A Plots 18 and 20 to 64, RSK carried out intrusive investigation works on 25th and 26th October 2016. The works undertaken are detailed in RSK letter report ref: RSK 27621 L05, dated February 2017 (presented in **Appendix B**) and summarised below.

The objective of the works was to characterise made ground and identify the potential presence of ACM and/or asbestos fibres in soil at each plot, to inform cover layer thickness requirements.

In the vicinity of each plot, a single trial pit was excavated to target the footprint of the proposed rear garden. It was not possible to investigate the footprint of Plots 30 to 34 due to access constraints. The locations of the exploratory holes are shown on **Figure 3**.

A soil sample was collected from each accessible plot, with a total of 41 representative soil samples collected.

The exploratory holes revealed that the site is underlain by a variable thickness of made ground overlying River Terrace Deposits. The ground conditions encountered are summarised below in **Table 3**.

Table 3: Ground conditions encountered during asbestos delineation works- Plots 18, & 20-64

Strata	Exploratory holes encountered	Depth to top of stratum m bgl	Thickness (m)
Made Ground	All locations except Plots 52, 62 and 64	Ground level	0.10 – 1.10
River Terrace Deposits	All locations except Plots 27, 37, 38, 40 41, 55, and Plot 19 Garden	0.70 – 1.20	Proven to 1.05

Fragments of suspected cement bonded asbestos were noted within made ground deposits encountered in Plots 27, 36, 37, 38, 39 and 50. Fragments of suspected cement bonded asbestos were also noted on the surface adjacent to Plots 40 and 58.

The majority of the samples submitted for analysis returned negative asbestos screens with the exception of those detailed below in **Table 4**.

Table 4: Summary of asbestos analysis results

Hole ID	Depth Range	Asbestos Species	Presenting As	Quantified?
Plot 36	0.50	Chrysotile	Loose Fibres	No
Plot 39	0.40 - 0.45	Chrysotile	Loose Fibres	No
Plot 47	0.40 - 0.50	Amosite	Loose Insulation	<0.001%
Plot 48	0.40 - 0.50	Chrysotile	Loose Fibres	No
Plot 49	0.50 - 0.60	Chrysotile	Cement	No
Plot 50	0.45 - 0.50	Amosite	Loose Fibres	No
Plot 61	0.50 - 0.60	Chrysotile	Loose Fibres	No

Based on frequency of asbestos testing already undertaken in this area of the site and in accordance with the protection measures already in place to protect construction workers and neighbouring residents, only one of the soil sample collected during this phase of works was submitted for asbestos quantification analysis (Plot 47 at 0.4 m to 0.5 m bgl).

It was recommended that handpicking for ACM at the ground surface also be completed across plots 22, 27 and 39, followed by removal of the upper 0.2 m of the existing ground profile through these plots.

On the basis of the results discussed above it was recommended that a 600 mm of clean capping layer, underlain by a geo-textile marker layer be placed in the gardens 64 27, 36-39, 43, 47, 48, 49, 50 and 61 (in addition to Plots 12 to 15, 17 and 19 identified during the first round of delineation works), whereby ACMs have been found to be present. A 450 mm cover layer is required across the gardens of all other plots in Phase 1A.

The capping layer thickness requirements for the entirety of Phase 1A is summarised on **Figure 3**.

2.2.6 North West Bund Supplementary Validation Phase 1A – (February 2017)

Following re-profiling works by Keltbray in the southern portion of the north west bund, RSK undertook supplementary validation works in this area on the 28th February 2017.

Five trial pits were hand excavated to depths of up to 0.80 m bgl designated TP101A to TP105A (as presented on **Figure 2**), in order to obtain representative soil samples to validate that the capping material had not been cross contaminated during re-profiling works and to determine the thickness of the capping layer.

The stratum observed within the trial pits was identified as a brown sandy gravelly clay with occasional cobbles of flint to a depth of 0.8 m. No made ground was identified in any of the trial pits. The trial pit logs and photographic log documenting the works are presented in **Appendix E**.

Topsoil was being placed at the time of sampling, therefore the capping layer will exceed the required 600 mm thickness. No geo-textile marker layer was observed during the validation visit. However, RSK observed the geo-textile marker layer being replaced following the re-profiling works prior to application of the subsoil and topsoil.

Validation samples collected from the natural site 'won' subsoil's within the capping were submitted for laboratory testing, at a range of depths between 0.50 m and 0.70 m bgl. None of the determinants tested were found to exceed the validation assessment criteria.

Information pertaining to the imported topsoil is provided in **Appendix G**.

2.2.7 Assessment of ACM hotspot materials removed from Phase 1B

A hotspot of ACM of similar composition to materials encountered in other areas of the site was identified in Phase 1B during enabling works in this area. In accordance with the remedial strategy CALA informed Keltbray and RSK of the discovery. Keltbray subsequently removed the impacted materials in accordance with their previously agreed method statements and existing Health and Safety Executive (HSE) licence. The extent of the hotspot and treatment area set up during the removal works are presented on **Figure 4**.

The materials were temporarily stored in Keltbrays designated treatment area to the east of the POS area in the centre of the site.

RSK attended site on the 12th April 2017, following discussions with Arun District Council, to screen the removed materials for volatiles using a PID. This work was undertaken to validate that volatile compounds were not present/or were present at sufficiently low concentrations, to render the materials suitable for placement within the central POS area, without posing a risk to controlled waters.

Whilst on-site RSK observed the hotspot materials to be segregated in the Keltbray designated treatment area, and clearly labelled in accordance with procedures specified in the Keltbray MMP.

The materials observed comprised greyish brown gravelly sand, with occasional clay content. Sand is coarse. Gravel is angular to sub-rounded, fine to very coarse fragments of brick, concrete and ACM (predominately cement tiles). No visual evidence of hydrocarbons contamination was observed. Olfactory observations could not be made due to requirements for respiratory personal protective equipment (RPE) to be used during the sampling works. Representative soil samples were collected from 16 locations across the stockpiled hotspot materials, with PID results ranging from <0.1 ppmV to 0.3 ppmV.

Based on the consistently low levels of volatiles and absence of visual evidence for hydrocarbon contamination within the materials, they were deemed suitable for placement and encapsulation within the central POS area. Photographs collected during the validation works area presented in **Appendix H**.

3 VALIDATION RESULTS SUMMARY

The remedial works are being carried out in a phased approach as the proposed development progresses. The following is applicable to the Phase 1A part of the site as shown within **Figure 3**.

3.1 Phase 1A

Investigation works prior to remediation of the site identified elevated pesticides in the vicinity of HA5 and elevated hydrocarbons and metals in made ground across Phase 1A. Additionally asbestos fibres and ACM were identified primarily within the bund materials but also locally across Phase 1A in made ground.

Subsequent delineation testing of the previously identified pesticide impacted area in the north east of Phase 1A, suggests that the impact has been sufficiently remediated with none of the samples sent for laboratory testing exceeding the recommended validation assessment criteria. Therefore, no further delineation works or remediation is deemed necessary in this area in relation to pesticides, other than the application of a 450 mm capping layer in garden and/or communal soft landscaping within this area.

Validation works conducted on the north west bund in June 2016 and February 2017 in regards the capping layer, have demonstrated that the capping layer thickness and chemical quality outlined in the agreed remedial strategy for the site has been achieved and that this area is suitable for use as communal soft landscaping. Therefore, no further validation is required with regards to the north west bund.

The asbestos delineation works conducted across Plots 1 to 64 (as detailed in **Sections 2.2.4** and **2.2.5**) have been used to refine the garden capping layer thickness requirements across Phase 1A on a plot by plot basis. The capping layer thickness required in each plots garden is presented on **Figure 3**.

Validation of the recommended capping layers within the garden and communal soft landscaping areas is still ongoing. In accordance with the agreed remedial strategy as plots/soft landscaping areas become available, validation sampling to demonstrate adequate capping layer thickness and chemical quality is being completed on a 1 in 50 m³ ratio for gardens and 1 in 250 m³ ratio in soft landscaping areas.

All garden validation testing data will then be submitted to the NHBC for approval prior to release of any CML's.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions - Phase 1A

Based upon the remedial works carried out to date within the Phase 1A, it is considered that the area is suitable for the proposed residential end use, subject to the results of additional validation gas assessment across Phase 1A and garden/soft landscaping validation works.

With exception to the gas membrane design, RSK are satisfied that the remedial works carried out to date by Cala Homes and Keltbray, have been carried out in accordance with the agreed remedial strategy.

Since the development works commenced RSK have collected a significant amount of additional data within Phase 1A (plots 1-64). Having reviewed the ground conditions and gas monitoring data from the nearby historic monitoring wells RSK anticipate that additional validation monitoring will demonstrate a sufficiently low risk that gas protection measures are not required in Phase 1A. As such rendering the installation of 1200 gauge membrane to be acceptable and negating the need for further verification information in relation to gas protection measures in this area of the site.

4.2 Recommendations – Phase 1A

In the event that the validation gas monitoring does not demonstrate sufficiently low concentrations, integrity testing shall need to be undertaken to demonstrate retrospectively the integrity of the 1200 gauge gas membranes installed across Phase 1A, and if necessary based on the results retrospective mitigation measures may be required.

Validation of the recommended capping layers within the garden and soft landscaped areas is still ongoing. All garden and soft landscaping validation testing data will then be submitted to the NHBC for approval prior to release of any CML's.

4.3 Conclusions - Phase 1B and 2

The gas membrane design drawings for the remainder of the site are in the process of being updated and shall be agreed with the NHBC and Local Authority prior to installation commencing across the remainder of the site.

Further remediation and validation of the site is ongoing in a phased approach.

4.4 Recommendations - Phase 1B and 2

The following validation and verification requirements need to be completed across Phases 1B and 2, prior to these areas of the site being deemed suitable for the proposed residential end use:

- Additional validation of the south west bund A following the placement of topsoil and in the vicinity of the formerly inaccessible area outside of the hoarding (Phase 1B);
- Validation that secure fencing and prickly vegetation has been implemented in regards to south west bund B (Phase 1B);
- Further delineation and removal of oily impacts observed in the vicinity of tank validation sampling location V2 (Phase 1B);
- Validation sampling in the vicinity of the historic boiler house (Phase 1B);
- Validation sampling in the vicinity of the south east bund following capping of this feature (Phase 2);
- Re-validation of north east bund following re-grading works in accordance with design layout changes (Phase 2);
- Re-validation of the central POS area capping materials following placement of surplus asbestos impacted materials beneath this area;
- Installation of gas membranes following confirmation that the gas membrane design for Phases 1B and 2 is acceptable to the NHBC and Local Authority once completed;
- Compilation of gas membrane installation verification information, including photographs of gas membranes in-situ, installation certificates and/or if deemed necessary 3rd party inspections;
- Garden and soft landscaping validation sampling and reporting; and
- Post remediation validation reporting for all of the above in relation to Phases 1B and 2.

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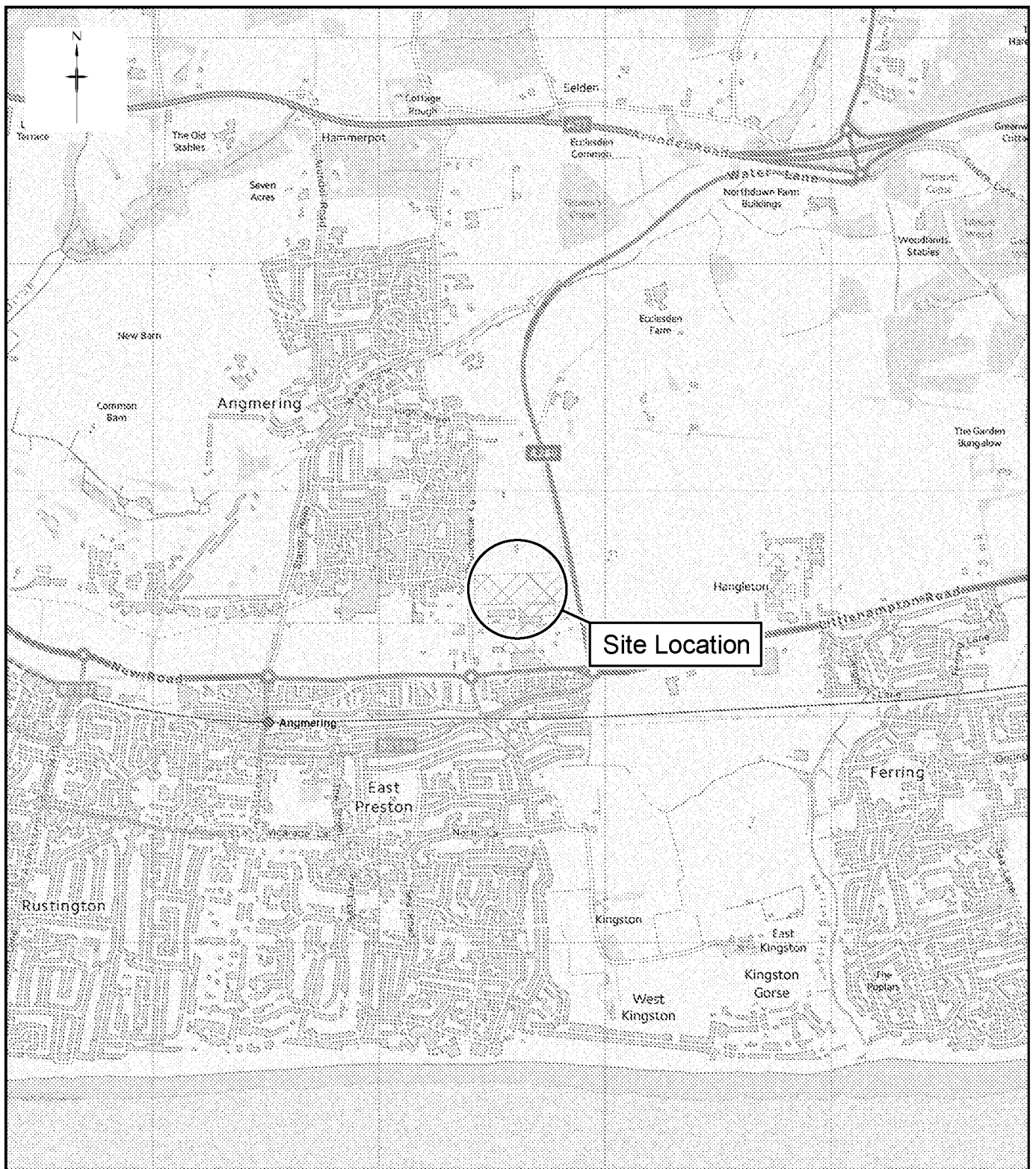
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FIGURES



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Client

CALA HOMES (SOUTH HOME COUNTIES) LTD

Project Title

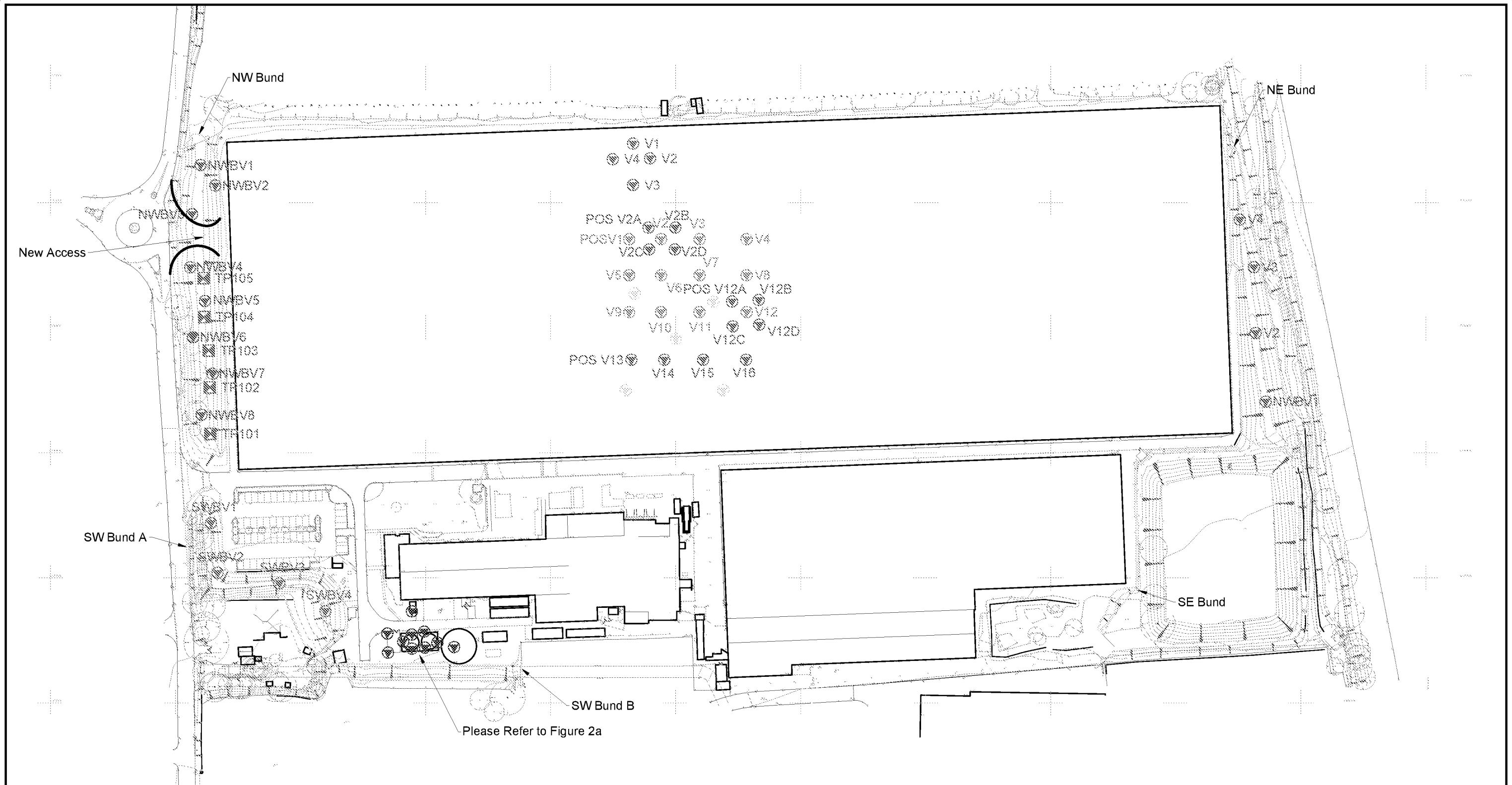
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Drawing Title

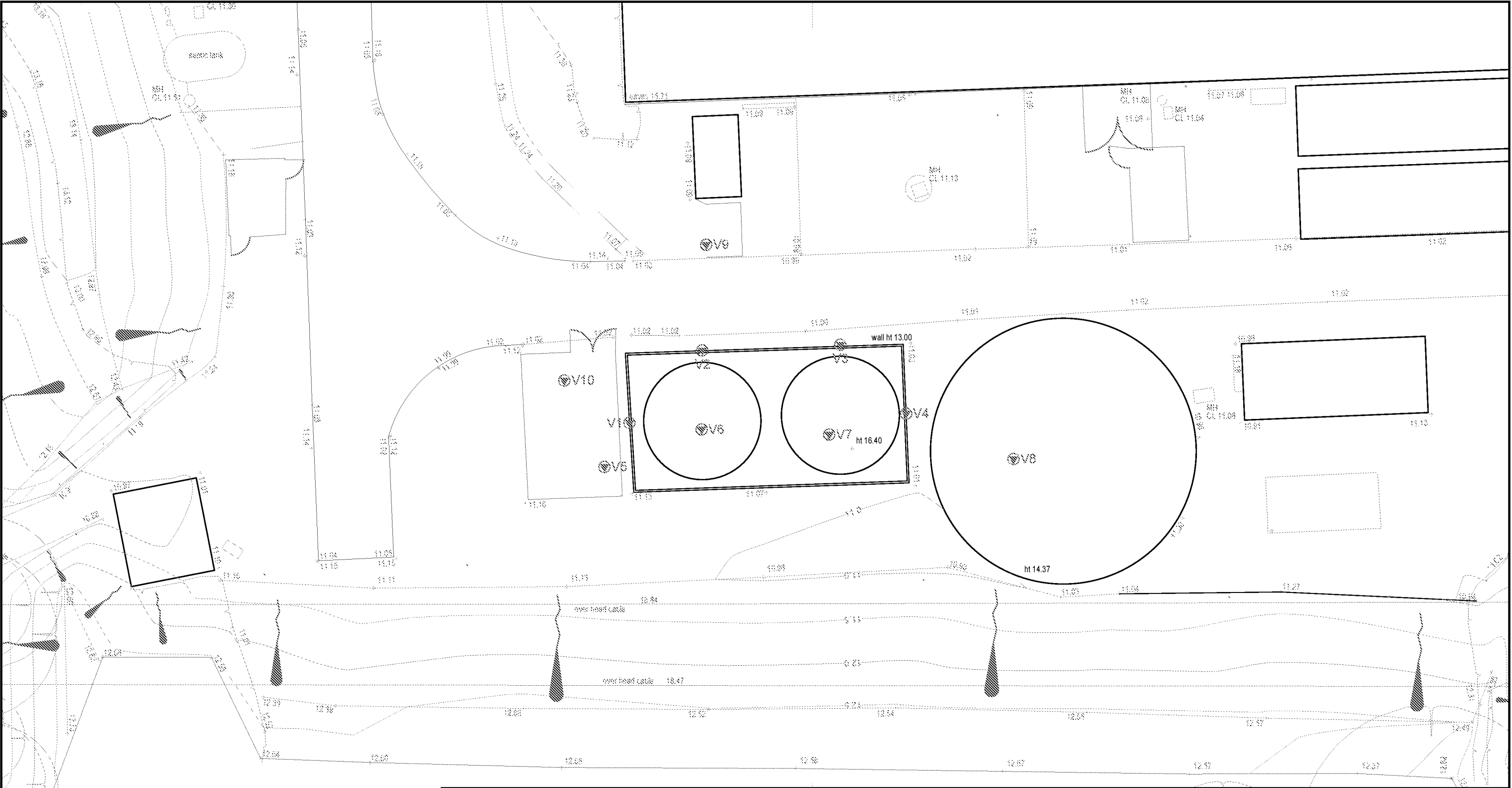
SITE LOCATION MAP

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Dimensions		Scale		Original Size		
m		1:25,000		A4		

Project Number	Drawing File	Drawing Number
27621 - R06	27621 - SLP.dwg	FIGURE 1



LEGEND Validation Sample Location - Northwest Bund Jun 2016 Validation Sample Location - Southwest Bund Jun 2016 Validation Sample Location - Public Open Space 1 Jul 2016 Validation Sample Location - Northeast Bund Jun 2016 Validation Sample Location - Public Open Space 22 Aug 2016 Extent of Bund Tank Validation Sample Location Jan/March 2016 Validation Sample Location - Northwest Bund February 2017 Trial Pit Location (TPPOS1-4) - Public Open Space April 2016 Pesticide Validation Location - Public Open Space April 2016							18 Frogmore Road Hemel Hempstead Hertfordshire HP3 9PT United Kingdom Tel: +44 (0) 1442 437500 Fax: +44 (0) 1442 437550 Email: info@rsk.co.uk Web: www.rsk.co.uk						Client CALA HOMES (SOUTH HOME COUNTIES) LTD									
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													Drawing Title VALIDATION SAMPLE LOCATION PLAN									
							Drawn AP		Date 29.03.17		Checked CL		Date 29.03.17		Approved CL		Date 29.03.17		Project No. 27621- R06		Drawing File 27621 (R06).dwg	
	Rev.		Date		Amendment		Drawn		Chkd.		Appd.		Scale 1:1500		Orig Size A3		Dimensions m		Drawing No. FIGURE 2			Rev. P1



LEGEND

Validation Trial Pit Location - January/March 2016

Rev.	Date	Amendment	Drawn	Chkd.	Appd.

18 Frogmore Road
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Drawn	Date	Checked	Date	Approved	Date
AP	29.03.17	CL	29.03.17	CL	29.03.17
Scale 1:200		Orig Size A3		Dimensions m	

Client CALA HOMES (SOUTH HOME COUNTIES) LTD	
Project Title FORMER WEST END NURSERY, ANGMERING	
Drawing Title TANK VALIDATION TRIAL PIT LOCATION PLAN	
Project No. 27621- R06	Drawing File 27621 (R06).dwg
Drawing No. FIGURE 2a	Rev. P1