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Hemel Hempstead
Hertfordshire
HP3 9RT

Our Ref: 27621-L11-dbj
NHBC Ref: 03070/2015/HO
Planning Ref: A/144/15/PL

11th May 2017

Brian Graham
NHBC
NHBC House
Davy Avenue
Milton Keynes
MK5 8FP

Dear Brian,

CRESSWELL PARK, ANGMERING, WEST SUSSEX - VOID MONITORING PHASE 1A (PLOTS 1 TO 64)

1.0 Background

RSK Environment Limited (RSK) was commissioned by CALA Homes (South Home Counties) Limited to complete a geoenvironmental assessment of the West End Nursery, Roundstone Lane, Angmering in February 2015, hereafter referred to as 'the site'. An additional intrusive investigation took place in June 2015 to provide further information of the bunds that surround the site.

Following these reports, RSK prepared a Remedial Strategy for the site in September 2015. This was further supplemented by an additional phase of investigation works reported in December 2015 to provide additional data to investigate the risks to the underlying aquifers. A revised version of the Remedial Strategy was produced in January 2016 and this is the current live document for the site.

Following the demolition and clearance of the site, CALA Homes are redeveloping the site for a residential development of 244 properties, with private gardens and some areas of communal soft landscaping (Figure 1).

2.0 Ground Gas Monitoring

Three gas monitoring visits were carried out at the site on 30th January 2015, 13th February 2015 and 24th February 2015. The results of the monitoring visits carried out are summarised below:

- Methane - Maximum concentration of 0.1%v/v;
- Carbon dioxide - Maximum concentration 13.4%v/v; and
- Flow - Maximum positive steady rate 0.1l/hr.



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Registered in Scotland No. 115539
www.rsk.co.uk

Based on the above concentrations, GSV's may be calculated as follows:

- $GSV_{\text{METHANE}} = (0.1 / 100) * 0.1 = 0.0001 \text{ l/hr; and}$
- $GSV_{\text{CARBON DIOXIDE}} = (13.4 / 100) * 0.1 = 0.0134 \text{ l/hr.}$

Monitoring results from the three visits conducted at the site to date would characterise the site as being Characteristic Situation 2 for apartments and 'Amber 1' for traditional low-rise houses, based on the concentrations of carbon dioxide consistently in excess of 5%v/v in BH1.

On this basis, low level ground gas protection measures would be considered necessary at the site. Low level gas protection measures would involve an appropriate membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into the buildings.

It is considered that the ground gas data collected is reasonably representative of likely worse case conditions at the site, given the low and falling pressure recorded during the monitoring on the 30th January 2015 of 982mbars.

3.0 Gas Protection Measures

RSK recommended that a detailed gas membrane installation design and implementation plan was to be completed in accordance with the recent updates in UK guidance (BS8485: 2015) and it will also need to detail the verification requirements.

RSK also advised that in addition to a ventilated sub floor void under the current gassing regime, a gas resistant 2000 gauge membrane will need to be installed. This must in accordance with the manufacturer's specifications beneath the entire footprint of the proposed buildings, including sealing of all joints and penetrations.

The gas installation and design plan will provide details of the verification required. 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. Additionally, validation such as 3rd party inspections may be required depending on the outcome of the detailed gas mitigation measures design and implementation plan.

4.0 Changes to Gas Protection Measures on Phase 1A

Due to an error by a third party who advised CALA Homes, 1200 gauge membranes and not the required 2000 gauge have been fully installed in Plots 1 to 38, with the perimeter membranes for Plots 39 to 64 also affected.

To provide further assessment to the risk from ground gas to these plots, RSK proposed to install an additional 6 monitoring wells located to provide targeted ground gas monitoring to previously identified sources and at least three further monitoring rounds with at least one undertaken during low and falling pressure. This proposal was submitted to and subsequently approved by the Local Authority and the NHBC.

Following a site meeting with CALA Homes, RSK proposed an alternative method of determining the risk to these plots, which comprised a series of void monitoring in 10% of the properties on Phase 1A. This process has been agreed in principal with the Local Authority and the NHBC, with the following sections providing the formal details for approval.

5.0 Proposed Void Monitoring

Void monitoring was chosen as the preferred assessment method as it provides primary data from potential surface emissions within the actual substructure of properties on site. Whilst it may appear to be an overly conservative method, the results of the monitoring will provide data that is more applicable to the risk on site than the boreholes would allow.

RSK are proposing to complete the monitoring over a two sessions in 7 of the plots on Phase 1A. The first is a weeklong monitoring programme with the air bricks left open. Monitoring will take place using a Gas Data GA2000 instrument that will take a measurement for 60 seconds every hour for carbon dioxide, methane, oxygen and barometric pressure. This will allow sufficient draw through into the meter of the air within the substructure and take a representative measurement.

The second session will also be over a weeklong period, but before this monitoring takes place, all of the air bricks for that plot will be sealed to prevent airflow within the substructure to provide a worst case scenario should some or all of the air bricks become obstructed over time.

The results of the monitoring will be directly assessed in line with BS8485: 2015 to determine the risk to the plot and overall phase. We are not proposing at this time to complete a detailed gas risk assessment.

6.0 Chosen Plots

RSK have reviewed all of the substructure plans for the site and have chosen plots that provide a mixture of substructure design, are located in close proximity to BH1 (which recorded the greatest concentration of carbon dioxide) and where two other exploratory positions encountered an organic odour.

The chosen plots for void monitoring are Plots 10, 20, 28, 30, 44, 48 and 55 as shown on Figure 2.

RSK have also assessed the best location for the void monitoring to take place on a plot by plot basis. Prevailing wind data from the West Sussex County Council - West Sussex Life 2014 document, which provides data between 2010 and 2103 for the Angmering area, has been used to help determine the best air brick to use to enter the void.

This has been used to consider the most probably location of dead zones within the substructure. The relevant section of the document has been included in Appendix B.

Drawings that show the substructures of the chosen plots, the available air bricks and the chosen monitoring point location have been included in Appendix C.

It should be noted that the void monitoring for Plots 39 to 64 will take place once the infill section of the membrane has been completed, screeded, and at least one course of bricks has been placed to form an effective seal of the membrane by the superstructure.

7.0 Conclusion

Whilst the lower specification membrane has been installed in Plots 1 to 38 and for the perimeters for Plots 39 to 64, RSK consider the use of void monitoring as a most appropriate, conservative and reliable method to provide primary data on the ground gassing regime under specifically selected properties on site.

We are proposing that the results of the void monitoring will provide the greatest level of confidence to the Local Authority and NHBC that where the 1200 gauge membrane has been used it will still provide a suitable level of protection. We trust that this formalisation of the proposed void monitoring is acceptable to the NHBC.

If there are any queries, please do not hesitate to contact the undersigned.

Yours sincerely
For RSK Environment Limited



Dave Jacob
Technical Director

Cc. James Rwodzi - Cala Homes (South Home Counties) Limited

FIGURES



<div>LEGEND</div> <div><div><div></div><div>Central Landscaped area. (Area ≈ 1341.62m²)</div></div><div><div></div><div>Area of bund in vicinity of access road. (Area ≈ 693m³)</div></div></div> <div><div>020406080100m</div><div>Scale 1 : 1,500</div></div>	<div><div><div>N</div><div></div></div></div>						<div><div><div><div>RSK</div><div><div>18 Frogmore Road Hemel Hempstead Hertfordshire HP3 9PT United Kingdom</div><div><div>Tel: +44 (0) 1442 437500 Fax: +44 (0) 1442 437590 Email: info@rsk.co.uk Web: www.rsk.co.uk</div></div></div></div></div></div>						Client CALA HOMES (SOUTH HOME COUNTIES) LTD																		
							Project Title WEST END NURSERY, ANGMERING																								
							Drawing Title PROPOSED DEVELOPMENT PLAN																								
							Drawn ASC		Date 11.01.16		Checked CL		Date 11.01.16		Approved CL		Date 11.01.16		Project No. 27621 - R03 (01)				Drawing File 27621 (R03-01).dwg								
Rev.		Date		Amendment				Drawn		Chkd.		Appd.		Scale 1:1500				Orig Size A3		Dimensions m				Drawing No. FIGURE 1						Rev. P1	



LEGEND

-  Proposed plots for void monitoring
-  Plots not currently ready to have void monitoring
-  Organic odour encountered
-  BS1



PROPOSED PLOTS FOR VOID MONITORING PHASE 1A ONLY

Client:	CALA Homes (South Home Counties) Ltd	Figure No:	2
Site:	Cresswell Place, Angmering	Job No:	27621
Scale:	NTS	Source:	CALA

APPENDIX A

SERVICE CONSTRAINTS

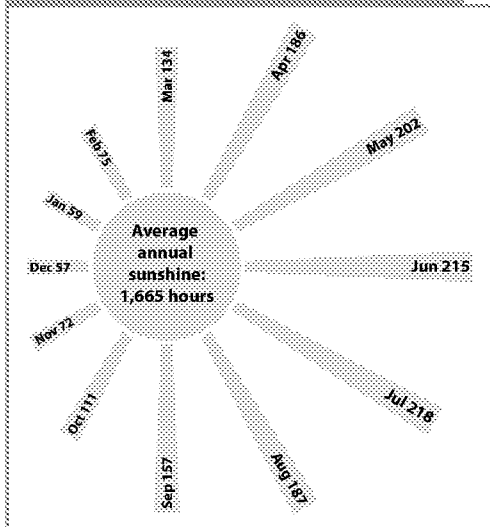
1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for CALA Homes (South Home Counties) Limited (the "client") in accordance with the terms of a contract between RSK and the "client". The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.
2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be** well advised to seek independent advice from a competent environmental consultant and/or lawyer.
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date hereof, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.
7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.
8. The phase II or intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.
9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site.

APPENDIX B WEST SUSSEX COUNTY COUNCIL WEATHER DATA



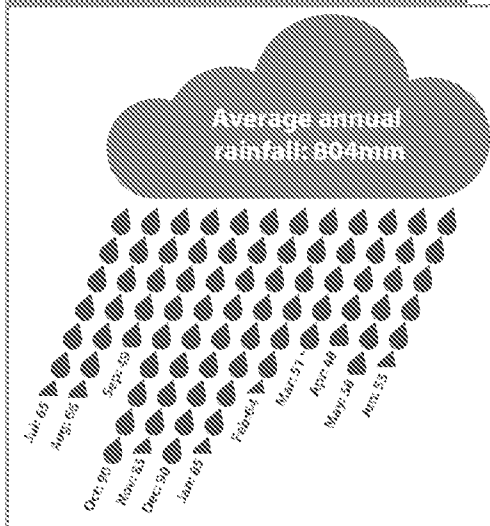
On average there were 1,665 hours of sunshine in the South East and Central South region over the last 10 years (July 2004 – June 2014). July typically sees the most sunshine, with an average of 218 hours, closely followed by June with 215 hours of sunshine. December typically has the least hours of sunshine with 57, followed by January with 59 hours. An average of 804mm of rainfall occurs in the South East and Central South region each year, with the wettest months being October and December with 90mm of rainfall each. April is the driest month on average, with 48mm of rainfall.

Figure 7.3 Average sunshine hours in the SE & Central South, 2004-2014



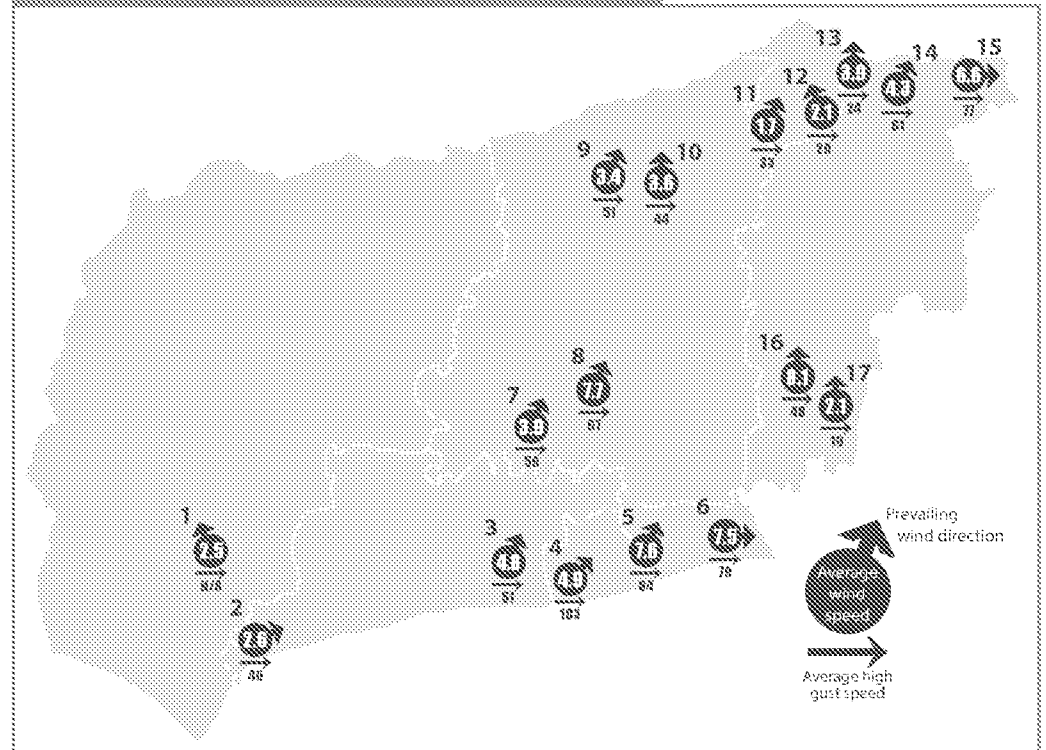
Source: Met Office regional climate summary

Figure 7.4 Average rainfall by month in the SE & Central South, 2004-2014



Source: Met Office regional climate summary

Figure 7.5 Average wind speeds and gusts recorded at West Sussex weather stations, 2010-2013



Source: Met Office regional climate summary

Coastal areas of West Sussex follow the regional pattern for a south-westerly prevailing wind, however inland areas typically see a more southerly prevailing wind. Average annual wind speeds varied between 1.7mph in Broadfield, Crawley and 8.1mph in Hurstpierpoint, Mid Sussex.

There is no clear pattern to average wind speeds recorded at independent weather stations across West Sussex, however the highest gust speeds (the highest speed recorded at any single point during the year, averaged across three years) were recorded along the coast, with West Worthing recording gusts over 100mph on average in the last three years.

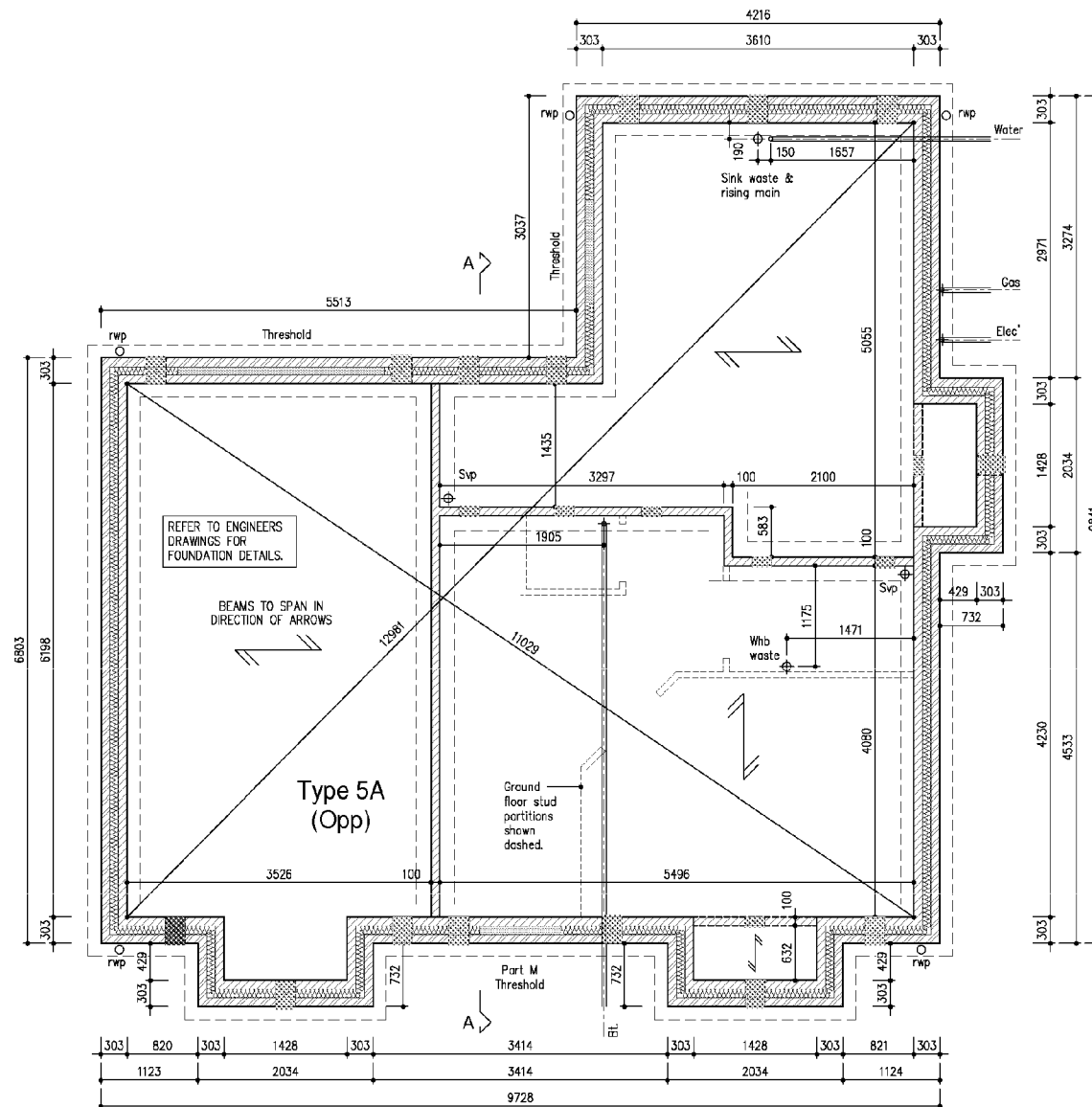
July is the sunniest month with an average of **215** sunshine hours

October and December are the rainiest

Wind speeds typically reach 100mph once a year along the coast

APPENDIX C SUBSTRUCTURE PLANS WITH CHOSEN VOID MONITORING POINT

Prevailing Wind Direction



Legend

-  Air brick or cross ventilation point
-  Location of void monitoring point



SUBSTRUCTURE PLAN WITH VOID MONITORING POINT - PLOT 10

Client: CALA Homes (South Home Counties) Limited

Site: Cresswell Park, Angmering

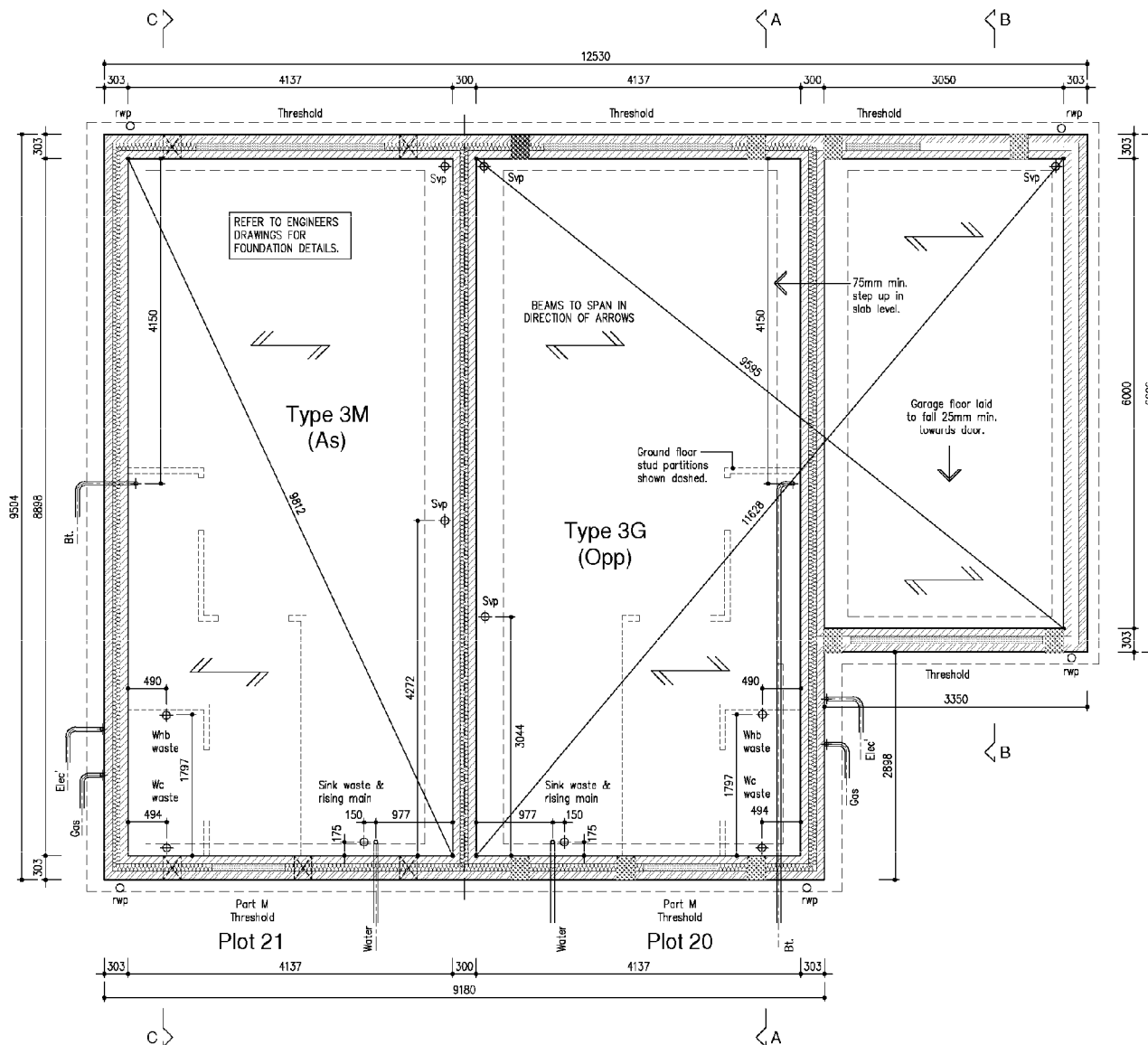
Scale: NTS

Appendix: C

Job No: 27621

Source: Faber Technical Limited

Prevailing Wind Direction



SUBSTRUCTURE PLAN WITH VOID MONITORING POINT - PLOT 20

Client: CALA Homes (South Home Counties) Limited

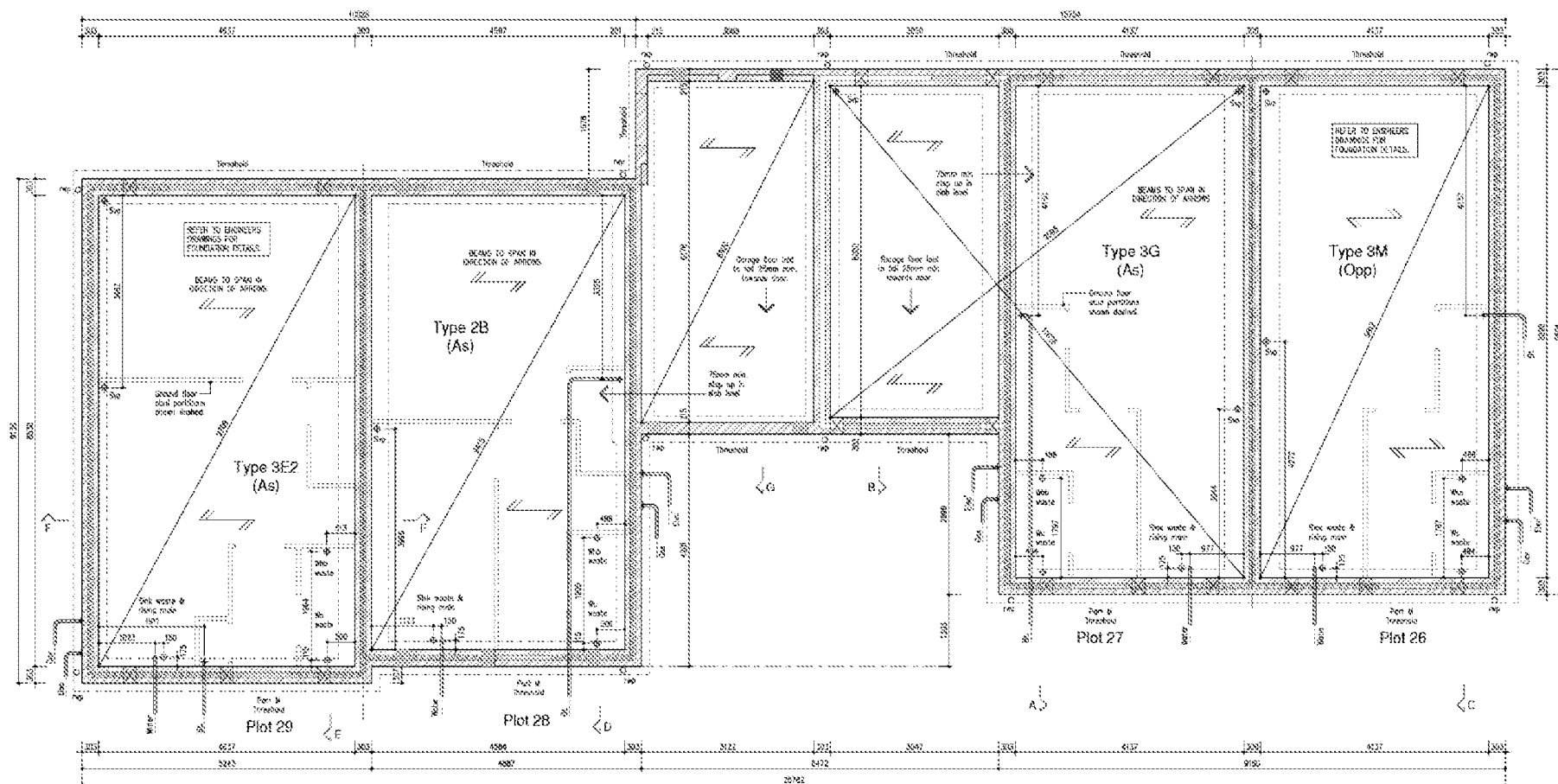
Site: Cresswell Park, Angmering

Scale: NTS

Appendix: C

Job No: 27621

Source: Faber Technical Limited



SUBSTRUCTURE PLAN WITH VOID MONITORING POINT - PLOT 28

Client: CALA Homes (South Home Counties) Limited

Site: Cresswell Park, Angmering

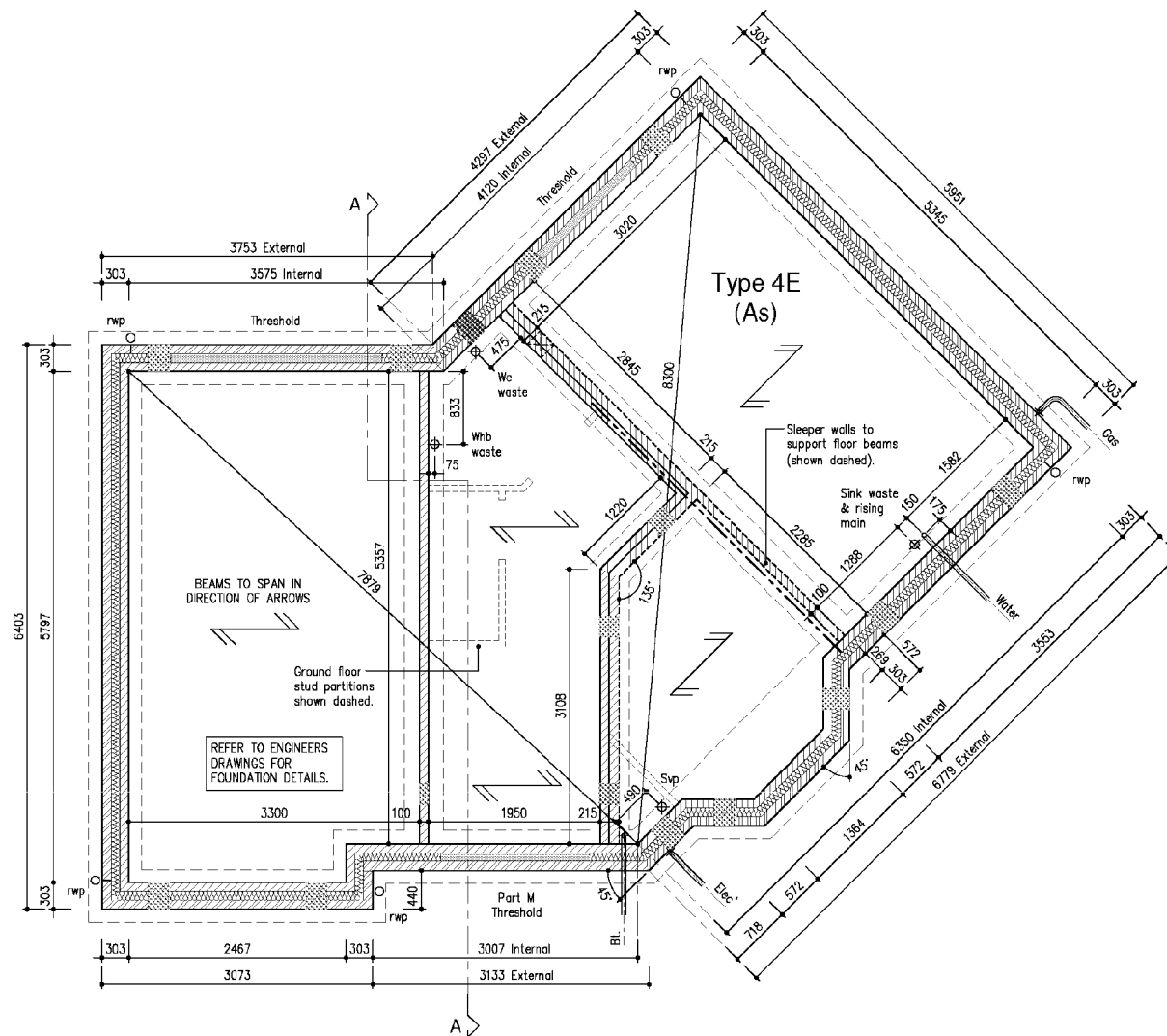
Scale: NTS

Appendix: C

Job No: 27621

Source: Faber Technical Limited

Prevailing Wind Direction



Legend

-  Air brick or cross ventilation point
 Location of void monitoring point



SUBSTRUCTURE PLAN WITH VOID MONITORING POINT - PLOT 30

Client:	CALA Homes (South Home Counties) Limited
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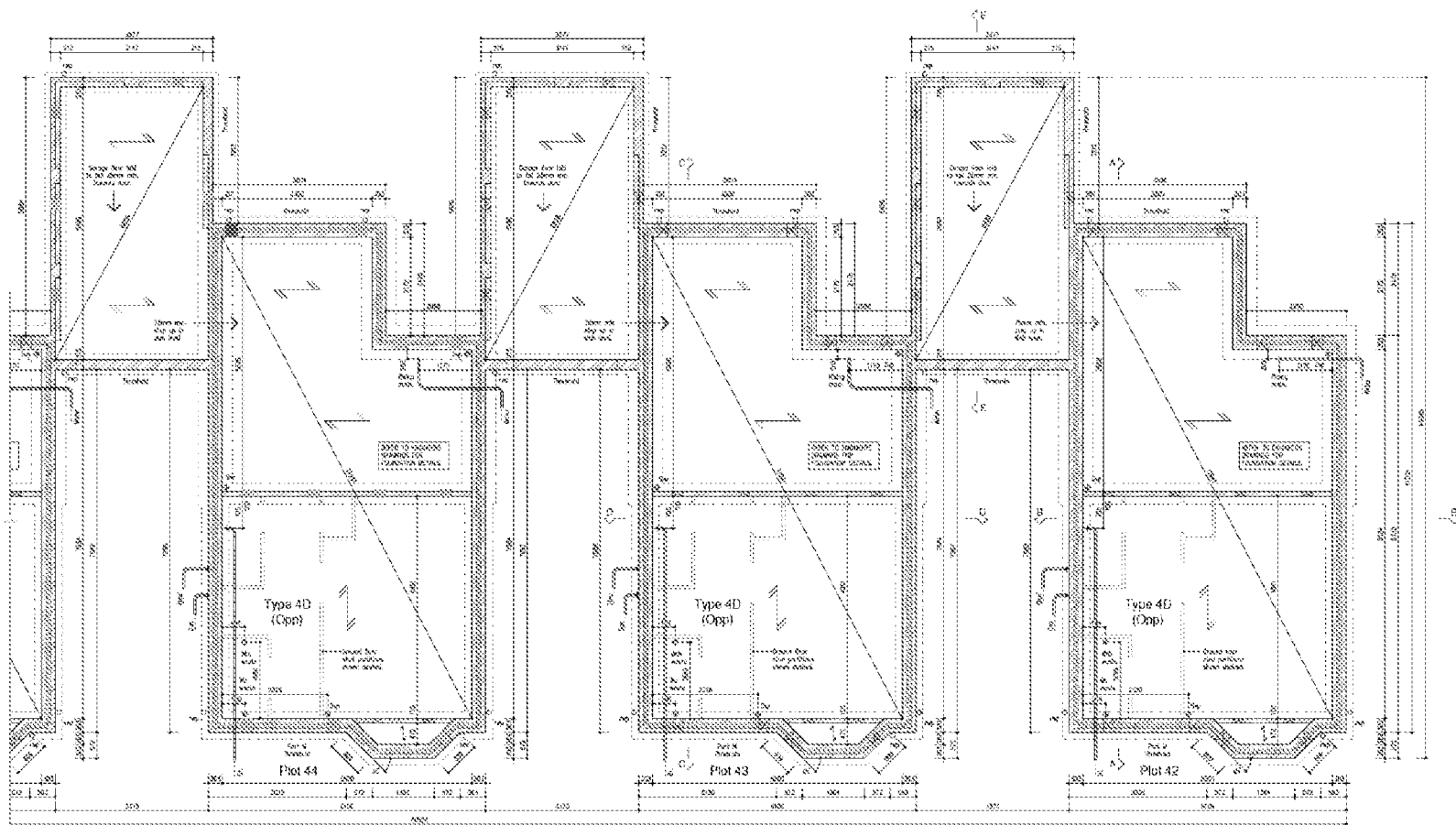
Appendix: C

Site: Cresswell Park, Angmering

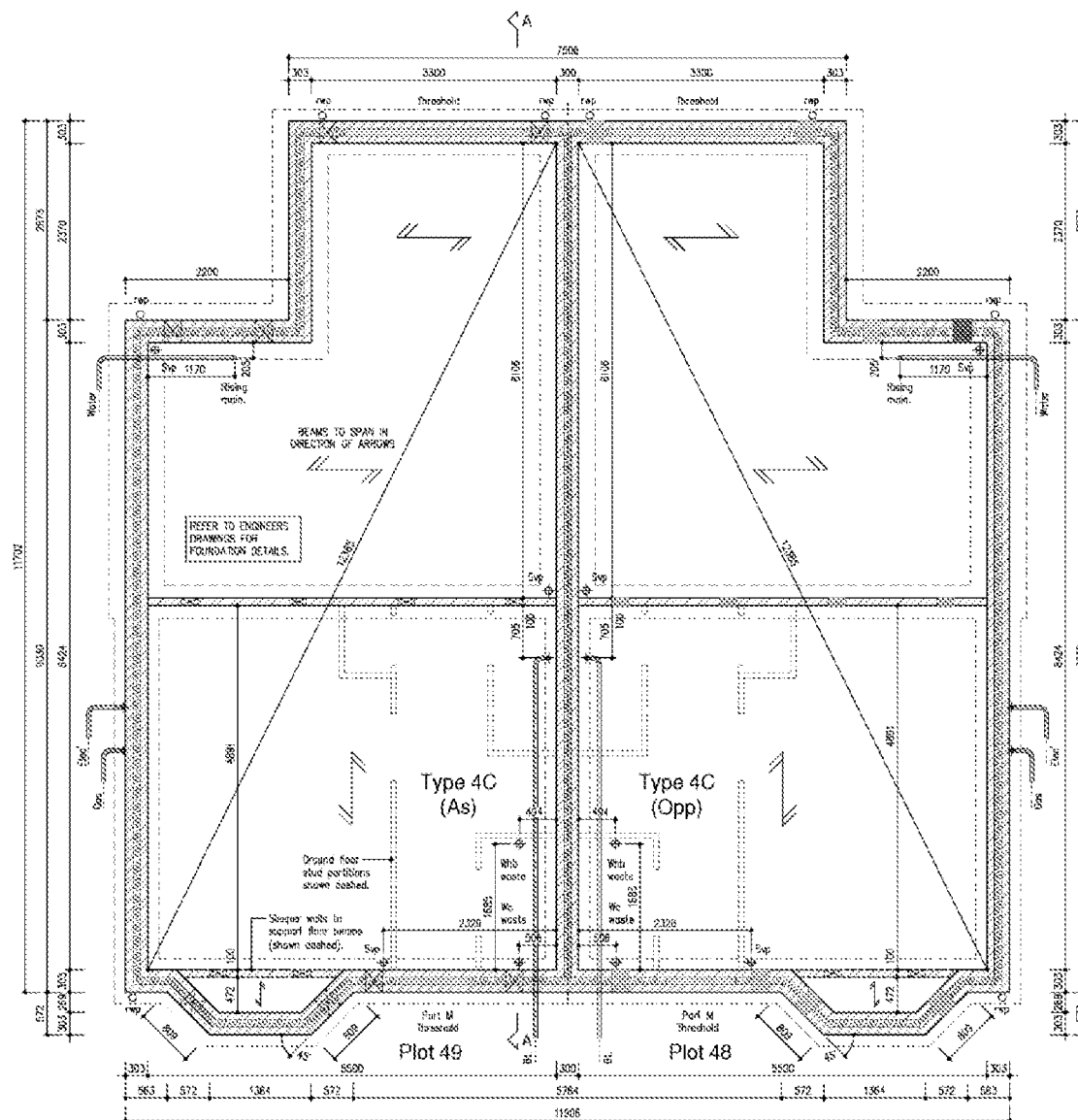
Job No: 27621

Scale: NTS

Source: Faber Technical Limited



Prevailing Wind Direction



Legend

- Air brick or cross ventilation point
- Location of void monitoring point



SUBSTRUCTURE PLAN WITH VOID MONITORING POINT - PLOT 48

Client: CALA Homes (South Home Counties) Limited

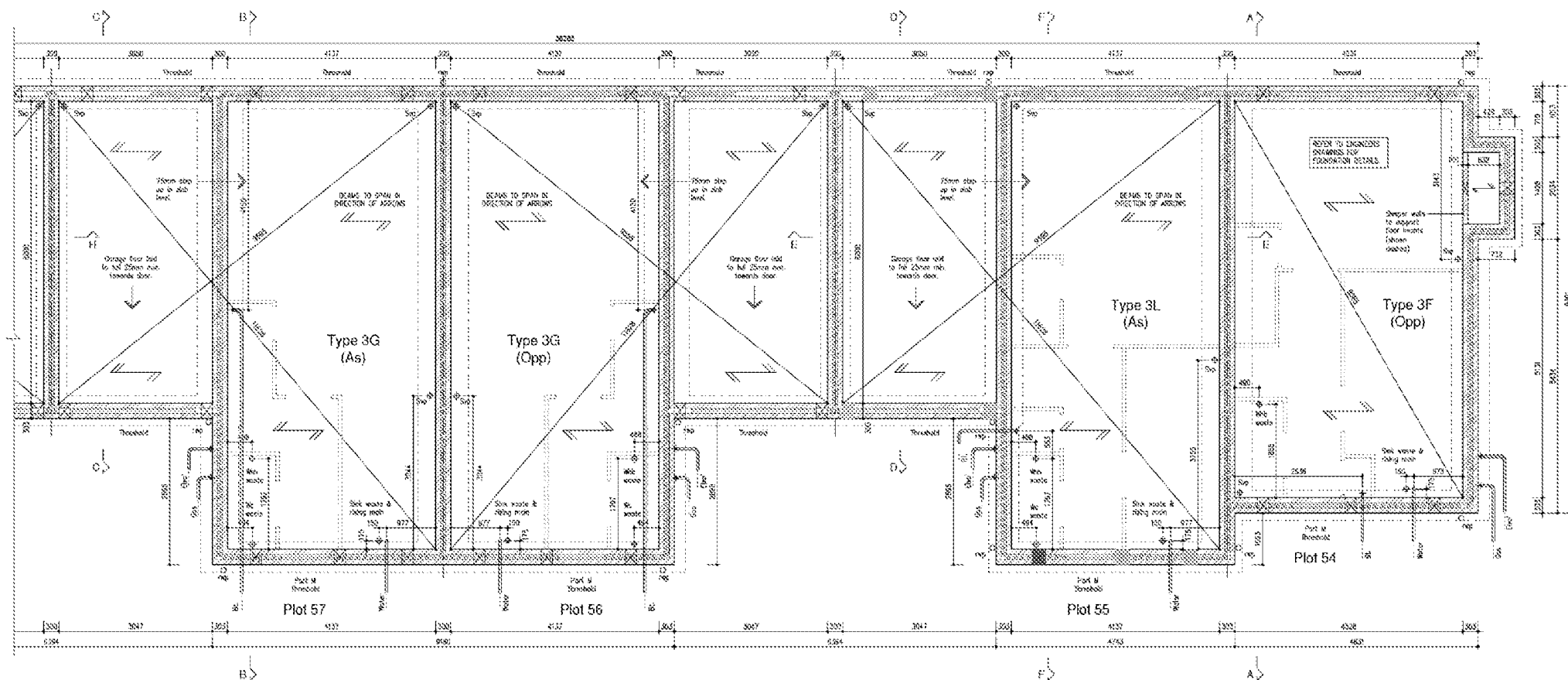
Site: Cresswell Park, Angmering

Scale: NTS

Appendix: C

Job No: 27621

Source: Faber Technical Limited



Legend

-  Air brick or cross ventilation point
-  Location of void monitoring point

Prevailing Wind Direction



SUBSTRUCTURE PLAN WITH VOID MONITORING POINT - PLOT 55

Client: CALA Homes (South Home Counties) Limited

Site: Cresswell Park, Angmering

Scale: NTS

Appendix: C

Job No: 27621

Source: Faber Technical Limited