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GREEN PARK VILLAGE FOUNDATION WORKS RISK ASSESSMENT

FOUNDATION WORKS RISK ASSESSMENT

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1. INTRODUCTION

1.1 Brief

Ramboll UK Limited (hereafter referred to as Ramboll) has been appointed by St Edward Homes Limited to produce a foundation works risk assessment for the Green Park Village (GPV) site in Reading.

This foundation works risk assessment has been prepared to assist with the discharge of planning condition 48 of planning permission 10/01461/OUT. The Planning Condition states that:

"Piling or any other foundation designs using penetrative methods shall not be permitted other than with the express written consent of the local planning authority, which may be given for those parts of the site where it has been demonstrated that there is no resultant unacceptable risk to groundwater."

This report provides the context and framework for piling and other penetrative foundation designs and provides justification of the choice of foundation methodology for the proposed development and mitigation measures to be adopted (if required).

It is the intention to revise and re-issue this document as the phased development progresses as the foundation design for each phase (s) is finalised. This version of the report covers the foundation solution for the following phases:

- Phase 1A East;
- Phase 1A West and Phase 1B;
- Phase 2;
- Phase 3;
- Phase 4; and
- Phase 5

The assessment will be updated with the details for Phase 6 in due course.

1.2 Proposed Development and Earthworks

The proposed development comprises approximately 737 residential properties, including housing with both private and communal gardens, a school, retirement care home, community uses, commercial premises and public open space. The proposed development also includes access roads and soft landscaping. The outline plans indicate the infilling of the north western portion of the Trout Lakes.

In order to facilitate the development, a significant earthworks programme is proposed to be undertaken to bring the site to minimum level of 40.2 metres Ordnance Datum (mAOD) for flood alleviation purposes. The filling operation will involve the import of circa 600,000 m³ of material under the agreed re-use of waste in construction bespoke environmental permit ref EPR/DB3206HL. Filling operations will also be conducted under the material requirements of the Ramboll Specification for Earthworks¹.

Table 1 provides a description of the proposed development for each phase.

¹ Ramboll (2017). Green Park Village Specification for Earthworks ref 1620000492/SP/001.

Table 1 Proposed Development at Each Phase

Phase	Proposed Development
Phase 1	For the purposes of the development programme, the Phase 1 area has been subdivided, with commencement within the Phase 1A part of the Phase 1 area having commenced. Phase 1 will comprise residential housing with gardens, areas of soft landscaping and associated infrastructure. The redevelopment will involve the demolition of all above ground structures and grubbing out of existing below ground features. As part of the redevelopment Phase 1 will be raised from an elevation of approximately 39 mAOD in Phase 1 West (Phase 1B), and from between 39.5 mAOD and 40.2 mAOD in Phase 1 East East and West, to a consistent elevation of 40.25 mAOD. Stockpiles of soil which had been stored within the Eastern Triangle area (Phase 3 and 4), have been utilised for the purpose of land raising at Phase 1A. The land raising is required for flood alleviation purposes, and has already commenced within the Phase 1A area.
Phase 2	Phase 2A will comprise a new care home facility with associated soft landscaping and car parking in the western part of Phase 2A. In addition there will be an area of residential apartments west of the care home building, the majority of which will be built over garages. Phase 2B will comprise a new primary school with sports pitches for dual school and local community use. Community facilities including a community hall will also be provided. Residential development is proposed in Phase 2C, comprising a single block of residential units with communal areas of soft landscaping.
Phase 3, 4 and 5	Phases 3, 4 and 5 will comprise residential housing with gardens, areas of soft landscaping and associated infrastructure. Generally ground levels are proposed to be raised by approximately 2 metres (in Phase 3 and 4) and 1.50 metres in Phase 5. Ground levels are to be raised for flood alleviation purposes.
Phase 6	Phase 6 will comprise commercial offices with areas of soft landscaping, associated infrastructure and a multi decked car park. Generally ground levels are proposed to be raised from between 38.5 mAOD and 39.9 mAOD (more commonly 39.5 mAOD) to 40.2 mAOD resulting in the placement of between 0.3 metres and 1.7 metres of fill upon existing ground levels. The outline plans also indicate the infilling of the north western portion of the Trout Lakes which will involve raising levels from approximately 35 mAOD to 40.2 mAOD (approximately 5.2 metres of fill).

1.3 Information Sources

This document draws on information from the following sources:

- i. Ramboll, August 2015. Green Park Village, Specification for Earthworks. Ref 1620000492/SP/001.
- ii. Ramboll, January 2016. Green Park Village, Remediation Statement for Pingemead Industrial Estate. Ref. 1620000492/RPT/005.
- iii. Ramboll, March 2016. Green Park Village, Ground Investigation Report. Ref 1620000492/RPT/002.
- iv. Ramboll, March 2016. Green Park Village, Ground Contamination Interpretative Report. Ref 1620000492/RPT/003.
- v. Ramboll, June 2016. Green Park Village, Supplementary Ground Contamination Interpretative Report for Pingemead Industrial Estate. Ref 1620000492/RPT/004.

Note that the March 2016 Ground Contamination Interpretative Report and Ground Investigation Report draw on information from a number of historical reports prepared by PBA.

1.4 Roles and Responsibilities

This document discusses the potential risks to the water environment resulting from the completion of piling and ground improvement at the site and is intended to be used in conjunction with the Construction Environmental Management Plan (CEMP) for the site works. The Contractor will be responsible for the detailed specification of piling methods, ground improvement and protocols.

Based on this Foundation Works Risk Assessment the Contractor shall prepare detailed method statements covering environmental matters associated with the piling and ground improvement works. The Contractor shall ensure that the works detailed in the method statements comply with applicable Environment Agency (EA) and Reading Borough Council (RBC) requirements.

Foundation works shall not commence until all the aforementioned approvals have been obtained, including all necessary permissions.

1.5 Constraints and Limitations

This document has been prepared for the use of St Edward Homes Limited. This report summarises information provided from a number of external sources and cannot offer any guarantees or warranties for the completeness or accuracy of information relied upon.

It should be noted that although every effort has been made to ensure the accuracy of the data obtained from the investigation, the possibility exists for variations in ground, ground gas and groundwater conditions between and around the exploratory hole locations.

The proposed risk management strategies and recommendations summarised in this report relate to details of the proposed development at the time of writing the report. Any substantial changes to the proposed design may require a reassessment of the implications of the environmental risks identified.

2. THE SITE

2.1 Site Setting

The site setting is covered in detail in the Ground Contamination Interpretative Report². The site location, phasing and proposed layout are contained in Figures 1 and 2.

2.2 Site Location and Description

The site is located approximately 4 km to the south of Reading town centre, Berkshire and occupies an area of approximately 24.6 hectares (ha) at National Grid reference (NGR) 469916, 170239. GPV is located immediately to the northwest of Longwater Avenue in Green Park with the southern boundary formed by Smallmead Road. The western boundary of the site is formed by the Reading-Basingstoke railway line. The site location plan is illustrated in Figure 1.

The site occupies an area of land which is immediately adjacent to authorised landfills (located north of the site) and historic landfills (located north and west of the site). Land at the site has been used for mineral extraction and landfilling at the western end of the site, with Pingemead Industrial Estate formerly present in the central portion of the site.

In the western part of the site existing lakes, known as Trout Lakes, are present and are surrounded by earth bunds.

The site has been split into 6 development phases as outlined in Table 1.

2.3 Site History

A review of previous reports obtained from St Edward Homes Limited and prepared by PBA indicates the site history to be that summarised below in Table 2.

Table 2 Site History

Date	Descriptions
1880s	- The site was designated as Smallmead Common. - The site was agricultural land with the western portion subdivided into smaller fields. - Smallmead Farm and cottages were located on the southern perimeter of the site. - The Reading to Basingstoke railway line was located adjacent to the western perimeter of the site. - Some workings were present (possibly borrow pits) near the western perimeter of the site, adjacent the railway line. - Smallmead Road and Kybes Lane were present along the southern perimeter of the site.
1900s	- The site was still agricultural land. - Smallmead Farm was no longer present on the 1900s historic map. - Smallmead cottages were still present on the southern perimeter of the site. - A new farm (Farm 2) was located 30 metres offsite to the south. - A gravel pit was noted in the north eastern portion of the site (Phase 4). - The workings (possible borrow pits) in the western portion of the site were no longer present. - Manor Farm Sewerage Works were located 100 metres to the northeast of the site.
1960s	- The site was still agricultural land. - The gravel pit noted on the 1900s historic map was still present onsite. - Some workings (possibly gravel pits) were located by Searls Farm (300 metres to the west of the site). - A small structure was located on the southern perimeter of the site.

² Ramboll (2016). Green Park Village, Ground Contamination Interpretative Report ref 1620000492/RPT/003.

Date	Descriptions
1970s	- The western portion of the site was occupied by gravel workings (the Trout Lakes). - The remainder of the site was open land. - A building was located within the centre of the site (Pingemead Industrial Estate). - To the north of the site, to the southwest at Kirtons Farm and to the northeast at the sewage works and Island Road, active gravel pits were indicated. - At Searls Farm the workings identified on the earlier maps were significantly extended. - To the northeast of the site the extent of the sewerage works and associated former sludge beds were delineated. - Smallmead Farm was extended with several additional buildings. - Approximately 100 metres to the southeast of the site was a 'refuse tip' (at present known as Smallmead 'tip'). - Burghfield electricity substation was noted 280 metres northwest of the site. - A speedway stadium was erected to the northeast of the site on the disused sludge beds.
1980s	- Several buildings associated with Pingemead Industrial Estate were located within the central portion of the site. - The gravel workings to the north of site (operated by Halls Aggregates) were extended. - Additional gravel workings occurred at the Kirtons Farm to the southwest of the site. - The former workings at the sewage works and Island Road were in filled. - The M4 motorway was constructed 540 metres to the south of the site.
1990s	- In 1992, four lakes forming the Trout Lakes were combined following an earlier Green Park construction phase and the north western lake was partially backfilled (the type of materials used is unknown). - It was understood by PBA that the Trout Lakes were deepened in the mid-1990s to gain fill material for construction. - The 1992 map indicate an brewery 1 km southeast of the site boundary
2000s	- A waste transfer and treatment facility was located on the western portion of the site (Phase 6). It was noted that mounds of stockpiled materials, skips and site buildings were present until 2007, when operations at the facility ceased. - Within the eastern portion of the site (Phase 3) a training centre belonging to Thames Valley University was first shown on the historical maps dated 2008. - A flood relief channel was constructed, approximately 200 metres northeast of the site.

2.4 Ground Investigations

The site has been subject to a series of predominantly geoenvironmental desk based studies and intrusive ground investigations. Historical ground investigations were undertaken by PBA between 2001 and 2015 and included the advancement of a total of 202No exploratory holes comprising 54No boreholes, 31No window samples and 117No trial pits.

Following these works further supplementary ground investigations have been undertaken by Ramboll in several phases of the site, as summarised in Table 3.

Table 3 Summary of Ramboll Ground Investigations

Phase	Summary Scope of Supplementary Investigations by Ramboll
Phase 1A West and 1B	15No window sample boreholes (R_WS403, R_WS405, R_WS406, R_WS407, R_WS12A and R_WS501 to R_WS510). 8No machine excavated trial pits (R_TP401 to R_TP408). 5No hand dug trial pits (R_HP402 to R_HP404 and R_HP406 to R_HP407).
Phase 2	5No window sample boreholes (R_WS401, RWS402, R_WS404, R_WS408 and R_WS409). 2No hand dug trial pits (R_HP01 and R_HP405).
Phase 3	10No window sample boreholes (RWS601 to RWS610). 3No machine dug trial pits (RTP601 to RTP603).
Phase 4	7No window sample boreholes (RWS611 to RWS615 and RWS638 to RWS639) 3No machine dug trial pts (RTP604 to RTP606)
Phase 5	7No window sample boreholes (RWS615 to RWS621). 30No machine excavated trial pits (RTP701 to RTP730).

The findings of the investigations by PBA and Ramboll have been used to inform the following sections and risk assessments.

2.5 Geology

The site geology has been assessed from a review of 1:50,000 scale digital geological mapping information obtained from the British Geological Survey (BGS) website and from previous intrusive ground investigations undertaken by PBA and Ramboll.

Information from the various historic investigations at the site indicates that the typical ground conditions comprise Topsoil and Made Ground, underlain by Alluvium; River Terrace Deposits of the Thames Group (drift), overlying the Lambeth Group, which in turn is underlain by the White Chalk Subgroup. The pre land raise geological profile of the site is summarised in Table 4. See Drawings 1620000492-RAM-GDR-00-DR-CG-001 to 1620000492-RAM-GDR-00-DR-CG-005 for geological cross sections.

Table 4 Geological Profile Site Wide

Stratum	Typical Description	Aquifer Classification	Depth Range of Strata (m bgl)*	Maximum Thickness (m)
Topsoil (TS)	Dark brown silty clay with occasional fine gravel	Unclassified	Ground level to 0.3	Up to approximately 0.4 m
Made Ground (MG)	Mainly at the former landfill area (western portion of the site), with localised pockets of Made Ground elsewhere. Bund material from the Trout Lakes typically is clayey with fragments of anthropogenic material. The area to the west of Phase 6 is thought to comprise an area of former workings which have been in-filled and the Alluvium and River Terrace Deposits appear to have been removed from these areas.	Unclassified	Ground level to 5.0	Up to approximately 4.7 m thick, occasionally thicker in some places
Alluvium (ALL)	Soft to firm silts and clays with sandy lenses	Unproductive strata	0.05 to 4.50	Approximately 0.1 m to 2.9 m thick. Locally absent
River Terrace Deposits (RTD)	Sand and gravel	Secondary A	0.30 to 6.00	Approximately 0.1 m to 3.55 m thick

Stratum	Typical Description	Aquifer Classification	Depth Range of Strata (m bgl)*	Maximum Thickness (m)
Reading Formation of the Lambeth Group (LMB)	Mottled (red/brown, grey) silty sandy clay with some sandy beds	Secondary A	1.9 to 20.2	Approximately 12.9 m to 15.55 m
White Chalk Subgroup (CHK)	Chalk with flints. Commonly recovered as putty chalk	Principal	15.7 to 30 (depth not proven)	Thickness not proven

* Metres below ground level

2.6 Hydrogeology

Groundwater bodies have been identified in the superficial strata and in the bedrock beneath the site. The River Terrace Deposits and Lambeth Group are classified as Secondary A Aquifers by the Environment Agency (EA) and the White Chalk Subgroup is classified as a Principal Aquifer. The elevation of the piezometric head within these groundwater bodies differs, and it is likely that they form separate water bodies, although there may be some hydraulic continuity in places.

In the superficial strata, groundwater has been identified with approximate piezometric head elevations of 37 mAOD to 38 mAOD with a groundwater flow direction towards the northeast. In the Lambeth Group, groundwater piezometric head elevation has been recorded at approximately 36 mAOD to 38 mAOD with a flow direction towards the east or southeast. Groundwater in the White Chalk Subgroup has been less well characterised, but most likely flows towards the east/southeast with groundwater piezometric head elevations between approximately 35 mAOD and 38 mAOD. The GPV site is not within a Nitrate Vulnerable Zone (NVZ).

There was a historic groundwater abstraction licence (number: 28/39/22/0463) at NGR 469900, 170180 in the name of Kennet Valley Park Limited located within the centre of Pingemead Industrial estate (Phase 1). This was a private water supply used for drinking, cooking, sanitary and washing and was associated with a groundwater Source Protection Zone (SPZ) that will become defunct following decommissioning during site development.

In addition a historic abstraction was located at Smallmead Farm at an approximate grid reference of 469900,170100. This abstracted waters from the Chalk at 45.72 mbgl but is understood to be disused and decommissioned.

Further groundwater abstractions have been identified at Smallmead Landfill located to the northwest of the site where groundwater is abstracted to facilitate the landfill works, according to PBA's June 2009 report.

2.7 Hydrology

Foundry Brook is present to the east of the site, being approximately 350 metres from the site boundary and flowing to the northeast. The other water features include Trout Lakes (located in the western portion of the site) which represent flooded, former gravel workings. A drainage ditch is present at the northern boundary of the site which flows in an easterly direction where it joins Foundry Brook.

The River Kennet is present approximately 650 metres to the north of the site, running in a west-east direction and flowing to the east. A flood relief channel (200 metres northeast of the site) was constructed as part of the Green Park Development flowing in a northerly direction and is understood to be clay lined.

3. FOUNDATION WORKS RISK ASSESSMENT METHODOLOGY

3.1 Methodology

This foundation works risk assessment is undertaken in accordance with guidance provided by the Environment Agency, namely, Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention NC/99/73³. In particular this risk assessment makes reference to six pollution scenarios detailed within NC/99/73 which are summarised in Table 5.

Table 5 Generic Pollution Scenarios

Scenario	Detail
1	Creation of preferential pathways through a low permeability layer (an aquitard) to allow potential contamination of an aquifer and/or surface water feature.
2	Creation of preferential pathways, through a low permeability surface layer, to allow migration of landfill gas, soil gas or vapours to surface.
3	Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface
4	Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials.
5	The driving of solid contaminants down into an aquifer during pile driving.
6	Contamination of groundwater, and subsequently, surface waters by wet concrete, cement paste or grout.

Section 4 of this report onwards provides the foundation works risk assessment for each phase of the development and will be updated on a phased basis following finalisation of proposed foundation methodologies.

3.2 General discussion of preferred piling technique and ground improvement

For the GPV site the preferred founding techniques are a combination of non-displacement piles and vibro-stone column ground improvement following the raising of site levels for flood alleviation purposes. These methods have the potential to affect the ground conditions and/or controlled waters through the six pollution scenarios outlined above.

While the specific potential risks will be assessed individually for each phase later in this report a summary of the main linkages associated with each technique is summarised below.

3.2.1 Non-Displacement Piles (Rotary Bored & Continuous Flight Auger)

Rotary bored and Continuous Flight Auger (CFA) piling techniques are both installed by a rotary boring method, through which there is limited prospect of drag-down of soil and an increase in stress around the pile acts to ensure that the soil closes up around the pile. There is little disturbance caused to the soil surrounding the pile, and there should be no formation of preferential pathways once piling is complete. There is potential for the creation of a temporary contaminant pathway around the pile, but this will be short lived (in the region of minutes) as cast in-situ methods ensure that a good seal is achieved around the annulus of each pile which will close the pathway.

3.2.2 Ground Improvement via Vibro-Stone Columns

³ Environment Agency (2001). Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention NC/99/73.

Vibro-Stone Columns (VSCs) involve the lateral displacement and densification of superficial deposits prior to filling the hole with coarse gravel and cobbles that are compacted in stages to a high density. There is the limited prospect of drag-down as soils are predominantly displaced laterally. While the surrounding ground is densified and the permeability reduced the stone column itself is likely to have a relatively high permeability owing to its inherent uniform grading. As VSCs are generally used for shallow foundations the risk of penetration of an aquitard into a regionally important aquifer is low but their use should be carefully considered due to the potential for the creation of vertical preferential pathways for contaminants and ground gases.

4. PHASE 1A EAST RISK ASSESSMENT

4.1 Introduction

The Phase 1A area is sited centrally within the GPV site and for the purposes of this assessment has been split into Phases 1A East and 1A West as shown in Figure 3. Due to the markedly different historical land uses and the development programme Phase 1A West is assessed separately with Phase 1B in Section 5.

Phase 1A East lies to the east of the drainage ditch which is lined by a series of trees, beyond which is open land. Along the southern boundary of the Phase 1A East area is a further tree-lined ditch.

The following sections describe the prevailing geoenvironmental setting in the area and provide the foundation works risk assessment for Phase 1A East.

4.2 Contamination Discussion

Historical ground investigations undertaken by PBA in the Phase 1A area to the east of the drainage ditch have encountered very limited evidence of soil contamination. These previous investigations also included the assessment of the soil stockpiles that are proposed for re-use during earthworks in Phase 1A East. Investigation locations are shown in Figure 3.

As part of the most recent ground investigations by PBA in 2015⁴ all inorganics (heavy metals) and organics (TPHs, BTEX and PAHs) were either recorded below laboratory limits of detection and/or the adopted generic assessment criteria (GAC) for a residential end use. Asbestos containing materials were also not encountered within the eleven samples screened as part of the most recent ground investigation.

Similarly soil leachate contaminant concentrations were very low with no determinands (comprising metals, pH, conductivity, sulphate, ammoniacal nitrogen and TPH) recorded above GAC adopted for the protection of controlled waters.

Within groundwater evidence of isolated inorganic contaminants was recorded, primarily within BH105 in the form of chromium and copper, but at concentrations only marginally in excess of assessment criteria. There was limited evidence of organic contamination in groundwater with no PAHs recorded at elevated concentrations. However, elevated concentrations of TPHs were recorded within the Chalk on a single occasion in 2002 at 2,000 µg/l using infra-red (IR) methods which are prone to interferences from non-petroleum sources. Concentrations of that order have not been recorded in BH105 since (or above GAC) and the risks are thus considered to be low.

Elevated concentrations of manganese, iron and ammonium were recorded in groundwater within in Phase 1A East but these were considered by PBA to be representative of regional trends rather than a site specific source.

The gassing regime in Phase 1A has been characterised by PBA⁴ as a Characteristic Situation of 1 / NHBC Green site based on the results of monitoring undertaken in 2015. During six monitoring visits methane concentrations were recorded below instrument limits of detection (<0.1%v/v) with carbon dioxide recorded below 4.0% v/v. Resultant gas screening values (GSVs) were calculated to be 0.0001 and 0.0004 respectively.

⁴ Peter Brett Associates (2015). Green Park Village, Report on Ground Investigation for Phase 1 ref 30158 Geo RPT 02.

Based on the results of historic ground investigations in the Phase 1A East area (including the stockpiled material proposed to be re-used in the land raise) the potential for contamination in soils and groundwater is considered to be very low.

4.3 Summary of Conceptual Site Model

Within Phase 1A East the potential for significant or widespread contamination in soils and groundwater is considered to be very low, as are the risks associated with ground gases. Consequently no pollutant linkages were identified due to the lack of contamination sources.

4.4 Proposed Development

4.4.1 General

Phase 1A will comprise residential housing with gardens, areas of soft landscaping and associated infrastructure. Fifty three private residential units are proposed within Phase 1A East. As part of the redevelopment Phase 1A will be raised from an elevation of approximately 39.5 mAOD to a consistent elevation of 40.25 mAOD using site won material compliant with the Ramboll Specification for Earthworks¹.

4.4.2 Proposed Foundation Methodology

Within Phase 1A East the founding methodology is proposed to comprise 600 mm diameter bottom fed vibro-stone columns that will terminate within the River Terrace Deposits at approximately 2 metres to 4 metres below land raise level (36.25 mAOD to 38.25 mAOD).

4.5 Foundation Works Risk Assessment

The Foundation Works Risk Assessment for Phase 1A East is contained in Table 6. Risk estimation has been undertaken in line with guidance provided by the NHBC and Environment Agency⁵.

Table 6 Foundation Works Risk Assessment for Phase 1A East

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Comment
Creation of preferential pathways through a low permeability layer (an aquitard) to allow potential contamination of an aquifer and/or surface water feature.	S	Contaminated Made Ground	Risk: Low VSCs used for ground improvement will penetrate through the land raise, topsoil and alluvium and will terminate within the River Terrace Deposits. The alluvium has been demonstrated to be discontinuous i.e. the superficial strata and surface water are already likely in continuity and no aquitard/ low permeability strata will be penetrated. Furthermore the contaminant loadings within Phase 1A East have been demonstrated to be low and adverse impact to the underlying Secondary Aquifer and surface water features is considered unlikely.
	P	Pile / soil interface	
	R	Secondary Aquifers	
Creation of preferential pathways, through a low permeability surface layer, to allow migration of landfill gas, soil gas or vapours to surface.	S	Soil Gas / Vapours	Risk: Low The site was classified by PBA ⁴ as having a Characteristic Situation of 1 (very low risk) and that ground gas protection measures are not required. Notwithstanding this the enabling and main works
	P	Pile / soil interface	

⁵ NHBC & Environment Agency (2008). R&D Publication 66:2008 Guidance for the Safe Development of Housing on Land Affected by Contamination.

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Comment
	R	Buildings, Construction Workers and End Users	contractors are required to have appropriate safe working practices and health and safety measures in place during works e.g. PPE, RPE and confined spaces entry systems etc.
Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface.	S	Contaminated Made Ground	Risk: Low Vibro-stone columns are a displacement method and minimal arisings will be created during ground improvement owing to the inherent methodology. The risk to construction workers will be further mitigated through the use of suitable health and safety precautions e.g. method statements. The use of appropriate personal protective equipment (PPE) will be adopted by the contractor during piling works.
	P	Direct Contact and Inhalation and Ingestion of Dust	
	R	Construction Workers	
Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials.	S	Contaminants in Soils and Groundwater	Risk: Low The contaminant loadings within Phase 1A East have been demonstrated to be low and it is considered unlikely that granular materials used as part of the VSCs will be adversely impacted.
	P	Direct Contact and Aggressive Attack	
	R	Below Ground Structures i.e. VSCs.	
The driving of solid contaminants down into an aquifer during pile driving.	S	Contaminated Made Ground	Risk: Low There is the limited prospect of drag-down as soils are predominantly displaced laterally. Should any occur it is only likely to take place over a few centimetres. Furthermore the contaminant loadings within Phase 1A East have been demonstrated to be low and adverse impact to the underlying Secondary Aquifer is considered unlikely.
	P	Pile / soil interface	
	R	Secondary Aquifers	
Contamination of groundwater, and subsequently, surface waters by wet concrete, cement paste or grout.	S	Construction Materials	Risk: Low As VSCs are proposed no concreting or grouting will be undertaken.
	P	Pile / soil interface	
	R	Secondary Aquifers	

The risks associated with ground improvement in Phase 1A East are thus considered to be low.

5. PHASE 1A WEST AND PHASE 1B RISK ASSESSMENT

5.1 Introduction

As previously mentioned the Phase 1 area is sited centrally within the GPV site and for the purposes of this assessment has been split into Phases 1A East, 1A West and Phase 1B as shown in Figure 3. As Phase 1A West and Phase 1B have the same historical setting, being part of the former Pingemead Industrial Estate, they have been assessed together herein. Phase 1A East has been assessed as part of the preceding chapter.

Prior to demolition the site was occupied by the Pingemead Industrial Estate which contained several notable land uses including aluminium fabricators, car servicing, oil distributors, a builders merchant, fly-tipped waste bunds, cesspits and a number of above ground fuel oil and diesel storage tanks. The site was covered by moderate condition hard-standing with vegetated areas present in the centre of the site and towards the eastern, western and southern margins of the site.

The following sections describe the prevailing geoenvironmental setting in the area and provide the foundation works risk assessment for Phase 1A West and Phase 1B.

5.2 Contamination Discussion

Ground Investigation

As part of the most recent ground investigations undertaken before and following demolition by Ramboll in 2016 there was limited evidence of contamination in Phase 1A West and Phase 1B. Exceedences of Generic Assessment Criteria (GAC) for beryllium (2.3 mg/kg max), lead (950 mg/kg max) and benzo(a)pyrene (6.9 mg/kg max) were recorded in disparate locations with TPH EC16-21 and EC21-35 (aliphatic and aromatic) recorded locally within RHP402 (980 mg/kg). Evidence of asbestos impact was identified in the area in the vicinity of the former Pingemead Industrial Estate buildings in the form of chrysotile and amosite but at low concentrations either below <0.002 % w/w or laboratory limits of detection (<0.001 % w/w).

The potential human health impacts associated with this contamination will be minimal as the proposed land raise will mitigate pollutant linkages to end users associated with heavy metals and asbestos. Due consideration to the presence of these contaminants will be given during foundation works as foundations will pass through the affected ground.

In relation to controlled waters the investigations carried out in 2016 identified low levels of inorganic contamination including ammonium, pH, chromium (III & VI), copper and lead within soil leachate, which, with the exception of ammonium has not been identified to be impacting groundwater beneath the site. Low levels of mercury have been identified in groundwater but in isolated locations at concentrations within an order of magnitude of its GAC so are unlikely to constitute a significant risk to controlled waters. TPHs, PAHs and chlorinated solvents in groundwater were recorded below GAC and/or laboratory limits of detection.

Elevated concentrations of ammonium have been persistently recorded in groundwater across Phase 1A West and Phase 1B but are understood to be reflective of regional diffuse impacts. Bacteria (E. Coli and coliforms) were encountered in groundwater in the River Terrace Deposits but given that the Industrial Estate has been vacant for a number of months and the onsite cesspits have been removed it is not considered likely that a replenishing source of bacteria is present on site. Given the absence of potable groundwater abstractions in the proposed development and the proposed thickness of land raise, human interaction with bacterially impacted waters is unlikely.

No contaminants of concern were identified in surface water within samples obtained from the Trout Lakes suggesting that, while limited, the controlled water impacts identified onsite in shallow groundwater are not migrating to the Lakes and are therefore unlikely to migrate to the surrounding ditches and Foundry Brook further afield.

Ground gas monitoring has resulted in Phase 1A West and Phase 1B being classified as a Characteristic Situation 1 area and as such no ground gas protection measures are required as part of development in these locations.

Enabling Works

Following enabling works at the site a number of potential below ground sources of contamination were encountered which were largely consistent with those outlined in Section 5.1. These sources were removed and successfully validated under the watching brief of Ramboll and are to be reported under separate cover⁶. However, in two locations underground fuel storage tanks (USTs) were removed independently by the demolition contractor and following removal petroleum hydrocarbon impacts were identified locally within groundwater at the site. Exceedences of TPH GAC within soils were not generally noted in the area, save for two locations on the boundary of Phase 1A West and Phase 1B (Void 2). Free phase hydrocarbons were identified in three open excavations (Void 1, Void 2 and Void 6 – see Figure 3) and were removed via manual surface skimming. Within subsequent monitoring approximately 10 mm of free product was recorded in RWS405 with dissolved phase impacts also identified in RWS405, RWS509, RWS508, RWS506 and RWS403. Speciated TPH concentrations generally ranged from <0.01 to 2.1 mg/l with significantly elevated concentrations recorded in RWS405 and RWS509 in the vicinity of Void 2 up to maximums of 480 mg/l (Aliphatic EC8-10) and 21 mg/l (Aromatic EC8-10 mg/l) respectively. Further remediation in this area is likely to be required. This is discussed in further detail in the Detailed Quantitative Risk Assessment for the Pingemead Industrial Estate site⁷.

5.3 Summary of Conceptual Site Model

Following the identification of the contamination highlighted above a conceptual site model was prepared for the area, as presented in the Ground Contamination Interpretative Report² and refined as part of the Supplementary Ground Contamination Interpretative Report and DQRA for the Pingemead Industrial Estate^{8,7}. This identified a number of potentially significant pollutant linkages, those of which are relevant to the proposed foundation works being summarised in Table 7.

Table 7 Potentially Significant Pollutant Linkages in Phase 1A West and Phase 1B

Contamination Identified	Associated Potentially Significant Pollutant Linkages	Risk
<u>Human Health</u> Asbestos in soils	Inhalation of released fibres associated with construction workers and site users.	Moderate
<u>Controlled Waters</u> Dissolved phase hydrocarbons in the River Terrace Deposits comprising Aliphatic EC6-8,	Migration in groundwater, including vertical pathway creation via foundations from shallow to deeper aquifers.	Moderate

⁶ Ramboll (2016). Green Park Village Pingemead Industrial Estate Enabling Works Verification Report ref 1620000492/RPT/009 (*in press*).

⁷ Ramboll (2016). Green Park Village Pingemead Industrial Estate Controlled Waters Detailed Quantitative Risk Assessment ref 1620000492/RPT/010,

⁸ Ramboll (2016). Green Park Village Supplementary Ground Contamination Interpretative Report for Pingemead Industrial Estate ref 1620000492/RPT/004.

Contamination Identified	Associated Potentially Significant Pollutant Linkages	Risk
Aliphatic EC8-10 and Aromatic EC8-10 bands in the vicinity of RWS405 and RWS509 and Aromatic EC10-12 and Aromatic EC12-16 bands in the vicinity of RWS405, RWS509, RWS508, RWS506 and RWS403.		
<u>Controlled Waters</u> Free phase hydrocarbons in the River Terrace Deposits in the vicinity of RWS405.	Migration in groundwater, including vertical pathway creation via foundations from shallow to deeper aquifers.	Moderate

Note – all other identified linkages were assessed as low or very low risk.

5.4 Proposed Development

5.4.1 General

Phase 1A West and Phase 1B are proposed to comprise residential housing with gardens, areas of soft landscaping and associated infrastructure. As part of the redevelopment ground levels will be raised from an elevation of approximately 39 mAOD to 40.25 mAOD using a combination of naturally occurring greenfield soils imported to site under a direct transfer materials management plan from a site in Warfield (for Phase 1A West) and inert materials compliant with the Ramboll Specification for Earthworks¹ and Bespoke Environment Permit ref EPR/DB3206HL for the site (for Phase 1B).

5.4.2 Proposed Foundation Methodology

Within Phase 1A West and Phase 1B the founding methodology is proposed to comprise 600 mm diameter bottom fed vibro-stone columns that will terminate within the River Terrace Deposits at approximately 2 metres to 4 metres below land raise level (36.25 mAOD to 38.25 mAOD).

5.5 Foundation Works Risk Assessment

The Foundation Works Risk Assessment for Phase 1A West and Phase 1B is contained in Table 8 Table 1 Risk estimation has been undertaken in line with guidance provided by the NHBC and EA⁵.

Table 8 Foundation Works Risk Assessment for Phase 1A West and Phase 1B

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Comment
Creation of preferential pathways through a low permeability layer (an aquitard) to allow potential contamination of an aquifer and/or surface water feature.	S	Contaminated Made Ground	Risk: Low VSCs used for ground improvement will penetrate through the land raise, topsoil and alluvium and will terminate within the River Terrace Deposits. The alluvium has been demonstrated to be discontinuous i.e. the superficial strata and surface water are already likely in continuity and no aquitard/ low permeability strata will be penetrated. With the exception of the hydrocarbon contamination identified in groundwater in the vicinity of Void 2 the contaminant loadings in Phase 1A West and Phase 1B are low. The hydrocarbon contamination surrounding Void 2 will also be subject to remediation to mitigate the risk of lateral migration to the Trout Lakes.
	P	Pile / soil interface	
	R	Secondary Aquifers	

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Comment
			Ground improvement via VSCs is unlikely to create preferential pathways or alter the current status quo as hydrocarbons are already present (and solely present) within groundwater within the RTD and VSCs will terminate within this strata and not penetrate through into deeper aquifers. Increased lateral permeability may occur locally within the stone column itself but this is likely to be spatially limited considering the densification of fine granular soils surrounding the column and the limited building / VSC coverage across Phase 1A and Phase 1B as a whole.
Creation of preferential pathways, through a low permeability surface layer, to allow migration of landfill gas, soil gas or vapours to surface.	S	Soil Gas / Vapours	Risk: Low The Phase 1A West and Phase 1B is classified as a Characteristic Situation of 1 (very low risk) and that ground gas protection measures are not required. Notwithstanding this the enabling and main works contractors are required to have appropriate safe working practices and health and safety measures in place during works e.g. PPE, RPE and confined spaces entry systems etc.
	P	Pile / soil interface	
	R	Buildings, Construction Workers and End Users	
Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface.	S	Contaminated Made Ground	Risk: Low Vibro-stone columns are a displacement method and minimal arisings will be created during ground improvement owing to the inherent methodology. The risk to construction workers will be further mitigated through the use of suitable health and safety precautions e.g. method statements. The use of appropriate personal protective equipment (PPE) will be adopted by the contractor during piling works.
	P	Direct Contact and Inhalation and Ingestion of Dust	
	R	Construction Workers	
Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials.	S	Contaminants in Soils and Groundwater	Risk: Low Based on the nature of the materials used it is considered unlikely that the granular materials used as part of the VSCs will be adversely impacted.
	P	Direct Contact and Aggressive Attack	
	R	Below Ground Structures i.e. VSCs	
The driving of solid contaminants down into an aquifer during pile driving.	S	Contaminated Made Ground	Risk: Low There is the limited prospect of drag-down as soils are predominantly displaced laterally. Should any occur it is only likely to take place over a few centimetres. Limited soils contamination has been identified within the Made Ground and Alluvium that could feasibly be dragged down into the River Terrace Deposits Secondary Aquifer. VSCs will not penetrate through the River Terrace Deposits into deeper aquifers.
	P	Pile / soil interface	
	R	Secondary Aquifers	
Contamination of groundwater, and subsequently, surface waters by wet concrete, cement paste or grout.	S	Construction Materials	Risk: Low As VSCs are proposed no concreting or grouting will be undertaken.
	P	Pile / soil interface	
	R	Secondary Aquifers	

The risks associated with ground improvement in Phase 1A West and Phase 1B are thus considered to be low.

6. PHASE 2 RISK ASSESSMENT

6.1 Introduction

The Phase 2 area is situated in the south-central part of the site, and is bounded by the existing Trout Lakes to the west, a ditch at the south easternmost boundary, Smallmead Road to the south, and Phase 1 area to the north and east.

Land at Phase 2 is currently disused pending the onset of development. As part of previous assessments the Phase was subdivided into three parts based on their historical land uses (Phase 2A, Phase 2B and Phase 2C). Phase 2A previously contained several disused houses, one of which was previously used as the GPV site office. Phases 2A and 2C incorporate the access road serving the derelict Pingemead Industrial Estate. Phase 2C incorporates the south eastern corner of Pingemead Industrial Estate which lies on the east side of a north-south trending ditch, and vacant land to the west side of that ditch. The area location and phasing is shown in Figure 4.

The following sections describe the prevailing geoenvironmental setting in the area and provide the foundation works risk assessment for Phase 2.

6.2 Contamination Discussion

As part of the most recent ground investigations undertaken by Ramboll in 2016 there was limited evidence of contamination in Phase 2. Single exceedences of beryllium (3.4 mg/kg) and lead (340 mg/kg) were identified in Phases 2A and 2B. Evidence of asbestos impact was identified in Phase 2B in the vicinity of the former Pingemead Industrial Estate buildings in the form of chrysotile and amosite but at concentrations below laboratory limits of detection.

The potential human health impacts associated with this contamination will be minimal as the proposed land raise will mitigate pollutant linkages to end users associated with heavy metals and asbestos. Due consideration to the presence of these contaminants will be given during foundation works as foundations will pass through the affected ground.

In relation to controlled waters the investigations carried out in 2016 identified low levels of inorganic contamination which is limited to ammonium within soil leachate. Low levels of mercury and zinc have been identified in groundwater but in isolated locations at concentrations within an order of magnitude of GAC and so are considered to be unlikely to constitute a significant risk.

Elevated concentrations of ammonium have been persistently recorded in groundwater across Phase 2 but is understood to be reflective of regional diffuse impacts⁸.

TPHs and chlorinated solvents were recorded below GAC and/or laboratory limits of detection across the phase. Concentrations of PAHs above GAC were recorded in three locations at a maximum of 2 to 5 times GAC for anthracene and flouranthene within the first groundwater monitoring but were below laboratory limits of detection in the second visit. As sustained elevated concentrations have not been identified the risk to controlled waters from these contaminants is considered to be limited.

Bacteria (E. Coli and coliforms) were encountered in groundwater in the River Terrace Deposits but given that the Industrial Estate has been vacant for a number of months and the onsite cesspits have been removed it is not considered likely that a replenishing source of bacteria is present on site. Given the absence of potable groundwater abstractions in the proposed development and the proposed thickness of land raise, human interaction with bacterially impacted waters is unlikely.

No contaminants of concern were identified in surface water within samples obtained from the Trout Lakes suggesting that, while limited, the controlled water impacts identified onsite in shallow groundwater are not migrating to the Lakes and are therefore unlikely to migrate to the surrounding ditches and Foundary Brook further afield.

Ground gas monitoring has resulted in Phase 2 being classified as a Characteristic Situation 1 area and such no ground gas protection measures are required as part of development.

6.3 Summary of Conceptual Site Model

Following the identification of the contamination highlighted above a conceptual site model was prepared for the area, as presented in the Ground Contamination Interpretative Report² and refined as part of the Supplementary Ground Contamination Interpretative Report for the Pingemead Industrial Estate³. This identified a number of potentially significant pollutant linkages, those of which are relevant to the proposed foundation works being summarised in Table 9.

Table 9 Potentially Significant Pollutant Linkages in Phase 2

Contamination Identified	Associated Potentially Significant Pollutant Linkages	Risk
<u>Human Health</u> Asbestos in soils	Inhalation of released fibres associated with construction workers and site users.	Moderate
<u>Controlled Waters</u> PAHs in groundwater in RWS401, RWS402 and RWS409	Migration in groundwater, including vertical pathway creation via foundations from shallow to deeper aquifers	Moderate/Low

Note – all other identified linkages were assessed as low or very low risk.

6.4 Proposed Development

6.4.1 General

Across Phase 2 ground levels are to be raised by between approximately 1.2 metres and 2.5 metres from between ~38.2 mAOD and ~40.7 mAOD using inert materials compliant with the Ramboll Specification for Earthworks¹ and Bespoke Environment Permit ref EPR/DB3206HL for the site.

The increase in levels is to provide a new care home facility and residential apartments in Phase 2A with associated soft landscaping and car parking. Phase 2B will comprise a new primary school with sports pitches for dual school and local community use. Community facilities including a community hall are also to be provided. Residential development is proposed in Phase 2C, comprising a single block of residential units with communal areas of soft landscaping.

6.4.2 Proposed Foundation Methodology

Within Phase 2 the founding methodology is proposed to comprise continuous flight auger piles that will terminate within the White Chalk Subgroup.

6.5 Foundation Works Risk Assessment

The Foundation Works Risk Assessment for Phase 2 is contained in Table 10. Risk estimation has been undertaken in line with guidance provided by the NHBC and EA⁵.

Table 10 Foundation Works Risk Assessment for Phase 2

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Comment
Creation of preferential pathways through a low permeability layer (an aquitard) to allow potential contamination of an aquifer and/or surface water feature.	S	Contaminated Made Ground	Risk: Low CFA piles will penetrate through the land raise, topsoil and alluvium, River Terrace Deposits and Lambeth Group and will terminate within the White Chalk Subgroup. Using CFA techniques the potential creation of permanent pathways to underlying aquifers and surface water features are limited as cast in-situ methods ensure that a good seal is achieved around the annulus of each pile which will close the pathway.
	P	Pile / soil interface	
	R	Secondary Aquifers	
Creation of preferential pathways, through a low permeability surface layer, to allow migration of landfill gas, soil gas or vapours to surface.	S	Soil Gas / Vapours	Risk: Low CFA piling will create a seal around the annulus of the pile thereby reducing permeability to the gassing strata of the Made Ground, Alluvium and unsaturated River Terrace Deposits. In addition the concrete/grout used for the piles is likely to be less permeable than the surrounding strata. As the Phase has been classified as a Characteristic Situation of 1 no ground gas protection measures are required. In addition the enabling and main works contractors are required to have appropriate safe working practices and health and safety measures in place during works e.g. PPE, RPE and confined spaces entry systems etc.
	P	Pile / soil interface	
	R	Buildings, Construction Workers and End Users	
Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface.	S	Contaminated Made Ground	Risk: Low CFA piling results in the generation of arisings at the surface, however the results of ground investigations at the site have not identified any significant contamination in soils with the exception of low levels of asbestos containing materials in isolated locations. The risk to construction workers will be mitigated through the use of suitable health and safety precautions e.g. method statements. The use of appropriate personal protective equipment (PPE) and respiratory protective equipment (RPE) will be adopted by the contractor during piling works. Pile and foundation arisings will be segregated and stored onsite for additional testing to determine their suitability for reuse in later phases of the development. Any unacceptable or contaminated arisings will be disposed off-site at a suitably licensed facility under an appropriate duty of care.
	P	Direct Contact and Inhalation and Ingestion of Dust	
	R	Construction Workers	
Direct contact of the piles or engineered	S	Contaminants in Soils and	Risk: Low

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Comment
structures with contaminated soil or leachate causing degradation of pile materials.		Groundwater	The Ground Investigation Report ⁹ for the site has identified the Design Sulphate Class (DS) to be DS-1 and the Aggressive Concrete Class (AC) to be AC-1 for this phase of the site. Consequently piles will be required to be designed to a worst case of DS-1 / AC-1.
	P	Direct Contact and Aggressive Attack	
	R	Below Ground Structures i.e. Piles.	
The driving of solid contaminants down into an aquifer during pile driving.	S	Contaminated Made Ground	Risk: Low Proposed piling method is CFA which is a non-displacement method of piling.
	P	Pile / soil interface	
	R	Secondary Aquifers	
Contamination of groundwater, and subsequently, surface waters by wet concrete, cement paste or grout.	S	Construction Materials	Risk: Low Piles are proposed to extend beneath groundwater levels within the Principal Aquifer. Whilst the risk of contamination cannot be discounted the impact is assessed as low as both concrete and grout have low mobility potential. Opportunities for the use of quick setting concrete / grout are to be explored to minimise potential for migration.
	P	Pile / soil interface	
	R	Secondary Aquifers	

The risks associated with CFA piling in Phase 2 are thus considered to be low.

⁹ Ramboll (2016). Green Park Village Ground Investigation Report ref 1620000492/RPT/002.

7. PHASE 3 RISK ASSESSMENT

7.1 Introduction

Phase 3 is present in the eastern portion of the site as shown in Figure 5. Phase 3 is bound by historic landfill sites to north, a drainage ditch at the northern boundary, an isolated ditch at the southernmost boundary, and other Phases (Phases 1 and 4) to the west and north. Phase 3 is predominantly open ground and is split into three sub phases Phase 3A, Phase 3B and Phase 3C. Phase 3A has recently been re-profiled and raised following the re-use of a number of stockpiles within the land raise in Phase 1A. Phase 3B is present at a lower (original) ground level. Phase 3C encompasses the trout lake and surrounding banks. The location of these sub phases is shown in Figure 2.

The following sections describe the prevailing geoenvironmental setting in the area and provide the foundation works risk assessment for Phase 3.

7.2 Contamination Discussion

As part of the most recent ground investigation undertaken by Ramboll in 2017¹⁰ Made Ground soils were identified to be mildly impacted with arsenic (max 89 mg/kg), lead (max 960 mg/kg) and copper (max 7,600 mg/kg). Associated human health risks were considered to be low as the land will be raised with 1 m to 2 m of imported material thus eliminating the direct contact, ingestion of soil and inhalation of dust pathways.

The risk assessment did not identify any significant controlled waters risks with no leachable contaminants identified in the unsaturated zone. The identified inorganic contaminants in groundwater, sulphate (290 mg/l max), arsenic (90 µg/l max), mercury (0.2m µg/l max) and nickel (35 µg/l max) were not considered significant due to their marginal exceedence or exceedence within an order of magnitude of adopted GAC. As no plausible sources for these contaminants were identified and similar concentrations have been encountered in other phases they were considered to reflect background concentrations rather than an on-site source of contamination.

Medium to heavy end hydrocarbons (>C10 aliphatics) up to 790 µg/l were identified in groundwater in discrete locations, however, no obvious on-site source was identified and given that these fractions are considered to be of low mobility and low risk to the water environment they were also not considered significant.

Bacteria (*E. Coli* and coliforms) was also recorded in groundwater, however, the exceedences were not considered significant given that groundwater is not used for a potable supply and human interaction with groundwater at the site in its proposed state is unlikely. Potential risks during the construction stage should be managed though adherence to good construction practice e.g. use of appropriate PPE.

Following a detailed assessment of ground gas risks¹¹ at the site Phase 3 has been classified as NHBC 'Green' with no specific protection measures required in addition to the sub-floor ventilation provided as part of the current design.

¹⁰ Ramboll (2017). Ground Contamination Interpretative Report Phase 3, Green Park Village ref 1620000492/RPT/012.

¹¹ Ramboll (2017). Ground Gas Risk Assessment, Green Park Village ref 1620000492/RPT/016.

7.3 Summary of Conceptual Site Model

Following the identification of the above a conceptual site model was prepared for the phase as presented in the Ground Contamination Interpretative Report¹⁰. The conceptual site model was further refined in relation to ground gas risk as part of the Ground Gas Risk Assessment¹¹ for the phase. Following these assessments no potentially significant pollutant linkages were identified that are of relevance to the proposed foundation works. Note that a potentially significant pollutant linkage is defined as risk rating of moderate/low or higher in accordance guidance provided by the NHBC and EA.

7.4 Proposed Development

7.4.1 General

Phase 3 of the GPV development will comprise residential housing with gardens, areas of soft landscaping and associated infrastructure. Within the phase ground levels are proposed to be raised by approximately 1 to 2 m using imported material compliant with the Ramboll Specification for Earthworks **Error! Bookmark not defined..**

7.4.2 Proposed Foundation Methodology

Within Phase 3 the founding methodology is proposed to comprise vibro-stone columns that will terminate within the River Terrace Deposits at a depth of up to approximately 4.0 m below land raise level ~36.2 mAOD.

7.5 Foundation Works Risk Assessment

The Foundation Works Risk Assessment for Phase 3 is contained in Table 11. Risk estimation has been undertaken in line with guidance provided by the NHBC and EA⁵

Table 11 Foundation Works Risk Assessment for Phase 3

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Comment
Creation of preferential pathways through a low permeability layer (an aquitard) to allow potential contamination of an aquifer and/or surface water feature.	S	Contaminated Made Ground	Risk: Low VSCs used for ground improvement will penetrate through the land raise, topsoil and alluvium and will terminate within the River Terrace Deposits. The alluvium has been demonstrated to be discontinuous i.e. the superficial strata and surface water are already likely in continuity and no aquitard/ low permeability strata will be penetrated. Furthermore the contaminant loadings within Phase 3 have been demonstrated to be low and adverse impact to the underlying Secondary Aquifer and surface water features is considered unlikely.
	P	Pile / soil interface	
	R	Secondary Aquifers	
Creation of preferential pathways, through a low permeability surface layer, to allow migration of landfill gas, soil gas or vapours to surface.	S	Soil Gas / Vapours	Risk: Low The site is classified as NHBC Green and no specific ground gas protection measures are required over and above the sub-floor ventilation already provided as part of the design. Notwithstanding this the enabling and main works contractors are required to have appropriate safe working practices and health and safety measures in place during works e.g. PPE, RPE and confined spaces entry systems etc.
	P	Pile / soil interface	
	R	Buildings, Construction Workers and End Users	

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Comment
Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface.	S	Contaminated Made Ground	Risk: Low Vibro-stone columns are a displacement method and minimal arisings will be created during ground improvement owing to the inherent methodology. The risk to construction workers will be further mitigated through the use of suitable health and safety precautions e.g. method statements. The use of appropriate personal protective equipment (PPE) will be adopted by the contractor during piling works.
	P	Direct Contact and Inhalation and Ingestion of Dust	
	R	Construction Workers	
Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials.	S	Contaminants in Soils and Groundwater	Risk: Low The contaminant loadings within Phase 3 have been demonstrated to be low and it is considered unlikely that granular materials used as part of the VSCs will be adversely impacted.
	P	Direct Contact and Aggressive Attack	
	R	Below Ground Structures i.e. VSCs.	
The driving of solid contaminants down into an aquifer during pile driving.	S	Contaminated Made Ground	Risk: Low There is the limited prospect of drag-down as soils are predominantly displaced laterally. Should any occur it is only likely to take place over a few centimetres. Furthermore the contaminant loadings within Phase 3 have been demonstrated to be low and adverse impact to the underlying Secondary Aquifer is considered unlikely.
	P	Pile / soil interface	
	R	Secondary Aquifers	
Contamination of groundwater, and subsequently, surface waters by wet concrete, cement paste or grout.	S	Construction Materials	Risk: Low As VSCs are proposed no concreting or grouting will be undertaken.
	P	Pile / soil interface	
	R	Secondary Aquifers	

The risks associated with ground improvement in Phase 3 are thus considered to be low.

8. PHASE 4 RISK ASSESSMENT

8.1 Introduction

Phase 4 is present in the central eastern portion of the site as shown in Figure 6. Phase 4 is bounded by historical landfill sites and a drainage ditch to the north with Phases 1, 3 and 5 located to the south, east and west. Phase 4 is currently used for the storage of construction materials and imported soil stockpiles for the wider GPV development. Prior to its use for this purpose it was re-profiled with a topsoil strip following the re-use of a number of historical stockpiles within the land raise in Phase 1A.

The following sections describe the prevailing geoenvironmental setting in the area and provide the foundation works risk assessment for Phase 4.

8.2 Contamination Discussion

As part of the most recent ground investigation undertaken by Ramboll in 2017¹² no contaminants of concern were identified in the site soils in relation to human health. Notwithstanding this risks will be further reduced as the land will be raised with approximately 2 m of imported material thus breaking the direct contact, ingestion of soil and inhalation of dust pathways from Made Ground at the site to human health.

The risk assessment did not identify any significant controlled waters risks with no leachable contaminants identified in the unsaturated zone. The identified inorganic contaminants in groundwater comprising sulphate (480 mg/l max), arsenic (26 µg/l max) and nickel 22 µg/l max) were not considered significant due to their marginal exceedence or exceedence within an order of magnitude of adopted GAC. As no plausible sources for these contaminants were identified and similar concentrations have been encountered in other phases they were considered to reflect background concentrations rather than an on-site source of contamination.

Heavy end hydrocarbons (>C16 aliphatics) up to 890 µg/l were identified in groundwater in three discrete locations, however, no obvious on site source was identified and given that these fractions are considered to be of low mobility and low risk to the water environment they were also not considered significant.

Bacteria (*E. Coli* and coliforms) was also recorded in groundwater, however, the exceedences were not considered significant given that groundwater is not used for a potable supply and human interaction with groundwater at the site in its proposed state is unlikely. Potential risks during the construction stage should be managed though adherence to good construction practice e.g. use of appropriate PPE.

Following a detailed assessment of ground gas risks¹¹ at the site Phase 4 has been classified as NHBC 'Green' with no specific protection measures required in addition to the sub-floor ventilation provided as part of the current design.

8.3 Summary of Conceptual Site Model

Following the identification of the above a conceptual site model was prepared for the phase as presented in the Ground Contamination Interpretative Report¹². The conceptual site model was further refined in relation to ground gas risk as part of the Ground Gas Risk Assessment¹¹ for the Phase. Following these assessments no potentially significant pollutant linkages were identified that are of relevance to the proposed foundation works. Note that a potentially significant

¹² Ramboll (2017). Ground Contamination Interpretative Report Phase 4, Green Park Village ref 1620000492/RPT/013

pollutant linkage is defined as risk rating of moderate/low or higher in accordance guidance provided by the NHBC and EA.

8.4 Proposed Development

8.4.1 General

Phase 4 of the GPV development will comprise residential housing with gardens, areas of soft landscaping and associated infrastructure. Within the phase ground levels are proposed to be raised by approximately 2 m using imported material compliant with the Ramboll Specification for Earthworks¹.

8.4.2 Proposed Foundation Methodology

Within Phase 4 the founding methodology is proposed to comprise vibro-stone columns that will terminate within the River Terrace Deposits. At this stage the termination depth has not been finalised, however, this is anticipated to be at a similar depth to Phase 3 at approximately 4.0 m below land raise level ~36.2 mAOD.

8.5 Foundation Works Risk Assessment

The Foundation Works Risk Assessment for Phase 4 is contained in Table 12. Risk estimation has been undertaken in line with guidance provided by the NHBC and EA⁵.

Table 12 Foundation Works Risk Assessment for Phase 4

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Comment
Creation of preferential pathways through a low permeability layer (an aquitard) to allow potential contamination of an aquifer and/or surface water feature.	S	Contaminated Made Ground	Risk: Low VSCs used for ground improvement will penetrate through the land raise, topsoil and alluvium and will terminate within the River Terrace Deposits. The alluvium has been demonstrated to be discontinuous i.e. the superficial strata and surface water are already likely in continuity and no aquitard/ low permeability strata will be penetrated. Furthermore the contaminant loadings within Phase 4 have been demonstrated to be low and adverse impact to the underlying Secondary Aquifer and surface water features is considered unlikely.
	P	Pile / soil interface	
	R	Secondary Aquifers	
Creation of preferential pathways, through a low permeability surface layer, to allow migration of landfill gas, soil gas or vapours to surface.	S	Soil Gas / Vapours	Risk: Low The site is classified as NHBC Green and no specific ground gas protection measures are required over and above the sub-floor ventilation already provided as part of the design. Notwithstanding this the enabling and main works contractors are required to have appropriate safe working practices and health and safety measures in place during works e.g. PPE, RPE and confined spaces entry systems etc.
	P	Pile / soil interface	
	R	Buildings, Construction Workers and End Users	
Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface.	S	Contaminated Made Ground	Risk: Low Vibro-stone columns are a displacement method and minimal arisings will be created during ground improvement owing to the inherent methodology. The risk to construction workers will be further mitigated through the use of suitable health and safety precautions e.g. method statements. The use of appropriate personal protective equipment (PPE) will be
	P	Direct Contact and Inhalation and Ingestion of Dust	

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Comment
	R	Construction Workers	adopted by the contractor during piling works.
Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials.	S	Contaminants in Soils and Groundwater	Risk: Low The contaminant loadings within Phase 4 have been demonstrated to be low and it is considered unlikely that granular materials used as part of the VSCs will be adversely impacted.
	P	Direct Contact and Aggressive Attack	
	R	Below Ground Structures i.e. VSCs.	
The driving of solid contaminants down into an aquifer during pile driving.	S	Contaminated Made Ground	Risk: Low There is the limited prospect of drag-down as soils are predominantly displaced laterally. Should any occur it is only likely to take place over a few centimetres. Furthermore the contaminant loadings within Phase 4 have been demonstrated to be low and adverse impact to the underlying Secondary Aquifer is considered unlikely.
	P	Pile / soil interface	
	R	Secondary Aquifers	
Contamination of groundwater, and subsequently, surface waters by wet concrete, cement paste or grout.	S	Construction Materials	Risk: Low As VSCs are proposed no concreting or grouting will be undertaken.
	P	Pile / soil interface	
	R	Secondary Aquifers	

The risks associated with ground improvement in Phase 4 are thus considered to be low.

9. PHASE 5 RISK ASSESSMENT

9.1 Introduction

Phase 5 is present in the central portion of the site as shown in Figure 7. Phase 5 is separated into two separate sub-phases, Phase 5A and 5B. Phase 5A in the west is currently vacant land following the land raise earthworks which occurred in three stages between August 2016 and June 2017. Localised areas on the southern section of Phase 5A are used for the storage of construction materials for Phase 1 to the south. Phase 5B is currently made up of the access road which runs from north to south along the western boundary of Phase 5B and also west to east along the northern boundary. A series of stockpiles line the eastern section of Phase 5B comprising imported material associated with the environmental permit and other site won material.

The following sections describe the prevailing geoenvironmental setting in the area and provide the foundation works risk assessment for Phase 5.

9.2 Contamination Discussion

Made Ground soils within Phase 5A were identified to be impacted with benzo(a)pyrene (12 mg/kg max), lead (1,400 mg/kg max), >C12 aromatic hydrocarbons (540 mg/kg max) and asbestos containing materials (ACM) in soils in 2016¹³. ACMs encountered typically comprised loose fibres, cement type/ bitumen ACMs, plus insulating and lagging materials with concentrations ranging from <0.001% to 0.557% w/w. These soils have subsequently been remediated and capped with a minimum of 1 m of inert materials imported under the site's environmental permit. A brightly coloured demarcation layer was installed between the Made Ground and imported fill as shown by the earthworks extents in Figure 8 and reported in the enabling works verification report¹⁴. As part of the ground investigation in 2017¹⁵ contaminants of concern within the remainder of the phase (Phase 5B) were limited to asbestos containing materials in one isolated location to the north of Phase 5A in an area which is yet to be filled (chrysotile/amosite loose fibres at 0.002 %w/w). This area is located away from proposed gardens and buildings and therefore disturbance of these soils during ground improvement through VSCs and / or piling is unlikely to occur.

The risk assessment within the 2017 Ground Contamination Interpretative Report¹⁵ did not identify any significant controlled waters risks. Leachable contaminants were limited to arsenic (10 µg/l max) and lead (7.8 µg/l max) which were not identified to be impacting groundwater, with these contaminants occurring below threshold values within groundwater at the same exploratory hole locations. Within groundwater inorganic contaminants comprised sulphate (290 mg/l), arsenic (18 µg/l max), mercury (0.13 µg/l max) and nickel (22 µg/l max) that were locally identified above thresholds but were not considered significant due to their marginal exceedence or exceedence within an order of magnitude of adopted thresholds. As no plausible sources for these contaminants were identified and similar concentrations have been encountered in other phases they were considered to reflect background concentrations rather than an on-site source of contamination.

Heavy end aliphatic petroleum hydrocarbons (>C16 aliphatics) up to 910 µg/l were recorded above thresholds in groundwater in three locations, however, due to these fractions being of low mobility and risk¹⁶ they were not considered significant. The hydrocarbons encountered may be

¹³ Ramboll (2016). Technical Note - Asbestos Ground Investigation Findings and Remedial Options. Ref. 1620000492/TN/003.

¹⁴ Ramboll (2017). Phase 5 Enabling Works Verification Report, Green Park Village ref 1620000492/RPT/011

¹⁵ Ramboll (2017). Ground Contamination Interpretative Report Phase 5, Green Park Village ref 1620000492/RPT/014

¹⁶ Environment Agency (2009). Petroleum Hydrocarbons in Groundwater: Supplementary Guidance for Hydrogeological Risk Assessment

related to historical activities associated with former car storage or from the former Pingemead Industrial Estate which is hydraulically up-gradient of Phase 5. This area contained below ground fuel storage tanks which were known to have leaked but these sources have since been removed and remediated¹⁷ and it was considered that suitable dilution and dispersion would occur prior to reaching sensitive receptors.

Bacteria (*E. Coli* and coliforms) was also recorded in groundwater, however, the exceedences were not considered significant given that groundwater is not used for a potable supply and human interaction with groundwater at the site in its proposed state is unlikely. Potential risks during the construction stage should be managed through adherence to good construction practice e.g. use of appropriate PPE.

Following a detailed assessment of ground gas risks¹¹ at the site Phase 5 has been classified as NHBC 'Green' with no specific protection measures required in addition to the sub-floor ventilation provided as part of the current design.

9.3 Summary of Conceptual Site Model

Following the identification of the contamination highlighted above a conceptual site model was prepared for the area, initially as part of the ground investigation technical note¹³ and latterly as part of the Ground Contamination Interpretative Report¹⁵. These identified a number of potentially significant pollutant linkages. Linkages of relevance to the proposed foundation works are summarised in Table 13.

Table 13 Potentially Significant Pollutant Linkages in Phase 5

Contamination Identified	Associated Potentially Significant Pollutant Linkages	Risk
<u>Human Health</u> Asbestos in soils	Inhalation of released fibres associated with construction workers and site users.	Moderate to High

9.4 Proposed Development

9.4.1 General

Phase 5 of the GPV development will comprise residential housing with gardens, areas of soft landscaping and associated infrastructure. Within the phase ground levels are proposed to be raised by approximately 1.5 m using imported material compliant with the Ramboll Specification for Earthworks¹.

9.4.2 Proposed Foundation Methodology

Within Phase 5 the founding methodology is proposed to comprise vibro-stone columns that will terminate within the River Terrace Deposits at a depth of up to approximately 3.0 m below land raise level ~37.2 mAOD.

¹⁷ Ramboll (2017). Pingemead Industrial Estate Verification Report, Green Park Village ref 1620000492/RPT/009.

9.5 Foundation Works Risk Assessment

The Foundation Works Risk Assessment for Phase 5 is contained in Table 12. Risk estimation has been undertaken in line with guidance provided by the NHBC and EA⁵.

Table 14 Foundation Works Risk Assessment for Phase 5

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Comment
Creation of preferential pathways through a low permeability layer (an aquitard) to allow potential contamination of an aquifer and/or surface water feature.	S	Contaminated Made Ground	Risk: Low VSCs used for ground improvement will penetrate through the land raise, topsoil and alluvium and will terminate within the River Terrace Deposits. The alluvium has been demonstrated to be discontinuous i.e. the superficial strata are already likely in continuity and no aquitard/ low permeability strata will be penetrated. Furthermore the contaminant loadings within Phase 5 have been demonstrated to be low and adverse impact to the underlying Secondary Aquifer and surface water features is considered unlikely. Furthermore VSCs are unlikely to alter the current status quo as the low concentrations of inorganics, hydrocarbons and bacteria are already present within groundwater within the RTD and VSCs will terminate within this stratum and not penetrate through into deeper aquifers. Increased lateral permeability may occur locally within the stone column itself but this is likely to be spatially limited considering the densification of fine granular soils surrounding the column.
	P	Pile / soil interface	
	R	Secondary Aquifers	
Creation of preferential pathways, through a low permeability surface layer, to allow migration of landfill gas, soil gas or vapours to surface.	S	Soil Gas / Vapours	Risk: Low The site is classified as NHBC Green and no specific ground gas protection measures are required over and above the sub-floor ventilation already provided as part of the design. Notwithstanding this the enabling and main works contractors are required to have appropriate safe working practices and health and safety measures in place during works e.g. PPE, RPE and confined spaces entry systems etc.
	P	Pile / soil interface	
	R	Buildings, Construction Workers and End Users	
Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface.	S	Contaminated Made Ground	Risk: Low Vibro-stone columns are a displacement method and minimal arisings will be created during ground improvement owing to the inherent methodology. The risk to construction workers will be mitigated through the use of suitable health and safety precautions e.g. method statements. Where arisings are generated from beneath the asbestos remediation demarcation layer the contractor will be required to adopt the procedures outlined in the asbestos management plan for the Phase ¹⁸
	P	Direct Contact and Inhalation and Ingestion of Dust	
	R	Construction Workers	
Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials.	S	Contaminants in Soils and Groundwater	Risk: Low It is considered unlikely that granular materials used as part of the VSCs will be adversely impacted.
	P	Direct Contact and Aggressive Attack	
	R	Below Ground Structures i.e. VSCs.	

¹⁸ Ramboll, (2017). Asbestos Management Plan – Green Park Village – Phase 5. Ref. 1620000492-GPV-P5-AMP-R3

Pollution Scenario	Source (S) Pathway (P) Receptor (R)		Comment
The driving of solid contaminants down into an aquifer during pile driving.	S	Contaminated Made Ground	Risk: Low There is the limited prospect of drag-down as soils are predominantly displaced laterally. Should any occur it is only likely to take place over a few centimetres. Limited soils contamination has been identified within the Made Ground and Alluvium that could feasibly be dragged down into and impact the River Terrace Deposits Secondary Aquifer. VSCs will not penetrate through the River Terrace Deposits into deeper aquifers.
	P	Pile / soil interface	
	R	Secondary Aquifers	
Contamination of groundwater, and subsequently, surface waters by wet concrete, cement paste or grout.	S	Construction Materials	Risk: Low As VSCs are proposed no concreting or grouting will be undertaken.

The risks associated with ground improvement in Phase 5 are thus considered to be low.

10. CONCLUSIONS

As part of this assessment a number of potential adverse environmental impacts have been considered and assessed on a qualitative basis in accordance with Environment Agency guidance. The overall risks associated with the proposed foundation works are considered to be low and the following piling methodologies are considered appropriate and suitably protective of controlled waters receptors:

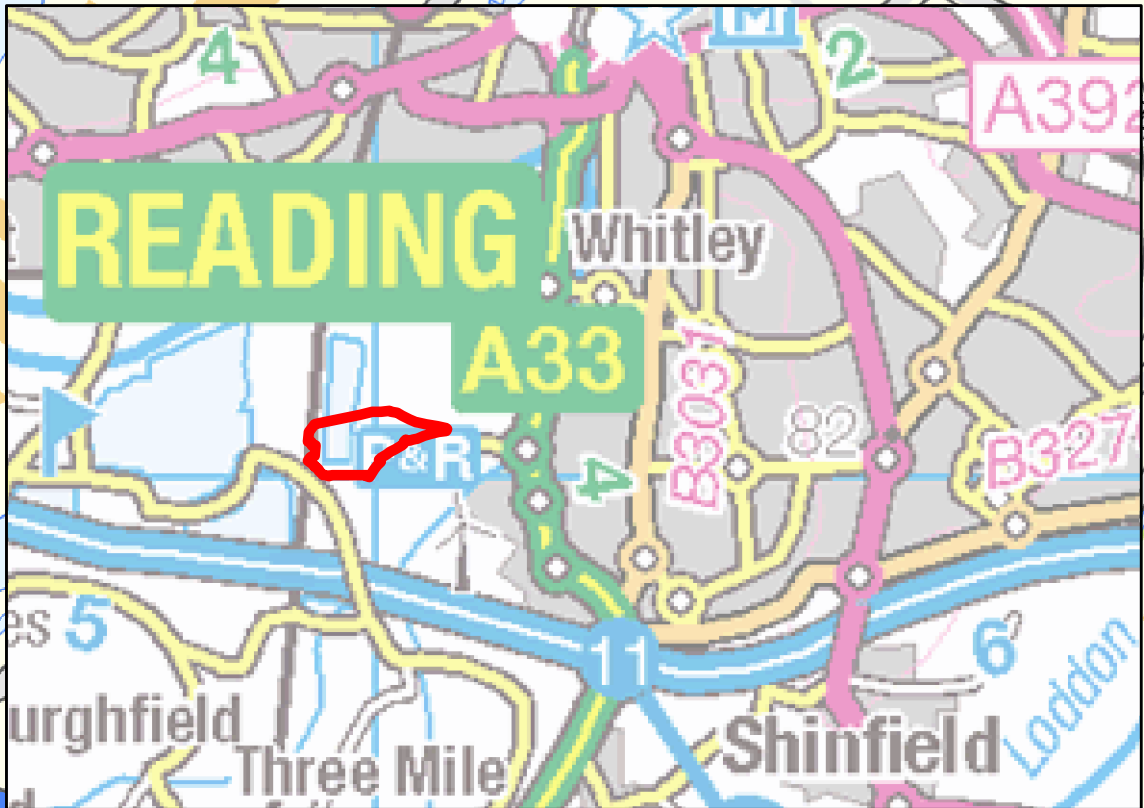
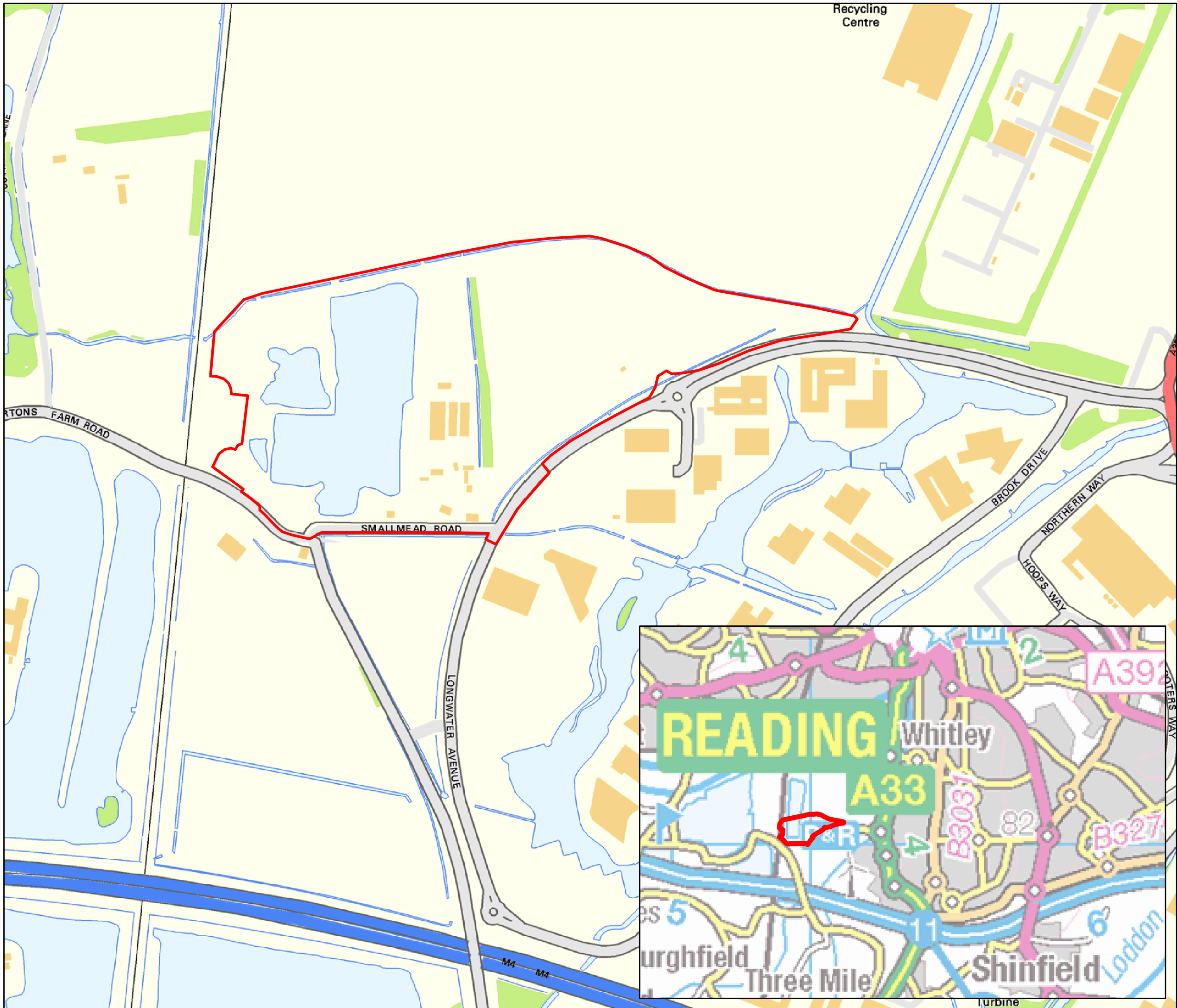
- Vibro-stone column ground improvement in Phase 1, Phase 3, Phase 4 and Phase 5.
- Continuous flight auger piles in Phase 2.

The risks associated with the installation of foundations in Phase 6 will be assessed in due course in line with the development programme.

This document should be submitted to both the Environment Agency and Reading Borough Council Environmental Health for comment and approval in relation to Planning Condition 48 prior to the commencement of foundation and ground improvement works.

APPENDIX 1

FIGURES



Site Boundary

1:5,000

1:50,000



Drawn at A3

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Client

St Edward Homes Ltd

Project Title

Green Park Village

Project Number

1620000492

Figure Title

Site Location Plan

RAMBOLL

Tel: 023 8081 7500
Fax: 023 8081 7600

southampton@ramboll.co.uk
www.ramboll.co.uk

Date

March 2016

Prepared By

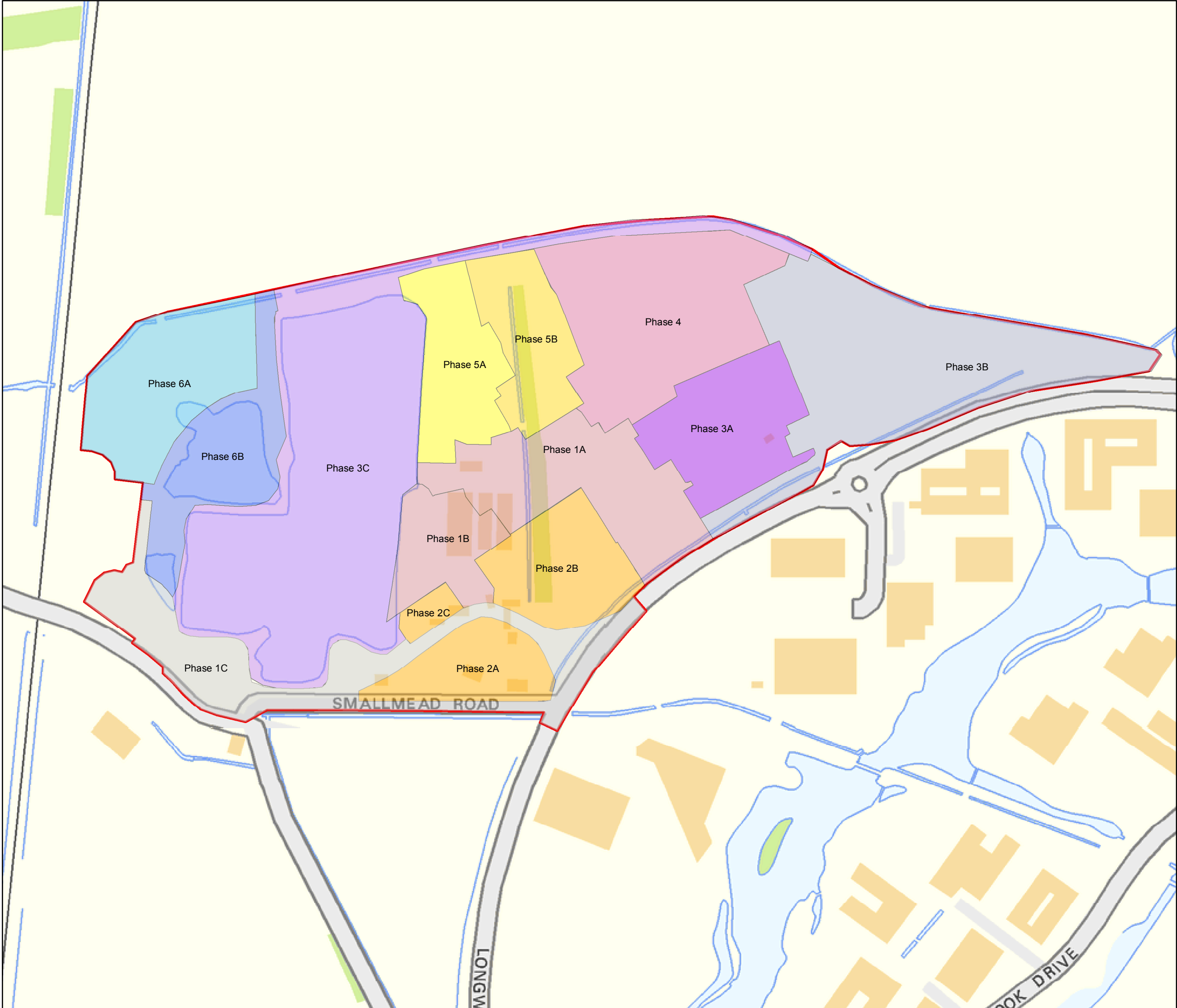
BH

Figure No.

Figure 1

Revision

01



 Site Boundary



1:3,000

Drawn at A3

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Client

**Berkeley Homes
(Western) Ltd**

Project Title

Green Park Village

Project Number

1620000492

Figure Title

Phase Plan



Tel: 023 8081 7500
Fax: 023 8081 7600

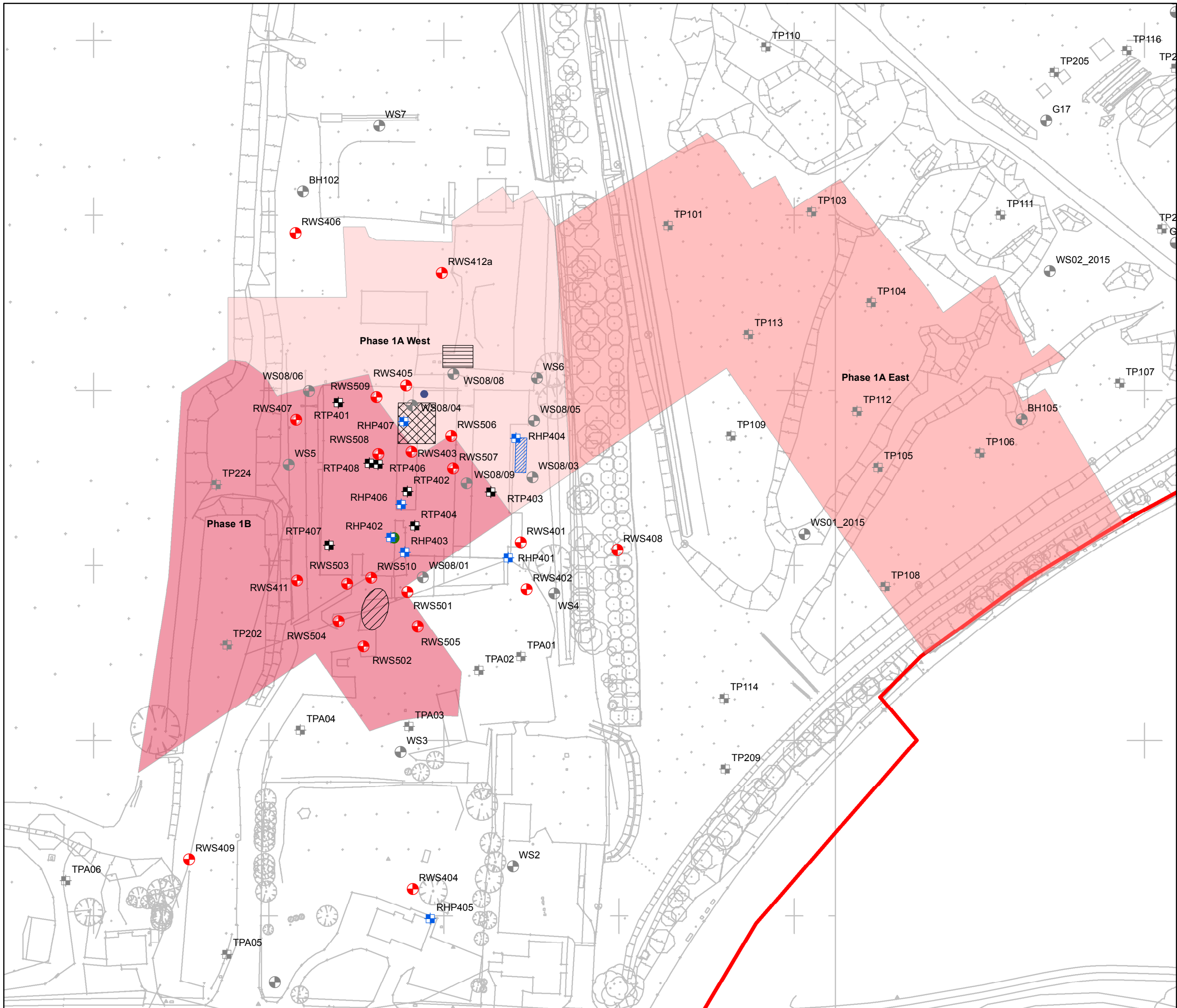
southampton@ramboll.co.uk
www.ramboll.co.uk

Date March 2016

Prepared By
BH

Figure No.
Figure 2

Revision
01



- Site Boundary
- Phase 1A East
- Phase 1A West
- Phase 1B
- Void 1
- Void 2
- Void 3 & 4
- Void 5
- Void 6
- Void East

- Hand Pit
- Trial Pit
- Window Sample
- Borehole (PBA)
- Trial Pit (PBA)

1:1,000
Drawn at A3



Client
St Edward Homes Ltd

Project Title
Green Park Village

Project Number
1620000492

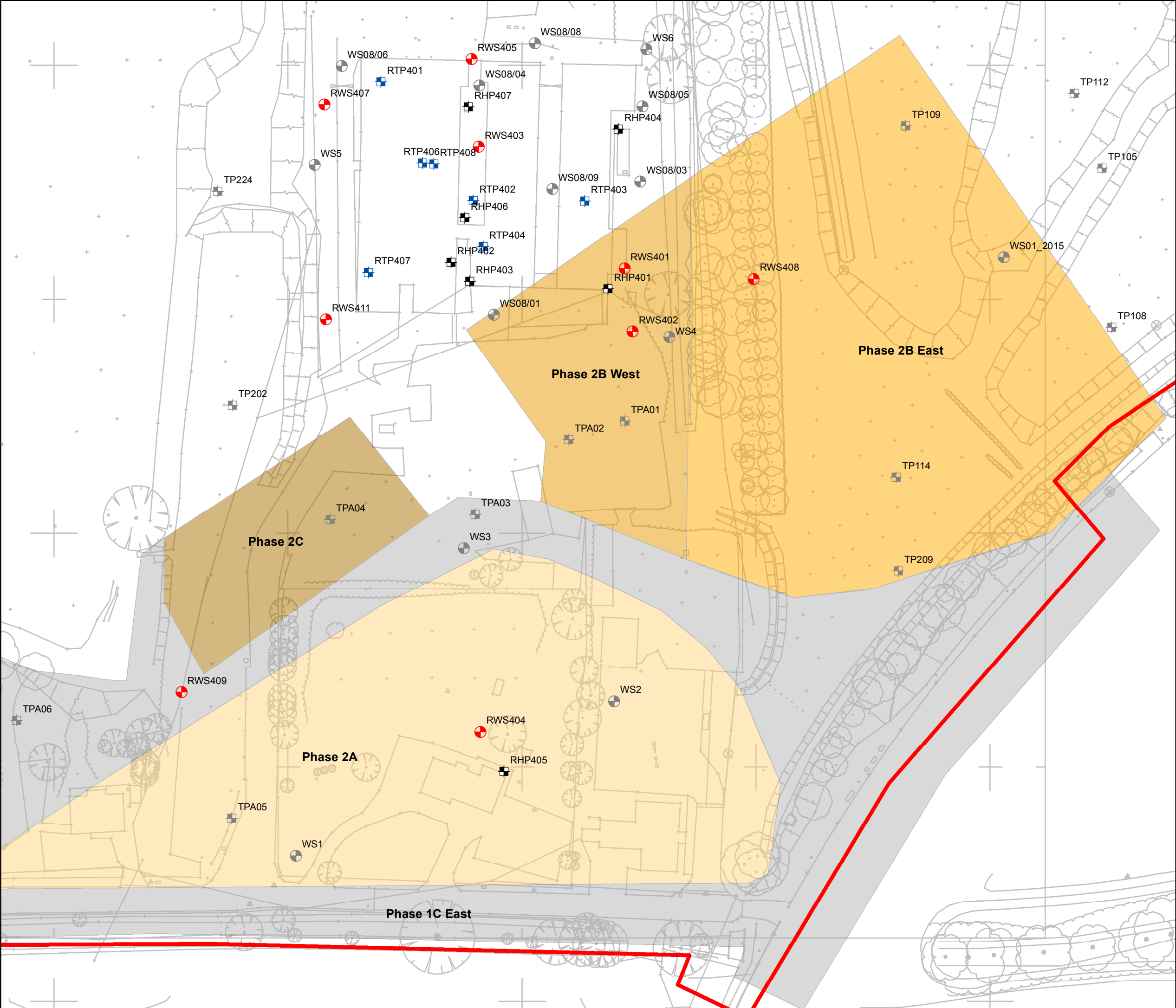
Figure Title
Phase 1 Phasing & Ground Investigation Plan



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www.ramboll.co.uk

Date	October 2016	Prepared By	TS
------	--------------	-------------	----

Figure No.	Figure 3	Revision	-
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- Site Boundary
- Phase 1C Access Road
- Phase 2A
- Phase 2B East
- Phase 2B West
- Phase 2C
- Hand Pit (Ramboll)
- Trial Pit (Ramboll)
- Window Sample (Ramboll)
- Borehole (PBA)
- Trial Pit (PBA)



1:750

Drawn at A3

Client

**St Edward
Homes Ltd**

Project Title

Green Park Village

Project Number

1620000492

Figure Title

**Phase 2 Phasing &
Ground Investigation Plan**



Tel: 023 8081 7500
Fax: 023 8081 7600

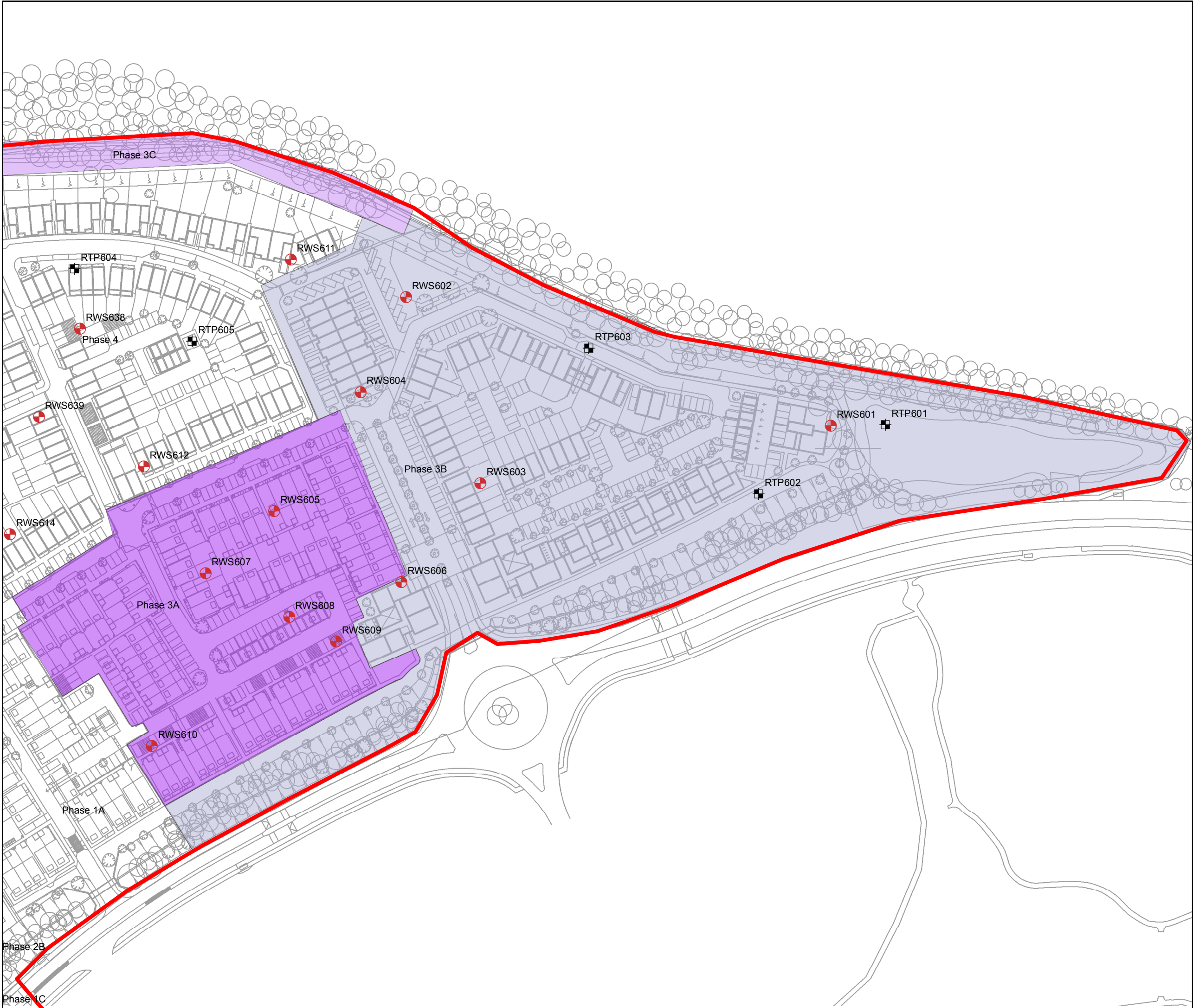
southampton@ramboll.co.uk
www.ramboll.co.uk

Date
July 2016

Prepared By
TS

Figure No.
Figure 4

Revision
01



- Site Boundary
- Phase 3A
- Phase 3B
- Phase 3C
- Borehole
- Trial Pit
- Window Sample Borehole



Drawn at A3
1:1,350

Client

St Edward Homes Ltd

Project Title

Green Park Village

Project Number

1620000492

Figure Title

Phase 3 Exploratory Hole Plan



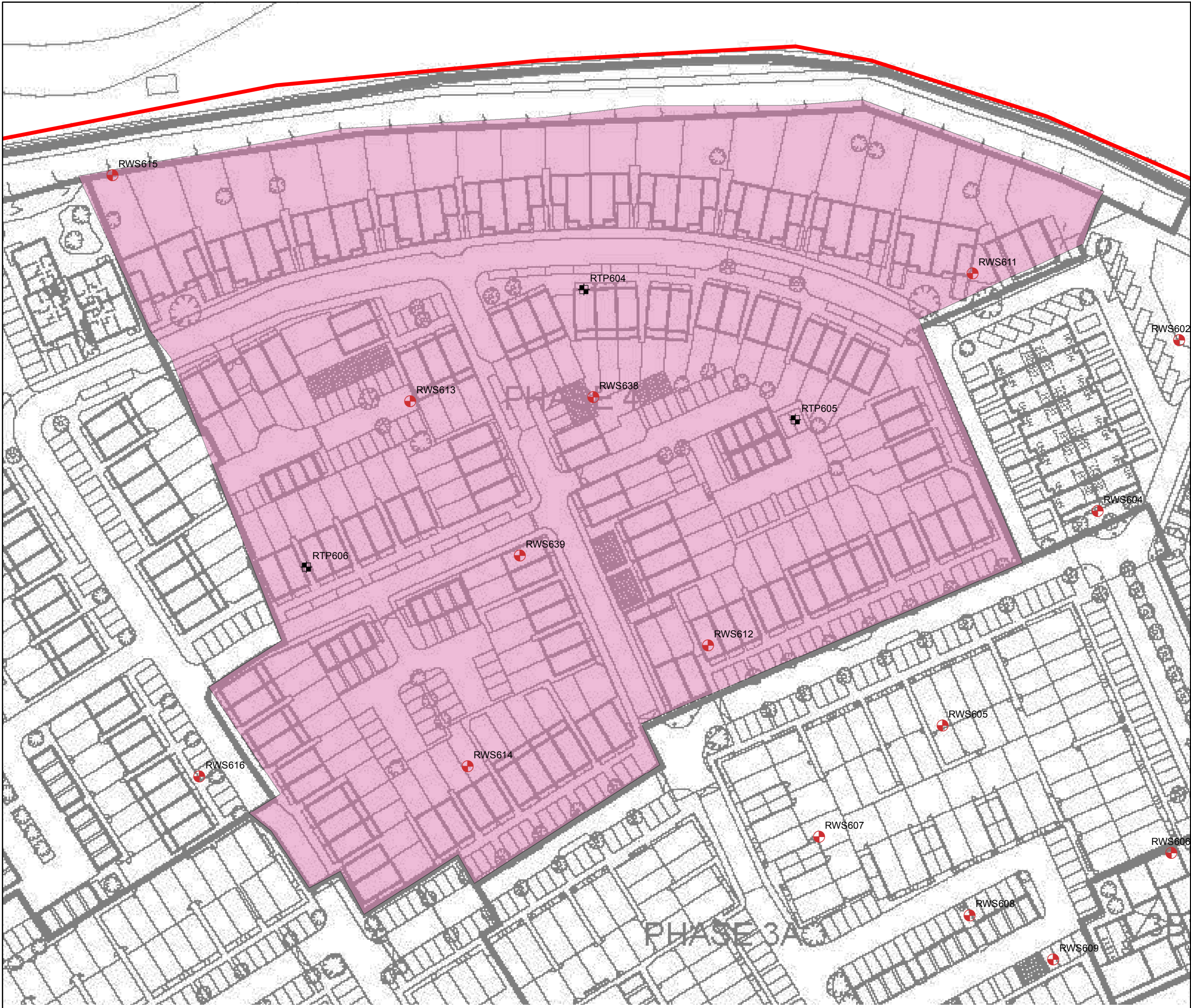
Tel: 023 8081 7500 southampton@ramboll.co.uk
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Date
July 2017

Prepared By
TS

Figure No.
Figure 5

Revision
-



Site Boundary

Borehole

Trial Pit

Window Sample Borehole

Phase 4



Drawn at A3
1:750



Client
St Edward Homes Ltd

Project Title
Green Park Village

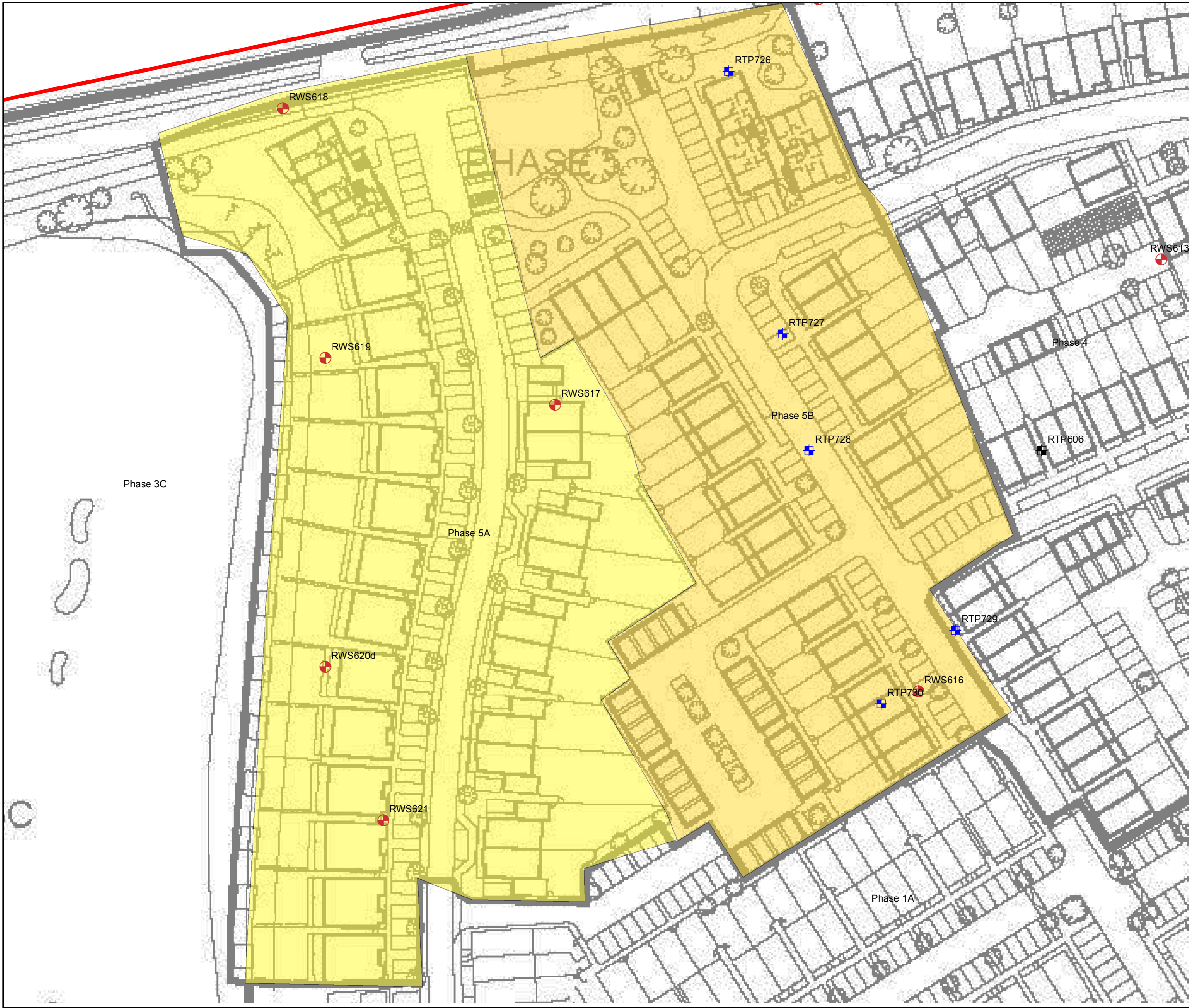
Project Number
1620000492

Figure Title
Phase 4 Exploratory Hole Plan

RAMBOLL

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Date	July 2017	Prepared By	TS
Figure No.	Figure 6	Revision	-



- Site Boundary
- Phase 5A
- Phase 5B
- Borehole
- Trial Pit
- Window Sample Borehole
- 2016 Trial Pits



Drawn at A3
1:650

Client

St Edward Homes Ltd

Project Title

Green Park Village

Project Number

1620000492

Figure Title

Phase 5 2017 Exploratory Hole Plan



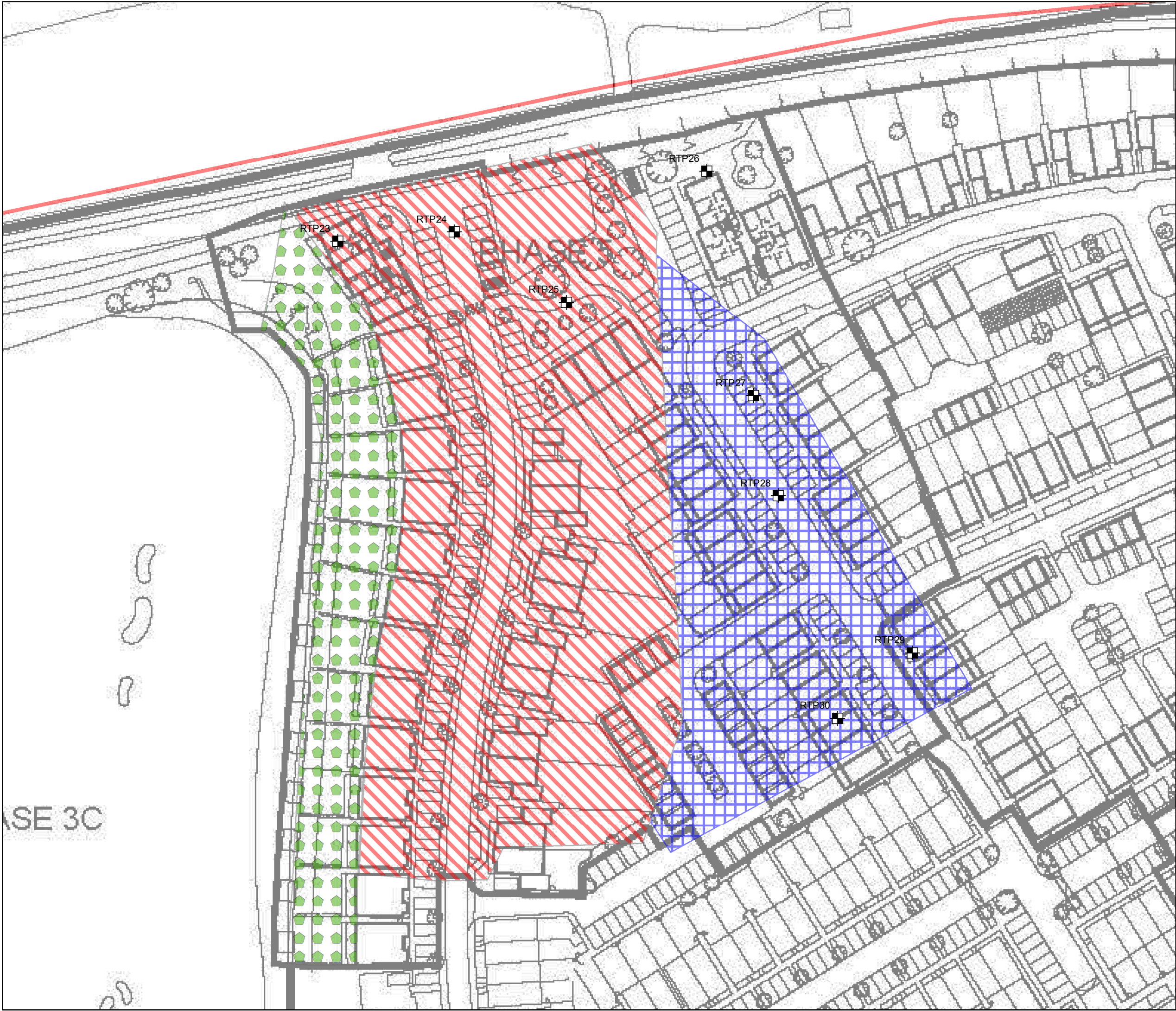
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Date July 2017

Prepared By
TS

Figure No.
Figure 7

Revision
-



Key

- As Built Additional Deliniation Trial Pits
- Stage 1 - August/September 2016
- Stage 2 - April /May 2017
- Stage 3 - June 2017

Note - Turnover and membrane placement area referenced from Wooldridge Ecotec Drawing Phase5A Area June 2017 ref 103C

Scale: 1:750
Drawn at A3
Baseplan adopted from BroadwayMalyanSite Layout Drawing PL-P1-002 rev P

Client
St Edward Homes Ltd

Project Title
Green Park Village

Project Number
1620000492

Figure Title
Phase 5 Asbestos Remediation Extents

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Date	July 2017	Prepared By	TS
Figure No.	Figure 8	Revision	-

APPENDIX 2

PHASE 1 INFORMATION



Reading Green Park- Solution Proposal

Review Of Information

Peter Brett Associates Report No 11321/300/SNK/KB/RP/LG Dated Aug 2002

Drawings: Proposed Site Layout Drawings

Solution –Bottom Feed Vibro Stone Columns

Keller attended on site on 15th April, 2015 to discuss possible foundation solution and it was clear that the site is underlain by predominantly a thin veneer of cohesive alluvium which is in turn underlain by waterlogged terrace gravels. Across a good portion of Phase 1 inert fill has been placed. We understand that this fill which is some 1.5-1.8m in thickness was placed 8 years ago. The thickness was borne out in trial pits.

Keller inspected 8 No Trial Pits in this material and 7 of these pits consisted of a firm gravelly and sandy CLAY with with some small lumps/pieces of organic material. In early discussions Keller advised that some tests to establish the organic content of this fill. The average percentage of organic material is around 3% with the maximum being 4.9%.

One trial pit was carried out in a zone of organic soil and this was considered marginal for ground treatment. The Earthworks contractor, Wooldridge confirmed that this known area of topsoil is to be removed.

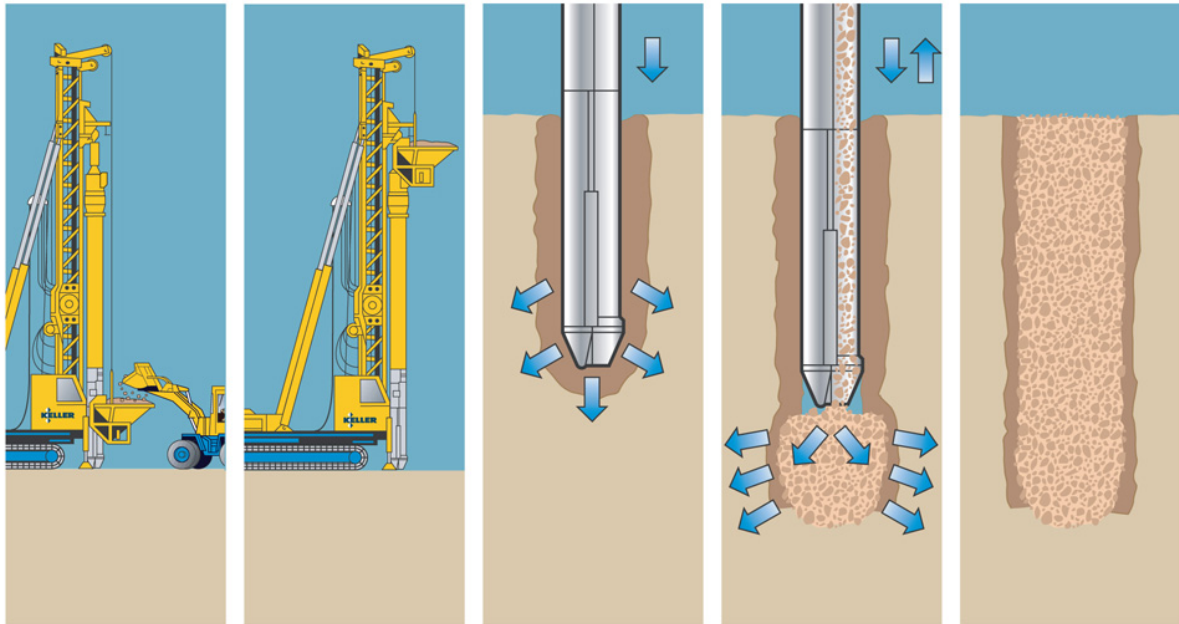
Wooldridge confirm that they will remove 600-700mm from the NEW fill and roll the formation –i.e. the 1.0 to 1.2m thickness of existing fill.

Thereafter levels will be made up in ENGINEERED cohesive fill to approx. 0.5m below finished floor levels.

We believe this site is suitable for improvement by bottom feed stone columns. There will be two treatment scenarios on this site and we discuss each in turn.

All Vibro will be carried out with Keller's Industry leading instrumentation which enables complete confidence that columns have been installed to the correct depth using the correct "pack up" parameters.

Construction sequence – Bottom Feed Process



♦ Stage 1

With the vibrocrane stabilised on hydraulic outriggers, the leaders are elevated to the vertical and the vibrator located on the ground at the stone column position. The skip is then charged with stone.

♦ Stage 2

The skip travels up the leaders and automatically discharges stone into the reception chamber at the vibrator.

♦ Stage 3

The vibrator penetrates the weak soils to the design depth under the action of the vibrations, compressed air and pull-down winch facility.

♦ Stage 4

At the required depth, stone is released and compacted by small upward and downward movements of the vibrator, the pull-down being employed on the downward compacting action.

♦ Stage 5

With the stone being added to the system as necessary at any stage of the construction procedure, a stone column of very high integrity, tightly interlocked with the surrounding soil, is built up to ground level.

Zone 1

This will probably be the first phase and we will treat a combination of EXISTING fill topped off with new ENGINEERED fill and thence the alluvium/terrace gravels.

Treatment Strategy

In view of the fact that the new fill material will have been rolled in place if necessary locally pre bore the stone columns to ensure the full depth of made ground is treated. We believe in this area the natural sand and gravel, which is grey in colour should be readily identified by pre boring which MAY be necessary. This will ensure the full depth of the fill is treated. We would generally treat some 0.5m to 1.0m into the sands and gravel. Where these gravels are loose treatment may continue in to the Lambeth Group.

Care will be taken to ensure consistent depths of treatment across individual plots. We will offer a post treatment bearing pressure of 125kN/m² which will be verified by Dummy Foundation Tests.

Zone 2

The stratigraphy across this area will be slightly different in that at this stage we believe there has not been fill placed. Here site levels will be raised (after topsoil removal) by between 1.2 and 1.5m of new fill and Keller have provided a specification for the use of cohesive fill to raise levels.

It is likely that we will need to pre bore this new fill.

In any event full depth treatment of the fill is also proposed in this area and again will offer 125kN/m² post treatment in this area and confirm with Dummy Foundation Tests.

Treatment Strategy

We will treat the full depth of the made ground treating in to the terrace gravels to refusal.

Testing Scheme

We propose to carry out the following load tests, as per the attached spec.

1 No Plate Load Test per day , loaded to 3 times x 125kN/m²

1 No Dummy Footing Test on a 0.6m by 1.5m long plate for each 15 Plots ,loaded to 125kN/m². The load will be left on over weekends.

Derek Taylor 20/4/15



**TESTING PROPOSALS FOR:
Reading, Green Park**

SUMMARY

	STANDARD PLATE LOAD TESTS	DUMMY FOOTING LOAD TESTS
TYPE	600mm plate, see attached spec	1500mm x 600mm steel beam, see attached spec
TEST LOCATIONS	Client to provide or Keller will choose at random	Client to provide or Keller will choose at random
RATIO*	1 per rig per day as NHBC standard	1 per week or per 15 plots approx
TOTAL NUMBER INCLUDED	TBA	TBA

*This is the overall ratio of testing and is not intended to reflect the actual programming of the tests on this site. It is sometimes appropriate to avoid testing too soon so there may be a delay before the first tests can be undertaken. There may also be other reasons which prevent us from testing on a particular day. Where appropriate, multiple tests will be undertaken on other days so as to maintain compliance with the above ratios. This will be appropriately managed by our Supervisor on site.

Please note that the tests are normally undertaken at the end of each working shift so as to avoid disruption to the construction works. It is also the most appropriate timing as testing is a quiet activity which will not disrupt neighbours etc.

SPECIFICATION FOR SHORT TERM PLATE LOAD TESTS ON STONE COLUMNS CONSTRUCTED BY VIBRO STABILISATION

The short term plate load test is carried out by excavating a shallow pit to a depth of approximately 600mm below the working platform and with a base size of about 1.0 metre square.

The area to be tested shall be cleared of all material before a 600mm diameter rigid steel plate is carefully bedded down onto the prepared surface.

The reaction of the tests is usually provided by the Vibro rig on site or a suitable excavator provided by others. The loading arrangements shall be capable of transferring safely the maximum load required to the test area.

The load onto the circular steel bearing plate is applied centrally by means of a hydraulic jack calibrated in tonnes.

The vertical movement of the bearing plate is recorded by a minimum of two dial gauges capable of measurement to within 0.1mm. Each gauge is mounted on a reference frame supported on rigid supports well clear of the test area.

Following each application of the load the settlement shall be measured at an interval of 5 minutes after each loading increment.

The maximum load shall be held for 10 minutes with settlements measured at intervals of 5 and 10 minutes after the final increase in applied loading.

The settlement shall then be measured on release of the load and again after 5 minutes.

TEST SCHEDULE

Description	Detail
Test Specification	Keller Standard
Plate Size	600 mm circular
Maximum Test Load	107 kN
Number of Test Increments	Min 5 No Equal Increments
Reading Intervals	5 minutes
Minimum Hold Period	5 minutes
Hold at Maximum Load	10 minutes with readings at 5 & 10 mins
Unloading	Release to zero in one increment
Final Reading	1 after 5 mins.
No of tests	1 test per rig/day as NHBC standards

SPECIFICATION FOR DUMMY FOOTING LOAD TESTS ON STONE COLUMNS CONSTRUCTED BY VIBRO STABILISATION

Short term load tests are carried out by excavating a shallow pit to a depth of approximately 600mm below the working platform and with a base size of about 2.0m metres square.

The area to be tested shall be cleared of all loose material before a 1.5m x 0.6m rigid steel plate is carefully bedded down onto the prepared surface spanning over one or two stone columns.

The reaction of the tests is usually provided by the Vibro rig on site or a suitable excavator provided by others. The loading arrangements shall be capable of transferring safely the maximum load required to the test area.

The load onto the steel bearing plate is applied centrally by means of a hydraulic jack calibrated in tonnes.

The vertical movement of the bearing plate is recorded by a minimum of two dial gauges capable of measurement to within 0.1mm. Each gauge is mounted on a reference frame supported on rigid supports well clear of the test area.

Following each application of the load the settlement shall be measured at intervals of five minutes.

The settlements at maximum load shall be measured at 5 minute intervals for a period of 15 minutes after the final increase in applied loading and thereafter at 15 minute intervals for a minimum period of one hour before leaving the test for a minimum of 12 hours (usually overnight).

After the minimum 12 hour hold period (i.e. the next morning), two settlement measurements at 5 minute intervals are to be taken prior to removing the applied load.

The settlement shall be measured on release of the load and again after 5 minutes.

TEST SCHEDULE

Description	Detail
Test Specification	Keller Foundations
Plate Size	1500mm x 600mm
Maximum Test Load	113 kN (125kN/m ²)
Number of Test Increments	Min 5 No Equal Increments
Incremental Reading Interval	5 minutes.
Incremental Min Hold Period	5 minutes
Hold Period at Max Load	Over Weekend Period
Reading Intervals at Maximum Load	5 min intervals for 15 mins & then 15 min intervals for 1 hour before leaving overnight. Two readings at 5 min intervals the next day
Unloading	Release to zero in one increment
Final Reading	1 after 5 mins.
No of tests	1 test per visit or 15 Plots

APPENDIX 3

PHASE 3 INFORMATION

General Notes

1. This drawing must not be scaled; work to figured dimensions only.
2. This drawing is to be read in conjunction with all relevant drawings, documents and specifications.
3. Typically for setting out refer to Architects drawings.

Column Schedule

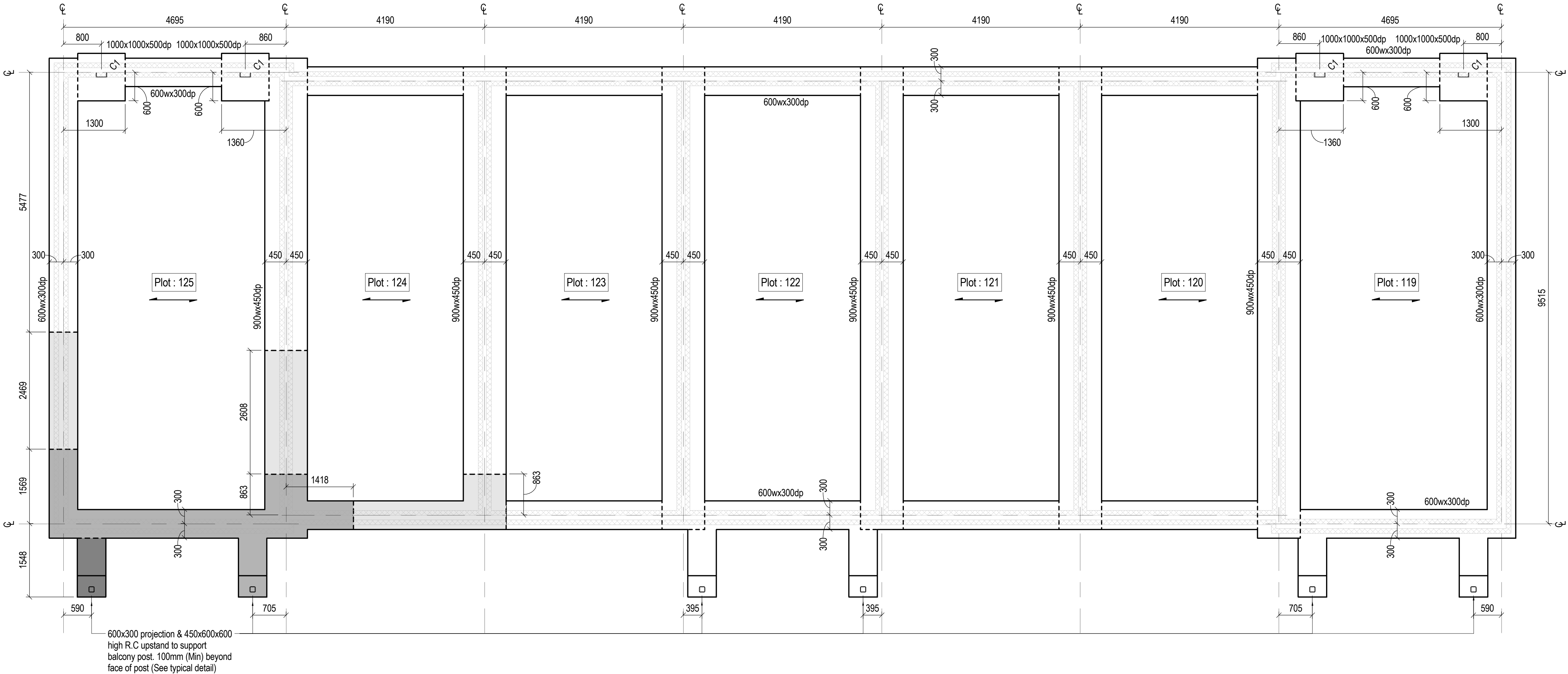
Column Ref.	Size (mm)
C1	PFC230x90x32

Denotes centre line of foundation

Denotes directional span of 175mm thk beam and block

Vibratory stone column ground improvement to be carried out by specialist contractor. Stone column to be provided at maximum 1800 C/C beneath all wall foundations. Single stone column to be provided directly beneath all balcony posts

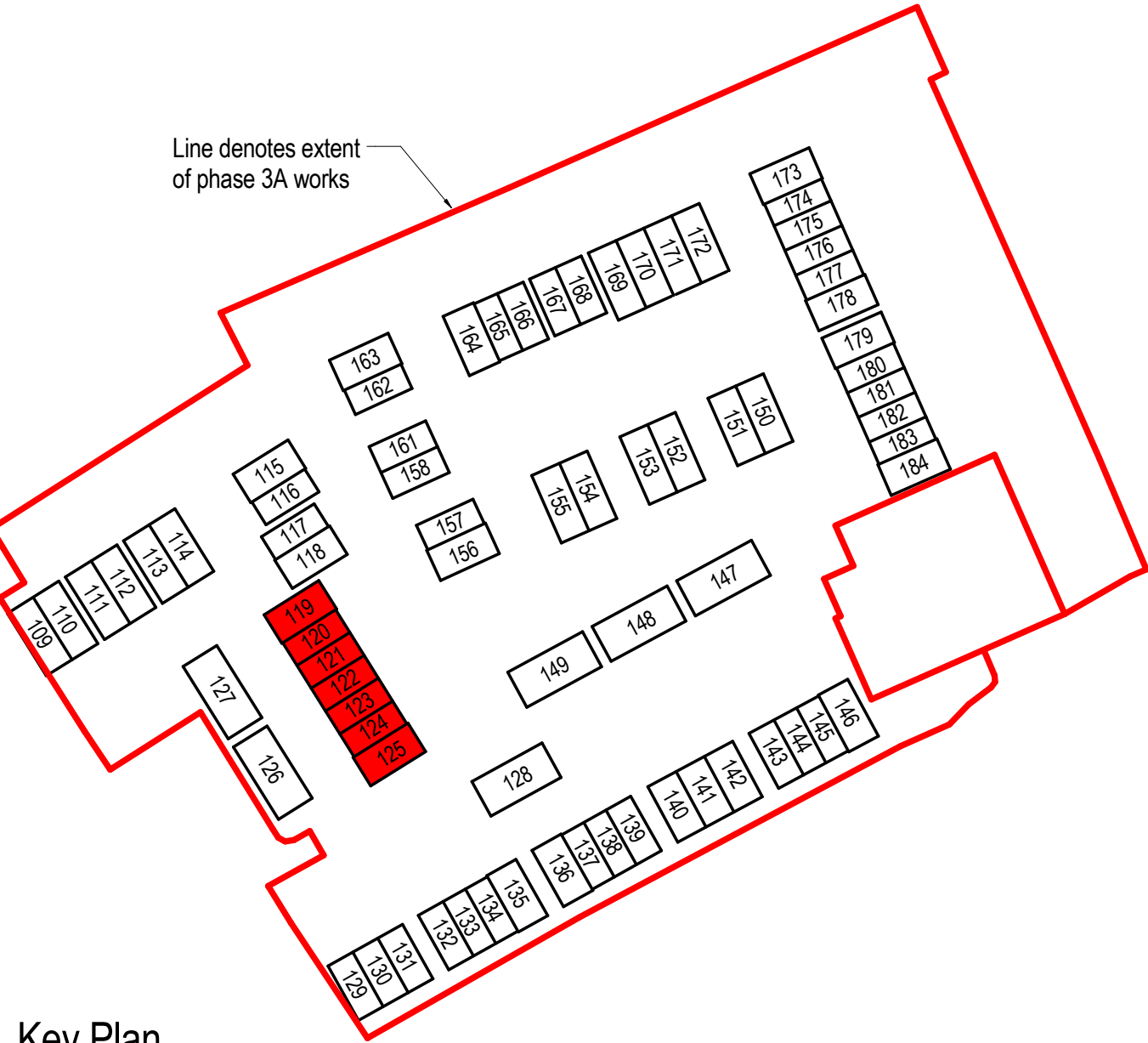
T.O.F for plots 119-125 to be 39.475



Foundation General Arrangement Plots 119 - 125

1 : 50

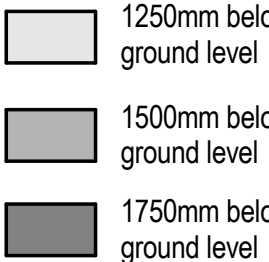
Line denotes extent of phase 3A works



Key Plan

1 : 1000

Key To Foundation Depths

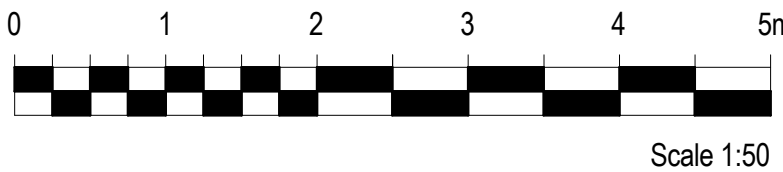


For typical sections refer to Glanville drawing No. 4160316_2000

For general notes refer to Glanville drawing No. 4160316_2000

For steel frame details including typical baseplate details & typical steelwork notes refer to Glanville drawing No. 4160316_2400

For setting out information, refer to architects / civil engineers drawings



C2	Top of foundations revised	30.11.2016	DB	DB
C1	Top of foundations revised.	16.09.2016	TM	DB
P1	Preliminary Issue	15.08.2016	DB	DB

Rev	Description	Date	By	Chkd
-----	-------------	------	----	------

Glanville
3 Grovelands Business Centre,
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Hertfordshire, HP2 7TE
Tel: (01442) 835999 Fax: (01442) 258924
postbox@glanvillegroup.com
www.glanvillegroup.com

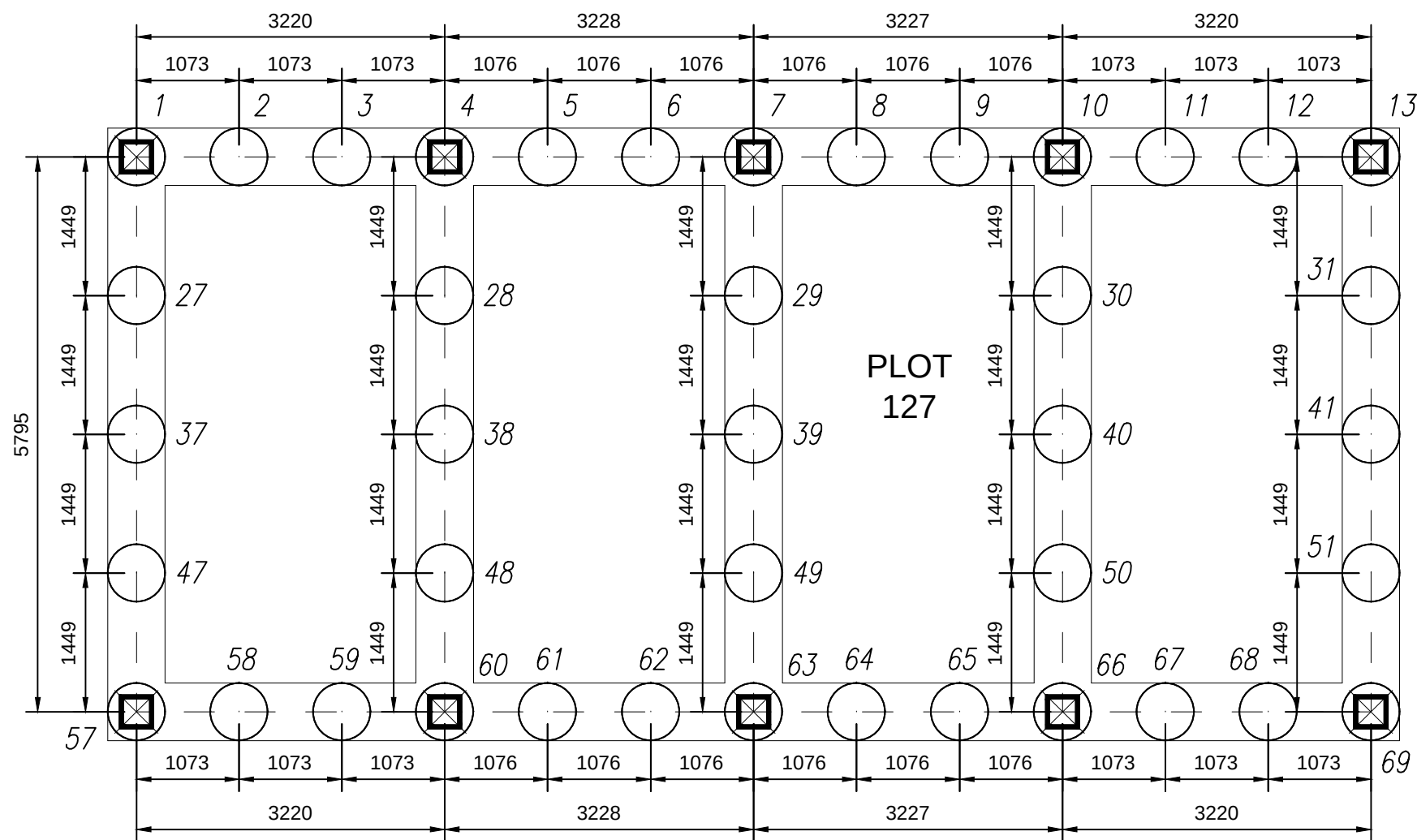
Client : **Berkeley**
Designed for life

Project : **Green Park Village Reading (Phase 3A)**

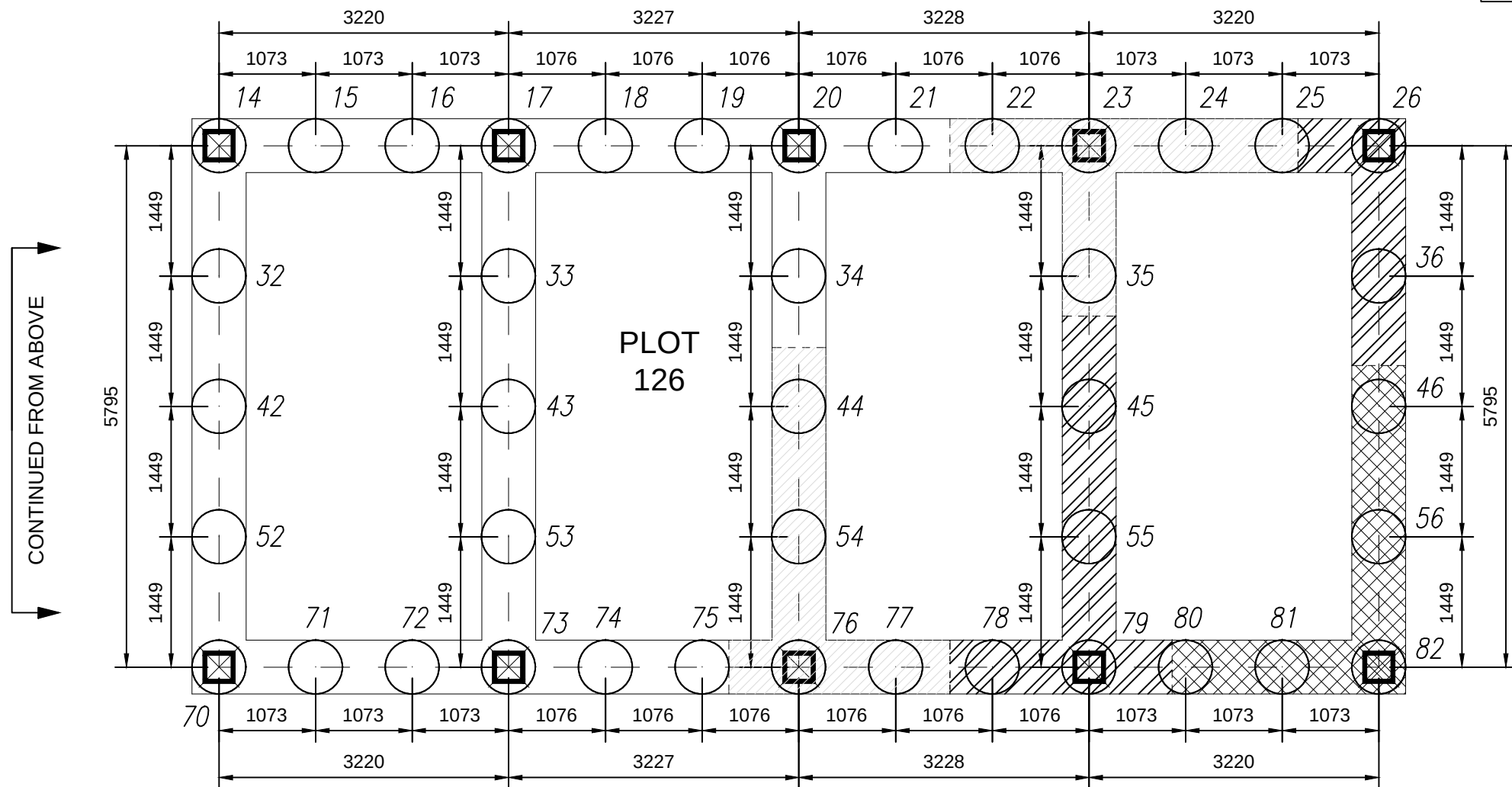
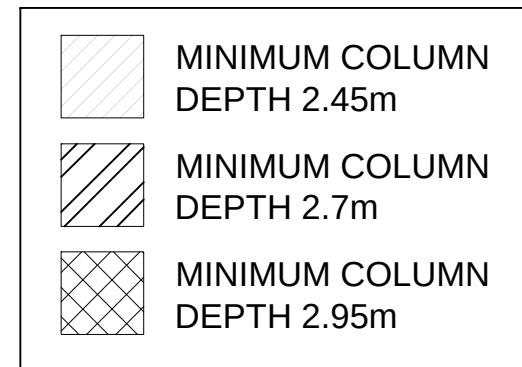
Title : **Foundation General Arrangement (House Types A3 + A3-1 + C3-1 + C2-2H)**

Project Engineer :	DB	Scale :	As indicated @ A1
Project Director :	AS	Date :	August 2016
Status:	CONSTRUCTION		

Drawing Number :	4160316_2024	Rev :	C2
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CONTINUED BELOW

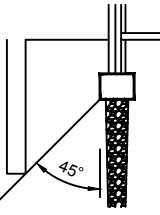


CONTINUED FROM ABOVE

AS BUILT DRAWINGS
'AS BUILT' DRAWINGS AND DESIGN CALCULATIONS
ARE SUPPLIED UPON REQUEST
PLEASE ALLOW 5 WORKING DAYS FOR ISSUE
THIS DRAWING MUST ONLY BE USED IN
CONJUNCTION WITH RELEVANT SETTING
OUT INFORMATION

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NOTES
1.) STONE COLUMNS ARE DESIGNED TO ACHIEVE A
GROUND BEARING PRESSURE OF:
125 kN/m² UNDER FOUNDATIONS
2.) ENSURE THAT THE MINIMUM CLEARANCE
BETWEEN EXCAVATIONS AND FOUNDATIONS IS NOT
LESS THAN THE DEPTH OF EXCAVATION MINUS THE
DEPTH OF THE STRUCTURAL FOUNDATION. (REF:
NHBC. STANDARDS CH4.6-54)
EXCAVATION AND DRAIN/
SERVICE TRENCHES SHOULD
BE ABOVE 45° LINE
3.) WHERE IT IS INTENDED TO
REGRADE OR RAISE THE
FOUNDATIONS FROM THE LEVEL
AGREED THIS IS TO BE REPORTED
TO ROGER BULLIVANT GI DEPT.
4.) PRIOR TO CONSTRUCTION OF ANY FLOOR SLAB IT
IS ESSENTIAL THAT THE FORMATION BE RE-GRADED
AND ROLLED
5.) CLIENT TO ENSURE SETTING OUT OF:
• CENTRE LINE AND INTERSECTIONS OF
FOUNDATION TRENCH. INDICATED THUS -
• CENTRE POINT OF PAD FOOTINGS
• SPRAY LINE OF CURVED FOUNDATIONS
25 INDICATES COLUMN NUMBER.
THIS DRAWING IS BASED ON GLANVILLE GROUP
DRAWING 4160316 - 2006 REVISION P1



COLUMN QUANTITY
FOUNDATIONS = 82

REV	DATE	DESCRIPTION
A1	13-09-16	ISSUED FOR CLIENT APPROVAL

DRAWING STATUS
CLIENT APPROVAL

ROGER BULLIVANT LIMITED
GROUND IMPROVEMENT
MIDLANDS / SOUTH
T:01332 977238
www.roger-bullivant.co.uk

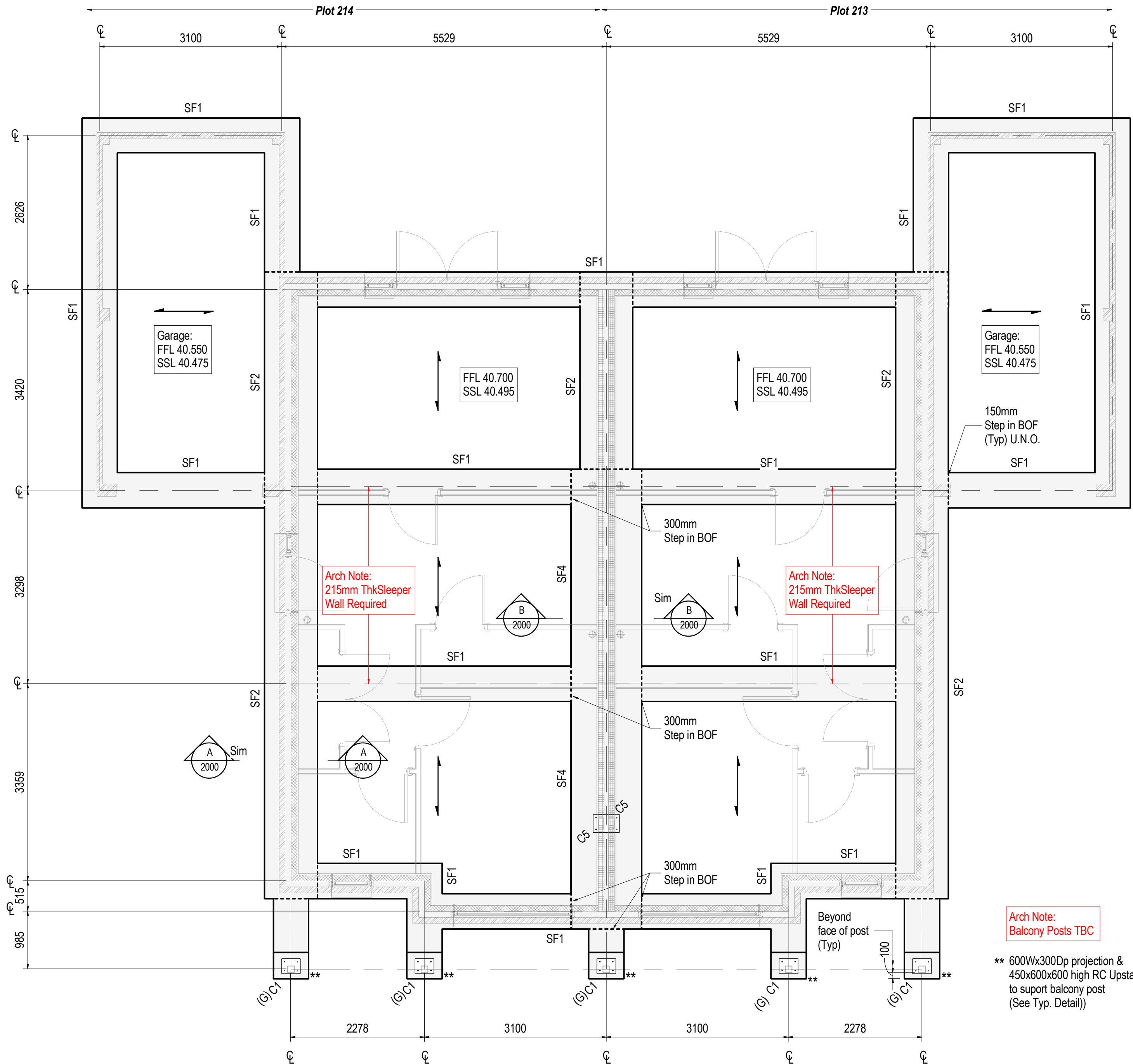
PROJECT
GREEN PARK VILLAGE (PHASE 3a)
READING
CLIENT
BERKELEY HOMES
DRAWING TITLE
PLOT 126 - 127
STONE COLUMN LAYOUT
SCALE
NTS
DATE
SEPT 16
DRAWN
KD
ENGINEER
EM
APPROVED BY RB ENGINEER
APPROVED
PROJECT NO.
MG.16.7187
DRG. NO.
07
REVISION
A1

APPENDIX 4

PHASE 5 INFORMATION

Vibratory Stone Column ground improvement to be carried out by Specialist Contractor.
Stone Column to be provided at maximum **1600** centres beneath all wall foundations under main building & garage party walls.
Stone Column to be provided at maximum **1850** centres under garage
Single Stone Column to be provided directly beneath all balcony posts

Top of concrete for all foundations to be **39.795** U.N.O.



Foundation Plan
1:50

Arch Note:
Balcony Posts TBC

** 600Wx300Dp projection & 450x600x600 high RC Upstand to support balcony post (See Typ. Detail))

- General Notes**
- This drawing must not be scaled; work to figured dimensions only.
 - This drawing is to be read in conjunction with all relevant drawings, documents and specifications.
 - Typically for setting out refer to Architects drawings.

For typical notes refer to dwg 4160518-2000

For typical Sections & Details refer to dwg 4160518-2000

All foundations to have mesh reinforcement as per drawing 4160518-2000

For setting out information refer to Architects / Civil Engineers drawings

Legend:

CL	Centre Line of wall & foundation
→	Span Direction of 175 Deep Beam & Block
TOF	Top of Foundation
BOF	Bottom of Foundation
(G)	Steel Galvanised

Foundation Schedule

Type Mark	Type
SF1	600x300Dp RC Strip Foundation
SF2	900x450Dp RC Strip Foundation
SF4	1200x600Dp RC Strip Foundation

Column Schedule

Column Ref.	Size (mm)
C1	SHS120x120x5.0
C5	RHS200x100x10.0

C2	Increased foundation depths removed to suit new planting	03.05.2017	AK	GA
C1	Construction issue	10.03.2017	DH	GA
P2	Foundations depth revised	03.03.2017	DH	GA
P1	Preliminary	19.02.2017	TM	GA

Rev	Description	Date	By	Chkd
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www.glanvillegroup.com

Client : **Berkeley**
Designed for life

Project : **Phase 5, Green Park Village**

Title : **Plot 213-214
Foundation Plan**

Project Engineer : GA Scale : As indicated @ A1
Project Director : AS Date : Feb' 2017
Status: CONSTRUCTION

Drawing Number : **4160518_ 2029** Rev : **C2**



APPENDIX 5

REPORT RELIANCE

Notwithstanding any other provisions of this report and in consideration of the sum of ten pounds (£10.00) paid by both St Edward Homes Limited, Berkeley Homes (Western) Limited and Berkeley Homes plc, we Ramboll UK Limited hereby acknowledge receipt of the aforementioned consideration and hereby irrevocably acknowledge and agree that St Edward Homes Limited, Berkeley Homes (Western) Limited and Berkeley Homes plc and any parties acquiring an interest in the works to be carried out at the site and/or the property/properties in respect of which this report has been carried out and/or the property and/or the land in respect of which this report has been carried out or any part or parts thereof (the Project) and/or any party providing finance and/or refinance in connection with the Project and any contractors involved in the development of the site/property to which this report relates and their assigns shall have relied and will continue to rely on the findings of this report and in so doing we acknowledge a duty of care to them provided that the duty of care shall be no greater in terms of obligation than that owed to the company/body who has commissioned the report from us as if the beneficiary had been named jointly with the company/body who have commissioned the report in such commission/appointment.