OXFORD ROAD,
BODICOTE
OXON

FLOOD RISK ASSESSMENT & DRAINAGE ADDENDUM REPORT

CREST NICHOLSON MIDLANDS

Date:	20th July 2018
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Rev:	**B**

DOCUMENT CONTROL RECORD

Document Issue:

Rev	Date	Issue Status	Prepared by	Checked by
-	20.07.18	First Issue for comment	C.Pendle	A.McShane
A	03.10.18	Updated following OCC comments	C.Pendle	A.McShane
B	07.01.19	Updated following OCC comments	C.Pendle	A.McShane

Notes:

Revision A:

This document has been revised and updated in response to Oxfordhire County Council's objection to the surface water drainage proposals.

This report includes the geotechnical update by Hydrock Consulting, development drainage calculations as well as the preliminary SUDs / drainage maintenance & management plan.

Revision B:

Chapter 4 relating to surface water has been revised and updated in response to Oxfordhire County Council's further queries. The update confirms the following:

- Updated surface water strategy and engineering layouts clarifies how all plots and the system are connected to the attenuation and final outfall.
- Paragraphs added on flood exceedance routing and how the the routes of the natural catchment are maintined.
- An SuDS maintenance plan has been issued as part of this FRA. The majority of the surface water system will be adopted by Thames Water Utilities and maintained under their standard term maintenance regieme.

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REFERENCES

Technical Guidance to the National Planning Policy Framework - NPPF (2012)
Department for Communities and Local Government ISBN: 978-1-4098-3410-6

Contains British Geological Survey materials © NERC (2018)

The SuDS Manual CIRIA C753, London, 2015

CIRIA Report 156 Infiltration drainage – Manual of good practice

1 Introduction

1.1 Scope

Crest Nichlson Midlands are seeking to clear Reserved Matters planning consent for the residential development of 95 units with associated infrastructure and open space.

1.2 MJA Consulting has been appointed to provide an updated Flood Risk Assessment & drainage strategy for the development as part of the planning permission. This report should be read in conjunction with the Flood Risk Assessment produced by Forge Engineerng Design Solutions, Ref: FEDS-214026 approved at outline planning, the Ground Investigation report provided by Hydrock Ref: BDC-HYD-GI-RP-GE-00001, dated April 2017. This statement should also be read with the Flood Risk Assessment undertaken Banners Gate Ltd for the adjacent Cala Homes Development.

1.3 The following report confirms the potential flood risks associated with the site and to provide an updated and suitable strategy for the disposal of surface and foul water based on the current information.

1.4 Report Structure

The National Planning Policy Framework (NPPF) and the Flood Risk and Coastal Planning Practice Guidance (PPG) is the current guidance on development and flood risk in England and Wales.

1.5 This report will take the structure of a 'Flood Risk Assessment' in accordance with the National Planning Policy Framework, the Flood Risk and Coastal Planning Practice Guidance, Environment Agency's Flood Risk Assessment Guidance and CIRIA Report 624 'Development and Flood Risk.

1.6 The objective of this report is:

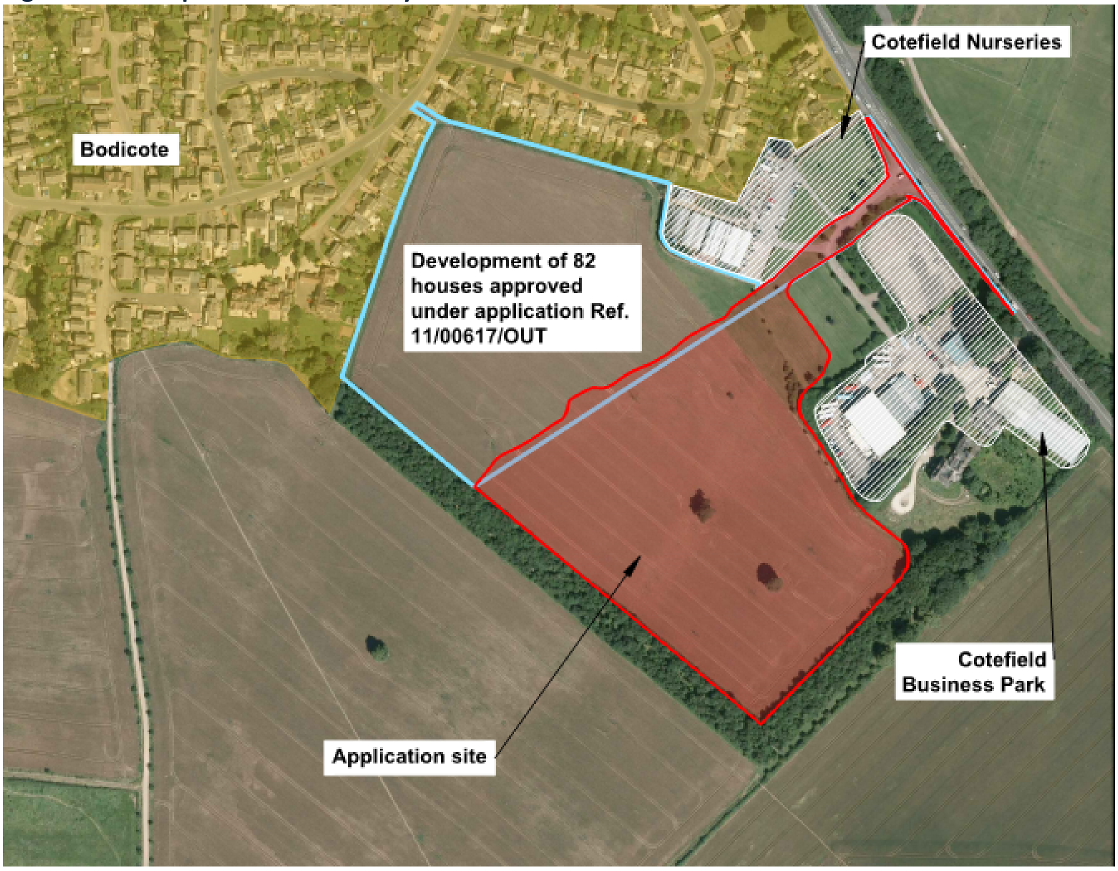
- To confirm whether the proposed development site is affected by current or anticipated future flooding from all sources for the lifetime of the site.
- To confirm that this development will not increase the risk of flooding to any offsite properties and land or increase the population within a floodplain.
- To undertake calculations to establish the foul and surface water runoff rates from the existing site and to assess the potential foul and surface water runoff from the proposed development.
- To detail a suitable strategy for the management of foul and surface water generated from the proposed development allowing for future climate change.
- To satisfy the approving planning authority that the most sustainable foul and surface water drainage solutions have been considered, in line with Environment Agency guidance, The Building Regulations (Document H 2002) and government legislation such as the Flood and Water Management Act 2010 (Defra) and The National Planning Policy Framework (NPPF & PPG).

2 The Development Site

2.1 Site Location and Description

The application site covers an area of approximately 4.5ha, and is located to the west of the A4260 Oxford Road. north west of the A4094 & River Wye. The site is bounded by other new and existing residential dwellings to the north, commercial properties to the north east and east, and agricultural land to the south east, south and south west.

Figure 1: Development site boundary



2.2 Topography

The site is located in a natural valley, with levels ranging from 114.130m to 102.27m AOD with the valley floor sloping down towards the south western boundary. The steepest gradients are in the southwestern part of the site, either side of the valley feature,
up to approximately 1 in 10.

2.3 Geology

The site is indicated by the BGS mapping (Sheet 218 and the mapping portal) to be underlain by Marlstone Rock Formation, comprising sandy, shelly and ooidal ferruginous limestone interbedded with ferruginous calcareous sandstone, and generally subordinate ferruginous mudstone.

The ground conditions found during the original and current investigation are in general accordance with the published geological literature.

Sub strata summary:

	Summary Description	Depth to Top (m bgl)	Thickness (m)
Topsoil	Soft dark brown sandy gravelly clay and clayey gravelly sand with rootlets	0	0.20 – 0.35
Head Deposits (southwest area of site on lower slopes)	Stiff greenish grey mottled orange silty sandy gravelly clay	0.30	>1.50 - >2.40
	Orange brown clayey gravelly sand		
	Soft blue grey / purple gravelly clay / silt		
Marlstone Rock Formation	Firm to stiff orange brown to greenish grey silty sandy gravelly CLAY, with fine to coarse angular to rounded gravel of limestone and ironstone.	0.20 - 0.30	0.50 - >2.80
	Orange brown clayey silty gravelly sand with limestone and ironstone gravel.		
	Moderately strong fractured grey brown limestone		
Dyrham Formation	Stiff blue grey silty CLAY, weathered to firm orange brown clay near the upper surface.	0.60 – 2.60	>0.20 - >1.60

Extract from Hydrock Report

2.5 Hydrogeology

The Marlstone Rock Formation is classified as a ‘Secondary A aquifer’ by the Environment Agency meaning it comprises ‘permeable layers capable of supporting water supplies at a local rather than strategic scale.

The Dyrham Formation is classified as Unproductive Strata and is likely to be lower in permeability than the Marlstone Rock. It is therefore expected that there may be a spring line along the boundary between them and any associated solifluction deposits.

The site is not within a Source Protection Zone for drinking water supply, but groundwater in the Marlstone Rock aquifer is considered to be vulnerable to pollution.

2.6 Groundwater

Groundwater strikes were encountered during the investigation 1.6 – 3.0m below ground. Where groundwater was not encountered, the groundwater level can be assumed to be deeper than the base of the trial pits. On this basis, the depth to groundwater where not encountered in the trial pits varies between >0.70m and >3.20m below existing ground level.

2.7 Soil Permeability

Infiltration testing was carried out as part of the site investigations in accordance with BRE 365.

The tests were undertaken in both within the Limestone & Clay layers. These results indicate fast infiltration into the limestone beds, where these occur as the outflow from the pit was greater than the inflow that could be gained from a water bowser. The clay horizons in the Marlstone Rock Formation are effectively impermeable for soakaway purposes.

Hydrock concluded that limestone beds within the Marlstone Rock are likely to be of limited thickness and may not be continuous, in which case they would not be reliable and may result in water being channelled through the limestone beds to their outcrop, rather than infiltrating generally into the ground. For these reasons, soakaways are not considered suitable.

If infiltration features were to be used within the higher areas of the site there are potential implications with regard to slope stability, this may manifest as spring lines at the interface between the Marlstone rock and Dryham Formation but could in certain circumstances result in slope instability.

Hydrock Consultants Ltd have provided further confirmation on the non-suitability of soakaways within the site with document C-05955-C/002. This statement confirms that the current surface water drainage proposals are geotechnically suitable for this site due to the increased risk of slip planes and spring lines forming. See Appendix D.

2.8 Local Watercourses

The nearest open watercourse is the Sor Brook which is located approximately 500m to the southwest of the Site.

2.9 Existing Utility Appuratus

Following further site investigations it has been found that two existing surface water systems run through the site, one of which takes highway runoff from the A4260 Oxford Road while the other receives runoff from the existing agricultural buildings and yards located to the north east of the site. Both of which discharge to the Sor Brook.
The site is also bisected by a Thames Water raw water main which feeds to the treatment works with Banbury.
All three of these piped systems will be diverted within the development layout.

2.10 Cala Homes Development:

The land associated with the Cala Homes development lies above and to the north of the Crest Nichlson development with falls from north to south from approximately 116.0m to 112.0m AOD. The sub strata found is similar to that on the Crest Nichlson development area.

As part of the approved drainage design the development runoff is attenuated and discharged through a new storm outfall which runs from the Cala Homes site through the Crest Nichlson site. The storm outfall then discharges in a south west direction to the Sor Brook.

The outfall has been designed to also take the attenuated flows from the Crest Nicholson site.

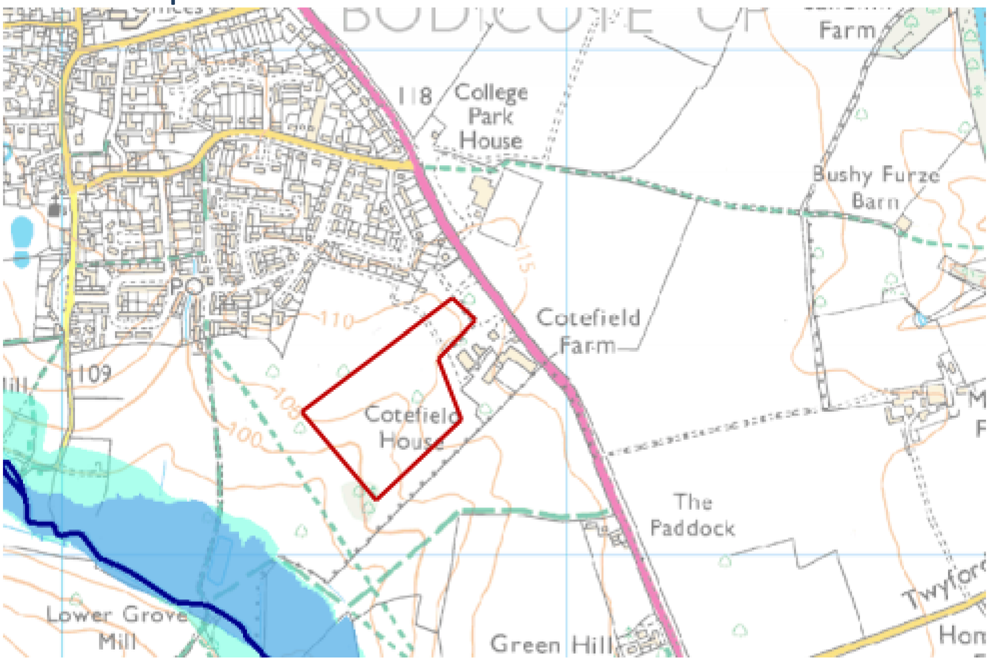
3 Flood Risk Assessment

3.1 A Flood Risk Assessment requires that an evaluation of all potential forms of flood risk to the site are considered.

In accordance with the Environment Agency's Flood Risk Assessment Guidance, NPPF, PPG and CIRIA Report 624, sources of flooding to be assessed include tidal, fluvial (rivers, streams and watercourses), pluvial (overland rainfall runoff), groundwater, artificial sources (canals and reservoirs) and existing / proposed sewerage and water mains infrastructure.

3.2 The Flood Risk Assessment produced by Forge Engineerng Design Solutions, Ref: FEDS-214026 approved at outline planning stage has confirmed that in accordance with the Environment Agency Flood Zone Mapping service indicates that the site is located in Flood Zone 1, which has a Low risk of fluvial flooding from Main Rivers. That is land having a less than 1 in 1,000 annual probability of river or sea flooding.

Flood Zone Map



Contains Environment Agency information © Environment Agency 2015

Key:

Main Rivers

Dark Blue ■ : (Flood Zone 3)
Shows the area that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area could be flooded: from the sea by a flood that has a 0.5 per cent (1 in 200) or greater chance of happening each year, or from a river by a flood that has a 1 per cent (1 in 100) or greater chance of happening each year.

Light Blue □ : (Flood Zone 2)
Shows the additional extent of an extreme flood from rivers or the sea.
These outlying areas are likely to be affected by a major flood, with up to a 0.1 per cent (1 in 1000) chance of occurring each year.
These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements.

Clear □: (Flood Zone 1)
Shows the area where flooding from rivers and the sea is very unlikely.
There is less than a 0.1 per cent (1 in 1000) chance of flooding occurring each year.

3.3 As confirmed by the latest Environment Agency 'Flood Zone Map', the site is located within the lowest risk category - Flood Zone 1.

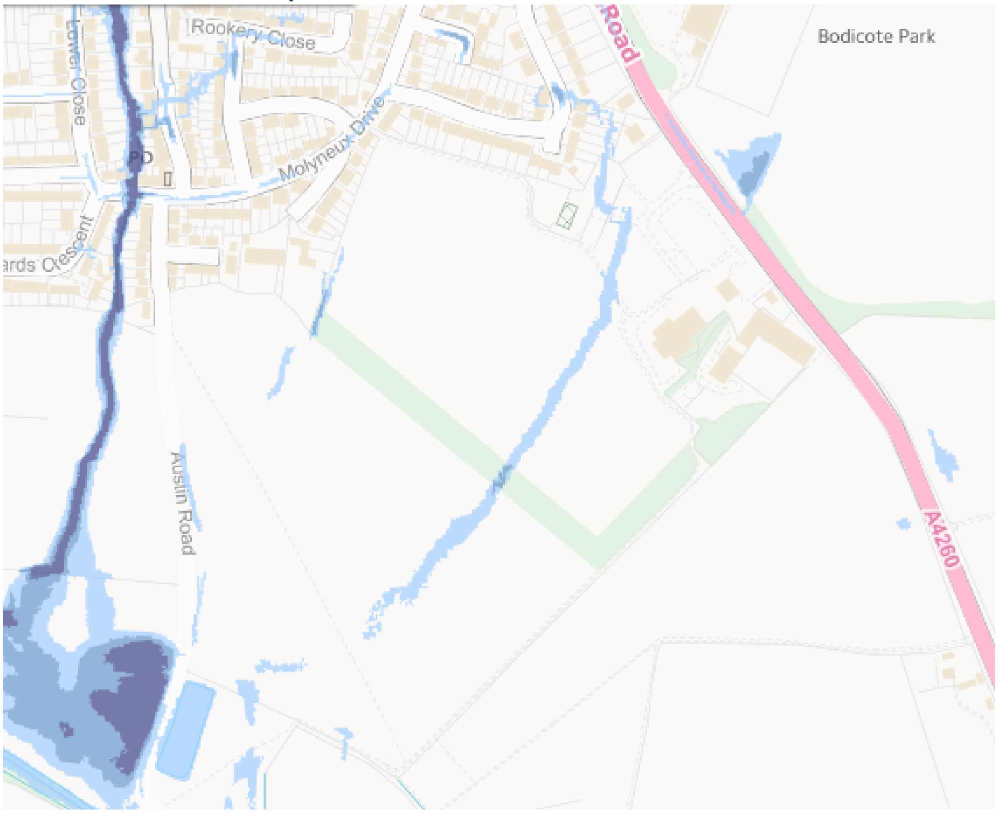
3.4 West Oxfordshire District Council (WODC) and Cherwell District Council (CDC) carried out a joint Level 1 Strategic Flood Risk Assessment (SFRA) for their districts, and published the final report in April 2009.
The aim of WODC and CDC's SFRA is to assess and map the different levels and types of flood risk in the study area for the land use planning process.

3.5 Within the context of the proposed development, there have been no recorded issues of flooding from potential sources including:

- Tidal.
- Fluvial (Main rivers and Ordinary watercourses).
- Groundwater.
- Existing foul and storm sewers and potable water main infrastructure.
- Artificial infrastructure (ponds, sewerage treatment plants etc.).

3.6 Since approval of the FRA the Environment Agency surface water flood mapping service has been updated. This indicates that the site has a strip of potential surface water flooding located on site, as highlighted on the extract plan. This is consistent with the topographical survey which incicates the valley feature running through the centre of the site.

Surface Water Flood Map



Contains Environment Agency information © Environment Agency 2015

3.7 While this is shown as flooding no recorded flooding data has been found within the site boundary and no evidence of additional surface water flooding at the site has been identified.
The route of the indicated flooding does follow the line of an existing surface water and highway drainage system which takes runoff from the A4260 Oxford Road to the Sor Brook.

3.8 Sequential Test

The flood risk technical guidance to the National Planning Policy Framework (NNPF) categorises residential developments as 'More Vulnerable' within the risk classification. 'More vulnerable' developments located within Flood Zone 1 are considered appropriate under the NPPF.

3.9 The NPPF guidance states that planning authorities should complete a risk based 'Sequential Test' at all stages of the planning process, to steer new development to areas with the lowest probability of flooding.
Under the requirements of the 'Sequential Test' and as the proposed development is already located within Flood Zone 1 (lowest risk), there are no more suitable, developable and deliverable alternative sites, better located from a flood risk perspective which could accommodate the proposed development.

4 Surface Water Drainage Strategy

4.1 The National Planning Policy Framework (NPPF) requires that developments do not exacerbate flood risks on the development site or to offsite parties and land. There is, therefore, a need to control surface water drainage and overland runoff to ensure there are no increases in peak rates and volumes of runoff as a result of the development.

4.2 Environment Agency guidance and government legislation such as the Flood and Water Management Act (Defra 2010) requires surface water drainage strategies for new developments to be in accordance with the ideals of 'sustainable development' via the provision of Sustainable Drainage Systems (SuDS).

4.3 The SUDs Manual and Building Regulations Document H (2015) details the appropriate hierarchy of potential methods for disposing of surface water from a development:

1. A soakaway or some other adequate infiltration system, or where that is not practicable;
2. A watercourse, or where that is not practicable;
3. A sewer.

4.4 Following the further ground investigatons which has highlighted that while the areas of limestone have a high potential for infiltration the discharge appears to be running between the layers of clay and limestone creating a high risk for groundwater springs within the site or as a worstcase senereo creation of a slipplane.

4.5 Based on the findings of the ground investigation as highlighted within Hydrock report the most suitable method of surface water disposal for the proposed development will be a fully attenuated surface water system with a controlled discharge to the new storm outfall sewer.

4.6 Existing Surface Water Runoff Peak Runoff Rate & Volume (Greenfield)

As part of the original Forge Engineerng Design FRA an assessment was made of the Greenfield runoff rate. These are calculated to determine the theoretical rate of discharge from the Greenfield site to surrounding areas and receiving watercourses in the vicinity.

4.7 The estimated Greenfield run-off for the site was calculated using the Institute of Hydrology's Report No. 124 methodology for sites with an area between 0 ha and 50 ha:

QBARrural = 0.00108 AREA0.89 SAAR1.17 SOIL2.17

Where,
0.00108 is a conversion factor for the units used
AREA is the site catchment area in km2
SAAR is the Standard Average Annual Rainfall
SOIL is the soil index classification.

4.8 The run-off rate is calculated for a 50 ha (0.5km2) catchment using the site's catchment details, and then interpolated using the site's total area to calculate the site's Greenfield run-off rate.

4.9 Using a SAAR of 654mm and SOIL of 0.400, the estimated existing site's Greenfield surface water run-off rate peak flow is:

QBARrural = 0.00108 x 0.500.89 x 6541.17 x 0.4002.17 = 0.1571 cumecs / 50 ha
which equates to QBarRrural = 157.1 l/s/ 50 ha
which equates to QBarGreenfield = 3.142 l/s/ha,
and for a site area of 4.50 ha = 14.1 l/s

4.10 For the site's catchment area of 4.50ha and specified storm events, the site's estimated Greenfield run-off rates and volumes were calculated to be:

Storm Event 1 in n year	Growth Curve Factor	Estimated Site's Run-off Rate Peak Flows (l/s)	Estimated Site's Run-off Peak Volume (m3)
QBAR Greenfield	-	14.1	304.6
1 in 1 year	0.85	12.0	259.2
1 in 30 year	2.27	32.0	691.2
1 in 100 year	3.19	45.0	972.0
1 in 100 year + 30% CC	4.15	58.5	1263.6

Extract from Flood Risk Assessment produced by Forge Engineerng Design Solutions

4.11 Surface Water design:

The surface water design will follow the principles previously set out in both the approved flood risk assessments undertaken by Forge Engineering Design and Banners Gate Ltd which confirm that a final discharge to the Sor Brook is required. This as previously described has already been provided for the adjacent Cala Homes development.

The surface water drainage strategy for the development is described below:

Roof Runoff:-

- Roof runoff will be collected by a conventional system of guttering and downpipes where it will be discharged to a main storm sewer.
- Water Butts are to be provided per plot where feasible on a rainwater downpipe to collect roof runoff for re-use.

Private Drives & Parking Courts:-

All private drives and parking courts will either drain via a traditional gully & piped system prior to outfalling to a the main storm drain.

Development Roads:-

Runoff from the highway areas will drain via deep trapped road gullies connecting directly to either the main piped storm drain.

Attenuation Tanks:-

Due to the layout and levels of the development the surface water flows will be split into two catchments; the majority of the site consisting of Phase 1 & part of Phase 2 will drain via the piped system to the main cellular attenuation tank located within the POS area. The remaining area of Phase 2 will discharge to an online piped attenuation tank located adjacent to the southern boundary.

The final flow from the development is restricted to a maximum discharge of 14.0 l/sec for all storm events which equates to the agreed QBar Greenfield runoff rate within the FRA. The discharge from the two attenuation tanks is split as 10.5 l/sec from the main cellular attenuation tank and 3.5l/sec from the online attenuation tank.

All attenuation has been designed to accommodate the necessary storage volumes to manage the 1:100 year storm event, plus an extra allowance of 40% for the predicted potential increase in peak rainfall up to 2115. This ensures that all surface water drainage features are designed to accommodate the extreme storm event and will minimise the occurrence or potential for surface flooding within the development.

4.12 The development surface water piped drainage network will be offered to Thames Water for adoption under a Section 104 agreement of the Water Industry Act 1991. The main attenuation tank will be constructed using a cellular type crate system and will be maintained via the development management company.

4.13 Flood Exceedance Routing:-

The attenuation tank systems have been designed to accommodate the 1 in 100 year storm event, plus an extra allowance of 40% climate change with no flooding. Should any flooding occur the flood exceedance routing will typically follow the topography of the development roads and natural catchment to the development low point located below the POS on the southern boundary.

The land to the south of the site is at a lower level as part of the natural catchment falling towards the Sor Brook; the natural flow path for any exceedance flows would still be maintained.

The SUDs maintenance plan highlights the proposed requirements, however this only relates to any private drainage and drainage falling within the management company remit; all other surface water drainage is to be adopted either by Thames Water Utilities or Oxfordshire County Council and be maintained accordingly.

5 Foul water drainage strategy

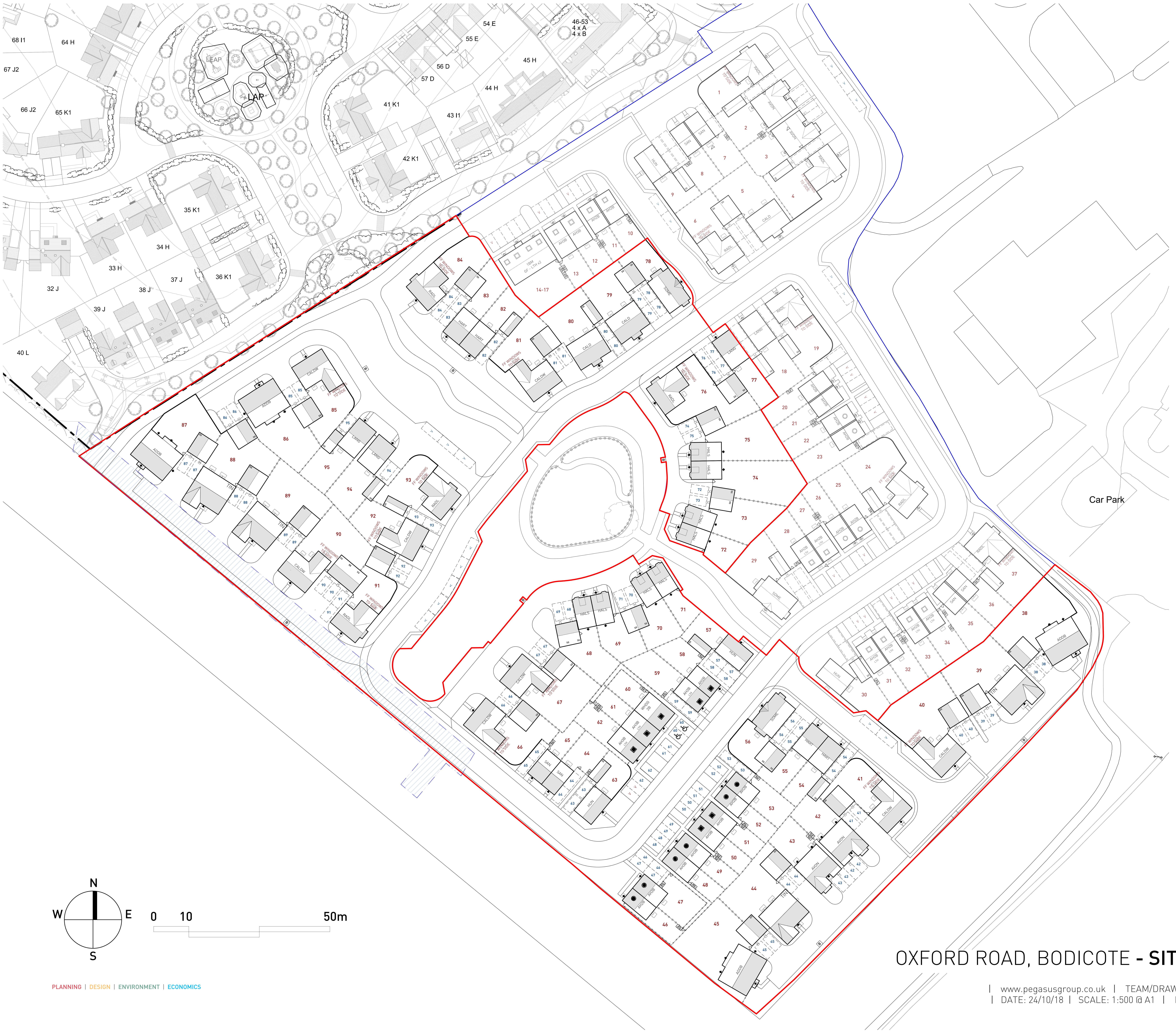
5.1 The foul water generated from each property will drain via gravity through the private house drainage before out-falling to a new sewer located typically within the development road network.

5.2 All plots will drain via a main gravity sewer system which will convey flows to the existing off site foul sewer constructed as part of the adjacent Cala Homes development.

5.3 The predicted peak foul sewer discharge from the site based on the Sewers for Adoption figure (4000 l/dwelling/day) for up to 95 units will be 4.4 l/sec.

5.5 The development foul drainage network will be offered to Thames Water for adoption under a Section 104 agreement of the Water Industry Act 1991.

APPENDIX A
SITE LAYOUT



KEY: SITE LAYOUT

APPLICATION BOUNDARY

SURFACE MATERIALS:

GARDEN/POS/HIGHWAY VERGE
(SEE DETAILED LANDSCAPE PROPOSALS)

TARMACADUM

BLOCK PAVING

CONCRETE SLAB

ENCLOSURE DETAILS:

1.8M HIGH BRICK WALL [BW]

1.8M HIGH TIMBER PANEL FENCING [PF]

1.8M HIGH CLOSE BOARDED FENCING [CBF]

1M HIGH BOW TOP RAILINGS

LANDSCAPING:

RETAINED TREE

INDICATIVE TREE PLANTING
(SEE DETAILED LANDSCAPE PROPOSALS)

OTHER:

AS — DWELLING PLOTTED AS SHOWN IN HOUSE PACK

OPP — DWELLING HANDED FROM HOUSE PACK

AFFORDABLE HOUSING
(SHARED OWNERSHIP)

AFFORDABLE HOUSING
(RENTED)

B — BIN COLLECTION POINT

GATE/PERSONNEL DOOR

PROPOSED DRAINAGE EASEMENT

SECURE CYCLE PARKING

Accommodation Schedule

Unit Type	No. Beds	Storeys	Sqft./unit	Sqm./unit	No. of Units
Open Market					
SANDOWN	2	2	771	71.6	2
HARTLEY	3	2	997	92.6	4
HUNTINGDON	3	2	1,027	95.4	2
LANGFORD	3	2	1,105	102.7	3
HALSTEAD	3	2.5	1,173	109.0	8
AVON	4	2	1,399	130.0	2
SOMERTON	4	2	1,514	140.7	2
CALDER	4	2	1,517	140.9	2
RADLEY	4	2	1,579	146.7	4
CALDWICK	4	2	1,723	160.1	8
TINDALL	5	2	2,118	196.8	4
ADDERBURY	5	2	2,081	193.3	4
		OM TOTAL			45
Affordable					
RENTED					
AH2B	2	2	769	71.4	1
AH2B LTH	2	2	874	81.2	1
AH2B WC	2	2	1,130	105.0	1
AH3B	3	2	911	84.6	2
AH3B LTH	3	2	1,028	95.5	2
		sub total	70%		7
INTERMEDIATE					
AH2B	2	2	769	71.4	4
AH3B	3	2	911	84.6	2
		sub total	30%		6
		AFF TOTAL	54%		13
					22%
		TOTAL UNITS			**58**

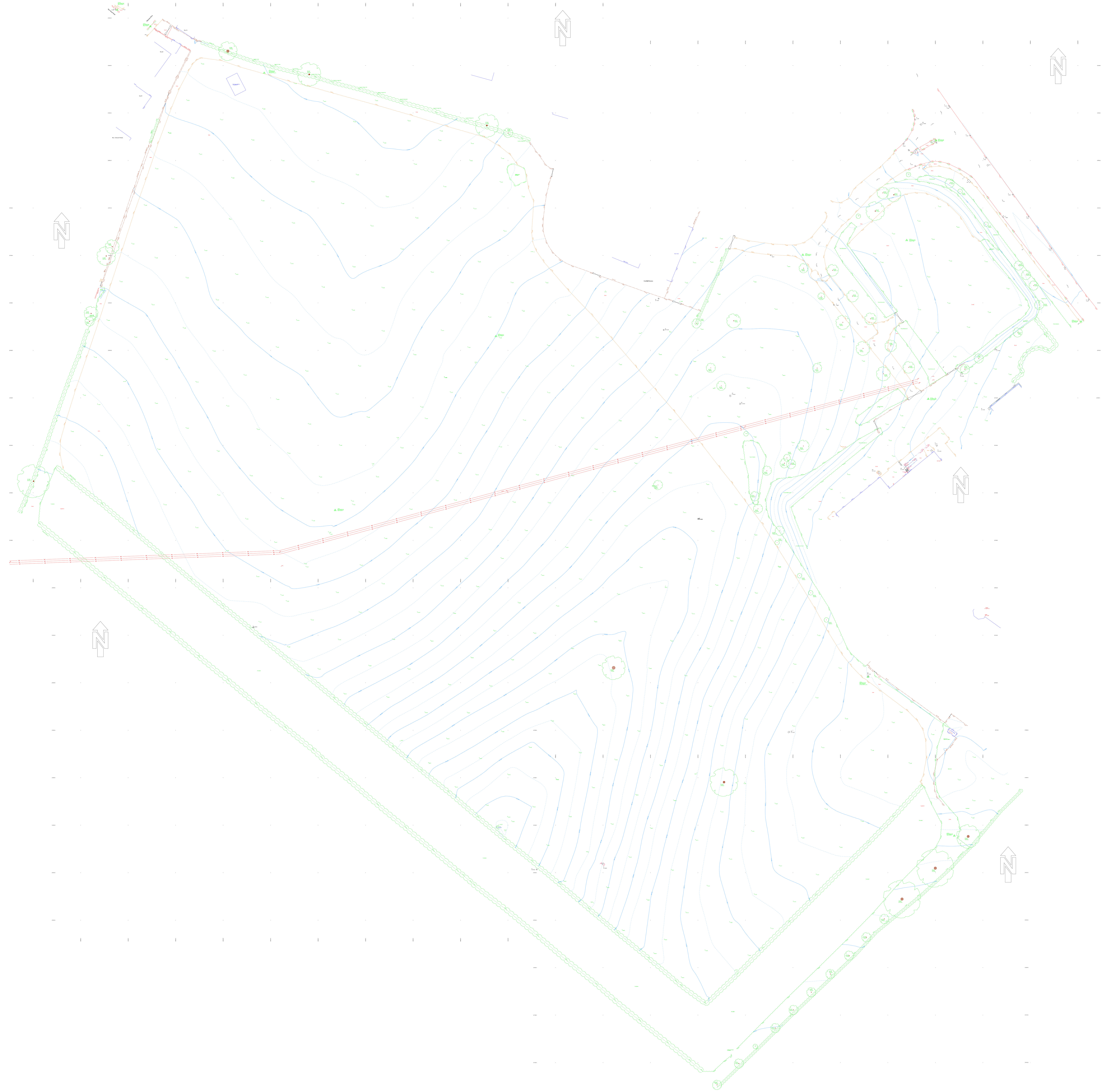
OXFORD ROAD, BODICOTE - SITE LAYOUT - PHASE 2

Pegasus
Design

| www.pegasusgroup.co.uk | TEAM/DRAWN BY: STH/JBS/THA | APPROVED BY: STH
| DATE: 24/10/18 | SCALE: 1:500 @ A1 | DRWG: P18-1568_01 SHEET NO: __ REV: F

PLANNING | DESIGN | ENVIRONMENT | ECONOMICS

APPENDIX B
TOPOGRAPHICAL SURVEY



Notes:

© This drawing and the building works depicted are the copyright of RPS and may not be reproduced or amended except by written permission. No liability will be accepted for amendments made by other persons.

The Contractor is to check and verify all building and site dimensions, levels and sewer invert levels at connection points before work starts. The Contractor is to comply in all respects with current Building Legislation, British Standard Specifications, Building Regulations, Construction (Design & Management) Regulations, Party Wall Act, etc. whether or not specifically stated on this drawing. This drawing must be read with and checked against any structural, geotechnical or other specialist documentation provided.

This drawing is not intended to show details of foundations, ground conditions or ground contaminants. Each area of ground relied upon to support any structure depicted (including drainage) must be investigated by the Contractor. A suitable method of foundation should be provided allowing for existing ground conditions. Any suspect or fluid ground, contaminates on or within the ground, should be further investigated by a suitable expert. Any earthwork constructions shown indicate typical slopes for guidance only & should be further investigated by a suitable expert.

Where existing trees are to be retained they should be subject to a full Arboricultural inspection for safety. All trees are to be planted so as to ensure they are a minimum of 5 metres from buildings and 3 metres from drainage and services. A suitable method of foundation is to be provided to accommodate the proposed tree planting.

Sketch proposals are for illustrative purposes only & as such are subject to detailed site investigation including ground conditions/contaminants, drainage, design & planning/density negotiations. Sketch proposals may be based upon enlargements of OS sheets & visual estimations of existing site features, accuracy will therefore need to be verified by survey. Sketch proposals have not been considered in respect of CDM Regulations.

Survey carried out to client specification and in accordance with RICS publication:
SURVEYS OF LAND , BUILDING & UTILITY SERVICES AT SCALES 1:500 & LARGER, 3rd EDITION.

Utility Services Location Note:

This survey has been carried out using a combination of observation and detection using electrolocation and ground probing radar equipment. Connections between reference points such as manholes are assumed to be straight unless bends are indicated. The accuracy is limited to the tolerances normally expected from the equipment used.

The following indications of completeness and accuracy are for guidance only:

In areas where there is a large concentration of services, the completeness will be between 80% and 90%. This will be reduced where there are obstructions at ground level.

Positional accuracy will vary with depth and pipe / duct material; an accuracy of +/- 150 mm is achievable in normal circumstances but this will be reduced for plastic pipes.

Existing information from historical plans is likely to be unreliable and is shown for guidance only.

Excavations in the area should be carried out with care and in accordance with HSG 47. No absolute guarantee of accuracy should be inferred from these plans.

The following text is an extract from Surveys of Land, Buildings and Utility Surveys at scales of 1:500 and Larger, 3rd Edition

"Electronic tracing is a reliable, method of locating buried services. ***On Heavy, built up sites 85% completeness is probably all that can be expected.*** *Plan accuracies of +/- 150mm may be achieved but this figure will depend on the depth of the service below ground level.* ***Where similar services run in close proximity, separation may be impossible. Successful tracing of non-metallic pipes may be limited.*** *Existing record information showing underground services is often incomplete and of doubtful accuracy. It should be regarded only as an indication and cannot be guaranteed"*

STANDARD ABBREVIATIONS

AV	AIR VALVE	FP	FLAG POLE	RL	RIDGE LEVEL
AR	ASSUMED ROUTE	G	GULLY	RMP	RESERVOIR MONITORING POINT
BB	BELISHA BEACON	GIP	GAS INLET POINT	RP	REFLECTOR POST
BdL	BED LEVEL	GP	GUIDE POST	RS	ROAD SIGN
BH	BOREHOLE	Grl	GRILLE COVER	RSP	RAILWAY SIGNAL POST
Bol	BOLLARD	GV	GAS VALVE COVER	RW	RETAINING WALL
BP	BOUNDARY POST	Hrl	HAND RAIL	RWP	RAINWATER PIPE
B Pvg	BLOCK PAVING	IC	INSPECTION COVER	Sap	SAPLING
BRck	BICYCLE RACK	IL	INVERT LEVEL	SB	SIGN BOARD
BS	BUS STOP	I/R	IRON RAILING FENCE	Shlt	SHELTER
BT	BRITISH TELECOM COVER	KO	KERB OUTLET	SL	SOFFIT LEVEL
BW	BRICK WALL	Lby	LIFEBUOY	Slt	SILT LEVEL
BWF	BARBED WIRE FENCE	Lck	LOCK GATE	SP	SIGN POST
Cat	CATENARY LEVEL	Ldr	LADDER	SPt	SAMPLING POINT
CATV	CABLE TV COVER	LOR	LOSS OF REFLECTION	SS	STRUCTURE SUPPORT
CB	CONTROL BOX	LOS	LOSS OF SIGNAL	ST	STOP TAP
C/B	CLOSE BOARDED FENCE	LP	LAMP POST	Sti	STILE
Cgd	CATTLE GRID	Mcy	MACHINERY	STP	STAND PIPE
CI	CAST IRON	MH	MANHOLE	StPo	STAY POST
CIP	CABLE INLET POINT	MgP	MOORING POST	Stu	STUMP
CL	COVER LEVEL	Mkr	MARKER POST	StW	STAY WIRE
C/L	CHAIN LINK FENCE	MS	MILESTONE	SV	STOP VALVE
Conc	CONCRETE	MU	ELECTRIC MOTOR	S/W	STONE WALL
CP	CATCHPIT	NP	NAME PLATE	Tac	TACTILE PAVING
CpL	COPING LEVEL	OSA	OFF SURVEY AREA	TBM	TEMPORARY BENCH MARK
Cpsn	CAPSTAN	OSBM	ORDNANCE SURVEY BENCH MARK	TCB	TELEPHONE CALL BOX
Cul	CULVERT	OGC	OVERGROUND CONDUIT	ThL	THRESHOLD LEVEL
CW	CONCRETE WALL	OHca	OVERHEAD CABLE UNIDENTIFIED	TEL	TELECOM COVER
DI	DUCTILE IRON	OHC	OVERHEAD CONDUIT	TL	TRAFFIC SIGNAL POLE
(dilap)	DILAPIDATED	OHE	OVERHEAD ELECTRIC	TM	TICKET MACHINE
(dis)	DISUSED	OHG	OVERHEAD GANTRY	TP	TELEGRAPH POLE
DPC	DAMP PROOF COURSE	OHStruct	OVERHEAD STRUCTURE	Tr	TROUGH
DSW	DRY STONE WALL	OHT	OVERHEAD TELECOM	UTL	UNABLE TO LOCATE
EIC	ELECTRICITY COVER	P	POST	UTR	UNABLE TO RAISE
EL	EAVES LEVEL	Pcg	PEDESTRIAN CROSSING	UTS	UNABLE TO SURVEY
EOT	END OF TRACE	P/F	PANEL FENCE	UTT	UNABLE TO TRACE
EP	ELECTRICTY POLE	PP	PETROL PUMP	VC	VITRIFIED CLAY
ER	EARTH ROD	P/R	POST & RAIL FENCE	VDP	VEHICLE DETECTION PAD
ESP	ELECTRICITY SUPPLY POINT	Psk	PENSTOCK	VP	VENT PIPE
ESW	ELECTRICITY SWITCH BOX	PV	VERTICAL PIPE	VW	VALVE WHEEL
FB	FOOTBRIDGE	Pyl	PYLON	WM	WATER METER COVER
FFL	FINISHED FLOOR LEVEL	PZ	PIEZOMETER	W/M	WIRE MESH FENCE
FH	FIRE HYDRANT	RE	RODDING EYE	WO	WASH OUT COVER
		RG	RAIN GAUGE	WSR	WATER LEVEL SENSOR

Utility Lines:

	SURVEY EXTENTS	D=1.00m	DEPTH INFORMATION
BT	BRITISH TELECOM	HW	HOT WATER
BT(r)	TAKEN FROM RECORDS	HW(r)	TAKEN FROM RECORDS
CTV	CATV CABLE	O/F	OPTIC FIBRE
CTV(r)	TAKEN FROM RECORDS	O/F(r)	TAKEN FROM RECORDS
CTV	CCTV CABLE	OIL	OIL PIPELINE
CTV(r)	TAKEN FROM RECORDS	OIL(r)	TAKEN FROM RECORDS
CW	COMBINED WATER	PWR	POWER FEATURE
CW(r)	TAKEN FROM RECORDS	SW	SURFACE WATER
DUC	EMPTY DUCT	SW(r)	TAKEN FROM RECORDS
DUC(r)	TAKEN FROM RECORDS	T	TELECOMMUNICATION CABLE
EA	EARTHING FEATURE	T(r)	TAKEN FROM RECORDS
EA(r)	TAKEN FROM RECORDS	TLM	TELEMETRY CABLE
E	ELECTRIC CABLE	TRA	TRAFFIC SIGNALS
E(r)	TAKEN FROM RECORDS	TRA(r)	TAKEN FROM RECORDS
FL	FUEL LINE	UK	UNKNOWN SERVICE
FL(r)	TAKEN FROM RECORDS	UK(r)	TAKEN FROM RECORDS
FW	FOUL WATER	VNT	VENT
FW(r)	TAKEN FROM RECORDS	VNT(r)	TAKEN FROM RECORDS
GAS	GAS	W	WATER
GAS(r)	TAKEN FROM RECORDS	W(r)	TAKEN FROM RECORDS
GPR	GPR FEATURE	11kV	11KV HV ELECTRIC
GPR(r)	TAKEN FROM RECORDS	11kV(r)	TAKEN FROM RECORDS
Helium	HELIUM FEATURE	PHOTO	PHOTO POSITION
Helium(r)	TAKEN FROM RECORDS	VIDEO START/END	VIDEO START/END
	SUB SURFACE ANOMALY		
REF:GPR02	REFERENCE TO GPR DATA IN REPORT		

Grid:	Datum:
Local Grid Deirived from NG GPS Observations to OS Active Network (OSTN02)	Ordnance Datum By GPS Observations to the to the OS Active Network (OSGM02) Stn1 =116.083m

Revision:	Amendments:	Date:	Name:
-	-	-	-
-	-	-	-
-	-	-	-
A	ORIGINAL ISSUE	April '14	JGC

RPS

THE SURVEY ASSOCIATION AFFILIATE MEMBER

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CLIENT:

RPS Planning & Development
(Abingdon)

PROJECT:

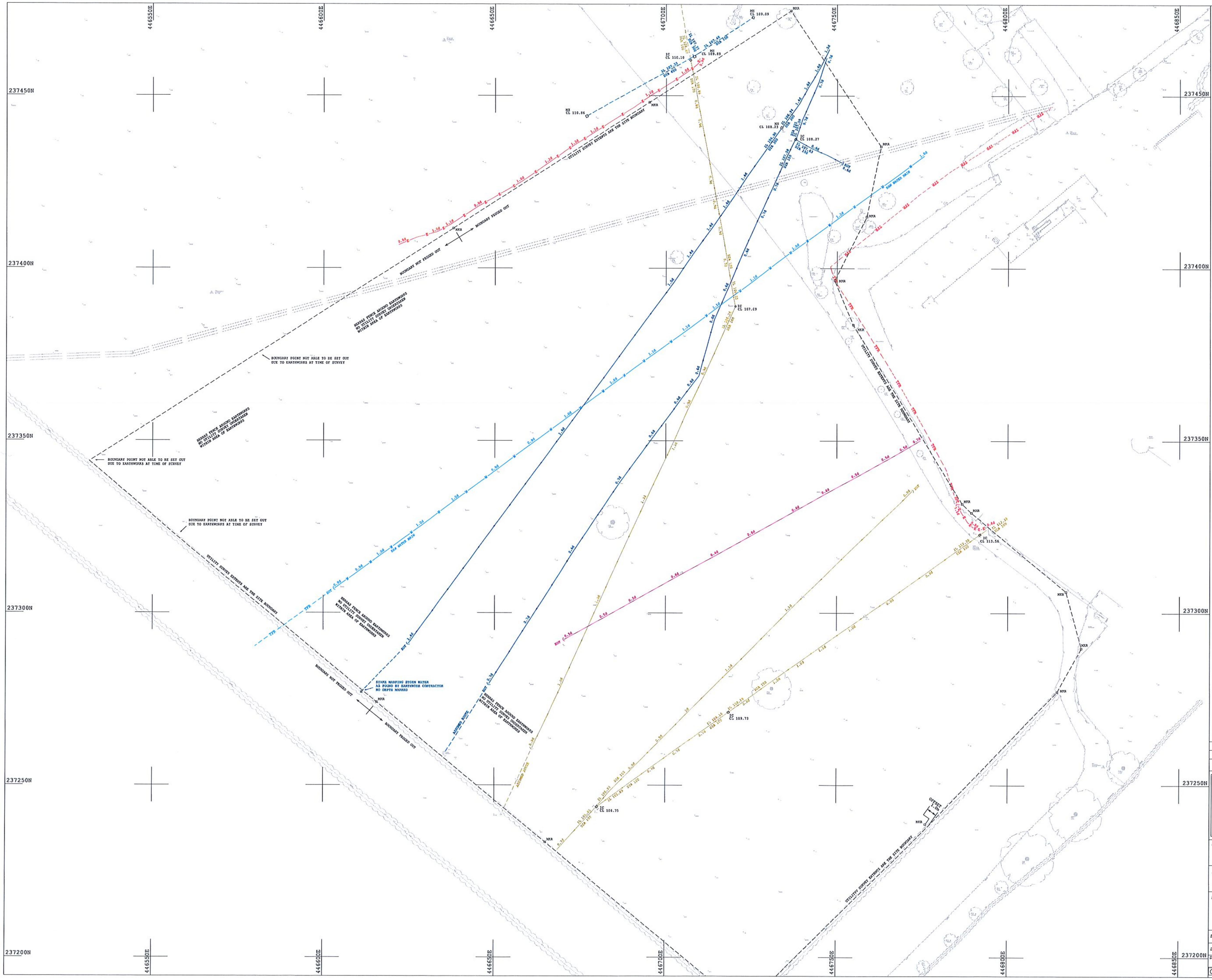
Cotefield Farm Phase II
Bodicote
Nr, Banbury

TITLE:

Topographical
Survey

Drawn: JGC	Checked: SP
Date: April 2014	Scale: 1:600 @ A0
Drg No: UAG3091_A_2D	Sheet: 1

ASSET & INFRASTRUCTURE MAPPING



KEY (Where Applicable)

UTLITIES AND SERVICES

NB - DASHED LINES ON UTILS INDICATE TAKEN FROM RECORD

A	UNDERGROUND ABANDONED SERVICE
TV	UNDERGROUND CABLE TELEVISION
C	UNDERGROUND COMMS CABLES
D	UNDERGROUND DUCTING
E	UNDERGROUND ELECTRICITY
FO	UNDERGROUND FIBRE OPTIC CABLE
FS	UNDERGROUND FUEL SUPPLY
G	UNDERGROUND GAS
AG	ABOVE GROUND GAS
	UNDERGROUND COMBINED WATER
	UNDERGROUND FOUL WATER
	UNDERGROUND SURFACE WATER
T	UNDERGROUND TELECOMS
S	UNDERGROUND TRAFFIC SIGNALS
	TRENCH SCAR
U	UNDERGROUND UNIDENTIFIED SIGNAL
W	UNDERGROUND WATER SUPPLY
AW	ABOVE GROUND WATER SUPPLY
	OVERHEAD ELECTRIC WIRES
	OVERHEAD TELEGRAPH CABLES
EOT	END OF TRACE
TFR	ROUTE TAKEN FROM RECORDS OR ASSUMED. (DASHED LINE WITH APPROPRIATE STYLE)
	REQUESTED SURVEY AREA
d	DEPTH. NB: SEE ACCURACY STATEMENTS AND ASSOCIATED REPORT.
	SITE BOUNDARY (LINE BETWEEN MARKER PEGS)

DISCLAIMER

DEPTH ESTIMATIONS, WHERE QUOTED, SHOULD BE TAKEN AS APPROXIMATE, DUE TO THE VARYING METHODS OF DETECTION USED MEASURING TO DIFFERENT POINTS ON THE SERVICE. GENERALLY DEPTHS SHOWN ALONG DRAINS AND SEWERS ARE TO THE INVERT LEVELS OF THE RELEVANT PIPE.
ELECTROMAGNETIC DETECTION METHODS ESTIMATE THE DEPTH TO THE CENTRE OF THE SERVICE AND ALLOWANCE SHOULD BE MADE FOR THE TOP OF LARGE DIAMETER SERVICES BEING SHALLOWER THAN THE ESTIMATED DEPTH.
GROUND PENETRATING RADAR DEPTH ESTIMATIONS ARE TAKEN TO THE TOP OF THE DETECTED SERVICE.
IT SHOULD BE NOTED THAT THE PLAN POSITION OF A DETECTED SERVICE IS, AS A GENERAL RULE, GOOD TO +/- 10% OF ITS ESTIMATED DEPTH.
WHERE SERVICES HAVE NOT BEEN ABLE TO BE DETECTED FROM ONSITE SEARCHES, THEN A COMBINATION OF INFORMATION TAKEN FROM RECORD DRAWINGS, RELEVANT SURFACE DETAILS AND TRENCH SCARS HAS BEEN USED WHILST EVERY EFFORT HAS BEEN MADE TO LOCATE ALL SERVICES THE COMPLETENESS OF ANY UTILITY SURVEY CANNOT BE GUARANTEED AND SAFE EXCAVATING PROCEDURES SHOULD BE EMPLOYED IRREGARDLESS OF THE INFORMATION SHOWN ON THIS DRAWING.

REPORT

ALWAYS REFER TO THE REPORT THAT ACCOMPANIES THIS DRAWING.

NOTES

DATUMS

ALL LEVELS RELATED TO PREVIOUS CONTROL.
COORDINATES RELATED TO PREVIOUS CONTROL.
DATA PRESENTED ON A LOCAL PLANE GRID.
DATUMS DETERMINED BY OTHERS.

No	INFORMATION	By	Date	Chkd

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LOCATION: LAND OFF OXFORD ROAD, BODICOTE, BANBURY

DRAWING TITLE: UTILTIY SURVEY & BOUNDARY SURVEY

SCALE: 1:500	SHEET SIZE: A1
DATE: 30.11.2017	DRAWING No: 17/065_01
DRAWN BY: FD / CHECKED BY: AH	REV

APPENDIX C
EXTRACTS FROM THE GROUND INVESTIGATION

Executive Summary and Conceptual Site Model

SITE INFORMATION AND SETTING	
Report Purpose	Phase 2 interpretative ground investigation and risk assessment.
Client	Crest Nicholson
Site Name and Location	Bodicote, Banbury, Oxfordshire.
Proposed Development	A development of 96 residential houses with associated infrastructure and gardens.
PHASE 2 – GROUND INVESTIGATION	
Hydrock Site Works	The Hydrock ground investigation comprised: • 18 trial pits to a maximum depth of 3.2m bgl; • 4 infiltration tests; • chemical testing of soils and leachates and geotechnical testing of soils;
Ground Conditions Encountered (All Data)	Marlstone Rock Formation – to >3.2 bgl , comprising brown gravelly clays with limestone beds. Dryham Formation – >3.2m bgl , blue grey silty clays.
Groundwater Encountered (All Data)	Groundwater was encountered at between 1.6m bgl and 3.0m bgl during the investigation.
GEO-ENVIRONMENTAL ASSESSMENT AND CONCLUSIONS	
Conclusions of Contamination Generic Risk Assessment	**Human health:** Pervasive arsenic. **Plant growth:** There are no chemicals of potential concern to plant life. **Ground gases or vapours:** Negligible risk from ground gases **Radon:** The site is in a Radon Affected Area (>10% of existing homes affected). **Water supply pipes:** Greenfield site with no significant contaminants of concern and standard pipework is envisaged. However, confirmation should be sought from the water supply company at the earliest opportunity.
Proposed Mitigation Measures	Full radon protective measures are necessary according to current guidance.

GEOTECHNICAL CONCLUSIONS	
Obstructions	Limestone beds are present within the ground at varying depths.
Groundworks and Earthworks	Excavation to proposed founding depth generally should be readily achievable with standard excavation plant. Heavy duty excavation plant/breaking equipment may be required to excavate the Limestone beds. Water seepages into excavations are likely to be adequately controlled by sump pumping.
Foundations	Strip/trench fill foundations from 0.90 m bgl, subject to the presence of existing trees within medium volume change potential soils. Piled foundations may be required where tree influence makes foundation depths greater than 2.50m. Allowable net bearing pressure of 100 kN/m^2 should be available, keeping total and differential settlement within acceptable limits. Deepening of foundations/heave protection is likely to be required to allow for the effects of trees.
Ground Floor Slabs	Suspended because of depth of presence of medium shrinkage potential clay soils. Suspended over a void where within the influencing distance of trees.
Road Pavement Design (CBR)	it is considered likely an equilibrium CBR of over 2.5% will be achievable over most of the site which can be used for preliminary design purposes, subject to in situ testing during construction.
Soakaways	Soakaway drainage is considered unsuitable for this site.
Buried Concrete	Design Sulfate Class - DS-1 and ACEC Class AC-1. Equivalent to Design Chemical Class DC-1 for a 50 year design life.
FUTURE CONSIDERATIONS	
Uncertainties and Limitations	There is insufficient gas monitoring to fully characterise the site in accordance with CIRIA Report665.
Further Work	The following further works will be required: • further investigation with boreholes and trial pits, together with further laboratory testing and monitoring to provide further information on the issues outlined in this report, particularly the extend and depth of the Head Deposits in the base and sides of the on-site valley feature; • discussions with piling contractors regarding their method for designing and emplacing piles; • discussions with service providers regarding the materials suitable for pipework etc.; • discussions with regulatory bodies regarding the conclusions of this report; • foundation depth in relation to trees assessment, following a tree survey to BS 5837:2012; and • detailed design of foundations.

This Executive Summary forms part of Hydrock Consultants Limited report number R/05995/001 (Issue 1) and should not be used as a separate document.

4.0 GROUND INVESTIGATION RECORDS AND DATA

4.1 Physical Ground Conditions

4.1.1 Summary of Strata Encountered

The following sections present a summary of the ground and groundwater conditions encountered and their properties, based on field observations, interpretation of the field data and laboratory test results, taking into account, excavation and sampling methods, transport, handling and specimen preparation.

All relevant data from the Hydrock investigation detailed in Section 3.0 as well as any suitable previous investigations mentioned in Section 1.4 are used from this point forward.

For the purposes of property designation, soils are divided into fine soils (clays and silts) and coarse soils (sands, gravels, cobbles and boulders) in accordance with BS 5930:2015.

Soil plasticity class for fine soils is based on the classification system of BS 5930:2015, adopting modified plasticity index values (based on percentage passing 425 µm sieve). Volume change potential of fine soils on change of moisture content has been assessed using guidance provided in NHBC Standards/BRE Digest 240 - Part 1.

The ground conditions proven during the current investigation are in general accordance with the published geological literature and expectations from the desk study and previous investigation works. However, a stratum derived from Head or solifluction deposits (flow of soil down a slope) was identified and is identified on the exploratory hole logs in Appendix C.

Details of the strata are described in the logs in Appendix C; a summary is presented in Table 4.1 and the individual strata are described in the sections below. Relevant geological cross sections are presented in Appendix A.

Table 4.1: Strata Encountered

Stratum	Summary Description	Depth to Top (m bgl)	Depth to Base (m bgl)	Thickness (m)
Topsoil	Soft dark brown sandy gravelly clay and clayey gravelly sand with rootlets.	0	0.20 - 0.35	0.20 – 0.35
Head Deposits (southwest area of site on lower slopes)	Stiff greenish grey mottled orange silty sandy gravelly clay	0.30	>1.80 - >2.70	>1.50 - >2.40
	Orange brown clayey gravelly sand			
	Soft blue grey / purple gravelly clay / silt			
Marlstone Rock Formation	Firm to stiff orange brown to greenish grey silty sandy gravelly CLAY, with fine to coarse angular to rounded gravel of limestone and ironstone.	0.20 - 0.30	0.70 - >3.10	0.50 - >2.80
	Orange brown clayey silty gravelly sand with limestone and ironstone gravel.			
	Moderately strong fractured grey brown limestone			
Dyrham Formation	Stiff blue grey silty CLAY, weathered to firm orange brown clay near the upper surface.	0.60 – 2.60	>2.00 > 3.20	>0.20 - >1.60

Head Deposits, derived from solifluction deposits, were identified in exploratory holes SA104, TP201 and TP202. It is likely that they are present along the lower parts of the slope and the base of the valley feature. Where Head Deposits were encountered, their thickness was not fully proven but as they are generally in the lower parts of the site they are likely to be mostly underlain by the Dyrham Formation.

The level of the boundary between the Marlstone Rock and the underlying Dyrham Formation away from the area potentially affected by cambering and solifluction is between 105.4mOD and 107.2mOD, with an average of approximately 106mOD. Possible cambering in the lower parts of the site may result in the boundary occurring at a slightly lower level.

4.1.2 Topsoil

For the purposes of this report, topsoil is defined in accordance with BS5930: 2015 as the upper layer of an *in situ* soil profile, usually darker in colour and more fertile than the subsoil layer below and which is a product of natural chemical, physical, biological and environmental processes. The topsoil identified in the logs does not imply compliance with BS 3882:2015. Subsoil has not been identified as a separate layer.

4.1.3 Possible Made Ground

Based on local anecdotal information, Made Ground may be present across the eastern corner of the site, although it was not identified in any of the exploratory holes.

4.1.4 Head Deposits

Head Deposits were identified in TP 201, TP202 and SA104. They were encountered in the lower parts of the valley feature in the southwestern part of the site.

The Head Deposits are formed by the down-slope migration of soils from higher up the slope and hence they are of variable composition and formed of disturbed mixtures of the cohesive and granular source materials. Their classification properties are considered to be similar to those described in the following sections, but in TP201 a layer of soft clay was noted between 1.50m and 1.60m depth, resulting from softening caused by water in the sand materials above and below the clay.

In SA104 a single hand shear vane reading of 75kPa was obtained indicating medium strength.

One plasticity index test on Head Deposits showed a plastic limit of 20%, liquid limit 33%, 93% passing the 425um sieve and a modified plasticity of 12% with a natural moisture content of 26%, showing it to be of medium plasticity and of low volume change potential.

However, the materials are inherently variable and its geotechnical properties are likely to vary.

4.1.5 Marlstone Rock Formation

'Marlstone Rock Formation' was encountered underlying the topsoil in the topographically higher parts of the site. This generally consisted of brown sandy gravelly clays with limestone and ironstone gravel and beds of ferruginous limestone.

Natural moisture contents in the fine units of these materials range from 20% to 41%, and modified plasticity indices range from 12% to 29%. On this basis, these soils are classified as of low to high plasticity (CL-CH soils) and of low to medium volume change potential.

Undrained shear strength parameters of the cohesive units of the Marlstone Rock Formation materials based on seven *in situ* hand vane tests undertaken on samples recovered from trial pits recorded values between 76kPa and 103kPa indicating high strength.

4.1.6 'Dyrham Formation'

'Dyrham Formation' strata were encountered underlying the Marlstone Rock Formation. This generally consisted of stiff blue grey silty clay.

Natural moisture contents in the fine units of these materials range from 21% to 29%, and the plasticity index in one sample was 22%. On this basis, these soils are classified as of intermediate plasticity (CI) and of medium volume change potential.

Based on comparison of the plasticity indices with the moisture content, the clays in the Dyrham Formation are stiff to very stiff and a characteristic value of its shear strength is considered to be 75kPa.

4.2 Obstructions

Four of the trial pits encountered obstructions during excavation in the Marlstone Rock Formation as summarised in Table 4.2.

Table 4.2: Obstructions Encountered During Hydrock Investigations

Exploratory Hole	Depth (m)	Description	Stratum
SA101	2.00	Limestone bed.	Marlstone Rock Formation
TP203	1.80	Limestone bed.	Marlstone Rock Formation
TP204	1.00	Limestone bed.	Marlstone Rock Formation
TP205	2.60	Limestone bed.	Marlstone Rock Formation

4.2.1 Sulfate Content

In accordance with BRE (Special Digest 1), the Design Sulfate (DS) classification and the Aggressive Chemical Environment for Concrete (ACEC) classification derived from laboratory tests undertaken are presented in Table 4.3. The assessment summary sheet is presented in Appendix D.

Table 4.3: Aggressive Chemical Environment Concrete Classification

Stratum	No. Tests	DS	ACEC
Marlstone Rock Formation	6	DS-1	AC-1

4.3 Groundwater

4.3.1 Groundwater Levels

Groundwater strikes encountered during the investigation are summarised in Table 4.5.

Table 4.2: Groundwater Data

Stratum	Exploratory Hole	Fieldwork
		Depth Groundwater Encountered (m bgl)
Marlstone rock	TP206	1.60
	TP212	3.00
	SA103	2.00

Where groundwater was not encountered, the groundwater level can be assumed to be deeper than the base of the trial pits. On this basis, the depth to groundwater where not encountered in the trial pits varies between >0.70m and >3.20m below existing ground level.

4.3.2 Infiltration Tests

The results of the infiltration testing undertaken are summarised in Table 4.5. The results sheets are presented in Appendix D. All testing was carried out in accordance with Hydrock's 1-day assessment methodology. This is in general accordance with BRE Digest 365 (BRE 2007) where infiltration rates allow three test runs during a working day (or where there is no infiltration), but where low infiltration rates were encountered the available time may not have been sufficient to fully comply with the BRE test method.

Where less than three tests were possible in a particular location the results provided should be considered indicative only and should not be used for design purposes. Further discussion concerning the suitability of infiltration testing at the site is provided in Section 7.7.

Table 4.5: Infiltration Test Results – Marlstone Rock Formation

Stratum	Trial Pit no.	Depth	Infiltration Rate (m/s)		
			Test 1	Test 2	Test 3
Limestone	SA101	2.0	Drainage too fast to measure	Drainage too fast to measure	Drainage too fast to measure
Clay	SA102	2.4	Too slow to measure	-	-
Clay	SA103	2.0	Too slow to measure	-	-
Clay	SA104	2.1	Too slow to measure	-	-

These results indicate fast infiltration into the limestone beds where these occur as the outflow from the pit was greater than the inflow that could be gained from a water bowser. The clay horizons in the Marlstone Rock Formation are effectively impermeable for soakaway purposes.

4.4 Geo-Environmental Results

The chemical test results for soil, leachate and groundwater are given in Appendix F, which also includes summary tables of the data.

Concentrations of the following determinands in soils were reported as below the laboratory limits of detection:

- Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene, Benzo(ghi)perylene, Cadmium (aqua regia extractable), Chromium (hexavalent); and Selenium (aqua regia extractable).

4.5 Updated Ground Model

The preliminary conceptual site model initially developed from the desk study and walk-over survey (Section 2.0) has been confirmed using the findings of the ground investigation.

APPENDIX D
HYDROCK CONSULTING GEOTECHNICAL STATEMENT

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By email only to marcus.thompson@crestnicholson.com

6 September 2018

Land adjacent to Oxford Road, Bodicote - Proposed Residential Development

Dear Marcus,

Following on from our telephone discussion of 23rd August 2018, Hydrock has prepared the following letter to discuss potential geotechnical issues arising from the use of infiltration style SuDs drainage on the site that have been raised by MJA Consulting in the Flood Risk Assessment & Drainage Addendum Report for the site. Hydrock has previously undertaken ground investigation works on the site (Desk Study Review and Ground Investigation Report referenced BDC-HYD-XX-GI-RP-GE-0001 and dated April 2017) to which MJA refer in their FRA.

The 4.5 ha site is located is located off the A4260 Oxford Road, Bodicote, approximately 3km south of Banbury, Oxfordshire. The nearest postcode is OX15 4AQ. The National Grid Reference of the approximate centre of the site is 446715E, 237293N. A site location plan is presented in Hydrock's Ground Investigation Report.

The topography of the site is dominated by a shallow valley feature sloping down from the northeast to the southwest, with slopes orientated towards the valley. Site elevations vary from approximately 110mOD in the northeast to 102mOD in the southwest, over a distance of approximately 225m.

The steepest gradients are in the southwestern part of the site, either side of the valley feature, up to approximately 1(v):10(h).

The ground investigation works have broadly confirmed the British Geological Survey mapping (Sheet 218 - Chipping Norton) with Marlstone Rock Formation comprising ferruginous limestones and sandstones overlying the Dryham Formation: clays with limestone and mudstone beds. Marlstone Rock Formation was encountered underlying the topsoil in the topographically higher parts of the site and generally consisted of brown sandy gravelly clays where weathered, with limestone and ironstone gravel and beds of ferruginous limestone present where less weathering had occurred. Dyrham Formation strata were encountered underlying the Marlstone Rock Formation and generally consisted of stiff blue grey silty clay.

The upper boundary of the Dyrham Formation is shown to outcrop part way down the slope, with the higher parts of the site being underlain by Marlstone Rock and the lower parts by Dyrham Formation. Head Deposits: solifluction deposits, were identified along the lower parts of the slope and the base of the valley feature.

The level of the boundary between the Marlstone Rock and the underlying Dyrham Formation away from the area potentially affected by solifluction, is between 105.4mOD and 107.2mOD, with an average of approximately 106mOD. Possible cambering in the lower parts of the slope may result in the boundary occurring at a slightly lower level. The boundary between the formations is anticipated to be approximately horizontal based upon BGS mapping. Conjectured cross-sections through the site are shown on the enclosed drawing BDC-HYD-XX-XX-DR-GE-0003.

Discussion

The ground model indicates that permeable stratum (limestone bands within the Marlstone Rock Formation), overlie impermeable stratum (clays of the Dyrham Formation). See enclosed cross section through the site.

The Hydrock investigation has shown that the Marlstone Rock Formation has become weathered near surface and has largely deteriorated to a clay (sometimes recorded as sand) overlying intact limestone although the limestone where encountered, increasingly weathers to clay down the slope. Infiltration testing by Hydrock has shown that the weathered clays of the Marlstone Rock Formation and the underlying Dyrham Formation, are effectively impermeable, with infiltration rates too slow to measure (i.e. no significant drop in water level was measured over a six hour time period during an infiltration test).

It is anticipated that infiltration may be possible into the limestone bands. However, Hydrock have previously stated in the ground investigation report that these bands are of limited thickness and therefore only have limited potential to store water. On this basis, there is likely to be excess water pressure within the limestone bands. The effectively impermeable Dyrham Formation beneath the limestone will curtail the vertical infiltration of groundwater and so it is possible that spring-lines will form, at the interface between the Marlstone Rock Formation and the Dyrham Formation. This could therefore result in water flowing out of the slope and potentially flooding parts of the development.

Where the interface between the Marlstone Rock Formation and the underlying Dyrham Formation strata is covered by the Head Deposits there is increased potential for the build-up of excess pore water pressures in the slope that could result in slope failure.

However, these situations are considered to only be plausible risks if infiltration drainage is constructed near the crest of the eastern slope. Under the current natural conditions on the site these situations are unlikely to occur as the weathered clays at the surface limit vertical infiltration into the underlying limestone beds. As such, it is considered that the risk of flooding or slope instability with the site in its current, natural, condition or developed adopting the drainage strategy proposed by MJA, are minimal.

Hydrock therefore consider that the drainage strategy proposed by MJA has fully considered the issues raised by Hydrock in its Ground Investigation Report and is a geotechnically suitable solution for the site.

Yours sincerely

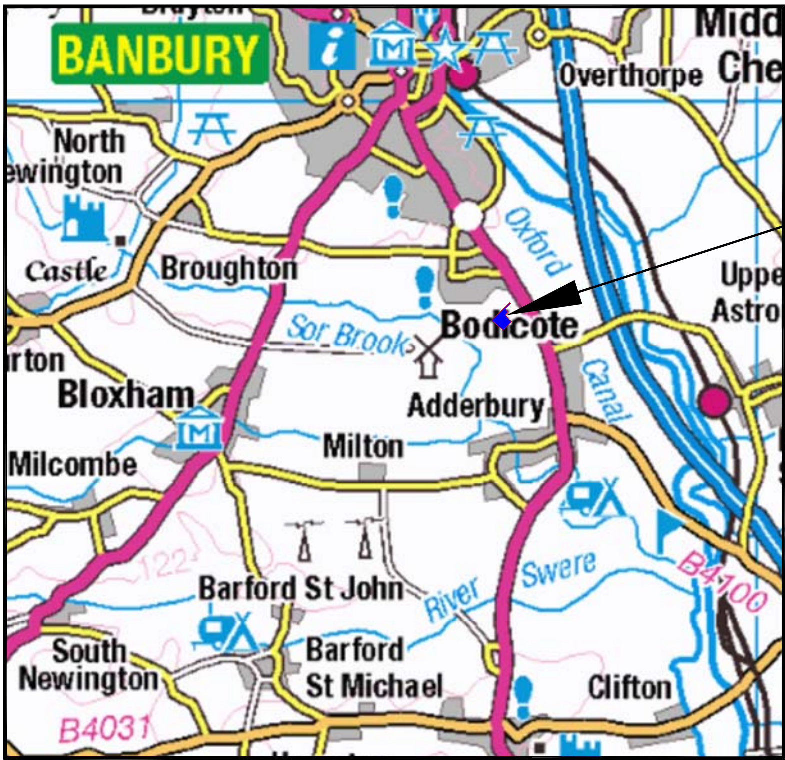
Julian Charlesworth
Principal Geo-environmental Consultant

E: juliancharlesworth@hydrock.com

Encl. Hydrock Drawing BDC-HYD-XX-ZZ-DR-GE-0003-P1.1-S0 - Conjectured Geological Cross Sections

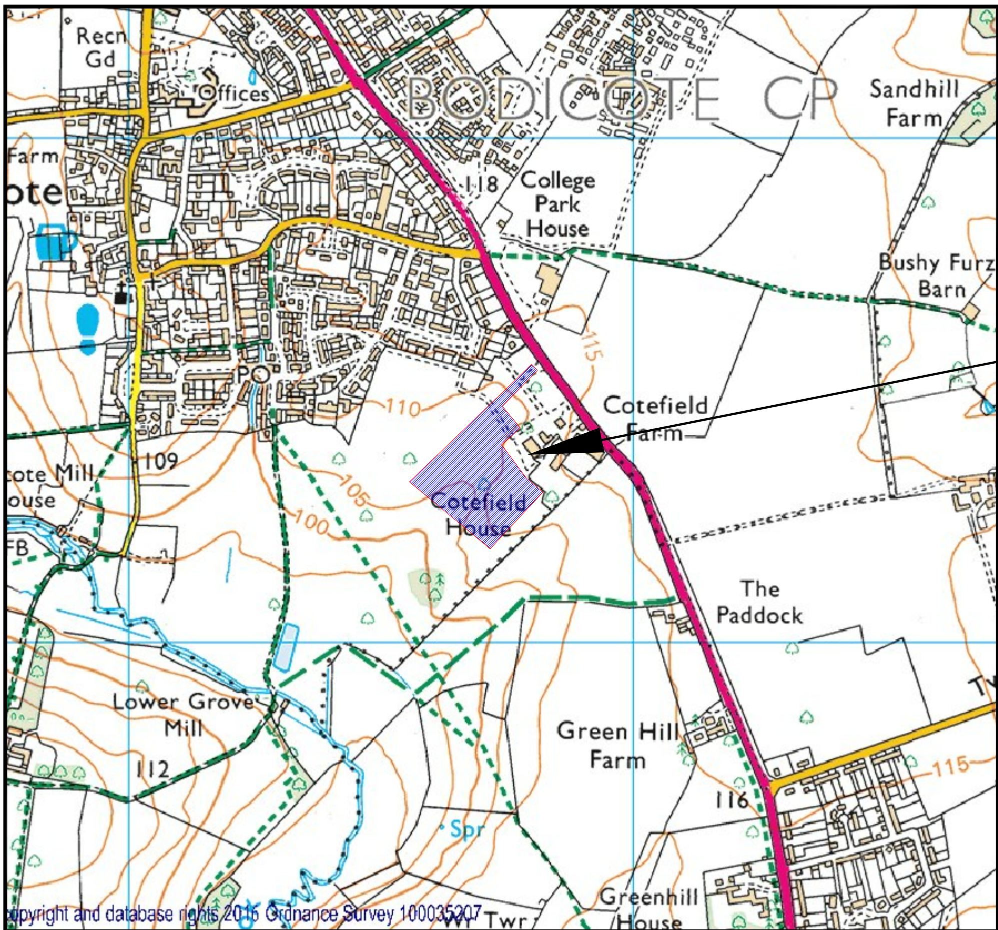
Notes:

1. Contains Ordnance Survey data © Crown copyright and database right 2015



THE SITE

0m 1000m 2000m 3000m 4000m 5000m Scale = 1:100,000



THE SITE

0m 200m 400m 600m 800m 1000m Scale = 1:15,000

Rev	Date	Description	By	Ckd

Architect :

Hydrock

Client :

Crest Nicholson

Project Title:

BODICOTE, OXFORDSHIRE

Drawing Title:

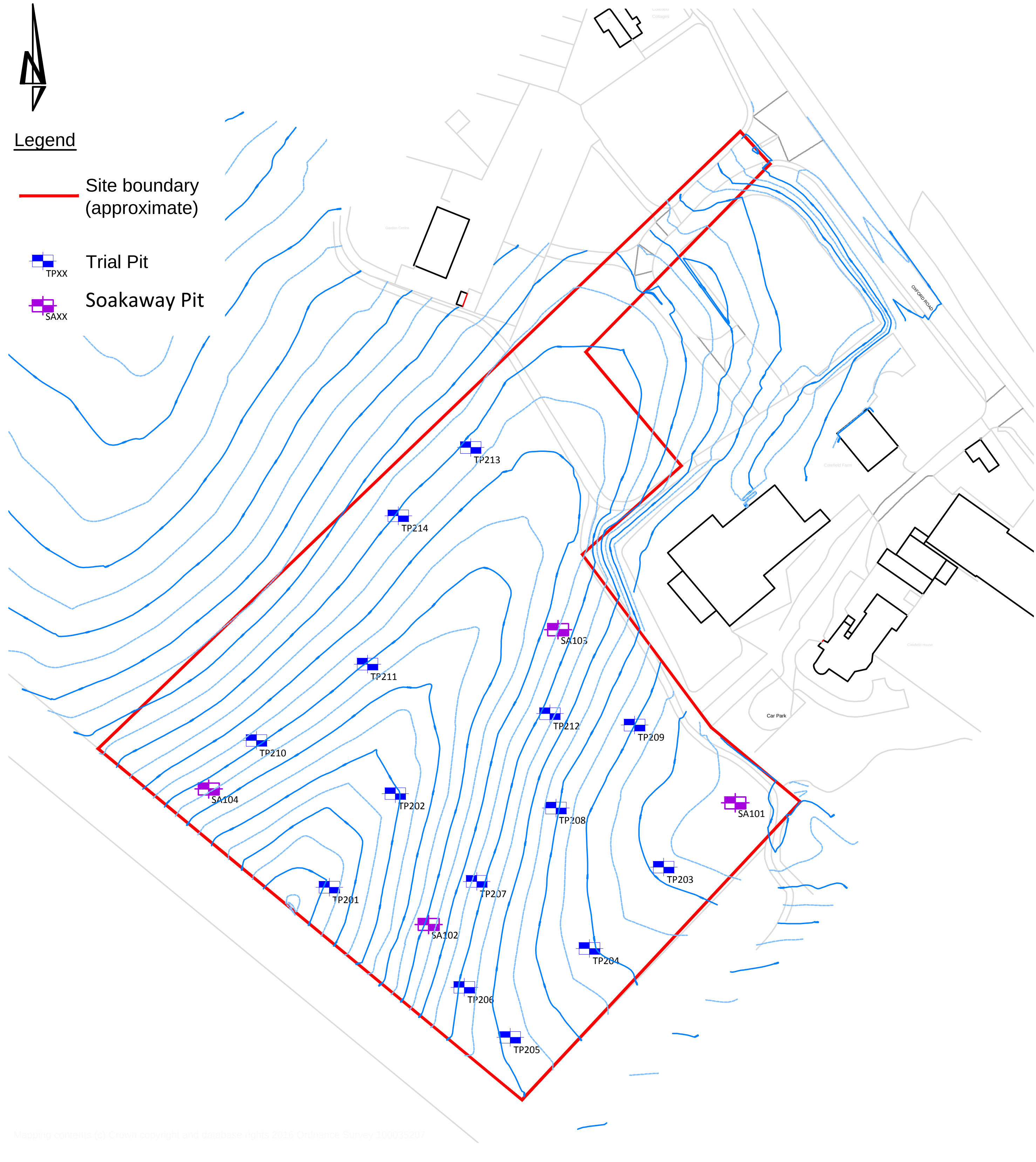
Site Location Plan

Reference: BDC-HYD-XX-ZZ-DR-GE-0001

Hydrock Job No: C-05955-C

Drawn	Checked	Scale @ A4	Date	Issue Date
SD	SC	See Drawing	21/03/17	21/03/17

Revision: P1.1 Status: S0



Rev	Date	Description	By	Ckd

Reference: BDC-HYD-XX-ZZ-DR-GE-0002

Client : Crest Nicholson

Project Title:

BODICOTE, OXFORDSHIRE

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Notes:

1. All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.
2. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications.
3. Topographical survey drawing number: UAG3091_A_2D by RPS, dated: April 2014.

Drawing Title:

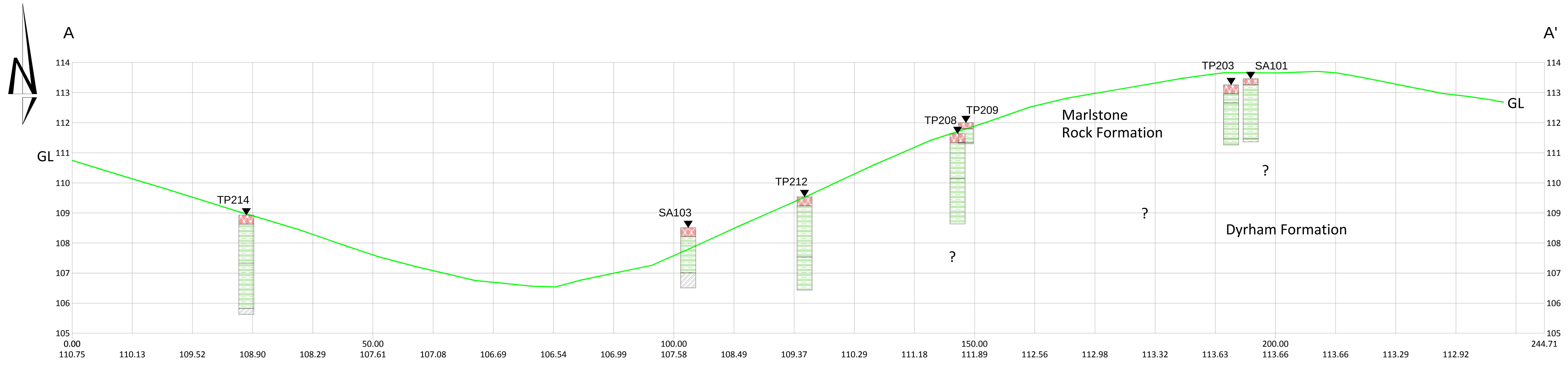
Exploratory Hole Location Plan

Hydrock Job No: C-05955-C

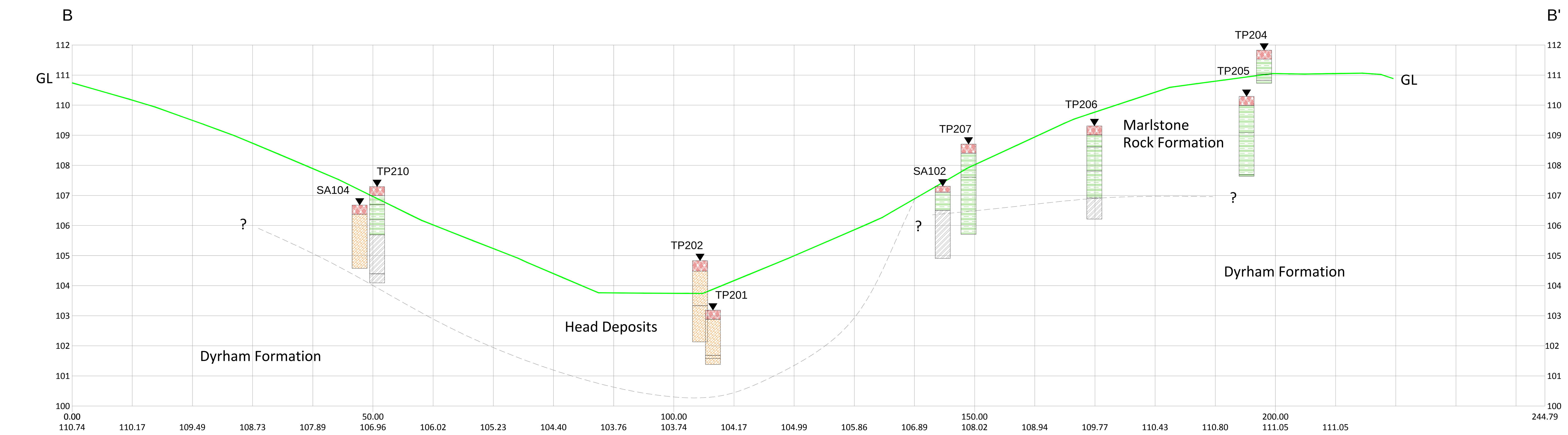
Drawn	Checked	Scale @ A4	Date	Issue Date
SD	JC	1:2000	20/03/17	20/03/17

Revision: P1.1

Status: S0



Scale Horiz 1:500 Vert 1:100



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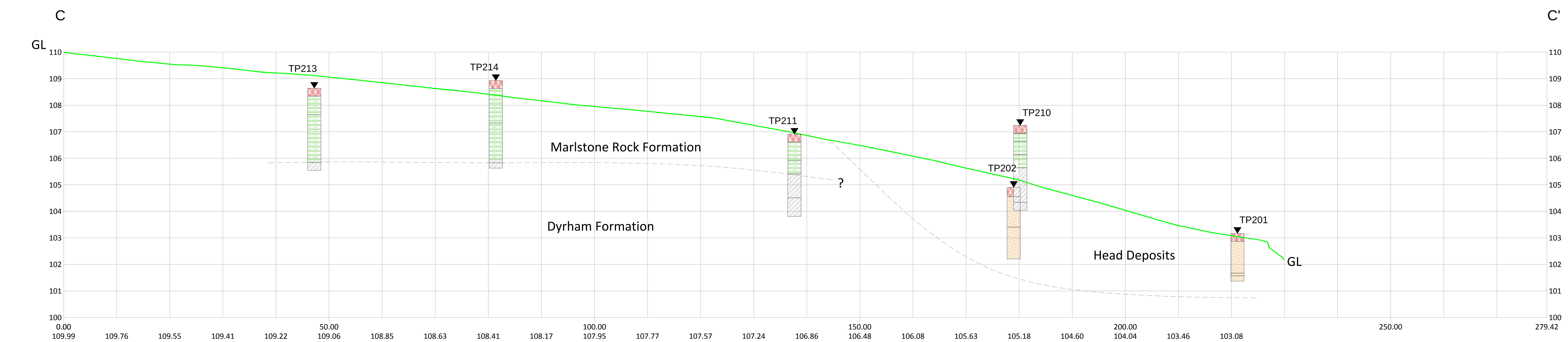

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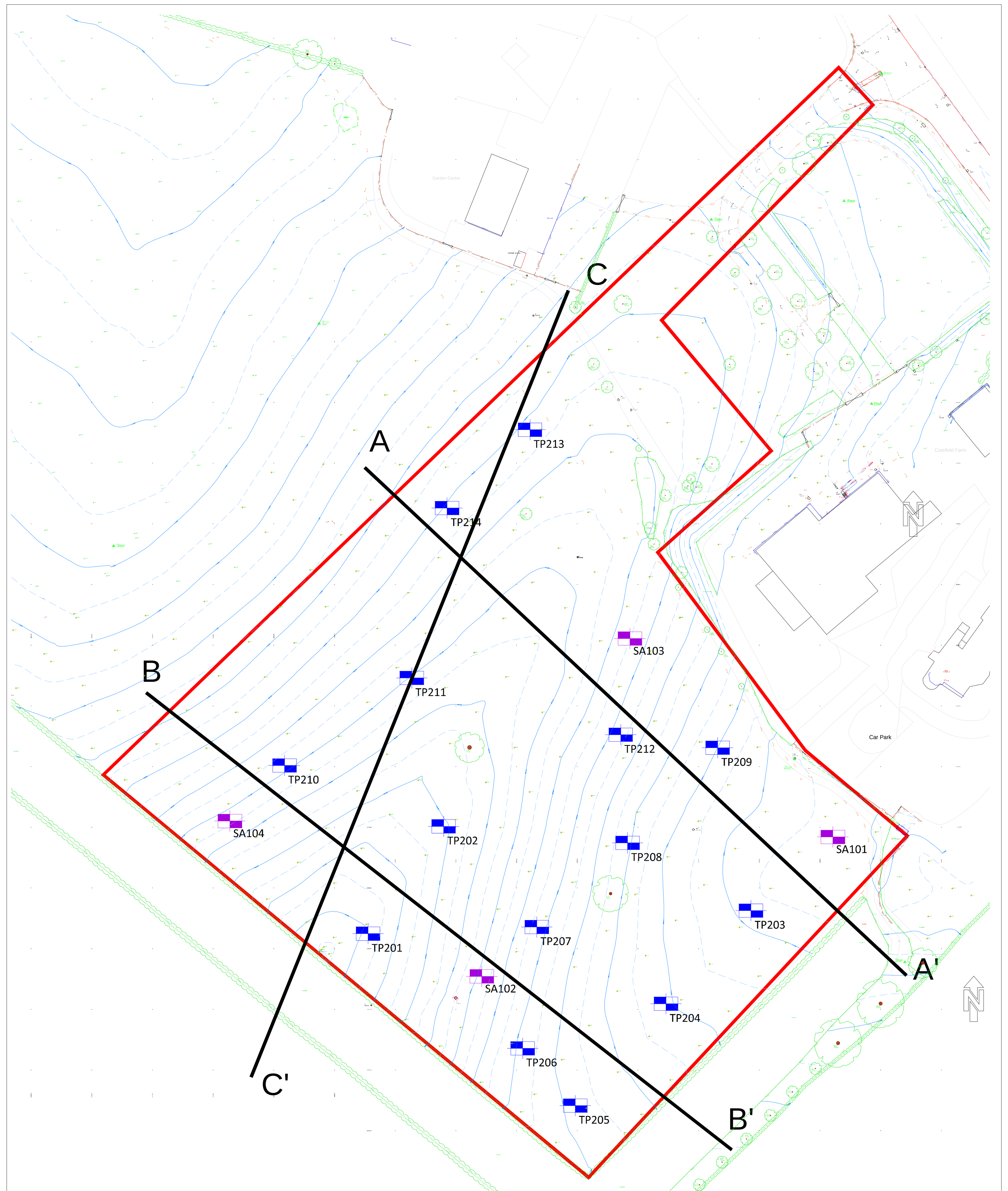

Scale 1:1250

Notes:

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3. Topographical survey drawing number: UAG3091_A_2D by RPS, dated: April 2014.

Legend

- Site boundary (approximate)
- Trial Pit (TPXX)
- Soakaway Pit (SAXX)
- Topsoil
- Marlstone Rock Formation
- Dyrham Formation
- Head Deposits

Rev	Date	Description	By	Ckd

Client : Crest Nicholson

Architect :

Project Title: BODICOTE, OXFORDSHIRE

Drawing Title: Conjectured Geological Cross Sections

Reference: BDC-HYD-XX-ZZ-DR-GE-0003

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Hydrock Job No: C-05955-C

Drawn	Checked	Scale @ A1	Date	Issue Date
SD	CV	As shown	04/04/17	04/04/17

Revision: P1.1

Status: S0