



Drainage Strategy Report

Southbourne Gardens, Ruislip

Landmark Builders Ltd

QUALITY MANAGEMENT

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REVISION SCHEDULE

Drainage Strategy Report Southbourne Gardens, Ruislip

Rev	Date	Details	Prepared By	Approved By
A	24.03.2020	First Issue	S. Griffiths	S. Griffiths

CONTRACT

The report describes work commissioned by Landmark Builders Ltd as outlined within fee proposal dated 22nd January 2020.

PURPOSE

This document has been prepared as a Drainage Strategy Report for Landmark Builders Ltd. G30 Consulting Ltd accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

G30 Consulting Ltd has no liability regarding the use of this report except to Landmark Builders Ltd.

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1. EXECUTIVE SUMMARY

Site Name	Southbourne Gardens, Ruislip
Location	Southbourne Gardens, Ruislip
Client	Landmark Builders Ltd
Grid Reference	511103, 187366
Area (ha)	0.090 ha
Discharge Rate (l/s)	5.0 l/s for 1 in 100 year + 40% CC storm events
Recommended SuDS	Rainwater harvesting Proprietary treatment systems Trees / vegetation Pervious pavements

2. INTRODUCTION

2.1 General

G30 Consulting Ltd have been commissioned by Landmark Builders Ltd to prepare a Drainage Strategy Report in relation to the proposed residential development at a former garage site off Southbourne Gardens.

2.2 Description of the Site

The site is located off Southbourne Gardens and is centred about Ordnance Survey Grid reference 511103, 187366. The site occupies an area of approximately 0.090ha.



Figure 1 - Site Location

The site is currently used for private garages which are orientated in a North South direction. The garages are accessed via a private access off Southbourne Gardens with a shared parking / turning facility running parallel to the garages. The access way is hard surfaced and positively drain.

2.3 Topography

A topographical survey of the site and the immediate surrounding area has been undertaken to confirm existing ground levels and physical features was undertaken by Bury Associates Ltd in December 2016. The topographical survey confirmed levels on site range from 46.670m located to the South of the site to 47.610m located in the North East corner of the site.

A copy of the topographical survey, drawing BA22961216_01 – Topographical Survey by Bury Associates Ltd can be found in Appendix A.

2.4 Geology and Groundwater

An intrusive ground investigation report has been undertaken by Ground and Water Limited in March 2020. The report confirmed that beneath the layer of made ground / concrete hard standing lies a layer of cohesive soils comprising an orange brown and grey / red mottled silty clay / dark grey silty clay with pockets of dark olive green silt. The cohesive layer had a depth of approximately 5.45m to 7.00m below existing ground levels.

Infiltration testing was beyond the scope of the investigation works undertaken as part of the report, however the report states that soakaways constructed within the cohesive material are unlikely to perform to a satisfactory standard.

A copy of the ground investigation report by Ground and Water Limited can be found in Appendix B.

2.5 Hydraulic Features

The nearest watercourse to the site is the River Colne which is located approximately 6.00km West of the site. Figure 2, below, shows the location of the River Colne relative to the site.

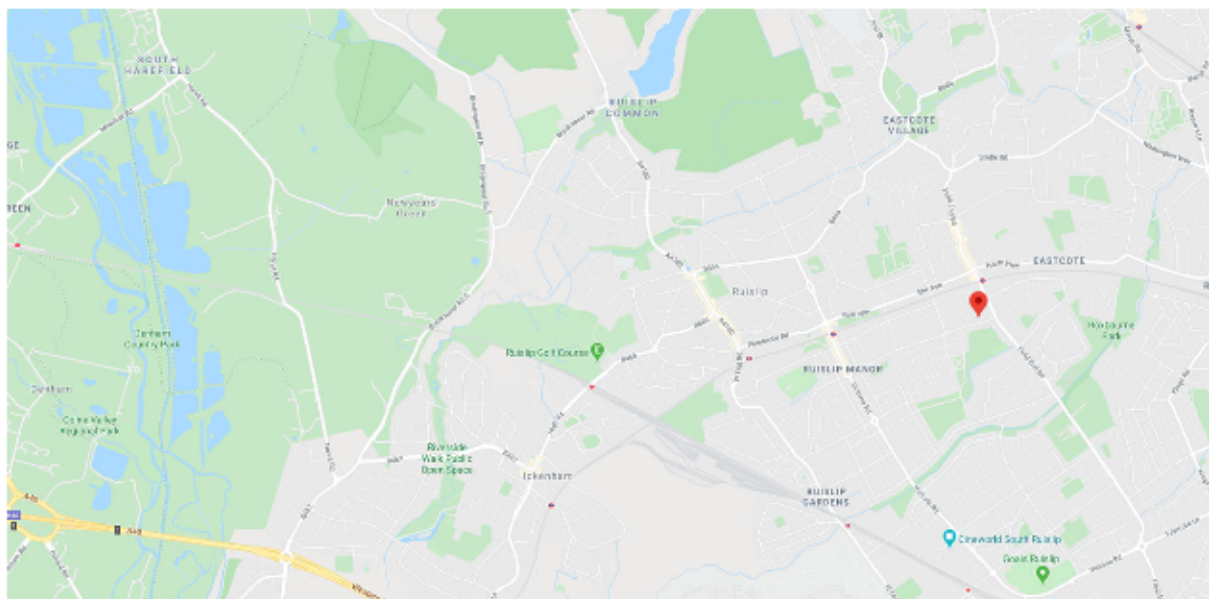


Figure 2 – River Colne located to the West of the site.

There are a number of minor watercourses in close proximity to the site the nearest being the Yeading Brook which is located approximately 0.80km South of the site. The Yeading Brook flows in a Southernly direction ultimately outfalling to the River Colne approximately 8.50km South of the site.

2.6 Current Site Drainage

Thames Water are responsible for adopted drainage in Ruislip. Thames Water sewer asset record plans have been obtained for the site and the surrounding roads to confirm what adopted assets are in close proximity to the site.

The sewer asset record plans show there is a combined water and surface water sewer within the extents of the site.

The surface water sewer is 150mm diameter which accepts surface water runoff from the rear of the properties 30 – 60 Southbourne Gardens. The sewer turns through 90 degrees at manhole 1308 which is located on site before heading to Southbourne Gardens.

A combined water manhole 1301 is located on site which runs along the Western elevation of property 58 – 60 Southbourne Gardens that ultimately discharges to the 225mm diameter combined water Southbourne Gardens.

A copy of Thames Water sewer asset record plans can be found in Appendix C.

At this time a CCTV drainage survey has not been undertaken of the existing drainage system on site, however manholes, gullies and rainwater downpipes were noted during the topographical survey which are assumed to discharge to the Thames Water surface water sewer.

A CCTV drainage survey is required to confirm existing outfalls from the development.

3. PROPOSED DEVELOPMENT

The proposed development requires the demolition of the existing garages and the hard-surfaced access way. In place of the garages a single building comprising 6 self-contained flats is to be constructed. As part of the development a new site access road and parking court are to be constructed to serve the properties.

Soft landscaping areas shall be incorporated around the private access road / parking spaces and to the rear / side of the new building.

A copy of the drawing 1547.A1.PL02 – Proposed Site Plan by m. j. d. architecture showing the proposed site arrangement can be found Appendix D.

4. SURFACE WATER DRAINAGE PROPOSAL

4.1 Requirements and Regulations

The means of draining surface water generated by a site is required to mirror the behaviour of the existing site run-off, so far as is practicable, to offset the off-site flood risk that might otherwise be created, or to bypass it entirely.

The following documents have been referred to as part of the development of the drainage strategy to ensure current standards and industry best practice are adhered to:

- Buildings Regulations Part H - Drainage and Waste Disposal
- Sewers for Adoption 6th Ed. - A Design and Construction Guide for Developers- March 2006
- Sewers for Adoption 7th Ed. - A Design and Construction Guide for Developers- August 2012
- CIRIA Report 753 - The SuDS Manual 2015
- BRE Digest 365 - Soakaway Design

In accordance with Building Regulations Part H- Drainage and Waste Disposal, surface water runoff generated by a site should look to discharge to one of the following listed in order of priority:

- An adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,
- A watercourse; or where that is not reasonably practicable,
- A surface water sewer; or where that is not reasonably practicable,
- A combined water sewer.

4.2 Surface Water Drainage Strategy

In accordance with the surface water hierarchy outlined in Building Regulations Part H, surface water runoff should look to discharge to soakaways or some other adequate infiltration system. At the time of producing this report on site infiltration testing in accordance with BRE 365 had not been undertaken to confirm percolation rates.

The use of infiltration drainage techniques was discussed with in the intrusive ground investigation report prepared by Ground and Water Limited which stated soakaways constructed within the cohesive material are unlikely to perform to a satisfactory standard.

was encountered which continued till the boreholes were abandoned.

Due to the cohesive nature of clay it is unlikely infiltration drainage techniques would be suitable within the development and as such has been discounted as the primary method of surface water disposal from the site.

The nearest watercourse to the site is River Colne which is located approximately 6.00 km West of the site. To discharge surface water runoff to the watercourse it would be necessary to cross Third Party land, as such a discharge to the watercourse is not considered feasible.

The sewer asset record plans show there is a combined water and surface water sewer within the extents of the site.

The surface water sewer is 150mm diameter which accepts surface water runoff from the rear of the properties 30 – 60 Southbourne Gardens. The sewer turns through 90 degrees at manhole 1308 which is located on site before heading to Southbourne Gardens.

A new surface water drainage system shall be constructed on site which will convey surface water runoff from the residential properties and the new private access road / parking spaces outfalling into the Thames Water surface water sewer located on site.

Individual SuDS features for the site have been reviewed based on the site characteristics, such as the underlying soil type and geology. As well as the design considerations from the development that may limit the feasibility of certain SuDS features from being implemented. Details of the specific SuDS features selected for the site can be found in Section 4.3.

A private flow control device shall be installed to restrict surface water runoff from the site to pre development rates. Surface water discharge rates from the site shall be discussed further in Section 4.4.

Attenuation storage shall be provided in the form of cellular crates to attenuate surface water runoff for storms, up to and including 1 in 100 years plus 40% Climate Change with a 10080-minute duration. Onsite attenuation requirements shall be discussed further in Section 4.5.

Proposed foul and surface water drainage layout plan, drawing 08-0052-001 can be found in Appendix E.

4.3 Use of SuDS

To ensure the quality of runoff leaving the site is treated to a suitable level, SuDS features have been assessed for their suitability within the proposed development. In accordance with CIRIA Report C753 - The SuDS Manual 2015 features have been considered and their suitability evaluated in relation to the development. Table 1 below details all the SuDS features that have been considered for this site and providing supporting evidence to why each SuDS features type have or have not been deemed suitable.

Table 1 – SuDS Selector Table

SuDS Selector Table		
Feature	Suitable Y / N	Evidence
Rainwater Harvesting	Y	Rainwater harvesting in the form of rainwater butts could be used to provide rainwater reuse for irrigation purposes.
Green Roofs	N	Green roofs are ideally suited to flat roofs, a pitched roof has been proposed and as such is not suitable for the development.
Infiltration Systems	N	Due to the underlying ground conditions infiltration systems are not considered to be suitable.
Proprietary Treatment Systems	Y	Trapped gullies could be used at the bottom of the rainwater downpipes to assist with the removal of sediment.
Filter Strips	N	Due to the site layout filter strips are not considered to be suitable.
Filter Drains	N	Due to the site layout filter drains are not considered to be suitable.
Swales	N	Due to the land take requirements these features are not suitable with the current site layout plan.
Bioretention Systems	N	Due to the land take requirements these features are not suitable with the current site layout plan.
Trees / vegetation	Y	New planting will be incorporated into the development which will assist with the disposal of surface water runoff.
Pervious Pavements	Y	Pervious pavements with a tanked voided stone sub-base are to be utilised within the parking area. The pervious surface will offer treatment of surface water runoff from the paved areas and attenuation storage.

Attenuation Storage Tanks	N	Attenuation storage tanks could be utilised but have been rejected in favour of a tanked voided stone sub-base beneath the pervious pavement.
Detention Basins	N	Due to the land take requirements these features are not suitable with the current site layout plan.
Ponds and Wetlands	N	Due to the land take requirements these features are not suitable with the current site layout plan.

4.4 Drainage Discharge and Outfalls

In the absence of a CCTV survey but due to the presence of a drainage system on site it is assumed that the site discharges surface water runoff to the existing Thames Water surface water sewer.

A pre-development peak runoff rate for the site has been calculated using the Modified Rational Method. The following equation has been used:

$$Q = CiA$$

Where:

$C = 2.78$

$i = 50 \text{ mm/hr}$

$A = 0.072 \text{ ha}$ (predevelopment impermeable area taken from site survey)

A peak pre-development surface water runoff rate of **10.0/s** has been calculated for the site. Brownfield sites should look to reduce existing discharge rates and as such a 50% reduction is proposed to the pre development peak runoff rate.

Surface water runoff from the site is therefore proposed to discharge at a peak rate of **5.0/s** for all storm events up to and including 1 in 100 year + 40% climate change, 10080-minute (7 days) duration.

4.5 Storage

Surface water attenuation calculations using XP Solutions MicroDrainage have been undertaken for the surface water drainage system. Based on an impermeable area of 470m² from the residential properties and the private access road / spaces discharging to the combined water Thames Water sewer approximately 13.9m³ of attenuation storage is required for all storm events up to and including 1 in 100 year + 40% climate change, 10080-minute (7 days) duration.

Attenuation storage shall be provided in the form of a tanked voided stone sub-base beneath the pervious paving within the parking court. The pervious paving will offer treatment of surface water runoff from the parking court as well as attenuation storage.

Copies of XP Solutions MicroDrainage surface water pervious paving calculations can be found in Appendix F.

4.6 Ownership and Maintenance

The private surface water drainage system shall be the responsibility of Landmark Builders Ltd to maintain under a long-term maintenance contract.

The surface water discharge to the Thames Water sewer shall be approved by Thames Water under a Section 106 application.

Future maintenance schedules for all the proposed SuDS features can be found in Appendix G.

5. FOUL WATER DRAINAGE PROPOSAL

5.1 Requirements and Regulations

The following documents have been referred as part of the development of the drainage strategy for the development to ensure current standards and industry best practices are adhered to:

- Buildings Regulations Part H - Drainage and Waste Disposal
- Sewers for Adoption 6th Ed. - A Design and Construction Guide for Developers- March 2006.
- Sewers for Adoption 7th Ed. - A Design and Construction Guide for Developers- August 2012.

In accordance with Building Regulations Part H - Drainage and Waste Disposal, foul effluent generated by a site should look to discharge to one of the following listed in order of priority:

- A public sewer; or, where that is not reasonably practicable,
- A private sewer communicating with a public sewer; or where that is not reasonably practicable,
- Either a septic tank which has an appropriate form of secondary treatment or another wastewater treatment system; or where that is not reasonably practicable,
- A cesspool

5.2 Foul Water Drainage Strategy

Thames Water are responsible for adopted drainage assets in West Drayton. Thames Water sewer asset record plans confirm the presence 300mm dia. combined water sewer which runs behind the back edge of footpath within Coleridge Way in an Easterly direction.

Foul water effluent is proposed to discharge to the adopted Thames Water combined water sewer. A new foul water drainage system is to be constructed on site to convey foul water effluent from the properties to the outfall.

Foul effluent is to discharge from the site to the combined water manhole on site at an unrestricted rate.

Proposed foul and surface water drainage layout plan, drawing 08-0052-001 can be found in Appendix E.

5.3 Operations and Management

The private foul water drainage system shall be the responsibility of Landmark Builders Ltd to maintain under a long-term maintenance contract.

The foul water discharge into the Thames Water sewer shall be approved by Thames Water under a Section 106 application.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Drainage Summary – Surface Water

The disposal of surface water runoff generated by the proposed development has been assessed in accordance with the guidance outlined within Building Regulations Part H – Drainage and Waste Disposal.

Sewer asset record plans show there is a combined water and surface water sewer within the extents of the site.

The surface water sewer is 150mm diameter which accepts surface water runoff from the rear of the properties 30 – 60 Southbourne Gardens. The sewer turns through 90 degrees at manhole 1308 which is located on site before heading to Southbourne Gardens.

A new surface water drainage system shall be constructed on site which will convey surface water runoff from the residential properties and the new private access road / parking spaces outfalling into the Thames Water surface water sewer located on site.

Surface water runoff from the site is therefore proposed to discharge at a peak rate of **5.0/s** for all storm events up to and including 1 in 100 year + 40% climate change, 10080-minute (7 days) duration.

Surface water attenuation calculations using XP Solutions MicroDrainage have been undertaken for the surface water drainage system. Based on an impermeable area of 470m² from the residential properties and the private access road / spaces discharging to the combined water Thames Water sewer approximately 13.9m³ of attenuation storage is required for all storm events up to and including 1 in 100 year + 40% climate change, 10080-minute (7 days) duration.

The private surface water drainage system shall be the responsibility of Landmark Builders Ltd to maintain under a long-term maintenance contract.

The surface water discharge to the Thames Water sewer shall be approved by Thames Water under a Section 106 application.

6.2 Drainage Summary – Foul Water

The disposal of foul water effluent generated by the proposed development has been assessed in accordance with the guidance outlined within Building Regulations Part H – Drainage and Waste Disposal.

Foul water effluent is proposed to discharge to the adopted Thames Water combined water sewer. A new foul water drainage system is to be constructed on site to convey foul water effluent from the properties to the outfall.

Foul effluent is to discharge from the site to the combined water manhole on site at an unrestricted rate.

The private foul water drainage system shall be the responsibility of Landmark Builders Ltd to maintain under a long-term maintenance contract.

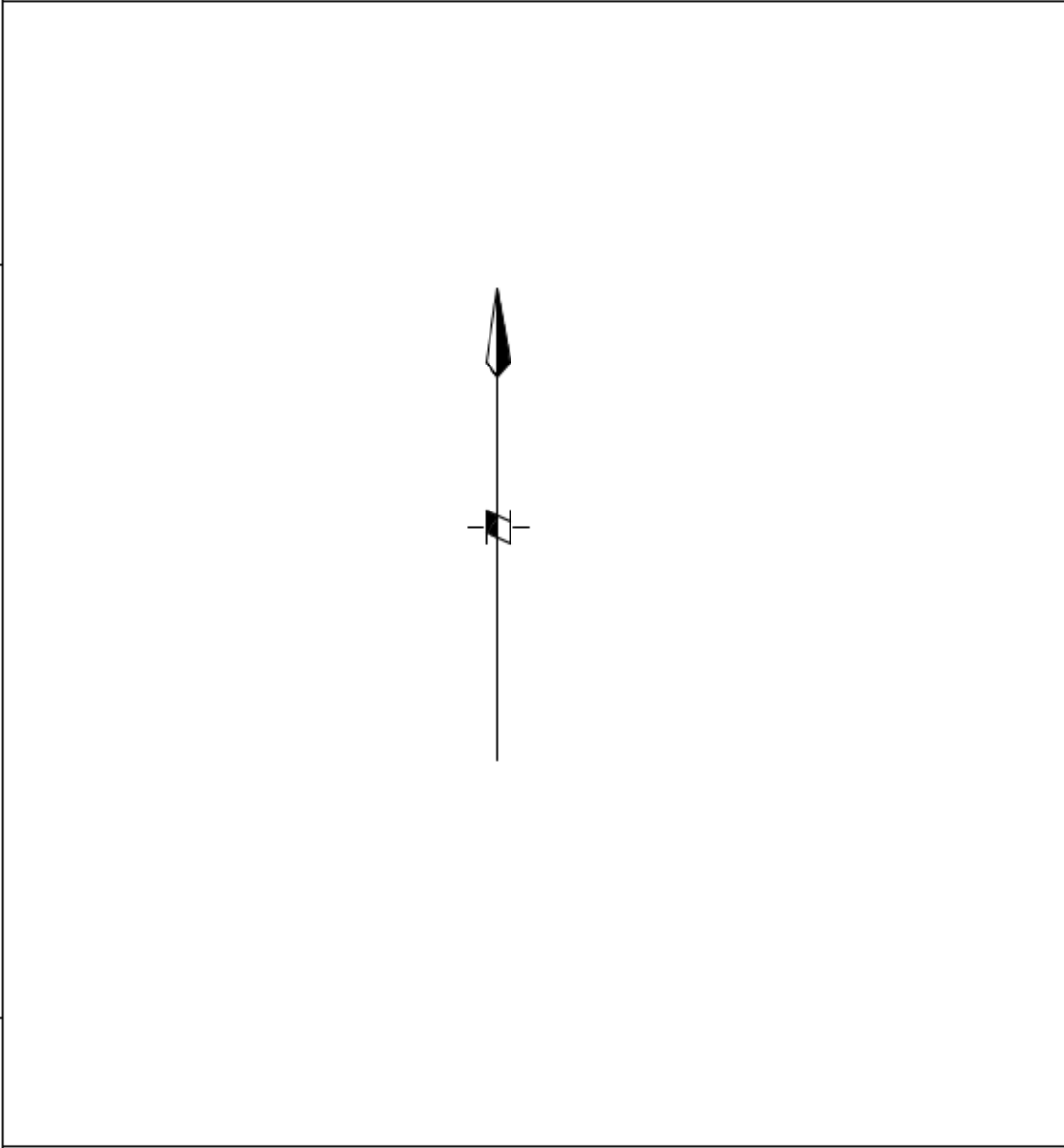
The foul water discharge into the Thames Water sewer shall be approved by Thames Water under a Section 106 application.

APPENDIX

APPENDIX A



NOTES
1. Levels : Ordnance Survey GPS Datum.
2. Grid : Ordnance Survey National Grid based on GPS Observations.
3. North Point indicative only.
4. Drainage pipe sizes are approximate as gauged from the surface.
5. Expert identification is advised for tree species.
6. Boundary detail may not represent the extent of legally conveyed ownership.
7. Survey carried out to client specification and in accordance with RICS publication: SURVEYS OF LAND, BUILDINGS & UTILITY SERVICES AT SCALES 1:500 & LARGER, 2nd EDITION.
8. Copyright of this survey, and all associated drawings and digital information, is owned by Bury Associates Limited. This information may not be sold on to a third party without prior permission of Bury Associates Limited and payment of the appropriate fee.



KEY	
INTERNAL FEATURES	
B	BEAM HEIGHT
C	CEILING HEIGHT
D	DOOR HEIGHT
P	PIPE HEIGHT
FL	FLOOR LEVEL
H	HEAD HEIGHT
S	SILL HEIGHT
SP	SPRING HEIGHT
LS	LIGHT SWITCH
ES	ELECTRICAL SOCKET
C	SLOPING CEILING (ARROW POINTS UP)
IH	IMMERSION HEATER
B	BOILER
R	RADIATOR
TS	TELEPHONE SOCKET
FA	FIRE ALARM
TVS	TV SOCKET
*	LIGHT
TOPOGRAPHICAL FEATURES	
AV	AIR VALVE
BA	BARRIER
BB	BELISHA BEACON
BH	BORE HOLE
BKW	BRICK WALL
BL	BOLLARD
BM	BENCH MARK
BS	BUS STOP
BT	BRITISH TELECOM COVER
BW	BARBED WIRE FENCE
CB	CONTROL BOX
C/B	CLOSE BOARDED FENCE
CCTV	CCTV CAMERA
CL	COVER LEVEL
C/L	CHAIN LINK FENCE
CP	CATCH PIT
CPS	CONCRETE PAVING SLABS
CTV	CABLE TELEVISION COVER
CW	CONCRETE WALL
DP	DOWN PIPE
EIC	ELECTRIC INSPECTION COVER
EP	ELECTRIC POLE
ER	EARTH ROD
FB	FLOWER BED
FH	FIRE HYDRANT
FL	FLOOR LEVEL
FP	FLAG POLE
FW	FOUL WATER
G	GULLY
GP	GATEPOST
GV	GAS VALVE
HR	HAND RAIL
HT	HEIGHT
IC	INSPECTION COVER
IL	INVERT LEVEL
IR	IRON RAILING FENCE
KO	KERB OUTLET
L/L	LARCH LAP FENCE
LP	LAMP POST
LVL	LEVEL
MH	MANHOLE COVER
MK	MARKER
MKE	ELECTRIC MARKER
MKF	FIRE HYDRANT MARKER
MKG	GAS MARKER
MKT	TELEPHONE MARKER
MKW	WATER MARKER
NB	NOTICE BOARD
NP	NAME PLATE
PB	POST BOX
PP	PETROL PUMP
PR	POST & RAIL FENCE
PT	POST
P/W	POST & WIRE FENCE
RE	RODDING EYE
RP	REFLECTOR POST
RS	ROAD SIGN
RW	RETAINING WALL
SC	STOP COCK
SIG	RAILWAY SIGNAL
SP	SIGN POST
ST	STONE WALL
SV	STOP VALVE
SW	SURFACE WATER
SY	STAY
TAC	TACTILE PAVING
TBM	TEMPORARY BENCH MARK
TCB	TELEPHONE CALL BOX
TL	TRAFFIC LIGHT
TM	TICKET MACHINE
TP	TELEPHONE POLE
TRP	TRIAL PIT
UTL	UNABLE TO LIFT
VT	VENT
WM	WATER METER
WO	WASH OUT
SS	SURVEY STATION



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CLIENT	Maddox Associates	Ralph Salmon 23 Hanover Square London W1S1JB
PROJECT	Southbourne Gardens Ruislip HA4 9SW	
DRAWING TITLE	Topographical Survey	
SCALE	1:200	SHEET SIZE A1
DRAWING NO.	BA22961216_01	DATE 07/12/16
		SURVEYOR JR
		DRAWN BY JR

APPENDIX B



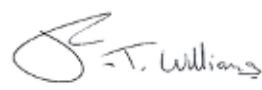
GROUND INVESTIGATION REPORT

for

THE RESIDENTIAL GARAGES OFF SOUTHBOURNE GARDENS, RUISLIP HA4 9SW

on behalf of

LANDMARK BUILDERS LIMITED

Report Reference: GWPR3537/GIR/March 2020		Status: FINAL
Issue:	Prepared By:	Verified By:
V1.01 March 2020		
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File Reference: Ground and Water/Project Files/ GWPR3537 The Residential Garages off Southbourne Gardens, Ruislip HA4 9SW		

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-

EXECUTIVE SUMMARY	
Proposed Development	At the time of reporting, March 2020, the proposed development was understood to comprise the demolition of the existing buildings and construction of a three storey block of residential flats, with ground floor private amenity areas and a communal garden.
Geology	The BGS Geological Map (Solid and Drift) for the Ruislip Manor area (North London Sheet No. 256) revealed the site was located on the bedrock deposits of the Lambeth Group. No areas of Made Ground or Worked Ground were noted in a close proximity of the site.
Hydrogeology	The site was located on a Secondary A Aquifer relating to the bedrock deposits of the Lambeth Group.
Radon	The site was not located in an area where Radon protection measures were likely to be required.
Soils Encountered	The ground conditions encountered within the trial holes was generally as anticipated from examination of the geology map. A capping of Made Ground (concrete hardstanding) (WS1 and WS3) and Topsoil (WS2) was noted from ground level overlying the soils of the Lambeth Group for the remaining depth of the trial holes.
Foundation Design	Given the depth of roots encountered in the boreholes, minimum foundation depths are likely to range between 3.30 – 4.30m bgl. This means the footings will need to be engineer designed. Given the increased costs of digging to such a depth, amount of waste produced and amount of concrete required and impracticality of forming traditional strip footings at this depth it is recommended that a piled foundation is adopted with piles taken through the Topsoil, Made Ground and into the underlying soils of the Lambeth Group. A preliminary pile design is given in section 5.3.
Infiltration Rates	Soakaways constructed within the Lambeth Group were unlikely to be successful.
Sub-Surface Concrete	According to BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' a Sulphate Design Class of DS-1 is appropriate for sub-surface concrete in contact with the soils encountered on site. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1.

The above information must be read in conjunction with the full report.

1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Landmark Builders Limited, on the 29th January 2020, to conduct a Ground Investigation on the residential garages off Southbourne Gardens, Ruislip HA4 9SW. The scope of the investigation was detailed within the Ground and Water Limited fee proposal ref.: GWQ5268, dated 22nd January 2020.

1.2 Aims of the Investigation

The aim of the investigation was understood to be to supply the client and their designers with information regarding the ground conditions underlying the site to assist them in preparing an appropriate scheme for development.

The investigation was to be undertaken to provide parameters for the design of foundations by means of in-situ and laboratory geotechnical testing undertaken on soil samples recovered from trial holes.

The techniques adopted for the investigation were chosen considering the anticipated ground conditions and development proposals on-site, and bearing in mind the nature of the site, limitations to site access and other logistical limitations.

1.3 Conditions and Limitations

This report has been prepared based on the terms, conditions and limitations outlined within Appendix A.

2.0 SITE SETTING

2.1 Site Location

The site comprised an 890m² irregular shaped plot of land, orientated in a north to south direction, located to the north of Southbourne Gardens, to the west of Green Lawns. The site was located in Eastcote, Ruislip Manor, greater north-west London.

The approximate O.S. National Grid reference for the site is TQ 11111 87365. A site location plan is given within Figure 1. A plan showing the site development area is given within Figure 2.

2.2 Site Description

At the time of the investigation in January 2020, the site comprised two blocks of residential garages with concrete hardstanding and trees on the north, south-west and south-east boundaries.

An aerial view of the site showing an approximate site boundary is given within Figure 3.

2.3 Proposed Development

At the time of reporting, March 2020, the proposed development was understood to comprise the demolition of the existing buildings and construction of a three storey block of residential flats, with ground floor private amenity areas and a communal garden. A plan of the proposed development is given in Figure 4.

2.4 Geology

The BGS Geological Map (Solid and Drift) for the Ruislip Manor area (North London Sheet No. 256) revealed the site was located on the bedrock deposits of the Lambeth Group. No areas of Made Ground or Worked Ground were noted in a close proximity of the site.

Lambeth Group

The Lambeth Group (formerly known as the Woolwich and Reading Beds) is a sedimentary complex comprising a basal bed (the Upnor Formation also known as the Bottom Bed) composed of glauconitic sand, sandy clay and gravel (well-rounded flint pebbles), with laterally variable sand and clay above. In the eastern part of the area the basal bed is mostly overlain by a shelly grey sandy clay or silty sand and laminated beds (Woolwich Formation). At the top of the sedimentary complex is the Reading Formation, which is made up of multi-coloured mottled clays and silty clays.

Lignite, or brown coal, a carbonaceous rock composed of plant remains which has not been subject to the same intensity of heat and pressure as has ordinary coal, is occasionally found within the Lambeth Group, as are individual logs and groups of logs indicating the position of a former log jam, which was covered by sand and clay at the time of deposition.

A BGS borehole ~1km north-east of the site revealed 0.60m of Made Ground over a gravelly silty clay to 1.50m bgl and then a stiff mottled (red, orange brown and blue grey) silty clay to 5.00m bgl.

2.5 Hydrogeology and Hydrology

An examination of the DEFRA website revealed the site was located on a **Secondary A Aquifer** relating to the bedrock deposits of the Lambeth Group. No designation was given for superficial deposits due to their likely absence.

Superficial drift deposits are described as permeable unconsolidated (loose) deposits e.g. sands and gravels. The bedrock is described as solid permeable formations e.g. sandstone, chalk and limestone.

Secondary aquifers include a wide range of drift deposits with an equally wide range of water permeability and storage capacities. **Secondary (A) Aquifers** consist of deposits with permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as Minor Aquifers.

Examination of the Environment Agency records showed that the site was not located within a Groundwater Source Protection Zone (SPZ) as classified in the Policy and Practice for the Protection of Groundwater.

There were no surface water features in a close proximity of the site. The south-westerly flowing Yeading Brook was located ~1km to the south.

From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at depth (>6m below existing ground level (bgl)) and it was considered that the groundwater was flowing in a south-easterly direction in accordance with the local topography towards the Yeading Brook.

Examination of the Environment Agency records showed that the site fell within a Flood Zone 1 (an area with a low probability of river or sea flooding).

2.6 Radon

BRE 211 (2015) Map 5 of London, Sussex and west Kent revealed the site **was not** located within an area where mandatory protection measures against the ingress of Radon were likely to be required. The site **was not** located within an area where a risk assessment was required.

3.0 FIELDWORK

3.1 Scope of Works

Site works were undertaken on the 31st January 2020 and comprised the drilling of 3No. Windowless Sampler Boreholes (WS1 – WS3) to a depth of between 5.45 – 7.45m bgl. Standard Penetration Tests (SPTs) were carried out at 1.00m intervals in the boreholes. A “Super Heavy” Dynamic Probe (DP2) was undertaken through the base of WS2 to a depth of 8.60m bgl where the density of the soils prevented further progress.

The approximate locations of the trial holes are given on Figure 5.

Prior to commencing the ground investigation, a walkover survey was carried out to identify the presence of underground services and drainage. Where underground services/drainage were suspected and/or positively identified, exploratory positions were relocated away from these areas.

As a further precautionary measure, the positions were hand scanned with a Cable Avoidance Tool (CAT scanner) to minimise the risk to services.

Upon completion of the site works, the trial holes were backfilled and made good/reinstated in relation to the surrounding area.

3.2 Sampling Procedures

Small disturbed samples were recovered from the trial holes at the depths shown on the trial hole records. Soil samples were generally retrieved from each change of strata and/or at specific areas of concern. Samples were also taken at approximately 0.5m intervals during broad homogenous soil horizons.

A selection of samples were despatched for geotechnical testing purposes.

4.0 ENCOUNTERED GROUND CONDITIONS

4.1 Soil Conditions

All exploratory holes were logged by Roger Foord of Ground and Water Limited, generally in accordance with BS EN 14688 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

The ground conditions encountered within the trial holes conformed to what was anticipated from examination of the geology map. A capping of Made Ground (concrete hardstanding) (WS1 and WS3) and Topsoil (WS2) was noted from ground level overlying the soils of the Lambeth Group for the remaining depth of the trial holes.

The ground conditions encountered during the investigation are described in this section. All trial hole logs can be seen in Appendix B and the trial hole location plan can be viewed in Figure 5.

For the purposes of discussion the succession of conditions encountered in the trial holes in descending order can be summarised as follows:

Topsoil (WS2 only)
Made Ground (WS1 and WS3 only)
Lambeth Group

Topsoil

Topsoil was encountered from ground level in WS2 to a depth of 0.50m bgl. The Topsoil comprised a dark brown silty clay.

Made Ground

Made Ground was encountered from ground level comprising a 0.20m and 0.30m thickness of concrete hardstanding in WS1 and WS3 respectively.

Lambeth Group

Soils described as the Lambeth Group and generally comprising cohesive soils were encountered underlying the Topsoil (WS2) and concrete hardstanding (WS1 and WS3) for the remaining depth of each of the boreholes at a depth of between 5.45 – 7.45m bgl. The soils generally comprised an orange brown and grey, locally red mottled silty clay. A dark grey silty clay with pockets of dark olive green silt was noted between 0.30 – 1.00m bgl in WS1. A band of grey very sandy clay/very clayey sand was noted between 5.40 – 5.90m bgl in WS2. The sand was fine grained.

Based on the refusal of WS2 and the high SPT result (181 N blow counts) at a depth of 7.00m bgl and the results of the dynamic probing it was assumed that extremely dense granular soils were encountered between 7.00 – 8.60m bgl in DP2.

For more complete information about the soils encountered during the investigation, reference should be made to the detailed trial hole records given within Appendix B.

4.2 Roots Encountered

The depth of roots encountered in the trial holes can be seen tabulated overpage.

Trial Hole	Depth of Fresh Root Penetration (m bgl)	Depth of Dark Brown/Black Friable Rootlets (m bgl)
WS1	None	None
WS2	4.00m	Fine rootlets were noted at 3.50m bgl during the geotechnical laboratory testing
WS3	3.00m	Fine rootlets were noted at 1.50m bgl during the geotechnical laboratory testing

It must be noted that the chance of determining actual depth of fresh root penetration through a narrow diameter borehole is low. Roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs.

4.3 Groundwater Conditions

Groundwater was encountered at 5.45m bgl in WS2 within the band of grey very sandy clay/very clayey sand that was noted between 5.40 – 5.90m bgl in WS2. Groundwater was not encountered in the remaining trial holes. Any groundwater seepages may have been masked by the speed of the drilling process.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site.

The site investigation was conducted in January 2020, when groundwater levels should be close to their annual maximum (highest elevation). The long-term groundwater elevation might increase at some time in the future due to seasonal fluctuation in weather conditions. Isolated pockets of groundwater may be perched within any Made Ground found at other locations around the site.

4.4 Obstructions

WS2 refused at a depth of 7.00m bgl. A “Super Heavy” Dynamic Probe (DP2) was undertaken through the base of WS2 between 7.00 - 8.60m bgl where the density of the soils prevented further progress.

No other artificial or natural sub-surface obstructions were noted during drilling of the boreholes.

5.0 INSITU AND LABORATORY GEOTECHNICAL TESTING

5.1 In-Situ Geotechnical Testing

5.1.1 Standard Penetrations Tests (SPTs)

Standard Penetration Tests (SPTs) were carried out at 1.00m intervals in the boreholes. The results of the SPT's have not been amended to take into account hammer efficiency, rod lengths and overburden pressure in accordance with Eurocode 7. A "Super Heavy" Dynamic Probe (DP2) was undertaken through the base of WS2 to a depth of 8.60m bgl where the stiffness of the clay prevented further progress. The test results are presented on the borehole logs within Appendix B.

Windowless Sampler Boreholes provide samples of the ground for assessment but they do not give any engineering data. The standard penetration test (SPT) is an in-situ dynamic penetration test designed to provide information on the geotechnical engineering properties of soil. The test uses a thick-walled sample tube, with an outside diameter of 50 mm and an inside diameter of 35 mm, and a length of around 650mm. This is driven into the ground at the bottom of a borehole by blows from a slide hammer with a weight of 63.5 kg falling through a distance of 760 mm. The sample tube is driven 150 mm into the ground and then the number of blows needed for the tube to penetrate each 75 mm up to a depth of 450 mm is recorded. The sum of the number of blows is termed the "standard penetration resistance" or the "N-value".

Dynamic Probing involves the driving of a metal cone into the ground via a series of steel rods. These rods are driven from the surface by a hammer system that lifts and drops a 63.5kg hammer onto the top of the rods through a set height, thus ensuring a consistent energy input. The number of hammer blows that are required to drive the cone down by each 100mm increment are recorded. These blow counts then provide a comparative assessment from which correlations have been published, based on dynamic energy, which permits engineering parameters to be generated. *(The Dynamic Probe 'Super Heavy' (SHDP) Tests were conducted in accordance with BS 1377; 1990; Part 9, Clause 3.2).*

The cohesive soils of the Lambeth Group were classified based on the table below.

Undrained Shear Strength from Field Inspection/ equivalent 'SPT's derived from SHDP results/ SPT results Cohesive Soils (EN ISO 14688-2:2004 & Stroud (1974))		
Classification	Undrained Shear Strength (kPa)	Field Indications
Extremely High	>300	-
Very High	150 – 300	Brittle or very tough
High	75 – 150	Cannot be moulded in the fingers
Medium	40 – 75	Can be moulded in the fingers by strong pressure
Low	20 – 40	Easily moulded in the fingers
Very Low	10 – 20	Exudes between fingers when squeezed in the fist
Extremely Low	<10	-

The assumed granular soils of the Lambeth Group were classified based on the table overpage.

Correlation between equivalent 'SPT's derived from SHDP results and granular classification	
Classification	SPT Blow Counts (N1)
Extremely Dense	>58
Very Dense	42 – 58
Dense	25 – 42
Medium Dense	8 – 25
Loose	3 – 8
Very Loose	0 – 3

An interpretation of the in-situ geotechnical testing results is given in the table below.

In-Situ Geotechnical Testing Results Summary					
Strata	SPT results/ equivalent 'SPT's derived from SHDP results	Equivalent Undrained Shear Strength (kPa)	Soil Type		Trial Hole/s
			Cohesive	Granular	
Lambeth Group "soft spot" (cohesive soils)	4 6 5*	20 30 25	Very Low/Low Low Low	-	WS1 (0.20 – 1.45m bgl) WS2 (1.00 – 1.45m bgl) WS2 (5.00 – 5.45m bgl)
Lambeth Group (cohesive soils)	19 – 21 10 – 23 37 13 – 25	95 – 105 20 – 115 185 65 – 125	High Medium – High Very High Medium – High		WS1 (1.45 – 5.45m bgl) WS2 (0.50 – 5.00m bgl) WS2 (5.90 – 7.00m bgl) WS3 (0.30 – 5.45m bgl)
Assumed Lambeth Group (granular soils)	181 >215*	-	-	Ext. Dense Ext. Dense	WS2 (7.00 – 7.45m bgl) DP2 (7.10 – 8.60m bgl)

**Soils potentially softened by groundwater*

It must be noted that field measurements of undrained shear strength are dependent on a number of variables including disturbance of sample, method of investigation and also the size of specimen or test zone etc.

5.2 Laboratory Geotechnical Testing

A programme of geotechnical laboratory testing, scheduled by Ground and Water Limited and carried out by K4 Soils Laboratory and DETS Limited, was undertaken on samples recovered from the Lambeth Group. The results of the tests are presented in Appendix C. The test procedures used were generally in accordance with the methods described in BS1377:2016/2018. Details of the specific tests used in each case are given below.

Standard Methodology for Laboratory Geotechnical Testing		
Test	Standard	Number of Tests
Atterberg Limit Tests	BS1377:2016:Part 2:Clauses 3.2, 4.3 & 5	5
Moisture Content Determination	BS1377:2018:Part 2:Clause 3.2	4
Water Soluble Sulphate & pH Tests	BS1377:2018:Part 3:Clause 7.6 and 12	1
BRE Special Digest 1 (incl. Ph, Total Sulphate, W/S Sulphate, Total Chlorine, W/S Chlorine, Total Sulphur, Ammonium as NH ₄ , W/S Nitrate, W/S Magnesium)	BRE Special Digest 1 "Concrete in Aggressive Ground (BRE, 2005).	2

5.2.1 Atterberg Limit Tests

A précis of Atterberg Limit Tests undertaken on five samples of the Lambeth Group can be seen tabulated below.

Atterberg Limit Tests Results Summary							
Stratum/Depth	Moisture Content (%)	Passing 425 μm sieve (%)	Modified PI (%)	Soil Class	Consistency Index (Ic)	Volume Change Potential	
						BRE	NHBC
Lambeth Group	19 – 36	95 – 100	26.0 – 60.1	CI – CV	Stiff (0.76 – 0.91)	Medium – Very High	Medium – High

NB: NP – Non-plastic

BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)

Soil Classification based on British Soil Classification System.

Consistency Index (Ic) based on BS EN ISO 14688-2:2004.

5.2.2 Comparison of Soil's Moisture Content with Index Properties

5.2.2.1 Liquidity Index Analyses

The results of the Atterberg Limit tests undertaken on five samples of the Lambeth Group were analysed to determine the Liquidity Index of the samples. This gives an indication as to whether the samples recovered showed a moisture deficit and their degree of consolidation. The results are tabulated below. The test results are presented within Appendix C.

Liquidity Index Calculations Summary					
Stratum/Trial Hole/Depth	Moisture Content (%)	Plastic Limit (%)	Modified Plasticity Index (%)	Liquidity Index	Result
Lambeth Group WS1/0.80 – 1.00m bgl Orangish brown mottled bluish grey slightly gravelly, slightly sandy silty CLAY (gravel was fine medium and sub-angular).	31	23	30.38	0.26	Overconsolidated
Lambeth Group WS2/2.00m bgl Light brown slightly mottled light grey slightly gravelly slightly sandy silty CLAY (gravel is fine to medium and sub-angular to rounded).	33	24	52.25	0.17	Heavily Overconsolidated
Lambeth Group WS2/3.00m bgl Brown slightly mottled grey and orangish brown slightly sandy silty CLAY	19	16	32	0.09	Heavily Overconsolidated
Lambeth Group WS2/6.00m bgl Reddish brown slightly mottled grey slightly sandy silty CLAY.	20	17	26	0.12	Heavily Overconsolidated
Lambeth Group WS3/1.50m bgl Brown slightly mottled bluish grey slightly gravelly silty CLAY with traces of fine rootlets (gravel was fine medium and sub-angular to angular).	36	28	60.14	0.13	Heavily Overconsolidated

Liquidity Index testing revealed no evidence for a potential moisture deficit within

the overconsolidated to heavily overconsolidated samples of the Lambeth Group tested.

5.2.2.2 Liquid Limit

A comparison of the soil moisture content and the liquid limit can be seen tabulated below.

Moisture Content vs. Liquid Limit				
Strata/Trial Hole/Depth/Soil Description	Moisture Content (MC) (%)	Liquid Limit (LL) (%)	40% Liquid Limit (LL)	Result
Lambeth Group WS1/0.80 – 1.00m bgl Orangish brown mottled bluish grey slightly gravelly, slightly sandy silty CLAY (gravel was fine medium and sub-angular).	31	54	21.6	MC > 0.4 x LL (Not Significantly Desiccated)
Lambeth Group WS2/2.00m bgl Light brown slightly mottled light grey slightly gravelly slightly sandy silty CLAY (gravel is fine to medium and sub-angular to rounded).	33	79	31.6	MC > 0.4 x LL (Not Significantly Desiccated)
Lambeth Group WS2/3.00m bgl Brown slightly mottled grey and orangish brown slightly sandy silty CLAY	19	48	19.2	MC < 0.4 x LL (Potentially significant moisture deficit)
Lambeth Group WS2/6.00m bgl Reddish brown slightly mottled grey slightly sandy silty CLAY.	20	43	17.2	MC > 0.4 x LL (Not Significantly Desiccated)
Lambeth Group WS3/1.50m bgl Brown slightly mottled bluish grey slightly gravelly silty CLAY with traces of fine rootlets (gravel was fine medium and sub-angular to angular).	36	90	36	MC > 0.4 x LL (Not Significantly Desiccated)

The results in the table above indicated that a potential significant moisture deficit was present within one sample of the Lambeth Group tested (WS2/3.00m) with the moisture content marginally below 40% of the liquid limit. The sample was described as a brown slightly mottled grey slightly sandy silty clay. Roots were noted to a depth of 4.00m bgl WS2. Consequently the apparent moisture deficit was likely to be related to a combination of the lithology of the soil (heavily overconsolidated soils) and the water demand of roots from nearby trees.

The results in the table above indicate that the remaining overconsolidated to heavily overconsolidated samples of the Lambeth Group tested showed no evidence of a significant moisture deficit.

5.2.3 Moisture Content Profiling

The moisture content versus depth plots for WS2 can be seen within Figure 6.

Figure 6 showed evidence for a possible moisture deficit within WS2 at a depth of ~2.50 – 3.00m bgl which coincided with the potential moisture deficit identified during the geotechnical testing.

5.2.4 Water Sulphate and pH Tests

Water soluble Sulphate and pH tests were undertaken on one sample from the Lambeth Group (WS3/1.50m bgl). The water soluble sulphate concentration was 280mg/l with a

pH of 7.6.

5.2.5 BRE Special Digest 1

In accordance with BRE Special Digest 1 'Concrete in Aggressive Ground' (BRE, 2005) two samples of the Lambeth Group (WS1/2.00m and WS3/1.00m bgl) were scheduled for laboratory analysis to determine parameters for concrete specification.

The results of the chemical analysis undertaken are given within Appendix D and a summary is tabulated below.

Summary of Results of BRE Special Digest Testing			
Determinand	Unit	Minimum	Maximum
pH	-	7.5	8.2
Ammonium as NH ₄	mg/l	<0.05	<0.05
Sulphur	%	<0.02	<0.02
Chloride (water soluble)	mg/l	3.1	20.2
Magnesium (water soluble)	mg/l	3.2	5.6
Nitrate (water soluble)	mg/l	<1.5	<1.5
Sulphate (water soluble)	mg/l	48	58
Sulphate (total)	%	<0.02	0.03

6.0 ENGINEERING CONSIDERATIONS

6.1 Soil Characteristics and Geotechnical Parameters

Based on the results of the intrusive investigation and geotechnical laboratory testing the following interpretations have been made with respect to engineering considerations.

- Topsoil was encountered from ground level in WS2 to a depth of 0.40m bgl. A 0.20 – 0.30m thickness of concrete hardstanding was noted in WS1 and WS2.

As a result of the inherent variability of Topsoil and Made Ground it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should, therefore, be taken through any Topsoil or Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

Made Ground may be found to deeper depth at other locations on the site.

- Soils described as the Lambeth Group and generally comprising cohesive soils were encountered underlying the Topsoil (WS2) and concrete hardstanding (WS1 and WS3) for the remaining depth of each of the boreholes at a depth of between 5.45 – 7.00m bgl. The soils generally comprised an orange brown and grey, locally red mottled silty clay. A dark grey silty clay with pockets of dark olive green silt was noted between 0.30 – 1.00m bgl in WS1. A band of grey very sandy clay/very clayey sand was noted between 5.40 – 5.90m bgl in WS2. The sand was fine grained.

Based on the refusal of WS2 and the high SPT result (181 N blow counts) at a depth of 7.00m bgl and the results of the dynamic probing it was assumed that extremely dense granular soils were encountered between 7.00 – 8.60m bgl in DP2.

In-situ testing revealed the cohesive soils of the Lambeth Group were generally shown to have a medium to very high undrained shear strength (65 – 185kPa). Soft spots with very low/low to low undrained shear strengths 20 – 25 kPa) were noted to 1.45m bgl in WS1 and WS2. A deeper soft spot in WS2 at a depth of 5.00 – 5.45m bgl was most likely a result of the soils being softened by the water strike were recorded at 5.45m bgl in WS2.

Geotechnical testing revealed the cohesive soils of the Lambeth Group to have **medium to very high volume change potential** in accordance with BRE240 and a **medium to high volume change potential** in accordance with NHBC Standards Chapter 4.2. Geotechnical analyses indicated these soils to be overconsolidated to heavily overconsolidated, stiff and with a potential moisture deficit in one sample (WS2/3.00m bgl) resulting from a combination of the lithology of the soil (heavily overconsolidated soils) and the water demand of roots from nearby trees.

The soils of the Lambeth Group comprised overconsolidated to heavily overconsolidated cohesive soils with occasional thin bands of granular soils and assumed extremely dense granular soils at depth. These were therefore likely to be a suitable stratum for lightly to moderately loaded spread foundations or deeper piled foundations. The settlements induced on loading are likely to be moderate to high.

The final design of foundations will need to take into account the volume change potential of the

soil, the depth of root penetration and/or desiccation and the likely serviceability and settlement requirements of the proposed structure. These parameters for design are discussed in the next section of this report.

- Roots were noted to a depth of 4.00m bgl in WS2 and 3.00m bgl in WS3. Fine rootlets were noted at 3.50m bgl in WS2 and 1.50m bgl in WS3 during the geotechnical laboratory testing. No roots were noted in WS1.
- Groundwater was encountered at 5.45m bgl in WS2 within the band of grey very sandy clay/very clayey sand that was noted between 5.40 – 5.90m bgl in WS2. Groundwater was not encountered in the remaining trial holes. Any groundwater seepages may have been masked by the speed of the drilling process.

6.2 Spread Foundations

At the time of reporting, March 2020, the proposed development was understood to comprise the demolition of the existing buildings and construction of a three storey block of residential flats, with ground floor private amenity areas and a communal garden. A plan of the proposed development is given in Figure 4.

The proposed development is likely to fall within Geotechnical Design Category 2 in accordance with Eurocode 7. The proposed foundation loads were not known to Ground and Water Limited at the time of reporting but are likely to range between 75 – 150kN/m².

Geotechnical testing revealed the cohesive soils of the Lambeth Group to have **medium to very high volume change potential** in accordance with BRE240 and a **medium to high volume change potential** in accordance with NHBC Standards Chapter 4.2. Geotechnical analyses indicated these soils to be overconsolidated to heavily overconsolidated, stiff and with a potential moisture deficit in one sample (WS2/3.00m bgl) resulting from a combination of the lithology of the soil (heavily overconsolidated soils) and the water demand of roots from nearby trees.

Consequently, foundations should be designed therefore in accordance with soils of **very high volume change potential** in accordance with BRE Digest 240 and **high volume change potential** in accordance with NHBC Chapter 4.2.

Due to the soils at shallow depth having the potential for volume change, foundations must not be placed within cohesive root penetrated and/or desiccated soils and the influence of the trees surrounding the site must be taken into account (**NHBC tree rings**). The base of foundation excavations must extend at least 300mm into non-root penetrated soils. Foundations must also be designed in accordance with NHBC Standards Chapter 4.2 and the proximity of nearby trees or recently removed trees (moisture recovery can take up to 15yrs to complete). Should a tree be removed from the footprint of the proposed structures then a piled foundation scheme should be considered.

Roots were noted to a depth of 4.00m bgl in WS2 and 3.00m bgl in WS3. Fine rootlets were noted at 3.50m bgl in WS2 and 1.50m bgl in WS3 during the geotechnical laboratory testing. No roots were noted in WS1.

Groundwater was encountered at 5.45m bgl in WS2 within the band of grey very sandy clay/very clayey sand that was noted between 5.40 – 5.90m bgl in WS2. Groundwater was not encountered in

the remaining trial holes. Any groundwater seepages may have been masked by the speed of the drilling process.

Minimum foundation depths were therefore likely to range between the minimum for the volume change potential of the soil (1.00m bgl) in the vicinity of WS1 to between 3.30m and 4.30m bgl over the remainder of the site. The final depth should however include the NHBC tree rings calculations, if any trees are influencing the foundations.

Examination of the proposed development plan (Figure 4) shows that the proposed structure falls within the part of the site where WS2 and WS3 were drilled. Given the depth of moisture deficit and roots noted strip footings are likely to be required to be excavated to a minimum depth of ~3.30 – 4.30m bgl. This means the footings will need to be engineer designed. **Given the increased costs of digging to such a depth, amount of waste produced and amount of concrete required and impracticality of forming traditional strip footings at this depth it is recommended that a piled foundation is adopted with piles taken through the Topsoil, Made Ground and into the underlying soils of the Lambeth Group.**

6.3 Piled Foundations

The construction and design of a piled foundation is a specialist job, and the advice of a reputable contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the foundation design, as the actual pile working load will depend on the particular type of pile and method of installation adopted.

The foundation would comprise a piled foundation with reinforced ground beams. For the cumulative pile capacity calculations, shaft friction over the desiccated levels should be ignored and piles should not be terminated within desiccated soils where moisture recovery following tree removal could occur.

Indicative limit loads and settlements for a bored pile have been given within the table below have been based on WS/DP2. An allowance for negative skin friction to occur within the top 4.0m of the soil has been included within the calculations where it could pass through any Topsoil, root penetrated soils and soils showing a possible moisture deficit. An adhesion factor of 0.45m has been applied.

The bearing values may be limited by the maximum permissible stress allowable on a concrete pile. To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

Bored Pile – Limit Loads and Settlement Parameters (Based on WS/DP2)						
Depth (m bgl)	Diameter (m)	Limit States (kN)			Settlement (Poulos Davis (1968))	
		Tip	Lateral	Total	Load (kN)	Total (Elastic + Rigid) (mm)
6.00	0.30	57.41	25.80	74.37	70	2.185
	0.45	129.18	38.70	147.99	140	2.913
	0.60	229.65	51.59	245.90	240	5.646

The bearing values given in the table above are applicable to single piles. Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of approximately 0.8 and a calculation made to check the factor of safety against block failure.

The piles will need to be designed in accordance with the volume change potential of the soils encountered, depth of desiccation, root penetration, etc. Temporary casing may be required where the upper portion of the pile passes through the Made Ground, particularly where perched water is encountered, to prevent necking of the concrete.

6.4 Excavations and Stability

Shallow excavations in the Topsoil, Made Ground and Lambeth Group are likely to be marginally stable at best. Long, deep excavations, through these strata are likely to become unstable, especially where groundwater strikes are noted.

Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported before excavations are entered by personnel.

6.5 Sub-Surface Concrete

For the classification given below, the “mobile” and “natural” case was adopted given the geology encountered and the history of the site.

Natural Ground – Lambeth Group

The water-soluble sulphates were found to range between 48 - 280mg/l (from the chemical laboratory and geotechnical laboratory tests). The total potential sulphate concentration (3x Sulphur) was found to range between <0.06% and 0.09%. The pH was 7.6 - 8.2.

Therefore, sulphate concentrations measured in 2:1 water/soil extracts taken from the natural ground and total potential sulphate concentrations, fell into Class **DS-1** of the BRE Special Digest 1, 2005, ‘Concrete in Aggressive Ground’ Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of **AC-1**.

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1, 2005, ‘Concrete in Aggressive Ground’ taking into account the pH of the soils.

6.6 Roads and Hardstanding

Intrusive works revealed Topsoil was encountered to a depth of 0.50m bgl.

Equilibrium CBR Assessment

Roads and hardstanding constructed on the cohesive soils of the Lambeth Group should be designed based on a CBR value of 4.0%. This is based on reference to Table C1 of TRL1132 and average construction conditions. Based on wet conditions a CBR of 2.5% should be adopted, with dry conditions a CBR of 4.5% being applicable.

Frost Susceptibility

Given that the cohesive soils of the Lambeth Group encountered beneath the site are mainly clay-based soils (poorly drained) with plasticity indexes above 20%, **these deposits are likely to be non-frost susceptible.**

All formation levels for roads and hardstanding should be proof rolled to highlight any soft areas which should then be dug out and replaced with selected granular material compacted in thin layers to a suitable specification.

6.7 Surface Water Disposal

Infiltration tests were beyond the scope of the investigation.

Soakaways constructed within the cohesive soils of the Lambeth Group were considered unlikely to perform to a satisfactory standard.

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources.

The principles of sustainable urban drainage system (SUDS) and the requirements of the London Plan Policy 5.13 Sustainable Drainage should be applied to reduce the risk of flooding from surface water ponding and collection associated with the construction of the basement.

In accordance with the London Plan Policy 5.13 Sustainable Drainage the surface water run-off should be managed as close to its source as possible in line with the following drainage hierarchy:

- store rainwater for later use;
- use infiltration techniques, such as porous surfaces in non-clay areas;
- attenuate rainwater in ponds or open water features for gradual release;
- attenuate rainwater by storing in tanks or sealed water features for gradual release;
- discharge rainwater direct to a watercourse;
- discharge rainwater to a surface water sewer/drain;
- discharge rainwater to the combined sewer.

Drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation.

6.8 Discovery Strategy

There may be areas of contamination that have not been identified during the course of the intrusive investigation. For example, there may have been underground storage tanks (UST's) not identified during the Desk Study and/or Ground Investigation for which there is no historical or contemporary evidence.

Such occurrences may be discovered during the demolition and construction phases for the redevelopment of the site.

Groundworkers should be instructed to report to the Site Manager any evidence for such contamination; this may comprise visual indicators, such as fibrous materials within the soil, discolouration, or odours and emission. Upon discovery advice must be taken from a suitably qualified person before proceeding, such that appropriate remedial measures and health and safety protection may be applied.

Should a new source of contamination be suspected or identified then the Local Authority will need to be informed.

6.9 Waste Disposal

The excavation of foundations is likely to produce waste which will require classification and then recycling or removal from site.

Under the Landfill (England and Wales) Regulations 2002 (as amended), prior to disposal all waste must be classified as;

- Inert;
- Non-hazardous, or;
- Hazardous.

The Environment Agency's Hazardous Waste Technical Guidance (WM2) document outlines the methodology for classifying wastes.

Once classified the waste can be removed to the appropriately licensed facilities, with some waste requiring pre-treatments prior to disposal.

INERT waste classification should be undertaken to determine if the proposed waste confirms to INERT or NON-HAZARDOUS Waste Acceptable Criteria (WAC).

6.10 Imported Material

Any soil which is to be imported onto the site must undergo chemical analysis to prove that it is suitable for the purpose for which it is intended.

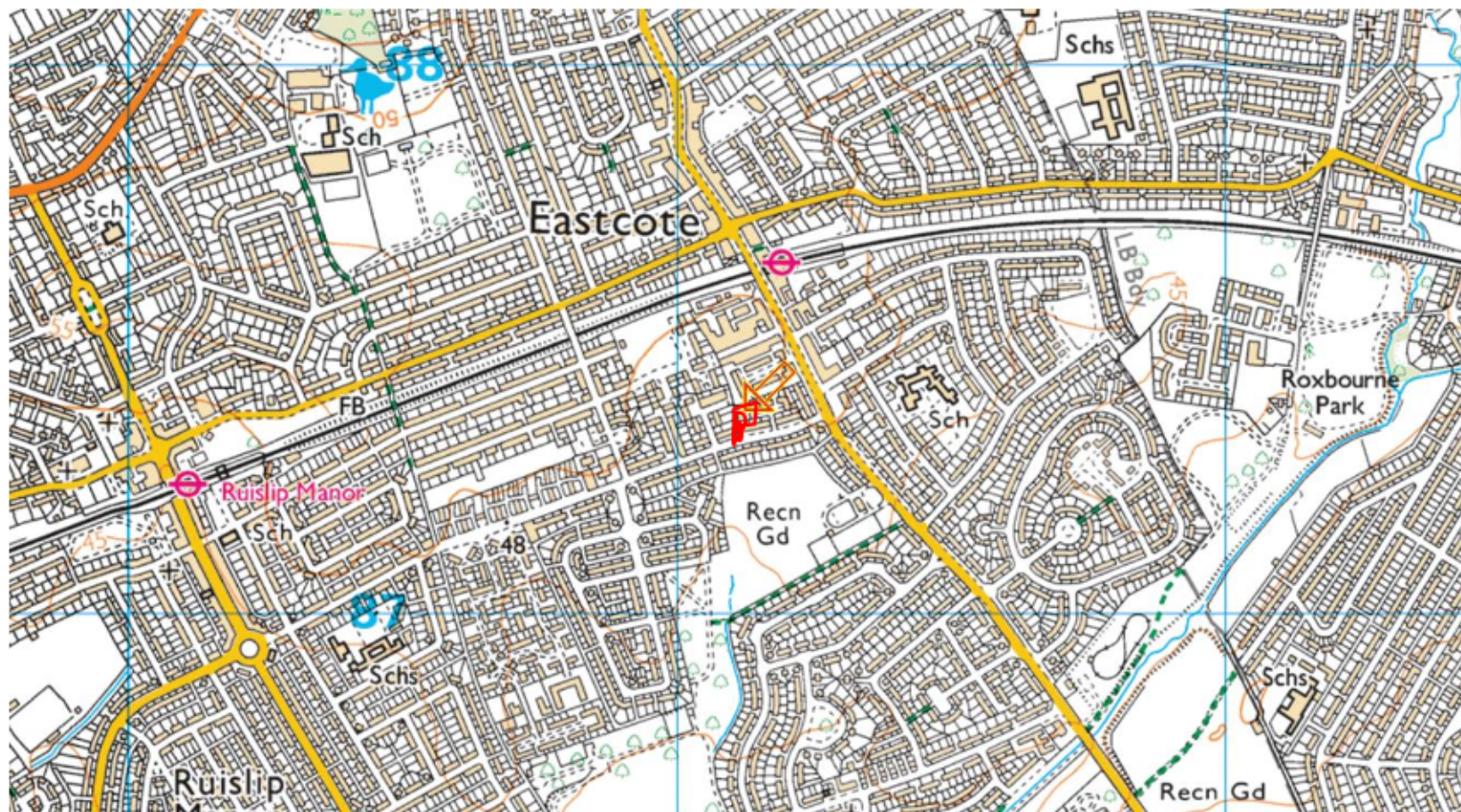
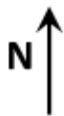
The Topsoil must be fit for purpose and must either be supplied with traceable chemical laboratory test certificates or be tested, either prior to placing (ideally) or after placing, to ensure that the human receptor cannot come into contact with compounds that could be detrimental to human health.

6.11 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust were generated as a result of construction activities.

The site should be securely fenced at all times to prevent unauthorised access. Washing facilities should be provided and eating restricted to mess huts.



APPROXIMATE SITE BOUNDARY

NOT TO SCALE

Project:

Residential Garages off Southbourne Gardens, Ruislip HA4 9SW

Client:

Landmark Builders Limited

Date:

March 2020

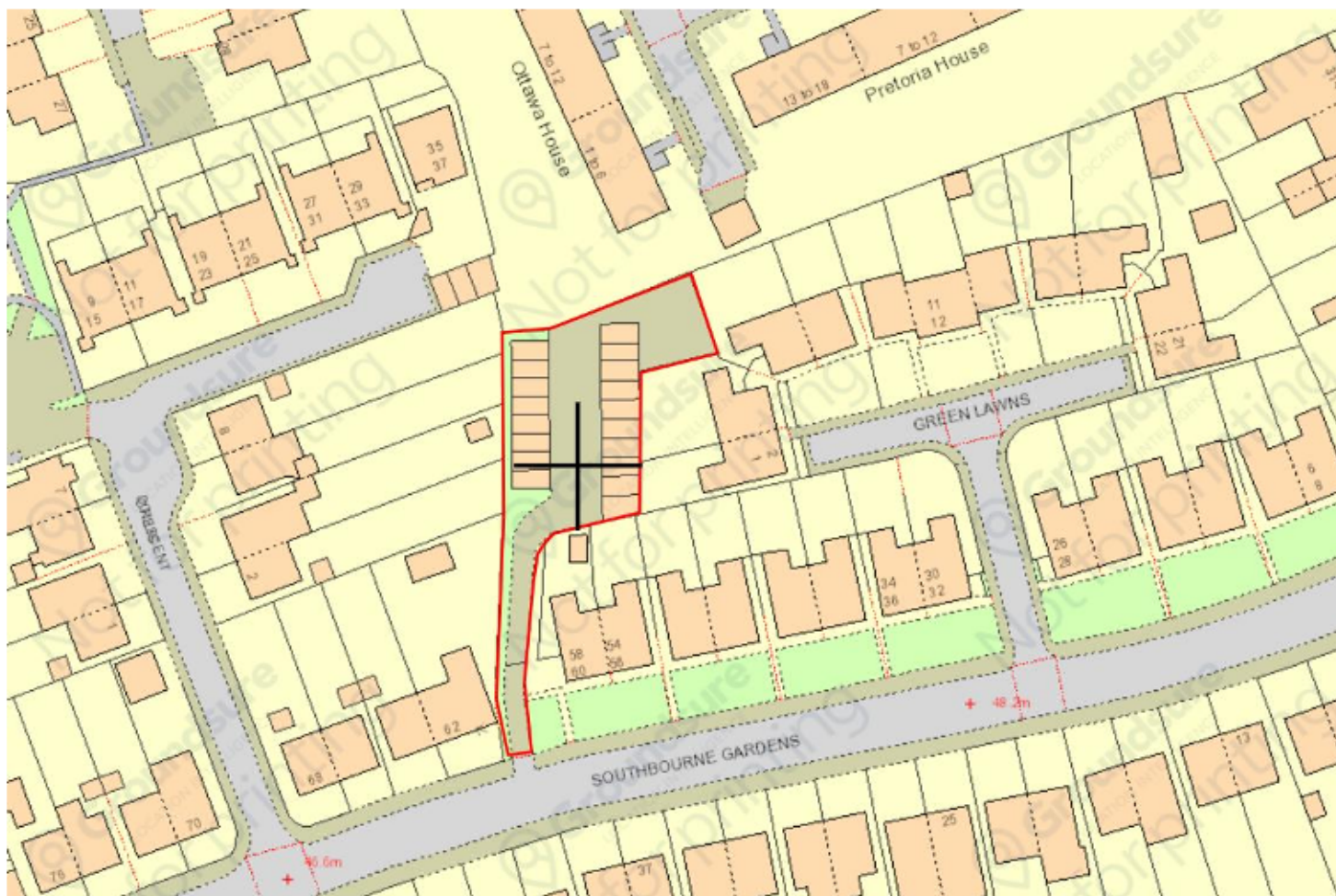
Site Location Plan

Ref:

GWPR3537

Figure 1

ground&water



APPROXIMATE SITE BOUNDARY

NOT TO SCALE

Project:

Residential Garages off Southbourne Gardens, Ruislip HA4 9SW

Client:

Landmark Builders Limited

Date:

March 2020

Site Development Area

Ref:

GWPR3537

Figure 2

ground&water



APPROXIMATE SITE BOUNDARY

NOT TO SCALE

Project:

Residential Garages off Southbourne Gardens, Ruislip HA4 9SW

Client:

Landmark Builders Limited

Date:

March 2020

Aerial View of the Site

Ref:

GWPR3537

Figure 3

ground&water



APPROXIMATE SITE BOUNDARY

NOT TO SCALE

Project:

Residential Garages off Southbourne Gardens, Ruislip HA4 9SW

Client:

Landmark Builders Limited

Date:

March 2020

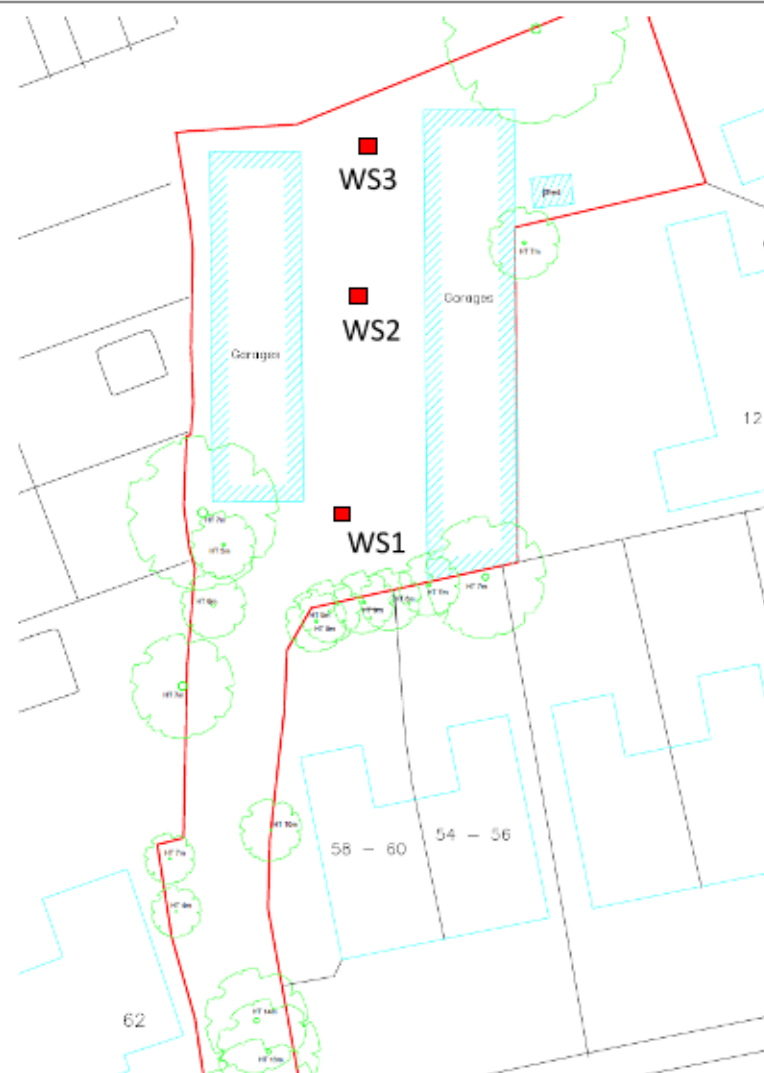
Proposed Development Plan

Ref:

GWPR3537

Figure 4

ground&water



APPROXIMATE SITE BOUNDARY

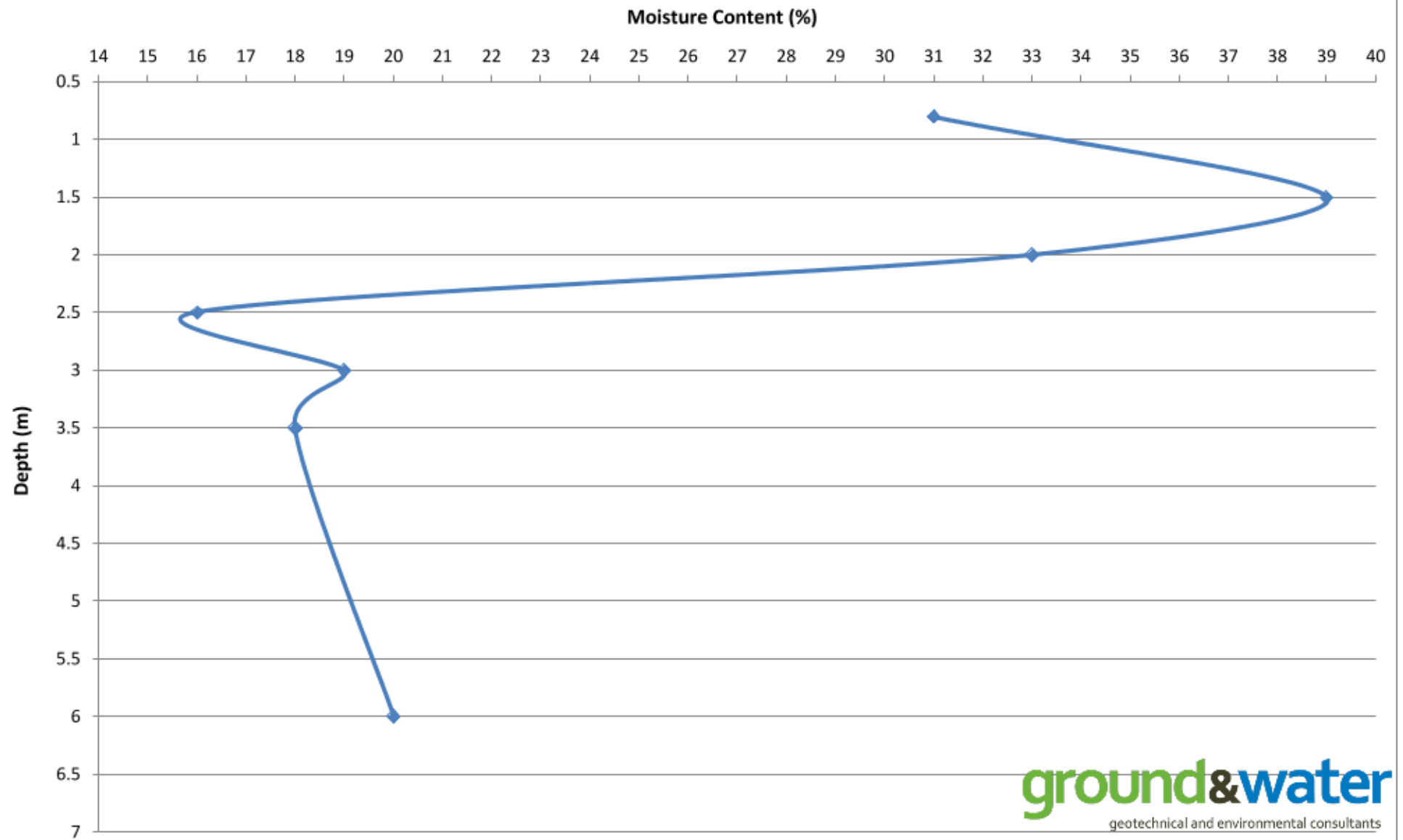
NOT TO SCALE

Project:		Residential Garages off Southbourne Gardens, Ruislip HA4 9SW	
Client:	Landmark Builders Limited	Date:	March 2020
	Trial Hole Location Plan	Ref:	GWPR3537

Figure 5

ground&water

Figure 6: Change in Moisture Content With Depth Within WS2



APPENDIX A

Conditions and Limitations

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The report has been prepared on the basis of information, data and materials which were available at the time of writing. Accordingly any conclusions, opinions or judgements made in the report should not be regarded as definitive or relied upon to the exclusion of other information, opinions and judgements.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief; as such these do not necessarily address all aspects of ground behaviour at the site. No liability is accepted for any reliance placed on it by others unless specifically agreed in writing.

Any decisions made by you, or by any organisation, agency or person who has read, received or been provided with information contained in the report ("you" or "the Recipient") are decisions of the Recipient and we will not make, or be deemed to make, any decisions on behalf of any Recipient. We will not be liable for the consequences of any such decisions.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

Any Recipient must take into account any other factors apart from the Report of which they and their experts and advisers are or should be aware. The information, data, conclusions, opinions and judgements set out in the report may relate to certain contexts and may not be suitable in other contexts. It is your responsibility to ensure that you do not use the information we provide in the wrong context.

This report is based on readily available geological records, the recorded physical investigation, the strata observed in the works, together with the results of completed site and laboratory tests. Whilst skill and care has been taken to interpret these conditions likely between or below investigation points, the possibility of other characteristics not revealed cannot be discounted, for which no liability can be accepted. The impact of our assessment on other aspects of the development required evaluation by other involved parties.

The opinions expressed cannot be absolute due to the limitations of time and resources within the context of the agreed brief and the possibility of unrecorded previous in ground activities. The ground conditions have been sampled or monitored in recorded locations and tests for some of the more common chemicals generally expected. Other concentrations of types of chemicals may exist. It was not part of the scope of this report to comment on environment/contaminated land considerations.

The conclusions and recommendations relate to the residential garages off Southbourne Gardens, Ruislip HA4 9SW.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sampler borehole implies the specific technique used to produce a trial hole.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot-by-plot basis prior to the construction of foundations. Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping.

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets, remain with Ground and Water Limited. Licence is for the sole use of the client and may not be assigned, transferred or given to a third party.

Only our client may rely on this report and should this report or any information contained in it be provided to any third party we accept no responsibility to the third party for the contents of this report save to the extent expressly outlined by us in writing in a reliance letter addressed from us to the third party.

Recipients are not permitted to publish this report outside of their organisation without our express written consent.

APPENDIX B

Fieldwork Logs

Percussion Drilling Log

Project Name: Residential Garages off Southbourne Gardens		Client: Landmark Builders Limited		Date: 31/01/2020	
Location: Ruislip HA4 9SW		Contractor:			
Project No. : GWPR3537		Crew Name:		Drilling Equipment:	
Borehole Number WS1	Hole Type WLS	Level	Logged By RF	Scale 1:50	Page Number Sheet 1 of 1

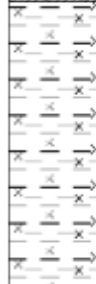
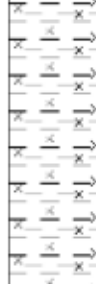
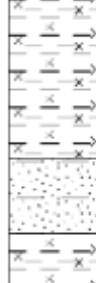
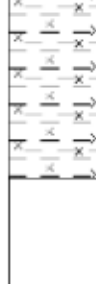
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D		0.20			MADE GROUND: Concrete.	
		0.50	D					LAMBETH GROUP: Dark grey silty CLAY with pockets of dark olive green silt.	
		0.80	D						
		1.00	D		1.00				
		1.00	SPT	N=4 (1,0/0,2,1,1)				LAMBETH GROUP: Orange brown and grey mottled silty CLAY.	1
		1.50	D						
		2.00	D						
		2.00	SPT	N=19 (3,5/5,5,4,5)					2
		2.50	D						
		3.00	D		3.00				
		3.00	SPT	N=14 (4,3/3,3,4,4)				LAMBETH GROUP: Dark orange brown, brown, red and grey mottled silty CLAY.	3
		3.50	D						
		4.00	D		4.00				
		4.00	SPT	N=18 (4,4/4,5,4,5)				LAMBETH GROUP: Dark orange brown and grey mottled silty CLAY.	4
		4.50	D						
		5.00	D						
		5.00	SPT	N=21 (5,6/6,5,5,5)					5
					5.45			End of Borehole at 5.450m	
									6
									7
									8
									9
									10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks No groundwater encountered. No roots noted.										
---	--	--	--	--	--	--	--	--	--	---

Percussion Drilling Log

Project Name: Residential Garages off Southbourne Gardens		Client: Landmark Builders Limited		Date: 31/01/2020	
Location: Ruislip HA4 9SW		Contractor:			
Project No. : GWPR3537		Crew Name:		Drilling Equipment:	
Borehole Number WS2	Hole Type WLS	Level	Logged By RF	Scale 1:50	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D	N=6 (1,1/1,2,2,1)	0.50		TOPSOIL: Dark brown silty clay.	1	
		0.50	D						
		0.80	D						
		1.00	D						
		1.00	SPT						
		1.50	D						
		2.00	D	N=10 (1,2/2,3,2,3)	2.50		LAMBETH GROUP: Grey and orange mottled silty CLAY with pockets of orange silt.	2	
		2.00	SPT						
		2.50	D						
		3.00	D						
		3.00	SPT						
		3.50	D						
		4.00	D	N=23 (5,5/6,6,5,6)	4.00		LAMBETH GROUP: Dark orange brown, brown, red and grey mottled silty CLAY.	3	
		4.00	SPT						
		4.50	D						
		5.00	D						
		5.00	SPT						
		5.50	D						
6.00	D	N=5 (0,0/1,1,2,1)	5.40		LAMBETH GROUP: Dark orange brown and grey mottled silty CLAY.	4			
6.00	SPT								
6.50	D								
7.00	D								
7.00	SPT								
7.45	D								
		N=37 (5,5/7,8,10,12)	5.90		LAMBETH GROUP: Grey very sandy CLAY/very clayey SAND. The sand was fine grained.	5			
6.00	D								
6.00	SPT								
6.50	D	N=181 (12,35/36,41,41,63)	7.45		LAMBETH GROUP: Dark red brown and orange brown mottled silty CLAY.	6			
7.00	D								
7.00	SPT								
		End of Borehole at 7.450m						7	
								8	
								9	
								10	

[illegible]

Remarks

Groundwater encountered at 5.45m bgl. Small roots noted to 4.00m bgl by driller. Borehole refused at 7.00m bgl.

Percussion Drilling Log

Project Name: Residential Garages off Southbourne Gardens		Client: Landmark Builders Limited		Date: 31/01/2020	
Location: Ruislip HA4 9SW		Contractor:			
Project No. : GWPR3537		Crew Name:		Drilling Equipment:	
Borehole Number WS3	Hole Type WLS	Level	Logged By RF	Scale 1:50	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D	N=13 (3,3/4,3,3,3)	0.30			MADE GROUND: Concrete.	1
		0.50	D					LAMBETH GROUP: Grey and orange mottled silty CLAY with pockets of orange silt.	
		0.80	D						
		1.00	D						
		1.00	SPT						
		1.50	D	N=12 (2,4/3,3,3,3)	2.00			LAMBETH GROUP: Dark orange brown, brown, red and grey mottled silty CLAY.	2
		2.00	SPT						
		2.00							
		2.50	D						
		3.00	D						
		3.00	SPT	N=22 (5,6/6,6,5,5)	3.00			LAMBETH GROUP: Grey and grey brown mottled silty CLAY.	3
		3.50	D						
		4.00	D						
		4.00	SPT						
		4.50	D						
		4.00	D	N=18 (4,5/4,4,5,5)	4.00			LAMBETH GROUP: Dark red brown, dark orange brown and grey mottled silty CLAY.	4
		4.00	SPT						
		4.50	D						
5.00	D								
5.00	SPT								
									5
					5.45			End of Borehole at 5.450m	
									6
									7
									8
									9
									10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks	
No groundwater encountered. Small roots noted to 3.00m bgl.	

Probe Log

Probe No
DP2
Sheet 1 of 2

Project Name: Residential Garages off
Southbourne Gardens

Project No.
GWPR3537

Co-ords:

Hole Type
DP

Location: Ruislip HA4 9SW

Level:

Scale
1:25

Client: Landmark Builders Limited

Dates: 31/01/2020

Logged By

Depth (m)	Blows/100mm																								Torque (Nm)
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	
1																									
2																									
3																									
4																									

Remarks:

Fall Height 750

Cone Base Diameter

Hammer Wt 64

Final Depth 8.60

Probe Type DPSH-B



Probe Log

Probe No
DP2
Sheet 2 of 2

Project Name: Residential Garages off Southbourne Gardens

Project No.
GWPR3537

Co-ords:

Hole Type
DP

Location: Ruislip HA4 9SW

Level:

Scale
1:25

Client: Landmark Builders Limited

Dates: 31/01/2020

Logged By

Depth (m)	Blows/100mm																								Torque (Nm)
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	
6																									
7																									
8																									
9																									

Remarks:

Fall Height 750

Cone Base Diameter

Hammer Wt 64

Final Depth 8.60

Probe Type DPSH-B



APPENDIX C
Geotechnical Laboratory Test Results



Summary of Natural Moisture Content, Liquid Limit and Plastic Limit Results

Job No. 27886	Project Name Residential Garages off Southbourne Gardens, Ruislip HA4 9SW	Programme	
		Samples received	14/02/2020
		Schedule received	06/02/2020
Project No. GWPR3537	Client Ground & Water Ltd	Project started	17/02/2020
		Testing Started	26/02/2020

Hole No.	Sample				Soil Description	NMC %	Passing 425µm %	LL %	PL %	PI %	Remarks
	Ref	Top m	Base m	Type							
WS1	-	0.80	-	D	Orangish brown mottled bluish grey slightly gravelly slightly sandy silty CLAY (gravel is fm and sub-angular)	31	98	54	23	31	
WS2	-	0.80	-	D	Orangish brown slightly mottled grey slightly sandy silty CLAY	31					
WS2	-	1.50	-	D	Orangish brown slightly mottled grey slightly gravelly slightly sandy silty CLAY (gravel is fm and sub-angular to rounded)	39					
WS2	-	2.00	-	D	Light brown slightly mottled light grey slightly gravelly slightly sandy silty CLAY (gravel is fm and sub-angular to rounded)	33	95	79	24	55	
WS2	-	2.50	-	D	Reddish brown slightly mottled grey slightly sandy silty CLAY with traces of fine rootlets	16					
WS2	-	3.00	-	D	Brown slightly mottled grey and orangish brown slightly sandy silty CLAY	19	100	48	16	32	
WS2	-	3.50	-	D	Reddish brown slightly mottled grey slightly sandy silty CLAY with traces of fine rootlets	18					
WS2	-	6.00	-	D	Reddish brown slightly mottled grey slightly sandy silty CLAY	20	100	43	17	26	
WS3	-	1.50	-	D	Brown slightly mottled bluish grey slightly gravelly silty CLAY with traces of fine rootlets (gravel is fm and sub-angular to angular)	36	97	90	28	62	

 2519	Test Methods: BS1377: Part 2: 1990: Natural Moisture Content : clause 3.2 Atterberg Limits: clause 4.3 and 5.0	Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU Tel: 01923 711 288 Email: James@k4soils.com	Checked and Approved Initials J.P Date: 28/02/2020
	Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)		MSF-5-R1(b)



Sulphate Content (Gravimetric Method) for 2:1 Soil: Water Extract and pH Value - Summary of Results
Tested in accordance with BS1377 : Part 3 : 2018, Clause 7.6 & Clause 12

Job No.	Project Name
27886	Residential Garages off Southbourne Gardens, Ruislip HA4 9SW

Programme	
Received	14/02/2020
Received	06/02/2020
Started	17/02/2020
Started	21/02/2020

Project No.	Client
GWPR3537	Ground & Water Ltd

[illegible]

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

Checked and Approved	
Initials	J.P
Date:	28/02/2020

Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

MSF-5-R29



Roger Foord
Ground & Water Ltd
2 The Long Barn
Norton Farm
Selborne Road
Alton
Hampshire
GU34 3NB

DETS Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410

DETS Report No: 20-01670

Site Reference: Residential Garages off Southbourne Gardens, Ruislip HA4 9SW

Project / Job Ref: GWPR3537

Order No: None Supplied

Sample Receipt Date: 10/02/2020

Sample Scheduled Date: 10/02/2020

Report Issue Number: 1

Reporting Date: 14/02/2020

Authorised by:

Dave Ashworth
Technical Manager

Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.



DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410



Soil Analysis Certificate						
DETS Report No: 20-01670	Date Sampled	31/01/20	21/01/20			
Ground & Water Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Residential Garages off Southbourne Gardens, Ruislip HA4 9SW	TP / BH No	WS1	WS3			
Project / Job Ref: GWPR3537	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	2.00	1.00			
Reporting Date: 14/02/2020	DETS Sample No	461885	461886			

Determinand	Unit	RL	Accreditation				
pH	pH Units	N/A	MCERTS	8.2	7.5		
Total Sulphate as SO ₄	mg/kg	< 200	NONE	< 200	309		
Total Sulphate as SO ₄	%	< 0.02	NONE	< 0.02	0.03		
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	48	58		
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.05	0.06		
Total Sulphur	%	< 0.02	NONE	< 0.02	< 0.02		
Ammonium as NH ₄	mg/kg	< 0.5	NONE	< 0.5	< 0.5		
Ammonium as NH ₄	mg/l	< 0.05	NONE	< 0.05	< 0.05		
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	6	40		
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	3.1	20.2		
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	< 3	MCERTS	< 3	< 3		
Water Soluble Nitrate (2:1) as NO ₃	mg/l	< 1.5	MCERTS	< 1.5	< 1.5		
W/S Magnesium	mg/l	< 0.1	NONE	5.6	3.2		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C

Subcontracted analysis (S)



DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410



Soil Analysis Certificate - Sample Descriptions

DETS Report No: 20-01670	
Ground & Water Ltd	
Site Reference: Residential Garages off Southbourne Gardens, Ruislip HA4 9SW	
Project / Job Ref: GWPR3537	
Order No: None Supplied	
Reporting Date: 14/02/2020	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
461885	WS1	None Supplied	2.00	18.1	Brown loamy clay
\$ 461886	WS3	None Supplied	1.00	20.9	Brown loamy clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample ^{US}

Unsuitable Sample ^{US}

\$ samples exceeded recommended holding times

Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 20-01670

Ground & Water Ltd

Site Reference: Residential Garages off Southbourne Gardens, Ruislip HA4 9SW

Project / Job Ref: GWPR3537

Order No: None Supplied

Reporting Date: 14/02/2020

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphénylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 - C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450°C	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (all: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (all: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

APPENDIX C

Asset location search



Property Searches

GThirty Consulting Ltd
Neepsend Triangle Business Cen
1 Burton Road
SOUTH YORKSHIRE
S3 8BW

Search address supplied 62
Southbourne Gardens
Ruislip
HA4 9SW

Your reference 08-0052

Our reference ALS/ALS Standard/2020_4148846

Search date 5 February 2020

Knowledge of features below the surface is essential for every development

The benefits of this knowledge not only include ensuring due diligence and avoiding risk, but also being able to ascertain the feasibility of any development.

Did you know that Thames Water Property Searches can also provide a variety of utility searches including a more comprehensive view of utility providers' assets (across up to 35-45 different providers), as well as more focused searches relating to specific major utility companies such as National Grid (gas and electric).

Contact us to find out more.



Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13



searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk



0845 070 9148

Search address supplied: 62, Southbourne Gardens, Ruislip, HA4 9SW

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This search provides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0845 070 9148, or use the address below:

Thames Water Utilities Ltd
Property Searches
PO Box 3189
Slough
SL1 4WW

Email: searches@thameswater.co.uk

Web: www.thameswater-propertysearches.co.uk

Waste Water Services

Please provide a copy extract from the public sewer map.

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority.

Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners.

This report relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus.

The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended these details be checked with the developer.

Clean Water Services

Please provide a copy extract from the public water main map.

With regard to the fresh water supply, this site falls within the boundary of another water company. For more information, please redirect your enquiry to the following address:

Affinity Water Ltd
Tamblin Way
Hatfield
AL10 9EZ
Tel: 0345 3572401

Asset location search



Property Searches

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0845 920 0800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

If you have any questions regarding sewer connections, budget estimates, diversions, building over issues or any other questions regarding operational issues please direct them to our service desk. Which can be contacted by writing to:

Developer Services (Waste Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

Clean Water queries

Should you require any advice concerning clean water operational issues or clean water connections, please contact:

Developer Services (Clean Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 511116,187353

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Based on the Ordnance Survey Map with the Sanction of the controller of H.M. Stationery Office, License no. 100019345 Crown Copyright Reserved.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
1307	48.84	47.85
0303	47.95	46.19
0302	47.63	46.7
031G	n/a	n/a
031F	n/a	n/a
031E	n/a	n/a
031D	n/a	n/a
0405	49.86	n/a
0406	49.88	n/a
0404	49.86	n/a
0403	49.92	n/a
0201	45.84	44.51
021A	n/a	n/a
0206	45.83	44.52
021D	n/a	n/a
021B	n/a	n/a
021C	n/a	n/a
0207	46.52	44.6
0208	46.56	44.66
0301	46.52	45.12
1316	46.69	45.87
1312	46.97	44.96
031B	n/a	n/a
1315	46.83	46.01
1304	47.02	45.55
031A	n/a	n/a
1309	47	46.17
1313	48.8	46.81
1303	46.94	45.67
131A	n/a	n/a
1311	48.81	47.79
1302	46.99	45.75
1308	46.99	46.19
0304	47.01	45.66
031C	n/a	n/a
1305	47.05	45.92
1306	47.47	46.32
1301	47.04	46.07
The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.		



ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

	Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.		Trunk Foul
	Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.		Trunk Surface Water
	Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.		Trunk Combined
	Storm Relief		Bio-solids (Sludge)
	Vent Pipe		Proposed Thames Water Foul Sewer
	Proposed Thames Surface Water Sewer		Proposed Thames Water Foul Sewer
	Gallery		Foul Rising Main
	Surface Water Rising Main		Combined Rising Main
	Sludge Rising Main		Proposed Thames Water Rising Main
	Vacuum		

Notes:

- 1) All levels associated with the plans are to Ordnance Datum Newlyn.
- 2) All measurements on the plans are metric.
- 3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
- 4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
- 5) 'na' or '0' on a manhole level indicates that data is unavailable.

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

	Air Valve
	Dam Chase
	Fitting
	Meter
	Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

	Control Valve
	Drop Pipe
	Ancillary
	Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

	Outfall
	Undefined End
	Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

	Public/Private Pumping Station
	Change of characteristic indicator (C.O.C.I.)
	Invert Level
	Summit

Areas

Lines denoting areas of underground surveys, etc.

	Agreement
	Operational Site
	Chamber
	Tunnel
	Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

	Foul Sewer		Surface Water Sewer
	Combined Sewer		Gully
	Culverted Watercourse		Proposed
			Abandoned Sewer

- 6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Terms and Conditions

All sales are made in accordance with Thames Water Utilities Limited (TWUL) standard terms and conditions unless previously agreed in writing.

1. All goods remain in the property of Thames Water Utilities Ltd until full payment is received.
2. Provision of service will be in accordance with all legal requirements and published TWUL policies.
3. All invoices are strictly due for payment 14 days from due date of the invoice. Any other terms must be accepted/agreed in writing prior to provision of goods or service, or will be held to be invalid.
4. Thames Water does not accept post-dated cheques-any cheques received will be processed for payment on date of receipt.
5. In case of dispute TWUL's terms and conditions shall apply.
6. Penalty interest may be invoked by TWUL in the event of unjustifiable payment delay. Interest charges will be in line with UK Statute Law 'The Late Payment of Commercial Debts (Interest) Act 1998'.
7. Interest will be charged in line with current Court Interest Charges, if legal action is taken.
8. A charge may be made at the discretion of the company for increased administration costs.

A copy of Thames Water's standard terms and conditions are available from the Commercial Billing Team (cashoperations@thameswater.co.uk).

We publish several Codes of Practice including a guaranteed standards scheme. You can obtain copies of these leaflets by calling us on 0800 316 9800

If you are unhappy with our service you can speak to your original goods or customer service provider. If you are not satisfied with the response, your complaint will be reviewed by the Customer Services Director. You can write to her at: Thames Water Utilities Ltd. PO Box 492, Swindon, SN38 8TU.

If the Goods or Services covered by this invoice falls under the regulation of the 1991 Water Industry Act, and you remain dissatisfied you can refer your complaint to Consumer Council for Water on 0121 345 1000 or write to them at Consumer Council for Water, 1st Floor, Victoria Square House, Victoria Square, Birmingham, B2 4AJ.

Ways to pay your bill

Credit Card	BACS Payment	Telephone Banking	Cheque
Call 0845 070 9148 quoting your invoice number starting CBA or ADS / OSS	Account number 90478703 Sort code 60-00-01 A remittance advice must be sent to: Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW. or email ps.billing@thameswater.co.uk	By calling your bank and quoting: Account number 90478703 Sort code 60-00-01 and your invoice number	Made payable to ' Thames Water Utilities Ltd ' Write your Thames Water account number on the back. Send to: Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW or by DX to 151280 Slough 13

Thames Water Utilities Ltd Registered in England & Wales No. 2366661 Registered Office Clearwater Court, Vastern Rd, Reading, Berks, RG1 8DB.

APPENDIX D



Scale Bar
0 1 2 3 4 5 6 7 8 9 10 Metres

1:200 @ A1

Notes:

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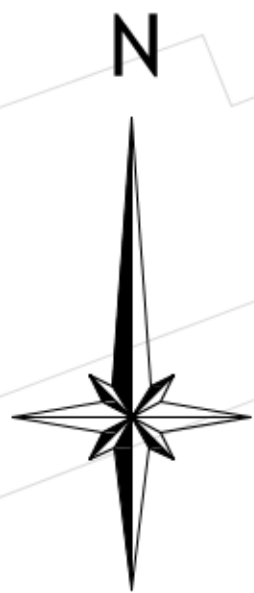
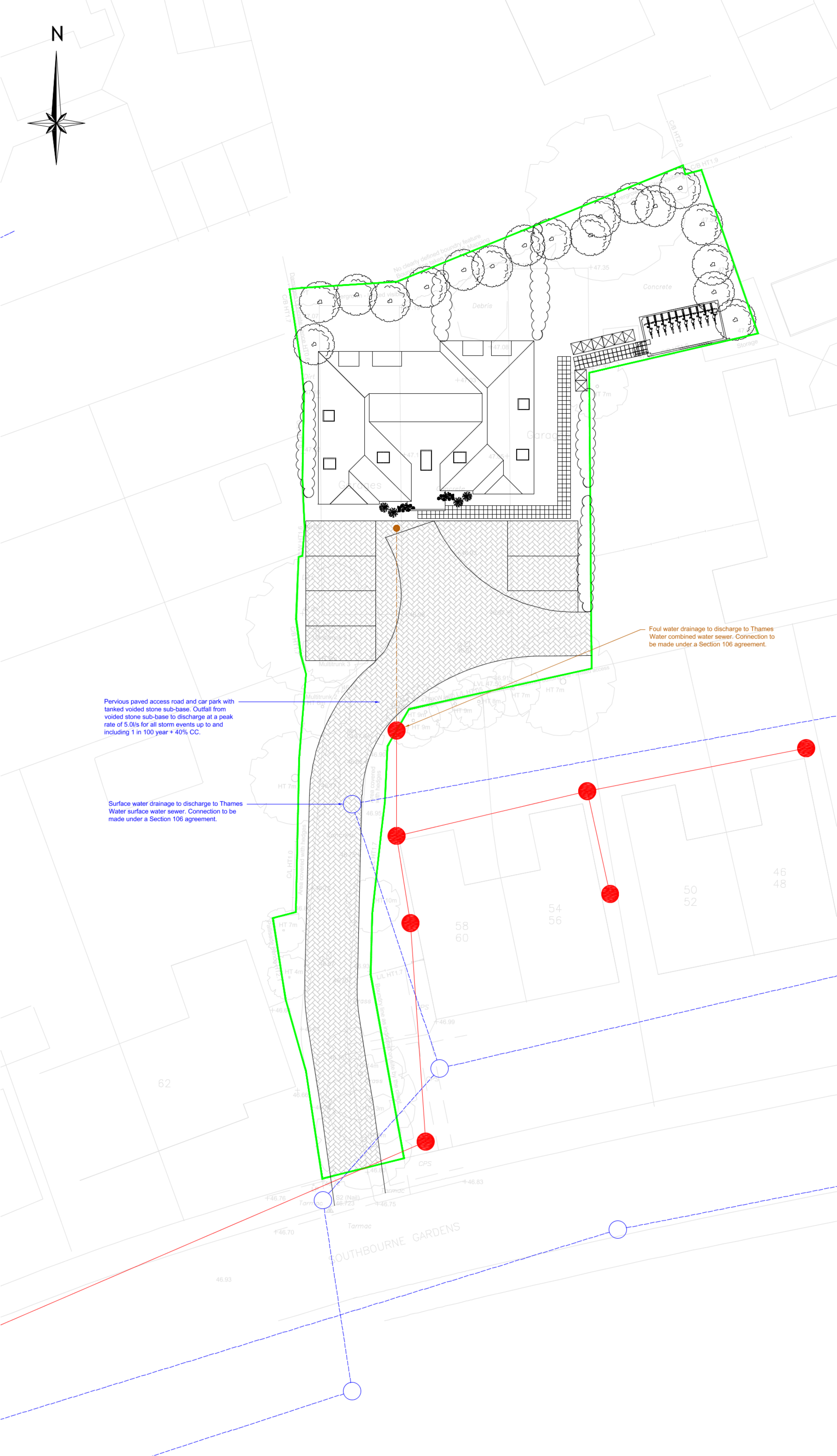
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Please refer to structural engineer's drawings
and calculations for all structural design.

Revision	Date	Description
m. j. d. architecture DESIGN WITH FLAIR 2A Allyn Park Southall Middlesex UB2 9QT Tel: 020 8571 3987 Fax: 020 8574 2766		
Name Landmark Builders Ltd.		
Site Garages Site, Southbourne Gardens Ruislip HA4 9SW		
Title Proposed Site Plan		
Scale 1:200 on A1 paper		
Date Feb. 2020		Rev. A
Dwg.No. 1547.A1.PL02		

PROPOSED SITE PLAN

APPENDIX E



- G30 Consulting Ltd**
- Copyright © 2019 G30 Consulting Ltd. All rights reserved.
- Copying of these plans in full or in part is not permitted unless the written consent of G30 Consulting Ltd is obtained.
- General Notes**
1. Do not scale this drawing.
 2. All dimensions are in millimeters unless stated otherwise.
 3. This drawing is to be read in conjunction with all other relevant drawings & specifications.
 4. All proprietary items to be installed in strict compliance with manufacturers instructions and recommendations.
 5. No works shall commence on site until approval has been obtained from all relevant Agencies / Authorities.
 6. All dimensions referred to in this drawing must be verified.

P1	First Issue	24.03.2020
Revision	Description	Date

PRELIMINARY



59 Springfield Road, Sheffield, South Yorkshire, S7 2GG
W: www.g30consulting.com
E: enquiries@g30consulting.com
T: 0114 349 2720

Project Landmark Builders Ltd Southbourne Gardens, Ruislip		
Title Foul and Surface Water Drainage Layout		

Drawn by SG	Checked by SG	Paper Size A1
Drawing Number 08-0052-001	Revision P1	Scale 1:125
		Date 24.03.2020

APPENDIX F

G30 Consulting Ltd		Page 1
Unit 6 Neepsend Triangle Business 1 Burton Road Sheffield S3 8BW	Southbourne Gardens, Ruislip 1 in 100 Year + 40% CC Attenuation Calculations	
Date 24/03/2020 File Pervious Paving.SRCX	Designed by S. Griffiths Checked by S. Griffiths	
XP Solutions	Source Control 2017.1.2	

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 39 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.105	0.105	0.0	3.4	3.4	9.4	O K
30 min Summer	9.127	0.127	0.0	4.4	4.4	11.4	O K
60 min Summer	9.139	0.139	0.0	4.7	4.7	12.5	O K
120 min Summer	9.139	0.139	0.0	4.7	4.7	12.5	O K
180 min Summer	9.132	0.132	0.0	4.5	4.5	11.9	O K
240 min Summer	9.123	0.123	0.0	4.3	4.3	11.1	O K
360 min Summer	9.110	0.110	0.0	3.7	3.7	9.9	O K
480 min Summer	9.101	0.101	0.0	3.2	3.2	9.0	O K
600 min Summer	9.093	0.093	0.0	2.9	2.9	8.4	O K
720 min Summer	9.087	0.087	0.0	2.6	2.6	7.8	O K
960 min Summer	9.078	0.078	0.0	2.2	2.2	7.0	O K
1440 min Summer	9.065	0.065	0.0	1.6	1.6	5.9	O K
2160 min Summer	9.054	0.054	0.0	1.2	1.2	4.8	O K
2880 min Summer	9.048	0.048	0.0	1.0	1.0	4.3	O K
4320 min Summer	9.041	0.041	0.0	0.7	0.7	3.7	O K
5760 min Summer	9.037	0.037	0.0	0.6	0.6	3.3	O K
7200 min Summer	9.033	0.033	0.0	0.5	0.5	3.0	O K
8640 min Summer	9.031	0.031	0.0	0.4	0.4	2.8	O K
10080 min Summer	9.029	0.029	0.0	0.4	0.4	2.6	O K
15 min Winter	9.118	0.118	0.0	4.1	4.1	10.6	O K
30 min Winter	9.144	0.144	0.0	4.8	4.8	12.9	O K
60 min Winter	9.154	0.154	0.0	5.0	5.0	13.9	O K
120 min Winter	9.146	0.146	0.0	4.9	4.9	13.2	O K
180 min Winter	9.132	0.132	0.0	4.5	4.5	11.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	144.018	0.0	11.0	19
30 min Summer	93.832	0.0	14.8	29
60 min Summer	58.167	0.0	18.9	46
120 min Summer	34.816	0.0	22.9	78
180 min Summer	25.441	0.0	25.2	110
240 min Summer	20.245	0.0	26.8	142
360 min Summer	14.656	0.0	29.2	202
480 min Summer	11.648	0.0	31.0	264
600 min Summer	9.740	0.0	32.4	326
720 min Summer	8.412	0.0	33.5	386
960 min Summer	6.670	0.0	35.4	508
1440 min Summer	4.802	0.0	38.1	752
2160 min Summer	3.452	0.0	40.9	1108
2880 min Summer	2.729	0.0	42.8	1472
4320 min Summer	1.957	0.0	45.3	2204
5760 min Summer	1.544	0.0	47.1	2936
7200 min Summer	1.284	0.0	48.3	3672
8640 min Summer	1.104	0.0	49.1	4400
10080 min Summer	0.972	0.0	49.6	5136
15 min Winter	144.018	0.0	12.5	19
30 min Winter	93.832	0.0	16.8	30
60 min Winter	58.167	0.0	21.4	48
120 min Winter	34.816	0.0	25.8	84
180 min Winter	25.441	0.0	28.4	116

G30 Consulting Ltd		Page 2
Unit 6 Neepsend Triangle Business 1 Burton Road Sheffield S3 8BW	Southbourne Gardens, Ruislip 1 in 100 Year + 40% CC Attenuation Calculations	
Date 24/03/2020 File Pervious Paving.SRCX	Designed by S. Griffiths Checked by S. Griffiths	
XP Solutions	Source Control 2017.1.2	

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	9.120	0.120	0.0	4.2	4.2	10.8	O K
360 min Winter	9.104	0.104	0.0	3.4	3.4	9.3	O K
480 min Winter	9.092	0.092	0.0	2.8	2.8	8.3	O K
600 min Winter	9.084	0.084	0.0	2.5	2.5	7.6	O K
720 min Winter	9.078	0.078	0.0	2.2	2.2	7.0	O K
960 min Winter	9.068	0.068	0.0	1.7	1.7	6.2	O K
1440 min Winter	9.055	0.055	0.0	1.3	1.3	5.0	O K
2160 min Winter	9.046	0.046	0.0	0.9	0.9	4.1	O K
2880 min Winter	9.042	0.042	0.0	0.7	0.7	3.7	O K
4320 min Winter	9.035	0.035	0.0	0.5	0.5	3.2	O K
5760 min Winter	9.031	0.031	0.0	0.4	0.4	2.8	O K
7200 min Winter	9.028	0.028	0.0	0.3	0.3	2.5	O K
8640 min Winter	9.026	0.026	0.0	0.3	0.3	2.3	O K
10080 min Winter	9.024	0.024	0.0	0.3	0.3	2.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	20.245	0.0	30.2	146
360 min Winter	14.656	0.0	32.9	210
480 min Winter	11.648	0.0	34.9	272
600 min Winter	9.740	0.0	36.5	332
720 min Winter	8.412	0.0	37.8	392
960 min Winter	6.670	0.0	39.9	520
1440 min Winter	4.802	0.0	42.9	756
2160 min Winter	3.452	0.0	46.2	1104
2880 min Winter	2.729	0.0	48.4	1472
4320 min Winter	1.957	0.0	51.3	2208
5760 min Winter	1.544	0.0	53.4	2952
7200 min Winter	1.284	0.0	54.8	3584
8640 min Winter	1.104	0.0	55.9	4272
10080 min Winter	0.972	0.0	56.6	5144

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File Pervious Paving.SRCX	Checked by S. Griffiths	
XP Solutions	Source Control 2017.1.2	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.500	Shortest Storm (mins)	15
Ratio R	0.417	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.047

Time (mins) Area			Time (mins) Area		
From:	To:	(ha)	From:	To:	(ha)
0	5	0.032	5	10	0.015

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XP Solutions	Source Control 2017.1.2	

Model Details

Storage is Online Cover Level (m) 10.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	30.0
Max Percolation (l/s)	83.3	Slope (1:X)	0.0
Safety Factor	1.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.000	Membrane Depth (m)	0

Orifice Outflow Control

Diameter (m) 0.085 Discharge Coefficient 0.600 Invert Level (m) 9.000

APPENDIX G

Operation and maintenance requirements for Rainwater Harvesting (Waterbutts)		
Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Inspection of the tank for debris and sediment build-up, inlets/outlets/withdrawal devices, overflow areas, pumps, filters.	Annually (and following poor performance)
	Cleaning of tank inlets, outlets, gutters, withdrawal devices and roof drain filters of silts and other debris.	Annually (and following poor performance)
Occasional maintenance	Cleaning and/or replacement of any filters.	Three monthly (or as required)
Remedial actions	Repair of overflow erosion damage or damage to tank	As required
	Pump repairs	As required

Maintenance procedures must be carried out as per CIRIA guidance C753 - The SuDS Manual page 229.

Operation and maintenance requirements for Proprietary Treatment Systems		
Maintenance Schedule	Required Action	Typical Frequency
Regular Inspections	Remove litter and debris and inspect for sediment, oil and grease accumulation	Six monthly
	Change the filter media	As recommended by manufacturer
	Remove sediment, oil, grease and floatables	As necessary- indicated by system inspections or immediately following significant spill
Regular Maintenance	Replacement of any filters	Three monthly (or as required)
Remedial Actions	Inspect for evidence of poor operation	Six monthly
	Inspect filter media and establish appropriate replacement frequencies	Six monthly
	Inspect sediment accumulation rates and establish appropriate removal frequencies	Monthly during first half year of operation, then every six months

Maintenance procedures must be carried out as per CIRIA guidance C753 - The SuDS Manual page 287.

Operation and maintenance requirements for Trees		
Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Remove litter and debris.	Monthly (or as required)
	Manage other vegetation and remove nuisance plants.	Monthly (at start, then as required).
Occasional maintenance	Check tree health and manage tree appropriately.	Annually
	Remove silt build-up from inlets and surface and replace mulch as necessary.	Annually, or as required.
	Water.	As required (in periods of drought).
Monitoring	Inspect silt accumulation rates and establish appropriate removal frequencies.	Half yearly

Maintenance procedures must be carried out as per CIRIA guidance C753 - The SuDS Manual page 382.

Operation and maintenance requirements for Pervious Pavements		
Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface).	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.
Occasional Maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying.	As required – once per year on less frequently used pavements.
Remedial Actions	Remediate and landscaping which through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving.	As required.
	Remedial works to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material.	As required.
	Rehabilitation of surface and upper substructure by remedial sweeping.	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging).

Monitoring	Initial inspection	Monthly for the three months after installation.
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action.	Three-monthly, 48 hours after large storms in first six months.
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually
	Monitor inspection chambers.	Annually

Maintenance procedures must be carried out as per CIRIA guidance C753 - The SuDS Manual page 430.