

Drainage Strategy Report

Acorn Lodge Development at

Pindar Oaks, Upper Sheffield Road, Barnsley, S70 4PX



For
CAS Behavioural Health
October 2017

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15689-L-RP-001 R1



Scope

This report has been commissioned by CAS Behavioural Health to assess the potential drainage proposals for the development at Pindar Oaks, Upper Sheffield Road, Barnsley.

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Report Ref:	15689-L-RP-001 R1	
Prepared by:	Alexander Platten	
Checked by:	Gavin Shepherd	

Revision	Comments	Date
R1	Initial Issue.	

Notation

DIA	Drainage Impact Assessment
EA	Environment Agency
FRA	Flood Risk Assessment
IDB	Internal Drainage Board
LLFA	Lead Local Flood Authority
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems

Contents

1. Introduction	1
1.1 Background.....	1
1.2 Existing Site	1
1.3 Proposed Development.....	1
1.4 Topography, Hydrology and Geology.....	1
2. Flood Risk	1
3. Existing Drainage.....	2
4 Surface Water Drainage Proposals.....	2
4.1 Sustainable Drainage Systems	2
4.2 Drainage Via Infiltration	3
4.3 Drainage to Watercourse	3
4.4 Drainage to Public Sewer.....	3
4.5 Attenuation Requirements	3
4.6 Maintenance Requirements	4
5. Foul Water Drainage Proposals	5
6. Conclusions	6
7. References	7

Appendices

Appendix I	Existing Site Layout
Appendix II	Site Layout Plans
Appendix III	Existing Drainage Layout
Appendix IV	Impermeable Areas Plan
Appendix V	Soakaway Test Report
Appendix VI	Microdrainage Storage Calculations
Appendix VII	Schematic Drainage Layout

1. Introduction

1.1 Background

Mason Clark Associates has been commissioned by CAS Behavioural Health to undertake a Drainage Strategy Report for a development at Pindar Oaks, Upper Sheffield Road in Barnsley.

This drainage assessment is carried out in accordance with the requirements of the National Planning Policy Guidance (NPPG), Environment Agency Guidance Note 3 and part H of the Building Regulations.

The objective of the assessment is to demonstrate that a drainage solution exists for the site, not to produce a technical design.

1.2 Existing Site

The site lies on previously developed land, which currently houses an area of hard surfacing for a sports surface, and the foundations for the northern block of the proposed development.

An existing site plan can be found in Appendix I of this report.

1.3 Proposed Development

The current proposal for the site consists of the construction of a new care facility for CAS Behavioural Health.

Layout plans can be found in Appendix II of this report.

1.4 Topography, Hydrology and Geology

Topographical levels at the site lie at approximately 121.00m AOD, while the adjacent access road lies slightly raised at approximately 122.500m AOD. Levels across the entire hospital site fall from west to east, where the site is situated at a lower elevation than Upper Sheffield Road.

Data from the BGS suggests that the bedrock beneath the site consists of Sandstone from the Woolley Edge Rock formation. There are no recorded superficial geological deposits at the site.

Ground investigation works carried out at the site show made ground down to a depth of 0.25-0.45m bgl, followed by sandy gravelly clay down to 0.97-1.95m bgl, below which lies the sandstone bedrock.

2. Flood Risk

According to Flood Risk maps provided by the Environment Agency the site is located in flood zone 1, which is land designated as having less than a 1 in 1,000 annual probability of river or sea flooding. However there may still be a risk from other sources of flooding at the site, such as surface water and groundwater, which are not considered within the flood zone designations.

In order to fully assess the risk of flooding to the proposed development, a separate Flood Risk Assessment should be carried out in accordance with available guidance from the EA/planning authority.

3. Existing Drainage

There is a substantial amount of existing drainage at the site, comprising both public and private systems. A 300mm diameter public sewer flows south-to-north through the centre of the site, between an existing building and the development site. Private surface water drainage on the eastern side of the site follows the site contours, draining to a soakaway on the eastern border. Drainage in the area immediately surrounding the development site drains to attenuation located beneath the car park, after which it discharges to the public sewer at a restricted rate of 2 l/s.

Foul drainage for the entire site drains to a single manhole located at the north-east corner of the development site. Foul drainage from the eastern side of the site is pumped up to this manhole via a rising main at a rate of 2 l/s.

According to as built drawings from JNM Engineering, the only area of the development site which is currently formally drained is the hard court, which comprises an area of 736.9m². This connects into a drain which runs along the eastern side of the development site and into the attenuation.

A plan of the existing drainage at the site can be found in Appendix III.

4 Surface Water Drainage Proposals

Section H3 of the Building Regulations 2010 states that the hierarchy for surface water disposal should be considered, where priority is given to; 1. Infiltration systems, 2. Watercourses and as a last resort 3. The public sewer.

The impermeable area of the proposed site equates to 1084m². Taking into consideration the existing impermeable area of 736.9m², this results in a net increase of 347.1m².

A plan of the impermeable areas can be found in Appendix IV.

4.1 Sustainable Drainage Systems

Sustainable drainage Overview

Drainage systems can contribute to sustainable development and improve urban design, by balancing the different issues that influence the development of communities. Approaches to manage surface water that take account of water quantity (flooding), water quality (pollution) and amenity issues are collectively referred to as Sustainable Drainage Systems (SuDS).

SuDS mimic nature and typically manage rainfall close to where it falls. SuDS can be designed to slow water down (attenuate) before it enters streams, rivers and other watercourses, they provide areas to store water in natural contours and can be used to allow water to soak (infiltrate) into the ground or evaporated from surface water and lost or transpired from vegetation (known as evapotranspiration).

SuDS are technically regarded a sequence of management practices, control structures and strategies designed to efficiently and sustainably drain surface water, while minimising pollution and managing the impact on water quality of local water bodies.

SuDS are more sustainable than traditional drainage methods because they:

- Manage runoff volumes and flow rates from hard surfaces, reducing the impact of urbanisation on flooding
- Protect or enhance water quality (reducing pollution from runoff)
- Protect natural flow regimes in watercourses
- Are sympathetic to the environment and the needs of the local community
- Provide an attractive habitat for wildlife in urban watercourses
- Provide opportunities for evapotranspiration from vegetation and surface water
- Encourage natural groundwater/aquifer recharge (where appropriate)
- Create better places to live, work and play.

SuDS principles

Sustainable drainage is a departure from the traditional approach to draining sites. There are some key principles that influence the planning and design process enabling SuDS to mimic natural drainage by:

- Storing runoff and releasing it slowly (attenuation)
- Allowing water to soak into the ground (infiltration)
- Slowly transporting (conveying) water on the surface
- Filtering out pollutants
- Allowing sediments to settle out by controlling the flow of the water

The above was taken from www.susdrain.org

4.2 Drainage Via Infiltration

Percolation testing has been carried out at the site, and it has been shown that the ground is practically impermeable at the location of the development. Therefore, it is not recommended that surface water is discharged via infiltration.

The soakaway test results can be found in Appendix V.

4.3 Drainage to Watercourse

There are no nearby watercourses within the vicinity of the site.

4.4 Drainage to Public Sewer

As percolation testing has shown the site to be unsuitable for the discharge of surface water, then surface water should be discharged to the public sewer. As there is an existing surface water system present at the site, it is recommended to connect into this drain as to avoid creating new connections onto the public sewer. The attenuation for the development should be based on an additional impermeable area of 347.1m² and the restricted discharge rate of 2 l/s, and should be designed to ensure that the proposed invert levels do not result in surcharging at the development due to levels lying below the existing attenuation.

4.5 Attenuation Requirements

In order to ensure that flood risk in the surrounding area is not increased as a result of the development it is required to store surface water runoff on site up to and including the 1 in 100 year event, plus a factor of 30% to account for an increase in rainfall intensity as a result of climate change.

General practice for Local Authorities states that surface water up to the 1 in 30 year event plus 30% for climate change is to be stored below ground/within dedicated attenuation systems, such as geocellular crates or a retention basin. Additional surface water from the 1 in 100 year event plus 30% can be stored above ground in areas of hardstanding, where site levels are designed to retain water in low risk areas such as car parks, and the drainage system is designed as to allow for surcharging during this event.

The feasibility of storing surface water above ground via design of site levels should be determined at the detailed design stage. Otherwise, attenuation should be sized as to store all runoff up to and including the 1 in 100 year event, plus 30% for climate change. As the existing attenuation already allows for the 736.9m² of impermeable area from the existing site, the storage should be sized to cater for the net increase of 347.1m².

Assuming that surface water is discharged to the public sewer at a restricted rate of 2 l/s as per the existing hydrobrake, estimated storage volumes are given in table 1 below. Geocellular storage crates have been used to model the attenuation.

Table 1: Storage Estimations

	1 in 30 year event (m³)	1 in 100 year event (m³)
Current Year	4.3	6.8
Plus 30% Climate Change	6.3	9.6

Due to the relatively low volumes given above, and the rapid change in levels across the site, it is recommended that all surface water is stored below ground for up to the 1 in 100 year event plus 30%. Full storage calculations should be carried out at the detailed design stage.

Microdrainage storage calculations can be found in Appendix VI. A schematic drainage layout can be found in Appendix VII.

4.6 Maintenance Requirements

The maintenance regime for the site will depend on the extents of the adoptable drainage system and the method of surface water attenuation. Yorkshire Water will generally adopt the following systems:

- Underground concrete structures including the following:
 - Oversized Pipes
 - Box Culverts
 - Carlow tanks
- Above ground *offline* storage structures including the following:
 - Detention basins
 - Swales

Once detailed proposals are available consultation should be opened with Yorkshire Water with a view towards establishing what systems will be accepted for adoption. Other systems, such as geocellular storage crates and soakaways will not be considered for adoption, and maintenance would be privately managed.

An indicative maintenance regime for geocellular crates can be found in table 2 below:

Table 2: Maintenance Schedule for Geocellular Storage Crates

Schedule	Required Action	Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Months for 3 months, then annually
	Remove sediment from pre-treatment structures and/or internal forbays.	Annually, or as required
Remedial Action	Repair/rehabilitate inlets, outlets and vents	Annually, or as required
Monitoring	Inspect/check all inlets, outlets and vents	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years, or as required.

5. Foul Water Drainage Proposals

It is recommended that all foul water is discharged via gravity to the existing foul drain, which is located along the eastern boundary of the development. Outlets from kitchen areas should be fitted with a grease trap, as to prevent grease and fats from kitchen waste from entering the public sewer system.

A schematic drainage layout can be found in Appendix VII.

6. Conclusions

- The existing site is considered to be developed, and has an existing impermeable area of 736.9m².
- The total area of the site is 2884 m². The proposed impermeable areas of the site total 1084m². The net increase in impermeable area is therefore 347.1m².
- The existing surface water drainage across the hospital site consists of 2 separate systems; surface water on the eastern side of the site is drained to a soakaway, while surface water on the western side/arising from the access road is stored in attenuation within the car park and discharged to the public sewer at 2 l/s. Foul water across the site is discharged to the public sewer from a manhole at the north-eastern corner of the development site, and foul water from the eastern side of the site is pumped up to this manhole via a rising main at 2 l/s.
- Soakaway testing has shown that infiltration methods of surface water disposal would not be suitable for this site.
- There are no watercourses in the nearby vicinity to allow for surface water discharge to watercourse.
- It is recommended that surface water is discharged to the existing surface water drain to the east of the site, making use of the existing hydrobrake to ultimately discharge the surface water to the public sewer.
- Based on the net increase in impermeable area of 347.1m², the required storage volume for the 1 in 100 year event plus 30% climate change is 9.6m³.
- It is recommended to store all surface water from the above event underground within a dedicated storage medium such as geocellular storage crates or oversized pipes.
- The maintenance regime for the attenuation system will depend upon the type of system specified and whether the storage is offered up for adoption to Yorkshire Water. Once more details are available consultation should be opened up with Yorkshire Water with a view towards their requirements for adopting the attenuation system. Otherwise, maintenance would be privately managed by the client, or a third party on the client's behalf.
- Foul water should be discharged via gravity to the adjacent public sewer or existing foul drain. All outlets from kitchen/food preparation areas should be fitted with a grease trap.

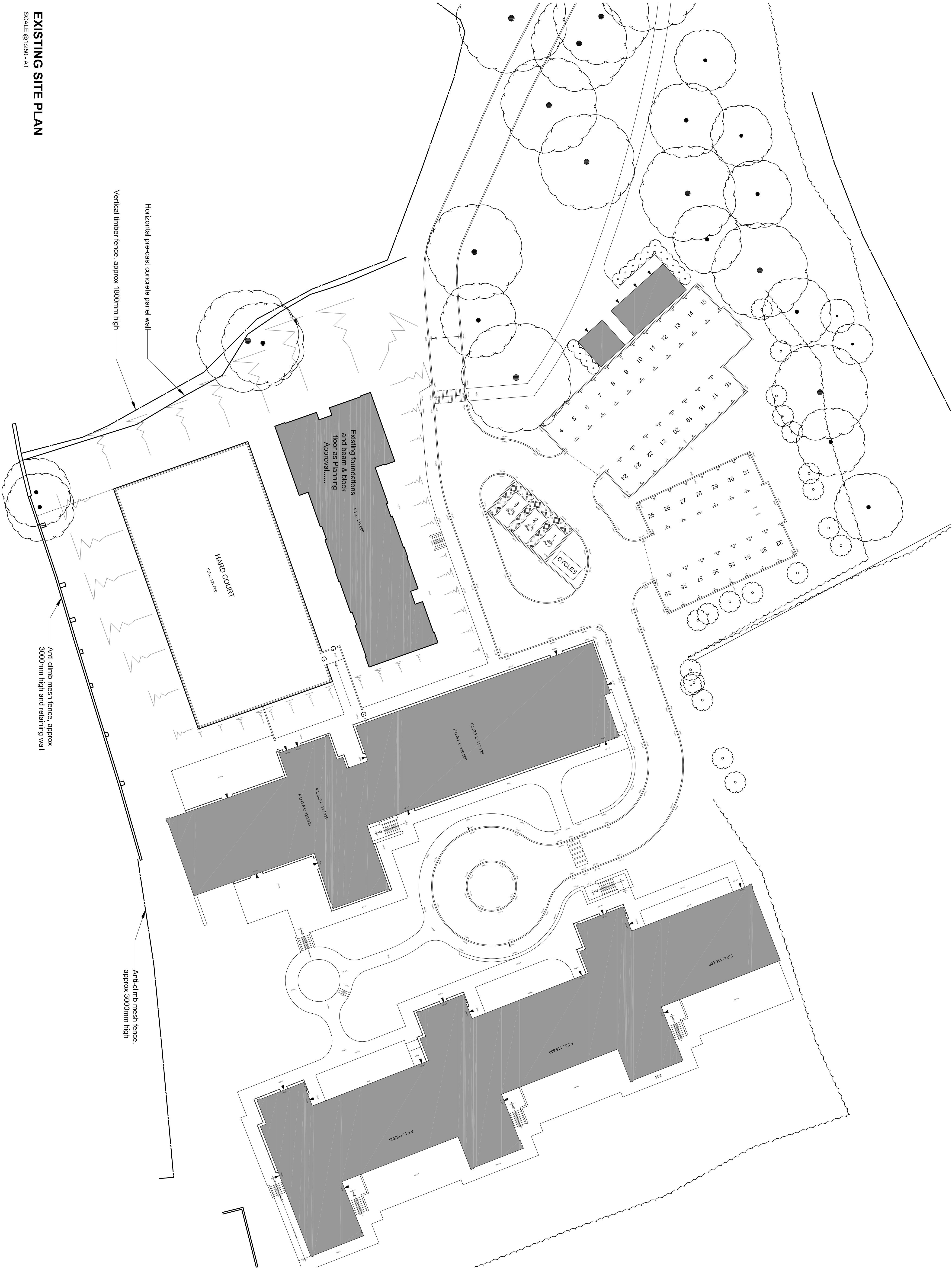
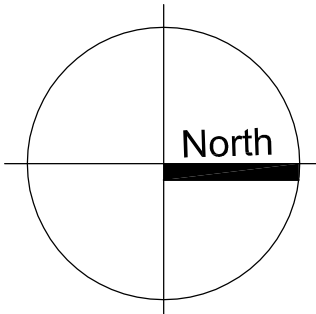
7. References

- National Planning Policy Framework - <https://www.gov.uk/government/publications/national-planning-policy-framework--2>
- UK Building Regulations – Approved Documents - <http://www.planningportal.gov.uk/buildingregulations/approveddocuments/>
- Climate Change Allowances for Planners - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/296964/LIT_8496_5306da.pdf

Appendix I

Existing Site Layout

Notes:
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Drawings:
Contractors must verify all dimensions on site before commencing any work or construction. Dimensions are given in millimetres and metres. Dimensions are given to the centre of the building unless otherwise stated.
Building works are liable to adjustment over the course of the design process due to the ongoing construction detailing developments.
Risk Assessment:
In accordance with CDM Regulation 7, 11 & 15, significant hazards have been identified and assessed. The assessment is based on the current design and is subject to change as the design evolves. The assessment is based on the current design and is subject to change as the design evolves.
Refer to the current Designer Risk Assessment Schedule for further details.



PLANNING

ar2 architects ltd

architects urban design interior design

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Project: ACORN LODGE
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20 BEDROOM RESIDENTIAL FACILITY

Client: CUS BEHAVIOURAL HEALTH

Drawing Title: EXISTING SITE PLAN Drawing Size: A1

Drawn: MW	Date: 06/08/2017	Scale: 1:200	Created: -
Reviewed by: RMB	Drawing No.: (00)041	Rev.: P1	

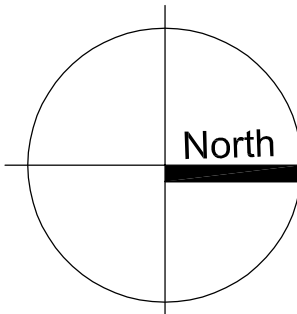
Appendix II

Site Layout Plans

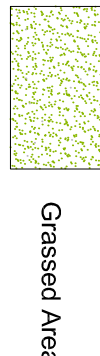
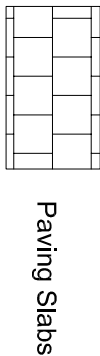
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Notes:
1. Building areas are based on adjustment over the course of the design process due to the ongoing construction detailing developments.
2. This drawing is not to be scaled. Use figured dimensions only. Subject to statutory approvals and survey.

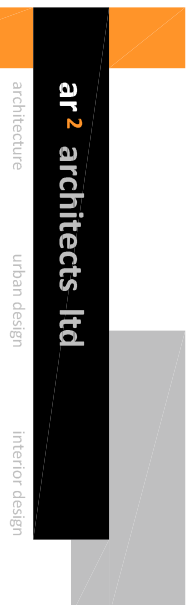
Notes:
1. Building areas are based on adjustment over the course of the design process due to the ongoing construction detailing developments.
2. This drawing is not to be scaled. Use figured dimensions only. Subject to statutory approvals and survey.



Key



PLANNING



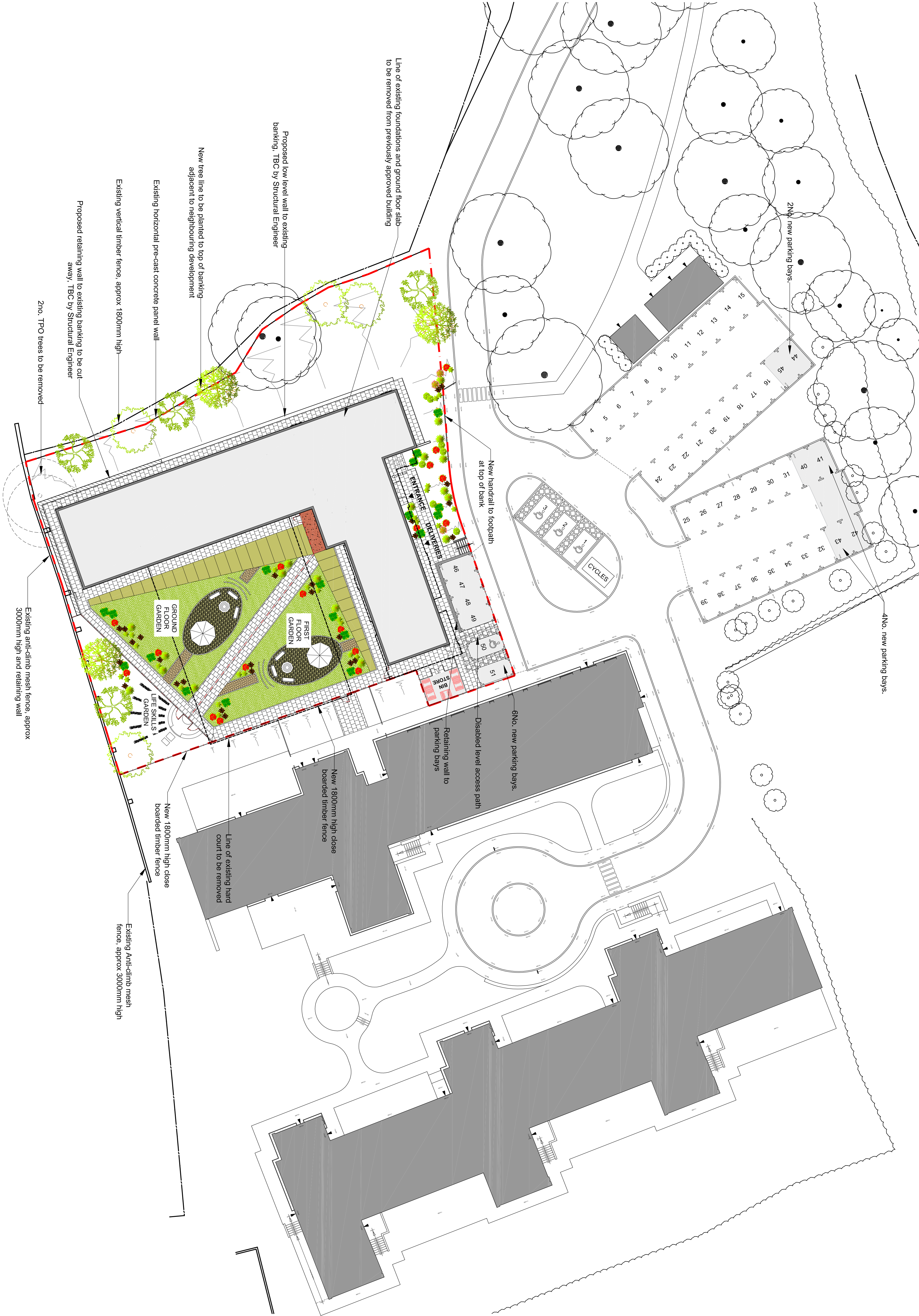
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Project: ACOORN LODGE
UPPER SHEPHERD ROAD, BARNLEY, S70 4PL
20 BEDROOM A&B1 FACILITY

Client: CDS BEHAVIOURAL HEALTH

Drawing Title: PROPOSED SITE PLAN Drawing Size: A1

Drawn By:	Date: 21.07.2017	Scale: 1:250	Cont'd: -
Reviewed By:	Drawing No:	Rev:	
888	1000-01	P1	

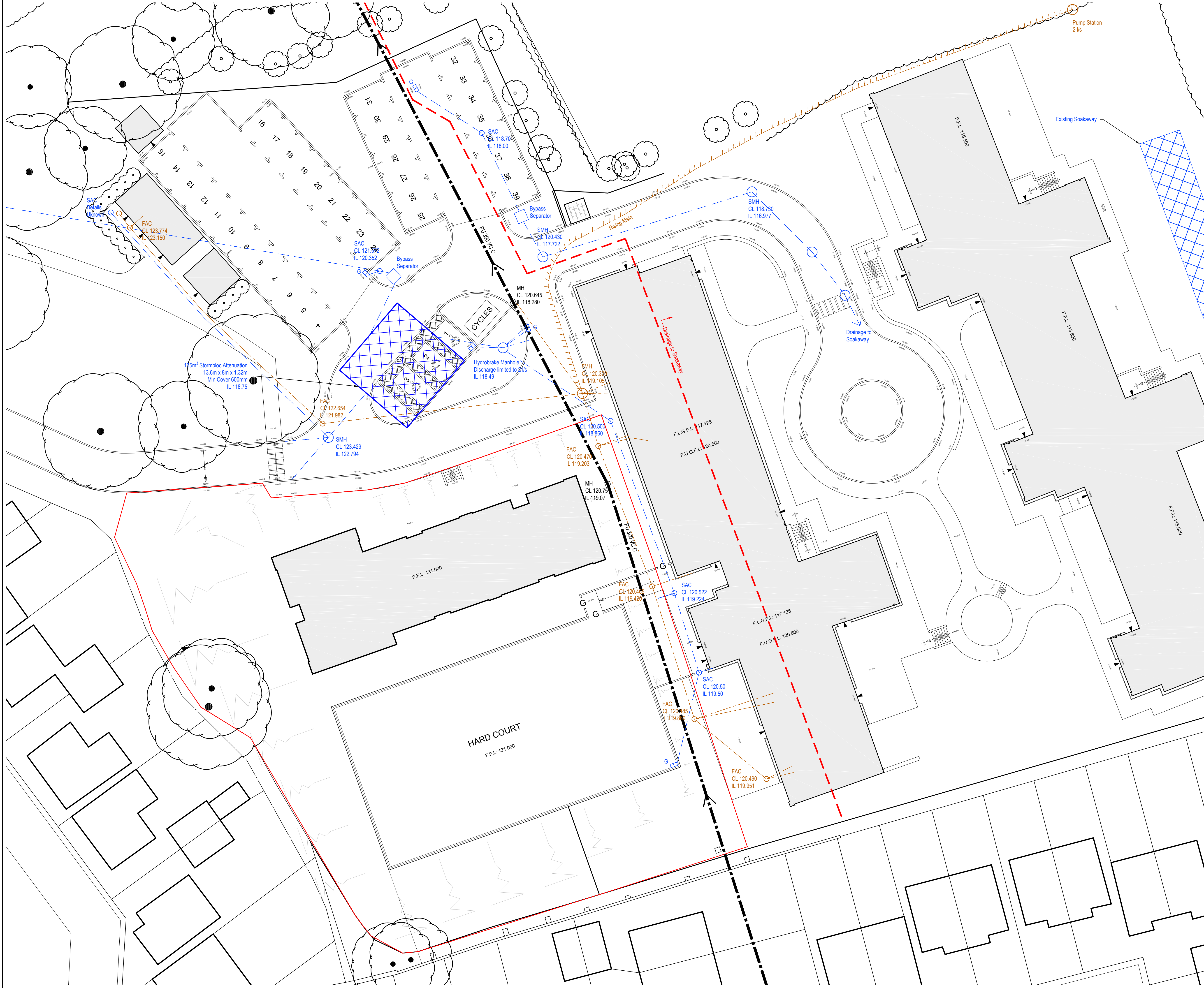


PROPOSED SITE PLAN

SCALE @1:250 - A1

Appendix III

Existing Drainage Layout



Notes

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3. This drawing is to be read in conjunction with the relevant contract drawings and documents, including the NBS specification.
4. All dimensions are in millimetres and all levels are in metres AOD unless noted otherwise.
5. All work shall be carried out in accordance with Local Authority, Statutory Authority and Health & Safety Regulations.

General notes

1. Drainage layout shown based on as-built drawings by JNM Engineering.
2. Shown drainage layout is indicative only and should not be relied upon for design or construction.
3. Full drainage details on eastern side of the site have been omitted.
4. Mason Clark accept no responsibility for the use of this drawing other than for illustrative purposes.

Key

- Site Boundary
- 1500 @ 1:150 Surface Water
- 1500 @ 1:150 Foul Water
- SMH Surface Water Manhole
- SAC Surface Water Access Chamber
- G Highway Gully (375x750) and C250 cover and frame with 1500 pipe (Class Z Bedding)
- Foul Water Rising Main
- PU 300 VC C Existing Combined Water Sewer (public sewer)
- Existing Attenuation

Rev	Details	By	Date

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civil and structural engineering consultants

Client: CAS Behavioural Health

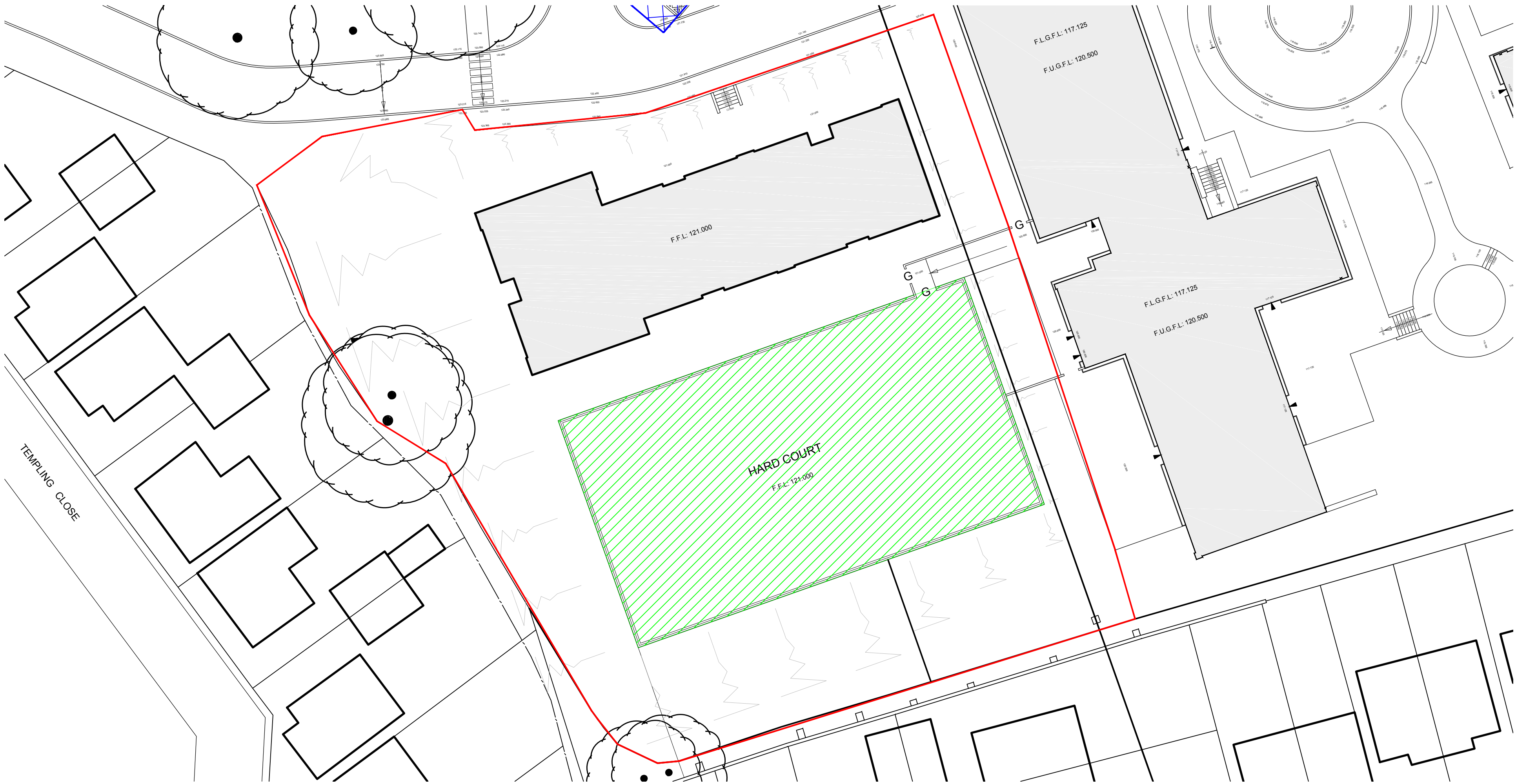
Project: Acorn Lodge

Title: Existing Drainage Layout

Drawn: AP	Checked:	Date: Sept 2017
Scale @ A1: 1:200		
Drawing No: 15689-L-DR-002	Rev: P1	

Appendix IV

Impermeable Areas Plan



Existing Site
Scale 1:250



Proposed Site
Scale 1:250

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3. This drawing is to be read in conjunction with the relevant contract drawings and documents, including the NBS specification.
4. All dimensions are in millimetres and all levels are in metres AOD unless noted otherwise.
5. All work shall be carried out in accordance with Local Authority, Statutory Authority and Health & Safety Regulations.

Key

- Existing Impermeable Areas= 736.9m²
- Proposed Impermeable Areas = 1084m²
- Total additional area = 347.1m²

Rev	Details	By	Date
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Client: CAS Behavioural Health			
Project: Acorn Lodge			
Title: Impermeable Areas Plan			
Drawn: AP	Checked:	Date: Sept 2017	
Scale @ A1:	As Shown		
Drawing No:	15689-L-DR-003	Rev:	P1

Appendix V

Soakaway Test Report

Our Ref J4044/17/E
28th September 2017

Mason Clark Associates
Church house
44 Newland Park
Hull
HU5 2DW

Environmental
Geotechnical
Specialists



For the attention of Mrs Hayley Smith

Dear Hayley

Ref: Soakaway Testing at Acorn Lodge, Barnsley

We thank you for your request to undertake percolation testing at the above mentioned site and take pleasure in enclosing the results of this work. The investigation was undertaken on the 25th September in accordance with your instruction to proceed. This letter describes the work undertaken, presents the data obtained and discusses the results of the tests.

Fieldworks

Two trialpits were excavated using a JCB 3CX in order to carry out soakaway testing. The tests were undertaken at the base of the pit at depths rational to the construction of soakaways. The soils exposed in the trial pits were logged on site in general accordance with BS5930: 2015 and full descriptions are given on the trialpit records which are also attached to this letter, along with the soakaway test results.

Geology

The available published geological data for the site has been examined and the following table presents the anticipated geology.

Table 1: Geological Data for the Site

Strata Type	Strata Name ¹	Previous Name	Description ²
Superficial Geology	N/A	N/A	None indicated within the published records.
Solid Geology	Woolley Edge Rock	N/A	Sandstone, coarse-grained in the north, becoming finer southwards.

¹ Sources: British Geological Survey (NERC) Map Sheets 87; Barnsley; Solid and Drift Edition, and the Geology of Britain Viewer [online resource from www.bgs.ac.uk]

² Sources: British Geological Survey (NERC) Lexicon of Named Rock Units [online resource from www.bgs.ac.uk]

GEOTECHNICAL
ENVIRONMENTAL

Strata Conditions

During the investigation the geological succession has been shown to include the following:

Table 2: Generalised strata profile

Depth to base (m)	Strata type	Positions strata was revealed	Groundwater strikes (m)
0.25 – 0.45	MADE GROUND (Granular)	Both	None
0.97 – +1.95	Sandy gravelly CLAY (Weathered rock)	Both	None
+1.0	SANDSTONE (Woolley Edge Rock)	TP2	None

'+' denotes that the strata extended below the termination depth of the investigated positions, thus the extent of the deposit is only proven to the depths indicated.

The trialpits were excavated within a basketball court. Beneath the playing surface, a granular sub-base of dolostone gravel was found to depths of up to 0.45m. Underlying this sub-base, sandy clay containing sandstone gravel and cobbles was revealed to the termination depths of the trialpits. These soils are anticipated to represent the weathered fraction of the Woolley Edge Rock, a named sandstone member. It should be appreciated that sandstone, recovered as tabular fine gravel was observed at the base of TP2.

Soakaway Tests

On reaching the elected soakaway test depth, the pit was trimmed and squared as much as practicable. Water was then introduced into the pit at a controlled rate to prevent collapse of the sides and the level monitored at time intervals relative to a reference bar at ground level. The results obtained from the soakaway tests are appended to this letter and are summarised below:

Table 3: Soakaway Test Results

Location	Soakage Area Dimensions (average) (m)	Test Depth (m)	Soil Description (base of pit)	Infiltration Rate (m/sec)	Drainage Characteristics
TP1	1.8 x 0.4	1.95	Sandy gravelly CLAY	*	Practically impermeable
TP2	1.95 x 0.4	0.98	Sandy gravelly CLAY	*	Practically impermeable

During the soakaway tests the water level did not achieve a fall from 75% to 25% of the effective depth of the storage volume in the two trialpits. The tests, therefore, could not be completed within the scope of the method provided in BRE Digest 365 due to the poor soakage rate of the exposed soils. Due to the negligible water movement it was not possible to extrapolate the results obtained in order to obtain a soil infiltration rate.

Discussion

The soils encountered beneath the site were found to be typical of weathered sandstone, comprising sandy clays with gravel and a low cobble content. The strata conditions and drainage characteristics appear to be comparable across the site.

In this instance the recorded infiltration rates suggest that the soils have poor drainage characteristics. Therefore, soakaways cannot be recommended at this site and an alternative form of drainage should be adopted.

References

Building Research Establishment (BRE) Digest 365, *Soakaway Design*, September 1991.

British Standards Institution (1999) BS5930: *Code of practice for site investigations*, B.S.I., London.

British Standards Institution (2007), Amendment No 1, BS5930: *Code of practice for site investigations*, B.S.I., London.

We trust that this information is of interest and should you have any other requirements do not hesitate to contact us.

For and on behalf of
Rogers Geotechnical Services,

Yours Faithfully

R.A. Palmer MSc FGS
Geotechnical and Environmental Engineer

C. E. Mason BSc FGS
Graduate Geotechnical Engineer



Plan not to scale and investigation positions approximated from site operative's notes.

Title: **Investigation Location Plan**



Rogers **Geotechnical Services** Ltd

Site Name:
Acorn Lodge

Job No:
J4044/17/E



Trial Pit Log

Trialpit No

TP1

Sheet 1 of 1

Project Name: Acorn Lodge

Project No.
J4044/17/E

Co-ords: -

Level:

Date

25/09/2017

Location: Upper Sheffield Road, Barnsley S70 4PL

Dimensions
(m):

1.8

Depth
1.95

0.4

Scale

1:50

Logged
JDMI

Client: Mason Clark Associates

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.06 0.25			MADE GROUND. (Brown textile topped gravelly SAND. Gravel is sub-rounded and rounded sub-spherical fine sandstone).
							MADE GROUND. (Cream sandy sub-angular to sub-rounded sub-spherical fine to coarse GRAVEL of dolostone).
							Firm inpart friable brown mottled orange and grey sandy gravelly CLAY with low cobble content. Gravel is angular and sub-angular cubic and tabular fine to coarse sandstone lithorelicts. (Weathered Woolley Edge Rock).
				1.95			End of pit at 1.95 m

1

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10

Remarks: Trialpit soakaway.

Stability:

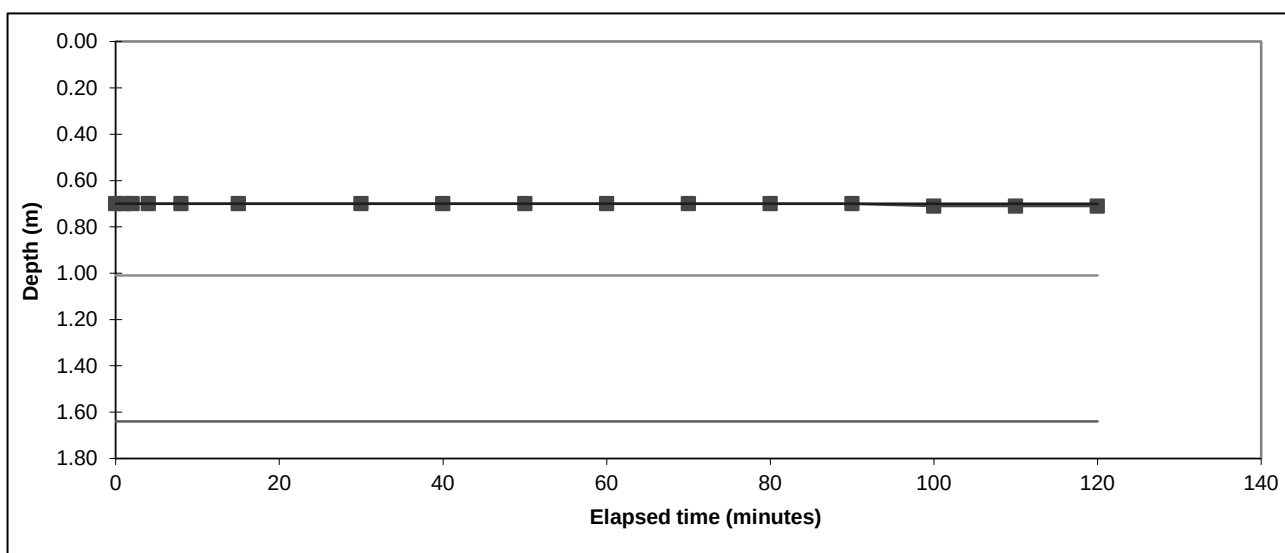


Rogers Geotechnical Services Ltd

Soakaway Test

Trial Pit No:	TP1	Test No:	1	Date:	25/09/2017
Length (m):	1.800	Datum Height:			0.00 m agl
Width (m):	0.40	Granular infill:	None		
Depth (m):	1.95	Porosity of infill:	1	(assumed)	

Elapsed time (minutes)	Water Depth (m below datum)	Elapsed time (minutes)	Water Depth (m below datum)
0	0.700	110	0.710
1	0.700	120	0.710
2	0.700		
4	0.700		
8	0.700		
15	0.700		
30	0.700		
40	0.700		
50	0.700		
60	0.700		
70	0.700		
80	0.700		
90	0.700		
100	0.710		



Start water depth for analysis (mbgl):	0.70		
75% effective depth (mbgl):	1.01	Elapsed time (mins):	#N/A
50% effective depth (mbgl):	1.33		
25% effective depth (mbgl):	1.64	Elapsed time (mins):	#N/A
Base of soakage zone (mbgl):	1.95		

Volume outflow between 75% and 25% effective depth (m³):

Mean surface area of outflow (m²): 3.45

(side area at 50% effective depth + base area)

Time for outflow between 75% and 25% effective depth (mins):

Soil infiltration rate (m/s):	Test incomplete as 25% effective depth not achieved. Unable to reliably determine soil infiltration rate.
--------------------------------------	--

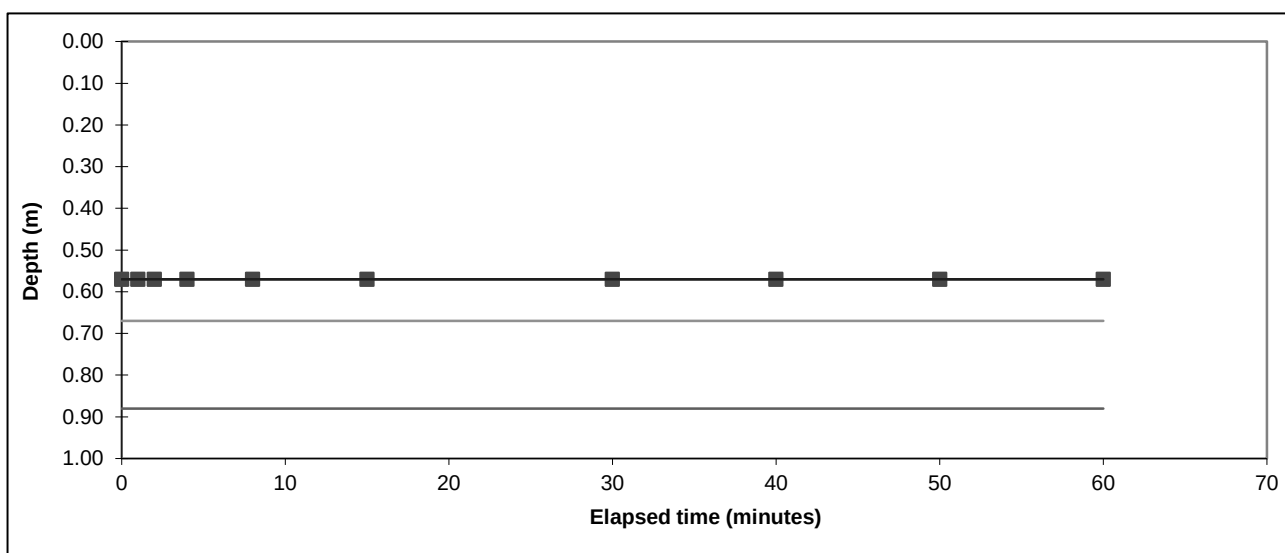
Remarks Results processed following BRE 365 (2007).

Client:	Mason Clark Associates	Job No:	J4044/17/E
Site:	Acorn Lodge		

Rogers Geotechnical Services Ltd

Soakaway Test

Trial Pit No:	TP2	Test No:	1	Date:	25/09/2017
Length (m):	1.950	Datum Height:			0.00 m agl
Width (m):	0.40	Granular infill:	None		
Depth (m):	0.98	Porosity of infill:	1	(assumed)	
	Elapsed time (minutes)	Water Depth (m below datum)	Elapsed time (minutes)	Water Depth (m below datum)	
	0	0.570			
	1	0.570			
	2	0.570			
	4	0.570			
	8	0.570			
	15	0.570			
	30	0.570			
	40	0.570			
	50	0.570			
	60	0.570			



Start water depth for analysis (mbgl):	0.57		
75% effective depth (mbgl):	0.67	Elapsed time (mins):	#N/A
50% effective depth (mbgl):	0.78		
25% effective depth (mbgl):	0.88	Elapsed time (mins):	#N/A
Base of soakage zone (mbgl):	0.98		

Volume outflow between 75% and 25% effective depth (m³):

Mean surface area of outflow (m²): 1.72

(side area at 50% effective depth + base area)

Time for outflow between 75% and 25% effective depth (mins):

Soil infiltration rate (m/s):	Test incomplete as 25% effective depth not achieved. Unable to reliably determine soil infiltration rate.
--------------------------------------	--

Remarks Results processed following BRE 365 (2007).
Unable to run test at 2.0m as specified due to unstable pits (loose sands/gravels).

Client:	Mason Clark Associates	Job No:	J4044/17/E
Site:	Acorn Lodge		

Appendix VI

Microdrainage Storage Calculations

Mason Clark Associates							Page 1
44 Newland Park Kingston upon Hull HU5 2DW			Acorn Lodge Storage Calculations 1 in 30 year				
Date Sept 2017 File 1 IN 30 YEAR.SRCX			Designed by AP Checked by				
Micro Drainage			Source Control 2015.1				
<u>Summary of Results for 30 year Return Period</u>							
Half Drain Time : 21 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	99.196	0.196	0.0	2.0	2.0	3.0	O K
30 min Summer	99.242	0.242	0.0	2.0	2.0	3.7	O K
60 min Summer	99.250	0.250	0.0	2.0	2.0	3.8	O K
120 min Summer	99.216	0.216	0.0	2.0	2.0	3.3	O K
180 min Summer	99.174	0.174	0.0	2.0	2.0	2.6	O K
240 min Summer	99.138	0.138	0.0	2.0	2.0	2.1	O K
360 min Summer	99.094	0.094	0.0	1.9	1.9	1.4	O K
480 min Summer	99.079	0.079	0.0	1.7	1.7	1.2	O K
600 min Summer	99.069	0.069	0.0	1.5	1.5	1.0	O K
720 min Summer	99.063	0.063	0.0	1.3	1.3	1.0	O K
960 min Summer	99.054	0.054	0.0	1.1	1.1	0.8	O K
1440 min Summer	99.045	0.045	0.0	0.8	0.8	0.7	O K
2160 min Summer	99.038	0.038	0.0	0.6	0.6	0.6	O K
2880 min Summer	99.034	0.034	0.0	0.5	0.5	0.5	O K
4320 min Summer	99.028	0.028	0.0	0.4	0.4	0.4	O K
5760 min Summer	99.025	0.025	0.0	0.3	0.3	0.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
15 min Summer	69.167	0.0	4.5	21			
30 min Summer	45.942	0.0	6.0	30			
60 min Summer	29.238	0.0	7.7	48			
120 min Summer	18.069	0.0	9.5	80			
180 min Summer	13.484	0.0	10.6	110			
240 min Summer	10.903	0.0	11.4	140			
360 min Summer	8.058	0.0	12.7	194			
480 min Summer	6.499	0.0	13.6	254			
600 min Summer	5.497	0.0	14.4	314			
720 min Summer	4.793	0.0	15.1	372			
960 min Summer	3.858	0.0	16.2	494			
1440 min Summer	2.837	0.0	17.9	736			
2160 min Summer	2.084	0.0	19.7	1100			
2880 min Summer	1.672	0.0	21.1	1464			
4320 min Summer	1.225	0.0	23.2	2172			
5760 min Summer	0.982	0.0	24.7	2936			
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Mason Clark Associates							Page 2
44 Newland Park Kingston upon Hull HU5 2DW			Acorn Lodge Storage Calculations 1 in 30 year				
Date Sept 2017 File 1 IN 30 YEAR.SRCX			Designed by AP Checked by				
Micro Drainage			Source Control 2015.1				
<u>Summary of Results for 30 year Return Period</u>							
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
7200 min Summer	99.023	0.023	0.0	0.2	0.2	0.4	O K
8640 min Summer	99.021	0.021	0.0	0.2	0.2	0.3	O K
10080 min Summer	99.020	0.020	0.0	0.2	0.2	0.3	O K
15 min Winter	99.226	0.226	0.0	2.0	2.0	3.4	O K
30 min Winter	99.281	0.281	0.0	2.0	2.0	4.3	O K
60 min Winter	99.283	0.283	0.0	2.0	2.0	4.3	O K
120 min Winter	99.218	0.218	0.0	2.0	2.0	3.3	O K
180 min Winter	99.150	0.150	0.0	2.0	2.0	2.3	O K
240 min Winter	99.104	0.104	0.0	2.0	2.0	1.6	O K
360 min Winter	99.075	0.075	0.0	1.6	1.6	1.1	O K
480 min Winter	99.063	0.063	0.0	1.3	1.3	1.0	O K
600 min Winter	99.056	0.056	0.0	1.1	1.1	0.9	O K
720 min Winter	99.051	0.051	0.0	1.0	1.0	0.8	O K
960 min Winter	99.045	0.045	0.0	0.8	0.8	0.7	O K
1440 min Winter	99.038	0.038	0.0	0.6	0.6	0.6	O K
2160 min Winter	99.032	0.032	0.0	0.4	0.4	0.5	O K
2880 min Winter	99.028	0.028	0.0	0.4	0.4	0.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
7200 min Summer	0.827	0.0	26.0	3656			
8640 min Summer	0.718	0.0	27.1	4312			
10080 min Summer	0.638	0.0	28.1	5088			
15 min Winter	69.167	0.0	5.1	21			
30 min Winter	45.942	0.0	6.7	32			
60 min Winter	29.238	0.0	8.6	52			
120 min Winter	18.069	0.0	10.6	86			
180 min Winter	13.484	0.0	11.9	116			
240 min Winter	10.903	0.0	12.8	140			
360 min Winter	8.058	0.0	14.2	196			
480 min Winter	6.499	0.0	15.3	254			
600 min Winter	5.497	0.0	16.2	314			
720 min Winter	4.793	0.0	16.9	374			
960 min Winter	3.858	0.0	18.1	496			
1440 min Winter	2.837	0.0	20.0	744			
2160 min Winter	2.084	0.0	22.0	1124			
2880 min Winter	1.672	0.0	23.6	1472			
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Mason Clark Associates						Page 3	
44 Newland Park Kingston upon Hull HU5 2DW			Acorn Lodge Storage Calculations 1 in 30 year				
Date Sept 2017 File 1 IN 30 YEAR.SRCX			Designed by AP Checked by				
Micro Drainage			Source Control 2015.1				
<u>Summary of Results for 30 year Return Period</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m ³)	Status
4320 min Winter	99.024	0.024	0.0	0.3	0.3	0.4	O K
5760 min Winter	99.021	0.021	0.0	0.2	0.2	0.3	O K
7200 min Winter	99.019	0.019	0.0	0.2	0.2	0.3	O K
8640 min Winter	99.018	0.018	0.0	0.2	0.2	0.3	O K
10080 min Winter	99.017	0.017	0.0	0.1	0.1	0.3	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)			
4320 min Winter	1.225	0.0	25.9	2196			
5760 min Winter	0.982	0.0	27.7	2904			
7200 min Winter	0.827	0.0	29.2	3552			
8640 min Winter	0.718	0.0	30.4	4328			
10080 min Winter	0.638	0.0	31.5	5144			
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Mason Clark Associates		Page 4																																										
44 Newland Park Kingston upon Hull HU5 2DW	Acorn Lodge Storage Calculations 1 in 30 year																																											
Date Sept 2017 File 1 IN 30 YEAR.SRCX	Designed by AP Checked by																																											
Micro Drainage		Source Control 2015.1																																										
<u>Rainfall Details</u> <table> <tr> <td>Rainfall Model</td> <td>FSR</td> </tr> <tr> <td>Return Period (years)</td> <td>30</td> </tr> <tr> <td>Region</td> <td>England and Wales</td> </tr> <tr> <td>M5-60 (mm)</td> <td>19.000</td> </tr> <tr> <td>Ratio R</td> <td>0.355</td> </tr> <tr> <td>Summer Storms</td> <td>Yes</td> </tr> <tr> <td>Winter Storms</td> <td>Yes</td> </tr> <tr> <td>Cv (Summer)</td> <td>0.750</td> </tr> <tr> <td>Cv (Winter)</td> <td>0.840</td> </tr> <tr> <td>Shortest Storm (mins)</td> <td>15</td> </tr> <tr> <td>Longest Storm (mins)</td> <td>10080</td> </tr> <tr> <td>Climate Change %</td> <td>+0</td> </tr> </table> <u>Time Area Diagram</u> Total Area (ha) 0.035 <table> <thead> <tr> <th>Time (mins)</th> <th>Area</th> <th>Time (mins)</th> <th>Area</th> <th>Time (mins)</th> <th>Area</th> </tr> <tr> <th>From: To: (ha)</th> <th></th> <th>From: To: (ha)</th> <th></th> <th>From: To: (ha)</th> <th></th> </tr> </thead> <tbody> <tr> <td>0 4 0.011</td> <td></td> <td>4 8 0.012</td> <td></td> <td>8 12 0.012</td> <td></td> </tr> </tbody> </table>			Rainfall Model	FSR	Return Period (years)	30	Region	England and Wales	M5-60 (mm)	19.000	Ratio R	0.355	Summer Storms	Yes	Winter Storms	Yes	Cv (Summer)	0.750	Cv (Winter)	0.840	Shortest Storm (mins)	15	Longest Storm (mins)	10080	Climate Change %	+0	Time (mins)	Area	Time (mins)	Area	Time (mins)	Area	From: To: (ha)		From: To: (ha)		From: To: (ha)		0 4 0.011		4 8 0.012		8 12 0.012	
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Mason Clark Associates		Page 5
44 Newland Park Kingston upon Hull HU5 2DW	Acorn Lodge Storage Calculations 1 in 30 year	
Date Sept 2017 File 1 IN 30 YEAR.SRCX	Designed by AP Checked by	
Micro Drainage Source Control 2015.1		

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 99.000
Infiltration Coefficient Base (m/hr) 0.00000
Infiltration Coefficient Side (m/hr) 0.00000
Safety Factor 2.0
Porosity 0.95

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	16.0	16.0	0.500	0.0	22.4
0.400	16.0	22.4			

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0075-2000-0400-2000
Design Head (m) 0.400
Design Flow (l/s) 2.0
Flush-Flo™ Calculated
Objective Minimise upstream storage
Diameter (mm) 75
Invert Level (m) 99.000
Minimum Outlet Pipe Diameter (mm) 100
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	2.0
Flush-Flo™	0.124	2.0
Kick-Flo®	0.285	1.7
Mean Flow over Head Range	-	1.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0	0.400	2.0	0.800	2.7
0.200	1.9	0.500	2.2	1.000	3.0
0.300	1.7	0.600	2.4	1.200	3.3

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44 Newland Park Kingston upon Hull HU5 2DW	Acorn Lodge Storage Calculations 1 in 30 year																																																	
Date Sept 2017 File 1 IN 30 YEAR.SRCX	Designed by AP Checked by																																																	
Micro Drainage	Source Control 2015.1																																																	
<u>Hydro-Brake Optimum® Outflow Control</u> <table><tr><td>Depth (m)</td><td>Flow (l/s)</td><td>Depth (m)</td><td>Flow (l/s)</td><td>Depth (m)</td><td>Flow (l/s)</td></tr><tr><td>1.400</td><td>3.5</td><td>3.000</td><td>5.0</td><td>6.500</td><td>7.3</td></tr><tr><td>1.600</td><td>3.7</td><td>3.500</td><td>5.4</td><td>7.000</td><td>7.5</td></tr><tr><td>1.800</td><td>3.9</td><td>4.000</td><td>5.7</td><td>7.500</td><td>7.8</td></tr><tr><td>2.000</td><td>4.1</td><td>4.500</td><td>6.0</td><td>8.000</td><td>8.1</td></tr><tr><td>2.200</td><td>4.3</td><td>5.000</td><td>6.4</td><td>8.500</td><td>8.3</td></tr><tr><td>2.400</td><td>4.5</td><td>5.500</td><td>6.7</td><td>9.000</td><td>8.6</td></tr><tr><td>2.600</td><td>4.7</td><td>6.000</td><td>7.0</td><td>9.500</td><td>8.8</td></tr></table>			Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	1.400	3.5	3.000	5.0	6.500	7.3	1.600	3.7	3.500	5.4	7.000	7.5	1.800	3.9	4.000	5.7	7.500	7.8	2.000	4.1	4.500	6.0	8.000	8.1	2.200	4.3	5.000	6.4	8.500	8.3	2.400	4.5	5.500	6.7	9.000	8.6	2.600	4.7	6.000	7.0	9.500	8.8
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)																																													
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2.200	4.3	5.000	6.4	8.500	8.3																																													
2.400	4.5	5.500	6.7	9.000	8.6																																													
2.600	4.7	6.000	7.0	9.500	8.8																																													
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Mason Clark Associates							Page 1
44 Newland Park Kingston upon Hull HU5 2DW			Acorn Lodge Storage Calculations 1 in 30 year + 30%				
Date Sept 2017 File 1 in 30 year + 30%.srcx			Designed by AP Checked by				
Micro Drainage			Source Control 2015.1				
<u>Summary of Results for 30 year Return Period (+30%)</u> Half Drain Time : 28 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	99.278	0.278	0.0	2.0	2.0	4.2	O K
30 min Summer	99.346	0.346	0.0	2.0	2.0	5.3	O K
60 min Summer	99.365	0.365	0.0	2.0	2.0	5.5	O K
120 min Summer	99.337	0.337	0.0	2.0	2.0	5.1	O K
180 min Summer	99.293	0.293	0.0	2.0	2.0	4.5	O K
240 min Summer	99.240	0.240	0.0	2.0	2.0	3.6	O K
360 min Summer	99.159	0.159	0.0	2.0	2.0	2.4	O K
480 min Summer	99.111	0.111	0.0	2.0	2.0	1.7	O K
600 min Summer	99.089	0.089	0.0	1.9	1.9	1.3	O K
720 min Summer	99.078	0.078	0.0	1.7	1.7	1.2	O K
960 min Summer	99.066	0.066	0.0	1.4	1.4	1.0	O K
1440 min Summer	99.053	0.053	0.0	1.0	1.0	0.8	O K
2160 min Summer	99.044	0.044	0.0	0.8	0.8	0.7	O K
2880 min Summer	99.039	0.039	0.0	0.6	0.6	0.6	O K
4320 min Summer	99.033	0.033	0.0	0.5	0.5	0.5	O K
5760 min Summer	99.029	0.029	0.0	0.4	0.4	0.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
15 min Summer	89.917	0.0	5.9	21			
30 min Summer	59.725	0.0	7.8	32			
60 min Summer	38.009	0.0	10.0	50			
120 min Summer	23.489	0.0	12.3	84			
180 min Summer	17.530	0.0	13.8	118			
240 min Summer	14.174	0.0	14.9	148			
360 min Summer	10.475	0.0	16.5	206			
480 min Summer	8.449	0.0	17.7	260			
600 min Summer	7.147	0.0	18.8	314			
720 min Summer	6.231	0.0	19.6	374			
960 min Summer	5.015	0.0	21.1	494			
1440 min Summer	3.688	0.0	23.2	736			
2160 min Summer	2.709	0.0	25.6	1088			
2880 min Summer	2.174	0.0	27.4	1468			
4320 min Summer	1.593	0.0	30.1	2180			
5760 min Summer	1.277	0.0	32.2	2920			
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Mason Clark Associates							Page 2
44 Newland Park Kingston upon Hull HU5 2DW			Acorn Lodge Storage Calculations 1 in 30 year + 30%				
Date Sept 2017 File 1 in 30 year + 30%.srcx			Designed by AP Checked by				
Micro Drainage			Source Control 2015.1				
<u>Summary of Results for 30 year Return Period (+30%)</u>							
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
7200 min Summer	99.026	0.026	0.0	0.3	0.3	0.4	O K
8640 min Summer	99.025	0.025	0.0	0.3	0.3	0.4	O K
10080 min Summer	99.023	0.023	0.0	0.2	0.2	0.4	O K
15 min Winter	99.320	0.320	0.0	2.0	2.0	4.9	O K
30 min Winter	99.396	0.396	0.0	2.0	2.0	6.0	O K
60 min Winter	99.416	0.416	0.0	2.0	2.0	6.3	O K
120 min Winter	99.364	0.364	0.0	2.0	2.0	5.5	O K
180 min Winter	99.292	0.292	0.0	2.0	2.0	4.4	O K
240 min Winter	99.207	0.207	0.0	2.0	2.0	3.2	O K
360 min Winter	99.104	0.104	0.0	2.0	2.0	1.6	O K
480 min Winter	99.079	0.079	0.0	1.7	1.7	1.2	O K
600 min Winter	99.068	0.068	0.0	1.5	1.5	1.0	O K
720 min Winter	99.061	0.061	0.0	1.3	1.3	0.9	O K
960 min Winter	99.053	0.053	0.0	1.0	1.0	0.8	O K
1440 min Winter	99.044	0.044	0.0	0.8	0.8	0.7	O K
2160 min Winter	99.037	0.037	0.0	0.6	0.6	0.6	O K
2880 min Winter	99.032	0.032	0.0	0.4	0.4	0.5	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
7200 min Summer	1.075	0.0	33.9	3560			
8640 min Summer	0.934	0.0	35.3	4376			
10080 min Summer	0.829	0.0	36.6	5112			
15 min Winter	89.917	0.0	6.6	22			
30 min Winter	59.725	0.0	8.8	32			
60 min Winter	38.009	0.0	11.2	52			
120 min Winter	23.489	0.0	13.8	90			
180 min Winter	17.530	0.0	15.5	126			
240 min Winter	14.174	0.0	16.7	154			
360 min Winter	10.475	0.0	18.5	204			
480 min Winter	8.449	0.0	19.9	256			
600 min Winter	7.147	0.0	21.0	316			
720 min Winter	6.231	0.0	22.0	374			
960 min Winter	5.015	0.0	23.6	496			
1440 min Winter	3.688	0.0	26.0	748			
2160 min Winter	2.709	0.0	28.7	1084			
2880 min Winter	2.174	0.0	30.7	1472			
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Mason Clark Associates		Page 3					
44 Newland Park Kingston upon Hull HU5 2DW	Acorn Lodge Storage Calculations 1 in 30 year + 30%						
Date Sept 2017 File 1 in 30 year + 30%.srcx	Designed by AP Checked by						
Micro Drainage	Source Control 2015.1						
<u>Summary of Results for 30 year Return Period (+30%)</u>							
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
4320 min Winter	99.027	0.027	0.0	0.3	0.3	0.4	O K
5760 min Winter	99.024	0.024	0.0	0.3	0.3	0.4	O K
7200 min Winter	99.022	0.022	0.0	0.2	0.2	0.3	O K
8640 min Winter	99.021	0.021	0.0	0.2	0.2	0.3	O K
10080 min Winter	99.019	0.019	0.0	0.2	0.2	0.3	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
4320 min Winter	1.593	0.0	33.7	2184			
5760 min Winter	1.277	0.0	36.0	2896			
7200 min Winter	1.075	0.0	37.9	3656			
8640 min Winter	0.934	0.0	39.5	4344			
10080 min Winter	0.829	0.0	41.0	5144			
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Mason Clark Associates		Page 4																																										
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Mason Clark Associates		Page 5																																																									
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Model Details Storage is Online Cover Level (m) 100.000 Cellular Storage Structure Invert Level (m) 99.000 Infiltration Coefficient Base (m/hr) 0.00000 Infiltration Coefficient Side (m/hr) 0.00000 Safety Factor 2.0 Porosity 0.95 <table><thead><tr><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th></tr></thead><tbody><tr><td>0.000</td><td>16.0</td><td>16.0</td><td>0.500</td><td>0.0</td><td>22.4</td></tr><tr><td>0.400</td><td>16.0</td><td>22.4</td><td></td><td></td><td></td></tr></tbody></table> Hydro-Brake Optimum® Outflow Control Unit Reference MD-SHE-0075-2000-0400-2000 Design Head (m) 0.400 Design Flow (l/s) 2.0 Flush-Flo™ Calculated Objective Minimise upstream storage Diameter (mm) 75 Invert Level (m) 99.000 Minimum Outlet Pipe Diameter (mm) 100 Suggested Manhole Diameter (mm) 1200 <table><thead><tr><th>Control Points</th><th>Head (m)</th><th>Flow (l/s)</th></tr></thead><tbody><tr><td>Design Point (Calculated)</td><td>0.400</td><td>2.0</td></tr><tr><td>Flush-Flo™</td><td>0.124</td><td>2.0</td></tr><tr><td>Kick-Flo®</td><td>0.285</td><td>1.7</td></tr><tr><td>Mean Flow over Head Range</td><td>-</td><td>1.6</td></tr></tbody></table> The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated <table><thead><tr><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th></tr></thead><tbody><tr><td>0.100</td><td>2.0</td><td>0.400</td><td>2.0</td><td>0.800</td><td>2.7</td></tr><tr><td>0.200</td><td>1.9</td><td>0.500</td><td>2.2</td><td>1.000</td><td>3.0</td></tr><tr><td>0.300</td><td>1.7</td><td>0.600</td><td>2.4</td><td>1.200</td><td>3.3</td></tr></tbody></table>			Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	0.000	16.0	16.0	0.500	0.0	22.4	0.400	16.0	22.4				Control Points	Head (m)	Flow (l/s)	Design Point (Calculated)	0.400	2.0	Flush-Flo™	0.124	2.0	Kick-Flo®	0.285	1.7	Mean Flow over Head Range	-	1.6	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	2.0	0.400	2.0	0.800	2.7	0.200	1.9	0.500	2.2	1.000	3.0	0.300	1.7	0.600	2.4	1.200	3.3
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Mason Clark Associates		Page 6																																																
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Mason Clark Associates						Page 1	
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Date Sept 2017 File 1 in 100 year.srcx			Designed by AP Checked by				
Micro Drainage			Source Control 2015.1				
<u>Summary of Results for 100 year Return Period</u> Half Drain Time : 29 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	99.181	0.181	0.0	2.0	2.0	4.3	O K
30 min Summer	99.229	0.229	0.0	2.0	2.0	5.4	O K
60 min Summer	99.250	0.250	0.0	2.0	2.0	5.9	O K
120 min Summer	99.236	0.236	0.0	2.0	2.0	5.6	O K
180 min Summer	99.206	0.206	0.0	2.0	2.0	4.9	O K
240 min Summer	99.175	0.175	0.0	2.0	2.0	4.2	O K
360 min Summer	99.126	0.126	0.0	2.0	2.0	3.0	O K
480 min Summer	99.097	0.097	0.0	1.9	1.9	2.3	O K
600 min Summer	99.084	0.084	0.0	1.8	1.8	2.0	O K
720 min Summer	99.075	0.075	0.0	1.6	1.6	1.8	O K
960 min Summer	99.064	0.064	0.0	1.3	1.3	1.5	O K
1440 min Summer	99.052	0.052	0.0	1.0	1.0	1.2	O K
2160 min Summer	99.043	0.043	0.0	0.7	0.7	1.0	O K
2880 min Summer	99.038	0.038	0.0	0.6	0.6	0.9	O K
4320 min Summer	99.032	0.032	0.0	0.4	0.4	0.7	O K
5760 min Summer	99.028	0.028	0.0	0.4	0.4	0.7	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
15 min Summer	89.467	0.0	5.9	21			
30 min Summer	60.002	0.0	7.9	32			
60 min Summer	38.413	0.0	10.1	50			
120 min Summer	23.755	0.0	12.5	84			
180 min Summer	17.675	0.0	13.9	116			
240 min Summer	14.231	0.0	14.9	146			
360 min Summer	10.446	0.0	16.4	204			
480 min Summer	8.388	0.0	17.6	260			
600 min Summer	7.069	0.0	18.5	318			
720 min Summer	6.143	0.0	19.3	378			
960 min Summer	4.918	0.0	20.6	496			
1440 min Summer	3.589	0.0	22.6	738			
2160 min Summer	2.613	0.0	24.7	1104			
2880 min Summer	2.084	0.0	26.2	1468			
4320 min Summer	1.512	0.0	28.6	2200			
5760 min Summer	1.202	0.0	30.3	2936			
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Mason Clark Associates							Page 2
44 Newland Park Kingston upon Hull HU5 2DW			Acorn Lodge Storage Calculations 1 in 100 year				
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Micro Drainage			Source Control 2015.1				
<u>Summary of Results for 100 year Return Period</u>							
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
7200 min Summer	99.025	0.025	0.0	0.3	0.3	0.6	O K
8640 min Summer	99.024	0.024	0.0	0.3	0.3	0.6	O K
10080 min Summer	99.022	0.022	0.0	0.2	0.2	0.5	O K
15 min Winter	99.207	0.207	0.0	2.0	2.0	4.9	O K
30 min Winter	99.264	0.264	0.0	2.0	2.0	6.3	O K
60 min Winter	99.287	0.287	0.0	2.0	2.0	6.8	O K
120 min Winter	99.256	0.256	0.0	2.0	2.0	6.1	O K
180 min Winter	99.205	0.205	0.0	2.0	2.0	4.9	O K
240 min Winter	99.157	0.157	0.0	2.0	2.0	3.7	O K
360 min Winter	99.095	0.095	0.0	1.9	1.9	2.3	O K
480 min Winter	99.077	0.077	0.0	1.7	1.7	1.8	O K
600 min Winter	99.067	0.067	0.0	1.4	1.4	1.6	O K
720 min Winter	99.060	0.060	0.0	1.2	1.2	1.4	O K
960 min Winter	99.052	0.052	0.0	1.0	1.0	1.2	O K
1440 min Winter	99.043	0.043	0.0	0.7	0.7	1.0	O K
2160 min Winter	99.036	0.036	0.0	0.5	0.5	0.8	O K
2880 min Winter	99.032	0.032	0.0	0.4	0.4	0.7	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
7200 min Summer	1.006	0.0	31.7	3672			
8640 min Summer	0.870	0.0	32.9	4408			
10080 min Summer	0.770	0.0	33.9	5104			
15 min Winter	89.467	0.0	6.6	22			
30 min Winter	60.002	0.0	8.8	33			
60 min Winter	38.413	0.0	11.3	54			
120 min Winter	23.755	0.0	14.0	90			
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1440 min Winter	3.589	0.0	25.3	738			
2160 min Winter	2.613	0.0	27.6	1104			
2880 min Winter	2.084	0.0	29.4	1464			
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Mason Clark Associates		Page 3					
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Micro Drainage	Source Control 2015.1						
<u>Summary of Results for 100 year Return Period</u>							
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
4320 min Winter	99.027	0.027	0.0	0.3	0.3	0.6	O K
5760 min Winter	99.024	0.024	0.0	0.3	0.3	0.6	O K
7200 min Winter	99.021	0.021	0.0	0.2	0.2	0.5	O K
8640 min Winter	99.020	0.020	0.0	0.2	0.2	0.5	O K
10080 min Winter	99.019	0.019	0.0	0.2	0.2	0.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
4320 min Winter	1.512	0.0	32.0	2172			
5760 min Winter	1.202	0.0	33.9	2880			
7200 min Winter	1.006	0.0	35.5	3672			
8640 min Winter	0.870	0.0	36.8	4272			
10080 min Winter	0.770	0.0	38.0	5184			
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Mason Clark Associates		Page 4																																										
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Mason Clark Associates						Page 1	
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Micro Drainage			Source Control 2015.1				
<u>Summary of Results for 100 year Return Period (+30%)</u> Half Drain Time : 43 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	99.249	0.249	0.0	2.0	2.0	5.9	O K
30 min Summer	99.320	0.320	0.0	2.0	2.0	7.6	O K
60 min Summer	99.354	0.354	0.0	2.0	2.0	8.4	O K
120 min Summer	99.347	0.347	0.0	2.0	2.0	8.2	O K
180 min Summer	99.320	0.320	0.0	2.0	2.0	7.6	O K
240 min Summer	99.285	0.285	0.0	2.0	2.0	6.8	O K
360 min Summer	99.214	0.214	0.0	2.0	2.0	5.1	O K
480 min Summer	99.161	0.161	0.0	2.0	2.0	3.8	O K
600 min Summer	99.123	0.123	0.0	2.0	2.0	2.9	O K
720 min Summer	99.099	0.099	0.0	2.0	2.0	2.4	O K
960 min Summer	99.080	0.080	0.0	1.7	1.7	1.9	O K
1440 min Summer	99.062	0.062	0.0	1.3	1.3	1.5	O K
2160 min Summer	99.051	0.051	0.0	1.0	1.0	1.2	O K
2880 min Summer	99.044	0.044	0.0	0.8	0.8	1.0	O K
4320 min Summer	99.037	0.037	0.0	0.6	0.6	0.9	O K
5760 min Summer	99.032	0.032	0.0	0.4	0.4	0.8	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
15 min Summer	116.307	0.0	7.6	22			
30 min Summer	78.003	0.0	10.2	33			
60 min Summer	49.937	0.0	13.1	52			
120 min Summer	30.882	0.0	16.2	88			
180 min Summer	22.977	0.0	18.1	122			
240 min Summer	18.500	0.0	19.4	156			
360 min Summer	13.580	0.0	21.4	216			
480 min Summer	10.904	0.0	22.9	274			
600 min Summer	9.189	0.0	24.1	328			
720 min Summer	7.986	0.0	25.1	382			
960 min Summer	6.394	0.0	26.8	498			
1440 min Summer	4.665	0.0	29.4	738			
2160 min Summer	3.397	0.0	32.1	1100			
2880 min Summer	2.709	0.0	34.1	1456			
4320 min Summer	1.965	0.0	37.1	2168			
5760 min Summer	1.563	0.0	39.4	2864			
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Mason Clark Associates							Page 2
44 Newland Park Kingston upon Hull HU5 2DW			Acorn Lodge Storage Calculations 1 in 100 year + 30%				
Date Sept 2017 File 1 IN 100 YEAR + 30%.SRCX			Designed by AP Checked by				
Micro Drainage			Source Control 2015.1				
Summary of Results for 100 year Return Period (+30%)							
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
7200 min Summer	99.029	0.029	0.0	0.4	0.4	0.7	O K
8640 min Summer	99.027	0.027	0.0	0.3	0.3	0.6	O K
10080 min Summer	99.025	0.025	0.0	0.3	0.3	0.6	O K
15 min Winter	99.286	0.286	0.0	2.0	2.0	6.8	O K
30 min Winter	99.366	0.366	0.0	2.0	2.0	8.7	O K
60 min Winter	99.404	0.404	0.0	2.0	2.0	9.6	O K
120 min Winter	99.387	0.387	0.0	2.0	2.0	9.2	O K
180 min Winter	99.344	0.344	0.0	2.0	2.0	8.2	O K
240 min Winter	99.290	0.290	0.0	2.0	2.0	6.9	O K
360 min Winter	99.180	0.180	0.0	2.0	2.0	4.3	O K
480 min Winter	99.111	0.111	0.0	2.0	2.0	2.6	O K
600 min Winter	99.086	0.086	0.0	1.8	1.8	2.0	O K
720 min Winter	99.075	0.075	0.0	1.6	1.6	1.8	O K
960 min Winter	99.062	0.062	0.0	1.3	1.3	1.5	O K
1440 min Winter	99.051	0.051	0.0	1.0	1.0	1.2	O K
2160 min Winter	99.042	0.042	0.0	0.7	0.7	1.0	O K
2880 min Winter	99.037	0.037	0.0	0.6	0.6	0.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
7200 min Summer	1.308	0.0	41.2	3616			
8640 min Summer	1.131	0.0	42.7	4312			
10080 min Summer	1.001	0.0	44.1	5136			
15 min Winter	116.307	0.0	8.5	23			
30 min Winter	78.003	0.0	11.5	34			
60 min Winter	49.937	0.0	14.7	56			
120 min Winter	30.882	0.0	18.1	94			
180 min Winter	22.977	0.0	20.3	130			
240 min Winter	18.500	0.0	21.7	168			
360 min Winter	13.580	0.0	23.9	226			
480 min Winter	10.904	0.0	25.6	274			
600 min Winter	9.189	0.0	27.0	322			
720 min Winter	7.986	0.0	28.2	380			
960 min Winter	6.394	0.0	30.1	500			
1440 min Winter	4.665	0.0	32.9	738			
2160 min Winter	3.397	0.0	35.9	1092			
2880 min Winter	2.709	0.0	38.2	1456			
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Micro Drainage

Acorn Lodge
Storage Calculations
1 in 100 year + 30%

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Source Control 2015.1

Page 3



Summary of Results for 100 year Return Period (+30%)

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
4320 min Winter	99.031	0.031	0.0	0.4	0.4	0.7	O K
5760 min Winter	99.027	0.027	0.0	0.3	0.3	0.6	O K
7200 min Winter	99.025	0.025	0.0	0.3	0.3	0.6	O K
8640 min Winter	99.023	0.023	0.0	0.2	0.2	0.5	O K
10080 min Winter	99.021	0.021	0.0	0.2	0.2	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
4320 min Winter	1.965	0.0	41.6	2188
5760 min Winter	1.563	0.0	44.1	2944
7200 min Winter	1.308	0.0	46.1	3640
8640 min Winter	1.131	0.0	47.9	4368
10080 min Winter	1.001	0.0	49.4	4992

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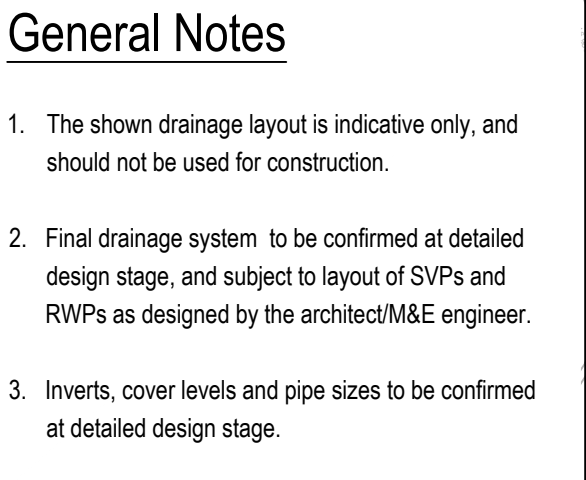
Mason Clark Associates		Page 4																																										
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<u>Hydro-Brake Optimum® Outflow Control</u> <table><thead><tr><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th></tr></thead><tbody><tr><td>1.400</td><td>3.5</td><td>3.000</td><td>5.0</td><td>6.500</td><td>7.3</td></tr><tr><td>1.600</td><td>3.7</td><td>3.500</td><td>5.4</td><td>7.000</td><td>7.5</td></tr><tr><td>1.800</td><td>3.9</td><td>4.000</td><td>5.7</td><td>7.500</td><td>7.8</td></tr><tr><td>2.000</td><td>4.1</td><td>4.500</td><td>6.0</td><td>8.000</td><td>8.1</td></tr><tr><td>2.200</td><td>4.3</td><td>5.000</td><td>6.4</td><td>8.500</td><td>8.3</td></tr><tr><td>2.400</td><td>4.5</td><td>5.500</td><td>6.7</td><td>9.000</td><td>8.6</td></tr><tr><td>2.600</td><td>4.7</td><td>6.000</td><td>7.0</td><td>9.500</td><td>8.8</td></tr></tbody></table>			Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	1.400	3.5	3.000	5.0	6.500	7.3	1.600	3.7	3.500	5.4	7.000	7.5	1.800	3.9	4.000	5.7	7.500	7.8	2.000	4.1	4.500	6.0	8.000	8.1	2.200	4.3	5.000	6.4	8.500	8.3	2.400	4.5	5.500	6.7	9.000	8.6	2.600	4.7	6.000	7.0	9.500	8.8
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Appendix VII

Schematic Drainage Layout



Notes

1. This drawing is subject to copyright and must not be reproduced, stored or transmitted in any form without prior permission from Mason Clark Associates.
2. This drawing is not to be scaled. All dimensions are to be checked on site by the contractor. Any discrepancies are to be notified to Mason Clark Associates. Obtain instructions prior to works commencing.
3. This drawing is to be read in conjunction with the relevant contract drawings and documents, including the NBS specification.
4. All dimensions are in millimetres and all levels are in metres AOD unless noted otherwise.
5. All work shall be carried out in accordance with Local Authority, Statutory Authority and Health & Safety Regulations.

	Surface Water
	Foul Water
	Surface Water Manhole
	Surface Water Access Chamber
	Rain water pipe
	Channel Drain
	Highway Gully (375x75) and C250 cover and frame with 1500 pipe (Class 2 Bedding)
	Rodding Eye
	Foul Water Manhole
	Foul Water Access Chamber
	Soil vent pipe
	Back Inlet Gully
	Existing Surface Water drainage
	Existing Foul Water drainage
	Existing Combined Water Sewer (public sewer)

Rev	Details	By	Date
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Client.			
CAS Behavioural Health			
Project.			
Acorn Lodge			
Title.			
Schematic Drainage Layout			
Drawn: AP		Checked:	Date: Oct 2017
Scale @ A1: 150			
Drawing No: 15689-L-DR-004		Rev:	P1



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<table><tr><td>CIVIL ENGINEERING Bridge design, maintenance and construction Wharfs, jetties and marine structures Highway design and maintenance Retaining wall and slope stability solutions Land remediation advice Road and sewer design to adoptable standards Section 38 and 104 Agreements Sewer requisitions and diversions Section 98 and 185 Agreements Flood Risk Assessments Coastal erosion flood breach analysis Flood risk management / prevention schemes Underground drainage design Stormwater attenuation SUDS Ponds, lakes and balancing ponds PROJECT MANAGEMENT BUILDING SURVEYS Building Surveys Design, Remedial Repair / Improvement Schemes Contract Administration & Contract advice Professional Opinion Reports Schedules of Condition Condition Surveys Measured Surveys Dilapidation Claims CDM Services Party Wall etc. Act representation Disabled adaptations</td><td>STRUCTURAL ENGINEERING Residential and commercial building structures Education and healthcare facilities Heavy industrial development Feasibility studies for development sites Building Regulations and Planning Applications Access and maintenance gantries Modular building design Blast design Subsidence management and resolution Temporary works design and specification Site and soils investigation Sulphate attack specialists Confined spaces assessments CONSERVATION ENGINEERING Engineer Accredited in Building Conservation CARE Registered Engineer Heritage and conservation engineering Listed Building refurbishment Historic Parks and Gardens Scheduled Ancient Monuments Monitoring and investigations Liaison with Local Conservation Officers Buildings at Risk and Managed Ruins EXPERT WITNESS SERVICES Civil & Structural engineering disputes Project Disputes Building Surveying Health and Safety Regulations</td></tr></table>			CIVIL ENGINEERING Bridge design, maintenance and construction Wharfs, jetties and marine structures Highway design and maintenance Retaining wall and slope stability solutions Land remediation advice Road and sewer design to adoptable standards Section 38 and 104 Agreements Sewer requisitions and diversions Section 98 and 185 Agreements Flood Risk Assessments Coastal erosion flood breach analysis Flood risk management / prevention schemes Underground drainage design Stormwater attenuation SUDS Ponds, lakes and balancing ponds PROJECT MANAGEMENT BUILDING SURVEYS Building Surveys Design, Remedial Repair / Improvement Schemes Contract Administration & Contract advice Professional Opinion Reports Schedules of Condition Condition Surveys Measured Surveys Dilapidation Claims CDM Services Party Wall etc. Act representation Disabled adaptations	STRUCTURAL ENGINEERING Residential and commercial building structures Education and healthcare facilities Heavy industrial development Feasibility studies for development sites Building Regulations and Planning Applications Access and maintenance gantries Modular building design Blast design Subsidence management and resolution Temporary works design and specification Site and soils investigation Sulphate attack specialists Confined spaces assessments CONSERVATION ENGINEERING Engineer Accredited in Building Conservation CARE Registered Engineer Heritage and conservation engineering Listed Building refurbishment Historic Parks and Gardens Scheduled Ancient Monuments Monitoring and investigations Liaison with Local Conservation Officers Buildings at Risk and Managed Ruins EXPERT WITNESS SERVICES Civil & Structural engineering disputes Project Disputes Building Surveying Health and Safety Regulations
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