SURFACE WATER DRAINAGE STRATEGY

AT

LAND ADJOINING 98 MILTON ROAD, BELVEDERE, KENT, DA17 5BA

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Date: 24 August 2017

1.0 PROPOSALS

1.1 The proposals are to construct a new three storey detached building forming 7No. flats of traditional construction.

1.2 The site is currently undeveloped and has evidence of a former use as allotment gardens with associated sheds etc.

2.0 PLANNING HISTORY

2.1 Planning approval was previously sought at the beginning of 2017 at which time it was suggested that the surface water design strategy could be dealt with by a robust pre-commencement SUDS drainage condition.

2.2 That application was subsequently withdrawn and resubmitted. The following quote is contained within the Planning Authority's response to the current application. *"I have received comments from my drainage colleagues who have recommended refusal of the application. They are of the opinion that surface water drainage/SUDS must be dealt with as part of the application process and are not prepared to have the matter conditioned"*.

3.0 ARCHIVE DOCUMENTS

3.1 Ground Investigation Report dated April 2001 and produced by Weeks. A part copy of a 2001 Ground Investigation Report has been consulted as part of the preparation of this Drainage Strategy Report.

3.2 Contained within that Ground Investigation Report are the following quotes.

"Except for a slight seepage encountered in borehole 2, ground water was not encountered in the exploratory holes".

"The discharge of surface water into shallow soakaways on the site would have to take account of any retaining structures required as part of the proposed development and the existing properties and services located down slope of Upper Abbey Road. Soakaways would elevate, at least locally, the ground water table, which would act to reduce the stability of the slopes and add to the forces acting to destabilise any retaining walls".

"In view of the comments made in Section 5.5.1 (above) it is recommended that surface water be either discharged off site into an existing system or alternatively, consideration could be

given to discharging the water at depth via borehole soakaways. In either case permission etc would be required from the relevant official bodies".

3.3 Drainage report dated 27 August 2009 produced by Gary Gabriel Associates.

3.4 The following quotes are taken from a drainage report from 2009. These quotes are clearly contradictory when compared to the recommendations contained within the Ground Investigation Report, and have apparently been made based on inaccurate assumptions.

"*It is assumed that the ground strata is clay. Therefore infiltration devices such as soakaways will not be suitable to drain surface water from the development.*

It is therefore proposed to outfall to the private drainage in the adjacent property, formerly 42 Ruskin Road. Following discussions with Thames Water, they have no objections to an indirect connection to the public sewer in Upper Abbey Road via this route, with the proposed discharge rate limited to 3 l/s. Copies of the emails exchanged with Thames Water confirming that they have no objections are included in Appendix D. The discharge rate will be controlled by a hydro-brake flow control device or similar, and attenuation provided by oversized pipes or manholes for a 1:100 year storm event with an allowance for climate change".

4.0 BOREHOLE SOAKAWAYS

4.1 From the Ground Investigation Report dated April 2001 it is clear that beneath the site ground conditions vary, but that there are layers into which surface water could be discharged. Borehole soakaways have the distinct advantage over shallow more conventional soakaways by delivering surface water to greater depth and avoiding any potential instability at the upper levels, which could complicate the design and performance of retaining structures at those upper levels.

4.2 Borehole soakaways have the potential to deliver contaminated water into areas where water extraction is undertaken, and as such, appropriate approvals are required from the Environment Agency.

4.3 Reference to the Environment Agency Ground Water Source Maps indicates that the site is not positioned above an area where water extraction takes place, and provided the borehole soakaways are constructed appropriately and collect surface water run-off from a known source, they would appear to be a solution that would be acceptable to, not only the Environment Agency, but Building Control as well.

4.4 The area of roof is circa 248sqm. By directing 50% of the run-off to the rear and 50% to the front of the proposed building, 124sqm plus 30% for climate change is still a relatively modest catchment area. It is therefore anticipated, that, subject to satisfactory site testing, there will be 2No. borehole soakaways.

4.5 Appended to this report are example calculations of a borehole soakaway design. The normal sequence of events is to undertake a test borehole, to gather test results indicating the rate of soakage from the borehole and, then applying those test results, to design the appropriate length of borehole and the appropriate size of chamber on top of the borehole into which roof run-off would be directed.

5.0 EXTERNAL HARD LANDSCAPED AREAS

5.1 Associated with the proposed building is an area of hard landscaping providing parking spaces for 7No. vehicles, bin stores, access paths etc.

5.2 From the Ground Investigation Report dated April 2001 it can be seen that there were areas of made ground and top soil, beneath which there was either slightly clayey very sandy flint gravel and sandy clay. It is proposed that all these hard landscaped areas are formed as permeable pavement. Permeable pavement is formed in such a way that rain falling on those areas passes straight through the surface finish and into the sub base where it can be stored, and infiltrate into the natural ground in much the same way as it would in the predeveloped condition.

5.3 Pollution is present on road and car park surfaces as a result of oil and fuel leaks, and drips, tyre wear, dust from the atmosphere etc. This type of pollution arises from a wide variety of sources and is spread throughout an urban area and is known as diffuse pollution. Rainfall washes the pollutants off the surface.

5.4 Conventional drainage systems, as well as attenuation tanks, effectively concentrate pollutants, which are flushed directly into the drainage system during rainfall and then into water courses or ground water. The impact of this is to reduce the environmental quality of water courses.

5.5 Permeable pavements deal with surface water close to where rainfall hits the ground. This is known as *"source control"* and is a fundamental part of the SUDS philosophy. They reduce the peak rate, total volume and frequency of run-off and help to replicate green field run-off characteristics from development sites. They also cleanse and remove pollution from run-off.

5.6 Permeable pavement is a relatively maintenance free SUDS compliant solution to rainwater run-off. Appended to this report is a typical example of the type of maintenance agreement that would be introduced following completion of the development and taken forward in perpetuity.

6.0 THE SUDS MANUAL (CIRIA C697)

6.1 The SUDS manual sets out the ideals of developing and maintaining a sustainable surface water disposal installation.

6.2 By introducing borehole soakaways and permeable pavement, all surface water falling on the site will be retained on the site.

7.0 FURTHER INVESTIGATIONS

7.1 The Ground Investigation Report dated April 2001 provides useful and important guidance in respect of ground conditions on the site, but there is the need to extend this former survey now to include a test borehole to determine the soakage potential from a borehole soakaway and to undertake a number of representative soakage tests at or about the anticipated underside of a new permeable pavement construction.

7.2 Using these test results, the design of the borehole soakaways and the permeable pavement can be completed, specifications and drawings produced for approval/construction purposes.

8.0 FOUL DRAINAGE

8.1 This strategy report is not intended to identify and report the proposals in respect of the foul underground drainage layout and connections. However, from previous documents it was reported that the foul drainage from the development site would drain via a new connection into the public foul sewer along Milton Road. This connection would be subject to approval by Thames Water who would also advise on whether the connection is by means of a manhole or a junction.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 From studying archive documents specifically related to this site, it is considered that borehole soakaways will be the most appropriate means of disposing of the surface water run-off from the roofs, and that this form of soakaway wholly meets the recommendations within the SUDS design manual.

9.2 The Environment Agency will need to be consulted regarding the use of borehole soakaways, but reference to their maps indicates that the site is not located above a sensitive area.

9.3 The use of permeable pavement for hard landscaped areas meets the requirements of Building Control and the SUDS ideals.

9.4 Because the above proposals would be designed to contain 100% of surface water falling on the site, consideration in respect of rainwater recycling, green roofs and other SUDS compliant techniques has not been pursued.

Paul S Boorman
IEng AMIStructE AMICE
Associate Director

APPENDIX A

EXAMPLE BOREHOLE SOAKAWAY CALCULATIONS

DESIGN RAINFALL

In accordance with the Wallingford Procedure

Tedds calculation version 2.0.00

Design rainfall intensity

Location of catchment area	London
Storm duration	D = **6** hr
Return period	Period = **100** yr
Ratio 60 min to 2 day rainfall of 5 yr return period	r = **0.440**
5-year return period rainfall of 60 minutes duration	M5_60min = **20.0** mm
Increase of rainfall intensity due to global warming	$p_{climate}$ = **30** %
Factor Z1 (Wallingford procedure)	Z1 = **1.53**
Rainfall for 6hr storm with 5 year return period	$M5\_6hr_1 = Z1 \times M5\_60min \times (1 + p_{climate})$ = **39.8** mm
Factor Z2 (Wallingford procedure)	Z2 = **1.89**
Rainfall for 6hr storm with 100 year return period	$M100\_6hr = Z2 \times M5\_6hr_1$ = **75.3** mm
Design rainfall intensity	I_{max} = M100_6hr / D = **12.5** mm/hr

Maximum surface water runoff

Catchment area	A_{catch} = **125** m^2
Percentage of area that is impermeable	p = **100** %
Maximum surface water runoff	$Q_{max} = A_{catch} \times p \times I_{max}$ = **0.4** l/s

Sheet No.

Job No.

Date

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Consider Deep borehole Soakaways Taking roof run-off, discharged to Soakaway via Trapped raddable gulleys to all downpipes.

See attached Test results from Ground and Environmental Services Ltd 7th March 2016.

Catchment Areas. Roof run off has been shared reasonably equally in four areas.

Maximum area of runoff = 520m² (impermiable.)

Return Period = 2 years.

Design Rainfall = (Wallingford Procedure)

Assume 30% increase for climate change 520 x 1.33 = 700m²

Storm duration 1 hour

Return Period 100 years.

From print out: Maximum surface water runoff 7.9 l/s

Qp = 0.022 m³/sec (Average gradient 1:40) = 22 l/s.

Assume 2.4m dia' rings forming chamber.

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SOAKAWAY DEPTH (MBGL)	EFF SOAKAWAY DEPTH (M)	EFF STORAGE VOLUME (M^3)	REDUCTION FACTOR	REQ'D DISCHARGE RATE (l/s)
3	1	4.524	4	5.5
4	2	9.048	13	2.54
5	3	13.571	40	0.55
6	4	18.095	40	0.55

DEPTH TO BASE OF LINER (MBGL)	PERFORATED LENGTH (M.)	SOAKAGE AREA (M^2)
9	3	1.884
12	6	3.77
15	9	5.645

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9	TOTAL AVAILABLE DISCHARGE (l/sec)			0.118
8	TOTAL AVAILABLE DISCHARGE (l/min.)	1.698	4.187	7.087
7	INCREMENTS OF AVAILABLE DISCHARGE (l/min.)	1.698	2.489	2.900
6	UNIT DESIGN SOAKAGE RATE (l/m²/min.) F.O.S. 2	0.0	1.32	1.54
5	UNIT FIELD SOAKAGE RATE (l/m²/min.) TEST RESULTS	1.8	2.63	3.07
4	AREA OF EXPOSED CHALK (m²)	1.885	1.885	1.885
3	MAXIMUM DRIVING HEAD (m)	5.9	5.5	12.5
2	INCREMENTS OF DISCHARGE (MBGL)	0 to 5.9	5.9 to 8.5	8.5 to 12.5
1	DEPTH TO BASE OF LINER (MBGL)	5.9	8.5	12.5

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SOAKAWAY DEPTH (MBGL)	EFF' STORAGE VOLUME (m^3)	REQ'D DISCHARGE RATE (l/s)	DEPTH TO BASE OF LINER (MBGL)	TOTAL AVAILABLE DISCHARGE (l/s)
3	4.524	5.5		
4	9.048	2.54	9	
5	13.571	0.55	12	
6	18.095	0.55	15	0.118

EXAMPLE

Job No

Sheet No

Please find enclosed results from the borehole soakaway excavated at your site in Lenham.

Due to trafficking issues around the site at the time of the borehole construction we were only able to carry out one proof test in the installed liner.

The results of the testwork undertaken indicated a good soakage potential and suggest that the borehole has the potential to be adopted in the design of the surface water drainage scheme.

Should you have any queries please do not hesitate to contact me.

Yours sincerely,

Enc.
Drillers Log
Falling Head Test Results

Borehole No. BH1

Sheet: 1 of 2

Equipment & Methods. Dando 150 _Backfill: 140mm well liner	Project Name: Project Location: Client:	Job No: 11564
Co-ordinates: E: N:	Ground Level (m):	Date Started:07/03/2016 Date Completed:10/03/2016

Samples and In situ Testing				Field Records	DESCRIPTION	Reduced Level (m)	Legend	Depth (Thick) (m)
Depth (m)	No.	Type	Result					
					MADE GROUND - Grass over dark brown clayey topsoil with many fine rootlets	-0.40		(0.40) 0.40
					Soft to firm mid brown silty CLAY (Head)	-1.10		(0.70) 1.10
					Firm to stiff mid brown silty CLAY with fine chalk gravel **(West Melbury Chalk Formation)**			(2.90)
					Firm mid brown silty CLAY with occasional medium angular flint gravel **(West Melbury Chalk Formation)**	-4.00		4.00 (0.50)
					Off white/grey highly weathered CHALK marl with abundant flints **(West Melbury Chalk Formation)**	-4.50		4.50 (1.50)
					Off white moderately weathered CHALK marl **(West Melbury Chalk Formation)**	-6.00		6.00 (9.00)
						-15.00		15.00
					End of Borehole 15.00 m (Thickness of basal layer not proven)			

EXAMPLE

Remarks: Stability: stable	Logged By: DPR	Checked By: CSS
	Scale: 1:100	Approved By:
	FIG No. .1	

Notes: For explanation of symbols and abbreviations, see Key Sheet.

Borehole No. BH1

Sheet: 2 of 2

Equipment & Methods.	Project Name:	Job No:
Dando 150 _Backfill: 140mm well liner	Project Location: Client:	11564
Co-ordinates:	**Ground Level (m):**	**Date Started:07/03/2016**
E: N:		Date Completed:10/03/2016

Water Level Observations During Boring

Date	Time	Depth of Hole (m)	Depth of Casing (m)	Depth to Water (m)	Remarks
7-3-16	00:00	9.00	6.00	DRY	End of shift
9-3-16	08:00	9.00	6.00	DRY	Start of shift
9-3-16	16:00	15.00	13.00	8.80	End of borehole

Hole Diameter by Depth Table

Depth of Hole (m)	Diameter of Hole (mm)	Diameter of Casing (mm)	Depth of Casing (m)
15.00	200	200	13.00

Water Strike Table

Depth of Strike (m)	Casing Depth (m)	Date	Time	Post Strike Depth (m)	Minutes After Strike	Sealed At (m)	Remarks
13.50	13.00	9-3-16		8.80	30		Water strike

EXAMPLE

Remarks:
Stability: stable

Logged By:	Checked By:
DPR	CSS
Scale: 1:100	Approved By:
FIG No. .2	

Notes: For explanation of symbols and abbreviations, see Key Sheet.

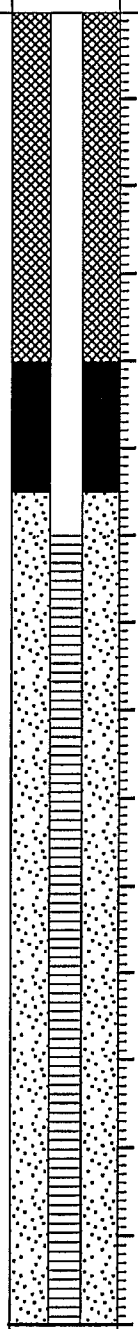
Hole ID. BH1
Installation Details & Readings

Sheet: 1 of 1

Equipment & Methods. Dando 150 _Backfill: 140mm well liner	Project Name: Project Location: Client:	Job No: 11564
Co-ordinates: E: N:	Ground Level (m):	Date Started:07/03/2016 Date Completed:10/03/2016

Installation Date : 10/03/2016 Depth to TOP Response Zone : 6 (m)

Installation Type : SP Depth to BASE Response Zone : 15 (m)



EXAMPLE

Compiled By: DPR	Checked By: CSS
Scale:	Approved By:
FIG No.	

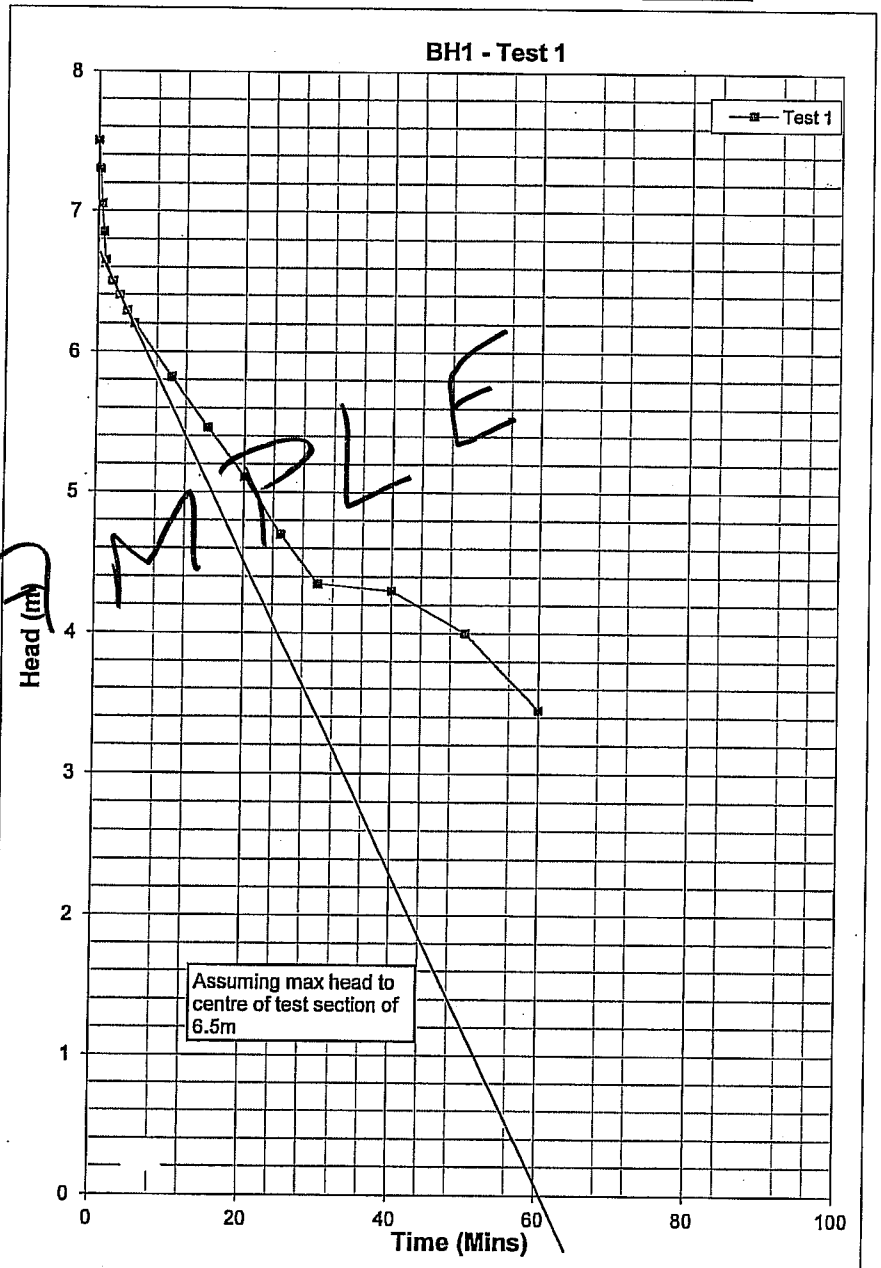
Notes: For explanation of symbols and abbreviations, see Key Sheet.

GSG PIEZO/STANDPIPE LOG LOGS.GPJ GSG-AGS3-STD TEMPLATE.GDT 18/3/16

BH1

Top section	6	m	Centre section	7.5	m	Diameter of Hole	0.2	m
Bottom section	9	m	Diameter of test section	0.2	m	Length of test section	3	m

Time (mins)	Depth	Head
0	0	7.5
0.25	0.2	7.3
0.5	0.45	7.05
0.75	0.65	6.85
1	0.85	6.65
2	1	6.5
3	1.1	6.4
4	1.21	6.29
5	1.3	6.2
10	1.68	5.82
15	2.04	5.46
20	2.39	5.11
25	2.8	4.7
30	3.15	4.35
40	3.2	4.3
50	3.5	4
60	4.05	3.45



KCC Methodology (l/m²/min)

$$Soakage = \frac{250 \cdot Hp \cdot d^2}{D \cdot L \cdot t_h}$$

=	1.80	L/m^2/min

Hp	6.7	m		th	62	mins

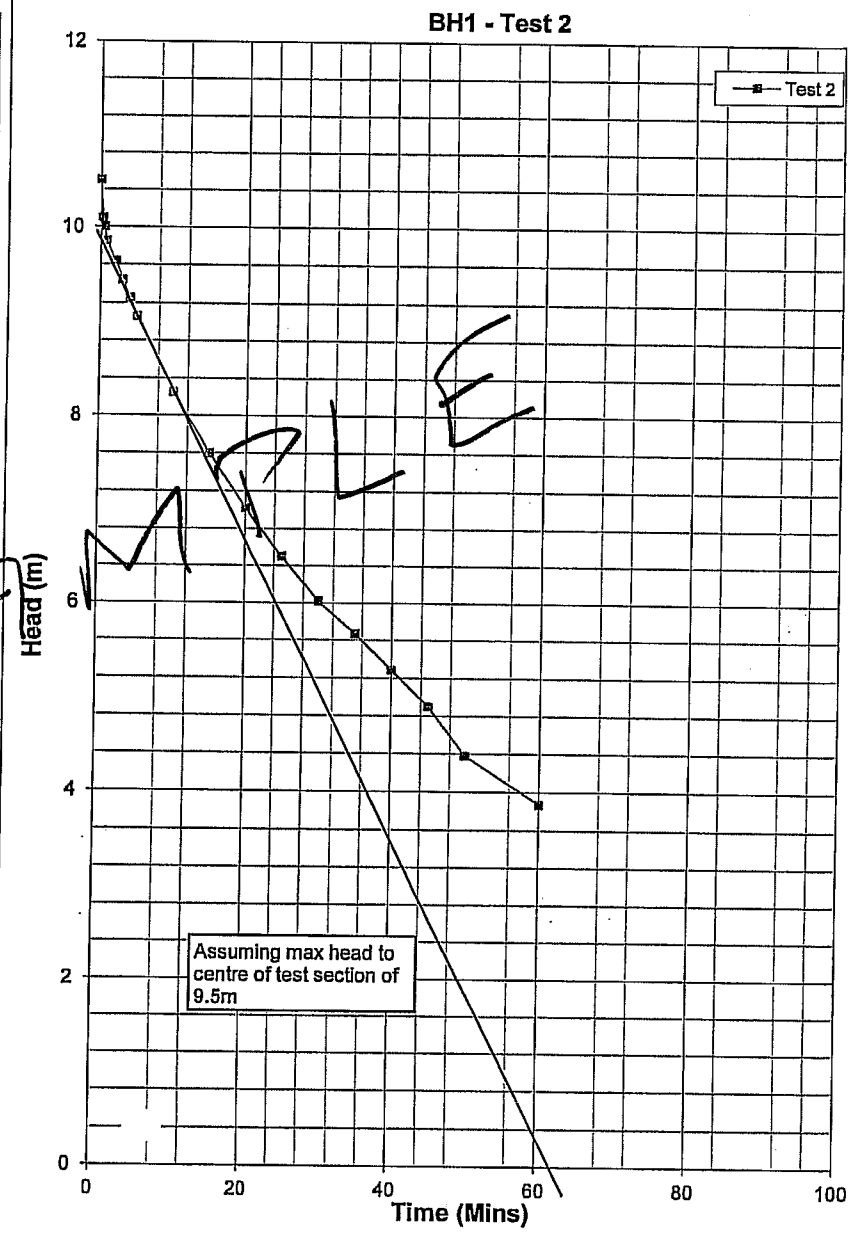
Based on test results obtained after BS5930:1999

k(approx) = 6.34 x10-5 m/s

BH1

Top section	9	m	Centre section	10.5	m	Diameter of Hole	0.2	m
Bottom section	12	m	Diameter of test section	0.2	m	Length of test section	3	m

Time (mins)	Depth	Head
0	0	10.5
0.25	0.4	10.1
0.5	0.5	10
0.75	0.65	9.85
2	0.86	9.64
3	1.06	9.44
4	1.25	9.25
5	1.44	9.06
10	2.25	8.25
15	2.9	7.6
20	3.48	7.02
25	4	6.5
30	4.48	6.02
35	4.83	5.67
40	5.22	5.28
45	5.6	4.9
50	6.12	4.38
60	6.63	3.87



KCC Methodology (l/m²/min)

$$Soakage = \frac{250 \cdot Hp \cdot d^2}{D \cdot L \cdot t_h}$$

=	2.63	L/m^2/min

Hp	9.8	m		th	62	mins

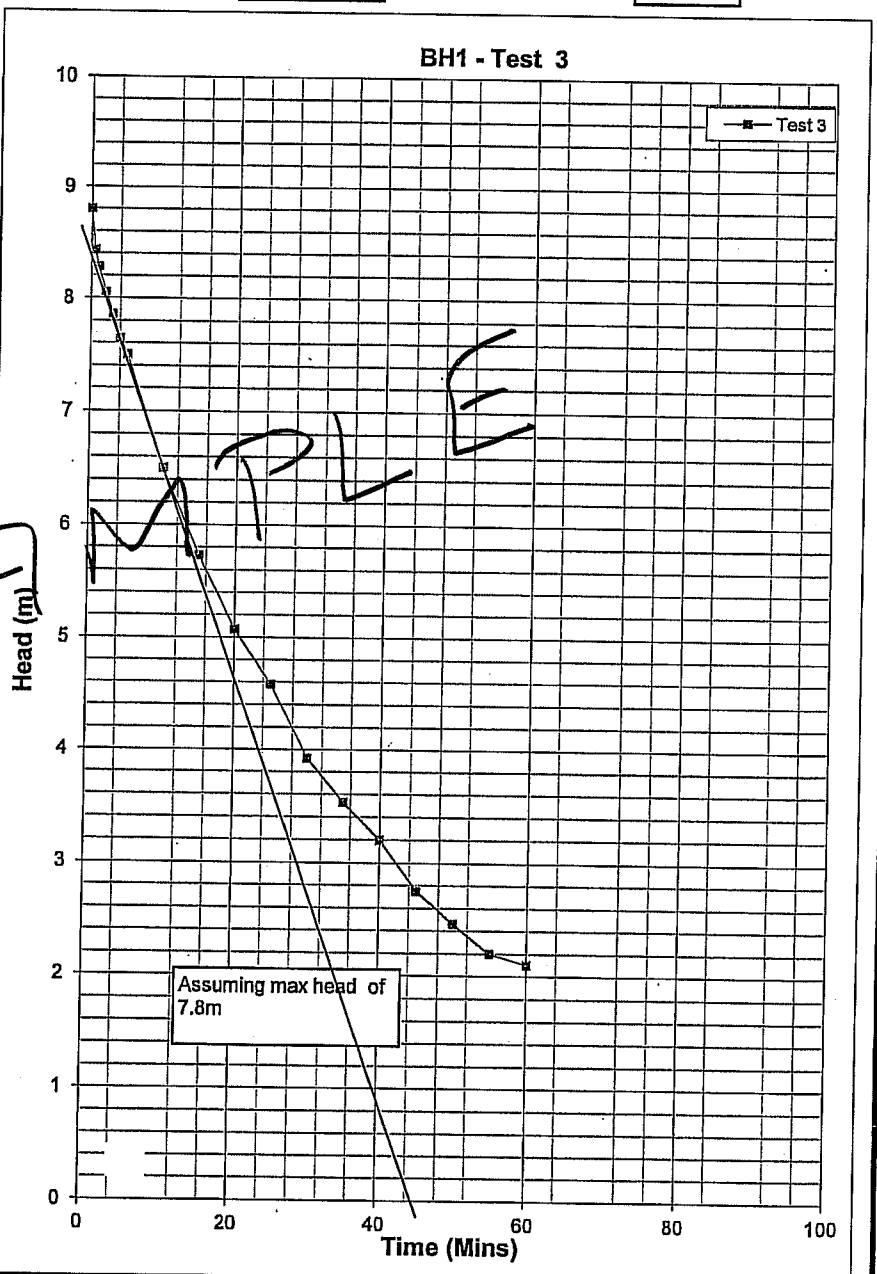
Based on test results obtained after BS5930:1999

k(approx) = 8.46 x10-5 m/s

BH1

Top section	12	m	Centre section	13.5	m	Diameter of Hole	0.2	m
Bottom section	15	m	Diameter of test section	0.2	m	Length of test section	3	m
Water level	8.8	m						

Time (mins)	Depth	Head
0	0	8.8
0.5	0.37	8.43
1	0.52	8.28
2	0.75	8.05
3	0.94	7.86
4	1.16	7.64
5	1.3	7.5
10	2.3	6.5
15	3.07	5.73
20	3.73	5.07
25	4.22	4.58
30	4.88	3.92
35	5.27	3.53
40	5.6	3.2
45	6.05	2.75
50	6.34	2.46
55	6.6	2.2
60	6.7	2.1



KCC Methodology (l/m²/min)

$$Soakage = \frac{250 \cdot Hp \cdot d^2}{D \cdot L \cdot t_h}$$

Hp	8.3	m		th	45	mins		

=	3.07	L/m^2/min

Based on test results obtained after BS5930:1999

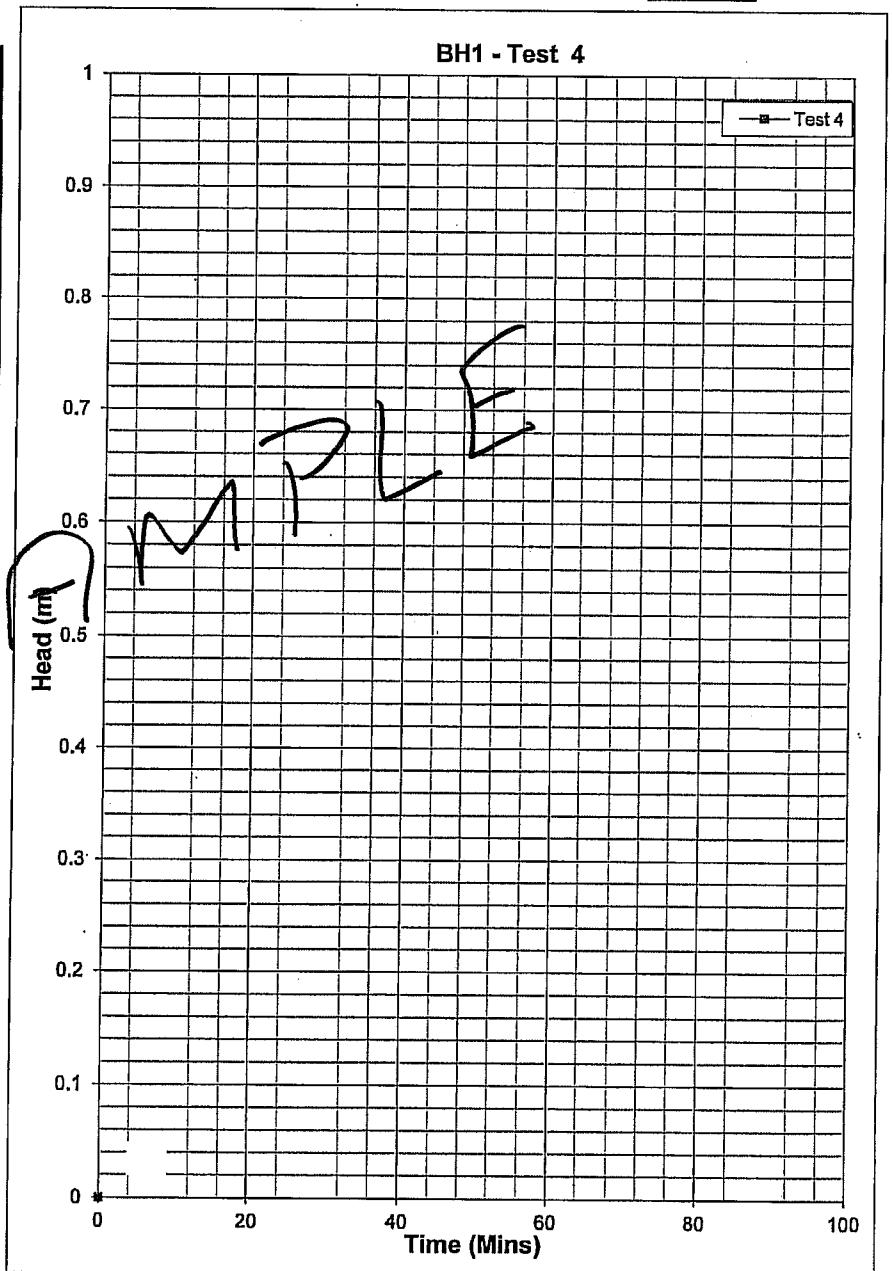
k(approx) = 1.27 x10-4 m/s

BH1

Top section	5	m	Centre section	10	m	Diameter of Hole	0.2	m
Bottom section	15	m	Diameter of test section	0.2	m	Length of test section	10	m
Water level	8.8	m						

Time (mins)	Depth	Head
0	8.8	0

EXAMPLE



KCC Methodology (l/m²/min)

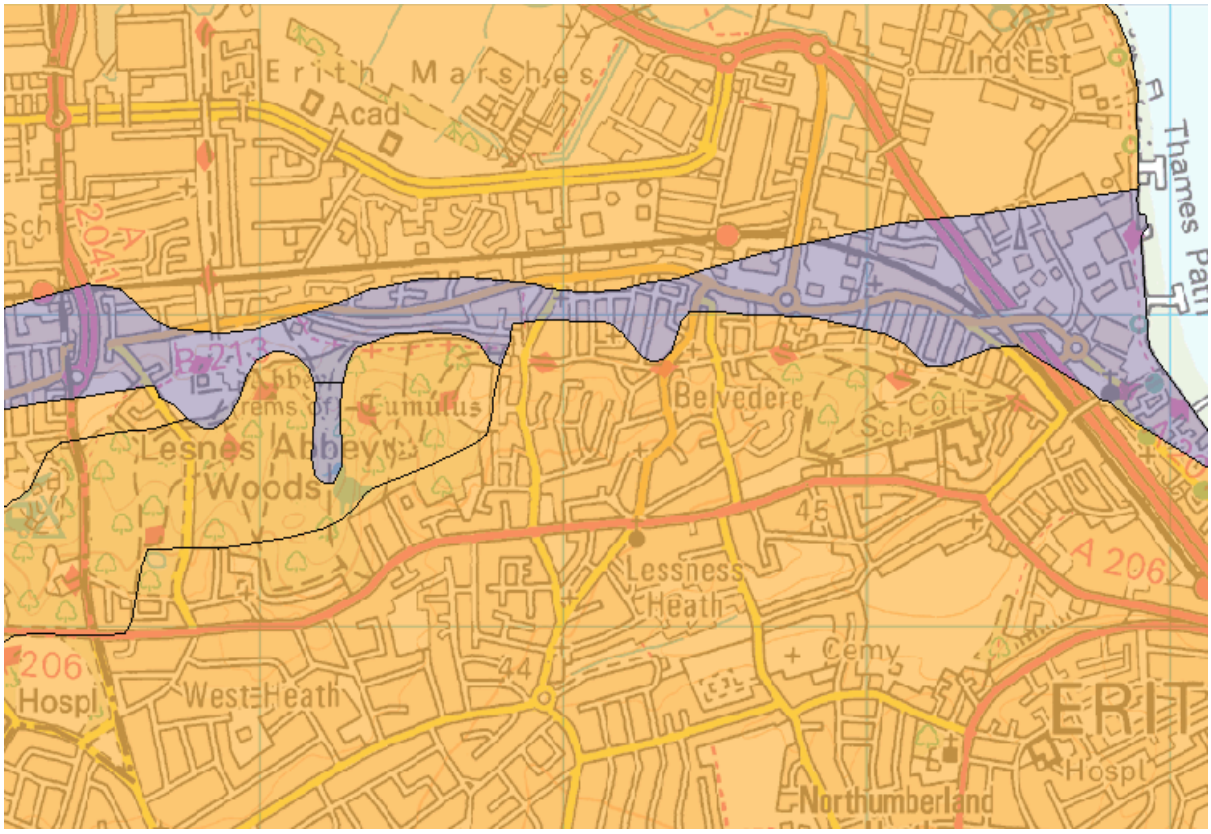
$$Soakage = \frac{250 \cdot Hp \cdot d^2}{D.L.t_h}$$

Hp		m		th		mins	
=		L/m^2/min					

TEST OF 140MM DIAMETER SOAKAWAY LINER. 350L OF WATER ADDED TO BH IN 60 SECONDS - UNABLE TO RAISE HEAD OF WATER ABOVE STARTING LEVEL OF 8.8M

APPENDIX B

ENVIRONMENT AGENCY PLAN


Erith Marshes
Acad
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Thames Path
Belvedere
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Sch
Lesnes Abbey
Woods
Lessness
Heath
A 206
Cemy
Hospl
West Heath
ERIT
Hospl
Northumberland

APPENDIX C

PERMEABLE PAVEMENT MAINTENANCE SCHEDULE

LAND ADJOINING 98 MILTON ROAD, BELVEDERE, KENT, DA17 5BA

SURFACE WATER DRAINAGE STRATEGY AND SUSTAINABLE DRAINAGE MANAGEMENT & MAINTENANCE PLAN

1.00 Maintenance of Permeable Access Road & Parking Spaces

1.01 It is the intention that the access road and parking spaces at this development will be designed with permeable paving finishes.

1.02 All maintenance operations are to be carried out in accordance with the manufacturer's recommendations.

1.03 Typical ongoing maintenance activities for permeable block paving are tabulated below in Table 1.

Table 1 – Block Paving Maintenance Activities – By Management Company

Maintenance Activity	Remedial Action	Inspection Frequency	
Check the surface and ensure it is free from debris, dirt etc	Clean surfacing as required and remove detrimental materials.	Pre-completion	Monthly
		Post completion – up to 1 year	Quarterly
		Ongoing	Annually or as required
Ensure the surface is clear of sediments	Sweep surface clean of silt and deleterious materials, top up joints with sealing grit as required.	Pre-completion	Monthly
		Post completion – up to 1 year	Quarterly
		Ongoing	Annually or as required
Inspect joints and carry out weed control	Remove weeds and top up joints with sealing grit as required	Pre-completion	Quarterly
		Post completion – up to 1 year	Quarterly
		Ongoing	Quarterly
Ensure paving dewaters after rain and between storms	Check joints for sedimentation, mechanically clean or jet wash and sweep surface free from silt. Refill joints with sealing grit as required.	Pre-completion	Monthly
		Post completion – up to 1 year	Quarterly
		Ongoing	Annually or as required
Inspect blocks for spalling or deterioration and joints for loss of grit	Replace blocks and top up sealing grit as required.	Pre-completion	Monthly
		Post completion – up to 1 year	Quarterly
		Ongoing	Annually or as required