SOIL INFILTRATION TESTING

Client	Bugler Developments Limited
Project Type	Soil Infiltration Testing
Site	Land at Sullivan Crescent, Harefield, UB9 6NL

Project	Version	Date
23-248.02	1	24 October 2023

1.0 INTRODUCTION

At the instruction of the Bugler Developments Limited [The Client], Aviron Associates Limited [Aviron] has undertaken soil infiltration testing in accordance with Building Research Establishment [BRE] Digest D365 - 2016, 'Soakaway Design' at the above referenced site.

The purpose of the works is to assess the infiltration of underlying soils in order to inform and support a drainage strategy for the proposed residential development of the site.

The soil infiltration testing follows on from Aviron's PRA + SI produced in October 2023, reference 23-248.01, which included a cable and percussion borehole and window sample drilling.

The ground conditions encountered at the site and summarised within the PRA + SI are as follows:

- Concrete hardstanding, to depths of up to 0.25m bgl.
- MADE GROUND noted routinely across the site to depths of between 0.4m and 0.9m bgl.
- Overlying natural horizon of medium dense and dense becoming locally very dense slightly clayey becoming gravelly and very gravelly SAND (Gerrards Cross Gravel) to depths of between 1.9m and 2.5m bgl.
- Firm and stiff, high strength, becoming very stiff, becoming fissured silty CLAY (London Clay Formation) to the termination depth of BH1 at 25.0m bgl.
- Claystone was noted between 9.7m and 9.9m bgl.
- Groundwater was encountered at depths of between 1.0m and 2.1m bgl during investigation works of 27 September 2023 and within monitoring wells installed into positions WS3 and WS5 at 1.34m and 0.85m bgl respectively on 3 October 2023.

In accordance with our instruction, one day of soil infiltration testing was completed at five locations tested within trial pits circa 0.7-0.8 metres (m) deep for permeable pavements and 1.4-2.5m deep for conventional soakaways.

Three cycles of filling/draining would be attempted within each pit to enable infiltration rates to be presented to support the conceptualisation of a drainage strategy.

2.0 BRE D365 INFILTRATION TESTING

Five trial pits were excavated using a JCB 3CX back-hoe excavator on 10 October 2023 following the rationale below:

- SP1, SP3 and SP5 were completed at 1.4m, 1.5m and 2.5m bgl respectively to seek 'SAND' at depth.
- SP2 and SP4 were completed at a depth of 0.7m and 0.8 bgl respectively to enable infiltration testing within the overlying fine soils for permeable paving.

In each case the rate of excavation was steady, and the sides of the trial pits were reasonable stable.

The locations of trial pits are illustrated in **Figure 1,** which is included as **Appendix I**.

The **trial pits logs** and **photographs** are presented in **Appendix II** and generally ground conditions are summarised in table 2.0.

Table 2.0: Summary of Ground Conditions Encountered			
Unit	**Description**	**From (bgl)**	**To (bgl)**
MADE GROUND	All positions. Tarmac and concrete hardstanding above CLAY, with various granular inclusions.	GL	0.4/0.5m
Cohesive Strata	SP1. Sandy, gravelly CLAY. SP2. Sandy, gravelly CLAY. SP3. Very sandy, very gravelly CLAY, with sand pockets. SP5. Sandy, gravelly CLAY.	0.4m 0.5m 0.4m 0.5m	1.4m 0.7m 1.5m 1.9m
Granular Strata	SP4. Very clayey, gravelly SAND. SP5. Slightly clayey, silty gravelly SAND.	0.4m 1.9m	0.8m 2.5m
Groundwater	All positions. No groundwater encountered to the maximum investigative depth of up to 2.5m bgl.		
GL = Ground Level			

3.0 TEST RESULTS

Trial pits SP1 to SP5 were filled with drinking water standard water pumped from a road going water bowser. The subsequent fall in water level was recorded against time over the period specified within the **results** which are presented in **Appendix III**.

The **calculation sheets** for are enclosed within **Appendix III** and indicate soil infiltration rates which are summarised within table 3.0.

Table 3.0: Soil Infiltration Rates				
Location (Test no.)	**Testing depths (m bgl)**	**Strata Tested**	**Infiltration Rate (m/s)**	**Comments**
SP1-1	0.76-1.4	CLAY	No rate	25% fill level not reached after 280 minutes.
SP2-1	0.315-0.7	MADE GROUND/CLAY	7.89×10^{-6}	Tested for 280 minutes, 75% and 25% full level reached. Relatively poor infiltration rate determined in the overlying MADE GROUND and CLAY horizon.
SP3-1	0.6-1.5	CLAY	No rate	75% fill level not reached after 220 minutes.
SP4-1	0.375-0.8	SAND	No rate	25% fill level not reached after 240 minutes.
SP3-1	0.83-2.5	CLAY/SAND	No rate	75% fill level not reached after 180 minutes.

5.0 GROUNDWATER

Groundwater was encountered at depths as shallow as 0.85m bgl within the monitoring wells installed into positions WS3 and WS5 on 3 October 2023.

6.0 CONCLUSIONS

The results should be presented to the project's drainage engineer for incorporation within their drainage scheme and should satisfy themselves with the results of the testing prior to finalising their design.

Permeable paving may be feasible locally, as noted in the shallow test undertaken in SP2-1, however the infiltration rate was noted to be relatively poor, and insufficient time was available to undertake repeat tests.

Consideration will also need to be given to the depth of perched water encountered across the site, noted at depths as shallow as 0.85m bgl, and the feasibility of drainage below this depth.

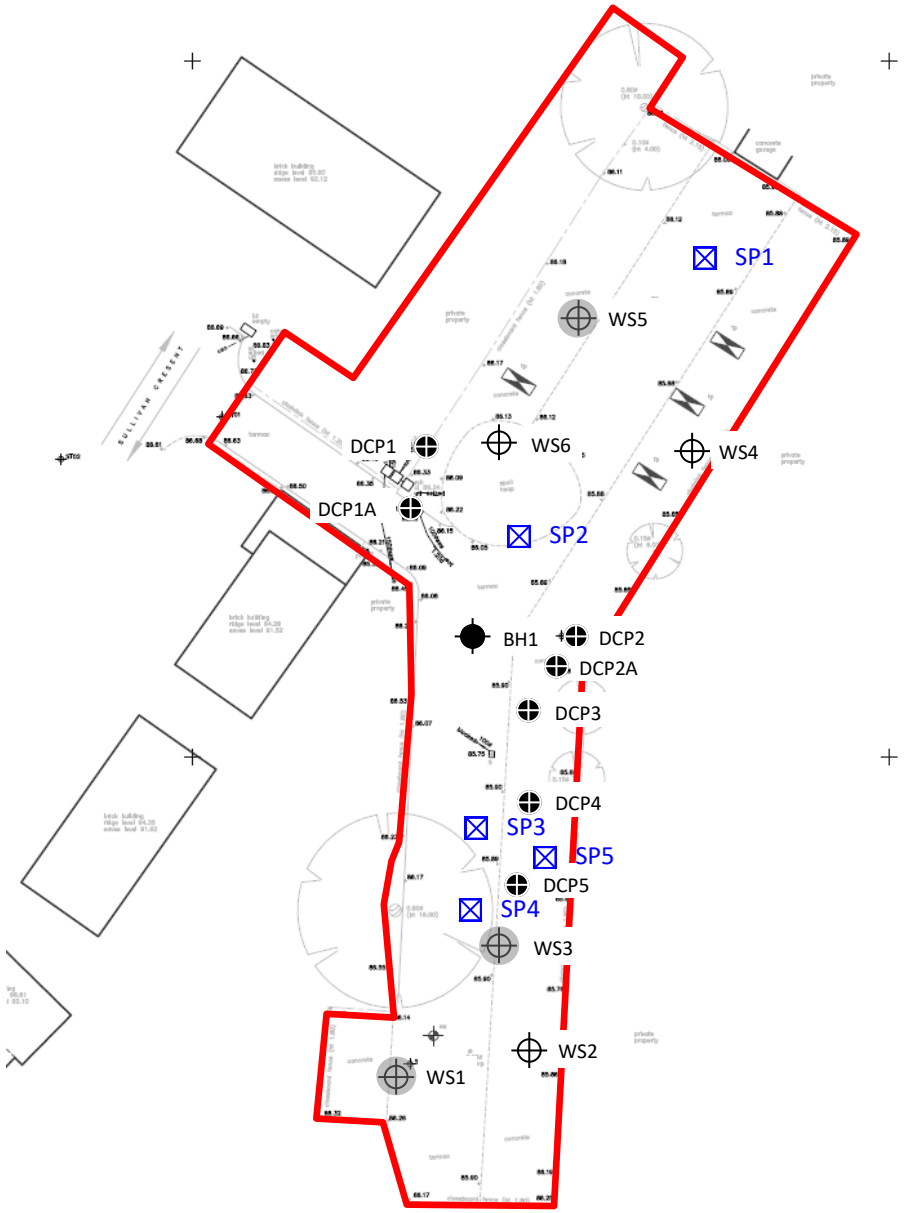
Project designers will need to consider if drainage infrastructure at shallow depth is appropriate.

We trust that you find the above to be satisfactory, however should you require any further information please do not hesitate to contact the undersigned.

Prepared by

James Burkitt BEng (Hons) CEnv MRICS
Managing Director

APPENDIX I
Figure 1 – Infiltration Test Location Plan



Legend

⊠ Machine Excavated Trial Pit/ Infiltration Test

Notes

SP1 + SP3 + SP5
Conventional soakaways

SP2 + SP4
Permeable paving

Figure 1

Drawing Title

Infiltration Test Location Plan

Project Number	23-248.02
Project Title	Land at Sullivan Crescent, Harefield, UB9 6NL
Drawn by	DN
Checked by	JB
Scale	NTS

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Appendix II
Trial Pit Logs and Photographs

Trial Pit Log

Project Name: Land at Sullivan Crescent	Client: Bugler Developments Limited	Date: 10/10/2023
Location: Harefield, UB9 6NL	Contractor:	
Project No. : 23-248.02	Crew Name:	Equipment: JCB 3CX

Location Number	Location Type	Level	Logged By	Scale	Page Number
SP1	TP		ac	1:25	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			Concrete
					0.40			Firm dark grey brown silty sandy gravelly clay with fine brick, concrete and coarse clinker fragments. Gravel is fine to coarse sub-angular to rounded of flint. MADE GROUND
								Firm becoming stiff orange brown and grey mottled sandy gravelly CLAY. Gravel is fine to medium sub-angular of flint.
					1.40			End of Trial Pit at 1.400m

1
2
3
4
5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
1.80	0.70	Sides of pit stable					

Remarks

Groundwater not encountered. Soakage test carried out.

Trial Pit Log

Project Name: Land at Sullivan Crescent	Client: Bugler Developments Limited	Date: 10/10/2023
Location: Harefield, UB9 6NL	Contractor:	
Project No. : 23-248.02	Crew Name:	Equipment: JCB 3CX

Location Number	Location Type	Level	Logged By	Scale	Page Number
SP2	TP		ac	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Concrete
					0.20			Firm dark grey brown silty sandy gravelly clay with fine brick, concrete and coarse clinker fragments. Gravel is fine to coarse sub-angular to rounded of flint. MADE GROUND
					0.50			Firm becoming stiff orange brown and grey mottled sandy gravelly CLAY. Gravel is fine to medium sub-angular of flint.
					0.70			End of Trial Pit at 0.700m

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
1.90	0.75	Sides of pit stable					

Remarks

Groundwater not encountered. Soakage test carried out.

Trial Pit Log

Project Name: Land at Sullivan Crescent	Client: Bugler Developments Limited	Date: 10/10/2023
Location: Harefield, UB9 6NL	Contractor:	
Project No. : 23-248.02	Crew Name:	Equipment: JCB 3CX

Location Number	Location Type	Level	Logged By	Scale	Page Number
SP3	TP		ac	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Concrete
					0.20			Firm dark grey brown silty sandy gravelly clay with fine brick, concrete and coarse clinker fragments. Gravel is fine to coarse sub-angular to rounded of flint. MADE GROUND
					0.40			Firm becoming stiff orange brown and grey mottled sandy gravelly CLAY. Gravel is fine to medium sub-angular of flint.
					1.40			Stiff orange brown mottled very sandy very gravelly CLAY. Gravel is coarse sub-angular of flint.Sand pockets
					1.50			End of Trial Pit at 1.500m

1
2
3
4
5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
1.80	0.70	Sides of pit stable					

Remarks

Groundwater not encountered. Soakage test carried out.

Trial Pit Log

Project Name: Land at Sullivan Crescent	Client: Bugler Developments Limited	Date: 10/10/2023
Location: Harefield, UB9 6NL	Contractor:	
Project No. : 23-248.02	Crew Name:	Equipment: JCB 3CX

Location Number	Location Type	Level	Logged By	Scale	Page Number
SP4	TP		ac	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.15			Concrete
					0.40			Firm dark grey brown silty sandy gravelly clay with fine brick, concrete and coarse clinker fragments. Gravel is fine to coarse sub-angular to rounded of flint. MADE GROUND
					0.80			Orange brown and grey mottled very clayey gravelly SAND Gravel is fine to medium sub-angular of flint.
								End of Trial Pit at 0.800m

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
1.60	0.75	Sides of pit stable					

Remarks

Groundwater not encountered. Soakage test carried out.

Trial Pit Log

Project Name: Land at Sullivan Crescent	Client: Bugler Developments Limited	Date: 10/10/2023
Location: Harefield, UB9 6NL	Contractor:	
Project No. : 23-248.02	Crew Name:	Equipment: JCB 3CX

Location Number	Location Type	Level	Logged By	Scale	Page Number
SP5	TP		ac	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.15			Concrete
					0.50			Firm dark grey brown silty sandy gravelly clay with fine brick, concrete and coarse clinker fragments. Gravel is fine to coarse sub-angular to rounded of flint. MADE GROUND
					1.90			Firm becoming stiff orange brown and grey mottled sandy gravelly CLAY. Gravel is fine to medium sub-angular of flint.
					2.50			Light brown slightly clayey silty gravelly fine SAND. Gravel is fine to coarse sub-angular of flint.
								End of Trial Pit at 2.500m

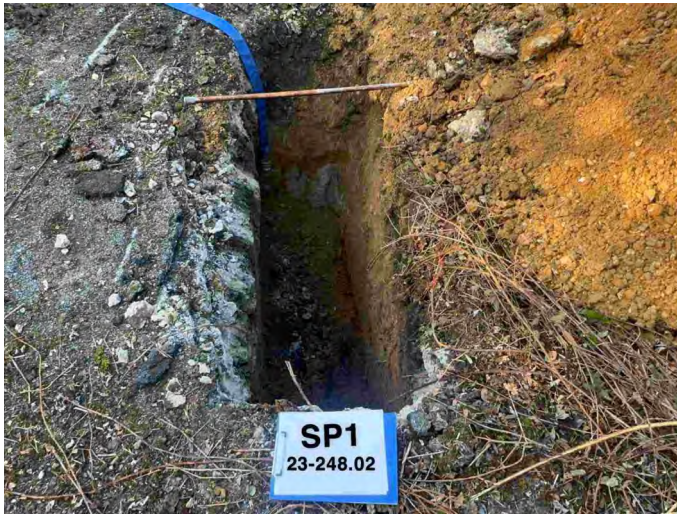
Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
2.00	0.80	Sides of pit stable					

Remarks

Groundwater not encountered. Soakage test carried out.

Exploratory Hole Photographs

Project Number 23-248.02 **Project Title** Land at Sullivan Crescent, Harefield, UB9 6NL **Taken by** AC **Date** 10/10/2023



SP1

SP2

SP3

SP1 arisings

SP2 arisings

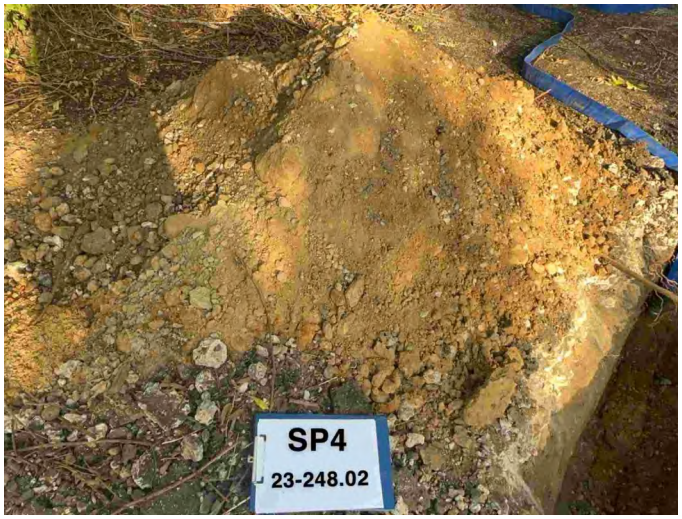
SP3 arisings

Exploratory Hole Photographs

Project Number 23-248.02 **Project Title** Land at Sullivan Crescent, Harefield, UB9 6NL **Taken by** AC **Date** 10/10/2023

SP4

SP5



SP4 arisings

SP5 arisings

Appendix III
Infiltration Test Results

Soil Infiltration Test

23-248.01: Land at Sullivan Crescent, Harefield, UB9 6NL

Test Pit SP1 - T1
Date: 10/10/2023
Readings Recorded By: AC

Pit Dimensions: **1.8m(l) x 0.7m(w) x 1.4m(d)**
Start Water Level: **0.76m**

Actual Storage Volume: **1.76 m^3**
Effective Depth: **0.64 m**

Time (mins)	Depth BGL (m)
0	0.760
1	0.760
2	0.770
3	0.775
4	0.775
5	0.775
10	0.790
15	0.800
20	0.810
30	0.820
80	0.875
120	0.920
200	0.980
220	0.990
240	0.995
260	1.000
280	1.005

$$\text{Soil infiltration rate, } f = \frac{V_{p75\text{-}25}}{a_{p50} \times t_{p75\text{-}25}}$$

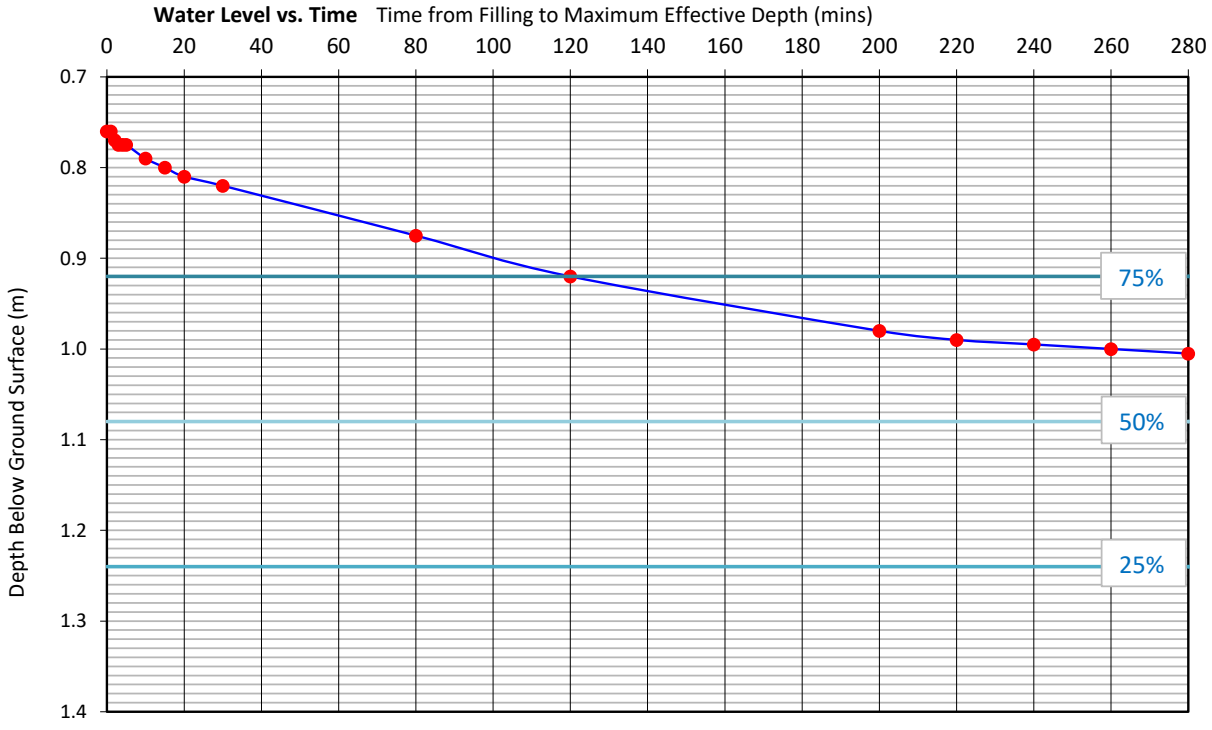
Effective Storage Volume, V: **1.8m x 0.7m x 0.64m**
V: **0.8064 m^3**

$V_{p75\text{-}25}$: **0.403 m^3**

Effective Internal Surface Area, a_{p50}: **1.152m2 + 0.448m2 + 1.26m2**
a_{p50}: **2.860 m^2**

Time of water level fall, $t_{p75\text{-}25}$: **- mins**
$t_{p75\text{-}25}$: **0 mins**
$t_{p75\text{-}25}$: **0 secs**

Soil infiltration rate, f : 0.4032/(2.86 x 0)
f : #DIV/0! ms^{-1}



Soil Infiltration Test

23-248.01: Land at Sullivan Crescent, Harefield, UB9 6NL

Test Pit SP2 - T1
Date: 10/10/2023
Readings Recorded By: AC

Pit Dimensions: **1.9m(l) x 0.75m(w) x 0.7m(d)**
Start Water Level: **0.315m**

Actual Storage Volume: **1.00 m^3**
Effective Depth: **0.39 m**

Time (mins)	Depth BGL (m)
0	0.315
1	0.320
2	0.325
3	0.330
4	0.335
5	0.340
10	0.365
15	0.395
20	0.420
30	0.470
60	0.530
100	0.565
140	0.585
180	0.595
220	0.600
240	0.600
260	0.605
280	0.605

$$\text{Soil infiltration rate, } f = \frac{V_{p75\text{-}25}}{a_{p50} \times t_{p75\text{-}25}}$$

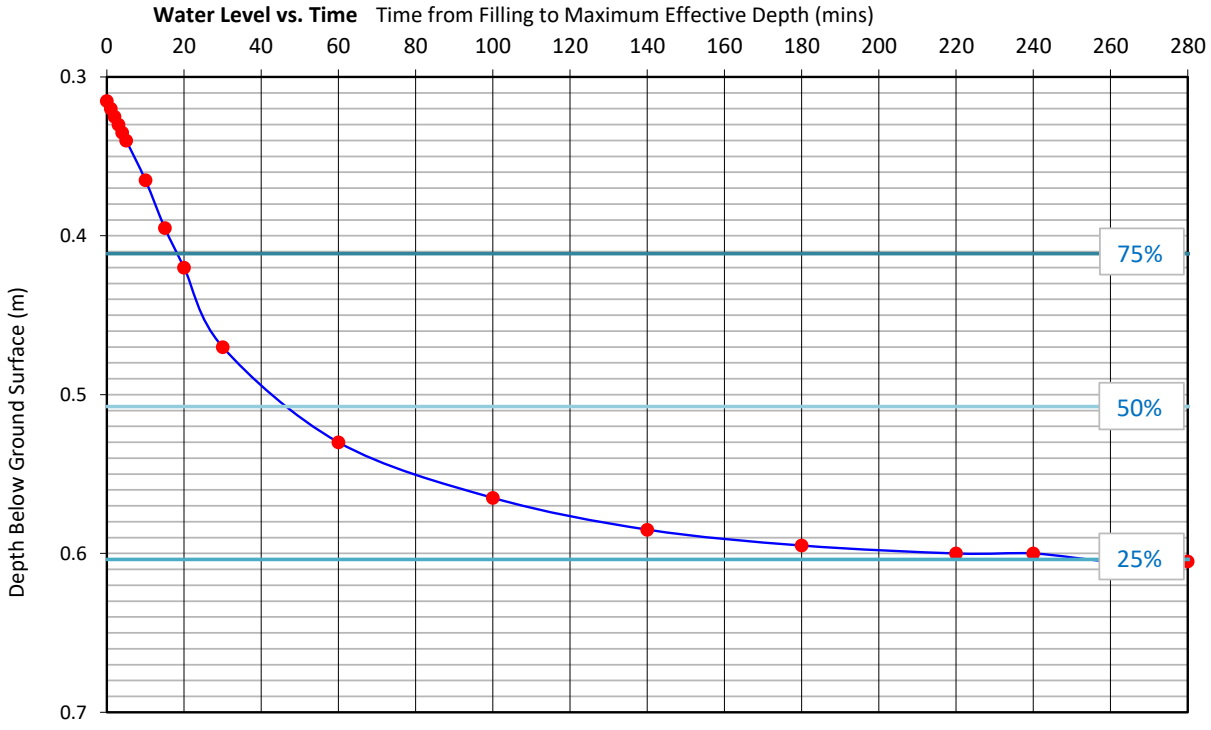
Effective Storage Volume, V: **1.9m x 0.75m x 0.385m**
V: **0.548625 m^3**

$V_{p75\text{-}25}$: **0.274 m^3**

Effective Internal Surface Area, a_{p50}: **0.7315m2 + 0.28875m2 + 1.425m2**
a_{p50}: **2.445 m^2**

Time of water level fall, $t_{p75\text{-}25}$: **255 - 18 mins**
$t_{p75\text{-}25}$: **237 mins**
$t_{p75\text{-}25}$: **14220 secs**

Soil infiltration rate, f : 0.2743125/(2.44525 x 14220)
f : 7.89E-06 ms^{-1}



Soil Infiltration Test

23-248.01: Land at Sullivan Crescent, Harefield, UB9 6NL

Test Pit SP3 - T1
Date: 10/10/2023
Readings Recorded By: AC

Pit Dimensions: **1.8m(l) x 0.7m(w) x 1.5m(d)**
Start Water Level: **0.6m**

Actual Storage Volume: **1.89 m^3**
Effective Depth: **0.90 m**

Time (mins)	Depth BGL (m)
0	0.600
1	0.605
2	0.605
3	0.610
4	0.615
5	0.620
10	0.645
15	0.655
20	0.670
30	0.680
60	0.700
80	0.715
100	0.735
120	0.750
140	0.770
160	0.790
180	0.800
200	0.810
220	0.815

$$\text{Soil infiltration rate, } f = \frac{V_{p75\text{-}25}}{a_{p50} \times t_{p75\text{-}25}}$$

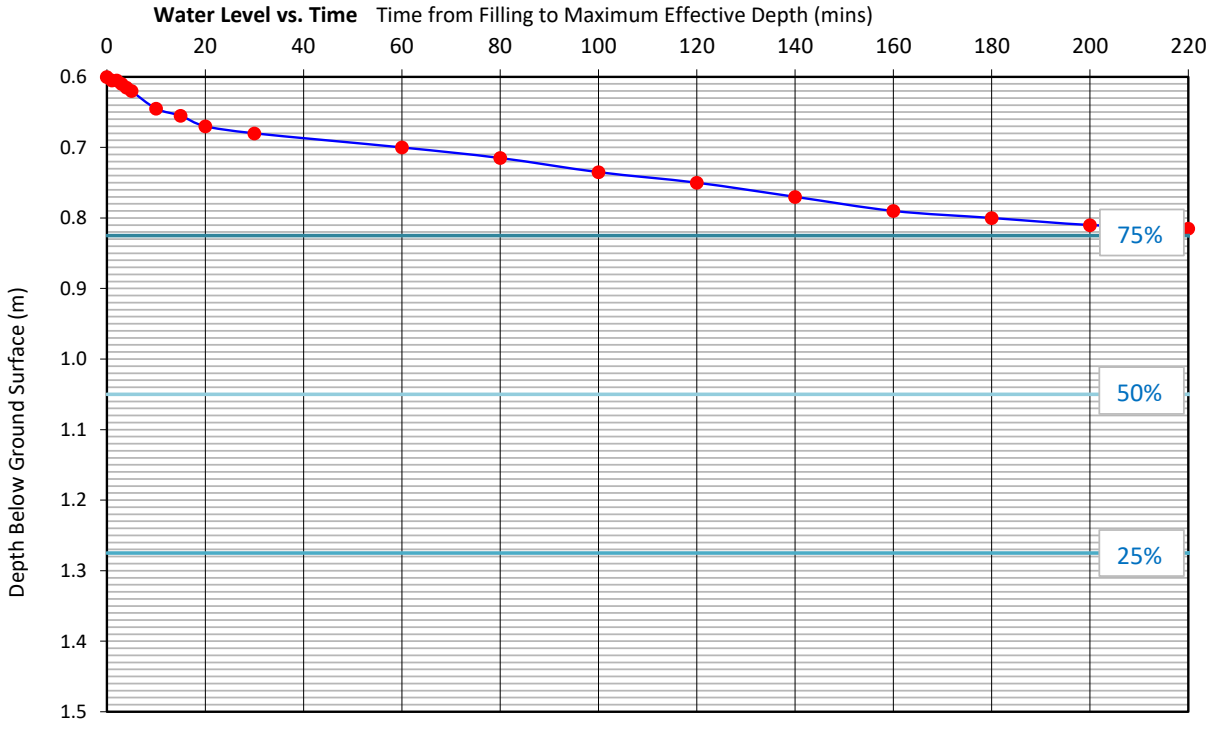
Effective Storage Volume, *V*: **1.8m x 0.7m x 0.9m**
V: **1.134 m^3**

$V_{p75\text{-}25}$: **0.567 m^3**

Effective Internal Surface Area, a_{p50}: **1.62m2 + 0.63m2 + 1.26m2**
a_{p50}: **3.510 m^2**

Time of water level fall, $t_{p75\text{-}25}$: **- mins**
$t_{p75\text{-}25}$: **0 mins**
$t_{p75\text{-}25}$: **0 secs**

Soil infiltration rate, *f* : 0.567/(3.51 x 0)
f **: #DIV/0! ms^{-1}**



Soil Infiltration Test

23-248.01: Land at Sullivan Crescent, Harefield, UB9 6NL

Test Pit SP4 - T1
Date: 10/10/2023
Readings Recorded By: AC

Pit Dimensions: **1.6m(l) x 0.75m(w) x 0.8m(d)**
Start Water Level: **0.375m**

Actual Storage Volume: **0.96 m^3**
Effective Depth: **0.43 m**

Time (mins)	Depth BGL (m)
0	0.375
1	0.380
2	0.385
3	0.390
4	0.390
5	0.390
10	0.410
15	0.420
20	0.430
30	0.440
60	0.480
100	0.505
140	0.530
180	0.545
220	0.555
240	0.560

$$\text{Soil infiltration rate, } f = \frac{V_{p75\text{-}25}}{a_{p50} \times t_{p75\text{-}25}}$$

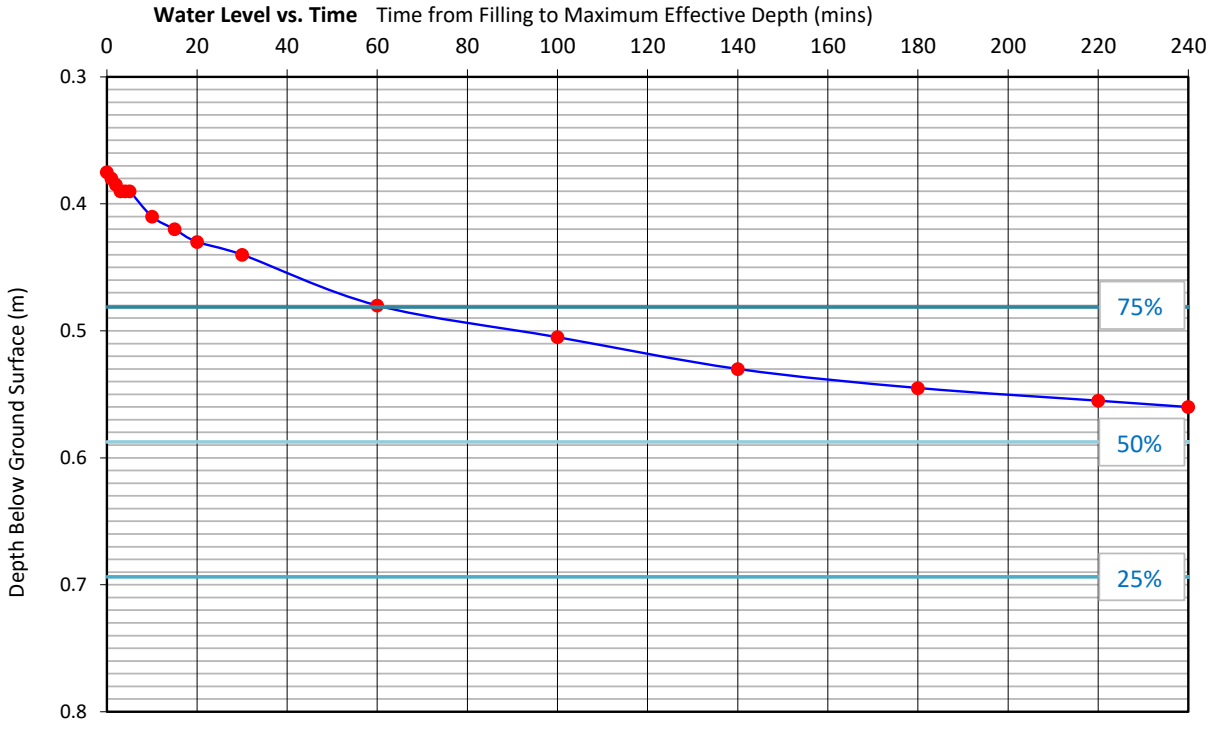
Effective Storage Volume, *V*: **1.6m x 0.75m x 0.425m**
V: **0.51 m^3**

$V_{p75\text{-}25}$: **0.255 m^3**

Effective Internal Surface Area, a_{p50}: **0.68m2 + 0.31875m2 + 1.2m2**
a_{p50}: **2.199 m^2**

Time of water level fall, $t_{p75\text{-}25}$: **- mins**
$t_{p75\text{-}25}$: **0 mins**
$t_{p75\text{-}25}$: **0 secs**

Soil infiltration rate, *f* : 0.255/(2.19875 x 0)
f **: #DIV/0! ms^{-1}**



Soil Infiltration Test

23-248.01: Land at Sullivan Crescent, Harefield, UB9 6NL

Test Pit SP5 - T1
Date: 10/10/2023
Readings Recorded By: AC

Pit Dimensions: **2m(l) x 0.8m(w) x 2.5m(d)**
Start Water Level: **0.83m**

Actual Storage Volume: **4.00 m^3**
Effective Depth: **1.67 m**

Time (mins)	Depth BGL (m)
0	0.830
1	0.830
2	0.835
3	0.835
4	0.845
5	0.850
10	0.880
15	0.910
20	0.935
30	0.975
40	0.995
50	1.010
60	1.015
80	1.020
100	1.025
120	1.030
140	1.035
160	1.035
180	1.045

Soil infiltration rate, $f = \dfrac{V_{p75\text{-}25}}{a_{p50} \times t_{p75\text{-}25}}$

Effective Storage Volume, V: **2m x 0.8m x 1.67m**
V: **2.672 m^3**

$V_{p75\text{-}25}$: **1.336 m^3**

Effective Internal Surface Area, a_{p50}: **3.34m2 + 1.336m2 + 1.6m2**
a_{p50}: **6.276 m^2**

Time of water level fall, $t_{p75\text{-}25}$: **- mins**
$t_{p75\text{-}25}$: **0 mins**
$t_{p75\text{-}25}$: **0 secs**

Soil infiltration rate, f : 1.336/(6.276 x 0)
f : #DIV/0! ms^{-1}