



## Infiltration Test Factual Report

<b>LOCATION</b>	Proposed Development, Lowfield Farm, Bolton Upon Dearne, S63 8GY
<b>ISSUE DATE</b>	3 <sup>rd</sup> May 2019
<b>FOR</b>	Michael Peverley
<b>CLIENT REF.</b>	
<b>OUR REF.</b>	G19196

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## Table of Contents

Section	Content	Page
<b>1</b>	<b>Introduction</b>	<b>3</b>
<b>2</b>	<b>Scope of Works</b>	<b>3</b>
<b>3</b>	<b>Investigation Findings</b>	<b>3</b>
<b>4</b>	<b>Calculations</b>	<b>5</b>
4.1	Infiltration Rate Calculations	5
4.2	Soakaway Design Calculations	5
<b>5</b>	<b>Comments</b>	<b>6</b>
<b>Appendix 1</b>	<b>Site plan</b>	
<b>Appendix 2</b>	<b>Infiltration Test Results</b>	
<b>Appendix</b>	<b>Soakaway Design Calculations</b>	



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## 1. Introduction

GeoInvestigate Ltd. has carried out calculations of infiltration rate and soakaway design dimensions based on infiltration test results provided by the client for testing carried out at the above location on 29<sup>th</sup> April 2019.

## 2. Scope of Works

Eight machine excavated trial pits were sunk at the site in the locations where soakaways are proposed for the new development.

All eight pits measured 1.60m long x 0.30m wide x 1.60m deep.

Water infiltration tests were undertaken in all eight pits according to the BRE 365 methodology. The tests were commenced with 500mm, 600mm or 700mm depths of water in the base of the pits and the water level was measured at regular intervals.

The site works were all carried out by the client with advice provided via telephone from Geoinvestigate Ltd. where required. The results provided by the client have been used in the calculations set out in the appendices of this report and it is therefore assumed that the data supplied to Geoinvestigate is both true and accurate.

The tests actually comprise the second tests undertaken in each pit with the first having been carried out with *slightly shallower overall depth (all pits 1.40m deep, each filled with 500mm of water)*. After additional excavation to depths at least 1.00m below the proposed invert level, the tests discussed in this report were then carried out.

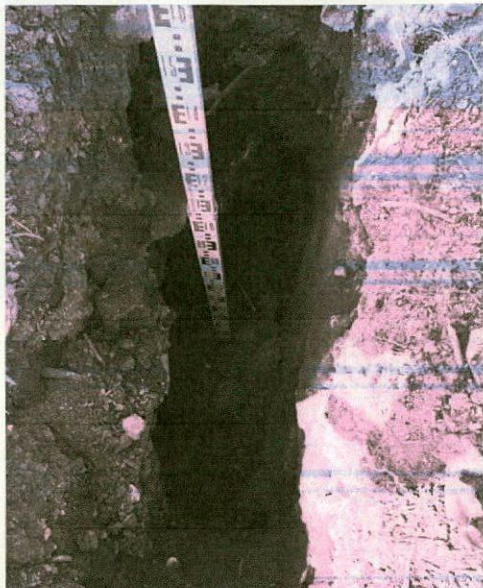
The first tests are considered to have been useful in that they will have surcharged the surrounding soils with an initial water flow/content and made the results of the second tests potentially slightly *conservative and therefore perhaps more representative of a soakaway's behaviour in repeat rainfall events*.

The locations of the tests are shown on the site plan provided in Appendix 1 of this report. The soakaway positions are marked with a box with a dashed outline in each plot containing a letter "S". Two of the locations have been moved to the positions marked with a red box where it is understood that preliminary testing had encountered low permeability soils.

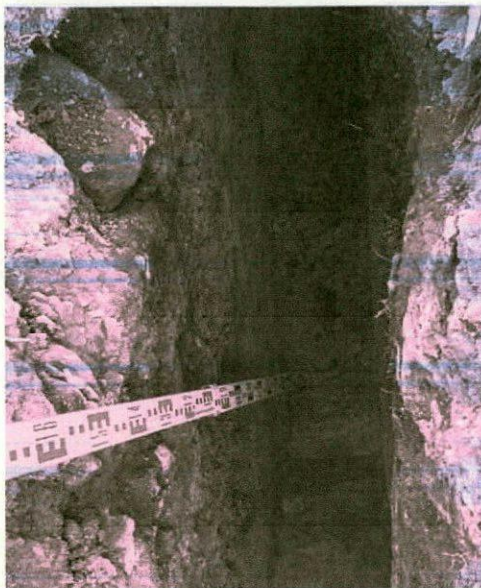
## 3 Investigation Findings

For clarity and to allow some comment/assessment of soils, the client has proved a number of photographs of the excavations to Geoinvestigate. A selection of these photographs is reproduced on the following pages with some comment about the soil types evident in the images.

**Plot 1:** Approx. 0.60m made ground over what appears to be sandy clay / clayey sand.



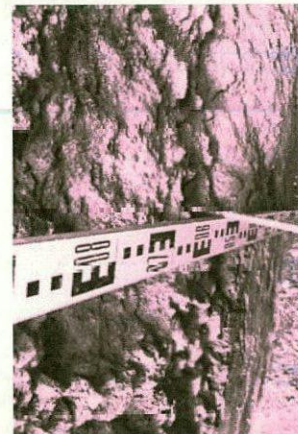
**Plot 2:** Approx. 0.40m topsoil/made ground over what appears to be gravelly clay.



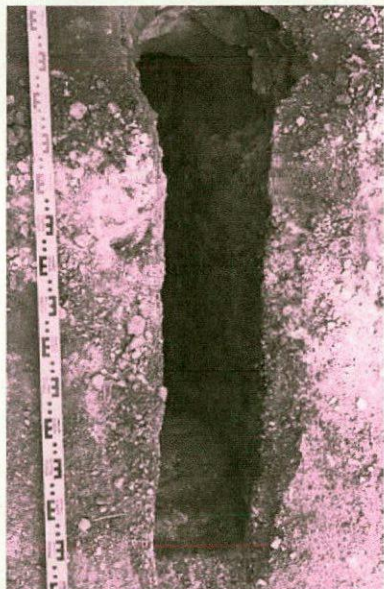
**Plot 3:** Approx. 0.70m made ground over what appears to be clayey sand.



**Plot 4:** 0.40m topsoil/made ground over what appears to be clayey sand. Possible sandy clay below 1.20m



**Plot 5:** Approx. 0.40m made ground over what appears to be sandy clay / clayey sand.

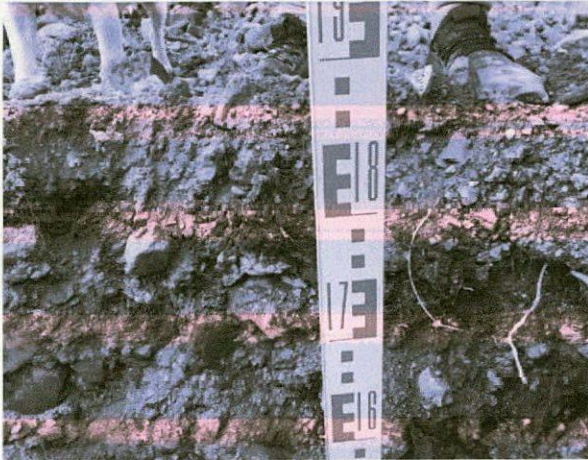


**Plot 6:** Approx. 0.40m made ground over what appears to be clayey gravelly sand.



**Plot 7:** Unclear. At least 0.30m made ground.

**Plot 8:** Approx. 0.40m made ground over what appears to be clayey sand / sandy clay.



## 4 Calculations

### 4.1 Infiltration Rate Calculations

The response zones of the tests were entirely within the natural subsoils (i.e. not draining into topsoil or made ground) as this would be the material into which the water would soak if soakaways were utilised at the site. The results of the tests, charts showing infiltration progress, and the calculated infiltration rates are presented on the infiltration test result sheets in Appendix 2.

The Infiltration ( $f$ ) values have been calculated for the tests according to the method described in BRE 365 and are presented below:

Location	Infiltration rate ( $\text{ms}^{-1}$ )
PLOT 1	$3.50 \times 10^{-5}$
PLOT 2	$5.20 \times 10^{-6}$
PLOT 3	$1.25 \times 10^{-5}$
PLOT 4	$1.51 \times 10^{-5}$
PLOT 5	$1.25 \times 10^{-5}$
PLOT 6	$1.29 \times 10^{-5}$
PLOT 7	$8.97 \times 10^{-6}$
PLOT 8	$1.02 \times 10^{-5}$

Note again that these values are reliant on the accuracy of the test results.

### 4.2 Soakaway Design Calculations

Soakaway design calculations have been carried out for each test location. These calculations have been done in accordance with the method set out in BRE 365 for a simple rectangular, gravel-filled soakaway and have used the rainfall data provided in that document and the infiltration rates calculated in Appendix 2.

Based on the apparent size of the proposed structures on the site plan provided to Geoinvestigate, drained areas of 200m<sup>2</sup> have been assumed for the soakaways serving plots 1-4 for the purpose of these calculations, and drained areas of 100m<sup>2</sup> have been assumed for the soakaways serving plots 5-8.

Suitable soakaway dimensions for simple rectangular, gravel-filled soakaways at these eight locations are presented in the table below. These designs assume the top of the soakaway will be buried at a depth of 0.50m and the soakaway will extend to 2.00m below ground level (i.e. an active depth of 1.50m). Dimensions can be recalculated to suit spatial requirements on site but the calculations and resultant dimensions have been manipulated to produce dimensions approximately in multiples of 0.50m to make subsequent measuring and excavation simple.

Location	Depth to top of Soakaway (m)	Depth of Soakaway (m)	Total Depth (m)	Chosen Length (m)	Calculated Width (m)
PLOT 1	0.50	1.50	2.00	3.50	2.44
PLOT 2	0.50	1.50	2.00	7.50	1.96
PLOT 3	0.50	1.50	2.00	6.00	1.92
PLOT 4	0.50	1.50	2.00	5.50	1.97
PLOT 5	0.50	1.50	2.00	3.50	1.49
PLOT 6	0.50	1.50	2.00	3.50	1.48
PLOT 7	0.50	1.50	2.00	3.00	1.99
PLOT 8	0.50	1.50	2.00	3.00	1.91

## 5 Comments

As discussed previously the calculations carried out are based on infiltration test results provided by the client and so are entirely reliant on these results. Any inaccuracies in the test results could have produced errors in the calculation but Geoinvestigate has no reason to suspect the results are anything other than entirely reliable.

No consideration has been given to the potential for contamination to be present in soils at the site and no comment is offered to this end. It is understood that the contamination situation at the site has been investigated. If contamination were present the installation of soakaways might be inadvisable due to the *potential for mobilisation of contaminants*. If any contamination were present at the site and remedial works were to take place then the use of soakaways would be dependant on disproving the mobility of any contaminated soils that might be proposed to be left in situ.

BRE 365 recommends that soakaways should be at least 5m from any building foundations. Care should be taken when locating the proposed soakaways to ensure this advice is followed.

————— END OF REPORT —————

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The findings and contents of this (intrusive) Site Investigation Report pertain solely to the study area(s) outlined herein and are based solely on the excavation findings reported to Geoinvestgate by the client. The findings and/or recommendations of this report do not take into account any ground conditions that may be present but have hitherto not been encountered or that Geoinvestgate might be currently unaware of and as such further investigation and/or a reconsideration of the findings of this report should be undertaken if such conditions are present or subsequently encountered, or an alternative development plan or land use is subsequently proposed.

This report considers various environmental and/or geological risks posed to the site and/or proposed development and offers advice accordingly as guidance only. The findings of this report will remain valid provided no change of ground or groundwater conditions, either natural or anthropogenic, take place and no warrantee is offered or implied.

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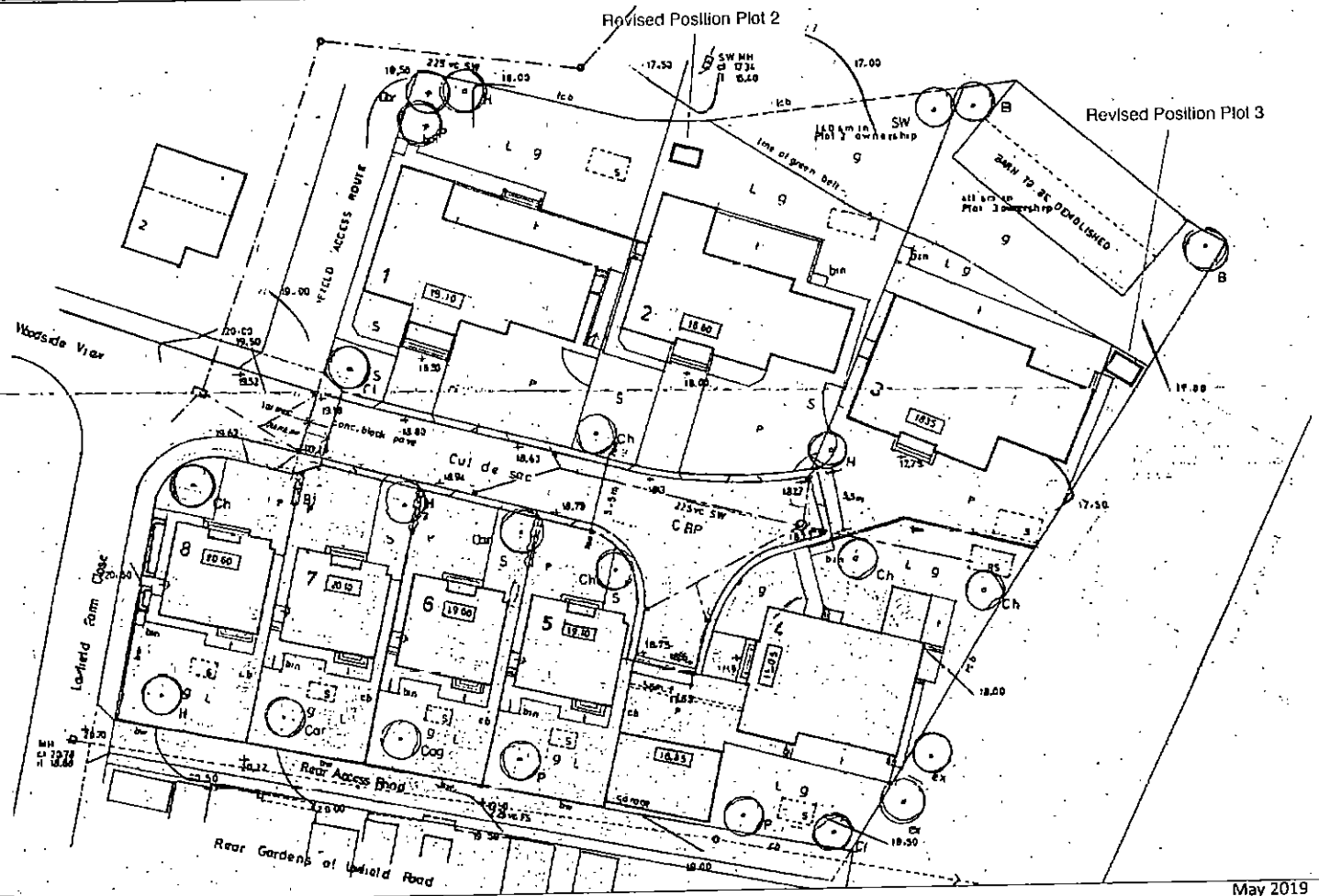


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## APPENDIX 1

### Site plan



APPENDIX 2  
Infiltration Test Results

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### Infiltration Test Result

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Lowfield Farm, Bolton Upon

Dearne, S63 8GY

29/04/19

#### Infiltration Test Plot 1

Time/s	Depth to water/m
0	1.100
60	1.140
120	1.170
180	1.220
240	1.260
300	1.300
600	1.310
900	1.330
1200	1.350
1500	1.360
1800	1.390
2100	1.460
2400	1.500
2700	1.520
3060	1.550

**Pit dimensions:**

Length 1.40 m  
 Width 0.30 m  
 Depth 1.60 m  
 Filled to 1.10m BGL (500mm initial depth of water)

Internal surface area of pit to 50% depth\* (m<sup>2</sup>): 1.270 (a<sub>p50</sub>)  
 Storage volume of pit 75% to 25% filled\*(m<sup>3</sup>): 0.105 (V<sub>p75-25</sub>)  
 Time to reach 75% depth\* (s): 188  
 Time to reach 25% depth\* (s): 2550  
 Time from 75% depth to 25% depth\* (s): 2362 (t<sub>p75-25</sub>)

\*of 500mm filled depth

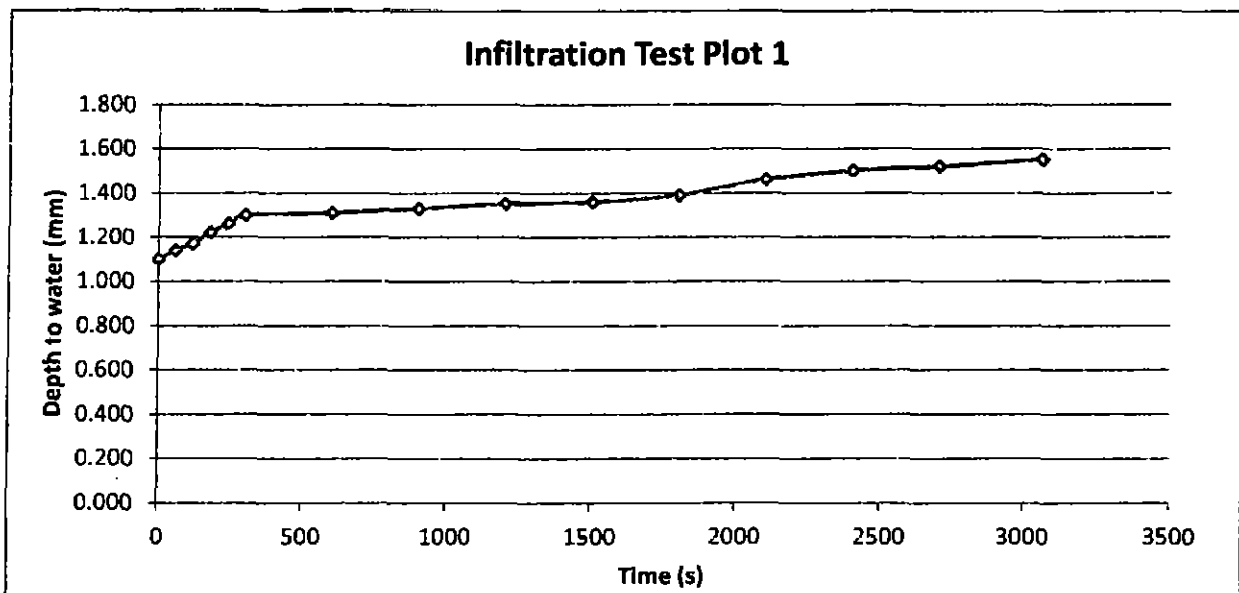
$$\text{Soil infiltration rate, } f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Source: BRE Digest 365 (BRE, 2007)

$$f = 0.105 / (1.270 \times 2362)$$

$$f = 3.50E-05$$

$$f = 3.50 \times 10^{-5} \text{ ms}^{-1}$$



**Infiltration Test Result**  
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Dearne, S63 8GY  
29/04/19

**Infiltration Test Plot 2**

Time/s	Depth to water/m
0	1.000
120	1.010
300	1.020
600	1.025
900	1.030
1500	1.030
1800	1.040
2700	1.055
3600	1.065
5400	1.075
6300	1.135
9600	1.170
10800	1.195
14400	1.255
21600	1.395
24000	1.435
25080	1.455

Pit dimensions:

Length 1.40 m  
Width 0.30 m  
Depth 1.60 m  
Filled to 1.00m BGL (600mm initial depth of water)

Internal surface area of pit to 50% depth\* (m<sup>2</sup>): 1.440 (a<sub>p50</sub>)  
Storage volume of pit 75% to 25% filled\*(m<sup>3</sup>): 0.126 (V<sub>p75-25</sub>)  
Time to reach 75% depth\* (s): 7700  
Time to reach 25% depth\* (s): 24540  
Time from 75% depth to 25% depth\* (s): 16840 (t<sub>p75-25</sub>)

\*of 600mm filled depth

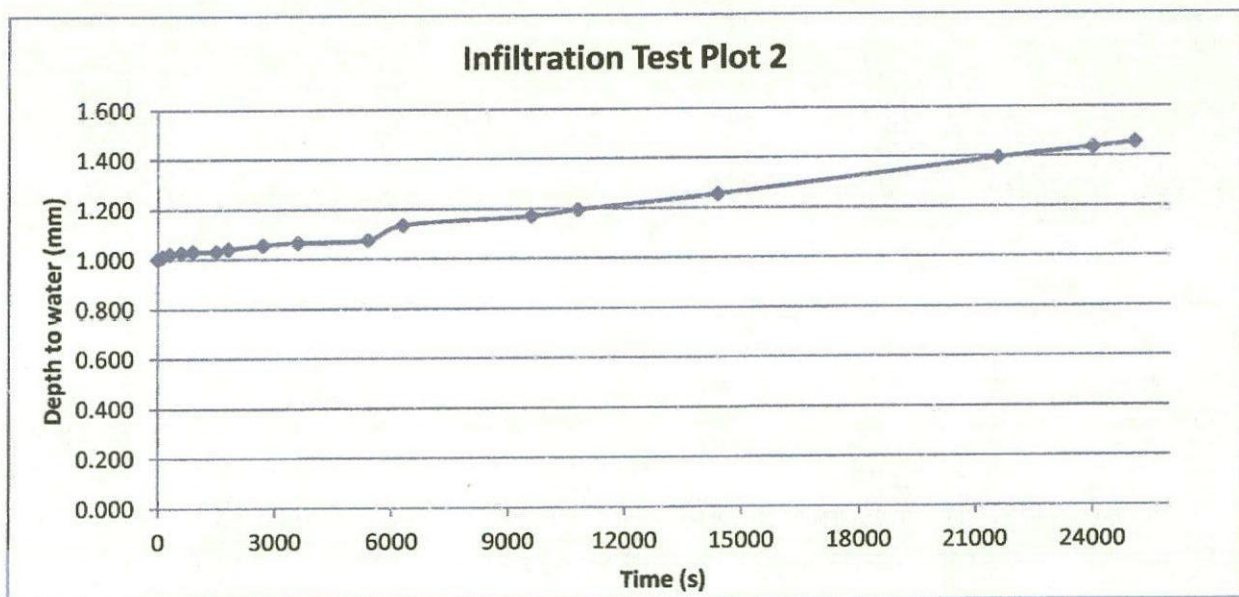
$$\text{Soil infiltration rate, } f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Source: BRE Digest 365 (BRE, 2007)

$$f = 0.126 / (1.440 \times 16840)$$

$$f = 5.20\text{E-}06$$

$$f = 5.20 \times 10^{-6} \text{ ms}^{-1}$$



**Infiltration Test Result**  
G19196  
Lowfield Farm, Bolton Upon  
Dearne, S63 8GY  
29/04/19

**Infiltration Test Plot 3**

Time/s	Depth to water/m
0	0.900
120	0.920
300	0.930
600	0.970
900	0.990
1200	1.015
1800	1.070
2700	1.140
3600	1.200
4200	1.220
4800	1.255
5400	1.300
6000	1.345
7200	1.390
8400	1.405
9600	1.435
10860	1.455

**Pit dimensions:**

Length 1.40 m  
Width 0.30 m  
Depth 1.60 m  
Filled to 0.90m BGL (700mm initial depth of water)

Internal surface area of pit to 50% depth\* (m<sup>2</sup>): 1.610 (a<sub>p50</sub>)  
Storage volume of pit 75% to 25% filled\*(m<sup>3</sup>): 0.147 (V<sub>p75-25</sub>)  
Time to reach 75% depth\* (s): 1900  
Time to reach 25% depth\* (s): 9200  
Time from 75% depth to 25% depth\* (s): 7300 (t<sub>p75-25</sub>)

\*of 700mm filled depth

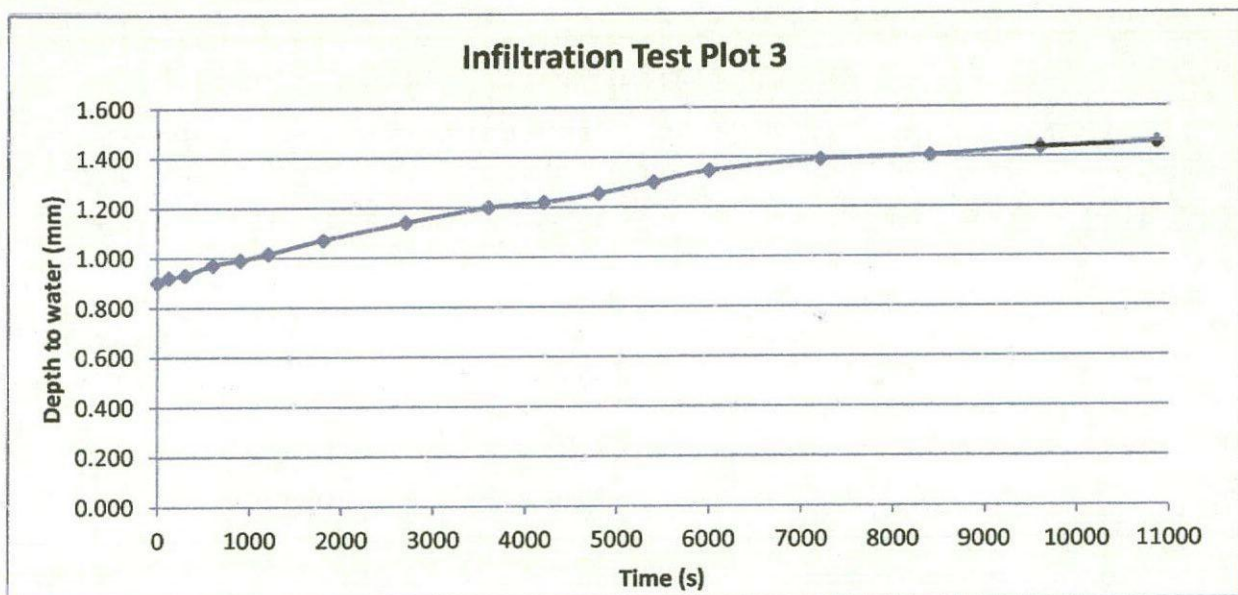
$$\text{Soil infiltration rate, } f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Source: BRE Digest 365 (BRE, 2007)

$$f = 0.147 / (1.610 \times 7300)$$

$$f = 1.25\text{E-}05$$

$$f = 1.25 \times 10^{-5} \text{ ms}^{-1}$$



**Infiltration Test Result**  
G19196  
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Dearne, S63 8GY  
29/04/19

**Infiltration Test Plot 4**

Time/s	Depth to water/m
0	1.000
120	1.030
240	1.070
300	1.090
600	1.130
900	1.180
1200	1.200
1800	1.235
2700	1.285
3600	1.325
4500	1.365
5400	1.420
6000	1.440
7140	1.460

Pit dimensions:

Length 1.40 m  
Width 0.30 m  
Depth 1.60 m  
Filled to 1.00m BGL (600mm initial depth of water)

Internal surface area of pit to 50% depth\* (m<sup>2</sup>): 1.440 (a<sub>p50</sub>)  
Storage volume of pit 75% to 25% filled\*(m<sup>3</sup>): 0.126 (V<sub>p75-25</sub>)  
Time to reach 75% depth\* (s): 720  
Time to reach 25% depth\* (s): 6500  
Time from 75% depth to 25% depth\* (s): 5780 (t<sub>p75-25</sub>)

\*of 600mm filled depth

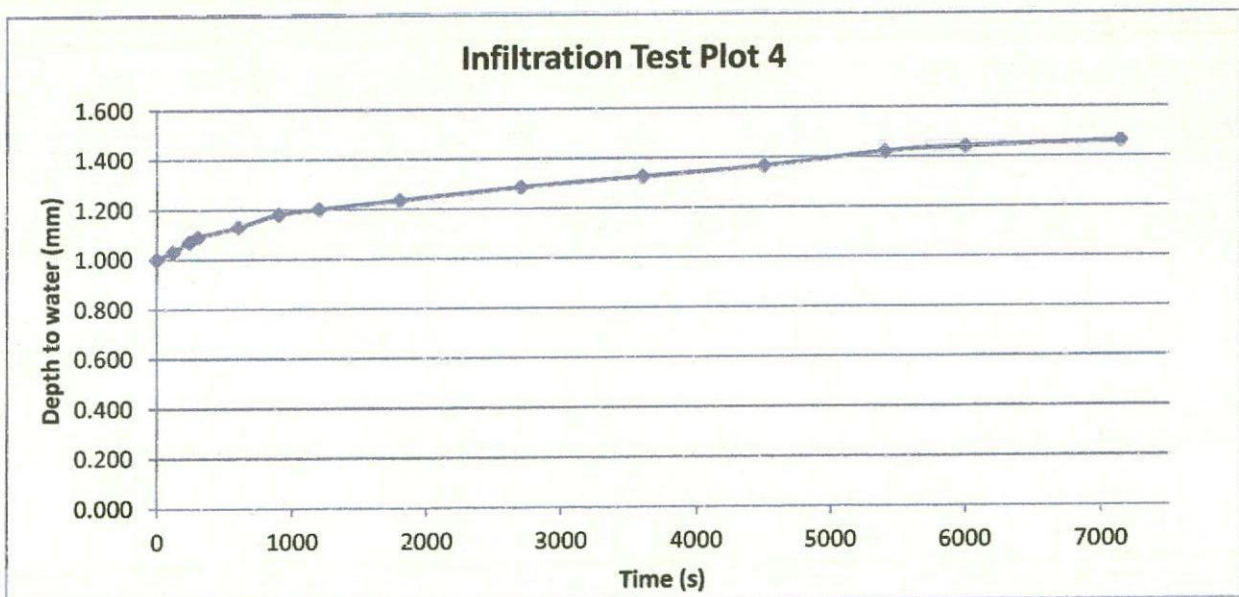
$$\text{Soil infiltration rate, } f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Source: BRE Digest 365 (BRE, 2007)

$$f = 0.126 / (1.440 \times 5780)$$

$$f = 1.51E-05$$

$$f = 1.51 \times 10^{-5} \text{ ms}^{-1}$$



**Infiltration Test Result**  
G19196  
Lowfield Farm, Bolton Upon  
Dearne, S63 8GY  
29/04/19

**Infiltration Test Plot 5**

Time/s	Depth to water/m
0	1.000
120	1.020
240	1.045
300	1.060
600	1.090
900	1.115
1200	1.150
1800	1.185
2700	1.220
3600	1.285
4500	1.320
5400	1.370
6000	1.395
7200	1.415
8520	1.455

Pit dimensions:

Length 1.40 m  
Width 0.30 m  
Depth 1.60 m  
Filled to 1.00m BGL (600mm initial depth of water)

Internal surface area of pit to 50% depth\* (m<sup>2</sup>): 1.440 (a<sub>p50</sub>)  
Storage volume of pit 75% to 25% filled\*(m<sup>3</sup>): 0.126 (V<sub>p75-25</sub>)  
Time to reach 75% depth\* (s): 1200  
Time to reach 25% depth\* (s): 8190  
Time from 75% depth to 25% depth\* (s): 6990 (t<sub>p75-25</sub>)

\*of 600mm filled depth

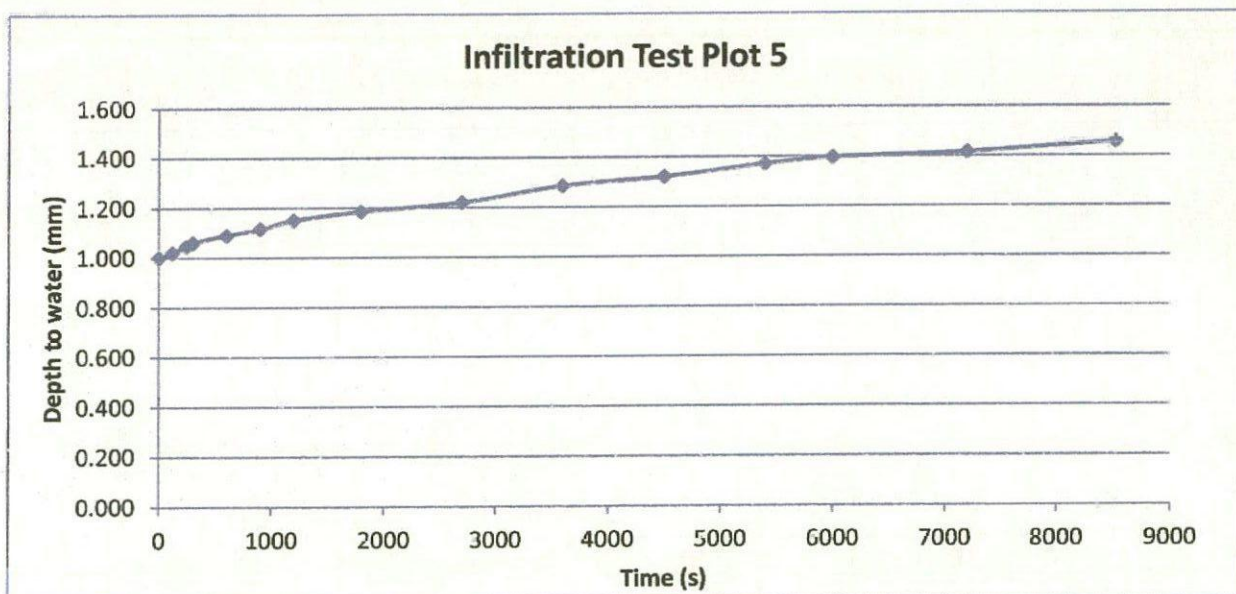
$$\text{Soil infiltration rate, } f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Source: BRE Digest 365 (BRE, 2007)

$$f = 0.126 / (1.440 \times 6990)$$

$$f = 1.25\text{E-}05$$

$$f = 1.25 \times 10^{-5} \text{ ms}^{-1}$$





## Infiltration Test Result

G19196  
 Lowfield Farm, Bolton Upon  
 Dearne, S63 8GY  
 29/04/19

### Infiltration Test Plot 6

Time/s	Depth to water/m
0	1.000
120	1.020
240	1.030
300	1.035
600	1.050
900	1.075
1200	1.095
1800	1.120
2700	1.190
3600	1.255
4500	1.315
5400	1.360
6000	1.395
7200	1.410
8400	1.440
9840	1.465

**Pit dimensions:**

Length 1.40 m  
 Width 0.30 m  
 Depth 1.60 m  
 Filled to 1.00m BGL (600mm initial depth of water)

Internal surface area of pit to 50% depth\* (m<sup>2</sup>): 1.440 (a<sub>p50</sub>)  
 Storage volume of pit 75% to 25% filled\*(m<sup>3</sup>): 0.126 (V<sub>p75-25</sub>)  
 Time to reach 75% depth\* (s): 2190  
 Time to reach 25% depth\* (s): 8970  
 Time from 75% depth to 25% depth\* (s): 6780 (t<sub>p75-25</sub>)  
 \*of 600mm filled depth

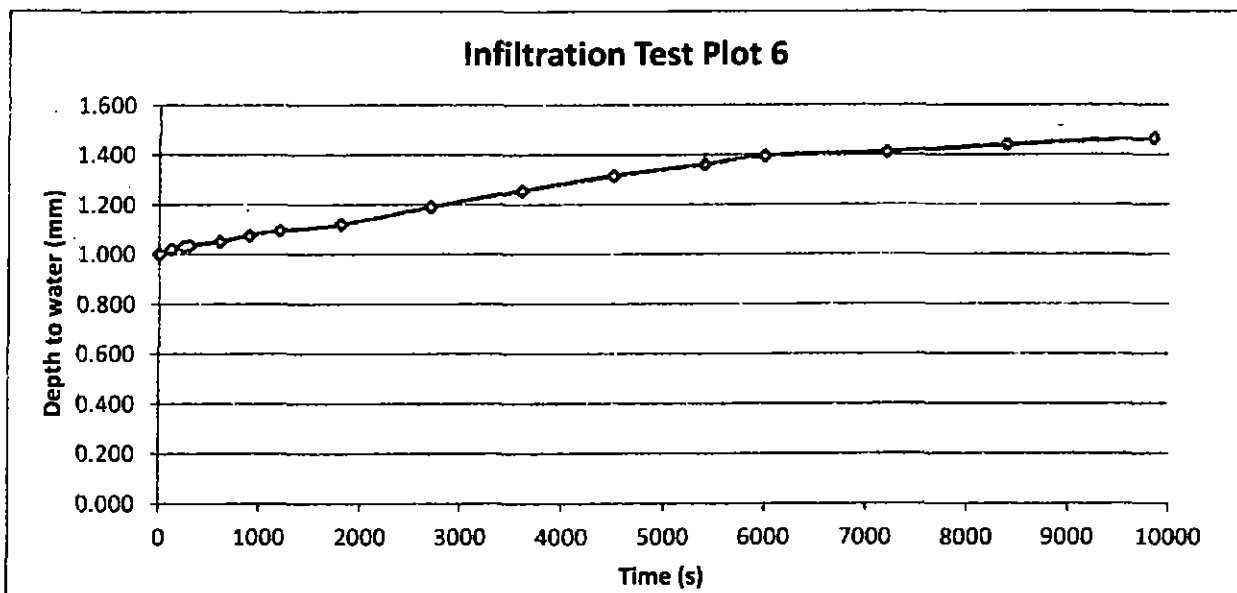
$$\text{Soil infiltration rate, } f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Source: BRE Digest 365 (BRE, 2007)

$$f = 0.126 / (1.440 \times 6780)$$

$$f = 1.29\text{E-}05$$

$$f = 1.29 \times 10^{-5} \text{ ms}^{-1}$$





**Infiltration Test Result**  
**G19196**  
 Lowfield Farm, Bolton Upon  
 Dearne, S63 8GY  
 29/04/19

**Infiltration Test Plot 7**

Time/s	Depth to water/m
0	1.000
120	1.020
240	1.050
300	1.060
600	1.075
900	1.090
1200	1.105
1800	1.150
2700	1.190
3600	1.245
4800	1.305
6000	1.375
7200	1.390
8400	1.400
9600	1.415
10800	1.435
12050	1.460

**Pit dimensions:**

Length 1.40 m  
 Width 0.30 m  
 Depth 1.60 m  
 Filled to 1.00m BGL (600mm initial depth of water)

Internal surface area of pit to 50% depth\* (m<sup>2</sup>): 1.440 (a<sub>p50</sub>)  
 Storage volume of pit 75% to 25% filled\*(m<sup>3</sup>): 0.126 (V<sub>p75-25</sub>)  
 Time to reach 75% depth\* (s): 1800  
 Time to reach 25% depth\* (s): 11560  
 Time from 75% depth to 25% depth\* (s): 9760 (t<sub>p75-25</sub>)  
 \*of 600mm filled depth

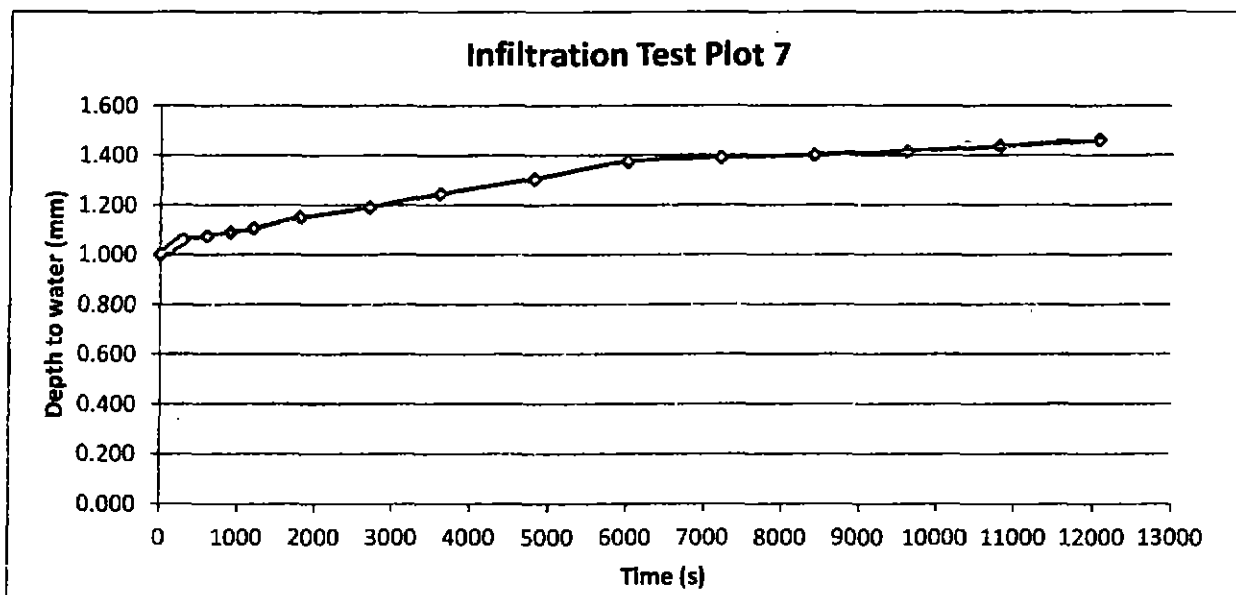
$$\text{Soil infiltration rate, } f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Source: BRE Digest 365 (BRE, 2007)

$$f = 0.126 / (1.440 \times 9760)$$

$$f = 8.97E-06$$

$$f = 8.97 \times 10^{-6} \text{ ms}^{-1}$$





**Infiltration Test Result**  
**G19196**  
 Lowfield Farm, Bolton Upon  
 Dearne, S63 8GY  
 29/04/19

**Infiltration Test Plot 8**

Time/s	Depth to water/m
0	1.000
120	1.015
240	1.030
300	1.040
600	1.055
900	1.085
1200	1.130
1800	1.160
2700	1.225
3600	1.275
4800	1.345
6000	1.400
7200	1.415
8400	1.435
10740	1.455

**Pit dimensions:**

Length 1.40 m  
 Width 0.30 m  
 Depth 1.60 m  
 Filled to 1.00m BGL (600mm initial depth of water)

Internal surface area of pit to 50% depth\* (m<sup>2</sup>): 1.440 (a<sub>p50</sub>)  
 Storage volume of pit 75% to 25% filled\*(m<sup>3</sup>): 0.126 (V<sub>p75-25</sub>)  
 Time to reach 75% depth\* (s): 1600  
 Time to reach 25% depth\* (s): 10150  
 Time from 75% depth to 25% depth\* (s): 8550 (t<sub>p75-25</sub>)  
 \*of 600mm filled depth

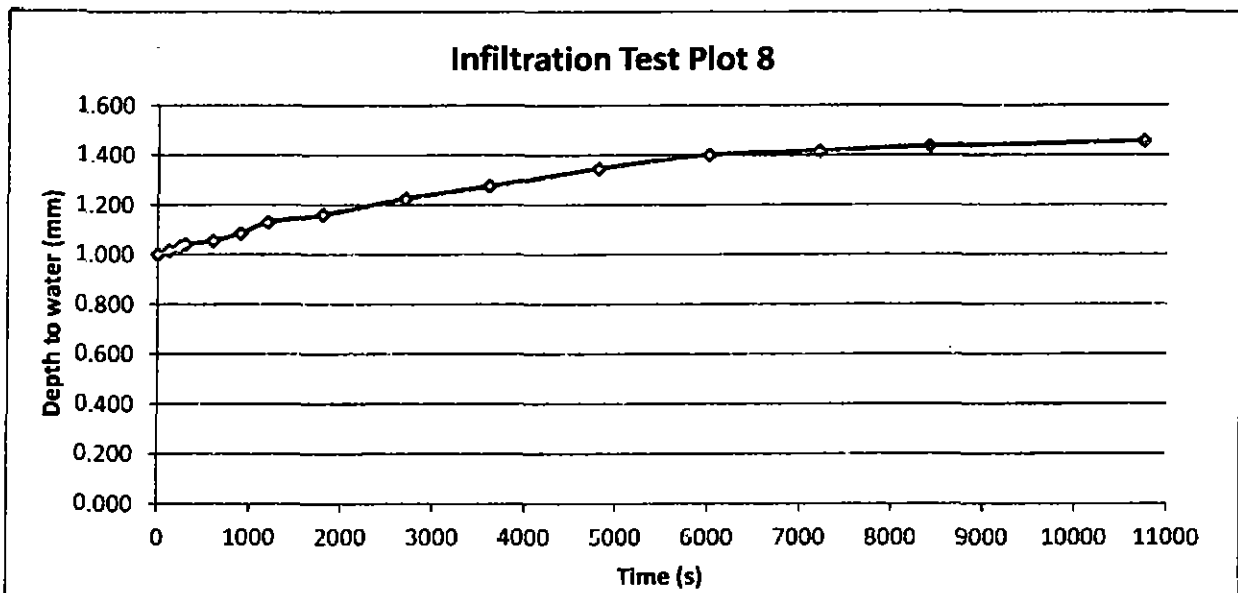
$$\text{Soil infiltration rate, } f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Source: BRE Digest 365 (BRE, 2007)

$$f = 0.126 / (1.440 \times 8550)$$

$$f = 1.02E-05$$

$$f = 1.02 \times 10^{-5} \text{ ms}^{-1}$$



APPENDIX 3  
Soakaway Design Calculations



**Soakaway Design Calculation**  
 G19196  
 Lowfield Farm, Bolton Upon Dearne,  
 S63 8GY  
 29/04/19

**PLOT 1**

**SOAKAWAY DESIGN FOR SIMPLE RECTANGULAR GRAVEL FILLED PIT**  
 Using method described in BRE Digest 365

$$I - O = S$$

$$I = A \times R$$

$$O = a_{50} \times f \times D$$

$I$  = inflow = outflow = required storage volume (all in  $m^3$ )  
 $A$  = Drained area of site ( $m^2$ )  $\times$  Rainfall in a ten year rainfall event of specified length ( $m$ )  
 $O$  = Outflow = half surface area (excluding base) ( $m^2$ )  $\times$  Infiltration rate ( $m/s$ )  $\times$  Specified storm duration ( $s$ )

Therefore:  $I = S + O$  (both expressible in terms of width)

$I$  can be calculated from Z1 and Z2 for each rainfall duration

$S$  = length (chosen)  $\times$  depth (chosen)  $\times$  width  $\times$  0.30 (30% pore space in gravel)  
 i.e.  $S = a$  known number  $\times w$

$O = a_{50} (m^2) \times f (m/s) \times \text{each rainfall duration (seconds)}$   
 $O = (1/2 \text{ depth} \times [2(\text{length}) + 2(\text{width})]) \times f (\text{known}) \times D (\text{known})$  ( $= 1/2 \cdot D \cdot 2(\text{Length} + \text{Depth}) + 1/2 \cdot D \cdot 2W \cdot \text{Depth}$ )

Rearrange to calculate width:

$I = S + O$  (both expressible in terms of width)

$w = \frac{I - O}{0.30 \times \text{length} + \text{depth} + \text{depth} \times f \times D}$

Input data:

$f$ @ 100 (from BRE 365 map)	35	[Ratio of 60 minute to 2 day rainfalls of 5 year return period multiplied by 100]
$f$	0.35	[Ratio of 60 minute to 2 day rainfalls of 5 year return period]
Drained area of site, $A (m^2)$	200	Site area soakaway must service
Infiltration rate $f (m/s)$	1.50E-05	Calculated from water infiltration testing, see report
Choose soakaway length (m)	3.5	Arbitrarily chosen to suit site needs
Choose soakaway depth (m)	1.5	Estimated appropriate depth
half depth (m)	0.75	Depth to 50% full
$S = 30\%$ of storage volume (pore space in granular fill)	1.575	$\times$ width [Width calculated below]
$a_{50} (m^2)$	1.25	$\times$ (width + half depth) [Width calculated below]

$a_{50}$  is 50% of the internal surface area of the soakaway excluding the base ( $= 2(\text{length} \times \text{depth}) + 2(\text{width} \times \text{depth})$ )

Rainfall Duration (D, min)	Z1 (from Table 1)	Z1 x 20mm	Z2 (from Table 1)	I (mm)	R (m)	Inflow (I, m <sup>3</sup> )	Duration D In seconds	Infl. Rate x D (s)	O (m <sup>3</sup> )	Required Width (m)	W (m)
10	0.51	10.2	1.22	12.444	0.012444	2.4888	600	2.10E-02	0.11025 x ( 3.15E-02 W)	1.48E+00	1.48
15	0.62	12.4	1.23	15.252	0.015252	3.0504	900	3.15E-02	0.165375 x ( 4.73E-02 W)	1.78E+00	1.78
30	0.79	15.8	1.24	19.592	0.019592	3.9184	1800	6.30E-02	0.33075 x ( 9.45E-02 W)	2.15E+00	2.15
60	1	20	1.24	24.8	0.0248	4.96	3600	1.26E-01	0.6615 x ( 1.89E-01 W)	2.44E+00	2.44
120	1.33	26.6	1.24	31.256	0.031256	6.2512	7200	2.52E-01	1.323 x ( 3.78E-01 W)	2.42E+00	2.42
240	1.5	30	1.22	36.6	0.0366	7.32	14400	5.04E-01	2.646 x ( 7.56E-01 W)	2.03E+00	2.03
360	1.69	33.8	1.21	40.898	0.040898	8.1796	21600	7.56E-01	3.969 x ( 1.13E+00 W)	1.55E+00	1.55
600	1.95	39	1.19	46.41	0.04641	9.282	36000	1.26E+00	6.615 x ( 1.89E+00 W)	7.70E-01	0.77
1440	1.48	29.6	1.22	36.112	0.036112	7.2224	86400	3.02E+00	15.876 x ( 4.54E+00 W)	1.42E+00	1.42

Chosen based on  $f$  from BRE 365, Table 1

Chosen based on Z1 x 20mm from BRE 365, Table 2

Correct Soakaway Dimensions:

Critical Storm duration (10 year return): 60 mins  
 Calculated soakaway width: 2.44 m  
 Previously chosen length: 3.50 m  
 Previously chosen Depth: 1.50 m  
 Storage Volume,  $S$ , when filled with gravel: 3.8 m<sup>3</sup>

Feasibility check:

Soakaway must be able to discharge 50% of its storage volume in 24 hours to function adequately.

$a_{50} (m^2)$ : 1.25  
 Time to discharge half volume ( $t_{50}$ , seconds): 6157 seconds  
 Time to discharge half volume ( $t_{50}$ , hours): 1.71 hours  
 Will soakaway discharge 50% volume in 24hrs? Yes  
 Conclusion: Soakaway design OK



**Soakaway Design Calculation**  
 G19196  
 Lowfield Farm, Bolton Upon Dearne,  
 S63 8GY  
 29/04/19

**PLOT 2**

**SOAKAWAY DESIGN FOR SIMPLE RECTANGULAR GRAVEL FILLED PIT**  
 Using method described in BRE Digest 365

$$I = Q \times S$$

$$I = A \times R$$

$$Q = a_{50} \times f \times D$$

Inflow = outflow = required storage volume (all in m<sup>3</sup>)  
 Inflow = Drained area of site (m<sup>2</sup>) x Rainfall in a ten year rainfall event of specified length (m)  
 Outflow = half surface area (excluding base) (m<sup>2</sup>) x infiltration rate (m<sup>3</sup>) x Specified storm duration (s)

Therefore:  $I = S \times Q$  (both expressible in terms of width)

$I$  can be calculated from Z1 and Z2 for each rainfall duration

$S$  = length (chosen) x depth (chosen) x width x 0.30 (30% pore space in gravel)  
 i.e.  $S = s \times \text{known number} \times W$

$Q = a_{50} \text{ (m}^3\text{)} \times f \text{ (m}^3\text{)} \times \text{each rainfall duration (seconds)}$   
 $Q = (\text{half depth} \times Z1(\text{length})) \times f \text{ (known)} \times D \text{ (known)} = (f \times D \times \text{Length} \times \text{Depth} + f \times D \times \text{Width} \times \text{Depth})$

Rearrange to calculate width:

$I = S \times Q$  (both expressible in terms of width)

$$W = \frac{I}{(0.30 \times \text{length} \times \text{depth}) + (\text{depth} \times f \times D)}$$

Input data:

$s \times 100$ (from BRE 365map)	35	(Ratio of 60 minute to 2 day rainfalls of 5 year return period multiplied by 100)
$r$	U.S	(Ratio of 60 minute to 2 day rainfalls of 5 year return period)
Drained area of site, $A$ (m <sup>2</sup> )	200	Site area soakaway must service
Infiltration rate $f$ (m/s)	5.70E-06	Calculated from water infiltration testing, see report
Choose soakaway length (m)	7.5	Arbitrarily chosen to suit site needs
Choose soakaway depth (m)	1.5	Estimated appropriate depth
half depth (m)	0.75	Depth to 50% full
$S$ = 30% of storage volume (pore space in granular fill)	3.375	$s \times \text{width}$ (Width calculated below)
$I$ (m <sup>3</sup> )	11.25	$I = 2(\text{width} \times \text{half depth}) \times \text{Length}$ (Width calculated below)

$a_{50}$  is 50% of the internal surface area of the soakaway excluding the base ( $= 2(\text{length} \times \text{half depth}) + 2(\text{width} \times \text{half depth})$ )

Rainfall Duration (D, min)	Z1 (from Table 1)	Z1 x 20mm	Z2 (from Table 2)	R (mm)	R (m)	Inflow (I, m <sup>3</sup> )	Duration D in seconds	Inf. Rate x D (s)	Q (m <sup>3</sup> )	Required Width (m)	W (m)
10	0.51	10.2	1.11	12.444	0.012444	2.888	600	3.12E-03	0.0151 + ( 4.66E-03 W)	7.16E-01	0.73
15	0.62	12.4	1.33	15.252	0.015252	3.0504	900	4.68E-03	0.0265 + ( 7.02E-03 W)	8.86E-01	0.89
30	0.79	15.8	1.24	19.592	0.019592	3.9184	1800	9.36E-03	0.1053 + ( 1.40E-02 W)	1.13E+00	1.13
60	1	20	1.24	24.8	0.0248	4.96	3600	1.87E-02	0.2106 + ( 2.81E-02 W)	1.40E+00	1.40
120	1.22	24.4	1.24	30.256	0.030256	6.0512	7200	3.74E-02	0.4212 + ( 5.62E-02 W)	1.64E+00	1.64
240	1.5	30	1.22	36.6	0.0366	7.32	14400	7.49E-02	0.8424 + ( 1.12E-01 W)	1.86E+00	1.86
360	1.69	33.8	1.21	40.898	0.040898	8.1796	21600	1.12E-01	1.2636 + ( 1.68E-01 W)	1.95E+00	1.95
600	1.95	39	1.19	46.42	0.04642	9.282	36000	1.87E-01	2.316 + ( 2.81E-01 W)	1.96E+00	1.96
1440	1.48	29.6	1.22	36.112	0.036112	7.2224	86400	4.49E-01	5.0544 + ( 6.74E-01 W)	5.35E-01	0.54

Chosen based on  $r$  from BRE 365, Table 1

Chosen based on Z1 x 20mm from BRE 365, Table 2

**Correct Soakaway Dimensions:**

Critical Storm duration (10 year event):	600 mins
Calculated soakaway width:	1.96 m
Previously chosen length:	7.50 m
Previously chosen Depth:	1.50 m
Storage Volume, $S$ , when filled with gravel:	6.6 m <sup>3</sup>

**Suitability check:**

Soakaway must be able to discharge 50% of its storage volume in 24 hours to function adequately.

$a_{50}$ (m <sup>2</sup> )	14.19 m <sup>2</sup>	$t_{50} = \frac{S \times 0.5}{a_{50} \times f}$
Time to discharge half volume ( $t_{50}$ , seconds):	44877 seconds	
Time to discharge half volume ( $t_{50}$ , hours):	12.47 hours	
Will soakaway discharge 50% volume in 24hrs?	Yes	
Conclusion:	Soakaway design OK	

1278G P1 White - Rotherham - Appendix

Contaminant	Source of GAC	Human Health Generic Assessment Criteria (mg/kg)						allotments (1%SOM)
		residential without plant uptake (1%SOM)	residential without plant uptake (2.5%SOM)	residential without plant uptake (6%SOM)	residential with plant uptake (1%SOM)	residential with plant uptake (2.5%SOM)	residential with plant uptake (6%SOM)	
TPH ali >EC10-EC12	S4UL	130 <sup>VAP</sup> (48)	330 <sup>VAP</sup> (118)	770 <sup>VAP</sup> (283)	130 <sup>VAP</sup> (48)	330 <sup>VAP</sup> (118)	760 <sup>VAP</sup> (283)	2200
TPH ali >EC12-EC16	S4UL	1100 <sup>SOL</sup> (24)	2400 <sup>SOL</sup> (59)	4400 <sup>SOL</sup> (142)	110 <sup>SOL</sup> (24)	2400 <sup>SOL</sup> (59)	4300 <sup>SOL</sup> (142)	11000
TPH ali >EC16-EC35	S4UL	65000 <sup>SOL</sup> (8.48)	92000 <sup>SOL</sup> (21)	110000	65000 <sup>SOL</sup> (8.4)	92000 <sup>SOL</sup> (21)	110000	260000
TPH ali >EC35-EC44	S4UL	65000 <sup>SOL</sup> (8.48)	92000 <sup>SOL</sup> (21)	110000	65000 <sup>SOL</sup> (8.48)	92000 <sup>SOL</sup> (21)	110000	260000
TPH aro EC05-EC07	S4UL	370	690	1400	70	140	300	13
TPH aro >EC07- EC08	S4UL	860	1800	3900	130	290	660	22
TPH aro >EC08- EC10	S4UL	47	110	270	34	83	190	8.6
TPH aro >EC10- EC12	S4UL	250	590	1200	74	180	380	13
TPH aro >EC12- EC16	S4UL	1800	2300 <sup>SOL</sup> (419)	2500	140	330	660	23
TPH aro >EC16- EC21	S4UL	1900	1900	1900	200	540	930	46
TPH aro >EC21- EC35	S4UL	1900	1900	1900	1100	1500	1700	370
TPH aro >EC35- EC44	S4UL	1900	1900	1900	1100	1500	1700	370
TPH >EC44-EC70	S4UL	1900	1900	1900	1600	1800	1900	1200
<b>VOCs - BTEX &amp; MTBE</b>								
Benzene	C4SL			0.87			3.3	



**Soakaway Design Calculation**  
**G19196**  
 Lowfield Farm, Bolton Upon Dearne,  
 S63 8GY  
 29/04/19

**PLOT 3**

**SOAKAWAY DESIGN FOR SIMPLE RECTANGULAR GRAVEL FILLED PIT**  
 Using method described in BRE Digest 365

$$I - O = S$$

$$I = A \times R$$

$$O = a_{50} \times l \times D$$

Inflow - outflow = required storage volume (all in m<sup>3</sup>)  
 Inflow = Drained area of site (m<sup>2</sup>) x Rainfall in a ten year rainfall event of specified length (m)  
 Outflow = half surface area (excluding base) (m<sup>2</sup>) x infiltration rate (m s<sup>-1</sup>) x specified storm duration (s)

Therefore:  $I = S + O$  (both expressible in terms of width)

l can be calculated from Z1 and Z2 for each rainfall duration

$S = \text{length (chosen)} \times \text{depth (chosen)} \times \text{width} \times 0.30$  (30% pore space in gravel)  
 i.e.  $S = a \text{ known number} \times w$

$O = a_{50} (\text{m}^2) \times l (\text{m}) \times \text{each rainfall duration (seconds)}$   
 $O = (\text{half depth} \times 2(\text{length}) + 2(\text{width})) \times l (\text{known}) \times D (\text{known})$  (i.e.  $D = 2(\text{length} \times \text{depth}) + 1.0.2W \times \text{depth}$ )

Rearrange to calculate width:

$l = S + O$  (both expressible in terms of width)

$$w = \frac{S + O}{0.30 \times \text{length} + \text{depth} + (\text{depth} \times l \div D)}$$

Input data:

r x 100 (from BRE 365map)	35	(Ratio of 60 minute to 2 day rainfalls of 5 year return period multiplied by 100)
r	0.35	(Ratio of 60 minute to 2 day rainfalls of 5 year return period)
Drained area of site, A (m <sup>2</sup> )	200	Site area soakaway must service
Infiltration rate f (m s <sup>-1</sup> )	1.25E-05	Calculated from water infiltration testing, see report
Choose soakaway length (m)	6	Arbitrarily chosen to suit site needs
Choose soakaway depth (m)	1.5	Estimated appropriate depth
half depth (m)	0.75	Depth to 50% full
S = 30% of storage volume (pore space in granular fill)	2.7	> width (Width calculated below)
$a_{50}$ (m <sup>2</sup> )	9	> 2(width + half depth) (Width calculated below)

$a_{50}$  is 50% of the internal surface area of the soakaway excluding the base ( $= 2(\text{length} \times \text{depth}) + 2(\text{width} \times \text{depth})$ )

Rainfall Duration (D, mins)	Z1 (from Table 1)	Z1 x 20mm	Z2 (from Table 2)	R (mm)	R (m)	Inflow (L, m <sup>3</sup> )	Duration D in seconds	Inf. Rate x D (s)	O (m <sup>3</sup> )	Required Width (m)	W (m)	
10	0.51	10.7	1.22	11.444	0.011444	2.4888	600	7.50E-03	0.0675	1.13E-02 W	8.93E-01	0.89
15	0.62	12.4	1.23	15.252	0.015252	3.0504	900	1.13E-02	0.10125	1.59E-02 W	1.09E+00	1.09
30	0.79	15.8	1.24	19.597	0.019597	3.9184	1800	2.25E-02	0.2025	3.38E-02 W	1.38E+00	1.36
60	1	20	1.24	24.8	0.0248	4.96	3600	4.50E-02	0.405	6.75E-02 W	1.65E+00	1.65
120	1.22	24.4	1.24	30.256	0.030256	6.0512	7200	9.00E-02	0.81	1.35E-01 W	1.85E+00	1.85
240	1.5	30	1.22	36.6	0.0366	7.32	14400	1.80E-01	1.62	2.70E-01 W	1.92E+00	1.92
360	1.69	33.8	1.21	40.898	0.040898	8.1796	21600	2.70E-01	2.43	4.05E-01 W	1.85E+00	1.85
600	1.95	39	1.19	46.41	0.04641	9.282	36000	4.50E-01	4.05	6.75E-01 W	1.55E+00	1.55
1440	1.48	29.6	1.22	36.112	0.036112	7.2224	86400	1.08E+00	9.72	1.62E+00 W	-5.78E-01	-0.58

Chosen based on r from BRE 365, Table 1

Chosen based on Z1 x 20mm from BRE 365, Table 2

**Correct Soakaway Dimensions:**

Critical Storm duration (10 year event): 240 mins  
 Calculated soakaway width: 1.92 m  
 Previously chosen length: 6.00 m  
 Previously chosen Depth: 1.50 m  
 Storage Volume, S, when filled with gravel: 5.2 m<sup>3</sup>

**Suitability check:**  
 Soakaway must be able to discharge 50% of its storage volume in 24 hours to function adequately.

$a_{50}$  (m<sup>2</sup>): 11.88 m<sup>2</sup>  
 Time to discharge half volume ( $t_{50}$ , seconds): 17449 seconds  
 Time to discharge half volume ( $t_{50}$ , hours): 4.85 hours  
 Will soakaway discharge 50% volume in 24hrs? Yes  
 Conclusion: Soakaway design OK

$$t_{50} = \frac{S \times 0.5}{a_{50} \times f}$$

- Construction workers; and
- Services personnel working in trenches.
- Construction Materials
- Buried concrete, which may be affected by high concentrations of sulphate and/or low pH, in the soils and groundwater underlying the site; and
- Buried water pipes.
- Controlled Waters
- Ecological Receptors
- Flora and fauna using the proposed development

## **8.0 CONCEPTUAL SITE MODEL**

The Conceptual Site Model (CSM) is a hypothesis of the nature and sources of contamination, potential receptors that may be the recipient of contamination arising from those sources and any pathways that may exist. It creates a plausible source-pathway-receptor pollutant linkage (*hazard*), set within the context of the ground and proposed end use of the site.

### **8.1 PRELIMINARY CONCEPTUAL SITE MODEL**

#### **8.1.1 SOIL CONTAMINATION**

Site is currently a cleared site with a demolition rubble stock pile formerly used as a farm

Historic agricultural practices and have the potential to have contaminated the site with various substances including

- Metals and metalloids;
- Polycyclic aromatic hydrocarbons (PAH's);
- Petroleum hydrocarbons
- pesticides

There is a requirement to raise ground level across the site.



**Soakaway Design Calculation**  
 G19196  
 Lowfield Farm, Bolton Upon Dearne,  
 S63 8GY  
 29/04/19

**PLOT 4**

**SOAKAWAY DESIGN FOR SIMPLE RECTANGULAR GRAVEL FILLED PIT**  
 Using method described in BRE Digest 365

$$I = O + S$$

$$I = A \times R$$

$$O = a_{50} \times J \times D$$

Inflow - outflow = required storage volume (all in m<sup>3</sup>)  
 Inflow = Drained area of site (m<sup>2</sup>) x Rainfall in a ten year rainfall event of specified length (m)  
 Outflow = half surface area (excluding base) (m<sup>2</sup>) x infiltration rate (m/s) x Specified storm duration (s)

Therefore:  $I = S + O$  (both expressible in terms of width)

I can be calculated from Z1 and Z2 for each rainfall duration

$S = \text{length (chosen)} \times \text{depth (chosen)} \times \text{width} \times 0.30$  (30% pore space in gravel)  
 i.e.  $S = a \text{ known number} \times w$

$O = a_{50} \text{ (m}^3\text{)} \times f \text{ (m/s)} \times \text{each rainfall duration (seconds)}$   
 $O = (\text{half depth} \times \text{length}) \times f \text{ (known)} \times D \text{ (known)} = (f \cdot D \cdot \text{Length} \cdot \text{Depth} + f \cdot D \cdot 2W \cdot \text{Depth})$

Rearrange to calculate width:

$I = S + O$  (both expressible in terms of width)

$$w = \frac{I - \text{length} \times \text{depth} \times f \times D}{(0.30 \times \text{length} \times \text{depth}) + (\text{depth} \times f \times D)}$$

**Input data:**

r x 100 (from BRE 365map)	33	(Ratio of 60 minute to 2 day rainfalls of 5 year return period multiplied by 100)
r	0.33	(Ratio of 60 minute to 2 day rainfalls of 5 year return period)
Drained Area of site, A (m <sup>2</sup> )	700	Site area soakaway must service
Infiltration rate I (m/s)	1.51E-05	Calculated from water infiltration testing, see report
Choose soakaway length (m)	5.5	Arbitrarily chosen to suit site needs
Choose soakaway depth (m)	1.5	Estimated appropriate depth
S = 30% of storage volume (pore space in granular fill)	2.475	x width (Width calculated below)
$a_{50}$ (m <sup>3</sup> )	8.75	x 2(width x half depth) (Width calculated below)

$a_{50}$  is 50% of the internal surface area of the soakaway excluding the base (= 2(length x H depth) + 2(width x H depth) )

Rainfall Duration (D, mins)	Z1 (from Table 1)	Z1 x 20mm	Z2 (from Table 2)	R (mm)	R (m)	Inflow (I, m <sup>3</sup> )	Duration D in seconds	Infl. Rate = I/D (s)	O (m <sup>3</sup> )	Required Width (m)	W (m)
10	0.51	10.2	1.22	12.444	0.012444	7.4888	600	9.06E-03	0.074745 x ( 1.36E-02 W)	9.70E-01	0.97
15	0.62	12.4	1.23	15.252	0.015252	10.504	900	1.36E-02	0.1121175 x ( 2.04E-02 W)	1.18E+00	1.18
30	0.79	15.8	1.24	19.597	0.019597	13.9184	1800	2.72E-02	0.224235 x ( 4.08E-02 W)	1.47E+00	1.47
60	1	20	1.24	24.8	0.0248	17.496	3600	5.44E-02	0.44847 x ( 8.15E-02 W)	1.76E+00	1.76
120	1.22	24.4	1.24	30.756	0.030756	21.512	7200	1.09E-01	0.89694 x ( 1.63E-01 W)	1.95E+00	1.95
240	1.5	30	1.22	36.6	0.0366	25.72	14400	2.17E-01	1.79388 x ( 3.26E-01 W)	1.97E+00	1.97
360	1.69	33.8	1.21	40.898	0.040898	28.796	21600	3.21E-01	2.69082 x ( 4.89E-01 W)	1.85E+00	1.85
600	1.95	39	1.19	46.41	0.04641	32.528	36000	5.44E-01	4.4847 x ( 8.15E-01 W)	1.46E+00	1.46
1440	1.48	29.6	1.22	35.112	0.035112	24.728	86400	1.30E+00	10.76328 x ( 1.96E+00 W)	7.99E-01	0.80

Chosen based on r from BRE 365 Table 1

Chosen based on Z1 X 20mm from BRE 365, Table 2

**Correct Soakaway Dimensions:**

Critical Storm duration (10 year event): 240 mins  
 Calculated soakaway width: 1.97 m  
 Previously chosen length: 5.50 m  
 Previously chosen Depth: 1.50 m  
 Storage Volume, S, when filled with gravel: 4.9 m<sup>3</sup>

**Soakability check:**

Soakaway must be able to discharge 50% of its storage volume in 24 hours to function adequately

$a_{50}$  (m<sup>3</sup>): 11.21 m<sup>3</sup>  
 Time to discharge half volume ( $t_{50}$ , seconds): 14474 seconds  
 Time to discharge half volume ( $t_{50}$ , hours): 4.01 hours

Will soakaway discharge 50% volume in 24hrs? Yes

Conclusion: Soakaway design OK

## 7.1 SOURCES

The following potential sources of contamination have been identified.

### 7.1.1 ONSITE

- agricultural use of the site
- Unknown use of the buildings

### 7.1.2 OFFSITE

- Allotments
- Unknown works

## 7.2 PATHWAYS

A pathway is defined as a mechanism or route by which a contaminant comes into contact with, or otherwise affects a receptor. Pathways by which the identified receptors may be impacted upon in the context of the proposed development are identified as follows:

- Ingestion;
- Skin contact;
- Inhalation;
- Plant uptake,
- Direct contact by buried structures;
- Leaching of soluble contamination into groundwater

## 7.3 RECEPTORS

Receptors are defined as people, living organisms, ecological systems, controlled waters, atmosphere, structures and utilities that could be adversely affected by contaminant(s).

- Human Health
  - Current users of the site;
  - Future users of the site;
  - Users of neighbouring sites;



**Soakaway Design Calculation**  
 G19196  
 Lowfield Farm, Bolton Upon Dearne,  
 S63 8GY  
 29/04/19

**PLOT 5**

**SOAKAWAY DESIGN FOR SIMPLE RECTANGULAR GRAVEL FILLED PIT**  
 Using method described in BRE Digest 365

$$I - O = S$$

$$I = A \times R$$

$$O = i_{50} \times F \times D$$

Inflow = outflow + required storage volume (all in m<sup>3</sup>)  
 $I_{flow} = \text{Drained area of site (m}^2) \times \text{Rainfall in a ten year rainfall event of specified length (m)}$   
 $O_{flow} = \text{half surface area (excluding base) (m}^2) \times \text{Infiltration rate (m}^3) \times \text{Specified storm duration (s)}$

Therefore:  $I = S + O$  (both expressible in terms of width)

$I$  can be calculated from Z1 and Z2 for each rainfall duration

$S = \text{length (chosen)} \times \text{depth (chosen)} \times \text{width} \times 0.30$  (30% pore space in gravel)  
 i.e.  $S = e \times \text{known} \times \text{unknown} \times w$

$O = i_{50} \text{ (m}^3) \times f \text{ (m}^2) \times \text{each rainfall duration (seconds)}$   
 $O = (f \times \text{half depth} \times 2(\text{length}) + 2(\text{width})) \times f \text{ (known)} \times D \text{ (known)} = (f \times 0.2 \times \text{Length} \times \text{depth} + f \times D \times 2 \times \text{width})$

Rearrange to calculate width:

$I = S + O$  (both expressible in terms of width)

$$w = \frac{I - (0.2 \times \text{Length} \times \text{depth} \times f + f \times D \times 2 \times \text{width})}{(0.30 \times \text{length} \times \text{depth}) + (\text{depth} \times f \times D)}$$

**Input data:**

$r = 100$ (from BRE 365-map)	35	(Ratio of 60 minutes to 2 day rainfalls of 5 year return period multiplied by 100)
$r$	0.30	(Ratio of 60 minutes to 2 day rainfalls of 5 year return period)
Drained area of site, $A$ (m <sup>2</sup> )	100	Site area soakaway must service
Infiltration rate $f$ (m <sup>3</sup> )	1.25E-05	Calculated from water infiltration testing, see report
Choose soakaway length (m)	3.5	Arbitrarily chosen to suit site needs
Choose soakaway depth (m)	1.5	Estimated appropriate depth
half depth (m)	0.75	Depth to 50% full
$S = 30\%$ of storage volume (pore space in granular fill)	1.575	$\times$ width (Width calculated below)
$i_{50}$ (m <sup>3</sup> )	5.75	$\times 2(\text{width} \times \text{half depth})$ (Width calculated below)

$i_{50}$  is 50% of the internal surface area of the soakaway excluding the base ( $= 2(\text{length} \times \text{depth}) + 2(\text{width} \times \text{depth})$ )

Rainfall Duration (D, min)	Z1 (from Table 2)	Z1 $\times$ 20mm	Z2 (from Table 2)	R (mm)	R [m]	Inflow [l, m <sup>3</sup> ]	Duration D in seconds	Inf. Rate $\times$ D (s)	O (m <sup>3</sup> )	Required Width [m]	W [m]	
10	0.51	10.2	1.22	12.444	0.012444	1.2444	600	7.50E-01	0.039375	3.13E-02	7.60E-01	0.76
15	0.62	12.4	1.23	15.251	0.015251	1.5251	900	1.13E-01	0.0590625	3.69E-02	9.21E-01	0.92
30	0.79	15.8	1.24	19.592	0.019592	1.9592	1800	2.25E-02	0.118125	1.38E-02	1.14E+00	1.14
60	1	20	1.24	24.8	0.0248	2.48	3600	4.50E-02	0.23625	6.75E-02	1.37E+00	1.37
120	1.22	24.4	1.24	30.256	0.030256	3.0256	7200	9.00E-02	0.4725	1.35E-01	1.49E+00	1.49
240	1.5	30	1.22	36.6	0.0366	3.66	14400	1.80E-01	0.945	2.70E-01	1.47E+00	1.47
360	1.69	33.8	1.21	40.898	0.040898	4.0898	21600	2.70E-01	1.4175	4.05E-01	1.35E+00	1.35
600	1.95	39	1.19	46.41	0.04641	4.641	36000	4.50E-01	2.3625	6.75E-01	1.01E+00	1.01
1440	1.48	29.6	1.22	35.112	0.035112	3.5112	86400	1.08E+00	5.67	1.62E+00	6.44E-01	0.64

Chosen based on  $r$  from BRE 365, Table 1

Chosen based on Z1  $\times$  20mm from BRE 365, Table 2

**Correct Soakaway Dimensions:**

Critical Storm duration (10 year event):	120 mins
Calculated soakaway width:	1.49 m
Previously chosen length:	3.50 m
Previously chosen Depth:	1.50 m
Storage Volume, $S$ , when filled with gravel:	2.4 m <sup>3</sup>

**Sustainability checks:**

Soakaway must be able to discharge 50% of its storage volume in 24 hours to function adequately

$i_{50}$ (m <sup>3</sup> ):	7.49 m <sup>3</sup>	$t_{50} = \frac{S \times 0.5}{i_{50} \times F}$
Time to discharge half volume ( $t_{50}$ , seconds):	12559 seconds	
Time to discharge half volume ( $t_{50}$ , hours):	3.49 hours	
Will soakaway discharge 50% volume in 24hrs?	Yes	
Conclusion:	Soakaway design OK	

**6.16 HISTORICAL TANK DATABASE**

None within 250m

**6.17 HISTORICAL ENERGY FACILITIES**

None within 250m

**6.18 HISTORICAL GARAGE AND MOTOR VEHICLE REPAIR DATABASE**

None within 250m

**6.19 POTENTIALLY INFILLED LAND**

None within 250m

**7.0 POLLUTANT LINKAGE ASSESSMENT**

The risk posed by any contaminants in soil or groundwater will depend on the nature of the hazard, the probability of exposure, the pathway by which exposure occurs, and the likely effects on the receptors. A contaminant is defined as a substance that has the potential to cause harm, while a risk is considered to exist if such a substance is present in sufficient concentration to cause harm and a pathway exists for a receptor to be exposed to the substance.

The following sections discuss all the identified potential on and off site sources, pathways and receptors in the context of the proposed development and plausible pollutant linkages which may represent a risk to identified receptors from the data gained from the desk study. At this stage the assessment is qualitative and aimed to determine all pollutant linkages, irrespective of significance or allowing for uncertainty.

Three impact potentials exist for any given site, these are:

- The site impacting upon itself;
- The site impacting on its surroundings; and
- The surroundings impacting on the site.

All three impacts need to be considered in a risk assessment.



**Soakaway Design Calculation**  
 G19196  
 Lowfield Farm, Bolton Upon Dearne,  
 S63 8GY  
 29/04/19

**PLOT 6**

**SOAKAWAY DESIGN FOR SIMPLE RECTANGULAR GRAVEL FILLED PIT**  
 Using method described in BRE Digest 365

$$I - O = S$$

$$I = A \times R$$

$$O = a_{50} \times f \times D$$

Inflow = outflow + required storage volume (all in m<sup>3</sup>)  
 Inflow = Drained area of site (m<sup>2</sup>) x Rainfall in a ten year rainfall event of specified length (m)  
 Outflow = half surface area (excluding base) (m<sup>2</sup>) x Infiltration rate (m/s) x Specified storm duration (s)

Therefore:  $I = S + O$  (both expressible in terms of width)

I can be calculated from Z1 and Z2 for each rainfall duration

$S = \text{length (chosen)} \times \text{depth (chosen)} \times \text{width} \times 0.30$  (30% pore space in gravel)  
 i.e.  $S = y$  known number  $\times w$

$O = a_{50} (\text{m}^3) \times f (\text{m}^3) \times \text{each rainfall duration (seconds)}$

$O = (0.5 \times \text{depth} \times (2 \times \text{length}) + 2 \times \text{width}) \times f (\text{known}) \times D (\text{known})$  (cf. D.2 length  $\times$  depth + 1 D.2w  $\times$  depth)

rearrange to calculate width:

$I = S + O$  (both expressible in terms of width)

$w = \frac{I - O}{(0.30 \times \text{length} \times \text{depth}) + (\text{depth} \times f \times D)}$

Input data:

r = 100 (from BRE 365map)	35	(Ratio of 60 minute to 2 day rainfalls of 5 year return period multiplied by 100)
i	0.35	(Ratio of 60 minute to 2 day rainfalls of 5 year return period)
Drained area of site, A (m <sup>2</sup> )	100	Site area soakaway must service
Infiltration rate f (m/s)	1.20E-05	Calculated from water infiltration testing, see report
Choose soakaway length (m)	3.5	Arbitrarily chosen to suit site needs
Choose soakaway depth (m)	1.5	Estimated appropriate depth
half depth (m)	0.75	Depth to 50% fill
S = 30% of storage volume (pore space in granular fill)	1.575	$\times$ width (Width calculated below)
$a_{50}$ (m <sup>3</sup> )	5.25	$\times 2(\text{width} \times \text{half depth})$ (Width calculated below)

$a_{50}$  is 50% of the internal surface area of the soakaway excluding the base (= 2(length  $\times$  X depth) + 2(width  $\times$  X depth))

Rainfall Duration (D, min)	Z1 (from Table 1)	Z1 $\times$ 20mm	Z2 (from Table 2)	R (mm)	R (m)	Inflow (L, m <sup>3</sup> )	Duration D in seconds	Infl. Rate $\times$ D (s)	O (m <sup>3</sup> )	Required Width (m)	W (m)	
10	0.51	10.2	1.22	12.444	0.012444	1.2444	600	7.74E-01	0.040635	1.16E-02 W	7.59E-01	0.76
15	0.62	12.4	1.23	15.252	0.015252	1.5252	900	1.16E-02	0.0609525	1.74E-02 W	9.20E-01	0.92
30	0.79	15.8	1.24	19.592	0.019592	1.9592	1800	2.32E-02	0.121905	3.48E-02 W	1.14E+00	1.14
60	1	20	1.24	24.8	0.0248	2.48	3600	4.64E-02	0.24381	6.97E-02 W	1.36E+00	1.36
120	1.21	24.4	1.24	30.256	0.030256	3.0256	7200	9.29E-02	0.48762	1.39E-01 W	1.48E+00	1.48
240	1.5	30	1.22	36.6	0.0366	3.66	14400	1.86E-01	0.97524	2.79E-01 W	1.45E+00	1.45
360	1.69	33.8	1.21	40.898	0.040898	4.0898	21600	2.79E-01	1.46286	4.18E-01 W	1.31E+00	1.32
600	1.95	39	1.19	46.41	0.04641	4.641	36000	4.64E-01	2.4361	6.97E-01 W	9.70E-01	0.97
1440	1.48	29.6	1.22	38.112	0.038112	3.8112	86400	1.37E+00	5.85144	1.67E+00 W	6.90E-01	0.69

Chosen based on r from BRE 365, Table 1

Chosen based on Z1  $\times$  20mm from BRE 365, Table 2

**Correct Soakaway Dimensions:**

Critical Storm duration (10 year event): 120 mins  
 Calculated soakaway width: 1.48 m  
 Previously chosen length: 3.50 m  
 Previously chosen Depth: 1.50 m  
 Storage Volume, S, when filled with gravel: 2.3 m<sup>3</sup>

**Suitability check:**

Soakaway must be able to discharge 50% of its storage volume in 24 hours to function adequately.

$a_{50}$  (m<sup>3</sup>): 2.47 m<sup>3</sup>  
 Time to discharge half volume ( $t_{50}$ , seconds): 12098 seconds  
 Time to discharge half volume ( $t_{50}$ , hours): 3.36 hours

Will soakaway discharge 50% volume in 24hrs? Yes

Conclusion: Soakaway design OK



**L19/0916/CAS/001**

**Project Reference - White - Rotherham**

**Analysis Methodologies**

Matrix	Determinant	Sample condition for analysis	Test Method used
Soil	Metals	Air Dried	In house method statement - MS - CL - ICP metals
Soil	PAH	As Received	In house method statement - MS - CL - PAH (As received)
Soil	Phenols	As Received	In house method statement - MS - CL - Phenols by Skalar
Soil	Chromium (hexavalent)	As Received	In house method statement - MS - CL - Hexavalent Chromium by Skalar
Soil	pH	As Received	In house method statement - MS - CL - pH in soils (using a 1:3 soil to water extraction)
Soil	CWG	As Received	In house method statements - MS - CL - EPH in soil and MS - CL - VPH
Soil	Pesticide Screen	As Received	In house method statement - MS - CL - Pesticides



**Soakaway Design Calculation**  
 G19196  
 Lowfield Farm, Bolton Upon Dearne,  
 S63 8GY  
 29/04/19

**PLOT 7**

**SOAKAWAY DESIGN FOR SIMPLE RECTANGULAR GRAVEL FILLED PIT**  
 Using method described in BRE Digest 365

$$I - O = S$$

$$I = A \times R$$

$$O = a_{50} \times J \times D$$

Inflow = outflow + required storage volume (all in m<sup>3</sup>)  
 Inflow = Drained area of site (m<sup>2</sup>) x Rainfall in a ten year rainfall event of specified length (m)  
 Outflow = half surface area (excluding base) (m<sup>2</sup>) x Infiltration rate (m/s) x Specified storm duration (s)

Therefore:  $I = S + O$  (both expressible in terms of width)

I can be calculated from Z1 and Z2 for each rainfall duration

S = length (chosen) x depth (chosen) x width x 0.30 (30% pore space in gravel)  
 Lc = a known number x w

$O = a_{50} (m^2) \times J (m/s) \times D (seconds)$   
 $O = (half\ depth \times (2 \times length)) \times J (known) \times D (known) = (L \times D \times length \times depth) + (L \times D \times width \times depth)$

Rearrange to calculate width:

$I = S + O$  (both expressible in terms of width)

$$w = \frac{(I - length \times depth \times J \times D)}{(0.30 \times length \times depth) + (depth \times J \times D)}$$

**Input data:**

r x 100 (from BRE 365map)	35	(Ratio of 60 minute to 2 day rainfalls of 5 year return period multiplied by 100)
r	0.35	(Ratio of 60 minute to 2 day rainfalls of 5 year return period)
Drained area of site, A (m <sup>2</sup> )	100	Site area soakaway must service
Infiltration rate J (m/s)	8.97E-06	Calculated from water infiltration testing, see report
Choose soakaway length (m)	3	Arbitrarily chosen to suit site needs
Choose soakaway depth (m)	1.5	Estimated appropriate depth
half depth (m)	0.75	Depth to 50% full
S = 30% of storage volume (pore space in granular fill)	1.35	= width (Width calculated below)
W <sub>50</sub> (m <sup>2</sup> )	4.5	= 2 x width x half depth (Width calculated below)

W<sub>50</sub> is 50% of the internal surface area of the soakaway excluding the base (= 2 x length x 1/2 depth + 2 x width x 1/2 depth)

Rainfall Duration (D, min)	Z1 (from Table 1)	Z1 x 20mm	Z2 (from Table 2)	R (mm)	R (m)	Inflow (I, m <sup>3</sup> )	Duration D in seconds	Inf. Rate = J (s)	O (m <sup>3</sup> )	Required Width (m)	W (m)	
10	0.51	10.2	1.22	12.444	0.012444	1.2444	600	5.38E-03	0.024719	8.07E-03 W	8.98E-01	0.90
15	0.62	12.4	1.23	15.252	0.015252	1.5252	900	6.07E-03	0.0363185	1.21E-02 W	1.09E+00	1.09
30	0.79	15.8	1.24	19.592	0.019592	1.9592	1800	1.61E-02	0.077637	2.42E-02 W	1.37E+00	1.37
60	1	20	1.24	24.8	0.0248	2.48	3600	3.23E-02	0.145314	4.84E-02 W	1.67E+00	1.67
120	1.22	24.4	1.24	30.256	0.030256	3.0256	7200	6.46E-02	0.290628	9.69E-02 W	1.89E+00	1.89
240	1.5	30	1.22	36.6	0.0366	3.66	14400	1.29E-01	0.581256	1.94E-01 W	1.99E+00	1.99
360	1.69	33.8	1.21	40.898	0.040898	4.0898	21600	1.94E-01	0.871884	2.91E-01 W	1.96E+00	1.96
600	1.95	39	1.19	46.41	0.04641	4.641	36000	3.23E-01	1.45314	4.84E-01 W	1.74E+00	1.74
1800	1.48	29.6	1.22	36.112	0.036112	3.6112	66400	7.75E-01	3.487536	1.16E+00 W	4.92E-02	0.05

Chosen based on r from BRE 365, Table 1

Chosen based on Z1 x 20mm from BRE 365, Table 2

**Correct Soakaway Dimensions:**

Critical Storm duration (10 year event): 240 mins  
 Calculated soakaway width: 1.99 m  
 Previously chosen length: 3.00 m  
 Previously chosen Depth: 1.50 m  
 Storage Volume, S, when filled with gravel: 7.7 m<sup>3</sup>

**Suitability check:**  
 Soakaway must be able to discharge 50% of its storage volume in 24 hours to function adequately.

$a_{50} (m^2)$  7.49 m<sup>2</sup>  
 Time to discharge full volume ( $t_{50}$  seconds): 20033 seconds  
 Time to discharge half volume ( $t_{25}$  hours): 5.56 hours  
 Will soakaway discharge 50% volume in 24hrs? Yes  
 Conclusion: Soakaway design OK



L19/0916/CAS/001

Project Reference - White - Rotherham

Sample Comments

NC Reference	Client Sample Reference	Sample Location	Comments
32874	TP1	TP1	VPH - Sample taken from container with headspace.
32875	TP2	TP2	VPH - Sample taken from container with headspace.
32876	TP3	TP3	VPH - Sample taken from container with headspace.
32877	TP4	TP4	VPH - Sample taken from container with headspace.
32878	TP5	TP5	VPH - Sample taken from container with headspace.
32879	TP6	TP6	VPH - Sample taken from container with headspace.
32880	TP7	TP7	VPH - Sample taken from container with headspace.
32881	TP8	TP8	VPH - Sample taken from container with headspace.



**Soakaway Design Calculation**  
**G19196**  
 Lowfield Farm, Bolton Upon Dearne,  
 S63 8GY  
 29/04/19

**PLOT 8**

**SOAKAWAY DESIGN FOR SIMPLE RECTANGULAR GRAVEL FILLED PIT**  
 Using method described in BRE Digest 365

$$I - O = S$$

$$I = A \times R$$

$$O = a_{50} \times f \times D$$

Inflow - outflow = required storage volume (all in m<sup>3</sup>)  
 Inflow = Drained area of site (m<sup>2</sup>) x Rainfall in a ten year rainfall event of specified length (m)  
 Outflow = half surface area (excluding base) (m<sup>2</sup>) x infiltration rate (m/s) x Specified storm duration (s)

Therefore:  $I = S + O$  (both expressible in terms of width)

$I$  can be calculated from Z1 and Z2 for each rainfall duration

$S = \text{length (chosen)} \times \text{depth (chosen)} \times \text{width} \times 0.30$  (30% pore space in gravel)  
 i.e.  $S = 6 \text{ known numbers} \times w$

$O = a_{50} (\text{m}^2/\text{s}) \times f (\text{m/s}) \times \text{each rainfall duration (seconds)}$   
 $O = (\text{half depth} \times [2(\text{length}) + 2(\text{width})]) \times f (\text{known}) \times D (\text{known}) = (0.2 \times \text{Length} \times \text{depth} + 0.2 \times \text{Width} \times \text{depth})$

Rearrange to calculate width:

$I = S + O$  (both expressible in terms of width)

$$w = \frac{I - (0.2 \times \text{length} \times \text{depth} \times f \times D)}{(0.30 \times \text{length} \times \text{depth}) + (\text{depth} \times f \times D)}$$

Input data:

$f \times 100$ (from BRE 365map)	35	(Ratio of 60 minute to 2 day rainfall of 5 year return period multiplied by 100)
$f$	0.35	(Ratio of 60 minute to 2 day rainfall of 5 year return period)
Drained area of site, $A$ (m <sup>2</sup> )	100	Site area soakaway must service
Infiltration rate $f$ (m/s)	1.02E-05	Calculated from water infiltration testing, see report
Choose soakaway length (m)	3	Arbitrarily chosen to suit site needs
Choose soakaway depth (m)	1.5	Estimated appropriate depth
half depth (m)	0.75	Depth to 50% full
$S = 30\%$ of storage volume (pore space in granular fill)	1.35	$\times$ width (Width calculated below)
$a_{50}$ (m <sup>2</sup> )	4.5	$\times 2(\text{length} \times \text{half depth}) + 2(\text{width} \times \text{half depth})$ (Width calculated below)

$a_{50}$  is 50% of the internal surface area of the soakaway excluding the base ( $= 2(\text{length} \times \text{H depth}) + 2(\text{width} \times \text{H depth})$ )

Rainfall Duration [D, min]	Z1 (from Table 1)	Z1 x 20mm	Z2 (from Table 2)	R (mm)	R (m)	Inflow [I, m <sup>3</sup> ]	Duration D in seconds	Infl. Rate x D (s)	O (m <sup>3</sup> )	Required Width (m)	W (m)
10	0.51	10.2	1.22	12.444	0.012444	1.2444	600	6.12E-03	0.02754	9.18E-03 W	8.95E-01
15	0.62	12.4	1.23	15.252	0.015252	1.5252	900	9.18E-03	0.04131	1.38E-02 W	1.09E+00
30	0.79	15.8	1.24	19.592	0.019592	1.9592	1800	1.84E-02	0.08262	2.75E-02 W	1.36E+00
60	1	20	1.24	24.8	0.0248	2.48	3600	3.67E-02	0.16524	5.51E-02 W	1.65E+00
120	1.22	24.4	1.24	30.256	0.030256	3.0256	7200	7.34E-02	0.33048	1.10E-01 W	1.85E+00
240	1.5	30	1.22	36.6	0.0366	3.66	14400	1.47E-01	0.66096	2.20E-01 W	1.91E+00
360	1.69	33.8	1.21	43.898	0.043898	4.3898	21600	2.20E-01	0.99144	3.30E-01 W	1.84E+00
600	1.95	39	1.19	46.41	0.04641	4.641	36000	3.67E-01	1.6524	5.51E-01 W	1.57E+00
1440	1.48	39.6	1.22	36.112	0.036112	3.6112	86400	8.81E-01	3.96576	1.32E+00 W	-1.33E-01

Chosen based on  $f$  from BRE 365, Table 1

Chosen based on Z1 x 20mm from BRE 365, Table 2

**Correct Soakaway Dimensions:**

Critical Storm duration (10 year event):	240 mins
Calculated soakaway width:	1.91 m
Previously chosen length:	3.00 m
Previously chosen Depth:	1.50 m
Storage Volume, $S$ , when filled with gravel:	2.6 m <sup>3</sup>

**Suitability check:**

Soakaway must be able to discharge 50% of its storage volume in 24 hours to function adequately.

$a_{50}$ (m <sup>2</sup> ):	7.36 m <sup>2</sup>	$t_{50} = \frac{S \times 0.5}{a_{50} \times f}$
Time to discharge half volume ( $t_{50}$ , seconds):	17163 seconds	
Time to discharge half volume ( $t_{50}$ , hours):	4.77 hours	
Will soakaway discharge 50% volume in 24hrs?	Yes	
Conclusion:	Soakaway design OK	



L19/0916/CAS/001

Project Reference - White - Rotherham

Sample Descriptions

NC Reference	Client Sample Reference	Sample Location	Description	Moisture Content (%)	Stone Content (%)
32874	TP1	TP1	Brown slightly sandy silty clay with rare rootlets	16	0.4
32875	TP2	TP2	Grey slightly sandy silty clay with rare rootlets	20	0.6
32876	TP3	TP3	Grey slightly sandy slightly gravelly	34	4.0
32877	TP4	TP4	Grey slightly sandy slightly gravelly rootlets	17	0.8
32878	TP5	TP5	Brown slightly sandy silty clay	13	5.5
32879	TP6	TP6	Brown slightly sandy silty clay	14	4.7
32880	TP7	TP7	Greyish brown slightly sandy silty clay	16	0.3
32881	TP8	TP8	Greyish brown slightly sandy silty clay	20	2.3