BLACKWELL
STRUCTURAL CONSULTANTS

1 Green Lodge Barn
Nobottle
Northampton
NN7 4HD

STRUCTURAL CALCULATIONS

Client: Liam Taylor

Houses Adjacent to 30 Victoria Road, Barnsley

11 February 2021

Engineer: Neil Blackwell BSc. C.Eng. M.I.C.E. M.I.Struct.E

14232

BLACKWELL
STRUCTURAL CONSULTANTS
Tel: 01604 755000
e: neil@blackwellconsultants.co.uk

Project				Job Ref.
Houses Adjacent to 30, Victoria Road, Barnsley				14232
Section				Sheet no.
Soakaway Design				1
Engineer	Date	Checked by	Date	Revision
Neil Blackwell	11/02/2021	Neil Blackwell	11/02/2021	-

CONTENTS

DESIGN CODES REFERENCED 2
GENERAL NOTES..... 2
LOADING ANALYSIS..... Error! Bookmark not defined.
SUPERSTRUCTURE DESIGN 3

BLACKWELL
STRUCTURAL CONSULTANTS
Tel: 01604 755000
e: neil@blackwellconsultants.co.uk

Project				Job Ref.
Houses Adjacent to 30, Victoria Road, Barnsley				14232
Section				Sheet no.
Soakaway Design				2
Engineer	Date	Checked by	Date	Revision
Neil Blackwell	11/02/2021	Neil Blackwell	11/02/2021	-

DESIGN CODES REFERENCED

The enclosed designs have been made in accordance with the following Eurocode Standards as required:

- Eurocode 0: Basis of Structural Design (EN 1990)
- Eurocode 1: Actions on Structures (EN 1991)
- Eurocode 2: Design of Concrete Structures (EN 1992)
- Eurocode 3: Design of Steel Structures (EN 1993)
- Eurocode 4: Design of Composite Steel and Concrete Structures (EN 1994)
- Eurocode 5: Design of Timber Structures (EN 1995)
- Eurocode 6: Design of Masonry Structures (EN 1996)
- Eurocode 7: Geotechnical Design (EN 1997)
- Eurocode 9: Design of Aluminium Structures (EN 1999)

GENERAL NOTES

Dimensions have been taken from Architect's drawings or measured site survey all drawn dimensions must be checked prior to construction. Dimensions shown within this calculation document are for design purposes only and must not be used for fabrication.

These calculations should be read in conjunction with the drawings provided. The Engineer must be contacted should any clarification be required or if alterations to the designs or specifications are made by the Architect, Client or Contractor.

Drawings are provided for connection details and to highlight structural features. It is assumed that the construction work is to be carried out by competent, experienced personnel and therefore exhaustive detailing is not required. If further information is required or differences between the assumed conditions and the conditions on site are discovered, for example the ground conditions, the Engineer must be contacted before work continues.

BLACKWELL
STRUCTURAL CONSULTANTS
Tel: 01604 755000
e: neil@blackwellconsultants.co.uk

Project				Job Ref.
Houses Adjacent to 30, Victoria Road, Barnsley				14232
Section				Sheet no.
Soakaway Design				3
Engineer	Date	Checked by	Date	Revision
Neil Blackwell	11/02/2021	Neil Blackwell	11/02/2021	-

SUPERSTRUCTURE DESIGN

Soakaway Design

SOAKAWAY DESIGN

In accordance with BRE Digest 365 - Soakaway design

Tedds calculation version 2.0.04

Design rainfall intensity

Location of catchment area	Sheffield	
Impermeable area drained to the system	A = **68.0** m^2	
Return period	Period = **100** yr	
Ratio 60 min to 2 day rainfall of 5 yr return period		r = **0.360**
5-year return period rainfall of 60 minutes duration		M5_60min = **18.9** mm
Increase of rainfall intensity due to global warming		$p_{climate}$ = **30** %

Soakaway / infiltration trench details

Soakaway type	Rectangular
Minimum depth of pit (below incoming invert)	d = **1200** mm
Width of pit	w = **1000** mm
Length of pit	l = **2001** mm
Percentage free volume	V_{free} = **95** %

Soil infiltration rate (BRE digest 365)

Length of trial pit	l_{trial} = **600** mm
Width of trial pit	b_{trial} = **600** mm
Depth of trial pit (below invert)	d_{trial} = **600** mm
Free volume (if fill used)	V_{trial} = **100** %
75% depth of pit	d_{75} = (d_{trial} × 0.75) = **450.00** mm
50% depth of pit	d_{50} = (d_{trial} × 0.50) = **300.00** mm
25% depth of pit	d_{25} = (d_{trial} × 0.25) = **150.00** mm
Test 1 - time to fall from 75% depth to 25% depth	T1 = **20** min
Test 2 - time to fall from 75% depth to 25% depth	T2 = **15** min
Test 3 - time to fall from 75% depth to 25% depth	T3 = **15** min
Longest time to fall from 75% depth to 25% depth	t_{lg} = max(T1, T2, T3) = **20** min
Storage volume from 75% to 25% depth	V_{p75_25} = (l_{trial} × b_{trial} × (d_{75} - d_{25})) × V_{trial} = **0.11** m^3
Internal surface area to 50% depth	a_{p50} = ((l_{trial} × b_{trial}) + (l_{trial} + b_{trial}) × 2 × d_{50}) = **1.08** m^2
Surface area of soakaway to 50% storage depth	A_{s50} = 2 × (l_{trial} + b_{trial}) × d_{trial} / 2 = **0.720** m^2
Soil infiltration rate	f = V_{p75_25} / (a_{p50} × t_{lg}) = **83.3×10^{-6}** m/s
Wetted area of pit 50% full	a_{s50} = l × d + w × d = **3600881** mm^2

Table equations

Inflow (cl.3.3.1)	I = M100 × A
Outflow (cl.3.3.2)	O = a_{s50} × f × D
Storage (cl.3.3.3)	S = I - O

BLACKWELL
STRUCTURAL CONSULTANTS
Tel: 01604 755000
e: neil@blackwellconsultants.co.uk

Project				Job Ref.
Houses Adjacent to 30, Victoria Road, Barnsley				14232
Section				Sheet no.
Soakaway Design				4
Engineer	Date	Checked by	Date	Revision
Neil Blackwell	11/02/2021	Neil Blackwell	11/02/2021	-

Duration , D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	100 year rainfall, M100 (mm)	Inflow (m^3)	Outflow (m^3)	Storage required (m^3)
5	0.36	8.8	1.88	16.6	1.13	0.09	1.04
10	0.51	12.5	1.95	24.4	1.66	0.18	1.48
15	0.62	15.2	1.99	30.3	2.06	0.27	1.79
30	0.79	19.4	2.03	39.3	2.67	0.54	2.13
60	1.00	24.6	2.01	49.4	3.36	1.08	2.28
120	1.22	30.0	1.97	59.1	4.02	2.16	1.86
240	1.48	36.4	1.92	69.8	4.75	4.32	0.42
360	1.67	41.0	1.88	77.2	5.25	6.48	0.00
600	1.90	46.7	1.84	85.7	5.83	10.80	0.00
1440	2.42	59.5	1.75	103.8	7.06	25.93	0.00

Required storage volume S_{req} = **2.28** m^3

Soakaway storage volume $S_{act} = l \times d \times w \times V_{free}$ = **2.28** m^3

PASS - Soakaway storage volume

Time for emptying soakaway to half volume $t_{s50} = S_{req} \times 0.5 / (a_{s50} \times f)$ = 1hr 3min 20s

PASS - Soakaway discharge time less than or equal to 24 hours

Use soakaway 2.0m x 1.0 x 1.2m deep Crates giving 95% storage volume

BLACKWELL
STRUCTURAL CONSULTANTS
Tel: 01604 755000
e: neil@blackwellconsultants.co.uk

Project				Job Ref.
Houses Adjacent to 30, Victoria Road, Barnsley				14232
Section				Sheet no.
Soakaway Design				5
Engineer	Date	Checked by	Date	Revision
Neil Blackwell	11/02/2021	Neil Blackwell	11/02/2021	-

Rainfall Intensity

DESIGN RAINFALL

In accordance with the Wallingford Procedure

Tedds calculation version 2.0.01

Design rainfall intensity

Location of catchment area	Sheffield	
Storm duration	D = **5** min	
Return period	Period = **100** yr	
Ratio 60 min to 2 day rainfall of 5 yr return period		r = **0.360**
5-year return period rainfall of 60 minutes duration		M5_60min = **18.9** mm
Increase of rainfall intensity due to global warming		$p_{climate}$ = **30** %
Factor Z1 (Wallingford procedure)	Z1 = **0.36**	
Rainfall for 5min storm with 5 year return period	$M5_5min_i = Z1 \times M5_60min \times (1 + p_{climate})$ = **8.8** mm	
Factor Z2 (Wallingford procedure)	Z2 = **1.88**	
Rainfall for 5min storm with 100 year return period	$M100_5min = Z2 \times M5_5min_i$ = **16.6** mm	
Design rainfall intensity	I_{max} = M100_5min / D = **199.8** mm/hr	

Maximum surface water runoff

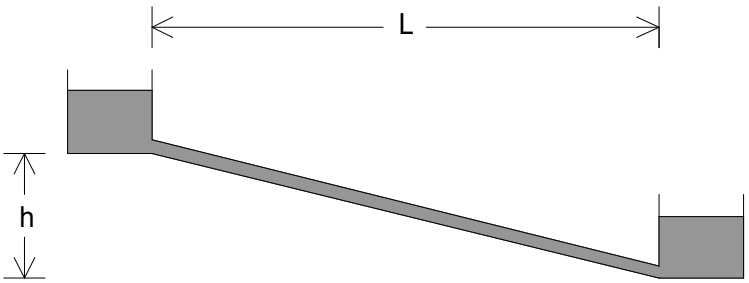
Catchment area	A_{catch} = **69** m^2
Percentage of area that is impermeable	p = **100** %
Maximum surface water runoff	$Q_{max} = A_{catch} \times p \times I_{max}$ = **3.8** l/s

Pipe Design

Q = 3.8 l/s = **0.0038** m^3/s

DESIGN OF A SURFACE WATER DRAIN

TEDDS calculation version 1.0.04



Drain design details

Design flow rate	Q_{design} = **3.80×10^{-3}** m^3/s
Length of the drain	L = **4.0** m
Fall along length of drain	h = **0.040** m

BLACKWELL
STRUCTURAL CONSULTANTS
Tel: 01604 755000
e: neil@blackwellconsultants.co.uk

Project				Job Ref.
Houses Adjacent to 30, Victoria Road, Barnsley				14232
Section				Sheet no.
Soakaway Design				6
Engineer	Date	Checked by	Date	Revision
Neil Blackwell	11/02/2021	Neil Blackwell	11/02/2021	-

Gradient of drain	i = h / L = **0.010 (1 in 100)**
	(Library item Drain design details)
Minimum flow velocity	V_{min} = **0.750** m/s
Minimum pipe diameter	D_{min} = **100** mm
Surface roughness	k_s = **0.6** mm
Mean hydraulic depth factor	m = **0.25**
Kinematic viscosity of fluid	ν = **1.31×10^{-6}** m^2/s

Using the Chezy equation

Constant	c = 56
Diameter of pipe required	$D = ((Q_{design}^2 \times 16) / (\pi^2 \times m \times c^2 \times i \times 1m/s^2))^{0.2}$ = **79** mm
Nearest pipe diameter	D_{chezy} = **100** mm
Flow velocity using Chezy	$V_{chezy} = c \times \sqrt{(m \times D_{chezy} \times i \times 1m/s^2)}$ = **0.885** m/s

Using the Escritt equation

Diameter of pipe required	$D = (Q_{design} \times 1000 \times \sqrt{(1 / i)} / 0.00035\ m^3/s)^{0.382} \times 1mm$ = **84** mm
Nearest pipe diameter	$D_{escritt}$ = **100** mm
Flow velocity using Escritt	$V_{escritt} = 26.738 \times (D_{escritt} / 1mm)^{0.62} \times 1$ m/s / ($\sqrt{(1 / i)} \times 60$) = **0.774** m/s

Using the Colebrook-White Equation for pipe running full and partially full

Design pipe diameter	$D_{design} = max(D_{chezy}, D_{escritt}, D_{min})$ = **100** mm
Constant	$Z = \sqrt{(2 \times (g_{acc} / 1m/s^2) \times (D_{design} /1000mm) \times i)}$ = **0.140**
Flow velocity	$V_{full} = -2\times Z\times log((k_s/(3.7\times D_{design}))+((2.51\times\nu)/(D_{design}\times Z\times 1m/s)))\times 1m/s$
	V_{full} = **0.765** m/s
Flow rate running full	$Q_{full} = V_{full} \times \pi \times D_{design}^2 / 4$ = **6.01×10^{-3}** m^3/s
	PASS - Maximum flow rate is greater than design flow rate

From Hydraulics Research Tables 35 and 36

Depth as proportion of D	x = **0.578**
Flow velocity at design flow rate	V_{design} = **0.808** m/s
	PASS - Design velocity is greater than 0.750 m/s

Use 100mm diameter pipework at 1:100 gradient