Scheme : **Cae Mor Farm, Llwynmawr, Llangollen**

Subject : **Soakaway Design**

Waterco Consultants have been instructed to undertake soakaway design in support of a proposed Egg Laying Unit at Cae Mor Farm, Llwynmawr, Llangollen. A Location Plan and a Proposed Site Plan are enclosed. This document details the required dimensions for a soakaway (or soakaways) to accommodate surface water runoff from the roof area and access road (including turning circle).

An infiltration test has been carried out by the client. The trial pit was located north of the proposed building. The trial pit was set at a depth of 1.2m with dimensions of 300mm wide x 300mm long x 300mm deep. The pit was filled with water (300mm deep) and the test was repeated three times to represent soil moisture conditions typical to those when a soakaway becomes operative. The test results are shown below:

Table 1 – Percolation Rates

Test	Time for water to drain (seconds)
1	85
2	155
3	180
Average	140

The average Percolation Rate (Vp) is 0.466mm/s.

The average Infiltration Rate, calculated in accordance with Building Regulations Part H, is calculated below:

Infiltration Rate = 10^{-3} / (**3** x Vp)
Infiltration Rate = 10^{-3} / 1.4
Infiltration Rate = **7.14^{-4} m/s**

01824 702220
www.waterco.co.uk
Waterco Ltd. Company No. 3577754
Eden Court, Lôn Parcwr Business Park, Ruthin, Denbighshire, LL15 1NJ

A summary of the required soakaway dimensions assuming a stone filled soakaway is provided in Table 2 below. The soakaways have been sized to accommodate a 1 in 100 year storm including a 30% addition for climate change. The calculations are enclosed.

Table 2 – Dimensions for stone filled soakaways – 30% void

Soakaway	Area (m^2)	Length (m)	Width (m)	Depth (m)	Design Volume (m^3)
Combined	2355	12	7.8	1.8	50.5m^3
Building	1425	8.4	6	1.8	27m^3
Access Road	930	6.5	4.5	1.8	15.8m^3

For comparison, the dimensions for a storm crate style soakaway are provided in Table 3 below. The dimensions have been rounded up to suit standard storm crate dimensions (1m x 0.5m x 0.4m).

Table 3 – Dimensions for storm crate style soakaways – 95% void

Soakaway	Area (m^2)	Length (m)	Width (m)	Depth (m)	Design Volume (m^3)
Combined	2355	9	5	1.6	68.4m^3
Building	1425	6.5	4	1.6	39.5m^3
Access Road	930	5	3	1.6	22.8m^3

In accordance with Part H of the Building Regulations and BRE365, soakaways should be located at least 5m away from building foundations.

We trust this completes your current requirements for this site however if you have any questions please don't hesitate to contact me.

01824 702220
www.waterco.co.uk
Waterco Ltd. Company No. 3577754
Eden Court, Lôn Parcwr Business Park, Ruthin, Denbighshire, LL15 1NJ

Yours sincerely,

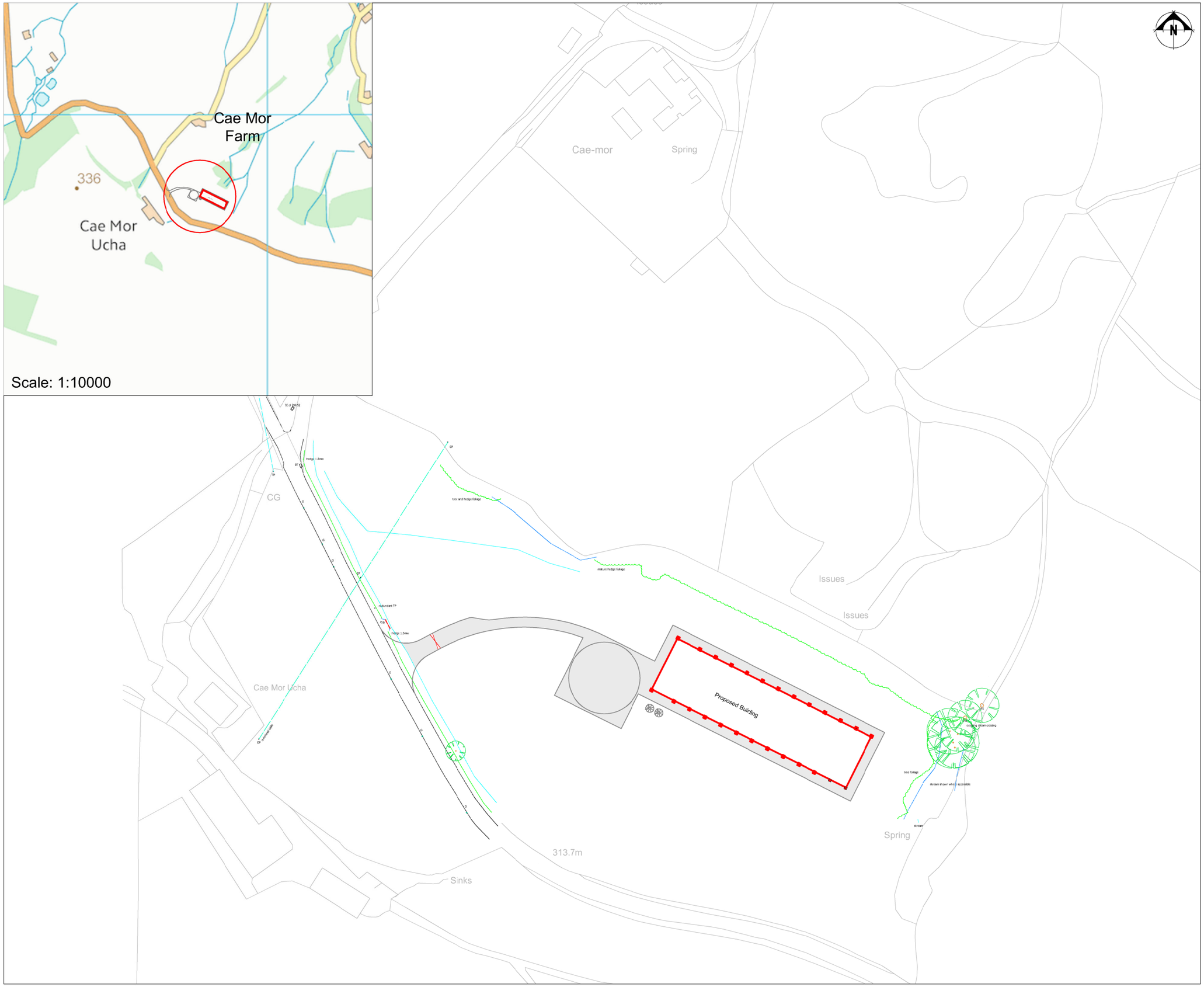
Johanne Williams

johanne.williams@waterco.co.uk

Enclosed documents

- Proposed Development Plan
- Trial Pit Location Plan
- Soakaway Calculation Sheets

01824 702220
www.waterco.co.uk
Waterco Ltd. Company No. 3577754
Eden Court, Lôn Parcwr Business Park, Ruthin, Denbighshire, LL15 1NJ



THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELATED DRAWINGS. ALL DIMENSIONS MUST BE CHECKED AND VERIFIED ON SITE BEFORE COMMENCING ANY WORK OR PRODUCING SHOP DRAWINGS. THE ORIGINATOR SHOULD BE NOTIFIED IMMEDIATELY OF ANY DISCREPANCY. THIS DRAWING IS COPYRIGHT AND REMAINS THE PROPERTY ROGER PARRY & PARTNERS.

KEY

Rev	Description	Date	Dr by	App by
Original by				

Roger Parry & Partners

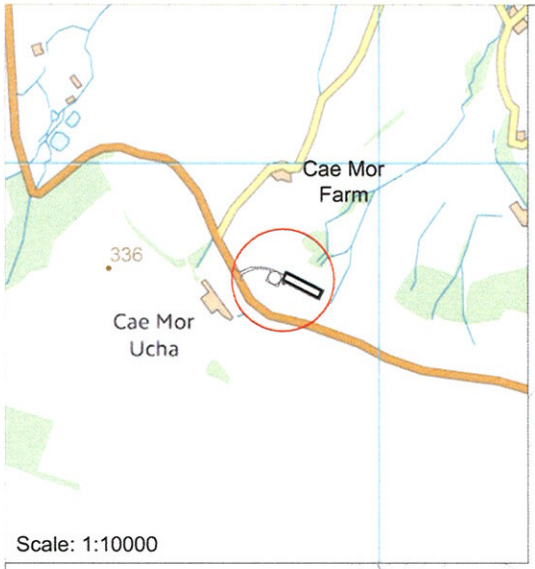
Residential - Agricultural - Commercial

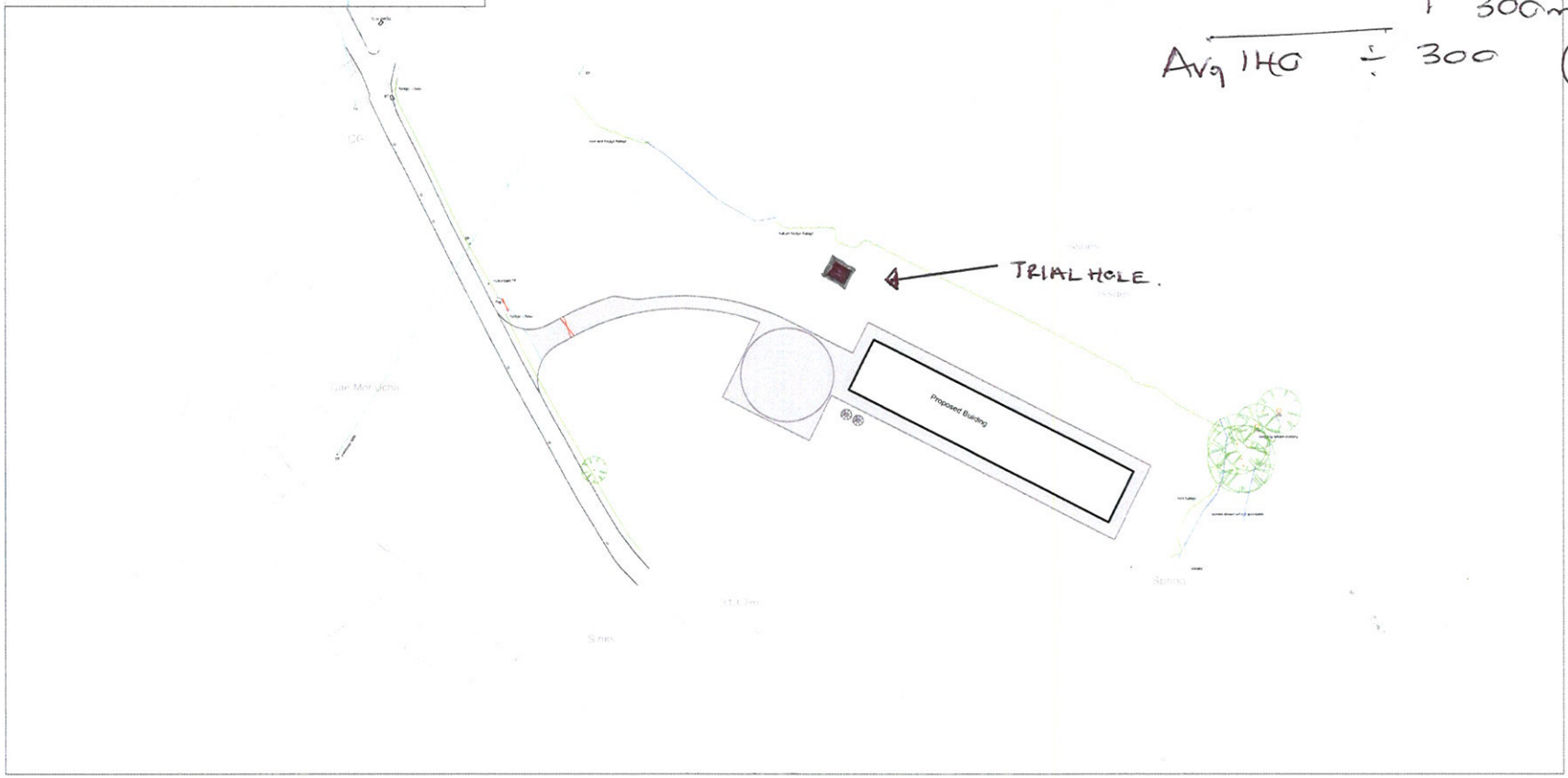
Job	16000 Free Range Egg Laying Unit
Title	Location Plan
Location	Cae Mor Farm Llwynmawr Llangollen LL20 7BE
Client	E & J Morris
Scales	1:1250 @ A3
Drawing No.	RJC-MZ-1845-01A
Drawn by	MZ — Date 2-07-2015

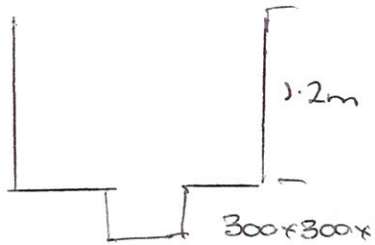
HOGSTOW HALL, MINSTERLEY
SHREWSBURY, SHROPSHIRE. SY5 0HZ
Tel: 01743 791336 Fax: 01743 792770
email: mail@rogerparry.net
Web address: www.rogerparry.net

Roger Parry & Partners LLP partnership no.OC312203
Registered Office Hogstow Hall, Minsterley, Shrewsbury, SY5 0HZ
Registered in England and Wales
A list of members of the LLP is available at the above address.

Ordnance Survey, ©Crown Copyright. All rights reserved. Licence no. 100019980







Test 1 – 85 sec
Test 2 – 155 sec
Test 3 – 180 sec
Avg 140 ÷ 300

Water drop of 300mm

47

THIS DRAWING IS TO BE REAION WITH ALL RELATED DRAWINGIONS MUST BE CHECKED AND VEREFORE COMMENCING ANY WORK OFIOP DRAWINGS. THE ORIGINATODTIFIED IMMEDIATELY OF ANY DISCR DRAWING IS COPYRIGHT AND PROPERTY ROGER PARRY &

KEY

Rev	Description	by	App by
Original by			

Roger & Part

Residential - Agricultal

Job	16000 Frgg La
Title	Location Pla
Location	Cae Mor Fa Llwynmawr Llangollen LL20 7BE
Client	E & J Morris
Scales	1:1250 @ A
Drawing No.	RJC-MZ-18-
Drawn by	MZ –2015

HOGSTOW HALL, MINSTE
SHREWSBURY, SHROPSH
Tel: 01743 791336 Fax: 017
email: mail@rogerparry.net
Web address: www.rogerparr

Ordnance Survey, ©Crown Copyright. All rights reserved. Licence no. 100019980

Determination of soakaway storage requirement and proposesd dimensions

Development description and estimate of Impervious areas

Proposed free range egg laying unit.

Total impervious area (including building, access road and turning circle) = 2355m²

Design Procedure from BRE Digest 365 with alternative return period 100yr

The design method for sizing a soakaway is based upon the equation of volumes:

S = I - O

Where: S = Required storage in the soakaway to balance inflow and outflow.
I = Inflow from Impermeable Areas drained to soakaway.
O = Outflow Infiltrating into the soil.

I = Total inflow Volume

I = Inflow to soakaway from on-site impervious areas
= Impervious Area, A x Total Rainfall (100yr Return Period)

O = Outflow Volume = as50 x f x D x 60

as50 = Internal Surface Area of soakaway to 50% effective depth (m²)
f = Soil Infiltration Rate (Taken from Infiltration Test Calc sheets) (m/s)
D = Storm Duration (mins)

f = Soil Infiltration Rate

300mm x 300mm x 300mm trail pit

Test 1 - 85 seconds
Test 2 - 155 seonds
Test 3 - 180 seconds
Average - 140 seconds

Average Percolation Rate - 0.466mm per second

Average Infiltration Rate 7.14 x 10^-4

Average infiltration rate used in design.

Rainfall Parameters

Storm return frequency - 1 in (yrs)	100.00	(Alternative to std 10yr as BRE Digest 365)
M5-60 min rainfall (mm)	20.00	(BRE Digest 365: 20mm to be taken for all UK
Climate change allowance (%)	30	
Adjusted M5-60min rain (mm)	26	(calculated)
Ratio (M5-60 / M5-2day) - r	0.30	(From Map on Page 3)

Drainage Area

Total impervious area **A** (m2) 2355.00

Soakaway Details

(Rectangular soakaway)

Length **L** (m) =	12.00	
Width **W** (m) =	7.80	
Effective Depth **d** (m) =	1.80	
Design Area (m²), **as50** (m2)=	35.64	Area of sidesto 50% depth
Percentage Voids **P** (%) =	30	Typical 30% for single size stone
Design Volume **V** (m3) =	**50.54**	(P/100xLxWxd)

Soil Infiltration

Infiltration Rate **f** (m/s) = 7.14E-04 From infiltration test results

Calculations in table below

Total rainfall R =M5-60 * Z1* Z2 (calculated page 3)
Inflow Volume, I = A x R (100% run-off)
Outflow Volume O = as50 * f * D * 60
Storage Volume S = I - O

	Storm duration (D)		R (M100-D)	I	O	S	
Crit D	(Minutes)	(Hrs)	(mm)	m³	m³	m³	
	15	0.25	30.57	71.988	22.902	49.086	
Crit D	30	0.50	40.64	95.705	45.805	49.900	Max
	60	1.00	52.05	122.582	91.609	30.973	
	120	2.00	63.38	149.248	183.218	0.000	
	240	4.00	76.98	181.294	366.436	0.000	
	360	6.00	86.02	202.568	549.654	0.000	
	600	10.00	99.16	233.529	916.091	0.000	
	1440	24.00	121.78	286.799	2198.617	0.000	
	Design Storage Requirement = Maximum Volume (m³) =					**49.900**	

Proposed Soakaway Dimension Check = **OK, but check Time of Emptying**

Time of Emptying of Soakaway (Taken from BRE Digest 365)
The soakaway should discharge from full to half-volume within 24 hours in readiness for subsequent storm inflow.

ts50 = Time to empty 50% of total storage volume

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.28 \text{ hrs}$$

< 24hrs, Therefore Design Acceptable

Summary of acceptable dimensions:

Length =	*12.00 m*
Width =	*7.80 m*
Effective Depth =	*1.80 m*

Values of Factor Z1 (From BRE 365 - Table 1)

Ratio	Rainfall Duration (mins)								
r	15	30	60	120	240	360	600	1440	
0.12	0.450	0.670	1.000	1.480	2.170	2.750	3.700	6.000	
0.15	0.480	0.690	1.000	1.420	2.020	2.460	3.230	4.900	
0.18	0.510	0.710	1.000	1.360	1.860	2.250	2.860	4.300	
0.20	*0.530*	*0.723*	*1.000*	*1.340*	*1.800*	*2.163*	*2.700*	*3.833*	**
0.21	0.540	0.730	1.000	1.330	1.770	2.120	2.620	3.600	
0.24	0.560	0.750	1.000	1.300	1.710	2.000	2.400	3.350	
0.25	*0.567*	*0.753*	*1.000*	*1.290*	*1.687*	*1.960*	*2.347*	*3.267*	**
0.27	0.580	0.760	1.000	1.270	1.640	1.880	2.240	3.100	
0.30	0.590	0.770	1.000	1.250	1.570	1.780	2.120	2.840	
0.33	0.610	0.780	1.000	1.230	1.530	1.730	2.040	2.600	
0.35	*0.617*	*0.787*	*1.000*	*1.223*	*1.497*	*1.690*	*1.947*	*2.480*	**
0.36	0.620	0.790	1.000	1.220	1.480	1.670	1.900	2.420	
0.39	0.630	0.800	1.000	1.210	1.460	1.620	1.820	2.280	
0.40	*0.633*	*0.803*	*1.000*	*1.207*	*1.447*	*1.603*	*1.793*	*2.240*	**
0.42	0.640	0.810	1.000	1.200	1.420	1.570	1.740	2.160	
0.45	0.650	0.820	1.000	1.190	1.380	1.510	1.680	2.030	

Calculating Design Rainfall, R (100yr Return Period)

Pro-rata values **

M5-60 rain (mm)	26.00	(Taken from Page 1)
Ratio M5-60/M5-2day	0.30	(Taken from Page 1)

	Duration (mins)	Duration (hrs)	Factor Z1	R (M5-D) (mm)	Z2 Values - M100			Prorata Z2	R (M100-D) (mm)
					Z2 low	Diff (mm)	Z2 high		
2	15.0	0.25	0.590	15.340	1.99	5.00	2.03	1.993	**30.568**
3	30.0	0.50	0.770	20.020	2.03	5.00	2.01	2.030	**40.639**
4	60.0	1.00	1.000	26.000	2.01	5.00	1.97	2.002	**52.052**
5	120.0	2.00	1.250	32.500	1.97	10.00	1.89	1.950	**63.375**
6	240.0	4.00	1.570	40.820	1.89	10.00	1.84	1.886	**76.982**
7	360.0	6.00	1.780	46.280	1.89	10.00	1.84	1.859	**86.016**
8	600.0	10.00	2.120	55.120	1.84	25.00	1.64	1.799	**99.163**
9	1440.0	24.00	2.840	73.840	1.84	25.00	1.64	1.649	**121.783**

Z2 Factors - England & Wales (from Wallingford Procedure)		
M5 Rain (mm)	**Diff (mm)**	**M100**
0	5	1.790
5	5	1.790
10	5	1.910
15	5	1.990
20	5	2.030
25	5	2.010
30	10	1.970
40	10	1.890
50	25	1.840
75	25	1.640
100	50	1.540
150	50	1.450
200	50	1.400

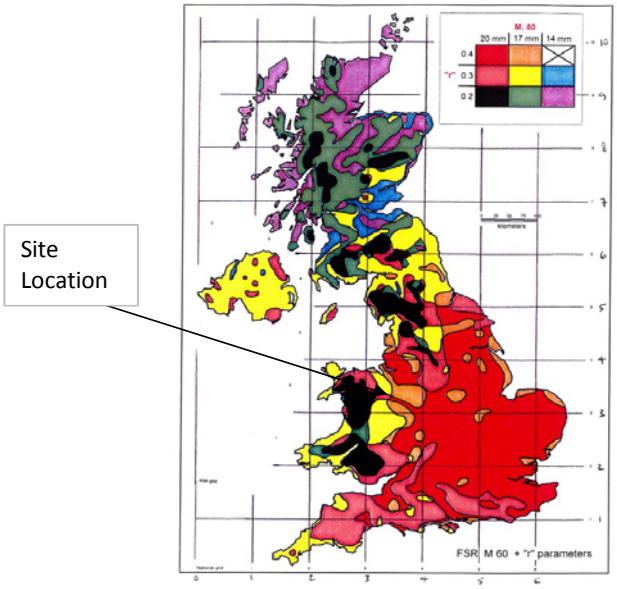


Figure 2 Hydrological rainfall zones of UK

Determination of soakaway storage requirement and proposesd dimensions

Development description and estimate of Impervious areas

Proposed free range egg laying unit.

Total impervious area (building only) = 1425m²

Design Procedure from BRE Digest 365 with alternative return period 100yr

The design method for sizing a soakaway is based upon the equation of volumes:

S = I - O

Where: S = Required storage in the soakaway to balance inflow and outflow.
I = Inflow from Impermeable Areas drained to soakaway.
O = Outflow Infiltrating into the soil.

I = Total inflow Volume

I = Inflow to soakaway from on-site impervious areas
= Impervious Area, A x Total Rainfall (100yr Return Period)

O = Outflow Volume = as50 x f x D x 60

as50 = Internal Surface Area of soakaway to 50% effective depth (m²)
f = Soil Infiltration Rate (Taken from Infiltration Test Calc sheets) (m/s)
D = Storm Duration (mins)

f = Soil Infiltration Rate

300mm x 300mm x 300mm trail pit

Test 1 - 85 seconds
Test 2 - 155 seonds
Test 3 - 180 seconds
Average - 140 seconds

Average Percolation Rate - 0.466mm per second

Average Infiltration Rate 7.14 x 10^-4

Average infiltration rate used in design.

Rainfall Parameters

Storm return frequency - 1 in (yrs)	100.00	(Alternative to std 10yr as BRE Digest 365)
M5-60 min rainfall (mm)	20.00	(BRE Digest 365: 20mm to be taken for all UK
Climate change allowance (%)	30	
Adjusted M5-60min rain (mm)	26	(calculated)
Ratio (M5-60 / M5-2day) - r	0.30	(From Map on Page 3)

Drainage Area

Total impervious area **A** (m2) 1425.00

Soakaway Details

(Rectangular soakaway)

Length **L** (m) =	8.40	
Width **W** (m) =	6.00	
Effective Depth **d** (m) =	1.80	
Design Area (m²), **as50** (m2)=	25.92	Area of sidesto 50% depth
Percentage Voids **P** (%) =	30	Typical 30% for single size stone
Design Volume **V** (m3) =	**27.22**	(P/100xLxWxd)

Soil Infiltration

Infiltration Rate **f** (m/s) = 7.14E-04 From infiltration test results

Calculations in table below

Total rainfall R =M5-60 * Z1* Z2 (calculated page 3)
Inflow Volume, I = A x R (100% run-off)
Outflow Volume O = as50 * f * D * 60
Storage Volume S = I - O

	Storm duration (D)		R (M100-D)	I	O	S	
Crit D	(Minutes)	(Hrs)	(mm)	m³	m³	m³	
Crit D	15	0.25	30.57	43.560	16.656	26.904	Max
	30	0.50	40.64	57.911	33.312	24.598	
	60	1.00	52.05	74.174	66.625	7.549	
	120	2.00	63.38	90.309	133.250	0.000	
	240	4.00	76.98	109.700	266.499	0.000	
	360	6.00	86.02	122.573	399.749	0.000	
	600	10.00	99.16	141.307	666.248	0.000	
	1440	24.00	121.78	173.541	1598.994	0.000	
	Design Storage Requirement = Maximum Volume (m³) =					**26.904**	

Proposed Soakaway Dimension Check = **OK, but check Time of Emptying**

Time of Emptying of Soakaway (Taken from BRE Digest 365)
The soakaway should discharge from full to half-volume within 24 hours in readiness for subsequent storm inflow.

ts50 = Time to empty 50% of total storage volume

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.20 \text{ hrs}$$

< 24hrs, Therefore Design Acceptable

Summary of acceptable dimensions:

Length =	*8.40 m*
Width =	*6.00 m*
Effective Depth =	*1.80 m*

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220		w1952
Client :	Roger Parry & Partners LLP		Page 3 of 3
Scheme :	Cae Mor Farm, Llwynmawr	Prefix	Rev.
Section :	Soakaway Design - Stone fill - Building Only	SD	A

Values of Factor Z1 (From BRE 365 - Table 1)

Ratio	Rainfall Duration (mins)								
r	15	30	60	120	240	360	600	1440	
0.12	0.450	0.670	1.000	1.480	2.170	2.750	3.700	6.000	
0.15	0.480	0.690	1.000	1.420	2.020	2.460	3.230	4.900	
0.18	0.510	0.710	1.000	1.360	1.860	2.250	2.860	4.300	
0.20	*0.530*	*0.723*	*1.000*	*1.340*	*1.800*	*2.163*	*2.700*	*3.833*	**
0.21	0.540	0.730	1.000	1.330	1.770	2.120	2.620	3.600	
0.24	0.560	0.750	1.000	1.300	1.710	2.000	2.400	3.350	
0.25	*0.567*	*0.753*	*1.000*	*1.290*	*1.687*	*1.960*	*2.347*	*3.267*	**
0.27	0.580	0.760	1.000	1.270	1.640	1.880	2.240	3.100	
0.30	0.590	0.770	1.000	1.250	1.570	1.780	2.120	2.840	
0.33	0.610	0.780	1.000	1.230	1.530	1.730	2.040	2.600	
0.35	*0.617*	*0.787*	*1.000*	*1.223*	*1.497*	*1.690*	*1.947*	*2.480*	**
0.36	0.620	0.790	1.000	1.220	1.480	1.670	1.900	2.420	
0.39	0.630	0.800	1.000	1.210	1.460	1.620	1.820	2.280	
0.40	*0.633*	*0.803*	*1.000*	*1.207*	*1.447*	*1.603*	*1.793*	*2.240*	**
0.42	0.640	0.810	1.000	1.200	1.420	1.570	1.740	2.160	
0.45	0.650	0.820	1.000	1.190	1.380	1.510	1.680	2.030	

Calculating Design Rainfall, R (100yr Return Period)

Pro-rata values **

M5-60 rain (mm)	26.00	(Taken from Page 1)
Ratio M5-60/M5-2day	0.30	(Taken from Page 1)

	Duration (mins)	Duration (hrs)	Factor Z1	R (M5-D) (mm)	Z2 Values - M100			Prorata Z2	R (M100-D) (mm)
					Z2 low	Diff (mm)	Z2 high		
2	15.0	0.25	0.590	15.340	1.99	5.00	2.03	1.993	**30.568**
3	30.0	0.50	0.770	20.020	2.03	5.00	2.01	2.030	**40.639**
4	60.0	1.00	1.000	26.000	2.01	5.00	1.97	2.002	**52.052**
5	120.0	2.00	1.250	32.500	1.97	10.00	1.89	1.950	**63.375**
6	240.0	4.00	1.570	40.820	1.89	10.00	1.84	1.886	**76.982**
7	360.0	6.00	1.780	46.280	1.89	10.00	1.84	1.859	**86.016**
8	600.0	10.00	2.120	55.120	1.84	25.00	1.64	1.799	**99.163**
9	1440.0	24.00	2.840	73.840	1.84	25.00	1.64	1.649	**121.783**

Z2 Factors - England & Wales (from Wallingford Procedure)		
M5 Rain (mm)	**Diff (mm)**	**M100**
0	5	1.790
5	5	1.790
10	5	1.910
15	5	1.990
20	5	2.030
25	5	2.010
30	10	1.970
40	10	1.890
50	25	1.840
75	25	1.640
100	50	1.540
150	50	1.450
200	50	1.400

Site Location

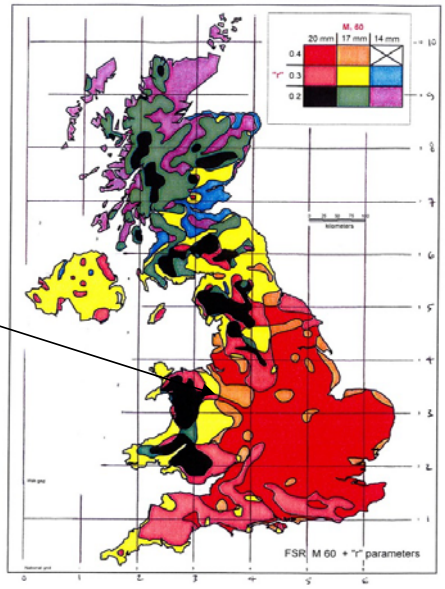


Figure 2 Hydrological rainfall zones of UK

Determination of soakaway storage requirement and proposesd dimensions

Development description and estimate of Impervious areas

Proposed free range egg laying unit.

Total impervious area (access road and turning circle) = 930m²

Design Procedure from BRE Digest 365 with alternative return period 100yr

The design method for sizing a soakaway is based upon the equation of volumes:

S = I - O

Where: S = Required storage in the soakaway to balance inflow and outflow.
I = Inflow from Impermeable Areas drained to soakaway.
O = Outflow Infiltrating into the soil.

I = Total inflow Volume

I = Inflow to soakaway from on-site impervious areas
= Impervious Area, A x Total Rainfall (100yr Return Period)

O = Outflow Volume = as50 x f x D x 60

as50 = Internal Surface Area of soakaway to 50% effective depth (m²)
f = Soil Infiltration Rate (Taken from Infiltration Test Calc sheets) (m/s)
D = Storm Duration (mins)

f = Soil Infiltration Rate

300mm x 300mm x 300mm trail pit

Test 1 - 85 seconds
Test 2 - 155 seonds
Test 3 - 180 seconds
Average - 140 seconds

Average Percolation Rate - 0.466mm per second

Average Infiltration Rate 7.14 x 10^-4

Average infiltration rate used in design.

Rainfall Parameters

Storm return frequency - 1 in (yrs)	100.00	(Alternative to std 10yr as BRE Digest 365)
M5-60 min rainfall (mm)	20.00	(BRE Digest 365: 20mm to be taken for all UK
Climate change allowance (%)	30	
Adjusted M5-60min rain (mm)	26	(calculated)
Ratio (M5-60 / M5-2day) - r	0.30	(From Map on Page 3)

Drainage Area

Total impervious area **A** (m2) 930.00

Soakaway Details

(Rectangular soakaway)

Length **L** (m) =	6.50	
Width **W** (m) =	4.50	
Effective Depth **d** (m) =	1.80	
Design Area (m²), **as50** (m2)=	19.80	Area of sidesto 50% depth
Percentage Voids **P** (%) =	30	Typical 30% for single size stone
Design Volume **V** (m3) =	**15.80**	(P/100xLxWxd)

Soil Infiltration

Infiltration Rate **f** (m/s) = 7.14E-04 From infiltration test results

Calculations in table below

Total rainfall R =M5-60 * Z1* Z2 (calculated page 3)
Inflow Volume, I = A x R (100% run-off)
Outflow Volume O = as50 * f * D * 60
Storage Volume S = I - O

	Storm duration (D)		R (M100-D)	I	O	S	
Crit D	(Minutes)	(Hrs)	(mm)	m³	m³	m³	
Crit D	15	0.25	30.57	28.429	12.723	15.705	Max
	30	0.50	40.64	37.794	25.447	12.347	
	60	1.00	52.05	48.408	50.894	0.000	
	120	2.00	63.38	58.939	101.788	0.000	
	240	4.00	76.98	71.594	203.576	0.000	
	360	6.00	86.02	79.995	305.364	0.000	
	600	10.00	99.16	92.222	508.939	0.000	
	1440	24.00	121.78	113.258	1221.454	0.000	
	Design Storage Requirement = Maximum Volume (m³) =					**15.705**	

Proposed Soakaway Dimension Check = **OK, but check Time of Emptying**

Time of Emptying of Soakaway (Taken from BRE Digest 365)
The soakaway should discharge from full to half-volume within 24 hours in readiness for subsequent storm inflow.

ts50 = Time to empty 50% of total storage volume

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.16 \text{ hrs}$$

< 24hrs, Therefore Design Acceptable

Summary of acceptable dimensions:

Length =	*6.50 m*
Width =	*4.50 m*
Effective Depth =	*1.80 m*

Values of Factor Z1 (From BRE 365 - Table 1)

Ratio	Rainfall Duration (mins)								
r	15	30	60	120	240	360	600	1440	
0.12	0.450	0.670	1.000	1.480	2.170	2.750	3.700	6.000	
0.15	0.480	0.690	1.000	1.420	2.020	2.460	3.230	4.900	
0.18	0.510	0.710	1.000	1.360	1.860	2.250	2.860	4.300	
0.20	*0.530*	*0.723*	*1.000*	*1.340*	*1.800*	*2.163*	*2.700*	*3.833*	**
0.21	0.540	0.730	1.000	1.330	1.770	2.120	2.620	3.600	
0.24	0.560	0.750	1.000	1.300	1.710	2.000	2.400	3.350	
0.25	*0.567*	*0.753*	*1.000*	*1.290*	*1.687*	*1.960*	*2.347*	*3.267*	**
0.27	0.580	0.760	1.000	1.270	1.640	1.880	2.240	3.100	
0.30	0.590	0.770	1.000	1.250	1.570	1.780	2.120	2.840	
0.33	0.610	0.780	1.000	1.230	1.530	1.730	2.040	2.600	
0.35	*0.617*	*0.787*	*1.000*	*1.223*	*1.497*	*1.690*	*1.947*	*2.480*	**
0.36	0.620	0.790	1.000	1.220	1.480	1.670	1.900	2.420	
0.39	0.630	0.800	1.000	1.210	1.460	1.620	1.820	2.280	
0.40	*0.633*	*0.803*	*1.000*	*1.207*	*1.447*	*1.603*	*1.793*	*2.240*	**
0.42	0.640	0.810	1.000	1.200	1.420	1.570	1.740	2.160	
0.45	0.650	0.820	1.000	1.190	1.380	1.510	1.680	2.030	

Calculating Design Rainfall, R (100yr Return Period)

Pro-rata values **

M5-60 rain (mm)	26.00	(Taken from Page 1)
Ratio M5-60/M5-2day	0.30	(Taken from Page 1)

	Duration (mins)	Duration (hrs)	Factor Z1	R (M5-D) (mm)	Z2 Values - M100			Prorata Z2	R (M100-D) (mm)
					Z2 low	Diff (mm)	Z2 high		
2	15.0	0.25	0.590	15.340	1.99	5.00	2.03	1.993	**30.568**
3	30.0	0.50	0.770	20.020	2.03	5.00	2.01	2.030	**40.639**
4	60.0	1.00	1.000	26.000	2.01	5.00	1.97	2.002	**52.052**
5	120.0	2.00	1.250	32.500	1.97	10.00	1.89	1.950	**63.375**
6	240.0	4.00	1.570	40.820	1.89	10.00	1.84	1.886	**76.982**
7	360.0	6.00	1.780	46.280	1.89	10.00	1.84	1.859	**86.016**
8	600.0	10.00	2.120	55.120	1.84	25.00	1.64	1.799	**99.163**
9	1440.0	24.00	2.840	73.840	1.84	25.00	1.64	1.649	**121.783**

Z2 Factors - England & Wales (from Wallingford Procedure)		
M5 Rain (mm)	**Diff (mm)**	**M100**
0	5	1.790
5	5	1.790
10	5	1.910
15	5	1.990
20	5	2.030
25	5	2.010
30	10	1.970
40	10	1.890
50	25	1.840
75	25	1.640
100	50	1.540
150	50	1.450
200	50	1.400

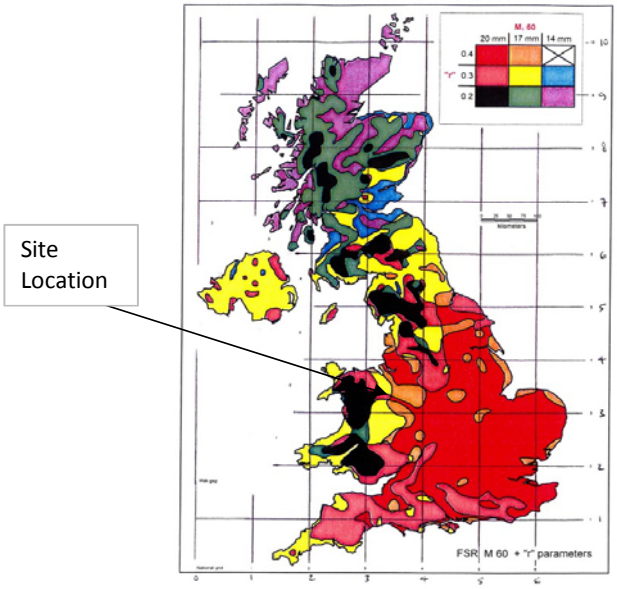


Figure 2 Hydrological rainfall zones of UK

Determination of soakaway storage requirement and proposesd dimensions

Development description and estimate of Impervious areas

Proposed free range egg laying unit.

Total impervious area (including building, access road and turning circle) = 2355m²

Design Procedure from BRE Digest 365 with alternative return period 100yr

The design method for sizing a soakaway is based upon the equation of volumes:

S = I - O

Where: S = Required storage in the soakaway to balance inflow and outflow.
I = Inflow from Impermeable Areas drained to soakaway.
O = Outflow Infiltrating into the soil.

I = Total inflow Volume

I = Inflow to soakaway from on-site impervious areas
= Impervious Area, A x Total Rainfall (100yr Return Period)

O = Outflow Volume = as50 x f x D x 60

as50 = Internal Surface Area of soakaway to 50% effective depth (m²)
f = Soil Infiltration Rate (Taken from Infiltration Test Calc sheets) (m/s)
D = Storm Duration (mins)

f = Soil Infiltration Rate

300mm x 300mm x 300mm trail pit

Test 1 - 85 seconds
Test 2 - 155 seonds
Test 3 - 180 seconds
Average - 140 seconds

Average Percolation Rate - 0.466mm per second

Average Infiltration Rate 7.14 x 10^-4

Average infiltration rate used in design.

Rainfall Parameters

Storm return frequency - 1 in (yrs)	100.00	(Alternative to std 10yr as BRE Digest 365)
M5-60 min rainfall (mm)	20.00	(BRE Digest 365: 20mm to be taken for all UK
Climate change allowance (%)	30	
Adjusted M5-60min rain (mm)	26	(calculated)
Ratio (M5-60 / M5-2day) - r	0.30	(From Map on Page 3)

Drainage Area

Total impervious area **A** (m2) 2355.00

Soakaway Details

(Rectangular soakaway)

Length **L** (m) =	9.00	
Width **W** (m) =	5.00	
Effective Depth **d** (m) =	1.60	
Design Area (m²), **as50** (m2)=	22.40	Area of sidesto 50% depth
Percentage Voids **P** (%) =	95	Typical 95% for storm crates
Design Volume **V** (m3) =	**68.40**	(P/100xLxWxd)

Soil Infiltration

Infiltration Rate **f** (m/s) = 7.14E-04 From infiltration test results

Calculations in table below

Total rainfall R =M5-60 * Z1* Z2 (calculated page 3)
Inflow Volume, I = A x R (100% run-off)
Outflow Volume O = as50 * f * D * 60
Storage Volume S = I - O

	Storm duration (D)		R (M100-D)	I	O	S	
Crit D	(Minutes)	(Hrs)	(mm)	m³	m³	m³	
	15	0.25	30.57	71.988	14.394	57.594	
Crit D	30	0.50	40.64	95.705	28.788	66.916	Max
	60	1.00	52.05	122.582	57.577	65.006	
	120	2.00	63.38	149.248	115.154	34.094	
	240	4.00	76.98	181.294	230.308	0.000	
	360	6.00	86.02	202.568	345.462	0.000	
	600	10.00	99.16	233.529	575.770	0.000	
	1440	24.00	121.78	286.799	1381.847	0.000	
	Design Storage Requirement = Maximum Volume (m³) =					**66.916**	

Proposed Soakaway Dimension Check = **OK, but check Time of Emptying**

Time of Emptying of Soakaway (Taken from BRE Digest 365)
The soakaway should discharge from full to half-volume within 24 hours in readiness for subsequent storm inflow.

ts50 = Time to empty 50% of total storage volume

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.59 \text{ hrs}$$

< 24hrs, Therefore Design Acceptable

Summary of acceptable dimensions:

Length =	*9.00 m*
Width =	*5.00 m*
Effective Depth =	*1.60 m*

Values of Factor Z1 (From BRE 365 - Table 1)

Ratio	Rainfall Duration (mins)								
r	15	30	60	120	240	360	600	1440	
0.12	0.450	0.670	1.000	1.480	2.170	2.750	3.700	6.000	
0.15	0.480	0.690	1.000	1.420	2.020	2.460	3.230	4.900	
0.18	0.510	0.710	1.000	1.360	1.860	2.250	2.860	4.300	
0.20	*0.530*	*0.723*	*1.000*	*1.340*	*1.800*	*2.163*	*2.700*	*3.833*	**
0.21	0.540	0.730	1.000	1.330	1.770	2.120	2.620	3.600	
0.24	0.560	0.750	1.000	1.300	1.710	2.000	2.400	3.350	
0.25	*0.567*	*0.753*	*1.000*	*1.290*	*1.687*	*1.960*	*2.347*	*3.267*	**
0.27	0.580	0.760	1.000	1.270	1.640	1.880	2.240	3.100	
0.30	0.590	0.770	1.000	1.250	1.570	1.780	2.120	2.840	
0.33	0.610	0.780	1.000	1.230	1.530	1.730	2.040	2.600	
0.35	*0.617*	*0.787*	*1.000*	*1.223*	*1.497*	*1.690*	*1.947*	*2.480*	**
0.36	0.620	0.790	1.000	1.220	1.480	1.670	1.900	2.420	
0.39	0.630	0.800	1.000	1.210	1.460	1.620	1.820	2.280	
0.40	*0.633*	*0.803*	*1.000*	*1.207*	*1.447*	*1.603*	*1.793*	*2.240*	**
0.42	0.640	0.810	1.000	1.200	1.420	1.570	1.740	2.160	
0.45	0.650	0.820	1.000	1.190	1.380	1.510	1.680	2.030	

Calculating Design Rainfall, R (100yr Return Period)

Pro-rata values **

M5-60 rain (mm)	26.00	(Taken from Page 1)
Ratio M5-60/M5-2day	0.30	(Taken from Page 1)

	Duration (mins)	Duration (hrs)	Factor Z1	R (M5-D) (mm)	Z2 Values - M100			Prorata Z2	R (M100-D) (mm)
					Z2 low	Diff (mm)	Z2 high		
2	15.0	0.25	0.590	15.340	1.99	5.00	2.03	1.993	**30.568**
3	30.0	0.50	0.770	20.020	2.03	5.00	2.01	2.030	**40.639**
4	60.0	1.00	1.000	26.000	2.01	5.00	1.97	2.002	**52.052**
5	120.0	2.00	1.250	32.500	1.97	10.00	1.89	1.950	**63.375**
6	240.0	4.00	1.570	40.820	1.89	10.00	1.84	1.886	**76.982**
7	360.0	6.00	1.780	46.280	1.89	10.00	1.84	1.859	**86.016**
8	600.0	10.00	2.120	55.120	1.84	25.00	1.64	1.799	**99.163**
9	1440.0	24.00	2.840	73.840	1.84	25.00	1.64	1.649	**121.783**

Z2 Factors - England & Wales (from Wallingford Procedure)		
M5 Rain (mm)	**Diff (mm)**	**M100**
0	5	1.790
5	5	1.790
10	5	1.910
15	5	1.990
20	5	2.030
25	5	2.010
30	10	1.970
40	10	1.890
50	25	1.840
75	25	1.640
100	50	1.540
150	50	1.450
200	50	1.400

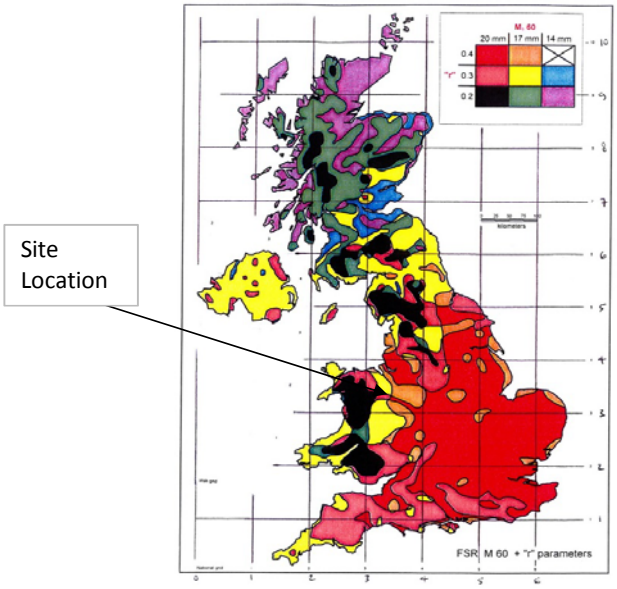


Figure 2 Hydrological rainfall zones of UK

Determination of soakaway storage requirement and proposesd dimensions

Development description and estimate of Impervious areas

Proposed free range egg laying unit.

Total impervious area (building only) = 1425m²

Design Procedure from BRE Digest 365 with alternative return period 100yr

The design method for sizing a soakaway is based upon the equation of volumes:

S = I - O

Where: S = Required storage in the soakaway to balance inflow and outflow.
I = Inflow from Impermeable Areas drained to soakaway.
O = Outflow Infiltrating into the soil.

I = Total inflow Volume

I = Inflow to soakaway from on-site impervious areas
= Impervious Area, A x Total Rainfall (100yr Return Period)

O = Outflow Volume = as50 x f x D x 60

as50 = Internal Surface Area of soakaway to 50% effective depth (m²)
f = Soil Infiltration Rate (Taken from Infiltration Test Calc sheets) (m/s)
D = Storm Duration (mins)

f = Soil Infiltration Rate

300mm x 300mm x 300mm trail pit

Test 1 - 85 seconds
Test 2 - 155 seonds
Test 3 - 180 seconds
Average - 140 seconds

Average Percolation Rate - 0.466mm per second

Average Infiltration Rate 7.14 x 10^-4

Average infiltration rate used in design.

Rainfall Parameters

Storm return frequency - 1 in (yrs)	100.00	(Alternative to std 10yr as BRE Digest 365)
M5-60 min rainfall (mm)	20.00	(BRE Digest 365: 20mm to be taken for all UK
Climate change allowance (%)	30	
Adjusted M5-60min rain (mm)	26	(calculated)
Ratio (M5-60 / M5-2day) - r	0.30	(From Map on Page 3)

Drainage Area

Total impervious area **A** (m2) 1425.00

Soakaway Details

(Rectangular soakaway)

Length **L** (m) =	6.50	
Width **W** (m) =	4.00	
Effective Depth **d** (m) =	1.60	
Design Area (m²), **as50** (m2)=	16.80	Area of sidesto 50% depth
Percentage Voids **P** (%) =	95	Typical 95% for storm crates
Design Volume **V** (m3) =	**39.52**	(P/100xLxWxd)

Soil Infiltration

Infiltration Rate **f** (m/s) = 7.14E-04 From infiltration test results

Calculations in table below

Total rainfall R =M5-60 * Z1* Z2 (calculated page 3)
Inflow Volume, I = A x R (100% run-off)
Outflow Volume O = as50 * f * D * 60
Storage Volume S = I - O

	Storm duration (D)		R (M100-D)	I	O	S	
Crit D	(Minutes)	(Hrs)	(mm)	m³	m³	m³	
	15	0.25	30.57	43.560	10.796	32.764	
Crit D	30	0.50	40.64	57.911	21.591	36.319	Max
	60	1.00	52.05	74.174	43.183	30.991	
	120	2.00	63.38	90.309	86.365	3.944	
	240	4.00	76.98	109.700	172.731	0.000	
	360	6.00	86.02	122.573	259.096	0.000	
	600	10.00	99.16	141.307	431.827	0.000	
	1440	24.00	121.78	173.541	1036.385	0.000	
	Design Storage Requirement = Maximum Volume (m³) =					**36.319**	

Proposed Soakaway Dimension Check = **OK, but check Time of Emptying**

Time of Emptying of Soakaway (Taken from BRE Digest 365)
The soakaway should discharge from full to half-volume within 24 hours in readiness for subsequent storm inflow.

ts50 = Time to empty 50% of total storage volume

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.46 \text{ hrs}$$

< 24hrs, Therefore Design Acceptable

Summary of acceptable dimensions:

Length =	*6.50 m*
Width =	*4.00 m*
Effective Depth =	*1.60 m*

Values of Factor Z1 (From BRE 365 - Table 1)

Ratio	Rainfall Duration (mins)								
r	15	30	60	120	240	360	600	1440	
0.12	0.450	0.670	1.000	1.480	2.170	2.750	3.700	6.000	
0.15	0.480	0.690	1.000	1.420	2.020	2.460	3.230	4.900	
0.18	0.510	0.710	1.000	1.360	1.860	2.250	2.860	4.300	
0.20	*0.530*	*0.723*	*1.000*	*1.340*	*1.800*	*2.163*	*2.700*	*3.833*	**
0.21	0.540	0.730	1.000	1.330	1.770	2.120	2.620	3.600	
0.24	0.560	0.750	1.000	1.300	1.710	2.000	2.400	3.350	
0.25	*0.567*	*0.753*	*1.000*	*1.290*	*1.687*	*1.960*	*2.347*	*3.267*	**
0.27	0.580	0.760	1.000	1.270	1.640	1.880	2.240	3.100	
0.30	0.590	0.770	1.000	1.250	1.570	1.780	2.120	2.840	
0.33	0.610	0.780	1.000	1.230	1.530	1.730	2.040	2.600	
0.35	*0.617*	*0.787*	*1.000*	*1.223*	*1.497*	*1.690*	*1.947*	*2.480*	**
0.36	0.620	0.790	1.000	1.220	1.480	1.670	1.900	2.420	
0.39	0.630	0.800	1.000	1.210	1.460	1.620	1.820	2.280	
0.40	*0.633*	*0.803*	*1.000*	*1.207*	*1.447*	*1.603*	*1.793*	*2.240*	**
0.42	0.640	0.810	1.000	1.200	1.420	1.570	1.740	2.160	
0.45	0.650	0.820	1.000	1.190	1.380	1.510	1.680	2.030	

Calculating Design Rainfall, R (100yr Return Period)

Pro-rata values **

M5-60 rain (mm)	26.00	(Taken from Page 1)
Ratio M5-60/M5-2day	0.30	(Taken from Page 1)

	Duration (mins)	Duration (hrs)	Factor Z1	R (M5-D) (mm)	Z2 Values - M100			Prorata Z2	R (M100-D) (mm)
					Z2 low	Diff (mm)	Z2 high		
2	15.0	0.25	0.590	15.340	1.99	5.00	2.03	1.993	**30.568**
3	30.0	0.50	0.770	20.020	2.03	5.00	2.01	2.030	**40.639**
4	60.0	1.00	1.000	26.000	2.01	5.00	1.97	2.002	**52.052**
5	120.0	2.00	1.250	32.500	1.97	10.00	1.89	1.950	**63.375**
6	240.0	4.00	1.570	40.820	1.89	10.00	1.84	1.886	**76.982**
7	360.0	6.00	1.780	46.280	1.89	10.00	1.84	1.859	**86.016**
8	600.0	10.00	2.120	55.120	1.84	25.00	1.64	1.799	**99.163**
9	1440.0	24.00	2.840	73.840	1.84	25.00	1.64	1.649	**121.783**

Z2 Factors - England & Wales (from Wallingford Procedure)		
M5 Rain (mm)	**Diff (mm)**	**M100**
0	5	1.790
5	5	1.790
10	5	1.910
15	5	1.990
20	5	2.030
25	5	2.010
30	10	1.970
40	10	1.890
50	25	1.840
75	25	1.640
100	50	1.540
150	50	1.450
200	50	1.400

Site Location

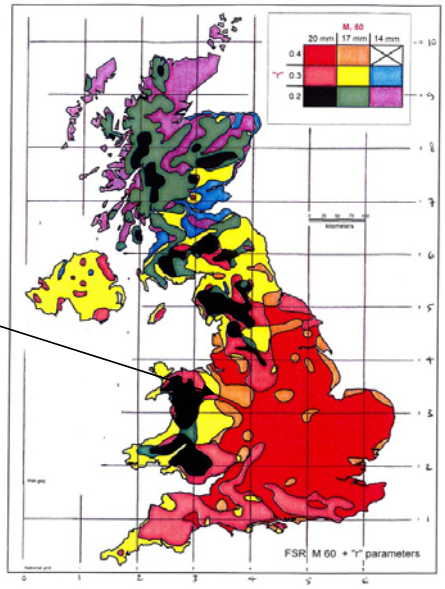


Figure 2 Hydrological rainfall zones of UK

Determination of soakaway storage requirement and proposesd dimensions

Development description and estimate of Impervious areas

Proposed free range egg laying unit.

Total impervious area (access road and turning circle) = 930m²

Design Procedure from BRE Digest 365 with alternative return period 100yr

The design method for sizing a soakaway is based upon the equation of volumes:

S = I - O

Where: S = Required storage in the soakaway to balance inflow and outflow.
I = Inflow from Impermeable Areas drained to soakaway.
O = Outflow Infiltrating into the soil.

I = Total inflow Volume

I = Inflow to soakaway from on-site impervious areas
= Impervious Area, A x Total Rainfall (100yr Return Period)

O = Outflow Volume = as50 x f x D x 60

as50 = Internal Surface Area of soakaway to 50% effective depth (m²)
f = Soil Infiltration Rate (Taken from Infiltration Test Calc sheets) (m/s)
D = Storm Duration (mins)

f = Soil Infiltration Rate

300mm x 300mm x 300mm trail pit

Test 1 - 85 seconds
Test 2 - 155 seonds
Test 3 - 180 seconds
Average - 140 seconds

Average Percolation Rate - 0.466mm per second

Average Infiltration Rate 7.14 x 10^-4

Average infiltration rate used in design.

Rainfall Parameters

Storm return frequency - 1 in (yrs)	100.00	(Alternative to std 10yr as BRE Digest 365)
M5-60 min rainfall (mm)	20.00	(BRE Digest 365: 20mm to be taken for all UK
Climate change allowance (%)	30	
Adjusted M5-60min rain (mm)	26	(calculated)
Ratio (M5-60 / M5-2day) - r	0.30	(From Map on Page 3)

Drainage Area

Total impervious area **A** (m2) 930.00

Soakaway Details

(Rectangular soakaway)

Length **L** (m) =	5.00	
Width **W** (m) =	3.00	
Effective Depth **d** (m) =	1.60	
Design Area (m²), **as50** (m2)=	12.80	Area of sidesto 50% depth
Percentage Voids **P** (%) =	95	Typical 95% for storm crates
Design Volume **V** (m3) =	**22.80**	(P/100xLxWxd)

Soil Infiltration

Infiltration Rate **f** (m/s) = 7.14E-04 From infiltration test results

Calculations in table below

Total rainfall R =M5-60 * Z1* Z2 (calculated page 3)
Inflow Volume, I = A x R (100% run-off)
Outflow Volume O = as50 * f * D * 60
Storage Volume S = I - O

	Storm duration (D)		R (M100-D)	I	O	S	
Crit D	(Minutes)	(Hrs)	(mm)	m³	m³	m³	
	15	0.25	30.57	28.429	8.225	20.203	
Crit D	30	0.50	40.64	37.794	16.451	21.344	Max
	60	1.00	52.05	48.408	32.901	15.507	
	120	2.00	63.38	58.939	65.802	0.000	
	240	4.00	76.98	71.594	131.604	0.000	
	360	6.00	86.02	79.995	197.407	0.000	
	600	10.00	99.16	92.222	329.011	0.000	
	1440	24.00	121.78	113.258	789.627	0.000	
	Design Storage Requirement = Maximum Volume (m³) =					**21.344**	

Proposed Soakaway Dimension Check = **OK, but check Time of Emptying**

Time of Emptying of Soakaway (Taken from BRE Digest 365)
The soakaway should discharge from full to half-volume within 24 hours in readiness for subsequent storm inflow.

ts50 = Time to empty 50% of total storage volume

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.35 \text{ hrs}$$

< 24hrs, Therefore Design Acceptable

Summary of acceptable dimensions:

Length =	*5.00 m*
Width =	*3.00 m*
Effective Depth =	*1.60 m*

Values of Factor Z1 (From BRE 365 - Table 1)

Ratio	Rainfall Duration (mins)								
r	15	30	60	120	240	360	600	1440	
0.12	0.450	0.670	1.000	1.480	2.170	2.750	3.700	6.000	
0.15	0.480	0.690	1.000	1.420	2.020	2.460	3.230	4.900	
0.18	0.510	0.710	1.000	1.360	1.860	2.250	2.860	4.300	
0.20	*0.530*	*0.723*	*1.000*	*1.340*	*1.800*	*2.163*	*2.700*	*3.833*	**
0.21	0.540	0.730	1.000	1.330	1.770	2.120	2.620	3.600	
0.24	0.560	0.750	1.000	1.300	1.710	2.000	2.400	3.350	
0.25	*0.567*	*0.753*	*1.000*	*1.290*	*1.687*	*1.960*	*2.347*	*3.267*	**
0.27	0.580	0.760	1.000	1.270	1.640	1.880	2.240	3.100	
0.30	0.590	0.770	1.000	1.250	1.570	1.780	2.120	2.840	
0.33	0.610	0.780	1.000	1.230	1.530	1.730	2.040	2.600	
0.35	*0.617*	*0.787*	*1.000*	*1.223*	*1.497*	*1.690*	*1.947*	*2.480*	**
0.36	0.620	0.790	1.000	1.220	1.480	1.670	1.900	2.420	
0.39	0.630	0.800	1.000	1.210	1.460	1.620	1.820	2.280	
0.40	*0.633*	*0.803*	*1.000*	*1.207*	*1.447*	*1.603*	*1.793*	*2.240*	**
0.42	0.640	0.810	1.000	1.200	1.420	1.570	1.740	2.160	
0.45	0.650	0.820	1.000	1.190	1.380	1.510	1.680	2.030	

Calculating Design Rainfall, R (100yr Return Period)

Pro-rata values **

M5-60 rain (mm)	26.00	(Taken from Page 1)
Ratio M5-60/M5-2day	0.30	(Taken from Page 1)

	Duration (mins)	Duration (hrs)	Factor Z1	R (M5-D) (mm)	Z2 Values - M100			Prorata Z2	R (M100-D) (mm)
					Z2 low	Diff (mm)	Z2 high		
2	15.0	0.25	0.590	15.340	1.99	5.00	2.03	1.993	**30.568**
3	30.0	0.50	0.770	20.020	2.03	5.00	2.01	2.030	**40.639**
4	60.0	1.00	1.000	26.000	2.01	5.00	1.97	2.002	**52.052**
5	120.0	2.00	1.250	32.500	1.97	10.00	1.89	1.950	**63.375**
6	240.0	4.00	1.570	40.820	1.89	10.00	1.84	1.886	**76.982**
7	360.0	6.00	1.780	46.280	1.89	10.00	1.84	1.859	**86.016**
8	600.0	10.00	2.120	55.120	1.84	25.00	1.64	1.799	**99.163**
9	1440.0	24.00	2.840	73.840	1.84	25.00	1.64	1.649	**121.783**

Z2 Factors - England & Wales (from Wallingford Procedure)		
M5 Rain (mm)	**Diff (mm)**	**M100**
0	5	1.790
5	5	1.790
10	5	1.910
15	5	1.990
20	5	2.030
25	5	2.010
30	10	1.970
40	10	1.890
50	25	1.840
75	25	1.640
100	50	1.540
150	50	1.450
200	50	1.400

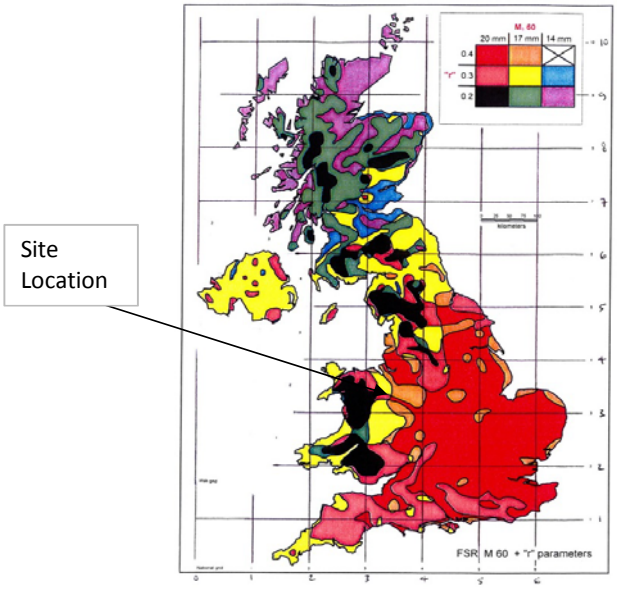


Figure 2 Hydrological rainfall zones of UK