

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 (V_p) is 0.466mm/s.

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

Infiltration Rate = $10^{-3} / (3 \times V_p)$

Infiltration Rate = $10^{-3} / 1.4$

Infiltration Rate = **7.14⁻⁴ m/s**

File Ref: w1952-151012-Soakaway Design

01824 702220

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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).

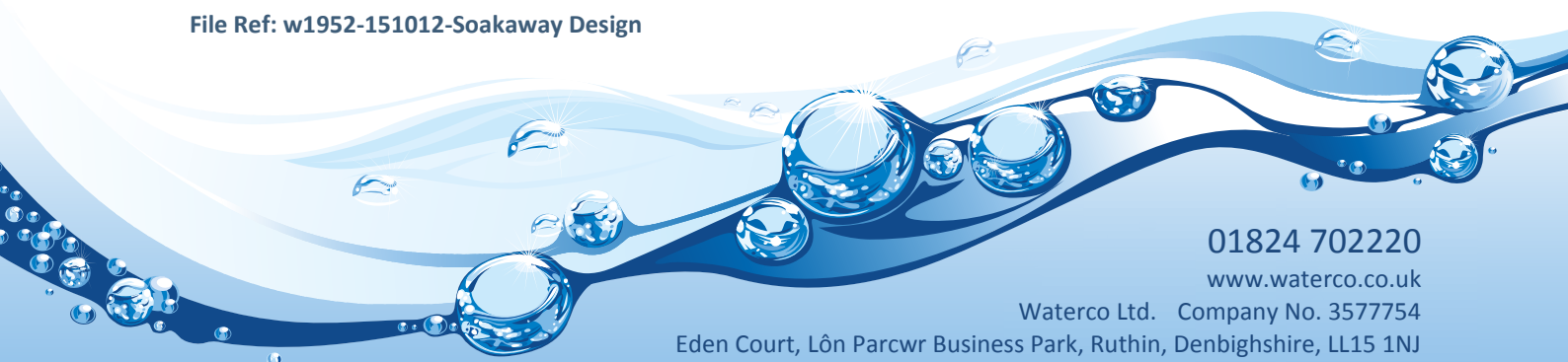
Table 3 – Dimensions for storm crate style soakaways – 95% void

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.

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Yours sincerely,

Johanne Williams

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Enclosed documents

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

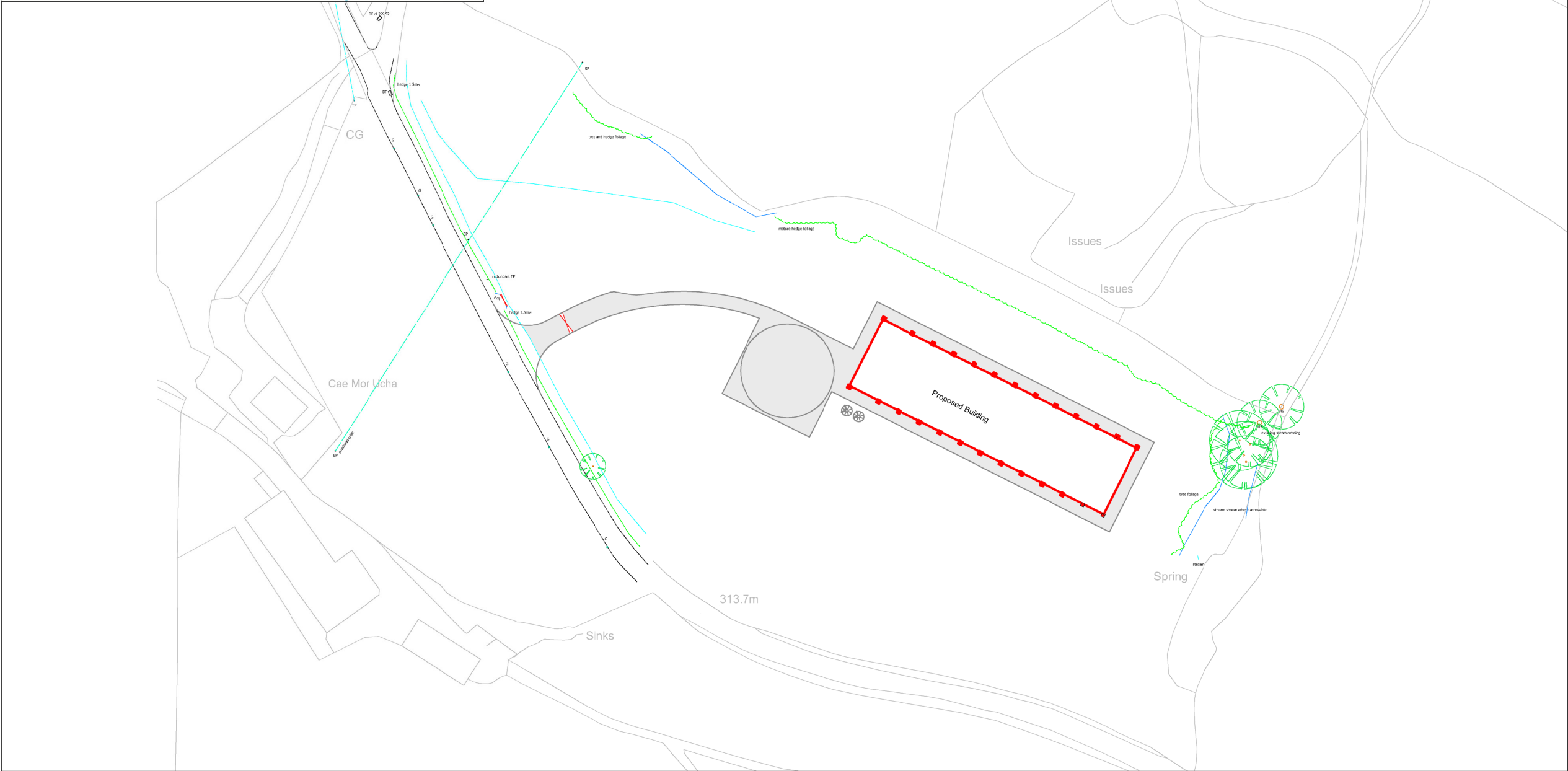
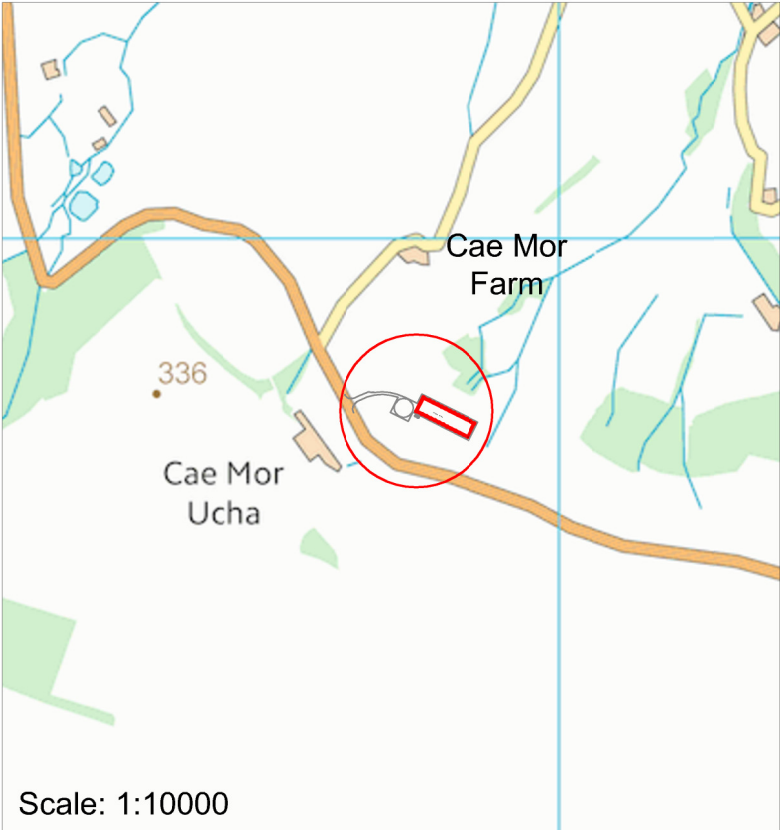
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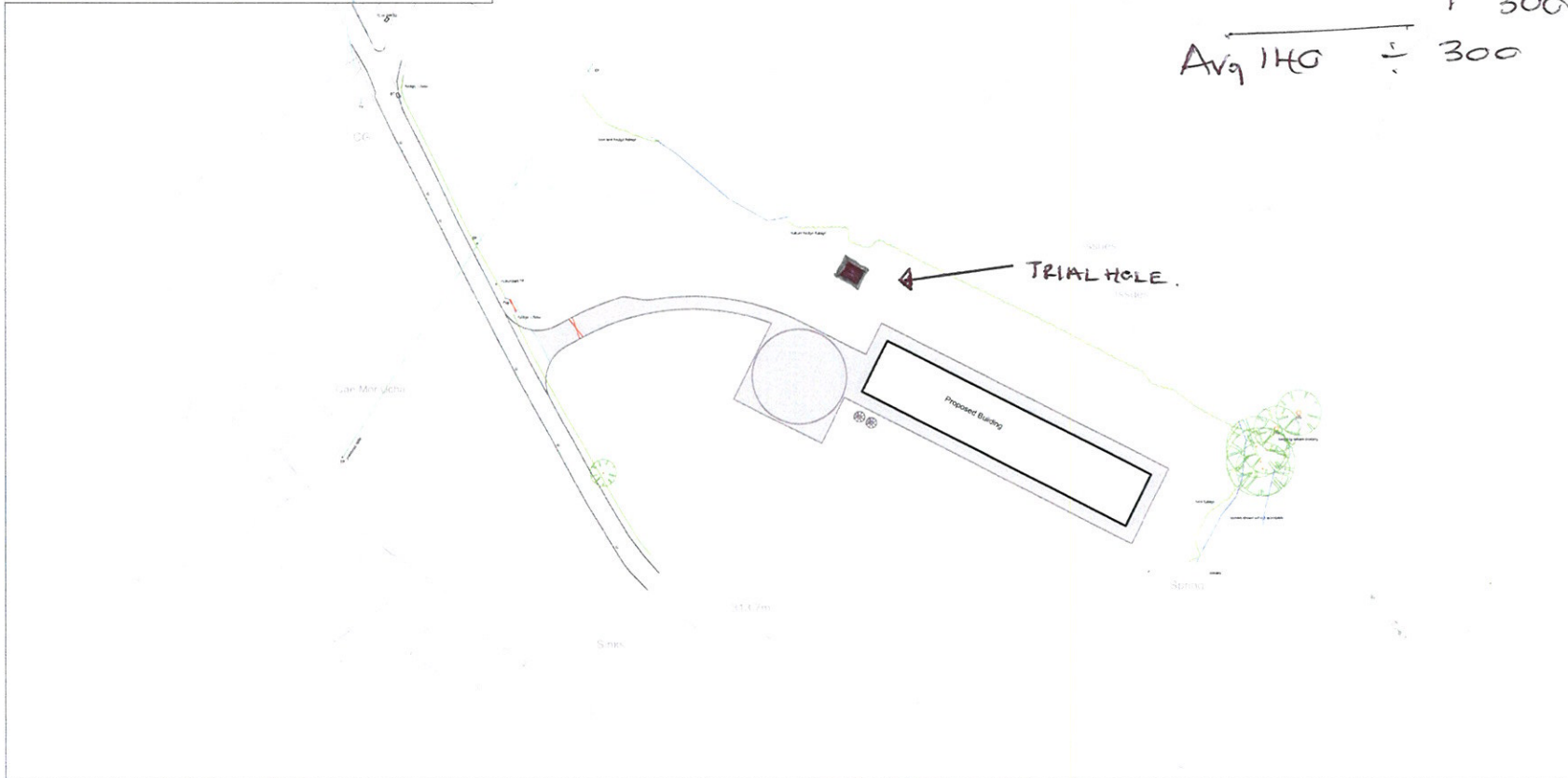
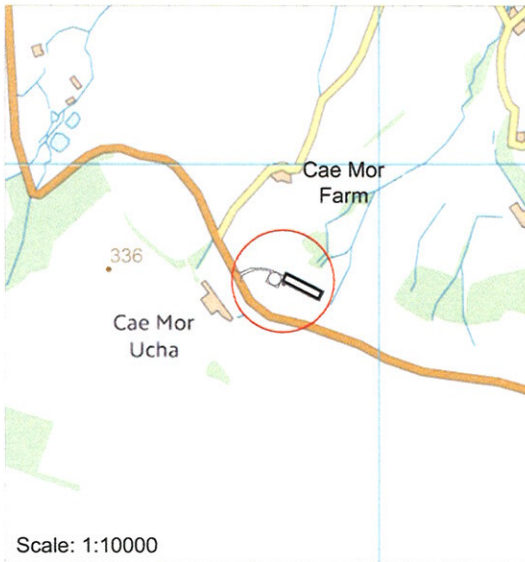
KEY

Rev	Description	Date	Dr by	App by
Original				



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	

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Rev Description Original by App by

Roger & Parry

Job	16000 Frgg La
Title	Location Pl
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

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	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	w1952
Client :	Roger Parry & Partners LLP	Page 1 of 3	
Scheme :	Cae Mor Farm, Llwynmawr	Prefix	Rev.
Section :	Soakaway Design - Stone fill	SD	A
Prepared By:	Johanne Williams	Date:	07/10/2015
Checked By:	Jordan Jones	Date:	12/10/2015
Approved By:	Aled Williams	Date:	12/10/2015

Determination of soakaway storage requirement and proposed 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 seconds
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.

Client :	Roger Parry & Partners LLP	Page 2 of 3	
Scheme :	Cae Mor Farm, Llwynmawr	Prefix	Rev.
Section :	Soakaway Design - Stone fill	SD	A

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
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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
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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		I	O	S
	(Minutes)	(Hrs)	(M100-D) (mm)	m³	m³
Crit D	15	0.25	30.57	71.988	22.902
	30	0.50	40.64	95.705	45.805
Crit D	60	1.00	52.05	122.582	91.609
	120	2.00	63.38	149.248	183.218
	240	4.00	76.98	181.294	366.436
	360	6.00	86.02	202.568	549.654
	600	10.00	99.16	233.529	916.091
	1440	24.00	121.78	286.799	2198.617
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

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.28 \text{ hrs} < 24\text{hrs, Therefore Design Acceptable}$$

Summary of acceptable dimensions:

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

Client : Roger Parry & Partners LLP

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Rev.

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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	15.340	1.99	5.00	2.03	1.993	30.568
3	30.0	0.50	20.020	2.03	5.00	2.01	2.030	40.639
4	60.0	1.00	26.000	2.01	5.00	1.97	2.002	52.052
5	120.0	2.00	32.500	1.97	10.00	1.89	1.950	63.375
6	240.0	4.00	40.820	1.89	10.00	1.84	1.886	76.982
7	360.0	6.00	46.280	1.89	10.00	1.84	1.859	86.016
8	600.0	10.00	55.120	1.84	25.00	1.64	1.799	99.163
9	1440.0	24.00	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

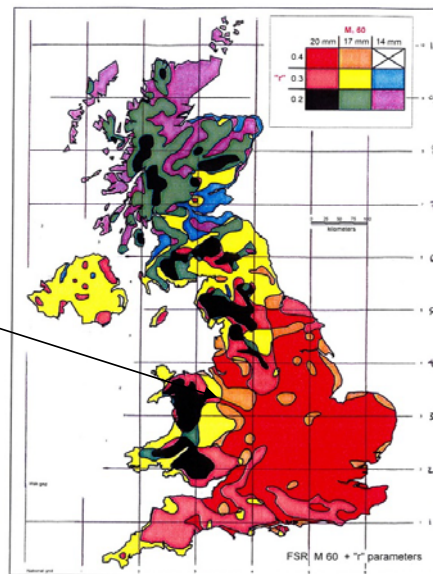


Figure 2 Hydrological rainfall zones of UK

	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	w1952
Client :	Roger Parry & Partners LLP	Page 1 of 3	
Scheme :	Cae Mor Farm, Llwynmawr	Prefix	Rev.
Section :	Soakaway Design - Stone fill - Building Only	SD	A
Prepared By:	Johanne Williams	Date:	07/10/2015
Checked By:	Jordan Jones	Date:	12/10/2015
Approved By:	Aled Williams	Date:	12/10/2015

Determination of soakaway storage requirement and proposed 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 seconds
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.

Client :	Roger Parry & Partners LLP	Page 2 of 3	
Scheme :	Cae Mor Farm, Llwynmawr	Prefix	Rev.
Section :	Soakaway Design - Stone fill - Building Only	SD	A

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
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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
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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

Crit D	Storm duration (D)		R	I	O	S	Max
	(Minutes)	(Hrs)	(M100-D) (mm)	m³	m³	m³	
Crit D	15	0.25	30.57	43.560	16.656	26.904	
	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

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.20 \text{ hrs} < 24\text{hrs, Therefore Design Acceptable}$$

Summary of acceptable dimensions:

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

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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

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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	15.340	1.99	5.00	2.03	1.993	30.568
3	30.0	0.50	20.020	2.03	5.00	2.01	2.030	40.639
4	60.0	1.00	26.000	2.01	5.00	1.97	2.002	52.052
5	120.0	2.00	32.500	1.97	10.00	1.89	1.950	63.375
6	240.0	4.00	40.820	1.89	10.00	1.84	1.886	76.982
7	360.0	6.00	46.280	1.89	10.00	1.84	1.859	86.016
8	600.0	10.00	55.120	1.84	25.00	1.64	1.799	99.163
9	1440.0	24.00	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

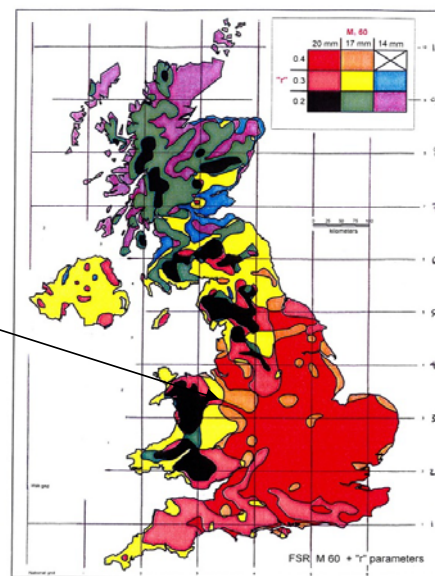


Figure 2 Hydrological rainfall zones of UK

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Client :	Roger Parry & Partners LLP	Page 1 of 3	
Scheme :	Cae Mor Farm, Llwynmawr	Prefix	Rev.
Section :	Soakaway Design - Stone fill - Access Road	SD	A
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Total impervious area (access road and turning circle) = 930m²

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

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D = Storm Duration (mins)

f = Soil Infiltration Rate

300mm x 300mm x 300mm trail pit

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Test 2 - 155 seconds
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Average Infiltration Rate 7.14 x 10⁻⁴

Average infiltration rate used in design.

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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
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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
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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

Crit D	Storm duration (D)		R	I	O	S	Max
	(Minutes)	(Hrs)	(M100-D) (mm)	m³	m³	m³	
Crit D	15	0.25	30.57	28.429	12.723	15.705	
	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

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.16 \text{ hrs} < 24\text{hrs, Therefore Design Acceptable}$$

Summary of acceptable dimensions:

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

Client : Roger Parry & Partners LLP

Page 3 of 3

Scheme : Cae Mor Farm, Llwynmawr

Prefix

Rev.

Section : Soakaway Design - Stone fill - Access Road

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	15.340	1.99	5.00	2.03	1.993	30.568
3	30.0	0.50	20.020	2.03	5.00	2.01	2.030	40.639
4	60.0	1.00	26.000	2.01	5.00	1.97	2.002	52.052
5	120.0	2.00	32.500	1.97	10.00	1.89	1.950	63.375
6	240.0	4.00	40.820	1.89	10.00	1.84	1.886	76.982
7	360.0	6.00	46.280	1.89	10.00	1.84	1.859	86.016
8	600.0	10.00	55.120	1.84	25.00	1.64	1.799	99.163
9	1440.0	24.00	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

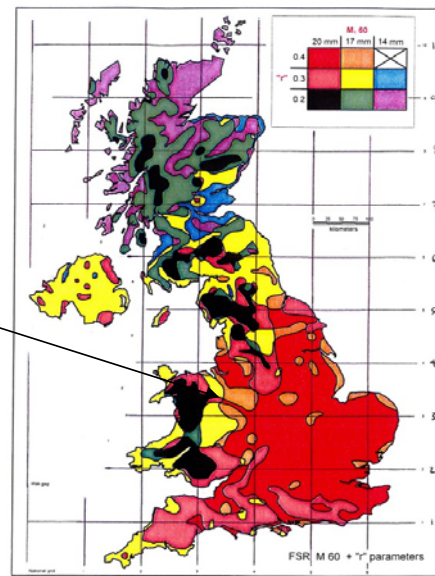


Figure 2 Hydrological rainfall zones of UK

	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	w1952
Client :	Roger Parry & Partners LLP	Page 1 of 3	
Scheme :	Cae Mor Farm, Llwynmawr	Prefix	Rev.
Section :	Soakaway Design - Storm Crate	SD	A
Prepared By:	Johanne Williams	Date:	07/10/2015
Checked By:	Jordan Jones	Date:	12/10/2015
Approved By:	Aled Williams	Date:	12/10/2015

Determination of soakaway storage requirement and proposed 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 seconds
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.

Client :	Roger Parry & Partners LLP	Page 2 of 3	
Scheme :	Cae Mor Farm, Llwynmawr	Prefix	Rev.
Section :	Soakaway Design - Storm Crate	SD	A

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
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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
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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
(Minutes)	(Hrs)	(mm)	m³	m³	m³
15	0.25	30.57	71.988	14.394	57.594
30	0.50	40.64	95.705	28.788	66.916
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

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.59 \text{ hrs} < 24\text{hrs, Therefore Design Acceptable}$$

Summary of acceptable dimensions:

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

Client : Roger Parry & Partners LLP

Page 3 of 3

Scheme : Cae Mor Farm, Llwynmawr

Prefix

Rev.

Section : Soakaway Design - Storm Crate

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	15.340	1.99	5.00	2.03	1.993	30.568
3	30.0	0.50	20.020	2.03	5.00	2.01	2.030	40.639
4	60.0	1.00	26.000	2.01	5.00	1.97	2.002	52.052
5	120.0	2.00	32.500	1.97	10.00	1.89	1.950	63.375
6	240.0	4.00	40.820	1.89	10.00	1.84	1.886	76.982
7	360.0	6.00	46.280	1.89	10.00	1.84	1.859	86.016
8	600.0	10.00	55.120	1.84	25.00	1.64	1.799	99.163
9	1440.0	24.00	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

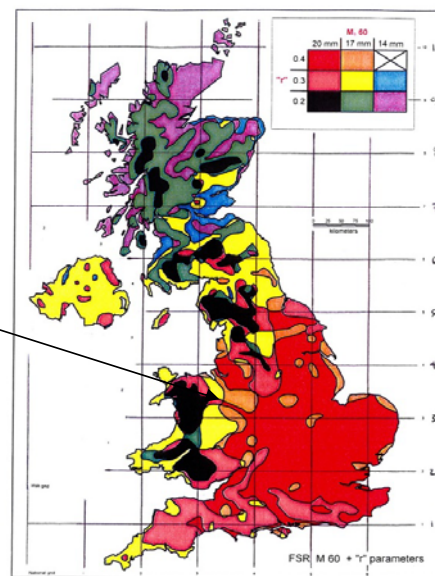


Figure 2 Hydrological rainfall zones of UK

	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	w1952
Client :	Roger Parry & Partners LLP	Page 1 of 3	
Scheme :	Cae Mor Farm, Llwynmawr	Prefix	Rev.
Section :	Soakaway Design - Storm Crate - Building	SD	A
Prepared By:	Johanne Williams	Date:	07/10/2015
Checked By:	Jordan Jones	Date:	12/10/2015
Approved By:	Aled Williams	Date:	12/10/2015

Determination of soakaway storage requirement and proposed 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 trial pit

Test 1 - 85 seconds

Test 2 - 155 seconds

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.

Client :	Roger Parry & Partners LLP	Page 2 of 3	
Scheme :	Cae Mor Farm, Llwynmawr	Prefix	Rev.
Section :	Soakaway Design - Storm Crate - Building	SD	A

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
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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
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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	I	O	S
(Minutes)	(Hrs)	(M100-D) (mm)	m³	m³	m³
15	0.25	30.57	43.560	10.796	32.764
30	0.50	40.64	57.911	21.591	36.319
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

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.46 \text{ hrs} < 24\text{hrs, Therefore Design Acceptable}$$

Summary of acceptable dimensions:

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

Client : Roger Parry & Partners LLP

Page 3 of 3

Scheme : Cae Mor Farm, Llwynmawr

Prefix

Rev.

Section : Soakaway Design - Storm Crate - Building

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	15.340	1.99	5.00	2.03	1.993	30.568
3	30.0	0.50	20.020	2.03	5.00	2.01	2.030	40.639
4	60.0	1.00	26.000	2.01	5.00	1.97	2.002	52.052
5	120.0	2.00	32.500	1.97	10.00	1.89	1.950	63.375
6	240.0	4.00	40.820	1.89	10.00	1.84	1.886	76.982
7	360.0	6.00	46.280	1.89	10.00	1.84	1.859	86.016
8	600.0	10.00	55.120	1.84	25.00	1.64	1.799	99.163
9	1440.0	24.00	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

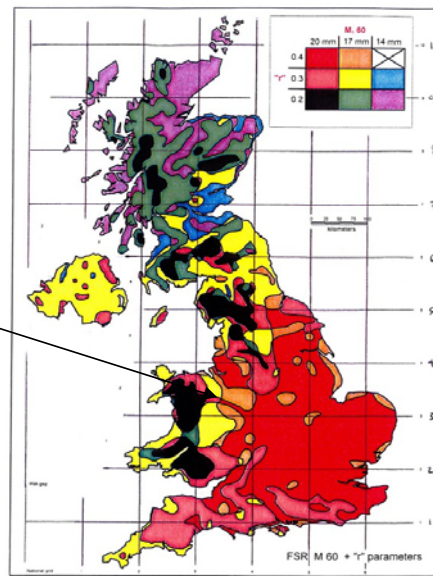


Figure 2 Hydrological rainfall zones of UK

	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	w1952
Client :	Roger Parry & Partners LLP	Page 1 of 3	
Scheme :	Cae Mor Farm, Llwynmawr	Prefix	Rev.
Section :	Soakaway Design - Storm Crate - Access	SD	A
Prepared By:	Johanne Williams	Date:	07/10/2015
Checked By:	Jordan Jones	Date:	12/10/2015
Approved By:	Aled Williams	Date:	12/10/2015

Determination of soakaway storage requirement and proposed 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 seconds
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.

Client :	Roger Parry & Partners LLP	Page 2 of 3	
Scheme :	Cae Mor Farm, Llwynmawr	Prefix	Rev.
Section :	Soakaway Design - Storm Crate - Access	SD	A

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
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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
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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		I	O	S
	(Minutes)	(Hrs)	(M100-D) (mm)	m³	m³
Crit D	15	0.25	30.57	28.429	8.225
	30	0.50	40.64	37.794	16.451
Crit D	60	1.00	52.05	48.408	32.901
	120	2.00	63.38	58.939	65.802
	240	4.00	76.98	71.594	131.604
	360	6.00	86.02	79.995	197.407
	600	10.00	99.16	92.222	329.011
	1440	24.00	121.78	113.258	789.627
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

$$ts50 = \frac{S \times 0.5}{as50 \times f \times 3600} = 0.35 \text{ hrs} < 24\text{hrs, Therefore Design Acceptable}$$

Summary of acceptable dimensions:

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

Client : Roger Parry & Partners LLP

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Scheme : Cae Mor Farm, Llwynmawr

Prefix

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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	15.340	1.99	5.00	2.03	1.993	30.568
3	30.0	0.50	20.020	2.03	5.00	2.01	2.030	40.639
4	60.0	1.00	26.000	2.01	5.00	1.97	2.002	52.052
5	120.0	2.00	32.500	1.97	10.00	1.89	1.950	63.375
6	240.0	4.00	40.820	1.89	10.00	1.84	1.886	76.982
7	360.0	6.00	46.280	1.89	10.00	1.84	1.859	86.016
8	600.0	10.00	55.120	1.84	25.00	1.64	1.799	99.163
9	1440.0	24.00	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

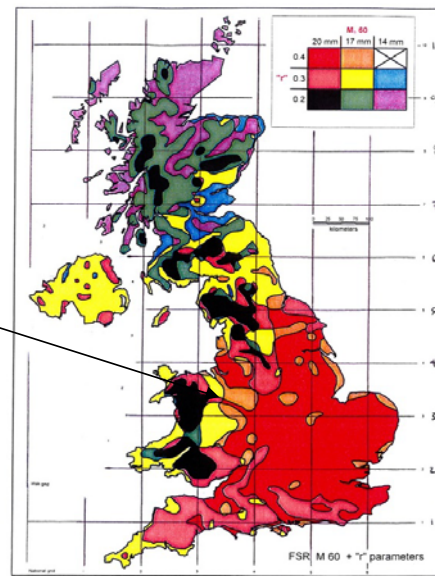


Figure 2 Hydrological rainfall zones of UK