

SOAKAWAY DESIGN CALCULATIONS

PLANNING APP. P2014/0495

NEATH PORT TALBOT C.B.C.

LAND ADJACENT TO

22 KNOLL ROAD

GODRERGRAIG

SWANSEA

SA9 2DE

11/11/2020

INTRODUCTION

As planning condition 3 for granted application P2014/0495 to Neath Port Talbot C.B.C. a drainage scheme for surface and storm water within the site needs to be produced. The SuDS standards for Wales establish a preferred hierarchy for stormwater disposal. Currently Priority Level 1 is collection and re-use. Rhondda Geotechnical Services were commissioned to investigate the possibility of ground infiltration (Priority Level 2) via a suitably sized soakaway. In order to investigate the possibility of an effective soakaway the procedures outlined in BRE Digest 365 (soakaway design 2016 revision) must be followed. These involve obtaining the soil infiltration characteristics (permeability) and then using this figure in the calculations outlined in the digest to design a suitably sized soakaway. In its most simple form this is:-

$I=O+S$ where I is the inflow from the impermeable area to be drained, O is the outflow infiltrating into the soil surrounding the soakaway during a rainfall event and S is the required storage of the soakaway to balance temporarily inflow and outflow during the length of a rainfall event.

To obtain the infiltration characteristic figure (f) a trial pit must be excavated and tested by filling it with water and timing how fast it runs away. This was done on 8/09/2020 by the author during an intrusive investigation to assess a contaminated land planning condition. The trial pit needs to be in the area where any soakaway would be constructed so any variation in ground conditions is catered for. The soakaway trial pit was dug with a 2 ton tracked excavator on the position it was meant to occupy. This was guided by the requirement to be at least five metres from any building or highway. The pit was rectangular 1.4m x 0.5m x 1.6m deep. The material it was excavated in was a very gravelly fluvioglacial deposit.

BS5930:2015 SOIL DESCRIPTION

G.L.-0.2m

Soft dark brown gravelly clayey SILT. Gravel is fine to medium, subrounded of Pennant Sandstone.

0.3m-1.6m

Dense yellowish brown, very sandy, silty, clayey GRAVEL. Gravel is fine to coarse subangular to subrounded of Pennant Sandstone. High cobble content of rounded quartzitic gritstone.

40 gallon plastic drums were used to fill the pit. Prior to the tests, all the drums were filled with a long hose from an on-site water supply. This meant the pit could be filled rapidly, which is a requirement of the guidance. A design invert depth of 0.3m was assumed for the purposes of the test. The pit was filled with water and the drop in levels measured and timed. The guidance requires measuring the time taken for the water to drop from 75% to 25% of the effective storage depth of the pit (the effective storage depth is the depth from the invert to the base of the pit). The test needs to be repeated three times, and the value from the slowest (invariably the third) test used. This produces a more conservative infiltration rate for the purpose of soakaway design. The infiltration calculations were done using the figures from the third test. The calculations are shown below. The figure arrived at was 2.28×10^{-5} m/s. Rainfall calculations then need to be carried out in order to design a suitably sized soakaway. The method outlined in the BRE365 must be followed to arrive at the rainfall figures.

INFILTRATION CALCULATION

$$V_{p75-25} = 1.4 \times 0.5 \times 0.65 = 0.455 \text{ m}^3$$

$$A_{p50} = (1.4 \times 0.65 \times 2) + (0.5 \times 0.65 \times 2) + (1.4 \times 0.5)$$

$$= 1.82 + 0.65 + 0.7 = 3.17 \text{ m}^2$$

$$T_{p75-25} = 105 \text{ mins. (6300 secs.)}$$

$$f = \frac{0.455}{3.17 \times 6300}$$

$$= \frac{0.455}{19971}$$

$$f = 2.28 \times 10^{-5}$$

DEVELOPMENT DETAILS

The proposed development is of four identical detached residential properties. The roof of each new building will have an area of 59.8 m^2 (rounded up to 60 m^2 for simplicity). There are no areas of impermeable hard landscaping, only permeable paving. Therefore only the roof area will need to be considered when calculating run off figures. The plots are large and it is intended to have individual soakaways for each property. The following design process is for a

single soakaway. The other three will all be identical as no variation in ground conditions was encountered during extensive trial pitting.

DESIGN RAINFALL AND INFLOW CALCULATIONS

The basis for design rainfall calculation is the M5-60min. figure. This represents the maximum rainfall in 60 minutes over a five year period. This has been revised for all areas of the U.K. to be 20mm. This is then multiplied by factor Z1 for different rainfall durations (D). Z1 is obtained from tables in the Digest which need to be read in conjunction with the value r. The value of r varies around the country and is read off an isohyet map in the Digest. From this map the value of r for Godrergraig is 0.24. This enables maximum rainfall to be calculated using a table in the Digest. The M5-60 value is $20 \times 1 = 20\text{mm}$. This table can be used for any rainfall duration. For example the maximum rainfall over a six hour period

$$\text{M5-360 (GODRERGRAIG)} = 20 \times 2.0 = 40\text{mm}.$$

In other words the maximum rainfall over a six hour period in a five year return period for Godrergraig would be 40mm. There is a further correction factor. This is known as Z2. This is dependent on the rainfall figure in the M5 column. Again this is obtained from a table in the digest and is multiplied by the M5 figure to produce a hundred- year return period.

$$\text{M100-360 (GODRERGRAIG)} = 40 \times 1.97 = 78.8\text{mm}.$$

In line with current best practise a further 30% increase is added to allow for climate change. This is not however a requirement of building regulations.

$$\text{M100-360 (GODRERGRAIG)} = 78.8 \times 1.3 = 102.44\text{mm}.$$

By now using this figure and multiplying it by the area of the site we can calculate the maximum volume of water flowing off the roof over a six hour period.

$$I = 60 \times 0.102 = 6.12\text{m}^3$$

OUTFLOW CALCULATION

The outflow is calculated by the equation $O = A_{50} \times f \times D$ where D is the storm duration and A_{50} is the area of the sides of the soakaway (not the base) at half the effective depth. The soakaway design can now be worked out by a process of trial and error aided by experience of differing soil permeability. The value of

f is known, D is variable so I-O=S can be worked out for the full range of rainfall durations (D) from 5 mins to 24hrs.

The soakaway design can utilise purpose made special plastic frames, or be a simple aggregate filled pit. Plastic frames will allow parking directly on top of a soakaway. They have an effective storage of 95% (manufacturers' figures). They are useful when space is limited. This is not the case here. The design given here will utilise a simple aggregate filled pit.

As an example the first trial calculation tabulated below (for an area of 60m²) will be based on an aggregate filled pit 3m x 2m x 2m depth. This gives an effective storage of 3.06m³ assuming 30% voids and a 0.3m invert depth. The value of A₅₀ will be (10 x 0.85) = 8.5m². The calculations for a range of rainfall durations can then be worked out. From this it can be seen that at no duration does I-O exceed the storage capacity of the design (columns O1 and S1). In fact there is a significant overcapacity. The developer indicated he was happy with the size and so there was no attempt to reduce the size. Even trimming 0.5m off the width would reduce storage to 2.3m³ which would clearly be inadequate given the value for A₅₀ would also be reduced. This design passes with a significant amount of extra capacity, so will fit the design criteria. It has a safety/inconvenience factor of 1.13. A further criterion is that 50% of the effective storage can be discharged over a 24 hour period. It can be seen that the design vastly exceeds this target.

60m2 ROOF AREA						O1 PIT 3x2x2 (EFF.STOR. 3.06m3-aggregate)					
GNOLL ROAD, GODRERGRAIG SOAKAWAY DESIGN CALCULATIONS											
		mm		mm	mm.		FIGURES IN CUBIC METRES				
MINS	Z1	M5	Z2	M10	GW	D(SECS)	I	O1	S1	O2	S2
5	0.31	6.2	1.84	11.408	14.83	300	0.89	0.058	0.83		
10	0.46	9.2	1.89	17.388	22.60	600	1.36	0.116	1.24		
15	0.56	11.2	1.92	21.504	27.96	900	1.68	0.174	1.50		
30	0.75	15	1.95	29.25	38.03	1800	2.28	0.348	1.93		
60	1	20	2	40	52.00	3600	3.12	0.696	2.42		
120	1.3	26	2.03	52.78	68.61	7200	4.12	1.392	2.72		
240	1.71	34.2	1.99	68.058	88.48	14400	5.31	2.784	2.52		
360	2	40	1.97	78.8	102.44	21600	6.15	4.176	1.97		
600	2.4	48	1.94	93.12	121.06	36000	7.26	6.96	0.30		
1440	3.35	67	1.91	127.97	166.36	86400	9.98	16.704	-6.72		

DESIGN NOTES

The soakaway pit should be lined with Terram prior to filling with clean aggregate to just above invert level. The aggregate should be of a uniform size, preferably >50mm. The design should have its upper surface covered with Terram, above invert level, to prevent silting up from above. The finished ground surface can then be laid on top of this. It is advisable to have some kind of removable silt trap in the drainage run to the soakaway, whichever design is utilised to minimise maintenance and ensure a long trouble free operational period. Since only rainwater off the roof is being disposed of an oil trap is not necessary.

Richard Davies BSc. (Hons), MSc., F.G.S.

11/11/2020



FIGURE 1
SOAKAWAY PIT ON EXCAVATION AND DURING TEST

APPENDIX 1

ORIGINAL FIELD

SOAKAWAY SHEETS

C



Environmental Scientifics Group

Soakaway Test Field Records

Project: GOORGCANIG

Project No: GA610

Trial pit No: 1

Test No: 2

Date: 8/10/20

Pit dimensions: Before test

After test¹

Length (m):	<u>1.4</u>	<u>1.4</u>
Width (m):	<u>0.5</u>	<u>0.5</u>
Depth (m):	<u>1.6</u>	<u>1.6</u>

Carried out by: R. Oakes

Groundwater level: 024 024

Water supply³: Hose to 220V

Granular infill used²: Yes / No

Pump type⁴: _____

Volume of water used (litres): 900

Time to add water (mins): 1 minute

Height of measuring datum (magl): GL

Estimated 25% effective depth⁵ (mbd): 1.27

Clock time	Elapsed time (mins)	Water depth (m below datum)
1035	0	0.33
1036	1	0.37
1037	2	0.41
1038	3	0.45
1039	4	0.49
1040	5	0.53
1041	6	0.56
1042	7	0.59
1043	8	0.62
1044	9	0.65
1045	10	0.68
1046	11	0.71
1047	12	0.74
1048	13	0.77
1049	14	0.80
1050	15	0.83
1051	16	0.86
1052	17	0.89

Clock time	Elapsed time (mins)	Water depth (m below datum)
1053	18	0.92
1054	19	0.95
1055	20	0.98
1100	25	1.00
1105	30	1.02
1110	35	1.04
1115	40	1.06
1125	50	1.10
1135	60	1.14
1145	70	1.19
1155	80	1.22
1205	90	1.25
1215	95	1.27

Remarks:

Notes:

- 1 Record dimensions after test if pit has collapsed during test.
- 2 Take a sample of the granular infill for determining its porosity.
- 3 Record size of bowser or other water supply



Environmental Scientifics Group

Soakaway Test Field Records

Project: GODRAGMILProject No: GR616Trial pit No: TP1Test No: 3Date: 8.10.20Pit dimensions: Before test After test¹

Length (m):	<u>1.4</u>	<u>1.4</u>
Width (m):	<u>0.5</u>	<u>0.5</u>
Depth (m):	<u>1.6</u>	<u>1.6</u>

Carried out by: R. DAVIES

MAKE SURE YOU LOG THE PIT!

Groundwater level: DRY DRYWater supply³ DRUMSGranular infill used² Yes / NoPump type⁴ —Volume of water used (litres): —Time to add water (mins): 1Height of measuring datum (magl): GLEstimated 25% effective depth⁵ (mbd): 1.27

Clock time	Elapsed time (mins)	Water depth (m below datum)
<u>3.30</u>	<u>0</u>	<u>0.39</u>
<u>3.31</u>	<u>1</u>	<u>0.42</u>
<u>3.32</u>	<u>2</u>	<u>0.45</u>
<u>3.33</u>	<u>3</u>	<u>0.48</u>
<u>3.34</u>	<u>4</u>	<u>0.51</u>
<u>3.35</u>	<u>5</u>	<u>0.54</u>
<u>3.36</u>	<u>6</u>	<u>0.57</u>
<u>3.37</u>	<u>7</u>	<u>0.60</u>
<u>3.38</u>	<u>8</u>	<u>0.63</u>
<u>3.39</u>	<u>9</u>	<u>0.65</u>
<u>3.40</u>	<u>10</u>	<u>0.67</u>
<u>3.41</u>	<u>11</u>	<u>0.69</u>
<u>3.42</u>	<u>12</u>	<u>0.70</u>
<u>3.43</u>	<u>13</u>	<u>0.71</u>
<u>3.44</u>	<u>14</u>	<u>0.72</u>
<u>3.45</u>	<u>15</u>	<u>0.73</u>
<u>3.46</u>	<u>16</u>	<u>0.74</u>
<u>3.47</u>	<u>17</u>	<u>0.75</u>

Clock time	Elapsed time (mins)	Water depth (m below datum)
<u>3.48</u>	<u>18</u>	<u>0.75</u>
<u>3.49</u>	<u>19</u>	<u>0.76</u>
<u>3.50</u>	<u>20</u>	<u>0.77</u>
<u>3.55</u>	<u>25</u>	<u>0.82</u>
<u>4.00</u>	<u>30</u>	<u>0.87</u>
<u>4.05</u>	<u>35</u>	<u>0.92</u>
<u>4.10</u>	<u>40</u>	<u>0.95</u>
<u>4.20</u>	<u>50</u>	<u>1.00</u>
<u>4.30</u>	<u>60</u>	<u>1.05</u>
<u>4.40</u>	<u>70</u>	<u>1.11</u>
<u>4.50</u>	<u>80</u>	<u>1.16</u>
<u>5.00</u>	<u>90</u>	<u>1.21</u>
<u>5.10</u>	<u>100</u>	<u>1.24</u>
<u>5.15</u>	<u>105</u>	<u>1.27</u>

Remarks:

Notes:

- 1 Record dimensions after test if pit has collapsed during test.
- 2 Take a sample of the granular infill for determining its porosity.
- 3 Record size of bowser or other water supply