

CALCULATION SHEET



Client GOWER HOMES			Job Title PROPOSED RESIDENTIAL DEVELOPMENT, THE SIDINGS, RAILWAY ROAD, WREXHAM	Job No 3916
By RW	Date 05.14	Chkd	Element SURFACE WATER DRAINAGE DESIGN TRENCH SOAKAWAY: ROOFS & PARKING	Sheet No CP3-4 1
DATA	CALCULATIONS			RESULTS
1.	<u>PURPOSE</u> The purpose of these calculations is to determine the size of the geocellular soakaways required to disperse the run-off from the shared private access roads, parking areas and roofs which are to be constructed as part of the above development. Separate Soakaways are to be constructed to disperse run-off from the adoptable access roads.			
2.	<u>SITE LAYOUT</u> The layout of the development site is shown on drawing N° 3916/ 02 and 03 (as revised) This drawing shows the proposed location of the geocellular soakaway in the public open space in Phase 1 and within the shared parking areas of Phase 2 including the impermeable area draining to these facilities.			
3.	<u>POROSITY TESTS</u> Porosity tests were carried out by Groundsolve Ltd in November 2013. The results of their investigations and percolation tests are included in their Geo-environmental Report issued December 2013 Ref:1432. The applicable results of these tests are summarised in Section 6 This geo-environmental report and investigation is limited to Phase 1 of the site with the exception of one trial pit TP7 excavated within Phase 2 of the development to the south.			
4.	<u>METHODOLOGY</u> Current best practice/design advice recommends that infiltration drainage systems should be designed to store the run-off from a 10% annual probability storm (1 in 10 year return period) and to half empty (by percolation) in a twenty-four hour period (CIRIA Report 156: Infiltration drainage - Manual of good practice). This latter requirement allows the system to cater for a succession of severe storm events However in order to achieve consistency between conventional drainage techniques (as set out in Sewers for Adoption), recent recommendations (CIRIA Report N° C609: Sustainable drainage systems - Hydraulic, structural and water quality advice) suggest that SUDS should be analysed for a 3.3% annual probability storm event (1 in 30 year return period) to ensure that internal flooding of properties and/or serious external flooding (SEF) does not occur. In addition, the Environment Agency, in pursuance of the requirements of TAN 15 (in Wales) and PPG25 (in England), recommends that greenfield run-off rates and volumes should be maintained after development for storm events up to a 1% annual probability (1 in 100 year return period). The additional water resulting from these severe storm events does not necessarily have to be stored within the SUDS, provided it can be contained by localised flooding of car parks and landscaped areas for short periods of time without adversely effecting residential or commercial property.			

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4. <u>METHODOLOGY</u> (continued) These calculations therefore adopt the following methodology: 1. Rainfall intensities for different storm conditions are to be determined using the Wallingford Procedure 2. The infiltration device is to be sized to store the run-off from a 10% annual probability storm below the level of the incoming pipe(s) 3. The infiltration device is to be analysed to ensure that the run-off from a 3.3% annual probability storm is contained without the system flooding (ie that there is sufficient storage provided within the facility) 4. The system is to be further tested against 1% annual probability storm events to assess the volume of flooding and to confirm that it will not adversely effect residential or commercial property 5. <u>METHOD OF ANALYSIS</u> These calculations adopt the method of analysis for 3-D Infiltration Systems set out in CIRIA Report N° 156: Infiltration systems - Manual of good practice. For a vertically sided structure (ie a soakaway or infiltration trench) the maximum depth of water (h_{max}) can be calculated by solving the following equation $h_{max} = a (e^{(-bD)} - 1)$ where $a = (A_b / P) - (A_d / Pq)$ and $b = (Pq) / (nA_b)$ The time to half empty ($t_{1/2}$) can be determined from the following equation: $t_{1/2} = \frac{n A_b}{q P} \log_e \left\{ \frac{h_{max} + A_b / P}{h_{max}/2 + A_b / P} \right\}$ The required inputs are: <table> <tr> <td>A_b</td> <td>area of base of infiltration device</td> <td>(m²)</td> </tr> <tr> <td>P</td> <td>perimeter of infiltration device</td> <td>(m)</td> </tr> <tr> <td>A_D</td> <td>area to be drained</td> <td>(m²)</td> </tr> <tr> <td>f</td> <td>infiltration rate from percolation tests</td> <td>(m/h)</td> </tr> <tr> <td>i, D</td> <td>intensity and duration of rainfall events with the required return period at the site location</td> <td>(m/h, h)</td> </tr> <tr> <td>n</td> <td>porosity of fill material (void volume/total volume)</td> <td></td> </tr> </table> The results of these calculations are set out below					A_b	area of base of infiltration device	(m ²)	P	perimeter of infiltration device	(m)	A_D	area to be drained	(m ²)	f	infiltration rate from percolation tests	(m/h)	i, D	intensity and duration of rainfall events with the required return period at the site location	(m/h, h)	n	porosity of fill material (void volume/total volume)	
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6.	<u>PERCOLATION TEST RESULTS</u> Porosity tests were carried out in October 2013 by GroundSolve Ltd to determine the infiltration rates within the underlying glacial sands and gravel's which are present at varying depths across the site. The location of the trial pits is shown on Figure 4 in their report. Below is a summary of the <u>lowest</u> infiltration rates derived from four trial pits where tests were undertaken including the existing Phase 1 soakaway. The results from the existing soakaway SA2 in Phase 2 have been ignored as the tests were abandoned due to heavy siltation. <table border="1"> <thead> <tr> <th>Trial Pit</th> <th>Measured Soil Infiltration Rate f (m/s)</th> </tr> </thead> <tbody> <tr> <td>TP 2 Test 1</td> <td>3.24E-06</td> </tr> <tr> <td>TP 4 Test 2</td> <td>1.34E-05</td> </tr> <tr> <td>TP 5 Test 2</td> <td>2.42E-04</td> </tr> <tr> <td>TP 7 Test 1</td> <td>6.44E-05</td> </tr> <tr> <td>Ex SA1 Test 1</td> <td>8.21E-05</td> </tr> <tr> <td colspan="2">Applicable Infiltration Rate</td> </tr> <tr> <td>Average</td> <td>8.10E-05</td> </tr> </tbody> </table>			Trial Pit	Measured Soil Infiltration Rate f (m/s)	TP 2 Test 1	3.24E-06	TP 4 Test 2	1.34E-05	TP 5 Test 2	2.42E-04	TP 7 Test 1	6.44E-05	Ex SA1 Test 1	8.21E-05	Applicable Infiltration Rate		Average	8.10E-05	
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7.	<u>DRAINED AREA: Roofs & Parking</u> The following impermeable areas drain to each of the geocellular soakaways <table border="1"> <thead> <tr> <th>Description</th> <th>Drained Area (m²)</th> </tr> </thead> <tbody> <tr> <td>Phase 1 - POS</td> <td>1725.654</td> </tr> <tr> <td> </td> <td> </td> </tr> <tr> <td>Phase 2 - North</td> <td>1052.534</td> </tr> <tr> <td>Phase 2 - Central</td> <td>740.425</td> </tr> <tr> <td>Phase 2 - South</td> <td>659.332</td> </tr> <tr> <td>Total</td> <td>1725.654</td> </tr> </tbody> </table>			Description	Drained Area (m ²)	Phase 1 - POS	1725.654			Phase 2 - North	1052.534	Phase 2 - Central	740.425	Phase 2 - South	659.332	Total	1725.654			
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DATA		CALCULATIONS			RESULTS	
8.	<u>DESIGN DATA</u>					
	From porosity tests	Measured infiltration rate	f	2.92E-01 m/hr		
	CIRIA C697 Pg. 4-31	Factor of safety (major inconvenience - roads)	F _s	10.0		
	CIRIA C697 Pg. 4-31	Porosity (geocellular units)	n	0.95		
	From Plan	Area to be drained	A _D	1,052.53 m ²		
	Assume a filter drain in a rectangular excavation filled with clean stone					
		Length, say	L	12.50 m		
		Width, say	W	3.00 m		
	9.	<u>SOAKAWAY DESIGN</u>				
		By Calculation, q = f/F _s	Effective infiltration coefficient (measured infiltration rate/factor of safety)	q		0.029 m/hr
From Plan		Area to be drained	A _D	1053 m ²		
By Calculation, A _b = L * W		Base Area of Filter Drain	A _b	37.50 m ²		
By Calculation, P = 2L + 2W		Perimeter of Soakaway	P	31.00 m		
CIRIA 156 Pg. 57 Factor a = (A _b /P) - (iA _D /Pq)		Factor a	a	varies		
CIRIA 156 Pg. 57 Factor b = (Pq/nA _b)		Factor b	b	0.025		

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9.	<u>SOAKAWAY DESIGN (continued)</u>											
	Duration		10 Year Return			30 Year Return			100 Year Return			
			i	Factor a	Max Depth m	i	Factor a	Max Depth m	i	Factor a	Max Depth m	
	min	hr	m/hr			m/hr			m/hr			
	5	0.083	0.090	-104.7	0.220	0.109	-125.9	0.264	0.137	-159.4	0.335	
	10	0.167	0.065	-75.1	0.315	0.080	-92.2	0.387	0.102	-118.0	0.495	
	15	0.250	0.053	-61.3	0.386	0.066	-75.7	0.476	0.084	-97.7	0.614	
	20	0.333	0.044	-50.5	0.423	0.054	-61.8	0.518	0.070	-80.3	0.673	
	25	0.417	0.038	-43.7	0.457	0.047	-53.9	0.564	0.061	-70.4	0.736	
	30	0.500	0.035	-39.5	0.495	0.043	-48.7	0.611	0.055	-63.5	0.796	
	45	0.750	0.026	-29.8	0.558	0.033	-37.0	0.694	0.043	-48.8	0.914	
	60	1.000	0.022	-24.9	0.621	0.028	-31.2	0.779	0.036	-41.1	1.025	
	90	1.500	0.017	-18.2	0.677	0.021	-22.9	0.852	0.027	-30.6	1.137	
	120	2.000	0.014	-14.9	0.733	0.017	-18.8	0.924	0.022	-25.0	1.231	
	240	4.000	0.008	-8.7	0.838	0.010	-11.1	1.063	0.014	-14.9	1.428	
	360	6.000	0.006	-6.2	0.875	0.008	-8.0	1.123	0.010	-10.7	1.508	
	600	10.000	0.004	-4.0	0.885	0.005	-5.2	1.155	0.007	-7.1	1.578	
	1440	24.000	0.002	-1.5	0.685	0.003	-2.1	0.947	0.004	-3.0	1.366	
	For 1 in 10 year return period storm											
	From Table	Maximum depth of water					h_{max}		0.885 m			
By calculation	Time for half emptying					$t_{1/2}$		9.41 hr			<24 hrs	
For 1 in 30 year return period storm												
Depth of storage required additional to 1 in 10 year return period								0.269 m				
Total depth of geocellular unit soakaway to be provided. Overall depth to suit drainage strata with 0.8m of cells into strata.								1.200 m				

CALCULATION SHEET



Client GOWER HOMES			Job Title PROPOSED RESIDENTIAL DEVELOPMENT, THE SIDINGS, RAILWAY ROAD, WREXHAM	Job No 3916
By RW	Date 05.14	Chkd	Element SURFACE WATER DRAINAGE DESIGN TRENCH SOAKAWAY: ROOFS & PARKING	Sheet No CP3-4 7
DATA	CALCULATIONS			RESULTS
9.	<u>SOAKAWAY DESIGN (continued)</u>			
	For 1 in 100 year return period storm			
	Potential flood volume (in excess of storage provided)			13.472 m³
	Assume flooding takes place uniformly over length of filter drain to a width of 10m, then average depth of flooding:			0.108 m
	The actual flood depth will be less as the flooded area will be larger. No allowance has been made for additional storage provided in the geocells, pipework and catchpits which will reduce this depth. The flooding will be contained within the car park and not effect the properties.			
10.	<u>SUMMARY</u>			
	The results of the analysis indicate the following:			
	Required depth of Filter Drain below lowest incoming pipe (ie depth for a 10% annual probability storm event)			0.885 m
	Minimum depth above incoming pipe invert and below ground level (ie additional storage for a 3.3% annual probability storm event)			0.269 m
	Potential flood volume from a 1% annual probability storm event			13.472 m³
	Total depth of trench soakaway to be provided			1.200 m
11.	<u>Additional Storage Provided For More Severe Events & Climate Change</u>			
	Additional depth is provided in the soakaway above the 1 in 30 year event level. The stone surround, 1.2m diameter catchpits and 150mm diameter pipework is not included in the calculations. The volume of storage will therefore be greater reducing the potential flood volume under 1 in 100 year return period storms and makes an allowance for climate change. Additional Storage Provided:			
	Within geocellular units			1.615 m³
	2 No at	2.10 m min deep (at say 60% volume)		2.850 m³
	1.0 m at	0.15 m diameter within trench (at say 60% volume)		0.011 m³
				4.475 m³