

CALCULATION SHEET



Client GOWER HOMES LTD			Job Title PROPOSED RESIDENTIAL DEVELOPMENT, PACKSADDLE BANK, PENTRE BYCHAN	Job No 5009
By RW	Date 08.16	Chkd RW	Element SURFACE WATER DRAINAGE ANALYSIS GEOCELLULAR SOAKAWAY DESIGN:	Sheet No P7 F/ 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 road.			
2.	<u>SITE LAYOUT</u> The layout of the development site and associated drainage layout is shown on drawing N° 5009/ 100 Drainage General Arrangement (as revised) This drawing shows the proposed location of the geocellular soakaways within the gardens, shared parking areas / access roads including the impermeable area draining to these facilities.			
3.	<u>POROSITY TESTS</u> Porosity tests were carried out by Groundsolve Ltd in March 2016. The results of their investigations and percolation tests are included in their report dated 16 th March 2016 Ref: 1754/BPW/LetRepSA/erw. The applicable results of these tests are summarised in Section 6			
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.	METHODOLOGY (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.	METHOD OF ANALYSIS 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 (Bettess 1996). 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: $t_{1/2} = \frac{n A_b}{q P} \text{Log}_e \left\{ \frac{h_{max} + A_b / P}{h_{max} / 2 + A_b / P} \right\}$ The required inputs are: 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) The results of these calculations are set out below			

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6. PERCOLATION TEST RESULTS Porosity tests were carried out in March 2016 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 1 of their report. Below is a summary of the <u>lowest</u> infiltration rates derived from the trial pits where tests were undertaken. <table border="1"> <thead> <tr> <th>Trial Pit</th> <th>Measured Soil Infiltration Rate f (m/s)</th> </tr> </thead> <tbody> <tr><td>TP 1 Test 3</td><td>2.862E-05</td></tr> <tr><td>TP 2 Test 2</td><td>2.312E-06</td></tr> <tr><td>TP 3 Test 3</td><td>1.476E-04</td></tr> <tr><td>TP 4 Test 3</td><td>8.784E-05</td></tr> <tr><td>TP 5 Test 2</td><td>2.053E-05</td></tr> <tr><td>TP 8 Test 3</td><td>1.776E-05</td></tr> <tr> <td colspan="2">Applicable Infiltration Rate</td></tr> <tr><td>Plot 1 & 2 Front</td><td>2.458E-05</td></tr> <tr><td>Plot 1 Rear</td><td>1.776E-05</td></tr> <tr><td>Plot 2 Rear</td><td>2.053E-05</td></tr> <tr><td>Plot 3 & 5-6 Drive</td><td>8.811E-05</td></tr> <tr><td>Plot 3 Drive</td><td>7.496E-05</td></tr> <tr><td>Plot 4 & 5</td><td>2.862E-05</td></tr> <tr><td>Plot 6, 7 & 8 Rear</td><td>8.784E-05</td></tr> <tr><td>Plot 7 Front</td><td>1.476E-04</td></tr> <tr><td>Plot 8 Front</td><td>2.053E-05</td></tr> <tr><td>Private Drive P9-11</td><td>2.053E-05</td></tr> <tr><td>Plot 9/10 Garage</td><td>1.915E-05</td></tr> <tr><td>Plot 9 to 11 front</td><td>1.776E-05</td></tr> <tr><td></td><td></td></tr> </tbody> </table> Median of all TP8 TP5 Ave TP1 & 3 Ave TP2 & 3 TP1 TP4 TP3 TP5 TP5 Ave TP5 & 8 TP8						Trial Pit	Measured Soil Infiltration Rate f (m/s)	TP 1 Test 3	2.862E-05	TP 2 Test 2	2.312E-06	TP 3 Test 3	1.476E-04	TP 4 Test 3	8.784E-05	TP 5 Test 2	2.053E-05	TP 8 Test 3	1.776E-05	Applicable Infiltration Rate		Plot 1 & 2 Front	2.458E-05	Plot 1 Rear	1.776E-05	Plot 2 Rear	2.053E-05	Plot 3 & 5-6 Drive	8.811E-05	Plot 3 Drive	7.496E-05	Plot 4 & 5	2.862E-05	Plot 6, 7 & 8 Rear	8.784E-05	Plot 7 Front	1.476E-04	Plot 8 Front	2.053E-05	Private Drive P9-11	2.053E-05	Plot 9/10 Garage	1.915E-05	Plot 9 to 11 front	1.776E-05		
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8.	<u>DESIGN DATA</u>				
	From porosity tests	Measured infiltration rate	f	5.31E-01 m/hr	
	CIRIA C753 Pg. 553	Factor of safety (minor inconvenience - garden)	F _s	10.0	
	CIRIA C697 Pg. 4-31	Porosity (geocellular units)	n	0.95	
	From Plan	Area to be drained	A _D	69.00 m ²	
	Geocellular soakaway in a rectangular excavation backfilled with clean stone				
		Length, say	L	2.50 m	
		Width, say	W	1.00 m	
	9.	<u>SOAKAWAY DESIGN</u>			
		By Calculation, q = f/F _s	Effective infiltration coefficient (measured infiltration rate/factor of safety)	q	0.0531 m/hr
From Plan		Area to be drained	A _D	69.00 m ²	
By Calculation, A _b = L * W		Base Area of Filter Drain	A _b	2.50 m ²	
By Calculation, P = 2L + 2W		Perimeter of Soakaway	P	7.00 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	0.157	

CALCULATION SHEET



Client GOWER HOMES LTD			Job Title PROPOSED RESIDENTIAL DEVELOPMENT, PACKSADDLE BANK, PENTRE BYCHAN						Job No 5009				
By RW	Date 08.16	Chkd RW	Element SURFACE WATER DRAINAGE ANALYSIS GEOCELLULAR SOAKAWAY DESIGN:						Sheet No P7 F/ 7				
DATA			CALCULATIONS						RESULTS				
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	0.089	-16.2	0.209	0.107	-19.5	0.252	0.135	-24.7		0.320	
	10	0.167	0.064	-11.6	0.299	0.079	-14.3	0.368	0.100	-18.2		0.470	
	15	0.250	0.052	-9.4	0.360	0.064	-11.6	0.445	0.082	-15.0		0.574	
	20	0.333	0.044	-7.7	0.393	0.053	-9.5	0.483	0.069	-12.4		0.630	
	25	0.417	0.038	-6.7	0.422	0.047	-8.3	0.524	0.060	-10.9		0.686	
	30	0.500	0.035	-6.1	0.455	0.042	-7.5	0.564	0.055	-9.8		0.739	
	45	0.750	0.026	-4.5	0.503	0.033	-5.7	0.630	0.043	-7.5		0.835	
	60	1.000	0.022	-3.8	0.548	0.028	-4.8	0.694	0.036	-6.4		0.921	
	90	1.500	0.017	-2.7	0.574	0.021	-3.5	0.730	0.027	-4.7		0.986	
	120	2.000	0.014	-2.2	0.596	0.017	-2.8	0.764	0.023	-3.8		1.032	
	240	4.000	0.009	-1.2	0.578	0.011	-1.6	0.753	0.014	-2.2		1.038	
	360	6.000	0.006	-0.8	0.506	0.008	-1.1	0.685	0.010	-1.6		0.955	
	600	10.000	0.005	-0.5	0.381	0.006	-0.7	0.536	0.007	-1.0		0.774	
	1440	24.000	0.002	-0.1	0.090	0.003	-0.2	0.184	0.004	-0.3		0.330	
	For 1 in 10 year return period storm												
	From Table	Maximum depth of water					h_{max}	0.596 m					
	By calculation	Time for half emptying					$t_{1/2}$	2.40 hr				<24 hrs OK	
	For 1 in 30 year return period storm												
	Depth of storage required additional to 1 in 10 year return period								0.167 m				
Total depth of geocellular units to be provided.								0.800 m					

CALCULATION SHEET



Client GOWER HOMES LTD			Job Title PROPOSED RESIDENTIAL DEVELOPMENT, PACKSADDLE BANK, PENTRE BYCHAN	Job No 5009
By RW	Date 08.16	Chkd RW	Element SURFACE WATER DRAINAGE ANALYSIS GEOCELLULAR SOAKAWAY DESIGN:	Sheet No P7 F/ 8
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)			0.565 m³
	Assume flooding uniformly over length and width of filter drain plus 2m either side, then average depth of flooding:			0.042 m
	In reality flood water will flow over to the storage area south of the access road. The actual flood depth will be significantly less. This volume does not take into account additional storage in the granular surround & beneath the geocells or the catchpits and pipework which will reduce the surface flood volume & depth.			
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)			0.596 m
	Minimum depth above incoming pipe invert and below ground level (ie additional storage for a 3.3% annual probability storm event)			0.167 m
	Potential flood volume from a 1% annual probability storm event			0.565 m³
	Total depth of geocells to be provided			0.800 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, 0.45m diameter catchpits and 100mm 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			0.086 m ³
	1 No at	0.65 m min deep catchpits (at say 80% volume)		0.083 m ³
~	3.0 m at	0.1 m diameter within trench (at say 75% volume)		0.018 m ³
				0.187 m³