St George’s Works, Trowbridge

Drainage calculations

For

Gaiger Brother Ltd

Document Version: 01
April 2018

Project Reference: 2017-364

Document Reference: CE-01-P01
Document Control

<table>
<thead>
<tr>
<th>Purpose/Status</th>
<th>Date</th>
<th>Rev.</th>
<th>Comments</th>
<th>Rev. By</th>
<th>Chk’d By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Control</td>
<td>12.04.2018</td>
<td>01</td>
<td>-</td>
<td>MD</td>
<td>MC</td>
</tr>
</tbody>
</table>

Prepared By: Max Day  
Engineer  

Approved By: Matthieu Crosnier  
Project Engineer

Disclaimer

This document has been prepared in accordance with the scope of Clegg Associates Ltd.’s appointment with its client and is subject to the terms of that appointment. It is confidential, addressed to and for the sole use and reliance of Clegg Associates Ltd.’s client. Clegg Associates Ltd. Accepts no liability for any use of this document other than by its client and only for the purposes, stated in the document, for which it was prepared and provided. No person other than the client may copy (in whole or in part) use or rely on the contents of this document, without the prior written permission of a Director of Clegg Associates Ltd. Any advice, opinions or recommendations within this document should be read and relied upon only in the context of the document as a whole. The contents of this document are not to be construed as providing legal, business or tax advice or opinion.
**Project Information**

**Notes:**

Architectural drawings and setting out information provided by others.

The dimensions used within these calculations are for design purposes only. Detailed measurements are to be taken from site by the building contractor. Should any inconsistencies occur inform the Engineer immediately.

The contractor is to act as the temporary works coordinator and should be competent and experienced enough to carry out the design and installation of temporary works to BS 5975 in order to maintain stability of the building and excavations.

**Reference Drawings:**

Proposed drainage strategy

Dwg No. 2017-364-GA-601-P2
Foul water

The foul water drainage system was designed in accordance with the Building Regulations Approved document H.

The development comprises 30 dwellings, for which a flow rate of 5.8l/s is given in Table 5 below.

The pipes were sized using the flows from table 5 along with recommended falls and pipe diameter from Diagram 9 below.

![Diagram 9](image)

**Table 5 Flow rates from dwellings**

<table>
<thead>
<tr>
<th>Number of dwellings</th>
<th>Flow rate (litres/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>5</td>
<td>3.5</td>
</tr>
<tr>
<td>10</td>
<td>4.1</td>
</tr>
<tr>
<td>15</td>
<td>4.6</td>
</tr>
<tr>
<td>20</td>
<td>5.1</td>
</tr>
<tr>
<td>25</td>
<td>5.4</td>
</tr>
<tr>
<td>30</td>
<td>5.8</td>
</tr>
</tbody>
</table>
Surface water

The surface water is to be attenuated and the discharge flow into the existing public sewer limited to 5l/s.

The attenuation system was designed using Tedds, in accordance with Ciria publication C753, as below.

ATTENUATION DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 1.0.03

EA_Defra method

Site characteristics

Location; Bristol
Hydrological region; 8
Soil type (Wallingford Procedure W.R.A.P map); 4
Standard percentage runoff; SPR = 0.47
Average annual rainfall; SAAR = 850 mm
5 year return period rainfall of 60 minute duration; M5_60min = 20.0 mm
Ratio 60-minute to 2 day rainfalls of 5 year return; r = 0.35
Rainfall intensity increase due to global warming; pcimate = 30%
Impervious area req. attenuation storage; β = 100.0 %

Catchment details

<table>
<thead>
<tr>
<th>Subcatchment</th>
<th>Name</th>
<th>Area (ha)</th>
<th>PIMP (%)</th>
<th>Impermeable area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1; 1;</td>
<td>1; 1</td>
<td>0.26; 0.26</td>
<td>90.0; 90.0</td>
<td>0.23; 0.23</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>0.26;</td>
<td>90.0;</td>
<td>0.23;</td>
</tr>
</tbody>
</table>

Greenfield runoff rates

Catchment area; AREA = 50.00 hectare
Greenfield runoff rate (50 hectare site); \( \alpha Q_{rural} = 0.00108m^3/s \times (AREA/1km^2)^{0.89} \times (SAAR/1mm)^{1.17} \times SPR^{2.17} = 303.0 l/s \)
Greenfield runoff rate; \( \alpha Q = \alpha Q_{rural} / AREA = 1.6 l/s \)
Greenfield runoff rate per unit area; \( \alpha Q_a = \alpha Q / A = 6.1 l/s / hectare \)

Estimated site discharges

FSR growth rate (1 year); \( FSR_{1yr} = 0.78 \)
Discharge (1 year); \( Q_{1yr} = \alpha Q \times FSR_{1yr} = 1.2 l/s \)
FSR growth rate (30 year); \( FSR_{30yr} = 1.95 \)
Discharge (30 year); \( Q_{30yr} = \alpha Q \times FSR_{30yr} = 3.1 l/s \)
FSR growth rate (100 year); \( FSR_{100yr} = 2.43 \)
Discharge (100 year); \( Q_{100yr} = \alpha Q \times FSR_{100yr} = 3.8 l/s \)

Estimated attenuation volume - 1 year

Attenuation storage vol (fig A7.1 - A7.8); \( Uvol_{1yr} = 130.5 m^3 / hectare \)
Basic storage volume; \( BSV_{1yr} = Uvol_{1yr} \times A = 33.93 m^3 \)
FEH rainfall factor (figs A11.1, A6.1.1 - A6.3.4); \( FF_{1yr} = 1.05 \)
Storage volume ratio (fig A8.1 - A8.8); \( SVR_{1yr} = 1.35 \)

Adjusted storage volume; \( ASV_{1yr} = SVR_{1yr} \times BSV_{1yr} = 45.77 \text{ m}^3 \)

Hydrological regional volume ratio (fig A9.1); \( HR_{1yr} = 1.03 \)

Final estimated attenuation storage; \( Vol_{1yr} = HR_{1yr} \times ASV_{1yr} = 47.02 \text{ m}^3 \)

**Estimated attenuation volume - 30 year**

Attenuation storage vol (fig A7.1 - A7.8); \( Uvol_{30yr} = 290.0 \text{ m}^3 / \text{hectare} \)

Basic storage volume; \( BSV_{30yr} = Uvol_{30yr} \times A = 75.40 \text{ m}^3 \)

FEH rainfall factor (figs A11.1, A6.1.1 - A6.3.4); \( FF_{30yr} = 1.00 \)

Storage volume ratio (fig A8.1 - A8.8); \( SVR_{30yr} = 1.46 \)

Adjusted storage volume; \( ASV_{30yr} = SVR_{30yr} \times BSV_{30yr} = 109.98 \text{ m}^3 \)

Hydrological regional volume ratio (fig A9.1); \( HR_{30yr} = 1.05 \)

Final estimated attenuation storage; \( Vol_{30yr} = HR_{30yr} \times ASV_{30yr} = 115.81 \text{ m}^3 \)

**Estimated attenuation volume - 100 year**

Attenuation storage vol (fig A7.1 - A7.8); \( Uvol_{100yr} = 362.0 \text{ m}^3 / \text{hectare} \)

Basic storage volume; \( BSV_{100yr} = Uvol_{100yr} \times A = 94.12 \text{ m}^3 \)

FEH rainfall factor (figs A11.1, A6.1.1 - A6.3.4); \( FF_{100yr} = 1.00 \)

Storage volume ratio (fig A8.1 - A8.8); \( SVR_{100yr} = 1.46 \)

Adjusted storage volume; \( ASV_{100yr} = SVR_{100yr} \times BSV_{100yr} = 137.29 \text{ m}^3 \)

Hydrological regional volume ratio (fig A9.1); \( HR_{100yr} = 1.09 \)

Final estimated attenuation storage; \( Vol_{100yr} = HR_{100yr} \times ASV_{100yr} = 150.11 \text{ m}^3 \)

**Attenuation storage required**

Vol. increase due to head-discharge relationship; \( p_{\text{hydro}} = 1.25 \)

Maximum attenuation storage required; \( V_{\text{req,max}} = Vol_{30yr} \times p_{\text{hydro}} = 144.8 \text{ m}^3 \)

**Interception storage**

Interception rainfall depth; \( d_{\text{int}} = 5 \text{ mm} \)

Volume of interception storage required; \( V_{\text{int,req}} = 0.8 \times A_{\text{imp}} \times d_{\text{int}} = 9.36 \text{ m}^3 \)

**Long term storage**

Proportion of paved area draining in to network; \( \alpha = 1.0 \)

Proportion of pervious area draining in to network; \( \beta = 0.5 \)

Rainfall depth for 100years, 6 hour event; \( RD = M_{100 \_360} = 81.7 \text{ mm} \)

Extra runoff vol of dev.runoff over greenfield runoff; \( Vol_x = \max(RD \times A \times (PIMP \times \alpha \times 0.8 + ((1 - PIMP) \times SPR) - SPR), 0) = 58.07 \text{ m}^3 \)

**Treatment volume**

Treatment volume (assume 80% runoff); \( T_{\text{vol}} = 0.8 \times A \times 15\text{mm} \times PIMP = 28.08 \text{ m}^3 \)
All pipework was designed in accordance with Approved document H and calculated design rainfall intensities. It was established that for small impermeable areas, a storm event of 5 minutes duration gives the maximum surface runoff rate. All pipes have a minimum diameter of 150mm at a fall of 1 in 80, which gives a capacity of 20l/s according to diagram 3 below.

**Diagram 3 Discharge capacities of rainwater drains running full**

![Diagram](image)

The impermeable area which would give a flow of 20l/s is equal to 520m², as per the Tedds calculation below, which is far less than the maximum area drained by one pipe. Therefore system is adequate.

**DESIGN RAINFALL**

In accordance with the Wallingford Procedure

**Design rainfall intensity**

- Location of catchment area; Bristol
- Storm duration; D = 5 min
- Return period; Period = 10 yr
- Ratio 60 min to 2 day rainfall of 5 yr return period; r = 0.350
- 5-year return period rainfall of 60 minutes duration; M5_60min = 20.0 mm
- Increase of rainfall intensity due to global warming; p climate = 30%
- Factor Z1 (Wallingford procedure); Z1 = 0.36

Rainfall for 5min storm with 5 year return period; M5_5min = Z1 × M5_60min × (1 + p climate) = 9.3 mm
Factor Z2 (Wallingford procedure); \( Z2 = 1.22 \)

Rainfall for 5min storm with 10 year return period; \( M_{10\_5\text{min}} = Z2 \times M_{5\_5\text{min}} = 11.3 \text{ mm} \)

Design rainfall intensity; \( I_{\text{max}} = \frac{M_{10\_5\text{min}}}{D} = 135.3 \text{ mm/hr} \)

**Maximum surface water runoff**

Catchment area; \( A_{\text{catch}} = 520 \text{ m}^2 \)

Percentage of area that is impermeable; \( p = 100 \% \)

Maximum surface water runoff; \( Q_{\text{max}} = A_{\text{catch}} \times p \times I_{\text{max}} = 19.5 \text{ l/s} \)