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Memorandum

TO: Selwyn District Council
Attention: Murray England

FROM: Andrew Brough, Richard Brunton

DATE: 6th Oct 2010

RE: Infiltration Basin Modelling

Pattle Delamore Partners Ltd (PDP) has been engaged by Selwyn District Council (SDC) to undertake further analysis of infiltration basins at two locations and provide information regarding the amount of treatment these basins provide given certain rainfall inputs. This memo presents the percentage of runoff volume treated and percentage of volume overflowed by hypothetical infiltration basins at two sites; Rolleston and Darfield.

Methodology

The volume of each infiltration basin was based on the first flush treatment volume from the catchment. Infiltration basins were designed for the first 10, 15, 20 and 25mm of runoff from impervious surfaces. Catchment properties were defined as follows;

Table 1.0: Typical Urban Catchment

Road	3,669	m^2
Footpath	688	m^2
Roof area	14,442	m^2
Park (impervious area)	110	m^2
Driveways	3,480	m^2
Other Hardstand	2,320	m^2
Impervious	**24,709 (including roof area)**	**44%**
Pervious	**31,352**	**56%**
Total Area	**56,061**	**m^2**

Runoff factors were obtained from information on volume based water quality volumes (WQV) runoff coefficients & detention. The following Runoff factors values were adopted for this analysis:

$$C = \frac{24709m^2 \times 0.9 + 31352m^2 \times 0.2}{56061m^2} = 0.51$$ With roof contributing to runoff

$$C = \frac{10267m^2 \times 0.9 + 31352m^2 \times 0.2}{41619m^2} = 0.37$$ With roof runoff going to ground

Two infiltration basins have been sized for each first flush treatment rainfall depth - one assuming a C factor of 0.51, the other a C factor of 0.37.

Basin Volume = C x Total Catchment area x Rainfall depth

Table 2.0 below shows the basin volumes determined for a range of first flush rainfall depths

Table 2.0: Infiltration Basin Sizing

First Flush Treatment Depth (mm)	Basin Volume (roof contributing to runoff) - C = 0.51 (m^3)	Basin Volume (roof discharged to ground) - C = 0.37 (m^3)
10	286	154
15	429	231
20	572	308
25	715	385

Basin assumptions:

- Each basin has an operating depth of 1m. The overflow operates once this depth is exceeded
- Each basin plan area is square in shape (length = width)
- Each basin has side slopes of 1:4

Rainfall series:

Two sites were analysed, Rolleston and Darfield. Rainfall for Rolleston and Darfield was obtained by scaling rainfall data from Christchurch Aero and Ridgens Road respectively. Scaling factors were obtained from Opus 2010, "Design Rainfall Scale Factors". Christchurch Aero was multiplied by a factor of 1.03 to obtain rainfall representative of Rolleston rainfall while Ridgens Road rainfall was multiplied by a factor of 1.20 to obtain representative rainfall for Darfield.

Infiltration basin modelling:

The infiltration basins were modelled using the following method;

Runoff from the catchment was determined by using the rational method in one hour time steps to calculate the runoff from impervious and pervious areas. The following assumptions were made in calculating runoff to the basin;

- Volumetric C = 0.51 and 0.37 scenarios are tested for sizing the basin and calculating runoff .
- Constant infiltration rate in the basin of 20mm/hr
- Infiltration can occur through the sides of the basin at 20mm/hr. Side wall infiltration depends on the depth of water within the basin

Results and Discussion

The results for the Rolleston site are shown below in Table 3.0 and Table 3.1. These tables report the percentage of runoff treated and the percentage of overflow from the basin for the entire Rolleston rainfall series.

Table 3.0: Performance of Infiltration Basin for Rolleston with WQ Volume C = 0.51 (roof contributing to runoff)

First Flush Treatment Depth (mm)	C factor for runoff	Basin Volume (m^3)	% Overflow	% Treated
10	0.51	286	27.8	72.2
15	0.51	429	16.3	83.7
20	0.51	572	9.6	90.4
25	0.51	715	6.0	94.0

Table 3.1: Performance of Infiltration Basin for Rolleston with WQ Volume C = 0.37 (roof discharged to ground)

First Flush Treatment Depth (mm)	Runoff C factor (from WWDG)	Basin Volume (m^3)	% Overflow	% Treated
10	0.37	154	26.8	73.2
15	0.37	231	15.6	84.4
20	0.37	308	9.3	90.7
25	0.37	385	5.7	94.3

The results for the Darfield site are shown below in Table 4.0 and Table 4.1. These tables report the percentage of runoff treated and the percentage of overflow from the basin for the entire Darfield rainfall series.

Table 4.0: Performance of Infiltration Basin for Darfield with WQ Volume C = 0.51

First Flush Treatment Depth (mm)	C factor for runoff	Basin Volume (m^3)	% Overflow	% Treated
10	0.51	286	45.0	55.0
15	0.51	429	31.2	68.8
20	0.51	572	21.6	78.4
25	0.51	715	15.2	84.8

Table 4.1: Performance of Infiltration Basin for Darfield with WQ Volume C = 0.37

First Flush Treatment Depth (mm)	C factor for runoff	Basin Volume (m^3)	% Overflow	% Treated
10	0.37	154	43.8	56.2
15	0.37	231	30.2	69.8
20	0.37	308	20.9	79.1
25	0.37	385	14.7	85.3

The results show that the higher the first flush treatment depth the basin is designed for the higher the treatment capacity of the basin. The results also show that by directing roof water to ground similar treatment capacities are observed compared to directing roof water into the stormwater system. However by directing roof water to ground the infiltration basin volume can be 46% smaller but still treat a similar percentage of rainfall.

Comparison with Other Analyses

Pattle Delamore Partners Ltd has carried out similar analyses for other clients where the impervious area of the catchments is higher than used to generate the results above. In those circumstances the percentage of the stormwater that is treated through the infiltration basin has been higher than calculated above. Those results are consistent with the results above in that as the impervious area increases, the size of the first flush infiltration basin increases and more stormwater is treated.

Recommendation

The amount of runoff that is treated through an infiltration basin is a function of the design rainfall depth and the impervious area of the catchment contributing runoff to the infiltration basin. The percentage of runoff that requires treatment to result in a less than minor effect on the environment is outside the scope of this analysis. However, it is often based on a pragmatic judgement of a reasonable area of land that can be made available for stormwater treatment. Selwyn District Council (SDC) will need to consider the reasonable availability of land for

stormwater treatment along with the potential effect on the environment when selecting the appropriate treatment volume. It is recommended that the first flush infiltration basins should be sized based on:-

- the design rainfall event selected by SDC, and
- the design impervious area of the catchment or subdivision which contributes runoff to the infiltration basin.