24 February 2010

Mr Murray England
Stormwater Engineer
Selwyn District Council
P.O Box 90
ROLLESTON 7643

Dear Murray,

Re: *Design rainfall scale factors*

During 2009 Opus reviewed all the rainfall information available for Selwyn District and developed a series of design rainfalls for those sites having high resolution temporal data. To allow these design rainfalls to be applied in a reliable and consistent manner across the district a series of scale factors was also compiled. These scale factors allow the adjustment of the design rainfalls from the nearest site to each of the communities within the district. A digital map was also provided of the scale factors necessary to adjust the design rainfalls for any place within the district.

The reason for the review of design rainfalls was to provide the most reliable site-specific rainfall information for use during planning and design. This was necessary because while HIRDS provides a national coverage of design rainfalls the various interpolation and smoothing routines used can produce anomalous values. Furthermore, site-specific data from records of reasonable length provide more accurate information than the generalised indices from HIRDS.

The aim of the 2009 report was to use a consistent and robust methodology to produce design rainfalls that most accurately reflect rainfall patterns at the local scale. These ensure that rainfall information used in planning and design are both appropriate and realistic. The use of rainfall values that are too high leads to over design and unwarranted expense. Rainfall values that are too low lead to increased risk and the potential for failure.

It is considered that the design rainfalls and various scale factors presented in Opus (2009) reflect accurately the spatial and temporal variability across the Selwyn District. It is considered that those data presented in Table 5.2 of that report are the most appropriate. However, it is also recognised that this Table is possibly more detailed and extensive than perhaps necessary. That is, it is suggested that some sites could be removed without the loss of resolution or accuracy.

The use of the Lincoln Broadfield design rainfalls was added following a review of an initial draft of this report. This site, however, only provides 9 years of data. Consequently, there is some uncertainty surrounding the design rainfalls derived from this record. It is therefore suggested that rather than using the design rainfalls derived from Lincoln Broadfield, those from Christchurch Aero (with 55 years of record) should be used. The scale factors using Christchurch Aero are also smaller. This means that the transformation of the data is less affected by any errors in the mean annual rainfall analysis, and how this might relate to the temporal variability of rainfall intensity.

The same argument could be used with regard to Coopers Knob and Ryans Bridge which both have short rainfall records relative to that from Christchurch Aero. It is therefore suggested that these two sites could also be removed, and Table 5.2 simplified accordingly.

There are a number of communities in the vicinity of Whitecliffs and Ridgens Road where either design rainfall table could be used and scaled appropriately. Neither of these sites provided 10-min resolution data and therefore these had to be extrapolated from lower resolution data. This creates some uncertainty in the short duration design rainfalls. The Whitecliffs rainfall record is 2 years (10%) longer than that from Ridgens Road. It should therefore provide slightly more representative design rainfall values. Also, as explained in the report, the Ridgens Road short duration events are affected by an extreme magnitude storm. This adds further uncertainty to the design rainfalls. As a consequence of the above, the design rainfalls from Whitecliffs are considered to be more accurate. They are also more conservative, being higher than the corresponding values derived from the Ridgens Road record.

The question is then which site to use, and how it should be scaled, to provide design rainfalls for those communities to the northeast of Whitecliffs (i.e., Sheffield and Waddington)? The mean annual rainfall distribution derived in Opus (2009) (Figure 1) and that from NIWA (Figure 2) both show a 'pocket' of lower rainfall extending to the northwest, essentially up the Waimakariri River. Both Sheffield and Waddington are towards this apparently lower rainfall zone.

Despite both NIWA and Opus defining a lower rainfall zone up the Waimakariri River there is some doubt as to whether this accurately reflects the actual rainfall pattern in the Selwyn District, or is simply an artefact of the rainfall record from Waimakariri Gorge. This is the only rain gauge in the area and has been used in both studies. Consequently, data from this single gauge dominates, and potentially distorts, any interpolation and the resulting rainfall pattern. Since there are no other rain gauges in the area, the true nature of this apparently low rainfall zone cannot be discerned. It is perhaps significant that a similar 'distortion' to the rainfall pattern does not exist in the vicinity of the Rakaia Gorge; or anywhere else in the district. It should be noted also that while a strong east-west rainfall gradient is to be expected, it is difficult to see a physical mechanism for a more dominant north-south pattern. The uncertainty caused by this single rainfall record must therefore be recognised.

In Opus (2009) it was recommended that the design rainfalls for Sheffield, Waddington, and Hororata be derived by scaling the Whitecliffs values since this is the closest rainfall station. The very strong rainfall gradient moving away from Whitecliffs or Ridgens Road, but particularly towards the Waimakariri Gorge, means that the scale factors are all very large when deriving the design rainfalls for other communities from these sites. This creates additional uncertainty with regard to these sites, but there is a strong argument for the consistency of methodology across the entire district. It is difficult to see a strong argument for using one methodology for some communities, and another for others. The fact that the mean annual rainfall distribution has a distinctive shape is already accommodated by both the scale factors, and the use of the closest rainfall site. While the design rainfalls from Ridgens Road could also be used for these communities, and may even provide more conservative values, an argument for this is difficult to sustain given the logic and standard approach used for all other sites.

Notwithstanding the above argument, the effect of the apparently low rainfall at Waimakariri Gorge on the generalised rainfall pattern, and consequently the various scaling factors, is of some concern. At this stage it is not possible to confirm whether the rainfall pattern, and consequently the scale factors, is real or simply an artefact of the availability of rainfall data. The conservative approach would therefore be to apply the unscaled Whitecliffs design rainfall tables (i.e., scale factor 1.00) to both Sheffield and Waddington. If the rainfall pattern is correct this would result in slight over-design. If the pattern is actually a distortion caused by the Waimakariri Gorge site, then because there is likely to be little rainfall variation north-south the values will be accurate. This will result in appropriate design standards.

The scale factors for Glentunnel, Coalgate, and Hororata should remain as in Opus (2009) since the east-west rainfall gradient identified is likely to be correct. Some confidence can therefore be placed in these scale factors and the resulting design rainfalls.

It is therefore suggested that for simplicity, and without the loss of any accuracy or reliability, Table 5.2 of Opus (2009) could be modified to exclude the use of Lincoln Broadfield, Coopers Knob, and Ryans Bridge (Table 1). The scale factors for Sheffield and Waddington could also be changed to 1.00 using the Whitecliffs design rainfall table to recognise the uncertainty caused by the rainfall record from Waimakariri Gorge. The use of the remaining design rainfalls and various scaling factors ensures a consistent methodology across the Selwyn District. From this it is possible to obtain reliable and defensible information.

The scale factors should all be to two decimal places to again show the consistency of methodology. To round to one decimal would in most cases produce a scale factor of 1.

I hope this provides a consistent and defensible argument for the information contained in Opus (2009).

If you would like to discuss this matter in more detail please do not hesitate to give me a call.

Yours sincerely

Dr Jack McConchie
Principal Water Resource Scientist
Work: +4 4717095
Mobile: 0272115973

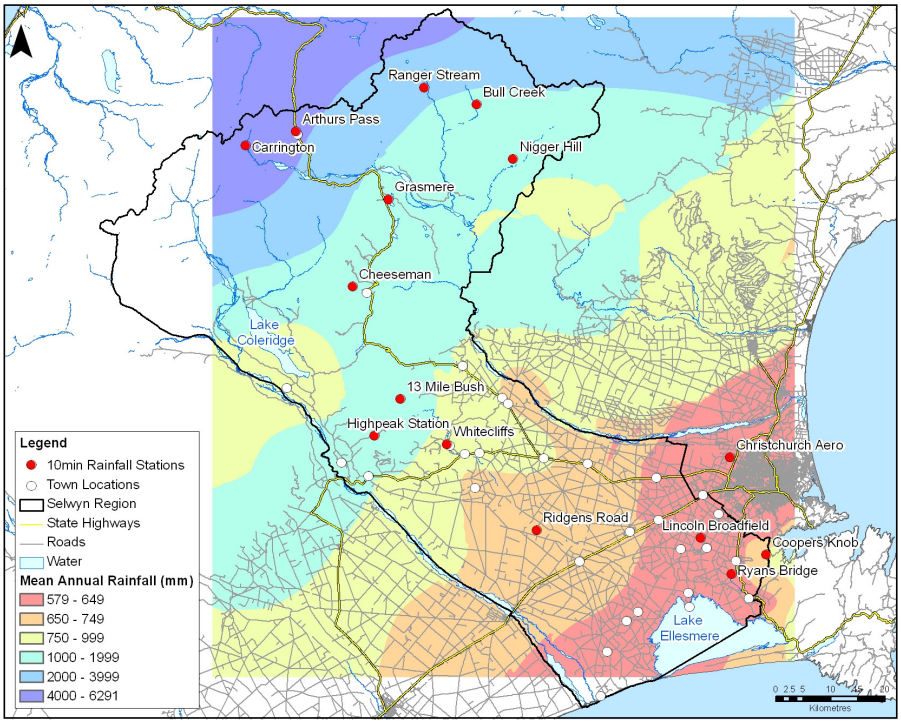

Figure 1: Mean annual rainfall pattern derived for Opus (2009).

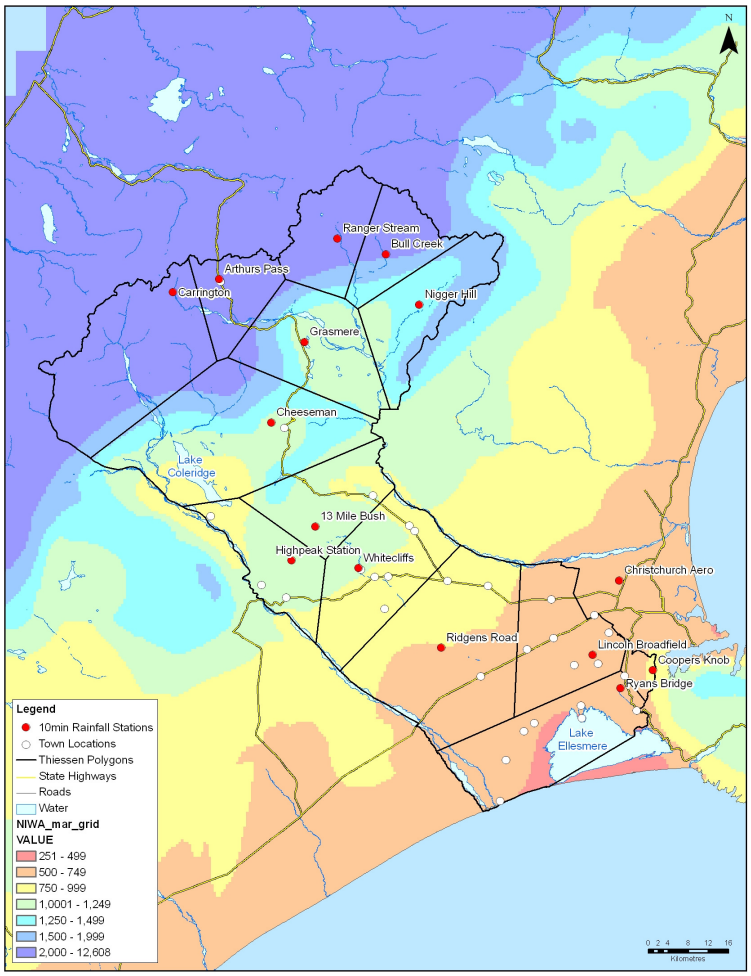

Figure 2: Mean annual rainfall pattern derived by NIWA.

Table 1 The scale factors for each township within the Selwyn District.

Rainfall Gauge	Township	Scale Factor
Arthurs Pass	Arthurs Pass	0.99
Cheeseman	Castle Hill	1.02
Highpeak Station	Lake Coleridge	0.72
	Terrace Downs	1.01
	Windwhistle	0.92
13 Mile Bush	Springfield	0.83
Ridgens Road	Darfield	1.20
	Kirwee	1.02
	Dunstandel	1.05
Whitecliffs	Whitecliffs	1.00
	Sheffield	1.00
	Waddington	1.00
	Glentunnel	0.92
	Coalgate	0.91
	Hororata	0.76
Christchurch Aero	West Melton	1.03
	Templeton	1.02
	Rolleston	1.03
	Burnham	1.06
	Prebbleton	1.03
	Springston	0.99
	Lincoln	0.96
	Tai Tapu	0.98
	Motukarara	1.01
	Upper Selwyn Huts	0.96
	Lower Selwyn Huts	0.98
	Doyleston	1.01
	Leeston	1.01
	Southbridge	0.98