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Graeme Horrell Consultancy Limited

Steve Pattinson
President
Save Our Hills (Upper Hutt) Inc
148 Pinehaven Road
Hut Valley
Wellington

Assessment of the average recurrence interval for the 30 m^3/s flood peak of 20 December 1976 in Pinehaven Stream

This flood was in response to a very rare rainfall event over the catchment, the nearest long term automatic recorder raingauge was at Taita 4 kilometres away and measured a 6 hour total rainfall depth of 181 mm. This was one of the 16 most extreme storm events in New Zealand included in the 1993 study by Thompson and Tomlinson on probable maximum precipitation (PMP). PMP is the upper limit of precipitation defined as the theoretically greatest depth of precipitation for a given duration that is meteorologically possible over a given storm area at a particular time of the year. Plotting the 181 mm rainfall on an extended Taita frequency distribution for the 6 hour duration using NIWA's High Intensity Rainfall Design System (HIRDS Ver3) provides an estimate in excess of 10,000 year return period. It is noted Bishop's report on this storm states "For durations of 60 minutes and over at Taita the return period exceeds 1000 years".

Bishop's estimate of the 30 m^3/s flood peak of 20 December 1976 in Pinehaven stream was assessed by estimating flow over weirs downstream. Bishop "Data for the Heretaunga Drain was supplied through Upper Hutt City council and the Pinehaven estimate obtained by subtracting the drain flow from the estimated flow at weirs downstream of the Pinehaven inflow." These would have been reliable estimates as only the velocity and peak water level would require assessing during the peak, while the area could be obtained from design diagrams or surveyed after the water receded. There are a total of 4 weirs (see Figures 1 to 5) downstream of the Heretaunga Drain confluence with Pinehaven stream, these would provide Mr Bishop with an accurate estimate.

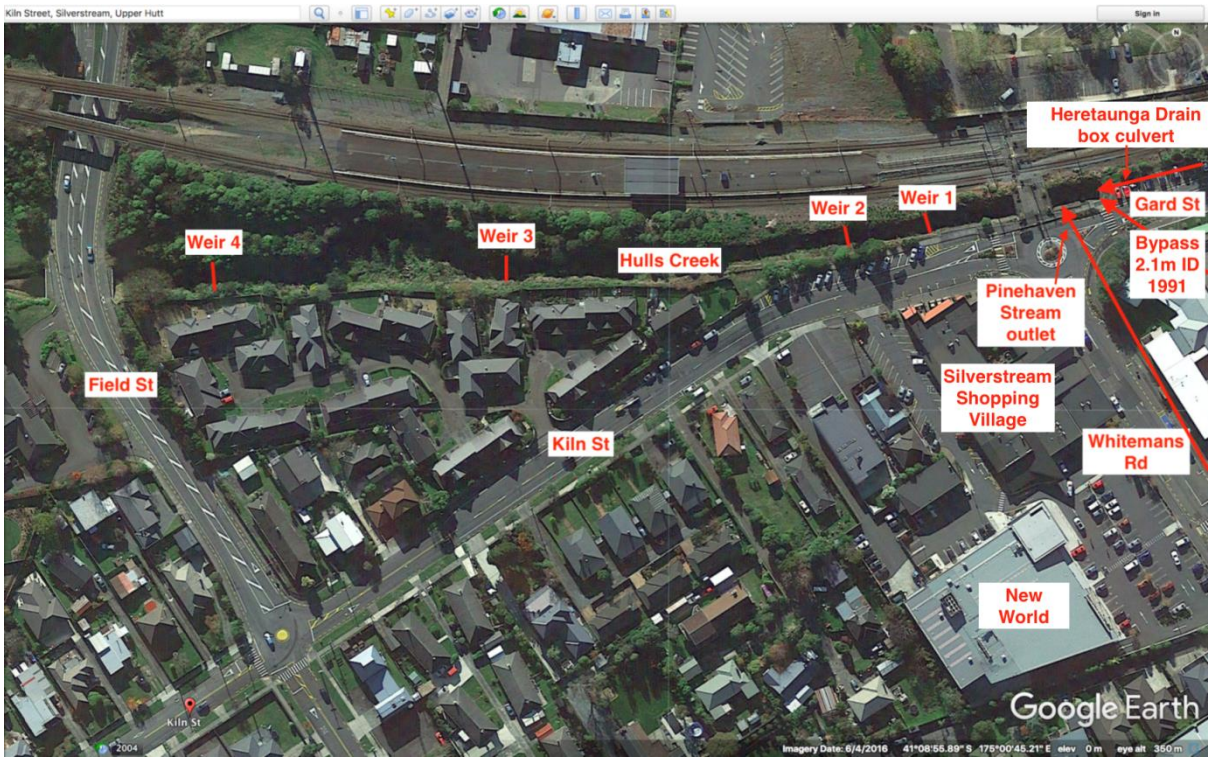

Figure 1: Location of four weirs downstream of the Heretaunga Drain and Pinehaven Stream confluence.

Figure 2: Weir 1

Figure 3: Weir 2

Figure 4: Weir 3

Figure 5: Weir 4

Methodology

Two methods of assessment were employed to estimate the average recurrence interval or return period of the 30 m^3/s flood peak estimated for this storm by Mr Bishop.

1/ Regional flood frequency analysis for small New Zealand basins (McKerchar and Pearson,1991)

Using McKerchar's (1991) recommended mean annual flood estimation method the mean annual flood was estimated to be 6.7 m^3/s. Applying Pearson's (1991) flood frequency groups, the catchment fits into group 4 with a resultant 100 year estimate of 22.5 m^3/s and 1000 year estimate of 35.6 m^3/s. The 30 m^3/s is estimated to have a return period of 500 years.

2/ Regional flood estimation for New Zealand (Henderson and Collins, 2016)

The mean annual flood was estimated to be 8.09 m^3/s. The resultant 100 year estimate of 19.9 m^3/s and 1000 year estimate of 26.67 m^3/s. The 30 m^3/s peak flow is estimated to have a return period in excess of 3000 years.

Comment on Bishop's assessment of return periods

Bishop states "Discussion on the theoretical return period of the 20 December flood (and associated damage) can only be based on a statistical analysis of available rainfall as no long term flow record from any of the small catchments is available." I agree with this method as it is unfortunate there

was no long standing flow recorder site which experienced this storm to aid in the flood flow return period assessment.
When discussing the magnitude of the event he states “Hence taking the 6 hour duration as representing the magnitude of the flood a return period, in terms of the data on which design for run-off has been based to date in the region, of 1000 years or more can be assigned to the event of 20 December.”
Further “The return period of the peak discharge will be a little in excess of the return period of the rainfall intensity over the significant duration. In the 20 December event the return period can be taken as lying between 50 and 200 years (note that the intensities at Kelburn are lower than for Lower Hutt but that the centre of the storm did not cover Kelburn).”
Whilst Bishop hints at flood peaks being a little in excess of the rainfall magnitude, but settles on 50 to 200 years. With the aid of regional flood frequency analysis today, it is apparent Mr Bishop’s magnitude assessment is an underestimation.

Summary

The two available regional analysis to assist in determining flood flows at ungauged catchments were used, both show the 30 m^3/s peak flow greatly exceeded the 100 year return period event.

The McKerchar and Pearson (1989) regional study used 342 flow recording stations, while their small NZ basin study (1991) used 117 flow recording stations less than 100 km^2 in area. Henderson and Collins (2016) regional study used 648 for which many stations added another 27 years to the 342 stations used by McKerchar and Pearson (1989). The Henderson and Collins method should provide the most reliable estimate due to the largely increased dataset for the analysis, however their standard error is larger ±49% while McKerchar and Pearson is ±22%.
From this flood frequency analysis it is estimated the 30 m^3/s peak flow is between 500 to 3000 year return period.

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Yours sincerely

Graeme Horrell

Graeme Horrell Consultancy Limited

1/670 Newtons Road,

5RD,

Christchurch 7675

Cell Phone 02102422022

Email graeme@ghcl.co.nz