

# Probability of Murphys Creek Floods Coinciding With Taylor River Floods

## Analysis

An issue is the degree to which Murphys Creek stormwater flood flows coincide with high Taylor River levels at their confluence.

The small urban Murphys Creek catchment responds to different rainfall events compared to the large rural hill catchment of the Taylor.

Large Taylor River floods require a rainfall over eight hours or more falling on an already wet catchment. An east to southeast weather pattern, usually in winter, provides this rain storm situation and wet antecedent soil conditions.

Murphys Creek responds to intense hourly rain events. These can occur in northerly and nor-westerly storms and the catchment will respond even with dry antecedent conditions as there is a high proportion of urban impermeable surfaces.

Council has a record of hourly rainfall and of Taylor River flood levels at Hutcheson Street since 1973. This memo examines the relative timing of these events, and thus the relative probability of the two coinciding.

The record from 1992 is particularly good following the installation of a continuous water level recorder at Hutcheson Street. Council also has a continuous Taylor flow record since 1960 at Borough weir just above the Taylor flood detention drain' and a record of flood flows outletting the dam since 1989.

The flow records from the Taylor Dam or upstream Borough weir are useful in assessing timing of flood peaks in Blenheim four hours downstream.

No flood flow records are held for Murphys Creek. Blenheim hourly rainfall is a good surrogate for Murphys Creek flows.

An analysis has been carried out on the degree of coincidence of heavy Blenheim hourly rainfalls with high Taylor River levels at Hutcheson Street using these 40 years of records.

The analysis selected those events above baseline minimums.

The minimum Blenheim hourly rainfall selected was 12 mm per hour, approximately a two year return period event.

The minimum Taylor River level at Hutcheson Street was a river level of 2,500 mm above mean sea level (MSL) as assessed for today's current river conditions.

The selection needed to satisfy one of these criteria.

A river level of 2,500 mm above MSL is 1.5 metres above average river level of 1,000 mm. The level represents when urban pumping stations just begin to be required to assist in removal of stormwater. A higher level of 2,800 mm may in fact be more indicative of when urban stormwater pumping really becomes required.

A Taylor River level of 2500 metres at Hutcheson Street is also approximately indicative of the levels of channel retaining walls constructed by landowners in the lower reaches of Murphys Creek.

All told 24 events were selected from the 40 years of available records.

Plots were made of the 24 hours (sometimes 36 or 48 hours) of the storm event. Each plot shows Blenheim hourly rainfall, the Taylor River level at Hutcheson Street, and the Taylor River flow outlet from the dam (or Taylor Dam inflow if outlet flow not available).

The plots show the size of each parameter and also the relative timing of each.

An example plot is shown on Figure 1 below for 6 May 2013. A three hour burst of rain of 12 to 15 mm per hour from 2.00 am to 5.00 am would have resulted in a significant Murphys Creek stormwater flood at 5.00 am. At that time the Taylor River at Hutcheson Street had only risen by a metre to 2,000 mm, and was not to peak until two hours later at 2,450 mm, a flow of only 32 m<sup>3</sup>/sec – barely a Taylor flood.

All the 24 plots were analysed. The events were categorised into three categories.

- (a) Blenheim heavy hourly rainfall coinciding with low Taylor River levels; ie; **a Murphys Creek stormwater flood event only**.
- (b) A Taylor flood peak a few hours after Blenheim hourly rainfall peak, ie; the **Murphys Creek stormwater event did not coincide with the later Taylor flood**.
- (c) High Taylor flood levels coinciding with Blenheim hourly rainfalls, ie; **both Murphys Creek stormwater and Taylor floods coinciding to some degree**

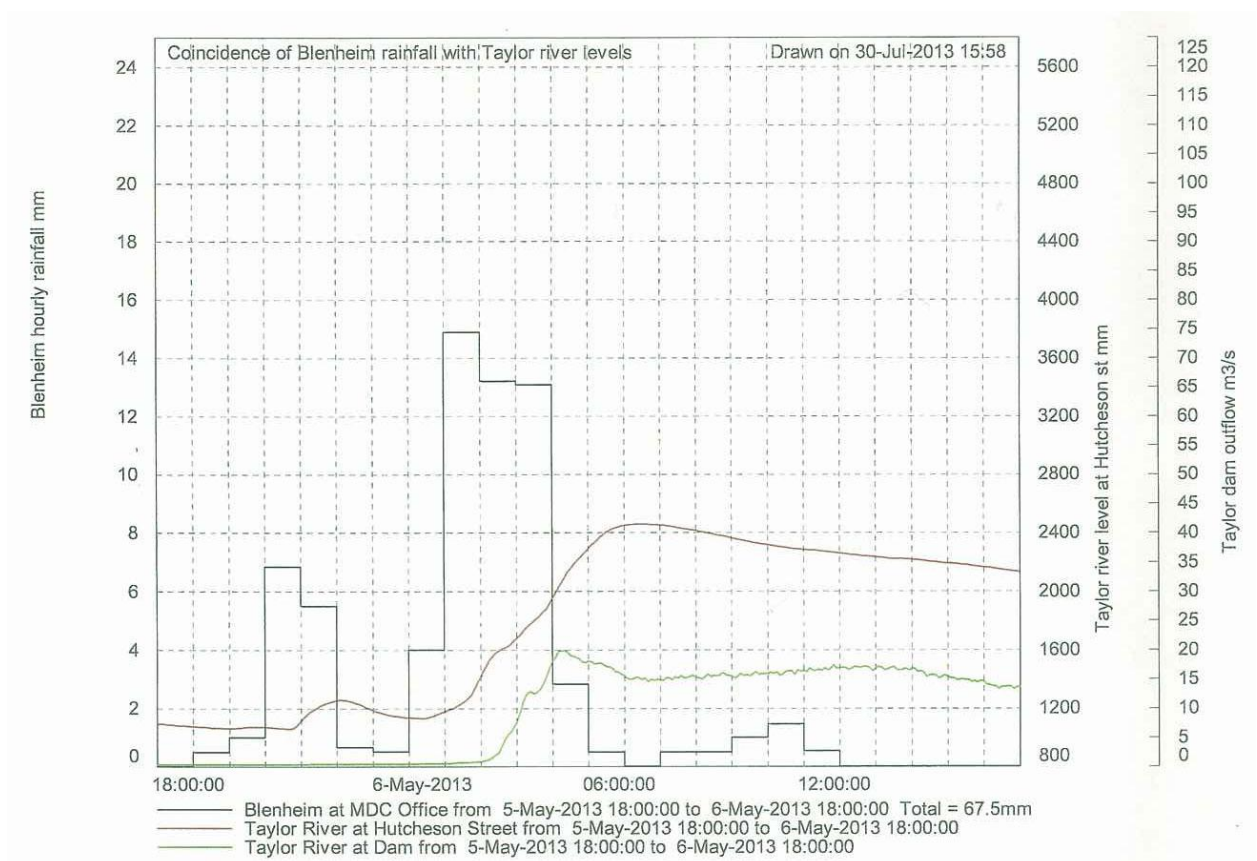


Figure 1

### Blenheim Hourly Rainfall Events Coinciding With Low Taylor River Levels

Of the 24 storm events analysed, seven were allocated into this category, being indicative of a Murphys Creek stormwater flood only with the Taylor River at normal low level.

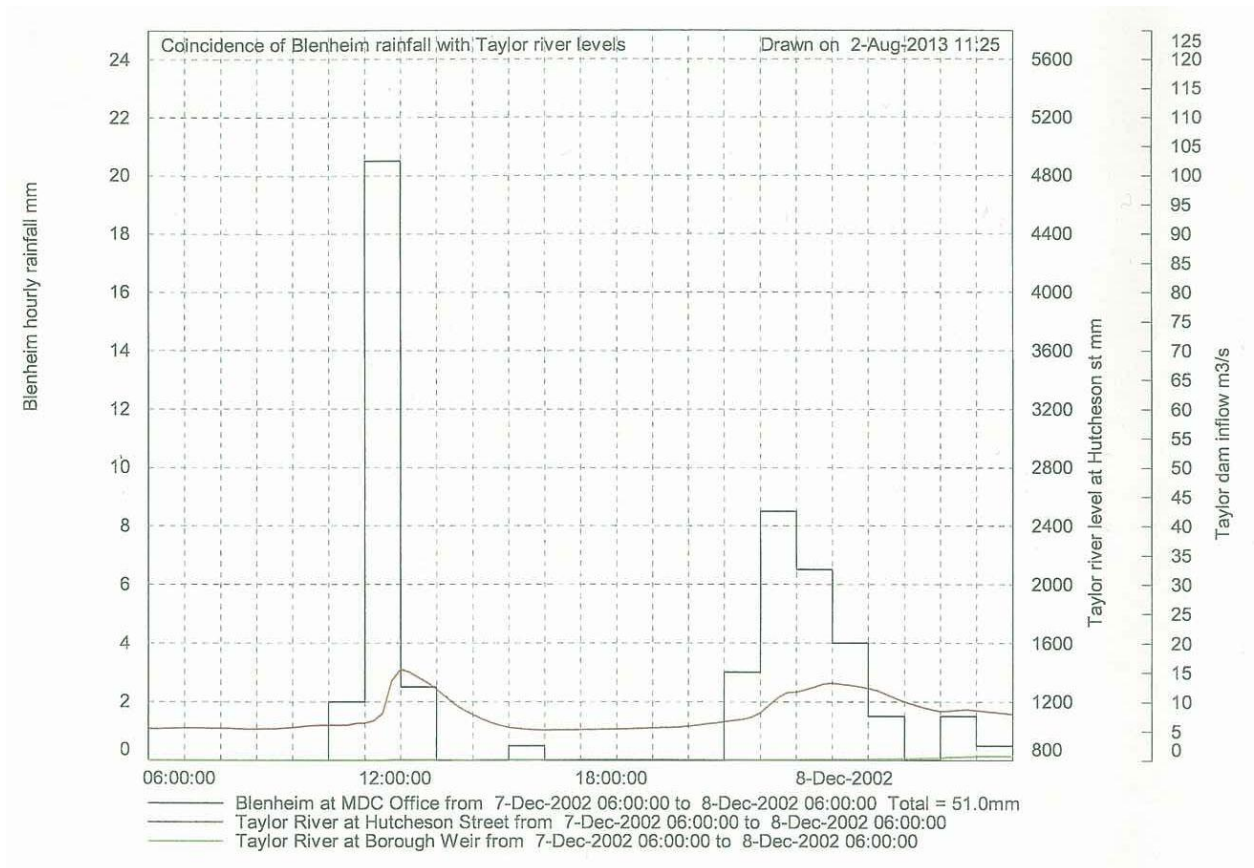
A summary of the seven events is shown in Table 2.

<b>Blenheim heavy hourly rainfall coinciding with low Taylor River levels</b>			
<b>Date</b>	<b>Blenheim peak hourly rainfall mm/hr</b>	<b>River level at Hutcheson Street at time of peak rainfall, mm above MSL</b>	<b>Estimated Taylor flow at time of Blenheim peak hourly rainfall, m<sup>3</sup>/s</b>
February 95	37	1,600	<15
February 96	24	1,200	<15
December 02	20.5	1,400	<15
February 98	18	1,200	<15
February 93	15	1,000	<15
May 94	14	1,100	<15
January 99	10	1,500	<15

Table 2

The four highest Blenheim hourly rainfalls in this category are also the four highest hourly rainfalls in the whole 24 storms over 40 years. All four rainfall events are rarer than a 1 in 10 year ARI and the February 1995 is rarer than a 1 in 100 year ARI.

These worst Blenheim rainfall events and Murphys Creek stormwater floods have occurred at times of low flow in the Taylor River.



**Figure 2**

The most recent example shown in Figure 2 is in December 2002 with an hourly rainfall of 20.5 mm in an hour (a 20 year ARI). At the time the flow from the Taylor Dam was less than 0.5 m<sup>3</sup>/sec, being less than Murphys Creek flow. The immediate rise of 300 mm of the Taylor River at Hutcheson Street would have been due to stormwater run-off from Blenheim stormwater run-off including Murphys Creek.

### **Taylor Flood Peak A Few Hours After Murphys Creek**

Murphys Creek responds to a rainfall event in approximately an hour. The much larger Taylor River requires a rainfall event exceeding eight hours to bring it into high flood.

A rain storm over Blenheim and the Taylor at the same time will therefore result in a Murphys Creek stormwater flood occurring and dropping to normal flow before the Taylor flood arrives.

This category therefore lists events where a significant Taylor flood occurred but its peak flow is several hours after the Blenheim hourly rainfall peak which has dropped to less than 1 mm/hour by the time the Taylor flood arrives.

Of the 24 events analysed, 10 are in this category.

Table 3 lists these events.

Taylor flood peak a few hours after Blenheim hourly rain peak					
Date	Peak river level at Hutcheson Street mm above MSL	Adjusted peak river level to allow for current river conditions, mm above MSL	Estimated peak flow today's conditions	Blenheim hourly rainfall at time of peak river level mm/hr	Blenheim hourly rainfall at time of peak river level mm/hr
Sep 1989	4,400	3,850	106	0	6
Mar 1979	4,300	3,500	80	0	5
Aug 2008	3,700	3,700	90	0.5	5.5
Mar 1975	4,500	3,700	88	0.5	5
Jun 1995	3,200	3,200	86	0	4
Jul 1996	3,500	3,500	81	0	2
Jun 2006	3,100	3,100	58	0	9
Jul 2012	3,000	3,000	54	0	3
Jul 2010	2,800	2,800	45	0.5	5
May 2013	2,450	2,450	35	1	15

Table 3

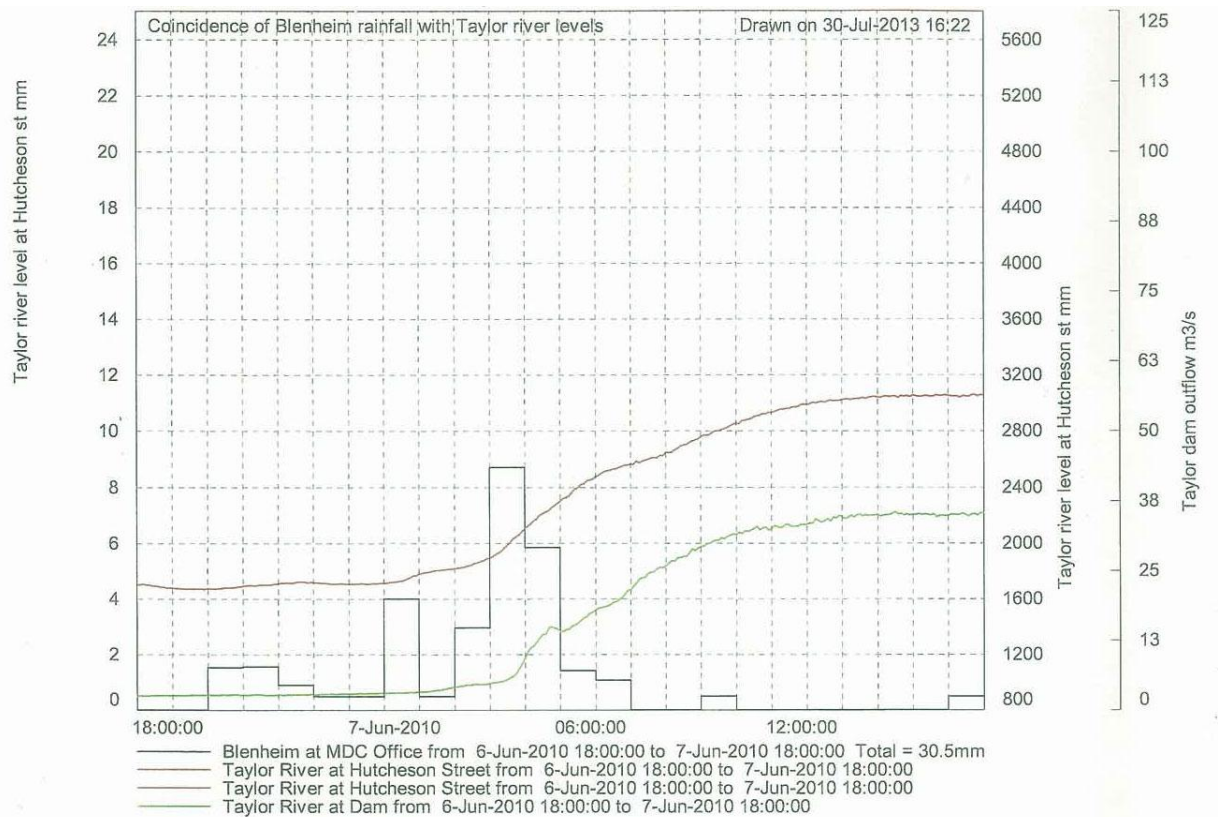


Figure 3

Figure 3 is the most recent example of this for the June 2010 event. The Taylor River peaked at 3,100 mm, but this was nine hours after Blenheim rain effectively ceased and Murphys Creek stormwater generated flow peak. A riparian landowner in lower Murphys Creek would not

readily be able to realise that Murphys Creek flood levels were rising, but the actual Murphys creek stormwater flood flow was dropping.

### High Taylor River Levels Coinciding With Blenheim Hourly Rainfall

Of the 24 storms analysed seven are when high Taylor River levels coincided with some Blenheim hourly rainfall. Even two of these seven are with river levels at Hutcheson Street of less than a relatively low 2,800 mm above MSL and pumping stations are only just being required. The Taylor river levels are those coinciding with high hourly rainfall and are not always when Taylor peak water levels were actually reached.

These are shown in Table 4.

<b>High Taylor River levels coinciding with Blenheim hourly rainfalls</b>				
<b>Date</b>	<b>River level at Hutcheson Street at time of Blenheim hourly rainfall, mm above MSL</b>	<b>Adjusted river level at Hutcheson Street to allow for current river conditions, mm above MSL</b>	<b>Estimated Taylor River flow in current river conditions, m<sup>3</sup>/s</b>	<b>Blenheim hourly rainfall at time of coinciding river level mm</b>
April 80	5,000	4,000	115	9
July 77	4,400	3,700	90	4
Sep 74	3,600	3,200	40	4.5
July 94	3,200	3,100	60	5
July 98	3,000	3,000	54	10
July 08	2,500	2,500	34	10
July 78	2,600	2,400	30	7.5

**Table 4**

The April 1980 flood stands out as being the worst event of this 'joint' probability of a quite heavy Blenheim hourly rainfall coinciding with the peak of a substantial Taylor River flood.

The Taylor River flood of 115 m<sup>3</sup>/sec is estimated as of a 15 year ARI; the coinciding 9 mm of rainfall in an hour is expected every eight months on average. This rainfall was a late kick in the rainfall towards the end of the storm event.

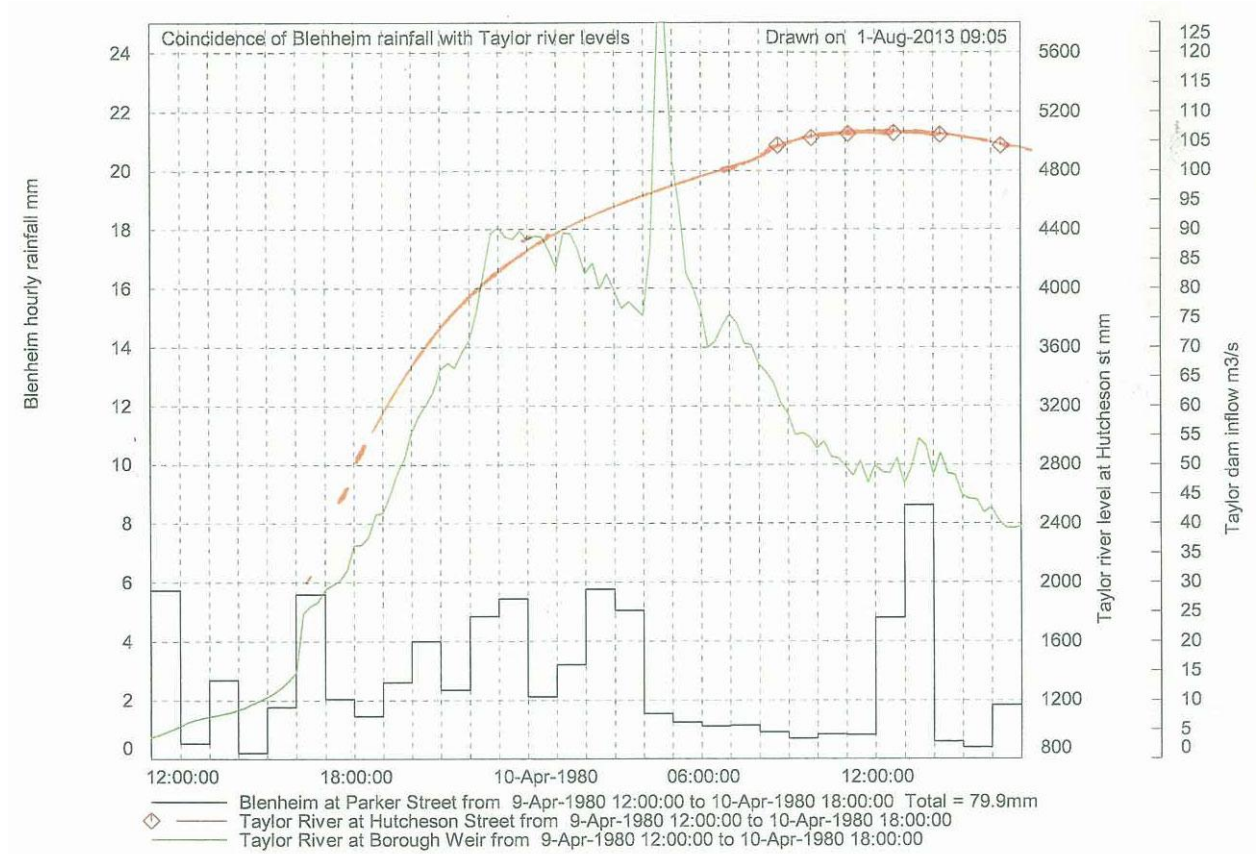


Figure 4

A plot of this event is shown in Figure 4. The late rainfall peak in the early afternoon of 10 April is clearly shown coinciding with the Taylor River peak.

### Assessment

Assigning probabilities to 'joint' events is difficult. A 50 year ARI Blenheim hourly rainfall is indicated by HIRDS 3 as being 25 m/hour, a bit more than the February 1996 event but less than the February 1995 event. The analysis herein has shown that such a peak rainfall event will only occur with the Taylor River close to normal levels of 1,400 mm above MSL at Hutcheson Street and 2700 mm above MSL at the mouth of Murphys Creek. This scenario is a candidate for being a 50 year ARI event.

Another scenario is based on a 50 year ARI Taylor flood of 147 m<sup>3</sup>/sec, being slightly larger than the July 2008 flood event of 136 m<sup>3</sup>/sec. This analysis has shown that such a peak would occur several hours after the peak Blenheim rainfall, and when that rainfall had fallen to 2 mm/hour or less. This scenario is a second candidate for being a 50 year ARI event.

A third scenario is the 1980 event, being the second largest Taylor flood in the 40 years of record. A peak Blenheim hourly rainfall of 9 mm/hour coincided with the peak of this flood. This scenario is third candidate for being 50 year ARI event.

**All three scenarios should be tested for Murphys Creek.** It is possible that any of the three different scenarios will be the worst case for different parts of the creek.