

MACKAY FLASH FLOOD

17 NOVEMBER 2000

1. Introduction

During the early morning hours of 17 November 2000, heavy rainfall was recorded in the Mackay area, causing widespread flash flooding. Roads and bridges throughout the district, as well as the railway line south of Mackay, were cut by floodwaters. Many businesses and schools remained closed for the day. Heavy crop losses also resulted.

The heavy rainfall was localised in the lower reach of the Pioneer River around Mackay and, while there were some river rises recorded, water levels in the Pioneer River remained well below minor flood levels.

This report discusses the meteorological conditions associated with the event. It also summarises the rainfall totals and rainfall intensities that were recorded across the district during the event.

2. Meteorological Summary

Surface and upper atmospheric synoptic scale features were studied in order to determine the cause of the intense rainfall (as well as the large rainfall totals) over the Mackay district. Two factors, discussed below, were identified.

1. A backing of winds with height to the east of a "sharpening" upper level trough, and;
2. A trough in the low-level easterly flow, off the coast from Mackay.

2.1 Upper Level Trough and Wind Profile

The "sharpening" of the upper level trough was best illustrated at the 500 hPa level. The trough was observed to extend further into the tropics between 9pm Thursday 16 and 9am Friday 17. At the same time, the winds on the eastern side of the trough were observed to increase in strength and the discontinuity (or change) in wind direction across the trough itself became better defined. (Prior to this, winds across the trough axis were mostly westerly, but by 9am Friday there was a distinct turning of the winds immediately to the east of the trough). The winds on the eastern side were more northerly during the time of most intense rainfall. By 9pm on Friday, the upper level trough had "relaxed". Figure 1 shows the changes in the trough at 500 hPa between 9am Thursday 16 November and 9pm Friday 17 November.

The upper wind profile for Mackay at 9pm on Thursday 16 November showed the winds to be backing with height. The winds in the low levels were from the northeast quadrant, and gradually backed with height such that the middle level winds (around 700 hPa) were

from the north. Above 600 hPa the winds were from the northwest. Unfortunately, no upper winds were available for Mackay at 3am Friday 17.

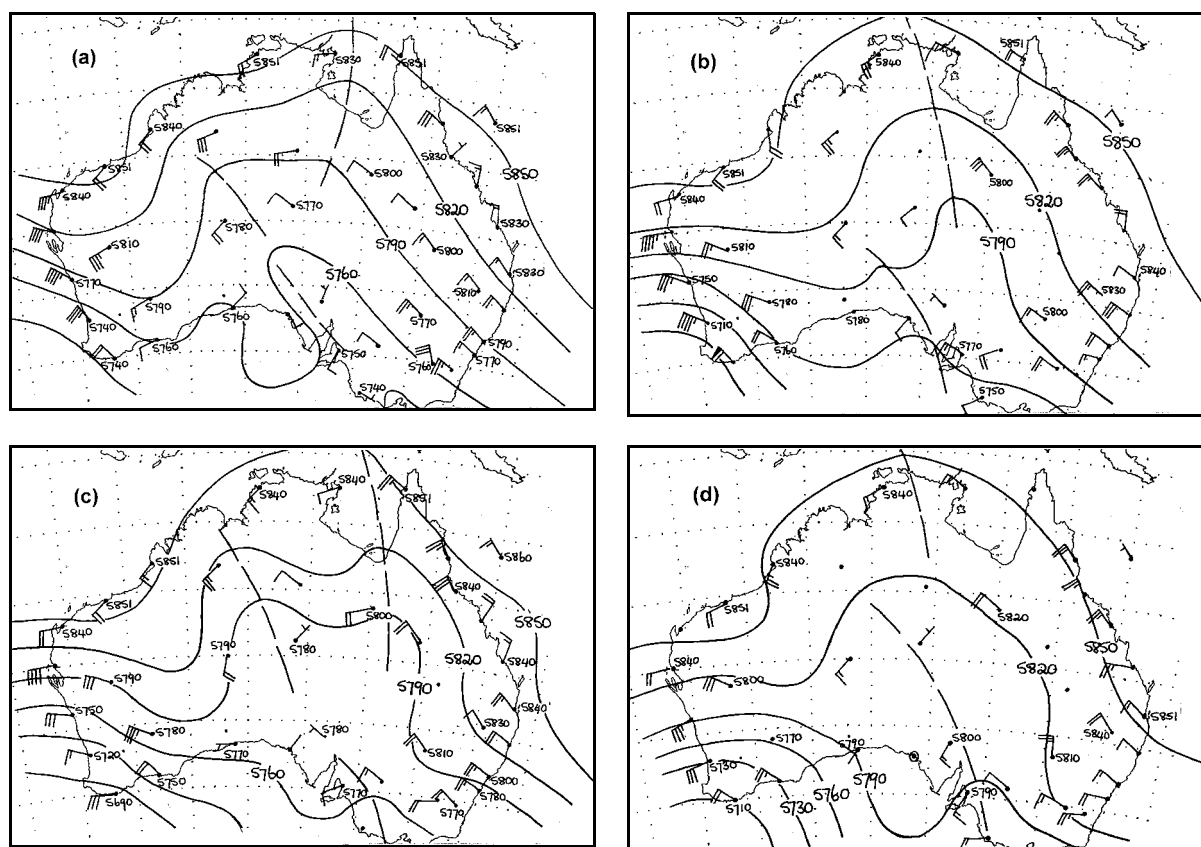


Figure 1 500 hPa Analyses

(a) 9am Thursday 16 Nov
(c) 9am Friday 17 Nov

(b) 9pm Thursday 16 Nov
(d) 9pm Friday 17 Nov

The upper wind profile for Mackay at 9am Friday also showed the backing winds with height. However the low-level winds were now blowing from the southeast quadrant and gradually backed with height to be from the northeast at 700 hPa. Winds at higher levels were from the northwest quadrant. Wind speeds above 850 hPa had eased by this time.

By 3pm Friday, the strong backing was no longer present. Low level winds were from the southeast quadrant and the winds in the middle levels were from the northeast and the wind speeds continued to ease. Table 1 shows the observed winds (direction and speed) between 9pm Thursday 16 November and 3pm Friday 17 November.

Extreme heavy rain events in Queensland have in the past been found to be associated with winds which back in direction with height. The direction, from which these low level winds blow from, is generally confined to the northeast quadrant.

The "sharpening" of the upper trough over Queensland and the observed backing of winds with height produced large-scale ascent over the eastern parts of Queensland, thus producing significant rainfall. The observed wind profiles were consistent with the most intense rainfall occurring between 9pm Thursday and 9am Friday and the easing of conditions during Friday afternoon.

Table 1
Observed Upper Winds for Mackay

Note that direction is in degrees and wind speed is given in knots.
For example 295/24 is a wind from 295 degrees - NW wind - at 24 knots.

| Pressure (hPa) | 9pm Thursday | 9am Friday | 3pm Friday |
|--------------------|--------------|------------|------------|
| 350 | 295/24 | N/A | N/A |
| 500 | 320/26 | N/A | N/A |
| 600 | 345/34 | 345/20 | 035/08 |
| 650 | 355/30 | 345/20 | 065/12 |
| 700 | 005/30 | 030/08 | 075/12 |
| 785 | 010/20 | 120/12 | 110/20 |
| 850 | 005/18 | 135/30 | 130/22 |
| 910 | 040/20 | 120/30 | 130/18 |
| 943 | 040/20 | 125/36 | 125/30 |

2.2 Surface Trough in the Easterly Flow

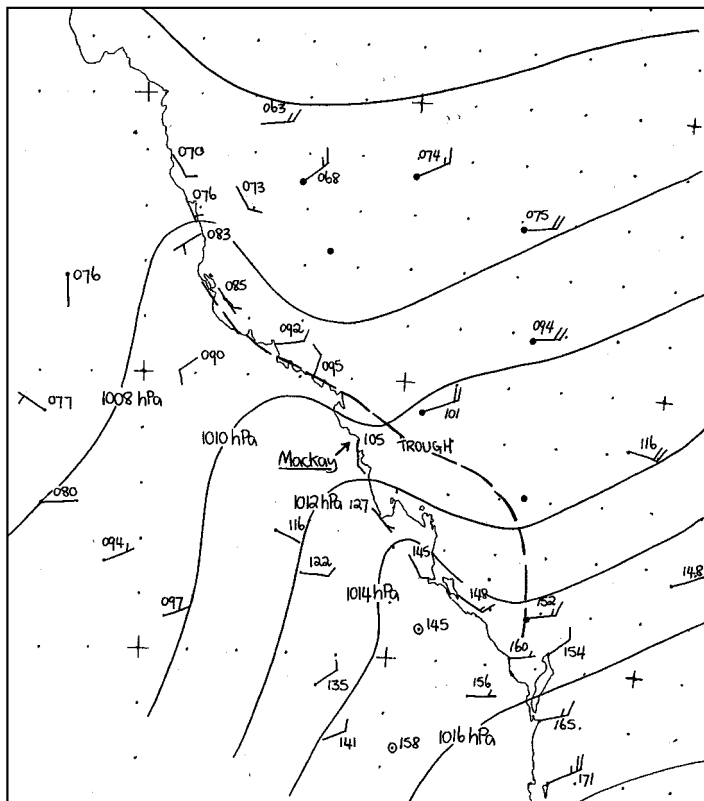


Figure 2 MSL Analysis 3am 17 Nov 2000

2.3 Meteorological Summary

The intense rainfall and large rainfall totals, recorded throughout Mackay and district on the morning of Friday 17 November, were due to strong broad scale ascent, concentrated around the Mackay area by a surface trough in the easterly flow just off the Central Queensland coast.

At 3pm Thursday 16 November, a 1027 hPa high was centred over the Tasman Sea and directing an easterly stream across the northern Tasman Sea and the Coral Sea. A trough was evident in the easterly flow just east of the North Queensland coast.

By 3am Friday the trough in the easterly flow was evident off the coast from Mackay. (Refer to Figure 2). The analysed position of the trough was along Bowen to Gannet Cay to Hervey Bay. The trough remained situated just off the coast from Mackay throughout Friday.

The low level trough in the easterly flow provided a region of low level convergence, thus creating an area of focus for the heaviest rainfall.

3. Rainfall Totals

Daily rainfall totals for the 24 hours to 9am Friday 17 November for the Mackay area are given in Table 1. The ALERT stations have a 300mm catch with a 1mm tipping bucket mechanism and are owned and operated by the Pioneer River Improvement Trust (PRIT). The other stations are official stations have a standard 203mm rain gauge, conform to Bureau standards and are recorded for the Bureau by Bureau officers or volunteer observers.

For the 24 hour period to 9am Friday 17 November, the highest rainfall was recorded at Sarina, about 30 km south of Mackay.

In the Mackay City area, the highest total of 343 mm was recorded at the PRIT ALERT station on Willetts Rd at the Gooseponds. Several other stations in and around the Mackay area recorded totals in excess of 300 mm. The heaviest falls seemed to be concentrated in the northern suburbs of Mackay. Only 15km from this area, totals were around 200mm. Figure 2 shows the location of stations referred to in Table 2.



Figure 3 Mackay Region

TABLE 2
Daily Rainfall (mm) to 9am 17 November 2000

| CBM Number | Station Name | Total (mm) |
|------------|-----------------------|------------|
| 033059 | Sarina | 418 |
| 533061 | Gooseponds ALERT | 343 |
| 033119 | Mackay | 328 |
| 033066 | Mackay East | 315 |
| 533061 | Rowallan Pk ALERT | 303 |
| 533060 | Hospital Br ALERT | 283 |
| 033047 | Te Kowai | 270 |
| 033300 | Dumbleton Rocks ALERT | 230 |
| 533058 | Greenmount ALERT | 213 |
| 533063 | Bakers Ck ALERT | 201 |

4. Temporal Patterns

One hourly rainfalls for selected stations in the Mackay area are given in Table 2 while the Gooseponds ALERT rainfall is shown in graphical form.

Both Table 3 and Figure 3 clearly show the rapid onset of the heavy rainfall at Mackay at about 1am in the morning of Friday 17 November.

Table 3
Hourly Rainfalls
(ending at the time shown)

| Time | Greenmount AL | Dumbleton Rocks AL | Rowallan Park AL | Bakers Creek AL | Hospital Bridge AL | Gooseponds AL | Mackay SYN |
|-------|---------------|--------------------|------------------|-----------------|--------------------|---------------|-------------|
| 2200 | 10.5 | 5.5 | 7.4 | 11.3 | 7.4 | 5.7 | 15.4 |
| 2300 | 11.3 | 6.9 | 25.5 | 29.0 | 12.0 | 12.6 | 9.2 |
| 0000 | 29.7 | 35.2 | 18.4 | 11.9 | 8.6 | 7.2 | 9.8 |
| 0100 | 4.7 | 11.6 | 16.5 | 1.5 | 1.9 | 4.1 | 5.6 |
| 0200 | 30.0 | 40.6 | 61.1 | 14.9 | 78.2 | 110.2 | 64.6 |
| 0300 | 19.5 | 26.8 | 65.1 | 22.3 | 53.9 | 73.9 | 63.2 |
| 0400 | 15.2 | 27.0 | 36.6 | 32.0 | 40.3 | 49.5 | 69.6 |
| 0500 | 6.1 | 12.5 | 16.9 | 11.6 | 15.2 | 24.1 | 30.4 |
| 0600 | 16.4 | 9.8 | 13.2 | 11.8 | 14.1 | 13.8 | 12.8 |
| 0700 | 8.3 | 6.0 | 8.1 | 6.1 | 10.0 | 7.3 | 6.6 |
| 0800 | 5.2 | 3.7 | 5.2 | 5.9 | 6.4 | 6.3 | 18.2 |
| 0900 | 7.4 | 5.9 | 10.5 | 6.7 | 9.0 | 8.8 | 10.8 |
| Total | 164.3 | 191.5 | 284.5 | 165.0 | 257.0 | 323.5 | 316.2 |

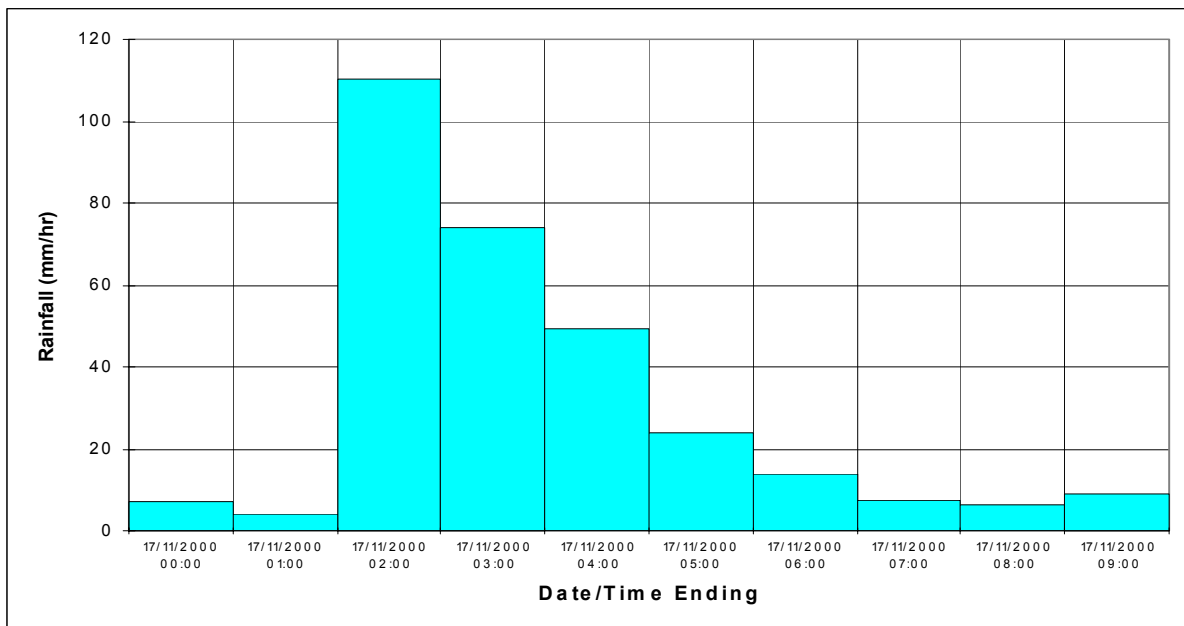


Figure 4 Gooseponds ALERT Rainfall

The heaviest hourly rainfall (constrained “clock hour” value) occurred between 1 and 2am Friday morning when over 110mm was recorded at Gooseponds ALERT station near the bridge on Willetts Rd. This station was only installed in September 2000.

Figure 5 shows the image of the Mackay radar at 1.30am on the morning of Friday 17 November. The circle shown is at 50km radius and the areas of most intense rainfall are shaded red. For a radius of about 3.5km around it, the radar is unable to provide any clear indication of rainfall intensities.

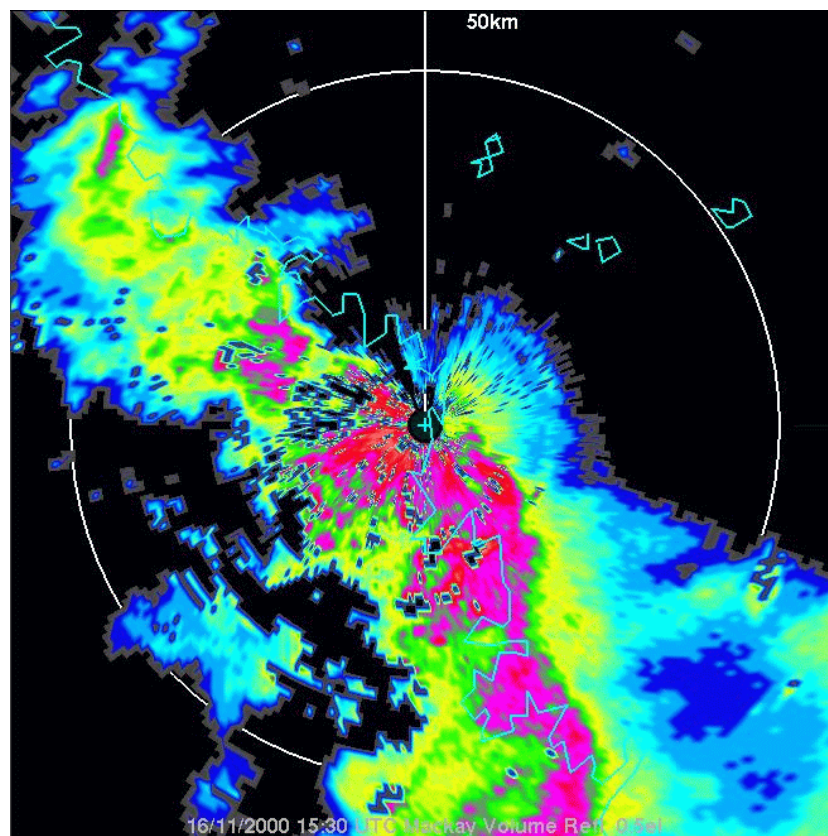


Figure 5 Mackay Radar 1.30am 17 Nov

4. Rainfall Records

The records at Mackay Post Office (033046) commenced in 1870. An analysis of highest daily totals at this station shows that the 17 November total was the 6th highest in the period of record. Records also indicate that it was the highest November daily total recorded at Mackay (in the 24 hours to 9am).

Table 4
Comparison of Record Daily Rainfall Totals
033046 Mackay PO

| Rank | Date | Rainfall |
|------|------------|----------|
| 1 | 22/01/1918 | 627 |
| 2 | 23/01/1918 | 438 |
| 3 | 23/12/1909 | 355 |
| 4 | 24/01/1918 | 346 |
| 5 | 20/01/1932 | 335 |
| 6 | 17/11/2000 | 328 |

5. Rainfall Frequencies

An intensity-frequency-duration (IFD) analysis of the most intense rainfall recorded at the Gooseponds ALERT station during this event is summarised in Table 5 and is shown diagrammatically on the design IFD analysis for Mackay (Figure 5). (The calculation of IFD design rainfall curves is described fully in Australian Rainfall and Runoff (AR&R), 1987.)

Table 5
Intensity-Frequency-Duration Analysis - Gooseponds ALERT

| Duration | Rainfall (mm) | Period Ending | Average Recurrence Interval (years) |
|----------|---------------|-----------------|-------------------------------------|
| 5 Mins | 15 | 1:40am 17/11/00 | 2 - 5 |
| 10 Mins | 27 | 1:45am 17/11/00 | 5 - 10 |
| 15 Mins | 40 | 1:50am 17/11/00 | 10 - 20 |
| 30 Mins | 75 | 2:00am 17/11/00 | 20 - 50 |
| 1 Hr | 123 | 2:20am 17/11/00 | > 100 |
| 2 Hrs | 191 | 3:15am 17/11/00 | > 100 |
| 3 Hrs | 234 | 4:10am 17/11/00 | > 100 |
| 6 Hrs | 281 | 6:50am 17/11/00 | > 100 |
| 12 Hrs | 312 | 6:55am 17/11/00 | 20 - 50 |
| 24 Hrs | 327 | 6:55am 17/11/00 | 10 - 20 |

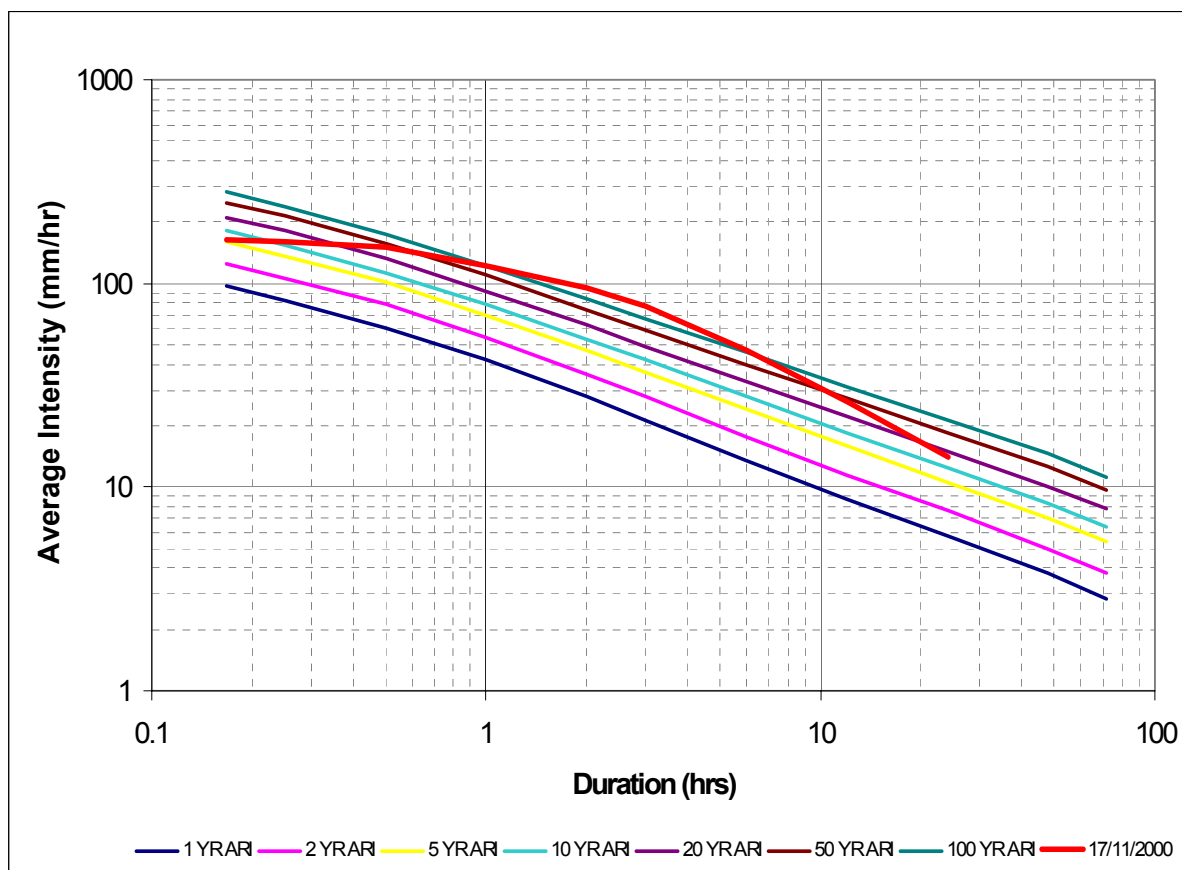


Figure 6 Mackay Intensity-Frequency-Duration Curves

Up to the 1 hour duration, recurrence intervals are below the 100 year Average Recurrence Interval (ARI) with the 5 minute duration not particularly significant.

The heaviest 1 hour rainfall of 123mm occurred between 1:20am and 2:20am on 17 November, exceeding the constrained "clock hour" value of 110mm recorded between 1am and 2am indicated above in Section 2.

The rainfall intensities for all durations from 1 hour to 6 hours significantly exceeded the 100 Year Average Recurrence Interval (1% Annual Exceedance Probability) intensity rainfalls for Mackay. Notwithstanding the uncertainty in the estimation of 100 year rainfalls, the amount by which the November 2000 falls exceeded the 100 year design rainfalls given by AR&R for periods between 1 and 6 hours is significant.