

June 2014 flood event

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Abstract

In early June 2014 a Tasman Sea low brought strong east to northeast winds and high rainfall to many parts of the Waikato Region. Flooding and damage was particularly severe in the northwest Coromandel, and to a lesser degree the Waihou and Lower Waikato.

The high rainfalls and flows caused significant damage to property and infrastructure including upper catchment slips, and significant downstream sediment and debris deposition.

This report provides an overview of the flood event including technical information on rainfall, flows, and observed flooding, and describes the role of Waikato Regional Council flood management including event costs, key learnings, future actions and recommendations.

Executive summary

In early June 2014 a Tasman Sea low pressure system brought heavy rain and strong east to northeast winds to the Waikato Region, causing flooding and in cases severe flood damage. The affected zones were the Coromandel, in particular the northwest of the Peninsula, Waihou Piako, and Lower Waikato.

The rainfall received at the gauges was typically not indicative of the scale of flooding at many locations highlighting the high spatial variation in rainfall and localised high intensity events. Over a three day period up to 365 mm of rain was recorded at council telemetry sites with estimated average recurrence intervals (ARI) of up to 60 years. Anecdotal reports on private Coromandel gauges and subsequent flood damage was indicative of considerably higher rainfall intensities likely to be well in excess of the 100 year ARI.

Flows in the northwest Coromandel catchments between Waiaro Bay and Port Jackson have not been quantified but the events were very extreme resulting in significant damage to property and infrastructure including upper catchment slips, significant downstream sediment and debris deposition, channel blockages, and channel redirection.

In the Waihou flooding was significant, with high flows experienced in the upper catchment estimated at 10-20 year ARI at Te Aroha with the highest flows on the readily available record (1982 to present). The Waihou scheme has a 100 year ARI design standard and whilst there was obviously flooding to property, overall the scheme performed very well as shown in aerial imagery. Recorded flows and levels in the Piako and Waitoa catchments were of the order of a 2-10 year ARI event, with a 50 year ARI event in the upper Waitoa. The Kauaeranga River had the highest flows on record since the scheme was completed circa 1990 and estimated at a 35 year ARI event.

Flooding to the Waikato catchments was primarily in the lower Waikato tributaries north and east of Huntly, namely the Mangawara and Tauhei Streams, and the Lake Waikare catchments including the Matahuru Stream. Flows in Mangawara and Tauhei are estimated at a 5-10 year ARI event, but those in the Matahuru were estimated at a 75 year ARI event. The flows in Matahuru and other Lake Waikare catchments contributed to high water levels in the lake with the third highest on record after 2008 and 1998.

Phase 1 of the Waikato Hydro System High Flow Management Plan was declared for a short time during the event due to flows exceeding 650 m³/s at Ngaruawahia with further heavy rain forecast. Flows in the main Waikato and Waipa Rivers were largely as expected and well within normal operating range throughout the event.

Estimated costs incurred from the June flood event are approximately \$290,000 most of which is attributed to works in the Coromandel (\$187,000) and the Waihou Piako (\$92,000), with \$10,000 in the Lower Waikato. The costs are funded from the respective zone disaster recovery funds, except for the Lower Waikato which was funded from operational budgets given the low value.

1 Introduction

1.1 Background

On Monday 9 June a deepening Tasman low began crossing the North Island with associated fronts, strong east to northeast winds and heavy rain. Over the following three days periods of intense rainfall occurred throughout the region resulting in flooding and in cases severe flood damage. The zones most affected were the Coromandel, Waihou Piako, and Lower Waikato.

The northwest Coromandel suffered particularly severe flood damage as high intensity rainfalls in the Moehau Range caused extreme flood and debris flows, bank erosion, sediment deposition, and in some places significant damage to infrastructure.

Flooding also affected to a lesser degree other parts of the region, including the Waihou River, Piako and Waitoa Rivers, Kauaeranga River at Thames, and Lower Waikato tributaries including the Matahuru Stream (Lake Waikare), Tauhei and Mangawara.

The last major flood event to affect a wider area of the region was Cyclone Wilma in January 2011 and previous to that was a similar event to this one in 2008.

An intense localised event in the Kaimai Ranges also occurred eight weeks previous in April 2014 and is described briefly in the following section.

1.2 April 2014 event

On 16 to 18 April 2014 the remnants of cyclone Ita resulted in intense localised rainfall and flooding in the Kaimai Ranges from Wairakau Road to State Highway 29. Landowners reported rainfall totals from 250 mm to 385 mm and whilst there is some uncertainty regarding rainfall intensities the event was likely of the order of a 100 year event for the 18 hill streams affected.

Large volumes of slip material were mobilised in the foothills of the Kaimai Ranges, causing debris and silt to spread over large areas downstream. Riparian protection, fences, bridges, and other farm assets were damaged and destroyed. Cleanup began on 18 April (Good Friday) with local contractors and Waikato Regional Council staff redirecting streams back in-channel, repairing badly eroded areas, and removing trees and debris from stream beds and paddocks. It took four weeks to get to a stage where all streams were back in-channel and the more serious erosion repaired. Work still continues on the less serious erosion areas, and costs to date are \$183,000, with potentially another \$20,000 going forward.

1.3 Purpose

The purpose of this report is to provide an overview of the June 2014 storm event and provide technical information gathered from the event that impacted the Coromandel, Waihou Piako and Lower Waikato zones.

2 Weather and warnings

2.1 Situation

A deepening low in the Tasman crossed the North Island bringing strong east to northeast winds with associated fronts and heavy rain. Surface pressure charts for the period 9 to 13 June show the passage of the low in Figure 1.

2.2 Pre-event warnings

The MetService issued a heavy rain warning for the Coromandel and heavy rain watch for the wider Waikato. Rain was expected to become heavy late morning (Monday 9 June) with 150 mm to 200 mm expected in the 48 hours from midday Monday to midday Wednesday (11 June). Rainfall rates were expected to reach 15 mm to 20 mm/hr at times.

On Tuesday (10 June) a severe weather update was issued expecting strong winds for the Coromandel Peninsula and eastern Waikato, namely the inland Kaimai Ranges. East to northeast winds were expected to gust to 120 km/h Tuesday afternoon until Wednesday morning. A further 100 mm to 150 mm of rainfall expected but rainfall intensities possibly higher than initially forecast, particularly overnight Tuesday.

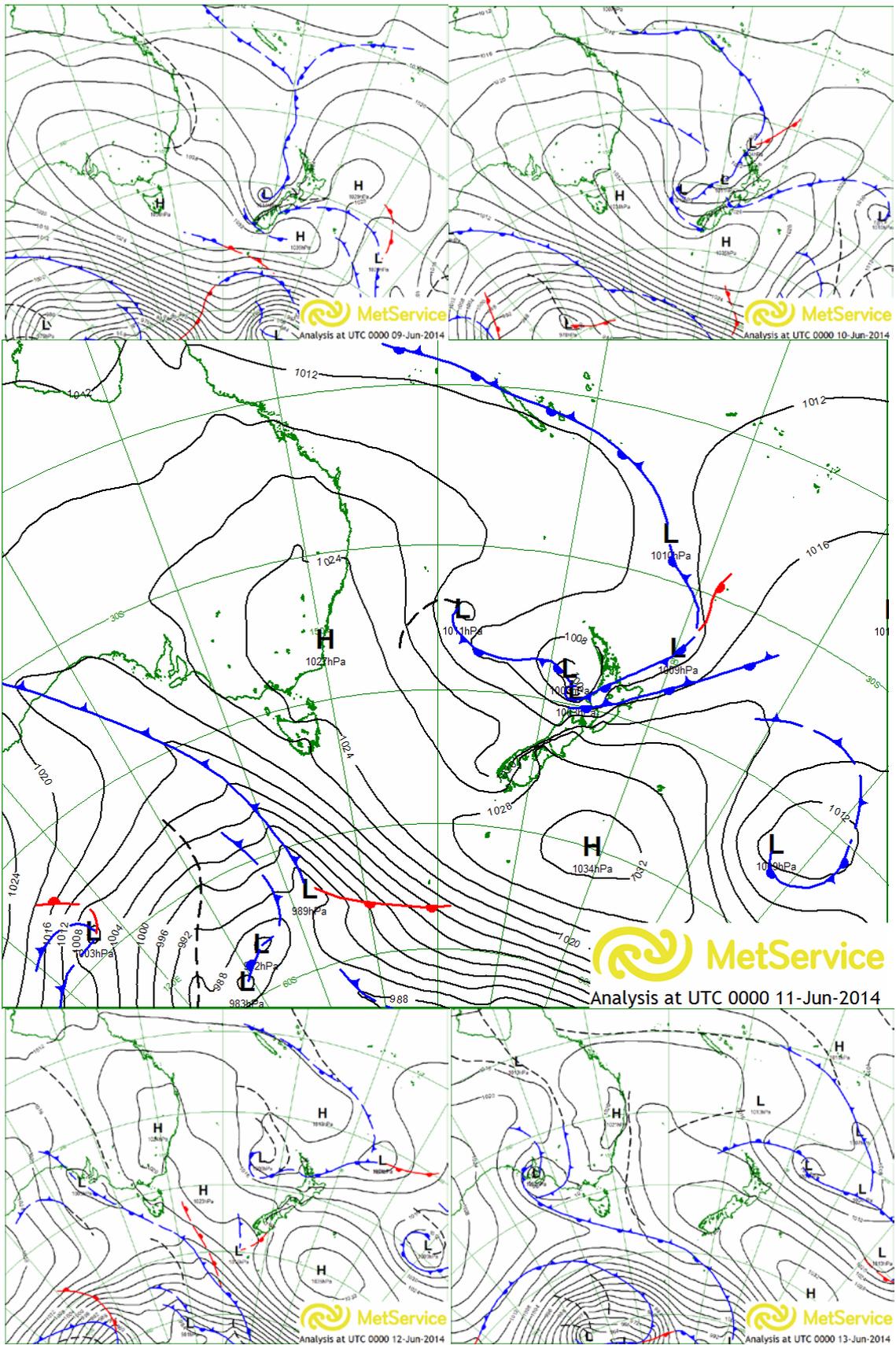


Figure 1: Tasman Sea surface pressure charts for the period 9 June to 13 June 2014
 (Source: MetService)

3 Rainfall

The highest rainfalls recorded during the event were typically in the Coromandel, Hauraki Plains and Lower Waikato (Hapuakohe Range) giving average recurrence interval (ARI) events of 2 - 60 years.

The rainfall received at the gauges has typically not been indicative of the scale of flooding at many locations, i.e.: flood levels were high relative to recorded rainfall totals and intensities. An example of this was the northwest Coromandel catchments, suggesting high spatial variation in rainfall and localised high intensity events. Rainfalls recorded over the region for the June 2014 event are described below and detailed in Figure 2 and Table 1.

In the Coromandel Ranges recorded rainfalls at Castle Rock, Pinnacles and Golden Cross were typically of 2-5 year ARI or less across durations up to 72 hours. 24 hour totals were 160 mm to 250 mm, with 72 hour totals 220 mm to 365 mm. Anecdotal reports from private local gauges in northwest Coromandel were 250 mm to 300 mm in three hours, and 450 mm in six hours (Adam Munro pers. comm.). These rainfall totals are considerably higher than those reflected at the Waikato Regional Council gauges and are indicative of the damage received in the northwest Coromandel as described later in this report. The reported anecdotal rainfall totals are well in excess of 100 year ARI, but are difficult to ascertain due to lack of measured intensity data.

The Waihou gauges received <2 - 5 year ARI rainfalls for durations up to 24 hours, and up to 5 - 10 year ARI for 48 to 72 hour durations with rainfall depths of 135 mm to 180 mm. Again the rainfalls received at the gauges are not indicative of the degree of flooding that eventuated in the Waihou River.

Piako rain gauges recorded <2 - 10 year ARI events with 60 mm to 80 mm in 24 hours, and 100 mm to 120 mm in 48 hours.

The highest rainfalls recorded were from the Maungakawa gauge in the Maukoro Canal and Matahuru catchments which received totals up to 60 year ARI with 90 mm in six hours, 148 mm in 48 hours, and 165 mm in 72 hours.

Waikato and Waipa rain gauges were typically <2 and up to 5 year ARI for durations up to 24 hours. The Ruakura gauge in Hamilton received 136 mm in 72 hours considered a 10 - 20 year ARI event. Lake Taupo gauges were typically also <2 - 5 year ARI with up to 120 mm in 72 hours.

In the west of the region high rainfalls were recorded at Waitetuna and Waingaro with 72 hour totals of 150 mm and ARI's of 5 - 20 years.

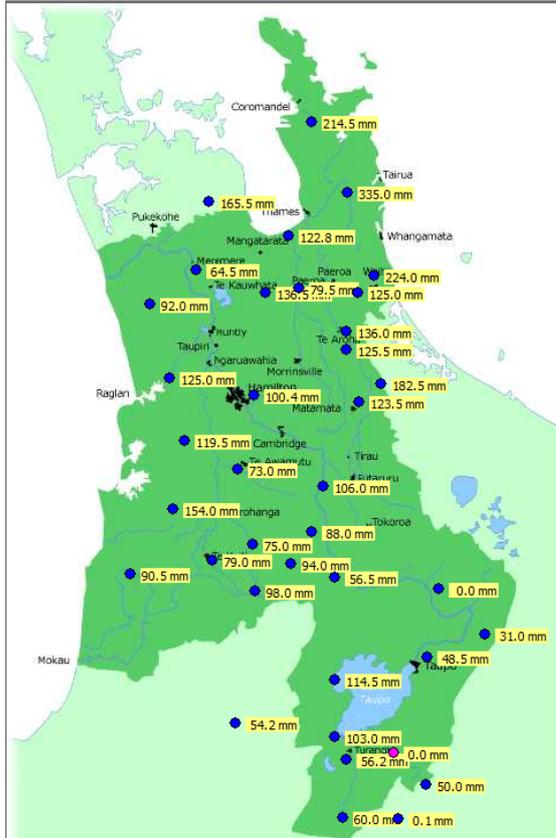
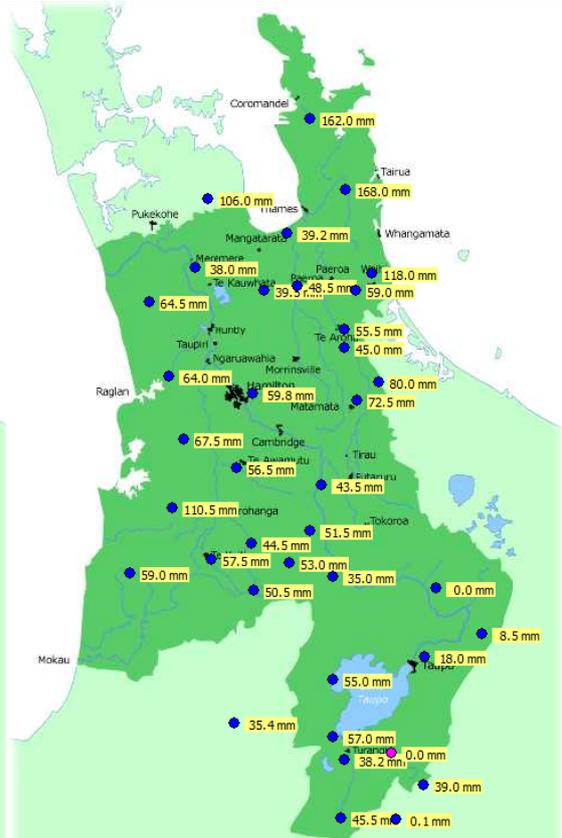
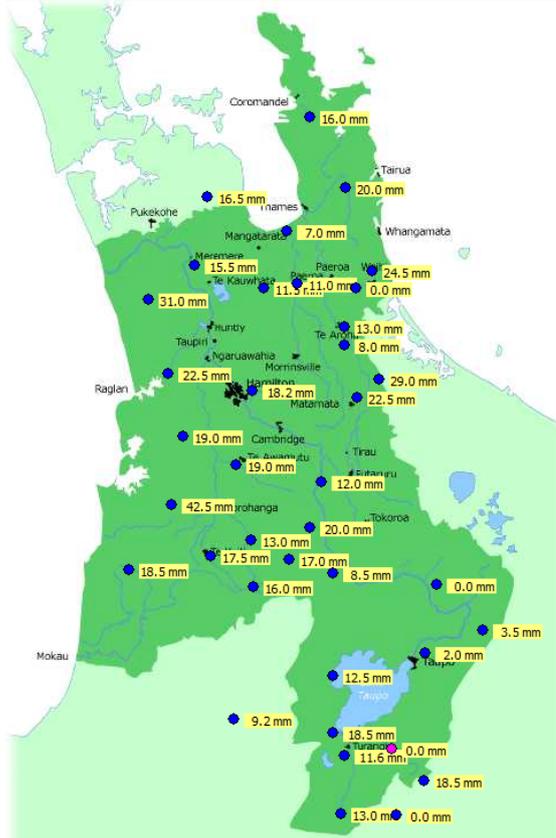


Figure 2: Rainfall totals for the period 00:00 9-13 June 2014 (sourced from Jones, 2014)

RAINGAUGE	Site No.	10 min		20 min		30 min		60 min		2 hour		6 hour		12 hour		24 hour		48 hour		72 hour	
		Rain	Rtn Pd	Rain	Rtn Pd	Rain	Rtn Pd	Rain	Rtn Pd	Rain	Rtn Pd	Rain	Rtn Pd								
Awaroa at Hauturu	36.5	6.5	<2	8.5	<2	11.5	<2	17	<2	22	<2	38	<2	57	<2	87	<2	134.5	<2	192.5	2 to 5
Kaawa at Wairamarama	201.4	4	<2	6	<2	7	<2	10	<2	16.5	<2	25.5	<2	31.5	<2	56.5	<2	89.5	<2	92.5	<2
Kaihere at Maungakawa	204.1	9.5	<2	16	2 to 5	19.5	2 to 5	35	10	53.5	20 to 30	90.5	30 to 60	103	30	111	10 to 20	147.5	20 to 30	165	20
Kauaeranga at Pinnacles	234.9	9	<2	14	<2	19	<2	35.5	2 to 5	65.5	2 to 5	135	2 to 5	193	2 to 5	248	<2	327	<2	364.5	<2
Mangaokewa at Te Kuiti	414.13	2.5	<2	3.5	<2	5.5	<2	9.5	<2	11	<2	22.5	<2	37	<2	51	<2	66	<2	112	2
Mangaokewa at Wharekiri	414.21	2	<2	4	<2	5.5	<2	8.5	<2	13	<2	21.5	<2	31.5	<2	54	<2	91	<2	111.5	<2
Mangaotaki at Waitanguru	428.4	2	<2	3.5	<2	4.5	<2	7.5	<2	12	<2	31.5	<2	44	<2	50.5	<2	85	<2	120.5	<2
Mangatangi at Dam	453.4	5.1	<2	9.2	<2	14.1	<2	24.2	2	41.7	5	57.5	2 to 5	76.5	2 to 5	128.6	5 to 10	163	5 to 10	171.9	5 to 10
Matawai at Castle Rock	534.1	5	<2	9	<2	12.5	<2	24.5	<2	43.5	<2	79	2	106	<2	185	2 to 5	212.5	2 to 5	223	<2
Ohinemuri at Queens Head	619.19																				
Otupoto at Otaipuhe	1882.2	3.5	<2	6.5	<2	9	<2	13.5	<2	21	<2	43	2	47.5	<2	62	<2	107	2 to 5	123.5	2 to 5
Piako at AppleTree Flood Pump	749.67	7.6	<2	10.8	<2	15.8	<2	24.8	2	46.4	5 to 10	52.8	2 to 5	57.2	2 to 5	84	2 to 5	118.8	5 to 10	129.6	5 to 10
Piako at Maukoro Landing	749.12	4	<2	5.5	<2	8	<2	12.5	<2	20.5	<2	38	<2	53	2	58	<2	100	5 to 10	119.5	5 to 10
Puniu at Bartons Corner Rd	818.2	3.5	<2	4	<2	4.5	<2	8	<2	13.5	<2	27	<2	42	<2	48.5	<2	70.5	<2	108.5	<2
Puniu at Ngaroma	818.7	2.5	<2	4.5	<2	6.5	<2	12	<2	16	<2	29.5	<2	37.5	<2	49.5	<2	87.5	<2	111.5	<2
Rapurapu at Kaimai Summit	872.4	4.5	<2	7	<2	9	<2	15.5	<2	25.5	<2	45	<2	70.5	<2	106	<2	160.5	<2	198	2
Tamihana at Matamata Aerodome	1345.1	6.5	<2	7	<2	8	<2	14	<2	17.5	<2	40.5	<2	51.5	<2	70.5	<2	134.5	5 to 10	167	5 to 10
Waihou at Te Aroha	1122.34	3.5	<2	6	<2	8.5	<2	16	<2	29	<2	66.5	2 to 5	81.5	2 to 5	104	2 to 5	155	5 to 10	178.5	5 to 10
Waikato at Ruakura*	1131.168							10.8	<2	15.6	<2	38.6	<2	54.2	2 to 5	61.2	<2	99.4	2 to 5	136.2	10 to 20
Waingarō at Ruakiwi Rd	1167.4	5.5	<2	9	<2	12	<2	17.5	<2	24.5	<2	48	2 to 5	48.5	2 to 5	81.5	2 to 5	121	5 to 10	147.5	10 to 20
Waipa at Otewa	1191.7	3.5	<2	5	<2	6.5	<2	9	<2	15	<2	22.5	<2	40	<2	57.5	<2	76.5	<2	108.5	<2
Waitekuri at Golden Cross	1239.15	5.5	<2	9	<2	12.5	<2	23	<2	36.5	<2	79.5	<2	103	<2	156.5	<2	230.5	<2	308	2 to 5
Waitetuna at Karamu	1247.38	8	<2	11.5	<2	14.5	<2	18	<2	25	<2	38.5	<2	50	<2	71.5	<2	114.5	2 to 5	152	5 to 10
Whangamarino at Control Structure	1293.6	2.5	<2	3.5	<2	5	<2	9	<2	16	<2	24.5	<2	28.5	<2	42	<2	62	<2	65	<2

Note: provisional raingauge records vs HIRDSv3 return period

Table 1: Rainfall depths and return periods for selected Waikato Regional Council rainfall stations for event of June 2014 (sourced from Jones, 2014)

4 River flows and levels

Very high river flows and levels were experienced in many Coromandel, Waihou Piako, and Lower Waikato catchments during the event. A summary of peak river levels and flows at key locations is provided in Table 2. A description of river flows and levels within the various zones follows.

Zone	Recorder site	Catchment	Peak level (m)	Flow (m ³ /s)	Event rise (m)
Coromandel	Smiths	Kauaeranga River	11.76	1033	5.5
	Broken Hills	Tairua River	4.27	351	2.7
Waihou Piako	Okauia	Waihou River	32.03	304	5.3
	Te Aroha	Waihou River	11.54	342	4.3
	Karangahake	Ohinemuri River*	15.36	352	3.5
Lower Waikato	Mercer	Waikato River	4.08	808	2.4
	Lake Waikare	Waikato River	5.96	n/a	0.44
	Matahuru	Matahuru	9.92	181	4.3
	Jefferis	Mangawara	20.67	76	4.0

* highest of 3 flood peaks

Table 2: Peak river levels and flows at key locations

4.1 Coromandel

The northwest Coromandel clearly received intense heavy rainfall and whilst not recorded at the Waikato Regional Council rainfall gauge sites (section 3), the intensity is particularly evident in the high flows and flood damage received between Waiaro Bay and Port Jackson. There are no river flow gauge sites in this heavily affected area. Waikato Regional Council flow gauge sites on the Coromandel are at Tairua, Opitonui and Tapu, the recorded flows and water levels are shown in Table 3 and Figure 3. The flooding and damage received in the Coromandel is described in more detail in section 5.1.

Gauge Site	Peak flow (m ³ /s)	Peak water level (m)	Peak Ttme (day – 24 h)	Estimated ARI (years)
Tairua	352	4.27	11 June 04:30	2
	276	3.89	12 June 02:00	<2
Opitonui	255	4.02	11 June 03:00	n/a
Tapu	48	n/a	11 June 04:00	<2

Table 3: Coromandel peak flows and water levels for 11-13 June 2014

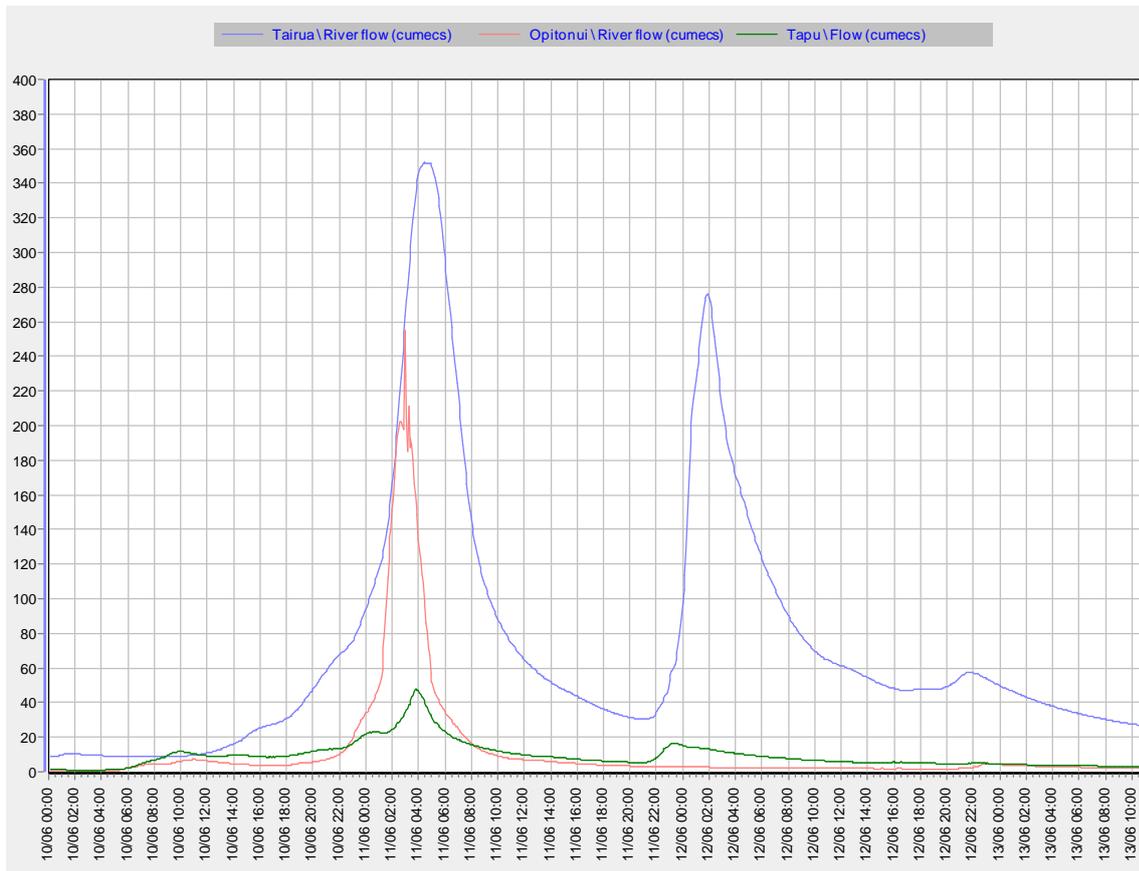


Figure 3: Flows recorded at Tairua, Opiotoni and Tapu gauges sites 10-13 June 2014

4.2 Waihou Piako

4.2.1 Kauaeranga River

The Kauaeranga River had its highest flows since 1990 when the scheme became operational with a significant flow passing over the spillway and State Highway 25 to the Firth of Thames.

At the gauge site the flow peaked at 04:55 on 11 June at 1033 m³/s (Figure 4) with a level of 11.77 m. The spillway was likely active for approximately two to three hours in the early hours between 03:00 and 06:00 hours. The high flows coincided with the high tide recorded at the Tararu tide gauge of 2.13 m at 05:19 on 11 June (Figure 4). A significant storm surge component is also noted with water levels 0.5 m to 0.7 m greater than the preceding and following high tides as described in section 4.5.

The peak flow was in the 20 - 50 year ARI range based on the design and statistical analyses in Grant, 2014. Analysis for this report of annual maxima from 1980 to present indicates the event was a 35 year ARI event.

A debris line extent survey of the Kauaeranga River spillway was undertaken as a means of confirming its operational effectiveness and level of service (noting that the spillway was designed to operate in events greater than a 5 year ARI).

The event provides a future opportunity to re-run the existing river model and calibrate modelled water levels against surveyed debris lines. This will allow a check on the scheme design performance levels.

Flooding and damage as a result of the event is described in section 5.2.1.

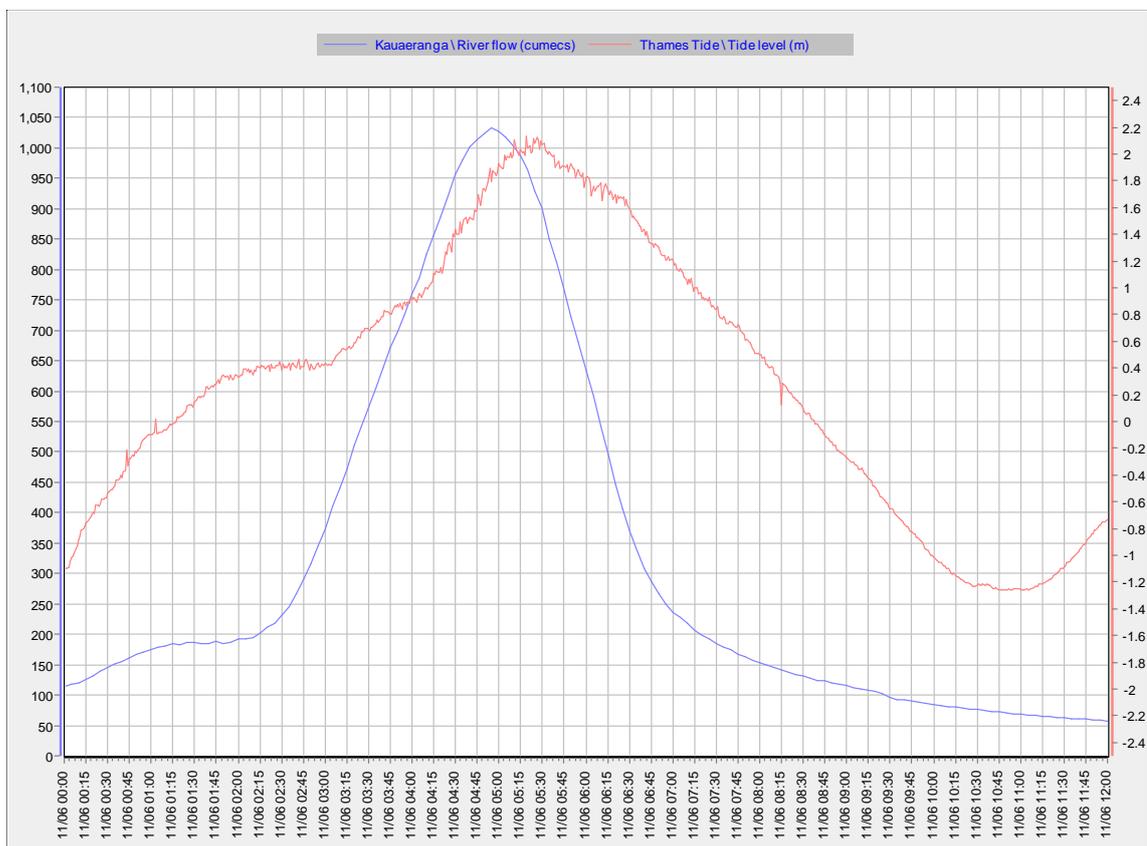


Figure 4: Flow recorded at Kauaeranga gauge and Tararu tide levels midday 10 June to midday 11 June 2014

4.2.2 Waihou River

Very high flows were experienced in the Waihou River during this event with peak flood levels occurring on 12 June (Figure 5).

At Okauia, the most upstream recorder site, a peak flow of 304 m³/s (32.04 m) occurred around midday on the 12 June.

At Shaftesbury above Te Aroha the flood peaked around 16:00 hours at 523 m³/s (18.53 m).

Downstream at Te Aroha, the peak occurred around 19:00 at 342 m³/s (11.54 m). Note that the flows at Te Aroha are less than those recorded upstream at Shaftesbury, this is possibly as the river is slightly throttled by the road and rail embankments which cross the floodplain upstream of the gauge site and flood storage is provided on the extensive upstream floodplain. It could also indicate a gauging/rating issues.

The flows recorded at all three of the above sites are the highest in the readily available record dating back to 1982. The flow recorded at Te Aroha equates to an ARI of approximately 10-20 years, based on analysis of annual maxima from 1965 to 2012.

Downstream of Te Aroha at Tirohia, a peak flow of 343 m³/s (5.88 m) was recorded at 05:00 13 June. This flow appears to be low and warrants further investigation e.g. rating curve.

The Ohinemuri at Karangahake had two flood peaks on 12 June at 06:00 and 17:00 of 243 m³/s and 352 m³/s, at 14.73 m and 15.37 m respectively. These flows are less than a two year ARI event.

At Puke Bridge at the confluence of the Waihou and Ohinemuri Rivers flood levels peaked at 4.19 m around midnight of 12 to 13 June.

Peak flows and levels in the Waihou and Ohinemuri at the various gauge sites are shown in Table 4 and Figure 5.

Gauge Site	Peak flow (m ³ /s)	Peak water Level (m)	Peak time (day – 24 h)	Estimated ARI (years)
Waihou:				
Okauia	304	32.04	12 June 12:00	n/a
Shaftesbury	523*	18.53	12 June 16:00	n/a
Te Aroha	342	11.54	12 June 19:00	10-20
Tirohia	343*	5.88	13 June 05:00	n/a
Ohinemuri:				
Karangahake	243	14.73	12 June 06:00	<2
	352	15.37	12 June 17:00	<2

* anomaly warranting further investigation.

Table 4: Waihou and Ohinemuri River peak flows and water levels for 11-13 June 2014

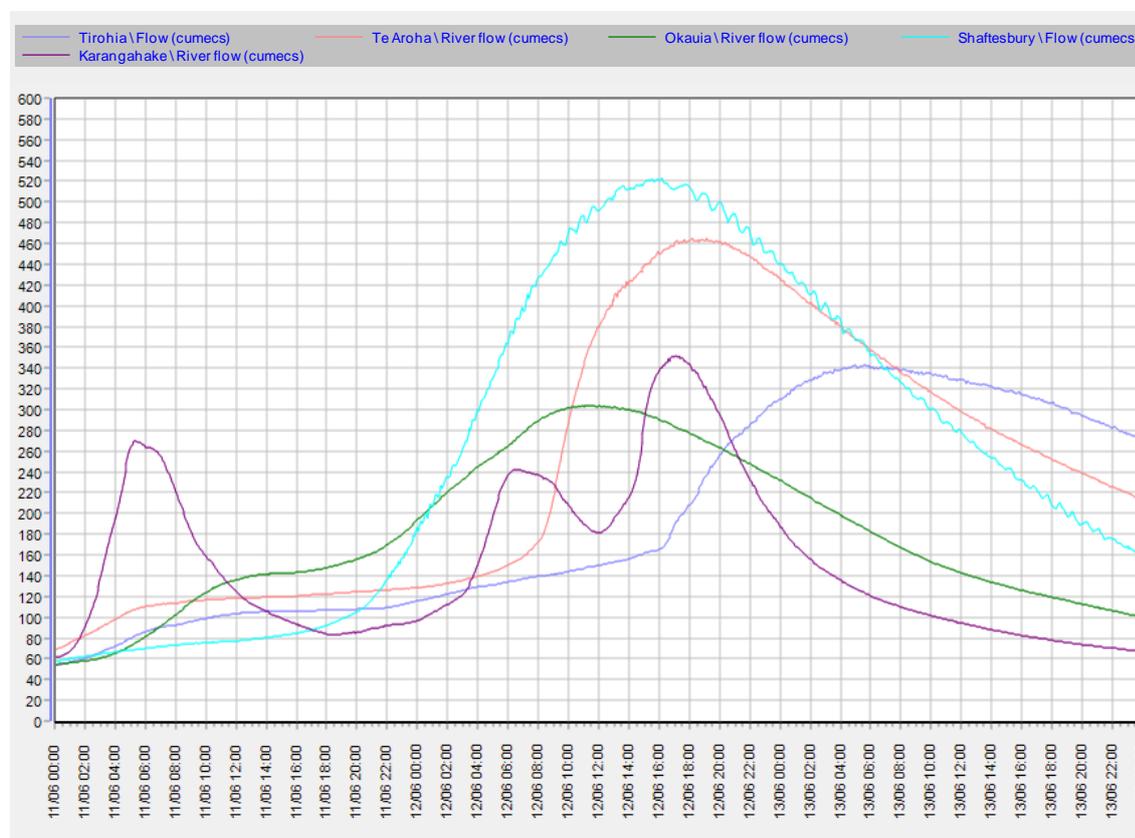


Figure 5: Flows recorded in the Waihou and Ohinemuri Rivers 11 June to 13 June 2014

4.2.3 Piako and Waitoa Rivers

Peak flows and levels in the Piako and Waitoa Rivers at the various gauge sites are shown in Figure 6, Figure 7 and Table 5.

The recorded flows and levels are of the order of a 2 - 10 year ARI event, with a 50 year ARI event in the upper Waitoa.

Gauge Site	Peak flow (m ³ /s)	Peak water level (m)	Peak time (day – 24 h)	Estimated ARI (years)
Piako:				
Kiwitahi	60	4.08	12 June 15:30	5-10
Piako P-T Road	122	6.87	13 June 09:00	5-10
MaukoroLanding	n/a	2.56	14 June 23:00	2-5
Waitoa:				
Waharoa	49	47.23	13 June 15:00	50
Mellon Road	61	8.42	14 June 07:00	5-10

Table 5: Piako and Waitoa River peak flows and water levels for 11-13 June 2014

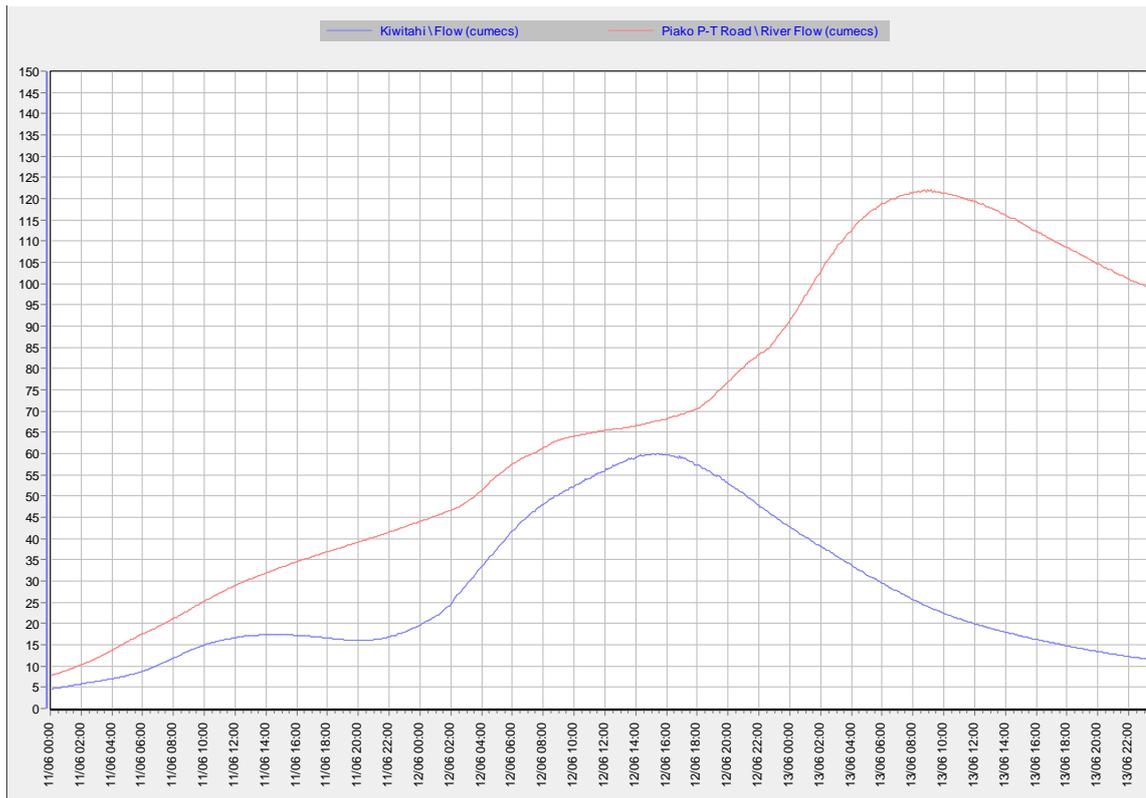


Figure 6: Flows recorded in the Piako River 11 June to 13 June 2014

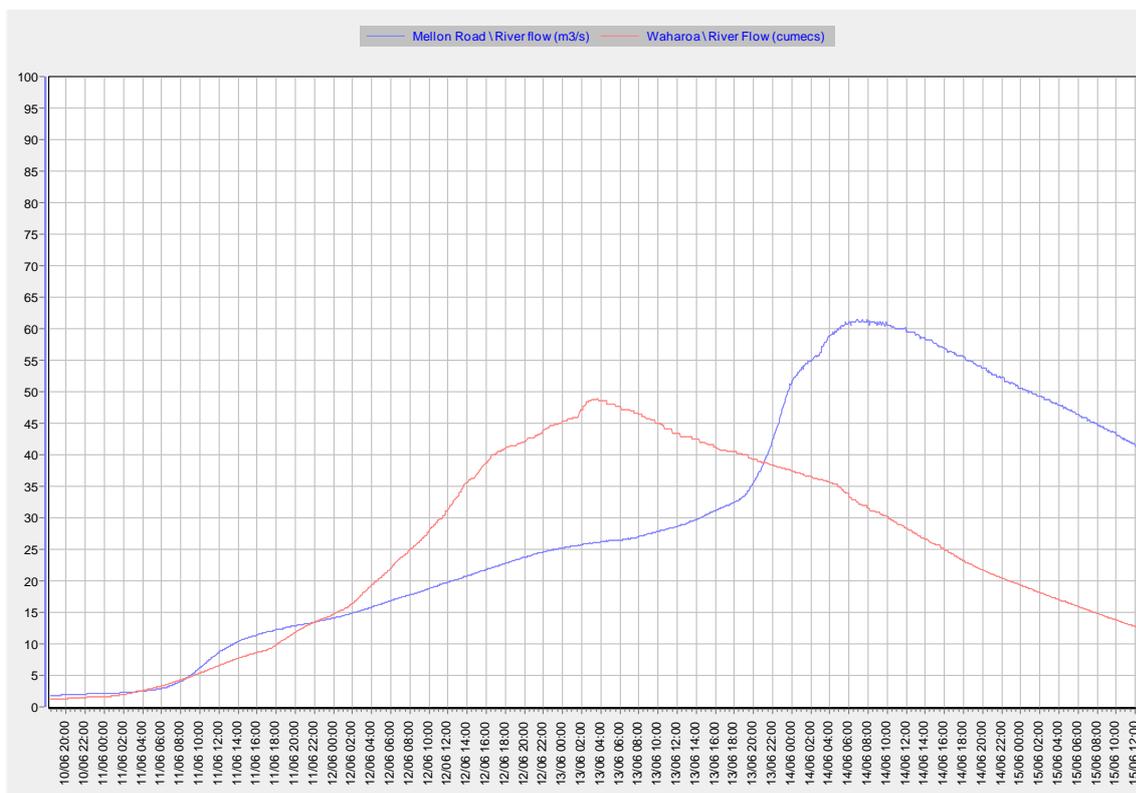


Figure 7: Flows recorded in the Waitoa River 11 June to 15 June 2014

4.3 Waikato and Waipa

4.3.1 Waipa River

Peak flows and levels in the Waipa River at the various gauge sites are shown in Table 6 and Figure 8. These flows are of the order of a two year ARI or less.

Gauge	Peak flow (m³/s)	Peak water level (m)	Peak time	Estimated ARI (years)
Te Kuiti	32	50.33	12 June 16:10	<2
Otewa	83	77.07	12 June 13:00	<2
Otorohanga	163	32.15	12 June 18:55	<2
Pirongia	332	n/a	13 June 23:05	n/a
Whatawhata	376	16.26	14 June 09:05	~2y

Table 6: Waipa River gauge peak flows and levels for 11 June to 15 June 2014

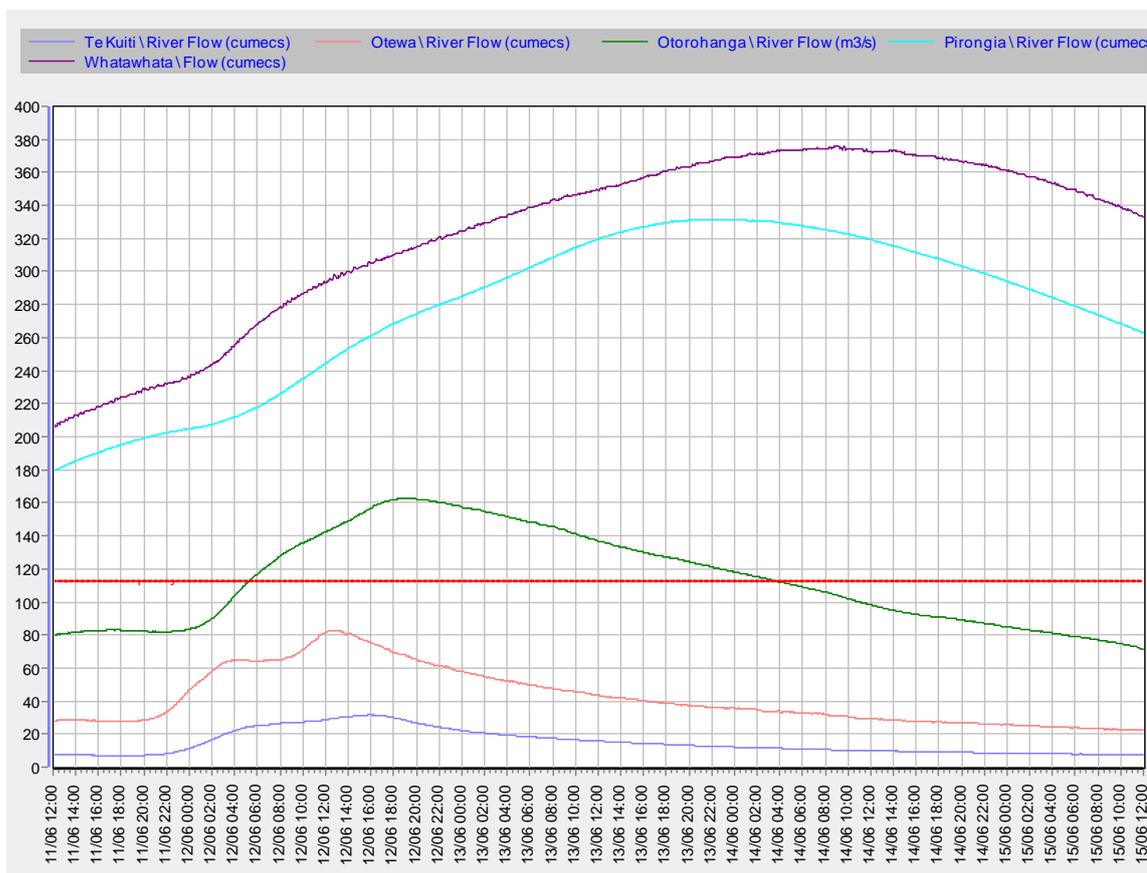


Figure 8: Flows recorded in the Waipa River 11 June to 15 June 2014

4.3.2 Waikato River

Peak flows and levels in the Waikato River at the various gauge sites are shown in Figure 9 and Table 7.

These flows are less than 2 - 5 year ARI events. Heavier rainfall was recorded in the Lower Waikato (Maungakawa) and resulted in higher ARI flows in the Mangawara of 5 - 10 year ARI, and also the Matahuru which had very high flows estimated at a 75 year ARI event.

Gauge	Peak flow (m ³ /s)	Peak water level (m)	Peak time	Estimated ARI (years)
Waikato River:				
Cambridge	508	n/a	12 June 15:10	<2
Hamilton	495	14.69	13 June 01:00	2-5
Ngaruawahia	796	11.73	13 June 05:20	2-5
Huntly	881	9.67	13 June 08:15	2-5
Rangiriri	831	7.58	13 June 12:20	<2
Mercer	808	4.08	14 June 14:45	<2
Mangawara River	76	20.67	12 June 07:05	5-10
Lake Waikare & Whangamarino:				
Lake Waikare	n/a	5.96	17 June 00:10	n/a
Matahuru	181	9.93	12 June 05:50	75
Mangatangi	54	12.01	11 June 10:15	2-5
Ropeway	n/a	4.09	16 June 10:40	<2

Table 7: Waikato River gauge peak flows and levels for 11 June to 17 June 2014

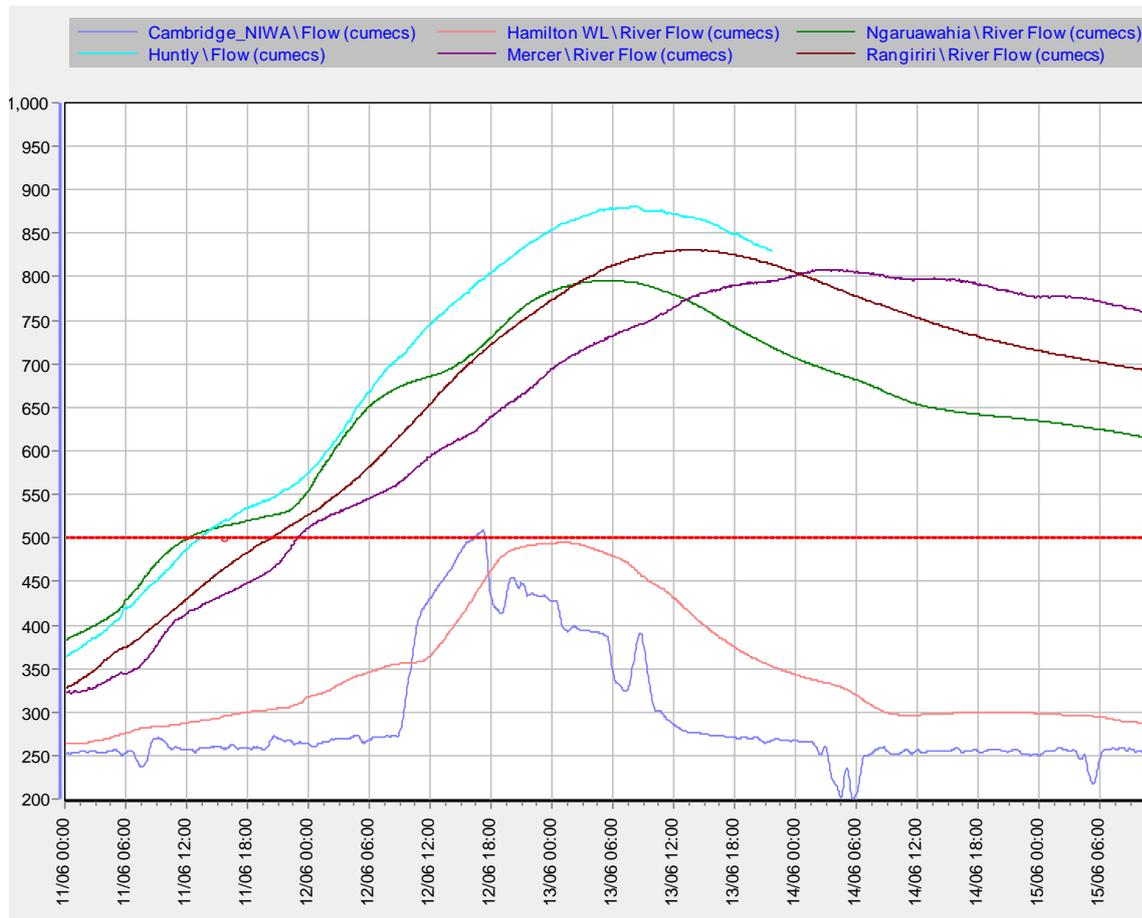


Figure 9: Flows recorded in the Waikato River 11 June to 15 June 2014

4.4 Hauraki pumps

During the event most pumps were above duty start level including:

- Ahikope
- Alexanders
- Bancrofts
- Mangawhero
- Mill Road 1 and 2
- Paeroa Main Drain
- Pouarua
- Stocks

4.5 Coastal observations

Elevated coastal water levels were experienced in the Firth of Thames and the east coast of the Coromandel Peninsula as a result of direct onshore winds and high seas during the event (Table 8). The Tararu and Whitianga tide gauge levels during the event are shown in Figure 10. Whilst the records show the peak water levels experienced, these are relatively common and would be expected several times during the year.

While the waves experienced were large they were not uncommon for the east coast, however the wave conditions were sustained over a long period of approximately 4 days or 8 high tides. Some east coast beaches, particularly Whangapoua, experienced a significant degree of erosion as a result. If the storm had produced very low air pressures and had occurred over a spring or king tide then increased coastal erosion and inundation could have caused significantly more issues

Recorder site	Sea area	Peak tide level (RL m)	Previous and following high tides (RL m)
Whitianga	Coromandel - east	1.4	1.0 – 1.2
Tararu	Firth of Thames	2.1	1.4 – 1.6

Table 8: Peak tide levels

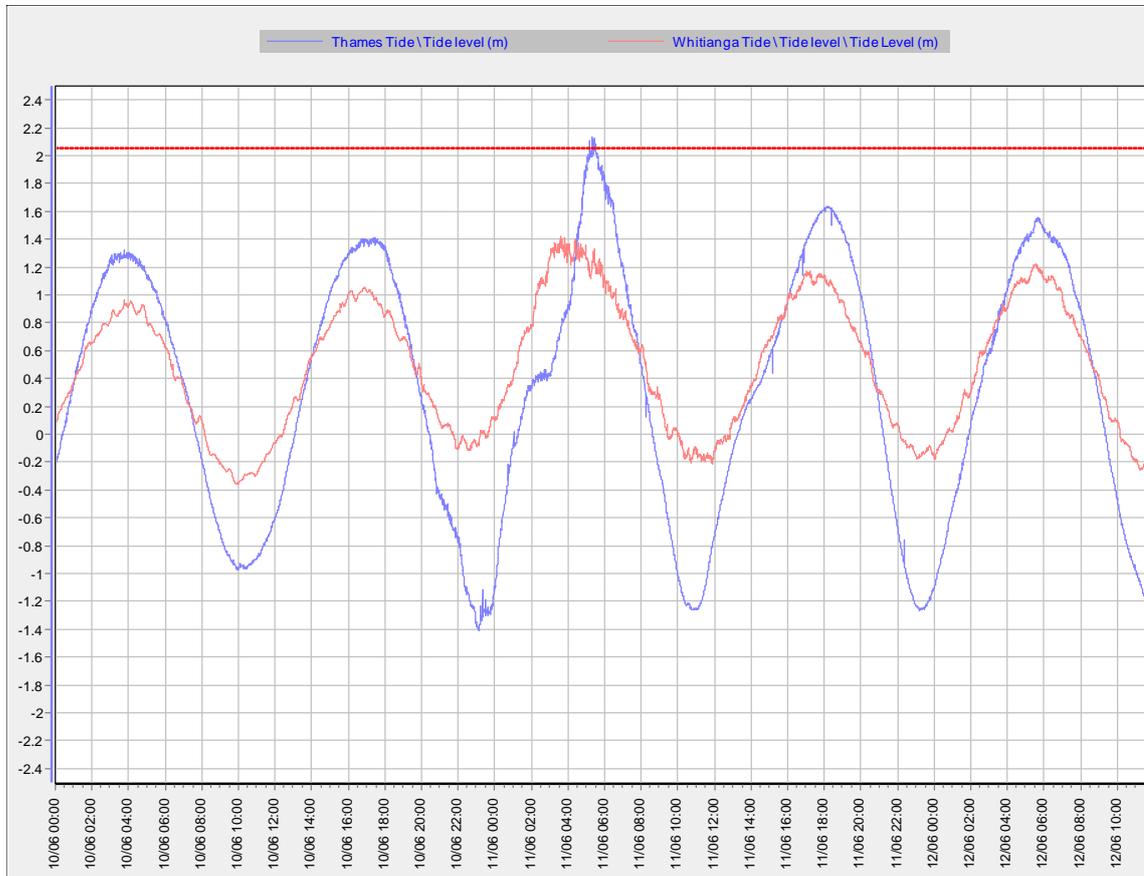


Figure 10: Thames and Whitianga tide gauge levels for the period 10 June to 12 June 2014

5 Flooding and damage

The June 2014 event caused significant flooding and damage primarily in the Coromandel, Waihou Piako and Lower Waikato zones described in the following sections.

5.1 Coromandel

Flooding and damage was received across a number of areas in the Coromandel. The most affected was the northwest peninsula catchments of the Moehau Range, primarily between Waiaro and Port Jackson, including the Ongohi, Ohinewai, Darkie and Pahi catchments (Figure 11 to Figure 16). Damage was also reported in Manaia to the south and Port Charles on the east coast. A further 140 mm of rain (anecdotal) on 12 July required and additional week of work for three excavators on gravel management.

In the northwest the June event caused significant damage to property and infrastructure including upper catchment slips, significant downstream sediment and debris deposition, channel blockages, channel redirection, a bridge washout, and flooding of farm buildings and one house.

Whilst there are no Waikato Regional Council rain gauges in the far north of the Coromandel, anecdotal reports describe rainfall intensities well in excess of 100 year ARI as described in section 3.

Reports from the public were first received on Thursday 12 June. Waikato Regional Council responded quickly to the event undertaking both ground and aerial inspections to gauge the extent of damage and the response needed. Council contractors were on-site within three days of the event. Connections were made with Thames Coromandel District Council, Civil Defence, Department of Conservation and Rural Support Trust. Councillors Graf and Husband also visited the area, meeting with landowners and residents.

On-site physical stream works carried out by council involved:

- Removing debris and blockages from streams.
- Redirecting streams back to channel.
- Clearing debris and material 10 metres back from the bank streams.
- Erosion control work.

In total the work involved 9 km of channel works over 13 streams and tributaries and almost 900 excavator hours. Fencing and any further clearing and burning of debris piles was the landowners' responsibility as part of their contribution to the works.

To date council expenditure in response to this event is in the order of \$187,000 (Beaufill et al., 2014). This includes physical works carried out by contractors, supervision of contractors, liaison with other agencies and communications. The remoteness of this part of the peninsula contributed to costs.

Due to the localised nature of storm events on the Coromandel Peninsula, it was fortunate that the storm was focused in the relatively sparsely populated and undeveloped northwest of the zone. Not to belittle the impact of the storm on the northwest community, but if the storm had been localised in some of the more developed areas of the Peninsula, then the scale of the effects on people and property could have been much worse. These types of events are not 'uncommon' for the Coromandel as a whole and this event heightens the need to be proactive about hazard risks and management.

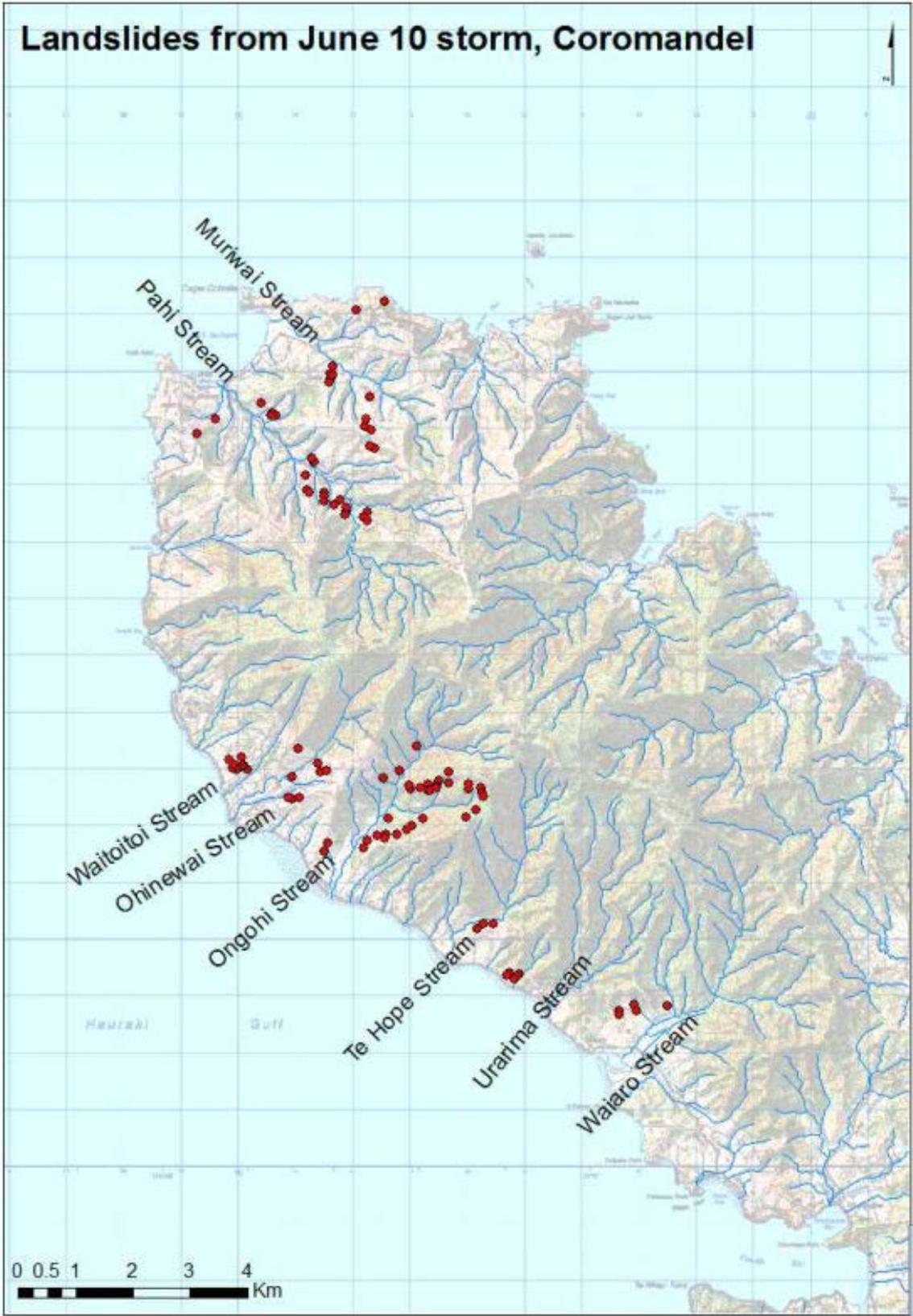


Figure 11: Map of catchment landslides based on helicopter footage/photos taken on flights into these areas – not reflective of landslides over the region as a whole (source: Aerial footage recorded by Kerry Smith, Waikato Regional Council and mapping by Brenda Rosser, GNS)



Figure 12: - Ongohi Stream floodplain debris and silt deposition



Figure 13: - Ongohi stream bridge damage



Figure 14: - Ohinewai stream damage



Figure 15: - Darkie stream damage



Figure 16: - Pahi stream

5.2 Waihou Piako

The Waihou Piako zone received widespread flooding. An aerial inspection was undertaken to determine the extent of inundation and to help prioritise response and remediation work for worst affected areas. Overall, while there was significant and widespread surface water ponding, floodwaters were generally well contained by Council's flood protection assets in this zone. The flooding and damage for each of the main rivers is described in the following sections.

5.2.1 Kauaeranga River

The Kauaeranga River had the highest flow since the scheme was constructed circa 1990. The scheme operated well as per design including spillway operation with significant excess flow discharging over the State Highway, through the Rhodes Park area to the Firth of Thames. The spillway was likely active for approximately 2 to 3 hours in the early hours of 11 June. The biggest loss other than the expected widespread debris and silt deposits across the floodplain, were 95 pregnant ewes that were swept away while grazing the Thames Jockey Club grounds.

5.2.2 Waihou River

Staff visited various sites on the Waihou throughout the event including an aerial inspection on the 12 June.

Flooding was significant particularly in the upper reaches. Upstream of the Ohinemuri the flows and river levels recorded were the highest on the available record since 1982. These flows were estimated as being of the order of 10-20 year ARI event at Te Aroha. The Waihou scheme has a 100 year ARI design standard and overall the scheme performed well as shown in the aerial imagery obtained.

The event provided an opportunity to re-run and calibrate an existing river model in the Te Aroha area. Flood levels were modelled for the recorded discharge at Te Aroha which matched closely with the flood levels recorded at the gauge and also matched

observed flood extents particularly in the Rewi Street area where residential properties received inundation.

Images of the flood inundation from the event are shown in Figure 17 to Figure 23



Figure 17: Waihou River - Kurere stream



Figure 18: Waihou Ohinemuri confluence



Figure 19: Waihou River – Awaiti North



Figure 20: Waihou River - Tirohia to Te Aroha



Figure 21: Waihou River – upstream of Te Aroha



Figure 22: Waihou River –Te Aroha



Figure 23: Waihou River – Rewi Street, Te Aroha

5.2.3 Piako & Waitoa Rivers

In the Piako and Waitoa the event has been estimated as a 2 - 10 year ARI event, with a 50 year ARI event in the upper Waitoa. Flood inundation during the event is shown in Figure 24 to Figure 28.



Figure 24: Waitoa River at Waitoa



Figure 25: Waitoa River at Campbell Road



Figure 26: Waitoa River at Waharoa



Figure 27: Piako River at Swamp Road



Figure 28: Piako River at Tahuna-Patetonga

5.3 Lower Waikato

The most affected areas of the Lower Waikato were largely confined to the tributaries located to the north and east of Huntly, namely the Mangawara and Tauhei Streams, and the Lake Waikare catchments including the Matahuru Stream.

The Matahuru River at Waiterimu Road peaked at 181 m³/s which is the largest event in the available record since 1984, approximately a 75 year ARI event. Significant inundation of the local floodplain and farmland occurred. Flows in the Matahuru and other Lake Waikare catchments contributed to high water levels in the lake. Lake Waikare water levels peaked at 5.96 m, the third highest on record after 2008 (6.07 m) and 1998 (6.30 m).

The Mangawara River peaked at 76 m³/s, within 30 mm of the 1998 peak water levels, with both the Southees and Smiths spillways operating.

The Tauhei also had a reasonable flow, estimated at 13-15 m³/s or approximately a 10 year ARI event at the Tauhei Road Bridge (Murray Mulholland pers comm.).

Operations staff worked all hours of the day checking the performance of Council's flood protection assets including liaising with and supporting landowners and responding to flood pump outages. Pump mechanical failures were recorded at both Mangatawhiri C3 and Motukaraka, but those breakdowns were not caused by the June event itself, but failure due to local issues and age of the assets. Other pump issues were mainly related to power supply failures.

Phase 1 of the Waikato Hydro System High Flow Management Plan was declared for a short time during the event due to flows exceeding 650 m³/s at Ngaruawahia with further heavy rain forecast. Flows in the main Waikato and Waipa Rivers were largely as expected and well within normal operating range throughout the event.

6 Flood management role

The Integrated Catchment Management Directorate's role in flood management is broad and covers the following key elements:

- Flood management (regional hazards team)
 - Provide the overall coordination of the event.
 - Act as technical lead agency for civil defence.
 - Activate and staff the Flood Response Room.
 - Monitor weather, catchment and water level conditions.
 - Assess risks (re: situational awareness).
 - Issue flood warnings and media statements in accordance to agreed procedures.
 - Work with technical and operations staff to confirm priority areas for response.
 - Collaborate with other agencies to ensure collective and coordinated response.

- Flood response (zone staff and technical team)
 - Model river flows and advise the Flood Management team of expected peaks.
 - Collaborate with other agencies to ensure collective and coordinated response.
 - Coordinate flood extent surveys of debris lines.
 - Undertake inspections of scheme assets and associated flood damage.
 - Provide advice and information to the flood management team.

- Flood recovery (zone staff)
 - Provide support for clean up and re-instatement of rivers and catchments.
 - Ongoing advice and support to landowners.
- Flood event reporting (regional hazards team)
 - Review/update plans and procedures (e.g. the Flood Warning Procedures Manual and the High Flow Management Plan).
 - Coordinate the preparation of a formal technical report to document the key features, damage costs, scale, issues, lessons learnt and future actions from the event.

7 Flood management

Following the receipt of severe weather warnings from MetService, Waikato Regional Council flood response staff undertook several proactive actions leading into the event including:

- Assessing current conditions (e.g. catchment wetness) to determine how quickly the catchments would react to the forecasted rain.
- Informing internal and external stakeholders (including RCS Zone Managers, operational staff and CDEM).
- Issuing press statements.

During the event, the Duty Emergency Management Community Safety Programme undertook the following actions:

- Activated the Flood Response Room to coordinate the overall management of the event.
- Issued Flood Advisories including river level warnings.
- Modelled river flows to determine forward peak flows/heights.
- Liaised with RCS operational staff to confirm areas of priority and response.
- Maintained contact with external agencies, particularly MetService, Mighty River Power and Civil Defence.

7.1 Event costs

A summary of the costs incurred from the June event to date for the key zones affected are provided in Table 9.

These costs are funded from their respective zone disaster recovery funds, except for the Lower Waikato which was funded from operational budgets given the low value. Funding from the disaster recovery reserve is allocated based on an assessment of costs resulting from a natural disaster event exceeding a 1-in-20 year level.

The reserves are specifically there for funding repair and restoration of the rivers and streams, and associated flood protection infrastructure. The required amount that is needed for the disaster funds has been assessed on the estimated damage costs to these systems, and other funding mechanisms such as insurance.

The approval of funding to be drawn from the reserve for the stream restoration works will be addressed through the submission of a report to the relevant zone subcommittee/council's Integrated Catchment Management Committee.

The accumulation of the zone and regional disaster reserves is achieved by placing an additional loading of 3% per annum onto the targeted rates for each catchment zone. This additional loading is allocated between the reserves as follows:

- Zone disaster recovery reserve – 1%
- Regional disaster recovery reserve – 2%

Zone	Estimated costs to date	Comments
Coromandel	\$187,000	This includes physical works carried out by contractors, supervision of contractors, liaison with other agencies and communications. An additional 140 mm of rain the area received on 12 July resulted in further works (estimated one week with three diggers on gravel management). The remoteness of this part of the peninsula contributes to cost.
Waihou Piako	\$92,000	Includes the Kauaeranga River, Matatoki River, Ngarua Stream (Piako), Puriri Stream and Warahoe Stream.
Lower Waikato	\$10,000	No major river costs incurred, with the exception of the Mangawara River system. \$10,000 contracted services costs associated with the removal of debris causing blockages and for some minor erosion control works as a consequence of high river flows within the Mangawara. Operations staff spent a total of 2 weeks (approx 50 hours per week) working with machinery to complete this work in the Mangawara.

Table 9: Summary of costs incurred from the June 2014 flood event

8 Key learnings and future actions

The key learnings identified from this event include:

- The emerging inadequacy of the Coromandel zone’s river and flood funding:
 - The zone disaster reserve contribution needs to be reinstated for the coming years and potentially increased to cover risks in these areas.
 - This learning applies to other zones.
- The need to better clarify the roles and responsibilities of council and landowners in respect to stream channel reinstatement work and the clearing up and disposal of flood debris (including who funds).
- The need to increase public education and awareness in respect to areas of flood risk and our flood management role.
- Proactive management of the event is essential for ensuring external agencies and landowners are advised early on of the risk and threat potential so they can marshal resources and/or remove stock/implements out of floodable areas.
- Floods of this nature are not all that uncommon for the region, and as demonstrated by the north Coromandel catchments, debris flows are an ever present threat given our steep terrain and vulnerability to high intensity rainfall events.
 - While large scale events are unlikely to be repeated frequently, in localised catchments, on average we should expect somewhere in the

region to experience a “100 year event” every 1 - 2 years (noting that a number of catchments have already experienced this scale of flooding this year).

9 Conclusions and recommendations

The June 2014 flood event was the most significant since January 2011. The event provided opportunities to test and review procedures and assets, raise council's profile, and train new staff.

The worst affected area was in the northwest Coromandel where extreme localised rainfall resulted in debris flows that caused significant damage to catchments, property and infrastructure. It was fortunate that the event did not affect the more populated and developed areas as the impact on people and property may have been far more severe. The Waihou and some Lower Waikato tributaries also received considerable flooding. In the Waihou zone there was significant and widespread surface water ponding but the scheme assets performed well in containing and directing floodwaters.

Waikato Regional Council's response to the event was swift and effective in respect to the overall management of the event and its provision of river management works and services. There has been widespread and positive community feedback in response to Waikato Regional Council's involvement in this event and follow up.

Based on experiences and learnings from the event it is recommended to:

- Investigate the development of a Waihou River Flood Forecasting model.
- Recalibrate the Kauaeranga River and spillway model.
- Investigate the adequacy the zone river and flood funding, in particular the disaster reserve contribution.
- Clarify the roles and responsibilities of council and landowners in respect to stream channel reinstatement and debris clearance, including funding.
- Increase public education and awareness in respect to areas of flood risk and our flood management role.

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