Office of the **Queensland Chief Scientist**

Flooding in Sandy Creek Catchment, Mackay, following Tropical Cyclone Debbie

An independent assessment

Report to the Minister of Energy, Biofuels and Water Supply

June 2017

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Queensland Chief Scientist

Queensland Government

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1. Executive summary

In March 2017 large areas of the Plane Basin in the Mackay region received very heavy rainfall associated with ex-tropical cyclone Debbie (T.C. Debbie), with 3-day (27—29 March) accumulated rainfall totals exceeding 550 mm at numerous stations. Many areas in the catchment had already experienced rainfall in the week preceding the event.

As a result of this heavy rainfall event, extensive flooding was experienced by communities within the Plane Basin, including North Eton, Eton, Drapers Siding, Homebush, Chelona and Balberra. Kinchant Dam, also located within the Plane Basin, is an off-stream storage facility supplying Eton Irrigation Area with water, holding approximately 62,800 ML of water at an average of 6.8 m depth, with a surface area of 920 ha when full. SunWater is the dam owner and operator.

Community concerns were raised about the operations of the dam and the potential contribution to the magnitude of flooding experienced at this time.

On 6 April 2017, the Queensland Chief Scientist Professor Suzanne Miller received a letter from the Minister for Main Roads, Road Safety and Ports and Minister for Energy, Biofuels and Water Supply, to undertake an assessment of the flooding that occurred in the Sandy Creek Catchment. Scope of the assessment included assemblage and presentation of hydrological and communications data, including the timing and content of messaging to downstream communities.

The Chief Scientist engaged with relevant parties including local communities and sought the advice of experts, as deemed necessary.

The scientific data provided, consistent between all agencies, leads us to conclude rainfall as the dominant source of water flow in the catchment which experienced considerable flooding.

In addition, whilst not designed as a flood mitigation dam, Kinchant Dam did achieve some attenuation of peak flood flows from its catchment. However, given both the relatively small proportion of the overall catchment upstream of the dam and the timing and size of the peak dam outflows, we conclude that early release from the dam would have had little or no significant impact on subsequent flooding, due to the very heavy rainfall experienced.

Community members also noted confusion regarding communications associated with warnings notifications including flooding timing, location and sources; the lead authority to source ‘points of truth’; and co-ordination for local-area assistance.

We suggest that options for delivery of information that are locally targeted and are technologically resilient are implemented. Clarity and consistency of messaging is critical as is clarity of responsibilities in delivering information and services to communities.

We support recent developments including changes to the Queensland Water Legislation (Dam Safety) Amendment Act 2017 and Reviews in Progress through Queensland Government Inspector-General Emergency Management, working across agencies and levels of government, towards continuous improvement of this process.

2. Fast facts

Why is the assessment being undertaken?

- To assemble and assess hydrological conditions and communications associated with flooding experienced by communities in the Pioneer Basin
- To address questions regarding the potential contribution of Kinchant Dam outflows to the magnitude of flooding experienced.

What and who: evidence gathering to inform – summary of process

- Observations, data, records of communication, responsibilities and procedures were sourced from representatives including: the local community, local disaster management groups, Mackay Regional Council (MRC), Queensland Department of Energy and Water Supply (DEWS), Department of Natural Resources and Mines (DNRM), Queensland Department of Science Information Technology and Innovation (DSITI), SunWater and the Bureau of Meteorology (BoM).

Key publications of relevance

- Queensland Government Emergency action plans, including Kinchant Dam[1] and SunWater Kinchant Dam updates[2]
- Inspector General Emergency Management (IGEM) Review of Seqwater and SunWater Warnings Communications 2015—2016[3]
- Queensland Government Water Monitoring Information Portal[4]
- Bureau of Meteorology Pioneer Basin Flood Warning Network[5]
- Mackay Local Disaster Management Group[6] and Mackay District Disaster Management Plan[7]

[1] <https://www.dews.qld.gov.au/water/dams/safety/eap> <http://data.dnrm.qld.gov.au/eap/kinchant-eap.pdf>

[2] <http://www.sunwater.com.au/sustainability/community/living-near-dams/kinchant-dam>

[3] <https://www.igem.qld.gov.au/reports-and-publications/documents/DamWarningsCommunications.pdf>

[4] <https://water-monitoring.information.qld.gov.au/>

[5] <http://www.bom.gov.au/qld/flood/brochures/pioneer/Pioneer_map.pdf>

[6] <http://www.mackay.qld.gov.au/services/emergency_management/disaster_management>

[7] <https://www.police.qld.gov.au/RegionalPolicing/central/Documents/MackayDDMP.pdf>

Snapshot summary of Kinchant Dam and Mackay Region

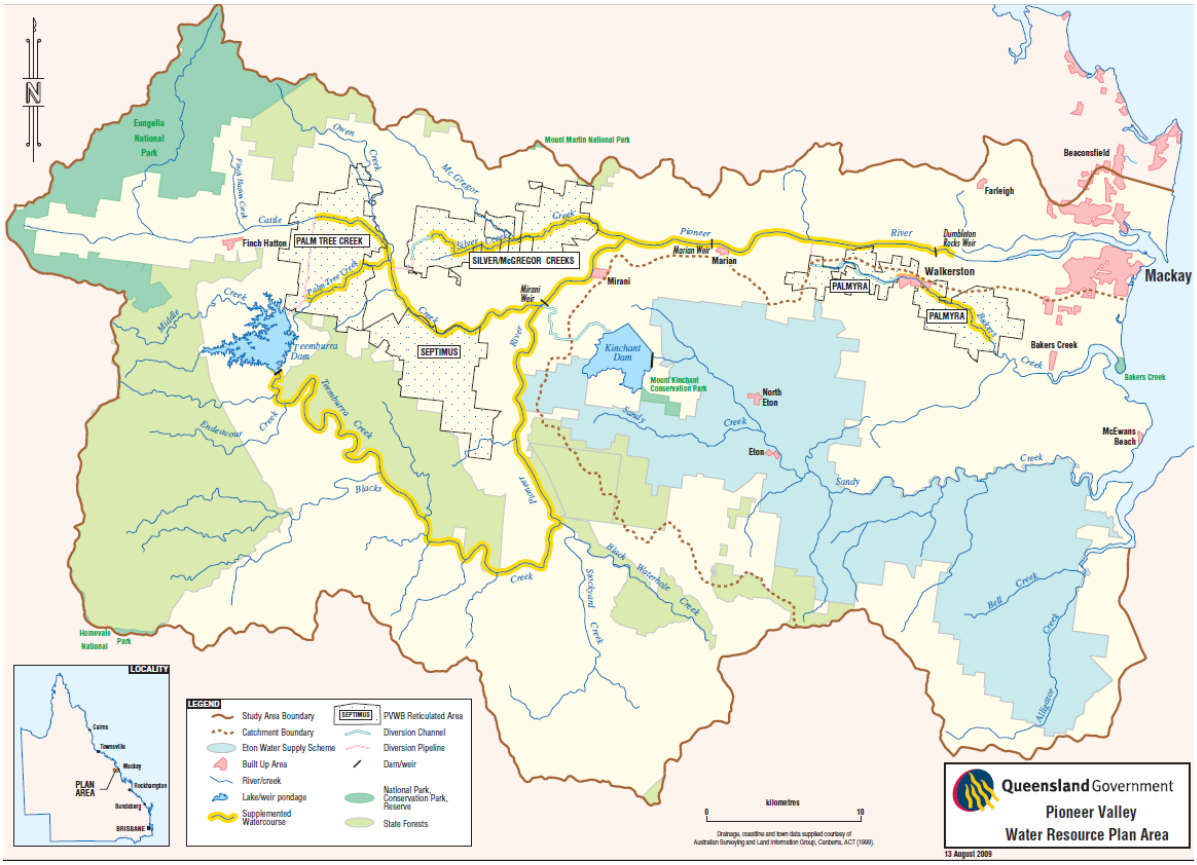


Figure 1. Pioneer Valley Water Resource Plan Area, including Kinchant Dam and downstream communities **Source:** <https://www.dnrm.qld.gov.au/__data/assets/pdf_file/0009/108756/pioneer-planning-area.pdf>

- The Pioneer Valley Water Resource Plan Area (Figure 1) comprises two catchment areas, representing the Pioneer and Plane Basins.
- Kinchant Dam has a small catchment area of approximately 31 km^2, [8] including the lake area itself[9]. A map provided by SunWater illustrates the Kinchant Dam catchment relative to the catchment of Sandy Creek upstream of Eton (Figure 2).
- Kinchant Dam is an off stream storage dam. The dam is filled by a pumped diversion supplied by Mirani Diversion Channel from Mirani Weir from the Pioneer River. Water can leave the dam and enter Sandy Creek below by two means:
    - (i) a regulator, which has a maximum discharge of 1730 ML/day, or approximately 20 m^3/s
    - (ii) an overflow spillway which starts to spill when lake level exceeds 58.21 m AHD (Australian Height Datum)[10].

[8] Note that Dam catchment area (32km^2) differs slightly to catchment area listed in the EAP (31km^2); SunWater advised that the dam catchment boundaries were determined based upon hydraulic modelling review of the catchment, and considering survey / LIDAR information available

[9] <http://data.dnrm.qld.gov.au/eap/kinchant-eap.pdf>

[10] Queensland Department of Science, Information Technology and Innovation, sourced from Kinchant Dam EAP.

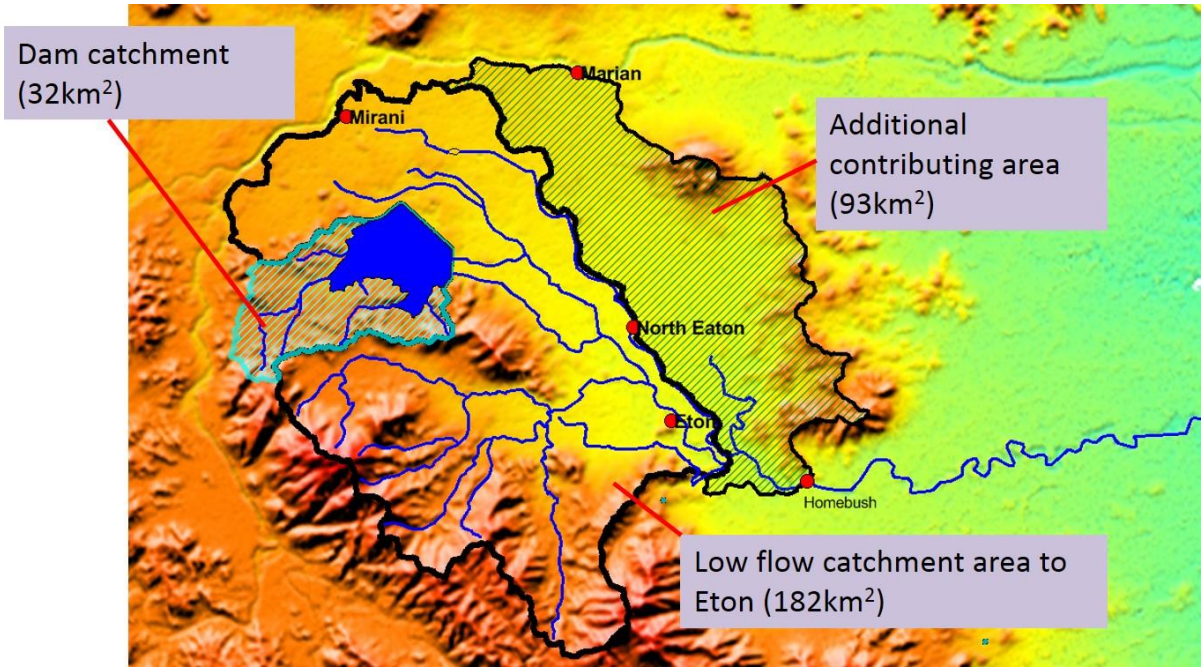


Figure 2. Catchment area at Kinchant Dam, Eton and Homebush, as provided by SunWater.[11] The shaded catchment northeast of Eton may flow into the catchment upstream of Eton in high flows.

- Kinchant Dam is located 14 km upstream of Eton and commands approximately 11.7% of the catchment upstream of Eton. It takes about 2.4 hours flow time from Kinchant Dam to Eton.
- Homebush gauging station (gauge 126001 named Sandy Creek @ Homebush), in the Plane Basin, is located approximately 7.3 km south-east from Eton. It has a total catchment area of between 320 - 330 km^2. It takes about 1.2 hours flow time from Eton to Homebush gauging station.

[11]. SunWater note that the catchment boundaries may not be precise or clearly defined, where elevation is relatively flat; also, that they are dependent on hydraulic assessment at which point high flows break-out from existing catchments / creeks and flow across to adjacent catchments.

3. Introduction

3.1. Terms of reference

The objective of this assessment report is to assemble best-available hydrological data and communication information associated with flooding in the Sandy Creek Catchment, downstream of Kinchant Dam, following T.C. Debbie.

3.2. Assembling the facts: approach

A timeline of events has been assembled and populated with observational data (rainfall and measured water flows) and expert interpretation of model-based information including potentials for Kinchant Dam to provide flood mitigation; flow rates and sources of water flow downstream of Kinchant Dam. Evidence of public communications from responsible parties has been matched against the timeline above.

Evidence-based information: observations and data sourced from:

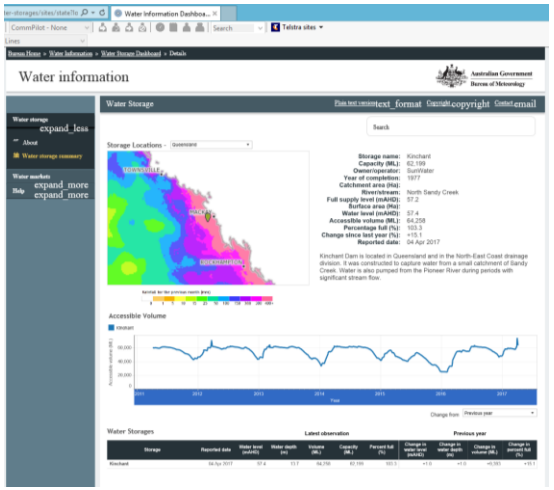
- community (photos, personal experiences)
- publicly available data (Queensland Government,; BoM)
- technical experts (researchers and those providing technical services, such as water testing and monitoring)
- regulatory compliance professionals (SunWater).

3.3. March 2017 flood event: how was information sourced?

3.3.1. Rainfall and Streamflow

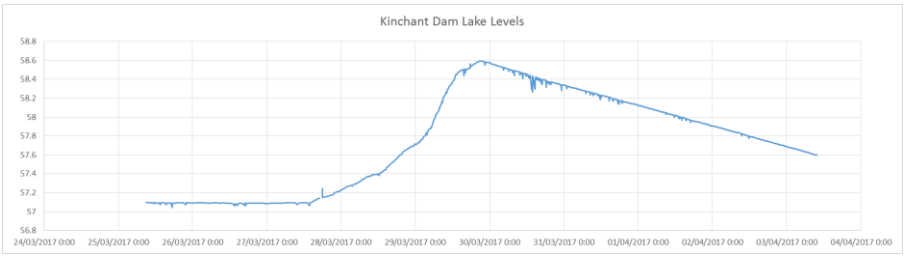
Information regarding rainfall, dam height and water gauging stations was publically available and sourced for this report. Additional information regarding flow rates, interpreted from the dam height and stream gauging station data, was provided by three sources: DEWS, DSITI and SunWater (Figure 3).

March 2017 Flood Event: How is information sourced re: rainfall, Dam Heights, Dam flow and downstream flood volumes?



Bureau of Meteorology (BOM) collect all data from state government agencies and water supply entities, including Kinchant Dam.[12]

SunWater Water Storage Levels [13] provide access to available storage level reports and storage level information, reporting values recorded in a time series window (preceding 5 days only) and redirecting to BOM for historical information.



Storage level data for Kinchant Dam is also provided directly to the Department for Natural Resources and Mines (DNRM) and stored in the Queensland Government electronic data management system (Hydstra). A rating curve is used to convert dam height into discharge data (hourly-interpolated flow, m^3/s).

Rating curves to calculate discharge data area are produced by government departments (DEWS, DSITI) as well as SunWater.

The Kinchant Dam emergency action plan (EAP) [14] prepared by SunWater contains some information re outlet structures and their maximum rates of release.

Figure 3. Overview of data sourcing in relation to rainfall, dam height, dam flow and downstream flood volumes in relation to Kinchant Dam.

[12]<http://reg.bom.gov.au/water/dashboards/#/water-storages/sites/state?location=Queensland&storage=Kinchant>

[13]<http://www.sunwater.com.au/__data/win/reports/win_storages.htm>

[14]<http://data.dnrm.qld.gov.au/eap/kinchant-eap.pdf>

Rainfall data sourced from the publicly available Queensland Government Water Monitoring Information Portal[15], which provides information on the eight open stations within the Pioneer Basin, suggests that most stations received in excess of 500mm rainfall during the 3-day period 27 March to 30 March 2017. A number of stations, including Marian-Eton Road station number 533119 recorded incomplete / missing data. Information provided through SunWater and DEWS, is consistent with these observations. Three-day rainfall totals recorded at rain gauges within and adjoining the Sandy Creek catchment are listed in Table 1, with locations of the gauges shown in Figure 4.

Table 1. Three-day accumulated rainfall totals (9am 27 March 2017 to 9am 30 March 2017)[1]

Name	Description	TOTAL (mm)
Boldon Mirani Rd TM	533154 : RN : Telemeter	687
Brightley TM	533127 : RN : Telemeter	172*
Greenmount ALERT	533058 : RN : Alert	649
Kinchant Dam TM	533124 : RN/RV : Telemeter	583
Marian Weir ALERT	533145 : RN/RV : Alert	899
Marian-Eton Rd TM	533119 : RN : Telemeter	147*
Mirani Weir ALERT	033302 : RN/RV : Alert	587
Mt Vince East TM	533139 : RN : Telemeter	581
Mt Vince West TM	533112 : RN : Telemeter	246*
Munburra Rd TM	533128 : RN : Telemeter	404
Sarich's ALERT	033299 : RN/RV : Alert	612
Walkerston ALERT	533142 : RN/RV : Alert	667
Whiteford's ALERT	033301 : RN/RV : Alert	599
Whiteford's TM	533026 : RN/RV : Telemeter	615

[1]Provided by DEWS. Source: BoM daily rainfall bulletin issues April 3, 2017. *Denotes incomplete or missing data. Description includes BoM station number.

[15] https://water-monitoring.information.qld.gov.au/>

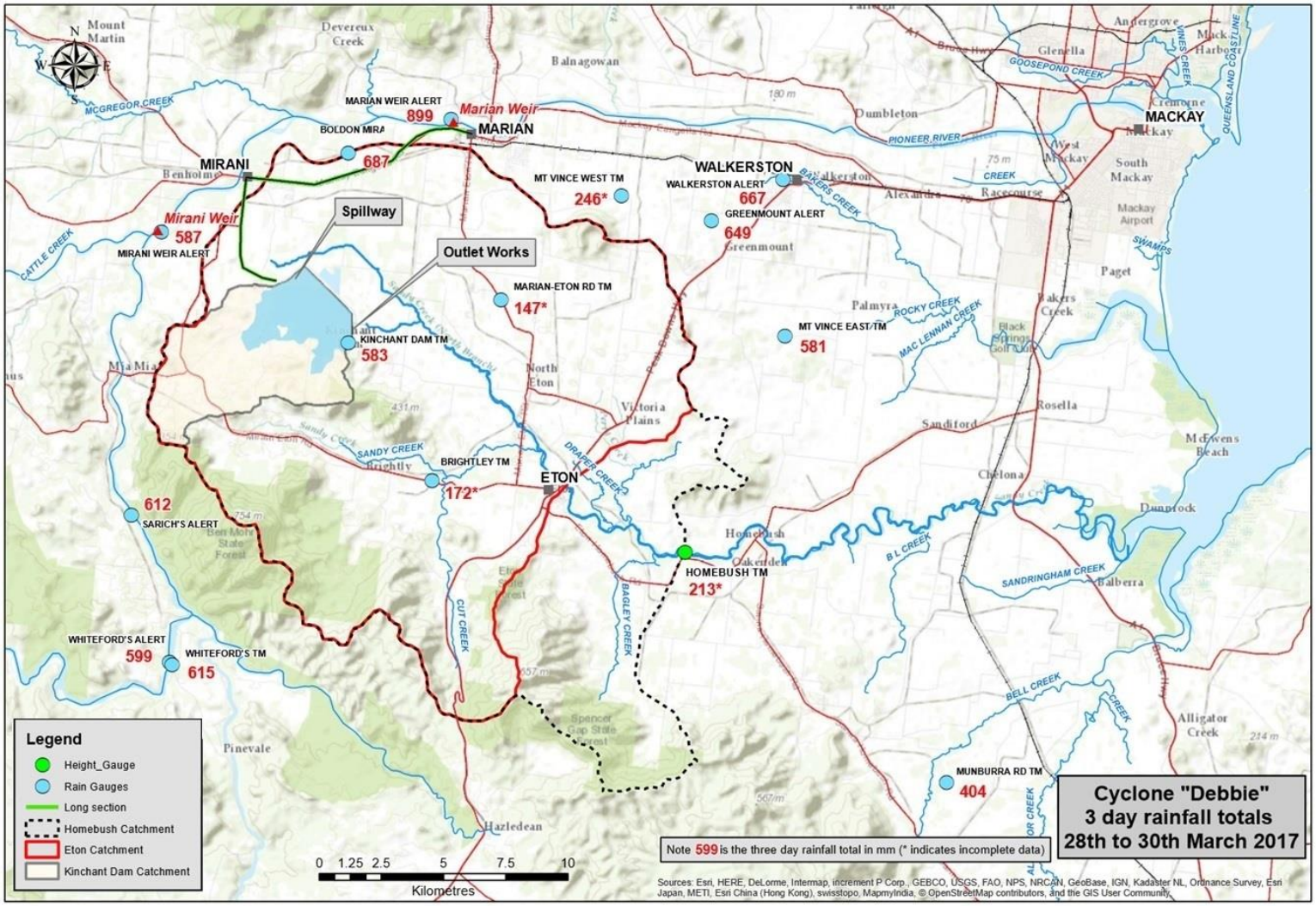


Figure 4. Cyclone Debbie 3 day rainfall totals (28 to 30 March 2017) as provided by DEWS.

Similar three-day daily rainfall totals were reported by Mackay Regional Council (Figure 5) from their live data rainfall and river height reporting system (ENVIROMON, also known as RIVERALERT), which reports live data by the minute on 25 council-owned gauges.

Enviromon Report - GROUP SUMMARY

Report Produced On 16/06/2017 05:02:35 (Local Time)
All timestamps are output in Local Time (E. Australia Standard Time).

START DATE 20/03/2017 9:00
END DATE 3/04/2017 9:00
TIME STEP 24 hours

Data has been calculated in the following manner :-
Cumulative Sensors :- Accumulations
Data interpolation at period end points :- No
Instantaneous Sensors :- Last Reading

==== REPORTS FOR Drainage Area - 125 Pioneer River

PERIOD START	PERIOD END	REENMOU	BAKERS CI	PLEVNA	IDGELAND	EEMBURR	RKE RAN	HITEFORD	ANNAVILL	SARICHS	ARKE RAN	EUNGELLA	ICH HATT	GARGETT	DOWS CK	IRANI WE	UMBLETO	PITAL BRI	MACKAY	ROWALLA	OSEPON	ALKERSTO	MARIAN	SUCROGE	MCCREAD
		5008	5010	6194	6191	6178	6152	6174	6197	6170	6150	6188	5002	6166	6185	6162	6158	5013	6154	5000	5005	5028	5031	5035	5038
		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
Last 10 minutes		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Last 30 minutes		-	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-
Last 1 hour		-	0	-	0	-	-	0	0	-	-	-	-	-	-	-	-	0	0	-	-	0	-	-	0
Last 3 hours		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Last 6 hours		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	2	0	0	0	1
Last 24 hours		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	2	0	0	0	1
2/04/2017 9:00	3/04/2017 9:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	2	0	0	0	1
1/04/2017 9:00	2/04/2017 9:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31/03/2017 9:00	1/04/2017 9:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30/03/2017 9:00	31/03/2017 9:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29/03/2017 9:00	30/03/2017 9:00	293	263	64	70	124	134	155	183	128	125	109	134	160	-	133	268	199	191	205	209	308	311	336	211
28/03/2017 9:00	29/03/2017 9:00	197	119	364	341	288	646	338	443	322	536	221	296	292	-	304	106	129	110	191	133	196	462	203	135
27/03/2017 9:00	28/03/2017 9:00	160	114	140	158	138	340	108	149	162	327	137	139	151	92	150	137	112	113	141	114	164	127	213	133
26/03/2017 9:00	27/03/2017 9:00	18	27	3	4	2	37	0	4	3	37	6	5	2	10	7	24	47	53	45	48	22	8	30	50
25/03/2017 9:00	26/03/2017 9:00	2	1	1	0	1	6	0	0	0	5	1	2	0	0	0	0	1	3	2	1	1	1	0	1
24/03/2017 9:00	25/03/2017 9:00	1	2	1	3	1	5	0	0	2	5	2	2	0	1	0	4	2	3	1	2	5	1	1	5
23/03/2017 9:00	24/03/2017 9:00	54	95	14	13	17	14	26	26	28	13	12	8	12	21	13	68	142	176	87	129	62	19	144	71
22/03/2017 9:00	23/03/2017 9:00	36	48	9	16	39	9	64	34	125	9	29	61	55	77	82	34	19	27	13	10	21	110	42	6
21/03/2017 9:00	22/03/2017 9:00	0	22	4	9	2	27	4	29	15	24	4	4	1	26	1	3	13	30	10	14	1	6	135	50
20/03/2017 9:00	21/03/2017 9:00	23	31	26	7	33	0	76	35	137	0	3	15	9	16	52	69	74	75	53	69	35	25	64	74

Figure 5. Cyclone “Debbie” 3 daily rainfall totals (0900hrs between 20th March and 2nd April 2017) as provided by Mackay Regional Council.

3.3.2. Hydrology: Kinchant Dam height and storage, dam and stream flow rates

Dam height and storage capacity was reported by SunWater (Figure 6) as follows:

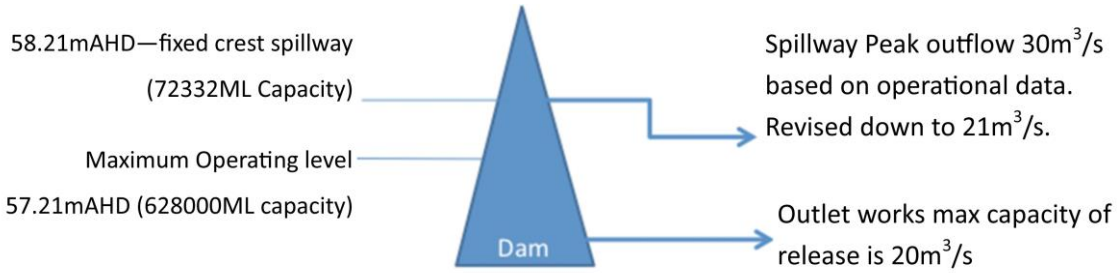


Figure 6. Overview of dam height (m), dam capacity (ML) and outflow (m^3/s), provided by SunWater.

DEWS provided a screenshot of Kinchant Dam storage levels (Figure 7), reported on SunWater's public website during the T.C. Debbie flood event.

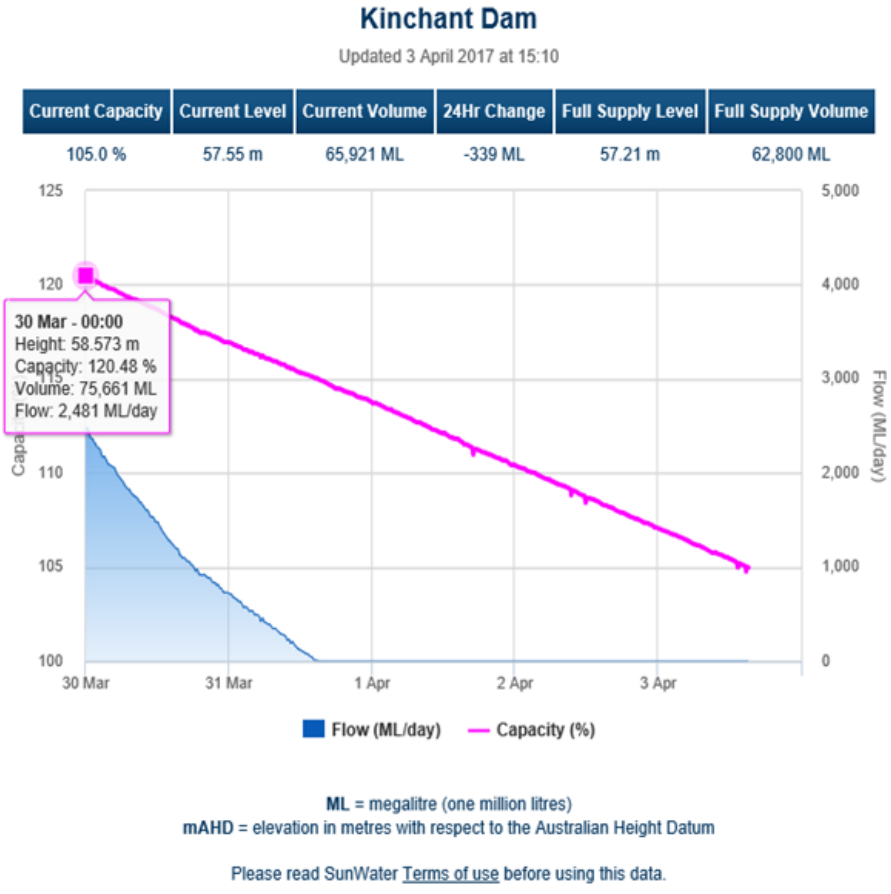


Figure 7. SunWater Screenshot provided by DEWS (<http://www.sunwater.com.au/__data/win/reports/win_storages.htm>)

Flow Rate: To date, information from Queensland departments and SunWater regarding the Kinchant Dam discharge peak flow range between 40 to 53m^3/s. Data provided by each source is overlaid in the figure provided by DEWS (Figure 8) which illustrates flow over time between Kinchant Dam discharge (spillway plus outlet works) and Homebush gauging station.

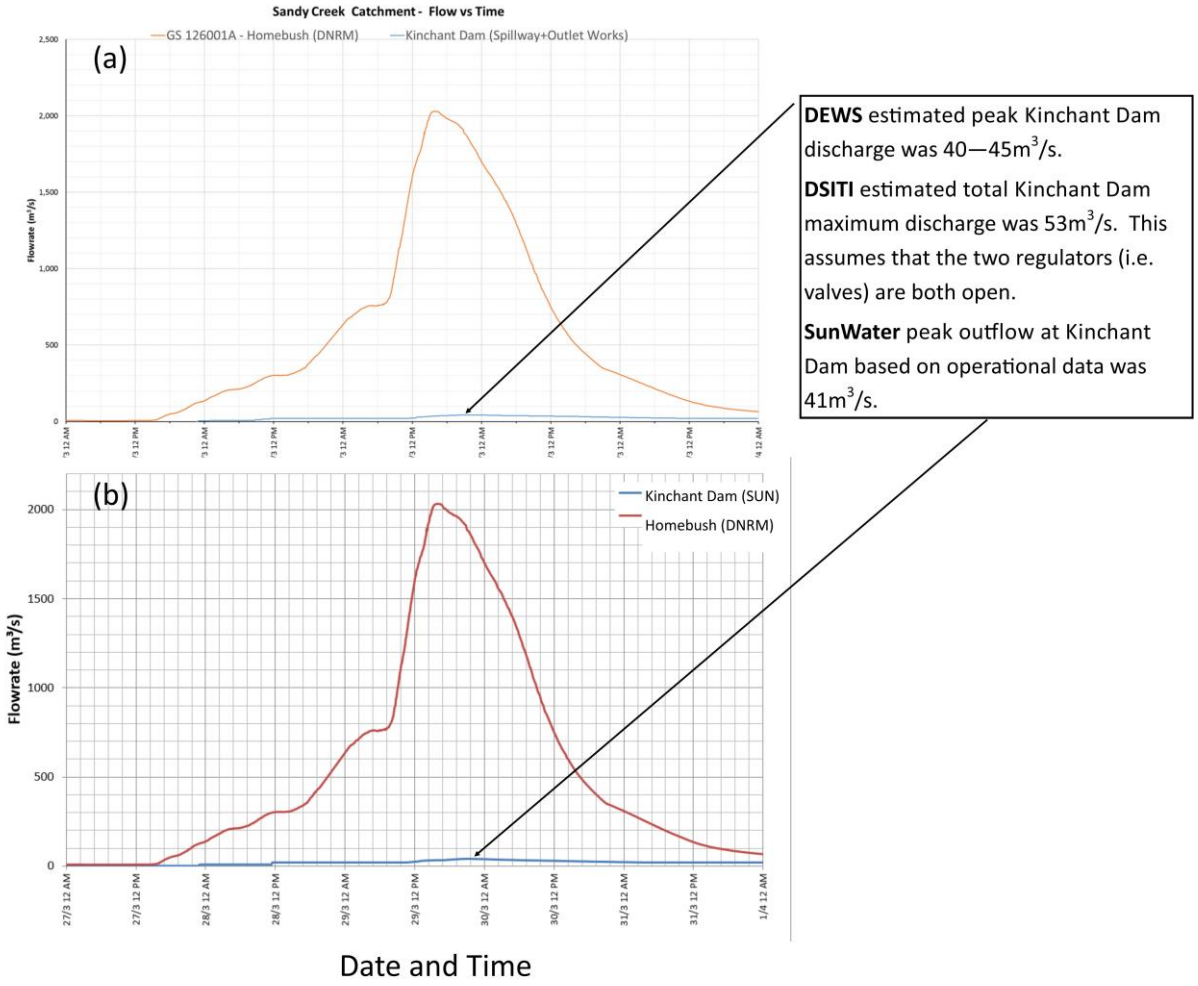
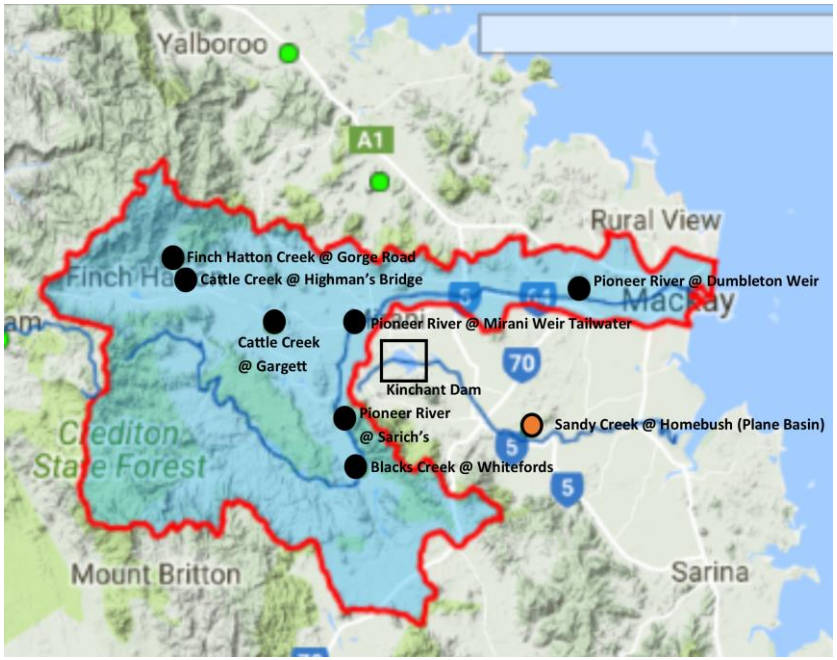


Figure 8. Hydrographs denoting flowrate (m^3/s) during 27 March to 01 April 2017 for (a) Kinchant Dam discharge (blue line) and Homebush Gauging Station (yellow line), as provided by DEWS and (b) Kinchant Dam (blue line) and Homebush Gauging Station (red line) as provided by SunWater. Kinchant Dam discharge flow rates as estimated by DSITI and SunWater, are also shown (popup box).

Further examples of flow rate, as expressed through the Water Monitoring Information Portal, are shown in Figures 9 and 10, below.



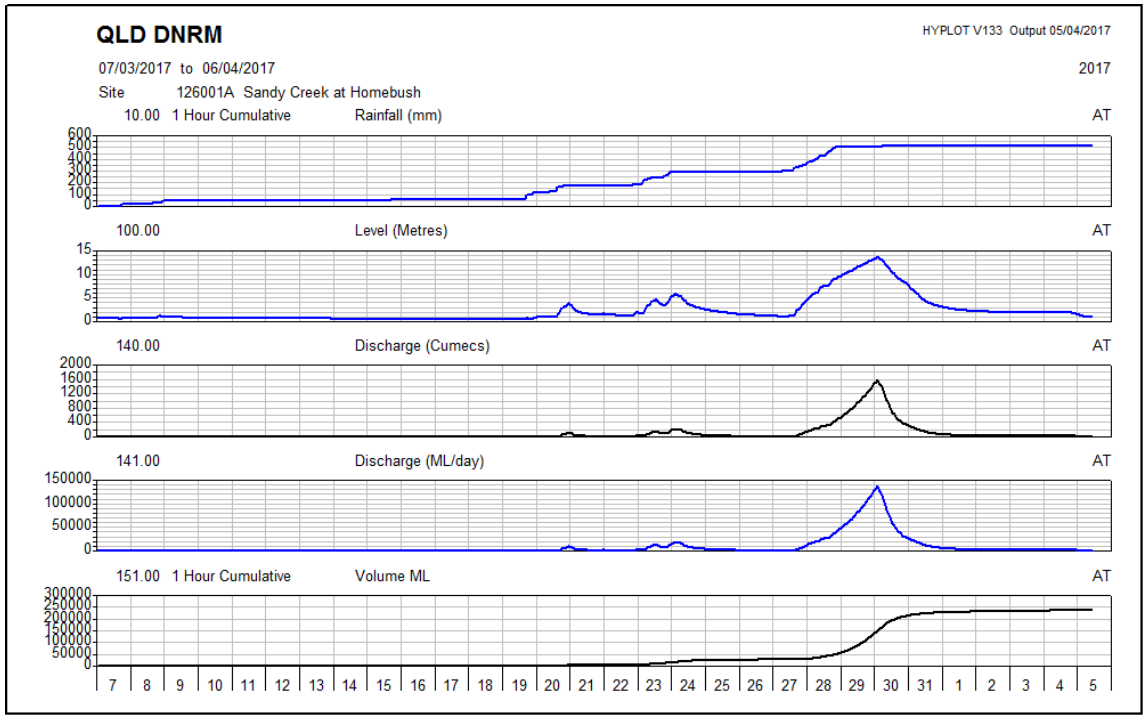


Figure 9. Sandy Creek @ Homebush Gauging Station, T.C Debbie records and location (marked with orange circle).[a]

a< https://water-monitoring.information.qld.gov.au/ >

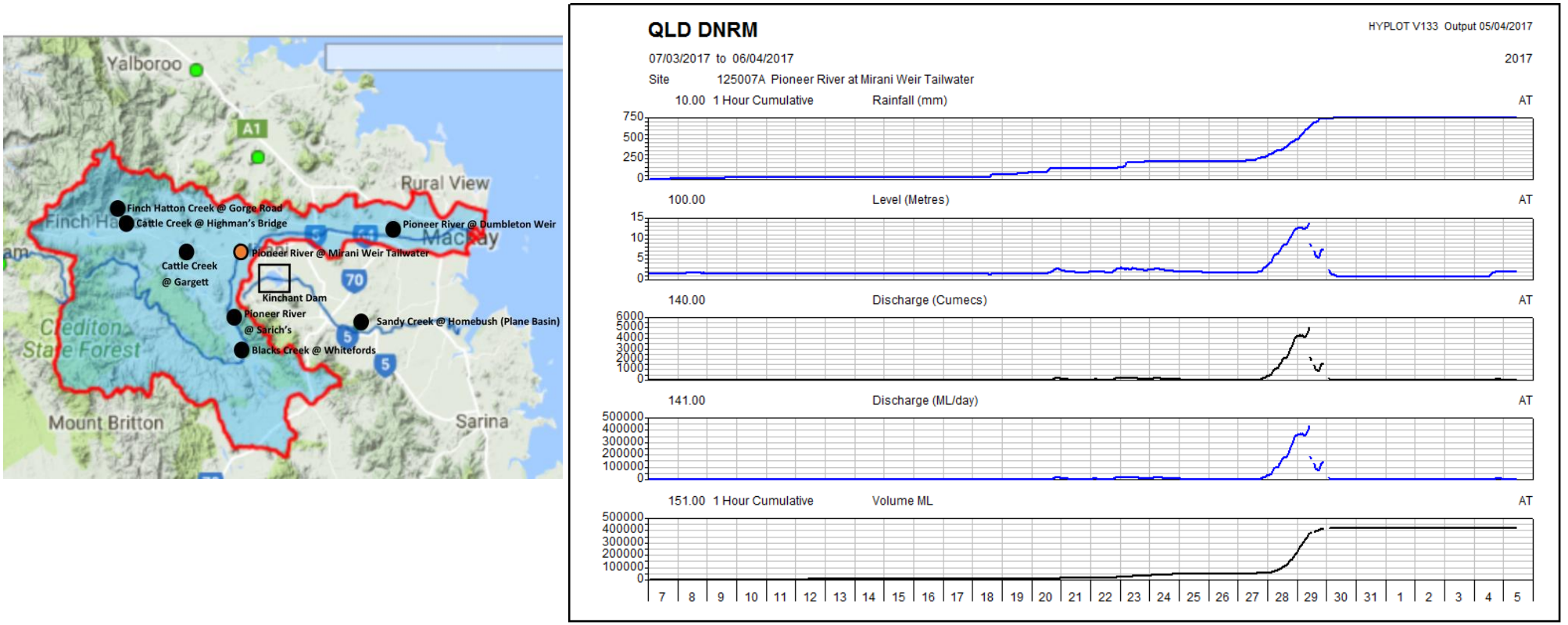


Figure 10. Pioneer River @ Mirani Weir Tailwater Gauging Station, T.C. Debbie records and location (marked with orange circle).[a]

a< https://water-monitoring.information.qld.gov.au/ >

3.3.3. Estimated flood volumes in the Sandy Creek catchment

Preliminary information from DEWS (Table 2) suggests that based on water levels recorded in Kinchant Dam, estimated flood volume (i.e. the rainfall run-off volume) at Kinchant Dam was approximately 15,000 to17,000 ML. The estimated flood volume for the total catchment upstream of Eton was approximately 198,000 ML and around 247,000 ML for the total catchment upstream of the Homebush river height gauge (DNRM GS 126001A).

Table 2 T.C. Debbie Sandy Creek flood data summary provided by DEWS

Rainfall	**Total (mm)**	**Period**
Kinchant Dam	583 / 564 [1]	28, 29 & 30 Mar.17
Brightley	172 [2]	28, 29 & 30 Mar.17
Marian–Eton Road	147 [2]	28, 29 & 30 Mar.17
Mirani (Mirani Weir)	587	28, 29 & 30 Mar.17
Flows	**Peak Q (m^3/s)**	**% of peak flow at Homebush gauge**
Peak flood flow at Homebush Gauge	2,031	100%
Estimated peak flow at Eton	1,500 [3]	74%
Estimated peak discharge from Kinchant Dam	40 – 45	2.5%
Flood Volumes	**Volume (ML)**	**% of flood volume at Homebush gauge**
Flood volume at Homebush gauge	247,000	100%
Estimated flood Volume at Eton	198,000 [3,4]	80%
Estimated flood volume at Kinchant Dam	15,000 – 17,000	6 – 7%
Catchment Factors	**Value**	**% of catchment**
Kinchant Dam Catchment Area	31 km^2	– 11.7% at Eton – 9.5% at Homebush gauging station (G.S.).
Catchment Area at Eton (Sandy Ck)	264 km^2	– 81.2% at Homebush G.S.
Catchment Area at Homebush gauge (Sandy Ck)	320 to 330 km^2	– 100% at Homebush G.S.
Approx. Stream distance Kinchant Dam to Eton	14 km	
Approx. flow travel time Kinchant Dam to Eton	2.4 hrs [5]	
Approx. Stream distance Eton to Homebush G.S.	7.3 km	
Approx. flow travel time Eton to Homebush G.S.	1.2 hrs [5]	
Kinchant Dam Storage	**Value**	
Dam Storage at start of event (Dam water level)	61,700 ML [6] (57.09 m AHD)	
Peak dam storage (Dam water level)	75,300 ML (58.5 m AHD [7])	
Peak temporary dam storage volume	13,600 ML	

1. Figures provided by SunWater and BoM
2. Incomplete rainfall data
3. Approx. triangular hydrograph calculation based on 80% of Homebush volume and 72 hour duration (no gauge at Eton)
4. Pro-rata value based on catchment area
5. Travel time based on assumed flow velocity of 6 km/h
6. Based on storage level at midnight on 27 March 2017

3.3.4. Potential for Pioneer River flood flow breakouts

Flood model mapping shown in the Kinchant Dam EAP[16] indicate that for very large to extreme events (i.e. 1 in 500 AEP), outbreaks from the Pioneer River into the Sandy Creek catchment occur between Mirani and Marian (Figure 11)

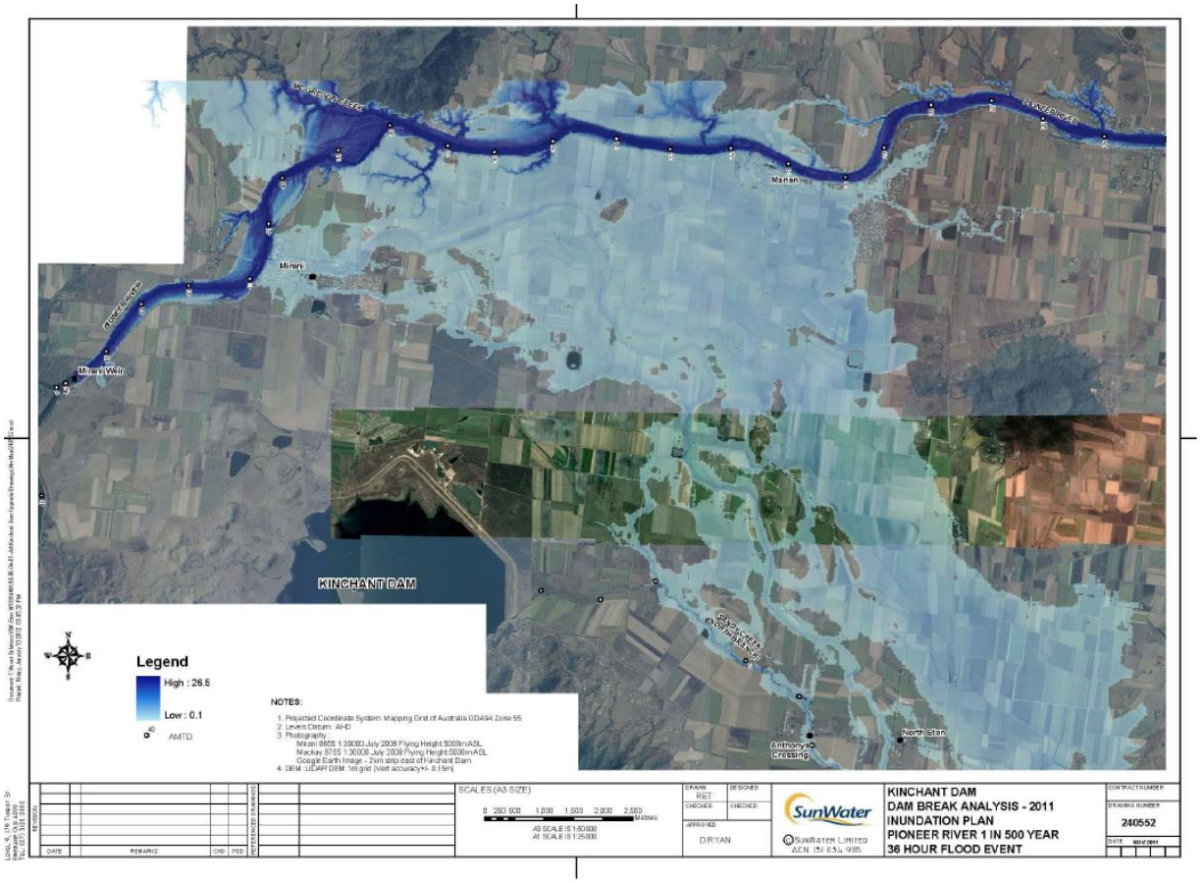


Figure 11. Flood inundation map Pioneer River 1 in 500 year 36 flood event. DEWS notes this map denotes flow breakouts from Pioneer River into Sandy Creek catchment for very large to extreme flood events.

A preliminary desktop assessment was undertaken by DEWS of available ground level data together with the maximum recorded levels at Mirani and Marian weirs during the ex-T.C. Debbie flood. The assessment indicated that it was unlikely that the peak flood level in the Pioneer River resulted in outbreaks at this location, as shown in Figure 12.

[16]<http://data.dnrm.qld.gov.au/eap/kinchant-eap.pdf> p. 145

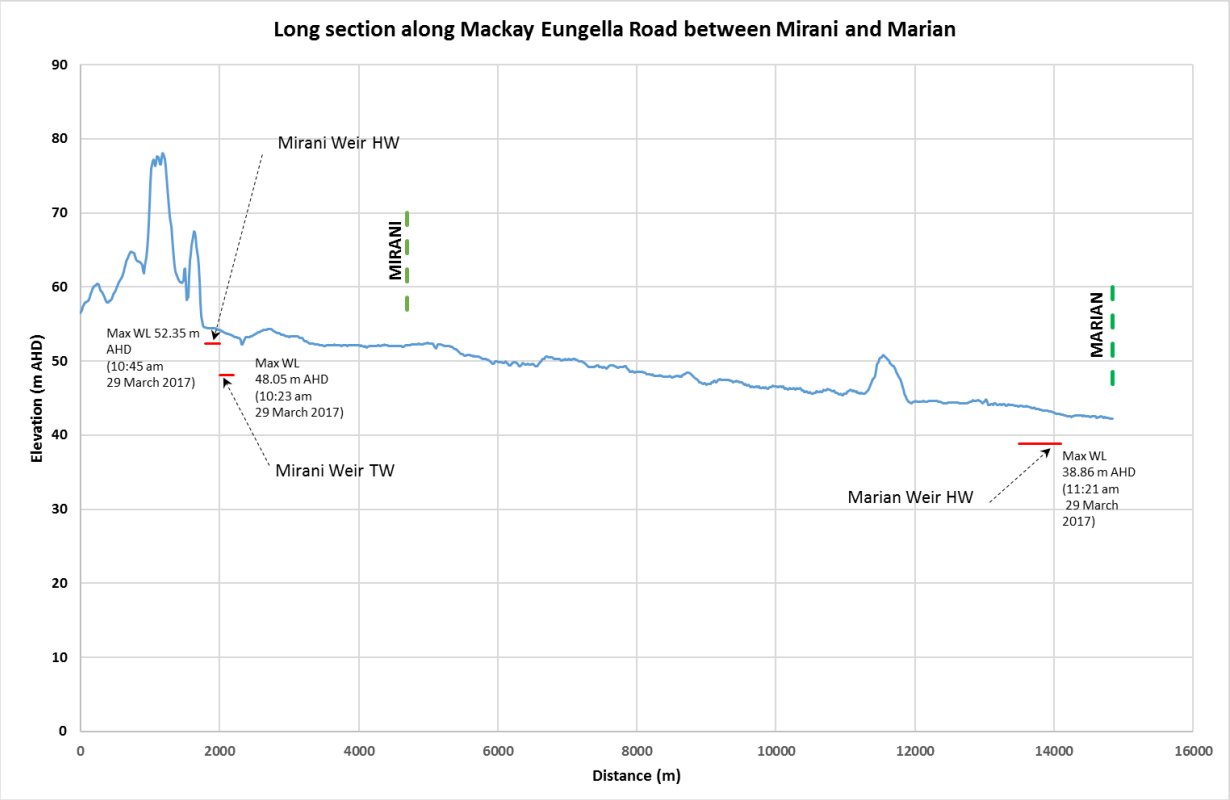


Figure 12. Long section along catchment divide between Pioneer River and Sandy Creek catchments, as assessed by DEWS. The alignment of the long section is as shown by the green line between Marian and Mirani in figure 4.

DEWS reported that further information from the Pioneer River Flood Study[17] indicates that breakouts between Mirani and Marian may occur during 1 in 200 AEP events. Information on Pioneer River water levels from the modelling study, corresponding to the 1 in 200 annual exceedance probability (AEP) event when breakouts occur, has not been accessed. Table 3 shows peak flood water level information in the Pioneer River associated with the T.C. Debbie flood event, as provided by DEWS.

[17]<http://mackay.qld.gov.au/__data/assets/pdf_file/0009/134892/Pioneer_River_Flood_Study_WRM,_Oct_2011.pdf>

Table 3. T.C. Debbie flood levels in Pioneer River compared to 2011 Pioneer River Flood Study, as provided by DEWS[18]

Location	Pioneer River flood levels (m)		
	1 in 100AEP (WRM 2011)	1 in 200 AEP (WRM 2011)	Tropical Cyclone Debbie
Mirani Weir (HW)	Not Reported	Not Reported	52.35
Mirani Weir (TW)	Not Reported	Not Reported	48.05
Mirani Town	48.44	Not Reported	*45.2* [a]
Marian Weir HW	43.19	Not Reported	38.86

[a] Estimated flood level based on constant flood slope between Mirani Weir TW gauge and Marian Weir HW gauge.

3.3.5. Flood mitigation ability of Kinchant Dam

DEWS preliminary information suggests that whilst not designed as a flood mitigation dam, Kinchant Dam, by virtue of its design (two main outlet structures which incorporate an 'informal' flood storage – i.e. due to the 1.0 m difference between maximum operating level and crest of the overflow spillway - of approximately 9,500 ML) does achieve some attenuation of peak flood inflows at the dam. However it is noted that, due to its location and the proportion of the catchment that Kinchant Dam commands (about 11.7% of the total catchment at Eton), the effects of this attenuation at Eton are insignificant.

DEWS also noted that a preliminary estimate of the volume of flood water through Eton as a result of T.C. Debbie was around 198,000 ML (Appendix 2).

[18]<http://mackay.qld.gov.au/__data/assets/pdf_file/0009/134892/Pioneer_River_Flood_Study_WRM,_Oct_2011.pdf> and BoM (for T.C. Debbie flood levels).

3.4. Messaging and communications

A summary of messaging and communications information as experienced by community members, populated against a timeline, is noted in Figure 13.


SunWater
Other public sources of information
20 March
21 March
22 March
23 March
24 March
25 March
26 March
27 March
17:00-18:00 SunWater advises through their mobile application, Facebook and SMS that predicted rainfall in the next few days may lead to releases from Kinchant Dam which is currently at 94.2% capacity
21:57 Releases could commence at Kinchant Dam within the next 24 to 48 hours. Dam is at 98% capacity. Dam level updateshttp://bit.ly/2mDps1g
14:32 High forecast rainfall, flood releases could commence at the dam within the next 24 to 48 hours
14:44 Advisory: With forecast rainfall flood releases could commence within the next 24 to 48 hours. This weather event also has the potential to progress to spillway discharge. Further updates will be provided as required
14:44 SunWater advises properties downstream of Kinchant Dam that with high forecast rainfall, flood releases could commence at the dam within the next 24 to 48 hours. The dam is currently at 97.9% capacity. This predicted weather event also has the potential to progress to spillway discharge. Further updates will be provided as required. Please monitor local conditions and forecasts
18:56 Emergency alert SMS have been sent to residents of Midge Point & St Helens Beach advising them to "act and evacuate" Mackay Regional Council
Media alert
Text/App
twitter
facebook
19:29 SMS Emergency Notification: "Kinchant Dam. Event: Flood. Advice: SunWater is expecting to commence flood releases from Kinchant Dam in the coming hours. Flood releases will result in the closure of Kinchant Dam Road where it crosses Sandy Creek (North Branch) known as Antony's Crossing. Given the heavy rain predicted by the Bureau of Meteorology, there is also the potential for spillway discharges during this event. Action: All unnecessary road travel should be avoided "
02:57 "We expect to start flood releases from #KinchantDam in the coming hours. Closure of downstream crossing Antony's Road imminent #TCDebbie"
01:36 In #Mackay, Cyclone Shelters located at Mackay Northern Beaches HS, Bowen SS, Proserpine SS and Heatley Secondary College. #CycloneDebbie QPS
19:45 "SunWater advises residents downstream of Kinchant Dam that we expect to commence flood releases from the dam in the coming hours. Flood releases will result in the closure of Kinchant Dam Road, where it crosses Sandy Creek (North Branch) otherwise known as Antony's Crossing. Given the heavy rain predicted by the Bureau of Meteorology there is also the potential for spillway discharges during this event"
10:00 Cyclone Debbie, 20,000 homes without power. Eton area had 77mm as at 9am Monday morning. Daily Mercury
14.25 Emergency Alert for Mackay. Storms Surge alert for Green, Red, and Orange zones on Monday evening and Tuesday morning. QPS
19:57 We expect to start flood releases from #KinchantDam in the coming hours. Closure of downstream crossing Antony's Road imminent #TCDebbie
20:03 SunWater advises residents downstream of Kinchant Dam that we are expecting to commence flood releases from the dam in the coming hours. Flood releases will result in the closure of Kinchant Dam Road, where it crosses Sandy Creek (North Branch) or otherwise known as Antony's Crossing. Given the heavy rain predicted by the Bureau of Meteorology, there is also the potential for spillway discharges during this event. All unnecessary road travel should be avoided
14.40 Emergency Alert for Mackay. Storms Surge alert for Green, Red, and Orange zones on Monday evening and Tuesday morning. Mackay Weather & District Updates
19:42: Retweet from BOM Queensland #CyloneDebbie making landfall as seen on #Bowen and #Mackay radars. Cyclone eye visible crossing near #AirlieBeach QFES
23:09 KinchantDam has reached maximum operating level and SunWater has commenced minor releases into Sandy Creek. The dam is currently at 100% capacity. These releases will result in the closure of Kinchant Dam Road, where it crosses Sandy Creek (North Branch) or otherwise known as Antony's crossing
19:45 Live video "The Mackay Local Disaster Management Group has been activated. Here is an update from chair, Mackay Mayor Greg Williamson, following a briefing from BOM. See the Emergency Action Guide for more details: http://www.mackay.qld.gov.au/.../0005/1.../EAG-2014-2017_Web.pdf. MRC

Figure 13. A summary of messaging and communications between 20 March and 30 March 2017

3.4.1. Definitions for reporting key dam levels and percentage storage capacity

Definitions of key dam levels and dam capacity and interpretations with respect to percentage capacity reported (previously and current), has been provided by DEWS and SunWater.

Department of Energy and Water Supply:

- Previous storage capacity of 100% was reported as 57.21m AHD (i.e. a storage capacity of 72,332 ML). Following the T.C. Debbie flood event, SunWater are now reporting on their website the storage capacity as a percentage capacity of Kinchant Dam storage expressed *relative to the spillway level (58.21m)*.
- This means previous capacity percentage of 100% at 57.21 m AHD is now reported as 86.8% capacity by SunWater.

SunWater:

- Kinchant Dam currently operates with a maximum operating level of 57.21m (AHD), which is 1.0m below the fixed spillway crest level of 58.21m (AHD). The Dam has historically typically been operated with a lower maximum operating level, i.e. below spillway crest level, though was allowed to fill above this for some periods in previous years. However a dam safety condition was identified some time ago (prior to T.C. Debbie), which has more rigidly enforced this maximum operating level of 57.21m (AHD) in recent years, and in accordance with operational procedures during T.C. Debbie. This reflects the improved factor of safety for the dam (compared to if the dam remained 'full' for long durations at the fixed spillway crest level). This has been in operation for some time, and will remain in effect until further engineering analyses are undertaken.
- Releases from Kinchant Dam's outlet works during T.C. Debbie were initiated by SunWater's operator at 11:00pm on 27 March 2017, when the storage level reached the maximum operating level of 57.21m (based on operational data recorded during the event). Outflows over the spillway did not occur until the level increased (due to inflows into the dam exceeding the maximum discharge flow through the outlet works) up to the fixed spillway crest level of 58.21m. This level was recorded to occur at 9:00 am on 29 March 2017 (again based on operational data from the dam's level sensor during the event).
- SunWater has historically referred to the current maximum operating level of 57.21m, at least for the period when the current operational rules have been in place, as the Full Supply Level. Similarly the dam capacity at this level has been referred to as 100% capacity during this time. This terminology is adopted in SunWater's Operations and Maintenance Manual, and in other documentation and reference material. During the event, SunWater issued communications and provided dam status updates with figures specifying the percentage storage capacity (as calculated at the time) based on this definition. This has led to some confusion in the community however, as spillway outflows will not occur until the dam is at 115% capacity in accordance with this convention (as the fixed spillway crest level is higher than the current 'reduced' full supply level).
- SunWater has since revised its terminology, to reduce confusion, and now refers to the level of 57.21m as the "Maximum Operating Level" (rather than the full supply

level). The higher level of 58.21m is the 'Fixed Spillway Crest Level'. The dam is now referred to as being at '100% capacity' when the level reaches the fixed spillway crest level, being when outflows first commence through the spillway. The storage capacity at the maximum operating level is now calculated as 86.8% (rather than 100% as previously stated). This is based on the storage volume at this level (62,800 ML) compared to the 'full' volume at the spillway crest level (72,332 ML). Communication post event is now revised in accordance with this convention.

4. Hydrologic assessment of the event

Based on information provided by Queensland Government departments and SunWater, peak outflow rates from the Kinchant Dam due to ex-T.C. Debbie appear within the range of 40 to 53 m^3/s. Homebush gauging station recorded flows in excess of 1500 m^3/s at about the same time. In addition, DEWS notes that while the capacity of Kinchant Dam to provide significant flood mitigation is limited because of the relatively small proportion of the catchment it commands, it does achieve some attenuation of peak flood inflows, with approximately 9,500 ML flood storage due to the 1.0m difference between maximum operating level and crest of the overflow spillway. A preliminary estimate[19] of the volume of flood water through Eton as a result of T.C. Debbie is 198,000 ML.

5. Communication

The Queensland Chief Scientist met with the Mackay Regional Council on 12 May 2017 to observe the Local Disaster Management Group debriefing session from T.C. Debbie. Information was provided from a range of agencies to help compile information on:

- assessment of the timeliness and content of messaging to downstream communities
- assessment of adherence with the Emergency Action Plan, including interactions with the Local Disaster Management Group in relation to Kinchant Dam operations.

Comprehensive assessment of the Emergency Action Plan and communications relating to the emergency response across the region is being undertaken by IGEM and is therefore not included in this assessment.

An integrated approach to community consultation was adopted, in accordance with other Government agency activities including IGEM flood community survey and on-ground engagement with local communities, to ensure community input (observational data, records of the event) was incorporated in the assessment process. Community engagement activities were undertaken in the form of email, phone-call and face-to-face discussions. Key findings of this activity is listed in Section 6.

[19] Provided by the Department of Energy and Water Supply.

6. Community engagement

The Queensland Chief Scientist and representatives of the Office of the Queensland Chief Scientist travelled to Eton on 24 and 25 June to listen to community experiences. In addition, members of the public were encouraged throughout the independent assessment to contact the office directly by phone, email or in writing to provide us with details of their experience.

Conversations occurred with community members who either lived or owned properties along Sandy Creek from North Eton to Chelona, representing a broad section of the community. Observations, statements, rainfall data, photos and videos were offered by community members to support their experience.

The conversations were carried out as semi-structured interviews. During the face-to-face meetings a number of key concerns from community members were raised.

Communications and messaging were the focus of these concerns, including:

- need to have “everyone on the same page”, with clear messaging, clear responsibility and clear co-ordination on ground, even when mains power based technology fails
- consistent messaging across relevant authorities to reduce unnecessary panic caused in the area, e.g. “police came to evacuate on Thursday morning when flood water had receded and dam was fine”; “authorities need to contact residents directly to avoid confusion through word-of-mouth or misinterpretation of messaging in an already stressful situation”; “having to call 000 numerous times and each time repeat my situation, when they should have that on file from my first phone call”, “why aren’t local area names noted or linked to their databases and localities when we are calling for help, no one knew e.g. Drapers Siding and people kept getting lost trying to find North Eton”
- greater understanding of the “local water flow pathways” under different rainfall and spillway outflow scenarios and “greater certainty regarding the source of flooding experienced within the community”
- Community members receive variable information about the flooding including flooding sources. Community members also noted the impact of SunWater releases couple with Kinchant Dam overflows ranged from “mitigating flooding”, “minimal impact”, “unsure” and “major cause” of flooding experienced.
- there was a strong expectation that Kinchant Dam should notify all downstream community members regarding water release from the Dam. Some community members who thought they were on the notifications list did not receive any messaging. Community members noted that messages about releases from the Kinchant Dam were either not received, or not received in a timely fashion, as communications (mobile, landline and NBN) and power were out before message(s) were sent. Community members also noted “why would an NBN tower be built close to Sandy Creek and a drain, when power outage was the main cause for communications failure”.
- greater understanding as to whether “SunWater should/could have been proactive in releasing water prior to the cyclone event, given the conditions forecast” “the timing

of release and impact this may/not have on an already wet area" and "interaction of releases with tide and whether this had any impact"

- greater engagement with community members when changes are made to local planning or infrastructure (e.g. build-up of roads or modification of culverts), so that certainty around these impacts, including localised water flow impacts, is provided
- increased preparedness - wanting "improved/new warning and communication systems in place to alert people that flash flooding is imminent and local options to act if it is (specific ideas around sirens, UHF-battery communications and helicopter use were provided)".

7. Conclusion

Considerably high levels of rainfall were observed throughout the Sandy Creek catchment over a short period of time (> 500mm over three-day period in many areas throughout the catchment) following T.C. Debbie landfall. Many areas in the catchment had already experienced (at least) between 100 to150 mm rainfall in the week preceding the event.

Hydrographs showing flowrate (m^3/s) over 27 March to 01 April 2017 reached in excess of 2000 m^3/s at Sandy Creek @ Homebush gauging station. The maximum discharge flow rate at Kinchant Dam was reported to range between 40 to 53 m^3/s.

Flood volume (i.e. the rainfall run-off volume) at Kinchant Dam was estimated as 15,000 to 17,000 ML. The estimated flood volume for the total catchment upstream of Eton was approximately 198,000ML and around 247,000 ML for the total catchment upstream of the Homebush river height gauge (DNRM G.S. 126001A).

Whilst not designed as a flood mitigation dam, Kinchant Dam, by virtue of its design (2 main outlet structures which incorporate an 'informal' flood storage) does achieve some attenuation of peak flood inflows at the dam. However, both the capacity of the dam and its location in the catchment mean it has insignificant impact on peak flood flows at the Homebush gauge.

Assessment of available ground level data, together with the maximum recorded levels at Mirani and Marian weirs during the ex-T.C. Debbie flood, indicated that it was unlikely that the peak flood level in the Pioneer River resulted in outbreaks at this location.

The scientific data provided, consistent with all agencies, leads us to conclude rainfall as the dominant source of water flow in the catchment which experienced considerable flooding.

A summary of messaging and communications between dates 20 March to 30 March 2017 suggests that SunWater operated in accordance with the Kinchant Dam Emergency Action Plan. However community members noted confusion regarding communications and the lead authority to source 'points of truth' associated with warnings notifications including flood timing, location and flood sources, as well as co-ordination for local-area assistance. Community members receive variable information about the flooding, including flooding sources.

We suggest that options for delivery of information that is locally-targeted, with emphasis on resilience of technology, are implemented. Clarity and consistency of messaging should be a priority (with some improvements already noted e.g. terminology relating to dam operating levels).

We support recent developments including changes to the *Water Legislation (Dam Safety) Amendment Act 2017* [20] and Reviews in Progress through Queensland Government Inspector-General Emergency Management[21], working across agencies and levels of government towards continuous improvement of this process.

[20] < https://www.legislation.qld.gov.au/LEGISLTN/ACTS/2017/17AC011.pdf>

[21] https://www.igem.qld.gov.au/Pages/reviews-in-progress.aspx

Appendix 1: Definitions

AHD Australian Height Datum

AEMO Australian Energy Market Operator

BOM Bureau of Meteorology

DDMG District Disaster Management Group

DEWS Queensland Department of Energy and Water Supply

DSITI Queensland Department of Science, Information Technology and Innovation

DNRM Department of Natural Resources and Mines

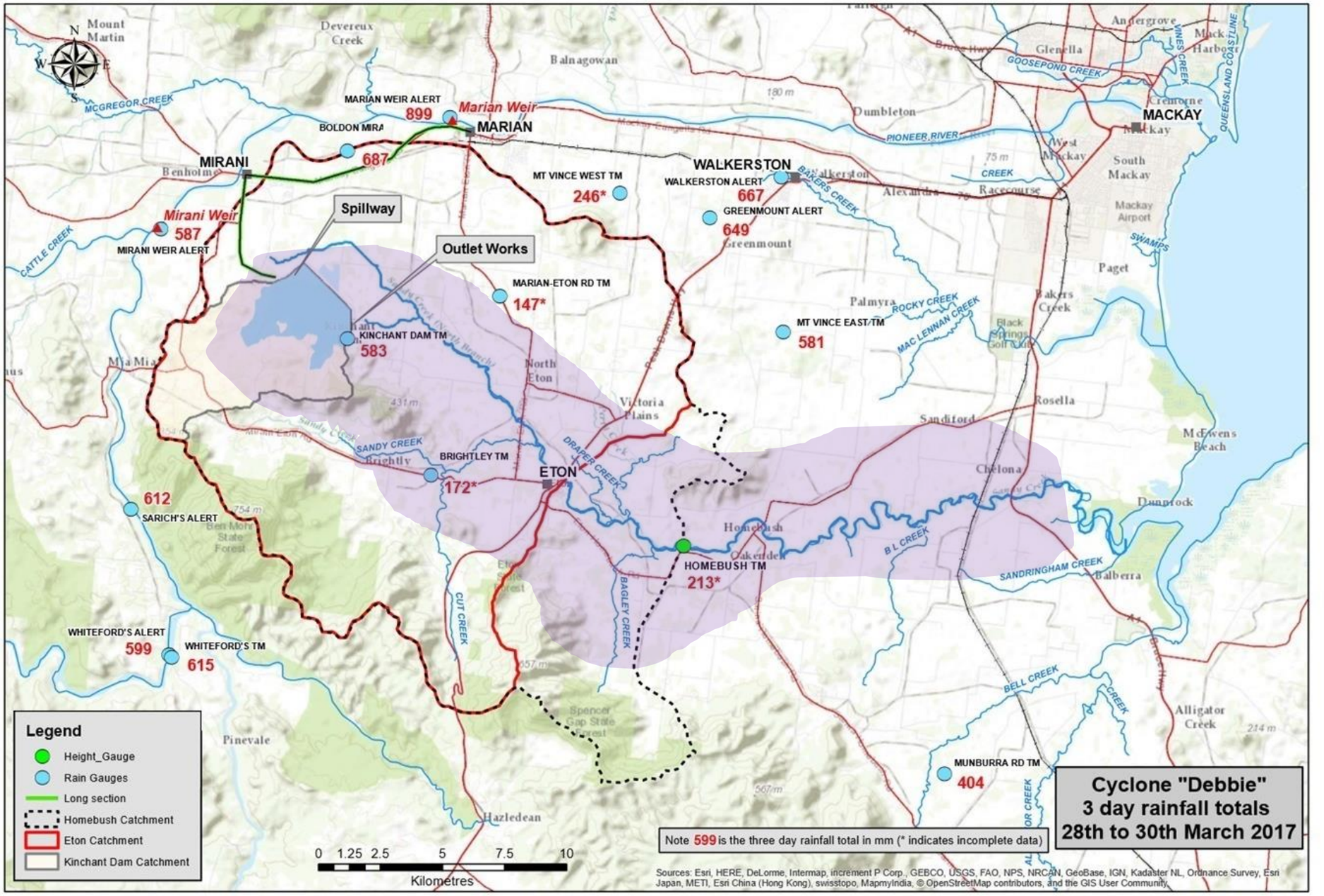
LDMG Local Disaster Management Group

m^3/s flow rate as cubic metres per second; cumecs

Appendix 2: Kinchant Dam key data, provided by DEWS

Description	Specification
Dam type	**Earth-fill and rock-fill dam**
Nominal crest elevation	EL 61.21 m
Embankment length	5,325 m (excluding spillway)
Dam Height (m) (above D/S toe)	22.3 m above streambed
Built height (above lowest foundation)	29.1 m
Reservoir	
Maximum operating level	EL 57.21 m
Historical recorded max storage—January 1991 Live storage (at FSL)	EL 58.56 m 62,800 ML
Reservoir surface area (at FSL)	920 ha
Minimum drawdown level	EL 42.30 m
Emergency spillway type	**Uncontrolled mass gravity ogee crest**
Crest level	EL 58.21 m
Crest length	60 m
Storage volume at spillway level *	72,332 ML
Maximum discharge capacity	30,240ML/d (350m^3/s)
Outlet works	
Outlet pipe size	2 x 1,350 mm
Guard valves	2 x 1,350 mm butterfly
Regulating valves	2 x 1,220 mm cone dispersion
Pipe centreline Discharge capacity at EL 57.21m (one valve open)	EL 42.91 m 860 ML/d (9.95 m^3/s)
Discharge capacity (two valves open)	1,760 ML/d (20.3 m^3/s)
Saddle Dam wall type Wall height (above D/S toe)	**Homogenous earth-fill** 3.0 m
Built height (above lowest foundation)	2.7 m
Wall length	170 m
Crest height	EL 61.21 m
Crest length	170 m

Appendix 3: Community engagement representation area



Notes: