February 2022 Flood Event

Report on the Operation of Somerset Dam and Wivenhoe Dam

April 2022

Executive Summary

Background

This report has been prepared to describe the 25/02/2022 to 09/03/2022 Flood Event at Somerset and Wivenhoe Dams, in accordance with the requirements in Chapter 4, Part 2, Division 9 of the *Water Supply (Safety and Reliability) Act 2008* (the Act). Details of Somerset and Wivenhoe Dams and the operational procedures can be found in the Manual.

Dam operations overview

The operation of Somerset and Wivenhoe Dams and corresponding selection of strategies and procedures adopted during the Flood Event as defined in the Manual are summarised in Table i and shown graphically in Figure i for Somerset Dam and Figure ii for Wivenhoe Dam. More detailed descriptions at relevant intermediate time intervals are presented in Section 4.2.

The periods summarised were selected to assist in describing the operations by reference to the implementation of the strategies and procedures defined in the Manual.

Table i: Chronological summary of flood operating strategies and procedures implemented during the Flood Event (replicated in Table 4-1)

Event	Date and time of decision
Flood Operations Centre mobilised.	23/02/2022 07:00
Operational releases from Somerset Dam.	23/02/2022 17:00
Flood event commencement criteria for Somerset Dam met. Somerset Dam Strategy Procedure 1a to 1d selected. Flood Mitigation Strategy Procedure 1a selected at Wivenhoe Dam.	25/02/2022 12:10
Flood Mitigation Strategy Procedure 1b selected at Wivenhoe Dam. Target flow at Moggill set to 2,000 m^3/s to achieve an appropriate position on the Flood Mitigation Guide Curve (as defined in Flood Mitigation Strategy Procedure 1b) with Wivenhoe Dam predicted peak lake level of 67.69 m AHD.	25/02/2022 15:00
Releases from Wivenhoe Dam commenced under Flood Mitigation Strategy Procedure 1b.	25/02/2022 22:00
Releases from Wivenhoe Dam ceased due to increase in downstream flows.	25/02/2022 23:00
Target flow at Moggill increased to 2,500 m^3/s with Wivenhoe Dam predicted peak lake level of 70.04 m AHD.	26/02/2022 03:00
Target flow at Moggill increased to 3,500 m^3/s with Wivenhoe Dam predicted peak lake level of 72.05 m AHD.	26/02/2022 11:00
Target flow at Moggill increased to 4,000 m^3/s with Wivenhoe Dam predicted peak lake level of 73.41 m AHD.	26/02/2022 20:00
Target flow at Moggill increased to 4,500 m^3/s with Wivenhoe Dam predicted peak lake level of 73.84 m AHD.	26/02/2022 22:00
Target flow at Moggill increased to 5,200 m^3/s with Wivenhoe Dam predicted peak lake level of 74.57 m AHD. Releases from Wivenhoe Dam recommenced under Flood Mitigation Strategy Procedure 1b.	27/02/2022 04:00
Somerset Dam peak lake level (103.17 m AHD) and peak release	27/02/2022 11:30

Event	Date and time of decision
(2,242 m^3/s).	
Target flow at Moggill increased to 5,750 m^3/s with Wivenhoe Dam predicted peak lake level of 74.78 m AHD. Consideration of preparation of an Alternative Procedure for Somerset Dam (continued through the evening of 27/02/2022).	27/02/2022 16:00
Target flow at Moggill increased to 6,000 m^3/s with Wivenhoe Dam predicted peak lake level of 74.84 m AHD.	27/02/2022 20:00
Somerset Dam Alternative Procedure approved by DRDMW and implemented to close sluices to temporarily reduce releases into Wivenhoe Dam.	28/02/2022 00:45
Peak lake level reached in Wivenhoe Dam (74.61 m AHD based on gauge board readings).	28/02/2022 02:00
Selection of Drain Down Strategy at Wivenhoe Dam.	28/02/2022 06:00
Somerset Dam Alternative Procedure ceased and Somerset Dam Strategy Procedure 2a selected (sluices fully opened at this time).	01/03/2022 02:00
Peak releases from Wivenhoe Dam (3,393 m^3/s).	03/03/2022 06:00
Flood releases ceased at Somerset Dam.	08/03/2022 07:00
Flood releases ceased at Wivenhoe Dam. Criteria met for end of Flood Event.	09/03/2022 14:00

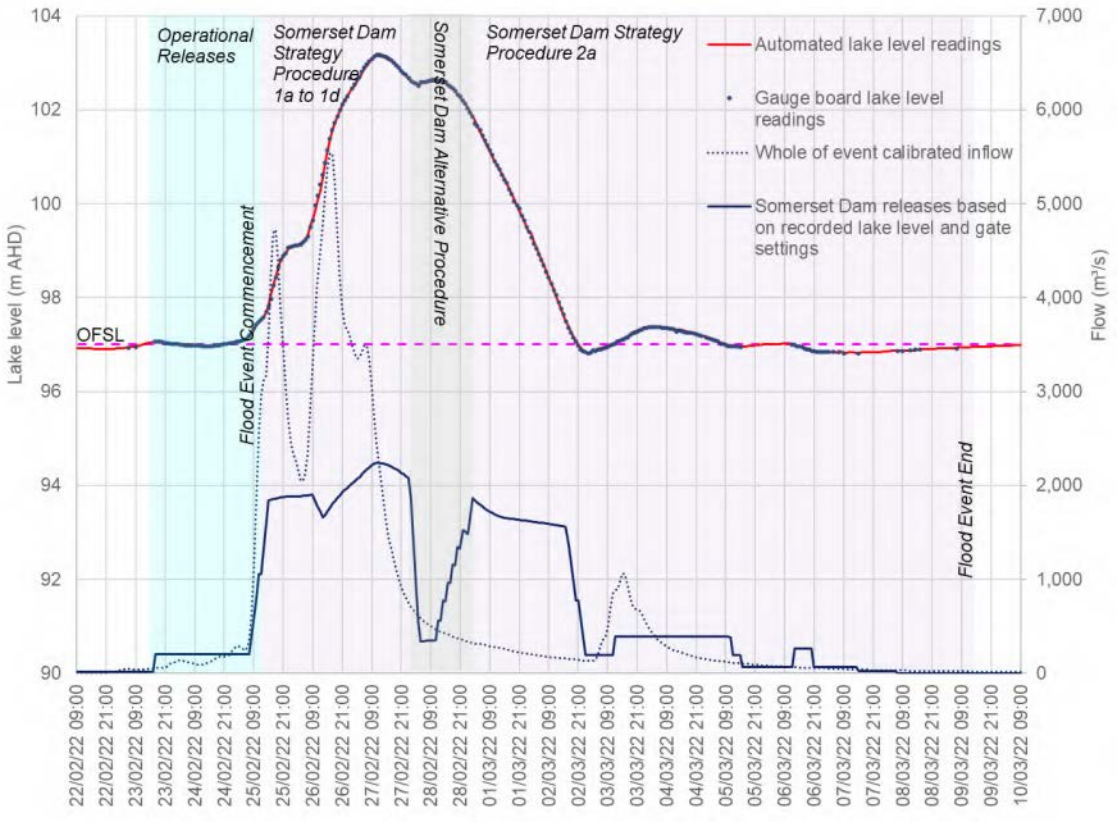

Figure i: Somerset Dam post-event analysis whole of event calibrated inflow, lake level (gauge board and automated readings) and releases (replicated in Figure 4-1)

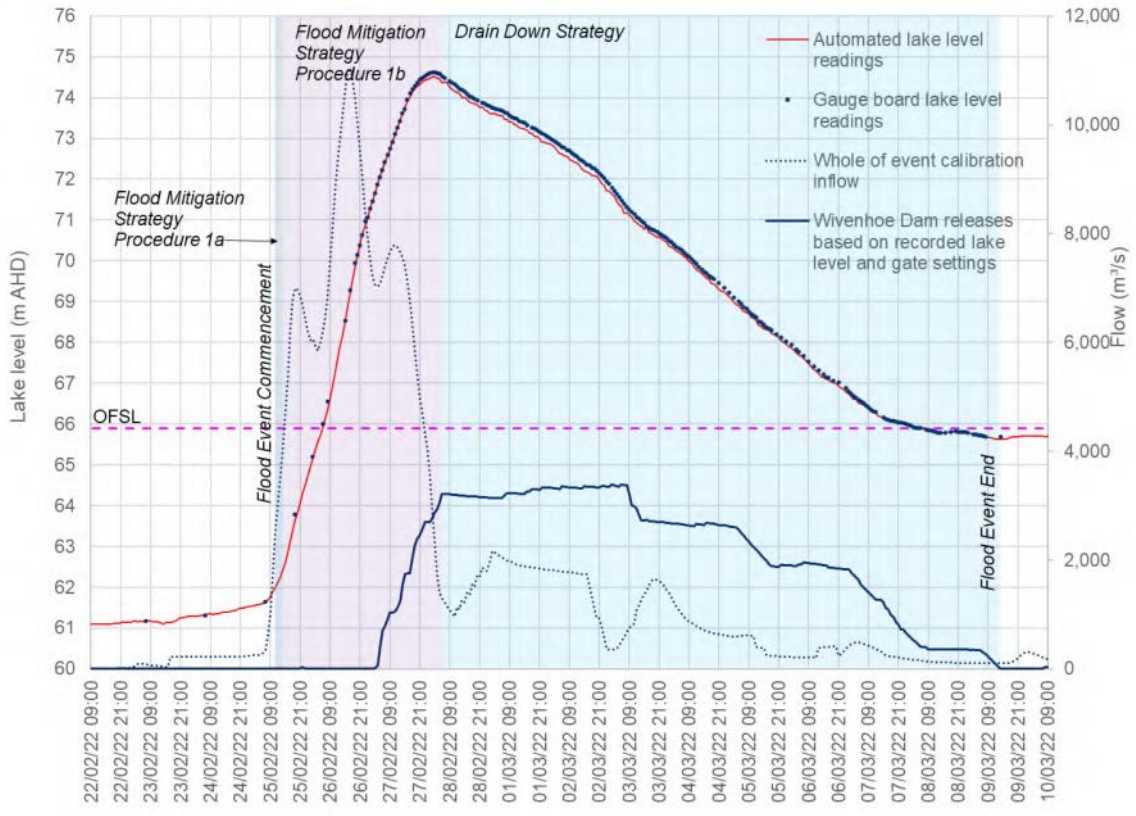

Figure ii: Wivenhoe Dam post-event analysis whole of event calibrated inflow, lake level (gauge board and automated readings) and releases (replicated in Figure 4-2)

Event data overview

Table ii and Table iii summarise the key data relevant to the Flood Event for Somerset Dam and Wivenhoe Dam respectively.

Table ii: Flood Event data summary for Somerset Dam

Statistic	Units	Value
Operational full supply level	m AHD	97
Accumulated Stanley River to Somerset Dam catchment average rainfall between 22/02/2022 09:00 and 10/03/2022 09:00[1]	mm	814
Somerset Dam lake level at 25/02/2022 12:10	m AHD	97.55
Flood Event peak lake level in Somerset Dam based on gauge board readings	m AHD	103.17
Flood Event peak inflow into Somerset Dam[†]	m³/s	5,555
Flood Event peak release from Somerset Dam	m³/s	2,242
Total inflow volume into Somerset Dam[2] between 22/02/2022 09:00 and 10/03/2022 09:00[1]	ML	902,000
Total release volume from Somerset Dam between 22/02/2022 09:00 and 10/03/2022 09:00[1]	ML	900,000
Somerset Dam lake level at 09/03/2022 14:00	m AHD	96.95

[1] These dates correspond with the hydrological modelling start and end times. Refer Section 2.3 for more information.
[2]Estimate of the peak inflow and total inflow volume based on post-event analysis of whole of event model calibration

Table iii: Flood Event data summary for Wivenhoe Dam

Statistic	Units	Value
Operational full supply level	m AHD	65.90
Accumulated Brisbane River to Wivenhoe Dam catchment average rainfall between 22/02/2022 09:00 and 10/03/2022 09:00[1]	mm	502
Wivenhoe Dam lake level at 25/02/2022 12:10	m AHD	62.16
Flood Event peak lake level in Wivenhoe Dam based on gauge board readings	m AHD	74.61
Flood Event peak inflow into Wivenhoe Dam excluding Somerset Dam releases[2]	m³/s	9,297
Flood Event peak inflow into Wivenhoe Dam including Somerset Dam releases[2]	m³/s	11,083
Flood Event peak release from Wivenhoe Dam	m³/s	3,393
Total inflow volume into Wivenhoe Dam excluding Somerset Dam releases[2] between 22/02/2022 09:00 and 10/03/2022 09:00[1]	ML	1,450,000
Total release volume from Wivenhoe Dam between 22/02/2022 09:00 and 10/03/2022 09:00[1]	ML	1,970,000
Wivenhoe Dam lake level at 09/03/2022 14:00	m AHD	65.64

[1] These dates correspond with the hydrological modelling start and end times. Refer Section 2.3 for more information.
[2] Estimate of the peak inflow and total inflow volume based on post-event analysis of whole of event model calibration

Figure iii and Figure iv illustrate the catchment average rainfall for the Stanley River to Somerset Dam catchment and the Brisbane River to Wivenhoe Dam catchment over the Flood Event respectively. Figure v and Figure vi illustrate the recorded and modelled lake level for Somerset Dam and Wivenhoe Dam respectively. Figure vii illustrates the post-event analysis whole of event calibration (with the benefit of hindsight) estimates of dam inflows to and recorded releases from Somerset Dam and Figure viii illustrates the whole of event calibration estimates of inflows (excluding Somerset Dam releases) to and releases from Wivenhoe Dam over the Flood Event.

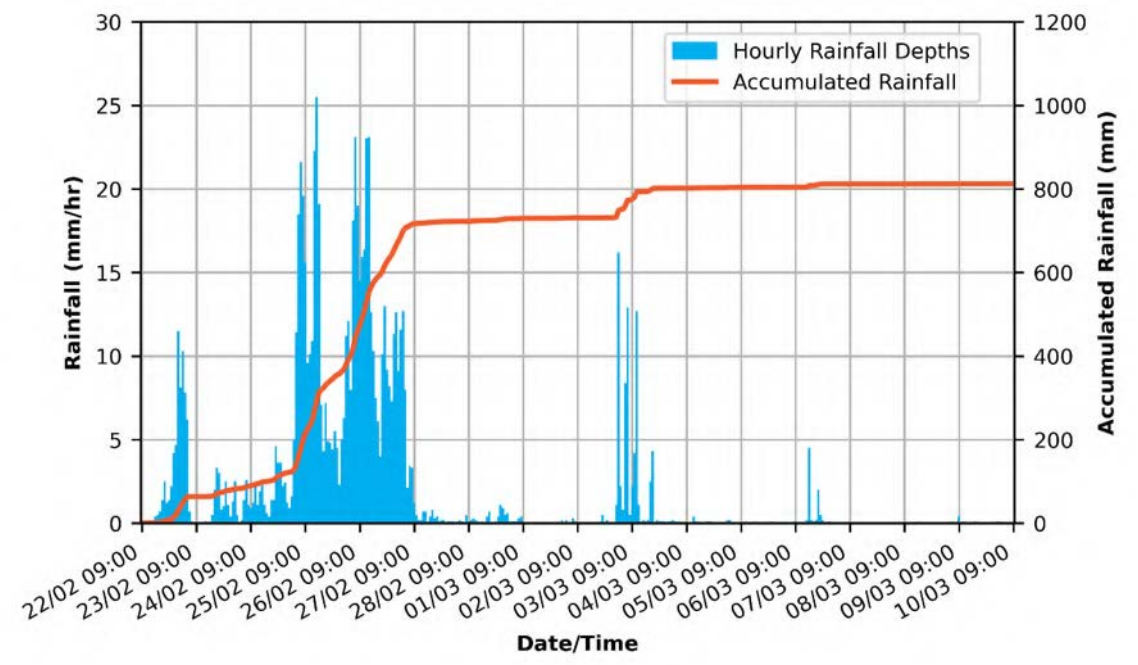

Figure iii: Stanley River to Somerset Dam catchment average rainfall in hourly increments and accumulated over the Flood Event for the period 22/02/2022 09:00 to 10/03/2022 09:00 (replicated in Figure 2-30)

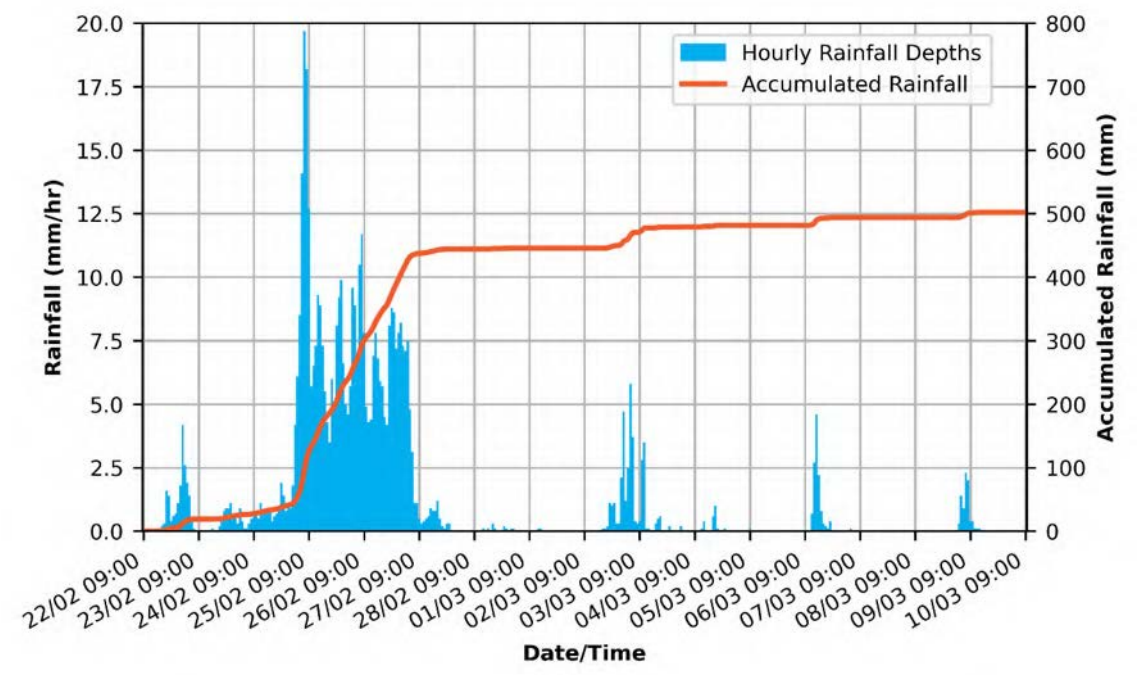

Figure iv: Brisbane River to Wivenhoe Dam catchment average rainfall in hourly increments and accumulated over the Flood Event for the period 22/02/2022 09:00 to 10/03/2022 09:00 (replicated in Figure 2-36)

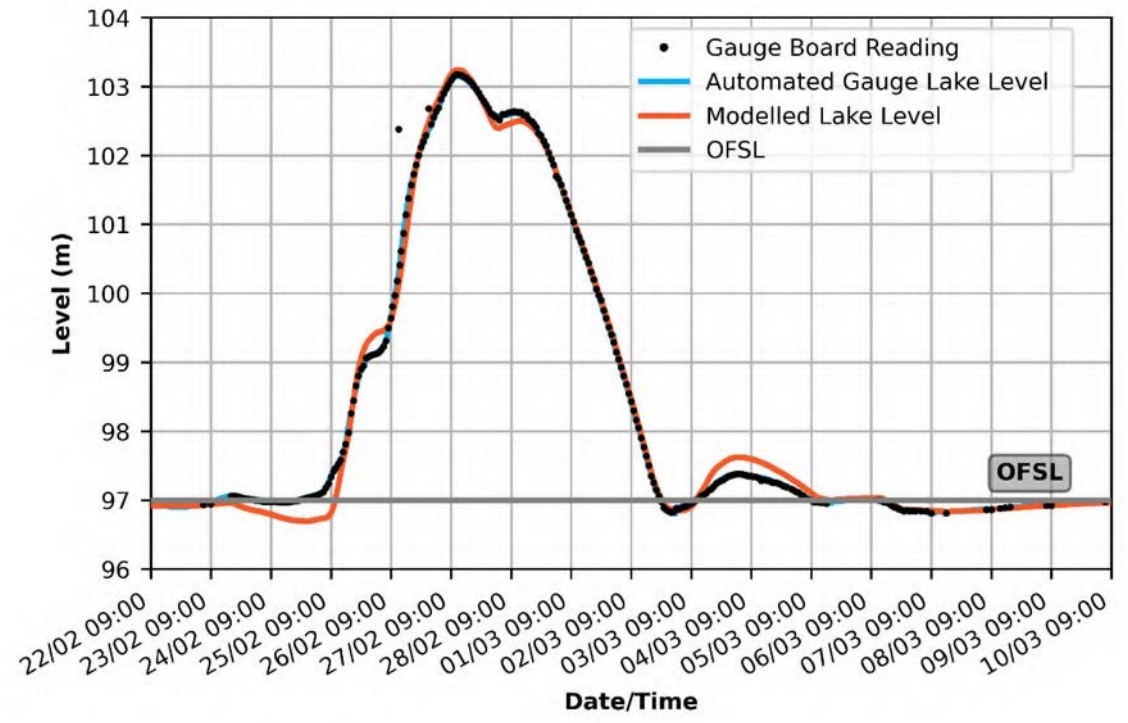

Figure v: Somerset Dam post-event analysis whole of event calibration modelled lake level compared to automated data and gauge board readings for the period 22/02/2022 09:00 to 10/03/2022 09:00 (replicated in Figure 7-24)

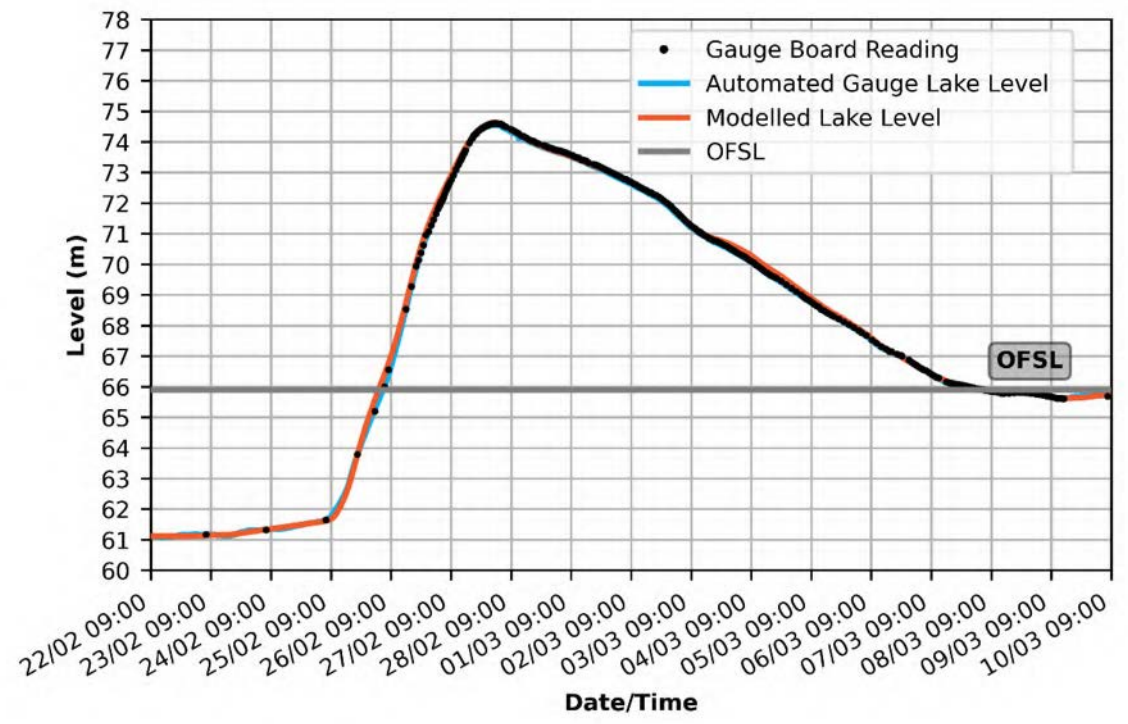

Figure vi: Wivenhoe Dam post-event analysis whole of event modelled lake level compared to automated data and gauge board readings for the period 22/02/2022 09:00 to 10/03/2022 09:00 (replicated in Figure 7-25)

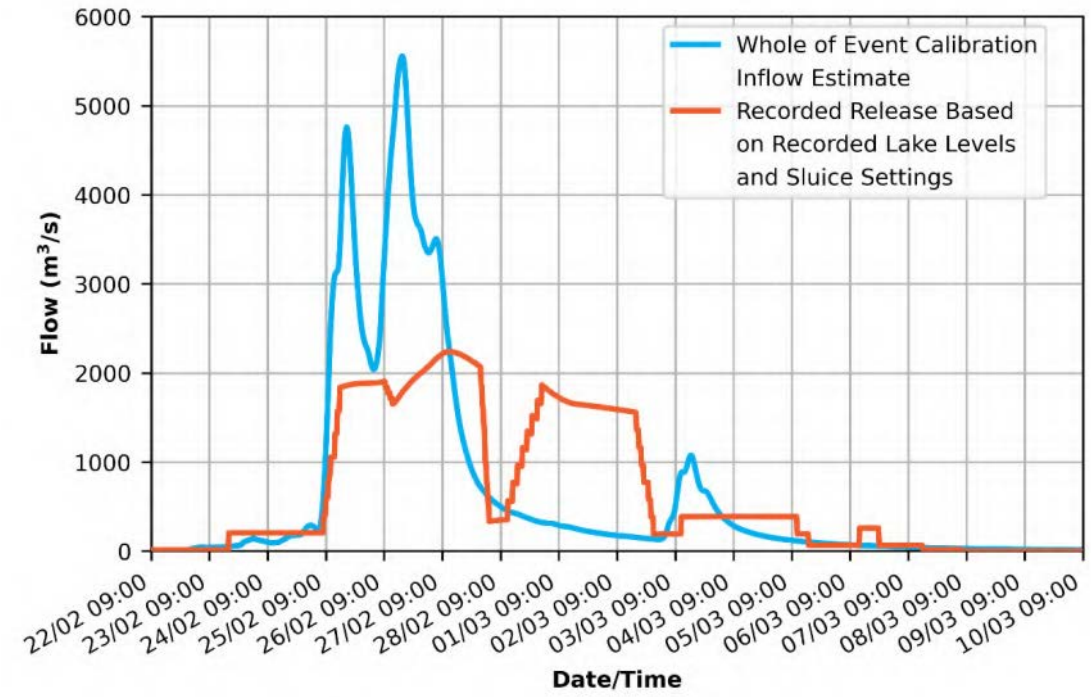

Figure vii: Somerset Dam modelled inflow hydrograph produced by the post-event analysis whole of event calibration (with the benefit of hindsight) and recorded release hydrograph for the period 22/02/2022 09:00 to 10/03/2022 09:00

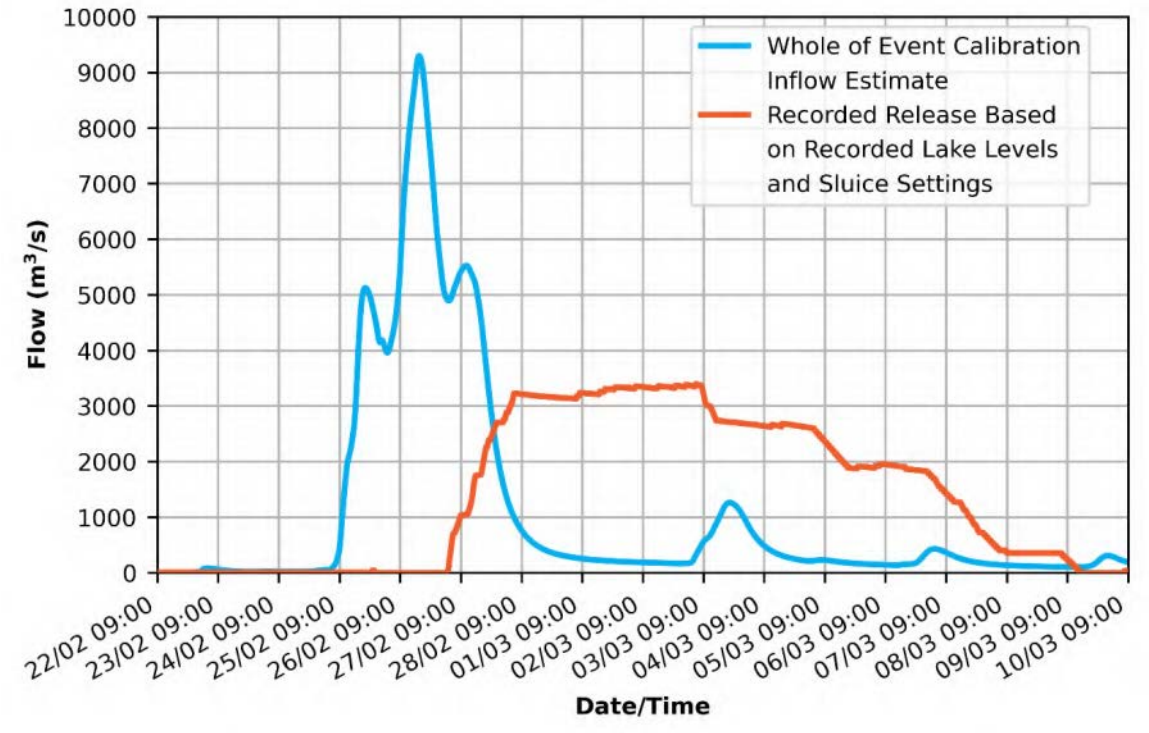

Figure viii: Wivenhoe Dam modelled inflow hydrograph produced by the post-event analysis whole of event calibration (with the benefit of hindsight) excluding Somerset Dam releases and recorded release hydrograph for the period 22/02/2022 09:00 to 10/03/2022 09:00

Communications

To assist with operational decision making and for sharing of information across agencies for coordinated flood response, communications occurred between Seqwater and the Bureau and other relevant stakeholder agencies throughout the Flood Event. The key forms of communication that were used with external stakeholders included:

- Situation Reports issued by Seqwater to relevant stakeholder agencies. Situation Reports were issued at least twice daily with a total of 34 Situation Reports being issued in total.
- Initial and then ongoing discussions with local government and Department of Transport and Main Roads regarding potential inundation of bridges, actual bridge closures, and re-opening of bridges.
- Participation in the Lower Brisbane River Communications Protocol videoconferences hosted by the Bureau with relevant stakeholder agencies also attending. 24 of these videoconferences occurred throughout the Flood Event.
- Advice and datasets were provided by Seqwater to relevant stakeholder agencies of actual and predicted releases (a total of 19 datasets were issued throughout the Flood Event).
- Notifications to inform the public of dam operations including by email, text message and the Seqwater website.

Event magnitude

Table iv shows a comparison between maximum 09:00 to 09:00 three-day catchment average rainfalls and maximum one hour rainfall intensities based on 15-minute catchment average data recorded in this Flood Event compared with the significant historical events of 1974, 2011 and 2013. This data has been sourced from the gridded historical rainfall database collated by Seqwater for the purpose of Seqwater's activities in calibrating the FFS hydrological models.

Table iv: Historical total catchment average rainfall and intensity comparison (replicated in Table 6-1)

	Event			
	1974	2011	2013	2022
Maximum 09:00 to 09:00 three-day rainfall total (mm)				
Stanley River to Somerset Dam	429	447	357	627
Brisbane River to Wivenhoe Dam	296	292	283	409
Lockyer Creek	312	288	298	406
Bremer River	460	216	320	331
Brisbane River between Wivenhoe Dam and Moggill	577	377	310	645
Brisbane River downstream of Moggill	623	155	306	637
Maximum one hour rainfall intensity (mm/hr) based on 15-minute catchment average data				
Stanley River to Somerset Dam	22.0	28.1	19.5	25.9
Brisbane River to Wivenhoe Dam	16.4	16.0	14.0	20.2
Lockyer Creek	30.7	24.2	12.9	18.2
Bremer River	22.2	20.2	15.1	16.4
Brisbane River between Wivenhoe Dam and Moggill	26.4	40.2	16.1	32.0
Brisbane River downstream of Moggill	34.9	17.5	27.5	27.9

The maximum 09:00 to 09:00 three-day catchment average rainfall totals recorded in the 2022 Flood Event for the Stanley River to Somerset Dam and Brisbane River to Wivenhoe Dam catchments were significantly higher than those recorded in the 1974, 2011 and 2013 events. The three-day catchment average rainfall totals over these catchments were both approximately 40% higher than those recorded in January 2011. The three-day catchment average rainfall totals were also higher for the downstream catchments in the 2022 Flood Event compared to January 2011. The three-day catchment average rainfall for the Brisbane River downstream of Moggill catchment in the 2022 Flood Event was more than three times larger than the value recorded in the January 2011 event. Maximum one hour rainfall intensities recorded during the 2022 Flood Event were higher than those in 2013, and comparable with those recorded during both the 1974 and 2011 events.

Table v shows a comparison between the peak lake level and total inflow and release volume for selected significant historic flood events compared to the 2022 Flood Event. There are several difficulties associated with making direct comparisons with historic flood events, which are detailed in Section 6.2. These include when the dams were constructed, lack of gauge data for earlier events and varying starting lake levels and operational procedures from event to event.

Table v: Comparison of historical flood event volumes from Seqwater, 2013 (replicated in Table 6-2)

Event	Somerset Dam			Wivenhoe Dam			
	Peak Lake Level (m AHD)	Inflow (ML)	Release (ML)	Peak Lake Level (m AHD)	Upper Brisbane River Inflow[1] (ML)	Total Inflow (ML)	Release (ML)
Feb 1893	N/A	1,340,000[2]	N/A	N/A	N/A	3,290,000[3]	N/A
Feb 1931	N/A	420,000[2]	N/A	N/A	790,000	1,210,000[3]	N/A
Mar 1955	103.47	510,000	430,000	N/A	720,000	1,150,000[3]	N/A
Jan 1968	N/A	460,000	380,000	N/A	550,000	930,000[3]	N/A
Jan 1974	106.57	710,000	440,000	N/A	1,170,000	1,610,000[3]	N/A
Jun 1983	101.58	170,000	110,000	N/A	800,000	920,000	470,000[4]
Mar 1989	102.59	360,000	380,000	69.78	300,000	670,000	670,000
Apr 1989	102.69	340,000	350,000	71.45	530,000	880,000	880,000
Feb 1999	102.96	450,000	240,000	70.45	950,000	1,190,000	1,190,000
May 2009	99.62	110,000	110,000	62.19	80,000	180,000	180,000
Mar 2010	99.41	210,000	190,000	66.43	210,000	400,000	400,000
Oct 2010	101.37	280,000	280,000	69.61	340,000	620,000	620,000
Mid Dec 2010	100.42	130,000	140,000	67.50	230,000	370,000	370,000
Late Dec 2010	99.98	150,000	140,000	69.35	380,000	530,000	530,000
Jan 2011	105.11	820,000	820,000	74.97	1,930,000	2,750,000	2,750,000
Jan 2013	101.62	260,000	240,000	70.31	620,000	860,000	860,000
Feb 2022[5]	103.17	902,000	900,000	74.61	1,450,000	2,352,000	1,970,000

[1]Upper Brisbane River catchment inflow (excluding Stanley River catchment/Somerset Dam releases)
[2] Flood event occurred prior to construction of Somerset Dam. Flood volume estimate based on calibrated hydrologic model,
[3] Flood event occurred prior to construction of Wivenhoe Dam. Flood volume estimate based on calibrated hydrologic model,
[4] Wivenhoe Dam was partially completed during this Flood Event,
[5] Based on whole of event calibration described in Section 7.2

Given the difficulties described above in comparing historic floods, the most valid comparison which can be made to the 2022 Flood Event is with the January 2011 event. Both dams were in place during the 2011 flood event and the aspects of their physical configurations which impact flood volumes were relatively similar. However, the operational procedures which were in place in January 2011 were those of Revision 7 of the Manual. The procedures implemented in the 2022 Flood Event were from Revision 16 of the Manual and vary from those in place in 2011. The Operational Full Supply Level at Somerset Dam in place in January 2011 was 99 m AHD. For the 2022 Flood Event OFSL was 97 m AHD. During both events, the lake level in Somerset Dam was close to the respective OFSLs at the start of the event. The Operational Full Supply Level at Wivenhoe Dam in place for the 2011 event was 67 m AHD, and the lake level was close to this at the start of the event. For the 2022 Flood Event, OFSL was 65.9 m AHD and the initial lake level at commencement of the Flood Event was 62.16 m AHD.

The total inflow and release volume at Somerset Dam in the 2022 Flood Event was larger than the 2011 event. Peak lake level was lower in 2022 than 2011, as a result of the difference in OFSL and operating procedures between the two events. The 2022 Flood Event had the largest estimated flood/inflow volume at the Somerset Dam site for all flood events excluding the 1893 flood of record.

The total inflow (i.e. including Somerset Dam releases) and release volume at Wivenhoe Dam in the 2022 Flood Event was lower than for the 2011 flood event. Peak lake level was also lower in 2022, which is likely to be influenced by the lower inflow volume, lower starting lake level and difference in operating procedures between the two flood events. The 2022 Flood Event and 2011 flood event have the largest total flood/inflow volumes by a significant margin at the Wivenhoe Dam site since the 1893 flood of record, although neither Somerset nor Wivenhoe Dams existed in 1893 and so a direct comparison is difficult.

Systems review and compliance

The operating procedures that applied in this Flood Event are described in the Wivenhoe Dam and Somerset Dam Manual of Operational Procedures for Flood Mitigation, Revision 16 (November 2021).

Based upon the evidence available from the Strategy Logs, Flood Forecasting System (FFS) simulations, Gate Operations Models, Gate Directives and recorded rainfall and river level data, the flood operations implemented at the dams during this Flood Event complied with the procedures in the Manual. In this Flood Event, an authorised Alternative Procedure for Somerset Dam was also implemented during part of the Flood Event.

Recommendations

Under section 385(1)(j) of the Act, this report must set out any recommended changes to the Manual and Flood Forecasting System that would allow the Manual to deal with a similar flood event more effectively.

It is recommended that Seqwater consider the following potential changes to the Manual and/or Flood Forecasting System (FFS):

- Continue to invest in the ongoing enhancement of the FFS.
- Continue to consider whether additional checks or processes could be implemented to ensure the FFS and Gate Operations Model data aligns to actual gate settings at the dams.
- Whether to add an additional outflow criterion or tighten the predicted peak lake level criteria for the commencement of a Flood Event to something less than 1.0 metre above OFSL at Somerset Dam as outlined in Section 13.2(b)(ii) of the Manual. At the start of the Flood Event, Somerset Dam was close to OFSL and making operational releases through the sluices, and the Wivenhoe Dam lake level was well below OFSL. In these particular circumstances, the Somerset Dam lake level could be at OFSL (97.0 m AHD) with all cone valves and sluices open releasing approximately 1,800 m^3/s without triggering the commencement of a flood event. Conceptually, such release rates are highly likely to be the result of sufficient rainfall to trigger flood events at both dams and it is recommended that

Seqwater consider whether to add an additional release criterion or tighten the lake level rise criteria to something less than 1.0 metre above OFSL at Somerset Dam. The requirement in Section 13.2 of the Manual that the determination of a Flood Event has commenced must be based on inflows determined from rain on ground remains effective.

- Continue to review, in partnership with DRDMW, the expediency of the process for approval of an Alternative Procedure under Section 18 of the Manual. Seqwater and DRDMW should plan to simulate the application of the protocol during exercises.
- Review Procedure 3c (Dam Safety Strategy) in the Manual following a flood of this magnitude. A relatively small amount of additional rainfall would have potentially placed operations into Procedure 3c of the Dam Safety Strategy. Invoking the Dam Safety Strategy requires increased emphasis to be placed on the primary objective in the Manual of preventing structural failure of the Dam. Procedure 3c of the Dam Safety Strategy allows for professional judgement to be made in balancing lake level and releases to continue achieving a flood mitigation benefit. In particular, consideration should be given as to whether further guidance could be included to inform the DSFOE as to how to balance lake level and flow at Moggill during operations in the Dam Safety Strategy.
- Review the lake level tolerance criteria for ending a Flood Event at Wivenhoe Dam in the Dam Drain Down Strategy Procedure 3b(ii)(a) in the Manual and determine whether additional flexibility should be provided for Flood Events that generate large baseflow volumes from the Upper Brisbane River catchment, while still achieving the objectives. Consideration of additional flexibility would need to continue to provide assurance that the level will return to OFSL at the end of a flood event and the flexibility solely be limited to situations with confidence in estimated baseflow from the catchment.

Contents

Tables

Figures

Glossary

Act means the *Water Supply (Safety and Reliability) Act 2008* (Qld) including any subordinate legislation made under it.

Actual Lake Level means the Lake Level at the staff headwater gauge with reasonable adjustments (where possible made by an engineer) to take into account prevailing conditions.

ADFD means the Australian Digital Forecast Database containing weather forecast data produced by the Bureau of Meteorology.

AHD means Australian Height Datum.

ALERT means Automated Local Evaluation in Real-Time System, a system of monitoring and displaying rainfall and water level data. It is a combination of field stations, communications networks and data collection software. ALERT sensors automatically transmit rainfall and water level data by radio to designated base stations at prescribed intervals or when a change in reading occurs.

Baseflow means ongoing small flows in rivers and creeks being principally supplied from groundwater (rather than immediately running off from rainfall). Usually insignificant when peak flows are being evaluated, but can be significant in evaluating the final shutdown of Dam releases at the conclusion of a Flood Event.

Bureau means the Bureau of Meteorology. The Bureau of Meteorology is Australia's national weather, climate and water agency. The Bureau of Meteorology operations under the authority of the *Meteorology Act 1955* (Cth) and the *Water Act 2007* (Cth) which provide the legal basis for its activities, while its operation is continually assessed in accordance with the national need for climatic records, water information, scientific understanding of Australian weather and climate and effective service provision to the Australian community.

Chief Executive means the Director-General of the Department of Regional Development, Manufacturing and Water or nominated delegate.

Communications Protocol means the current version of the Communications Protocol for Flood Releases from Seqwater's Gated Dams (Wivenhoe Dam, Somerset Dam and North Pine Dam).

Dam means Wivenhoe Dam and Somerset Dam and "Dam" means either Wivenhoe Dam or Somerset Dam depending on the context used.

Dam Operator means a person with the required qualifications, experience and training who has been approved by Seqwater to fulfil the role of a Dam Operator under Section 3.8 of the Manual.

DRDMW means the Queensland Government Department of Regional Development, Manufacturing and Water.

Downstream Catchment Flow means the estimate of the flow from the catchments downstream of Wivenhoe Dam excluding the releases from Wivenhoe Dam, and is derived with the FFS.

Duty Senior Flood Operations Engineer or **DSFOE** means a Senior Flood Operations Engineer who is on duty and, whilst on duty, has the responsibilities set out in Section 3.2 of the Manual.

Emergency Action Plan or **EAP** when referring to Wivenhoe Dam means the current Emergency Action Plan for Wivenhoe Dam prepared and approved in accordance with Chapter 4 Part 1 Division 2A of the Act. When referring to Somerset Dam means the current Emergency Action Plan for Somerset Dam prepared and approved in accordance with Chapter 4 Part 1 Division 2A of the Act.

Enviromon is the Bureau of Meteorology data collection software used to collect and display real time rainfall and water level data.

FFS means the Flood Forecasting System. The FFS is described in Section 7 of the Manual.

Flood Event means a flood event that commences in accordance with Section 13.2 or Section 17.3(c) and Section 17.4(b) of the Manual and ends in accordance with Section 13.2 of the Manual.

Flood Mitigation Guide Curve means the relationship between the Predicted Peak Lake Level in Wivenhoe Dam and the Target Flow at Moggill. It is developed from WSDOS to achieve an appropriate balance between use of the Flood Storage Compartments of the Dams and mitigation of downstream flooding. Refer to Figure 14.1.1 of the Manual for the Flood Mitigation Guide Curve corresponding to an OFSL of 65.9 m AHD.

FEWS is a software package developed by Deltares that incorporates a hydrological forecast and warning system. FEWS is one component of the FFS.

Flood Operations Centre or **FOC** means the Centre used by Flood Operations Engineers to manage Flood Events.

Flood Operations Engineer means a person with the required qualifications, experience and training (set out in Section 3.8 of the Manual) who has been approved by Seqwater to fulfil the role of a Duty Flood Operations Engineer under the Manual.

Flood Operations Engineers means the collective group of persons who individually have designation as either a Flood Operations Engineer or a Senior Flood Operations Engineer.

Flood Storage Compartment means the storage volume in a Dam between the Operational Full Supply Level and the Maximum Flood Storage Level. Flood waters are temporarily stored in the Flood Storage Compartment during a Flood Event.

FSL or **Full Supply Level** means the level of the water surface when the reservoir is at maximum operating level, excluding periods of flood discharge.

Full Supply Level (range of definitions). The following terms are used in this report:

- **Operational Full Supply Level** or **Operational FSL** or **OFSL** means the Lake Level defining the top of the Water Supply Compartment. The Operational Full Supply Level for a Dam is determined as follows:

a. If neither a Temporary Full Supply Level nor a Reduced Full Supply Level is in place, then the Operational Full Supply Level is:

i. When referring to Wivenhoe Dam, the level specified in the Central Brisbane River Water Supply Scheme Resource Operations Licence, which is 65.9 m AHD. This was the Operational Full Supply Level for Wivenhoe Dam in this Flood Event;

ii. When referring to Somerset Dam, the level specified in the Stanley River Water Supply Scheme Resource Operations Licence, which is 97.0 m AHD. This was the Operational Full Supply Level for Somerset Dam in this Flood Event.

b. If a Temporary Full Supply Level is in place but no Reduced Full Supply Level is in place, then the Operational Full Supply Level is the Temporary Full Supply Level.

c. If a Reduced Full Supply Level is in place but no Temporary Full Supply Level is in place, then the Operational Full Supply Level is the Reduced Full Supply Level.

d. If both a Temporary Full Supply Level and a Reduced Full Supply Level are in place, then the Operational Full Supply Level is the lower of the two levels.

Gate Operations Model means a tool used to derive the Release Plan. The Gate Operations Model is discussed in more detail in Section 7.5 of the Manual.

Gauging Station means a location at which rainfall and/or water level is measured. Water level is measured in metres, either in reference to a local datum or Australian Height Datum. Flow in cubic metres per second (m^3/s) can be inferred using a water level versus discharge rating.

Judged likely or **judges it likely** means an event or circumstance being, in the professional judgement of a Duty Engineer, sufficiently certain to occur.

Judged very likely means an event or circumstance being, in the professional judgement of a Duty Engineer, certain or near certain to occur.

Lake Level means the still water surface elevation in the Dam and when used in the Manual, Lake Level shall mean the Actual Lake Level, unless specifically indicated to the contrary such as by the use of the prefix predicted.

Manual or **Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam** means the current version of the Manual.

Maximum Flood Storage Level means the defined Lake Level in a Dam above which it is considered that the Dam structure may fail suddenly and with little warning.

a. The Maximum Flood Storage Level for Wivenhoe Dam is 80.0 m AHD;

b. The Maximum Flood Storage Level for Somerset Dam is 108.7 m AHD with the removable flood barrier in position; and

c. The Maximum Flood Storage Level for Somerset Dam is 107.45 m AHD without the removable flood barrier in position.

Monitoring Network means the network of rainfall and water level Gauging Stations which provides data in near real-time and enables continuous monitoring of rainfall and stream levels

within the Dam catchment. The Monitoring Network is part of the FFS and is described in Section 7.2 of the Manual.

OOA means 'out of action' in relation to the operation of a rainfall or river height gauge that provides catchment data.

Operations Manual means either the Central Brisbane River Water Supply Scheme Operations Manual or the Stanley River Water Supply Scheme Operations Manual, depending on the context used, and is not used during Flood Events. The function of the Operations Manual is described further in Section 1.1 of the Manual.

Power Station means the Wivenhoe pumped storage hydro-electric power station associated with Wivenhoe Dam and Splityard Creek Dam.

Predicted means, unless the context requires otherwise, the prediction of the event or circumstance made by a Duty Engineer using the FFS.

Predicted Peak, when referring to a Lake Level, means the Predicted Peak Lake Level that takes into account all the Dam releases (including operational releases made under the Operations Manual) planned from the Dam that are contained in the Release Plan.

Rain on Ground means rain that has already fallen in the catchment up to the time of the analysis and excludes rainfall forecasts.

Rainfall Forecast means a prediction of future rainfall provided by the Bureau; see also Bureau Provided Forecast or BPF.

Release Plan means the planned releases of water from the Dam approved by the DSFOE in accordance with the Manual and is used to issue Dam release directives to the Dam Supervisor. The Release Plan is discussed in more detail in Section 8 of the Manual.

Resource Operations Licence or **ROL** means:

a. In the case of Somerset Dam, the Stanley River Water Supply Scheme Resource Operations Licence (as amended from time to time);

b. In the case of Wivenhoe Dam, the Central Brisbane River Water Supply Scheme Resource Operations Licence (as amended from time to time).

Seqwater means the Queensland Bulk Water Supply Authority, trading as Seqwater.

Target Flow at Moggill means a target for the water flow in the Brisbane River at Moggill as the result of planned and actual Wivenhoe Dam releases combined with Downstream Catchment Flow. The Target Flow at Moggill can be less than the peak Downstream Catchment Flow at Moggill.

URBS means Unified River Basin Simulator.

Water Act means the *Water Act 2000* (Qld), including any subordinate legislation made under it.

Water Supply Compartment means the storage volume in the reservoir up to the Operations Full Supply Level.

WISKI means the system that collects and stores data such as telemetry and dam operator readings (gauge boards and gate settings).

WSDOS means the *Wivenhoe and Somerset Dams Optimisation Study*.

Note: Levels in this document related to dams (including lake level) are referenced in metres Australian Height Datum (m AHD). Gauged water levels are referenced in metres to the specific gauge datum.

1. Introduction

1.1 Reporting requirements

This report has been prepared to describe the 25/02/2022 to 09/03/2022 Flood Event at Somerset and Wivenhoe Dams, in accordance with the requirements in Chapter 4, Part 2, Division 9 of the Act. Details of Somerset and Wivenhoe Dams and the operational procedures can be found in the Manual.

This report documents the essential information to meet the requirements of the Act. Table 1-1 summaries the sections of the report addressing each of the requirements as listed under the Act.

Table 1-1: Reporting requirements

Section / subsection in Water Supply (Safety and Reliability) Act 2008	Report section addressing requirement
1) A flood event report or a flood event interim report must - (a) describe the flood event to which it relates; and	Executive Summary 1 Introduction 2.1 Lead up to the Flood Event 6 Flood Event Magnitude 7 Post-Event Hydrology Analysis
(b) describe the implementation of the flood mitigation manual for the dam in relation to the flood event, including relevant details of — (i) communications made, strategies used and actions taken in response to the flood event; and (ii) the reasons for the use of the strategies;	Executive Summary 1.3 Flood event 4 Dam Operations 5 External communications 8.1 Compliance with the Manual 8.6 Effectiveness of the Manual
(c) state the amount of the following that was forecast when the flood event started and measured during the flood event – (i) rainfall in, or affecting, the catchment area of the dam; (ii) inflow to the dam; and	2 Flood Event Data 3.2 Model runs 4.2 Strategy timeline and reasons for selection 6 Flood Event Magnitude 7 Post-Event Hydrology Analysis Appendix B
(d) state the level of the water surface of the dam that was forecast when the flood event started and the levels measured during the flood event; and	2 Flood Event Data 3.2 Model runs 4 Dam Operations 6 Flood Event Magnitude 7 Post-Event Hydrology Analysis Appendix C Appendix D
e) state the amount of the outflow from the dam that was - (i) forecast under the flood mitigation manual when the flood event started; and (ii) measured during and after the flood	2.6 Lake levels and releases 3.2 Model runs 4.2 Strategy timeline and reasons for selection 6 Flood Event Magnitude 7 Post-Event Hydrology Analysis Appendix A Appendix B
(f) include an assessment of the adequacy of the	2 Flood Event Data

Section / subsection in Water Supply (Safety and Reliability) Act 2008	Report section addressing requirement
forecast system for the dam; and	3 Flood Modelling 4.2 Strategy timeline and reasons for selection 7 Post-Event Hydrology Analysis 8.3 Assessment of the Flood Forecasting System Appendix G
(g) describe any damage to the dam caused by the flood event, including by attaching photographs of the damage; and	8.5 Dam infrastructure performance Appendix F
(h) state whether and to what extent any damage to the dam has been caused or contributed to by the flood event; and	8.5 Dam infrastructure performance Appendix F
(i) include an assessment of whether and to what extent the flood mitigation manual effectively dealt with the flood event; and	4 Dam Operations 8.1 Compliance with the Manual 8.6 Effectiveness of the Manual
(j) recommend any changes to the flood mitigation manual and forecast system that would allow the manual to deal with a similar flood event more effectively; and	8.3 Assessment of the Flood Forecasting System 8.6 Effectiveness of the Manual
(k) include details of any other matter that is relevant to how the flood event was dealt with under the flood mitigation manual; and	Executive Summary 1 Introduction 2.5.1 Tides 6 Flood Event Magnitude 8.2 Operational arrangements 8.4 Record keeping
(l) include any other relevant matter prescribed under a regulation.	Not applicable to this Flood Event.
(2) If the owner of the dam carried out or purported to carry out an authorised alternative procedure in relation to the flood event, the flood event report or the flood event interim report must also include the authorisation request information for the procedure.	4.2 Strategy timeline and reasons for selection 5.6 Authorisation of the Somerset Dam Alternative Procedure Appendix E
(3) Subsection (1) does not prevent a flood event report from dealing with 2 or more flood events if – (a) the flood events are related; and (b) the chief executive has agreed to the report dealing with the flood events.	Not applicable to this Flood Event.

1.2 Summary of basis of reporting

This report was prepared from the following contemporaneous records generated during the Flood Event:

- The rainfall, river level, rated flow and Dam lake level and release data were sourced after the Flood Event from information archived in the Flood Forecasting System (FFS).
- The FFS model simulations were collated from model runs archived during the Flood Event.
- The summary descriptions of the strategies selected and the reasons for their implementation are based on the contemporaneous records of the Somerset Dam and

Wivenhoe Dam Strategy Log, Flood Operations Centre Event Log, Situation Reports, Gate Directives and data from the Gate Operations Model and FFS model runs relevant to each period.

- The description of communications was prepared from documents sent by or received in the Flood Operations Centre email database. The Somerset Dam and Wivenhoe Dam Strategy Log and the Flood Operations Centre Event Log were referred to for time references or miscellaneous communications.
- Interviews with the Seqwater Senior Flood Operations Engineers on duty during the Flood Event were conducted on 23/03/2022 and 24/03/2022. These interviews were used to confirm details of a range of hydrological model runs, flood operating decisions and communications undertaken throughout the Flood Event. Feedback was also sought from the Senior Flood Operations Engineers on their views of the efficiency and suitability of the procedures in the Manual.

Conclusions, opinions and recommendations in this report were based on the observations of the HARC project team that prepared this report.

1.3 Flood event timeline overview

An overview of the key times and dates of the Flood Event are listed in Table 1-2. Further detailed information including context and decisions for changes to Release Plans at intermediate time periods is provided in subsequent sections of this report.

Table 1-2: Key event times

Date	Operating Milestone
23/02/2022 07:00	Flood Operations Centre mobilised.
25/02/2022 12:10	Criteria met for commencement of Flood Event, based on predicted lake level at Somerset Dam judged likely to exceed 98.0 m AHD considering operational releases. Somerset Dam Strategy and Wivenhoe Dam Flood Mitigation Strategy Procedure 1a selected.
25/02/2022 15:00	Wivenhoe Dam Flood Mitigation Strategy Procedure 1b selected.
25/02/2022 22:00	Releases from Wivenhoe Dam commenced under Flood Mitigation Strategy Procedure 1b.
25/02/2022 23:00	Releases from Wivenhoe Dam ceased under Flood Mitigation Strategy Procedure 1b due to increase in downstream flows.
25/02/2022 23:00 to 27/02/2022 04:00	Inflows to Somerset Dam and Wivenhoe Dam and predicted Downstream Catchment Flows at Moggill increase as further rainfall occurs. Frequent reassessment of predicted peak lake level in the dams and Release Plans. No releases occurred from Wivenhoe Dam in this period.
27/02/2022 04:00	Releases from Wivenhoe Dam recommence under Flood Mitigation Strategy Procedure 1b.
27/02/2022 11:30	Somerset Dam peak lake level (103.17 m AHD) and release (2,242 m^3/s) reached.
28/02/2022 00:45	Somerset Dam Alternative Procedure approved by DRDMW and implemented.

Date	Operating Milestone
28/02/2022 02:00	Peak lake level reached in Wivenhoe Dam (74.61 m AHD based on gauge board readings)
28/02/2022 06:00	Wivenhoe Dam Drain Down Strategy selected.
01/03/2022 02:00	Somerset Dam Alternative Procedure ceased and Somerset Dam Strategy Procedure 2a reinstated for sluice operations.
03/03/2022 06:00	Peak releases from Wivenhoe Dam (3,393 m³/s).
08/03/2022 07:00	Flood releases ceased at Somerset Dam.
09/03/2022 14:00	Flood releases ceased at Wivenhoe Dam. Criteria met for end of Flood Event.

1.4 Reliance statement

Data and records were supplied by Seqwater to Hydrology and Risk Consulting Pty Ltd (HARC) for the purposes of review and to inform the preparation of this Flood Event Report. The analysis and opinions expressed in this report are based on the information supplied and HARC has not undertaken independent verification of the raw source data.

The report on dam infrastructure performance addressing sections 385(1)(g) and (h) of the Act and included in Appendix F was provided by Seqwater. This report was prepared by a Registered Professional Engineer of Queensland who is an employee of Seqwater and who has experience in dam safety engineering. The content of the report in Appendix F was outside of the scope of HARC's engagement. HARC has not verified nor expressed any opinion on the content of the report in Appendix F.

This Flood Event Report has been prepared to satisfy the requirements of Chapter 4, Part 2, Division 9 of the Act. The information provided in this report should not be relied upon for any purposes without the user of the report making their own determination of the fitness for purpose of the report for their needs.

2. Flood Event Data

2.1 Lead up to the Flood Event

The Flood Event occurred during the 2021-2022 northern wet season, defined as October to April by the Bureau. Prior to the event, the season had been characterised by above average rainfall recorded across many parts of South East Queensland.

The Bureau issued a climate outlook on 06/01/2022. This outlook stated that February to April rainfall was likely to be above median for parts of northern and eastern Australia. The key climate driver referenced in the Bureau outlook was the El Niño Southern Oscillation, which was in an active La Niña phase prior to and during the Flood Event. La Niña conditions increase the chances of above average rainfall across large parts of eastern Australia during summer.

2.2 Gauging station network performance

The ALERT gauging station network is used to inform operations at Somerset Dam and Wivenhoe Dam as well as the monitoring of catchments in South East Queensland where other Seqwater referable dams are located. The network consists of 355 rainfall gauges and 245 water level gauges at field stations throughout the region.

In the lead up to the Flood Event, a number of rainfall and water level gauges across the network had been flagged as suspect or Out of Action (OOA). The gauges relevant to the operation of Somerset Dam and Wivenhoe Dam were:

- The Lyons Bridge rainfall and water level gauge which was decommissioned on 11/02/2022 and thus data was not available at this site for this Flood Event.
- The water level gauge at Jindalee which was OOA at the start of the Flood Event. The gauge was subsequently repaired on 28/02/2022 at approximately 12:00. Note that the Jindalee gauge is downstream of Moggill and hence is not critical for decision making, although it can be useful to enhance confidence in the rated flows at Moggill.
- The Redbank Creek rainfall gauge which had an intermittent issue with ALERT transmissions prior to the Flood Event. The gauge was deemed to be returning suspect data from the start of the Flood Event and periods of OOA occurred during the event. Data from this gauge was not used throughout the Flood Event.
- The Wivenhoe Dam Headwater rainfall gauge which had failed to report some periods of rainfall prior to the Flood Event. The gauge was deemed to be either OOA or reporting suspect data during the event. Data from this gauge was not used throughout the Flood Event.

A summary of the sensors relevant to the operation of Somerset Dam and Wivenhoe Dam that were marked as suspect or OOA in the lead up to the Flood Event is presented in Table 2-1.

Table 2-1: Gauges relevant to the operation of Somerset Dam and Wivenhoe Dam marked as suspect or out of action (OOA) in the lead up to the Flood Event

Rain	River	Name	Issue
ALERT ID	ALERT ID		
6633		Lyons Bridge AL-P	Site was decommissioned prior to the Flood Event
	6634	Lyons Bridge AL-P	
	6731	Jindalee AL	Level sensor failed prior to the Flood Event and was restored on 28/02/2022
6611		Redbank Creek AL	Data either suspect or gauge OOA throughout the Flood Event
6636		Wivenhoe Dam HW AL-P	Data either suspect or gauge OOA throughout the Flood Event

A map of the rainfall gauges that were marked as suspect or out of action in the lead up to the Flood Event in Table 2-1 is shown in Figure 2-1.

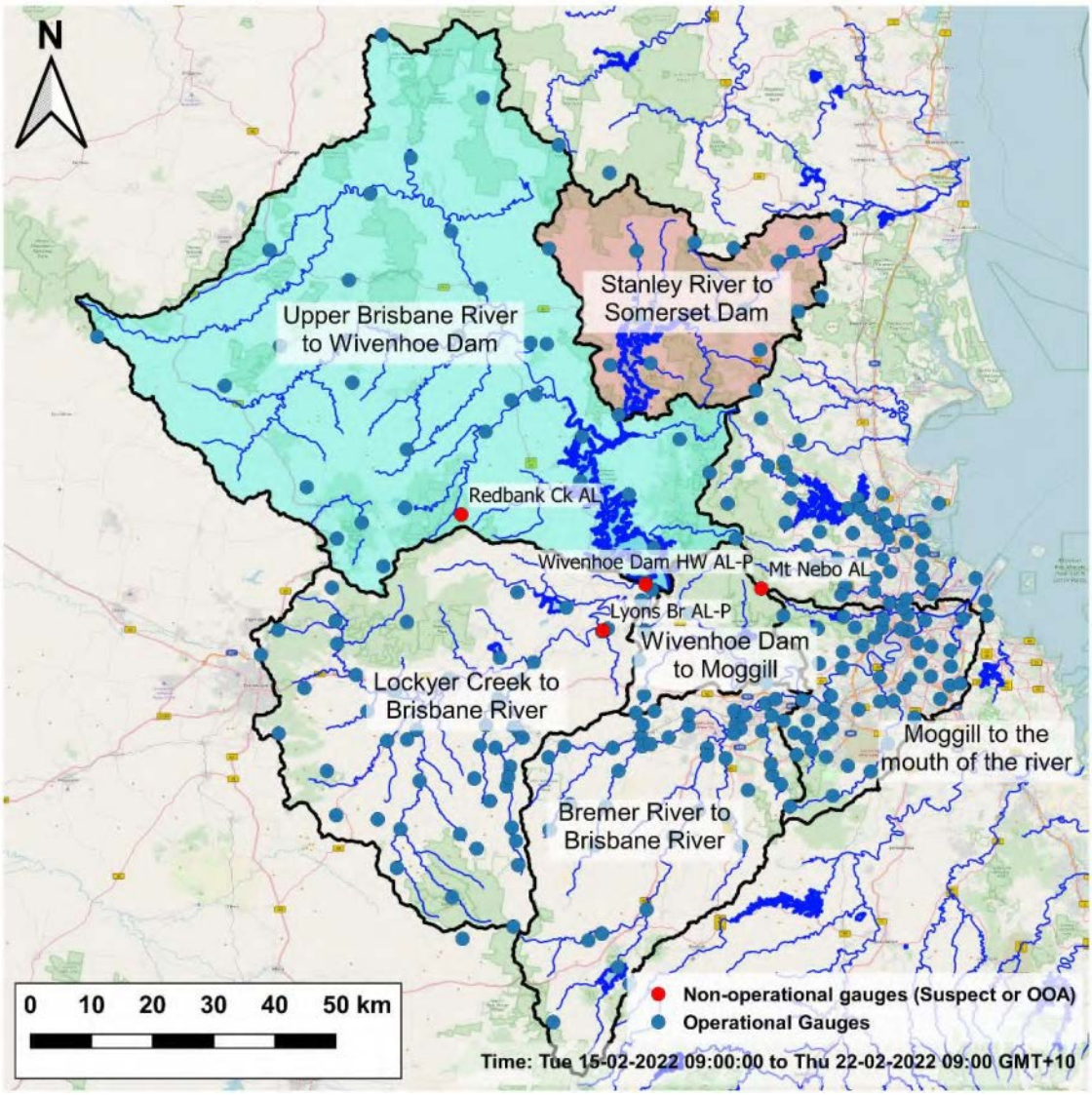

Figure 2-1: Rainfall gauges marked as suspect or out of action in the lead up to the Flood Event

There were further gauges that were identified as suspect or out of action during the Flood Event. Of these, seven rainfall gauges and seven water level gauges were relevant to the operation of Somerset Dam and Wivenhoe Dam as shown in Table 2-2 and Table 2-3.

Table 2-2: Gauges relevant to the operation of Somerset Dam and Wivenhoe Dam marked as suspect during the Flood Event

Rain ALERT ID	River ALERT ID	Name	Issue
6520		Boat Mountain AL	Intermittent missing or suspect data during the flood event
6714		Ferris Knob AL	Intermittent missing or suspect data during the flood event
	6551	Five Mile Bridge AL	Water level under-reading based on gauge readings

Rain ALERT ID	River ALERT ID	Name	Issue
6618		Glen Esk AL	Intermittent missing or suspect data during the flood event
6720		Kilcoy Creek AL	Intermittent missing or suspect data during the flood event
	6718	Linville AL	Sharp drop in level noticed on 27/2/2022, possible flood damage to gauge
6619		Mt Castle AL	Intermittent missing or suspect data during the flood event
	6560	Savages Crossing AL	Drop in level occurred on 27/2/2022. Appeared to be corrected on 07/03/2022[1].
6540		Yarraman AL	Intermittent missing or suspect data during the flood event

[1] Note that after the Flood Event, data at this gauge was retrieved and was available for post-event analysis in this report.

Table 2-3: Gauges relevant to the operation of Somerset Dam and Wivenhoe Dam marked as out of action (OOA) during the Flood Event

Rain ALERT ID	River ALERT ID	Name	Issue
	6557	Glenore Grove AL	Gauge data failed from 25/2/2022, likely from flood damage
6568		O'Reillys Weir AL	Gauge data failed from 26/02/2022, likely from flood damage
	6569	O'Reillys Weir AL	
	6747	Whyte Island AL	Gauge not reporting overnight on 27/02/2022 as a result of power issues. Note this gauge does not affect decision making at Wivenhoe Dam as it is well downstream of Moggill.
	6644	Wivenhoe Dam TW AL	Gauge data failed from 26/02/2022, likely from flood damage. Note this gauge has limited to no value during flood operations because it is influenced by backwater effects and hence does not produce reliable rated flows.

A map of the rainfall gauges that were marked as suspect or out of action during the Flood Event in Table 2-2 and Table 2-3 is shown in Figure 2-2.

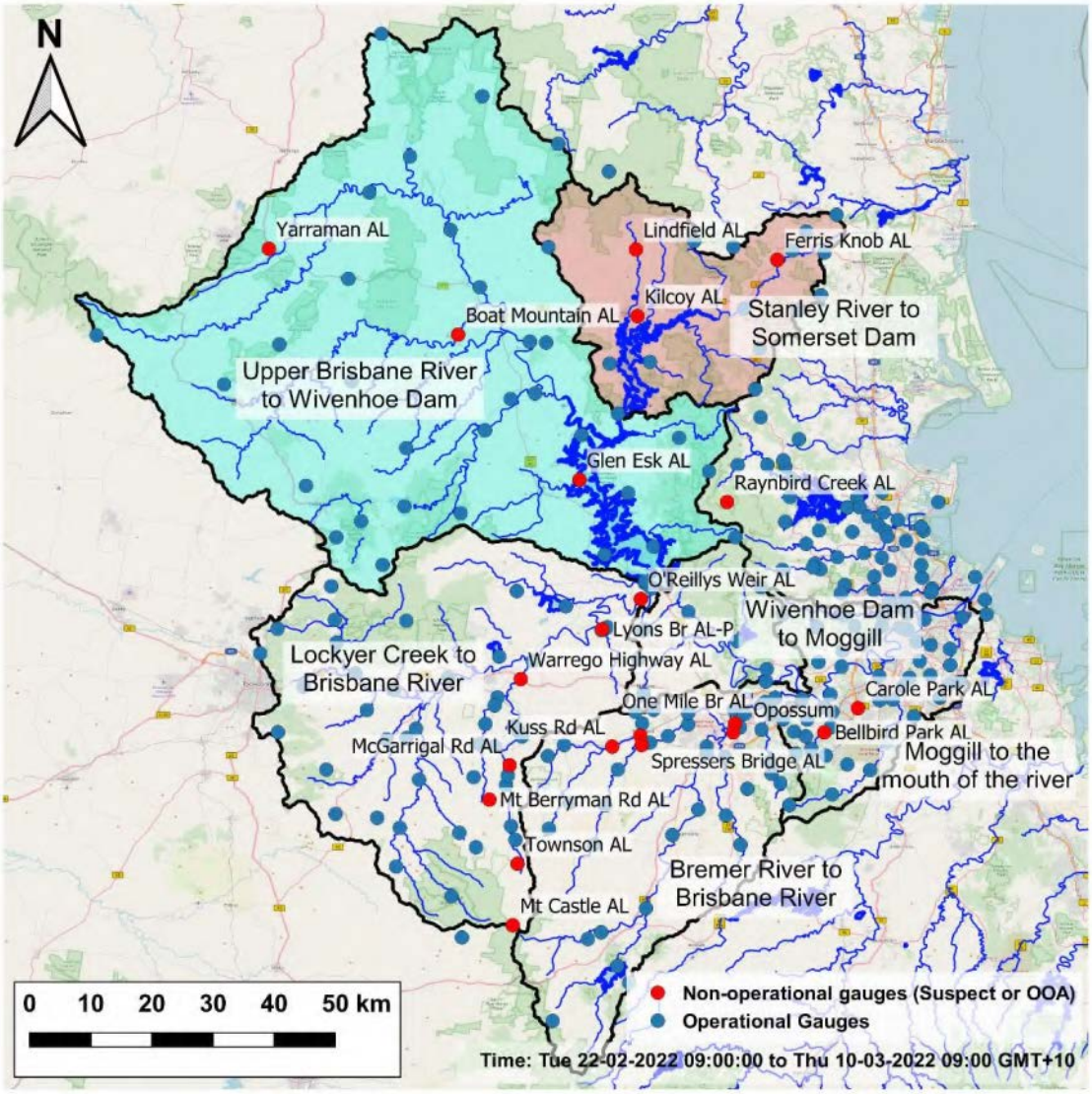

Figure 2-2: Rainfall gauges that were flagged as suspect or out of action during the Flood Event (shown in red)

2.3 Rainfall

This section presents an analysis of the rainfall recorded across the Brisbane River basin during the Flood Event. Whilst the Flood Event commenced at 25/02/2022 12:10, the hydrologic modelling undertaken to support dam operations in the Flood Forecasting System (FFS) requires a lead in period prior to the start of the event. By convention, hydrologic model users typically select a start time at 09:00 to align with Bureau daily read rainfall data. The corresponding hydrologic model start time selected for the Flood Event was therefore set by the DSFOE as 22/02/2022 09:00 in order to account for rainfall since this start time. The data that is presented throughout this report typically aligns with that model start time, and covers the period up to 10/03/2022 09:00, corresponding to the 09:00 on the day after the end of the Flood Event.

Note that in this section, rainfall data is typically presented as daily values, or as hourly values for the discussion on temporal pattern in Section 2.3.4. The FFS uses the raw rainfall data aggregated to a 15 minute time step as an input to the hydrologic modelling, however this time step was considered to be too short for the purposes of concise data reporting, display and analysis in this Flood Event report.

Throughout the remainder of this section of the report, recorded rainfall data has been aggregated to a Brisbane River basin sub-catchment scale for presentation and analysis. The sub-catchments used in this report are consistent with Section 4.2 of the Manual, namely:

- Stanley River to Somerset Dam;
- Brisbane River to Wivenhoe Dam;
- Lockyer Creek to the junction with the Brisbane River;
- Bremer River to the junction with the Brisbane River (including Warrill Creek and Purga Creek);
- Brisbane River from Wivenhoe Dam to Moggill; and
- Brisbane River downstream of Moggill.

A map showing these sub-catchment boundaries, sourced from Section 4.2 of the Manual, is included as Figure 2-3.

Data from rainfall gauges across South East Queensland was collected by the Enviromon[1] system in real-time and analysed in the FFS. The recorded rainfall data is represented in the FFS as a point rainfall value and is subsequently gridded to provide coverage over the catchment as an appropriate input to the hydrologic models across the Brisbane River basin to support dam operation decision making under the Manual.

The daily rainfall recorded in the 24 hours to 09:00 for each day of the Flood Event for selected rainfall gauges within the Somerset Dam and Wivenhoe Dam catchments is summarised in Table 2-4 and the data for rainfall gauges downstream of Wivenhoe Dam is summarised in Table 2-5.

[1] Enviromon collects real time ALERT gauge data.

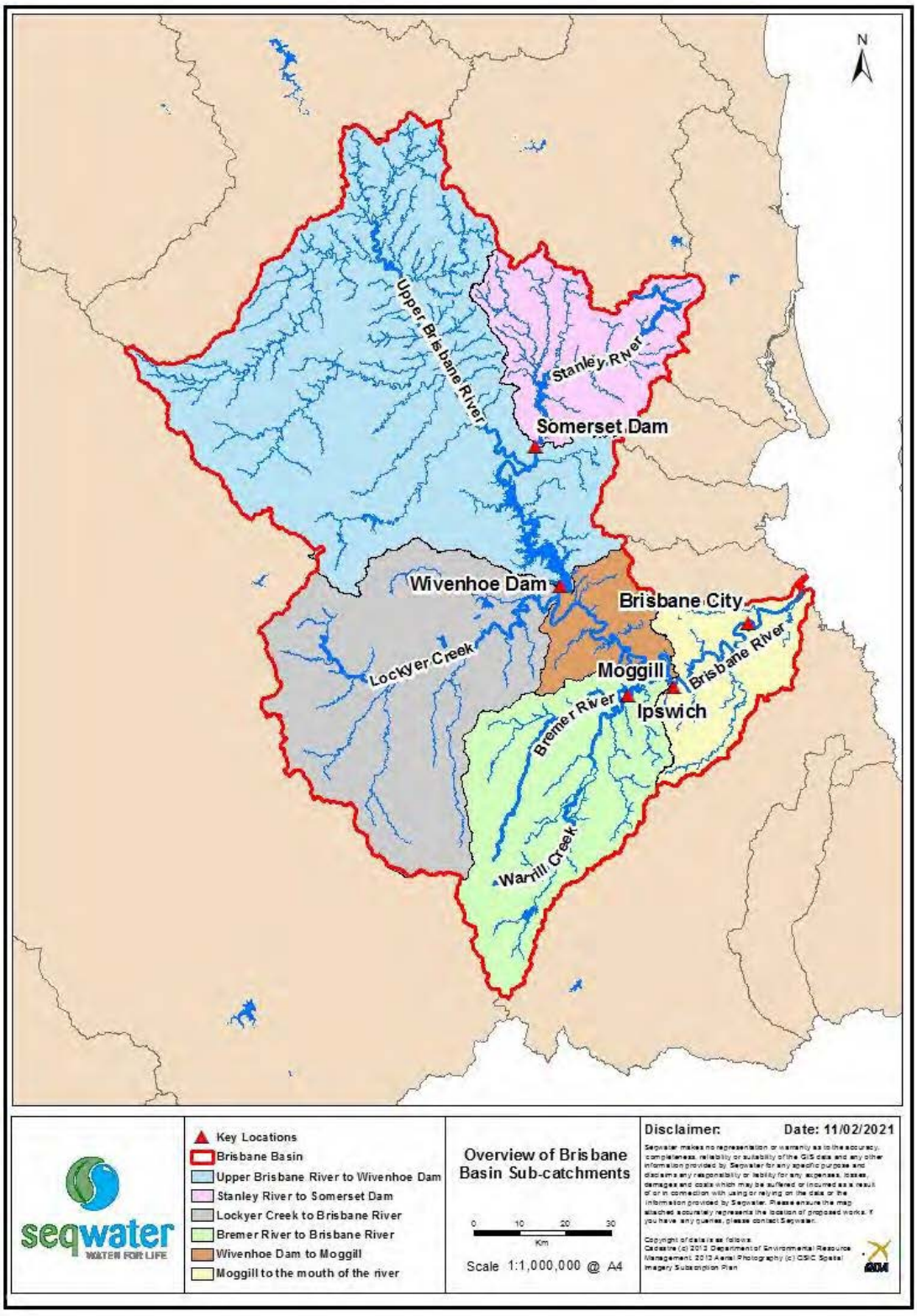

Figure 2-3: Brisbane River basin sub-catchments used for presentation and analysis of rainfall data (Source: Section 4.2 of the Manual)

Table 2-4: Daily rainfall totals in the 24 hours to 09:00 for selected rainfall gauges in the Somerset Dam and Wivenhoe Dam catchments (Source: FFS)

Rainfall in the 24 hours to 09:00 on date	Gauge																													
	Blackbutt	Bryden	Caboonbah†	Cooyar Ck	Cressbrook Dam †	Crows Nest	Devon Hills	Eskdale	Ferris Knob†	Glen Esk†	Gregors Ck	Hazeldean	Jimna	Kilcoy	Kluvers Lkt	Lindfield	Linville†	Monsildale	Mt Glorious	Mt Binga	Mt Stanley	Nukinenda	Rosentreters Br	St Aubyns	Top of Brisbane	West Bellthorpe	Westvale	Wivenhoe Dam TW	Woodford	Yarraman†
23/02	5	57	15	1	18	11	23	35	103	-	23	31	15	29	64	-	13	1	76	5	0	16	36	1	0	78	35	16	52	1
24/02	14	10	8	1	2	3	12	5	27	-	12	23	2	25	24	-	3	6	56	10	1	9	6	11	1	15	19	5	29	1
25/02	74	101	42	60	141	104	105	131	115	-	106	120	98	118	136	-	73	104	252	101	82	120	132	85	70	134	103	48	119	-
26/02	159	231	4	168	2	100	207	148	245	-	217	233	256	224	326	-	184	152	711	109	173	129	177	80	112	214	234	339	266	-
27/02	102	166	-	92	-	103	150	131	238	-	161	198	135	225	243	-	130	131	463	100	128	125	147	86	65	186	225	200	238	-
28/02	2	20	-	0	-	0	2	0	4	-	6	0	2	4	14	-	6	0	219	2	1	1	10	0	0	8	1	51	3	-
1/03	1	2	-	1	-	1	0	0	8	0	2	3	3	2	2	-	1	1	17	1	1	0	0	1	1	10	0	1	5	-
2/03	0	0	-	2	-	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
3/03	26	22	-	59	-	16	18	25	42	11	46	10	12	37	36	45	44	9	10	17	18	25	29	25	9	74	10	16	70	-
4/03	8	1	-	14	-	1	22	1	20	1	13	11	32	15	3	44	28	29	7	1	13	2	2	1	2	45	10	2	33	-
5/03	3	0	-	1	-	9	0	0	0	0	0	2	0	0	0	0	0	18	0	11	4	0	0	0	0	0	2	0	0	0
6/03	0	0	-	0	-	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
7/03	6	6	-	28	-	6	3	27	0	16	3	0	16	15	7	5	13	23	13	1	35	5	10	16	5	15	0	1	9	22
8/03	0	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/03	0	2	4	0	7	9	0	14	-	8	6	0	0	0	1	2	0	0	1	15	0	19	5	44	4	0	0	3	0	0
10/03	0	0	2	0	1	2	0	0	-	1	0	0	2	0	0	0	0	0	0	2	0	1	1	1	5	0	0	0	0	0
Total (mm)	**400**	**618**	**75**	**427**	**171**	**365**	**542**	**517**	**802**	**40**	**595**	**633**	**573**	**694**	**856**	**96**	**495**	**474**	**1825**	**375**	**456**	**452**	**555**	**351**	**274**	**780**	**640**	**682**	**824**	**24**

†Rainfall gauge data marked as suspect or Out of Action (OOA) during the Flood Event

Table 2-5: Daily rainfall totals in the 24 hours to 09:00 for selected rainfall gauges downstream of Wivenhoe Dam (Source: FFS)

Rainfall in the 24 hours to 09:00 on date	Gauge																								
	Adams Br	Atkinson Dam	Bill Gunn Dam	Five Mile Bridge	Forest Hill	Glenore Grove	Gold Ck Res	Harrisville	Helidon	Jindalee	Kalbar Weir	Lake Clarendon Dam	Little Egypt	Moogerah Dam	Mt Castle†	Mt Crosby	O'Reillys Weir	Rosewood	Savages Crossing	Showground Weir	Tarome	Tenthill	Thornton	Toowoomba	Washpool	West Woodbine
23/02	5	51	13	16	38	40	61	6	21	30	4	53	3	3	-	18	14	15	11	14	3	17	4	18	14	4
24/02	3	5	2	5	1	2	7	5	4	10	10	1	2	7	-	12	4	4	11	2	12	0	5	5	10	0
25/02	112	67	102	75	76	74	79	97	91	67	121	97	77	106	-	72	50	87	36	95	108	100	159	146	78	76
26/02	108	307	176	245	265	259	285	106	246	207	60	285	197	42	-	245	309	208	314	174	51	334	116	138	104	134
27/02	96	168	77	167	93	95	259	94	107	173	69	125	60	74	-	179	183	133	184	76	64	106	80	86	98	60
28/02	86	29	33	123	24	20	289	119	14	196	105	20	13	72	-	215	52	82	102	33	71	27	46	5	196	16
1/03	1	5	3	3	1	1	8	1	0	5	2	8	0	1	-	2	0	2	0	5	0	4	0	0	1	0
2/03	2	0	0	0	0	0	0	9	0	0	4	0	0	2	-	0	0	0	1	0	8	0	2	0	3	0
3/03	46	24	48	57	45	44	35	33	19	40	21	53	35	56	-	53	25	43	27	46	35	51	52	11	38	63
4/03	1	5	0	0	0	1	5	1	6	4	2	1	0	3	1	3	2	1	3	0	0	0	1	3	0	7
5/03	1	0	0	15	0	0	1	2	0	0	1	0	0	14	13	0	0	0	0	0	25	0	7	0	2	0
6/03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
7/03	17	24	14	13	24	15	13	32	26	29	43	10	21	35	31	21	0	14	5	13	35	3	24	22	66	29
8/03	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	2	0	1	0	0	0
9/03	0	4	0	0	0	1	1	0	0	3	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
10/03	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Total (mm)	**478**	**689**	**468**	**719**	**567**	**553**	**1043**	**505**	**534**	**764**	**442**	**654**	**408**	**417**	**47**	**820**	**639**	**589**	**695**	**458**	**414**	**642**	**497**	**434**	**611**	**398**

†Rainfall gauge data marked as suspect or Out of Action (OOA) during the Flood Event

A map of the rainfall gauges with the accumulated rainfall over the duration of the Flood Event is shown for the dam catchments and downstream catchment in Figure 2-4 and Figure 2-5 respectively.

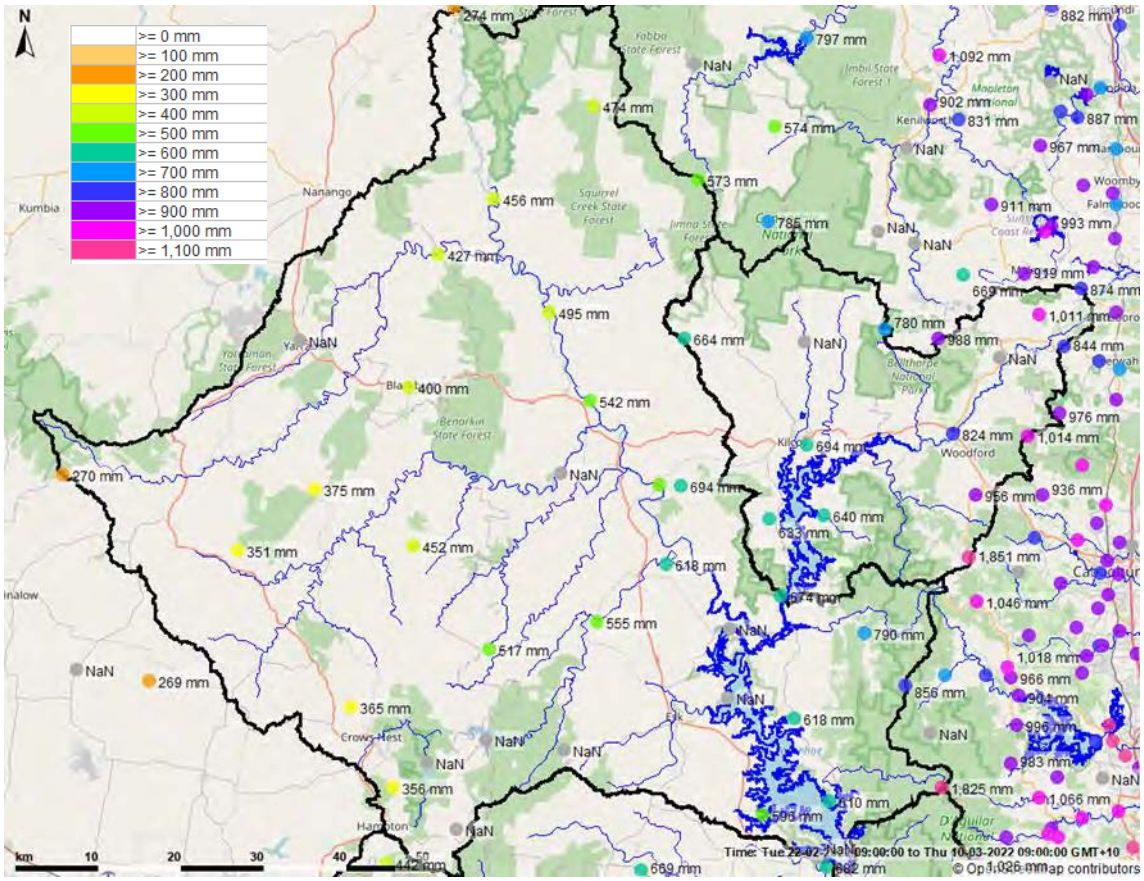

Figure 2-4: Total rainfall recorded at rainfall gauges in the dam catchments between 22/02/2022 09:00 and 10/03/2022 09:00 (16 day accumulation)

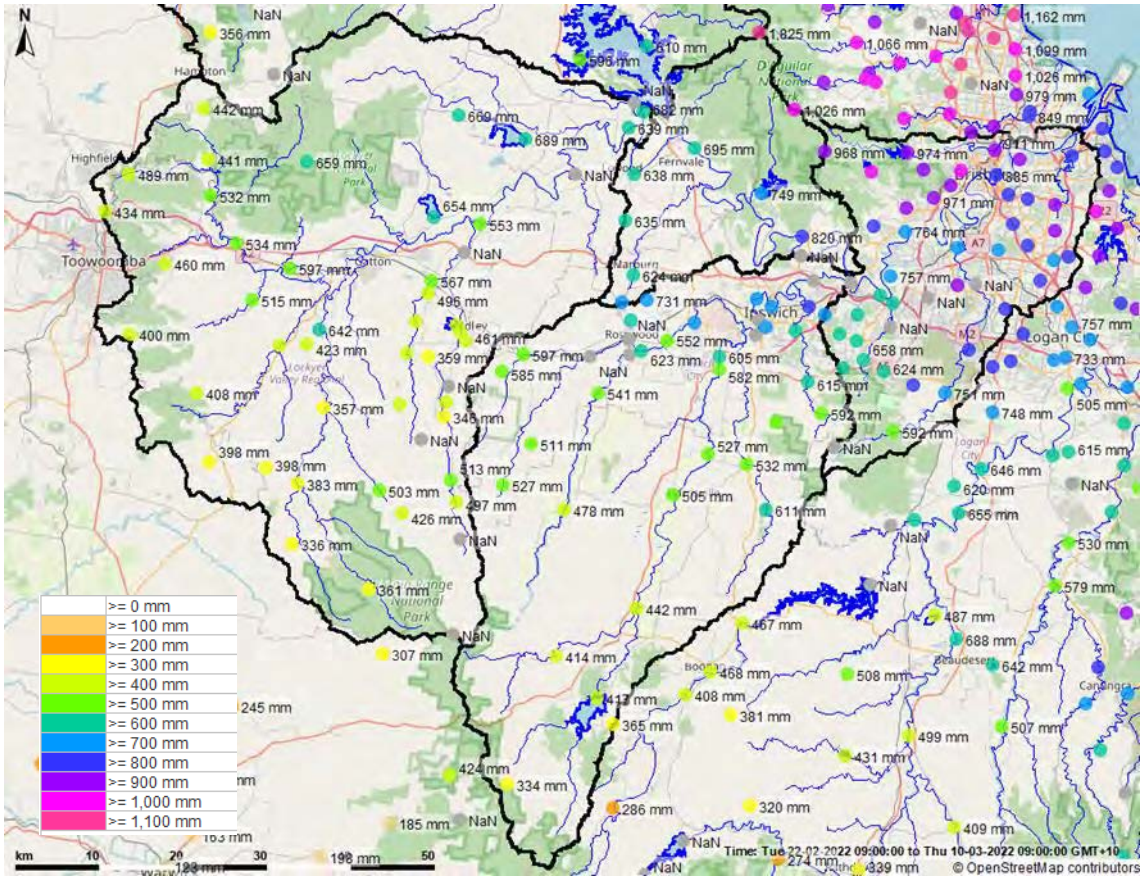

Figure 2-5: Total rainfall recorded at rainfall gauges in downstream catchments between 22/02/2022 09:00 and 10/03/2022 09:00 (16 day accumulation)

2.3.1 Catchment average rainfall

The average rainfall for the Brisbane River basin and its six sub-catchments was determined by fitting a gridded surface to the recorded gauge rainfalls and using polygon outlines of the catchment and sub-catchment boundaries to determine the mean rainfall from the grid. These catchment average rainfall values are shown in Table 2-6 and Figure 2-6.

Table 2-6: Brisbane River basin sub-catchment average rainfall depth (22/02/2022 09:00 to 10/03/2022 09:00)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	814
Brisbane River to Wivenhoe Dam	502
Lockyer Creek	523
Bremer River	517
Brisbane River from Wivenhoe Dam to Moggill	806
Brisbane River downstream of Moggill	830

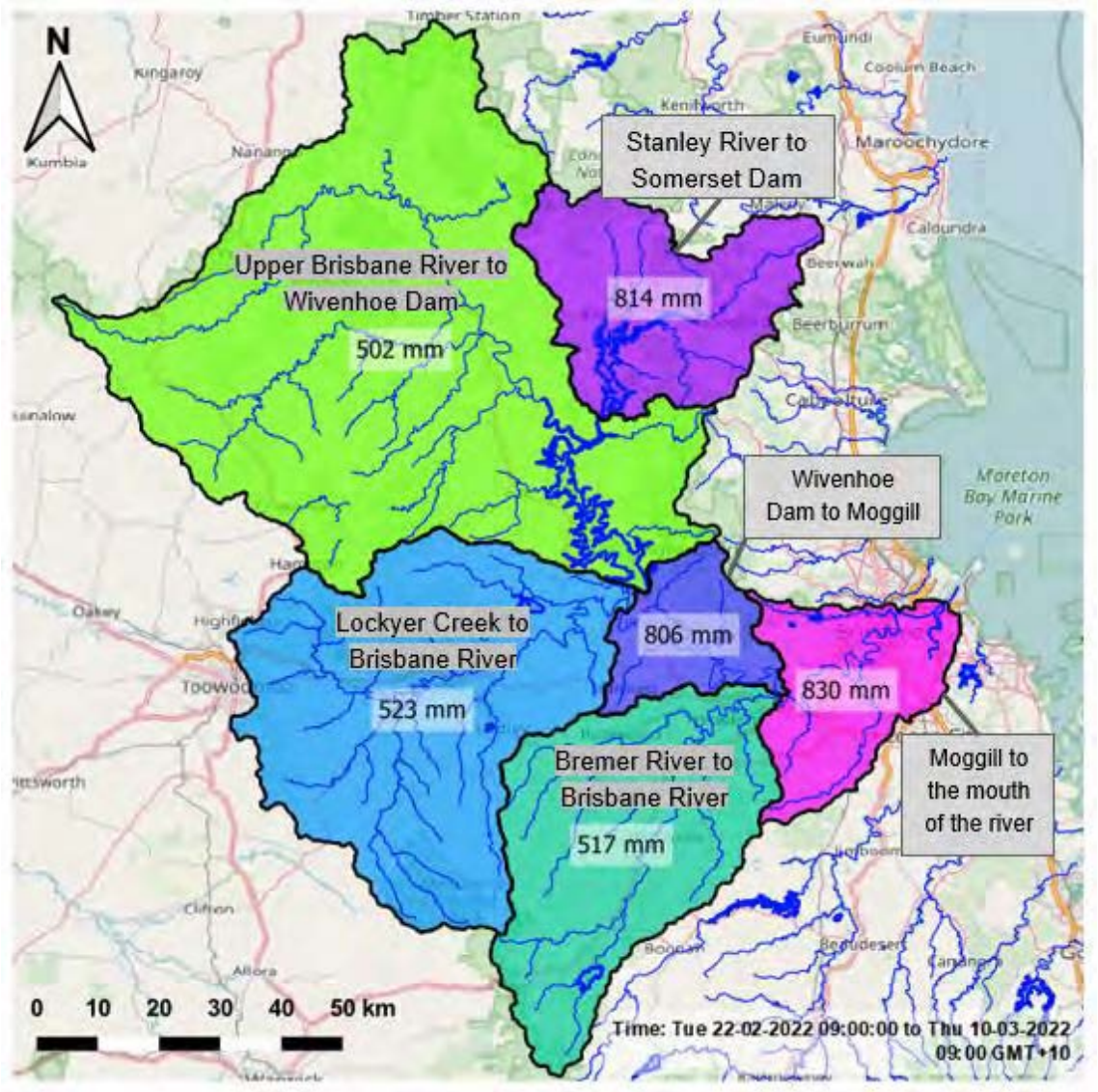

Figure 2-6: Brisbane River basin sub-catchment average rainfall depth (22/02/2022 09:00 to 10/03/2022 09:00)

The daily catchment average rainfall recorded for the Brisbane River basin sub-catchments is shown in Figure 2-7 to Figure 2-12.

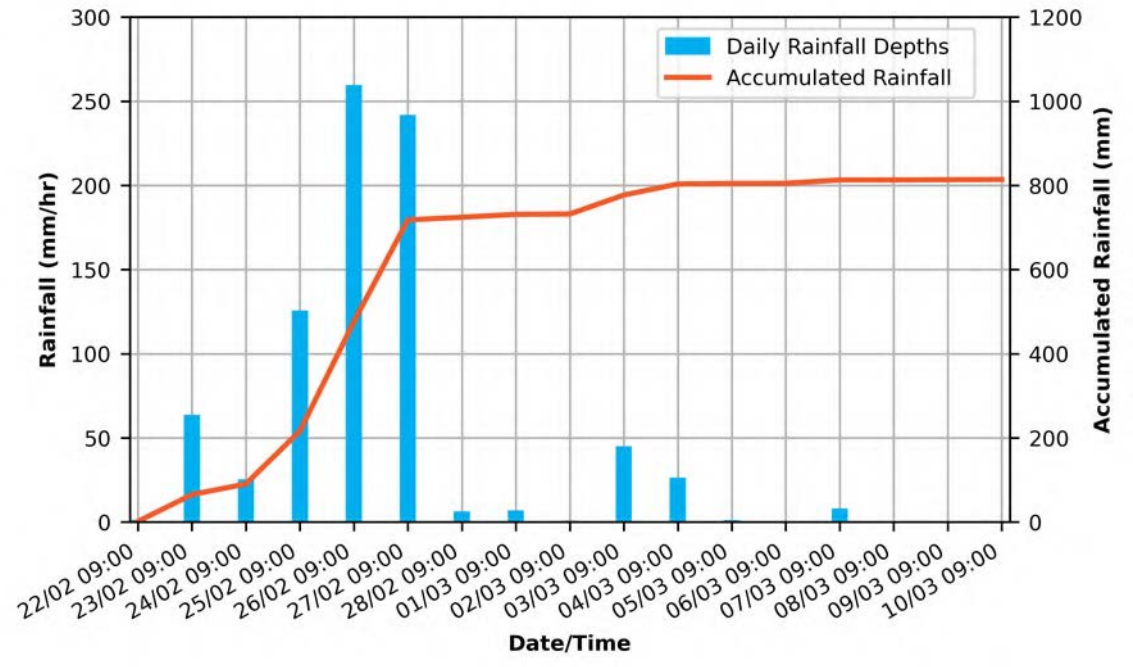

Figure 2-7: Stanley River to Somerset Dam catchment average rainfall from 22/02/2022 09:00 to 10/03/2022 09:00

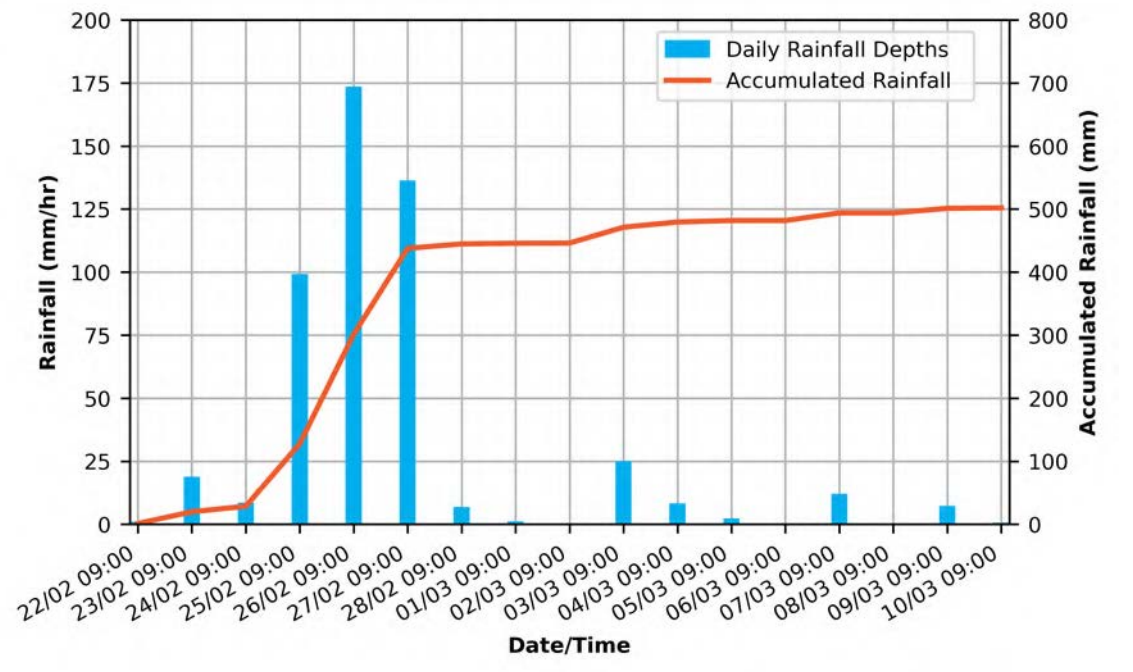

Figure 2-8: Brisbane River to Wivenhoe Dam catchment average rainfall from 22/02/2022 09:00 to 10/03/2022 09:00

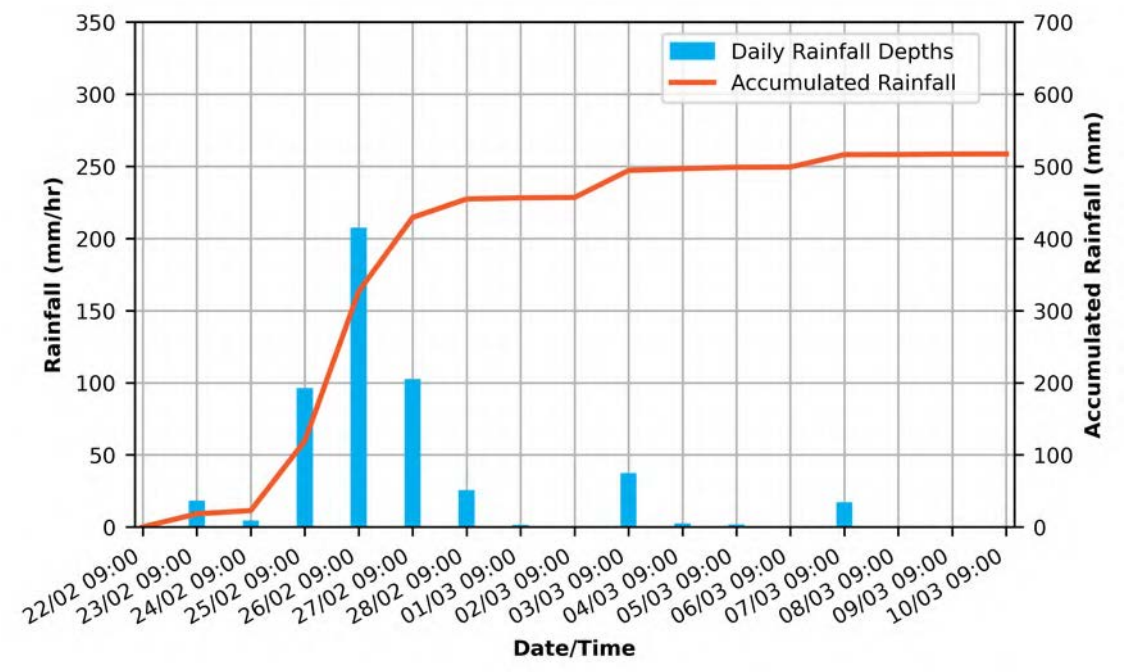

Figure 2-9: Lockyer Creek catchment average rainfall from 22/02/2022 09:00 to 10/03/2022 09:00

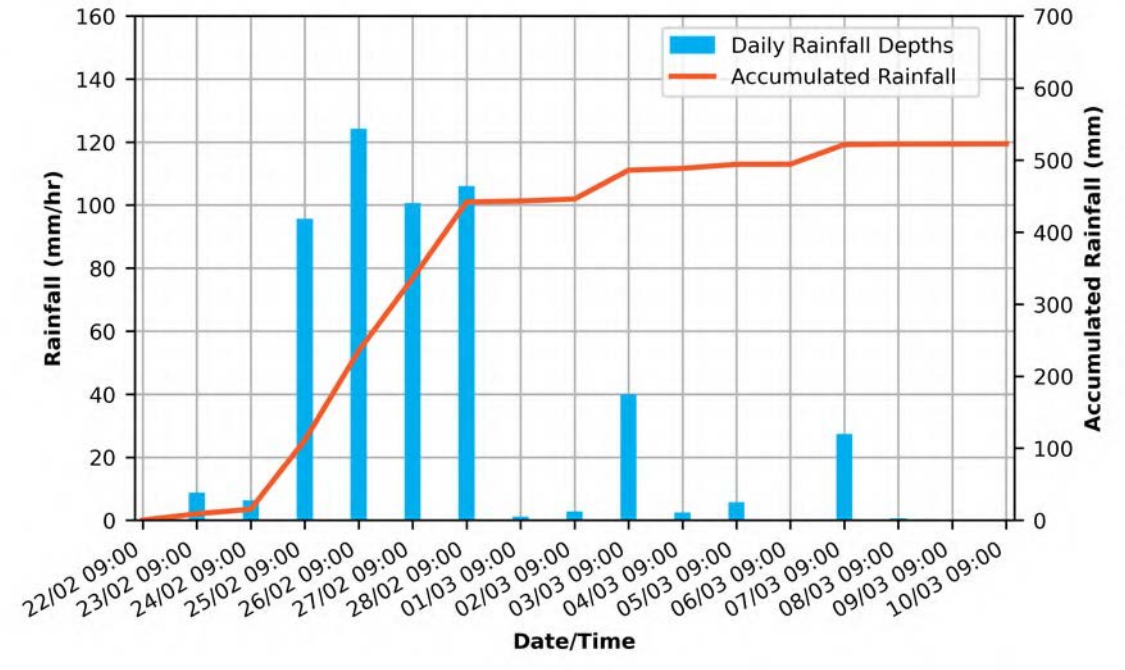

Figure 2-10: Bremer River catchment average rainfall from 22/02/2022 09:00 to 10/03/2022 09:00

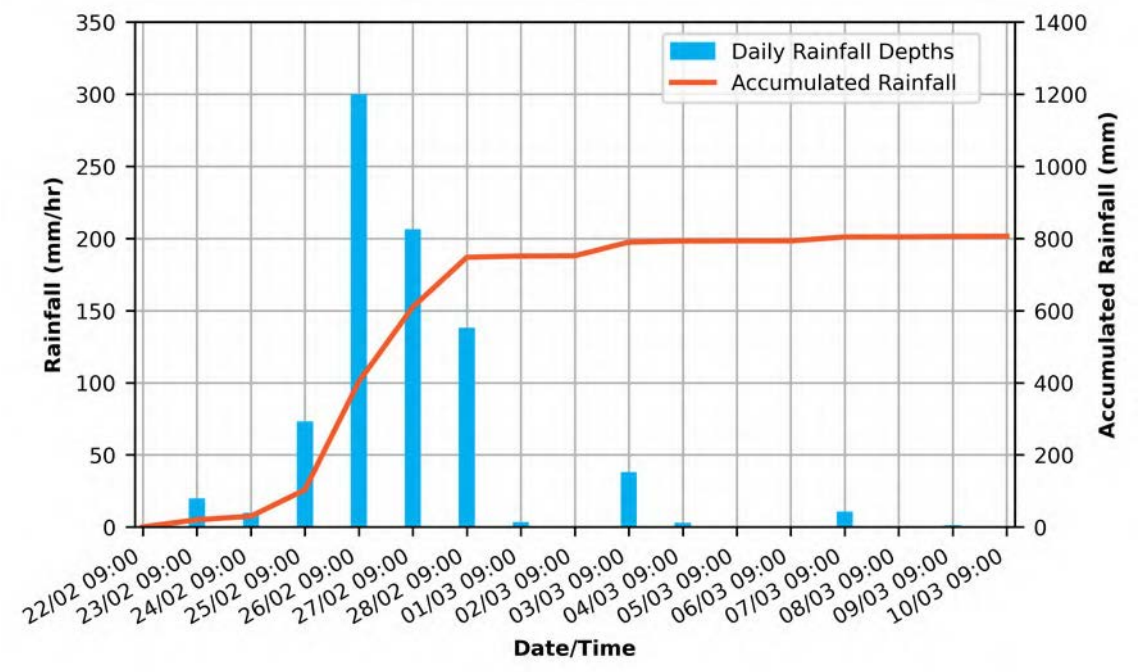

Figure 2-11: Brisbane River from Wivenhoe Dam to Moggill catchment average rainfall from 22/02/2022 09:00 to 10/03/2022 09:00

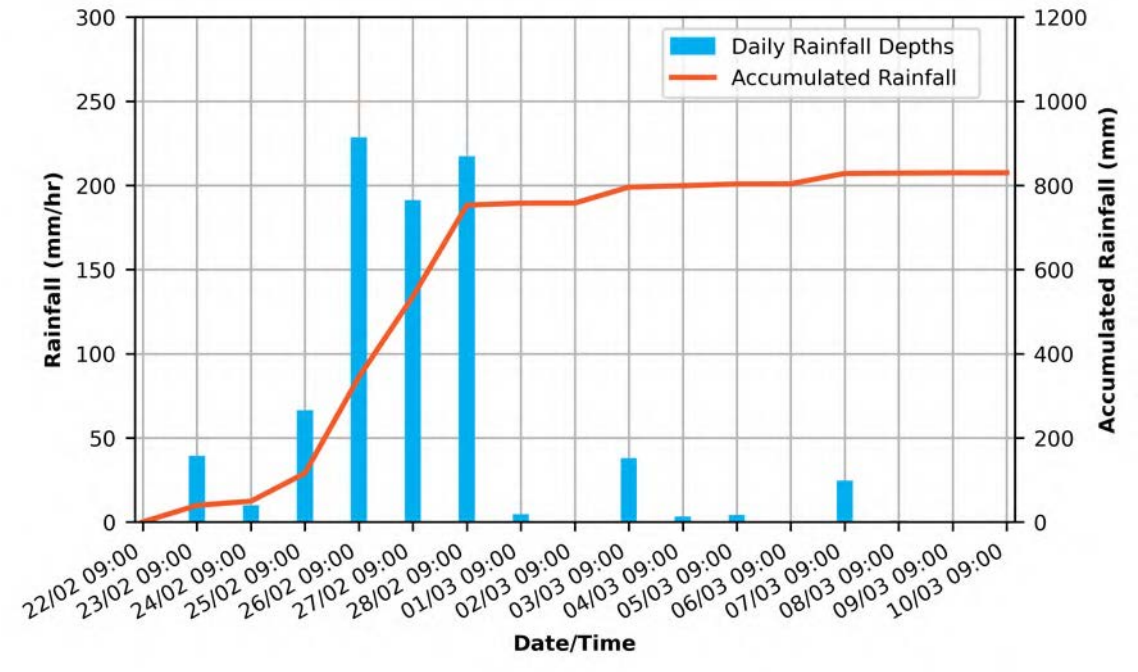

Figure 2-12: Brisbane River downstream of Moggill catchment average rainfall from 22/02/2022 09:00 to 10/03/2022 09:00

2.3.2 Spatial distribution of rainfall over the catchment

The spatial distribution of the rainfall over the Brisbane River basin sub-catchments accumulated over the period from 22/02/2022 09:00 to 10/03/2022 09:00 was extracted from the processed gridded rainfall data in the FFS and shown in Figure 2-13.

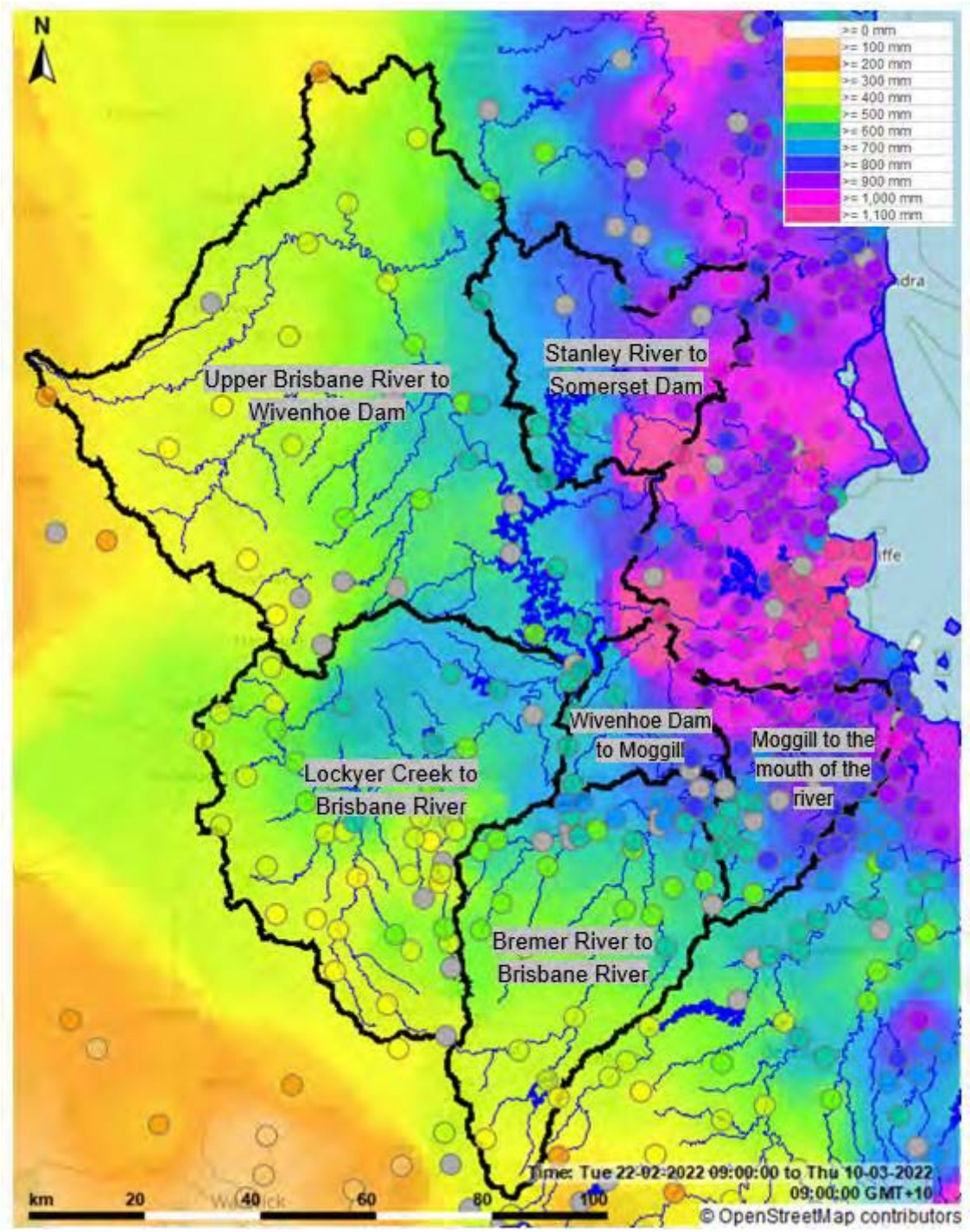

Figure 2-13 Spatial distribution of rainfall for the Brisbane River basin and its sub-catchments for 22/02/2022 09:00 to 10/03/2022 09:00

2.3.3 Daily rainfall totals

The daily rainfall totals recorded in Environmon were extracted from the FFS for the Brisbane River basin and processed gridded estimates of the daily rainfall totals for each day of the Flood Event are displayed in Figure 2-14 to Figure 2-29.

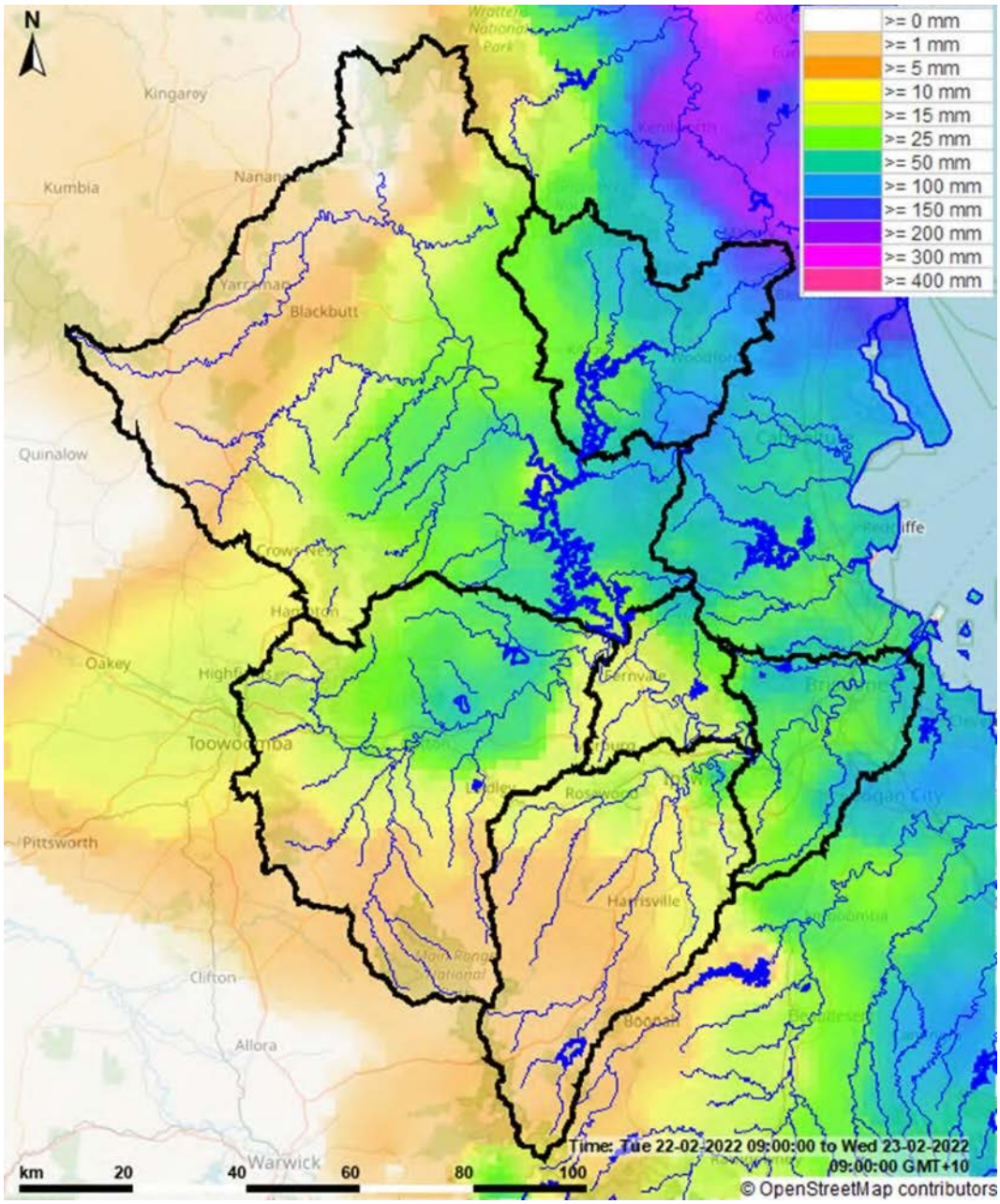

Figure 2-14: Daily rainfall (mm) 24 hours to 23/02/2022 09:00 (Source: FFS)

In the 24 hours to 23/02/2022 09:00, rainfall across South East Queensland intensified along the coast. There was widespread rainfall in the Stanley River catchment and with rainfall progressively intensifying through the day. The Mt Mee rainfall gauge recorded a rainfall total of 115 mm. There was some significant rainfall recorded the lower reaches of the Lockyer Creek, as well as within the Brisbane River catchment upstream of Wivenhoe Dam.

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 23/02/2022 09:00 is shown in Table 2-7.

Table 2-7: Daily catchment average rainfall (mm) totals in the 24 hours to 23/02/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	64
Brisbane River to Wivenhoe Dam	19
Lockyer Creek	18
Bremer River	9
Brisbane River from Wivenhoe Dam to Moggill	20
Brisbane River downstream of Moggill	39

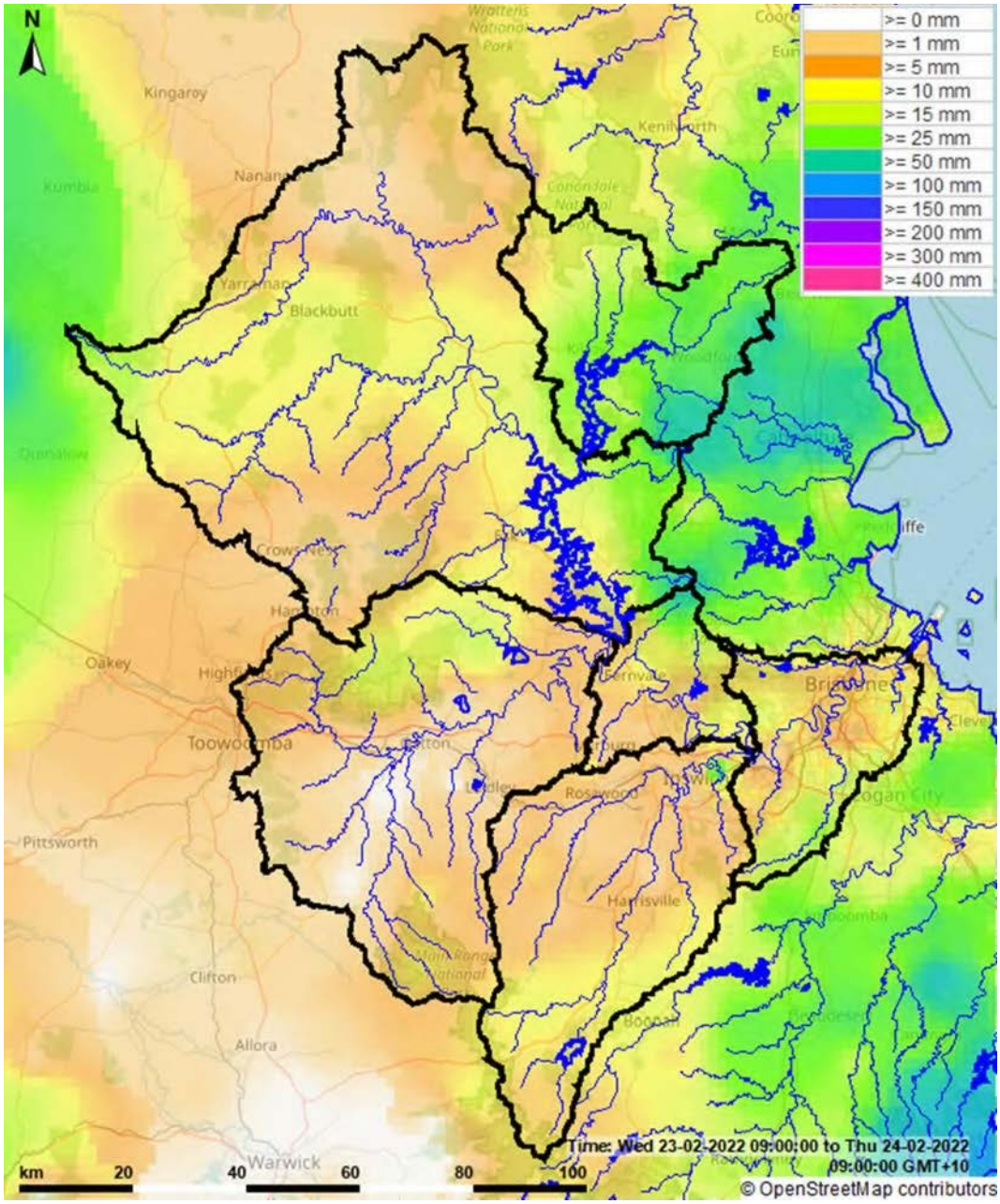

Figure 2-15: Daily rainfall (mm) 24 hours to 24/02/2022 09:00 (Source: FFS)

In the 24 hours to 24/02/2022 09:00, rainfall eased across South East Queensland. Lower rainfall totals were recorded in the Lockyer Creek and Brisbane River to Wivenhoe Dam catchments than in the previous 24 hours. However, there was still a significant amount of rainfall recorded in the upper parts of the Stanley River to Somerset Dam catchment with 56 mm recorded at Mt Mee and 54 mm recorded at Mt Glorious.

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 24/02/2022 09:00 is shown in Table 2-8.

Table 2-8: Daily catchment average rainfall (mm) totals in the 24 hours to 24/02/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	25
Brisbane River to Wivenhoe Dam	9
Lockyer Creek	5
Bremer River	6
Brisbane River from Wivenhoe Dam to Moggill	10
Brisbane River downstream of Moggill	10

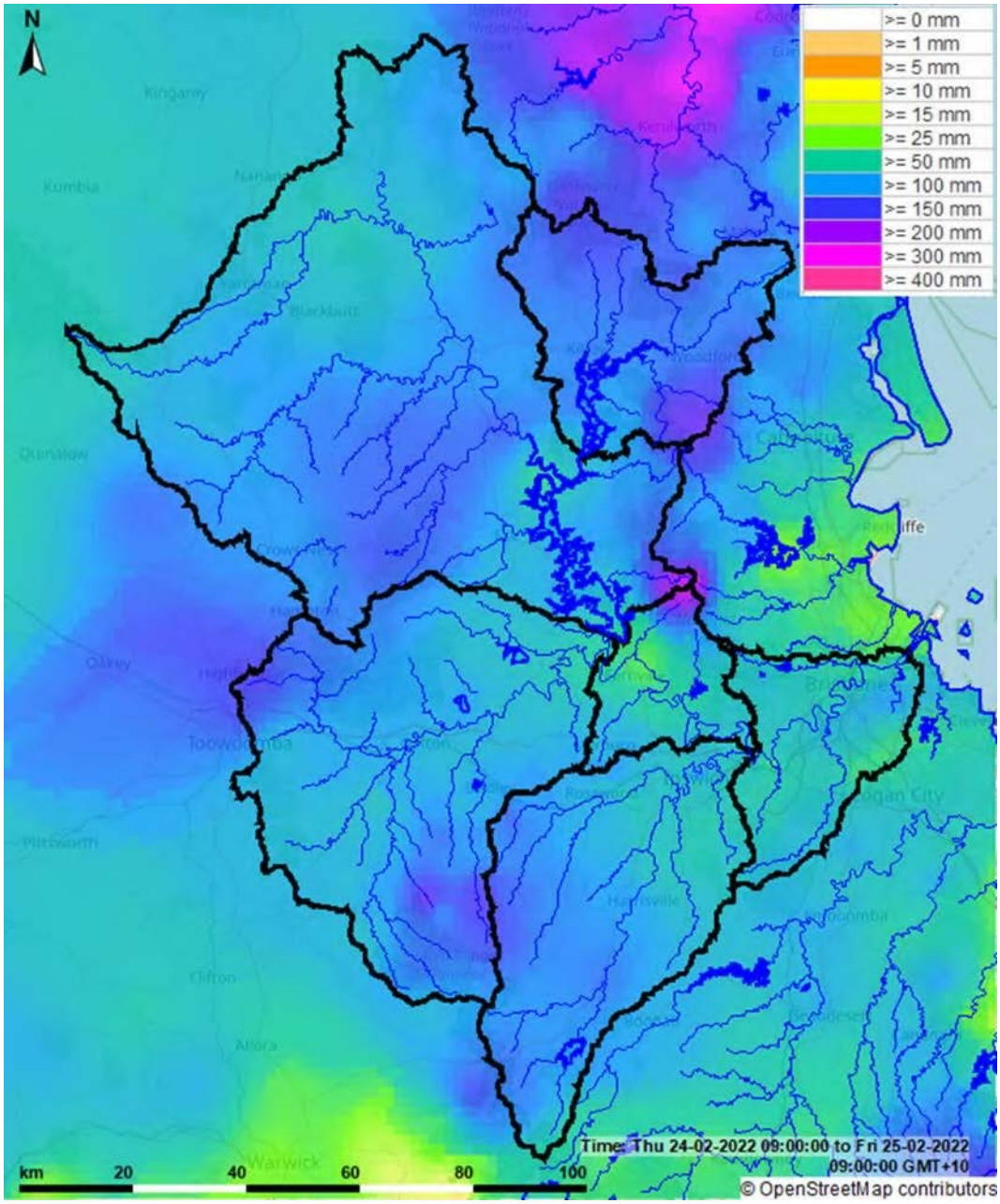

Figure 2-16: Daily rainfall (mm) 24 hours to 25/02/2022 09:00 (Source: FFS)

In the 24 hours to 25/02/2022 09:00, rainfall intensified across South East Queensland. There was widespread rainfall in all of the Brisbane River basin sub-catchments, with rainfall totals of up to 250 mm recorded at Mt Glorious and 170 mm recorded at Mt Mee.

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 25/02/2022 09:00 is shown in Table 2-9.

Table 2-9: Daily catchment average rainfall (mm) totals in the 24 hours to 25/02/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	126
Brisbane River to Wivenhoe Dam	99
Lockyer Creek	97
Bremer River	96
Brisbane River from Wivenhoe Dam to Moggill	73
Brisbane River downstream of Moggill	66

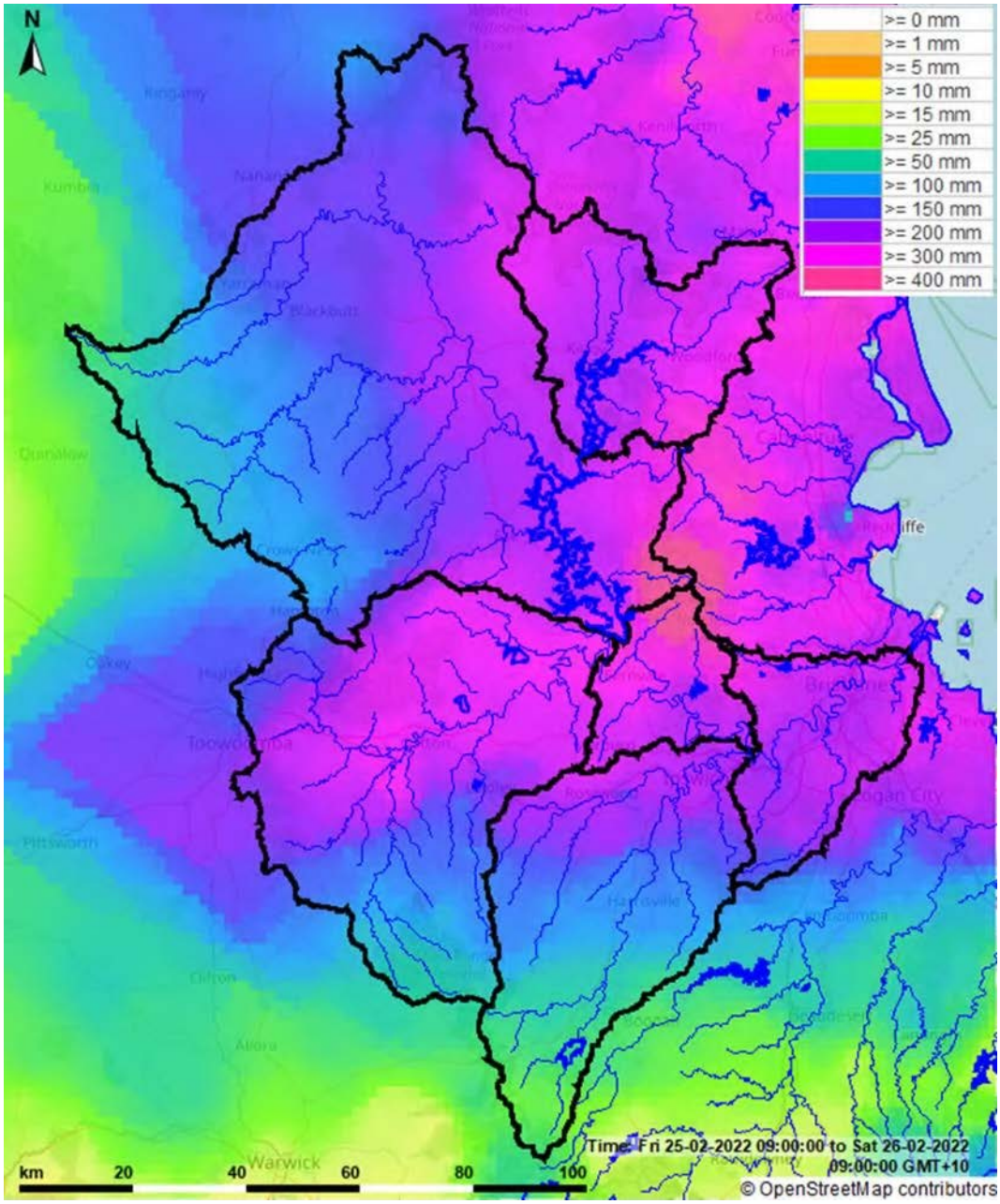

Figure 2-17: Daily rainfall (mm) 24 hours to 26/02/2022 09:00 (Source: FFS)

In the 24 hours to 26/02/2022 09:00, rainfall further intensified across South East Queensland. There was widespread rainfall across the Brisbane River basin. Large precipitation totals were recorded at several sites, particularly those at higher elevations, which were subject to significant orographic effects. 710 mm was recorded at Mt Glorious and 331 mm was recorded at Mt Mee. There was heavy rainfall recorded in parts of the Brisbane River to Wivenhoe Dam catchment.

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 26/02/2022 09:00 is shown in Table 2-10.

Table 2-10: Daily catchment average rainfall (mm) totals in the 24 hours to 26/02/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	260
Brisbane River to Wivenhoe Dam	174
Lockyer Creek	208
Bremer River	124
Brisbane River from Wivenhoe Dam to Moggill	300
Brisbane River downstream of Moggill	229

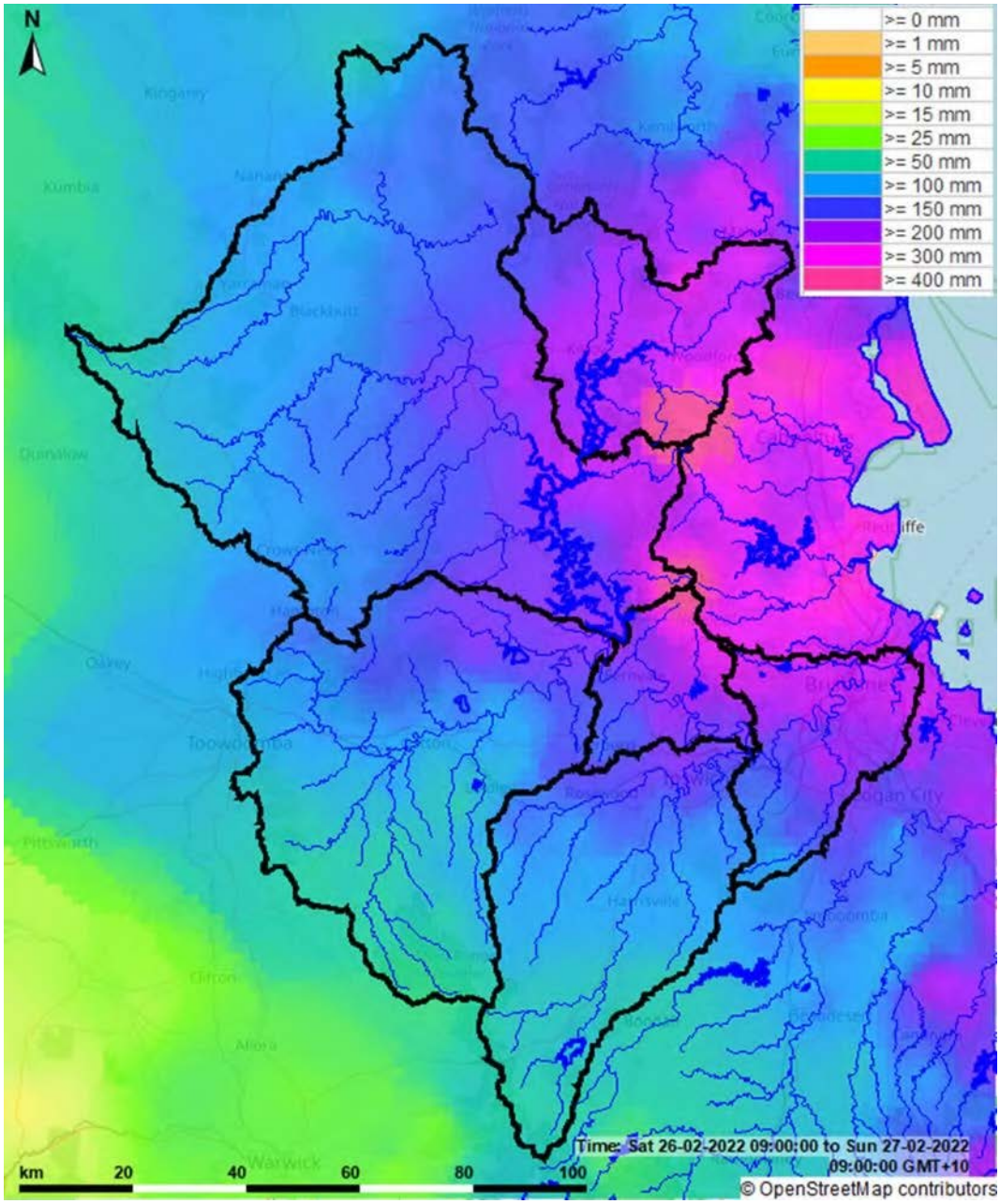

Figure 2-18: Daily rainfall (mm) 24 hours to 27/02/2022 09:00 (Source: FFS)

In the 24 hours to 27/02/2022 09:00, intense widespread rainfall continued across South East Queensland. Large rainfall totals were again recorded at several sites, with particularly large totals recorded at gauges located at higher elevations, which were likely due to orographic effects (465 mm recorded at Mt Glorious and 580 mm recorded at Mt Mee).

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 27/02/2022 09:00 is shown in Table 2-11.

Table 2-11: Daily catchment average rainfall (mm) totals in the 24 hours to 27/02/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	242
Brisbane River to Wivenhoe Dam	136
Lockyer Creek	103
Bremer River	101
Brisbane River from Wivenhoe Dam to Moggill	207
Brisbane River downstream of Moggill	191

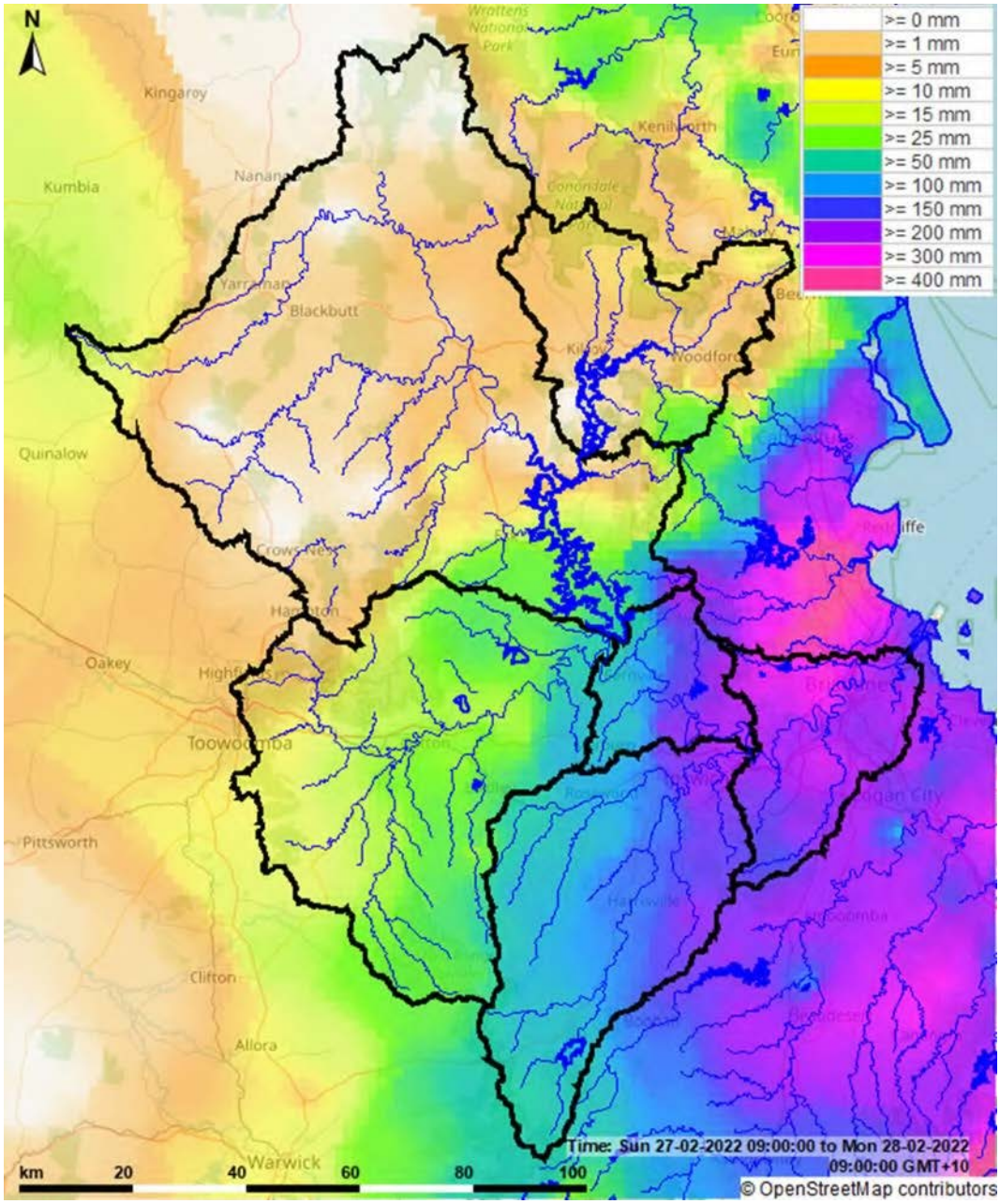

Figure 2-19: Daily rainfall (mm) 24 hours to 28/02/2022 09:00 (Source: FFS)

In the 24 hours to 28/02/2022 09:00, the weather system that had brought intense widespread rainfall in South East Queensland started to move southward, towards the Gold Coast and northern NSW. The rainfall totals in the Brisbane River to Wivenhoe Dam, Stanley River to Somerset Dam and Lockyer Creek catchments were lower than on each of the previous two days. However, there was still a significant amount of rainfall in the Brisbane River downstream of Moggill sub-catchment and parts of the Bremer River catchment. For example, the Brisbane CBD recorded 310 mm.

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 28/02/2022 09:00 is shown in Table 2-12.

Table 2-12: Daily catchment average rainfall (mm) totals in the 24 hours to 28/02/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	6
Brisbane River to Wivenhoe Dam	7
Lockyer Creek	26
Bremer River	106
Brisbane River from Wivenhoe Dam to Moggill	138
Brisbane River downstream of Moggill	217

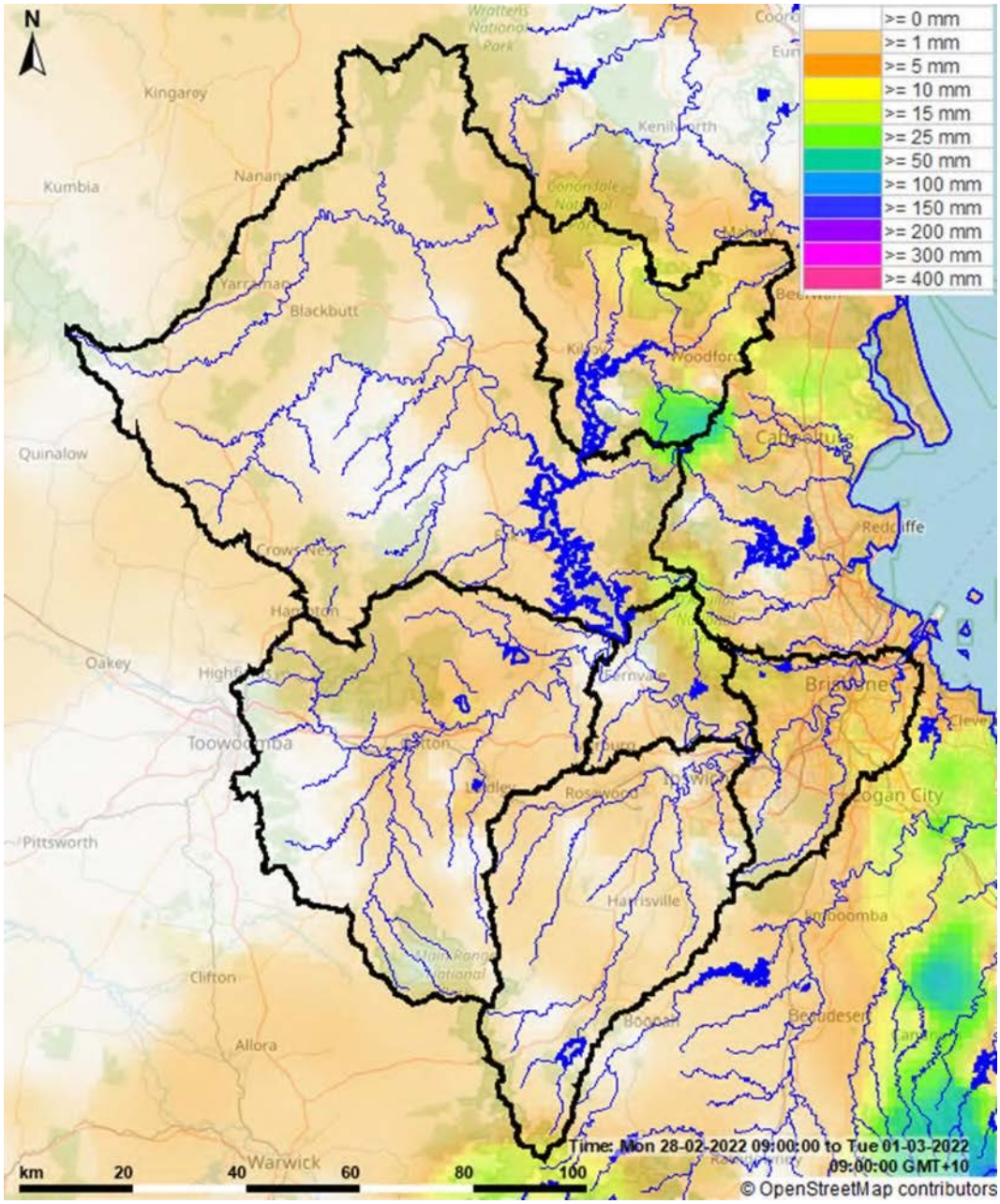

Figure 2-20: Daily rainfall (mm) 24 hours to 01/03/2022 09:00 (Source: FFS)

In the 24 hours to 01/03/2022 09:00, the rainfall subsided across the Brisbane River basin, as the centre of the low pressure system continued to move towards and then into northern NSW. Rainfall totals were largest at higher elevations, due to orographic effects (50 mm at Mt Mee and 17 mm at Mt Glorious).

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 01/03/2022 09:00 is shown in Table 2-13.

Table 2-13: Daily catchment average rainfall (mm) totals in the 24 hours to 01/03/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	7
Brisbane River to Wivenhoe Dam	1
Lockyer Creek	2
Bremer River	1
Brisbane River from Wivenhoe Dam to Moggill	3
Brisbane River downstream of Moggill	5

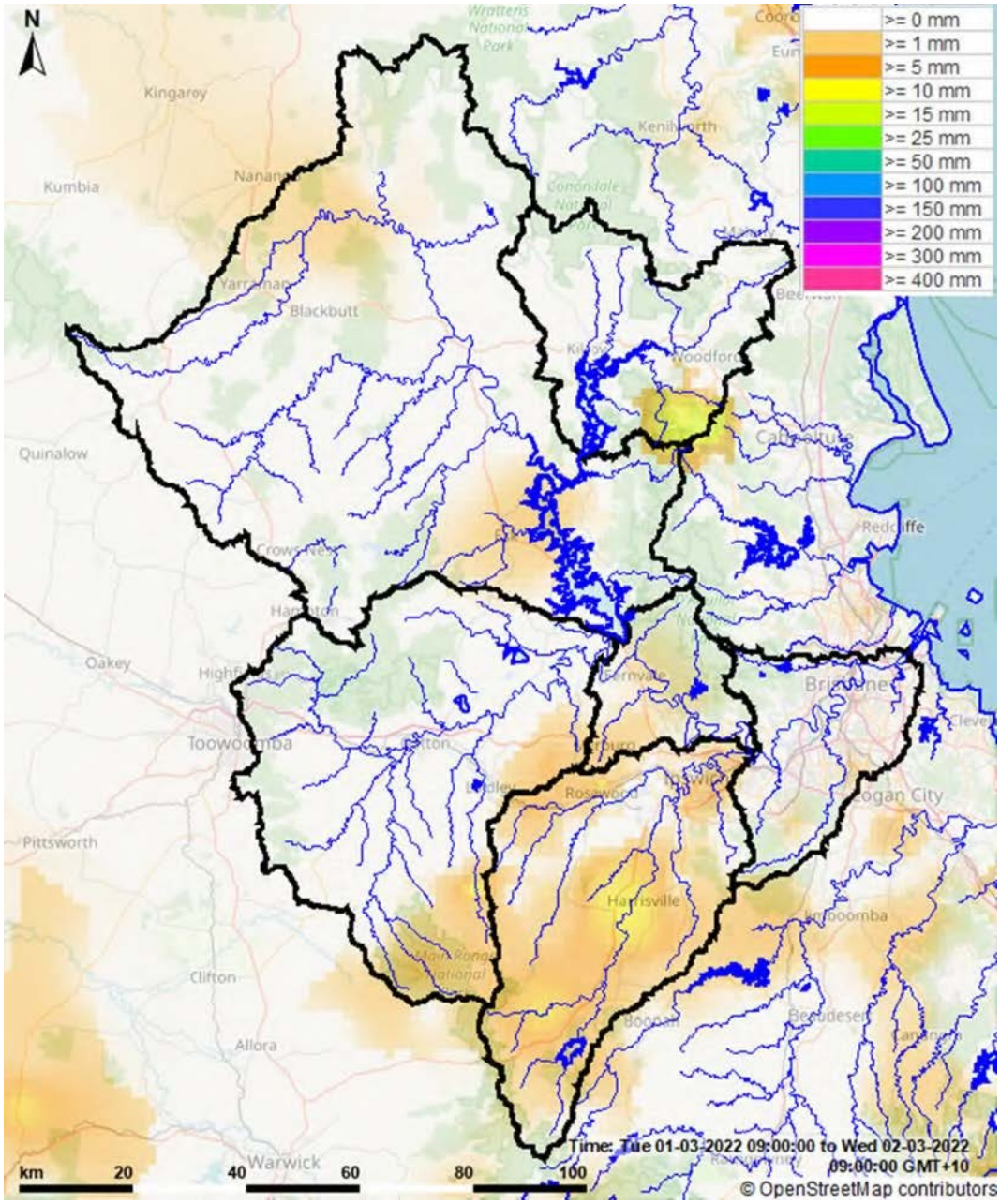

Figure 2-21: Daily rainfall (mm) 24 hours to 02/03/2022 09:00 (Source: FFS)

In the 24 hours to 02/03/2022 09:00, no rainfall was recorded across much of the Brisbane River basin. Small rainfall totals were recorded at some sites, for example 9 mm of rainfall was recorded in the Bremer River catchment.

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 02/03/2022 09:00 is shown in Table 2-14.

Table 2-14: Daily catchment average rainfall (mm) totals in the 24 hours to 02/03/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	1
Brisbane River to Wivenhoe Dam	0.2
Lockyer Creek	1
Bremer River	3
Brisbane River from Wivenhoe Dam to Moggill	1
Brisbane River downstream of Moggill	0

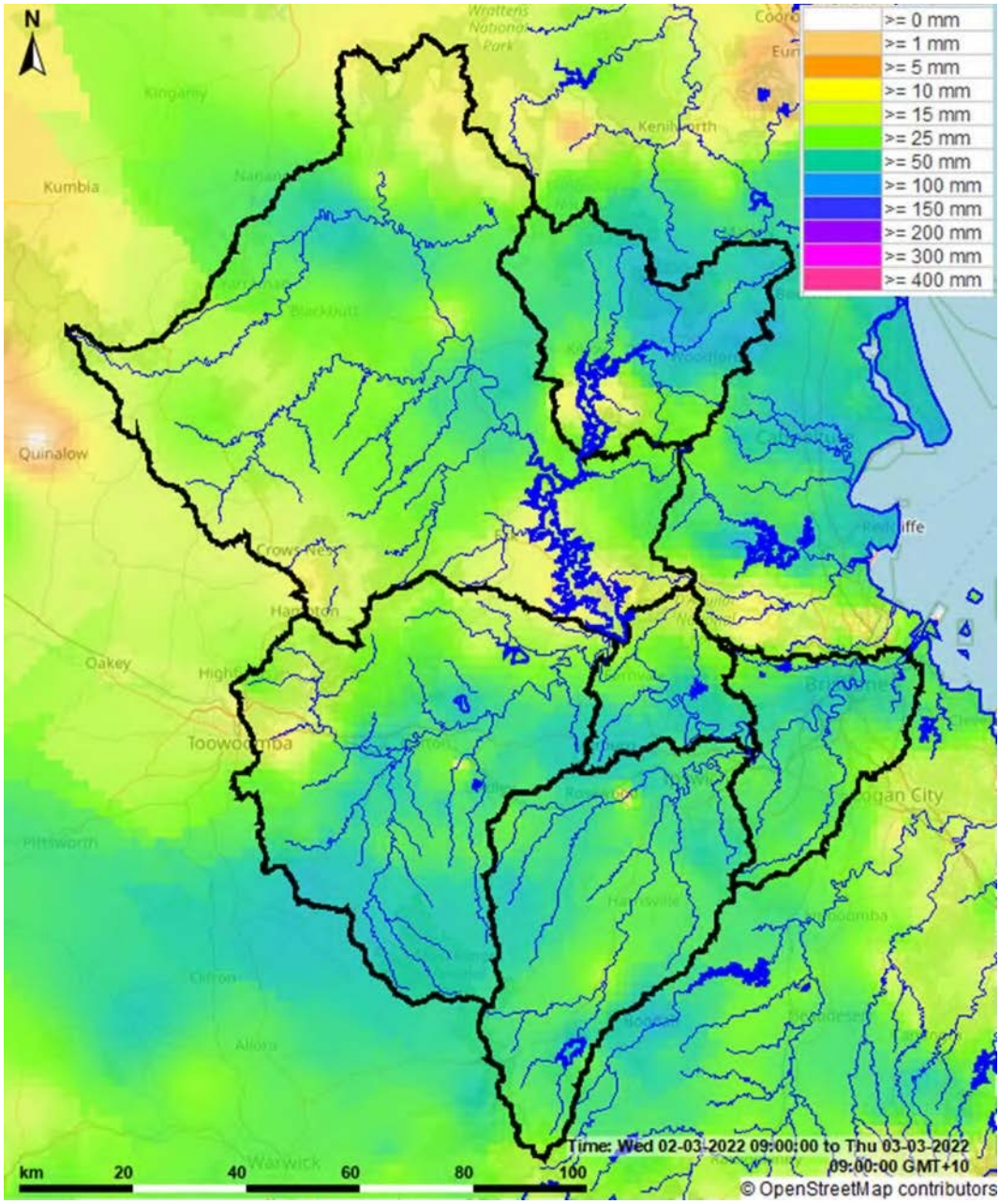

Figure 2-22: Daily rainfall (mm) 24 hours to 03/03/2022 09:00 (Source: FFS)

In the 24 hours to 03/03/2022 09:00, rainfall in South East Queensland re-intensified. There was widespread rainfall recorded in all of the Brisbane River basin sub-catchments. The highest rainfall totals were recorded in the Lockyer Creek catchment, with 63 mm of rain recorded at the West Woodbine gauge. Significant totals were also recorded in the Brisbane River between Wivenhoe Dam and Moggill, and the Brisbane River downstream of Moggill.

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 03/03/2022 09:00 is shown in Table 2-15.

Table 2-15: Daily catchment average rainfall (mm) totals in the 24 hours to 03/03/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	45
Brisbane River to Wivenhoe Dam	25
Lockyer Creek	37
Bremer River	40
Brisbane River from Wivenhoe Dam to Moggill	38
Brisbane River downstream of Moggill	38

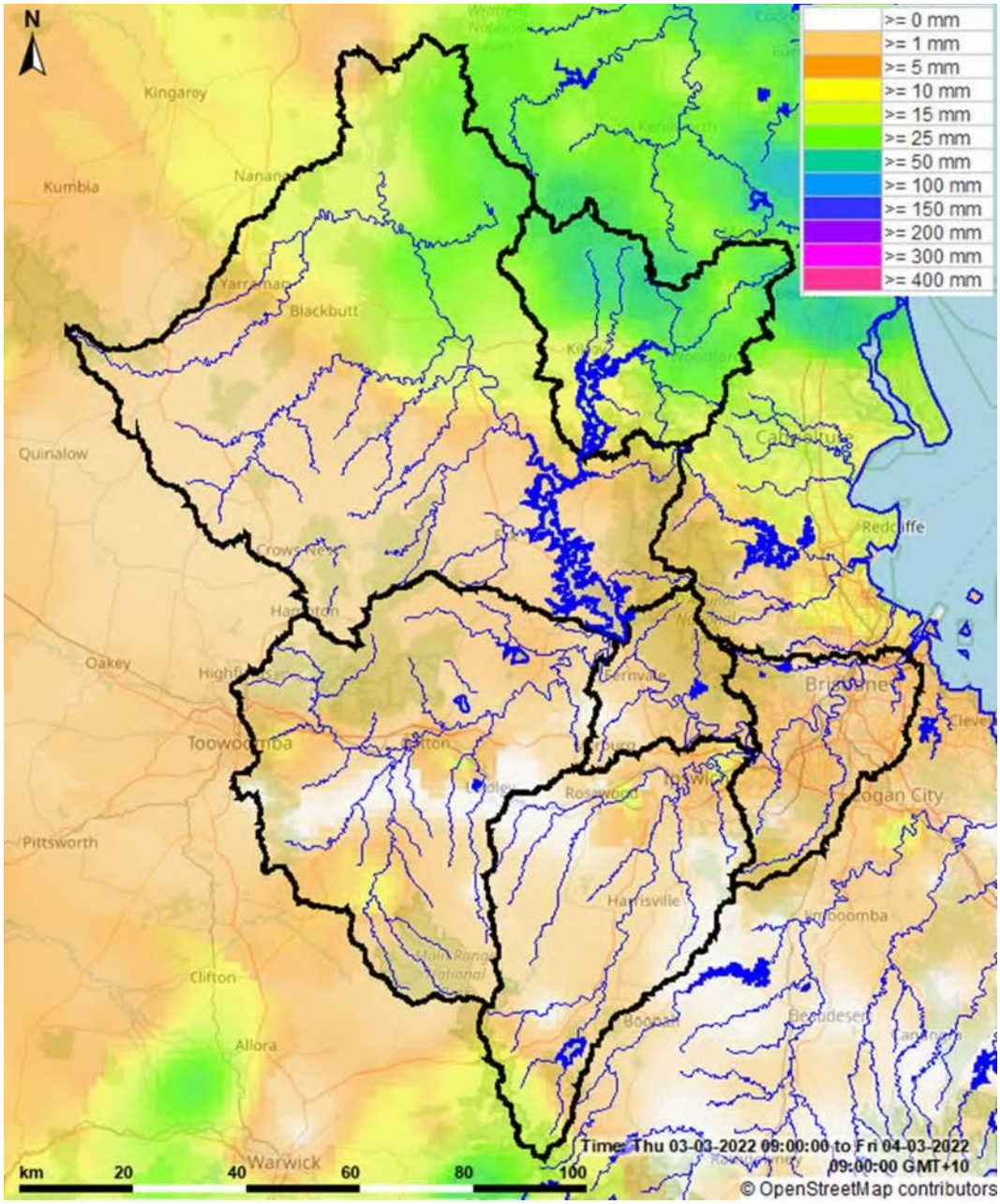

Figure 2-23: Daily rainfall (mm) 24 hours to 04/03/2022 09:00 (Source: FFS)

In the 24 hours to 04/03/2022 09:00, the largest rainfall totals in the Brisbane River basin were recorded in the Stanley River to Somerset Dam catchment and in the upper reaches of the Brisbane River to Wivenhoe Dam catchment (for example 44 mm at Lindfield and 45 mm at West Bellthorpe).

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 04/03/2022 09:00 is shown in Table 2-16.

Table 2-16: Daily catchment average rainfall (mm) totals in the 24 hours to 04/03/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	26
Brisbane River to Wivenhoe Dam	8
Lockyer Creek	3
Bremer River	3
Brisbane River from Wivenhoe Dam to Moggill	3
Brisbane River downstream of Moggill	3

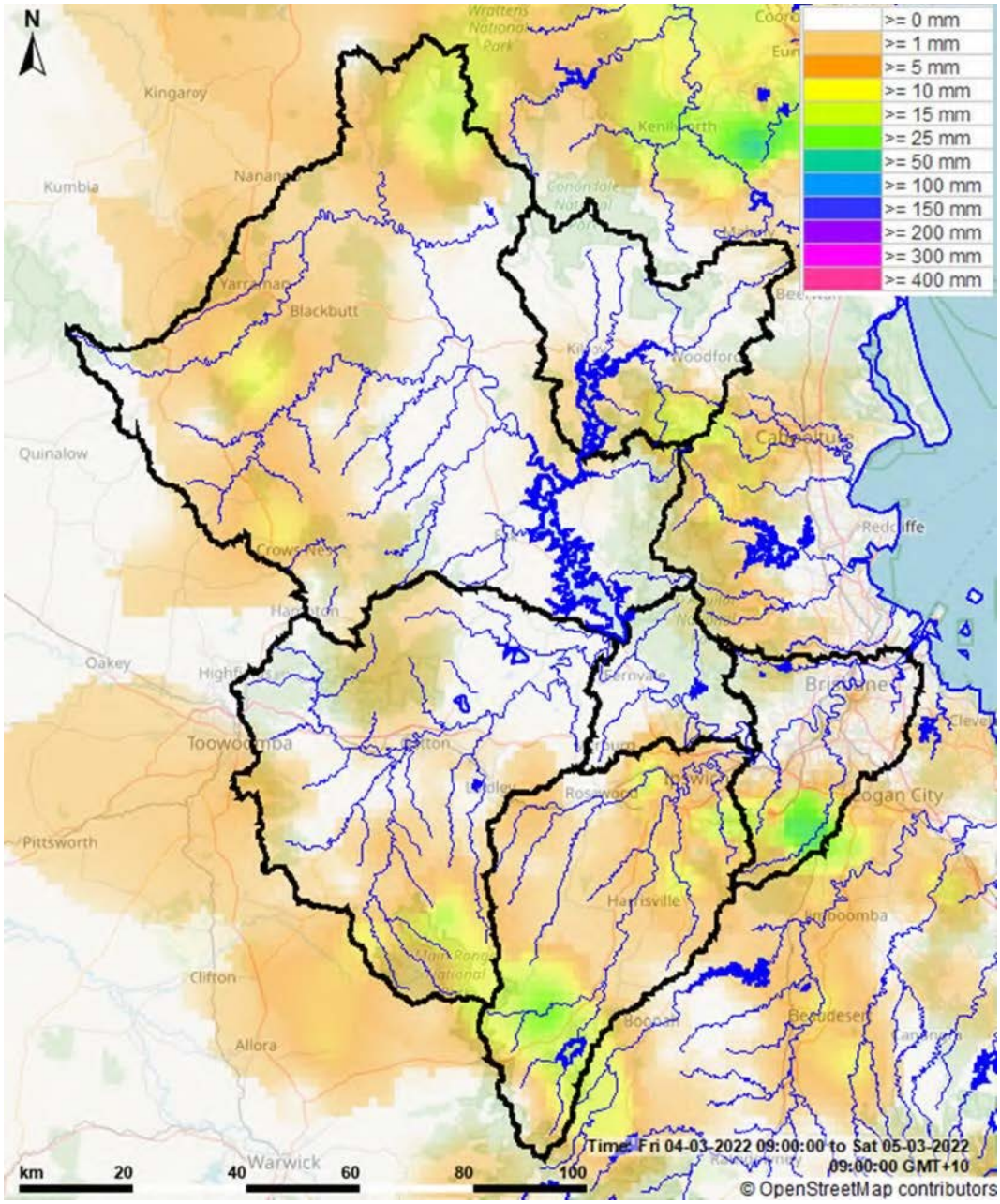

Figure 2-24: Daily rainfall (mm) 24 hours to 05/03/2022 09:00 (Source: FFS)

In the 24 hours to 05/03/2022 09:00, rainfall continued to ease across the Brisbane River basin. Small rainfall totals were recorded in the upper reaches of the Stanley River to Somerset Dam, Brisbane River to Wivenhoe Dam and Lockyer Creek catchments.

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 05/03/2022 09:00 is shown in Table 2-17.

Table 2-17: Daily catchment average rainfall (mm) totals in the 24 hours to 05/03/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	1
Brisbane River to Wivenhoe Dam	2
Lockyer Creek	2
Bremer River	6
Brisbane River from Wivenhoe Dam to Moggill	0.4
Brisbane River downstream of Moggill	4

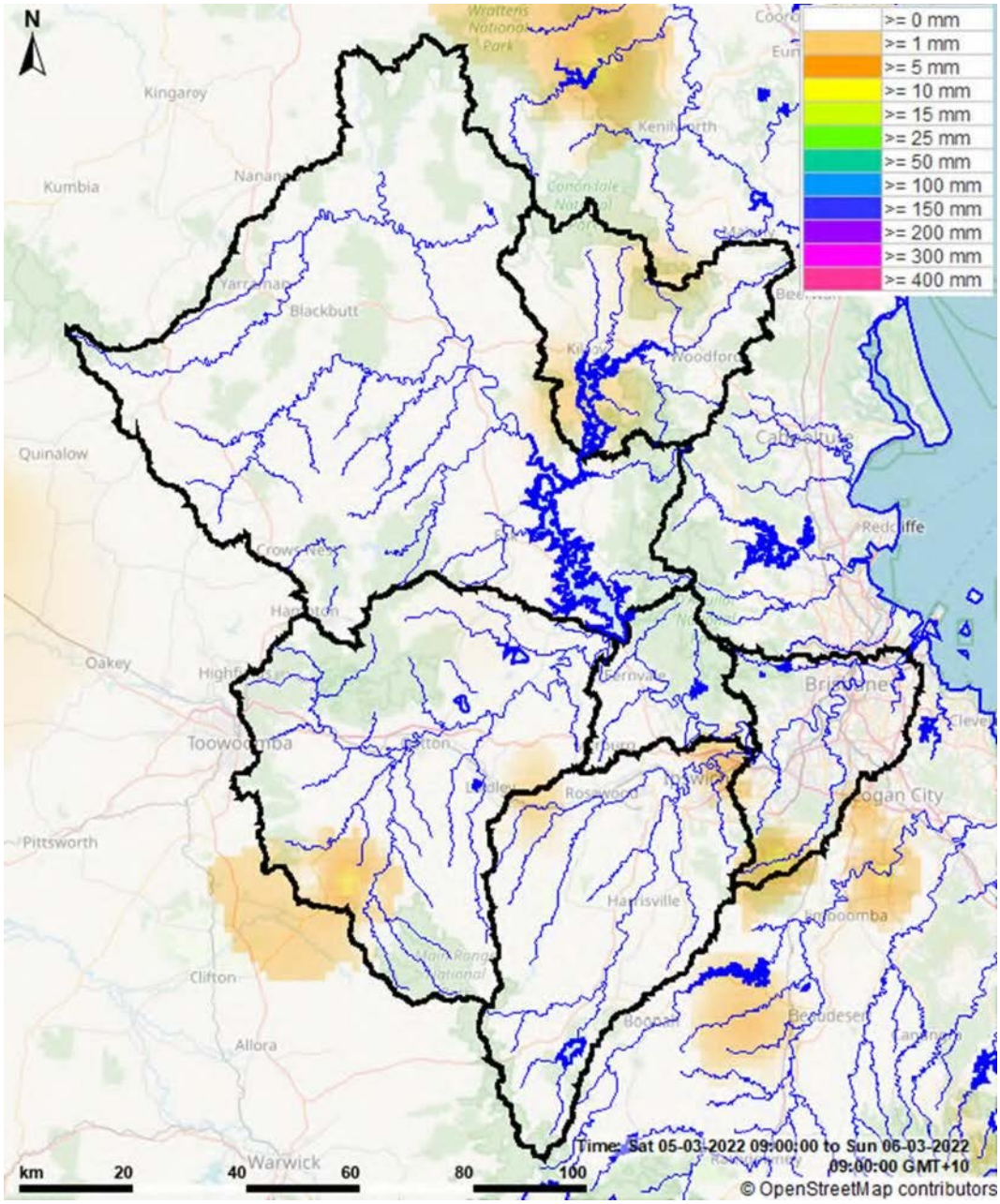

Figure 2-25: Daily rainfall (mm) 24 hours to 06/03/2022 09:00 (Source: FFS)

In the 24 hours to 06/03/2022 09:00, there were isolated showers in the Brisbane River basin.

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 06/03/2022 09:00 is shown in Table 2-18.

Table 2-18: Daily catchment average rainfall (mm) totals in the 24 hours to 06/03/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	0.3
Brisbane River to Wivenhoe Dam	0
Lockyer Creek	0.2
Bremer River	0
Brisbane River from Wivenhoe Dam to Moggill	0
Brisbane River downstream of Moggill	0.4

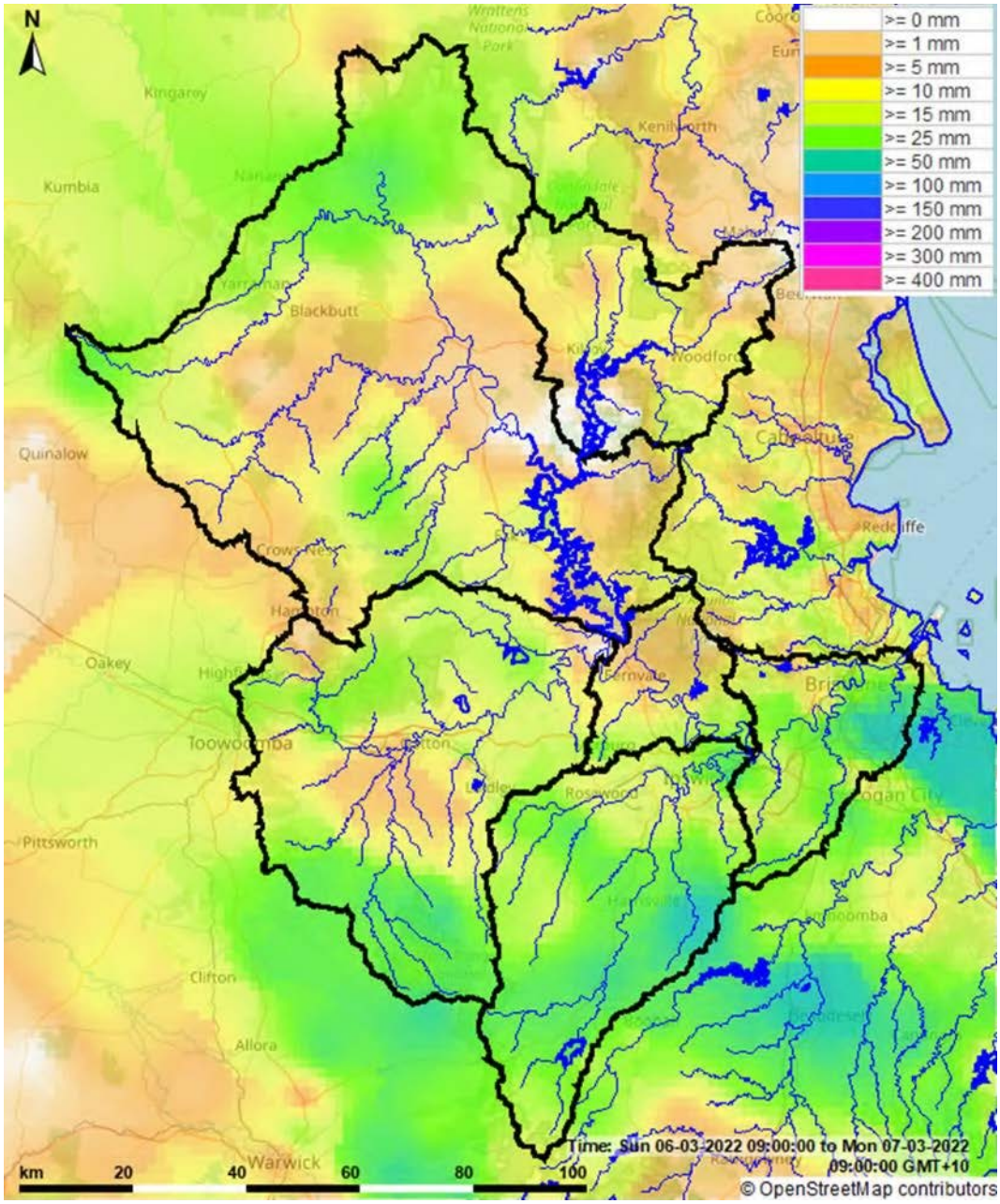

Figure 2-26: Daily rainfall (mm) 24 hours to 07/03/2022 09:00 (Source: FFS)

In the 24 hours to 07/03/2022 09:00, rainfall in South East Queensland intensified yet again. There was widespread heavy rainfall recorded in parts of the Brisbane River basin, particularly across the upper parts of the Brisbane River to Wivenhoe Dam and Lockyer Creek sub-catchments and across the Bremer River sub-catchment.

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 07/03/2022 09:00 is shown in Table 2-19.

Table 2-19: Daily catchment average rainfall (mm) totals in the 24 hours to 07/03/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	8
Brisbane River to Wivenhoe Dam	12
Lockyer Creek	17
Bremer River	27
Brisbane River from Wivenhoe Dam to Moggill	11
Brisbane River downstream of Moggill	25

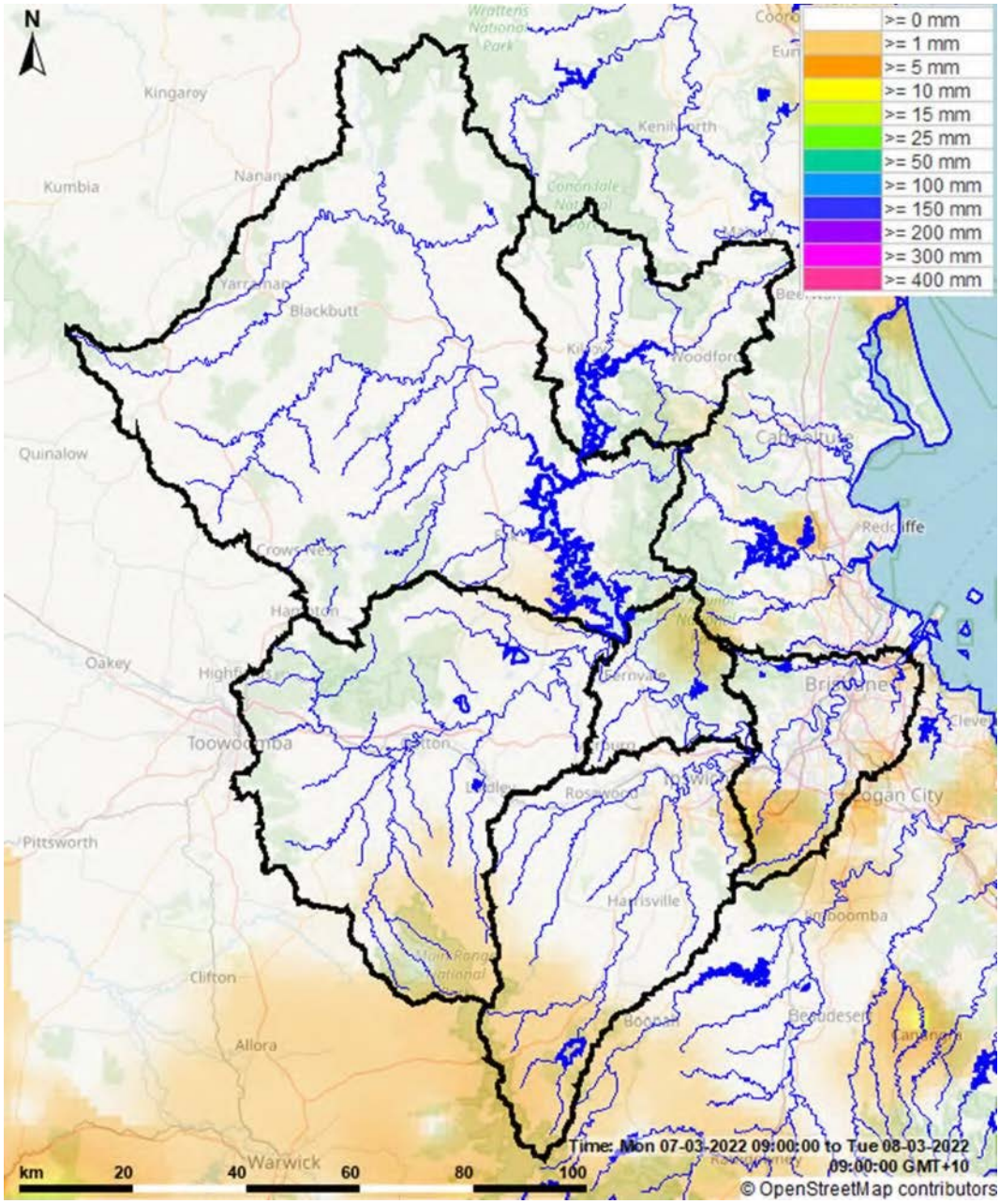

Figure 2-27: Daily rainfall (mm) 24 hours to 08/03/2022 09:00 (Source: FFS)

In the 24 hours to 08/03/2022 09:00, there were relatively light rainfalls recorded at some sites in the Brisbane River basin.

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 08/03/2022 09:00 is shown in Table 2-20.

Table 2-20: Daily catchment average rainfall (mm) totals in the 24 hours to 08/03/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	0
Brisbane River to Wivenhoe Dam	0
Lockyer Creek	0.2
Bremer River	1
Brisbane River from Wivenhoe Dam to Moggill	0.3
Brisbane River downstream of Moggill	1

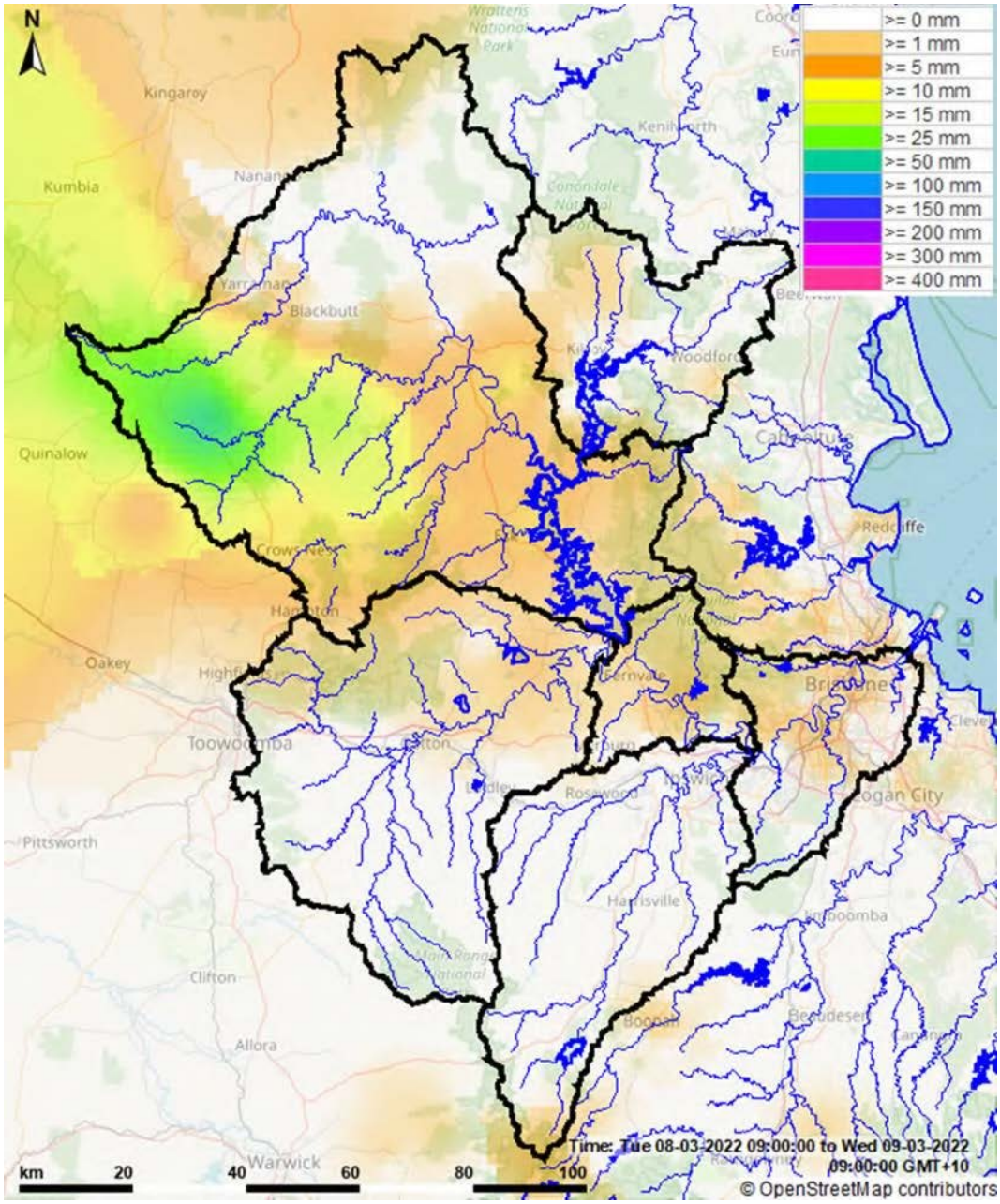

Figure 2-28: Daily rainfall (mm) 24 hours to 09/03/2022 09:00 (Source: FFS)

In the 24 hours to 09/03/2022 09:00, rainfall reintensified in the upper reaches of the Brisbane River to Wivenhoe Dam catchment (44 mm recorded at St Aubyns). However, there was minimal or no rainfall was recorded at sites in the Stanley River to Somerset Dam and Lockyer Creek catchments.

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 09/03/2022 09:00 is shown in Table 2-21.

Table 2-21: Daily catchment average rainfall (mm) totals in the 24 hours to 09/03/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	1
Brisbane River to Wivenhoe Dam	7
Lockyer Creek	1
Bremer River	0
Brisbane River from Wivenhoe Dam to Moggill	1
Brisbane River downstream of Moggill	1

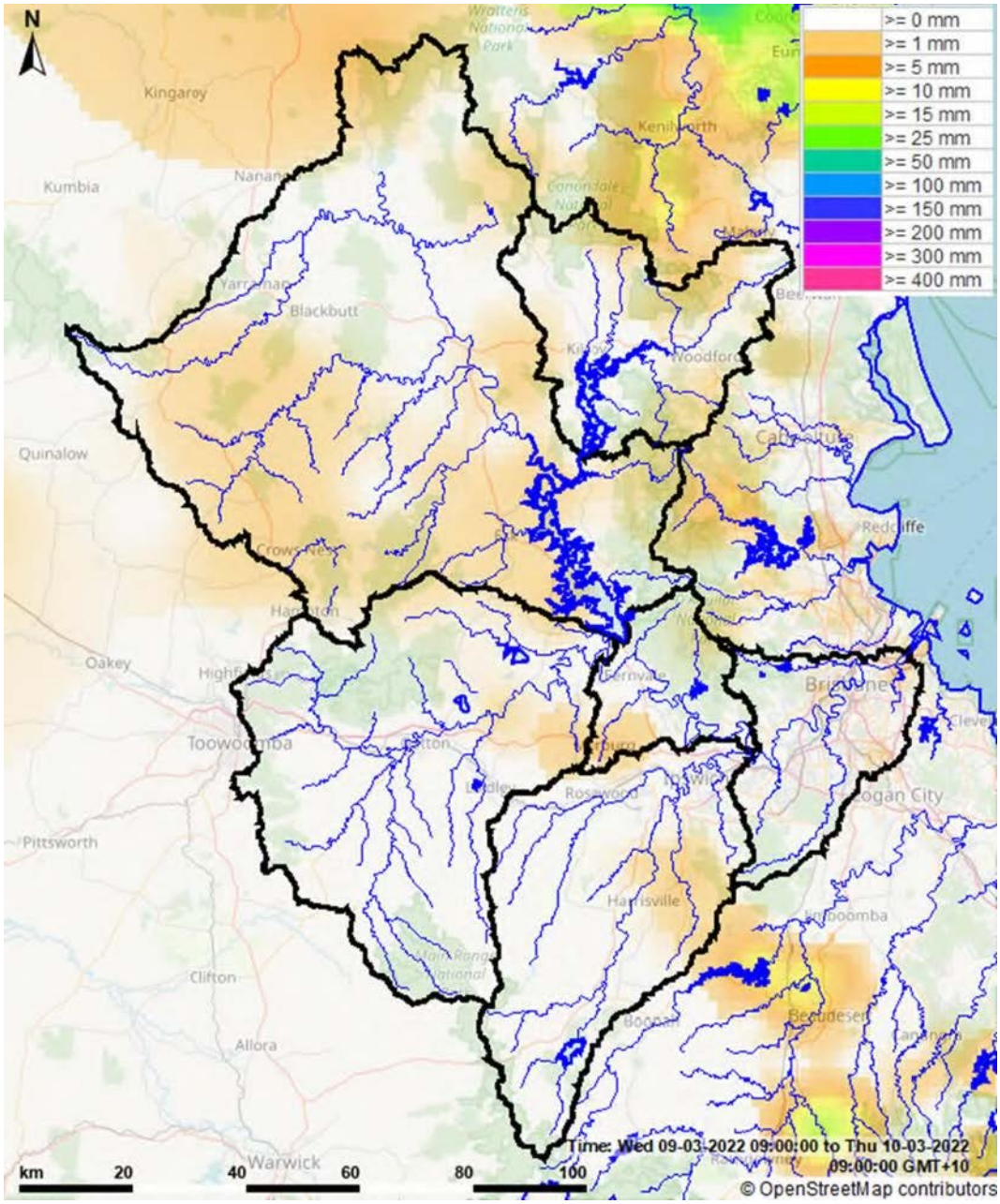

Figure 2-29: Daily rainfall (mm) 24 hours to 10/03/2022 09:00 (Source: FFS)

In the 24 hours to 10/03/2022 09:00, the rainfall subsided across the Brisbane River basin.

The catchment average rainfall recorded in the Brisbane River basin sub-catchments for the 24 hours to 10/03/2022 09:00 is shown in Table 2-22.

Table 2-22: Daily catchment average rainfall (mm) totals in the 24 hours to 10/03/2022 09:00 (Source: FFS)

Brisbane River basin sub-catchment	Catchment average rainfall depth (mm)
Stanley River to Somerset Dam	1
Brisbane River to Wivenhoe Dam	1
Lockyer Creek	0
Bremer River	0.2
Brisbane River from Wivenhoe Dam to Moggill	0.4
Brisbane River downstream of Moggill	0

2.3.4 Catchment average temporal patterns

The catchment average hourly rainfall temporal pattern for the Brisbane River basin sub-catchments was determined by calculating the average rainfall in each sub-catchment from the gridded rainfall data. This was calculated in the FFS and is presented in Figure 2-30 to Figure 2-50.

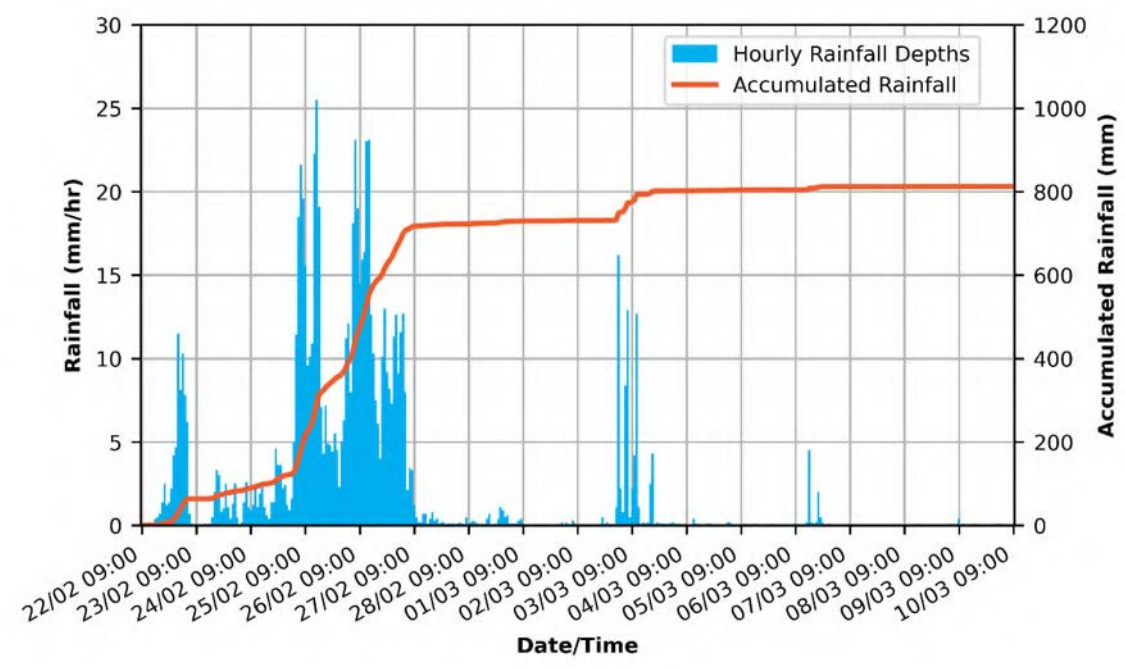

Figure 2-30: Stanley River to Somerset Dam catchment average rainfall in hourly increments and accumulated over the Flood Event for the period 22/02/2022 09:00 to 10/03/2022 09:00 (replicated in Figure iii)

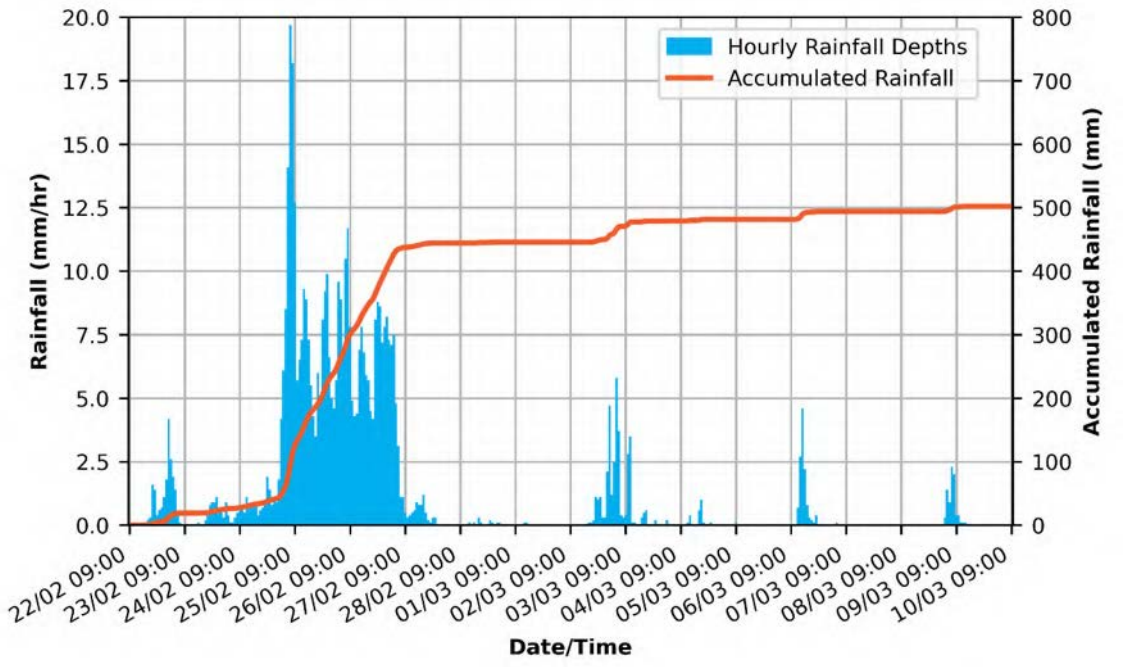

Figure 2-31: Brisbane River to Wivenhoe Dam catchment average rainfall in hourly increments and accumulated over the Flood Event for the period 22/02/2022 09:00 to 10/03/2022 09:00 (replicated in Figure iv)

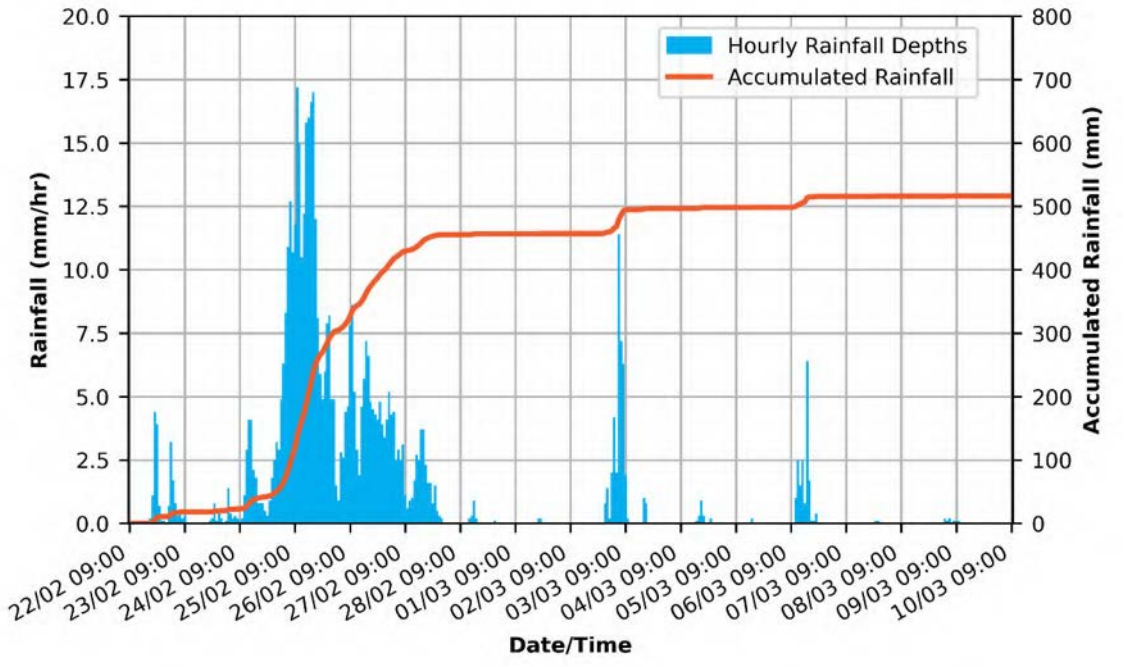

Figure 2-32: Lockyer Creek catchment average rainfall in hourly increments and accumulated over the Flood Event for the period 22/02/2022 09:00 to 10/03/2022 09:00

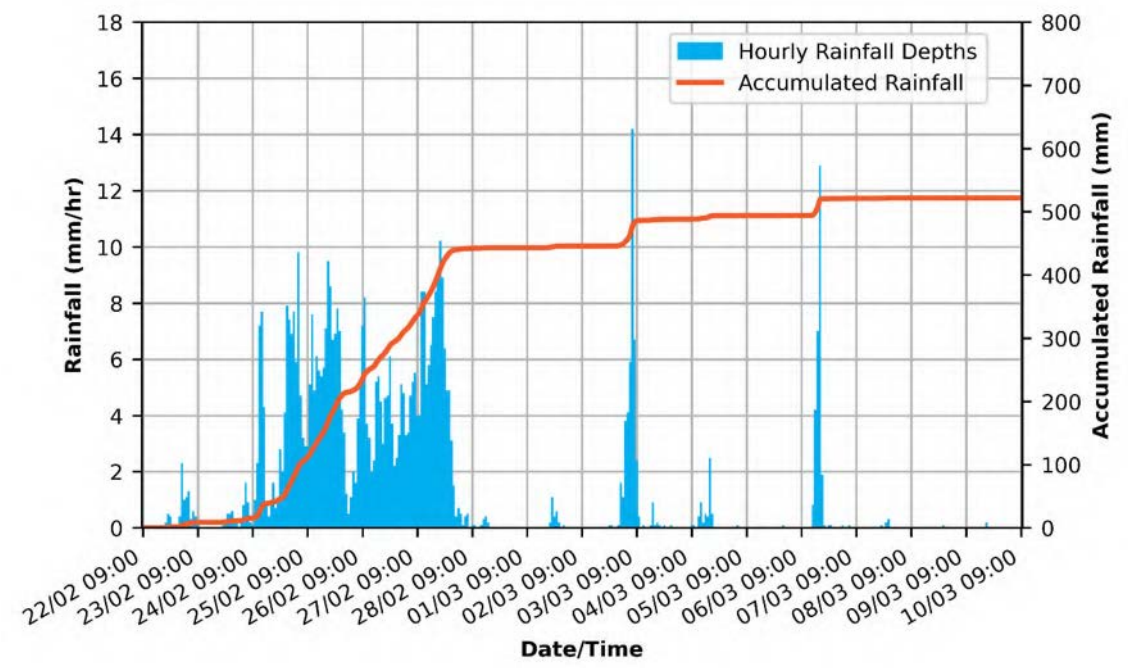

Figure 2-33: Bremer River catchment average rainfall in hourly increments and accumulated over the Flood Event for the period 22/02/2022 09:00 to 10/03/2022 09:00

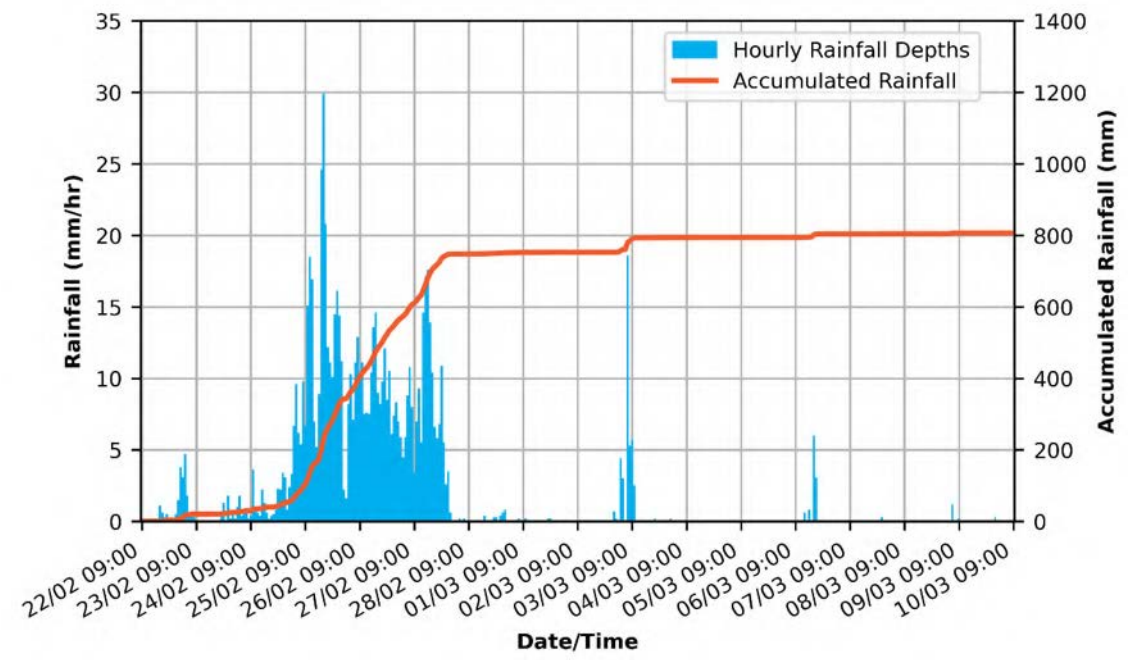

Figure 2-34: Brisbane River from Wivenhoe Dam to Moggill catchment average rainfall in hourly increments and accumulated over the Flood Event for the period 22/02/2022 09:00 to 10/03/2022 09:00

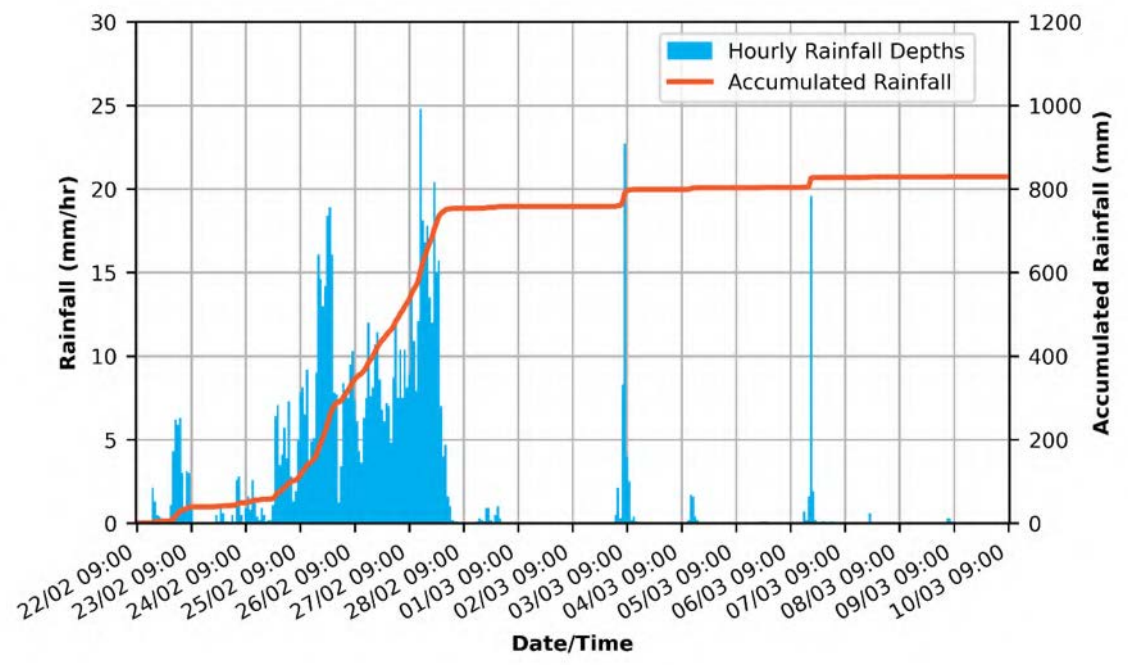

Figure 2-35: Brisbane River downstream of Moggill catchment average rainfall in hourly increments and accumulated over the Flood Event for the period 22/02/2022 09:00 to 10/03/2022 09:00

A comparison of the accumulated sub-catchment average hourly rainfall temporal patterns for all of the Brisbane River basin sub-catchments is shown in Figure 2-36.

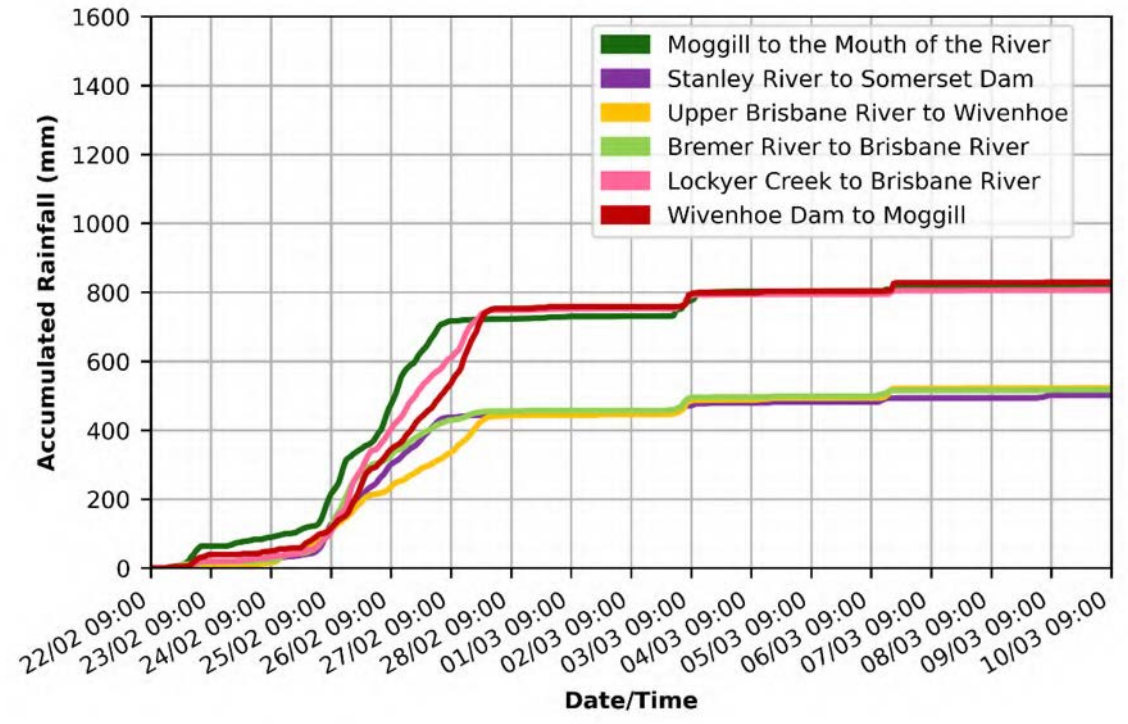

Figure 2-36: Brisbane River basin sub-catchment average accumulated hourly temporal patterns from 22/02/2022 09:00 to 10/03/2022 09:00

2.4 Forecast rainfall

Forecast rainfall data was part of the numerical weather predictions issued by the Bureau and provided to the Flood Operations Centre at least twice per day over the course of the Flood Event. Forecast rainfall information was provided as a gridded dataset for three percentile exceedance values; 50th, 25th and 10th percentiles[2]. In this context, the percentile exceedance values refer to the expected likelihood of those rainfalls occurring at point locations[3]. The data is provided by the Bureau generally twice per day, usually between 04:00 and 06:00 and 16:00 and 18:00, using grids with a three-hour time step. Further information on this forecast rainfall data, and the limitations associated with it, is available in Appendix K of the Manual.

Table 2-23 to Table 2-28 present recorded and forecast catchment average rainfall depths for the Brisbane River basin sub-catchments in the period of the Flood Event between 22/02/2022 07:00 and 10/03/2022 07:00 for the forecasts that were available in the FFS in the morning of each day. The forecasts were presented in this manner to provide a concise summary of the data; Table 2-23 to Table 2-28 do not represent every rainfall forecast that was issued during the Flood Event. Note that these values are presented from 07:00 each day in order to provide a consistent comparison between forecast and recorded rainfall depths, as forecast rainfall data is not defined to exactly to 09:00 each day. As per the description in Section 2.3, the recorded rainfall data has been aggregated to a daily time step for the purposes of comparison in Table 2-23 to Table 2-28, with the daily aggregation period changed to 07:00 to 07:00. During the Flood Event, the FFS was configured to use recorded rainfall data on a 15-minute time step in the hydrological models.

The rainfall forecast data in Table 2-23 to Table 2-28 is presented as a range between the 25th and 50th percentile exceedance values from the grids issued by the Bureau.

[2] Other forecast precipitation products in this suite included the ADFD mean. The forecasts were available as mm per day, and mm per 3-hours. The mm per 3-hours forecast precipitation data is presented in this report.
[3] Further information in Appendix K of the Manual describes the complexity of point rainfall probability not representing areal rainfall probability.

Table 2-23: Forecast catchment average rainfall (mm) for the Stanley River to Somerset Dam catchment from 22/02/2022 to 10/03/2022

Date forecast was issued (typically between 04:00 and 06:00)	Forecast rainfall (mm) for 24 hours to 23/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 24/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 25/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 26/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 27/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 28/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 01/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 02/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 03/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 04/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 05/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 06/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 07/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 08/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 09/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 10/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 11/03/2022 07:00
22/02/2022	0 - 1	1 - 17	15 - 69	7 - 42	0 - 5	0 - 0	-	-	-	-	-	-	-	-	-	-	-
23/02/2022	-	26 - 66	64 - 138	28 - 76	1 - 7	0 - 2	0 - 2	-	-	-	-	-	-	-	-	-	-
24/02/2022	-	-	86 - 160	16 - 66	5 - 32	0 - 4	0 - 1	0 - 1	-	-	-	-	-	-	-	-	-
25/02/2022	-	-	-	51 - 169	12 - 39	1 - 4	0 - 0	0 - 1	0 - 1	-	-	-	-	-	-	-	-
26/02/2022	-	-	-	-	161 - 317	1 - 15	0 - 2	0 - 0	0 - 3	0 - 8	-	-	-	-	-	-	-
27/02/2022	-	-	-	-	-	8 - 31	0 - 6	0 - 0	0 - 1	0 - 4	0 - 5	-	-	-	-	-	-
28/02/2022	-	-	-	-	-	-	0 - 4	0 - 0	0 - 0	1 - 10	2 - 11	0 - 4	-	-	-	-	-
01/03/2022	-	-	-	-	-	-	-	0 - 0	0 - 1	2 - 26	1 - 9	0 - 3	1 - 10	-	-	-	-
02/03/2022	-	-	-	-	-	-	-	-	0 - 2	7 - 55	1 - 9	0 - 3	1 - 10	0 - 1	-	-	-
03/03/2022	-	-	-	-	-	-	-	-	-	19 - 53	1 - 9	0 - 4	1 - 11	0 - 5	0 - 3	-	-
04/03/2022	-	-	-	-	-	-	-	-	-	-	0 - 5	0 - 4	0 - 8	0 - 5	0 - 5	0 - 10	-
05/03/2022	-	-	-	-	-	-	-	-	-	-	-	0 - 3	1 - 7	0 - 0	0 - 0	0 - 2	0 - 0
06/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	12 - 36	0 - 0	0 - 0	2 - 14	0 - 6
07/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0	0 - 0	5 - 36	0 - 3
08/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0	6 - 38	0 - 4
09/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 - 30	0 - 2
10/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0
Recorded catchment average rainfall (mm from 07:00 to 07:00)	**64**	**23**	**93**	**261**	**271**	**10**	**7**	**1**	**42**	**29**	**1**	**0**	**8**	**0**	**0**	**1**	**0**

Table 2-24 Forecast catchment average rainfall (mm) for the Brisbane River to Wivenhoe Dam catchment from 23/02/2022 to 10/03/2022

Date forecast was issued (typically between 04:00 and 06:00)	Forecast rainfall (mm) for 24 hours to 23/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 24/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 25/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 26/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 27/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 28/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 01/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 02/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 03/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 04/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 05/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 06/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 07/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 08/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 09/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 10/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 11/03/2022 07:00
22/02/2022	0 - 1	0 - 4	6 - 46	2 - 24	0 - 2	0 - 0	-	-	-	-	-	-	-	-	-	-	-
23/02/2022	-	9 - 26	48 - 114	18 - 49	0 - 3	0 - 0	0 - 0	-	-	-	-	-	-	-	-	-	-
24/02/2022	-	-	79 - 151	7 - 44	1 - 16	0 - 1	0 - 0	0 - 0	-	-	-	-	-	-	-	-	-
25/02/2022	-	-	-	35 - 128	2 - 13	0 - 2	0 - 0	0 - 0	0 - 2	-	-	-	-	-	-	-	-
26/02/2022	-	-	-	-	102 - 203	0 - 8	0 - 0	0 - 1	0 - 3	0 - 6	-	-	-	-	-	-	-
27/02/2022	-	-	-	-	-	8 - 30	0 - 3	0 - 0	0 - 1	0 - 3	0 - 2	-	-	-	-	-	-
28/02/2022	-	-	-	-	-	-	0 - 2	0 - 0	0 - 0	1 - 11	1 - 10	0 - 3	-	-	-	-	-
01/03/2022	-	-	-	-	-	-	-	0 - 0	0 - 1	3 - 26	0 - 6	0 - 3	0 - 7	-	-	-	-
02/03/2022	-	-	-	-	-	-	-	-	0 - 3	7 - 50	0 - 6	0 - 3	0 - 7	0 - 0	-	-	-
03/03/2022	-	-	-	-	-	-	-	-	-	18 - 53	0 - 5	0 - 5	1 - 9	0 - 3	0 - 1	-	-
04/03/2022	-	-	-	-	-	-	-	-	-	-	0 - 2	0 - 3	1 - 9	0 - 4	0 - 3	0 - 7	-
05/03/2022	-	-	-	-	-	-	-	-	-	-	-	0 - 2	1 - 6	0 - 0	0 - 0	0 - 3	0 - 0
06/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	8 - 25	0 - 0	0 - 0	2 - 13	0 - 4
07/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0	0 - 0	3 - 28	0 - 2
08/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0	2 - 25	0 - 2
09/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 9	0 - 1
10/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0
Recorded catchment average rainfall (mm from 07:00 to 07:00)	**19**	**8**	**70**	**185**	**154**	**9**	**1**	**0**	**24**	**9**	**2**	**0**	**12**	**0**	**5**	**3**	**0**

Table 2-25: Forecast catchment average rainfall (mm) for the Lockyer Creek catchment from 23/02/2022 to 10/03/2022

Date forecast was issued (typically between 04:00 and 06:00)	Forecast rainfall (mm) for 24 hours to 23/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 24/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 25/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 26/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 27/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 28/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 01/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 02/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 03/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 04/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 05/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 06/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 07/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 08/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 09/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 10/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 11/03/2022 07:00
22/02/2022	0 - 1	0 - 4	5 - 46	2 - 19	0 - 0	0 - 0	-	-	-	-	-	-	-	-	-	-	-
23/02/2022	-	10 - 32	30 - 87	8 - 26	0 - 2	0 - 0	0 - 0	-	-	-	-	-	-	-	-	-	-
24/02/2022	-	-	90 - 168	10 - 55	0 - 8	0 - 0	0 - 0	0 - 1	-	-	-	-	-	-	-	-	-
25/02/2022	-	-	-	24 - 82	1 - 15	0 - 1	0 - 0	0 - 1	0 - 3	-	-	-	-	-	-	-	-
26/02/2022	-	-	-	-	67 - 142	0 - 9	0 - 1	0 - 2	0 - 4	0 - 6	-	-	-	-	-	-	-
27/02/2022	-	-	-	-	-	18 - 77	0 - 2	0 - 0	0 - 1	0 - 3	0 - 2	-	-	-	-	-	-
28/02/2022	-	-	-	-	-	-	0 - 2	0 - 0	0 - 0	1 - 11	1 - 9	0 - 4	-	-	-	-	-
01/03/2022	-	-	-	-	-	-	-	0 - 0	0 - 2	2 - 21	0 - 8	0 - 4	0 - 7	-	-	-	-
02/03/2022	-	-	-	-	-	-	-	-	0 - 4	7 - 41	0 - 8	0 - 4	0 - 7	0 - 1	-	-	-
03/03/2022	-	-	-	-	-	-	-	-	-	16 - 48	0 - 5	0 - 6	1 - 10	0 - 4	0 - 3	-	-
04/03/2022	-	-	-	-	-	-	-	-	-	-	0 - 3	0 - 3	1 - 10	0 - 2	0 - 1	0 - 4	-
05/03/2022	-	-	-	-	-	-	-	-	-	-	-	0 - 0	1 - 7	0 - 0	0 - 0	0 - 2	0 - 0
06/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	10 - 30	0 - 0	0 - 0	1 - 8	0 - 1
07/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0	0 - 0	3 - 21	0 - 1
08/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0	1 - 13	0 - 0
09/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 1	0 - 0
10/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0
Recorded catchment average rainfall (mm from 07:00 to 07:00)	**18**	**5**	**74**	**218**	**111**	**30**	**2**	**1**	**29**	**11**	**2**	**0**	**17**	**0**	**1**	**0**	**0**

Table 2-26: Forecast catchment average rainfall (mm) for the Bremer River catchment from 23/02/2022 to 10/03/2022

Date forecast was issued (typically between 04:00 and 06:00)	Forecast rainfall (mm) for 24 hours to 23/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 24/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 25/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 26/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 27/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 28/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 01/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 02/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 03/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 04/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 05/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 06/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 07/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 08/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 09/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 10/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 11/03/2022 07:00
22/02/2022	0 - 1	0 - 7	5 - 41	2 - 19	0 - 0	0 - 0	-	-	-	-	-	-	-	-	-	-	-
23/02/2022	-	19 - 61	27 - 81	8 - 28	0 - 3	0 - 0	0 - 0	-	-	-	-	-	-	-	-	-	-
24/02/2022	-	-	61 - 122	12 - 65	0 - 9	0 - 0	0 - 0	0 - 2	-	-	-	-	-	-	-	-	-
25/02/2022	-	-	-	25 - 79	6 - 31	0 - 1	0 - 0	0 - 2	0 - 3	-	-	-	-	-	-	-	-
26/02/2022	-	-	-	-	52 - 129	1 - 31	0 - 2	0 - 2	0 - 4	0 - 7	-	-	-	-	-	-	-
27/02/2022	-	-	-	-	-	27 - 95	0 - 4	0 - 0	0 - 1	0 - 4	0 - 3	-	-	-	-	-	-
28/02/2022	-	-	-	-	-	-	1 - 5	0 - 0	0 - 0	1 - 10	1 - 12	0 - 4	-	-	-	-	-
01/03/2022	-	-	-	-	-	-	-	0 - 0	0 - 1	2 - 23	1 - 16	0 - 4	0 - 8	-	-	-	-
02/03/2022	-	-	-	-	-	-	-	-	0 - 2	6 - 41	1 - 16	0 - 4	0 - 8	0 - 2	-	-	-
03/03/2022	-	-	-	-	-	-	-	-	-	19 - 54	1 - 15	1 - 10	1 - 13	0 - 6	0 - 3	-	-
04/03/2022	-	-	-	-	-	-	-	-	-	-	0 - 5	0 - 5	1 - 11	0 - 3	0 - 2	0 - 3	-
05/03/2022	-	-	-	-	-	-	-	-	-	-	-	0 - 1	1 - 8	0 - 0	0 - 0	0 - 1	0 - 0
06/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	17 - 49	0 - 0	0 - 0	1 - 8	0 - 0
07/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0	0 - 0	3 - 18	0 - 0
08/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0	1 - 11	0 - 0
09/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 4	0 - 0
10/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0
Recorded catchment average rainfall (mm from 07:00 to 07:00)	**8**	**7**	**90**	**118**	**104**	**115**	**1**	**3**	**31**	**11**	**6**	**0**	**27**	**1**	**0**	**0**	**0**

Table 2-27: Forecast catchment average rainfall (mm) for the Brisbane River from Wivenhoe Dam to Moggill catchment from 23/02/2022 to 10/03/2022

Date forecast was issued (typically between 04:00 and 06:00)	Forecast rainfall (mm) for 24 hours to 23/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 24/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 25/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 26/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 27/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 28/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 01/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 02/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 03/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 04/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 05/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 06/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 07/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 08/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 09/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 10/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 11/03/2022 07:00
22/02/2022	0 - 1	0 - 13	8 - 53	4 - 25	0 - 2	0 - 0	-	-	-	-	-	-	-	-	-	-	-
23/02/2022	-	34 - 91	45 - 106	15 - 43	0 - 6	0 - 0	0 - 1	-	-	-	-	-	-	-	-	-	-
24/02/2022	-	-	64 - 138	22 - 97	2 - 18	0 - 2	0 - 1	0 - 1	-	-	-	-	-	-	-	-	-
25/02/2022	-	-	-	41 - 126	10 - 34	0 - 3	0 - 1	0 - 1	0 - 2	-	-	-	-	-	-	-	-
26/02/2022	-	-	-	-	95 - 223	1 - 22	0 - 2	0 - 1	0 - 3	0 - 6	-	-	-	-	-	-	-
27/02/2022	-	-	-	-	-	34 - 113	0 - 5	0 - 0	0 - 1	0 - 4	0 - 4	-	-	-	-	-	-
28/02/2022	-	-	-	-	-	-	1 - 11	0 - 0	0 - 0	1 - 11	2 - 11	0 - 4	-	-	-	-	-
01/03/2022	-	-	-	-	-	-	-	0 - 0	0 - 1	3 - 22	1 - 16	0 - 4	1 - 10	-	-	-	-
02/03/2022	-	-	-	-	-	-	-	-	0 - 3	7 - 47	1 - 16	0 - 4	1 - 10	0 - 1	-	-	-
03/03/2022	-	-	-	-	-	-	-	-	-	24 - 67	1 - 15	0 - 7	2 - 14	0 - 6	0 - 2	-	-
04/03/2022	-	-	-	-	-	-	-	-	-	-	0 - 5	0 - 5	1 - 11	0 - 3	0 - 2	0 - 5	-
05/03/2022	-	-	-	-	-	-	-	-	-	-	-	0 - 1	1 - 8	0 - 0	0 - 0	0 - 0	0 - 0
06/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	16 - 45	0 - 0	0 - 0	1 - 8	0 - 1
07/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0	0 - 0	3 - 18	0 - 0
08/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0	1 - 12	0 - 1
09/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 7	0 - 0
10/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0
Recorded catchment average rainfall (mm from 07:00 to 07:00)	**20**	**10**	**57**	**294**	**218**	**149**	**3**	**1**	**27**	**14**	**0**	**0**	**11**	**0**	**1**	**1**	**0**

Table 2-28: Forecast catchment average rainfall (mm) for the Brisbane River downstream of Moggill catchment from 23/02/2022 to 10/03/2022

Date forecast was issued (typically between 04:00 and 06:00)	Forecast rainfall (mm) for 24 hours to 23/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 24/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 25/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 26/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 27/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 28/02/2022 07:00	Forecast rainfall (mm) for 24 hours to 01/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 02/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 03/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 04/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 05/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 06/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 07/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 08/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 09/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 10/03/2022 07:00	Forecast rainfall (mm) for 24 hours to 11/03/2022 07:00
22/02/2022	0 - 1	1 - 19	9 - 55	4 - 25	0 - 1	0 - 0	-	-	-	-	-	-	-	-	-	-	-
23/02/2022	-	57 - 150	47 - 109	17 - 49	0 - 6	0 - 0	0 - 0	-	-	-	-	-	-	-	-	-	-
24/02/2022	-	-	58 - 135	27 - 104	3 - 19	0 - 2	0 - 1	0 - 0	-	-	-	-	-	-	-	-	-
25/02/2022	-	-	-	44 - 129	13 - 42	1 - 4	0 - 1	0 - 1	0 - 1	-	-	-	-	-	-	-	-
26/02/2022	-	-	-	-	89 - 202	4 - 41	0 - 3	0 - 1	0 - 3	0 - 6	-	-	-	-	-	-	-
27/02/2022	-	-	-	-	-	30 - 94	0 - 8	0 - 0	0 - 2	0 - 6	0 - 4	-	-	-	-	-	-
28/02/2022	-	-	-	-	-	-	2 - 15	0 - 0	0 - 0	1 - 10	2 - 13	0 - 3	-	-	-	-	-
01/03/2022	-	-	-	-	-	-	-	0 - 0	0 - 1	3 - 23	1 - 20	0 - 4	0 - 10	-	-	-	-
02/03/2022	-	-	-	-	-	-	-	-	0 - 2	7 - 51	1 - 20	0 - 4	0 - 10	0 - 1	-	-	-
03/03/2022	-	-	-	-	-	-	-	-	-	29 - 84	1 - 26	0 - 12	1 - 16	0 - 6	0 - 1	-	-
04/03/2022	-	-	-	-	-	-	-	-	-	-	1 - 8	0 - 6	1 - 11	0 - 4	0 - 3	0 - 5	-
05/03/2022	-	-	-	-	-	-	-	-	-	-	-	0 - 2	1 - 8	0 - 0	0 - 0	0 - 0	0 - 0
06/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	17 - 51	0 - 0	0 - 0	0 - 5	0 - 0
07/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0	0 - 0	2 - 13	0 - 0
08/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0	1 - 11	0 - 0
09/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 10	0 - 0
10/03/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 - 0
Recorded catchment average rainfall (mm from 07:00 to 07:00)	**35**	**13**	**55**	**224**	**192**	**234**	**5**	**0**	**11**	**30**	**4**	**0**	**25**	**1**	**1**	**0**	**0**

2.5 Gauging station hydrographs

This section presents hydrographs of the water levels recorded at key gauging stations in the Brisbane River basin during the Flood Event.

The peak water level recorded between 22/02/2022 09:00 to 10/03/2022 09:00 for selected key gauges in the Brisbane River basin (with Bureau flood classification levels where they have been defined by the relevant local government) has been summarised in Table 2-29. Note that flood classification level information is not used operationally for decision making at Somerset Dam and Wivenhoe Dam. It is presented to here to help illustrate the magnitude of the Flood Event.

Table 2-29: Peak water level summary of selected Brisbane River basin river gauges for the period from 22/02/2022 to 10/03/2022

Station Name	Peak Water Level (m)	Flood Classification Level
Stanley River to Somerset Dam		
Peachester	9.79	Major
Woodford	9.91	Major
Brisbane River to Wivenhoe Dam		
Linville	9.85	Major
Devon Hills	10.50	Major
Gregors Creek	12.45	N/A
Lockyer Creek		
Helidon	9.07	Major
Gatton	15.50	Major
Mulgowie	8.03	Major
Rifle Range Road	16.80	Major
Brisbane River from Wivenhoe Dam to Moggill		
Lowood	16.70	Moderate
Savages Crossing	17.7	Moderate
Mt Crosby	18.8	Moderate
Moggill	14.2	Moderate
Bremer River		
Warrill Creek at Amberley	9.82	Major
Purga Creek at Loamside	8.85	Major
Bremer River at Walloon	10.30	Major
Ipswich	16.70	Major
Brisbane River downstream of Moggill		
Jindalee	10.04	N/A
Brisbane City	3.85	Major

A map showing selected water level gauges in the Stanley River to Somerset Dam and the Brisbane River to Wivenhoe Dam sub-catchments is shown in Figure 2-37. Water level hydrographs at these key gauges for Stanley River to Somerset Dam are shown in Figure 2-39 to Figure 2-40 and for the Brisbane River to Wivenhoe Dam in Figure 2-41 to Figure 2-44.

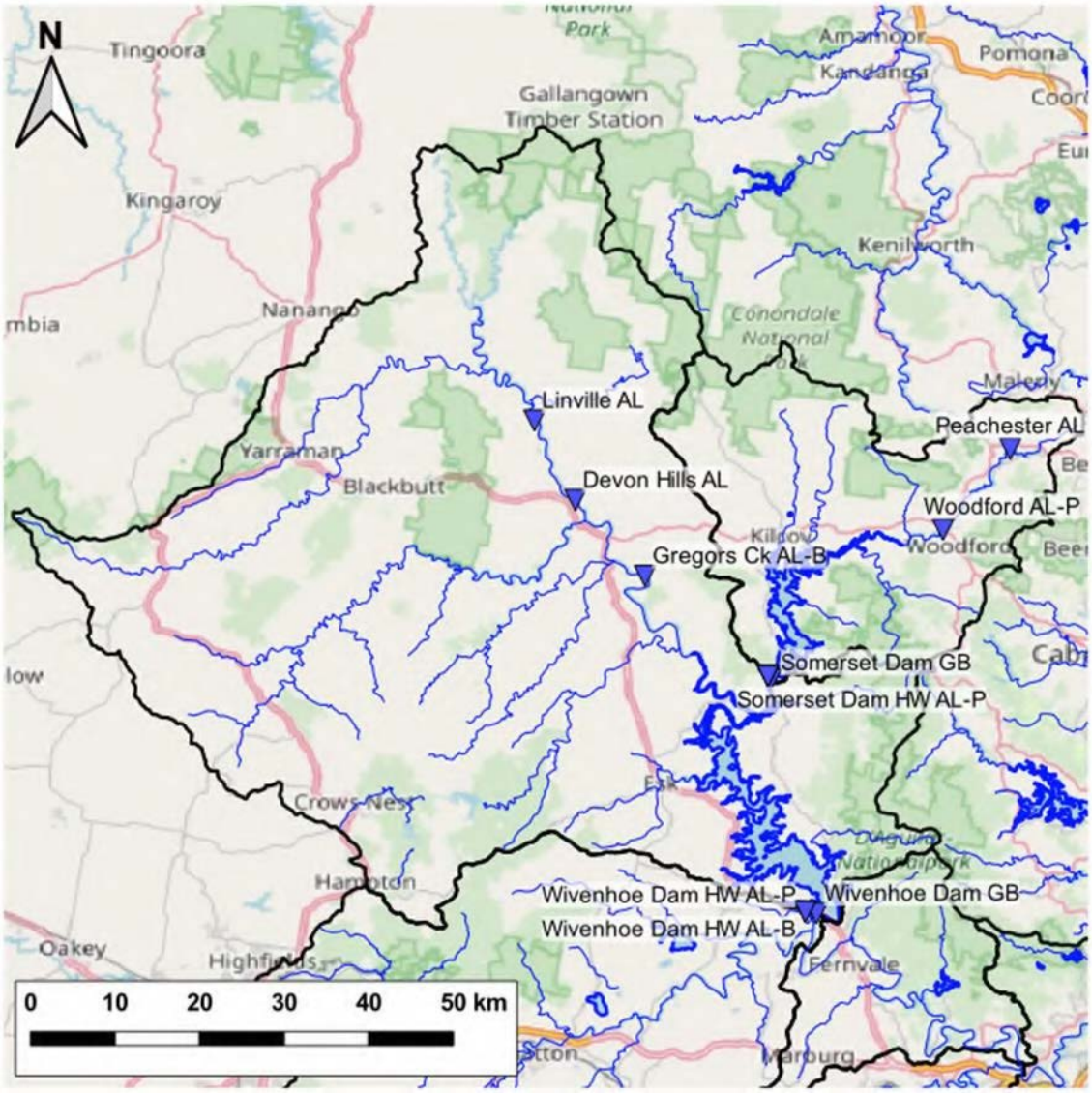

Figure 2-37: Stanley River to Somerset Dam and Brisbane River to Wivenhoe Dam water level gauge locations

Stanley River to Somerset Dam

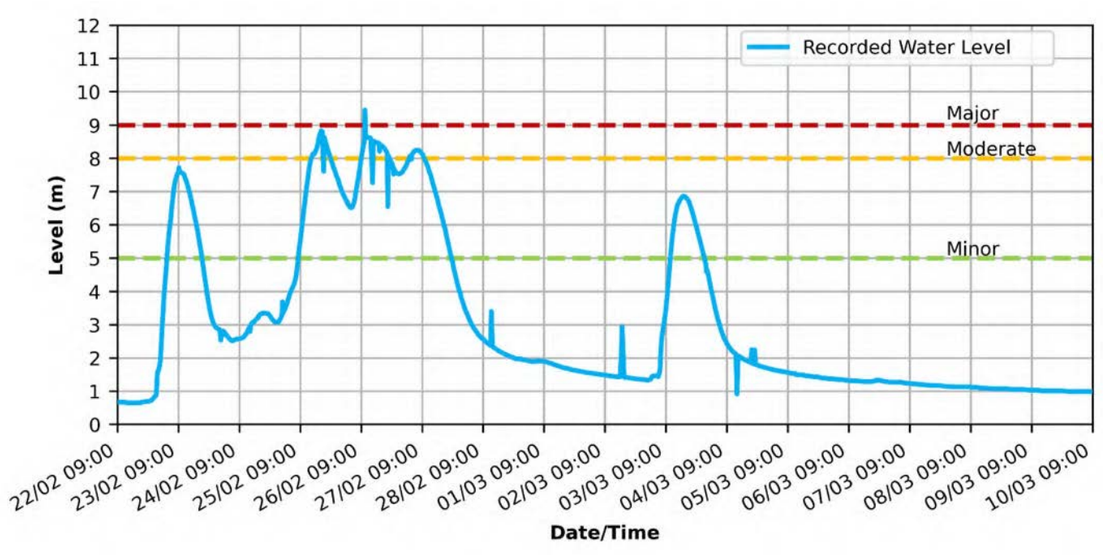

Figure 2-38: Recorded water level for Stanley River at Peachester for the Flood Event

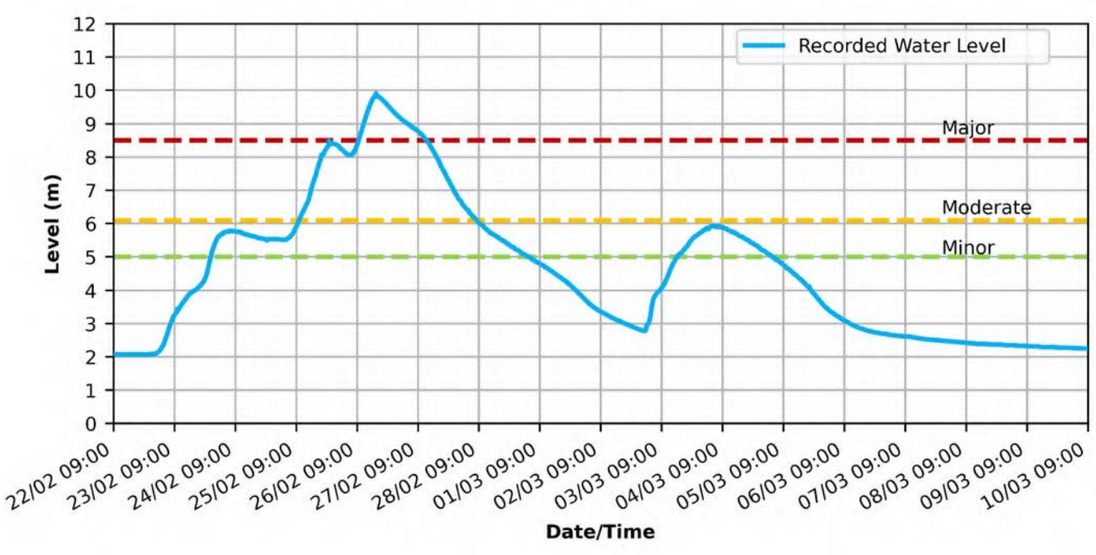

Figure 2-39: Recorded water level for Stanley River at Woodford for the Flood Event

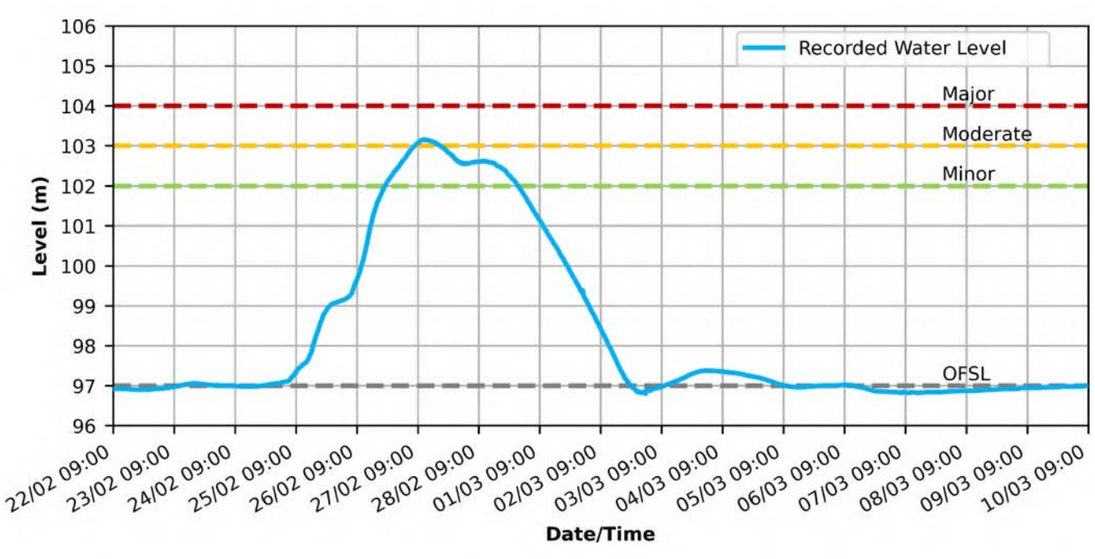

Figure 2-40: Recorded lake level at Somerset Dam for the Flood Event

Brisbane River to Wivenhoe Dam

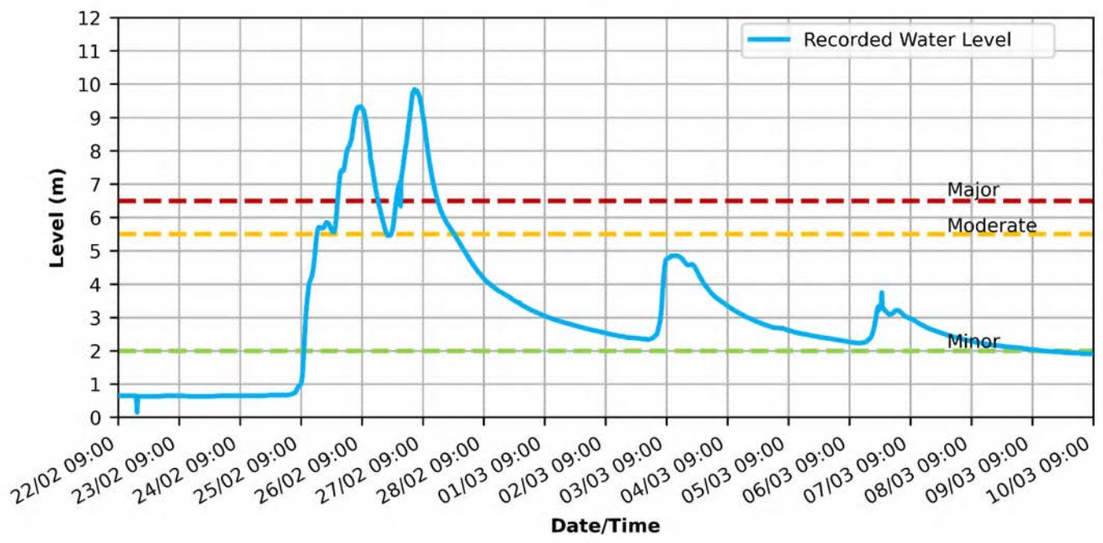

Figure 2-41: Recorded water level for Brisbane River at Linville for the Flood Event

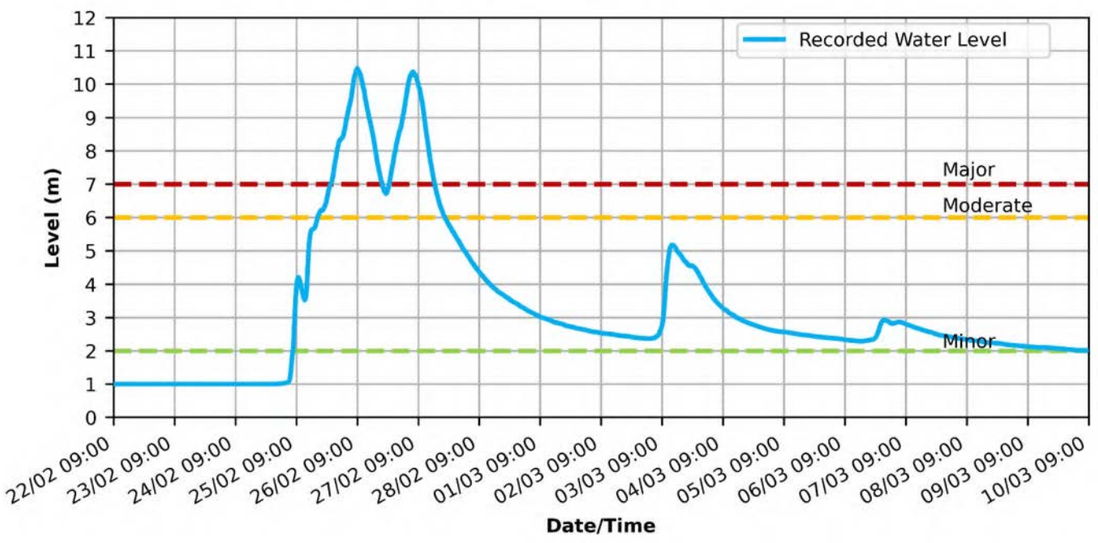

Figure 2-42: Recorded water level Brisbane River at Devon Hills for the Flood Event

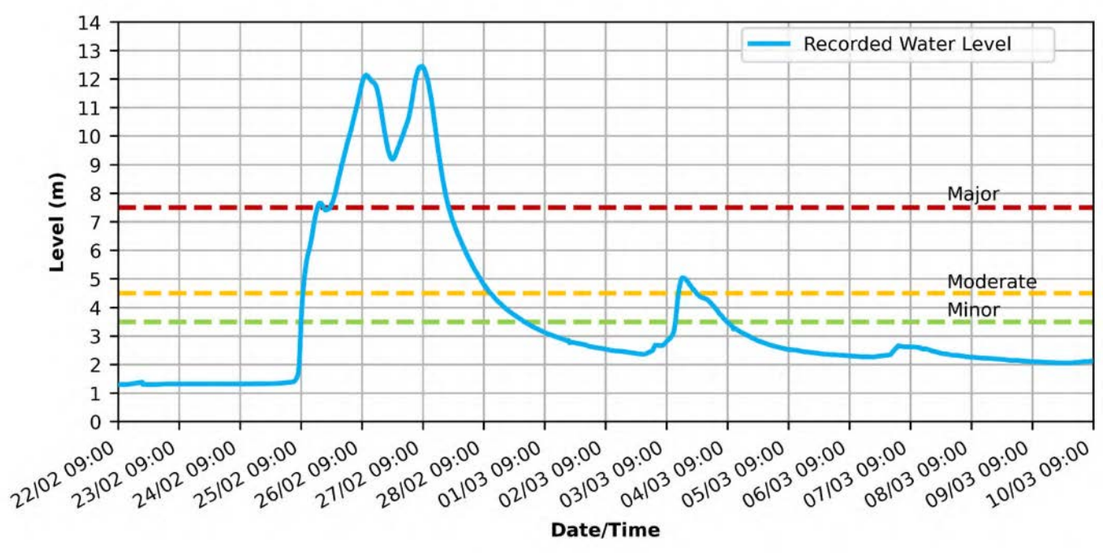

Figure 2-43: Recorded water level for Brisbane River at Gregors Creek for the Flood Event

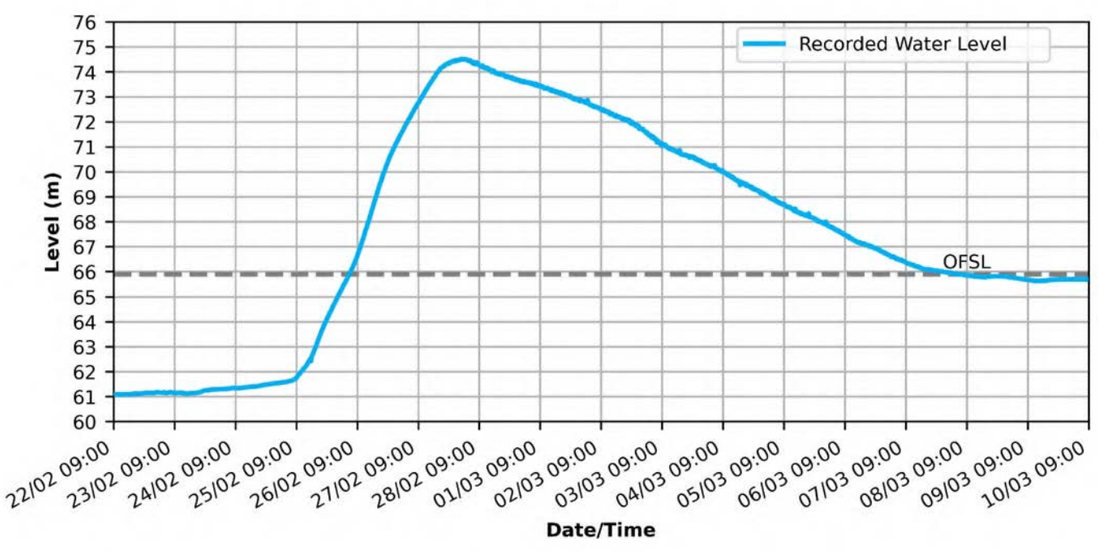

Figure 2-44: Recorded lake level at Wivenhoe Dam for the Flood Event

A map of selected water level gauges for the Lockyer Creek sub-catchment is shown in Figure 2-45. Water level hydrographs at these key gauges are presented in Figure 2-46 Figure 2-49.

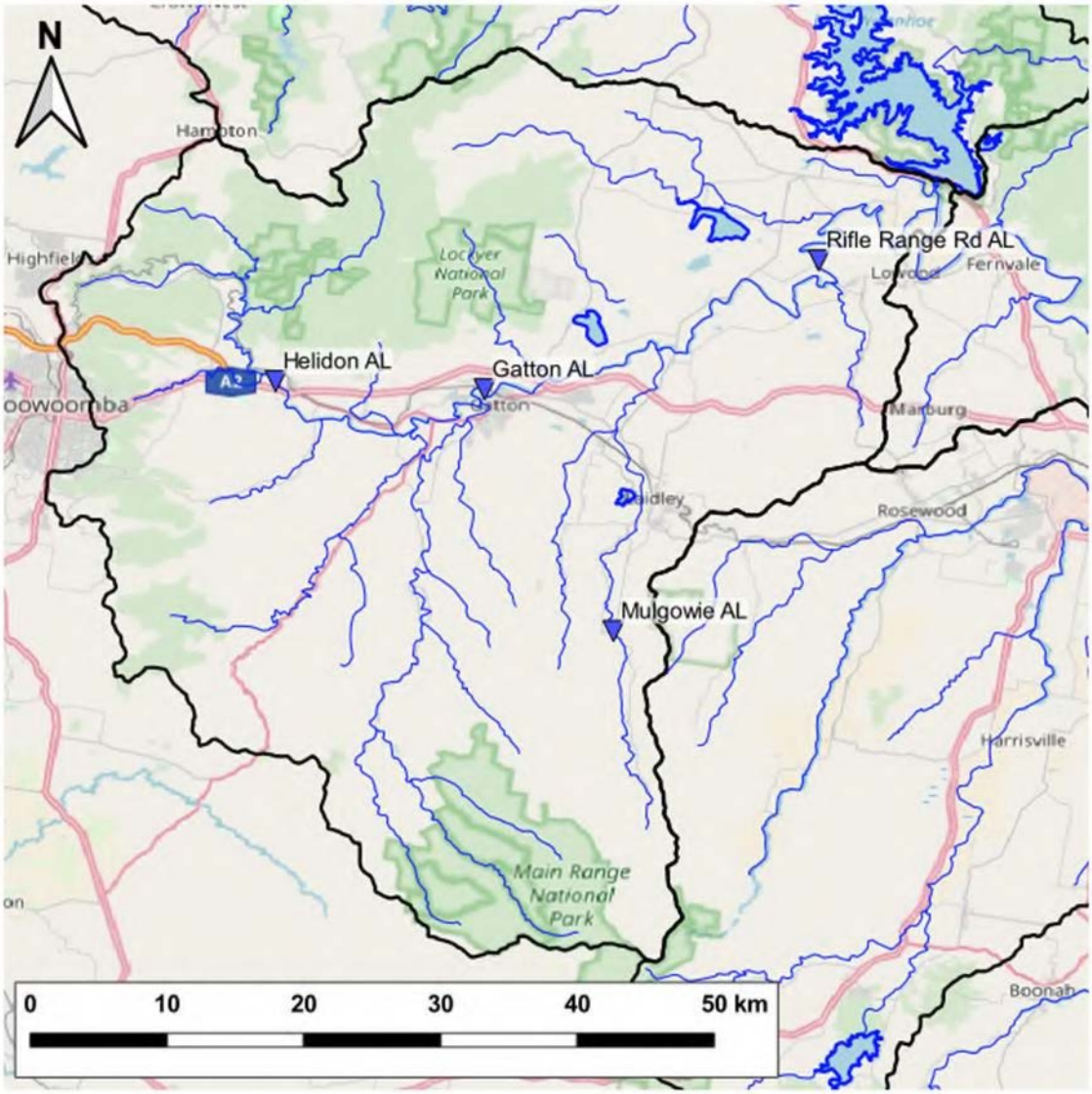

Figure 2-45: Lockyer Creek water level gauge locations

Lockyer Creek

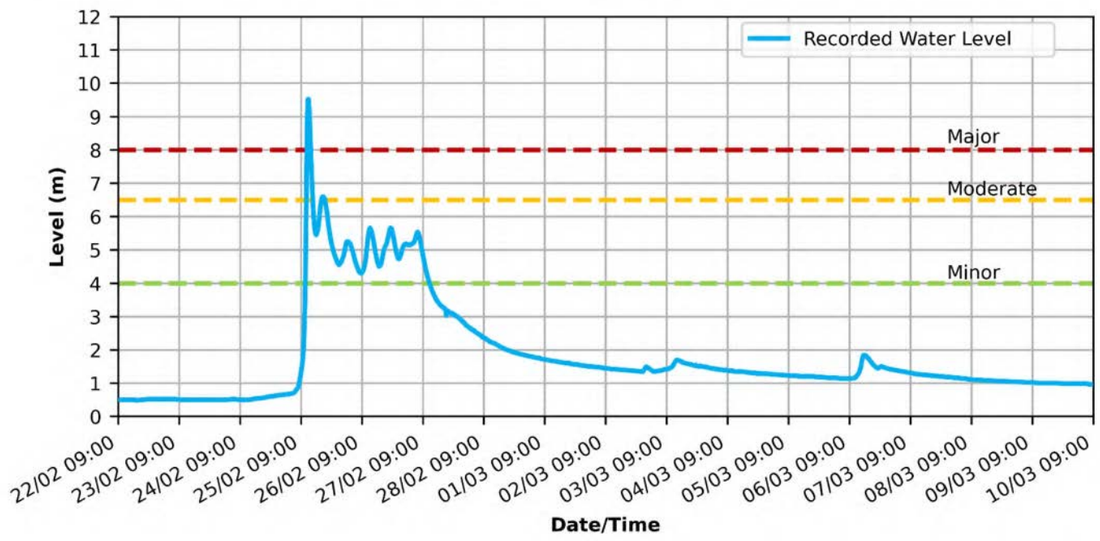

Figure 2-46: Recorded water level for Lockyer Creek at Helidon for the Flood Event

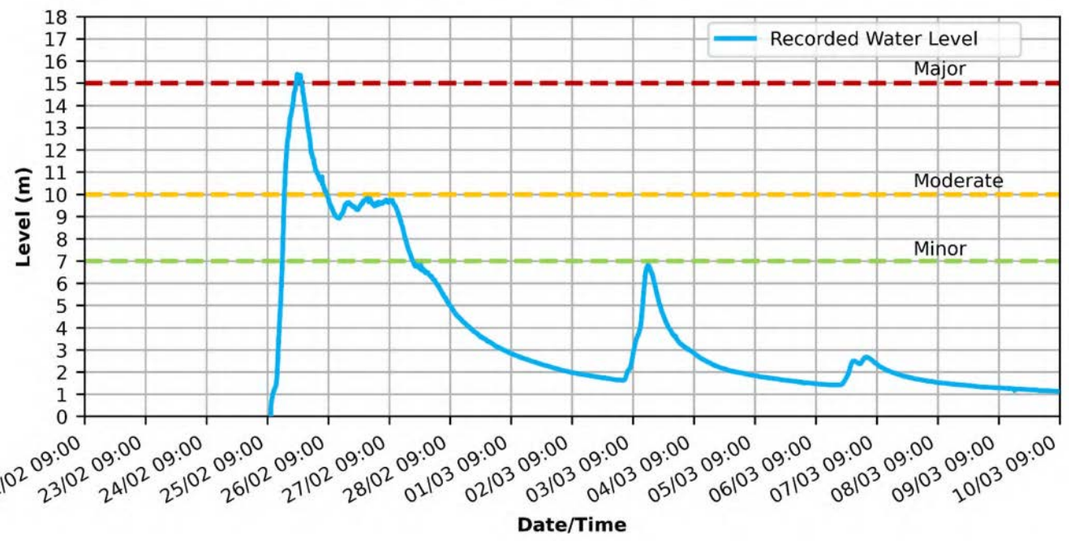

Figure 2-47: Recorded water level for Lockyer Creek at Gatton for the Flood Event

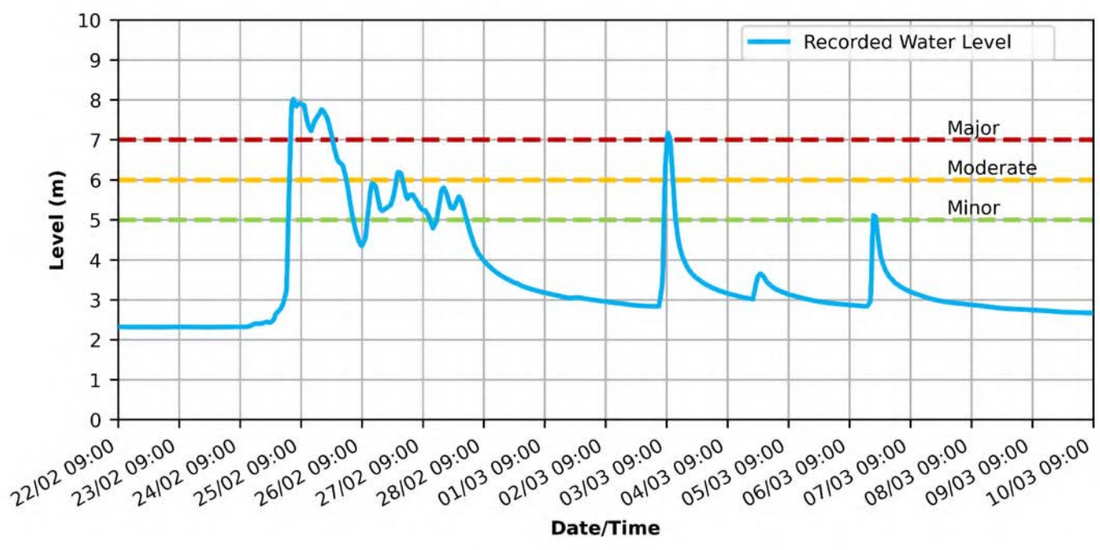

Figure 2-48: Recorded water level for Laidley Creek at Mulgowie for the Flood Event

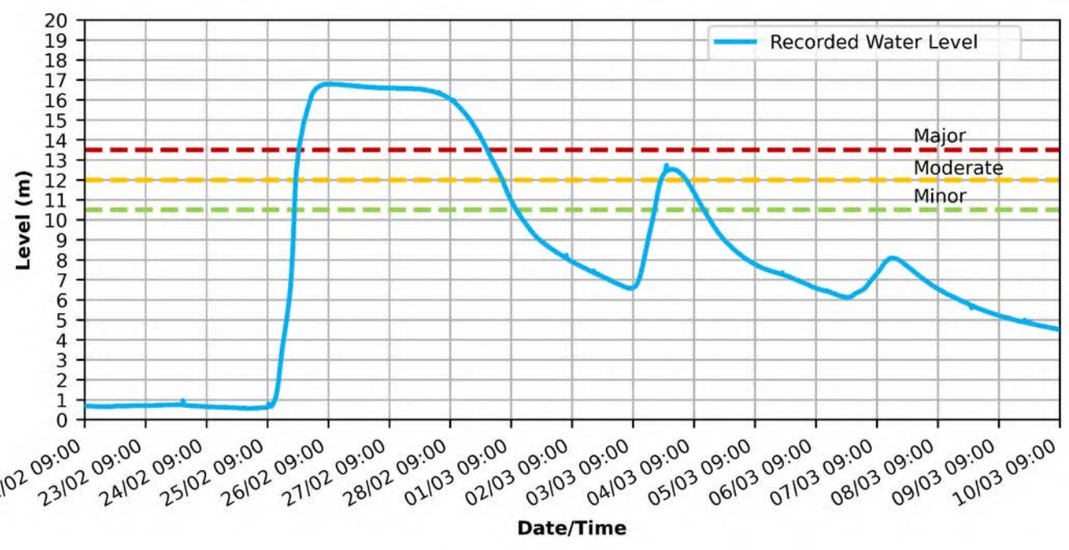

Figure 2-49: Recorded water level for Lockyer Creek at Rifle Range Rd for the Flood Event

A map of selected water level gauges for the Bremer River catchment is shown in Figure 2-50. Selected water level hydrographs at key gauges are presented in Figure 2-51 to Figure 2-54.

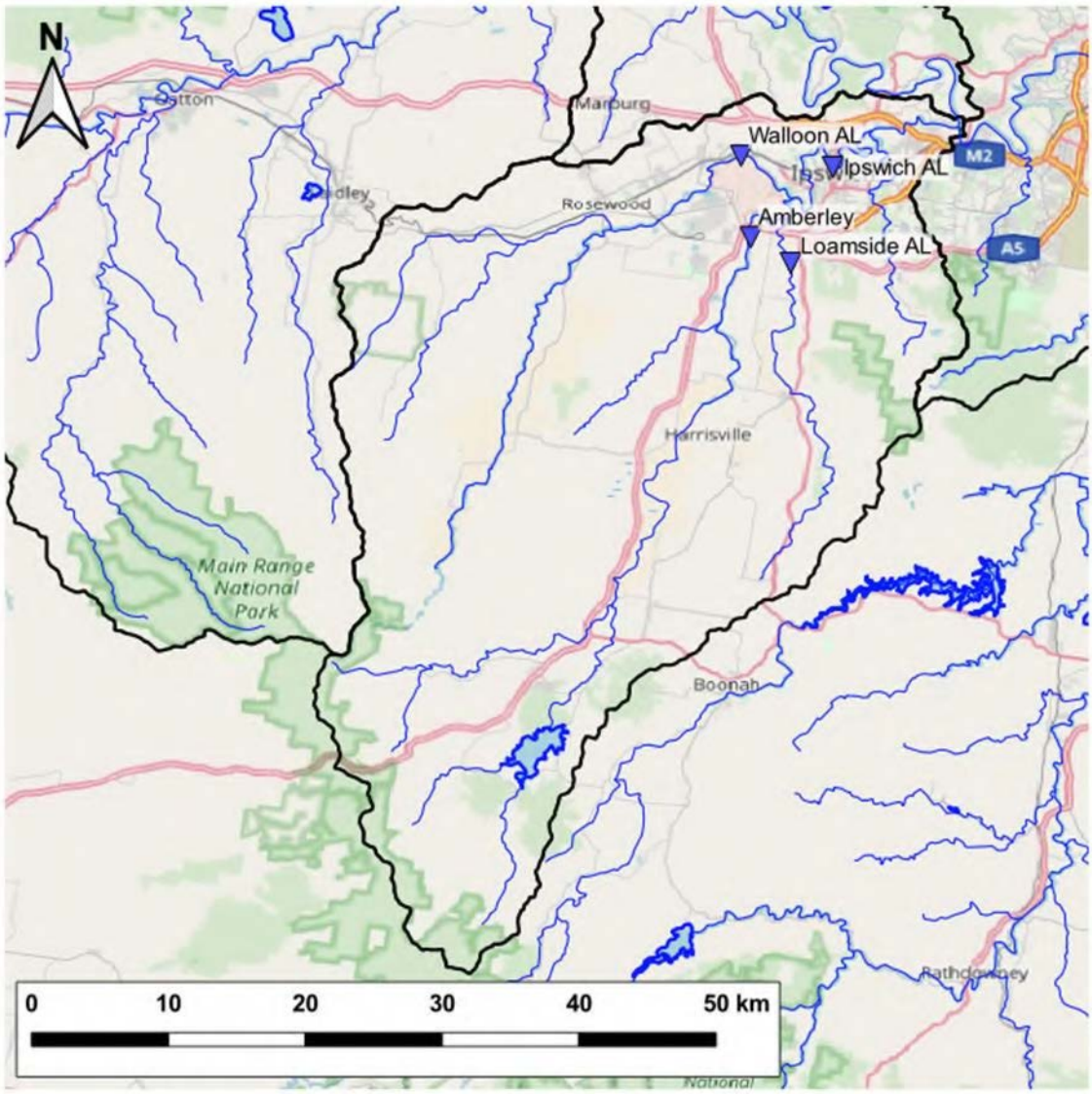

Figure 2-50: Bremer River water level gauge locations

Bremer River

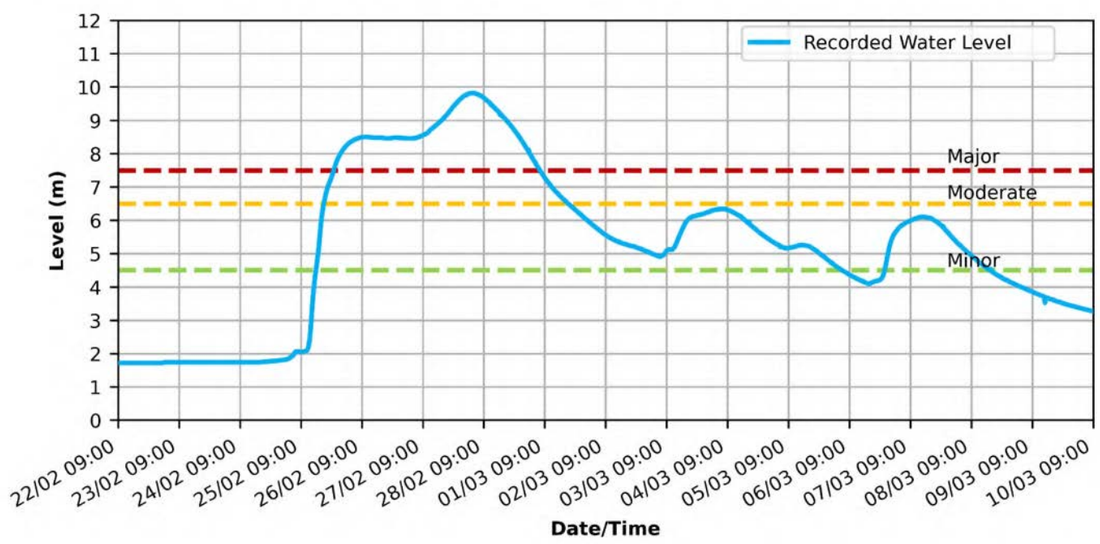

Figure 2-51: Recorded water level for Warrill Creek at Amberley for the Flood Event

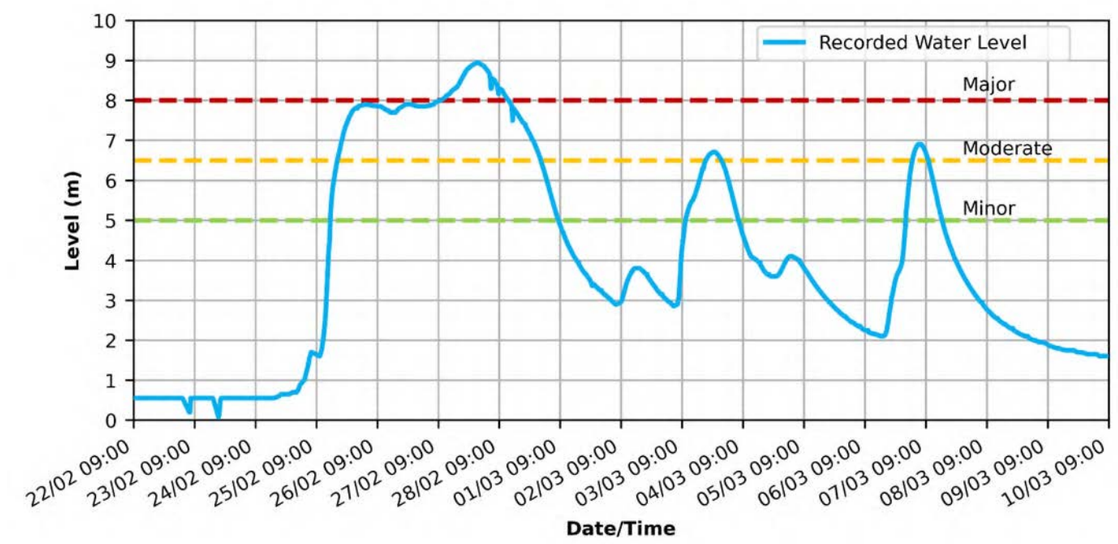

Figure 2-52: Recorded water level for Purga Creek at Loamside for the Flood Event

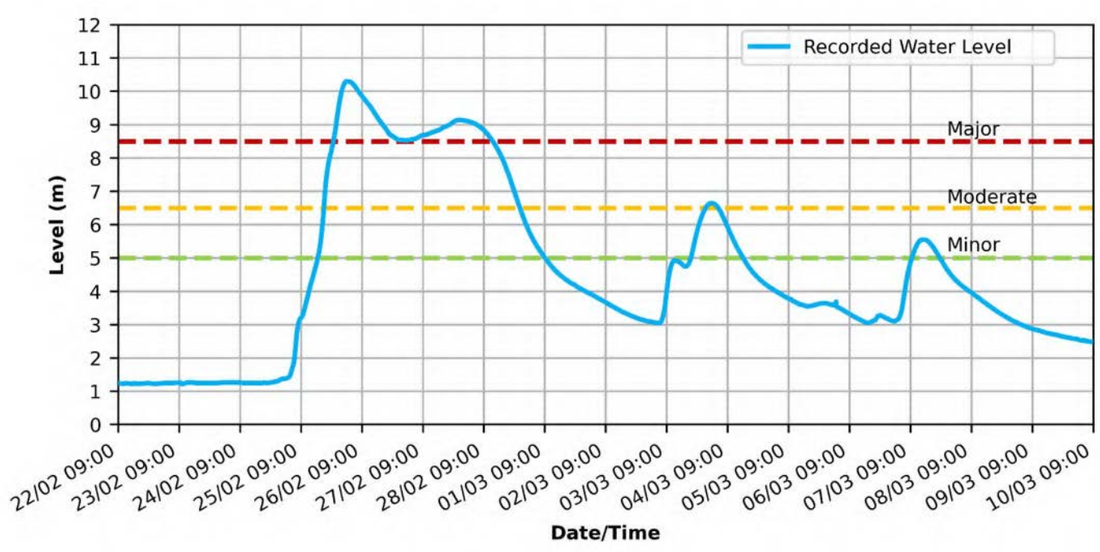

Figure 2-53: Recorded water level for Bremer River at Walloon for the Flood Event

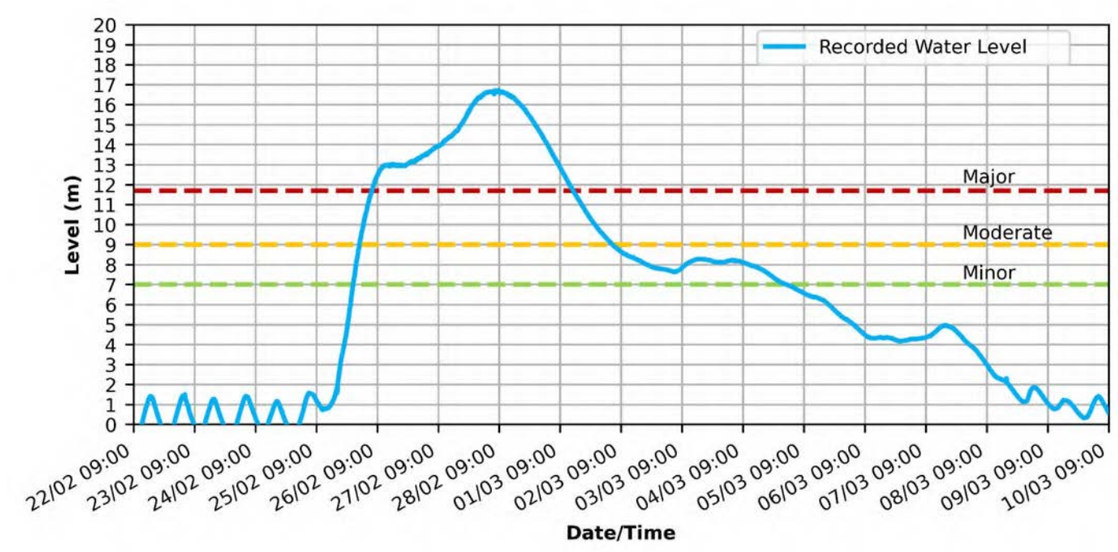

Figure 2-54: Recorded water level for Bremer River at Ipswich for the Flood Event

A map of selected water level gauges for the Brisbane River between Wivenhoe Dam and Moggill catchment is shown in Figure 2-55. Water level hydrographs at these key gauges are shown in Figure 2-56 to Figure 2-58.

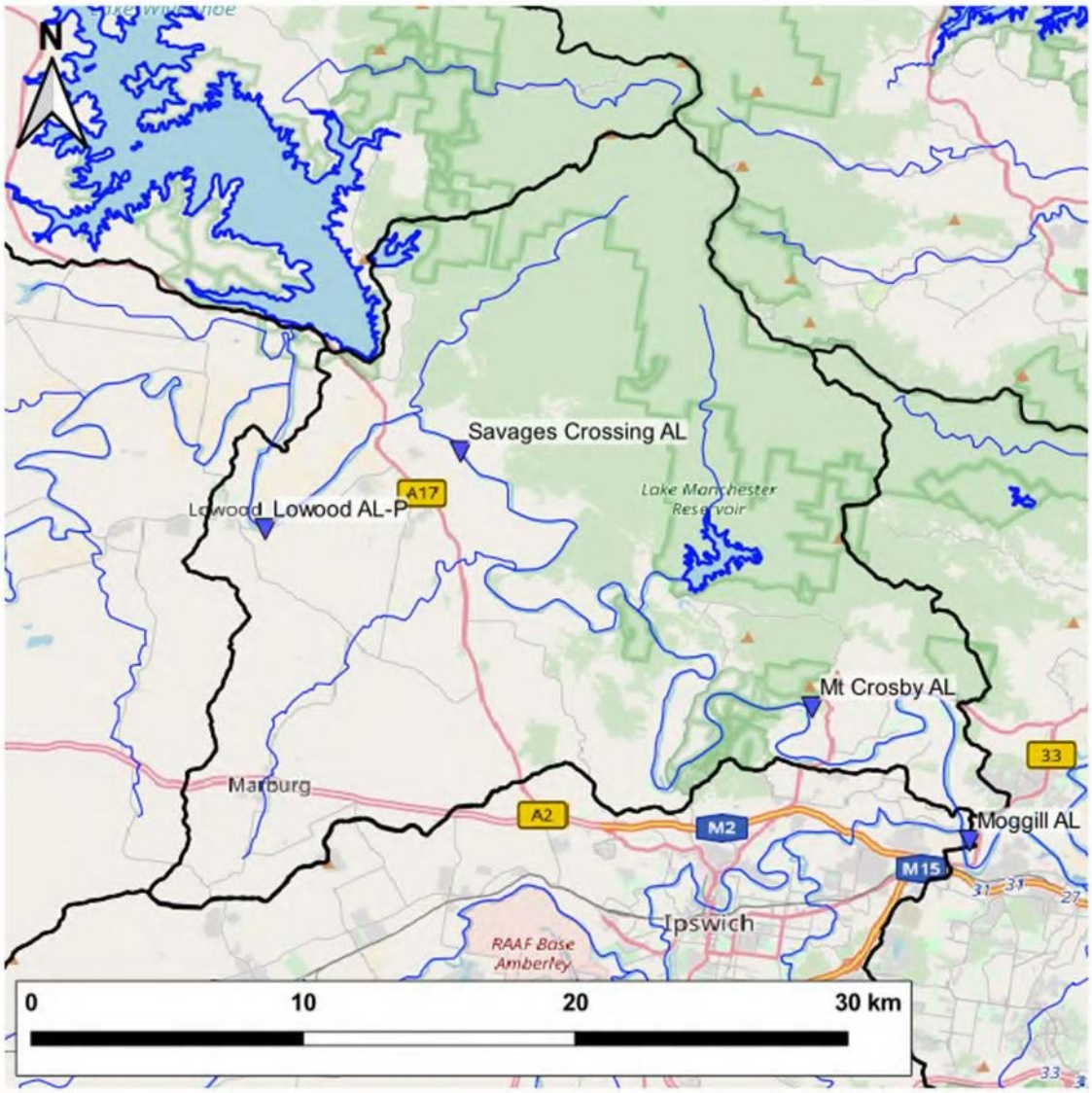

Figure 2-55: Brisbane River between Wivenhoe Dam and Moggill water level gauge locations

Brisbane River between Wivenhoe Dam and Moggill

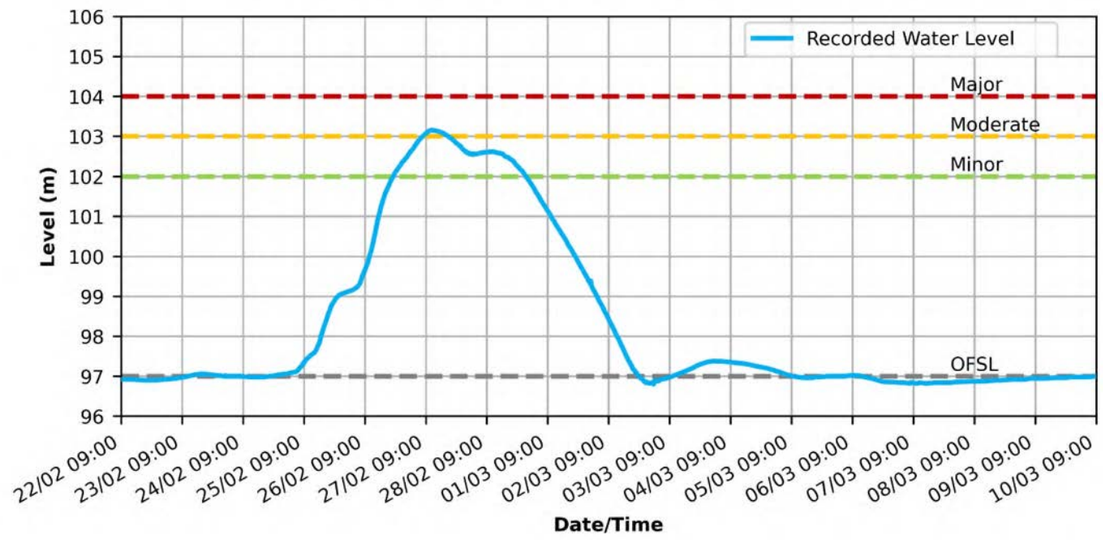

Figure 2-56: Recorded water level for Brisbane River at Lowood for the Flood Event

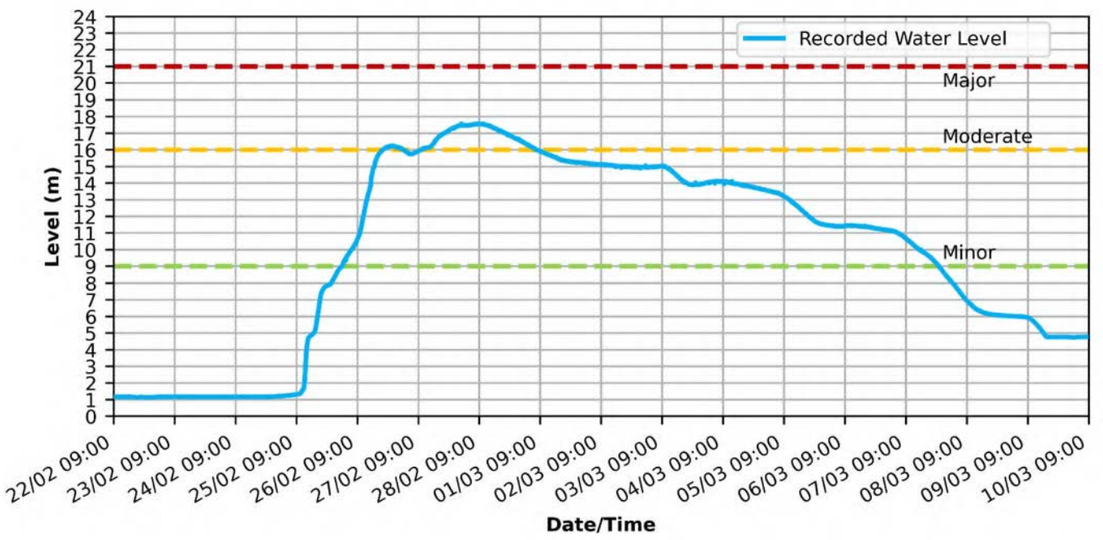

Figure 2-57: Recorded water level for Brisbane River at Savages Crossing for the Flood Event

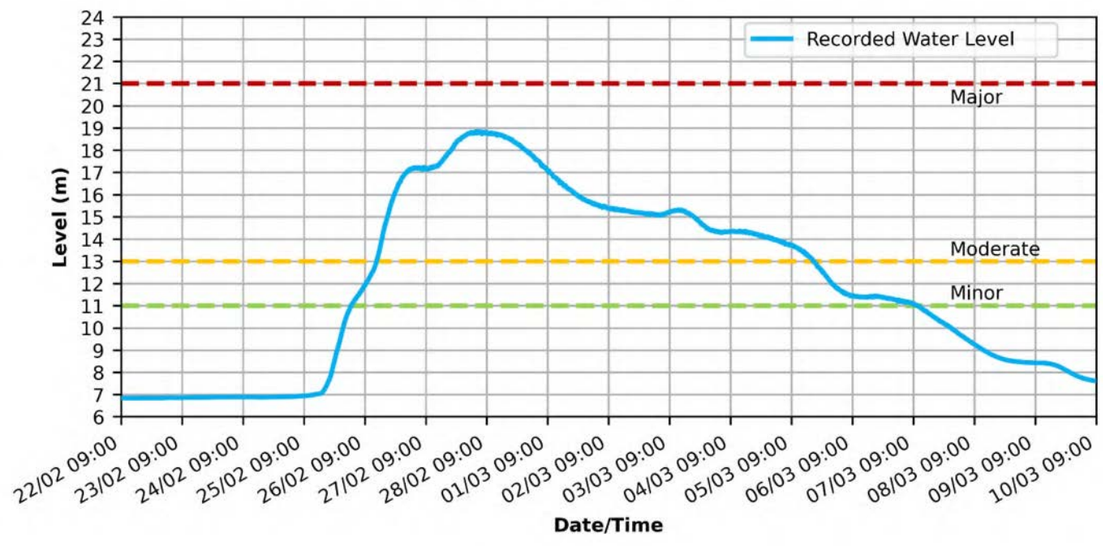

Figure 2-58: Recorded Water Level for Brisbane River at Mt Crosby for the Flood Event

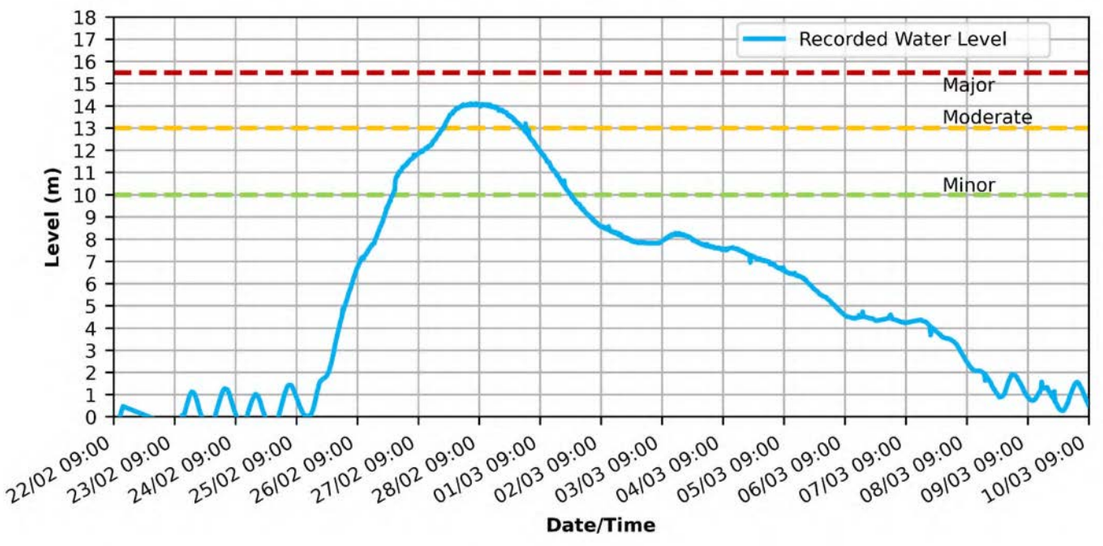

Figure 2-59: Recorded water level at for Brisbane River at Moggill for the Flood Event

A map of selected water level gauges for the Brisbane River downstream of Moggill sub-catchment is shown in Figure 2-60. Water level hydrographs at these key gauges are shown in Figure 2-61 to Figure 2-62. Gauges downstream of Moggill do not inform decision making but are provided to assist in understanding of flooding outcomes downstream of Moggill.

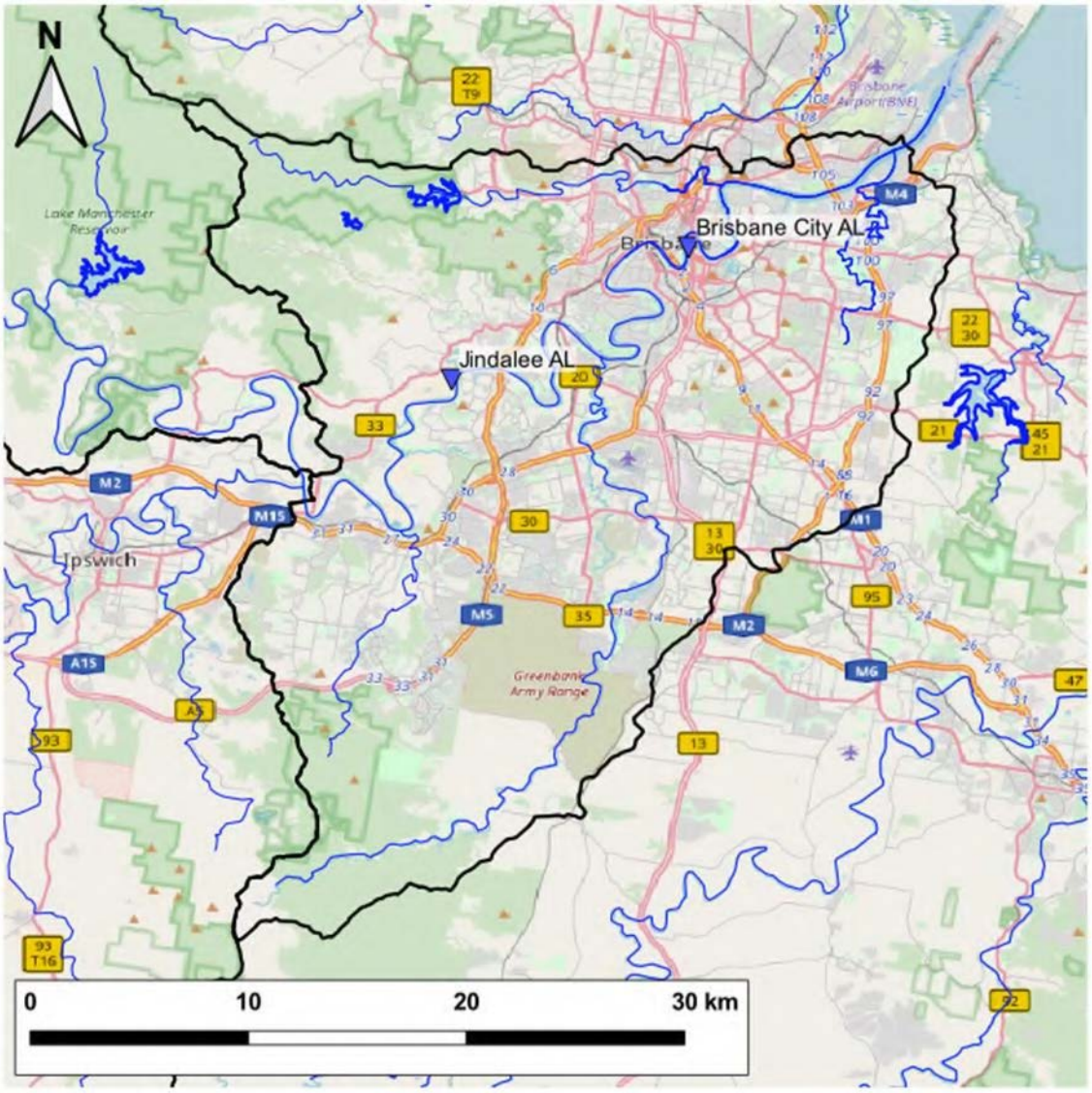

Figure 2-60: Brisbane River downstream of Moggill water level gauge locations

Brisbane River downstream of Moggill

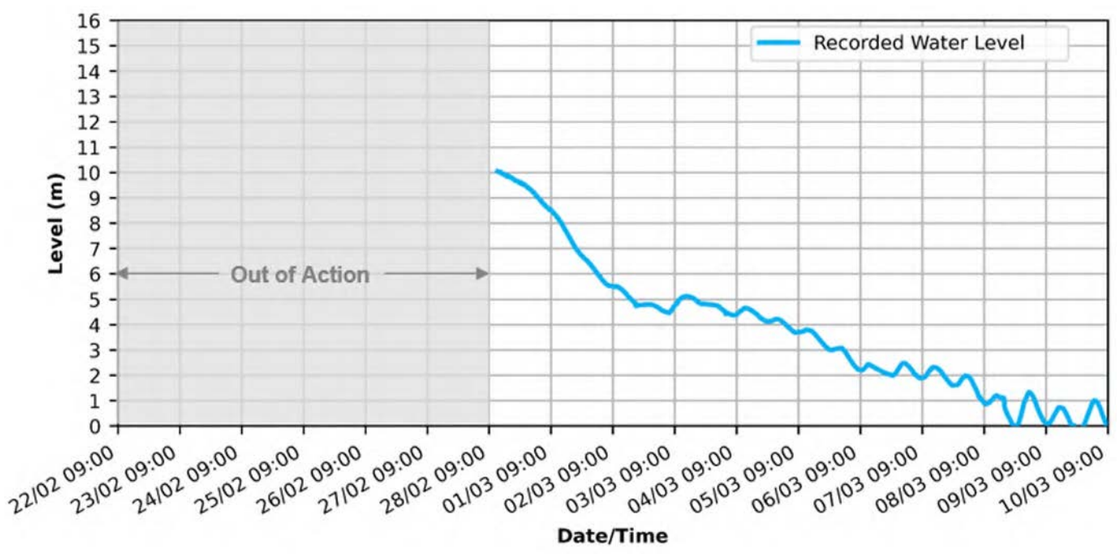

Figure 2-61: Recorded water level for Brisbane River at Jindalee for the Flood Event

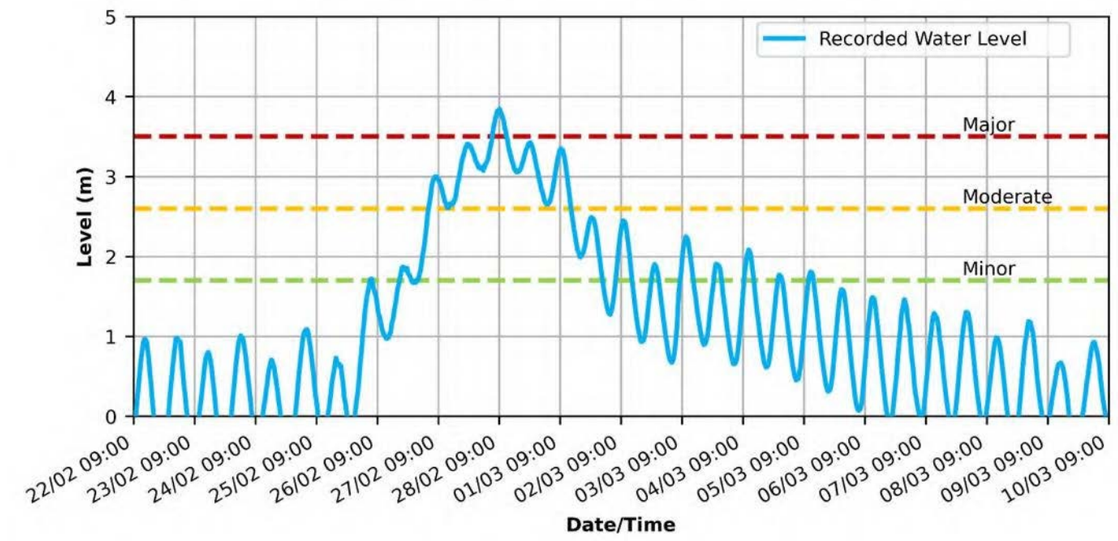

Figure 2-62: Recorded water level for Brisbane River at Brisbane City for the Flood Event

As described in Section 2.2, the Jindalee gauge was Out Of Action at start of the Flood Event but was restored on 28/02/2022 at approximately 12:00.

2.5.1 Tides

As described in Section 10.5 of the Manual, the operational procedures for Wivenhoe Dam do not consider tidal influences in the lower Brisbane River. Water levels in the Brisbane River downstream of Mt Crosby and the lower reaches of the Bremer River are influenced by a combination of dam releases, downstream catchment flows and tide. Hence, the tide data at the mouth of the Brisbane River is included for completeness to assist in the understanding of flood levels that occurred in this part of the basin.

Figure 2-63 illustrates the predicted and recorded tides at Brisbane River mouth over the duration of the Flood Event. In this case, predicted tidal levels have been sourced from astronomical tide tables.

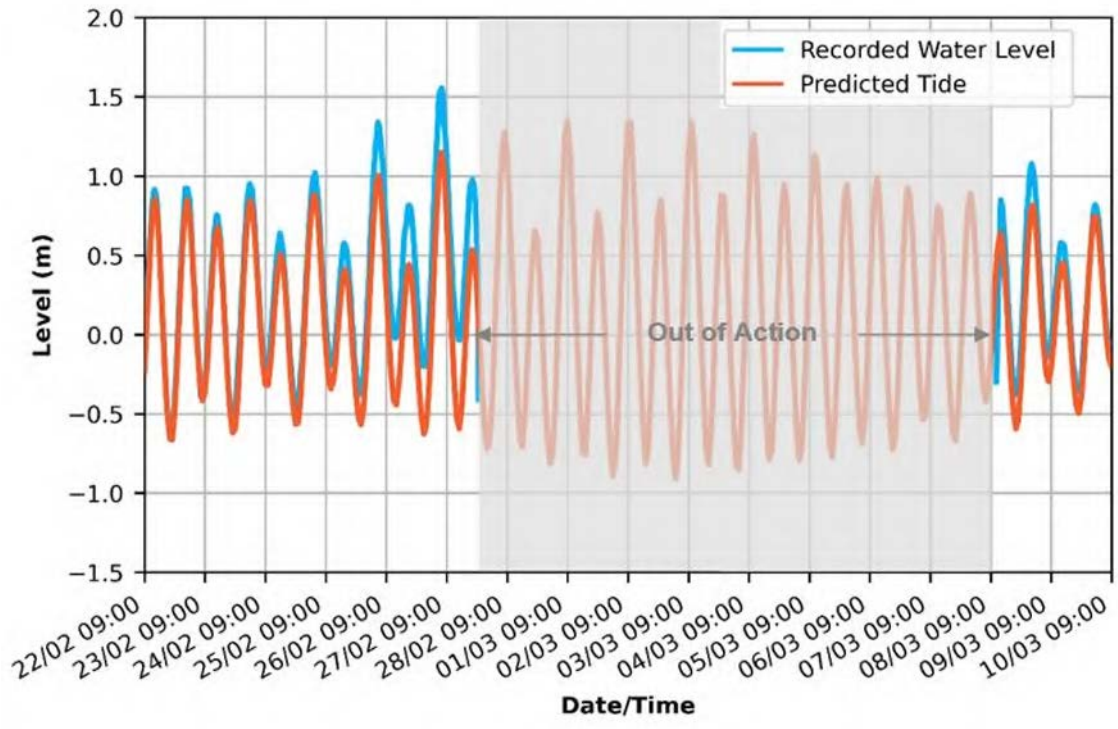

Figure 2-63: Predicted and recorded tides at Brisbane River mouth (Whyte Island)

There was a period of time between 27/02/2022 15:00 and 08/03/2022 11:00 when the water level sensor at Whyte Island was out of action.

Tide levels at the mouth of the Brisbane River were similar to the predicted tidal levels prior to the Flood Event. However, notably on 27/02/2022, the recorded level was up to 0.46 metres above the predicted tide level. This was due to the slow moving low pressure trough over South East Queensland influencing sea levels, which would not have been accounted for in the astronomical tide predictions.

2.6 Lake levels and releases

The recorded lake levels and releases for the Flood Event at Somerset Dam and Wivenhoe Dam are shown in Figure 2-64 to Figure 2-65 and Figure 2-66 to Figure 2-67 respectively and tabulated in Appendix C and Appendix D. The lake level data is comprised of a comparison of automated lake level readings and manual gauge board readings. Release data was extracted from the FFS.

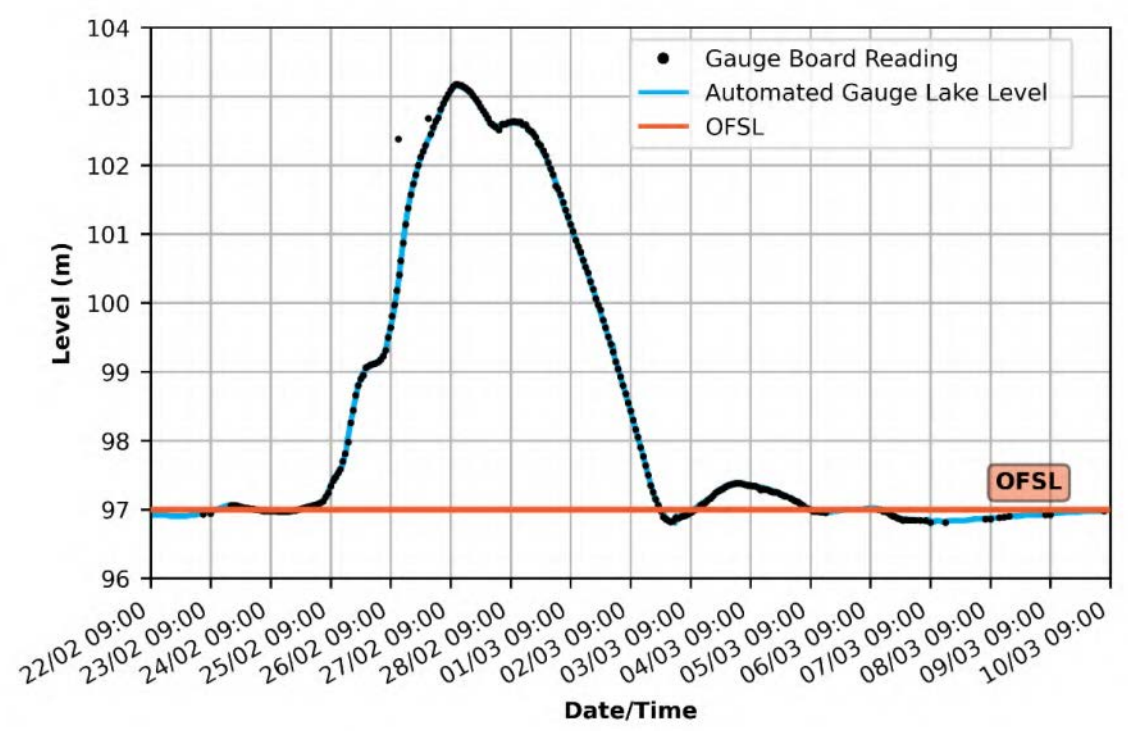

Figure 2-64: Somerset Dam lake level comparing automated water level data and gauge board readings for the period 22/02/2022 09:00 to 10/03/2022 09:00

The automated lake level data in Figure 2-64 matched the manual gauge board readings throughout the event for the majority of the measurements. The mean difference between the automated and gauge board data was less than 22 mm. The most significant differences between the automated and gauge board data were observed on 27/02/2022, where the gauge board data was up to 310 mm below the automated data. There were two values that appeared to be outliers from the gauge board data (most likely as a result of data transcription errors) and were excluded from the mean difference and maximum calculation.

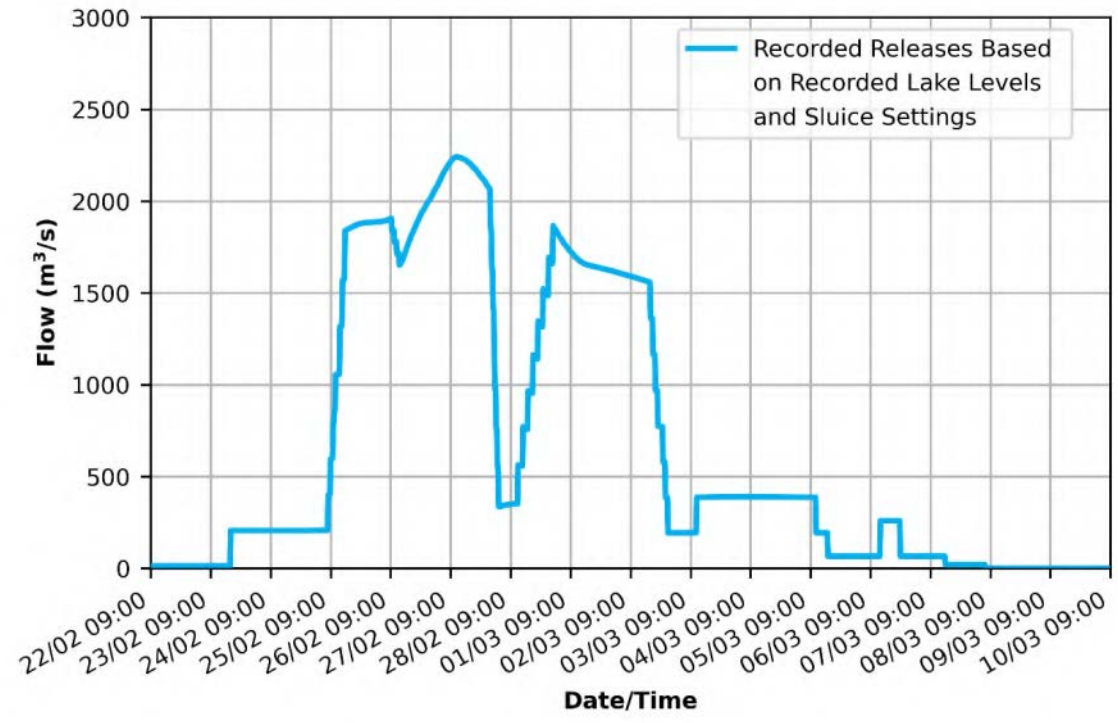

Figure 2-65: Somerset Dam recorded release hydrograph for the period 22/02/2022 09:00 to 10/03/2022 09:00

The peak lake level in Somerset Dam was 103.17 m AHD and peak release of 2,242 m^3/s occurred on 27/02/2022 at approximately 11:30.

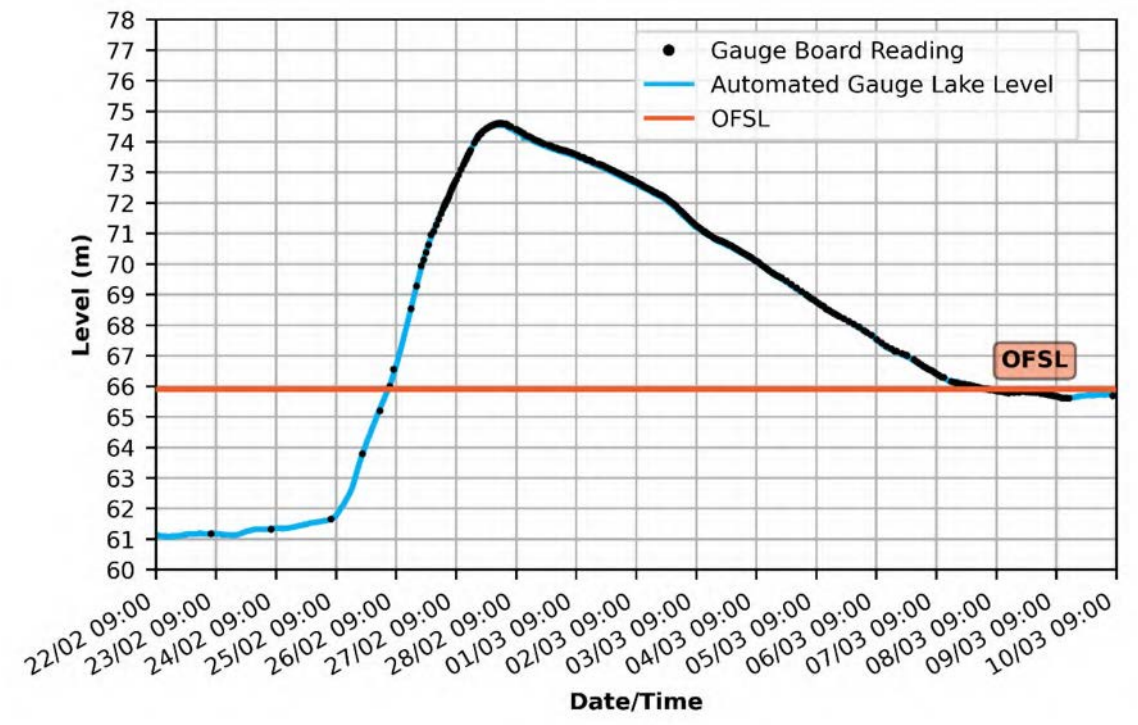

Figure 2-66: Wivenhoe Dam lake level comparing automated water level data and gauge board readings for the period 22/02/2022 09:00 to 10/03/2022 09:00

The automated lake level data in Figure 2-67 generally matched the manual gauge board readings throughout the event. The mean difference between the automated and gauge board data was less than 39 mm. The most significant differences between the automated and gauge board data were observed on 26/02/2022, when the gauge board data was up to 180 mm below the automated data. The offset was apparent in all measurements recorded from approximately 27/02/2022 15:00 until the lake level in Wivenhoe Dam fell below approximately 68 m AHD.

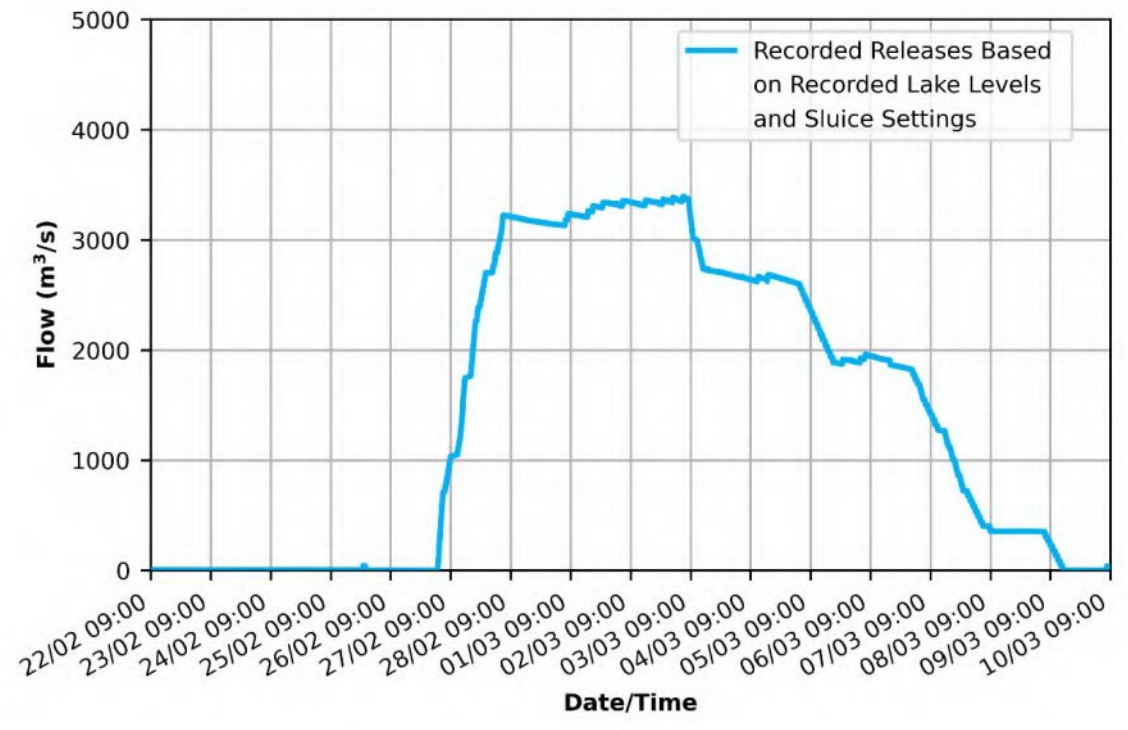

Figure 2-67: Wivenhoe Dam recorded release hydrograph for the period 22/02/2022 09:00 to 10/03/2022 09:00

The peak lake level in Wivenhoe Dam was 74.61 m AHD at 28/02/2022 02:00 (based on gauge board readings) and the peak release of 3,393 m³/s occurred at 03/03/2022 06:00.

2.6.1 Splityard Creek Dam

A Communications Protocol is in place between Seqwater and CleanCo, the operators of Splityard Creek Power Station. The power station extracts water from Wivenhoe Dam and pumps it up to Splityard Creek Dam. This water is held in the dam and then released back into Wivenhoe, to generate hydro-electricity.

Table 2-30 provides a summary of the operations at Splityard Creek Power Station during the course of the Flood Event. The actual release periods do not always occur exactly on the change of hour, so the extraction and release periods are rounded to the nearest hour. The rate (m3/s) that is shown is the actual volume released or extracted divided by the duration of the period to the nearest hour. This means the definition of the extraction and release volumes ensures alignment with the Gate Operations Model which is defined in 1 hour time steps.

Table 2-30: Splityard Creek Power Station operations

Start	End	Release from Splityard to Wivenhoe (m³/s)	Extraction from Wivenhoe to Splityard (m³/s)
27/02/2022 08:00	27/02/2022 11:00		167
28/02/2022 17:00	28/02/2022 20:00	160	
01/03/2022 09:00	01/03/2022 11:00		189
01/03/2022 17:00	01/03/2022 20:00	165	
02/03/2022 09:00	02/03/2022 11:00		189
02/03/2022 17:00	02/03/2022 20:00	254	
03/03/2022 06:00	03/03/2022 06:00	7	
03/03/2022 18:00	03/03/2022 20:00	292	
04/03/2022 09:00	04/03/2022 13:00		317
04/03/2022 17:00	04/03/2022 20:00	288	
05/03/2022 07:00	05/03/2022 13:00		193
05/03/2022 17:00	05/03/2022 20:00	254	
06/03/2022 08:00	06/03/2022 12:00		388
06/03/2022 14:00	06/03/2022 21:00	188	
07/03/2022 02:00	07/03/2022 05:00		150
07/03/2022 08:00	07/03/2022 12:00		233
07/03/2022 17:00	07/03/2022 20:00	321	
08/03/2022 02:00	08/03/2022 05:00		150
08/03/2022 08:00	08/03/2022 11:00		217
08/03/2022 16:00	08/03/2022 21:00	418	
09/03/2022 02:00	09/03/2022 03:00		150
09/03/2022 04:00	09/03/2022 04:00	29	
09/03/2022 05:00	09/03/2022 08:00		200
09/03/2022 09:00	09/03/2022 11:00		400
09/03/2022 12:00	09/03/2022 12:00		300

Over the duration of the Flood Event the net volume that was extracted or released into Wivenhoe Dam was 6,346 ML. The net extractions and releases represented an extremely small proportion of total flood inflow to Wivenhoe Dam.

3. Flood Modelling

This section describes the flood modelling platforms and model runs used to estimate catchment flows into Somerset Dam and Wivenhoe Dam as well as Downstream Catchment Flows during the Flood Event. The inflows to the dams, and the Downstream Catchment Flow (without effect of Wivenhoe releases) are independent of dam operation decisions. The modelled lake levels for the dams are dependent on dam inflows and dam releases. The dam releases implementation is described further in Section 4.

3.1 Flood modelling platforms

Two hydrologic modelling platforms were available to the Flood Operations Centre to estimate flows at gauging stations and inflow to the Dams. These are important components of the FFS and are described further below:

- **Seq-FEWS - Primary modelling platform**: Data from Enviromon[4], WISKI[5] and the Bureau[6] are regularly imported into FEWS. The observed data is manually quality controlled. The URBS hydrological models are integrated in FEWS, which allows users to change model parameter values and set inputs to calibrate and execute the models. The output results from the URBS models are imported and stored in FEWS for visualisation and further analysis. The results are then exported for input into the Gate Operations Model.
- **Operational Standalone - Backup modelling platform**: Similar to the primary system, an operational standalone FEWS is available on the network drive and can be quickly deployed on the local workstations at the Flood Operations Centre. This system does not require any backend FEWS services and has similar functionalities as the operational system but imports data from a network drive.

The primary modelling system was used throughout the Flood Event. Further background information about the FFS, FEWS and the Brisbane River basin URBS model is provided in Section 7.4 of the Manual.

3.2 Model runs

Estimates of catchment flow hydrographs, lake level predictions in response to Release Plans and Downstream Catchment Flows are required for decision making to apply the procedures in the Manual. These predictions are made with the models in the FFS, calibrated to the available data in real time. This is described further in Sections 7 and 8 of the Manual.

The primary focus of model calibration is lake level at Somerset Dam and Wivenhoe Dam as well as key locations in downstream catchments such as Glenore Grove, Walloon, Amberley and Moggill for the estimation of Downstream Catchment Flows. Rated flows at gauges upstream of Somerset and Wivenhoe Dams are used to develop additional confidence in the

[4] Enviromon collects real time ALERT gauge data.
[5] WISKI collects and stores other data such as telemetry, dam operator readings (gauge boards and gate settings).
[6] Bureau of Meteorology data feeds include modelling results and rainfall forecasts.

estimates of inflow to those dams. Similarly, a range of other gauges in the downstream catchment are used to enhance estimates of Downstream Catchment Flows and provide redundancy in case of gauge failure. During the Flood Event, the gauge at Glenore Grove failed, and so the focus of calibration for catchment flows from Lockyer Creek shifted to Lowood.

A list of the hydrologic model runs undertaken during the Flood Event is presented in Appendix B. The list of model runs included in Appendix B covers those runs which were archived in the FFS as part of dam operation release planning during the Flood Event. Of the 345 archived runs, 192 were imported into the Gate Operations Model and used to develop or check release plans. 30 of these model runs were associated with key event or Release Plan decisions made throughout the Flood Event. These 30 model runs are summarised in Table 3-1. The data for each run summarised in Table 3-1 includes predicted peak inflow and lake level at the dams, as well as the selected target flow at Moggill and predicted flow at Moggill with and without releases from Wivenhoe Dam. Note that predicted peak lake level is influenced by the Release Plan in place at the time, and further discussion on setting of release plans is included in Section 4.2. The process of selecting the target flow at Moggill during flood operations under the Wivenhoe Dam Flood Mitigation Strategy Procedure 1b is also discussed further in Section 4, however one important consideration is the prediction of Downstream Catchment Flow.

As defined in the Manual, Downstream Catchment Flow means the estimate of flow from the catchments downstream of Wivenhoe Dam (i.e. Lockyer Creek, the Bremer River, Warrill Creek, Purga Creek and the Brisbane River between Wivenhoe Dam and Moggill), excluding releases from Wivenhoe Dam. When Wivenhoe Dam is not releasing, the rated flow at Moggill represents the Downstream Catchment Flow. Once releases from the dam commence, Downstream Catchment Flow cannot be directly measured and must be estimated in the FFS. The column in Table 3-1 summarising predicted peak flow at Moggill excluding Wivenhoe Dam releases represents the FFS estimates of Downstream Catchment Flow produced by the Flood Engineers. Downstream Catchment Flow is important to release decision planning at Wivenhoe Dam under the Flood Mitigation Strategy Procedure 1b, particularly for timing and magnitude of releases from the Dam. This is discussed further in Section 4.

The model runs selected and data summarised in Table 3-1 are provided to illustrate the hydrologic modelling used to inform release planning. This table represents a small but representative proportion of the combined inputs and outputs to the large series of model runs undertaken across the Flood Event.

Table 3-1: Summary of selected key FFS model runs used to inform Somerset Dam and Wivenhoe Dam operational decisions

Run Time[1]	FFS Run ID	Somerset Dam			Wivenhoe Dam			Target flow at Moggill (m^3/s)[3]	Predicted Peak Flow at Moggill with no releases from Wivenhoe (m^3/s)	Predicted Peak Flow at Moggill (m^3/s)[3]	Associated operational decision (note these decisions occur at a different time to the model run and are described further in Section 4)
		Estimated Peak Lake Level (m AHD)[2]	Estimated Dam Peak Inflow (m^3/s)	Estimated Peak Release (m^3/s)[2]	Estimated Peak Lake Level (m AHD)[2]	Estimated Dam Peak Inflow (m^3/s)	Estimated Peak Release (m^3/s)[2]				
23/02/2022 05:30	342	97.48	177	13	61.35	44	0	N/A	29	29	Flood Operations Centre mobilised
25/02/2022 12:00	301	98.03	2,664	1,860	65.82	1,821	4	N/A	849	849	Flood event commenced based on criteria applicable to Somerset Dam. Somerset Dam Strategy and Wivenhoe Dam Flood Mitigation Strategy Procedure 1a selected.
25/02/2022 13:00	299	98.25	2,693	1,866	66.13	2,101	4	N/A	1,043	1,043	Predicted Dam inflows rising. Consideration given to selecting Flood Mitigation Strategy Procedure 1b
25/02/2022 14:00	295	98.54	3,255	1,870	67.69	3,634	4	2,000	1,334	1,334	Planned for releases from Wivenhoe Dam to commence at 22:00 under Flood Mitigation Strategy Procedure 1b
25/02/2022 15:15	293	98.90	3,880	1,892	67.21	4,291	1,294	2,000	1,718	1,917	Predicted flows in all catchments increasing
25/02/2022 18:15	284	99.00	3,945	1,894	67.98	4,903	1,895	2,000	2,139	2,139	
25/02/2022 22:00	275	99.07	3,945	1,897	68.96	5,132	1,991	2,000	2,799	2,799	Releases from Wivenhoe Dam to cease at 23:00 due to increase in Downstream Catchment Flows

Run Time[1]	FFS Run ID	Somerset Dam			Wivenhoe Dam			Target flow at Moggill (m^3/s)[3]	Predicted Peak Flow at Moggill with no releases from Wivenhoe (m^3/s)	Predicted Peak Flow at Moggill (m^3/s)[3]	Associated operational decision (note these decisions occur at a different time to the model run and are described further in Section 4)
		Estimated Peak Lake Level (m AHD)[2]	Estimated Dam Peak Inflow (m^3/s)	Estimated Peak Release (m^3/s)[2]	Estimated Peak Lake Level (m AHD)[2]	Estimated Dam Peak Inflow (m^3/s)	Estimated Peak Release (m^3/s)[2]				
26/02/2022 02:00	268	99.09	3,945	1,898	70.04	5,207	2,021	2,500	3,148	3,148	Target flow at Moggill progressively increased to achieve an appropriate position on the Flood Mitigation Guide Curve under Flood Mitigation Strategy Procedure 1b. No flood releases from Wivenhoe Dam
26/02/2022 05:30	258	99.10	3,945	1,898	70.55	4,827	2,059	2,800	3,493	3,495	
26/02/2022 08:30	252	99.55	3,945	1,915	71.78	5,824	2,849	3,200	3,660	3,677	
26/02/2022 10:15	248	99.88	3,945	1,926	72.05	6,512	2,901	3,500	3,958	3,953	
26/02/2022 14:00	243	102.03	4,719	1,915	72.74	7,514	3,678	3,800	4,201	4,197	
26/02/2022 17:00	240	102.71	5,198	1,926	73.12	8,241	4,092	3,900	4,667	4,663	
26/02/2022 19:15	237	102.85	5,198	1,940	73.41	8,335	3,888	4,000	4,879	4,883	
26/02/2022 21:30	232	103.04	5,198	2,023	73.84	8,359	4,083	4,500	5,625	5,621	
26/02/2022 22:45	229	103.11	5,198	2,031	73.64	8,387	4,963	4,500	5,670	5,666	
27/02/2022 01:30	220	102.83	5,086	2,133	74.18	8,387	5,157	5,000	5,751	5,747	
27/02/2022 03:45	208	102.97	5,086	2,179	74.57	8,387	5,119	5,200	5,792	5,788	Releases from Wivenhoe re-commence Flood Mitigation Strategy Procedure 1b
27/02/2022 13:45	188	103.02	5,086	2,196	74.72	8,273	5,228	5,300	5,699	5,694	Target flow at Moggill progressively increased to achieve an appropriate

Run Time[1]	FFS Run ID	Somerset Dam			Wivenhoe Dam			Target flow at Moggill (m^3/s)[3]	Predicted Peak Flow at Moggill with no releases from Wivenhoe (m^3/s)	Predicted Peak Flow at Moggill (m^3/s)[3]	Associated operational decision (note these decisions occur at a different time to the model run and are described further in Section 4)
		Estimated Peak Lake Level (m AHD)[2]	Estimated Dam Peak Inflow (m^3/s)	Estimated Peak Release (m^3/s)[2]	Estimated Peak Lake Level (m AHD)[2]	Estimated Dam Peak Inflow (m^3/s)	Estimated Peak Release (m^3/s)[2]				
27/02/2022 15:45	184	103.82	5,086	2,469	74.44	8,273	4,875	5,750	5,696	5,692	position on the Flood Mitigation Guide Curve under Flood Mitigation Strategy Procedure 1b.
27/02/2022 16:45	181	103.02	5,086	2,197	74.86	8,273	5,468	5,750	5,696	5,816	
27/02/2022 19:30	177	105.11	5,086	2,994	74.22	8,273	5,366	6,000	5,971	5,696	
28/02/2022 00:00	172	103.02	5,086	2,197	74.91	8,273	5,500	6,000	5,707	6,306	Somerset Dam Alternative Procedure implemented
28/02/2022 02:00	169	103.02	5,086	2,197	74.82	8,273	5,364	N/A	5,738	6,152	Drain Down Strategy selected at Wivenhoe Dam
28/02/2022 12:00	158	103.21	5,369	2,259	74.54	8,210	3,456	N/A	5,743	6,151	Cessation of Somerset Dam Alternative Procedure
03/03/2022 12:15	114	103.25	5,563	2,274	74.63	8,875	3,405	N/A	6,717	6,927	Adjustment of releases at Wivenhoe Dam in response to renewed rainfall and predictions of downstream catchment flows
03/03/2022 15:00	107	103.25	5,563	2,274	74.63	8,875	3,405	N/A	6,712	6,924	
08/03/2022 07:00	22	103.25	5,559	2,273	74.62	9,290	3,407	N/A	6,507	6,687	Releases cease at Somerset Dam
09/03/2022 12:30	2	103.24	5,555	2,270	74.63	9,297	3,411	N/A	6,507	6,687	Releases cease at Wivenhoe Dam

Run Time[1]	FFS Run ID	Somerset Dam			Wivenhoe Dam			Target flow at Moggill (m^3/s)[3]	Predicted Peak Flow at Moggill with no releases from Wivenhoe (m^3/s)	Predicted Peak Flow at Moggill (m^3/s)[3]	Associated operational decision (note these decisions occur at a different time to the model run and are described further in Section 4)
		Estimated Peak Lake Level (m AHD)[2]	Estimated Dam Peak Inflow (m^3/s)	Estimated Peak Release (m^3/s)[2]	Estimated Peak Lake Level (m AHD)[2]	Estimated Dam Peak Inflow (m^3/s)	Estimated Peak Release (m^3/s)[2]				
											Flood event ended
09/03/2022 16:15	1	103.24	5,555	2,270	74.63	9,297	3,411	N/A	6,507	6,687	Final FFS model run

[1] Note all models started at 22/02/2022 09:00. The run time tabulated here is the time the model run was undertaken. Model results provide predictions catchment flows up to ten days past this run time based on rain on ground recorded between 22/02/2022 09:00 and the run time.

[2] Predicted peak lake levels and releases are influenced by the decisions made in the Release Plans. Additional detail on Release Plans and operational decisions is provided in Section 4.

[3] Selection of target flow at Moggill under Wivenhoe Dam Flood Mitigation Procedure 1b and the influences of Wivenhoe Dam releases on estimated flow at Moggill is described further in Section 4.

It should be noted that estimates of peak flow and lake level vary across the model runs shown in Table 3-1. The reasons for this are twofold. Firstly, as the event unfolds, additional rain on ground is recorded at gauge sites and used to update the models in conjunction with additional lake level records. Secondly, the calibration of the model is continually refined during the Flood Event for the specific purpose of making estimated projections of conditions beyond the time of the model run. The process of model calibration seeks to develop a reasonable match between the simulated lake level or flow hydrograph from the FFS to the complete available recorded hydrograph at the location of interest at run time. The calibration particularly aims to match to the current conditions and the trend of the recent conditions immediately before the run time. Matching these current and immediately preceding conditions is prioritised to help inform the development of Release Plans which are suitable for the current observed conditions. The result of this prioritisation of the most recent data for calibration is that during the later stages of the Flood Event, the calibration to earlier inflow conditions may deviate from the observed data as an unintended consequence of aiming to provide a better match to the most recent observed data.

Figure 3-1 and Figure 3-2 show the modelled lake level for Somerset Dam and Wivenhoe Dam respectively from the final archived model run of the Flood Event (run on 09/03/2022 at 16:15 and included as the last row in Table 3-1), compared to recorded lake level. The simulated lake levels in URBS provided a good match to the recorded lake level data at both dams.

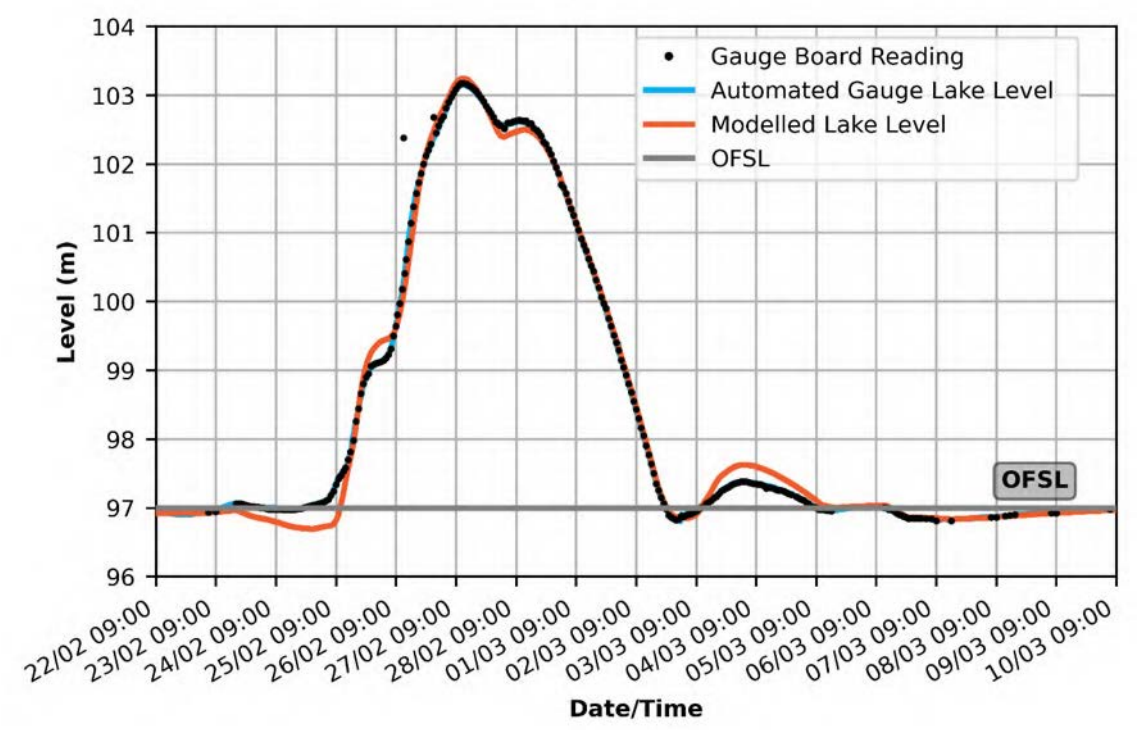

Figure 3-1: Somerset Dam modelled lake level compared to automated data and gauge board readings for the period 22/02/2022 09:00 to 10/03/2022 09:00 sourced from the last archived model run 09/03/2022 16:15

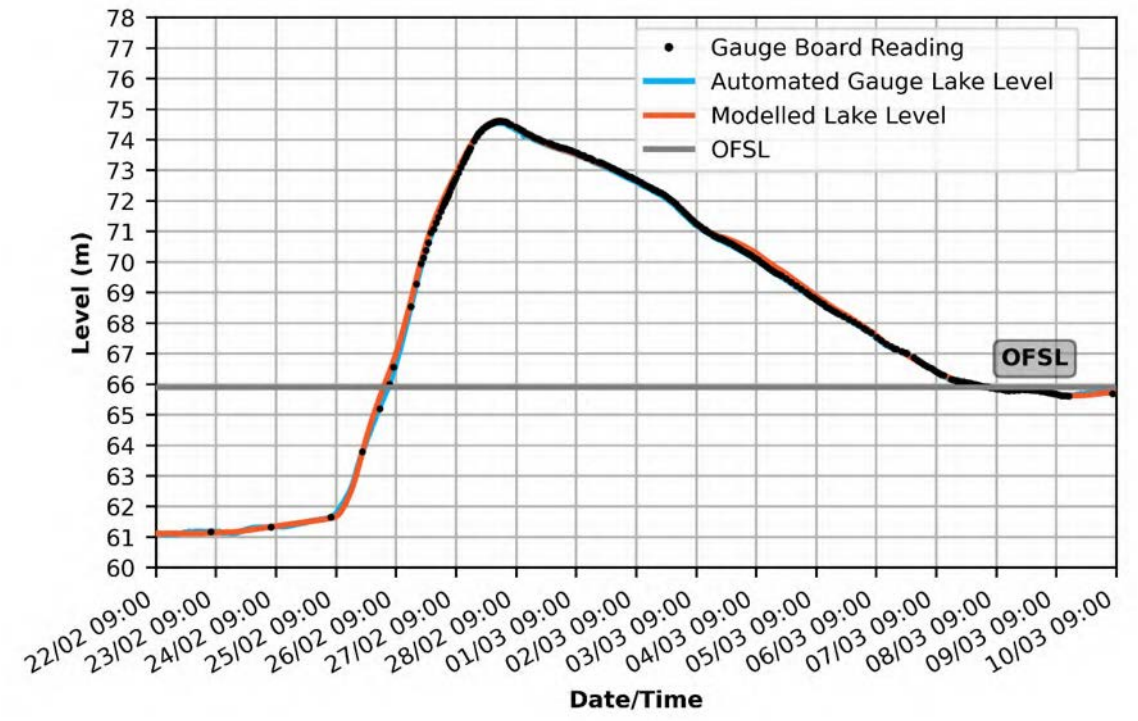

Figure 3-2: Wivenhoe Dam modelled lake level compared to automated data and gauge board readings for the period 22/02/2022 09:00 to 10/03/2022 09:00 sourced from the last archived model run 09/03/2022 16:15

Figure 3-3 to Figure 3-5 illustrate the modelled hydrographs for the selected archived model runs shown in Table 3-1 for the Somerset Dam inflow, the Wivenhoe Dam inflow, Downstream Catchment Flow (i.e. flow at Moggill excluding Wivenhoe Dam releases) and total flow at Moggill (i.e. including Wivenhoe Dam releases) respectively.

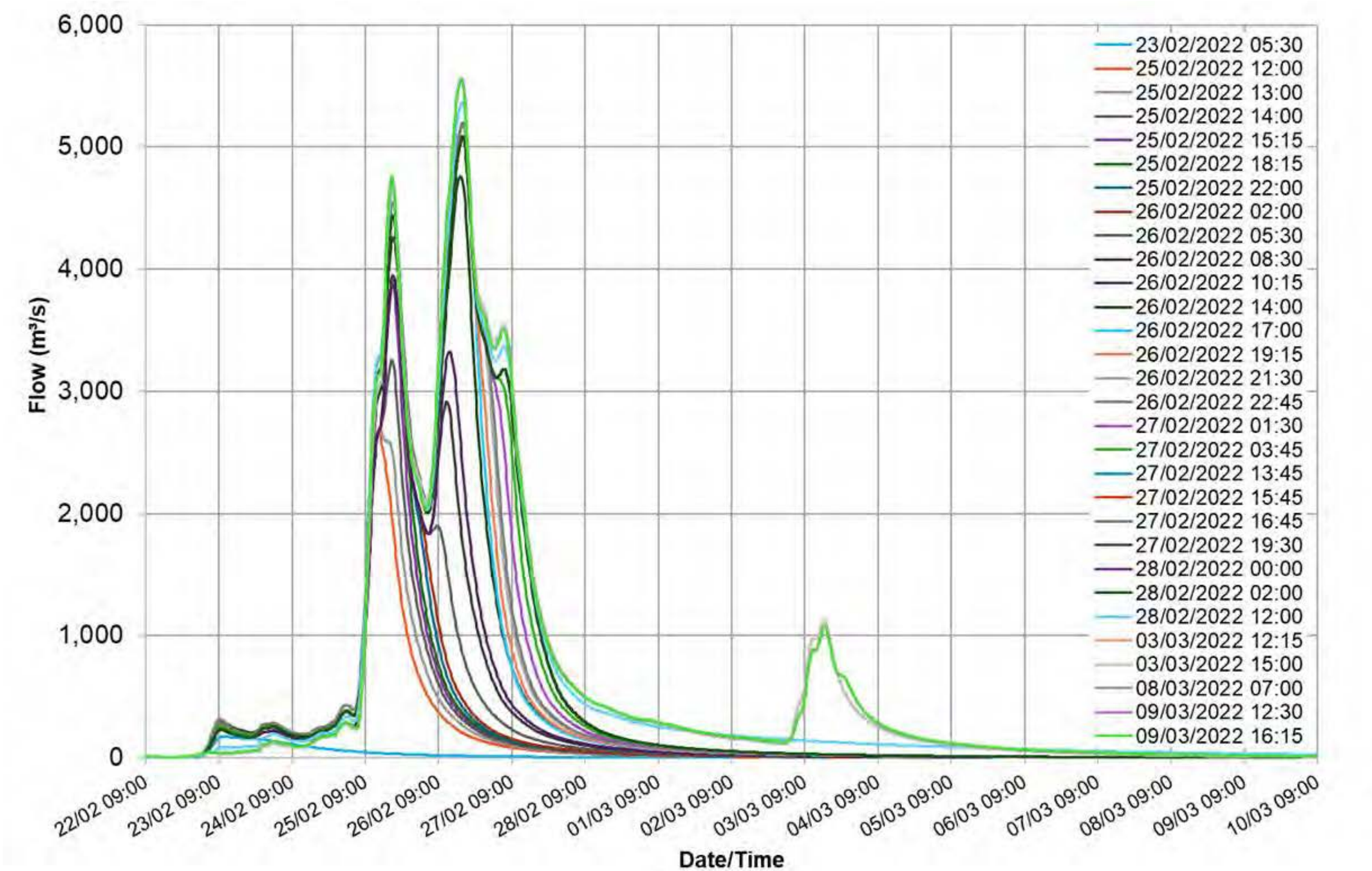

Figure 3-3: Modelled Somerset Dam inflow for each selected key model run

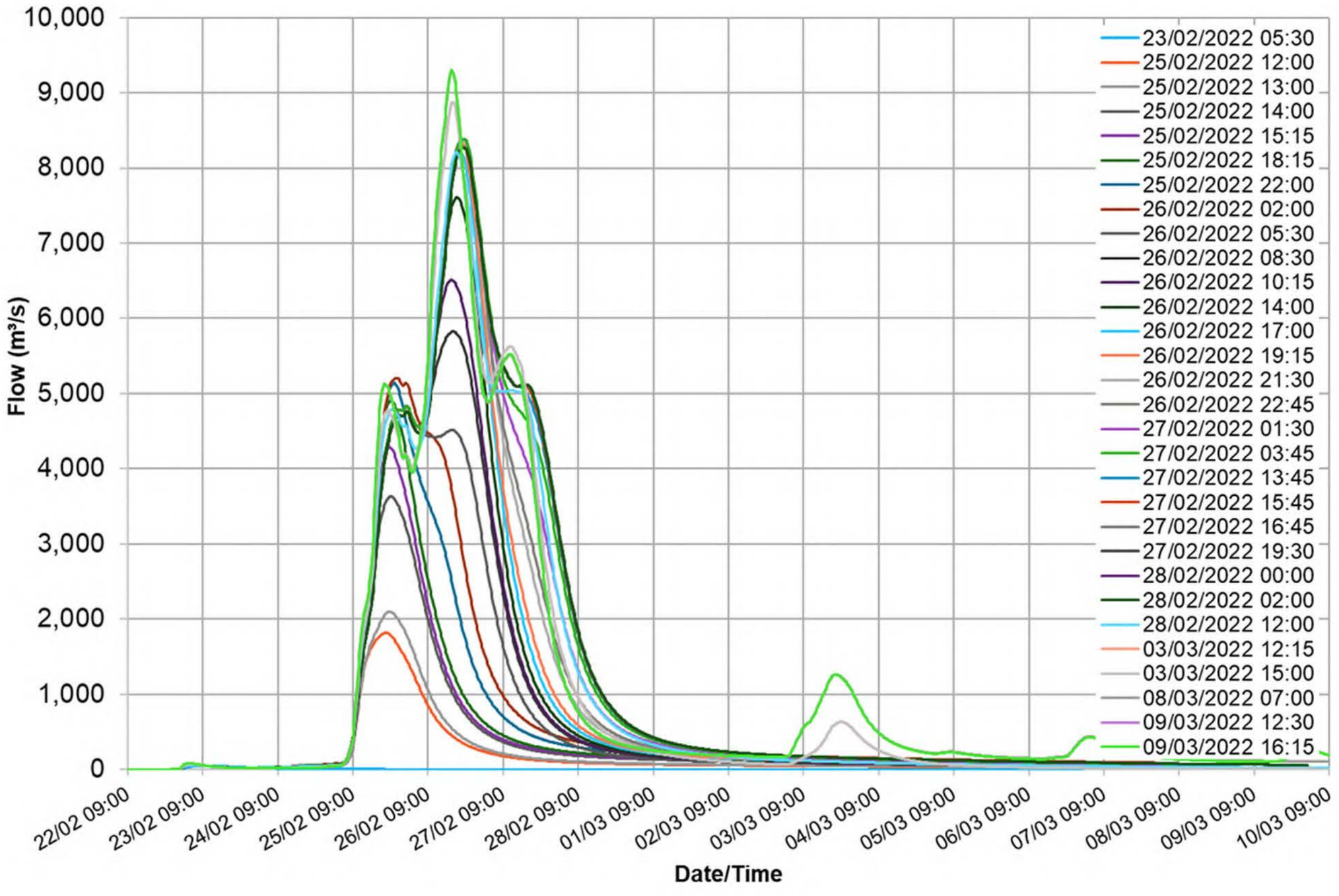

Figure 3-4: Modelled Upper Brisbane River catchment inflow into Wivenhoe Dam (excluding Somerset Dam releases) for each selected key model run

Figure 3-5: Modelled hydrographs for Downstream Catchment Flow (flow at Moggill that excludes the influence of Wivenhoe Dam releases) for each selected key model run

4. Dam Operations

This section describes the operations conducted at Wivenhoe Dam and Somerset Dam for the Flood Event using the procedures in the Manual.

4.1 Gate operations communications

Communications were maintained between the Seqwater Flood Operations Centre and dam operators at all times during the Flood Event. The primary methods of communication adopted were email and telephone. Gate Directives were generally emailed from the Flood Operations Centre to the Dam Operator, often with a preceding phone call to alert the Dam Operator to the incoming email. It was typical practice during the Flood Event for the Dam Operator to send a return email to the Flood Operations Centre confirming receipt of the Gate Directive, and then subsequent email(s) once each gate setting change listed in the Gate Directive was completed. A range of other ad hoc communications took place between the Dam Operators and Flood Operations Centre staff over the course of the Flood Event.

As a result of this, the Loss of Communication procedure described in Section 16.4 of the Manual was not required for this Flood Event. The relevant procedures in the Manual which were applied during the Flood Event are therefore those in Sections 14 (for Wivenhoe Dam), 15 (for Somerset Dam) and 18 (for an Alternative Procedure).

4.2 Strategy timeline and reasons for selection

The operation of Somerset and Wivenhoe Dams and corresponding selection of strategies and procedures adopted during the Flood Event as defined in the Manual are summarised in Table 4-1 and shown graphically in Figure 4-1 and Figure 4-2. A description of the key operating milestones and intermediate decision points is provided further below to contextualise the information presented. The periods summarised were selected to assist in describing the operations and how they were aligned with the flood strategies and procedures defined in the Manual.

The summary descriptions are based on contemporaneous records of the Strategy Log, interviews with the Senior Flood Operations Engineers, Situation Reports, Gate Directives, and data from the Gate Operations Model and FFS relevant to each period. Note that predicted dam inflows and Downstream Catchment Flow at Moggill for selected key FFS model runs are summarised in Section 3.2.

Additional data and information that should be read in conjunction with the summary provided in this section of the report are included as Appendices as follows:

- Appendix A: Record of Wivenhoe Dam gate operations and Somerset Dam crest gate, sluice and regulator operations
- Appendix B : Tabulated summary of the FFS modelling runs used to support decision making.

It should be noted here that inflow to a dam cannot be measured directly and thus must be calculated from other data sets. For the application of the procedures in the Manual, decisions are based on real-time estimates of dam inflows and Downstream Catchment Flow derived with models run by the Flood Engineers in the FFS and updated progressively through the course of the Flood Event. This is described in more detail in Section 3.2. Section 7 of this report presents a post-event analysis (with the benefit of hindsight) of dam inflows. These post-event estimates of inflow are presented on Figure 4-1 and Figure 4-2, for the purpose of showing a single estimate of inflows on these summary plot. It is important to note that this information was not available to the Flood Engineers when the operating decisions described in this section were implemented.

Table 4-1: Chronological summary of flood operating strategies and procedures implemented during the Flood Event (replicated in Table i)

Event	Date and time of decision[1]
Flood Operations Centre mobilised	23/02/2022 07:00
Operational releases from Somerset Dam	23/02/2022 17:00
Flood event commencement criteria for Somerset Dam met Somerset Dam Strategy Procedure 1a to 1d selected Flood Mitigation Strategy Procedure 1a selected at Wivenhoe Dam	25/02/2022 12:10
Flood Mitigation Strategy Procedure 1b selected at Wivenhoe Dam Target flow at Moggill set to 2,000 m^3/s to achieve an appropriate position on the Flood Mitigation Guide Curve (as defined in Flood Mitigation Strategy Procedure 1b) with Wivenhoe Dam predicted peak lake level of 67.69 m AHD.	25/02/2022 15:00
Releases from Wivenhoe Dam commenced under Flood Mitigation Strategy Procedure 1b	25/02/2022 22:00
Releases from Wivenhoe Dam ceased due to increase in downstream flows	25/02/2022 23:00
Target flow at Moggill increased to 2,500 m^3/s with Wivenhoe Dam predicted peak lake level of 70.04 m AHD.	26/02/2022 03:00
Target flow at Moggill increased to 3,500 m^3/s with Wivenhoe Dam predicted peak lake level of 72.05 m AHD.	26/02/2022 11:00
Target flow at Moggill increased to 4,000 m^3/s with Wivenhoe Dam predicted peak lake level of 73.41 m AHD.	26/02/2022 20:00
Target flow at Moggill increased to 4,500 m^3/s with Wivenhoe Dam predicted peak lake level of 73.84 m AHD.	26/02/2022 22:00
Target flow at Moggill increased to 5,200 m^3/s with Wivenhoe Dam predicted peak lake level of 74.57 m AHD. Releases from Wivenhoe Dam recommenced under Flood Mitigation Strategy Procedure 1b.	27/02/2022 04:00
Somerset Dam peak Lake Level (103.17 m AHD) and release (2,242 m^3/s) reached.	27/02/2022 11:30
Target flow at Moggill increased to 5,750 m^3/s with Wivenhoe Dam predicted peak lake level of 74.78 m AHD. Consideration of preparation of an Alternative Procedure for Somerset Dam (continued through the evening of 27/02/2022).	27/02/2022 16:00
Target flow at Moggill increased to 6,000 m^3/s with Wivenhoe Dam predicted peak lake level of 74.84 m AHD.	27/02/2022 20:00
Somerset Dam Alternative Procedure approved by DRDMW and implemented to close sluices to temporarily reduce releases into Wivenhoe	28/02/2022 00:45

Event	Date and time of decision[1]
Dam.	
Peak lake level reached in Wivenhoe Dam (74.61 m AHD based on gauge board readings).	28/02/2022 02:00
Selection of Drain Down Strategy at Wivenhoe Dam.	28/02/2022 06:00
Somerset Dam Alternative Procedure ceased and Somerset Dam Strategy Procedure 2a selected (sluices fully opened at this time).	01/03/2022 02:00
Peak releases from Wivenhoe Dam (3,393 m^3/s).	03/03/2022 06:00
Flood releases ceased at Somerset Dam.	08/03/2022 07:00
Flood releases ceased at Wivenhoe Dam. Criteria met for end of Flood Event.	09/03/2022 14:00

1 Note that time of decision differs to time of model run shown in Table 3-1 because completion of a model run does not necessarily immediately lead to a decision determination.

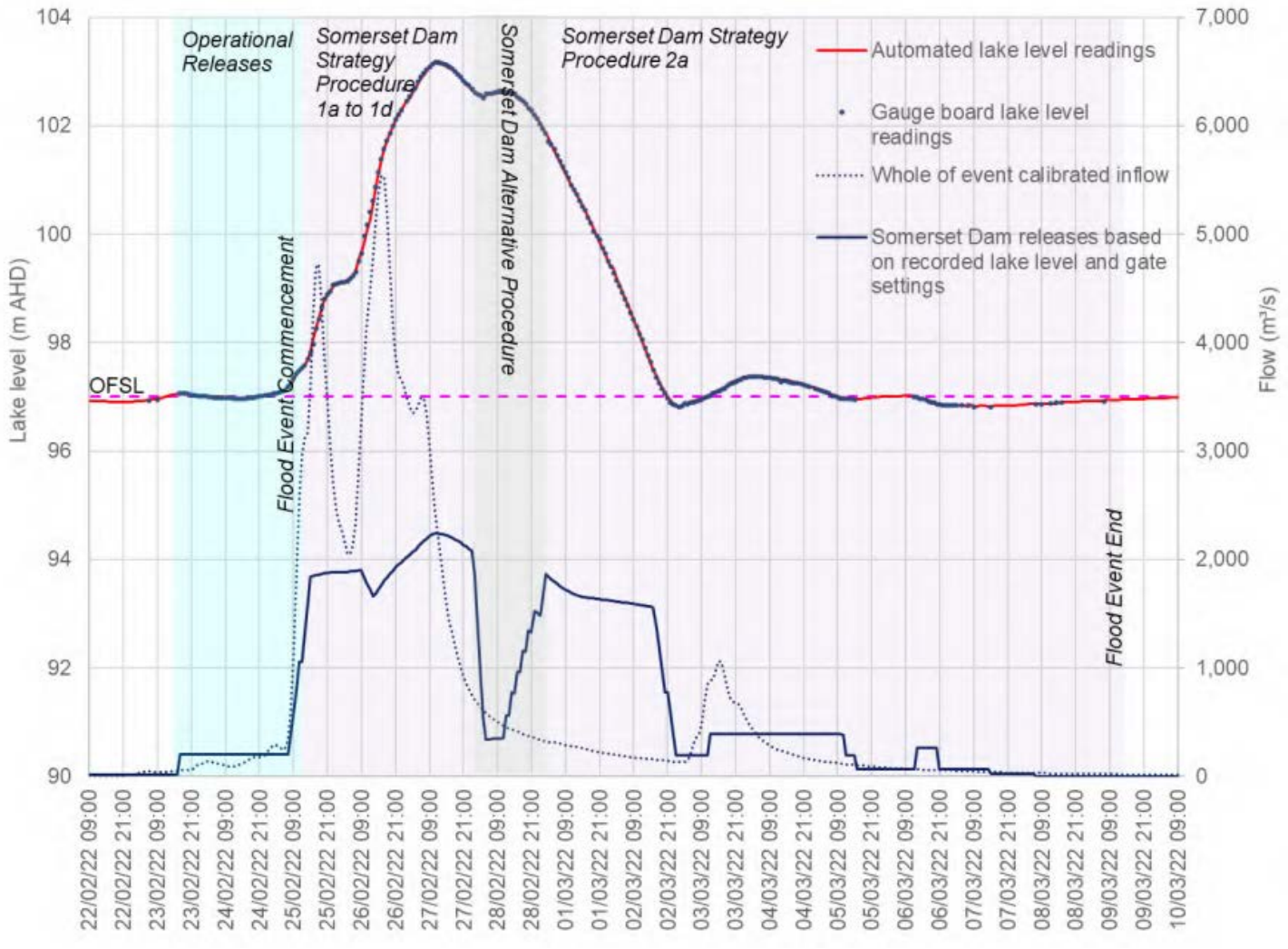

Figure 4-1: Somerset Dam post-event analysis whole of event calibrated inflow, lake level (gauge board and automated readings) and releases (replicated in Figure i)

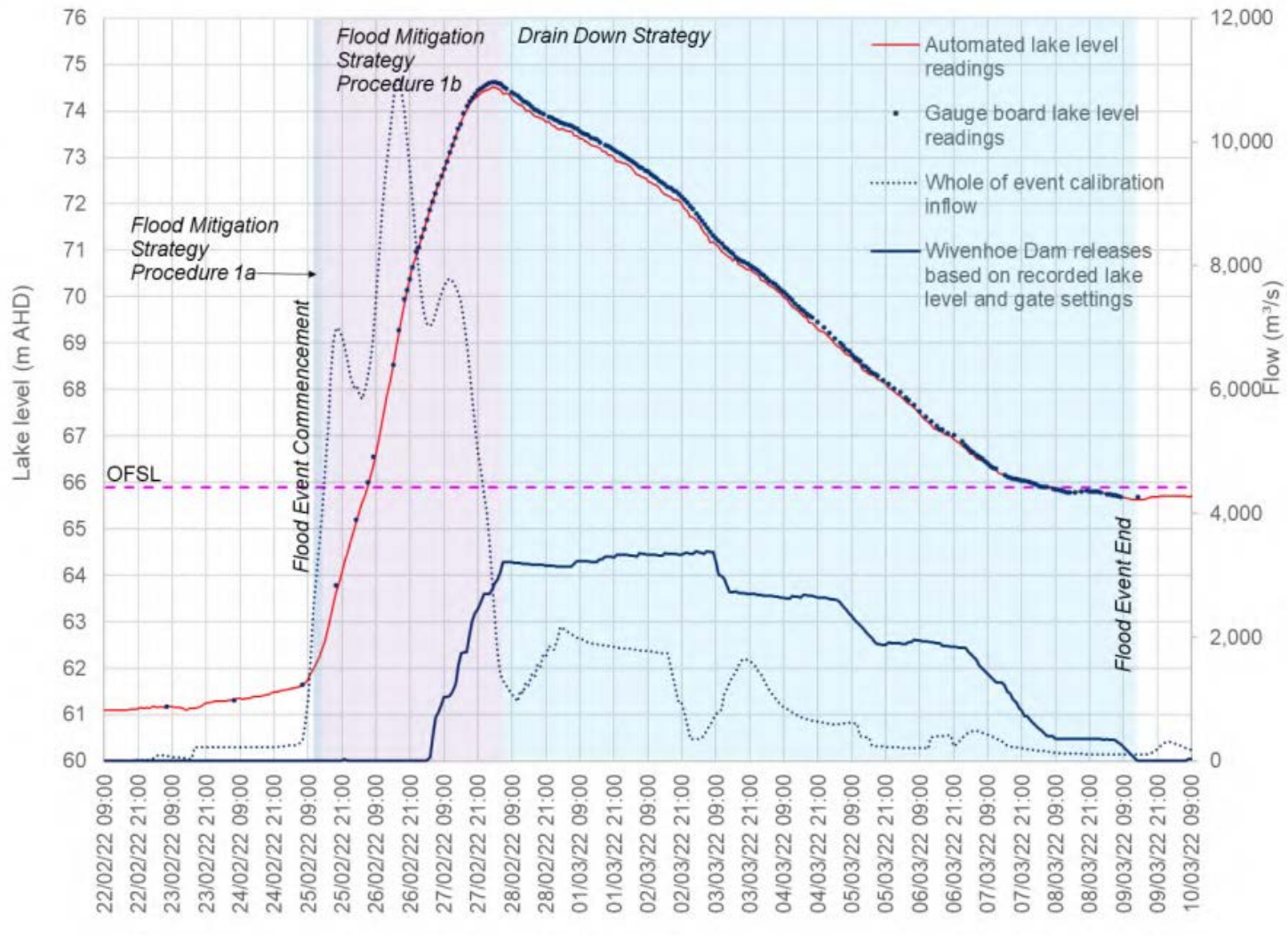

Figure 4-2: Wivenhoe Dam post-event analysis whole of event calibrated inflow, lake level (gauge board and automated readings) and releases (replicated in Figure ii)

Operational Releases from Somerset Dam and Wivenhoe Dam prior to commencement of Flood Event

Operational releases were commenced at Somerset Dam under the Operations Manual at 23/02/2022 17:00 aimed at keeping the lake level near OFSL. Operational releases from Somerset Dam were maintained at just over 200 m³/s for a 40-hour period to 25/02/2022 07:00 while estimated inflows gradually rose from 50 m³/s to 340 m³/s.

Minor releases for water supply from Wivenhoe Dam were maintained during this period (constant of 4 m³/s). The lake level at the end of this period was 0.18 m above OFSL (97.18 m AHD) in Somerset Dam, and 4.56 m below OFSL (61.34 m AHD) in Wivenhoe Dam. Verbal and written rainfall and flood forecast updates and severe weather warnings provided by the Bureau during this period indicated widespread rainfall and flooding was expected across South East Queensland over the coming days.

Flood Event Commencement

The criteria to commence a Flood Event at Somerset Dam were met at 25/02/2022 12:10 in accordance with Section 13.2(b)(ii) of the Manual. Under continued operational releases, the predicted peak lake level was judged likely to rise more than 1.0 metre above OFSL (98.0 m AHD). Once the Flood Event commenced, the Somerset Dam Strategy was selected. Releases after 25/02/2022 12:10 were made under the procedures in the Manual.

Once the Flood Event commenced, Flood Mitigation Strategy Procedure 1a was selected for Wivenhoe Dam.

Release rates from Somerset Dam and Wivenhoe Dam at the commencement of the Flood Event were approximately 1,000 m³/s, and 4 m³/s respectively, with lake levels at 97.55 m AHD (0.55 m above OFSL) in Somerset Dam, and 62.16 m AHD (3.74 m below OFSL) in Wivenhoe Dam.

The general intent of the Wivenhoe Dam release plan under Flood Mitigation Strategy Procedure 1a aimed to maintain the predicted peak lake level to less than 66.4 m AHD (0.5 m above OFSL), whilst preserving the water supply compartment storage and aiming to maintain the flow at Moggill to below 2,000 m³/s.

Releases from Wivenhoe Dam were maintained at 4 m³/s for approximately 3 hours (from 25/02/2022 12:10 – 15:00). The lake level in Wivenhoe Dam at the end of this period was 62.60 m AHD (3.31 m below OFSL).

Selection of Flood Mitigation Strategy Procedure 1b at Wivenhoe Dam

Flood Mitigation Strategy Procedure 1b was selected for Wivenhoe Dam at approximately 25/02/2022 15:00 on the basis that the predicted peak lake level in Wivenhoe Dam would exceed 66.4 m AHD (0.5 m above OFSL). Flood Mitigation Strategy Procedure 1b balances the predicted peak lake level of Wivenhoe Dam with the selected target flow at Moggill.

The initial Release Plan under Procedure 1b adopted a Target Flow at Moggill of 2,000 m³/s. With this target flow, it was identified at approximately 25/02/2022 15:00 that releases would commence at 25/02/2022 22:00. Notifications to relevant stakeholder agencies related to downstream bridge closures were made between approximately 17:40 and 20:30 as described

in Section 5. The first Gate Directive was issued at 25/02/2022 20:39 following receipt of advice confirming bridge closures had occurred. An initial release of 88 m³/s from Wivenhoe Dam was made, however Gate Directive 2 was issued shortly after at 25/02/2022 22:30, with a change in release decision informed by updated modelling runs identifying that increased Downstream Catchment Flows would exceed the then selected Target Flow at Moggill. The lake level in Wivenhoe Dam at this point reached 64.41 m AHD (1.49 m below OFSL). No releases from Wivenhoe Dam were made over the following 30 hours, for reasons described further below relating to updating the selected Target Flow at Moggill while the magnitude of the estimated dam inflow and Downstream Catchment Flow increased. Over this period the lake level increased by 7.55 m to 71.96 m AHD (6.06 m above OFSL).

Releases recommenced at 27/02/2022 04:00. Further delay of the release commencement was not feasible due to the constraint in procedure 1c(i)(b) to avoid gates overtopping. Releases commenced with the aim of Wivenhoe Dam releases arriving after the peak of the estimated Downstream Catchment Flow at Moggill. Release plans were developed and iterated under Procedure 1b using the Flood Mitigation Guide Curve for Wivenhoe Dam (shown in Figure 4-3) to balance selection of Target Flow at Moggill and predicted peak lake level in Wivenhoe Dam.

From the evening of 25/02/2022 until the peak lake level in Wivenhoe Dam (74.61 m AHD based on gauge board readings, 8.71 m above OFSL) was reached (28/02/2022 02:00), the Target Flow at Moggill was updated 14 times and 11 Gate Directives were issued for releases on and after 27/02/2022 04:00. The Target Flow at Moggill was updated based on changes in predicted peak lake level (which is influenced by the Release Plan and changes in the estimated dam inflows) and predicted Downstream Catchment Flows from FFS model runs. The Target Flow at Moggill was incrementally increased over this period[7] starting at 2,000 m³/s and reaching a maximum of 6,000 m³/s. The predicted peak lake level when the maximum adopted Target Flow at Moggill of 6,000 m³/s was first adopted (27/02/2022 20:00) was 74.84 m AHD (8.32 m above OFSL). Subsequent model runs increased the predicted peak lake level to 74.91 m AHD (9.01 m above OFSL), 0.09 m below the criterion in the Manual at which the Dam Safety Strategy must be selected. The actual peak lake level recorded during the event from manual gauge board readings was 74.61 m AHD (8.71 m above OFSL) at 28/02/2022 02:00. Releases from Wivenhoe Dam at the time the lake level peaked were approximately 2,800 m³/s.

Procedure 1b of the Flood Mitigation Strategy requires a Release Plan to be developed which plots on an acceptable region of the Flood Mitigation Guide Curve set out in Figure 14.1.1 of the Manual. Achieving an acceptable outcome required an iterative process to develop the Release Plan at each stage during the application of the Flood Mitigation Strategy Procedure 1b.

Figure 4-3 shows the escalation of the predicted peak lake level and Target Flow at Moggill in Procedure 1b as rainfall continued and estimated Downstream Catchment Flows and dam inflows continued to increase. Figure 4-3 also shows when the selection of Target Flows at Moggill were determined to be both acceptable and unacceptable during trialled iterations of the

[7] Range of flow targets selected at Moggill during Flood Mitigation Strategy Procedure 1b: 2,000 m³/s, 2,500 m³/s, 2,800 m³/s, 3,200 m³/s, 3,500 m³/s, 3,800 m³/s, 3,900 m³/s, 4,000 m³/s, 4,500 m³/s, 5,000 m³/s, 5,200 m³/s, 5,300 m³/s, 5,750 m³/s and 6,000 m³/s.

Release Plans. Instances when the Target Flow at Moggill plotted in the unacceptable region of the Flood Mitigation Guide Curve (i.e. the yellow or red sections of the plot) led to further iterations of the Release Plans to trial higher Target Flows at Moggill to continue to progress up the Flood Mitigation Guide Curve.

During the period from late in the evening on 25/02/2022 to recommencement of releases in Procedure 1b at 27/02/2022 04:00, minor changes in the Target Flow at Moggill (for example, to change position from unacceptable to acceptable regions on the Flood Mitigation Guide Curve) had no material impact on Release Plans. This is because the Downstream Catchment Flow at Moggill exceeded the selected Target Flows. This meant the appropriate decision was to not release water from Wivenhoe Dam until the early morning of 27/02/2022.

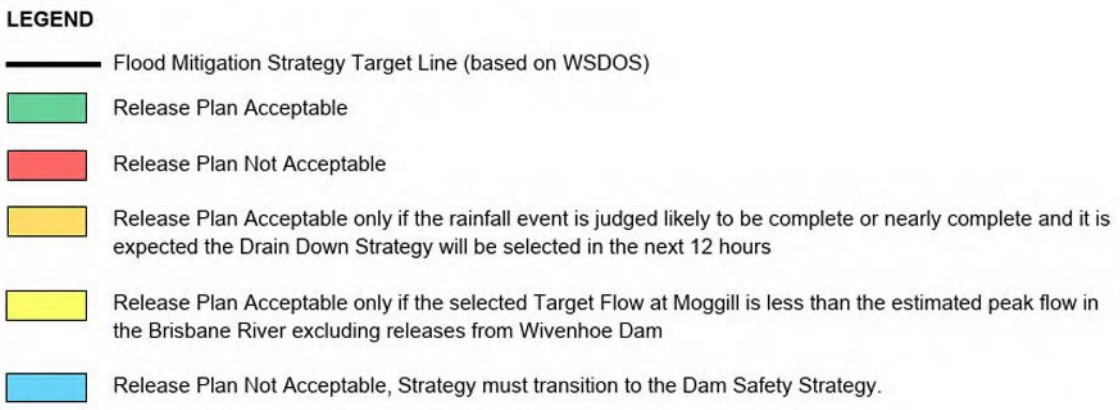

Figure 4-3: Wivenhoe Dam Flood Mitigation Guide Curve showing the trialled Target Flow at Moggill and predicted peak lake level as Release Plans were progressively updated

Release planning during this part of the Flood Event was intensive. 93 hydrologic model runs were completed and archived in the FFS, 91 iterations of the Gate Operations Model were archived and Gate Directives 3 to 15 were issued. Data was extracted from the Gate Operations Models during this period to illustrate the process of release planning. The following data was extracted on an hourly time step from the Gate Operations Models on a rolling basis:

- Predicted Downstream Catchment Flow at Moggill (derived in the FFS using rain on ground without Wivenhoe Dam releases) and adjusted for travel time lag for the releases from Wivenhoe Dam to reach Moggill. This time series is composed of modelled estimates of Downstream Catchment Flows at Moggill which varied over time as additional rainfall is recorded and the FFS estimates of flows are updated as model calibration is adjusted. These flows are time shifted to account for travel time lag between Wivenhoe Dam and Moggill, and represent predictions rather than actual recorded flows.
- Wivenhoe Dam planned releases. The planned releases are determined in each Gate Operations Model, however not each model iteration is used to develop a Gate Directive. Actual releases are similar to but not identical to planned releases in the Gate Operations Model. This is because the planned releases are calculated based on modelled lake level (which may vary from recorded lake level).
- Target Flow at Moggill. The Target Flow is progressively updated as the Flood Event escalates with increasing inflows into the dam and increasing Downstream Catchment Flow, and is selected to appropriately balance the adopted Target Flow at Moggill with predicted lake level at Wivenhoe Dam.

These rolling time series were progressively updated from each of the Gate Operations Models. As the run time of successive Gate Operations Models moves forward in time, the rolling time series is replaced with the later data. This data provides a visual representation of the evolution of the selected Target Flow at Moggill, estimated Downstream Catchment Flows and planned releases during this period, and is shown in Figure 4-4.

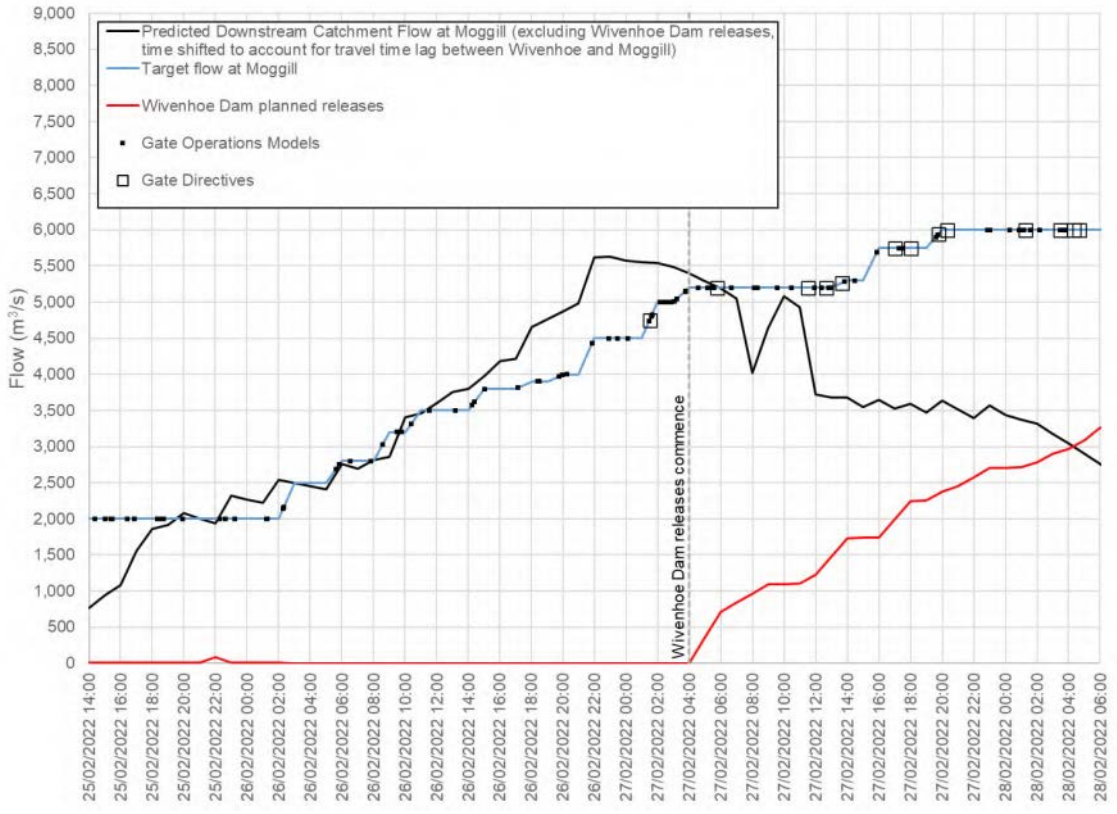

Figure 4-4: Wivenhoe Dam Flood Mitigation Strategy Procedure 1b release planning

Figure 4-4 shows that:

- The modelled estimates of Downstream Catchment Flows at Moggill (excluding Wivenhoe Dam releases) were progressively increasing over the period that Flood Mitigation Strategy Procedure 1b was selected, until 26/02/2022 23:00. After this time, predicted Downstream Catchment Flow at Moggill stabilised and began to fall, noting that there were some fluctuations as the model calibration varied in response to additional rainfall and rated flow data.
- The modelled estimates of the Downstream Catchment Flows exceeded the selected Target Flow for around 30 hours after 25/02/2022 22:00 (accounting for the travel time lag between Wivenhoe Dam and Moggill) which guided the decision to not release from Wivenhoe Dam during this period and to resume releases at 27/2/2022 04:00. This was consistent with Flood Mitigation Strategy Procedure 1b(vi), which specifies that the Release Plan should aim to minimise Dam releases during periods where the Downstream Catchment Flow is greater than the selected Target Flow at Moggill.

Consideration for exiting Flood Mitigation Strategy Procedure 1b under Procedure 2c exit criteria occurred between 28/02/2022 02:00 and 06:00 on the basis that rainfall was judged as complete or nearly complete, dam inflows were sufficiently understood and combined flood storage volumes in Wivenhoe and Somerset Dams had begun to fall. Release rates from Somerset Dam and Wivenhoe Dam at this time were approximately 340 m³/s, and 3,220 m³/s respectively, with lake levels of 102.58 m AHD (5.58 m above OFSL) in Somerset Dam, and 74.53 m AHD (8.63 m above OFSL) in Wivenhoe Dam.

Implementation of Somerset Dam Alternative Procedure

During the afternoon of 27/02/2022, after the lake level in Somerset Dam had peaked, and prior to Wivenhoe Dam peak lake level and selection of the Drain Down Strategy, an Alternative Procedure for Somerset Dam was considered and developed in accordance with Section 18 of the Manual. At this time, the Alternative Procedure was only under consideration, and was not implemented until 28/02/2022 00:45 after approval had been given by the nominated delegate of the DRDMW Chief Executive. Communications relating to the approval process are described in more detail in Section 5.6, and included consultation and preparation of Alternative Procedure Authorisation Request Information in accordance with Section 18.2 of the Manual.

The Alternative Procedure was considered because:

- The lake level in Somerset Dam had peaked and was continuing to fall.
- The lake level in Somerset Dam was over 6 m below the Maximum Flood Storage Level (and hence there was minimal risk to the structural safety of the dam).
- Rainfall over the Somerset Dam catchment was easing.
- Rainfall forecasts and Bureau advice that were used for situational awareness were indicating little further rainfall was expected over the Somerset Dam catchment.

Based on the assessment of the catchment and dam conditions at this time, it was concluded that there was thus an opportunity to slow releases into Wivenhoe Dam if the sluice gates at Somerset Dam could be closed. This would require that Somerset Dam Strategy Procedure 1d be disregarded. Whilst at this time, rainfall had eased over both dam catchments, continuing heavy falls were occurring over downstream catchments. The opportunity to reduce inflows into Wivenhoe Dam was considered favourable during the latter stages of the Flood Mitigation Strategy Procedure 1b and the early stages of the Drain Down Strategy. This occurred while rated and predicted flows at Moggill were not yet showing signs of easing.

The conditions that gave rise to potential for the Alternative Procedure for Somerset Dam were relatively unique to this Flood Event, and were based on the combination of the current lake level and predicted lake level trends in the dams, status of flooding in the downstream catchments and notably the pattern and timing of rainfall. It was considered prudent to define the Alternative Procedure with constraints on the time period for its application and the maximum lake level rise in Somerset Dam that would be permitted to achieve the Objective of preventing structural failure of the Dam. Further information on communications pertaining to the approval process for the Alternative Procedure is provided in Section 5.6, and the Alternative Procedure Authorisation Request Information and DRDMW letter of approval are provided in Appendix E.

The Alternative Procedure was approved at 28/02/202 00:40 and was implemented shortly afterwards in Gate Directives 5 (issued 28/02/2022 00:45) and 6 (issued 28/02/2022 01:45). All sluices at Somerset Dam were closed by 04:15. The Alternative Procedure was implemented for a period of approximately 26 hours and was ceased at 01/03/2022 02:00 after the reopening of the sluices commenced at 28/02/2022 12:15.

Inflows to Somerset Dam during the Alternate Procedure period progressively receded with the lake level initially stabilising and then dropping once sluice releases recommenced.

At 01/03/2022 02:00 the Somerset Dam Strategy Procedure 2a (with conditions relevant for the rainfall event being judged likely to be complete or nearly completed) was selected with the aim of returning the lake level to OFSL. The Somerset Dam lake level was 101.85 m AHD (4.85 m above OFSL) at this time.

Selection of Drain Down Strategy at Wivenhoe Dam

Conditions were met to select the Drain Down Strategy at 28/02/2022 06:00 with the aim of balancing downstream flooding considerations and draining the flood storage compartment of Wivenhoe Dam.

Key considerations for developing Drain Down Strategy Release Plans included time to drain the flood storage compartment, flow rates at Moggill, minimising community disruption and accounting for outflows from Somerset Dam. Several adjustments were required to Drain Down Release Plans during the falling limb to account for increased inflows from catchment rainfall upstream and downstream of Wivenhoe Dam.

During the drain down period, Release Plans were prepared which aimed to reduce the total flow at Moggill to less than 3,500 m^3/s. At the start of the drain down period (28/02/2022 06:00), the rated flow at Moggill was 6,680 m^3/s. As the modelled Downstream Catchment Flow at Moggill continued to recede, releases from Wivenhoe Dam were gradually increased to a peak of approximately 3,400 m^3/s on 03/03/2022 06:00. Rated flow at Moggill fell below 3,500 m^3/s on 02/03/2022 20:15.

Further rainfall that occurred on catchments downstream of Wivenhoe Dam on 02/03/2022 and 03/03/2022 resulted in modelled estimates of Downstream Catchment Flow at Moggill increasing from approximately 110 m^3/s on 03/03/2022 09:00 to a second peak of approximately 630 m^3/s between 04/03/2022 09:00 and 05/03/2022 11:00. Release Plans were adjusted at this stage to reduce Wivenhoe Dam releases from approximately 3,300 m^3/s to approximately 2,700 m^3/s by 03/03/2022 14:00.

Further rainfall in the dam catchments also increased the inflows into the Dams and the drain down period was extended in accordance with Drain Down Strategy Procedure 1b on 04/03/2022 01:00 and again on 07/03/2022 03:00. The rate of reduction of releases after 3/3/2022 also considered the guidance on recession rates in Appendix I of the Manual for Drain Down Strategy Procedure 1d(i).

End of Flood Event releases at Somerset Dam

Releases ceased at Somerset Dam at 08/03/2022 07:00 with the lake level at 0.13 m below OFSL (96.87 m AHD), after it was judged likely that there was sufficient baseflow to meet the criterion in Somerset Dam Strategy Procedure 2b (i).

End of Flood Event with completion of flood releases at Wivenhoe Dam

The Wivenhoe Dam Drain Down Strategy exit criteria nominated in the Manual include lake level tolerances to cease releases, with accounting for baseflow. Under Drain Down Strategy Procedure 3b(ii)(a), releases must cease when the lake level is more than 0.3 m below OFSL.

Just before the end of the Flood Event, these criteria were challenging to achieve given the volume of baseflow being generated from the catchment for an event of this magnitude.

Releases ceased at Wivenhoe Dam and the Flood Event ended at 09/03/2022 14:00 with the lake level at 0.29 m below OFSL (65.61 m AHD based on a gauge board reading), after it was judged likely that there was sufficient baseflow to meet the criterion in Drain Down Strategy Procedure 3b (i).

4.3 Review of gate and sluice open and closing rates

The Manual provides specific criteria within the operating procedures for Somerset Dam and Wivenhoe Dam at around the rate at which the Somerset Dam sluices and Wivenhoe Dam gates can be opened or closed. A summary of the relevant criteria for Somerset Dam is as follows:

- Somerset Dam Strategy 1d(iii) – the sluices may be opened or closed progressively at one hour intervals. This can be exceeded to ensure that the structural failure requirements in criteria (iv) are met.
- Somerset Dam Strategy 2a(i) – the sluices must be operated at intervals not less than one hour.

The total number of sluices open and the rate of sluice opening and closing at Somerset Dam during the Flood Event is shown in Figure 4-5. It can be seen that the rate of sluice opening and closing is uniformly at one per hour as required under the Manual, with the exception of a short period at the start of the implementation of the Alternative Procedure. During this time, the rate of closing of the sluices reached three per hour at 28/02/2022 02:45. The implementation of the Alternative Procedure allowed the Somerset Dam Strategy Procedure 1d(iii) to be disregarded, and as such the limit on the rate of sluice operation defined by that procedure was not relevant. The faster rate closing of the sluices from the time of implementation of the Alternative Procedure was a key component of the overall effectiveness of the procedure, as there was only a limited time over which implementation of the procedure would realise the expected benefit in reduction of inflow to Wivenhoe Dam.

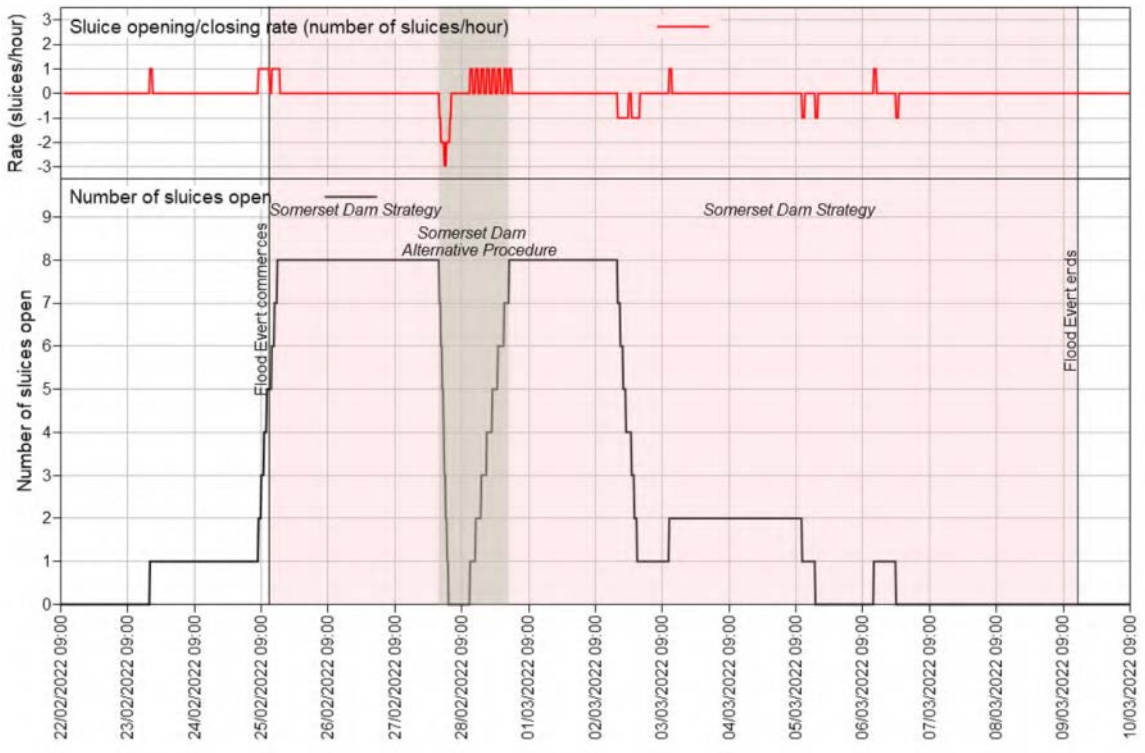

Figure 4-5: Somerset Dam total sluice opening and rate of change of sluice settings

For Wivenhoe Dam, Table 14.5.1 in the Manual provides target minimum intervals defined in Section 14.5 of the Manual for radial gate operations applicable under the Flood Mitigation Strategy and the Drain Down Strategy. This table provides gate opening rates corresponding to a range of estimated flow rates in the Brisbane River at Fernvale Bridge (equivalent to Lowood). It is also noted that in the Drain Down Strategy, once flows decrease below approximately 2,000 m^3s, Appendix I provides information on historic flood recession rates which can be used to determine Release Plans (and hence rate of gate closure). The practical application of these procedures for the Flood Event can be summarised as follows:

- When releases re-commenced at Wivenhoe Dam under Flood Mitigation Strategy Procedure 1b on 27/02/2022 04:00, the rated flow at Lowood was approximately 3,300 m^3/s. Rated flow at Lowood remained above 1,500 m^3/s for the remainder of the time that the Flood Mitigation Strategy was selected. As such, the target minimum interval for Wivenhoe Dam gate operations was 10 minutes.
- For the period between the selection of the Drain Down Strategy at 28/02/2022 06:00 and approximately 07/03/2022 03:00, the rated flow at Lowood was between 1,500 and 6,000 m^3/s. As such, the target minimum interval for Wivenhoe Dam gate operations (both opening and closing) during this period was also 10 minutes.
- After flows drop 1,500 m^3/s at approximately 28/02/2022 06:00, the rate of recession of releases is guided by Appendix I of the Manual. This does not contain specific target minimum operating intervals or gate closing rates.

The total gate opening and the interval between gate operations at Wivenhoe Dam and the rated flow at Lowood (Fernvale Bridge) during the Flood Event is shown in Figure 4-5. The time series showing interval since the last gate operation (in minutes) is sourced from WISKI data, and is capped at 60 minutes for ease of plotting (sometimes the interval is hundreds or thousands of minutes). It can be seen that the minimum gate operation interval recorded for the flood event was 10 minutes, which is the same as the Manual Table 14.5.1 requirement when flows at Lowood (Fernvale Bridge) are between 1,500 and 6,000 m^3/s. Rated flow at Lowood was within this range during all gate operations except for those undertaken after 07/03/2022 03:00, when there is no specific target minimum operating interval defined by the Manual under the Drain Down Strategy.

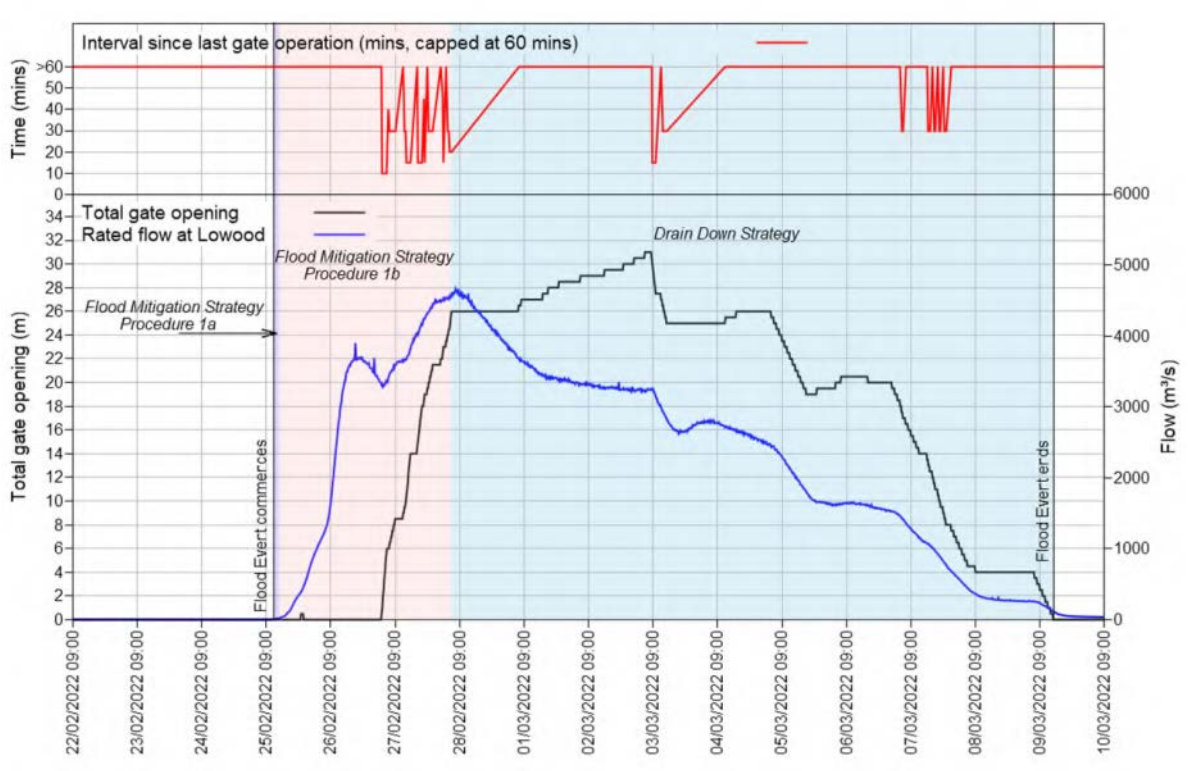

Figure 4-6: Wivenhoe Dam total gate opening, gate opening intervals and rated flow at Lowood

5. External communications

This section describes the external communications activities undertaken by Seqwater during the Flood Event, including the issue of Situation Reports, advice to stakeholders and general communications. This section of the report provides an overview of these activities as required under section 385(1)(b)(i) of the Act. It is not a detailed review covering all aspects of communications activities undertaken by Seqwater during the Flood Event.

5.1 Overview

5.1.1 Summary of communication types

Key forms of communication with external stakeholders during the Flood Event included:

- Activation level status, summarising the Emergency Action Plan activation level of the Dams (refer Section 5.2)
- Flood Event Situation Reports (refer Section 5.3)
- Advice on the commencement of planned releases from the Dams (refer Section 5.4)
- Advice on releases that were likely to contribute to the inundation of roads and bridges (refer Section 5.5)
- Somerset Dam and Wivenhoe Dam release hydrographs to relevant Stakeholder Agencies (refer Section 5.5)

5.1.2 Sources of communications data and information

For the purpose of this report, the description of communications was prepared from documents that were sent by, or received in, the Flood Operations Centre email database or documented in the Flood Operations Centre Event Log. Additional information was also sourced from interviews with the Senior Flood Operations Engineers and recordings of relevant telephone calls and videoconferences made during the Flood Event.

5.1.3 Communications protocol

Communications about the Dam flood operations were informed by the Communications Protocol for Releases from Seqwater's Gated Dams (Wivenhoe Dam, Somerset Dam, and North Pine Dam) April 2020 Version 2.1 (the Protocol). All relevant stakeholder agencies were supplied a copy of the Protocol prior to the Flood Event.

The Protocol defines the respective agency and stakeholder responsibilities. The Protocol also defines the communication of the Emergency Action Plan status of activation for the Flood Operations Centre (such as Alert, Lean forward, Stand up, Stand down), to align with established State Government terminology for disaster and emergency management response. The primary means of communications about the dam operations to relevant stakeholder agencies are Situation Reports. The Protocol defines when Situation Reports will be issued, the recipients of Situation Reports, and suggested content of Situation Reports. The Protocol also defines the communication between the Flood Operations Centre and relevant stakeholder

agencies responsible for bridge closures for situations where dam releases will contribute to inundation of downstream bridges.

The Protocol is directed towards respective stakeholder agency responsibilities to distribute information to:

- Support public safety;
- Keep agency stakeholders engaged and informed; and
- Support Queensland Government disaster management activities.

For Seqwater's role in dam flood operations, the Protocol is specifically relevant to the issuing of Situation Reports, and notification of actual and predicted dam releases to the Bureau and other relevant stakeholder agencies.

5.2 Timeline of external communications

A table showing the dates and times when key external communications conducted under the protocol were released is included as Table 5-1.

Table 5-1: Chronological summary of key external communications conducted under the provisions of the Communications Protocol for Releases from Seqwater's Gated Dams

Event	Date	Time
Notification via email to relevant stakeholder agencies that the Flood Operations Centre has moved to Alert activation level and flood releases are possible.	22/02/2022	19:48
Notification via email to relevant stakeholder agencies that the Flood Operations Centre has moved to Lean Forward activation level.	23/02/2022	01:07
Situation Report #1 issued to stakeholders	23/02/2022	07:00
Notification via email to relevant stakeholder agencies that the Flood Operations Centre has moved to Stand Up activation level.	23/02/2022	12:36
Situation Report #2 issued to stakeholders	23/02/2022	13:00
Situation Report #3 issued to stakeholders	23/02/2022	19:00
Situation Report #4 issued to stakeholders	24/02/2022	07:00
Situation Report #5 issued to stakeholders	24/02/2022	19:00
Situation Report #6 issued to stakeholders	25/02/2022	06:30
Situation Report #7 issued to stakeholders	25/02/2022	09:30
Situation Report #8 issued to stakeholders	25/02/2022	13:00
Modelled releases for Wivenhoe Dam (m^3/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	25/02/2022	16:53
Situation Report #9 issued to stakeholders	25/02/2022	18:30
Modelled releases for Wivenhoe Dam (m^3/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	25/02/2022	19:53
Numerous phone and email communications initiated by the Flood Operations Centre to provide advice to relevant stakeholder agencies around the potential for planned releases from Wivenhoe Dam to impact	25/02/2022	17:40 to 20:30

Event	Date	Time
Colleges Crossing, Kholo Bridge and Mt Crosby Weir bridge. The decision to cease releases from Wivenhoe Dam at 23:00 meant that subsequent inundation of these bridges resulted from Downstream Catchment Flows not Wivenhoe Dam releases.		
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	25/02/2022	21:53
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	25/02/2022	23:36
Situation Report #10 issued to stakeholders	25/02/2022	02:50
Situation Report #11 issued to stakeholders	26/02/2022	06:15
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	26/02/2022	07:02
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	26/02/2022	06:31
Situation Report #12 issued to stakeholders	26/02/2022	07:30
Several phone calls with relevant stakeholder agencies regarding the status of Fernvale Bridge, which was closed due to Downstream Catchment Flows by 13:00.	26/02/2022	05:00 to 11:00
Release plan advice #1 for Wivenhoe Dam issued to stakeholders	27/02/2022	12:15
Release plan advice #2 for Wivenhoe Dam issued to stakeholders	27/02/2022	01:45
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	27/02/2022	02:52
Release plan advice #3 for Wivenhoe Dam issued to stakeholders	27/02/2022	01:45
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	27/02/2022	04:51
Situation Report #13 issued to stakeholders	27/02/2022	06:30
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	27/02/2022	10:43
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	27/02/2022	14:01
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	27/02/2022	18:16
Situation Report #14 issued to stakeholders	27/02/2022	18:30
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	27/02/2022	10:26
Release plan advice #4 for Wivenhoe Dam issued to stakeholders	27/02/2022	11:30
Release plan advice #5 for Wivenhoe Dam issued to stakeholders	28/02/2022	04:00
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	28/02/2022	04:56

Event	Date	Time
Situation Report #15 issued to stakeholders	28/02/2022	05:30
Situation Report #16 issued to stakeholders	28/02/2022	19:00
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	01/03/2022	04:03
Situation Report #17 issued to stakeholders	01/03/2022	06:00
Situation Report #18 issued to stakeholders	01/03/2022	18:15
Situation Report #19 issued to stakeholders	02/03/2022	06:30
Situation Report #20 issued to stakeholders	02/03/2022	18:30
Situation Report #21 issued to stakeholders	03/03/2022	06:45
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	03/03/2022	14:03
Situation Report #22 issued to stakeholders	03/03/2022	18:00
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	03/03/2022	18:15
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	04/03/2022	02:39
Situation Report #23 issued to stakeholders	04/03/2022	05:00
Release plan advice #6 for Wivenhoe Dam issued to stakeholders	04/03/2022	06:00
Situation Report #24 issued to stakeholders	04/03/2022	18:00
Situation Report #25 issued to stakeholders	05/03/2022	05:30
Situation Report #26 issued to stakeholders	05/03/2022	18:00
Situation Report #27 issued to stakeholders	06/03/2022	06:00
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	06/03/2022	06:59
Situation Report #28 issued to stakeholders	06/03/2022	18:00
Situation Report #29 issued to stakeholders	07/03/2022	06:30
Modelled releases for Wivenhoe Dam (m³/s), and actual and modelled water level data for Wivenhoe Dam and Somerset Dam (m AHD) issued to stakeholders.	07/03/2022	14:41
Situation Report #30 issued to stakeholders	07/03/2022	18:00
Situation Report #31 issued to stakeholders	08/03/2022	07:00
Situation Report #32 issued to stakeholders	08/03/2022	19:00
Situation Report #33 issued to stakeholders	09/03/2022	07:00
Situation Report #34 issued to stakeholders	09/03/2022	14:15
Notification via email to relevant stakeholder agencies that the Flood Operations Centre has moved to Stand Down activation level and flood releases have ceased.	09/03/2022	15:47

5.3 Situation Reports

5.3.1 Content and preparation

The Situation Reports were prepared with the intent to communicate key information regarding the current status of the dams, strategies and associated dam operations to relevant stakeholder agencies. The Situation Reports also describe a forward outlook, as best as can be provided based on information and trends known at the time of each report and time available to prepare the report. A generic report structure and content guidance for Situation Reports is included as an Appendix in the Protocol.

Each Situation Report summarised the operations of the three gated dams[8] operated by Seqwater. The relevant aspects of the Wivenhoe and Somerset Dam operations described in the Situation Reports included:

- Situation Report number, date and time of preparation and time of next Situation Report being issued.
- Time of Flood Event commencement and time of commencement of Dam releases.
- Fixed Full Supply Level and Operational Full Supply Level.
- Current lake levels (in m AHD).
- Current applicable operation strategy selected in accordance with the Manual.
- Current estimate of dam inflow volume from FFS modelling start time (22/02/2022 09:00 as per Section 2.3) to current time.
- Estimate of catchment average rainfall in last 12 hours.
- Current release rate from the dams.
- Current and expected inundation status of downstream bridges.
- External URL links to BoM weather and warnings.
- Seqwater Flood Operations Centre Operational Status Overview.
- Key messages relevant to the current situation at each dam including future outlook. These key messages often described expected trends in the downstream river flows.

The Situation Reports were approved by the DSFOE for each shift and prepared using live operational data. It is important to note that in real-time operations, inflow rate and volume predictions evolve as the event unfolds, as more data is collected and as improved FFS model calibration is achieved. The Situation Reports were based on the then-current best estimate of inflow volume which was refined as the Flood Event progressed.

5.3.2 Distribution of Situation Reports

Situation Reports were distributed to the agencies or groups listed below in Table 5-2.

[8] North Pine Dam flood operations are provided in the same Situation Reports.

Table 5-2: Distribution of Situation Reports

State Government	Local Government	Other Agencies/ Stakeholders
Department of Regional Development, Manufacturing and Water	Brisbane City Council	Bureau of Meteorology (Flood Warning Centre and Regional Forecasting Centre)
Department of Transport and Main Roads (including Maritime Safety)	Ipswich City Council	Queensland Urban Utilities and Unity Water
Department of Premier and Cabinet	Somerset Regional Council	CleanCo
Department of Community Services	Moreton Bay Regional Council	Internally within Seqwater including all Flood Operations Centre and Dam Operations personnel, executive management, media and communications personnel
Emergency Management Queensland including State Disaster Coordination Centres	Redland City Council	
Queensland Police Service	Scenic Rim Regional Council	
	Lockyer Valley Regional Council	
	Toowoomba Regional Council	

5.3.3 Situation Reports issued

For the Flood Event, 34 Situation Reports were issued, equating to twice per day for the duration of the event. Table 5-3 presents a summary of the Situation Reports and key information relevant to Somerset Dam and Wivenhoe Dam that was presented in each report.

Table 5-3: Summary of Situation Reports

SitRep No.	Preparation Time & Date	Key advice provided regarding Somerset and Wivenhoe Dam operations
1	23/02/2022 07:00	**Flood Operations Centre at STAND UP** • Flood warning issued by the BoM for Stanley River catchment • Heavy rainfall forecast to occur across Somerset and Wivenhoe Dam catchments over coming days. • Flood releases not currently occurring from Somerset or Wivenhoe Dams. • Operational releases likely to occur from Somerset Dam over coming days.
2	23/02/2022 13:00	• N/A - SitRep content relevant to North Pine Dam only.
3	23/02/2022 19:00	• Operational releases commenced from Somerset Dam at 17:00 hrs. • No flood releases currently being made from Wivenhoe Dam.
4	24/02/2022 07:00	• Severe Weather Warning issued by BoM at 05:17 am 24/2 advising of heavy rainfall across South East Queensland through Thursday into Friday 25/2.
5	24/02/2022 19:00	• Rainfall commenced. Only small catchment average rainfall totals recorded upstream of Somerset and Wivenhoe dams to date.
6	25/02/2022 06:30	• Severe Weather Warnings updated by BoM at 04:49 25/2 advising of heavy rainfall across South East Queensland for Friday potentially extending into Saturday (26/2) morning.

SitRep No.	Preparation Time & Date	Key advice provided regarding Somerset and Wivenhoe Dam operations
7	25/02/2022 09:30	• Heavy rainfall in the Somerset Dam and Wivenhoe Dam catchments in the past several hours. • Severe Weather Warnings and Flood Warnings are current for the Somerset Dam and Wivenhoe Dam catchments. • Current release rate @ 09:30: o Somerset Dam = 600 m³/s o Wivenhoe Dam = 4 m³/s
8	25/02/2022 13:00	**FLOOD EVENT declared.** • Current release rate @ 12:30: o Somerset Dam = 1,320 m³/s o Wivenhoe Dam = 4 m³/s
9	25/02/2022 18:30	**Applicable Strategy: FLOOD MITIGATION.** • Current release rate @ 18:00: o Somerset Dam = 1,872 m³/s o Wivenhoe Dam = 4 m³/s
10	26/02/2022 02:50	• Releases from Wivenhoe ceased in order to mitigate downstream flooding. Modelling indicates Wivenhoe releases may restart Sunday morning. • Inundation of Mt Crosby weir bridge is expected within a few hours due to downstream flooding, not due to Wivenhoe Dam releases. • Current release rate @ 02:50: o Somerset Dam = 1,898 m³/s o Wivenhoe Dam = 0 m³/s
11	26/02/2022 06:15	• Mt Crosby weir bridge now inundated. • Inundation of Brisbane Valley Highway Bridge at Fernvale is expected later today. • Current release rate @ 06:15: o Somerset Dam = 1,898 m³/s o Wivenhoe Dam = 0 m³/s
12	26/02/2022 19:30	• Current modelling indicates Wivenhoe releases may restart overnight to coincide with a reducing flow coming from Lockyer Creek. • The road bridges at Mt Crosby Weir and Fernvale have been closed due to flows from Lockyer Creek and the local catchments of the Brisbane River downstream of Wivenhoe Dam • Current release rate @ 19:30: o Somerset Dam = 1,697 m³/s o Wivenhoe Dam = 0 m³/s
13	27/02/2022 06:30	• Wivenhoe Dam releases recommenced at 04:00 this morning after the peak of the Lockyer Creek flow at Lowood. • Releases from Wivenhoe Dam will not arrive further downstream at Moggill until tonight. • The magnitude of expected flooding is higher than the January 2013 flood and well below the January 2011 flood. • Current release rate @ 06:00: o Somerset Dam = 2,140 m³/s o Wivenhoe Dam = 710 m³/s
14	27/02/2022 18:30	• Current release rate @ 17:00: o Somerset Dam = 2,130 m³/s o Wivenhoe Dam = 2,010 m³/s

SitRep No.	Preparation Time & Date	Key advice provided regarding Somerset and Wivenhoe Dam operations
15	28/02/2022 05:30	**Applicable Strategy: Flood mitigation. The Drain Down Strategy will be implemented around 06:00 this morning.** **ALTERNATIVE PROCEDURE implemented for Somerset Dam.** • All road bridges downstream to Moggill expected to be inundated for up to one week. • Current release rate @ 04:30: o Somerset Dam = 437 m³/s o Wivenhoe Dam = 2,974 m³/s
16	28/02/2022 19:00	• Current release rate @ 18:30: o Somerset Dam = 1,125 m³/s o Wivenhoe Dam = 3,176 m³/s
17	01/03/2022 06:00	• Wivenhoe Dam releases will be increased slightly over the coming days as the flows from tributaries recede. • Current release rate @ 06:00: o Somerset Dam = 1,775 m³/s o Wivenhoe Dam = 3,141 m³/s
18	01/03/2022 18:15	• Current release rate @ 18:24: o Somerset Dam = 1,643 m³/s o Wivenhoe Dam = 3,319 m³/s
19	02/03/2022 06:30	• Current release rate @ 06:30: o Somerset Dam = 1,593 m³/s o Wivenhoe Dam = 3,377 m³/s
20	02/03/2022 18:30	• Releases from Wivenhoe Dam are planned to continue until around next Monday to drain the flood storage compartment. This is subject to potential change as a result of future rainfall in the catchment. • Current release rate @ 18:00: o Somerset Dam = 1,157 m³/s o Wivenhoe Dam = 3,383 m³/s
21	03/03/2022 06:45 (incorrect day entered into official SitRep - correction made here)	• Current release rate @ 06:30: o Somerset Dam = 190 m³/s o Wivenhoe Dam = 3,400 m³/s
22	03/03/2022 18:00 (incorrect day entered into official SitRep - correction made here)	• Wivenhoe Dam releases reduced in response to river level rises from downstream overnight local rainfall (30 - 70 mm) in Lockyer Creek, Warrill Creek, the Bremer River and the mid Brisbane catchments. • Further rainfall expected Thursday night and Friday. • Releases from Wivenhoe Dam are planned to continue until Monday or possibly Tuesday to drain the flood storage compartment subject to further rainfall. • Current release rate @ 18:00: o Somerset Dam = 390 m³/s o Wivenhoe Dam = 2,710 m³/s

SitRep No.	Preparation Time & Date	Key advice provided regarding Somerset and Wivenhoe Dam operations
23	04/03/2022 05:00	• Relatively small flows from the Thursday rainfall in Lockyer Creek, Warrill Creek, the Bremer River and the mid Brisbane catchments have peaked. • Minimal rainfall forecast for Friday. • Releases from Wivenhoe Dam are planned to continue until Tuesday to drain the flood storage compartment. • Current release rate @ 05:00: o Somerset Dam = 390 m³/s o Wivenhoe Dam = 2,672 m³/s
24	04/03/2022 18:00	• Current release rate @ 18:00: o Somerset Dam = 390 m³/s o Wivenhoe Dam = 2,671 m³/s
25	05/03/2022 05:30	• Current release rate @ 05:00: o Somerset Dam = 197 m³/s o Wivenhoe Dam = 2,501 m³/s
26	05/03/2022 18:00	• Current release rate @ 18:00: o Somerset Dam = 70 m³/s o Wivenhoe Dam = 1,870 m³/s
27	06/03/2022 06:00	• Wivenhoe Dam releases will be progressively reduced over multiple days commencing from Saturday morning. • Current release rate from Dam @ 06:00: o Somerset Dam = 70 m³/s o Wivenhoe Dam = 1,930 m³/s
28	06/03/2022 18:00	• Current release rate @ 18:00: o Somerset Dam = 260 m³/s o Wivenhoe Dam = 1,870 m³/s
29 - Revised	07/03/2022 06:30	• Current release rate @ 06:00: o Somerset Dam = 66 m³/s o Wivenhoe Dam = 1,553 m³/s
30	07/03/2022 18:00	• All road bridges downstream to Moggill are forecast to be clear of inundation by Wednesday afternoon, or into the evening; however reopening times are dependent on road inspection by third parties. • Current release rate @ 18:00: o Somerset Dam = 20 m³/s o Wivenhoe Dam = 1,000 m³/s
31	08/03/2022 07:00 (incorrect day and date entered into official SitRep - correction made here)	**FLOOD RELEASES CEASE AT SOMERSET DAM.** • Fernvale Bridge and Mt Crosby weir are now clear of inundation. • Burtons Bride, Kholo Bridge, and Colleges Crossing are currently inundated and are now expected to gradually become clear of inundation between late today to early Thursday. • Current release rate @ 07:00: o Somerset Dam = 0 m³/s o Wivenhoe Dam = 401 m³/s
32	08/03/2022 19:00	• Fernvale Bridge, Mt Crosby Weir Bridge, Burtons Bridge, and Kholo Bridge are now clear of inundation but not yet open to traffic. • Colleges Crossing is currently inundated and expected to become clear of inundation early Thursday morning. • Current release rate @ 19:00: o Somerset Dam = 0 m³/s o Wivenhoe Dam = 353 m³/s

SitRep No.	Preparation Time & Date	Key advice provided regarding Somerset and Wivenhoe Dam operations
33	09/03/2022 07:00	• Flood releases from Wivenhoe Dam are expected to finish today. Ongoing operational release may be required beyond Wednesday. • Current release rate @ 06:00: o Somerset Dam = 0 m3/s o Wivenhoe Dam = 350 m3/s
34	09/03/2022 14:15	**FLOOD RELEASES CEASE AT WIVENHOE DAM:** Flood releases from Wivenhoe Dam ceased at 14:00 9/3/22. • Operational releases to continue from Wivenhoe Dam into the weekend and beyond - below release rates which produce flood impacts downstream.

5.4 Information to the public

Seqwater provided several communication pathways to inform the public of dam operations. These included email/SMS notification via the Dam Release Notification Service, access to a 1800 telephone recorded message, website updates, media releases and media interviews.

There were a number of messages relevant to Somerset Dam and Wivenhoe Dam released to subscribers of the Dam Release Notification Service during the Flood Event. Examples of these messages include:

- Notification that the Seqwater Flood Operations Centre was at Alert status and flood releases were possible sent to over 22,500 communication modes[9] on 22/02/2022 at 20:39.
- Notification to Mid Brisbane River Irrigators of potential releases from Wivenhoe Dam sent to 2,071 communication modes on 23/02/2022 at 15:39.
- Notification of operational releases from Somerset Dam sent to over 15,000 communication modes on 23/02/2022 at 16:47.
- Notification on commencement of flood releases at Somerset Dam sent to over 16,000 communication modes on 25/2/2022 at 13:43.
- Notification on commencement of releases at Wivenhoe Dam sent to nearly 22,000 communication modes on 25/2/2022 at 15:57.
- Similar updates and notifications issued on a further nine occasions during the Flood Event.

5.5 Other communications

5.5.1 General communications

Communications were undertaken between Seqwater and relevant external agencies to:

[9] The communication modes adopted by Seqwater include email notifications, text messages sent to mobile phones, calls by the public to a 1800 telephone number with a pre-recorded message and notifications via Apple and Android smart phone apps. An individual may receive a message via multiple modes, depending on how they choose to access notifications from Seqwater.

- Discuss with the Bureau the most up to date understanding of the weather situation.
- Provide advice to stakeholders to support their activities in response to flooding and actual or potential road closures.

A combined Flood Operations Centre Event Log was used to record the operations for all Seqwater referable dams, including Somerset and Wivenhoe Dams. Telephone calls to and from the Flood Operations Centre telephone number were recorded. The types of matters and situations when communication was undertaken with external agencies included:

- Contact with the Bureau for briefing of forecasts and obtaining updates on trends.
- Initial and then ongoing discussions with local government and Department of Transport and Main Roads regarding potential inundation of bridges, actual bridge closures, and re-opening of bridges.
- Provision of release data and Release Plans for Wivenhoe Dam to relevant stakeholder agencies as listed in Table 5-1.

Specific communications with relevant stakeholder agencies relating to bridge closures occurred via phone calls and emails initiated by the Flood Engineers (or supporting Flood Officers) on 25/2/2022 between approximately 17:40 and 20:30. These communications provided advice to local government and operators of the transport network on bridge closures due to Wivenhoe Dam releases at Colleges Crossing, Kholo Bridge and Mt Crosby Weir bridge. As releases from Wivenhoe Dam were subsequently ceased, these notifications were superseded by closure of those bridges as a result of Downstream Catchment Flows before the substantive Wivenhoe Dam releases occurred. There were further discussions with relevant stakeholder agencies on 26/02/2022 between approximately 05:00 and 11:00 on the status of Fernvale Bridge, which was closed as a result of Downstream Catchment Flows by 26/02/2022 13:00.

The specific communications with the Bureau were conducted as part of the Lower Brisbane River Communication Protocol videoconferences between the Bureau, Seqwater and relevant local governments. These teleconferences were held at the following times:

1. 22/02/2022 14:00
2. 23/02/2022 10:00
3. 24/02/2022 10:00
4. 24/02/2022 21:00
5. 25/02/2022 10:00
6. 25/02/2022 21:00
7. 26/02/2022 10:00
8. 26/02/2022 16:00
9. 26/02/2022 21:00
10. 27/02/2022 07:00
11. 27/02/2022 10:00
12. 27/02/2022 14:00
13. 27/02/2022 21:00
14. 28/02/2022 10:00
15. 28/02/2022 18:00
16. 01/03/2022 10:00
17. 02/03/2022 09:30
18. 03/03/2022 09:30
19. 04/03/2022 09:30
20. 05/03/2022 09:30
21. 06/03/2022 09:30
22. 07/03/2022 09:30
23. 08/03/2022 09:30
24. 09/03/2022 09:30

Other ad hoc communications occurred between Seqwater and the Bureau and were recorded in the Flood Operations Centre Event Log. The Flood Operations Centre also received all

Flood Warnings and Severe Weather Warnings from the Bureau. These were used to inform situational awareness of the developing and changing weather conditions throughout the Flood Event.

5.5.2 Splityard Creek Dam operations

The Splityard Creek power station operations extract water from Wivenhoe Dam and pumps it up to Splityard Creek Dam. This water is held in the dam and then released back into Wivenhoe, to generate hydro-electricity.

The SFOEs were in contact with CleanCo regarding releases into Wivenhoe Dam. This included agreeing a delay in releases from Splityard Creek Dam near the timing of the peak lake level of Wivenhoe Dam. CleanCo agreed to this request and delayed releases until the 28/02/2022 17:00, after the lake level in Wivenhoe Dam had peaked.

Table 2-30 of Section 2.6.1 shows the extractions and releases made from Splityard Creek Dam during the Flood Event.

5.6 Authorisation of the Somerset Dam Alternative Procedure

As described in Section 4.2, an Alternative Procedure for Somerset Dam was approved on 28/02/2022 at 00:40 and implemented at 00:45. As required under the Section 18 of the Manual, the DSFOE sought approval from the Chief Executive DRDMW prior to implementing the Alternative Procedure. First contact with the nominated delegate of the DRDMW Chief Executive occurred in a phone call with two of the SFOEs (including the DSFOE) at 27/02/2022 16:00. Subsequently, at the request of DRDMW, all four SFOEs participated in a videoconference with the nominated delegate of the Chief Executive DRDMW at 27/02/2022 18:30. These two discussions constituted an initial verbal briefing and discussion of the Authorisation Request Information for the Somerset Dam Alternative Procedure.

The nominated delegate of the Chief Executive DRDMW called the Flood Operations Centre at approximately 27/02/2022 21:18 to request the Authorisation Request Information be provided in writing. A memorandum was prepared and approved by the DSFOE summarising the grounds for the Alternative Procedure, a description of the procedure itself, dam safety considerations and the criteria under which the Alternative Procedure would be ceased. The memorandum comprised a formal written version of the Authorisation Request Information required under Section 18.1 of the Manual. This memorandum was emailed to the nominated delegate of the Chief Executive DRDMW at 27/02/2022 22:46. Minor revisions were subsequently emailed to DRDMW at 23:51 and 28/02/2022 00:07.

The nominated delegate of the Chief Executive DRDMW provided verbal advice to the DSFOE that approval was granted for the Alternative Procedure at 28/01/2022 00:40. The procedure was enacted via Somerset Dam Gate Directives 5 and 6 issued at 28/01/2022 00:45 and 01:45, with all sluices at the dam closed by 28/01/2022 04:15. The DSFOE subsequently received formal written approval of the Alternative Procedure by email at 28/02/2022 00:59.

The memorandum containing the Authorisation Request Information and the DRDMW authorisation approval letter for the Somerset Dam Alternative Procedure is included in Appendix E of this report.

6. Flood Event Magnitude

This section of the report compares the magnitude of the rainfall and flood volumes generated by this Flood Event to other significant historical events.

6.1 Comparison with historic rainfalls

Table 6-1 shows a comparison between maximum 09:00 to 09:00 three-day catchment average rainfalls and maximum one hour rainfall intensities based on 15-minute catchment average data recorded in this Flood Event compared with the significant historical events of 1974, 2011 and 2013. These events have been selected for comparison here due to the fact that they are relatively recent; there are likely to be other events in the historic record which may have larger rainfall totals and intensities. The focus of the comparison is on the January 2011 event as direct comparisons between estimated inflow and recorded peak lake level and release volumes at the dams can be made for that event, for the reasons discussed further in Section 6.2.

This data has been sourced from the gridded historical rainfall database collated by Seqwater for the purpose of Seqwater's activities in calibrating the FFS hydrological models.

The maximum 09:00 to 09:00 three-day catchment average rainfall totals recorded in the 2022 Flood Event for the Stanley River to Somerset Dam and Brisbane River to Wivenhoe Dam catchments were significantly higher than those recorded in the 1974, 2011 and 2013 events. The three-day catchment average rainfall totals over these catchments were both approximately 40% higher than those recorded in January 2011. The three-day catchment average rainfall totals were also higher for the downstream catchments in the 2022 Flood Event compared to January 2011. The three-day catchment average rainfall for the Brisbane River downstream of Moggill catchment in the 2022 Flood Event was more than three times larger than the value recorded in the January 2011 event. Maximum one hour rainfall intensities recorded during the 2022 Flood Event were higher than those in 2013, and comparable with those recorded during both the 1974 and 2011 events.

Table 6-1: Historical total catchment average rainfall and intensity comparison (replicated in Table iv)

	Event			
	1974	2011	2013	2022
Maximum 09:00 to 09:00 three-day rainfall total (mm)				
Stanley River to Somerset Dam	429	447	357	627
Brisbane River to Wivenhoe Dam	296	292	283	409
Lockyer Creek	312	288	298	406
Bremer River	460	216	320	331
Brisbane River between Wivenhoe Dam and Moggill	577	377	310	645
Brisbane River downstream of Moggill	623	155	306	637
Maximum one hour rainfall intensity (mm/hr) based on 15-minute catchment average data				
Stanley River to Somerset Dam	22.0	28.1	19.5	25.9
Brisbane River to Wivenhoe Dam	16.4	16.0	14.0	20.2
Lockyer Creek	30.7	24.2	12.9	18.2
Bremer River	22.2	20.2	15.1	16.4
Brisbane River between Wivenhoe Dam and Moggill	26.4	40.2	16.1	32.0
Brisbane River downstream of Moggill	34.9	17.5	27.5	27.9

6.2 Comparison with historic floods

Comparing historic flood events in the Brisbane River basin is complicated by the fact that construction of Somerset Dam between 1935 and 1955 and Wivenhoe Dam between 1978 and 1985, as well as variation in OFSL and operating procedures over time have significantly impacted release volumes from both dams. In addition to this, there is an extensive history of flood records in the Brisbane River basin stretching back to the late 1800s, however recorded data for these early floods at the dam sites is not available for comparison.

Table 6-2 shows a comparison between the peak lake level and total inflow and release volume for selected significant historic flood events compared to the 2022 Flood Event. Further to this discussion above, it should be noted in Table 6-2 that:

- Flood volume records at the Somerset Dam site are not available for the February 1893 and February 1931 flood events and so these estimates are based on hydrologic models calibrated by Seqwater to recorded data in other parts of the Brisbane River basin.
- Flood volume records at the Wivenhoe Dam site are not available prior to 1985, and so estimates for flood events before this date are based on hydrologic models calibrated by Seqwater to recorded data in other parts of the Brisbane River basin.
- Peak lake level records are only provided for those events after construction of Somerset Dam was completed in 1955 and construction of Wivenhoe Dam was completed in 1985. The peak lake level for the historic flood events is influenced by factors such as the starting lake level for that flood event, the Operational Full Supply Level in place at the time and the operating procedures in place at the time. All of these factors have varied by a greater or lesser degree over the period of the flood events in Table 6-2.

- For Wivenhoe Dam, flood volume estimates are provided separately for the upper Brisbane River catchment (i.e. excluding releases from Somerset Dam) and the total catchment (i.e. including releases from Somerset Dam). For the 1893 and 1931 events, which occurred prior to the construction of Somerset Dam, this data represents estimates of the flood volume in each catchment.
- There are different sources of data for these estimates and records which vary depending on the exact method used to obtain them. The data provided in Table 6-2 is sourced from Seqwater (2013), and varies slightly from the data presented in Appendix I of the Manual.

Table 6-2: Comparison of historical flood event peak lake level, peak flow and flow volumes from Seqwater, 2013 (replicated in Table v)

Event	Somerset Dam			Wivenhoe Dam			
	Peak Lake Level (m AHD)	Inflow (ML)	Release (ML)	Peak Lake Level (m AHD)	Upper Brisbane River Inflow[1] (ML)	Total Inflow (ML)	Release (ML)
Feb 1893	N/A	1,340,000[2]	N/A	N/A	N/A	3,290,000[3]	N/A
Feb 1931	N/A	420,000[2]	N/A	N/A	790,000	1,210,000[3]	N/A
Mar 1955	103.47	510,000	430,000	N/A	720,000	1,150,000[3]	N/A
Jan 1968	N/A	460,000	380,000	N/A	550,000	930,000[3]	N/A
Jan 1974	106.57	710,000	440,000	N/A	1,170,000	1,610,000[3]	N/A
Jun 1983	101.58	170,000	110,000	N/A	800,000	920,000	470,000[4]
Mar 1989	102.59	360,000	380,000	69.78	300,000	670,000	670,000
Apr 1989	102.69	340,000	350,000	71.45	530,000	880,000	880,000
Feb 1999	102.96	450,000	240,000	70.45	950,000	1,190,000	1,190,000
May 2009	99.62	110,000	110,000	62.19	80,000	180,000	180,000
Mar 2010	99.41	210,000	190,000	66.43	210,000	400,000	400,000
Oct 2010	101.37	280,000	280,000	69.61	340,000	620,000	620,000
Mid Dec 2010	100.42	130,000	140,000	67.50	230,000	370,000	370,000
Late Dec 2010	99.98	150,000	140,000	69.35	380,000	530,000	530,000
Jan 2011	105.11	820,000	820,000	74.97	1,930,000	2,750,000	2,750,000
Jan 2013	101.62	260,000	240,000	70.31	620,000	860,000	860,000
Feb 2022[5]	103.17	902,000	900,000	74.61	1,450,000	2,352,000	1,970,000

[1]Upper Brisbane River catchment inflow (excluding Stanley River catchment/Somerset Dam releases)
[2] Flood event occurred prior to construction of Somerset Dam. Flood volume estimate based on calibrated hydrologic model,
[3] Flood event occurred prior to construction of Wivenhoe Dam. Flood volume estimate based on calibrated hydrologic model,
[4] Wivenhoe Dam was partially completed during this Flood Event,
[5] Based on whole of event calibration described in Section 7.2

Given the difficulties described above in comparing historic floods, the most valid comparison which can be made to the 2022 Flood Event is with the January 2011 event. Both dams were in place during the 2011 flood event and the aspects of their physical configurations which impact flood volumes were relatively similar. However, the operational procedures which were in place in January 2011 were those of Revision 7 of the Manual. The procedures implemented in the

2022 Flood Event were from Revision 16 of the Manual and vary from those in place in 2011. The Operational Full Supply Level at Somerset Dam in place in January 2011 was 99 m AHD. For the 2022 Flood Event OFSL was 97 m AHD. During both events, the lake level in Somerset Dam was close to the respective OFSLs at the start of the event. The Operational Full Supply Level at Wivenhoe Dam in place for the 2011 event was 67 m AHD, and the lake level was close to this at the start of the event. For the 2022 Flood Event, OFSL was 65.9 m AHD and the initial lake level at commencement of the Flood Event was 62.16 m AHD.

The total inflow and release volume at Somerset Dam in the 2022 Flood Event was larger than the 2011 event. Peak lake level was lower in 2022 than 2011, as a result of the difference in OFSL and operating procedures between the two events. The 2022 Flood Event had the largest estimated flood/inflow volume at the Somerset Dam site for all flood events excluding the 1893 flood of record.

The total inflow (i.e. including Somerset Dam releases) and release volume at Wivenhoe Dam in the 2022 Flood Event was lower than for the 2011 flood event. Peak lake level was also lower in 2022, which is likely to be influenced by the lower inflow volume, lower starting lake level and difference in operating procedures between the two flood events. The 2022 Flood Event and 2011 flood event have the largest total flood/inflow volumes by a significant margin at the Wivenhoe Dam site since the 1893 flood of record, although neither Somerset nor Wivenhoe Dams existed in 1893 and so a direct comparison is difficult.

7. Post-Event Hydrology Analysis

7.1 Purpose

This section of the report documents flow data for the Flood Event as well as the methodology and results of a post-event hydrologic model calibration with the benefit of hindsight for the purpose of providing a more fulsome description of the Flood Event for section 385(1)(a) of the Act.

Post-event analysis is considered important for significant flood events and long duration events. Calibration of the catchment flows at each point in time during the event aims to obtain a reasonable match to recorded conditions relevant for making Release Plan decisions at that point in time. However, such real time calibrations may not provide the best overall definition of the Flood Event.

Comparison is made between the calibrated URBS parameter values adopted for the whole of event calibration (developed with the benefit of hindsight) and the URBS parameter values developed by the DSFOEs during the Flood Event (calibrated progressively during the event using the data that was available to that point in the event). Hydrological data from the event was also analysed to estimate reverse routed inflow hydrographs to Somerset Dam and Wivenhoe Dam (developed with the benefit of hindsight), which were compared with the inflow hydrographs estimated from URBS from the whole of event calibration. These assessments were undertaken with the benefit of hindsight and can be expected to differ from the data or information available to the Flood Engineers during the Flood Event.

It should be noted here that inflow to a dam cannot be measured directly and thus must be calculated from other data sets. There are three different types of inflow estimates documented in this report:

- Real time estimates of inflow derived with model runs in the FFS by the Flood Engineers and updated progressively through the course of the Flood Event. This is discussed in Section 3.2.
- Whole of event calibration inflow calculated from an FFS model calibration (with the benefit of hindsight) as part of post-event hydrologic analysis. To assist with this calibration, consideration has also been given to upstream gauges and the level data for upstream gauges presented in Section 2.5 has been converted to rated flow estimates which are presented in Section 7.2.1.
- Reverse routed inflow calculated as part of post-event hydrologic analysis on recorded lake level and release data.

7.2 Whole of event calibration

7.2.1 Rated flow hydrographs

Rated flow data for selected key gauges in the Brisbane River basin is shown in Figure 7-1 to Figure 7-19. This data was used to support the whole of event calibration estimates of flow at key gauge sites. Whilst the focus of real time model calibration during the actual operations was to lake level at Somerset Dam and Wivenhoe Dam, and rated flow at Moggill, the whole of event calibration with the benefit of hindsight and more time available allows the overall fit to be improved by considering other gauges throughout the Brisbane River basin.

Rated flow data was calculated from the recorded water level data at each gauge (shown in Section 2.5) using the relevant gauge rating tables from the FFS. It should be noted that there is a significant degree of uncertainty associated with some of these rating tables, particularly for flows that exceed the confinement of the channel of a watercourse and engage the surrounding floodplain. Some of the gauge sites in the Brisbane River basin are difficult to access, particularly during flood events. This means that gaugings are difficult to obtain for these gauges, and stable, reliable rating tables are difficult to establish. Gaugings that were carried out by Seqwater during the Flood Event are presented in Section 7.2.2.

The rating tables for these gauges from the FFS used during the Flood Event are tabulated in Appendix G. It is to be noted that rating tables for Brisbane River at Moggill, Jindalee and the Bremer River at Ipswich have not been included in Appendix G, as these ratings are tidally dependant and thus do not have a one to one (stage to discharge) relationship like the other gauges presented in Appendix G.

Stanley River to Somerset Dam

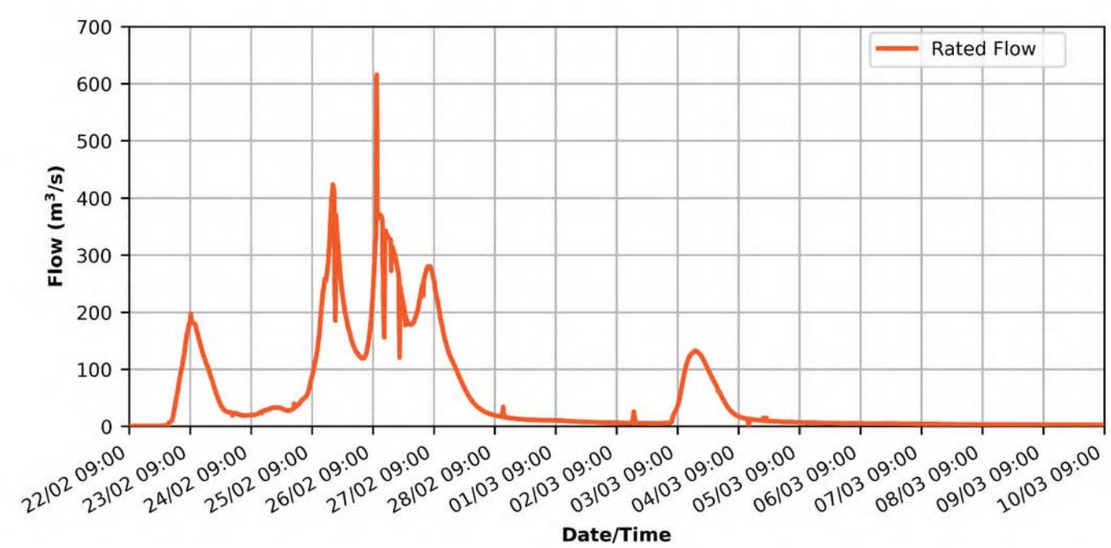

Figure 7-1: Rated flow for Stanley River at Peachester for the Flood Event

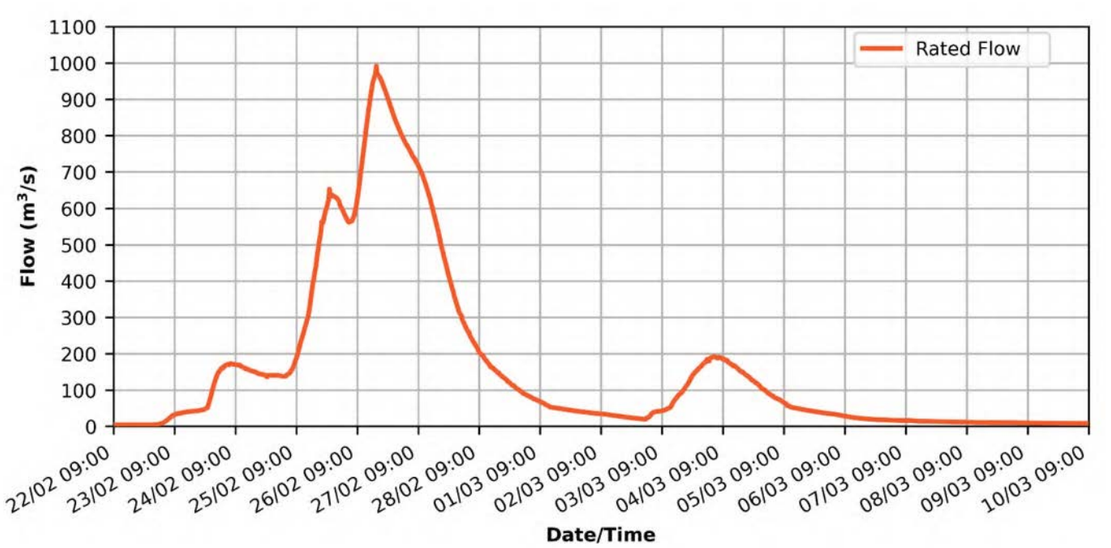

Figure 7-2: Rated flow for Stanley River at Woodford for the Flood Event

Brisbane River to Wivenhoe Dam

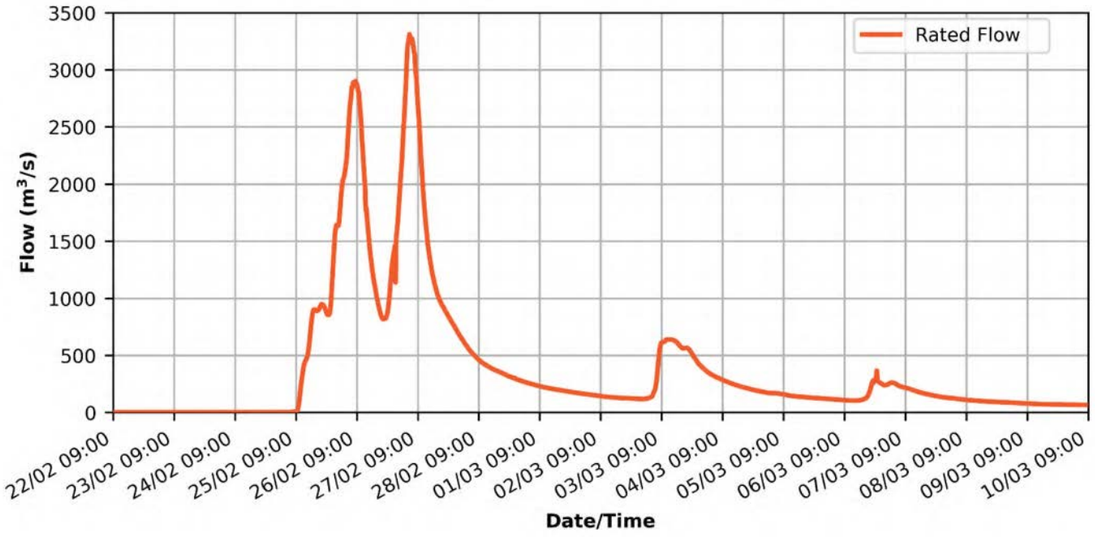

Figure 7-3: Rated flow for Brisbane River at Linville for the Flood Event

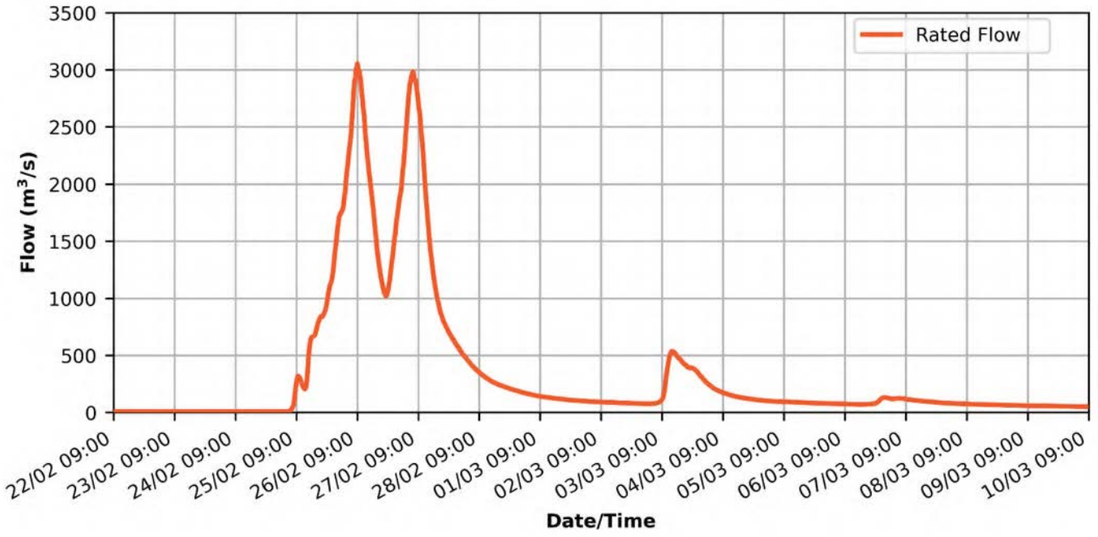

Figure 7-4: Rated flow for Brisbane River at Devon Hills for the Flood Event

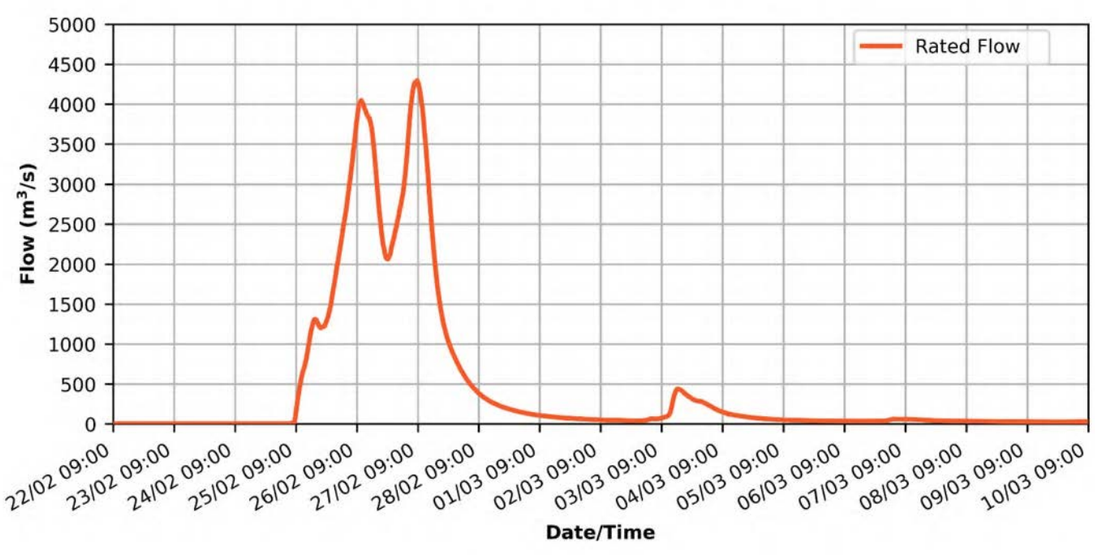

Figure 7-5: Rated flow for Brisbane River at Gregors Creek for the Flood Event

Lockyer Creek

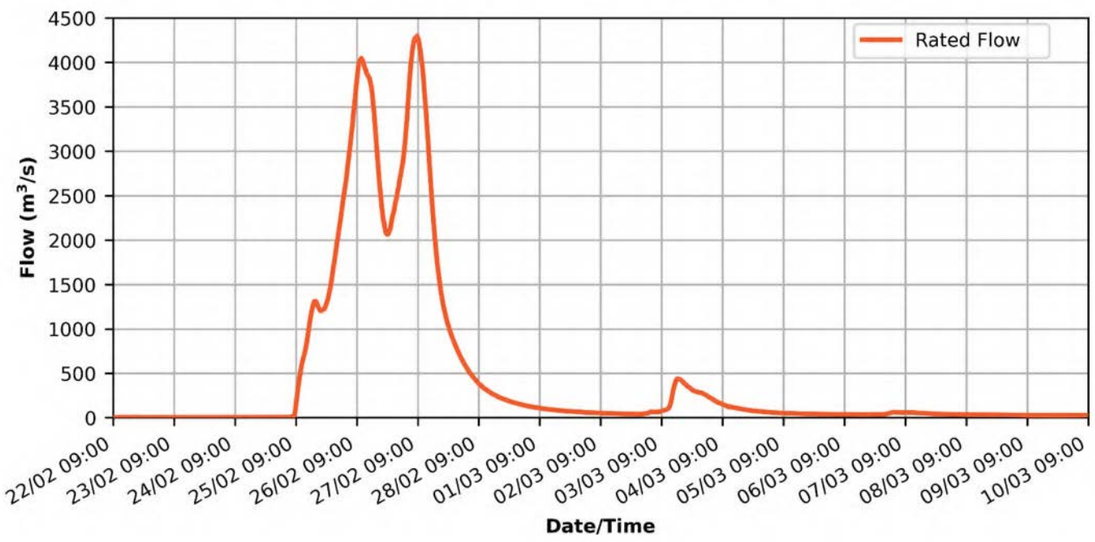

Figure 7-6: Rated flow for Lockyer Creek at Helidon for the Flood Event

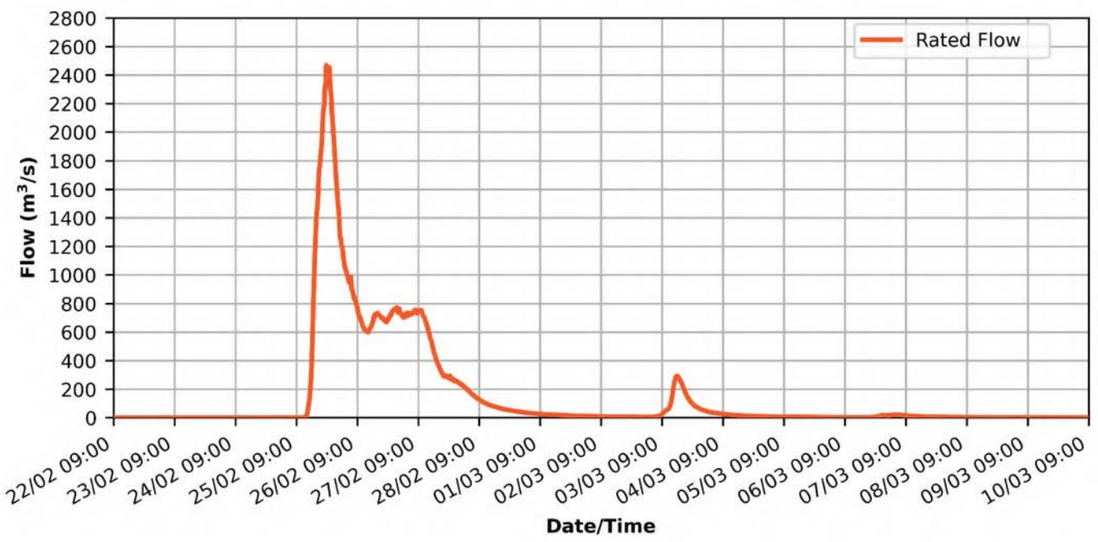

Figure 7-7: Rated flow for Lockyer Creek at Gatton for the Flood Event

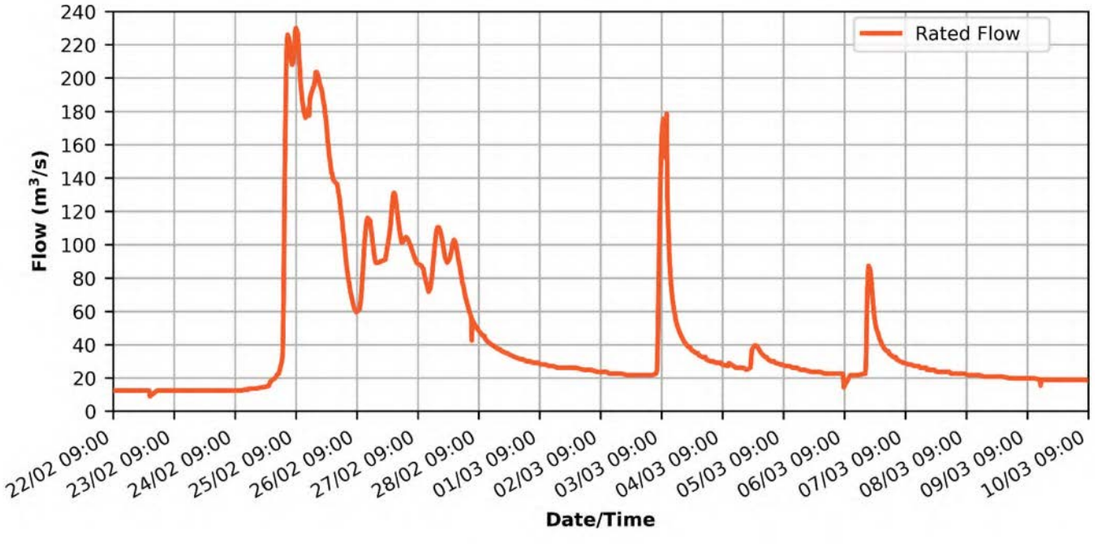

Figure 7-8: Rated flow for Laidley Creek at Mulgowie for the Flood Event

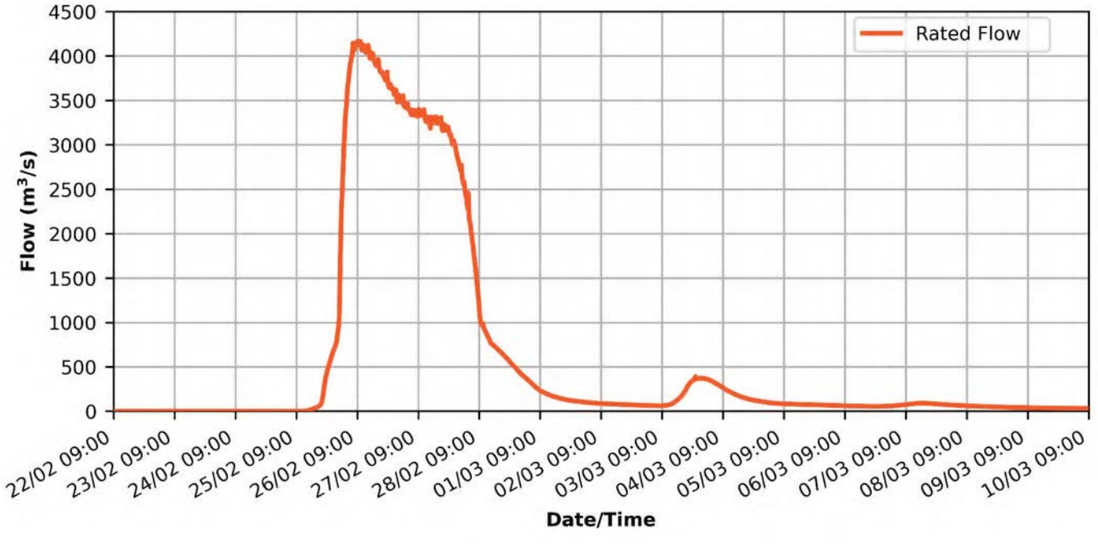

Figure 7-9: Rated flow for Lockyer Creek at Rifle Range Rd for the Flood Event

Note that this gauge rating is known to be unreliable for flow rates above approximately 1,000 m³/s. It is presented in this report because of the failure of the more reliable Glenore Grove gauge early in the Flood Event.

Bremer River

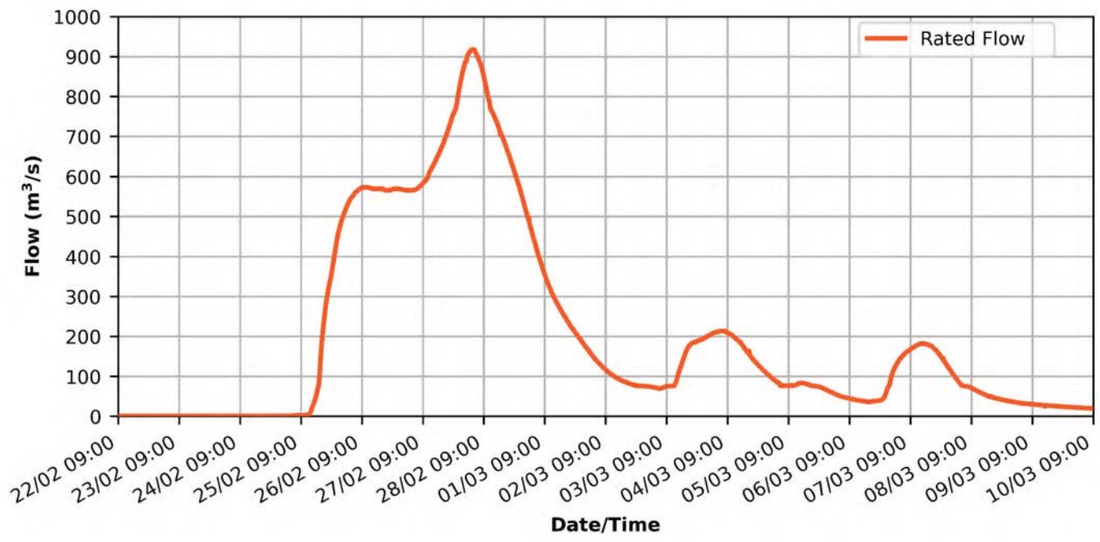

Figure 7-10: Rated flow for Warrill Creek at Amberley for the Flood Event

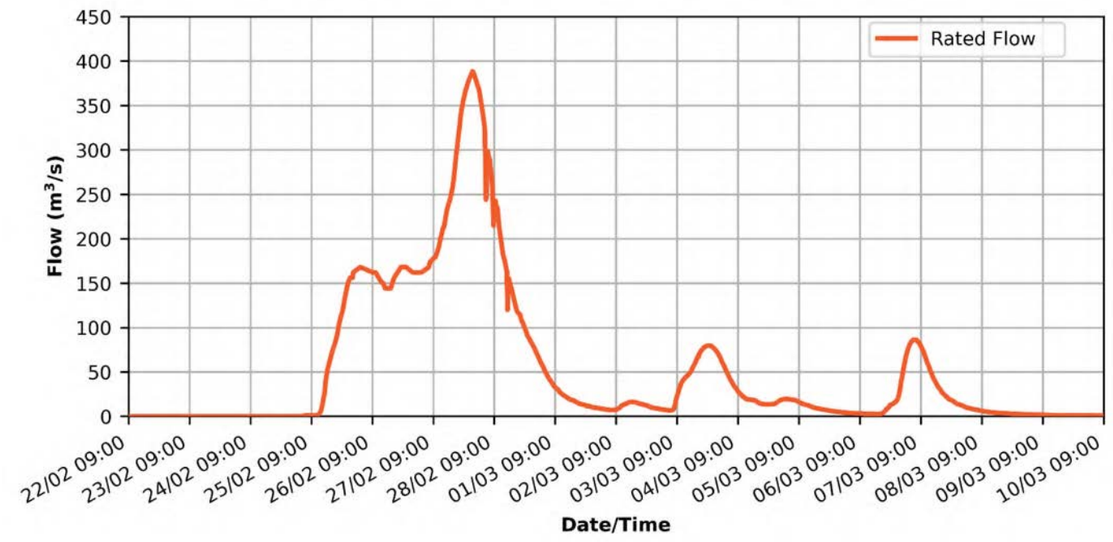

Figure 7-11: Rated flow for Purga Creek at Loamside for the Flood Event

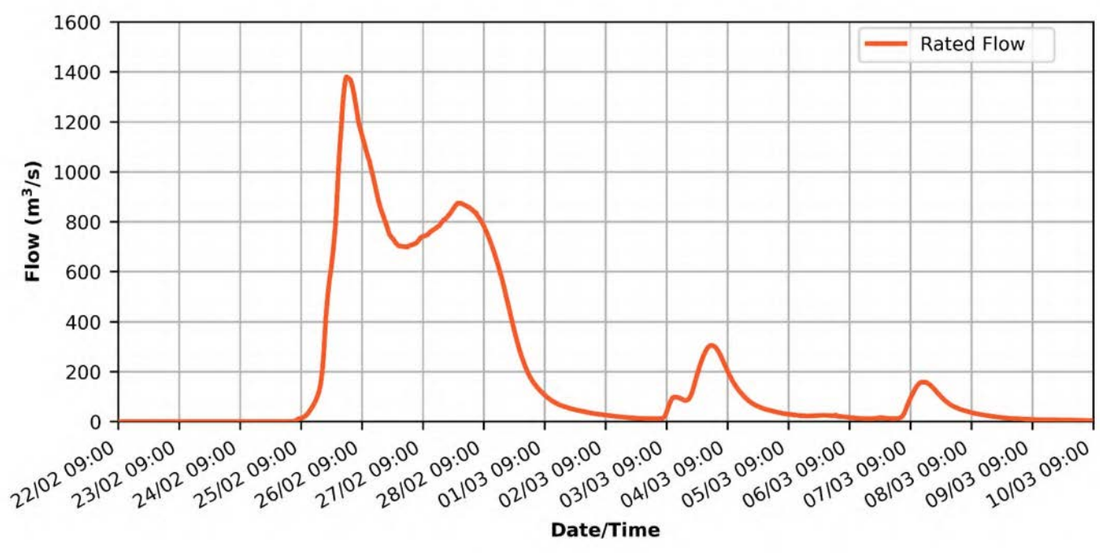

Figure 7-12: Rated flow for Bremer River at Walloon for the Flood Event

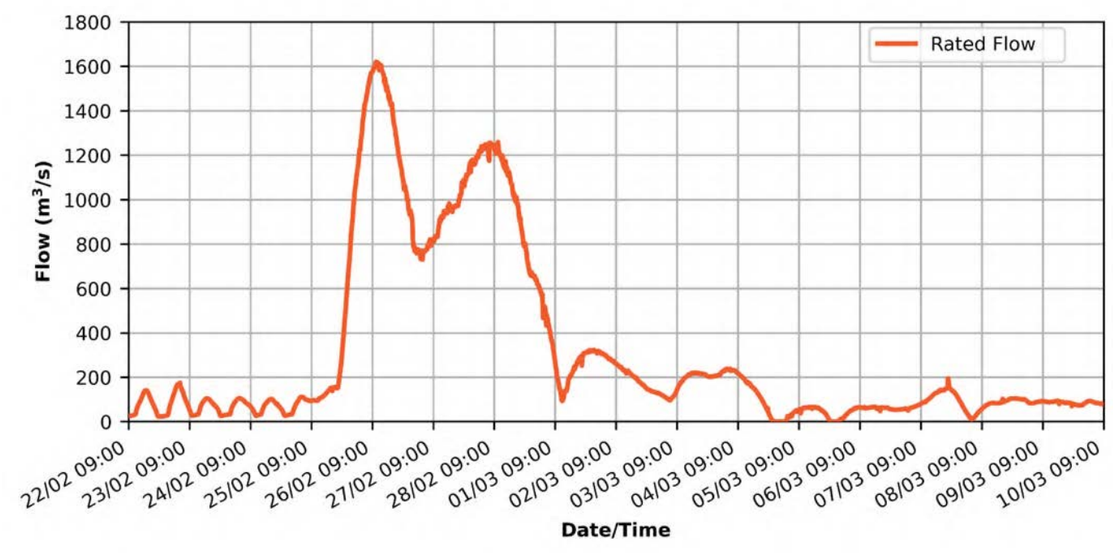

Figure 7-13: Rated flow for Bremer River at Ipswich for the Flood Event

Brisbane River between Wivenhoe Dam and Moggill

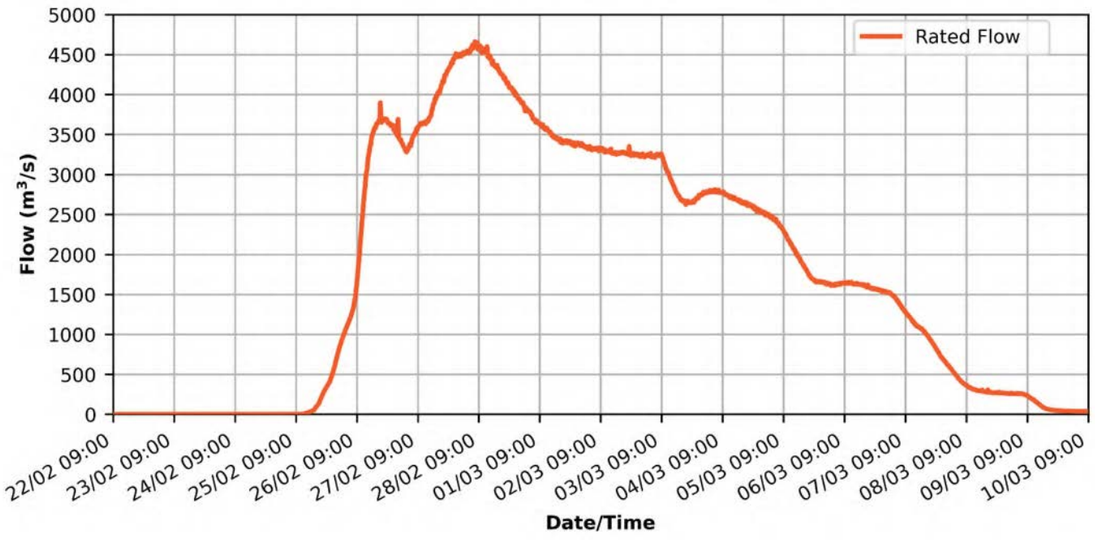

Figure 7-14: Rated flow for Brisbane River at Lowood for the Flood Event

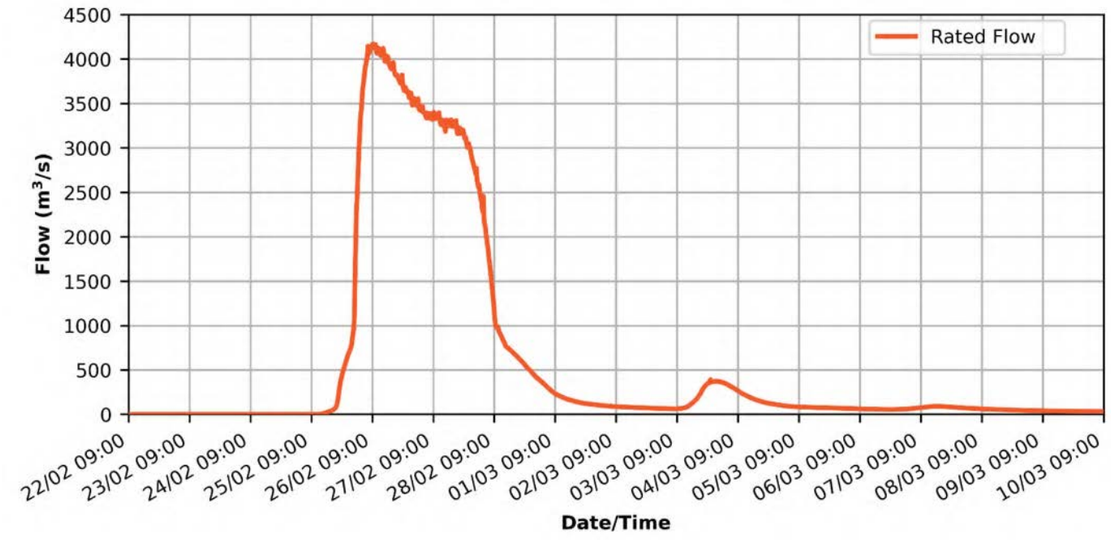

Figure 7-15: Rated flow for Brisbane River at Savages Crossing for the Flood Event

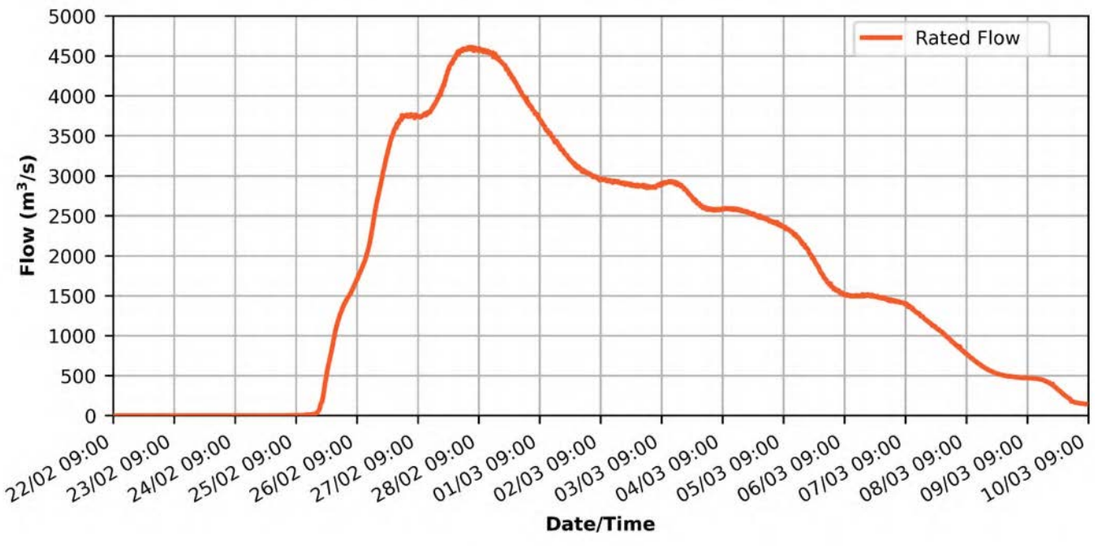

Figure 7-16: Rated flow for Brisbane River at Mt Crosby for the Flood Event

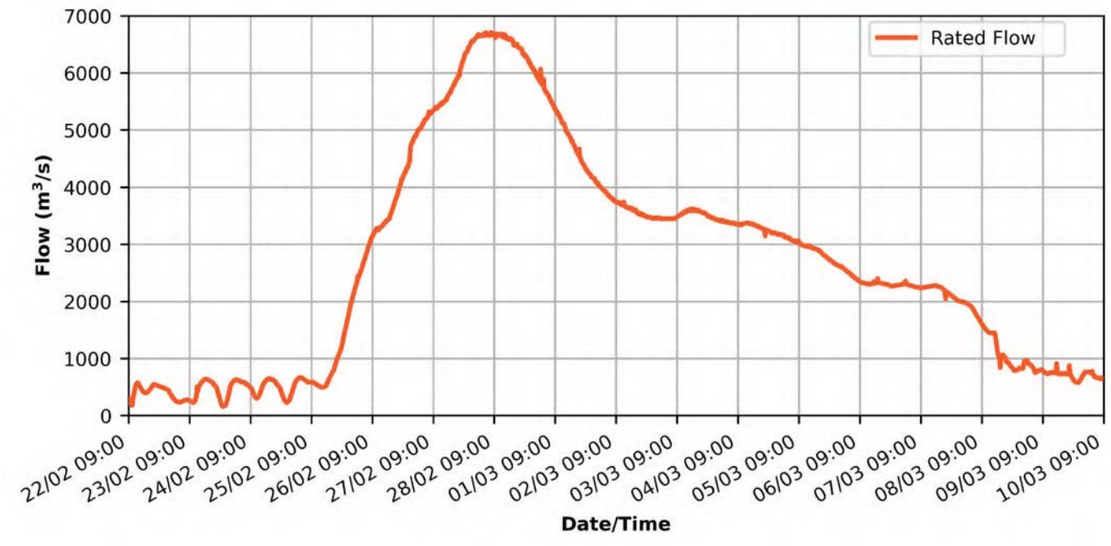

Figure 7-17: Rated flow for Brisbane River at Moggill for the Flood Event

Brisbane River downstream of Moggill

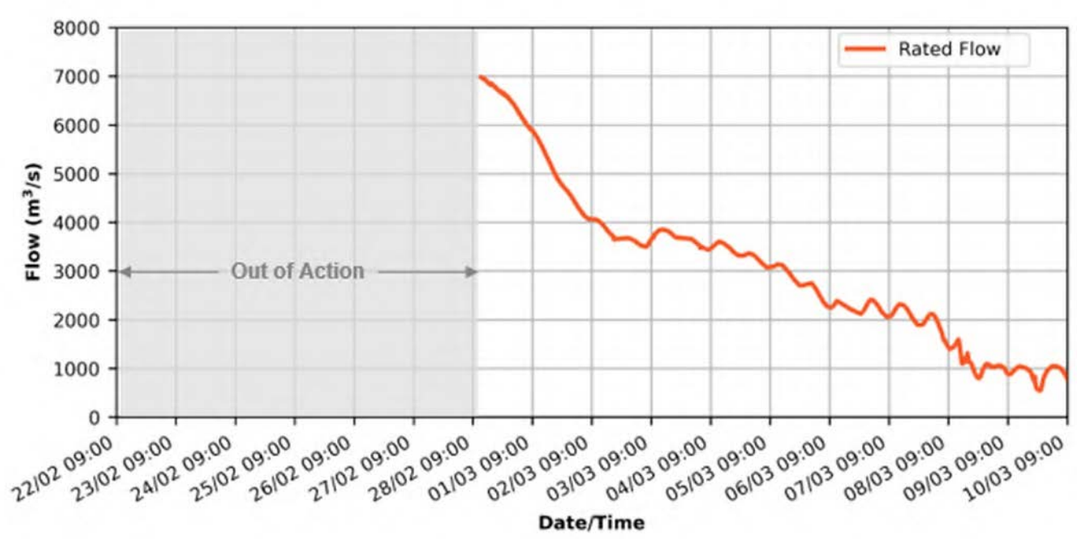

Figure 7-18: Rated flow for Brisbane River at Jindalee for the Flood Event

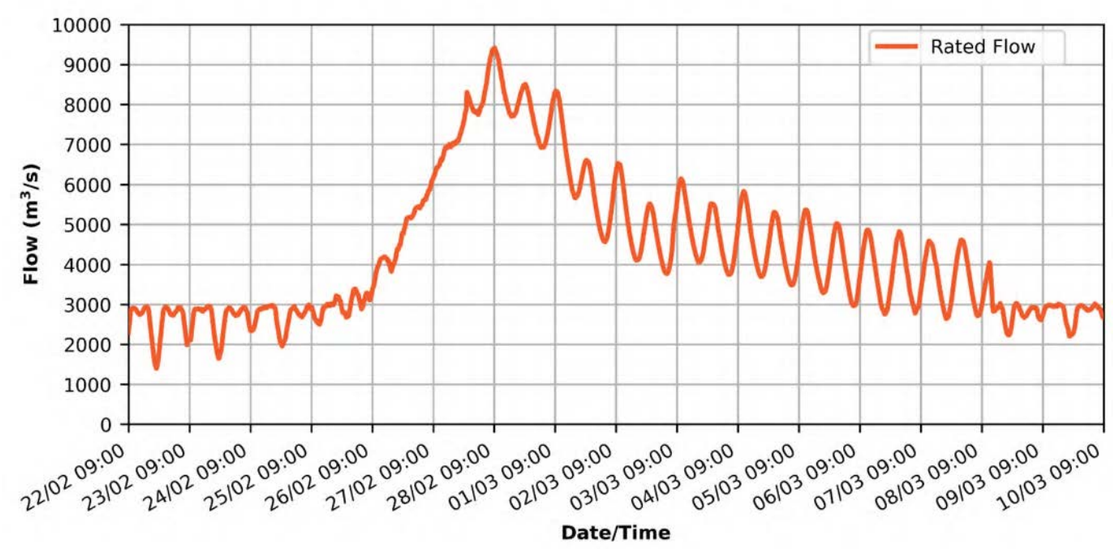

Figure 7-19: Rated flow for Brisbane River at Brisbane City for the Flood Event

7.2.2 Flow gaugings

During floods, Seqwater arranged for hydrographers to measure streamflow at selected water level gauges using an Acoustic Doppler Current Profiler (ADCP). This process is referred to as 'flow gauging' and the information obtained is very valuable as an input to developing and confirming a reliable rating at each gauge.

It should be noted that deployment of personnel to undertake flow gaugings during flood events is difficult due to site access and occupational health and safety considerations. As a result, it is not possible to obtain flow gaugings at many sites or at the time of peak water levels during the event.

Gaugings were completed for the Brisbane River at Jindalee and Bremer River at Five Mile Bridge, during the period from 01/03/2022 to 4/03/2022 and from 04/03/2022 to 08/03/2022 respectively. The gauged results are shown in Table 7-1 and Table 7-2.

Table 7-1: Brisbane River at Jindalee gaugings

Date	Discharge (m^3/s)	Start gauge board height (m)	End gauge board height (m)
01/03/2022 14:03	5,589	N/A	N/A
02/03/2022 12:29	4,110	5.36	5.34
03/03/2022 11:03	3,812	5.02	5.07
04/03/2022 11:00	3,388	4.53	4.61

A comparison plot of the rated discharge against the gaugings taken at Jindalee is shown in Figure 7-20.

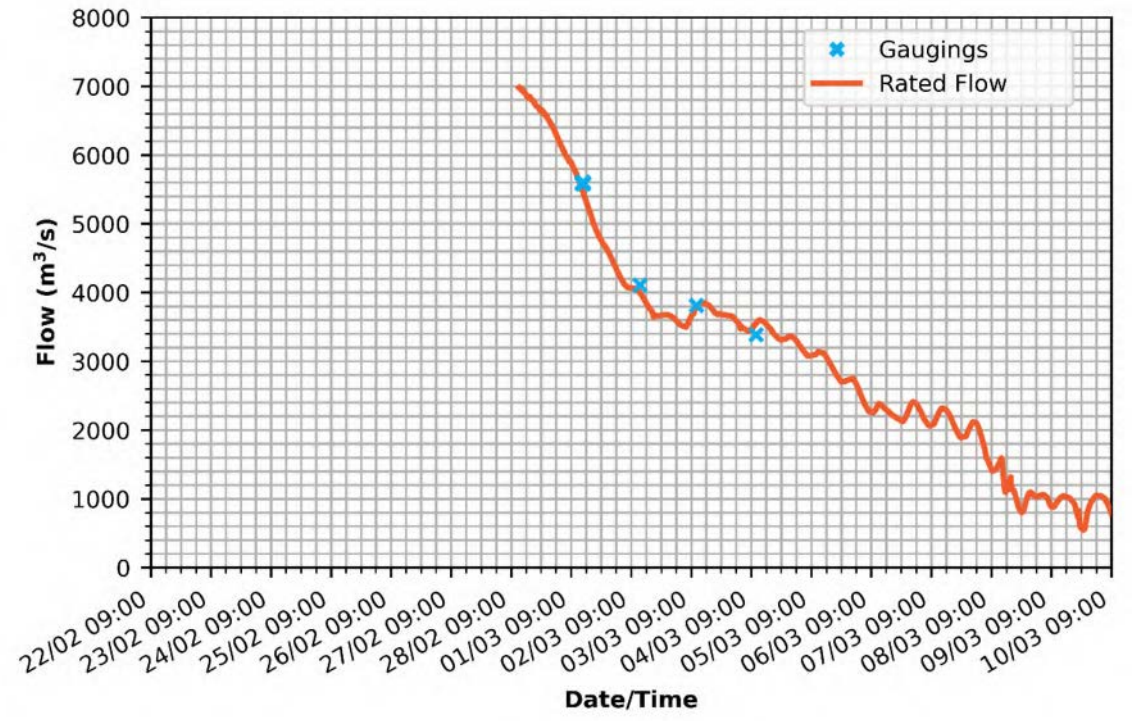

Figure 7-20: Comparison of gauged flow at Jindalee and rated flow

The gaugings at Jindalee were recorded after the peak of the Flood Event on the receding limb of the hydrograph. The four flow gaugings are generally consistent with the rated flow, which provides confidence that the rating curve at this gauge is reasonable.

Table 7-2: Bremer River at Five Mile Bridge gaugings

Date	Discharge (m³/s)	Start gauge board height (m)	End gauge board height (m)
4/03/2022 13:23	75	4.20	3.90
8/03/2022 11:53	22	2.85	2.76

A comparison plot of the simulated hydrograph extracted from URBS and the gaugings taken at Five Mile Bridge is shown in Figure 7-21. Water level data and hence the rated flow at Five Mile Bridge was suspect due to an error with the continuous gauge water level readings during the Flood Event. Therefore, the simulated flow from the last approved model run from FEWS was used to compare the gaugings recorded during the Flood Event. The gaugings shown in Figure 7-21 matched the simulated flows in URBS but it is inconclusive as to whether the gaugings would match the currently adopted rating curve at this location.

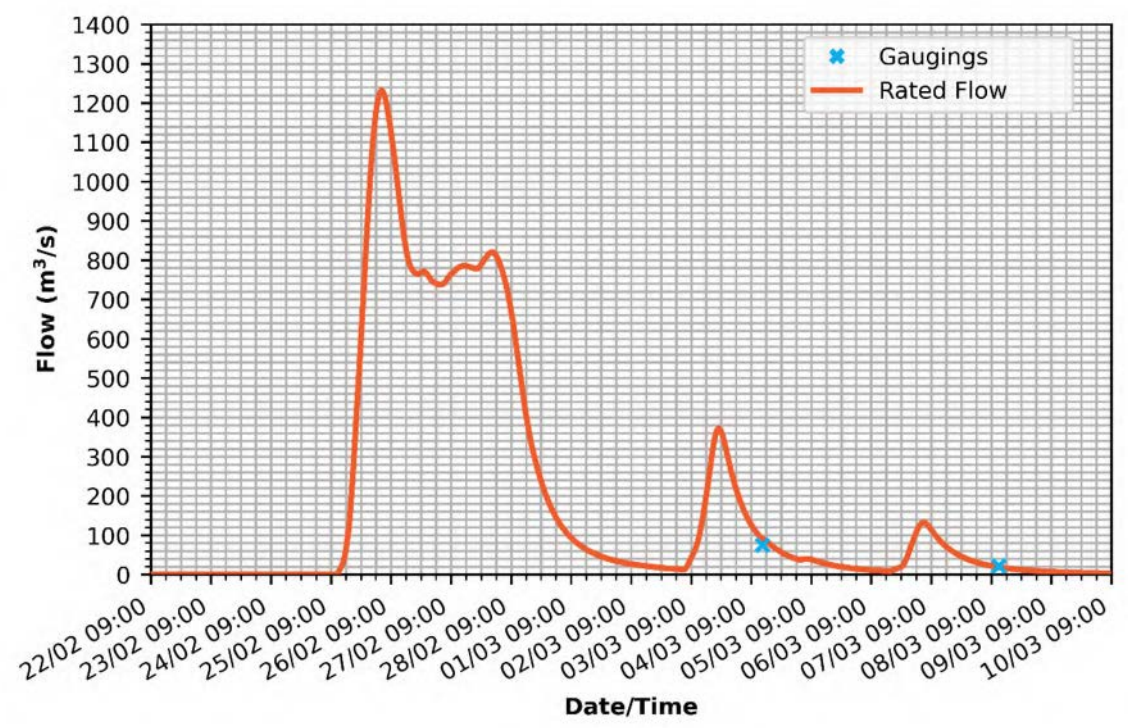

Figure 7-21: Comparison of gauged flow at Five Mile Bridge and simulated flow from the last archived run

7.2.3 URBS model calibration

The list of archived model runs in the FFS was used to select which model run was used as the initial starting point for the whole of event calibration. The archived model run that was selected was the last run completed for the Flood Event. The run time for that model was 09/03/2022 16:15.

The aim of the whole of event calibration was to use the benefit of hindsight to achieve a generally good match to the overall Flood Event data. The selected archived model run already provided a reasonable match throughout the catchment, so this process focused on minor adjustments to model parameter values at key locations to determine if the calibration could be enhanced with the benefit of hindsight.

Three sets of parameter values were modified throughout the Flood Event by the Flood Engineers to achieve calibration of the model:

- The rainfall-run-off loss parameters: Initial Loss (IL), Initial Loss Recovery Rate (RIL) and Continuing Loss (CL)
- The URBS routing parameters: Alpha (α) and Beta (β)
- The baseflow parameters: baseflow constant (BC), baseflow recession constant (BR) and the baseflow exponent (BM) and the baseflow scaling factor

URBS has three additional routing parameters, which were kept at their default values for all model runs undertaken during the flood event. These were the exponent on non-linear routing

within sub-catchments (m = 0.8), exponent on non-linear routing within stream reaches (n = 1.0) and the Muskingum routing translation parameter (x = 0.25). These default values were also retained for the whole of event calibration.

Minor adjustments were made to the URBS input parameter values to see if better fits could be achieved at the primary calibration points within the:

- Lockyer Creek catchment;
- Bremer River catchment; and
- Middle to Lower Brisbane River catchment.

The URBS model parameter values for Warrill Creek, Purga Creek and Lake Manchester were not modified from the last archived run. The contribution of these catchments on the total flows along the Bremer and Brisbane Rivers were relatively small and the adopted parameter values produced relatively good fits at the key calibration locations.

The URBS model parameters for the Stanley River model and Upper Brisbane model were also not modified as the last archived model resulted in a good calibration to lake level at Somerset Dam and Wivenhoe Dam. The parameters were initially adjusted to better fit Peachester, Woodford, Gregors Creek and Linville gauges, however, fitting the hydrographs at those gauges tended to compromise the fit to lake level at Somerset Dam and Wivenhoe Dam.

The final parameter values that were adopted for the whole of event calibration are summarised in Table 7-3.

Table 7-3: Summary of whole of event calibration model parameter values adopted (changed values from selected archive run highlighted)

URBS model parameters	Approved run parameters produced during the Flood Event					Adopted parameters produced with the benefit of hindsight				
	Stanley	Upper Brisbane	Lockyer	Bremer River	Lower Brisbane	Stanley	Upper Brisbane	Lockyer	Bremer River	Lower Brisbane
Initial loss (mm)	90	105	120	100	90	90	105	120	80	90
Continuing loss (mm/h)	2.0	3.0	3.0	0.4	2.5	2.0	3.0	3.0	0.4	4.0
Infiltration capacity [IF] (mm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Recovering initial loss factor [RF]	0.14	0.05	0.13	0.3	0.1	0.14	0.05	0.1	0.3	0.1
Alpha [α]	0.14	0.1	0.25	0.27	0.27	0.14	0.1	0.28	0.37	0.22
Beta [β]	2.1	2.0	3.0	4.5	3.0	2.1	2.0	2.7	3.4	3.0
Baseflow scaling factor	0	0	0	0	0	0	0	0	0	0
Persistent baseflow [B0]	0	0	-	0	-	0	0	-	0	-
Baseflow recession [BR]	0.69	0.90	-	0.6	-	0.69	0.90	-	0.6	-
Baseflow constant [BC]	0.085	0.018	-	0.02	-	0.085	0.018	-	0.01	-
Baseflow exponent [BM]	1.0	1.0	-	1.0	-	1.0	1.0	-	1.0	-

Compared with the archived FFS model run selected as the starting point for calibration, the parameter values that were modified were the initial loss, continuing loss, alpha and beta parameters. Some of the URBS model parameter values for the recovering initial loss factor, baseflow recession and baseflow constant were refined, however they only resulted in minor changes with the final simulated hydrographs. The significant changes in the model parameter values were:

- The continuing loss was changed from 2.5 mm/h to 4.0mm/h for the Lower Brisbane model
- Alpha was increased from 0.14 to 0.23 for the Stanley River model and 0.27 to 0.37 for the Bremer River model
- Beta was increased for the Upper Brisbane model from 1.5 to 2.0 and decreasing from 4.5 to 3.4 for the Bremer River model

The aim of modifying the model parameter values was to improve the fit at the primary calibration location but not compromise the lake level match at Somerset Dam and Wivenhoe Dam as well as the rated flow at the Moggill gauge.

7.2.4 Calibration results

The URBS model parameter values developed with the benefit of hindsight (summarised in Figure 7-24) were modelled in the FFS to generate hydrographs at key locations. The resulting estimates of inflow to Somerset Dam and Wivenhoe Dam are shown in Figure 7-22 and Figure 7-23 respectively. The modelled hydrographs are compared to observed lake level and rated flows at key locations to demonstrate the fit as shown in Figure 7-24 to Figure 7-30.

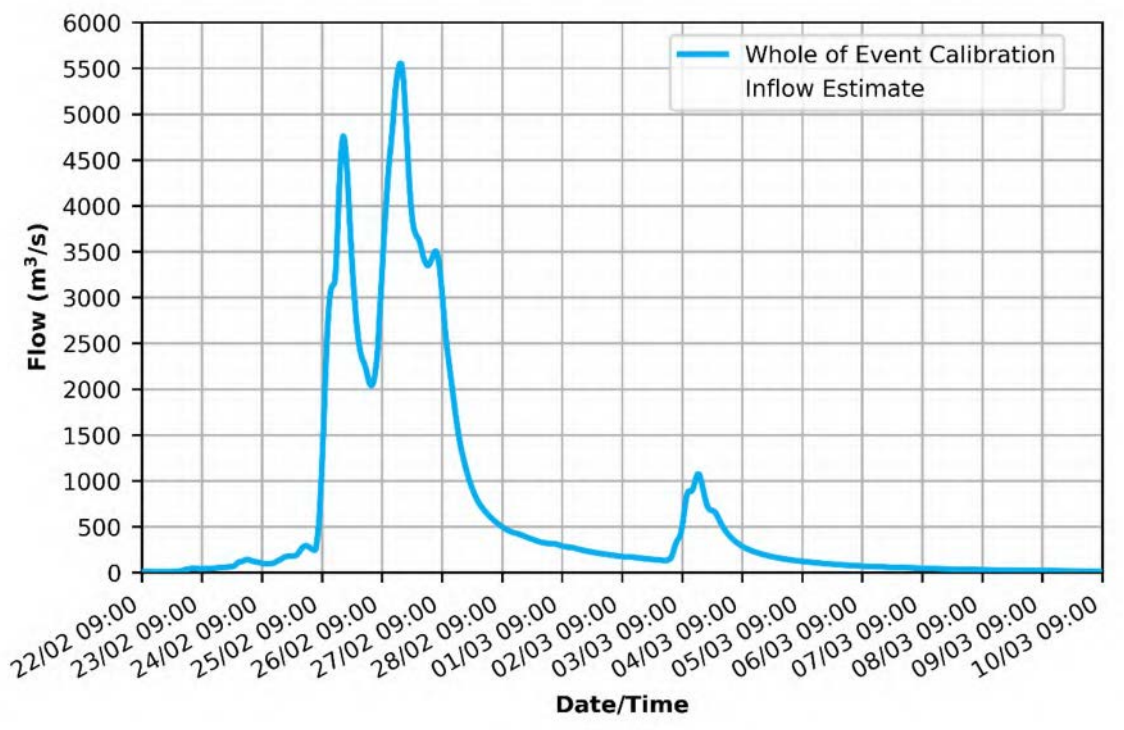

Figure 7-22: Somerset Dam modelled inflow hydrograph produced by the post-event analysis whole of event calibration (with the benefit of hindsight)

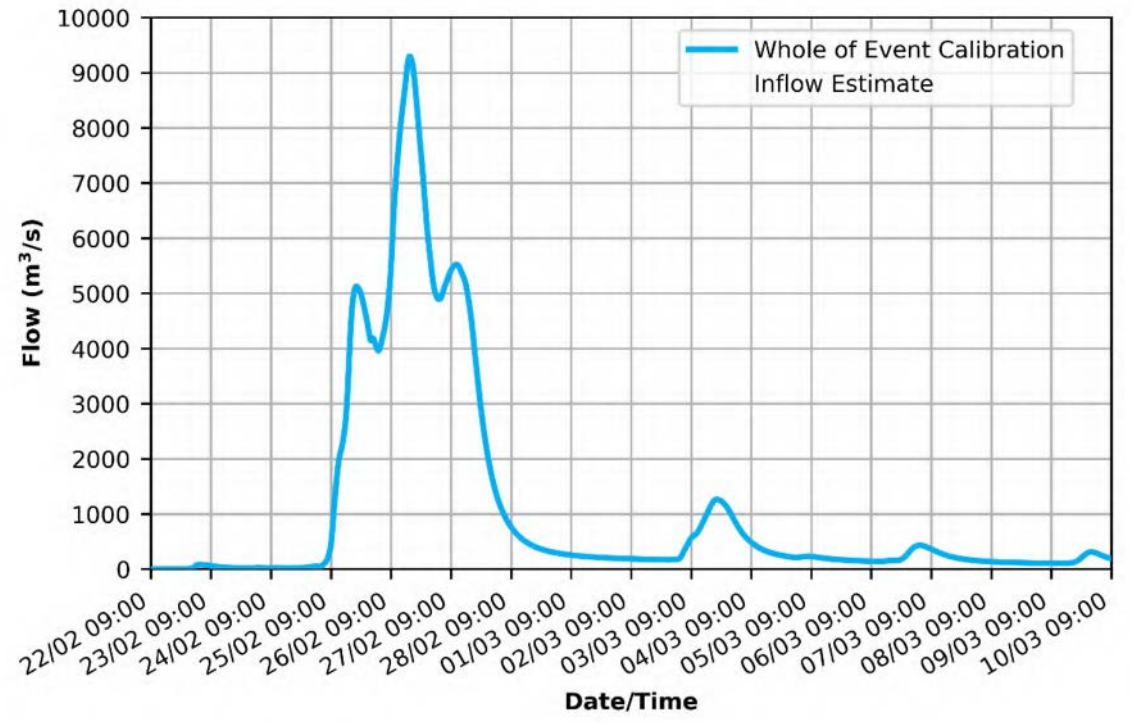

Figure 7-23: Wivenhoe Dam modelled inflow hydrograph excluding Somerset Dam releases produced by the post-event analysis whole of event calibration (with the benefit of hindsight)

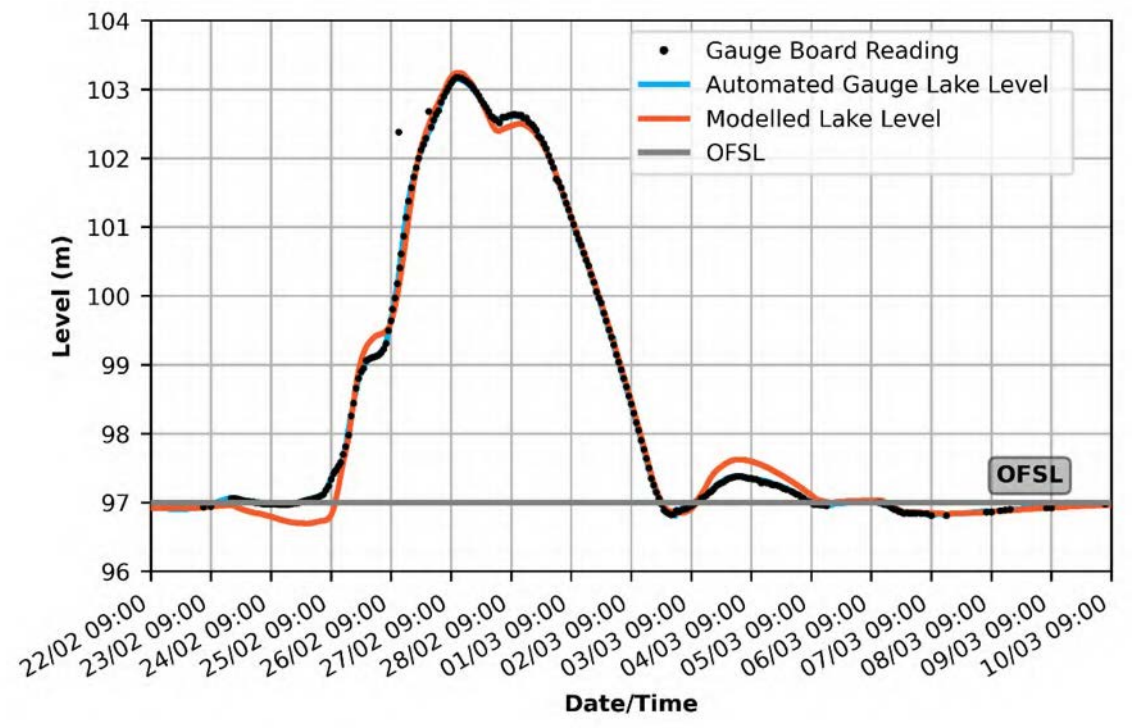

Figure 7-24: Somerset Dam post-event analysis whole of event calibration modelled lake level compared to automated data and gauge board readings for the period 22/02/2022 09:00 to 10/03/2022 09:00 (replicated in Figure v)

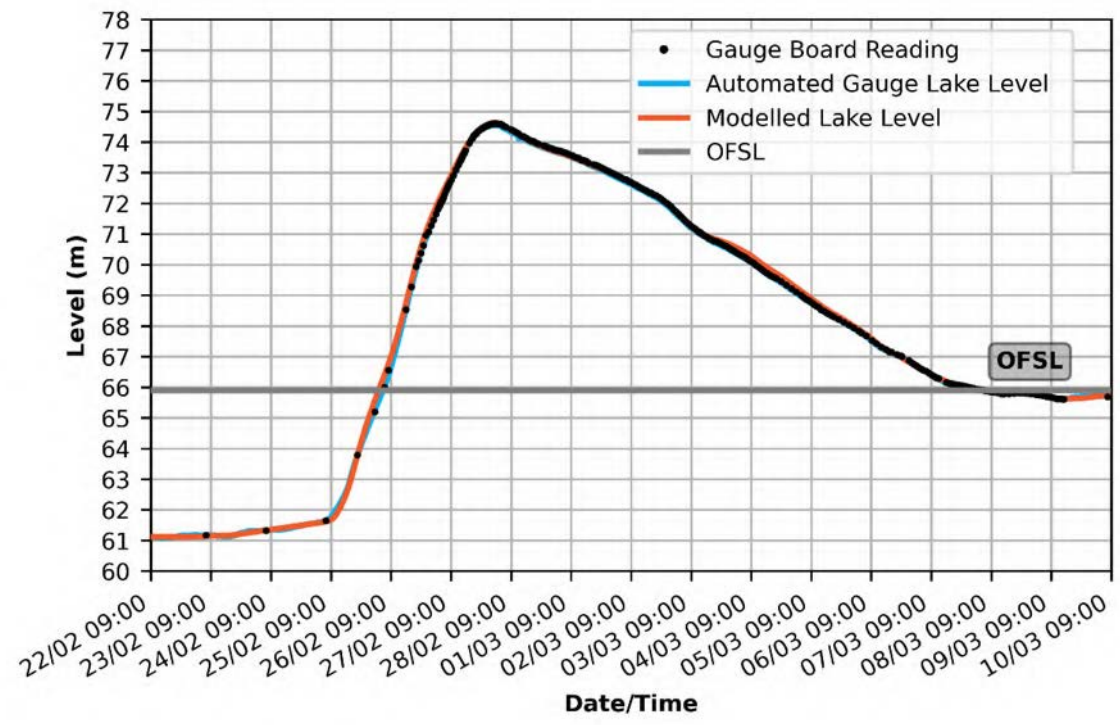

Figure 7-25: Wivenhoe Dam post-event analysis whole of event calibration modelled lake level compared to automated data and gauge board readings for the period 22/02/2022 09:00 to 10/03/2022 09:00 (replicated in Figure vi)

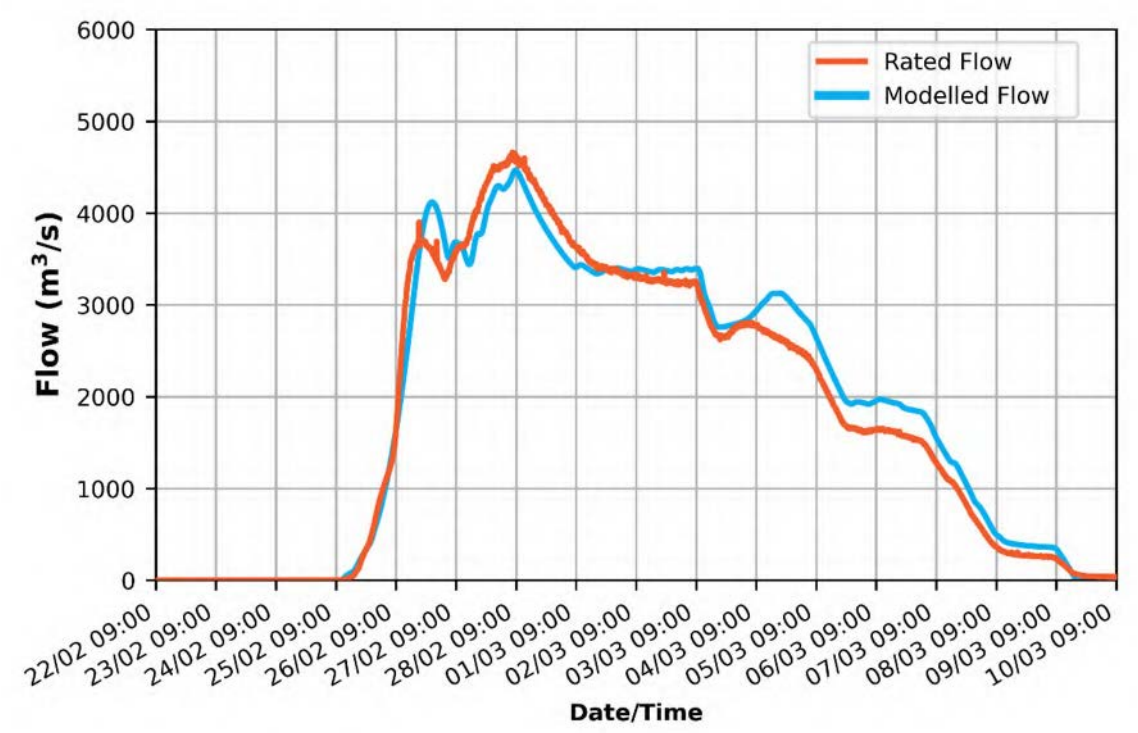

Figure 7-26: Post-event analysis whole of event calibration result (with the benefit of hindsight) at Lowood

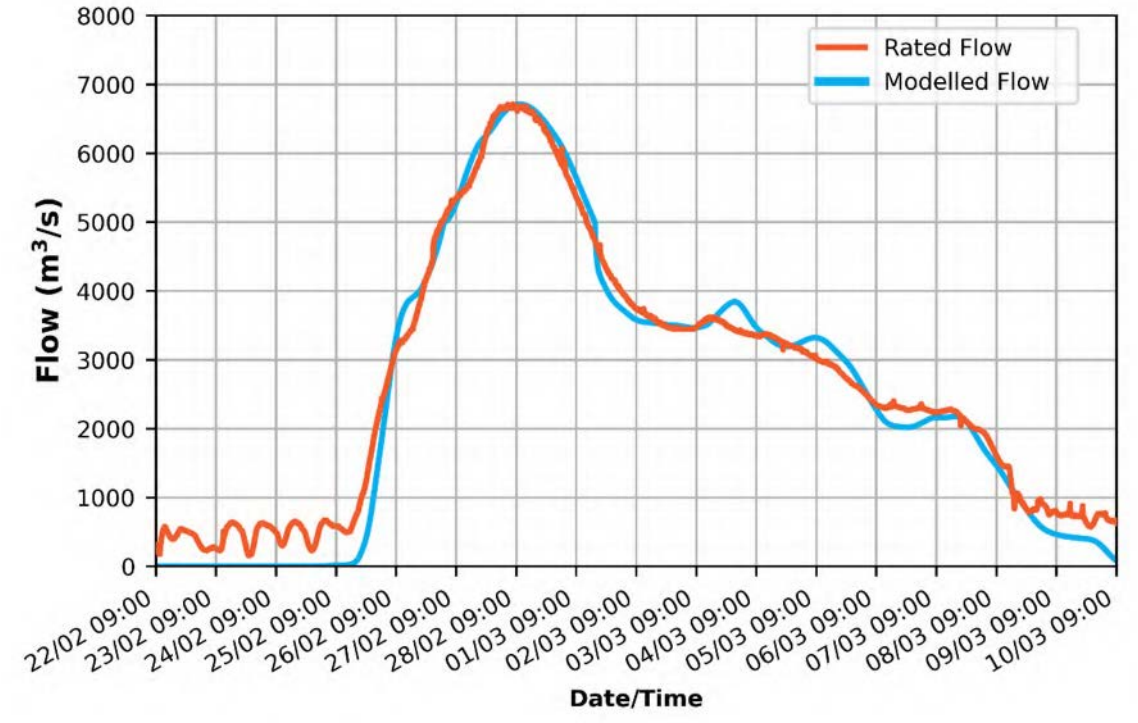

Figure 7-27: Post-event analysis whole of event calibration result (with the benefit of hindsight) at Moggill

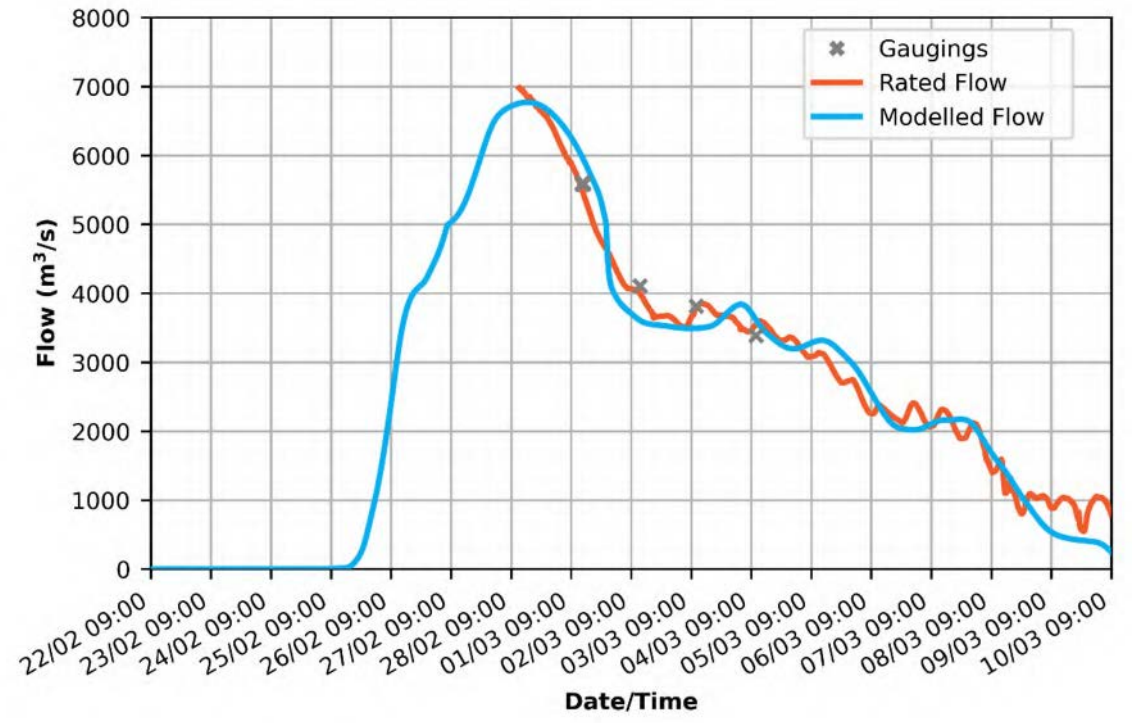

Figure 7-28: Post-event analysis whole of event calibration result (with the benefit of hindsight) at Centenary Bridge compared with rated flow and flow gaugings

The results show that the updated model parameters improved the fit at several key locations in the Brisbane River catchment. In particular, the calibration in the Bremer River catchment improved without any adverse impacts on the calibration at Moggill. The modelled levels in Wivenhoe Dam and Somerset Dam match well with the recorded data. The catchment that was more difficult to calibrate than the others was the Lockyer Creek catchment. Gatton was the only gauge that was used for the whole of event calibration because the Glenore Grove gauge malfunctioned during the flood (refer to Table 2-3 in Section 2.2). The hydrograph at Lowood (Figure 7-26) did not match the observed data as well especially for the initial peak from the Lockyer Creek catchment. Adjustments were made to the Lockyer Creek catchment by modifying alpha, continuing loss and the infiltration capacity to better fit the first two peaks.

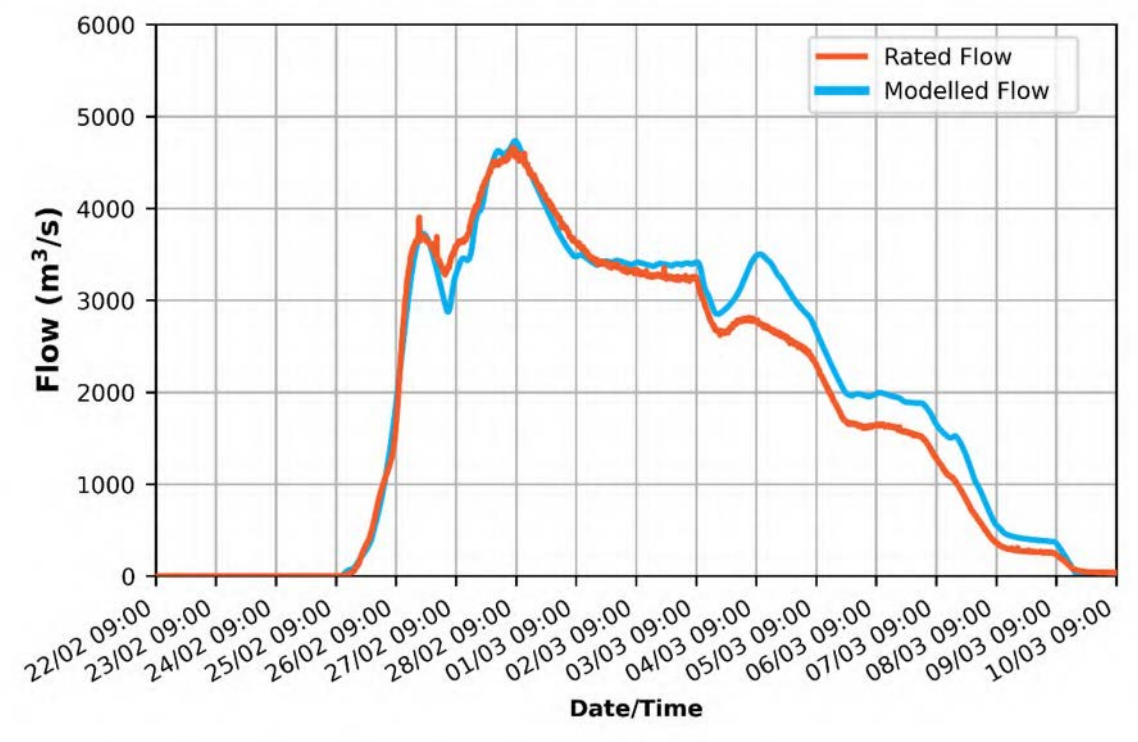

Figure 7-29: Whole of event calibration result (with the benefit of hindsight) at Lowood with revised Lockyer Creek parameter values to better match Lockyer Creek at Gatton

There was a trade-off with improving the fit at Lowood against the fit at Moggill, Jindalee and Brisbane City because the calibration at Moggill (Figure 7-30) was poorer using this approach than the previous attempt (Figure 7-27). This may be because floodplain storage routing influences between Lowood and Moggill are difficult to simulate for this range of flow. The Lockyer Creek catchment parameter values from Table 7-3 were therefore adopted in lieu of the modified parameters to fit Lowood because of the better match at Moggill, Jindalee and Brisbane City.

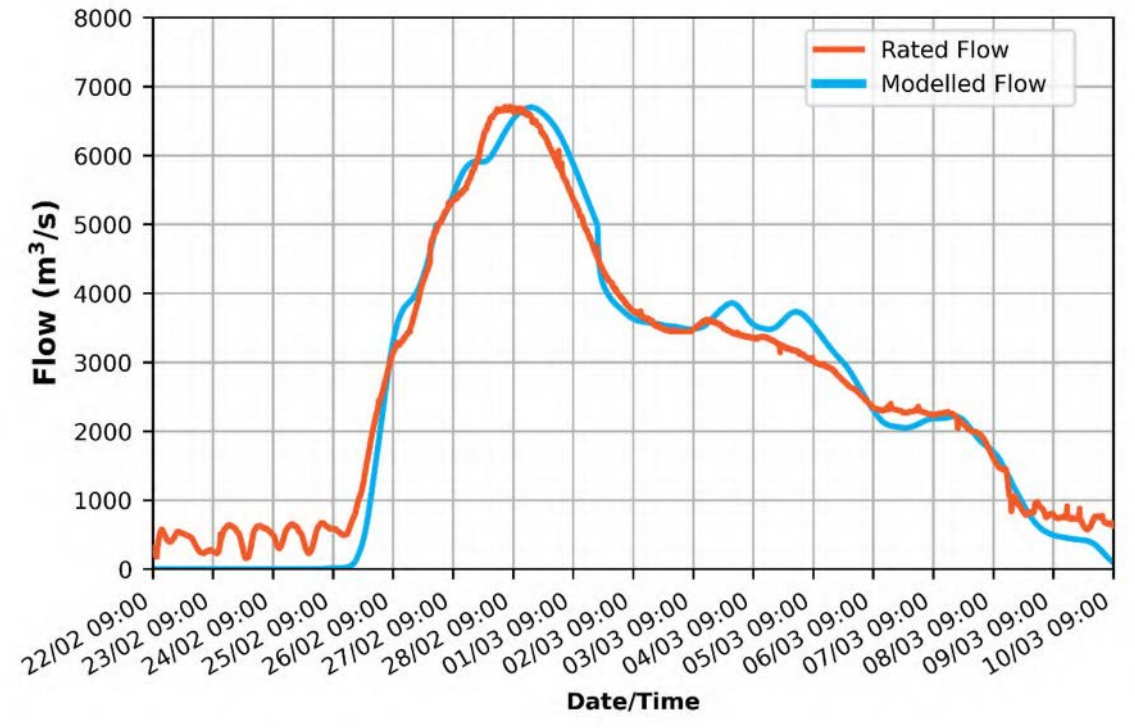

Figure 7-30: Whole of event calibration result (with the benefit of hindsight) at Moggill with revised parameter values to better match Lockyer Creek inflows (Figure 7-29)

7.3 Reverse routed inflows

Reverse routing is a technique that can be used to derive an estimate of inflow for a dam, based on recorded lake levels (converted to storage volumes) and releases. For each time step, inflow is based on the change in storage volume and the releases over that time step.

The following information was extracted from the data provided by Seqwater for the reverse routing assessment:

- Recorded lake level hydrographs for Somerset Dam and Wivenhoe Dam;
- Recorded release hydrographs from Somerset Dam and Wivenhoe Dam, based on recorded lake level and gate settings; and
- Elevation-storage relationship for Somerset Dam and Wivenhoe Dam.

Lake level hydrograph

The recorded lake level data for Somerset Dam and Wivenhoe Dam was extracted from the FFS. There were several different lake level data sources that were considered for use in the reverse routing assessment. These are summarised in Table 7-4.

Table 7-4: Lake level data sources used to inform the reverse routing assessment

Somerset Dam		Wivenhoe Dam	
Data source	**Gauge ID**	**Data source**	**Gauge ID**
Bureau gauge	143305A	Bureau gauge	143036A
Seqwater automated gauge P	540159	Seqwater automated gauge	540302
Seqwater automated gauge P2	540471	Gauge board readings	40763
Gauge board reading	40189		

The recorded lake level data from the Bureau and Seqwater automated gauges was compared with the gauge board reading data to validate the levels in Somerset and Wivenhoe Dam. The lake level data was generally consistent between all of the datasets, therefore the Seqwater automated lake level data was adopted for the reverse routing calculation. The adopted lake level hydrographs for Somerset Dam and Wivenhoe Dam are shown in Figure 7-31 and Figure 7-32 respectively.

Figure 7-31: Adopted Somerset Dam lake level hydrograph for reverse routing

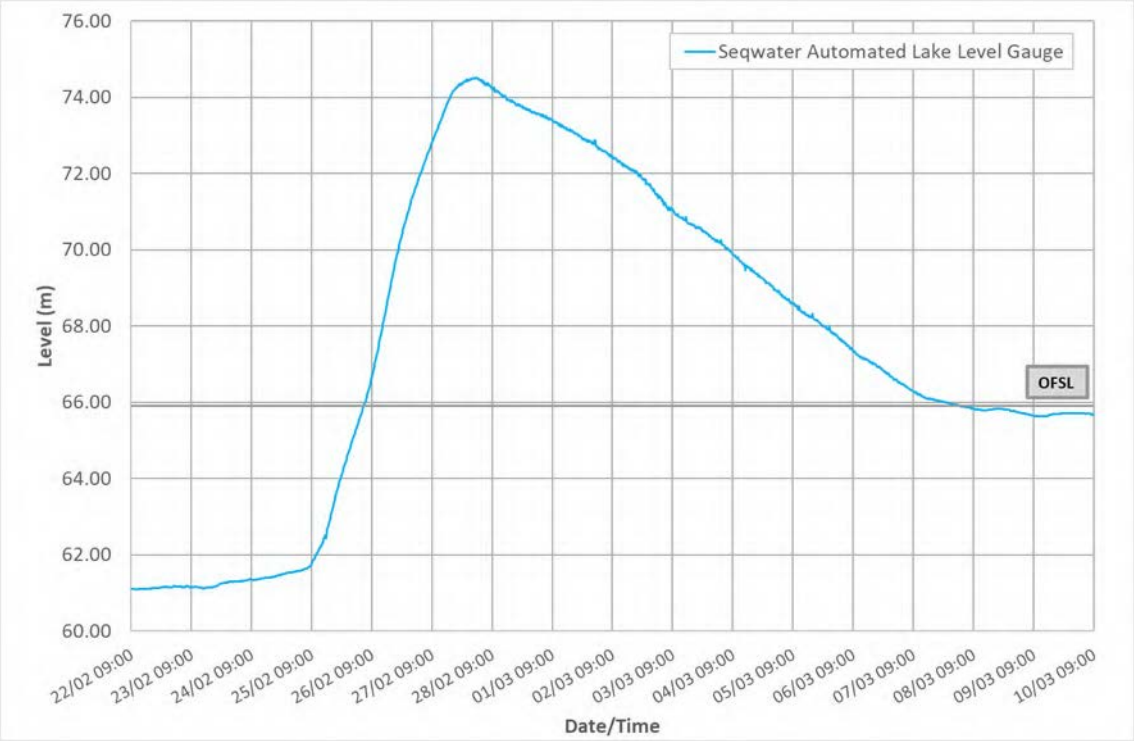

Figure 7-32: Adopted Wivenhoe Dam lake level hydrograph for reverse routing

Recorded release hydrographs

The recorded release hydrographs for Somerset Dam and Wivenhoe Dam, based on recorded lake levels and gate settings, were extracted from the FFS. Note that the data was used as recorded in the FFS, and no attempt was made to adjust the data to account for differences between settings in the Gate Operations Models and FFS described in Section 8.3.4.

Elevation-storage relationship

The elevation-storage curves were obtained from the Gate Operations Model for Somerset Dam and Wivenhoe Dam. The elevation storage-curve for Somerset Dam and Wivenhoe Dam is shown in Figure 7-33 and Figure 7-34.

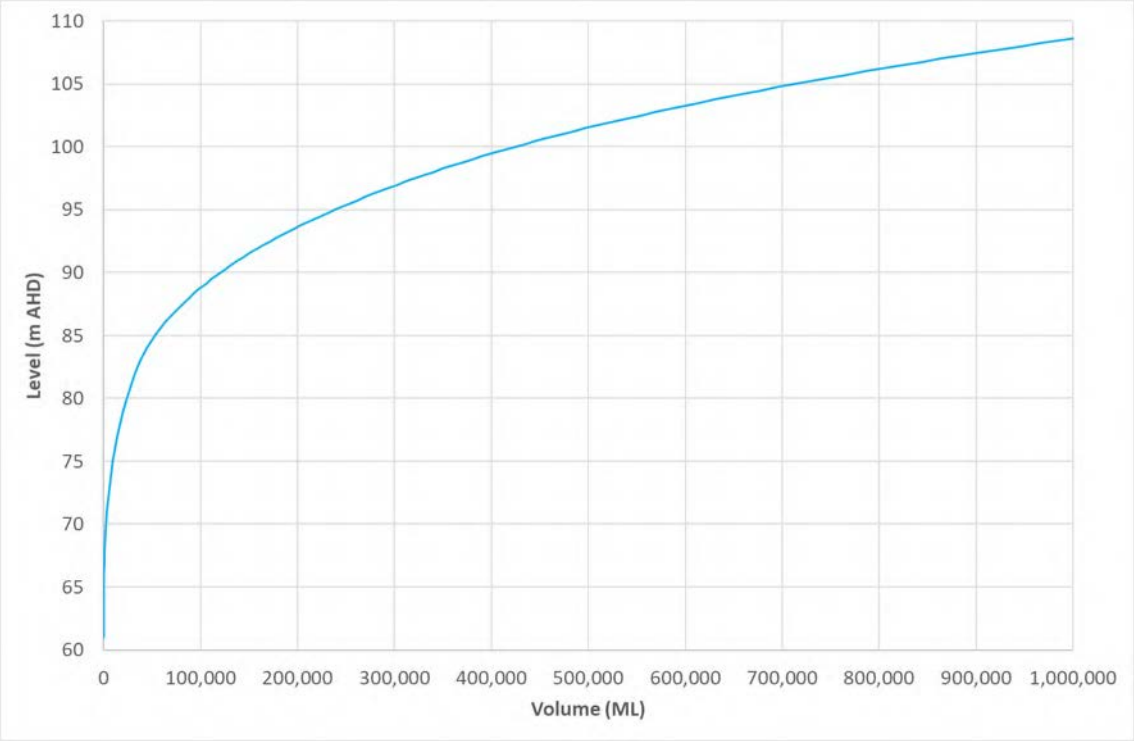

Figure 7-33: Somerset Dam storage-elevation relationship

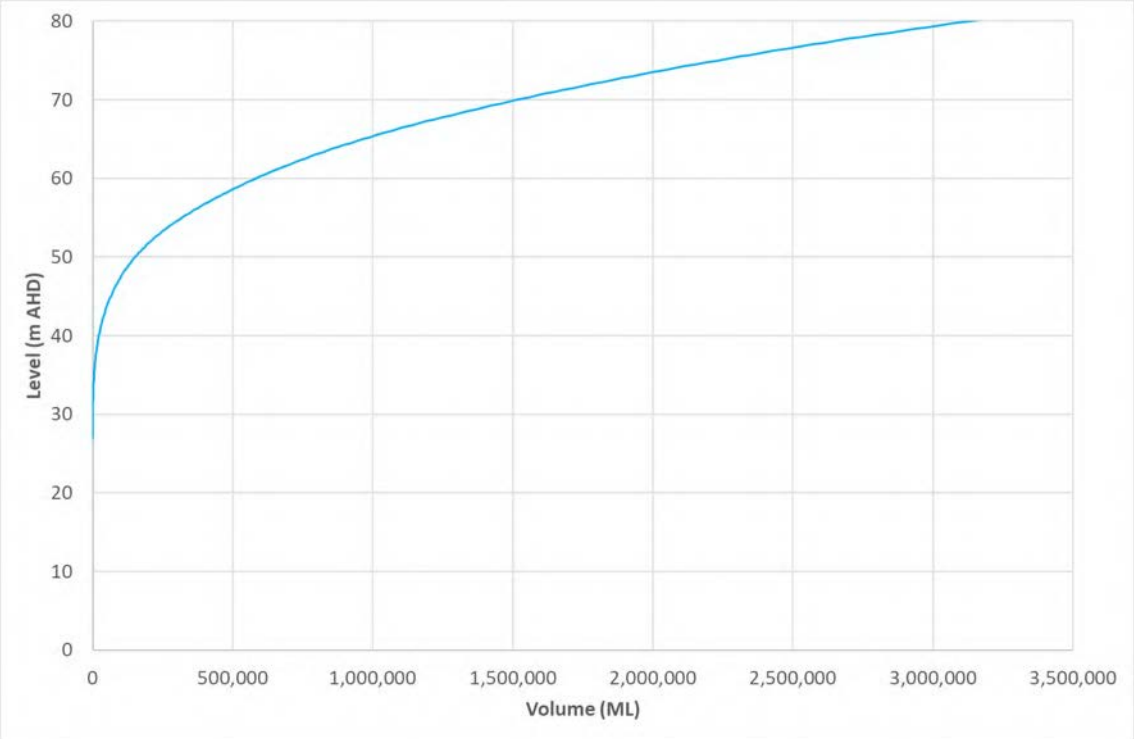

Figure 7-34: Wivenhoe Dam storage-elevation relationship

The reverse routing process is dependent on the time step chosen for the lake volume and calculations. There is a trade-off between temporal resolution and the noise (uncertainty in the

estimated values for each time step) of the reverse routed inflow hydrograph. A smaller time step will typically improve the representation of the peak flows but it can result in a very "noisy" hydrograph, with the value for each time step subject to larger uncertainties. The time step that was chosen for the Somerset Dam and Wivenhoe Dam reverse routed inflows was 120 minutes. This tended to produce a plausible inflow hydrograph that did not have a significant amount of noise when the inflows were above approximately 500 m^3/s.

The other consideration that was made for the reverse routing assessment was the influence of Somerset Dam releases on the Wivenhoe Dam inflows. In order to isolate the contribution of the Upper Brisbane River inflows into Wivenhoe Dam, the recorded Somerset Dam releases were subtracted from the reverse routing calculations. This was an effective way to compare the inflow hydrograph to the URBS inflow hydrograph.

The reverse routed hydrographs for Somerset Dam and Wivenhoe Dam are shown in Figure 7-35 and Figure 7-36 respectively. The whole of event calibration inflow estimates have also been plotted to demonstrate differences between the two methods. The Somerset Dam recorded release hydrograph has also been included on Figure 7-36 to demonstrate the contribution of the Somerset releases in relation to estimated Wivenhoe Dam inflows.

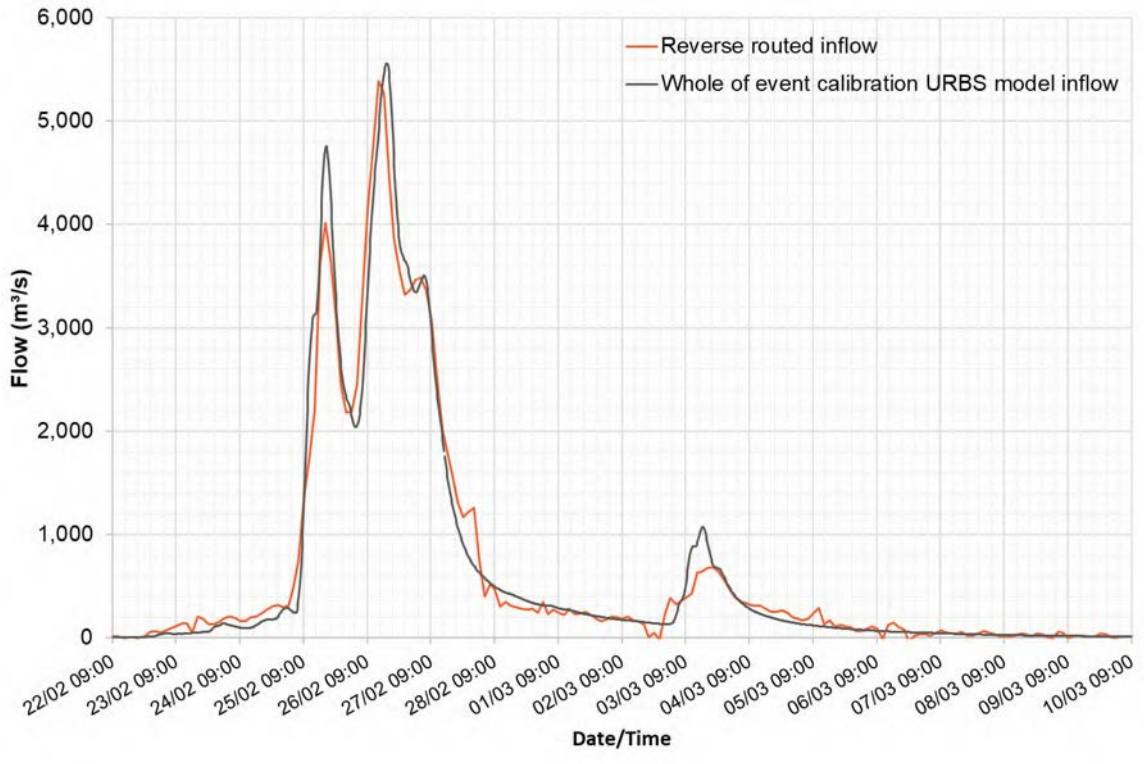

Figure 7-35: Post-event analysis reverse routed inflow calculation for Somerset Dam

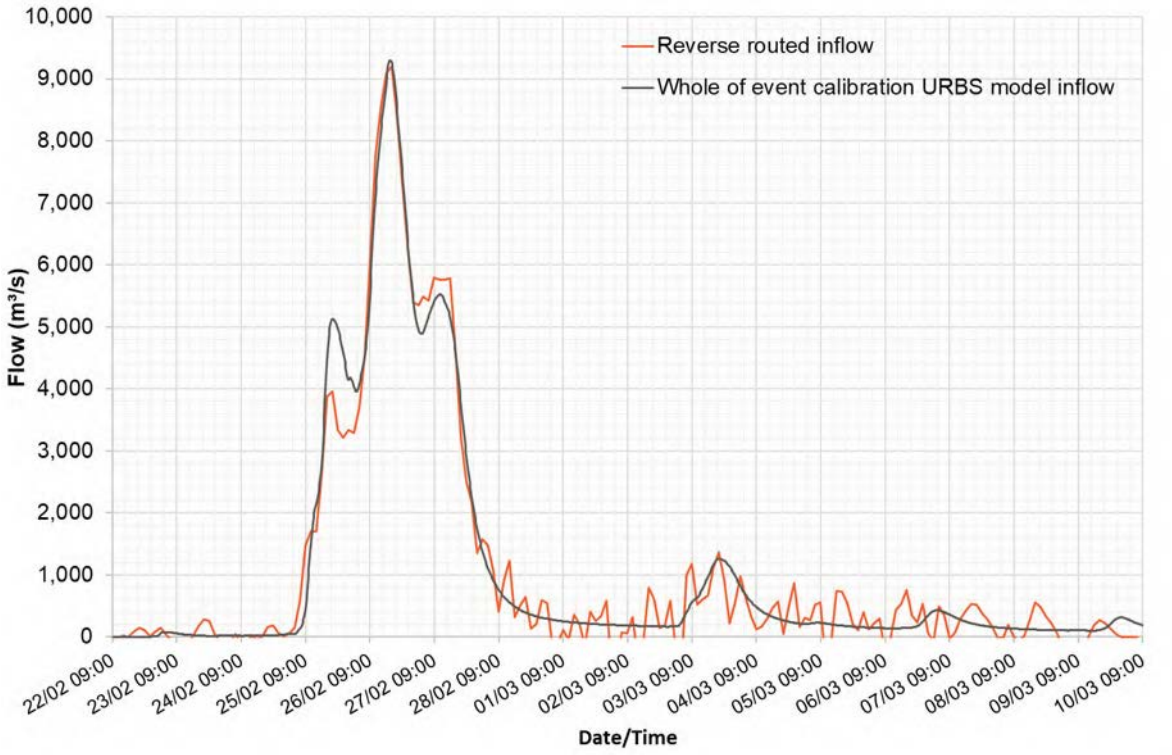

Figure 7-36: Post-event analysis reverse routed inflow calculation for Wivenhoe Dam

The reverse routed inflow estimate (using a time step of 120 minutes) for both the Somerset Dam and Wivenhoe Dam inflows corresponded closely to the whole of event calibration inflow. There was some noise in the rising and receding limbs of the reverse routed inflow hydrograph estimate when inflows were less than approximately 500 m^3/s. Adoption of a longer time step would dampen this noise however, the shape of the peak would be compromised. The resolution of the lake level readings is a key source of noise in reverse routing analyses.

8. Event Review

This section of the report summarises the operation of Somerset Dam and Wivenhoe Dam during the Flood Event, and as required under the Act, provides an assessment of:

- The implementation of the Manual, including record keeping;
- The effectiveness of the Manual;
- The Flood Forecasting System; and
- The performance of and any damage to the Dams.

8.1 Compliance with the Manual

The operating procedures that applied in this Flood Event are described in the Wivenhoe and Somerset Dam Manual of Operational Procedures for Flood Mitigation, Revision 16 (November 2021).

Based upon the evidence available from the Strategy Logs, Flood Forecasting System (FFS) simulations, Gate Operations Models, Gate Directives and recorded rainfall and river level data, the flood operations implemented at the dams during this Flood Event complied with the procedures in the Manual.

A detailed description of the operating procedures applied at the Dams during the Flood Event is provided in Section 4.2. Throughout the Flood Event, there were a number of key decisions made by the SFOEs which were critical for this Flood Event. These are described in more detail below:

- The decision that the criteria for the commencement of the Flood Event at Somerset Dam described in Section 13.2 of the Manual were met on 25/02/2022 at 12:10. At this time it was judged likely that the lake level would exceed 1 metre above OFSL including operational releases. Operational releases from Somerset Dam were substantial with five sluices and one regulator with a total release close to 1,000 m^3/s.
- The decision on 25/02/2022 at 22:30 to cease releases from Wivenhoe Dam under Flood Mitigation Strategy Procedure 1b. The combination of the lake level in Wivenhoe Dam, careful estimation of downstream catchment flows and application of the Flood Mitigation Guide Curve in Flood Mitigation Strategy Procedure 1b justified this decision.
- The decision on 27/02/2022 at 4:00 to commence releases from Wivenhoe Dam under Flood Mitigation Strategy Procedure 1b. The hydrologic modelling and release plan simulations undertaken to this point were consistent with the Flood Mitigation Guide Curve (for the balance of predicted peak lake level and Target Flow at Moggill) and made effective use of the Wivenhoe Dam flood compartment to store and delay outflows from the Upper Brisbane River catchment whilst high flows from downstream catchments were occurring.
- The activities on 27/02/2022 which identified the conditions which supported the development of the Somerset Dam Alternative Procedure, and the subsequent completion of the approval protocol in Section 18 of the Manual. The Somerset Dam Alternative Procedure was implemented at 28/02/2022 00:45 and reduced the outflows from Somerset

Dam into Wivenhoe Dam around the time of the peak lake level at Wivenhoe Dam. Situational awareness, careful monitoring of rainfall and streamflow data and professional judgement in application of the FFS justified this decision and it was implemented consistently with the Objectives and Alternative Procedures sections of the Manual.

- The decision to transition to the Drain Down Strategy at Wivenhoe Dam on 28/2/2022 at 06:00. This was justified on the basis of advice from the Bureau indicating that rainfall was likely to be nearly complete, the FFS calibrations quantified predicted inflows well and gauge board evidence that the combined storage in Somerset and Wivenhoe Dams had started to fall. An important consideration here was that selection of the Drain Down Strategy allowed for additional flexibility to manage releases to account for potential inflows from downstream catchments and limit further potential rises of downstream river flows.
- The decision to reduce outflows from Wivenhoe Dam on 2/3/2022 at 12:00 in response to heavy rainfall over the catchment downstream of Wivenhoe Dam. This decision assisted in limiting further rises in downstream flood flow.
- The decision to extend the Drain Down Strategy past seven days on 7/3/2022 at 03:00. This decision enabled the final stages of gate closure to be managed in accordance with the Manual and assisted in meeting multiple criteria such as ending the Flood Event with the storage at OFSL and consideration of protection of the riverine environment in response to improved estimates of baseflow.

The available evidence suggests that the dam operations undertaken during this Flood Event achieved the Objectives stated in the Manual. Dam safety was prioritised, both Somerset Dam and Wivenhoe Dam ended the flood event at OFSL, significant flood mitigation benefits for the Mid and Lower Brisbane River were achieved and protection of the riverine environment was considered.

Figure 8-1 was prepared to demonstrate the effectiveness of the procedures in the Manual for this Flood Event. It shows:

- Whole of event calibration estimate of inflow (refer Section 7.2), recorded lake level, recorded outflows and strategies selected for Somerset Dam (top panel).
- Whole of event calibration estimate of inflow (refer Section 7.2), recorded lake level, recorded outflows and strategies selected for Wivenhoe Dam (middle panel).
- Whole of event calibration estimate of Downstream Catchment Flow at Moggill (i.e. excluding Wivenhoe Dam releases, refer Section 7.2), whole of event calibration estimate of total flow at Moggill (i.e. including Wivenhoe Dam releases, refer Section 7.2) and rated flow at Moggill (bottom panel).

Figure 8-1 demonstrates that:

- The volume of the Flood Storage Compartment reserved for flood mitigation purposes (i.e. between OFSL and 75 m AHD) was almost completely filled during the Flood Event. There is a total storage volume of 1,180,000 ML between OFSL and 75 m AHD. The peak lake level of Wivenhoe Dam for this Flood Event was 74.61 m AHD, which is 0.39 m below 75 m AHD. There is only approximately 60,000 ML of additional storage between 74.61 and 75 m AHD (approximately 5% of the total volume of the Flood Storage Compartment

reserved for flood mitigation purposes). The Dam Safety Strategy at Wivenhoe Dam must be selected if the predicted peak lake level is judged very likely to exceed 75 m AHD. This threshold was not reached during the Flood Event and the Dam Safety Strategy was not selected.

- The timing of releases from Wivenhoe Dam was aligned to the selected Target Flow at Moggill as it was revised using the information available at the time during the period when Flood Mitigation Strategy Procedure 1b was selected. The substantive quantity of the total releases from Wivenhoe Dam occurred when Downstream Catchment Flows were receding.
- The estimated peak inflow to Wivenhoe Dam (including releases from Somerset Dam) was approximately 11,100 m^3/s. The peak release from Wivenhoe Dam was approximately 3,400 m^3/s.
- The estimated peak flow at Moggill using Downstream Catchment Flows (i.e. excluding releases from Wivenhoe Dam) was approximately 6,300 m^3/s. The peak rated flow at Moggill for the Flood Event was approximately 6,700 m^3/s. Based on this analysis, releases from Wivenhoe Dam contributed less than 7% of the peak flow at Moggill.
- The Somerset Dam Alternative Procedure was effective in reducing inflows to Wivenhoe Dam around the time of the peak lake level at Wivenhoe Dam.
- The reduction of Wivenhoe Dam releases during the period when the Drain Down Strategy limited renewed rises in downstream river flows.

Further quantification of the flood mitigation benefits achieved by the application of the procedures in the Manual to Somerset Dam and Wivenhoe Dam for this Flood Event would require additional hydrologic modelling to be undertaken, which is outside the scope of this report.

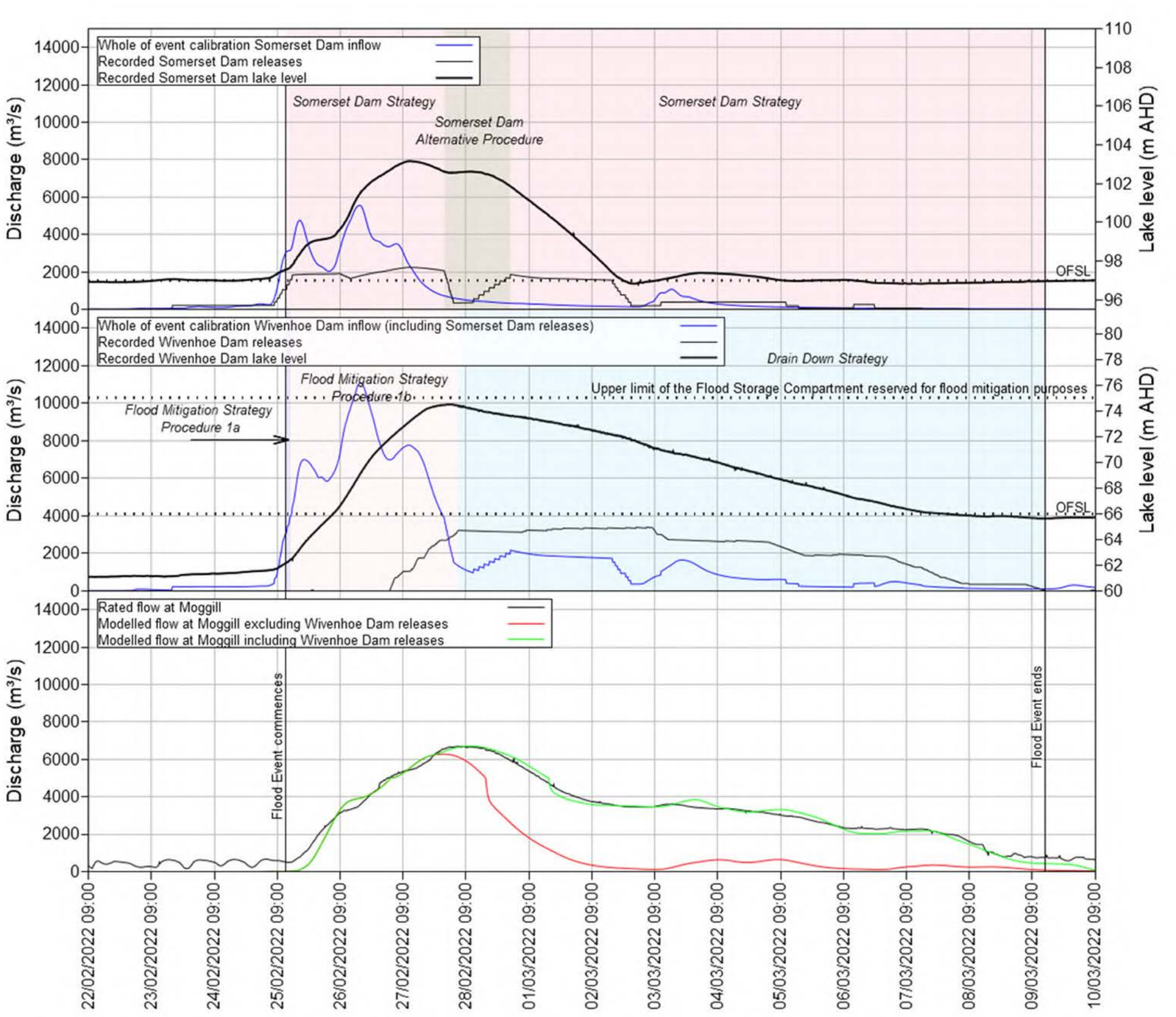

Figure 8-1: Summary of Somerset Dam (top panel) and Wivenhoe Dam (middle panel) inflows, releases and lake level, and flow at Moggill (bottom panel) during the Flood Event

8.2 Operational arrangements

Staffing at both the Flood Operations Centre and the dam sites met the requirements of Section 3.1 of the Manual.

In the lead up to the Flood Event, Seqwater had access to a pool of four Senior Flood Operations Engineers (SFOEs). The training, qualifications and experience of the SFOEs complied with Section 3.8 of the Manual. Over the course of the event, evidence from attendance records and rosters demonstrate that three of these SFOEs were available to fill the Duty Senior Flood Operations Engineer (DSFOE) role in the Flood Operations Centre on a rotating basis, with one SFOE confined to isolation for much of the Flood Event as a result of being identified as a close contact under COVID-19 regulations. This SFOE was available to provide support to the Flood Operations Centre team as a DFOE on a remote basis throughout the event with full access to the FFS and related operational systems. A pool of available Flood Operations Engineers and Flood Officers supported the DSFOE on a rostered basis inside the Flood Operations Centre. A pool of Dam Operators staffed the dam sites on a rostered basis throughout the event to carry out operations at the Dams. All staff filling operational roles in the Flood Operations Centre and at the Dams during the Flood Event had appropriate experience, training and qualifications for their role. Staffing levels in the Flood Operations Centre and at the Dams were consistent with the Manual.

There is evidence from the Strategy Log and interviews conducted with the SFOEs that workload in the Flood Operations Centre, while intense at times, did not have an impact on the operation of the Dams using the procedures in the Manual.

8.3 Assessment of the Flood Forecasting System

8.3.1 Monitoring network

The rainfall and river level gauge network that Seqwater had access to during the Flood Event is described in Section 2.2. This network performed well during the Flood Event. Data from the network provided a crucial basis for understanding the temporal and spatial characteristics of the rainfall, as well as the response of the multiple catchments that are considered in implementing the operational procedures in the Manual.

Of the rainfall gauges available to Seqwater, only seven relevant to the operation of Somerset Dam and Wivenhoe Dam were identified as not reporting or likely erroneous during the Flood Event. This is not unexpected for an event of this magnitude, and similar in nature to the January 2011 event where 14 rainfall gauges were not operating correctly (Seqwater, 2011).

The river level/streamflow monitoring network was critical to support understanding of catchment flood flows. In general, it performed well during the Flood Event. As expected during any major flood event, some gauge equipment was damaged and not functional. The impact of this on estimation of catchment flows with the FFS, and hence strategy and release planning, was more significant for the lower end of Lockyer Creek where two gauges (Glenore Grove and O'Reillys Weir) were out of action, adding to the difficulties in estimating inflows from Lockyer Creek. This didn't inhibit decision making as described below.

Despite the loss of the Glenore Grove and O'Reillys Weir gauges, there was sufficient flexibility and redundancy with the availability of other gauges to allow reasonable estimates of Lockyer Creek inflows to be developed. This was done principally by shifting the calibration focus to the Lowood gauge. There appears to be little more that could be done to provide further redundancy in streamflow gauging on the lower reaches of Lockyer Creek during large flood events, due to the nature of the creek channel and floodplain geomorphology there. It may be possible to further strengthen the existing monitoring system by providing additional backup data logger and transmittal facilities co-located with existing equipment, either in the same site facilities enclosure or via an additional enclosure at a different location at the gauge site. It is noted that gauge site redundancy is a particular issue when considering the possibility of closely spaced flood events, where damage to gauges during one event may not be able to be easily rectified before the start of a following event.

The Flood Operations Centre were able to obtain a feed from a local government flood camera at the Glenore Grove bridge, which provided a useful qualitative check on flow conditions there. Such cameras could be a useful addition to other gauge sites.

There is evidence that during some periods of the Flood Event there were discrepancies between automated and gauge board level readings of the Wivenhoe Dam lake level. Such discrepancies are not uncommon during flood events, and occur due to measurement uncertainty and variable lake levels within the reservoir.

8.3.2 Assessment of data collection system

Data collection systems are used to ingest data from a variety of sources into the FFS. The key data being ingested for this event included gauged rainfall and river level data (via Enviromon), gate settings and reservoir gauge board readings (via WISKI) and Bureau forecast rainfall and flood forecasts (via File Transfer Protocol).

The data collection systems used by Seqwater performed well during the event, and there is no evidence to suggest that decision making was adversely impacted by data latency or unavailability as a result of the collection systems.

Section 8.3.4 describes a number of relatively minor discrepancies noted between gate settings recorded in WISKI and the Gate Operation Spreadsheets. Some of these discrepancies may be the result of transcription error when gate settings are manually entered into WISKI.

8.3.3 Assessment of modelling platform

Seqwater have invested significant effort in the development of the FFS over the last decade, and this Flood Event was the first time it was used as the primary flood modelling and estimation tool for a major event in the Brisbane River catchment. 345 individual model simulations of the Brisbane River catchment were completed and archived in the FFS during the Flood Event. The system appeared to perform well, and feedback from the SFOEs and review of the archived model runs suggests that it was an efficient and useful tool for simulating and forecasting catchment flood flows and dam lake levels.

The FFS has a number of attributes that were critical to its performance during the Flood Event, namely:

- The URBS hydrologic models incorporated in the FFS are detailed and their performance has been extensively calibrated to historic flood events.
- The FFS ingests and provides a range of data for model input and analysis in a centralized location. This includes gauged rainfall, water level and streamflow data, dam gate and sluice settings, forecast rainfall data from the Bureau, relevant flood forecast hydrographs from the Bureau and contextual information such as flood class levels at key gauge sites.
- The analysis and preparation of rainfall data is sufficiently sophisticated and flexible as to generate reasonable gridded estimates of rain on ground data from gauge information, as well as blending this data with forecast rainfall provided by the Bureau.
- The process of real time Flood Event model calibration is enhanced by the ability to efficiently switch between flexible and scalable plots of gauged and modelled water level, streamflow and lake level at all gauges of interest.
- Model parameter values can be efficiently input and adjusted as the Flood Event unfolds, and appropriate guidance is provided within the FFS on typical ranges of parameter values based on physical limits and evidence from historic calibrations.
- The model runs on a 15 minute time step which is sufficient resolution to support the development of release plans.
- Key operational considerations (such as modelled and rated flow at Moggill) are clearly labelled in the FFS enhancing the user's ability to easily identify the critical points of interest.
- Data and model results can be readily imported and exported to support interoperability with other applications such as the Gate Operations Spreadsheet and to support communications activities such as Situation Reports.
- Model simulations used as inputs to release planning decisions are approved by the SFOEs and FOEs and archived in a database which can be readily extracted and viewed.

Given the critical importance of the FFS to operational decision-making during Flood Events, it is recommended that Seqwater continue to invest in the ongoing enhancement of the FFS. This is consistent with the requirements of Section 3.9 of the Manual.

8.3.4 Assessment of Gate Operations Model

The Gate Operations Model performed satisfactorily during the Flood Event. The model has a number of key advantages which make it a useful tool for decision making during flood operations, including:

- The effect of changes to gate settings on reservoir water levels, outflows and estimated downstream flows can be assessed virtually instantaneously. This allows the Flood Engineers to quickly trial a range of possible release plans.
- The spreadsheet contains a series of important visual cues which significantly increase situational awareness for flood engineers. This allows timing of changes to gate settings,

gate overtopping alerts and inconsistencies between gate settings in FEWS and the spreadsheet to be readily identified and acted on.

- The spreadsheet calculations occur on an hourly time step, which is preferable for trialling and confirming the development of release plans, particularly this Flood Event, which had a relatively long duration.

It is noted that Seqwater have a forward program of works to develop functionality within FEWS which will, over time, incorporate gate operations modelling in the modelling platform of the FFS. This is a reasonable and proactive area for development, given the critical nature of the spreadsheet and its central role in decision making and development of release plans.

There is evidence that during the course of the Flood Event, there were several occasions where discrepancies in gate settings arose between the Gate Operations Model, Gate Directives and the recorded gate settings stored in the WISKI database. These were limited periods of minor discrepancies. They include:

- The Somerset Dam spillway crest radial gates were fully opened as prescribed in Procedure 1B of the Somerset Dam Strategy at the start of the Flood Event on 25/02/2022 at 12:10. The opening of these gates was subsequently recorded in WISKI at 14:00, noting that at this time, the lake level in Somerset Dam was below the spillway crest radial gate sill level. This is inconsistent with the Gate Operations Spreadsheet models up to and including the spreadsheet 202202270005NR_SDWD-Ops_Rev16_v003.xlsm (i.e. 27/02/2022 at 00:05), which shows those gates as fully closed. This discrepancy was amended in spreadsheet 202202270128 NR_SDWD-Ops_Rev16_v003.xlsm (i.e. 27/02/2022 at 01:28) and was correct for all subsequent spreadsheets. This discrepancy was only material after 26/02/2022 at 13:00 when the lake level at Somerset Dam exceeded the spillway crest radial gate sill level of 100.45 m AHD. At the time when the correction was made, the Gate Operations Model was underpredicting the actual release from Somerset Dam by a maximum of 290 m^3/s. The real time estimates of inflows to Somerset Dam and Wivenhoe Dam at this point during the Flood Event were approximately 3,700 and 8,300 m^3/s respectively. As such, this discrepancy was a minor underprediction of the Somerset Dam release in the context of catchment flood flows. There is no evidence that this discrepancy affected decision making or development of release plans at either Somerset Dam or Wivenhoe Dam.
- Gate Operations Directive 4 for Somerset Dam was issued on 26/02/2022 at 09:10. This directive required all four regulators to be fully closed over the period commencing 26/02/2022 at 09:15 and ending 26/02/2022 at 12:15. This change was subsequently recorded in WISKI consistent with the Gate Operations Directive. However, the Gate Operations Spreadsheet immediately prior to this directive (202202260834NR_SDWD-Ops_Rev16_v003.xlsm, i.e. 26/02/2022 at 08:34) shows that the regulators were not modelled to commence closing until 26/02/2022 at 17:00. This discrepancy between the Gate Operations Spreadsheets and Gate Directive 4 persisted for several iterations of the Gate Operations Spreadsheet until the spreadsheet titled 202202261133NR_SDWD-Ops_Rev16_v003.xlsm (i.e. 26/2/2022 at 11:33), which was adjusted to be consistent with the Gate Directive. The result of this discrepancy is that for several hours, there was a slight mismatch between the forecast outflow from Somerset Dam modelled in the Gate

Operations Spreadsheets and actual regulators operations and directives. The maximum difference in releases resulting from this discrepancy was approximately 250 m^3/s, at a time when total inflow to Wivenhoe Dam (including Somerset Dam releases) was estimated to be approximately 6,700 m^3/s. There is no evidence that this discrepancy affected decision making or development of release plans at either Somerset Dam or Wivenhoe Dam.

- Gate Operations Directive 3 for Wivenhoe Dam was issued on 27/02/2022 at 01:30. This directive required several changes to gate settings, one of which was that Gate 3 was to be opened from 3.5 m to 4.0 m on 27/02/2022 at 05:30. This change was subsequently recorded in WISKI consistent with the Gate Operations Directive. Later that day, WISKI data entry error appeared to occur, which indicated that Gate 3 was closed back to 3.5 m at 06:30. Gate Operations Directive 7 was issued at 13:40. One of the changes listed in this directive was that Gate 3 was to be opened from 4.0 m to 4.5 m at 14:00. WISKI data indicates that this gate was opened at that time from 3.5 m to 4.5 m, restoring consistency between the gate settings in WISKI and the Gate Operations Model. This discrepancy had no material impact on simulation of flows, decision making or development of release plans at Wivenhoe Dam.

There is no evidence to suggest that any of these relatively minor discrepancies between planned and recorded gate settings had any influence on the development of release plans or decision making at Somerset Dam or Wivenhoe Dam. These observations are illustrative of a potential issue associated with the manual transcription of gate settings both in the Flood Operations Centre and at the Dams. It is noted that data in WISKI is time stamped at the time of entry; as such it is possible that gate settings at the dams can be changed in accordance with Gate Directives, but delays in entering the changes into WISKI can lead to some of the discrepancies identified here.

The databases and modelling tools established and used by Seqwater are sufficiently mature and robust to provide visual cues to the Flood Engineers that alert them of any major discrepancies. It is recommended that Seqwater consider whether other checks or processes could be implemented which might further reduce the likelihood of potential discrepancies of gate settings used in the modelling.

8.4 Record keeping

Extensive records were kept covering a range of Flood Operations Centre and dam site activities throughout the duration of the Flood Event. These included:

- The dam Strategy Log, which is a critical source for recording the release plan and operational decision making throughout the Flood Event.
- 345 approved and archived hydrologic model runs in the FFS.
- Gate Directives, of which 17 were issued for Somerset Dam and 44 for Wivenhoe Dam
- Emails and letters relating to the approval of the alternative procedure for Somerset Dam.
- Flood Operations Centre attendance records.
- Sent and received emails from the Flood Operations Centre inbox.
- Recordings of telephone conversations from the Flood Operations Centre.

- Recordings of the Lower Brisbane River Communications Protocol videoconferences.

The extent and nature of record keeping during this Flood Event complied with the requirements of the Manual.

8.5 Dam infrastructure performance

There was no evidence of significant issues associated with performance of dam infrastructure as part of this Flood Event. All gates, sluices and valves operated reliably throughout the Flood Event.

Some damage was sustained to Somerset Dam and Wivenhoe Dam as a result of the Flood Event, a report that was prepared by Seqwater that describes the damage to the dams as a result of the Flood Event is included in Appendix F of this report.

The Somerset Dam – Dam Safety Inspection Report (Appendix F) identified the following damage to Somerset Dam as a result of the Flood Event:

- Superficial damage to the downstream surface of the concrete spillway.
- Significant water ingress (with consequent damage to electrical systems) to the hydro-electric power station. This damage was assessed to have no impact on the structural safety of the dam.

The Somerset Dam – Dam Safety Inspection Report states that the above damage was caused by the Flood Event and does not threaten the structural safety of the dam.

In addition, the Somerset Dam – Dam Safety Inspection Report noted that:

- Sluice J failed to close fully on the first attempt. Sluice J was reopened and closed again immediately afterwards on the second attempt and achieved the intended outcome with no significant leakage. This may have been caused by dislodgement of small damaged sections of the top and bottom rubber seals of the sluice. The damage does not impact the functionality of the sluice and the damaged seals have been scheduled for replacement.
- Some elevated piezometer readings during the Flood Event were noted in relation to Monolith J. These piezometers returned to normal values after the Flood Event concluded.

The Wivenhoe Dam – Dam Safety Inspection Report (Appendix F) identified the following damage to Wivenhoe Dam as a result of the Flood Event:

- Some damage to the downstream surface of the Main Dam Earth Embankment was observed in the area where the Brisbane River flowed prior to the dam being constructed. This is likely to have been caused by high tailwater levels resulting ponding water against this section of the Main Dam Earth Embankment.
- Some damage to the downstream surface of the concrete spillway was observed. This damage appeared to be caused by the abrasive force of the water flowing through the spillway over the course of the flood event.

- Significant water ingress (with consequent damage to electrical systems) to the hydro-electric power station. This damage was assessed to have no impact on the structural safety of the dam.

The Wivenhoe Dam – Dam Safety Inspection Report states that the above damage was caused by the Flood Event and does not threaten the structural safety of the dam.

8.6 Effectiveness of the Manual

There is evidence from the Strategy Logs as well as interviews with the SFOEs that the operational procedures in the Manual provided an effective guide to decision making during the Flood Event. At each change in strategy, the Strategy Logs document the relevant criteria from the Manual and record the assessment by the DSFOE against those criteria to justify the change. The SFOEs all remarked that the Manual procedures achieve a balance between providing sufficient guidance to achieve the Objectives and allowing for professional judgement to be applied when adapting to changing circumstances. The development, approval and implementation of the Somerset Dam Alternative Procedure on 28/2/2022 is an example of the application of professional judgement within the constraints set out in Section 18 of the Manual.

There are several instances where it is recommended that Seqwater continue to consider relatively minor improvements to the manual as a result of this Flood Event. These include:

- Section 13.2 of the Manual provides criteria for the determination of the commencement of a flood event. For Somerset Dam, these criteria state that the event commences when it is judged likely that the predicted lake level will rise more than 1.0 metre above the OFSL at Somerset Dam (based on rain on ground estimates accounting for operational releases). At the start of the Flood Event, Somerset Dam was close to OFSL and making operational releases through the sluices, and the Wivenhoe Dam lake level was well below OFSL. In these particular circumstances, the Somerset Dam lake level could be at OFSL (97.0 m AHD) with all cone valves and sluices open releasing approximately 1,800 m^3/s without triggering the commencement of a flood event. Conceptually, such release rates are highly likely to be the result of sufficient rainfall to trigger flood events at both dams and it is recommended that Seqwater consider whether to add an additional release criterion or tighten the lake level rise criteria to something less than 1.0 metre above OFSL at Somerset Dam. The requirement in Section 13.2 of the Manual that the determination of a Flood Event has commenced must be based on inflows determined from rain on ground remains effective.
- Section 18 of the Manual documents the protocol to be followed to seek authorisation for an Alternative Procedure at Somerset Dam. This protocol was followed during the Flood Event on the evening of 27/02/2022. Given that the application of the protocol may be needed at any time of the day or night during a Flood Event and that it requires engagement with DRDMW, it is recommended that Seqwater and DRDMW continue to review the expediency of the protocol for approval of an alternative procedure. Seqwater and DRDMW should also plan to simulate the application of the protocol during exercises.

  In regards to the Alternative Procedure for Somerset Dam which was adopted for part of the Flood Event, there appears to be minimal evidence that this should be incorporated as a standing procedure in the Manual. The circumstances under which this procedure both

met dam safety criteria and contributed to flood mitigation were sufficiently unique to the Flood Event, namely:

- The particular spatial and temporal characteristics of the rainfall and how this varied across different catchments, with rainfall clearing from the Somerset Dam catchment earlier than for the Wivenhoe Dam catchment.
- The status of and trend in lake levels at Somerset and Wivenhoe Dams at the time.
- The relative timing of Upper Brisbane River, Stanley River and Lockyer Creek inflows.

In addition to this, the manner in which the alternative procedure was defined included a number of criteria specific to the Flood Event, such as the maximum lake level rise limit of 0.3 metres and the maximum period of application of 36 hours. Such criteria may not be appropriate for other events.

- The Flood Event was of sufficient magnitude that operations at Wivenhoe Dam were close to moving from the Flood Mitigation Strategy to the Dam Safety Strategy. Interviews conducted with the SFOEs indicate that the potential for the strategy to change was discussed on 27/2/2022. A relatively small amount of additional rainfall would have potentially placed operations into Procedure 3c of the Dam Safety Strategy. Invoking the Dam Safety Strategy requires increased emphasis to be placed on the primary objective in the Manual of preventing structural failure of the Dam. Procedure 3c of the Dam Safety Strategy allows for professional judgement to be made in balancing lake level and releases to continue achieving a flood mitigation benefit. Whilst this strategy was not invoked during the Flood Event, it is recommended that Seqwater review Dam Safety Strategy Procedure 3c following a flood of this magnitude. In particular, consideration should be given as to whether further guidance could be included to inform the DSFOE as to how to balance lake level and flow at Moggill during operations in the Dam Safety Strategy.
- The Wivenhoe Dam Drain Down Strategy exit criteria nominated in the Manual include lake level tolerances to cease releases, with accounting for baseflow. Under Drain Down Strategy Procedure 3b(ii)(a), releases must cease when the lake level is more than 0.3 m below OFSL. During the Flood Event, these criteria were challenging to achieve given the volume of baseflow being generated from the catchment for an event of this magnitude. In hindsight, it is likely that the Objectives would still have been met if there was additional flexibility available in the Manual regarding these lake level criteria. For example, releases could have continued with the lake level well below 0.3 m below OFSL, given that there was a good model calibration which provided confidence that the baseflow volume would have been sufficient to refill the lake level to OFSL. It is recommended that Seqwater consider the lake level criteria in Wivenhoe Dam Drain Down Strategy Procedure 3b(ii)(a) and determine whether additional flexibility can be provided while still achieving the objectives, particularly for large, long duration flood events where baseflow volumes are likely to be high. Consideration of additional flexibility would need to continue to provide assurance that the level will return to OFSL at the end of a flood event and the flexibility solely be limited to situations with confidence in estimated baseflow from the catchment. This recommendation is only applicable to Wivenhoe Dam as the size of the upper Brisbane River catchment can produce higher rates of baseflow that make this tolerance not directly comparable to those used for Somerset Dam and North Pine Dam (which have much smaller catchments).

9. Refences

HARC. (2022). *February 2022 Flood Event: Report on the Operation of North Pine Dam*.

Seqwater. (2013). January 2013: Report on the operation of Somerset Dam and Wivenhoe Dam.