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EXECUTIVE SUMMARY

Somerset Dam and Wivenhoe Dam are located in the Brisbane River Basin. The Dams are dual purpose storages that provide urban water supplies (including drinking water) to South East Queensland as well as flood mitigation benefits to areas impacted by flood flows along the Brisbane River below Wivenhoe Dam.

In the 25 days prior to Thursday 6 January 2011, above-average levels of rainfall were received in the Dam catchment areas and the Dams successfully operated as flood mitigation dams on a number of occasions during this period. Further rain fell in the Dam catchments on Thursday 6 January 2011 leading to another mobilisation of Seqwater's Flood Operations Centre . The rainfall continued in various parts of the Brisbane River Basin until Wednesday 12 January 2011, resulting in the largest inflows into both Dams ever recorded. During this time, and for a period following the peak of the floods, the Dams were operated as flood mitigation storages in accordance with *The Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam (Revision 7)* (**"the Manual"**). The Manual defines the objectives and procedures for operating Somerset Dam and Wivenhoe Dam during flood events. An understanding of the Manual is important when reading this Report.

This Flood Event that impacted the Dams between Thursday 6 January 2011 and Wednesday 19 January 2011 can be defined in the range of large (1 in 100 years) to rare (1 in 2,000 years) in accordance with *Australian Rainfall and Runoff (Book 6)* (AR&R). Studies associated with the design and operation of Wivenhoe Dam that date back to 1971, indicate a flood of this magnitude would be expected to result in urban damage below Moggill. The *Wivenhoe - Somerset Interaction Study* which was prepared to support the 2009 review of the Manual, is the most recent investigation undertaken that supports this expectation.

Background

Flood events that impact Somerset Dam and Wivenhoe Dam are caused by rainfall events that vary in intensity, duration and distribution over a catchment area exceeding 7,000km^2 above the Dams. When making decisions about releasing water from the Dams during flood events, consideration is also given to rain falling in Brisbane River catchment areas not controlled by the Dams. These catchment areas, which include the Lockyer Creek and Bremer River catchments, also cover an area in the order of 7,000km^2 and rain falling in these catchments will also vary in intensity, duration and distribution. Accordingly, the Manual must account for an infinite number of flood event scenarios.

The current level of forecasting technology does not make it possible for the Bureau of Meteorology (BoM) to provide completely accurate rainfall forecasts for the Dam catchment areas. A degree of uncertainty exists in all weather forecasts and the further forward in time forecasts are provided, the greater the degree of uncertainty.

As it is not possible to provide a specific procedure for Dam operation during every possible flood event, the Manual takes the approach of providing objectives and strategies to guide operational decision-making during a flood event. The objective followed and strategy chosen at any point in time depends on the actual water levels in the Dams as well as flood modelling predictions based on the best observed and forecast rainfall and stream flow information available at the time.

It is not possible to predict the range of objectives and strategies that will be used during the course of a flood event, before or at any time during the event, prior to the event peak. Objectives and strategies change as flood events progress, as rainfall is received in the catchment and as forecast rainfall amounts change. For small floods, objectives and strategies relate to minimising flood impacts in rural areas, while as the scale of the flood increases, the emphasis changes to protecting urban areas and maintaining the structural safety of the Dam.

The primary objectives of the Manual, in order of importance, are:

- Ensure the structural safety of the Dams;
- Provide optimum protection of urbanised areas from inundation;
- Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;
- Retain the storage at Full Supply Level (FSL) at the conclusion of the flood event;

- Minimise impacts to riparian flora and fauna during the drain down phase of the flood event.

While ensuring the Dams are operated during flood events within these objectives, Seqwater's duty of care to the public is also a primary consideration when making flood releases from the Dams. Every attempt is made to ensure public roads are closed prior to inundation by Dam outflows and that authorities are provided with enough time to prepare for community isolations and to undertake evacuations. Every attempt is also made to ensure urban damage is minimised, and that Dam outflows with the potential to contribute to urban damage are delayed until it is apparent no other options are available without risking the safety of the Dams.

It is also important to note that, under the Manual's current operating rules, both Somerset Dam and Wivenhoe Dam are expected to fail during the Probable Maximum Flood, if such an event ever occurs.

Significance of the January 2011 Flood Event

The January 2011 Flood Event has been defined as a large to rare event by AR&R, The Institution of Engineers Australia (Engineers Australia) national guidelines for the estimation of design flood characteristics. The flood level classifications adopted by BoM define the Event as a major flood. Relevant statistics that demonstrate this are:

- Rainfall recorded in the catchment area above Wivenhoe Dam indicates that the catchment average rainfall intensity for the 72 hour period to Tuesday 11 January 2011 at 19:00 had an annual recurrence interval of between 1 in 100 years and 1 in 200 years. The catchment average rainfall intensity for the 120 hour period to Tuesday 11 January 2011 at 19:00 also had an annual recurrence interval of between 1 in 100 years and 1 in 200 years. At some individual rainfall stations within the Brisbane River catchment, rainfall estimates beyond the annual exceedance probability (AEP) limit of extrapolation (1 in 2,000 years) were recorded for durations of between 6 hours and 48 hours.
- On Tuesday morning 11 January 2011, water levels in Wivenhoe Dam began rising rapidly in response to very heavy localised rainfall in the area immediately upstream of the Dam. At the time, the BoM radar indicated this rain was located in an area which does not have any real time rain gauges. Post flood analysis suggests the rainfall required to reproduce this rise could exceed an annual recurrence interval of 1 in 2,000 years and may be well into the extreme category. Rainfall of this intensity and duration over the Wivenhoe Dam lake area at such a critical stage of the Flood Event, was unprecedented.
- The volume of total inflow into Wivenhoe Dam during the Event was 2,650,000ML. This volume has been calculated to be almost double (190%) the comparable volume of inflow from the January 1974 flood event, and comparable with the flood of 1893.
- The inflow into Wivenhoe Dam during the Event is represented by two individual floods, with the peak of each flood separated by about 30 hours. The maximum flow rate at the first peak is estimated to be around 200% of the comparable flow rate calculated from the January 1974 event, while the maximum flow rate at the second peak is estimated to be approximately 230% of the comparable flow rate from the January 1974 event (Source of January 1974 flow: *Brisbane River and Pine River Flood Study, October 1994, Report No. 23a*).
- The peak water level recorded at many gauges in the Brisbane River, including the Brisbane City gauge, exceeded the BoM-defined major flood level.

EXECUTIVE SUMMARY

Operations during the January 2011 Flood Event

1. During the January 2011 Flood Event, operational decisions were made in accordance with the Manual. Dam outflows contributing to downstream flooding were delayed until it was apparent no other option was available, without risking the safety of Wivenhoe Dam.
2. Two separate floods entered Wivenhoe Dam during the Event. The first flood into Wivenhoe Dam was similar in nature and magnituge to the comparable flood flows of the January 1974 event. The combined mitigation effect of Somerset and Wivenhoe Dams ensured this first flood did not result in urban damage below Moggill however, achieving this result did cause significant filling of the Dams' flood storage compartments.
3. The second flood was also similar in nature and magnituge to the comparable flood flows of the January 1974 event. Rainfall which occurred directly on and near the Wivenhoe Dam lake area contributed to the second flood. Post flood analysis suggests the intensity of this rainfall could have exceeded an annual recurrence interval of 1 in 2,000 years and may be well into the extreme category. The location of this rainfall on and near the Dam also reduced available mitigation options.
4. Due to the level to which the flood compartments were filled by the first flood, the second flood could not be completely contained without risking the safety of the Dams and therefore the inflow of water to the Brisbane River resulted in urban damage below Moggill. The extent of this damage however was greatly reduced by the the operation of the Dams.

Rainfall forecasts in the early stages of the Event did not support flood releases being made from Wivenhoe Dam, greater than those that actually occurred. An increase to flood releases in the later stages of the Event (prior to the morning of Tuesday 11 January 2011) had the potential to increase urban damage, due to the possible southward movement of the prevailing weather system. Had the rainfall on Tuesday 11 January 2011 fallen south of the Dam, the transition to an operating strategy to protect the safety of the Dam may have been avoided however, urban damage would have likely increased under this scenario, due to the loss of the mitigation effects provided by the Dam.

Given the current level of forecasting technology available, there was an extremely high degree of difficulty in predicting the actual quantity, intensity and spatial distribution of the Event rainfall. This resulted in a high level of uncertainty in predicting the likely Dam inflows in advance of rainfall on the ground and is demonstrated by the three-day and five-day forecast rainfall model results.

The available recorded data shows the January 2011 Flood Event was unprecedented in the history of Somerset and Wivenhoe Dams and rivals the largest floods in the recorded flood history of the region. However, the successful operation of the Dams as flood mitigation storages is considered to have had a major effect on reducing the flood damages in the areas downstream of the Dams.

Flood mitigation benefits of Somerset Dam and Wivenhoe Dam

Wivenhoe Dam provided clear and greatly significant flood mitigation benefits during the January 2011 Flood Event as demonstrated below:

- Figure 9.1.2 demonstrates the significant mitigation benefits of Wivenhoe Dam during this Flood Event. The peak of the outflow from the Dam was approximately 40% lower than the peak of the inflow meaning that, just below the Dam, the maximum hourly flow rate in the Brisbane River was reduced by around 40%.
- Without the mitigating effects of Wivenhoe Dam, the peak flood height measured at the Port Office gauge near the Brisbane CBD would have been approximately 2.0m higher than was experienced.
- Based on the current damage curves, these projected reductions in the flood peak height equate to significant reductions in the potential for the loss of life as well as monetary savings in regard to property damages in the order of up to $5 billion. *(Source: Flood Damage Tables - River PMF tab; provided to Seqwater by the Brisbane City Council).*
- Without the above flow rate reductions provided by Wivenhoe Dam, it is estimated up to 14,000 more properties would have been impacted by the January 2011 Flood Event. *(Source: Flood Damage Tables - River PMF tab; provided to Seqwater by the Brisbane City Council).*

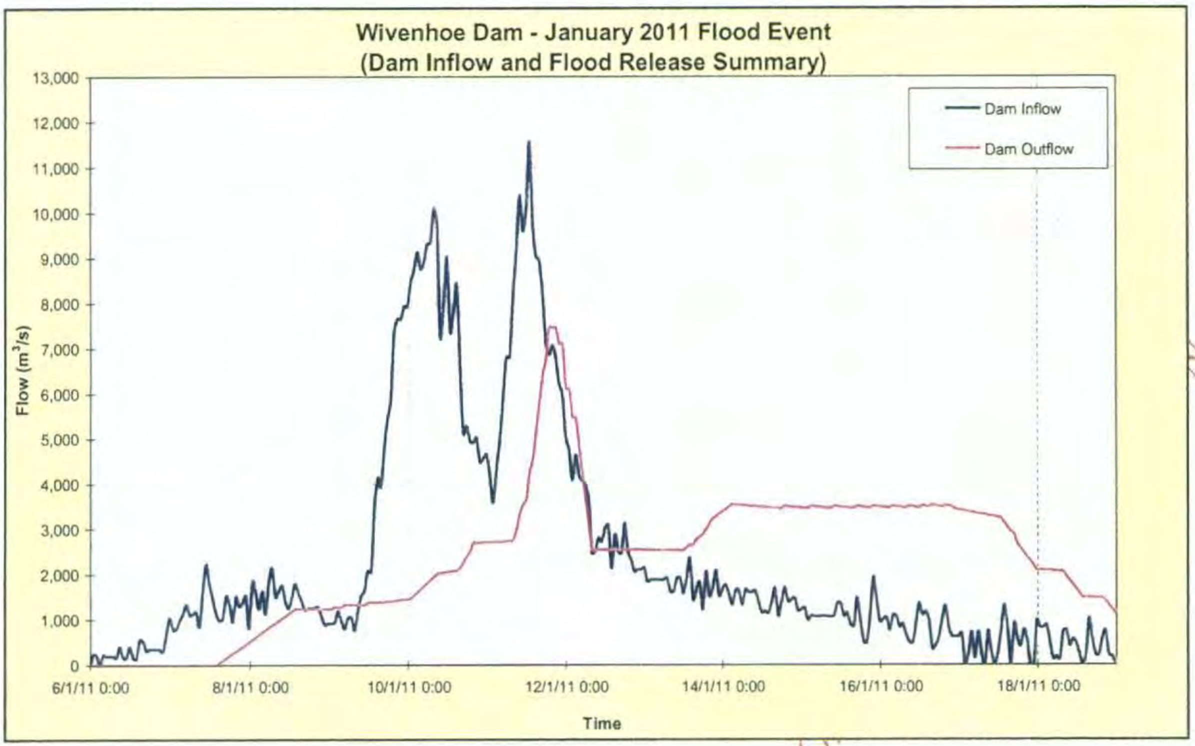

Figure 9.1.2 – *Wivenhoe Dam inflow and release summary for the January 2011 Flood Event*

Conclusions

The significant conclusions drawn from the information contained in this Report include:

- During the January 2011 Flood Event, Somerset Dam and Wivenhoe Dam were operated in accordance with *The Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam (Revision 7)*.
- The data collection and flood modelling systems used to support decisions made during the Event performed well and assisted informed decision-making, in accordance with the Manual.
- BoM rainfall forecasts did not support the additional release of flood water early in the Event.
- During the Event, Seqwater followed the Department of Environment and Resource Management's draft Communications Protocol which was compiled after the October 2010 flood event. This Protocol was developed to ensure effective communication between local, State and Commonwealth agencies impacted by the release of floodwater from the Dams.
- The January 2011 Flood Event was an extremely large and rare flood event. The combined effects of Somerset Dam and Wivenhoe Dam did reduce flood damages downstream however, they could not fully mitigate the impacts of the Event without putting the safety of the Dams at risk.
- Studies associated with the design and operation of Wivenhoe Dam dating back to 1971, indicate a flood of the magnitude of the January 2011 Flood Event would be expected to result in urban damage below Moggill.
- The combined effects of Somerset Dam and Wivenhoe Dam provided clear and greatly significant flood mitigation benefits during the January 2011 Flood Event.

1 INTRODUCTION

1.1 Preface

Given the potential significant impact on downstream populations and property, it is imperative Somerset and Wivenhoe Dams are operated during flood events in accordance with clearly defined and pre-determined procedures. The current procedures are contained in Revision 7 of *The Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam* ("the Manual") that was gazetted in January 2010. The Manual is an approved flood mitigation manual under the *Queensland Water Supply (Safety and Reliability) Act 2008*. An understanding of the Manual is important when reading this Report.

The Manual requires the owner of Somerset and Wivenhoe Dams (currently Seqwater) to prepare a report after each flood event impacting the Dams. A flood event is defined as a situation where either Somerset and or Wivenhoe Dams exceed their Full Supply Level (FSL) and flood water releases are made. The report must contain details of the procedures used during the flood event, the reasons why procedures were used and other pertinent information. Seqwater must forward the report to the Director General of the Department of Environment and Resource Management (DERM) within six weeks of the completion of the flood event.

This document and its associated volumes comprise the required report relating to the January 2011 Flood Event impacting Somerset and Wivenhoe Dams that commenced on Thursday 6 January 2011 and concluded on Wednesday 19 January 2011. It is due for submission by Wednesday 2 March 2011.

1.2 Meaning of terms

In this report, the following terms are defined as below:

"Act" means the Water Supply (Safety and Reliability) Act 2008;

"AEP" means annual exceedance probability, the probability of a specified event being reached or exceeded in any one year. This may be expressed as a ration (e.g. 1 in Y) or a percentage;

"Agency" includes a person, a local government and a department of state government within the meaning of the *Acts Interpretation Act 1954*;

"AHD" means Australian Height Datum;

"ALERT" means Automated Local Evaluation in Real Time System and a system of monitoring and displaying rainfall and water level data. It is a combination of field stations, communications networks and data collection software;

"AMTD" means the Adopted Middle Thread Distance which is the distance along the centre line of the mainstream from a junction, usually in kilometres;

"AR&R" means *Australian Rainfall and Run-off (Book 6)*, The Institution of Engineers Australia (Engineers Australia) national guidelines for the estimation of design flood characteristics;

"BoM" means the Bureau of Meteorology;

"Chairperson" means the Chairperson of Seqwater;

"Chief Executive" means the Director General of the Department of Environment and Resource Management or nominated delegate;

"Controlled Document" means a document subject to managerial control over its contents, distribution and storage. It may have legal and contractual implications;

"Dams" means Somerset Dam and Wivenhoe Dam;

1 INTRODUCTION

"**Dam Crest Flood**" the flood event which, when routed through the storage with the storage initially at Full Supply Level, results in the still water level in the storage reaching the lowest point in the dam embankment, excluding wind and wave effects

"**Dam Supervisor**" means the senior on-site officer at Somerset or Wivenhoe Dam as the case may be;

"**DERM**" means the Queensland Government department, the Department of Environment and Resource Management;

"**Duty Flood Operations Engineer**" means the Senior Flood Operations Engineer or Flood Operations Engineer rostered on duty to be in charge of Flood Operations at the Dams;

"**EL**" means elevation in metres Australian Height Datum;

"**Enviromon**" is the Bureau of Meteorology data collection software used to collect and display rainfall and water level data;

"**ERRTS**" means Event Reporting Radio Telemetry System;

"**Flood Event**" is a situation where the Duty Flood Operations Engineer expects the water level in either of the Dams to exceed the Full Supply Level;

"**Flood-Col**" is the data collection software used in the Flood Operations Centre to collect and display rainfall and water level data;

"**Flood-Ops**" is the modelling software used in the Flood Operations Centre to model the runoff from the catchments;

"**Flood Operations Centre**" means the centre used by Flood Operations Engineers during a Flood Event to manage the Event;

"**Flood Operations Engineer**" means a person designated to direct flood operations at the Dams in accordance with Section 2.4 of 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 Operations Manager**" means the Flood Operations Engineer responsible for the overall management of the Flood Operations Centre leading up to or 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;

"**Gauge**" when referred to in (m) means river level referenced to AHD or a local datum, and when referred to in (m^3/s) means flow rate in cubic metres per second;

"**IFD**" means Intensity Frequency Duration and refers to the statistical analysis of rainfall intensities.

"Manual" or "Manual of Operational Procedures for Flood Events at Wivenhoe Dam and Somerset Dam" means the current version (Revision 7) of the Manual;

"**m^3/s**" means a rate of water flow being one cubic metre of water per second or 1,000 litres of water per second;

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

1 INTRODUCTION

"Operating Target Line" means the Wivenhoe/Somerset Operating Target Line from Strategy S2 of the Manual.

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

"QPF" means Quantitative Precipitation Forecast provided by the Bureau of Meteorology and is an estimate of the predicted rainfall in millimetres, usually in the next 24 hours;

"RTFM" means Real Time Flood Model and is a combination of Flood-Col, Flood-Ops and other ancillary software;

"SD" means State Datum, which is a level height datum that is different from AHD.

"Senior Flood Operations Engineer" means a person designated in accordance with Section 2.3 of the Manual under whose general direction the procedures in the Manual must be carried out;

"Seqwater" means the Queensland Bulk Water Supply Authority trading as Seqwater;

"URBS" means Unified River Basin Simulator.

Note: Dam levels in this document represented as metres (m) are metres Australian Height Datum (m AHD).

1.3 Background

The primary objectives of the procedures contained in the Manual in order of importance are:

1. Ensure the structural safety of the Dams;
2. Provide optimum protection of urbanised areas from inundation;
3. Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;
4. Retain the storage at Full Supply Level (FSL) at the conclusion of the flood event;
5. Minimise impacts to riparian flora and fauna during the drain down phase of the flood event.

In meeting these objectives, the Dams must be operated to account for the potential effects of closely spaced flood events. Normal operating procedures require stored floodwaters to be emptied from the Dams within seven days of the flood event peak passing through the Dams. During flood events, Somerset Dam and Wivenhoe Dam are operated in conjunction to maximise the overall flood mitigation capabilities of the two Dams.

1.4 Wivenhoe Dam

Wivenhoe Dam is a dual purpose storage facility that provides urban water supplies (including drinking water) to South East Queensland as well as flood mitigation benefits to areas impacted by flood flows along the Brisbane River below the Dam. Depending on the origin, magnitude and spatial extent of the flood, Wivenhoe Dam can be operated in a number of ways to reduce flooding downstream of the Dam. Maximum overall flood mitigation can be achieved by operating Wivenhoe Dam in conjunction with Somerset Dam.

The capacity of the urban water supply compartment that relates to Wivenhoe Dam's FSL is 1,165,000ML. The reservoir volume above the FSL that is used as temporary flood storage is 1,450,000ML. How much of this flood storage compartment is utilised during a flood event depends on the initial reservoir level below the FSL, the magnitude of the flood being regulated and the procedures adopted.

Radial gates and an auxiliary spillway are the primary infrastructure used to release water during flood events at Wivenhoe Dam. The arrangement of the radial gates is shown in Figure 1.4.1.

[redacted]

Figure 1.4.1 – Wivenhoe Dam infrastructure – arrangement of radial gates

An auxiliary spillway was constructed in 2005 as part of an upgrade to improve Wivenhoe Dam's flood immunity. The auxiliary spillway consists of a three bay fuse plug spillway at the right abutment. In association with other constructions at the Dam, the spillway gives the Dam Crest Flood an AEP of approximately 1 in 100,000 years.

Once a flood event is declared, the magnitude of the event is assessed by predicting:

- The maximum storage levels in Somerset and Wivenhoe Dams;
- The peak flow rate at the Lowood gauge, excluding Wivenhoe Dam releases;
- The peak flow rate at the Moggill gauge, excluding Wivenhoe Dam releases.

According to the Manual, the spillway gates are not to be opened for flood control purposes prior to the reservoir level exceeding 67.25m.

The strategies contained in the Manual require significant control over Dam releases to be exercised, as well as knowledge of flows into the Brisbane River from both Lockyer Creek and the Bremer River, below Wivenhoe Dam.

In small floods, releases are controlled to ensure the combined flow from Lockyer Creek and Wivenhoe Dam is less than the limiting values contained in the strategies, to delay the submergence of bridges and to minimise disruption to rural life in the Brisbane and Stanley River valleys. Figure 1.4.2 shows the location of bridges impacted by Dam releases and the approximate river flow rate at which they are closed to traffic.

* Note: Colleges Crossing is also affected by tides

Figure 1.4.2 – Submergence flows for bridges

During larger floods, releases from Wivenhoe Dam are controlled to protect urbanised areas from inundation. The releases are controlled so the combined flow from Wivenhoe Dam, Lockyer Creek and the Bremer River is either minimised or kept below the threshold level for urban damage which is 4,000m^3/s at Moggill.

In large flood events, releases from Wivenhoe Dam are also controlled to ensure the structural safety of the Dam is not put at risk of failure.

1.5 Somerset Dam

Somerset Dam is able to be operated in a number of ways to regulate the flood level of Stanley River. Somerset and Wivenhoe Dams are to be operated in conjunction to optimise the flood mitigation benefits downstream of Wivenhoe Dam. Radial gates, sluice gates and regulator valves are the primary infrastructure used to release water during flood events at Somerset Dam. The arrangement of this infrastructure is shown in Figure 1.5.1.

[redacted]

Figure 1.5.1 – Somerset Dam infrastructure – arrangement of radial gates, sluice gates and regulator valves

1.6 Operating Somerset Dam in conjunction with Wivenhoe Dam

The strategies used to operate Somerset Dam during a flood event are intended to maximise the benefits of the flood storage capabilities of the Dam while protecting the structural safety of both Somerset and Wivenhoe Dams. To achieve this, a Wivenhoe/Somerset Operating Target Line (Figure 1.6.1) is used to set a goal for balancing the use of the flood storage in each Dam.

The Wivenhoe/Somerset Operating Target Line was selected based on the following factors:

- Equal minimisation of flood level peaks in both Dams in relation to their associated failure levels;
- Minimisation of flows in the Brisbane River downstream of Wivenhoe Dam;
- Consideration of the time needed at the onset of a flood event to properly assess the magnitude of the flood event and the likely impacts. This is to ensure the likely optimal strategy to maximise the flood mitigation benefits of the storages can be selected.

The target point on the Operating Target Line at any point in time is based on the maximum storage levels in Somerset and Wivenhoe Dams, using the best forecast rainfall and stream flow information available at the time. Gate operations enable the progressive movement of the duty point towards the target line. It is not necessarily possible to adjust the duty point directly towards the target line in a single gate operation.

1 INTRODUCTION

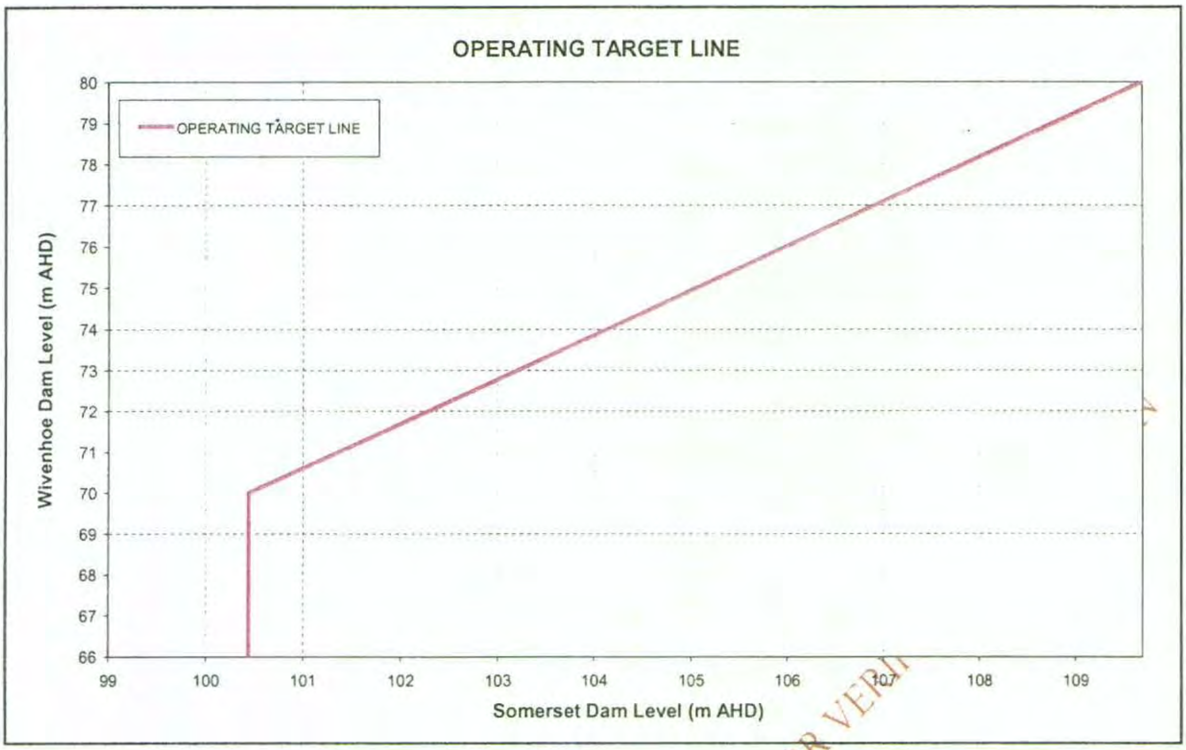

Figure 1.6.1 – Wivenhoe/Somerset Operating Target Line

2

2 FLOOD EVENT SUMMARY

2.1 Summary of the January 2011 Flood Event

The following summary must be read in conjunction with *The Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam (Revision 7)* ("the Manual"). It provides a detailed summary of the operation of Somerset and Wivenhoe Dams during the January 2011 Flood Event. Each table below covers a period of the Event during which one of the following occurred:

- There was a transition or change to the flood operation strategy used, as defined by the Manual;
- There was a period of stability during which no gate operations from either Somerset Dam or Wivenhoe Dam were directed;
- There was a period of sustained gate operations (either opening or closing) at either Somerset Dam or Wivenhoe Dam.

Each table also provides a summary of relevant background information and a summary of the information that was used to make decisions during the period covered by the table. This information includes:

- Details of the time period;
- Relevant background information from the period leading up to and during the period;
- Changes in Dam conditions during the period;
- Rainfall information (including forecast rainfall) and model results available during the period;
- The strategy used and/or adopted during the period.

The source data for the information shown in the tables below can be found in the following Appendices of this Report:

- Appendix A – Model results
- Appendix B – Flood volume summary
- Appendix C – Quantitative Precipitation Forecasts (QPF)
- Appendix D – Catchment rainfall
- Appendix E – Situation reports
- Appendix G – Severe weather warnings
- Appendix H – Flood Event notification email
- Appendix L – Flood operations directives
- Appendix M – Flood Event log

Note: Dam levels in this document represented as metres (m) are in metres Australian Height Datum (m AHD).

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 1 of 20

Date/time	Background	Dam conditions	Rainfall and model results	Strategy

Commenced
Thursday
06 Jan 2011
07:42
 	
Completed
Friday
07 Jan 2011
02:00
	Strategy W1A and Strategy W1B; and Strategy S2
	• Catchment conditions prior to the Event are as described in Section 6.0. The Event was considered a continuation of the ongoing wet period that commenced in October 2010.
	• No significant rainfall occurred in the 24 hours to 09:00 on 5 Jan 2011.
	• Catchment average rainfalls in the 24 hours to 08:00 on 6 Jan 2011 were:
	  • Wivenhoe Dam 25mm;
	  • Somerset Dam 21mm;
	  • Lockyer Creek 23mm;
	  • Bremer River 23mm.
	• Event mobilisation occurred at 07:42 on 6 Jan 2011, using Strategies W1A and S2.
	• Once mobilisation occurred, 24/7 staffing of the Flood Operations Centre and Dams continued until official de-mobilisation was announced. This occurred at 12:00 on 19 Jan 2011.
	• Duty Engineer was called back early from holidays to assist with the management of the Event.
	• Transitioned from Strategy W1A to W1B once the Wivenhoe lake level exceeded 67.50m.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 53mm;
		• Somerset Dam 44mm;
		• Lockyer Creek 53mm;
		• Bremer River 54mm.
		
		Wivenhoe Dam level rose from 67.31m to 67.52m over the 18-hour period.
		
		Somerset Dam level rose from 99.34m to 99.55m over the 18-hour period.
			• Catchment average rainfalls during this period were:
			  • Wivenhoe Dam 28mm;
			  • Somerset Dam 23mm;
			  • Lockyer Creek 30mm;
			  • Bremer River 31mm.
			• Forecast 24-hour catchment average rainfall at 16:00 on 6 Jan 2011 was 25mm.
			• Estimated peak Wivenhoe Dam level: 68.2m (excluding forecast); 68.7m (including forecast).
			• Estimated peak Somerset Dam level: 99.7m (excluding forecast); 100.1m (including forecast).
			• Estimated total Dam inflow: 204,000ML (excluding forecast); 343,000ML (including forecast).
			• Estimated peak flow at Lowood excluding Wivenhoe Dam releases: 470m³/s (excluding forecast); 720m³/s (including forecast).
			• Estimated peak flow at Moggill excluding Wivenhoe Dam releases: 550m³/s (excluding forecast); 960m³/s (including forecast).
			• These peaks were not expected to occur for more than 24 hours beyond period end. Colleges Crossing remained open in the short term. Estimated peak Wivenhoe Dam outflow: 1,220m³/s (excluding forecast); 1,260m³/s (including forecast).
				Strategy W1A and Strategy W1B
				Strategy S2
				(Lake level greater than 67.25m, maximum release 110m³/s)
				• Peak inflows into the Brisbane River from Lockyer Creek were estimated to be in the order of 400m³/s. These flows would not inundate Colleges Crossing until the morning of 7 Jan 2011.
				• Lake level was not expected to reach 67.50m (Strategy W1B) until 7 Jan 2011. Lake level may not exceed 68.5m.
				• Endeavoured to keep Colleges Crossing trafficable by limiting combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 175m³/s.
				• Water was held in Wivenhoe Dam in an attempt to keep Colleges Crossing trafficable in accordance with Strategy W1A. Low level releases continued from the Mini-Hydro at this time and at various stages during the Event. However, these releases (in the order of 13m³/s) have low relative significance and are not referred to specifically in the remainder of this summary document.
				• In accordance with Strategy S2, the crest gates at Somerset Dam were raised to enable uncontrolled discharge. The low level sluices were kept closed. Some regulator releases continued from December as part of previous event drain down, (in the order of 35m³/s) and these were shut down at 18:00 on 7 Jan 2011.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 2 of 20

Date/time	Background	Dam conditions	Rainfall and model results	Strategy

Commenced Friday 07 Jan 2011 02:00
 	
Completed Friday 07 Jan 2011 09:00
	Strategy W1B and Strategy S2
	• Transitioned from Strategy W1A to W1B due to the Wivenhoe lake level exceeding 67.50m.
	• Transitioned from Strategy W1B to W1C once the Wivenhoe lake level exceeded 67.75m.
	• Colleges Crossing was inundated by natural river flows during this period.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 64mm;
		• Somerset Dam 60mm;
		• Lockyer Creek 57mm;
		• Bremer River 60mm.
		
		Wivenhoe Dam level rose from 67.52m to 67.75m over the seven-hour period.
		
		Somerset Dam level rose from 99.55m to 99.65m over the seven-hour period.
			• Catchment average rainfalls during this period were:
			  • Wivenhoe Dam 11mm;
			  • Somerset Dam 15mm;
			  • Lockyer Creek 4mm;
			  • Bremer River 5mm.
			• Forecast 24 hour catchment average rainfall at 10:00 on 6 Jan 2011 was 25mm.
			• Estimated peak Wivenhoe Dam level: 68.2m (excluding forecast); 68.5m (including forecast).
			• Estimated peak Somerset Dam level: 99.8m (excluding forecast); 100.2m (including forecast).
			• Estimated total Dam inflow: 242,000ML (excluding forecast); 380,000ML (including forecast).
			• Estimated peak flow at Lowood excluding Wivenhoe Dam releases: 470m^3/s (excluding forecast); 670m^3/s (including forecast).
			• Estimated peak flow at Moggill excluding Wivenhoe Dam releases: 570m^3/s (excluding forecast); 970m^3/s (including forecast).
			• Estimated peak Wivenhoe Dam outflow: 1,220m^3/s (excluding forecast); 1,250m^3/s (including forecast).
				Strategy W1B and Strategy S2 (Lake level greater than 67.50m, maximum release 380m^3/s)
				• Endeavoured to keep Burtons Bridge trafficable by limiting combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 430m^3/s.
				• Peak inflows into the Brisbane River from Lockyer Creek were estimated to be in the order of 470m^3/s. These flows may not be sufficient to inundate Burtons Bridge.
				• Lake level was not expected to reach 67.75m (Strategy W1C) for at least six hours. Lake level may not exceed 68.5m.
				• Water was held in Wivenhoe Dam in an attempt to keep Burtons Bridge trafficable in accordance with Strategy W1B.
				• In accordance with Strategy S2, the crest gates at Somerset Dam were raised to enable uncontrolled discharge and the low level regulators and sluices at Somerset Dam were kept closed.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 3 of 20				
Date/time	**Background**	**Dam conditions**	**Rainfall and model results**	**Strategy**

Commenced Friday 07 Jan 2011 09:00
 	
Completed Friday 07 Jan 2011 15:00
	Strategy W1C and Strategy S2
	• At around 09:00 it became apparent flows from Lockyer Creek into the Brisbane River, combined with local Brisbane River inflows downstream of Wivenhoe Dam, would be sufficient to inundate all bridges below the Dam, with the exception of Mt Crosby Weir Bridge and Fernvale Bridge. Burtons Bridge was inundated by natural river flows near the end of this period.
	• All impacted Councils were notified of the situation and that releases would commence from Wivenhoe Dam. Releases were timed to occur at 15:00 to allow bridges to be closed and arrangements to be made to cater for rural community isolation. The impacted rural communities had been isolated over the Christmas period and time was needed for suitable arrangements to be made to allow these communities to prepare for another potentially extended period of isolation. Releases were timed to start in accordance with the Manual requirements of keeping Burtons Bridge and Kholo Bridge open to traffic when operating under Strategy W1C.
	• Transitioned from Strategy W1C to Strategy W1D once the Wivenhoe Dam lake level exceeded 68.0m.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 89mm;
		• Somerset Dam 90mm;
		• Lockyer Creek 71mm;
		• Bremer River 71mm.
		
		Wivenhoe Dam level rose from 67.75m to 68.03m over the six-hour period.
		
		Somerset Dam level rose from 99.65m to 99.94m over the six-hour period.
			• Catchment average rainfalls during this period were:
			  ◦ Wivenhoe Dam 24mm;
			  ◦ Somerset Dam 30mm;
			  ◦ Lockyer Creek 14mm;
			  ◦ Bremer River 12mm.
			• Forecast 24-hour catchment average rainfall at 10:00 on 7 Jan 2011 was 25mm.
			• Estimated peak Wivenhoe Dam level: 68.4m (excluding forecast); 68.9m (including forecast).
			• Estimated peak Somerset Dam level: 100.3m (excluding forecast); 100.6m (including forecast).
			• Estimated total Dam inflow: 346,000ML (excluding forecast); 483,000ML (including forecast).
			• Estimated peak flow at Lowood excluding Wivenhoe Dam releases: 530m^3/s (excluding forecast); 710m^3/s (including forecast).
			• Estimated peak flow at Moggill excluding Wivenhoe Dam releases: 660m^3/s (excluding forecast); 1,040m^3/s (including forecast).
			• Estimated peak Wivenhoe Dam outflow: 1,240m^3/s (excluding forecast); 1,270m^3/s (including forecast).
				Strategy W1C
				(Lake level greater than 67.75m, maximum release 500m^3/s)
				• Due to the further rain and observed stream rises, it became apparent flows from Lockyer Creek into the Brisbane River, combined with local Brisbane River inflows downstream of Wivenhoe Dam, would be sufficient to inundate all bridges downstream of the Dam, with the exception of the Mt Crosby Weir Bridge and Fernvale Bridge.
				• Releases from Wivenhoe Dam were managed in an attempt to ensure Mt Crosby Weir Bridge and Fernvale Bridge remained trafficable in accordance with Strategies W1D and W1E.
				• In accordance with Strategy S2, the crest gates at Somerset Dam were raised to enable uncontrolled discharge, and the low level regulators and sluices at Somerset Dam were kept closed.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 4 of 20				
Date/time	**Background**	**Dam conditions**	**Rainfall and model results**	**Strategy**

Commenced Friday 07 Jan 2011 15:00
 	
Completed Saturday 08 Jan 2011 14:00
	Transition from Strategy W1D to W1E to W3; and Strategy S2
	Wivenhoe Directives #1 to #4.
	Somerset Directives #1 to #3.
	• Gates opened continuously at Wivenhoe Dam for 23 hours, in accordance with standard gate opening sequence at a rate or 0.5m of opening per hour.
	• Transitioned from Strategy W1D to W1E when the Wivenhoe Dam level exceeded 68.25m (22:00 on 7 Jan 2011).
	• Transitioned from Strategy W1E to W3 as it became apparent Wivenhoe Dam level would exceed 68.50m (08:00 on 8 Jan 2011). Strategy W2 was by-passed as it was not possible to achieve this strategy by limiting the flow in the Brisbane River to less than the naturally occurring peaks at Lowood and Moggill. This is because the calculated naturally occurring peaks at Lowood and Moggill were 530m^3/s and 770m^3/s respectively, whereas the release rate from the Dam was already 940m^3/s. Limiting releases to these naturally occurring peak flows would also have compromised the Dam drain down requirements.
	• At 14:00 on 8 Jan 2011, Wivenhoe Dam discharge was 1,239m^3/s. All rural bridges below the Dam, with the exception of Mt Crosby Weir Bridge and Fernvale Bridge, were flooded.
		Total rainfall from 0800 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 92mm;
		• Somerset Dam 95mm;
		• Lockyer Creek 72mm;
		• Bremer River 72mm.
		
		Wivenhoe Dam level rose from 68.03m to 68.61m over the 23-hour period.
		
		Somerset Dam level rose from 99.94m to 100.44m over the 23-hour period.
			• Catchment average rainfalls during this period were:
			  • Wivenhoe Dam 3mm;
			  • Somerset Dam 5mm;
			  • Lockyer Creek 1mm;
			  • Bremer River 1mm.
			• Forecast 24-hour catchment average rainfall at 10:00 on 8 Jan 2011 was 40mm.
			• Estimated peak Wivenhoe Dam level: 68.7m (excluding forecast); 69.1m (including forecast).
			• Estimated peak Somerset Dam level: 100.5m (excluding forecast); 100.6m (including forecast).
			• Estimated total Dam inflow: 420,000ML (excluding forecast); 662,000ML (including forecast).
			• Estimated peak flow at Lowood excluding Wivenhoe Dam releases: 530m^3/s (excluding forecast); 530m^3/s (including forecast).
			• Estimated peak flow at Moggill excluding Wivenhoe Dam releases: 770m^3/s (excluding forecast); 940m^3/s (including forecast).
			• Estimated peak Wivenhoe Dam outflow: 1,480m^3/s (excluding forecast); 1,540m^3/s (including forecast).
			• This flow was significantly greater than the calculated natural peak that excluded Wivenhoe Dam releases.
				Strategy W3 and Strategy S2 (Lake level greater than 68.50m, maximum release 4,000m^3/s)
				• Inflows from Lockyer Creek into the Brisbane River had inundated all bridges downstream of the Dam, with the exception of the Mt Crosby Weir Bridge and Fernvale Bridge.
				• The strategy transitioned from W1 to W3 as it became apparent Wivenhoe Dam level was likely to exceed 68.5m and Strategy W2 couldn't be applied.
				• Strategy W3 required the flow at Moggill to be lowered to 4,000m^3/s as soon as possible after the naturally occurring peak at Moggill (excluding Wivenhoe Dam releases). This was already achieved.
				• Strategy W3 also required lower level Manual objectives to be considered. Therefore consideration was given to minimising disruption to downstream rural life and endeavouring to keep Mt Crosby Weir Bridge and Fernvale Bridge trafficable. There was also awareness Wivenhoe Dam outflows were already more than doubling the natural peak flow at Moggill.
				• Due to rainfall on the ground, it was apparent the Somerset Dam level would exceed 100.45m. Accordingly, two sluice gates were opened during this period to allow Dam levels to move towards the Operating Target Line in accordance with Strategy S2.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 5 of 20				
Date/time	**Background**	**Dam conditions**	**Rainfall and model results**	**Strategy**

Commenced Saturday 08 Jan 2011 14:00
 	
Completed Sunday 09 Jan 2011 01:00
	Strategy W3 and Strategy S2
	• Releases maintained from both Wivenhoe and Somerset Dams to ensure Mt Crosby Weir Bridge and Fernvale Bridge remained trafficable.
	• No change to gate settings over this period. Wivenhoe Dam discharge was 1,240m^3/s. All rural bridges below the Dam, with the exception of the Mt Crosby Weir Bridge and Fernvale Bridge, were flooded.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 100mm;
		• Somerset Dam 111mm;
		• Lockyer Creek 75mm;
		• Bremer River 75mm.
		
		Wivenhoe Dam level rose very slightly from 68.61m to 68.63m over the 13-hour period.
		
		Somerset Dam level fell from 100.44m to 100.32m over the 13-hour period.
			• Catchment average rainfalls during this period were:
			  • Wivenhoe Dam 8mm;
			  • Somerset Dam 16mm;
			  • Lockyer Creek 3mm;
			  • Bremer River 2mm.
			• Forecasted 24-hour catchment average rainfall at 16:00 on 8 Jan 2011 was 40mm.
			• Estimated peak Wivenhoe Dam level: 68.7m (excluding forecast); 69.9m (including forecast).
			• Estimated peak Somerset Dam level: 100.5m (excluding forecast); 100.6m (including forecast).
			• Estimated total Dam inflow: 457,000ML (excluding forecast); 697,000ML (including forecast).
			• Estimated peak flow at Lowood excluding Wivenhoe Dam releases: 530m^3/s (excluding forecast); 530m^3/s (including forecast).
			• Estimated peak flow at Moggill excluding Wivenhoe Dam releases: 770m^3/s (excluding forecast); 840m^3/s (including forecast). This peak is estimated to have occurred at 05:00 on 8 Jan 2011.
			• Estimated peak Wivenhoe Dam outflow: 1,480m^3/s (excluding forecast); 1,520m^3/s (including forecast). This flow was significantly greater than the calculated natural peak that excluded Wivenhoe Dam releases.
				Strategy W3 and Strategy S2 (Lake level greater than 68.50m, maximum release 4,000m^3/s)
				• Strategy W3 required the flow at Moggill to be lowered to 4,000m^3/s as soon as possible after the naturally occurring peak at Moggill (excluding Wivenhoe Dam releases). This was already achieved.
				• Strategy W3 also required lower level Manual objectives to be considered. Therefore, with lake levels rising slightly (Wivenhoe Dam) and falling (Somerset Dam) consideration during this period remained on minimising disruption to downstream rural life and endeavouring to keep Mt Crosby Weir Bridge and Fernvale Bridge trafficable.
				• There was also awareness Wivenhoe Dam outflows were already more than doubling the natural peak flow at Moggill. Increasing the Wivenhoe Dam release to produce a flow at Moggill of up to 3,000m^3/s during this period would have moved the operating strategy back to W1 in around 18 hours. This approach was not justifiable at the time given the impacts of such a flow down the river system that included localised flooding in Brisbane.
				• With the Somerset Dam level still expected to exceed 100.45m, and the level in Wivenhoe Dam remaining relatively static, releases from Somerset Dam continued. Closing of the sluices would have resulted in Dam levels quickly moving under the Operating Target Line requiring sluice re-opening within a short period.

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2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 6 of 20				
Date/time	**Background**	**Dam conditions**	**Rainfall and model results**	**Strategy**

Commenced Sunday 09 Jan 2011 01:00
Completed Sunday 09 Jan 2011 08:00
	Strategy W3 and Strategy S2 Wivenhoe Directives #5 to #7.
	• Releases increased marginally from Wivenhoe Dam to account for the passing of the Lockyer Creek peak while ensuring Mt Crosby Weir Bridge and Fernvale Bridge remained trafficable.
	• Wivenhoe Dam discharge increased from 1,240m^3/s to 1,334m^3/s.
	• There were no changes to Somerset Dam gate settings over this period.
	• All rural bridges below the Dam, with the exception of the Mt Crosby Weir Bridge and Fernvale Bridge, were flooded.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 112mm;
		• Somerset Dam 146mm;
		• Lockyer Creel 76mm;
		• Bremer River 75mm.
		Wivenhoe Dam level fell from 68.63m to 68.56m over the seven-hour period.
		Somerset Dam level fell from 100.32m to 100.28m over the seven-hour period.
			• Catchment average rainfalls during this period were:
			  • Wivenhoe Dam 12mm;
			  • Somerset Dam 36mm;
			  • Lockyer Creek 1mm;
			  • Bremer River 0mm.
			• Forecast 24-hour catchment average rainfall at 16:00 on 8 Jan 2011 was 40mm.
			• Estimated peak Wivenhoe Dam level: 68.7m (excluding forecast); 69.3m (including forecast).
			• Estimated peak Somerset Dam level: 100.5m (excluding forecast); 101.0m (including forecast).
			• Estimated total Dam inflow: 569,000ML (excluding forecast); 814,000ML (including forecast).
			• Estimated peak flow at Lowood excluding Wivenhoe Dam releases: 530m^3/s (excluding forecast); 530m^3/s (including forecast).
			• Estimated peak flow at Moggill excluding Wivenhoe Dam releases: 770m^3/s (excluding forecast); 780m^3/s (including forecast). This peak is estimated to have occurred at 05:00 on 8 Jan 2011.
			• Estimated peak Wivenhoe Dam outflow: 1,500m^3/s (excluding forecast); 1,550m^3/s (including forecast). This flow is significantly greater than the calculated natural peak that excluded Wivenhoe Dam releases.
				Strategy W3 and Strategy S2 (Lake level greater than 68.50m, maximum release 4,000m^3/s)
				• Strategy W3 required the flow at Moggill to be lowered to 4,000m^3/s as soon as possible after the naturally occurring peak at Moggill (excluding Wivenhoe Dam releases). This was already achieved.
				• Strategy W3 also required lower level Manual objectives to be considered. Therefore, with lake levels falling at both dams, consideration during this period remained on minimising disruption to downstream rural life and endeavouring to keep Mt Crosby Weir Bridge and Fernvale Bridge trafficable.
				• There was also awareness Wivenhoe Dam outflows were already more than doubling the natural peak flow at Moggill. Increasing the Wivenhoe Dam release to produce a flow at Moggill of up to 3,000m^3/s during this period would have moved the operating strategy back to W1 in around 18 hours. This approach was not justifiable at the time given the impacts of such a flow down the river system that included localised flooding in Brisbane.
				• With the Somerset Dam level still expected to exceed 100.45m, and the level in Wivenhoe Dam falling, releases from Somerset Dam continued. Closing of the sluices would have resulted in dam levels quickly moving under the Operating Target Line requiring sluice re-opening within a short period, particularly given the rainfall that occurred in the Somerset Dam catchment during this period.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 7 of 20

Date/time	Background	Dam conditions	Rainfall and model results	Strategy

Commenced Sunday 09 Jan 2011 08:00
 	
Completed Sunday 09 Jan 2011 14:00
	Strategy W3 and Strategy S2 Wivenhoe Directives #7. Somerset Directives #4 to #5.
	• Releases increased marginally from Wivenhoe Dam to account for the passing of the Lockyer Creek peak while ensuring Mt Crosby Weir Bridge and Fernvale Bridge remained trafficable.
	• Wivenhoe Dam discharge increased from 1,334m^3/s to 1,386m^3/s.
	• Somerset Dam sluice gates opened progressively over this period to allow Dam levels to move towards the Operating Target Line in accordance with Strategy S2.
	• All rural bridges below the Dam, with the exception of the Mt Crosby Weir Bridge and Fernvale Bridge, were flooded.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 146mm;
		• Somerset Dam 199mm;
		• Lockyer Creek 94mm;
		• Bremer River 90mm.
		
		Wivenhoe Dam level rose very slightly from 68.56m to 68.58m over the six-hour period.
		
		Somerset Dam level rose from 100.28m to 100.47m over the six-hour period.
			• Catchment average rainfalls during this period were:
			  • Wivenhoe Dam 34mm;
			  • Somerset Dam 53mm;
			  • Lockyer Creek 18mm;
			  • Bremer River 15mm.
			• Forecast 24-hour catchment average rainfall at 10:00 on 9 Jan 2011 was 50mm.
			• Estimated peak Wivenhoe Dam level: 70.0m (excluding forecast); 71.3m (including forecast).
			• Estimated peak Somerset Dam level: 100.7m (excluding forecast); 101.1m (including forecast).
			• Estimated total Dam inflow: 804,000ML (excluding forecast); 1,108,000ML (including forecast).
			• Estimated peak flow at Lowood excluding Wivenhoe Dam releases: 530m^3/s (excluding forecast); 690m^3/s (including forecast).
			• Estimated peak flow at Moggill excluding Wivenhoe Dam releases: 770m^3/s (excluding forecast); 1,210m^3/s (including forecast). This peak was estimated to have occurred at 05:00 on 8 Jan 2011.
			• Estimated peak Wivenhoe Dam outflow: 1,490m^3/s (excluding forecast); 1,560m^3/s (including forecast). This flow was significantly greater than the calculated natural peak that excluded Wivenhoe Dam releases.
				Strategy W3 and Strategy S2 (Lake level greater than 68.50m, maximum release 4,000m^3/s)
				• With lake levels rising at both Dams and heavy rain being experienced in the Dam catchments, consideration was given to transitioning from minimising disruption to downstream rural life to protecting urban areas from inundation.
				• However, using the BoM rainfall forecasts, a three day assessment (see Appendix K) showed the lower limit of three day forecast inflow to be similar to the October 2010 flood event, with the upper limit similar to the February 1999 flood event. Therefore, during this period, consideration remained on minimising disruption to downstream rural life and endeavouring to keep Mt Crosby Weir Bridge and Fernvale Bridge trafficable. This was the approach used during both the October 2010 the February 1999 flood event.
				• With Dam levels under the Operating Target Line at the end of this period, releases continued from Somerset Dam.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 8 of 20				
Date/time	**Background**	**Dam conditions**	**Rainfall and model results**	**Strategy**

Commenced Sunday 09 Jan 2011 14:00
 	
Completed Sunday 09 Jan 2011 19:00
	Strategy W3 and Strategy S2
	• During this period, releases continued from both Dams at a level that ensured Mt Crosby Weir Bridge and Fernvale Bridge remained trafficable. Gate settings were unchanged and the Wivenhoe Dam discharge was 1,411m^3/s.
	• Due to rainfall on the ground and the modelled rapid lake level rises, a decision was made to focus on protecting urban areas from inundation at 19:00.
	• Councils, the Dam Safety Regulator and Seqwater's CEO were notified of the decision soon after 19:00. The ramifications of the decision were that the new estimated peak flow at Moggill of 3,300m^3/s would impact properties and begin to damage urban areas below Moggill. Brisbane City Council damage tables indicated at flows of 3,000m^3/s, damage costs would exceed $5.0 million and 2,600 properties would be impacted in some way. The level of impact would increase significantly as flows increased and therefore the focus was on minimising the flow at Moggill.
	• A decision was made at 19:00, to staff the Flood Operations Centre with at least two Duty Engineers at all times until the peak of the Event had occurred.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 208mm;
		• Somerset Dam 305mm;
		• Lockyer Creek 116mm;
		• Bremer River 96mm.
		
		Wivenhoe Dam level rose from 68.58m to 68.97m over the five-hour period.
		
		Somerset Dam level rose from 100.47m to 101.43m over the five-hour period.
			• Catchment average rainfalls during this period were:
			  ◦ Wivenhoe Dam 62mm;
			  ◦ Somerset Dam 106mm;
			  ◦ Lockyer Creek 22mm;
			  ◦ Bremer River 6mm.
			• Forecast 24-hour catchment average rainfall at 16:00 on 9 Jan 2011 was 65mm.
			• Estimated peak Wivenhoe Dam level:
			72.1m (excluding forecast);
			73.9m (including forecast).
			• Estimated peak Somerset Dam level:
			102.3m (excluding forecast);
			103.0m (including forecast).
			• Estimated total Dam inflow:
			1,272,000ML (excluding forecast);
			1,712,000ML (including forecast).
			• Estimated peak flow at Moggill excluding Wivenhoe Dam releases:
			770m^3/s (excluding forecast);
			1,940m^3/s (including forecast).
			This peak was estimated to have occurred at 05:00 on 8 Jan 2011.
			• Estimated peak flow at Moggill including Wivenhoe Dam releases:
			3,300m^3/s (excluding forecast);
			*4,400m^3/s (including forecast).
				Strategy W3 and Strategy S2 (Lake level greater than 68.50m, maximum release 4,000m^3/s)
				• Lake levels were continuing to rise at both Dams, and combined with heavy rain in the Dam catchments during this period, it was decided at the end of the period to no longer consider minimising disruption to downstream rural life and to focus only on protecting urban areas from inundation.
				• Towards the end of this period, it became apparent Moggill was likely to experience a second naturally occurring peak on 10 Jan 2011 or later. The Manual required the flow at Moggill to be minimised prior to this peak occurring. This requirement competed with the need to protect urban areas by not allowing the Wivenhoe Dam to reach a level that invoked Strategy W4. It was decided the best course of action was to increase releases as quickly as possible to the limit of non-damaging flows at Moggill. However, before this could occur, Councils needed to be advised, bridges needed to be closed and actions needed to be taken to prepare rural communities for isolation and urban areas below Moggill for river flows approaching 3,500m^3/s.
				• With Dam levels under the Operating Target Line during this period, releases continued from Somerset Dam.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 9 of 20

Date/time	Background	Dam conditions	Rainfall and model results	Strategy

Commenced Sunday 09 Jan 2011 19:00
 	
Completed Monday 10 Jan 2011 01:00
	Strategy W3 and Strategy S2
	• Agency notifications commenced at 19:00. Brisbane City Council, the Dam Safety Regulator and Seqwater's CEO were advised the likely peak flow at Moggill would exceed 3,000m³/s.
	• Brisbane City Council damage tables indicated, at flows of 3,000m³/s, damage costs would exceed $5.0 million and 2,600 properties would be impacted in some way. The level of impact would increase significantly as flows increased, and therefore the focus was on minimising the flow at Moggill.
	• Fernvale Bridge was closed by police at around 01:00 on 10 Jan 2011. A directive was issued to increases releases from Wivenhoe Dam.
	• Gate settings did not change over this period due to the potential danger to the public associated with inundating Fernvale Bridge from Wivenhoe Dam outflows prior to the bridge being closed to traffic. Councils also required time to prepare for the isolation of rural communities, the onset of urban damage below Moggill and to undertake any necessary evacuations. Wivenhoe Dam discharge was 1,473m³/s. All rural bridges below the Dam, with the exception of Mt Crosby Weir Bridge and Fernvale Bridge, were flooded.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 232mm;
		• Somerset Dam 343mm;
		• Lockyer Creek 131mm;
		• Bremer River 102mm.
		
		Wivenhoe Dam level rose from 68.97m to 69.9m over the six-hour period.
		
		Somerset Dam level rose from 101.43m to 102.54m over the six-hour period.
			• Catchment average rainfalls during this period were:
			  • Wivenhoe Dam 24mm;
			  • Somerset Dam 38mm;
			  • Lockyer Creek 14mm;
			  • Bremer River 6mm.
			• Forecast 24-hour catchment average rainfall at 16:00 on 9 Jan 2011 was 65mm.
			• Estimated peak Wivenhoe Dam level:
			72.9m (excluding forecast);
			74.7m (including forecast).
			• Estimated peak Somerset Dam level:
			102.9m (excluding forecast);
			103.4m (including forecast).
			• Estimated total Dam inflow:
			1,468,000ML (excluding forecast);
			1,922,000ML (including forecast).
			• Estimated peak flow at Moggill excluding Wivenhoe Dam releases:
			820m³/s (excluding forecast);
			2,000m³/s (including forecast).
			This peak was estimated to occur at 16:00 on 10 Jan 2011.
			• Estimated peak flow at Moggill including Wivenhoe Dam releases:
			3,240m³/s (excluding forecast);
			4,480m³/s (including forecast).
				Strategy W3 and Strategy S2
				(Lake level greater than 68.50m, maximum release 4,000m³/s)
				• Consideration now focused on protecting urban areas from inundation. However, before releases were increased to and above the limit of non-damaging floods at Moggill, Councils and other impacted agencies were notified so appropriate actions could be taken, including any necessary evacuations and the closure of the Mt Crosby Weir Bridge and Fernvale Bridge.
				• The Manual requires the flow at Moggill to be minimised prior to its naturally occurring peak. This requirement was balanced against the need to protect urban areas by releasing water from the Dams in an attempt to keep the Wivenhoe Dam lake below a level that would invoke Strategy W4. Based on an estimated 16 hour travel time between the Dam and Moggill, this did occur.
				• With Dam levels under the Operating Target Line during this period, releases continued from Somerset Dam.
				• Although there was a full awareness of the rainfall forecasts and associated potential flood impacts, the strategy was not to release flows that would cause high level urban inundation until it was certain it could not be avoided. Model results continued to indicate this may be possible.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 10 of 20				
Date/time	**Background**	**Dam conditions**	**Rainfall and model results**	**Strategy**

Commenced Monday 10 Jan 2011 01:00
 	
Completed Monday 10 Jan 2011 09:00
	Strategy W3 and Strategy S2 Wivenhoe Directives #8 to #10.
	• Gates opened continuously at Wivenhoe Dam for eight hours in accordance with standard gate opening sequence at a rate of 0.5m of opening per hour.
	• Wivenhoe Dam discharge increased from 1,473m^3/s to 2,015m^3/s. All rural bridges below the Dam were flooded.
	• Further gate openings at Wivenhoe Dam were paused at 09:00 in an attempt to allow the Lockyer Creek and Bremer River peaks to pass Moggill, and to restrict Brisbane River flows at Moggill to 3,500m^3/s. This was achieved following discussions with Brisbane City Council that advised a flow of 3,500m^3/s at Moggill would fully submerge 322 properties and impact 7,000 properties.
	• No gate movements occurred at Somerset Dam during this period, with Dam levels plotting under the Operating Target Line. This meant the only gate movements allowable at Somerset Dam under Strategy S2 would be openings and this did not happen to limit further rises in Wivenhoe Dam.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 244mm;
		• Somerset Dam 373mm;
		• Lockyer Creek 143mm;
		• Bremer River 120mm.
		
		Wivenhoe Dam level rose from 69.97m to 71.56m over the eight-hour period.
		
		Somerset Dam level rose from 102.54m to 103.08m over the eight-hour period.
			• Catchment average rainfalls during this period were:
			  ◦ Wivenhoe Dam 12mm;
			  ◦ Somerset Dam 30mm;
			  ◦ Lockyer Creek 12mm;
			  ◦ Bremer River 18mm.
			• Forecast 24 hour catchment average rainfall at 16:00 on 9 Jan 2011 was 65mm.
			• Estimated peak Wivenhoe Dam level:
			72.9m (excluding forecast);
			74.5m (including forecast).
			• Estimated peak Somerset Dam level:
			103.1m (excluding forecast);
			103.5m (including forecast).
			• Estimated total Dam inflow:
			1,531,000ML (excluding forecast);
			1,985,000ML (including forecast).
			• Estimated peak flow at Moggill excluding Wivenhoe Dam releases:
			1,090m^3/s (excluding forecast);
			2,090m^3/s (including forecast).
			This peak was estimated to occur at 16:00 on 10 Jan 2011.
			• Estimated peak flow at Moggill including Wivenhoe releases:
			3,420m^3/s (excluding forecast);
			4,680m^3/s (including forecast).
				Strategy W3 and Strategy S2 (Lake level greater than 68.50m, maximum release 4,000m^3/s)
				• Consideration was given to protecting urban areas from inundation and minimising urban damage.
				• Due to advice received from Brisbane City Council that a flow of 3,500m^3/s at Moggill would fully submerge 322 properties and impact 7,000 properties, an attempt was made to remain below this flow level.
				• The approach in the Manual which states the intent of Strategy W3 is to limit the flow in the Brisbane River at Moggill to less than 4,000m^3/s, was adopted. Advice received from Brisbane City Council that the upper limit of non-damaging floods was below the 4,000m^3/s stated in the Manual was noted and taken into account in the decision making processes.
				• With Dam levels under the Operating Target Line during this period, releases continued from Somerset Dam.
				• Although there was full awareness of the rainfall forecasts and associated potential flood impacts, the strategy was not to release flows that would cause high level urban inundation until it was certain it could not be avoided. Model results continued to indicate this may be possible.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 11 of 20				
Date/time	**Background**	**Dam conditions**	**Rainfall and model results**	**Strategy**

Commenced Monday 10 Jan 2011 09:00
 	
Completed Monday 10 Jan 2011 15:00
	Strategy W3 and Strategy S2
	• Gate settings at Wivenhoe Dam did not change over this period. Wivenhoe Dam discharge was 2,087m^3/s. All rural bridges below the Dam were flooded.
	• At 15:00, the attempt to restrict Brisbane River flows at Moggill to 3,500m^3/s was abandoned due to rainfall in the Dam catchments. A new target of 4,000m^3/s was set in accordance with the Manual, on the basis that Strategy W3 intends to limit the flow in the Brisbane River at Moggill to less than 4,000m^3/s and minimise urban damage.
	• Gate movements at Somerset Dam did not change during this period, with Dam levels plotting under the Operating Target Line. This meant the only gate movements allowable at Somerset Dam under Strategy S2 was openings and this was not done to limit further rises in Wivenhoe Dam.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 274mm;
		• Somerset Dam 407mm;
		• Lockyer Creek 169mm;
		• Bremer River 149mm.
		
		Wivenhoe Dam level rose from 71.56m to 72.54m over the six-hour period.
		
		Somerset Dam level rose from 103.08m to 103.43m over the six-hour period.
			• Catchment average rainfalls during this period were:
			  ◦ Wivenhoe Dam 34mm;
			  ◦ Somerset Dam 31mm;
			  ◦ Lockyer Creek 27mm;
			  ◦ Bremer River 30mm.
			• Forecast 24 hour catchment average rainfall at 10:00 on 10 Jan 2011 was 75mm.
			• Estimated peak Wivenhoe Dam level:
			73.6m (excluding forecast);
			75.2m (including forecast).
			• Estimated peak Somerset Dam level:
			103.4m (excluding forecast);
			103.7m (including forecast).
			• Estimated total Dam inflow:
			1,708,000ML (excluding forecast);
			2,162,000ML (including forecast).
			• Estimated peak flow at Moggill excluding Wivenhoe Dam releases:
			1,500m^3/s (excluding forecast);
			2,570m^3/s (including forecast).
			This peak was estimated to occur at 20:00 on 10 Jan 2011.
			• Estimated peak flow at Moggill including Wivenhoe Dam releases:
			3,910m^3/s (excluding forecast);
			5,180m^3/s (including forecast).
				Strategy W3 and Strategy S2
				(Lake level greater than 68.50m, maximum release 4,000m^3/s)
				• Consideration focused on protecting urban areas from inundation and minimising urban damage.
				• It was decided at 15:00 to attempt to remain below a target flow of around 4,000m^3/s at Moggill.
				• Continued to follow the approach in the Manual which states the intent of Strategy W3 is to limit the flow in the Brisbane River at Moggill to less than 4,000m^3/s.
				• With Dam levels under the Operating Target Line during this period, releases continued from Somerset Dam.
				• Although there was full awareness of the rainfall forecasts and associated potential flood impacts, the strategy was not to release flows that would cause high level urban inundation until it was certain it could not be avoided. Model results continued to indicate this may be possible.

January 2011 Flood Event – Period 12 of 20				
Date/time	**Background**	**Dam conditions**	**Rainfall and model results**	**Strategy**

Commenced Monday 10 Jan 2011 15:00
 	
Completed Monday 10 Jan 2011 20:00
	Strategy W3 and Strategy S2 Wivenhoe Directive #11.
	• Gates opened continuously at Wivenhoe Dam for five hours in line with standard gate opening sequence, at a rate or 1.0m of opening per hour. Wivenhoe Dam discharge increased from 2,087m^3/s to 2,695m^3/s.
	• In accordance with the Manual, a target of 4,000m^3/s at Moggill was set, on the basis of the intent of Strategy W3 to limit the flow in the Brisbane River at Moggill to less than 4,000m^3/s and minimise urban damage.
	• Further gate openings at Wivenhoe Dam were paused at 20:00 in an attempt to allow the Lockyer Creek and Bremer River peaks to pass Moggill and to restrict Brisbane River flows at Moggill to 4,000m^3/s.
	• No gate movements occurred at Somerset Dam during this period, with Dam levels plotting under the Operating Target Line. This limited further rises in Wivenhoe.
	• Initial advice on a major flash flood originating in the Lockyer headwaters was received from BoM at 17:32. No volume or flow details were available and gauges in the area were not indicating a significant event. The event would not impact on the Brisbane River for 24 hours.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 279mm;
		• Somerset Dam 415mm;
		• Lockyer Creek 174mm;
		• Bremer River 153mm.
		
		Wivenhoe Dam level rose from 72.53m to 73.06m over the five-hour period.
		
		Somerset Dam level rose from 103.43m to 103.45m over the five-hour period.
			• Catchment average rainfalls during this period were:
			  • Wivenhoe Dam 4mm;
			  • Somerset Dam 8mm;
			  • Lockyer Creek 5mm;
			  • Bremer River 3mm.
			• Forecast 24-hour catchment average rainfall at 16:00 on 10 Jan 2011 was 38mm.
			• Estimated peak Wivenhoe level: 73.6m (excluding forecast); 74.3m (including forecast).
			• Estimated peak Somerset level: 103.5m (excluding forecast); 103.5m (including forecast).
			• Estimated total Dam inflow: 1,731,000ML (excluding forecast); 1,982,000ML (including forecast).
			• Estimated peak flow at Moggill excluding Wivenhoe Dam releases: 1,500m^3/s (excluding forecast); 1,840m^3/s (including forecast). This peak was estimated to occur at 20:00 on 10 Jan 2011.
			• Estimated peak flow at Moggill including Wivenhoe Dam releases: 3,980m^3/s (excluding forecast); 4,470m^3/s (including forecast).
			• The extreme rainfall that occurred in Lockyer Creek catchment during this period was not recorded in the remotely-accessible rain gauges in the catchment, and was not indicated on the BoM weather radar.
				Strategy W3 and Strategy S2 (Lake level greater than 68.50m, maximum release 4,000m^3/s)
				• Consideration focused on protecting urban areas from inundation and minimising urban damage.
				• The target maximum flow at Moggill was now 4,000m^3/s. The approach in the Manual which states the intent of Strategy W3 is to limit the flow in the Brisbane River at Moggill to less than 4,000m^3/s, continued to be followed.
				• With Dam levels under the Operating Target Line during this period, Somerset Dam releases continued.
				• The reduced rainfall forecast justified retaining the target of 4,000m^3/s at Moggill, while the Wivenhoe Dam peak of 74.3m (including forecast) indicated it may be possible to keep urban damage within tolerable limits. A discussion was held with the Dam Safety Regulator to request permission to exceed a level of 74.0m in Wivenhoe Dam for a short period (maximum 12 hours) without invoking Strategy W4, if the safety of the Dam could be guaranteed and urban damage reduced. The Regulator agreed with this approach and provided permission.
				• The strategy continued to not release flows that would cause high level urban inundation until it was certain it could not be avoided. Model results continued to indicate this may be possible.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 13 of 20				
Date/time	**Background**	**Dam conditions**	**Rainfall and model results**	**Strategy**

Commenced Monday 10 Jan 2011 20:00
 	
Completed Tuesday 11 Jan 2011 04:00
	Strategy W3 and Strategy S2
	• Gate openings at Wivenhoe Dam were paused at 20:00 in an attempt to restrict flows at Moggill to close to 4,000m³/s. There were no changes to gate settings at Wivenhoe Dam over this period. The Dam discharge was 2,726m³/s.
	• In accordance with the Manual, a target flow of 4,000m³/s at Moggill was set on the basis of Strategy W3 to limit the flow in the Brisbane River at Moggill to less than 4,000m³/s. However, Brisbane City Council damage tables indicated this would still impact 5,325 properties and cause damage exceeding $47.0 million.
	• At 17:32, initial advice was provided about a significant flash flood originating in the Lockyer Creek headwaters. Details were received at 20:00. The focus was on developing strategies to manage these potential flows, however, as any strategy would involve significantly reducing outflows from Wivenhoe Dam, the strategies were not adopted.
	• During this period the plotted dam levels drifted just above the Operating Target Line. This lead to a decision at 04:00 to start closing down releases from Somerset Dam to limit further rises in Wivenhoe Dam.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 323mm;
		• Somerset Dam 437mm;
		• Lockyer Creek 186mm;
		• Bremer River 167mm.
		
		Wivenhoe Dam level rose from 73.06m to 73.40m over the eight-hour period.
		
		Somerset Dam level fell from 103.45m to 103.23m over the eight-hour period.
			• Catchment average rainfalls during this period were:
			  ◦ Wivenhoe Dam 44mm;
			  ◦ Somerset Dam 22mm;
			  ◦ Lockyer Creek 12mm;
			  ◦ Bremer River 14mm.
			• Forecast 24-hour catchment average rainfall at 16:00 on 10 Jan 2011 was 38mm.
			• Estimated peak Wivenhoe level: 74.1m (excluding forecast); 74.9m (including forecast).
			• Estimated peak Somerset level: 103.5m (excluding forecast); 103.7m (including forecast).
			• Estimated total dam inflow: 2,016,000ML (excluding forecast); 2,267,000ML (including forecast).
			• Estimated peak flow at Moggill excluding Wivenhoe Dam releases: 1,500m³/s (excluding forecast); 1,810m³/s (including forecast). This peak was estimated to have occurred at 20:00 on 10 Jan 2011.
			• Estimated peak flow at Moggill including Wivenhoe Dam releases: 4,040m³/s (excluding forecast); 4,540m³/s (including forecast).
				Strategy W3 and Strategy S2 (Lake level greater than 68.50m, maximum release 4,000m³/s)
				• Consideration focused on protecting urban areas from inundation and minimising urban damage. The target maximum flow at Moggill remained 4,000m³/s. The approach in the Manual which states the intent of Strategy W3 is to limit the flow in the Brisbane River at Moggill to less than 4,000m³/s, continued to be followed.
				• Model results showed a peak level in the Dam close to 74.0m was possible, but appeared increasing unlikely.
				• With Dam levels moving above the Operating Target Line during this period, it was decided to begin closing down releases from Somerset Dam to limit further rises in Wivenhoe Dam.
				• Although there was full awareness of the rainfall forecasts and associated potential flood impacts, the strategy was not to release flows that would cause high level urban inundation until it was certain it could not be avoided. Model results continued to indicate this may be possible however, as rainfall continued, the strategy was reviewed each hour. At 21:00 the Dam Safety Regulator was asked for permission to exceed a level of 74.0m in Wivenhoe Dam for a short period (maximum 12 hours) without invoking Strategy W4, provided the safety of the Dam could be guaranteed. This was considered carefully during the period in view of the continued rainfall.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 14 of 20				
Date/time	**Background**	**Dam conditions**	**Rainfall and model results**	**Strategy**

Commenced Tuesday 11 Jan 2011 04:00
 	
Completed Tuesday 11 Jan 2011 08:00
	Transition from Strategy W3 to Strategy W4; and Strategy S2 Wivenhoe Directive #12. Somerset Directive #6.
	
	• Extreme intense rainfall (estimated after the Event to exceed **1 in 500 year intensities**) commenced on and close to the Wivenhoe Dam lake area during this period. If the centroid of this rainfall was located further east or south, it may have been possible to avoid transition to Strategy W4.
	
	• Because the extreme intense rainfall was occurring on and close to the Dam rather than in the northern areas of the Dam catchment, response time was minimised and quick action was needed to protect the safety of the Dam. Accordingly, at 08:00, a decision was made to transition to Strategy W4. Significant urban damage was not to be avoided and the Dam Safety Regulator, Seqwater's CEO and the Councils were advised.
	
	• Gate settings were not changed at Wivenhoe Dam over this period. Wivenhoe Dam discharge was 2,832m^3/s.
	
	• Sluice gate openings at Somerset Dam were reduced from five to two as the plotted dam levels had drifted just above the Operating Target Line.
		Total rainfall from 08:00 on 6 Jan2011 to the end of this period:
		
		• Wivenhoe Dam 356mm;
		• Somerset Dam 483mm;
		• Lockyer Creek 240mm;
		• Bremer River 183mm.
		
		Wivenhoe Dam level rose from 73.40m to 73.70m over the four-hour period.
		
		Somerset Dam level rose from 103.23m to 103.46m over the four-hour period.
			• Catchment average rainfalls during this period were:
			  ◦ Wivenhoe Dam 33mm;
			  ◦ Wivenhoe Dam (local) 78mm;
			  ◦ Somerset Dam 46mm;
			  ◦ Lockyer Creek 54mm;
			  ◦ Bremer River 16mm.
			
			• Forecast 24-hour catchment average rainfall at 16:00 on 10 Jan 2011 was 38mm.
			
			• Estimated peak Wivenhoe level: 74.5m (excluding forecast); 75.1m (including forecast).
			
			• Estimated peak Somerset Dam level: 103.9m (excluding forecast); 104.2m (including forecast).
			
			• Estimated total Dam inflow: 2,210,000ML (excluding forecast); 2,460,000ML (including forecast).
			
			• Estimated peak flow at Moggill including Wivenhoe Dam releases: 5,870m^3/s (excluding forecast).
				Strategy W4 and Strategy S2 (Lake level predicted to exceed 74.00m, no maximum release rate)
				
				• At 08:00, model results showed restricting the peak level in the Dam close to 74.0m was no longer possible due to the high intensity rainfall experienced over this period.
				
				• At 08:00 it was decided to transition to Strategy W4 and the Dam Safety Regulator, Seqwater's CEO and Councils were advised. It was now apparent significant urban damage resulting from releases from Wivenhoe Dam could not be avoided due to the extreme intense rainfall (estimated after the Event to exceed **1 in 500 year intensities**) that commenced on and close to the Wivenhoe Dam lake area during this period.
				
				• As Dam levels moved above the Operating Target Line during this period, releases from Somerset Dam were progressively closed down to limit further rises in Wivenhoe Dam (sluices were closed down at hourly intervals in accordance with the Manual).

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 15 of 20

Date/time	Background	Dam conditions	Rainfall and model results	Strategy

Commenced Tuesday 11 Jan 2011 08:00
 	
Completed Tuesday 11 Jan 2011 13:00
	Strategy W4 and Strategy S2
	Wivenhoe Directive #12 to #14.
	Somerset Directive #7.
	
	• Extreme intense rainfall (estimated after the Event to exceed 1 in 500 year intensities) continued on and close to the Wivenhoe Dam lake area during this period. If the centroid of this rainfall was located further east or south, it may have been possible to avoid transition to Strategy W4.
	
	• Because the extreme intense rainfall was occurring on and close to the Dam rather than in the northern areas of the Dam catchment, response time was minimised and quick action was needed to protect the safety of the Dam. Once Strategy W4 is invoked, the Manual requires the opening of gates in accordance with standard sequences until the storage level of Wivenhoe Dam begins to fall. Accordingly gates were opened continuously at Wivenhoe Dam for five hours in accordance with the standard gate opening sequence at an average rate of 2.0m of opening per hour. This increased the Dam discharge from 2,753m^3/s to 4,250m^3/s. The threshold limit for urban damage had been exceeded and the lake level continued to rise.
	
	• During this period Somerset Dam sluice gate openings were closed to limit rises in Wivenhoe Dam in accordance with Strategy S2.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		
		• Wivenhoe Dam 382mm;
		• Somerset Dam 570mm;
		• Lockyer Creek 287mm;
		• Bremer River 237mm.
		
		Wivenhoe Dam level rose from 73.70m to 74.39m over the five-hour period.
		
		Somerset Dam level rose from 103.46m to 103.83m over the five-hour period.
			• Catchment average rainfalls during this period were:
			  ◦ Wivenhoe Dam 27mm;
			  ◦ Wivenhoe Dam (local) 85mm;
			  ◦ Somerset Dam 86mm;
			  ◦ Lockyer Creek 47mm;
			  ◦ Bremer River 56mm.
			
			• Forecast 24-hour catchment average rainfall at 10:00 on 11 Jan 2011 was 100mm.
			
			• A portion of the extreme intense rainfall in the Dam catchment fell in an un-gauged area (e.g. on the lake area) making it difficult for the model to accurately predict lake level rises. Accordingly, operations at Wivenhoe Dam commenced gauge board readings every 30 minutes during this period and relayed this information to the Flood Operations Centre by telephone.
			
			• Estimated peak Wivenhoe Dam level:
			75.0m (excluding forecast);
			76.2m (including forecast).
			
			• Estimated peak Somerset Dam level:
			104.8m (excluding forecast);
			105.7m (including forecast).
			
			• Estimated total Dam inflow is:
			2,506,000ML (excluding forecast);
			3,123;000ML (including forecast).
				Strategy W4 and Strategy S2
				(Lake level predicted to exceed 74.00m, no maximum release rate)
				
				• The strategy was to protect the structural safety of the Dam.
				
				• The Manual requires actions under Strategy W4 to ensure Wivenhoe Dam gate openings occur in accordance with standard sequences until the storage level of Wivenhoe Dam begins to fall.
				
				• The Dam level continued to rise at 13:00. During this period, a Dam Operator relayed Wivenhoe Dam gauge board readings to the Flood Operations Centre every 30 minutes. All four Duty Engineers were present in the Flood Operations Centre and flood operations decisions were made every half hour upon receipt of the gauge board readings.
				
				• With Dam levels above the Operating Target Line during this period, releases from Somerset Dam were closed down (all sluices closed at 10:00) to limit further rises in Wivenhoe Dam.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 16 of 20				
Date/time	**Background**	**Dam conditions**	**Rainfall and model results**	**Strategy**

Commenced Tuesday 11 Jan 2011 13:00
 	
Completed Tuesday 11 Jan 2011 19:00
	Strategy W4 and Strategy S2 Wivenhoe Directive #12 to #14.
	
	• Extreme rapid lake level rises in Wivenhoe Dam continued during this period. The QPF issued at 16:00 was for a catchment average rainfall of 75mm over the next 24 hours.
	
	• Gates were opened continuously at Wivenhoe Dam for six hours in accordance with Strategy W4 and the standard gate opening sequence at an average rate of 4.5m of opening per hour.
	
	• Wivenhoe Dam discharge was increased from 4,250m^3/s to 7,464m^3/s. Significant damage to urban areas below Moggill could not be avoided. Estimated peak inflow during this period exceeded 12,000m^3/s.
	
	• No releases were made from Somerset Dam to limit increases in Wivenhoe Dam in accordance with Strategy S2.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		
		• Wivenhoe Dam 397mm;
		• Somerset Dam 610mm;
		• Lockyer Creek 325mm;
		• Bremer River 278mm.
		
		Wivenhoe Dam level rose from 74.39m to 74.97m over the six-hour period.
		
		Somerset Dam level rose from 103.83m to 104.60m over the six-hour period.
			• Catchment average rainfalls during this period were:
			  • Wivenhoe Dam 15mm;
			  • Wivenhoe Dam (local) 35mm;
			  • Somerset Dam 40mm;
			  • Lockyer Creek 38mm;
			  • Bremer River 40mm.
			
			• Forecast 24-hour catchment average rainfall at 16:00 on 11 Jan 2011 was 75mm. However, catchment average rainfalls totals this period were:
			  • Wivenhoe Dam 8mm;
			  • Wivenhoe Dam (local) 13mm;
			  • Somerset Dam 19mm;
			  • Lockyer Creek 9mm;
			  • Bremer River 8mm.
			
			• A portion of the extremely intense rainfall in the Dam catchment fell in an un-gauged area (e.g. on the dam lake area) making it difficult for the model to accurately predict lake level rises.
			
			• Estimated peak Wivenhoe Dam level: 75.0m (excluding forecast); 75.2m (including forecast).
			
			• Estimated peak Somerset Dam level: 105.2m (excluding forecast); 105.9m (including forecast).
			
			• Estimated total dam inflow: 2,659,000ML (excluding forecast); 3,289,000ML (including forecast).
				Strategy W4 and Strategy S2 (Lake level predicted to exceed 74.00m, no maximum release rate)
				
				• The strategy was to protect the structural safety of the Dam.
				
				• The Manual requires actions under Strategy W4 to ensure Wivenhoe Dam gate openings occur in accordance with standard sequences until the storage level of Wivenhoe Dam begins to fall.
				
				• The lake level in both Dams continued to rise during this period. A Dam operator relayed Wivenhoe Dam gauge board readings to the Flood Operations Centre every 30 minutes. All four Duty Engineers were present in the Flood Operations Centre and decisions were made every half hour upon receipt of the gauge board readings.
				
				• With Dam levels above the Operating Target Line during this period no releases were made from Somerset Dam to limit further rises in Wivenhoe Dam.
				
				• The water level in Wivenhoe Dam peaked at 19:00 on 11 Jan 2011 at 74.97m.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 17 of 20

Date/time	Background	Dam conditions	Rainfall and model results	Strategy

Commenced Tuesday 11 Jan 2011 19:00
 	
Completed Tuesday 11 Jan 2011 21:00
	Strategy W4 and Strategy S2 Wivenhoe Directive #15 to #24.
	
	• Gate settings at Wivenhoe Dam did not change over this period. Wivenhoe Dam discharge is 7,458m^3/s.
	
	• The lake level in Wivenhoe Dam stabilised and then fell slightly at 21:00. At the same time a decision was made to close down the gates as quickly as possible to reduce urban flood impacts. This decision required gate openings below minimum recommended settings however, it was made in an attempt to minimise urban damage below Moggill (an objective that has to be considered under Strategy W4). Gates would have been re-opened if further lake level rises were experienced.
	
	• In accordance with Strategy S2, there were no releases made from Somerset Dam.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		
		• Wivenhoe Dam 398mm;
		• Somerset Dam 610mm;
		• Lockyer Creek 326mm;
		• Bremer River 278mm.
		
		During this two hour period, the lake level in Wivenhoe Dam stabilised at 74.97m and then fell slightly to 74.95m at 21:00.
		
		Somerset Dam level rose from 104.60m to 104.78m over the two-hour period.
			• Catchment average rainfalls during this period were:
			  • Wivenhoe Dam 1mm;
			  • Somerset Dam 1mm;
			  • Lockyer Creek 1mm;
			  • Bremer River 1mm.
			
			• Forecast 24-hour catchment average rainfall at 16:00 on 11 Jan 2011 was 75mm.
			
			• A portion of the extreme intense rainfall in the Dam catchment fell in an un-gauged area (e.g. on the dam lake area) which made it difficult for the model to accurately predict lake level behaviour.
			
			• Estimated peak Wivenhoe Dam level:
			75.0m (excluding forecast);
			75.2m (including forecast).
			
			• Estimated peak Somerset Dam level:
			105.2m (excluding forecast);
			105.9m (including forecast).
			
			• Estimated total Dam inflow:
			2,659,000ML (excluding forecast);
			3,289,000ML (including forecast).
				Strategy W4 and Strategy S2 (Lake level predicted to exceed 74.00m, no maximum release rate)
				
				• The strategy was to protect the structural safety of the Dam.
				
				• The Manual requires actions under Strategy W4 to ensure Wivenhoe Dam gate openings occur in accordance with standard sequences until the storage level of Wivenhoe Dam begins to fall.
				
				• The Dam level stabilised during this period and then fell slightly at 21:00. A Dam Operator relayed Wivenhoe Dam gauge board readings to the Flood Operations Centre every 30 minutes. All four Duty Engineers were present in the Flood Operations Centre and decisions were made every half hour upon receipt of the gauge board readings.
				
				• With Dam levels above the Operating Target Line during this period, no releases were made from Somerset Dam to limit further rises in Wivenhoe Dam.
				
				• The water level in Wivenhoe Dam peaked at 19:00 on 11 Jan 2011 at 74.97m.

2 FLOOD EVENT SUMMARY

January 2011 Flood Event – Period 18 of 20				
Date/time	**Background**	**Dam conditions**	**Rainfall and model results**	**Strategy**

Commenced Tuesday 11 Jan 2011 21:00
 	
Completed Wednesday 12 Jan 2011 08:00
	Strategy W4 and Strategy S2 Wivenhoe Directive #25 to #34.
	• During this period, Wivenhoe Dam gates were closed as quickly as possible without causing rises in the lake level. This was done to reduce urban flood impacts downstream. This decision was made in an attempt to minimise urban damage below Moggill (an objective that must be considered under this strategy).
	• Gates were closed continuously at Wivenhoe Dam for 11 hours in accordance with the standard gate closing sequence, at an average rate of just over 3.6m of opening per hour.
	• Wivenhoe Dam discharge was decreased from 7,464m^3/s to 2,547m^3/s. All rural bridges below the dam remained flooded and significant damage to urban areas below Moggill had occurred.
	• No releases were made from Somerset Dam in accordance with Strategy S2.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 399mm;
		• Somerset Dam 613mm;
		• Lockyer Creek 328mm;
		• Bremer River 279mm.
		
		Wivenhoe Dam level fell from 74.97m to 74.78m over the 11-hour period.
		
		Somerset Dam level rose from 104.78m to 105.11m over the 11-hour period.
			• Catchment average rainfalls during this period were:
			  • Wivenhoe Dam 1mm
			  • Somerset Dam 3mm;
			  • Lockyer Creek 3m;
			  • Bremer River 1m.
			• Forecast 24-hour catchment average rainfall at 16:00 on 11 Jan 2011 was 75mm.
			• Peak Wivenhoe Dam level: 74.97m at 19:00 on 11 Jan 2011.
			• Peak Somerset Dam level: 105.1m at 06:00 on 12 Jan 2011.
			• Estimated total Dam inflow: 2,650,000ML.
				Strategy W4 and Strategy S2 (Lake level predicted to exceed 74.00m, no maximum release rate)
				• The strategy was to protect the structural safety of the Dam.
				• The Manual requires actions under Strategy W4 to ensure Wivenhoe Dam gate openings occur in accordance with standard sequences until the storage level of Wivenhoe Dam begins to fall.
				• As the lake level was falling slightly, a decision was made to quickly reduce releases from Wivenhoe Dam to as low a level as possible, to minimise urban damage below Moggill.
				• It was calculated that reducing to a discharge of 2,547m^3/s from Wivenhoe Dam would:
				  • Not increase the downstream flood peak;
				  • Not cause the water level in Wivenhoe Dam to rise and;
				  • Allow the Dam to be drained back to FSL in seven days, in accordance with the Manual.
				• With Dam levels above the Operating Target Line during this period, no releases were made from Somerset Dam to limit further rises in Wivenhoe Dam.

January 2011 Flood Event – Period 19 of 20

2 FLOOD EVENT SUMMARY

Date/time	Background	Dam conditions	Rainfall and model results	Strategy

Commenced Wednesday 12 Jan 2011 08:00
 	
Completed Thursday 13 Jan 2011 12:00
	Transition from Strategy W4 to the Drain Down Phase
	Somerset Directives #8 to #9.
	• Wivenhoe Dam gate settings did not change over this period. Wivenhoe Dam discharge was 2,534m^3/s and all rural bridges below the Dam remained flooded.
	• Releases from Somerset Dam began during this period as the plotted Dam levels fell below the Operating Target Line. These actions were undertaken in accordance with Strategy S2 and to allow the D'Aguilar Highway to be re-opened as soon as possible. Releases from Somerset Dam continued even though plotted Dam levels later rose above the Operating Target Line during this period, to allow the Dam to be drained back to FSL in seven days, in accordance with the Manual.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 401mm;
		• Somerset Dam 619mm;
		• Lockyer Creek 330mm;
		• Bremer River 280mm.
		
		Wivenhoe Dam level fell from 74.78m to 74.61m over the 28-hour period.
		
		Somerset Dam level fell from 105.11m to 103.96m over the 28-hour period.
			• Catchment average rainfalls during this period were:
			  ◦ Wivenhoe Dam 2mm;
			  ◦ Somerset Dam 6mm;
			  ◦ Lockyer Creek 6mm;
			  ◦ Bremer River 6mm.
			• Forecast 24-hour catchment average rainfall at 10:00 on 12 Jan 2011 was 10mm.
				Drain Down Phase
				(Stored floodwaters emptied from the Dam in seven days)
				• During this period the strategy transitioned from Strategy W4. The target was to protect the structural safety of the dam to the Drain Down Phase of the Event.
				• Once the Drain Down Phase commenced, the target was to release stored floodwaters from the Dam within seven days of the flood peak passing through the dams, while controlling downstream impacts. Considerations impacting the duration and timing of the Drain Down Phase in this instance included:
				  ◦ Causing no renewed increases in river levels below the Dam (except where they were unavoidable due to tidal influences);
				  ◦ Maintaining an adequate release rate to ensure temporary pumps providing water supplies to the Lowood area could continue to operate;
				  ◦ Minimising bank slumping impacts along the river, particularly in key areas such as Coronation Drive (as requested by Brisbane City Council);
				  ◦ Re-opening Brisbane Valley Highway and key rural bridges as quickly as possible;
				  ◦ Achieving FSL in the Dams at the conclusion of the Event.

2 FLOOD EVENT SUMMARY

Date/time	Background	Dam conditions	Rainfall and model results	Strategy

Commenced Thursday 13 Jan 2011 12:00
 	
Completed Wednesday 19 Jan 2011 12:00
	Drain Down Phase
	Wivenhoe Directives #35 to #62
	Somerset Directives #10 to #13.
	• During this period, releases from Wivenhoe Dam were increased as the peaks from Lockyer Creek and Bremer River subside. Downstream impacts were controlled to ensure that, at no time during this phase, downstream water levels rose, except if impacted by tidal influences.
	• During this period, stored flood water in Somerset Dam was drained into Wivenhoe Dam in accordance with the drain down target of seven days. Importance was placed on opening the D'Aguilar Highway as soon as possible.
		Total rainfall from 08:00 on 6 Jan 2011 to the end of this period:
		• Wivenhoe Dam 415mm;
		• Somerset Dam 626mm;
		• Lockyer Creek 337mm;
		• Bremer River 288mm.
		
		Wivenhoe Dam level fell from 74.61m to 66.89m over the six-day period.
		
		Somerset Dam level fell from 103.96m to 99.00m over the six-day period.
			• Catchment average rainfalls during this six day period were:
			  • Wivenhoe Dam 14mm;
			  • Somerset Dam 7mm;
			  • Lockyer Creek 7mm;
			  • Bremer River 8mm.
				Drain Down Phase
				• During this period the target was to release stored floodwaters from the Dam within seven days of the flood peak passing through the Dams, while controlling downstream impacts. Considerations impacting the duration and timing of the Drain Down Phase in this instance included:
				  • Causing no renewed increases in river levels below the Dam (except where unavoidable due to tidal influences);
				  • Maintaining an adequate release rate to ensure temporary pumps providing water supplies to the Lowood area could continue to operate;
				  • Minimising bank slumping impacts along the river, particularly in key areas such as Coronation Drive (as requested by Brisbane City Council);
				  • Re-opening Brisbane Valley Highway and key rural bridges as quickly as possible;
				  • Achieving FSL in the Dams at the conclusion of the Event.

3

3 EVENT MOBILISATION AND STAFFING

3.1 Catchment conditions at Event commencement

In the 25 days leading up to the January 2011 Flood Event, three separate flood events impacted Somerset and Wivenhoe Dams. Flood releases were made from Wivenhoe Dam on all but five of those days. The total outflow from the three additional events was around 690,000ML and the details of these events are as follows:

Event	Event start date	Event end date	Volume released (ML)
1	13/12/2010	16/12/2010	70,000
2	17/12/2010	24/12/2010	150,000
3	26/12/2010	02/01/2011	470,000

During these events, requests were received from Councils and residents, either isolated or adversely impacted by bridge closures downstream of the Dam, to curtail releases as soon and as quickly as possible. This was a significant issue at the time as bridge closures had occurred over the traditional Christmas/New Year holiday period, including closures on Christmas and New Year's Day. However releases during these events were always made in accordance with the Manual.

Less than four days separated the end date of Event 3 and the commencement of the January 2011 Flood Event. This meant that any significant drain down of Somerset and Wivenhoe Dams during this period was impossible without causing significant bridge inundation downstream of the Dam and without exceeding minor flood levels in the Lower Brisbane River. These actions were not able to be justified by the Manual, particularly as Section 8.3 states the following in relation to Wivenhoe Dam:

> **"The spillway gates are not to be opened for flood control purposes prior to the reservoir level exceeding EL 67.25."**

This issue is also discussed in Section 17.0.

Finally, due to the rainfall that occurred in the Dam catchments throughout December 2010, at the start of the January 2011 Flood Event, the catchment conditions were near saturation. However, the catchment was highly responsive, with the initial loss varying between 0 and 30mm. Continuing loss rates were also unusually low. Because the degree of catchment saturation increased as the Event progressed, very high levels of run-off generation were experienced throughout the Event.

3.2 Event mobilisation

There was no significant rainfall in the 24 hours to 09:00 on Wednesday 5 January 2011 however, in the 24 hours to 08:00 Thursday 6 January 2011, catchment average rainfall totals were:

- Wivenhoe Dam 28mm;
- Somerset Dam 21mm;
- Lockyer Creek 23mm;
- Bremer River 23mm.

This rainfall was sufficient to trigger event mobilisation at 07:42 Thursday 6 January 2011, using Strategies W1A and S2. Based on the rainfall at that time and subsequent model runs, the Somerset lake level was forecast to peak at 99.7m (excluding forecast) and 100.0m (including forecast). The Wivenhoe lake level was forecast to peak at 68.3m (excluding forecast) and 68.4m (including forecast).

The following actions were undertaken as soon as mobilisation occurred:

- 24/7 staffing commenced at the Flood Operations Centre with at least one Duty Flood Operations Engineer and at least one trained Flood Officer present (minimum two persons);
- 24/7staffing commenced at the Dams with at least two trained Dam Operators present;
- The one absent Flood Operations Engineer was called back early from annual leave to assist with the management of the Event.

Staffing of the Flood Operations Centre and the Dams continued on this basis until event de-mobilisation at 12:00 Wednesday 19 January 2011. During critical periods, all four Flood Operations Engineers were present in the Flood Operations Centre and were actively involved in flood event decision-making processes. These Engineers generally lived in the Flood Operations Centre building during the critical 96 hours of the Event, as did a number of the trained Flood Officers.

3.3 Qualifications of staff on duty

Flood Operations Engineers

The four Flood Operations Engineers approved by the Chief Executive to direct the operations of Somerset and Wivenhoe Dams during flood events are:

- Flood Operations Engineer 1
- Flood Operations Engineer 2
- Flood Operations Engineer 3
- Flood Operations Engineer 4

The approved Engineers all hold a current Certificate of Registration as a Registered Professional Engineer of Queensland, as well as tertiary degrees in engineering. All Engineers had demonstrated to the Chief Executive they have:

1. Knowledge of design principles related to the structural, geotechnical and hydraulic design of large dams, and;
2. At least a total of five years suitable experience, having demonstrated their expertise in at least two of the following areas:
   - Investigation, design or construction of major dams;
   - Operation and maintenance of major dams;
   - Hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology;
   - Applied hydrology with particular reference to flood forecasting and/or flood forecasting systems.

3 EVENT MOBILISATION AND STAFFING

Flood Operations Engineers 1, 2 and 3 are three of the most experienced and expert Engineers in the industry, in relation to their knowledge of Brisbane River flood hydrology. Flood Operations Engineer 4 is one of the most experienced Engineers in Australia in relation to the operation and maintenance of gated dams. The Flood Operations Engineers' resumes are included in Appendix N.

Flood Officers

Nine Flood Officers, trained in Flood Operations Centre duties, assisted in the Flood Operations Centre during the Event.

1. Flood Officer 1;
2. Flood Officer 2;
3. Flood Officer 3;
4. Flood Officer 4;
5. Flood Officer 5;
6. Flood Officer 6;
7. Flood Officer 7;
8. Flood Officer 8;
9. Flood Officer 9.

Dam Operators

Thirteen Dam Operators, trained in Flood Operations Centre duties, operated Somerset and Wivenhoe Dams during the Event.

1. Dam Operator 1;
2. Dam Operator 2;
3. Dam Operator 3;
4. Dam Operator 4;
5. Dam Operator 5;
6. Dam Operator 6;
7. Dam Operator 7;
8. Dam Operator 8;
9. Dam Operator 9;
10. Dam Operator 10;
11. Dam Operator 11;
12. Dam Operator 12;
13. Dam Operator 13.

3.4 Flood Operations Centre staffing

Flood Operations Centre staffing details for the duration of the Event are recorded in Tables 3.3.1, 3.3.2 and 3.3.3 below. Each table has been compiled in accordance with the confirmed Event Roster.

Shift start time	Shift finish time	Flood Operations Engineers	Notes
Thu 06/01/2011 07:00	Thu 06/01/2011 19:00	Engineer 2	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Thu 06/01/2011 19:00	Fri 07/01/2011 07:00	Engineer 1	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Fri 07/01/2011 07:00	Fri 07/01/2011 19:00	Engineer 2	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Fri 07/01/2011 19:00	Sat 08/01/2011 07:00	Engineer 3	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Sat 08/01/2011 07:00	Sat 08/01/2011 19:00	Engineer 1	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Sat 08/01/2011 19:00	Sun 09/01/2011 07:00	Engineer 4	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Sun 09/01/2011 07:00	Sun 09/01/2011 19:00	Engineer 2	A meeting of all four Flood Operations Engineers was held at 15:30 to discuss strategy and the developing situation. Additionally, standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Sun 09/01/2011 19:00	Mon 10/01/2011 07:00	Engineer 3 Engineer 1	Due to the developing rainfall scenario, Engineer 2 assisted until 22:00 on 09/01/2011 to provide an extended shift handover at the commencement of this shift. It was also decided at this time to have two Engineers on duty until the peak of the Event had passed. The handover at the end of this shift involved all four Flood Operations Engineers discussing strategy and the developing situation.
Mon 10/01/2011 07:00	Mon 10/01/2011 19:00	Engineer 2 Engineer 4	The handover at either end of this shift involved all four Flood Operations Engineers discussing strategy and the developing situation.
Mon 10/01/2011 19:00	Tue 11/01/2011 07:00	Engineer 3 Engineer 1	The handover at either end of this shift involved all four Flood Operations Engineers discussing strategy and the developing situation.

3 EVENT MOBILISATION AND STAFFING

Shift start time	Shift finish time	Flood Operations Engineers	Notes
Tue 11/01/2011 07:00	Tue 11/01/2011 19:00	Engineer 2 Engineer 4	Engineer 1 and Engineer 3 assisted from 13:00 on 11/01/2011. The handover at either end of this shift involved all four Flood Operations Engineers discussing strategy and the developing situation.
Tue 11/01/2011 19:00	Wed 12/01/2011 07:00	Engineer 3 Engineer 1	Engineer 4 and Engineer 2 assisted until 23:00 on 09/01/2011. The handover at the end of this shift involved all four Flood Operations Engineers discussing strategy and the developing situation.
Wed 12/01/2011 07:00	Wed 12/01/2011 19:00	Engineer 2 Engineer 4	The handover at either end of this shift involved all four Flood Operations Engineers discussing strategy.
Wed 12/01/2011 19:00	Thu 13/01/2011 07:00	Engineer 3 Engineer 1	The handover at either end of this shift involved all four Flood Operations Engineers discussing strategy.
Thu 13/01/2011 07:00	Thu 13/01/2011 19:00	Engineer 2 Engineer 4	The handover at the commencement of this shift involved all four Flood Operations Engineers discussing strategy. A standard shift handovers occurred at the end of this shift in accordance with the Flood Procedure Manual
Thu 13/01/2011 19:00	Fri 14/01/2011 07:00	Engineer 1	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Fri 14/01/2011 07:00	Fri 14/01/2011 19:00	Engineer 2	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Fri 14/01/2011 19:00	Sat 15/01/2011 07:00	Engineer 4	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Sat 15/01/2011 07:00	Sat 15/01/2011 19:00	Engineer 2	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Sat 15/01/2011 19:00	Sun 16/01/2011 07:00	Engineer 3	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Sun 16/01/2011 07:00	Sun 16/01/2011 19:00	Engineer 1	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Sun 16/01/2011 19:00	Mon 17/01/2011 07:00	Engineer 4	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Mon 17/01/2011 07:00	Mon 17/01/2011 19:00	Engineer 3	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Mon 17/01/2011 19:00	Tue 18/01/2011 07:00	Engineer 2	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.

Shift start time	Shift finish time	Flood Operations Engineers	Notes
Tue 18/01/2011 07:00	Tue 18/01/2011 19:00	Engineer 1	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Tue 18/01/2011 19:00	Wed 19/01/2011 07:00	Engineer 4	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.
Wed 19/01/2011 07:00	Wed 19/01/2011 14:00	Engineer 2	Standard shift handovers occurred at either end of this shift in accordance with the Flood Procedure Manual.

***Table 3.3.1** – Flood Operations Centre staffing – Flood Operations Engineers*

Shift start times	Shift finish times	Flood Officers	Notes
Thu 06/01/2011 07:00	Thu 06/01/2011 19:00	Flood Officer 7	
Thu 06/01/2011 19:00	Fri 07/01/2011 07:00	Flood Officer 1	
Fri 07/01/2011 07:00	Fri 07/01/2011 19:00	Flood Officer 8	
Fri 07/01/2011 19:00	Sat 08/01/2011 07:00	Flood Officer 7	
Sat 08/01/2011 07:00	Sat 08/01/2011 19:00	Flood Officer 3	
Sat 08/01/2011 19:00	Sun 09/01/2011 07:00	Flood Officer 2	
Sun 09/01/2011 07:00	Sun 09/01/2011 19:00	Flood Officer 1	
Sun 09/01/2011 19:00	Mon 10/01/2011 07:00	Flood Officer 6	
Mon 10/01/2011 07:00	Mon 10/01/2011 19:00	Flood Officer 8	
Mon 10/01/2011 19:00	Tue 11/01/2011 07:00	Flood Officer 9	
Tue 11/01/2011 07:00	Tue 11/01/2011 19:00	Flood Officer 4 Flood Officer 2	Flood Officer 9 assisted as needed as he was living in the building during this period.
Tue 11/01/2011 19:00	Wed 12/01/2011 07:00	Flood Officer 3 Flood Officer 9	
Wed 12/01/2011 07:00	Wed 12/01/2011 19:00	Flood Officer 1 Flood Officer 2	Flood Officer 9 assisted as needed as he was living in the building during this period.
Wed 12/01/2011 19:00	Thu 13/01/2011 07:00	Flood Officer 7	
Thu 13/01/2011 07:00	Thu 13/01/2011 19:00	Flood Officer 9	
Thu 13/01/2011 19:00	Fri 14/01/2011 07:00	Flood Officer 4	
Fri 14/01/2011 07:00	Fri 14/01/2011 19:00	Flood Officer 1	
Fri 14/01/2011 19:00	Sat 15/01/2011 07:00	Flood Officer 2	
Sat 15/01/2011 07:00	Sat 15/01/2011 19:00	Flood Officer 3	
Sat 15/01/2011 19:00	Sun 16/01/2011 07:00	Flood Officer 4	
Sun 16/01/2011 07:00	Sun 16/01/2011 19:00	Flood Officer 6	
Sun 16/01/2011 19:00	Mon 17/01/2011 07:00	Flood Officer 7	
Mon 17/01/2011 07:00	Mon 17/01/2011 19:00	Flood Officer 8	
Mon 17/01/2011 19:00	Tue 18/01/2011 07:00	Flood Officer 9	
Tue 18/01/2011 07:00	Tue 18/01/2011 19:00	Flood Officer 5	
Tue 18/01/2011 19:00	Wed 19/01/2011 07:00	Flood Officer 1	

Shift start times	Shift finish times	Flood Officers	Notes
Wed 19/01/2011 07:00	Wed 19/01/2011 14:00	Flood Officer 2	

Table 3.3.2 – Flood Operations Centre staffing – Flood Officers

Shift start times	Shift finish times	Wivenhoe Dam Operators	Somerset Dam Operators
Thu 06/01/2011 07:00	Thu 06/01/2011 19:00	Dam Operator 10 Dam Operator 11	Dam Operator 2 Dam Operator 13
Thu 06/01/2011 19:00	Fri 07/01/2011 07:00	Dam Operator 7 Dam Operator 6	Dam Operator 4 Dam Operator 5
Fri 07/01/2011 07:00	Fri 07/01/2011 19:00	Dam Operator 10 Dam Operator 11	Dam Operator 2 Dam Operator 13
Fri 07/01/2011 19:00	Sat 08/01/2011 07:00	Dam Operator 7 Dam Operator 6	Dam Operator 4 Dam Operator 8
Sat 08/01/2011 07:00	Sat 08/01/2011 19:00	Dam Operator 10 Dam Operator 12	Dam Operator 2 Dam Operator 3
Sat 08/01/2011 19:00	Sun 09/01/2011 07:00	Dam Operator 7 Dam Operator 9	Dam Operator 4 Dam Operator 1
Sun 09/01/2011 07:00	Sun 09/01/2011 19:00	Dam Operator 10 Dam Operator 12	Dam Operator 2 Dam Operator 13
Sun 09/01/2011 19:00	Mon 10/01/2011 07:00	Dam Operator 7 Dam Operator 9	Dam Operator 4 Dam Operator 1
Mon 10/01/2011 07:00	Mon 10/01/2011 19:00	Dam Operator 10 Dam Operator 12	Dam Operator 2 Dam Operator 13
Mon 10/01/2011 19:00	Tue 11/01/2011 07:00	Dam Operator 7 Dam Operator 9	Dam Operator 4 Dam Operator 1
Tue 11/01/2011 07:00	Tue 11/01/2011 19:00	Dam Operator 10 Dam Operator 12 Dam Operator 7 from 14:00	Dam Operator 2 Dam Operator 13
Tue 11/01/2011 19:00	Wed 12/01/2011 07:00	Dam Operator 7 Dam Operator 6	Dam Operator 4 Dam Operator 1
Wed 12/01/2011 07:00	Wed 12/01/2011 19:00	Dam Operator 10 Dam Operator 12	Dam Operator 2 Dam Operator 13
Wed 12/01/2011 19:00	Thu 13/01/2011 07:00	Dam Operator 7 Dam Operator 6	Dam Operator 4 Dam Operator 1
Thu 13/01/2011 07:00	Thu 13/01/2011 19:00	Dam Operator 10 Dam Operator 12	Dam Operator 2 Dam Operator 13
Thu 13/01/2011 19:00	Fri 14/01/2011 07:00	Dam Operator 7 Dam Operator 6	Dam Operator 4 Dam Operator 1
Fri 14/01/2011 07:00	Fri 14/01/2011 19:00	Dam Operator 10 Dam Operator 11	Dam Operator 2 Dam Operator 13
Fri 14/01/2011 19:00	Sat 15/01/2011 07:00	Dam Operator 7 Dam Operator 5	Dam Operator 4 Dam Operator 1
Sat 15/01/2011 07:00	Sat 15/01/2011 19:00	Dam Operator 10 Dam Operator 11	Dam Operator 2 Dam Operator 13

3 EVENT MOBILISATION AND STAFFING

Shift start times	Shift finish times	Wivenhoe Dam Operators	Somerset Dam Operators
Sat 15/01/2011 19:00	Sun 16/01/2011 07:00	Dam Operator 7 Dam Operator 5	Dam Operator 4 Dam Operator 1
Sun 16/01/2011 07:00	Sun 16/01/2011 19:00	Dam Operator 10 Dam Operator 11	Dam Operator 2 Dam Operator 13
Sun 16/01/2011 19:00	Mon 17/01/2011 07:00	Dam Operator 7 Dam Operator 5	Dam Operator 4 Dam Operator 1
Mon 17/01/2011 07:00	Mon 17/01/2011 19:00	Dam Operator 10 Dam Operator 6	Drain down complete
Mon 17/01/2011 19:00	Tue 18/01/2011 07:00	Dam Operator 7 Dam Operator 5	Drain down complete
Tue 18/01/2011 07:00	Tue 18/01/2011 19:00	Dam Operator 10 Dam Operator 6	Drain down complete
Tue 18/01/2011 19:00	Wed 19/01/2011 07:00	Dam Operator 7 Dam Operator 5	Drain down complete
Wed 19/01/2011 07:00	Wed 19/01/2011 14:00	Dam Operator 10 Dam Operator 9	Drain down complete

Table 3.3.3 – Flood Operations Centre staffing – Wivenhoe Dam Operators

4

4 FLOOD EVENT PROCEDURES

4.1 Introduction

Seqwater has prepared a Flood Procedure Manual that assigns responsibilities to Seqwater personnel around flood event preparation, mobilisation and operation, in relation to Seqwater's Dams, including Somerset and Wivenhoe Dams.

The relationship between the Flood Procedure Manual and *The Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam* is outlined in Figure 4.1.1.

SEQWATER FLOOD PROCEDURE MANUAL (Internal document)	→	The Flood Procedure Manual assigns responsibilities to Seqwater personnel around flood preparation, flood event mobilisation and flood event operations
		↓
THE MANUAL OF OPERATIONAL PROCEDURES FOR FLOOD MITIGATION AT WIVENHOE DAM AND SOMERSET DAM ("the Manual") (Document gazetted under the *Water Supply Act 2008*)	←	Personnel responsible for determining water releases from controlled spillway dams during flood events use *The Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*, to guide flood event decision making

Figure 4.1.1 – Relationship between the Flood Procedure Manual and The Manual of Operations Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam

The Flood Procedure Manual is an internal document and is registered in Seqwater's internal document control system (Qpulse). Controlled hardcopies are issued to the following personnel:

Agency	Responsible person	Location
Seqwater	Dam and Source Operations Manager	Margaret Street, Brisbane
Seqwater	Principal Hydrologist	Margaret Street, Brisbane
Seqwater	Senior Flood Operations Engineer	Flood Operations Centre, Brisbane
Seqwater	Principal Engineer Dam Safety	Karalee
Seqwater	Operations Coordinator, South	Karalee
Seqwater	Operations Coordinator, North	Landers Shute
Seqwater	Operations Coordinator, Central	Wivenhoe Dam
Seqwater	Storage Supervisor	Wivenhoe Dam
Seqwater	Storage Supervisor	Leslie Harrison Dam
Seqwater	Storage Supervisor	North Pine Dam
Seqwater	Storage Supervisor	Somerset Dam

Table 4.1.2 – Location of controlled hardcopies of the Seqwater Flood Procedure Manual

The issue date for the current Flood Procedure Manual is January 2010.

4.2 Flood Operations Centre preparedness

Prior to the January Flood Event, Flood Operations Engineer 2 was designated the Flood Operations Manager in accordance with the requirements of the Seqwater Flood Procedure Manual. In conjunction with Flood Operations Engineer 1 (a Senior Flood Operations Engineer), Flood Operations Engineer 2 was responsible for the overall management of the Flood Operations Centre leading up to the Event and ensured:

- A Flood Operations Engineer and three Flood Officers were on close call at all times, and ready to attend the Flood Operations Centre if called;
- Sufficient Flood Operations Engineers and Flood Officers were available to staff the Flood Operations Centre if a flood event was declared;
- Contact details for Flood Operations Engineers and Flood Officers were up-to-date;
- Current copies of the following documents were available in the Flood Operations Centre:
  - *The Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam (Revision 7)* ("the Manual");
  - Wivenhoe Dam – Emergency Action Plan;
  - Somerset Dam – Emergency Action Plan.
- The following facilities were available in the Flood Operations Centre:
  - The data collection and modelling systems required to manage flood events at Somerset and Wivenhoe Dams;
  - Sufficient stationary and forms;
  - Landline telephone, mobile telephone, satellite telephone, Seqwater radio network, facsimile and email communication systems;
  - Power systems and back-up power systems required to ensure computer system reliability during the Flood Event.

As defined by the Seqwater Flood Procedure Manual, the role and responsibilities of the Flood Operations Manager are completely separate to the roles and responsibilities of Flood Operations Engineers. However, a single person can hold both roles at any point in time.

When one of the Flood Operations Engineers is on call, this person is referred to as the Duty Flood Operations Engineer. There is always a single designated Duty Flood Operations Engineer on call 24 hours a day, seven days a week.

When on call, the Duty Flood Operations Engineer – one of the four Flood Operations Engineers described in Section 3.3 – ensured they:

- Were contactable at all times by telephone;
- Had constant access to facilities that provided appropriate real-time monitoring of dam and catchment conditions;
- Were able to travel to the Flood Operations Centre in two hours to direct the mobilisation and operation of the Flood Event, without compromising the safety of the Dams or the intent of the Manual;
- As incoming Duty Flood Operations Engineer, organised the handover from the current duty staff;
- As outgoing Duty Flood Operations Engineer, prepared a status summary sheet for Somerset and Wivenhoe Dams;
- Contacted the Flood Operations Manager if any issues arose with the potential to adversely impact the operations of Flood Operations Centre.

When on call, the nine Flood Officers described in Section 3.3 ensured they:

- Were contactable at all times by telephone;
- Reported to the Duty Flood Operations Engineer if at any time while being on call they became unfit for duty;

- Were able to travel to the Flood Operations Centre within two hours of being called;
- Attended the close call handover meetings organised by the Duty Flood Operations Engineers.

4.3 Flood Operations Centre mobilisation

The Seqwater Flood Procedure Manual requires the Duty Flood Operations Engineer to declare a flood event and mobilise the Flood Operations Centre, if the Duty Flood Operations Engineer considers it likely the FSL of Somerset Dam or Wivenhoe Dam will be exceeded as a result of rainfall occurring in the Dam catchments and flood releases are likely. The Flood Operations Centre is mobilised as soon as a flood event is declared. Flood Operations Engineer 2 was the Duty Flood Operations Engineer who declared the January 2011 Flood Event by email at 07:42 on Thursday 6 January 2011 (see Appendix H).

When the Flood Operations Centre was mobilised, the Duty Flood Operations Engineer ensured that the following actions were undertaken:

- Notified the Senior Flood Operations Engineers of the mobilisation;
- Commenced recording significant events in the Event Log;
- Contacted the required Flood Officers to commence duty at the Flood Operations Centre;
- Contacted the Seqwater Operations Coordinator responsible for Somerset Dam and Wivenhoe Dam, and provided instructions to send Dam operations staff to the Dams. The Operations Coordinator was also advised of the expected duration of the Flood Event to allow time to organise suitable staffing arrangements for the duration of the Event;
- Established 09:00, Sunday 2 January 2011 as the start time for the Event, for the purposes of modelling predictions;
- Established a suitable directory structure within the computer network to manage the Flood Event data;
- Examined and cleaned all rainfall and stream flow data for the Event prior to use in the flood modelling systems;
- Derived inflow hydrographs for:
  - Wivenhoe Dam;
  - Somerset Dam;
  - Lockyer Creek catchment;
  - Bremer River catchment;
- Examined these derived inflow hydrographs across a variety of appropriate rainfall scenarios;
- Inputted the derived inflow hydrographs for Somerset Dam, Wivenhoe Dam, Lockyer Creek catchment and Bremer River catchment into Somerset and Wivenhoe Dams operations spreadsheet and ran this program;
- Determined gate operations strategies for Somerset and Wivenhoe Dams based on the resulting data from the operations spreadsheet and in accordance with the strategies outlined in the Manual;
- Advised Brisbane City Council, Ipswich City Council and Somerset Regional Council of the gate operations strategies to allow roads to be closed prior to inundation;
- Directed gate operations at the Dams as appropriate by instructing the Dam Supervisors by email and facsimile of gate movements. Instructions were also given verbally by telephone prior to written instructions being released;
- Advised Seqwater's Dam and Source Operations Manager of gate operations by providing a copy of all Flood Operations Directives and regular updates, including advice of longer-term strategies to manage the Flood Event. This allowed Seqwater to provide appropriate flood event advice to the public and other stakeholders, including the Queensland Water Commission and the Water Grid Manager;
- Advised the Bureau of Meteorology, Brisbane City Council and the Dam Safety Regulator of the gate operations strategies and actual and projected water releases from Wivenhoe Dam.

4.4 Flood Operations Centre operations

During the Flood Event, the four Flood Operations Engineers worked closely together to ensure the following took place, in accordance with the Flood Procedure Manual:

- Suitable staffing arrangements were in place for the Flood Operations Centre and the impacted Dams for the duration of the Flood Event;
- Staff working in the Flood Operations Centre during the Event signed the Flood Event Shift Log at the start and end of a shift. However, because a number of staff were living in the building housing the Flood Operations Centre during the Event, some sign on and sign off details were not properly recorded. This has been recognised as an area for improvement for future flood events.

During the Flood Event, the Senior Flood Operations Engineer set the overall strategy for the management of the Flood Event in accordance with the Manual. The Duty Flood Operations Engineers directed the operations of the Flood Control Centre in accordance with the overall strategy. In situations where two or more Flood Operations Engineers were on duty simultaneously, these duties were shared equally. The Duty Flood Operations Engineers ensured the following actions took place during the Event, in accordance with the Flood Procedure Manual:

- All significant events were recorded in the Event Log;
- The integrity of the ALERT System was maintained;
- Flood releases from the Dams were in accordance with the Manual, and the RTFM was used to support the decision making processes around the releases;
- Software issues impacting on the operation of the ALERT System were identified and resolved.
- All notifications specified in the Flood Manuals and Emergency Action Plans were recorded in the Event Log;
- Accurate plots of headwater levels were maintained for each of the Dams;
- Appropriate handovers took place at the end of each shift to ensure incoming Officers had the following information:
  - Reservoir storage elevations at each Dam;
  - Radial gate, sluice gate and regulator valve openings at each Dam;
  - Flood release procedures being applied and the reason for their selection;
  - Status of compliance with the Flood Manuals and Emergency Action Plans;
  - Status of the communication systems;
  - Status of the data gathering network;
  - Status of computer systems and Flood Modelling Systems;
  - Any areas of concern associated with the management of the Flood Event;
  - Areas in which the discretion has been exercised in accordance with the Flood Manuals.
- Flood Officers on duty in the Flood Operations Centre undertook all duties as directed by the Duty Flood Operations Engineer;
- Brisbane City Council, Ipswich City Council and Somerset Regional Council were contacted as appropriate to allow roads to be closed prior to inundation and for any necessary arrangements to be made for community isolation and/or necessary evacuations. (The Manual allows for immediate releases to be initiated if the safety of a Dam is at risk. However, in accordance with Seqwater's duty of care to public safety when making Dam releases, every attempt is made to close impacted roads prior to inundation by water outflows from gate operations, and to make appropriate arrangements for community isolation and evacuations due to the risk to public safety.)
- Gate operations were directed at the Dams as appropriate, by instructing the Dam Supervisors by email and facsimile about gate movements. Instructions were also explained verbally by telephone prior to the written instructions being released;
- Seqwater's Dam and Source Operations Manager was advised of all gate operations by providing a copy of all Flood Operations Directives and regular updates, including advice of longer-term strategies to

manage the Flood Event. This allowed Seqwater to provide appropriate flood event advice to the public and other stakeholders, including the Queensland Water Commission and the Water Grid Manager;

- The Bureau of Meteorology, Brisbane City Council and the Dam Safety Regulator were advised of the gate operation strategies and actual and projected water releases from Wivenhoe Dam.

As the flood event progressed a number of issues arose including the potential for the Flood Operations Centre to loose mains power and a breakdown in communication between the main and back-up Flood Operations Centres. These issues were addressed through the procedures outlined above and the respective building managers and Energex were were aware of the critical nature of the function of the FOC. The main FOC located in Turbot Street did not loose mains power or telephone communications throughout the event, whilst the Back-up facility, located in George Street did resort to standby power for the period the CBD was affected by the flood. This did result in the wireless bridge which links the main and back-up FOCs dropping out for a short period of time, but this link was quickly re-established once the standby power was

4 FLOOD EVENT PROCEDURES

4.5 Somerset Dam and Wivenhoe Dam preparedness

Prior to the Flood Event, the Seqwater Operations Coordinator responsible for Somerset and Wivenhoe Dams ensured the following actions took place during in accordance with the Flood Procedure Manual:

- At least two Dam Operators were on close call for both Somerset Dam and Wivenhoe Dam at all times;
- Sufficient Dam Operators were available to staff Somerset Dam and Wivenhoe Dam should a major flood event be declared;
- Contact details for the Dam Operators were up-to-date;
- Current copies of the following documents were available at Somerset Dam and Wivenhoe Dam:
    - *The Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam (Revision 7)*;
    - Emergency Action Plan;
    - Standing Operating Procedures;
    - Operation and Maintenance Manual.
- The following facilities were available at Somerset Dam and Wivenhoe Dam:
    - Sufficient stationary and forms;
    - Landline telephone, mobile telephone, satellite telephone, Seqwater radio network, facsimile and email communication systems;
    - Power systems and back-up power systems to ensure computer systems and communication systems were able to operate reliability during the Flood Event.
- All preventive maintenance work was undertaken at both Dams in accordance with the Dam Operation and Maintenance Manuals.
- The flood release infrastructure and associated back-up systems at both Dams was kept operationally-ready;
- While on close call, Dam Operators ensured:
    - They were contactable at all times by telephone;
    - In the event of being "unfit for duty" they reported to the Duty Flood Operations Engineer currently on close call;
    - They were able to travel to the Dam they were assigned to within two hours of being called.

4.6 Somerset Dam and Wivenhoe Dam mobilisation

Following notification the Flood Event had been declared, the Seqwater Operations Coordinator responsible for Somerset Dam and Wivenhoe Dam, ensured the following actions were completed in accordance with the Flood Procedure Manual:

- The Principal Engineer Dam Safety was notified of the mobilisation;
- Significant events were recorded in the Event Log;
- The Dam Operators on close call were contacted and directed to travel to the Dams. Two Dam Operators were directed to each site and at least two Dam Operators remained on duty at all times during the Event;
- During each shift, Dam Operators were nominated to be the Dam Supervisors for the purposes of managing the Flood Event.

As each Dam Supervisor arrived at their assigned Dam, the Dam Supervisor completed the following actions in accordance with the Flood Procedure Manual:

- Checked communication existed with the Flood Operations Centre;
- Commenced recording significant events in the Event Log;
- Completed the Flood Readiness Checklist contained in the Flood Procedure Manual (*see Appendix I*);
- Undertook flood operations as directed by the Flood Operations Centre.

4.7 Somerset Dam and Wivenhoe Dam operations

As the Flood Event commenced, the Dam Supervisor at Somerset Dam and Wivenhoe Dam ensured the following actions took place in accordance with the Flood Procedure Manual. At the beginning of each shift, a new Dam Supervisor was appointed.

- All significant events were recorded in the Event Log;
- Flood releases were undertaken in accordance with directions provided by the Flood Operations Centre;
- All notifications required by the Manuals and Emergency Action Plans were made;
- Handovers at the end of each shift were conducted to ensure incoming Officers were aware of:
  - Reservoir storage elevations at each Dam;
  - Radial gate, sluice gate and regulator valve openings at each Dam;
  - Status of the communication systems;
  - Any areas of concern associated with the management of the Flood Event.
- The Duty Flood Operations Engineer was advised of any issues arising during the Event with the potential to adversely impact flood operations.

  (Note: During the Event, Wivenhoe Dam experienced a temporary loss of mains power however, this did not impact Dam operations as the on-site, standby diesel generator provided full power during this time. Two other separate back-up power systems were also available to ensure the continued operation of the radial gates if needed.)

5

5 DATA COLLECTION SYSTEM PERFORMANCE

5.1 Background

A real time flood monitoring and forecasting system has been established to monitor rainfall and water levels in the Dam catchments and to provide adequate, accurate and timely information for informed decision-making.

Field stations consisting of rainfall and water level gauges use the Event Reporting Radio Telemetry System (ERRTS) to communicate data to the Flood Operations Centre. More than one gauge may be located at an individual field station. Water level gauges are often located at the Department of Environment and Resource Management (DERM) gauging stations; DERM is responsible for the maintenance of the water level gauges and Seqwater for the ERRTS equipment.

Rainfall gauges consist of a standard tipping bucket. Water level gauges vary in type and model but include shaft encoders, wet pressure transducers and dry pressure transducers. At a rainfall gauge, an event is defined as the tip of the bucket. At a water level rainfall gauge, an event is defined as an incremental increase or decrease in water level.

When an event is triggered at a gauge, data is transmitted via VHF radio through a series of redundant radio repeaters to the Flood Operations Centre and other data collection centres. Each signal has a unique identification number. When the signal arrives at the Flood Operations Centre base station, they are relayed to computer hardware platforms serial port via a decoder, time stamped, read, decoded, accepted or rejected, filtered, validated and then stored in a gauge database in the Centre's Flood-Col and Enviromon databases. Redundant base stations at Mineral House and the Land Centre in Brisbane's CBD are synchronised with the Flood Operations Centre data base.

The Flood-Col and Enviromon databases contain gauge details including:

- Gauge name;
- ALERT number;
- Type of gauge;
- Calibration information;
- Alarm thresholds;
- Rating curve information, if applicable.

Both Flood-Col and Enviromon allow filtered gauge data to be viewed in either a text or graphical format. . Information that can be viewed or edited includes height, discharge, rainfall pluviographs, rainfall hyetographs, lake levels and Dam volumes and applications are also available for viewing groups of gauges.

The combination of ERRTS field stations, rainfall gauges and water level gauges, radio network and data collection software is an ALERT system. ALERT or Automated Local Evaluation in Real Time System, has become a standard for flood warning system in Australia and the United States of America and is widely used by the Bureau of Meteorology (BoM) and other flood warning agencies throughout the world.

Flood-Ops is the modelling software used to analyse and produce forecast runoff. It extracts data from the Flood-Col database, calculates areal rainfalls and generates hydrographs of runoff. Model parameters can be adjusted and forecast rainfall included as an option. Results can be displayed and imported into gate operation models. The ALERT system, Flood-Ops and ancillary software make up the Real Time Flood Model (RTFM).

5.2 Field station descriptions

Seqwater operates 75 rain gauges and 71 river gauge field stations within and around the Brisbane River Basin. Of these 146 sites, 129 operate under the ALERT system and the remaining 17 operate as telephone telemeter gauging stations, but are not directly available in the operational suite.

Manual gauge board readings are taken at Somerset and Wivenhoe Dams to confirm the ALERT data received from these sites. These manual observations form the basis of gate operations.

In addition to the Seqwater owned and operated network, the Flood Operations Centre also has access to Enviromon which collects data from an additional 225 rain gauges and nearly 200 water level gauges throughout South East Queensland.

The location of the rainfall stations are shown in Figure 5.2.1 and the Seqwater water level network is shown in Figure 5.2.2.

Figure 5.2.1 – Seqwater rainfall station network as at January 2011

Figure 5.2.2 – Seqwater water level network as at January 2011

Prior to the January 2011 floods, four out of 75 rain gauges (95% availability) and six out of 71 river gauges (92% availability) were marked as being 'out of action'. In line with standard practice, the data collected from some gauges was also marked as 'suspect' at that time, and therefore required examination prior to being used in modelling. These gauges are listed in Table 5.2.3 and Table 5.2.4.

In many instances, more than one gauge is located on an individual station site to allow for the periodic non-operation of individual gauges. Accordingly, due to this in-built network redundancy, the presence of these non-operational gauges did not impact on data quality during the Event.

Rain ID	Site	Status date 6 Jan 2011	Comment
6517	Gregors Creek AL-B	Out of action	Redundant gauge. Another rainfall gauge is available at this site.
6526	Helidon AL	Out of action	Data from adjacent stations at Toowoomba and Gatton was used as a substitute for this data. However, data from this station was available for use through the BoM Environmon system.
6600	Kilcoy AL	Suspect	Although this data was marked suspect and was missing occasional observations, upon review, the data appeared correct and was used in modelling.
6736	Kuss Road AL	Out of action	This site is located in the Bremer River catchment and the data is of limited value in gate operations decision making.
6646	Lowood AL-B (pump station)	Suspect	Although this data was marked suspect and was missing occasional observations, upon review, the data appeared correct and was used in modelling. This gauge is also a redundant gauge. Another rainfall gauge is available at this site.
6621	Nukinenda AL	Suspect	Although this data was marked suspect and was missing occasional observations, upon review, the data appeared correct and was used in modelling.
6559	Savages Crossing AL	Suspect	Although this data was marked suspect and was missing occasional observations. Upon review the data appeared correct and was used in modelling.
6593	Somerset Dam HW AL-P	Suspect	Although this data was marked suspect and was missing occasional observations, upon review, the data appeared correct and was used in modelling. This gauge is also redundant gauge. Another rainfall gauge is available at this site and manual readings are also available.
6995	Somerset Dam HW AL-B2	Suspect	Redundant gauge. Another dam height gauge is available at this site and manual readings are also available.
6565	Tenthill AL	Suspect	Although this data was marked suspect and was missing occasional observations, upon review, the data appeared correct and was used in modelling.
6602	Top of Brisbane AL	Suspect	Although this data was marked suspect and was missing occasional observations, upon review, the data appeared correct and was used in modelling.
6744	Wilsons Peak AL	Out of action	Data from adjacent stations at Tarome and Kalbar was used as a substitute for this data.
6540	Yarraman AL	Suspect	Although this data was marked suspect and was missing occasional observations, upon review, the data appeared correct and was

used in modelling.

Table 5.2.3 – Rainfall gauges marked out of action or suspect at Flood Event commencement

River ID	Site	Status date 6 Jan 2011	Comment
6654	Amberley AL-B	Out of action	Redundant gauge. Another stream height gauge is available at this site. This station has been marked for relocation.
6652	Amberley AL-P	Suspect	This data was marked suspect as it was reporting at a high frequency however, upon review, the data appeared correct and was used in modelling.
6524	Cressbrook Dam AL	Out of action	The downstream stream height gauge at Rosentretter provides more useful information than this site.
6518	Gregors Creek AL-B	Out of action	Redundant gauge. Another river height gauge is available at this site.
6650	Lowood AL-P	Out of action	Redundant gauge. Another river height gauge is available at this site.
6631	Lyons Bridge AL-B	Suspect	This data was marked suspect as it was reporting erratically however, upon review, the data appeared correct and was used in modelling. Additionally, this is a redundant gauge. Another river height gauge is available at this site.
6594	Somerset Dam HW AL-P	Suspect	This is a redundant gauge. Another dam height gauge is available at this site and manual readings are also available. Only a slight difference was noted between this gauge and the manual observations.
6566	Tenthill AL	Out of action	The downstream stream height gauge at Gatton provides more useful information than this site.
6743	Walloon AL-B	Out of action	This is a redundant gauge. Another river height gauge is available at this site.
6642	Wivenhoe Dam TW AL-B	Suspect	Gate settings and discharge curves provide more accurate flow estimates than this gauge during flood releases.

Table 5.2.4 – Water Level gauges marked out of action or suspect at Flood Event commencement

The January 2011 floods damaged a number of stations. After the Event, eight out of 75 rain gauges (89% availability) and 16 out of 71 river gauges (77% availability) were marked 'out of action'. In line with standard practice, the data collected from some gauges was also marked as 'suspect' during the Flood Event, and therefore required close examination prior to being used in modelling. Details of all these stations are contained in Table 5.2.5 and Table 5.2.6.

Some gauges did not operate during the Flood Event as some sites were inundated with water, damaged by debris, impacted by lighting strikes or lost power. There were also some stations completely destroyed by the flood flows. By surveying the aftermath of the flood and its impacts along the river channels, it is easy to see how this occurred.

Rain ID	Site	Status date 19 Jan 2011	Comment
6633	Lyons Bridge AL-P	Out of action from 15:00 on 11 Jan 2011	Although this data was marked out of action in the system, it was also available for use through the BoM Environmon system.
6630	Lyons Bridge AL-B	Out of action from 09:00 on 11 Jan 2011	Although this data was marked out of action in the system, it was also available for use through the BoM Environmon system.
6568	O'Reillys Weir AL	Out of action from 19:34 on 11 Jan 2011	This site was severely damaged by flood water at the time indicated. This was late in the Event and rainfall after this time was minimal.
6641	Wivenhoe Dam TW AL-B	Out of action from 22:30 on 11 Jan 2011	This site was severely damaged by flood water at the time indicated. This was late in the Event and rainfall after this time was minimal. Manual readings are also available at this site.

Table 5.2.5 – Additional Rainfall gauges marked out of action or suspect during theFlood Event

River ID	Site	Status date 19 Jan 2011	Comment
6756	Burtons Bridge	Out of action from 08:00 on 12 Jan 2011	The adjacent stream height gauges at Savages Crossing and Mt Crosby Weir provide more useful information than this site during high flows.
6527	Helidon	Out of action from 14:40 on 8 Jan 2011	The downstream stream height gauge at Glenore Grove was used as a substitute for this data.
6578	Gatton	Out of action from 17:31 on 10 Jan 2011	The downstream stream height gauge at Glenore Grove was used as a substitute for this data.
6757	Kholo Bridge	Out of action from 15:20 on 11 Jan 2011	The adjacent stream height gauges at Savages Crossing and Mt Crosby Weir provide more useful information than this site during high flows.
6737	Kuss Road	Out of action from 15:22 on 8 Jan 2011	This site is located in the Bremer River catchment and the data is of limited value in gate operations decision making.
6647	Lowood AL-B	Out of action from 07:30 on 14 Jan 2011	The adjacent stream height gauge at Savages Crossing provides more useful information than this site during high flows.
6758	Mt Crosby AL-B	Out of action from 16:30 on 10 Jan 2011	This is a redundant gauge. Another river height gauge is available at this site.
6569	O'Reillys Weir	Out of action from 07:30 on 11 Jan 2011	This station is impacted by backwater from Wivenhoe Dam releases. This cannot be avoided. Data from adjacent stations at Lyons Bridge and Savages Crossing was used as a substitute for this data.
6591	Somerset Dam HW AL-B	Suspect from the time manual gauge readings commenced	This is a redundant gauge. Another dam height gauge is available at this site and manual readings are also available. Only a slight difference was noted between this gauge and the manual observations.
6637	Wivenhoe Dam HW AL-A	Out of action from 10:00 on 11 Jan 2011	This is a redundant gauge and manual readings are available at this site.

River ID	Site	Status date 19 Jan 2011	Comment
6638	Wivenhoe Dam HW AL-B	Out of action from 11:00 on 10 Jan 2011	This is a redundant gauge and manual readings are available at this site.

Table 5.2.6 – Additional Water Level gauges marked out of action or suspect during the Flood Event

For the duration of the Flood Event, just over 130,000 individual observations, 32,000 rainfall and nearly 100,000 water level readings were received from the ALERT network in the Flood Operations Centre. This provides an indication of the system load that is required to be managed during the Event.

Table 5.2.7 below shows the number of readings received from each rainfall and water level gauge.

Alert ID	Station name	Gauge type	Number of readings
6500	Mt Glorious AL-B	RN	128
6511	Mt Pechey AL	RN	430
6514	Gregor Ck AL-P	RN	548
6517	Gregor Ck AL-B	RN	2
6520	Boat Mountain AL	RN	462
6523	Cressbrook Dam AL	RN	442
6526	Helidon AL	RN	57
6529	St Aubyns AL	RN	443
6540	Yarraman AL	RN	472
6542	Cooyar Ck AL	RN	489
6550	Walloon AL-P	RN	416
6553	Rosentretters Br AL	RN	400
6556	Glenore Grove AL	RN	456
6559	Savages Crossing AL	RN	655
6562	Kalbar Weir AL	RN	336
6565	Tenthill AL	RN	81
6568	O'Reillys Weir AL	RN	527
6571	Harrisville AL	RN	300
6574	Caboonbah AL	RN	484
6577	Gatton AL	RN	447
6580	Adams Br AL	RN	437
6583	Showground Weir AL	RN	513
6590	Somerset Dam HW ALERT-B	RN	532
6593	Somerset Dam HW ALERT-P	RN	567
6596	Crows Nest AL	RN	463
6598	Toowoomba AL	RN	443
6600	Kilcoy AL	RN	551
6601	Mt Binga AL	RN	498
6602	Top of Brisbane AL	RN	221
6603	Blackbutt AL	RN	543
6604	Toogoolawah AL	RN	491
6606	West Woodbine AL	RN	330
6607	Lindfield AL	RN	688
6608	Jimna AL	RN	469
6610	Kluvers Lkt AL	RN	696
6615	Thornton AL	RN	390
6617	Little Egypt AL	RN	341
6619	Mt Castle AL	RN	583
6621	Nukinenda AL	RN	449
6623	Tarome AL-P	RN	391
6630	Lyons Br AL-B	RN	639
6633	Lyons Br AL-P	RN	614
6636	Wivenhoe Dam HW ALERT-B	RN	605
6641	Wivenhoe Dam TW ALERT-B	RN	515
6643	Wivenhoe Dam TW ALERT-P	RN	648
6646	Lowood AL-B	RN	538
6649	Lowood AL-P	RN	552
6651	Amberley AL-P	RN	406
6653	Amberley AL-B	RN	389
6680	Mt Glorious AL-P	RN	980
6690	Mt Mee AL-P	RN	769
6701	Mt Mee AL-B	RN	676
6702	Woodford AL-B	RN	652
6705	Woodford Al-P	RN	686
6708	Devon Hills AL	RN	523
6711	Baxters Ck AL	RN	687

Alert ID	Station name	Gauge type	Number of readings
6714	Ferris Knob AL	RN	587
6716	West Bellthorpe AL	RN	802
6717	Linville AL	RN	479
6730	Jindalee AL	RN	343
6733	Rosewood Al	RN	480
6736	Kuss Rd Al	RN	106
6739	Washpool AL	RN	292
6742	Walloon AL-B	RN	410
6748	Brisbane City AL	RN	382
6751	Mt Crosby AL	RN	313
6754	Moggill AL-P	RN	306
6774	Wilsons Peak AL-P	RN	1
6775	Peachester AL	RN	133
2168	Ipswich AL	WL	1763
6515	Gregor Ck AL-P	WL	1799
6521	Boat Mountain AL	WL	2177
6524	Cressbrook Dam AL	WL	1424
6527	Helidon AL	WL	407
6543	Cooyar Ck AL	WL	1529
6551	Walloon AL-P	WL	1230
6554	Rosentretters Br AL	WL	895
6557	Glenore Grove AL	WL	3666
6560	Savages Crossing AL	WL	4220
6563	Kalbar Weir AL	WL	1247
6566	Tenthill AL	WL	86
6569	O'Reillys Weir AL	WL	1341
6572	Harrisville AL	WL	1057
6578	Gatton AL	WL	3598
6581	Adams Br AL	WL	4666
6584	Showground Weir AL	WL	1179
6591	Somerset Dam HW ALERT-B	WL	808
6594	Somerset Dam HW ALERT-P	WL	899
6595	Somerset Dam HW ALERT (test)	WL	1153
6627	Maroon Dam AL	WL	1268
6631	Lyons Br AL-B	WL	1989
6634	Lyons Br AL-P	WL	2670
6637	Wivenhoe Dam HW ALERT-B	WL	7212
6638	Wivenhoe Dam HW ALERT-B2	WL	1161
6642	Wivenhoe Dam TW ALERT-B	WL	2407
6644	Wivenhoe Dam TW ALERT-P	WL	4854
6645	Splityard Ck Dam AL	WL	918
6647	Lowood AL-B	WL	2366
6650	Lowood AL-P	WL	2
6652	Amberley AL-P	WL	5315
6654	Amberley AL-B	WL	1113
6655	Buaraba Creek AL	WL	2999
6703	Woodford AL-B	WL	1048
6706	Woodford AL-P	WL	1138
6709	Devon Hills AL	WL	1631
6718	Linville AL	WL	1611
6720	Kilcoy Creek AL	WL	3715
6731	Jindalee AL	WL	1465
6734	Rosewood AL	WL	1070
6737	Kuss Rd AL	WL	791
6740	Washpool AL	WL	1
6743	Walloon AL-B	WL	133
6747	Whyte Island AL	WL	4667
6749	Brisbane City AL	WL	1653
6752	Mt Crosby AL	WL	3562
6755	Moggill AL-P	WL	1569
6756	Burtons Bridge AL	WL	1716
6757	Kholo Bridge AL	WL	1324
6758	Mt Crosby AL-B	WL	555
6776	Peachester AL	WL	1714

Key: RN = Rainfall; WL = Water level

***Table 5.2.7** – Number of readings received from each rainfall and water level gauge in the ALERT network*

5.3 Network maintenance

5 DATA COLLECTION SYSTEM PERFORMANCE

Seqwater's hydrographic unit is responsible for the operation and maintenance of the rainfall and water level network. This unit is assisted by RoadTek, a division of Main Roads.

Most rainfall stations are standalone instruments or are co-located with river level stations. Where possible, ALERT water level gauges take advantage of data provided by DERM owned and maintained gauging stations to provide a robust source of reliable water level sensing.

A number of the sites damaged during the January 2011 Flood Event have already been reinstated by Seqwater staff.

6

6 EVENT DATA

6.1 Introduction

A real time flood monitoring and forecasting system has been established to monitor rainfall and water levels in the Dam catchments and to provide adequate, accurate and timely information for informed decision-making. This system is described in detail in Section 5. Following is a description of the operational rainfall and river height data collected during the January 2011 Flood Event using this system, as well as a description of other supporting information used by the Flood Operations Centre to support decision-making during the Event.

It should be noted, the data contained in this Section is operational data which was collected during the Event and upon which operational decisions were made. The data is considered accurate, however only real time validation of the data has been undertaken. Given the time constraints for preparation of this Report, it is recognised that more information may become available over time to add to the Event data presented in this Section.

6.2 Forecast rainfall

Forecast rainfall tools provided by the Bureau of Meteorology (BoM) that were examined and considered in decision making during the January 2011 Flood Event were:

- 24 hour Quantitative Precipitation Forecasts (QPF) for the Dam catchments.
- The BoM weather radar (available through www.bom.gov.au);
- BoM SILO meteograms forecast rainfall (based on BoM ACCESS Model);
- BoM interactive weather and wave forecast rainfall maps (based on BoM ACCESS Model);
- BoM water and the land forecast rainfall (based on an ensemble of several numerical weather prediction models);
- BoM severe weather warnings.

Of these, QPF are considered the primary forecast tool as they are provided by BoM to give specific forecast information in relation to the Dam catchment areas. The QPF leading up to and during the Event are shown in Table 6.2.1 following. In relation to the data shown in this table, the following observations can be made:

- The QPF provided a reasonable representation of the actual daily rainfall recorded until 16:00 Saturday 8 January 2011. The QPF forecasts issued to 16:00 Saturday 8 January 2001 **overestimated** rainfall during this period by only 21%. This is considered an excellent result. However, the total catchment average rainfall recorded during this five-day period was only in the order of 100mm.
- In the five forecasts issued between 16:00 Saturday 8 January 2011 and 10:00 Tuesday 11 January 2011, the QPF **underestimates** daily actual catchment average rainfall by between 160% to 340%, with an average error of 225%. This was the critical rainfall period, with the catchment average rainfall recorded during this two-and-a-half day period being in the order of 300mm.
- For the two forecasts issued during the period between 10:00 Tuesday 11 January 2011 and 16:00 on Tuesday 11 January 2011, the QPF **overestimates** daily actual catchment average rainfall by between 196% to 625%, with an average error of 270%. The total catchment average rainfall recorded during this period was only in the order of 45mm.
- The QPF provided a reasonable representation of the actual rainfall recorded after 10:00 on Wednesday 13 January 2011.

6 EVENT DATA

Somerset and Wivenhoe Dam catchments Catchment average rainfall							
Date / time of issue	Forecast for 24 hours to	Forecast rainfall				Recorded for 24 hours to	
		Min	Max	Isolated	Average		Recorded
		mm	mm	mm	mm		mm
Mon 03-01-2011 11:36	04/01/2011 09:00	5	10		8	04/01/2011 09:00	5
Mon 03-01-2011 16:00	04/01/2011 15:00	10	20		15	04/01/2011 15:00	4
Tue 04-01-2011 11:30	05/01/2011 09:00	10	20		15	05/01/2011 09:00	0
Tue 04-01-2011 16:00	05/01/2011 15:00	5	15		10	05/01/2011 15:00	2
Wed 05-01-2011 10:03	06/01/2011 09:00	20	30		25	06/01/2011 09:00	26
Wed 05-01-2011 16:00	06/01/2011 15:00	30	50		40	06/01/2011 15:00	44
Thu 06-01-2011 10:21	07/01/2011 09:00	30	50		40	07/01/2011 09:00	38
Thu 06-01-2011 16:00	07/01/2011 15:00	20	30		25	07/01/2011 15:00	43
Fri 07-01-2011 10:03	08/01/2011 10:00	20	30		25	08/01/2011 10:00	26
Fri 07-01-2011 16:04	08/01/2011 16:00	20	30		25	08/01/2011 16:00	6
Sat 08-01-2011 10:03	09/01/2011 09:00	30	50		40	09/01/2011 09:00	28
Sat 08-01-2011 16:00	09/01/2011 15:00	30	50		40	09/01/2011 15:00	80
Sun 09-01-2011 10:03	10/01/2011 09:00	40	60		50	10/01/2011 09:00	149
Sun 09-01-2011 16:00	10/01/2011 15:00	50	80		65	10/01/2011 15:00	125
Mon 10-01-2011 10:03	11/01/2011 10:00	50	100		75	11/01/2011 10:00	120
Mon 10-01-2011 16:00	11/01/2011 16:00	25	50	100	38	11/01/2011 16:00	129
Tue 11-01-2011 10:13	12/01/2011 10:00		>100		100	12/01/2011 10:00	51
Tue 11-01-2011 16:13	12/01/2011 16:00	50	100		75	12/01/2011 16:00	12
Wed 12-01-2011 10:03	13/01/2011 10:00	10	10		10	13/01/2011 10:00	2
Wed 12-01-2011 16:00	13/01/2011 16:00	5	5		5	13/01/2011 16:00	1
Thu 13-01-2011 14:25	14/01/2011 16:00	5	5		5	14/01/2011 16:00	0
Thu 13-01-2011 16:00	14/01/2011 15:00	5	5		5	14/01/2011 15:00	0
Fri 14-01-2011 10:03	15/01/2011 09:00	3	3		3	15/01/2011 09:00	0
Fri 14-01-2011 16:00	15/01/2011 15:00	3	3		3	15/01/2011 15:00	0

Table 6.2.1 – Actual and forecast rainfall comparison (BoM QPF)

As well as examining and modeling the QPFs, the ACCESS model result data provided by BoM allows three day and five day rainfall forecasts to be examined and considered in flood event decision making.

A summary of this data is shown in the following table that contains translated rainfall forecasting results using ACCESS model result data provided by BoM during the critical period of the Event (between 6 and 11 January 2011). The original BoM data has been translated to forecast catchment average rainfall results, based on a derived catchment centroid rainfall, estimated by using Seqwater's Flood Early Warning Modelling System.

Comparison of actual and forecast rainfall from BoM ACCESS model								
Forecast date and time	Somerset Dam catchment average rainfall				Wivenhoe Dam catchment average rainfall (excluding Somerset Dam catchment)			
	3 Days from		5 Days from		3 Days from		5 Days from	
	Actual rainfall (mm)	Forecast rainfall (mm)	Actual rainfall (mm)	Forecast rainfall (mm)	Actual rainfall (mm)	Forecast rainfall (mm)	Actual rainfall (mm)	Forecast rainfall (mm)
06/01/2011 00:00	90	73	403	115	79	90	275	114
06/01/2011 12:00	150	85	515	133	87	51	335	78
07/01/2011 00:00	298	189	568	206	180	133	347	144
07/01/2011 12:00	321	123	536	137	183	79	322	89
08/01/2011 00:00	332	191	527	206	205	207	309	218
08/01/2011 12:00	447	165	527	169	284	136	309	139
09/01/2011 00:00	500	230	510	231	298	267	301	268
09/01/2011 12:00	441	140	446	141	271	170	273	171
10/01/2011 00:00	278	463	280	465	169	171	170	171
10/01/2011 12:00	218	59	219	60	140	389	141	390
11/01/2011 00:00	196	19	197	19	105	231	105	231

Table 6.2.2 Actual and forecast rainfall comparison (BoM ACCESS model)

Table 6.2.2 above shows:

- There are variations in excess of 700% between successive three-day catchment average rainfall forecasts made 12 hours apart;
- There are variations in excess of 700% between successive five-day catchment average rainfall forecasts made 12 hours apart;
- There are eight instances in which actual rainfall recorded is greater than 200% (highest is more than 1,000%) of the three-day forecast rainfall;
- There are three instances in which the three-day forecast rainfall is greater than 150% (highest is 280%) of the actual rainfall recorded;
- There are nine instances in which actual rainfall recorded is greater than 300% (highest is over 1,000%) of the five-day forecast rainfall;
- There are two instances in which the five-day forecast actual rainfall is greater than 200% (highest is 280%) of the actual rainfall recorded.

These results show that three day and five day forecasts only provide an indication of future rainfall and these forecasts cannot be used as a basis of flood operations decision making where public safety in both rural and urban areas is directly impacted. This forecasting information uses the most up-to-date technology available within BoM at the present time. Future improvements in this area will be examined with interest in order to maximise the flood mitigation benefits of the Dams.

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6.3 Event rainfall totals

As discussed in Section 5, Seqwater uses a network automated rainfall stations within the Brisbane River catchment area to gather rainfall data during flood events. Data from this network is automatically collected in real time using a radio telemetry collection system and sent in real time to the Flood Operations Centre. Every millimetre of rainfall recorded at each station is sent immediately to the Flood Operations Centre as it is recorded.

Data sent to the Flood Operations Centre in this way is operational data that has not been validated. Both manual and automatic data checking was undertaken in the Flood Operations Centre at regular and routine intervals over the course of the Event.

Table 6.3.1 shows the daily rainfall totals collected by the Flood Operations Centre (both Flood-Col and Enviromon) at each of the rainfall stations during the Event. Stations highlighted in **bold** are configured in the flood models and used in modelling of flows.

6 EVENT DATA

Alert ID	BoM ID	Station	Location		Rainfall (mm) 24 hours ending 09:00								8 day total
			Latitude	Longitude	6/01	7/01	8/01	9/01	10/01	11/01	12/01	13/01	
6500	540184	Mt Glorious-B	-27.3120	152.7470									
6511	541057	Mt Pechy	-27.3167	152.0817	44	16	16	7	81	101	18	0	283
6514	540139	**Gregor Ck-P**	-26.9800	152.4040	27	39	11	25	221	77	25	1	426
6517	540140	Gregor Ck-B	-27.0000	152.4040									
6520	540141	**Boat Mountain**	-26.9789	152.2847	40	52	20	25	179	62	26	4	408
6523	540142	Cressbrook Dam	-27.2650	152.1950	32	28	14	7	94	120	11	1	307
6526	540143	**Helidon**	-27.5440	152.1130	56	42	25	6	101	33	0	0	263
6529	540144	St Aubyns	-27.0619	151.8944	25	26	23	20	74	123	8	2	301
6540	540145	**Yarraman**	-26.8358	151.9692	32	40	21	20	113	130	0	1	357
6542	540146	Cooyar Ck	-26.7417	152.1367	23	55	28	18	118	118	3	1	364
6550	540147	**Walloon-P**	-27.6170	152.6680	25	14	14	3	69	42	114	0	281
6553	540148	Rosentretters Br	-27.1383	152.3294	28	27	25	4	129	111	23	4	351
6555	540479	Atkinson Dam	-27.4320	152.4640	44	28	9	5	109	119	98	0	412
6556	540149	Glenore Grove	-27.5242	152.4081	16	24	13	4	84	77	129	0	347
6559	540150	**Savages Xing**	-27.4410	152.6680	4	27	5	5	113	246	144	0	544
6562	540151	Kalbar Weir	-27.9230	152.6010	42	39	7	4	15	67	55	0	229
6565	540152	**Tenthill**	-27.6360	152.2140									
6568	540153	O'Reillys Weir	-27.4197	152.5892	10	36	6	2	98	146	206	0	504
6571	540154	**Harrisville**	-27.8150	152.6406	14	19	10	1	30	76	53	0	203
6574	540155	Caboonbah	-27.1460	152.4900	24	23	39	9	130	154	54	0	433
6577	540156	**Gatton**	-27.5564	152.2731	17	36	21	4	87	68	88	0	321
6580	540157	Adams Br	-27.8294	152.5108	33	30	13	2	36	93	92	1	300
6583	540158	**Showground Weir**	-27.6386	152.3844	13	27	18	1	68	103	117	0	347

Alert ID	BoM ID	Station	Location		Rainfall (mm) 24 hours ending 09:00								8 day total
			Latitude	Longitude	6/01	7/01	8/01	9/01	10/01	11/01	12/01	13/01	
6590	540160	**Somerset Dam HW-B**	-27.1200	152.5510	20	18	42	22	159	136	65	1	463
6593	540159	**Somerset Dam HW-P**	-27.1000	152.5510									
6596	540161	**Crows Nest**	-27.2308	152.0311	44	21	15	11	115	98	18	0	322
6598	540162	**Toowoomba**	-27.5114	151.9536	44	18	27	9	81	117	24	1	321
6600	540163	**Kilcoy**	-26.9481	152.5836	12	38	18	24	179	96	61	2	430
6601	540494	Mt Binga	-26.9920	151.9850	38	39	35	22	121	118	13	2	388
6602	540164	**Top of Brisbane**	-26.4772	152.1567	45	52	70	17	41	66	0	0	291
6603	540493	Blackbutt	-26.8860	152.1020	45	75	30	33	160	107	13	0	463
6604	540165	**Toogoolawah**	-27.0858	152.3722	16	26	22	12	177	103	27	2	385
6605	540492	Eskdale	-27.1670	152.1860									
6606	540166	**West Woodbine**	-27.7847	152.1497	35	17	5	4	17	88	33	0	199
6607	540491	Lindfield	-26.8370	152.5810	50	34	18	90	271	86	65	1	615
6608	540167	**Jimna**	-26.6610	152.4510	29	44	28	42	117	47	22	1	330
6609	540490	Monsildale	-26.5820	152.3250	25	43	62	49	117	160	4	2	462
6610	540168	Kluvers Lookout	-27.2070	152.7030	4	52	24	17	126	164	191	4	582
6611	540489	Redbank Creek	-27.2770	152.2890	32	40	21	7	130	170	27	1	428
6612	540488	Mt Stanley	-26.6820	152.2050	24	61	32	32	137	160	2	1	449
6613	540487	Hazeldean	-27.0280	152.5370	9	38	32	18	204	123	90	5	519
6614	540486	Westvale	-27.0170	152.6100									
6615	540169	**Thornton**	-27.8211	152.3800	23	31	12	5	46	123	98	0	338
6617	540170	**Little Egypt**	-27.7042	152.0650	50	18	8	1	30	92	30	1	230
6619	540171	**Mt Castle**	-27.9636	152.3756	52	55	17	4	88	195	122	21	554
6621	540172	**Nukinenda**	-27.0567	152.1072	11	43	19	13	114	113	10	2	325

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Alert ID	BoM ID	Station	Location		Rainfall (mm) 24 hours ending 09:00								8 day total
			Latitude	Longitude	6/01	7/01	8/01	9/01	10/01	11/01	12/01	13/01	
6623	540173	Tarome	-27.9867	152.5008	31	55	9	0	26	81	82	0	284
6624	540474	Moogerah Dam	-28.0310	152.5450	23	55	16	1	21	96	76	0	288
6626	540475	Maroon Dam	-28.1840	152.6340	20	19	1	5	34	78	46	0	203
6630	540175	Lyons Br-B	-27.4717	152.5236	25	25	13	4	83	130	239	0	519
6633	540174	Lyons Br-P	-27.4717	152.5236	26	22	11	5	75	114	214	0	467
6636	540177	Wivenhoe Dam HW-B	-27.3550	152.5960	6	29	6	4	87	135	197	0	464
6641	540179	Wivenhoe Dam TW-B	-27.3900	152.5960	8	32	6	5	99	157	206	0	513
6643	540178	Wivenhoe Dam TW-P	-27.4100	152.5960	7	30	7	2	101	160	218	0	525
6646	540183	Lowood-B	-27.4700	152.5930	8	29	7	4	104	183	210	0	545
6649	540182	Lowood-P	-27.4900	152.5930	6	22	8	9	99	163	194	0	501
6651	540180	Amberley-P	-27.6780	152.6990	39	13	16	3	68	32	86	0	257
6653	540181	Amberley-B	-27.6783	152.6989	38	12	16	3	59	32	81	1	242
6656	540472	Bill Gunn Dam	-27.6320	152.3790	13	31	23	1	74	102	132	0	376
6658	540473	Lake Clarendon Dam	-27.5160	152.3530	21	35	20	5	88	76	134	0	379
6680	540138	Mt Glorious-P	-27.3220	152.7470	29	46	16	24	204	260	228	2	809
6690	540185	Mt Mee-P	-27.0700	152.7800	10	55	46	30	220	137	179	10	687
6701	540246	Mt Mee-B	-27.0700	152.7800	9	55	49	28	219	138	179	9	686
6702	540338	Woodford-B	-26.9300	152.7600	8	42	43	37	181	88	196	5	600
6705	540337	Woodford-P	-26.9500	152.7600	8	41	43	38	182	88	196	5	601
6708	540188	Devon Hills	-26.9000	152.3210	28	42	43	55	162	68	16	1	415
6711	540189	Baxters Ck	-27.1958	152.8000	3	37	23	17	127	170	192	0	569
6714	540190	Ferris Knob	-26.8542	152.8167	0	33	24	90	250	78	224	11	710
6716	540191	West Bellthorpe	-26.8230	152.6780	50	30	14	104	312	134	95	7	746

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Alert ID	BoM ID	Station	Location		Rainfall (mm) 24 hours ending 09:00								8 day total
			Latitude	Longitude	6/01	7/01	8/01	9/01	10/01	11/01	12/01	13/01	
6717	540261	**Linville**	-26.8050	152.2720	30	39	32	37	139	51	34	0	362
6730	540192	**Jindalee**	-27.5322	152.9239	24	35	8	5	75	26	45	0	218
6733	540193	**Rosewood**	-27.6600	152.6030	21	14	17	3	67	54	152	0	328
6736	540194	**Kuss Rd**	-27.6658	152.5414									
6739	540195	**Washpool**	-27.8290	152.7550	12	20	11	1	24	60	38	0	166
6742	540196	**Walloon-B**	-27.6100	152.6680	26	16	14	6	67	42	113	0	284
6748	540198	**Brisbane City**	-27.4730	153.0300	49	36	12	15	105	20	41	0	278
6751	540199	**Mt Crosby**	-27.5300	152.7980	4	39	11	6	86	25	73	0	244
6754	540200	**Moggill-P**	-27.5950	152.8630	3	39	6	5	60	35	52	0	200
6759	540277	North Pine Dam-B	-27.2750	152.9300	4	45	4	9	82	53	67	0	264
6760	540202	North Pine Dam	-27.2650	152.9300	3	45	4	8	83	52	65	0	260
6763	540203	Petrie	-27.2700	152.9750	6	57	5	12	121	63	55	0	319
6766	540204	Lake Kurwongbah	-27.2500	152.9500	7	52	7	10	127	60	72	1	336
6769	540205	Drapers Xing	-27.3500	152.9167	2	47	8	9	123	47	84	2	322
6774	540207	**Wilsons Peak-P**	-28.2440	152.4860									
6775	540059	Peachester	-26.8400	152.8406									
6778	540060	Samford	-27.3610	152.8790	21	41	6	9	131	51	99	2	360

Table 6.3.1 – Daily rainfall totals by station for the duration of the January 2011 Flood Event

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The following maps (Figure 6.3.2 to Figure 6.3.11) illustrate the data in Table 6.3.1.

Rainfall in the 24 hours to 09:00 on Wednesday 5 January 2011

In the 24 hours to 09:00 on Wednesday 5 January 2011, only small rainfall totals, generally less than 5mm, were recorded in the Brisbane Basin. The word "None" on the map signifies that no reports were received from the station during the period. Figures in red also indicate errors in the data.

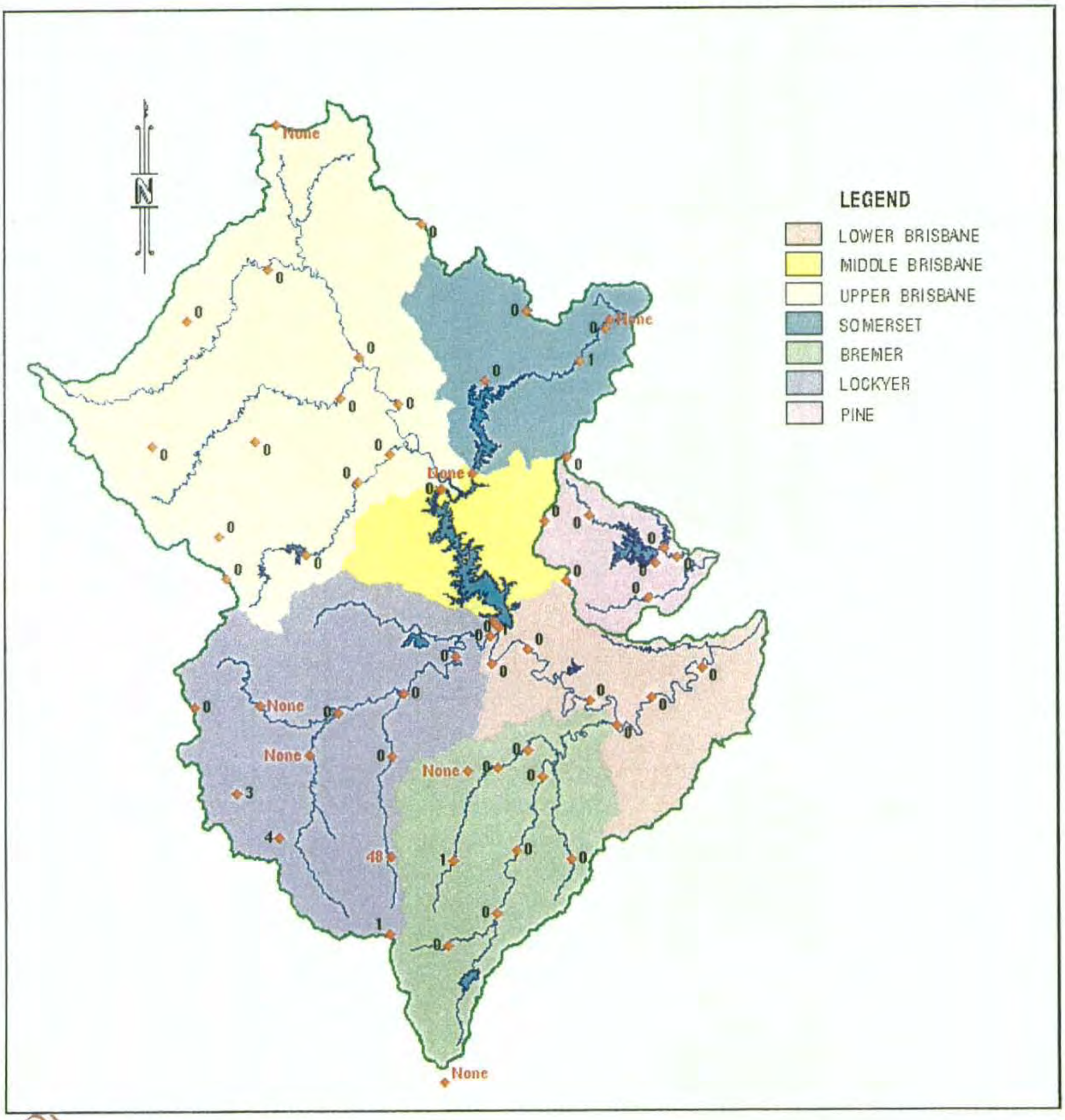

Figure 6.3.2 – Rainfall in the 24 hours to 09:00, Wednesday 5 January 2011

Rainfall in the 24 hours to 09:00 on Thursday 6 January 2011

In the 24 hours to 09:00 on Thursday 6 January 2011, widespread rainfall was recorded throughout the area, with totals ranging from 20mm to 56mm. The highest totals in this period were concentrated in the Upper Brisbane catchment, around Boat Mountain and Cooyar.

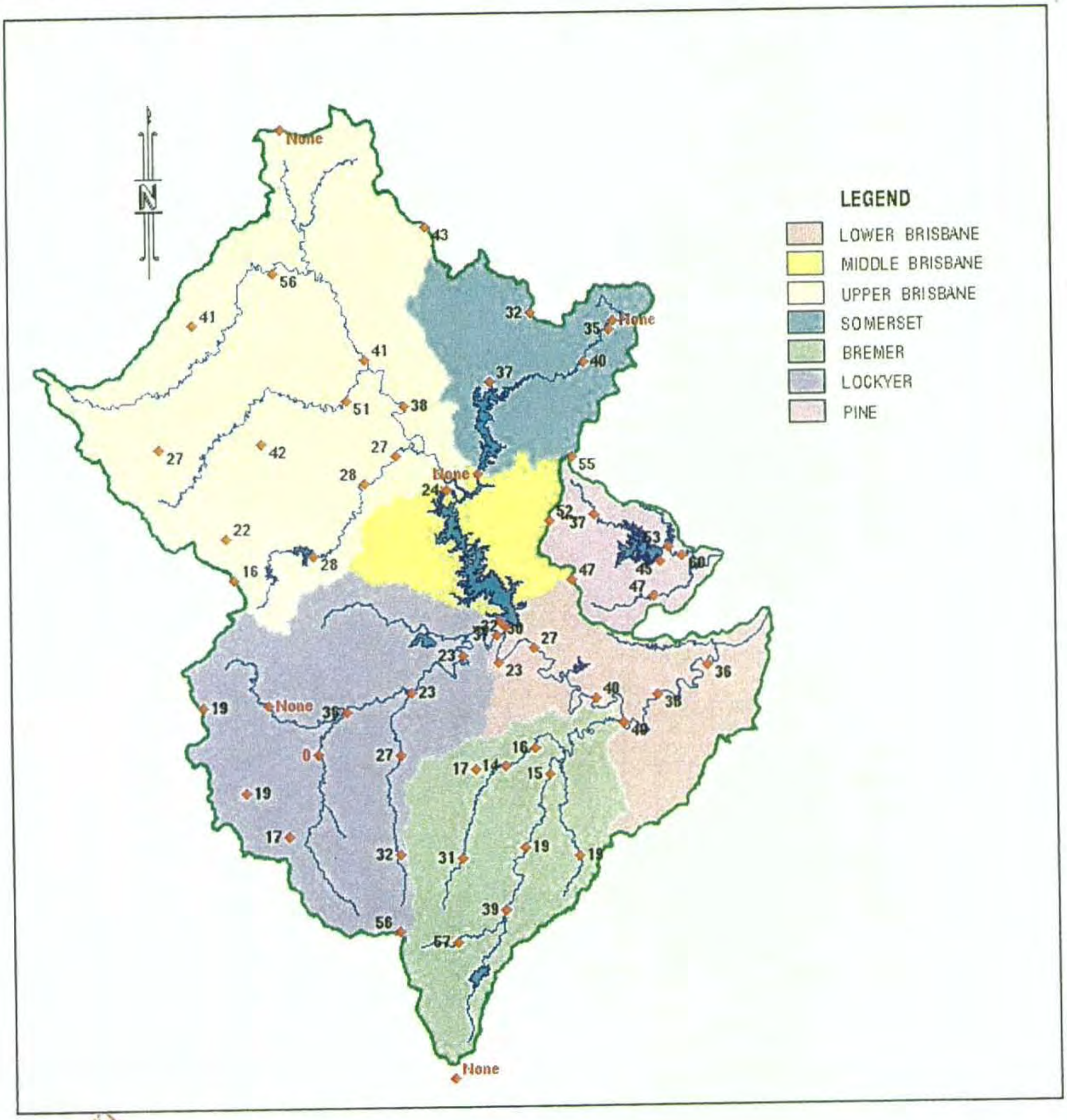

Figure 6.3.3 - Rainfall in the 24 hours to 09:00, Thursday 6 January 2011

Rainfall in the 24 hours to 09:00 on Friday 7 January 2011

Compared to the previous period, rainfall generally eased in the 24 hours to 09:00 on Friday 7 January. Rainfall in the period was again wide-spread, however totals were generally between 10mm to 30mm, with an occasional isolated higher total in the Upper Brisbane River and Stanley River catchments.

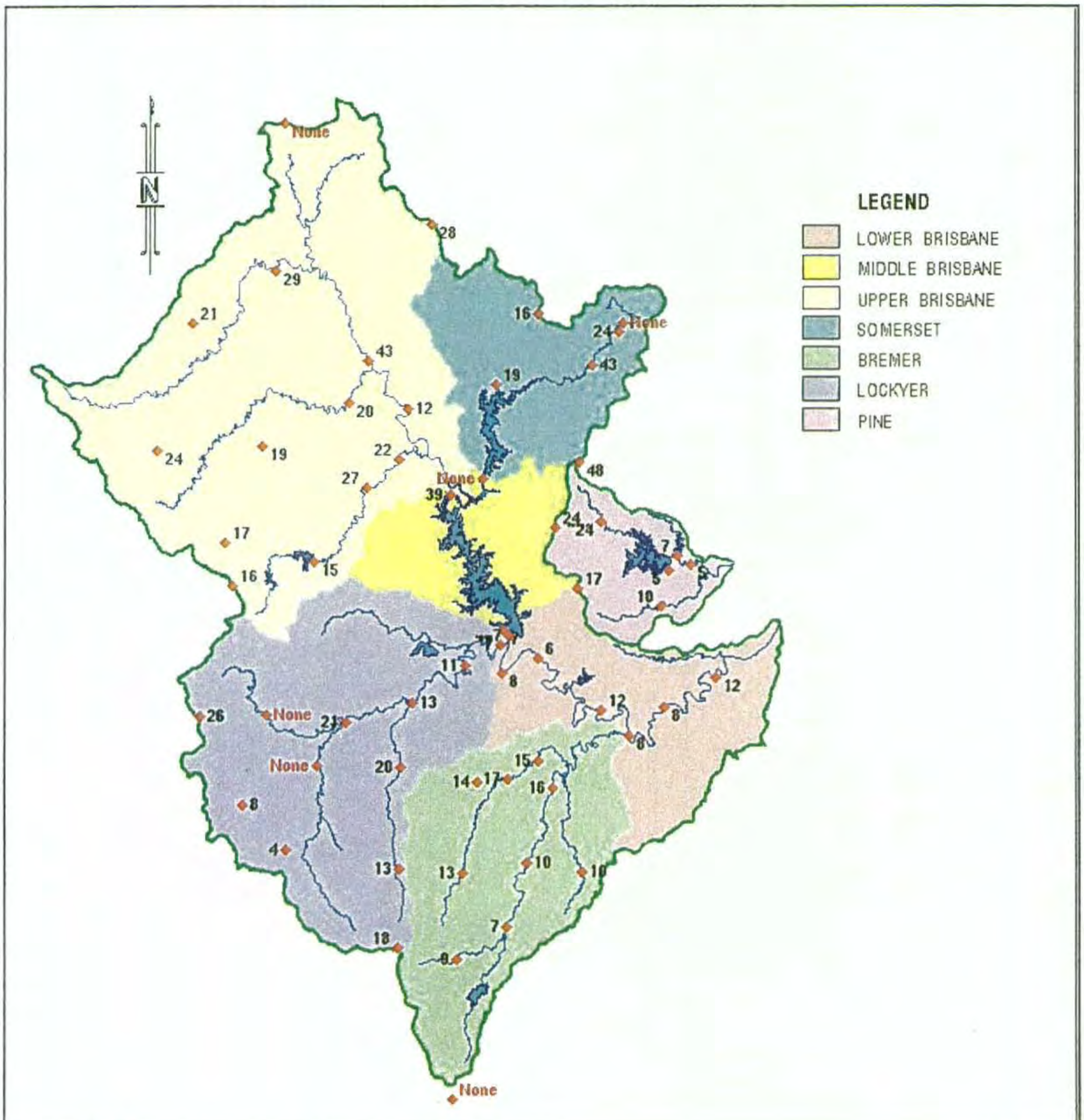

Figure 6.3.4 - Rainfall in the 24 hours to 09:00, Friday 7 January 2011

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Rainfall in the 24 hours to 09:00 on Saturday 8 January 2011

The highest totals in the 24 hours to 09:00 on Saturday 8 January 2011 were recorded in the headwater areas around Ferris Knob and Bellthorpe West, with totals around 100mm. High rainfall continued to be recorded in the Upper Brisbane River around Devon Hills. Elsewhere in the basin downstream of Wivenhoe Dam, totals were generally less than 10mm.

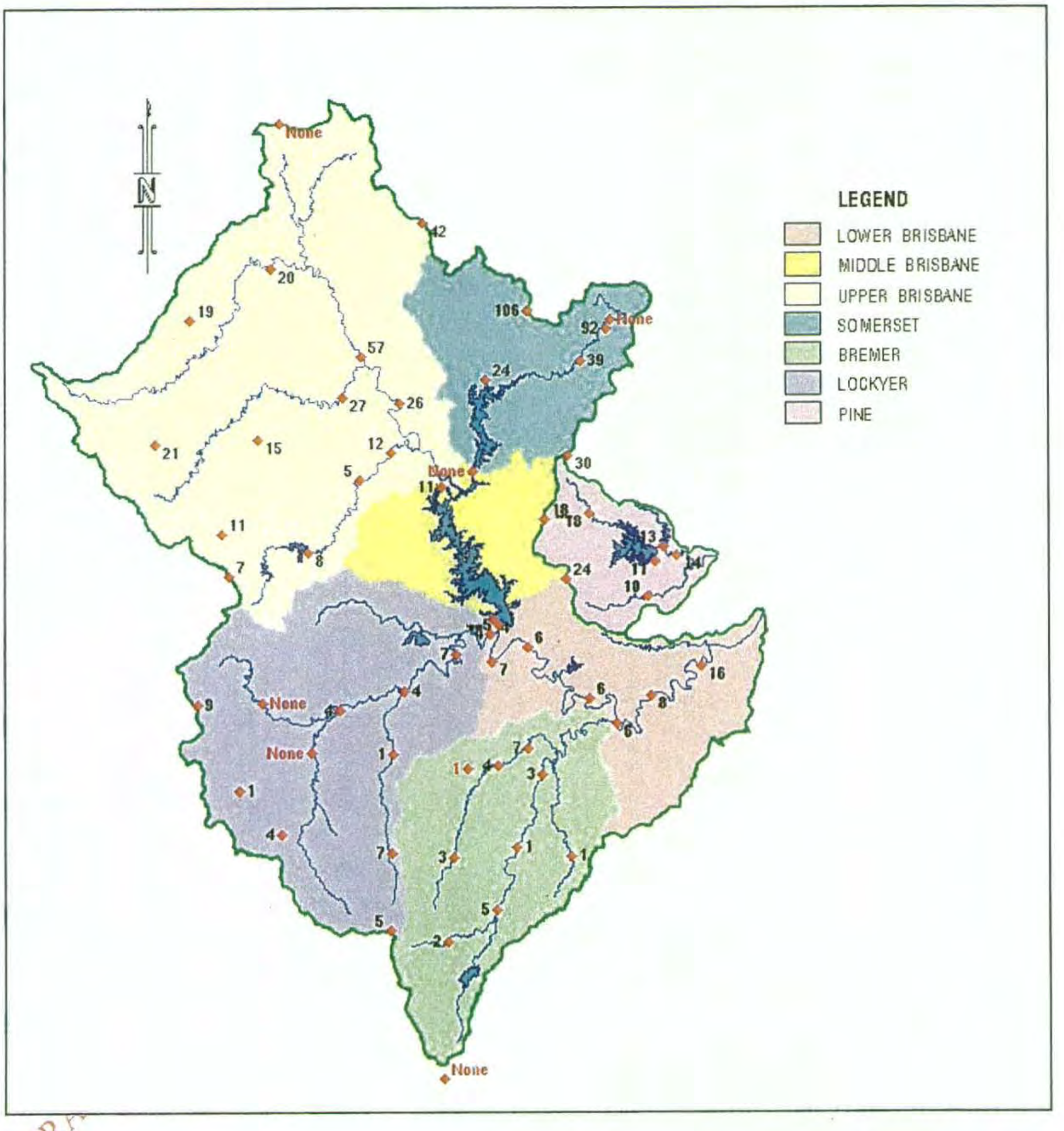

Figure 6.3.5 - Rainfall in the 24 hours to 09:00, Saturday 8 January 2011

Rainfall in the 24 hours to 09:00 on Sunday 9 January 2011

Rainfall throughout the basin was widespread in the 24 hours to 09:00 on Sunday 9 January 2011. Totals were generally below 30mm, but with isolated higher totals just over 40mm in the upper reaches of the Stanley River catchments around Ferris Knob and around the centre of the Upper Brisbane River catchment around Devon Hills.

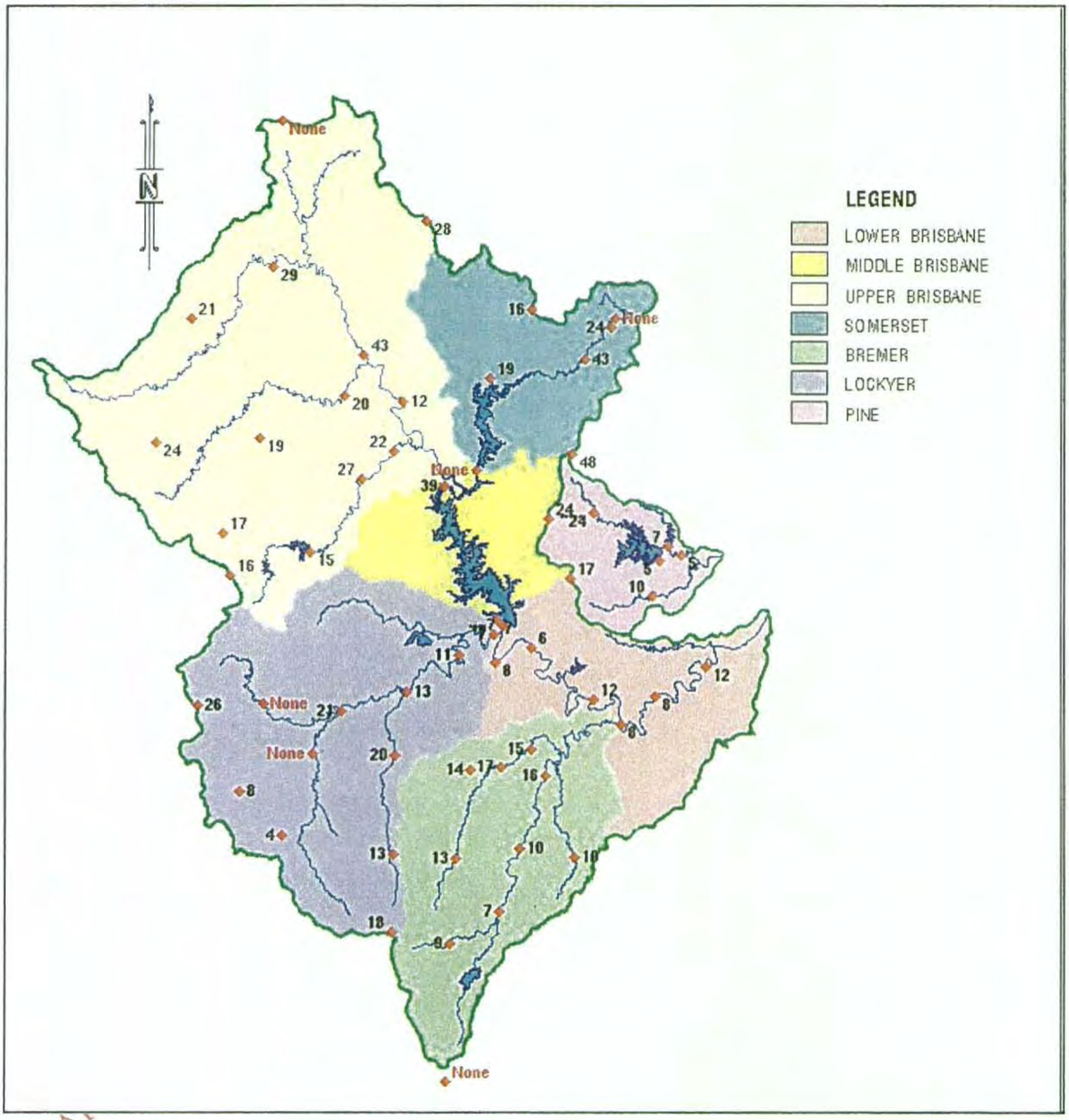

Figure 6.3.6 - Rainfall in the 24 hours to 09:00, Sunday 9 January 2011

Rainfall in the 24 hours to 09:00 on Monday 10 January 2011

The rainfall in the 24 hours to 09:00 on Monday 10 January 2011 was especially high in the Stanley River catchment. The highest daily Event total of 310mm was recorded at Bellthorpe West. Falls in other parts of the Stanley River catchment ranged from 180mm to 250mm in the same period. In the Upper and Middle Brisbane River catchments, 24-hour totals ranged from 73mm at St Aubins to 284mm at Mt Glorious just east of Wivenhoe Dam. Widespread rain between 100mm and 200mm was recorded in other parts of the catchment.

Rainfall in the Lockyer Creek catchment ranged from 15mm at Woodbine West to nearly 80mm at Toowoomba. The heaviest falls in the Bremer River system were concentrated in the lower reaches, with totals of up to 70mm recorded. In the headwater of the Bremer River, totals were much lower. This was the first day since the start of the Event that heavy rainfall was recorded in the Lower Brisbane River catchment, with 24 hour totals up to 113mm.

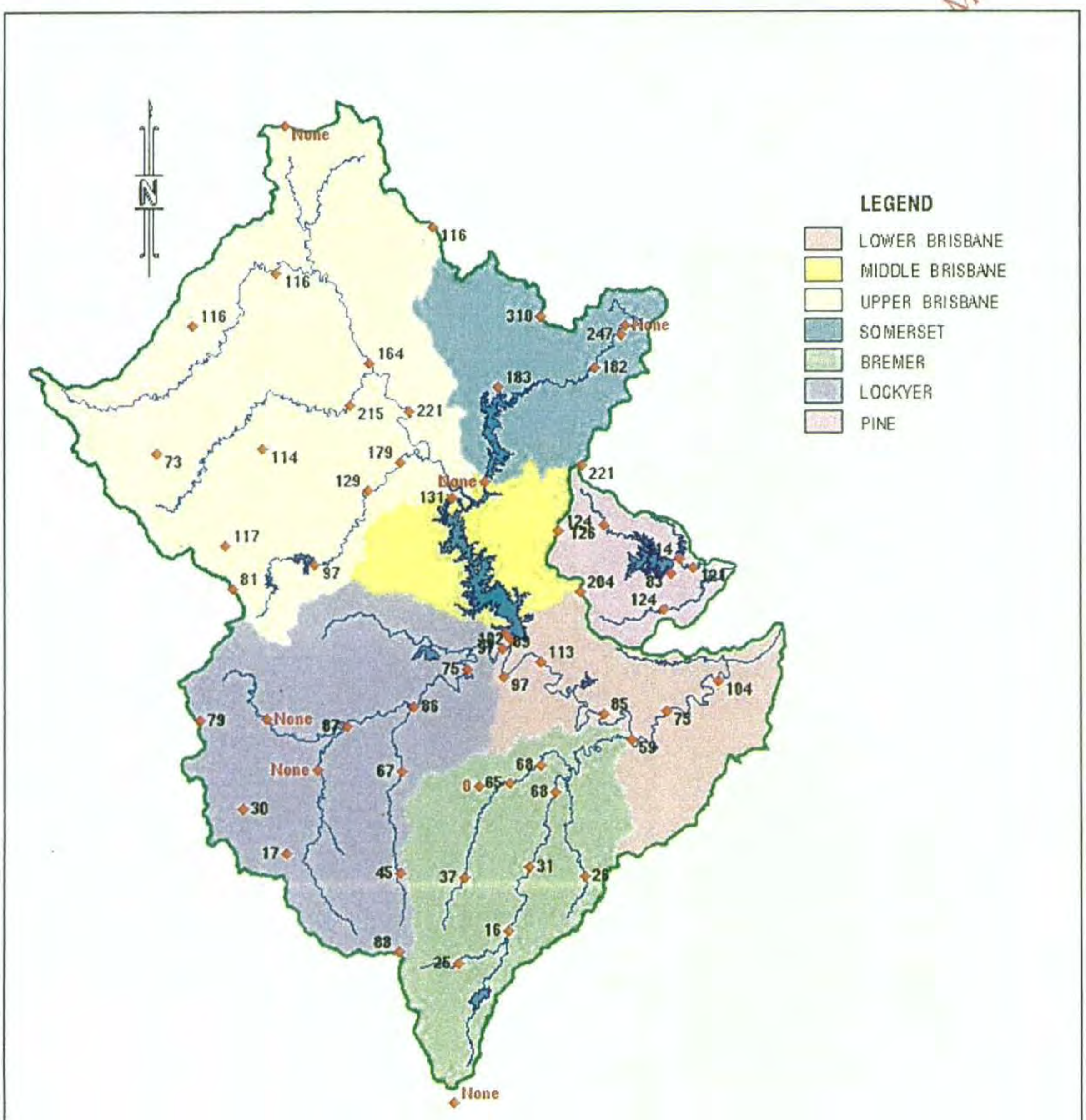

Figure 6.3.7 - Rainfall in the 24 hours to 09:00, Monday 10 January 2011

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Rainfall in the 24 hours to 09:00 on Tuesday 11 January 2011

Heavy rain continued to be recorded throughout the Brisbane Basin in the 24 hours to 09:00 on Tuesday 11 January 2011, with the highest totals in the area around the lower Middle Brisbane River and upper reaches of the Lower Brisbane River catchment, with totals up to 262mm at Mt Glorious. In the Stanley River catchment, totals between 80mm and 130mm were again reported widely throughout the catchment.

Particularly heavy rainfall was recorded in the upper reaches of Lockyer Creek around Toowoomba, which recorded 116mm in the period, with most of this falling the previous afternoon. Very large totals were also recorded in the headwater area of Laidley Creek, where nearly 200mm was reported at Mount Castle. In the Bremer River catchment, rainfall was still widespread, although totals were generally below 70mm.

Totals in the Lower Brisbane River area were generally below 30mm, although there were very high totals around Fernvale.

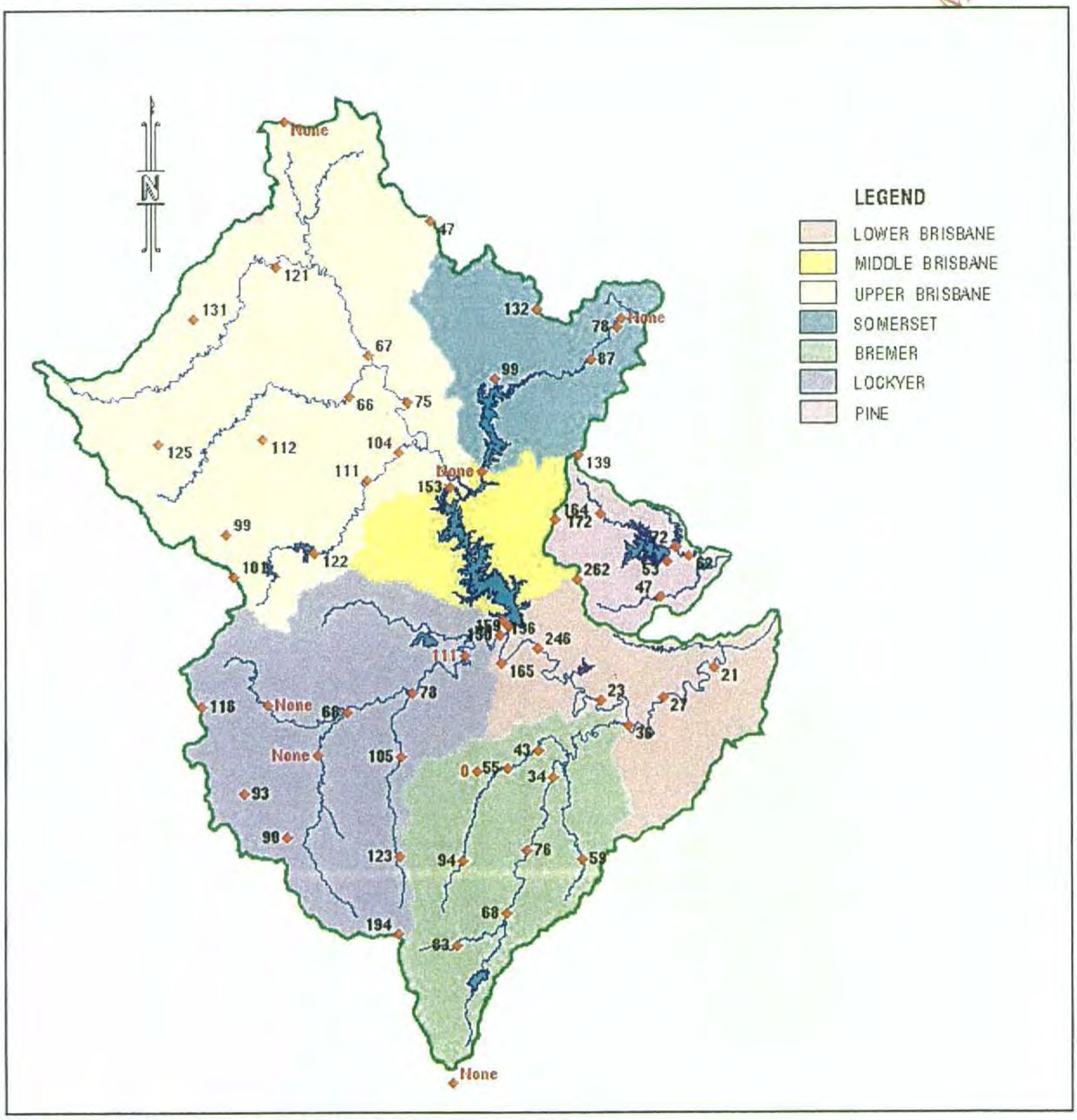

Figure 6.3.8 - Rainfall in the 24 hours to 09:00, Tuesday 11 January 2011

Rainfall in the 24 hours to 09:00 on Wednesday 12 January 2011

High rainfall continued to be recorded in the upper reaches of the Stanley River, with falls in excess of 220mm in the 24 hours to 09:00 on Thursday 12 January 2011.

In the Upper Brisbane River catchment, rainfall had eased with 24-hour totals generally less than 30mm. However, heavy rainfall continued in the area around Wivenhoe Dam and just south, with totals between 150mm and 230mm in the area, most of which fell in the previous afternoon.

Heavy rain continued in the Laidley Creek, Bremer River and Warrill Creek catchments, with totals up to 120mm.

Elsewhere in the Lower Brisbane River catchment, totals ranged from 40mm to 70mm.

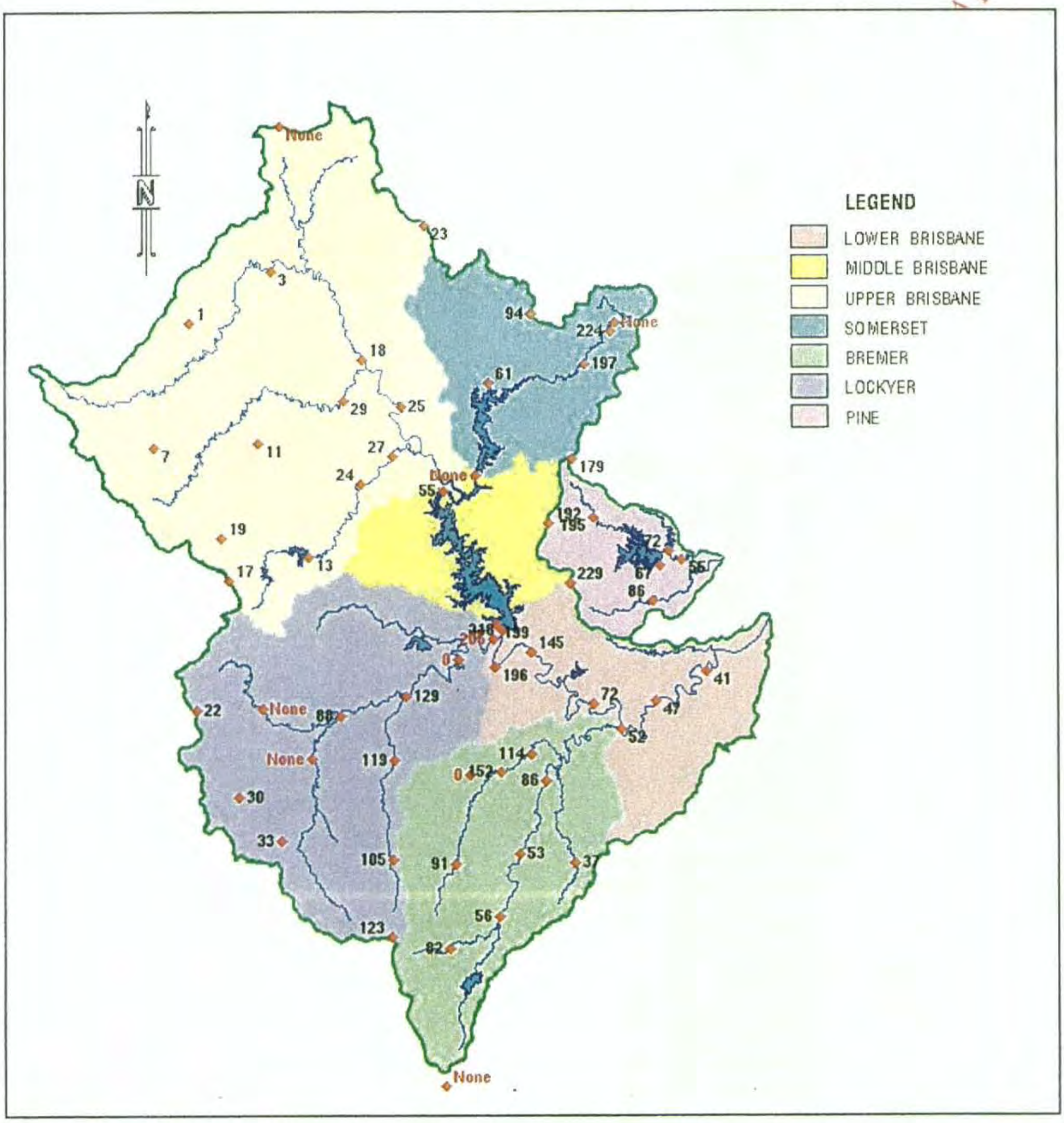

Figure 6.3.9 – Rainfall in the 24 hours to 09:00, Wednesday 12 January 2011

6 EVENT DATA

Rainfall in the 24 hours to 09:00 on Thursday 13 January 2011

By 09:00 on Thursday 13 January 2011, the rainfall event was virtually complete, with totals generally below 10mm in the 24-hour period, with only an isolated higher total of 22mm at Mount Castle in Upper Laidley Creek.

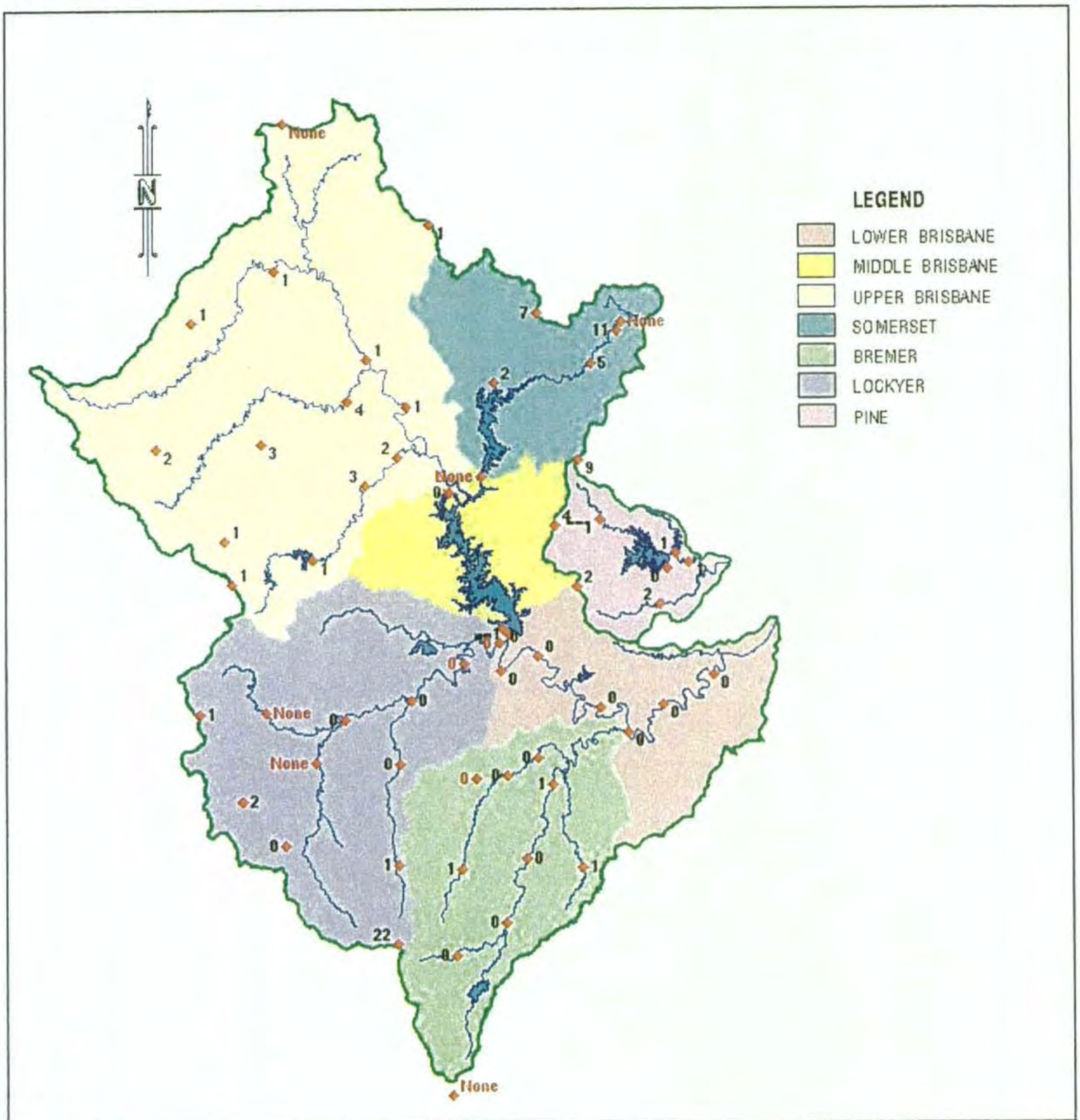

Figure 6.3.10 - Rainfall in the 24 hours to 09:00, Thursday 13 January 2011

Rainfall in the six days to 09:00 on Thursday 13 January 2011

Figure 6.2.11 below shows the rainfall distribution during the six-day period to 09:00 on Thursday 13 January 2011.

The highest totals were recorded in the headwater ridges in the Stanley River catchment and along the D'Aguilar Range from Mt Mee to Mt Glorious. Elsewhere through the Stanley, Upper Brisbane River and Middle Brisbane River catchments, rainfall totals - while still significant - were half those recorded at elevated stations.

This effect was not as pronounced in the Lockyer Creek and Bremer River catchments, where the totals over the period tended to be more uniform. In the Lower Brisbane River area, totals in urban areas were half of those recorded around Fernvale and Lowood.

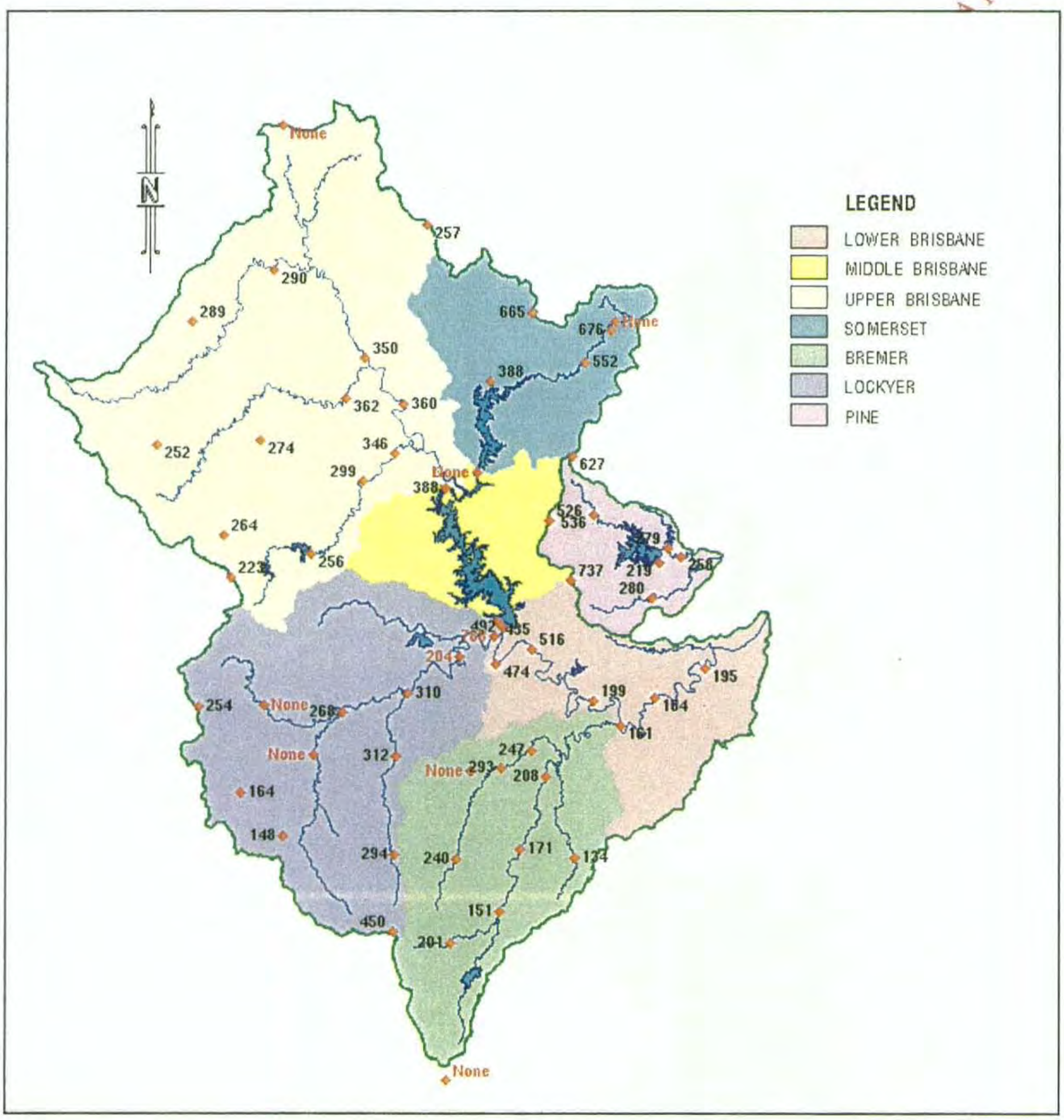

Figure 6.3.11 - Rainfall in the six days to 09:00, Thursday 13 January 2011

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Over the nine-day period ending 09:00 on Thursday 13 January 2011, the highest rainfall total in any of the Seqwater operated gauges was 814 millimetres at the Mt Glorious gauge, just to the east of Wivenhoe Dam.

Individual highest daily (24 hours to 09:00 on the date indicated) rainfall includes:

- Bellthorpe West 106mm, Sunday 9 January 2011
- Bellthorpe West 310mm, Monday 10 January 2011
- Mt Glorious 262mm, Tuesday 11 January 2011
- Lyons Bridge 242mm, Wednesday 12 January 2011

Average rainfall for each subcatchment in the Brisbane Basin is determined by applying a weighting to the rainfall depth at each available station within the subcatchment. Within the operational system, the Brisbane Basin is divided into the two subcatchments shown in the table below.

The Somerset catchment represents the average catchment rainfall in the Stanley River to Somerset Dam.

The Upper Brisbane River catchment, as represented in Table 6.3.12, represents the total Wivenhoe Dam catchment, excluding the Somerset Dam catchment, and is a weighted average of the Upper and Middle Brisbane River catchments shown in Figure 6.3.13. For example, the weighted average of the Upper Brisbane River catchment (359mm) and Middle Brisbane River catchment (525mm) shown on the map gives a catchment average of 401mm for the Event.

Daily catchment rainfall										
Period ending 9am	**Stanley**		**Upper Brisbane**		**Lockyer**		**Bremer**		**Lower**	
	Period	**Σ**	**Period**	**Σ**	**Period**	**Σ**	**Period**	**Σ**	**Period**	**Σ**
	mm	**mm**	**mm**	**mm**	**mm**	**mm**	**mm**	**mm**	**mm**	**mm**
6/01	21	21	27	27	30	30	28	28	20	20
7/01	38	59	38	65	27	57	31	59	35	55
8/01	32	91	27	92	15	72	12	71	10	65
9/01	56	147	21	113	5	77	3	74	9	74
10/01	225	372	131	244	66	143	45	119	90	164
11/01	113	485	117	361	102	245	75	194	73	237
12/01	128	613	38	399	84	329	84	278	82	319
13/01	5	618	2	401	2	331	2	280	0	319

Table 6.3.12 – Daily rainfall throughout the total Wivenhoe Dam catchment (excluding Somerset Dam catchment)

The following map (Figure 6.3.13) illustrates the data contained in Table 6.3.12, summarised over the period of the Event during which significant rainfall was recorded. Catchment rainfall in the eight days to 09:00 Thursday 13 January 2011.

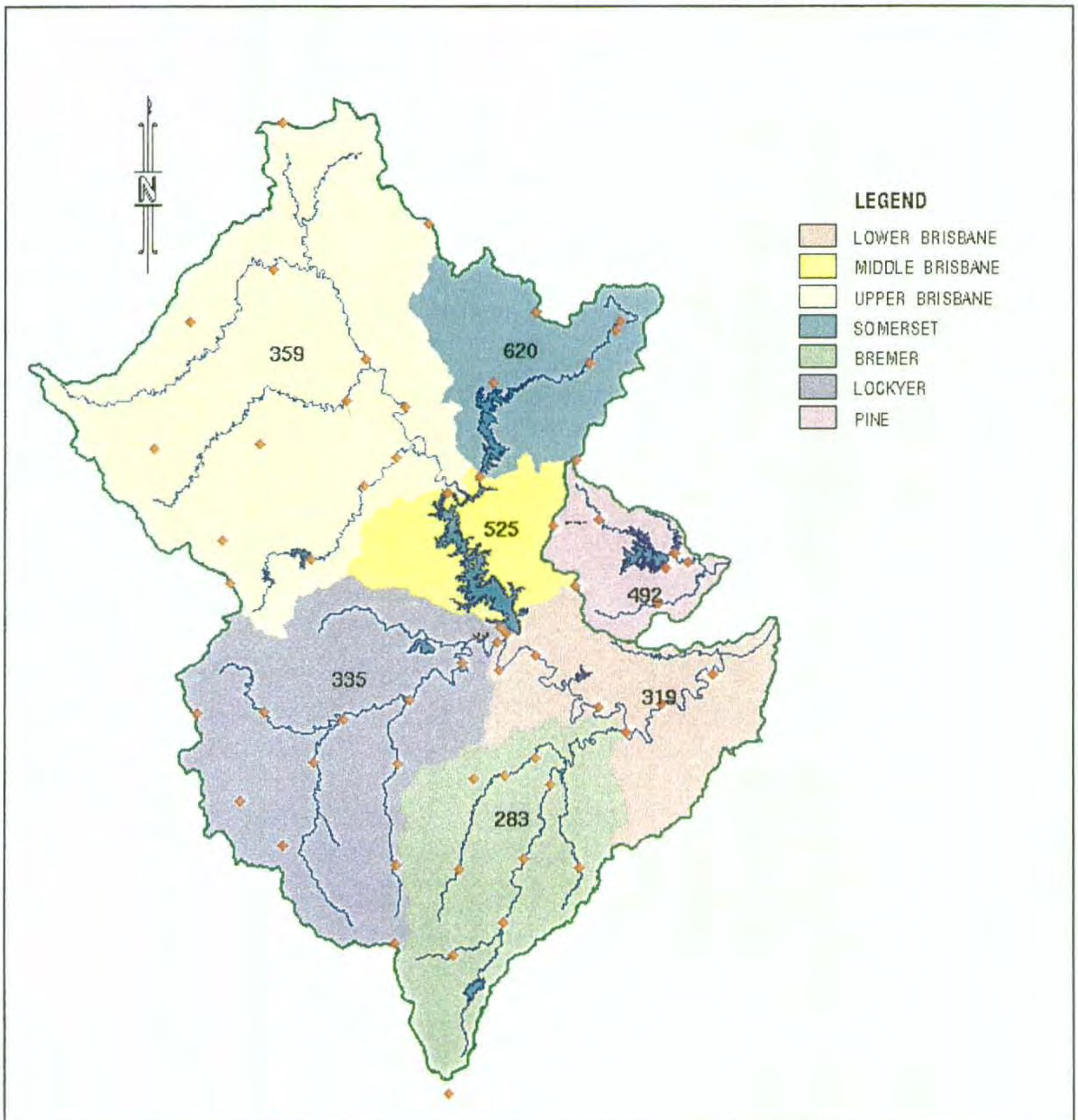

Figure 6.3.13 - Catchment rainfall in the eight days to 09:00. Thursday 13 January 2011

The following catchment average rainfall hyetographs (Figure 6.2.14 to Figure 6.2.19) do not necessarily reflect the localised high intensity rainfall recorded throughout the Basin at various times and locations.

Catchment rainfalls can include hourly intensities at individual stations which can be up to five times the catchment average.

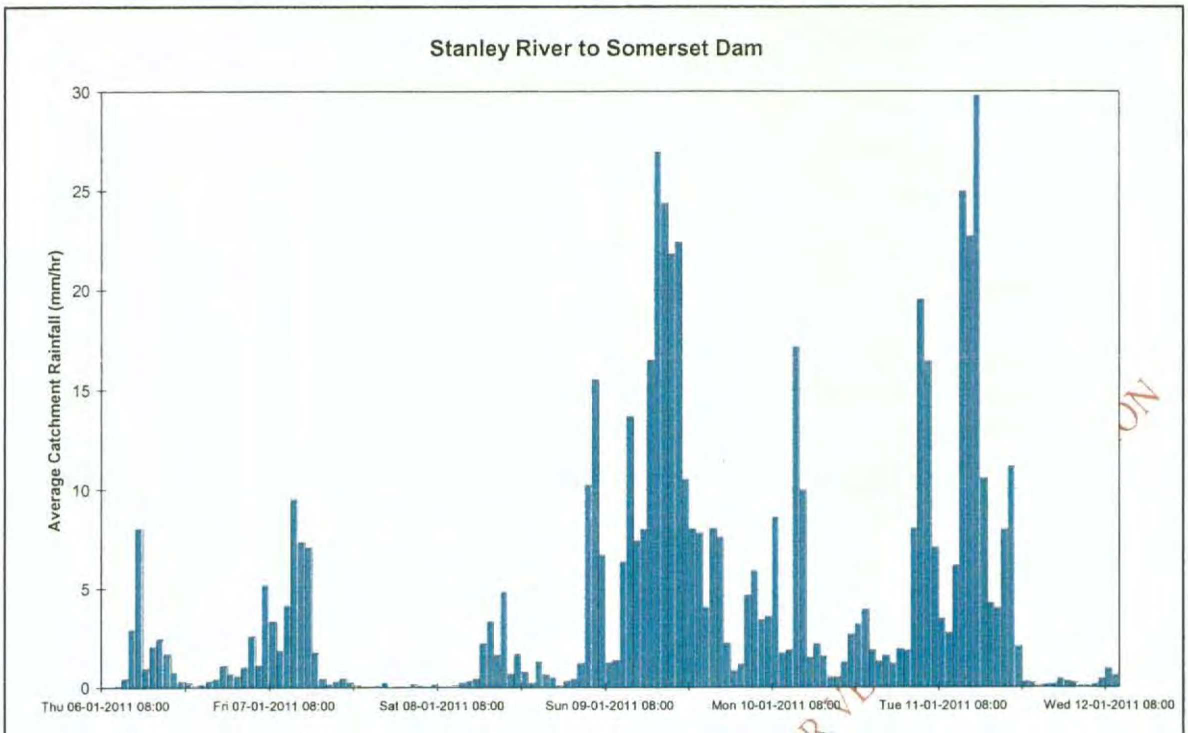

Figure 6.3.14 – Stanley River average hourly rainfalls

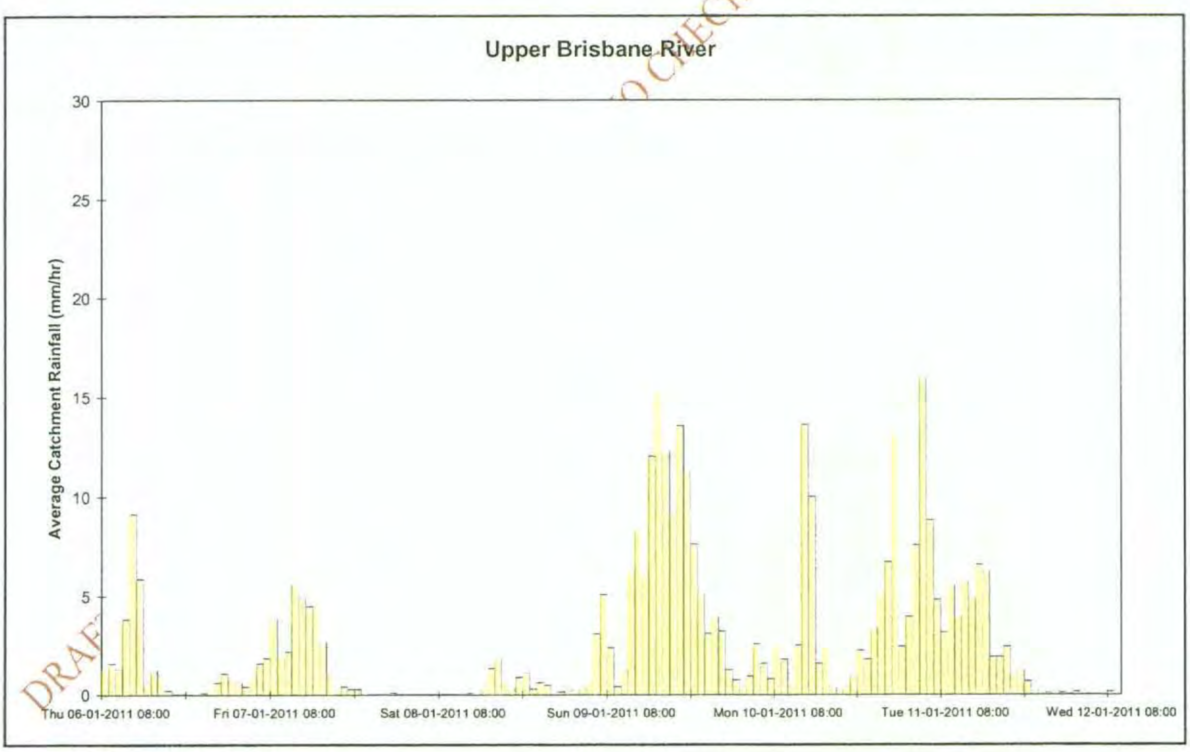

Figure 6.3.15 – Upper Brisbane River average hourly rainfalls

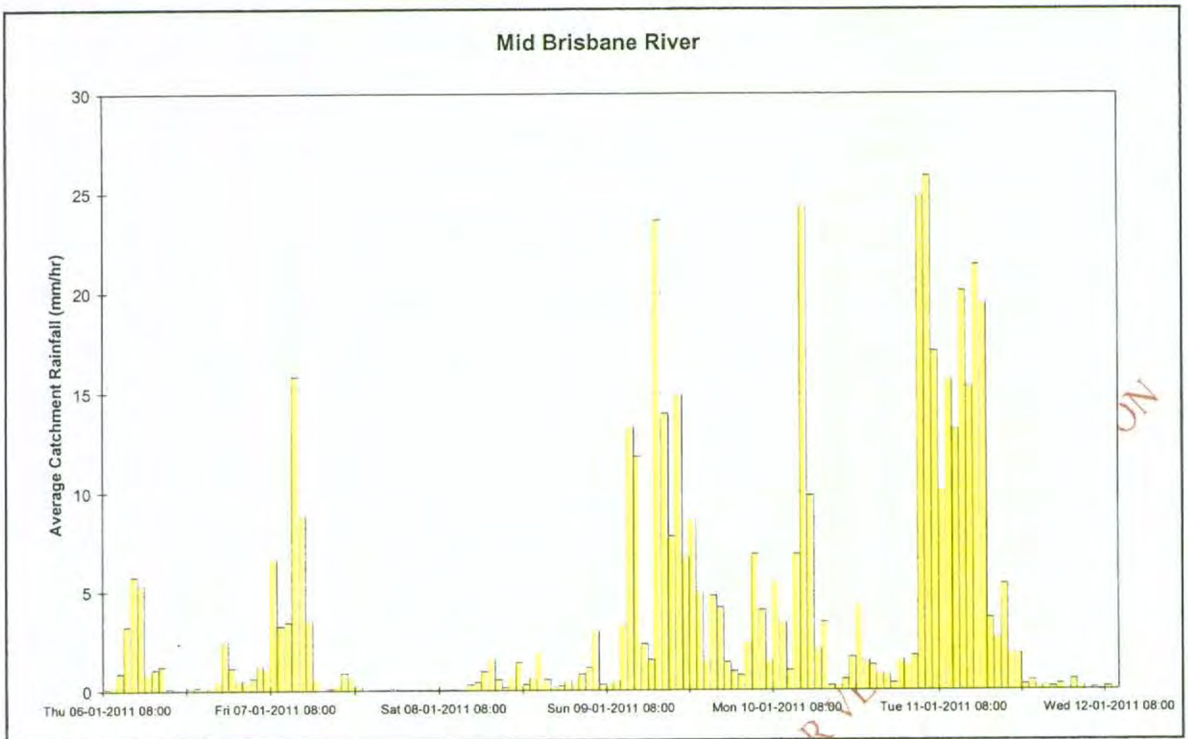

Figure 6.3.16 – Middle Brisbane River average hourly rainfalls

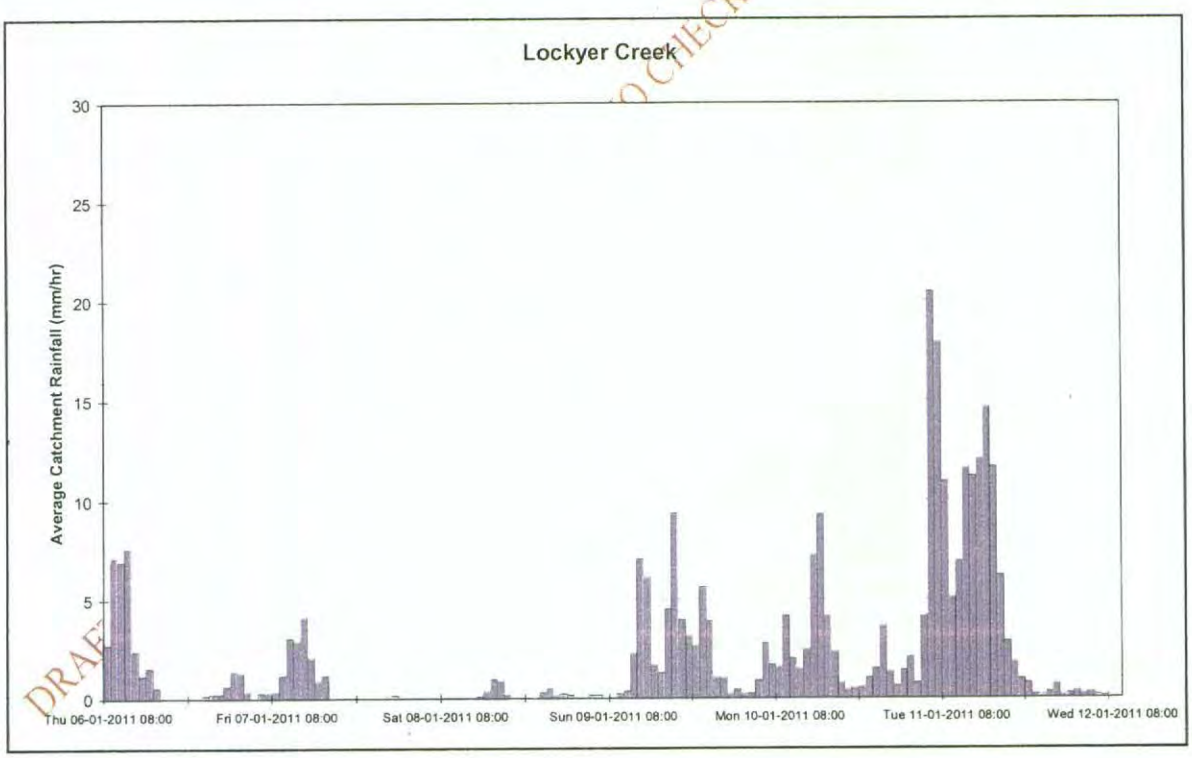

Figure 6.3.17 – Lockyer Creek average hourly rainfalls

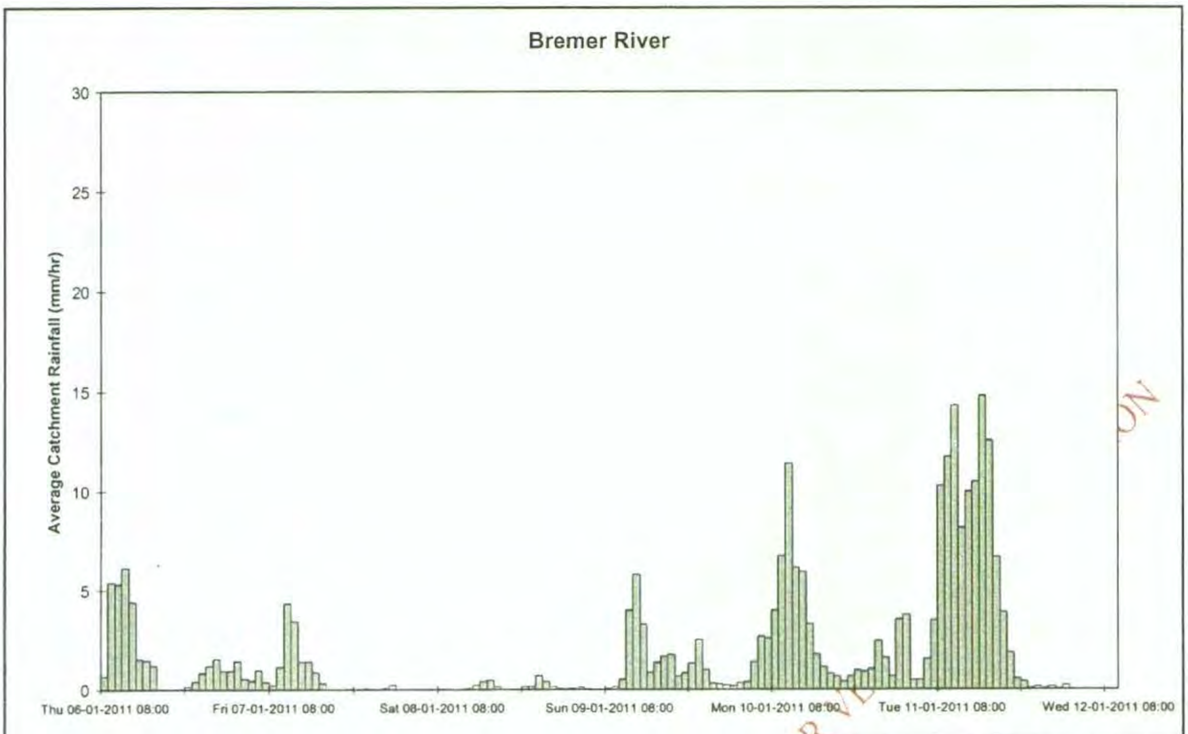

Figure 6.3.18 – Bremer River average hourly rainfalls

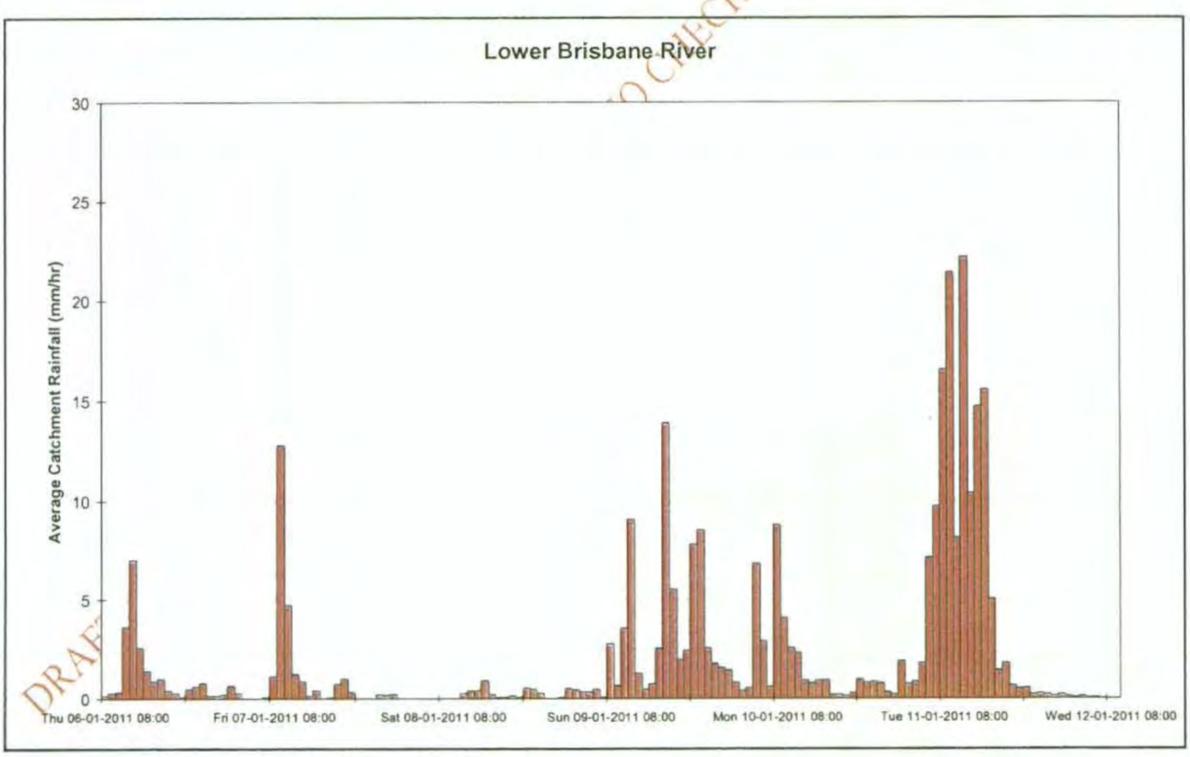

Figure 6.3.19 – Lower Brisbane River average hourly rainfalls

The average catchment rainfall graphs clearly show a number of individual and linked rainfall bursts over the duration of the Event. The two most intense bursts occurred relatively late in the Event between the following periods:

- The morning and evening of Sunday 9 January 2011
- The early morning and afternoon of Tuesday 11 January 2011, interspersed with a period of lower rainfall.

An intense burst at the end of the Event, followed by a relatively sudden end to the rainfall, is characteristic of most of these temporal patterns. Tables of hourly rainfall for all stations used during the Event (demonstrating this pattern) are contained in Appendix O, with one table per day during the period Wednesday 5 January 2011 to Thursday 13 January 2011.

Significant hourly rainfall totals include:

Location	Time	Hourly rainfall (mm)
Lindfield in the upper reaches of Sheepstation Creek	14:00 Sunday 9 January 2011	54
Blackbutt in the upper reaches of the Brisbane River	16:00 Sunday 9 January 2011	54
Savages Crossing on the Brisbane River near Fernvale	09:00 Tuesday 11 January 2011	93
Ferris Knob in the upper reaches of the Stanley River	11:00 Wednesday 12 January 2011	69

Table 6.3.20 – Significant hourly rainfall totals

6.4 Event rainfall temporal patterns

Temporal patterns are critical to the flood modelling process and the resulting inflow hydrographs. They define the distribution of the rainfall with time, and indicate the distinct periods of heavy rainfall that occurred throughout the Brisbane Basin. Temporal patterns for selected representative stations are contained in Appendix T. The following conclusions can be drawn from examining this data:

- For this Event, the West Bellthorpe gauge represents the temporal pattern of the Somerset Dam catchment.
- For this Event, the Gregors Creek gauge represents the temporal pattern of the catchment area in the upper reaches of the Brisbane River.
- The period of heaviest rainfall recorded in both the West Bellthorpe gauge and the Gregors Creek gauge occurred on the afternoon and evening of Sunday 9 January 2011.
- At Toowoomba, near the headwaters of Lockyer Creek, high intensity rainfall occurred on the afternoon of Monday 10 January 2011 and resulted in flash flooding. This rainfall was not closely reflected in the catchment average rainfall patterns.
- Around the time the floodwaters (resulting from the first period of heavy rainfall) arrived at Wivenhoe Dam from the upper reaches of the Brisbane River, the next critical period of heavy rainfall occurred on the morning of Tuesday 11 January 2011 in the area immediately around the Wivenhoe Dam reservoir. This huge burst of inflow into the Dam required immediate action to avoid a situation that would risk the safety of the Dam.
- Hourly rainfall totals during the critical period of heavy rainfall, on the morning of Tuesday 11 January 2011 in the area immediately around Wivenhoe Dam, are summarised in Table 6.4.1. The table shows heavy rainfall commenced about 05:00 and continued until 14:00. This is believed to have contributed to the very high level inflows into Wivenhoe Dam during this period.

Hourly rainfall stations around Wivenhoe Dam reservoir

Hour ending	**Wivenhoe Dam**	**Mt Glorious**	**Kluvers Lookout**	**Mt Mee**	**Somerset Dam**	**Caboonbah**	**Toogoolawah**	**Rosentretters**	**Cressbrook Dam**
	6636	**6680**	**6610**	**6690**	**6590**	**6574**	**6604**	**6553**	**6523**
	mm	**mm**	**mm**	**mm**	**mm**	**mm**	**mm**	**mm**	**mm**
03:00 11 Jan	1	3	2	4	1	0	0	0	2
04:00 11 Jan	0	9	1	9	0	0	1	1	0
05:00 11 Jan	3	14	12	14	37	32	23	19	13
06:00 11 Jan	20	27	26	24	40	24	3	4	18
07:00 11 Jan	32	28	46	29	4	6	2	1	0
08:00 11 Jan	35	57	7	9	3	10	0	0	0
09:00 11 Jan	38	71	40	15	0	4	0	0	0
10:00 11 Jan	32	51	36	16	0	0	0	2	0
11:00 11 Jan	31	50	50	24	8	2	3	0	1
12:00 11 Jan	36	39	33	33	3	4	5	5	3
13:00 11 Jan	52	28	33	59	24	11	2	0	1
14:00 11 Jan	39	28	20	9	19	24	3	0	2

Hourly rainfall stations around Wivenhoe Dam reservoir									
Hour ending	Wivenhoe Dam	Mt Glorious	Kluvers Lookout	Mt Mee	Somerset Dam	Caboonbah	Toogoolawah	Rosentretters	Cressbrook Dam
	6636	6680	6610	6690	6590	6574	6604	6553	6523
	mm	mm	mm	mm	mm	mm	mm	mm	mm
15:00 11 Jan	3	5	7	5	2	2	0	0	0

Table 6.4.1 – Hourly rainfall totals recorded between 03:00 and 15:00, Tuesday 11 January 2011

6 EVENT DATA

6.5 Event water levels

Seqwater uses a network of 34 automated stream height stations within the Brisbane River catchment area to gather Dam level and stream height data during flood events. Data from this network is automatically collected in real time using a radio telemetry collection system and is sent in real time to the Flood Operations Centre. Every recorded change in water level at each station is also sent directly to the Flood Operations Centre as it is recorded.

Data sent to the Flood Operations Centre in this way is operational data and is not validated. Both manual and automatic data checking is undertaken in the Flood Operations Centre at regular and routine intervals over the course of the Event.

While the vast majority of the water level data contained in this Report was collected automatically via the Seqwater ALERT network, manual observations of gauge boards at Somerset and Wivenhoe Dams were also collected via email and phone during the Event. These gauge board observations are more reliable than the automatically provided readings and, therefore, provided the basis for gate operations at the Dams.

Table 6.5.1 includes details of the peak heights recorded by the automatic gauging stations used during the Event. Multiple peaks were recorded at a number of stations through the period and are shown in the table in descending order. The table is based on data received in the Flood Operations Centre during the Event and has not been verified by field survey. The figures identified in *italics* are the maximum heights recorded prior to failure of the gauge.

Primary ALERT ID	Watercourse	Station	Gauge zero		Date and time	Peak heights	
			m	Datum		Elevation	GH
6776	Stanley River	Peachester	125.03	AHD	9/01/2011 20:28	134.07	9.04
					11/01/2011 15:19	133.99	8.96
					8/01/2011 22:37	129.07	4.04
	Stanley River	Woodford	107.51	AHD	11/01/2011 18:35	116.95	9.44
					10/01/2011 5:56	116.09	8.58
					7/01/2011 19:26	112.61	5.1
6591	Stanley River	Somerset Dam	0.00	AHD	12/01/2011 4:57	104.99	104.99
					10/01/2011 19:42	103.39	103.39
					8/01/2011 7:54	100.43	100.43
6543	Cooyar Creek	Damsite	160.68	SD	11/01/2011 2:06	170.90	10.22
					9/01/2011 17:28	170.14	9.46
					6/01/2011 15:13	168.56	7.88
6718	Brisbane River	Linville	115.30	AHD	11/01/2011 4:09	126.34	11.04
					9/01/2011 21:00	125.44	10.14
					7/01/2011 23:15	122.18	6.88
6709	Brisbane River	Devon Hills	99.00	AHD	9/01/2011 21:24	110.25	11.25
					11/01/2011 8:55	109.89	10.89
					8/01/2011 0:58	106.15	7.15
6521	Emu Creek	Boat Mountain	107.84	SD	11/01/2011 8:28	118.94	11.1
					10/01/2011 0:16	118.86	11.02
					10/01/2011 18:04	113.82	5.98
6515	Brisbane River	Gregors Creek	82.40	AHD	9/01/2011 22:17	96.89	14.5

6 EVENT DATA

Primary ALERT ID	Watercourse	Station	Gauge zero		Date and time	Peak heights	
			m	Datum		Elevation	GH
					11/01/2011 11:20	95.69	13.3
					8/01/2011 3:35	90.25	7.86
6524	Cressbrook Creek	Cressbrook Dam	0.00	AHD	11/01/2011 10:29	284.18	284.18
6554	Cressbrook Creek	Rosentretters	102.00	AHD	10/01/2011 16:27	108.80	6.8
					11/01/2011 14:12	108.12	6.12
					9/01/2011 19:03	107.70	5.7
6638	Brisbane River	Wivenhoe Dam	0.00	AHD	11/01/2011 19:00	74.97	74.94
6527	*Lockyer Creek*	*Helidon*	*128.65*	*AHD*	*10/01/2011 14:53*	*141.39*	*12.74*
6566	Tenthill Creek	Tenthill	123.85	AHD			
6578	*Lockyer Creek*	*Gatton*	*87.54*	*AHD*	*10/01/2011 17:43*	*102.34*	*14.8*
6584	Laidley Creek	Showground Weir	97.00	AHD	11/01/2011 16:07	106.36	9.36
					10/01/2011 19:13	106.30	9.3
					6/01/2011 17:10	106.26	9.26
6557	Lockyer Creek	Glenore Grove	67.12	AHD	11/01/2011 17:02	82.45	15.34
					10/01/2011 23:33	81.73	14.62
					10/01/2011 7:04	80.13	13.02
6634	Lockyer Creek	Lyons Bridge	47.53	AHD	11/01/2011 17:27	64.84	17.31
					7/01/2011 3:12	60.54	13.01
					8/01/2011 5:21	59.70	12.17
6569	*Lockyer Creek*	*O'Reilly's Weir*	*23.62*	*AHD*	*11/01/2011 19:41*	*47.30*	*23.68*
6642	*Brisbane River*	*Wivenhoe Dam Tailwater*	*0.00*	*AHD*	*11/01/2011 15:35*	*46.64*	*46.64*
6647	Brisbane River	Lowood Pump Station	23.07	AHD	11/01/2011 23:46	45.98	22.91
6560	Brisbane River	Savages Crossing	18.43	AHD	12/01/2011 2:11	42.66	24.23
6756	Brisbane River	Burtons Bridge	15.06	AHD	12/01/2011 1:26	33.88	18.82
6757	*Brisbane River*	*Kholo Bridge*			*11/01/2011 15:28*		*12.77*
6752	Brisbane River	Mt Crosby Weir	0.00	AHD	12/01/2011 10:03	26.12	26.12
6581	Bremer River	Adams Bridge	75.50	AHD	11/01/2011 19:00	80.55	5.05
					10/01/2011 14:45	80.05	4.55
					6/01/2011 14:16	80.01	4.51
6737	Weston Creek	Kuss Road	45.06	AHD			
6734	Bremer River	Rosewood	35.42	SD	11/01/2011 15:32	40.33	4.91
					10/01/2011 23:32	38.63	3.21
					7/01/2011 0:17	38.41	2.99
6551	Bremer River	Walloon	22.97	AHD	11/01/2011 16:54	31.87	8.9

Primary ALERT ID	Watercourse	Station	Gauge zero		Date and time	Peak heights	
			m	Datum		Elevation	GH
					11/01/2011 3:15	29.37	6.4
					7/01/2011 4:18	28.83	5.86
6563	Warrill Creek	Kalbar Weir	74.60	AHD	11/01/2011 19:36	80.29	5.69
					10/01/2011 16:15	79.19	4.59
					6/01/2011 15:39	77.35	2.75
6572	Warrill Creek	Harrisville	45.69	SD	11/01/2011 19:44	51.60	5.91
					10/01/2011 22:59	50.80	5.11
					7/01/2011 18:41	50.00	4.31
6652	Warrill Creek	Amberley	19.87	AHD	12/01/2011 8:26	27.99	8.12
					8/01/2011 2:47	25.07	5.2
2168	Bremer River	Ipswich	0.00	AHD	12/01/2011 12:58	15.96	15.96
6755	Brisbane River	Moggill	0.00	AHD	12/01/2011 14:47	17.72	17.72
6731	Brisbane River	Jindalee	0.00	AHD	12/01/2011 17:50	12.90	12.9
6749	Brisbane River	City Gauge	0.00	AHD	13/01/2011 2:57	4.45	4.45

***Table 6.5.1** – Peak heights recorded at automatic gauging stations during the January 2011 Flood Event*

Height hydrographs (Figure 6.5.2 to Figure 6.5.12) for selected key stations within the Brisbane River Basin are plotted below. During the Event, Flood Officers were responsible for basic data checking. A full set of the heights recorded at each flood monitoring station is contained in Appendix Q.

Stanley River at Woodford

The Stanley River at Woodford is a key gauging station upstream of Somerset Dam, however it only represents around 20% of the catchment to the Dam. This gauge operated reliably and provided sufficiently accurate operational data for modelling purposes during the Event.

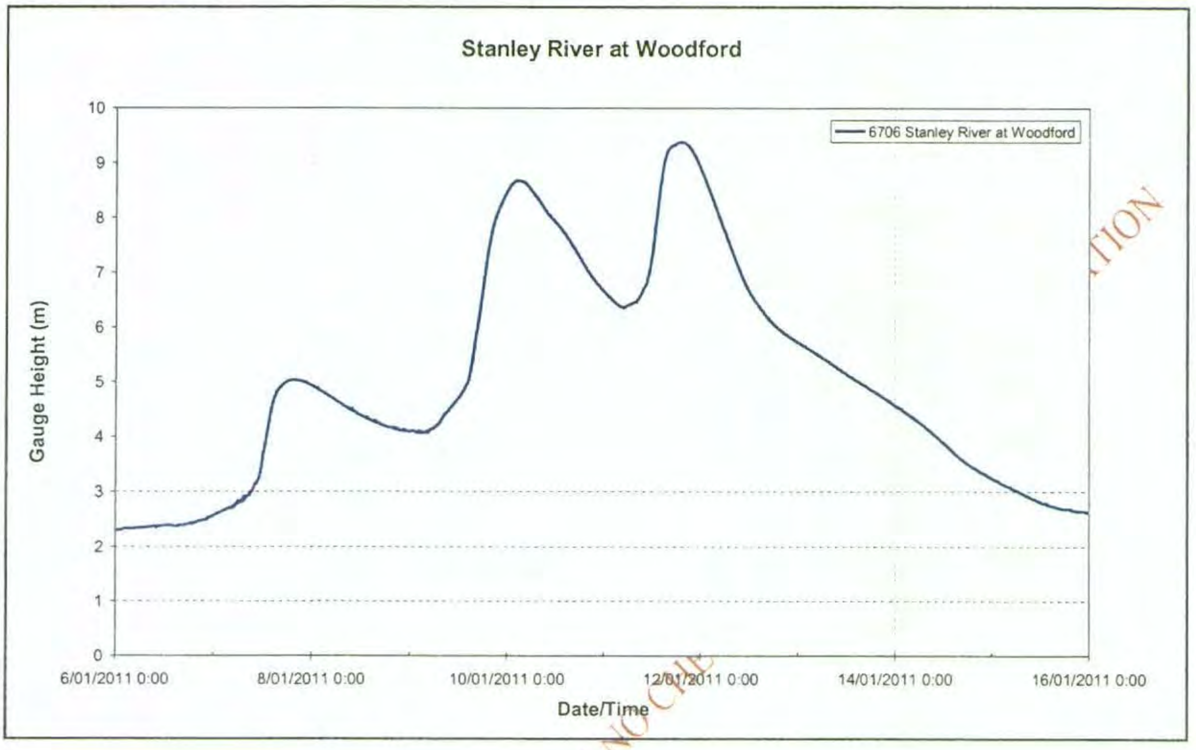

Figure 6.5.2 – Gauge height. Stanley River at Woodford

Somerset Dam

There are two automatic gauges at Somerset Dam, which provided readings slightly under the manual gauge board readings. As discussed previously, Dam operations were based on the data provided by gauge board readings.

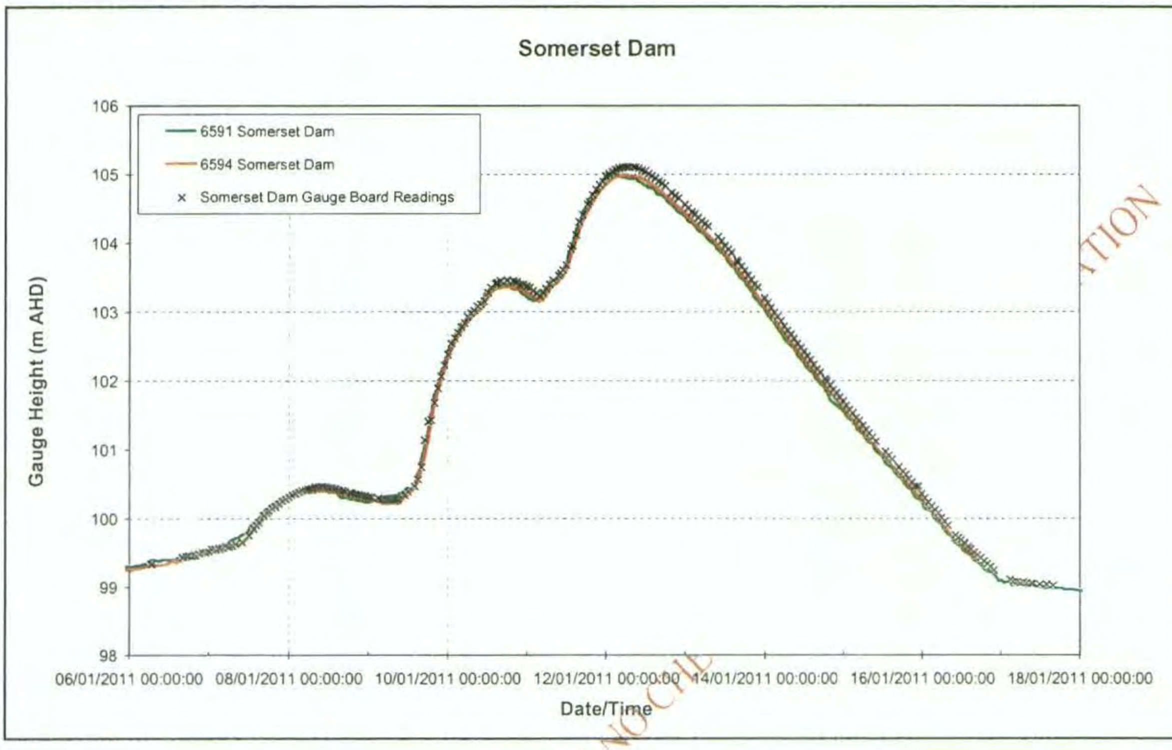

Figure 6.5.3 - Gauge height, Somerset Dam

Brisbane River at Gregors Creek

The Brisbane River at Gregors Creek is the key gauging station upstream of Wivenhoe Dam. When combined with the outflow from Somerset Dam, this gauge represents almost 75% of the catchment to the Dam. This gauge operated reliably and provided sufficiently accurate operational data for modelling purposes during the Event.

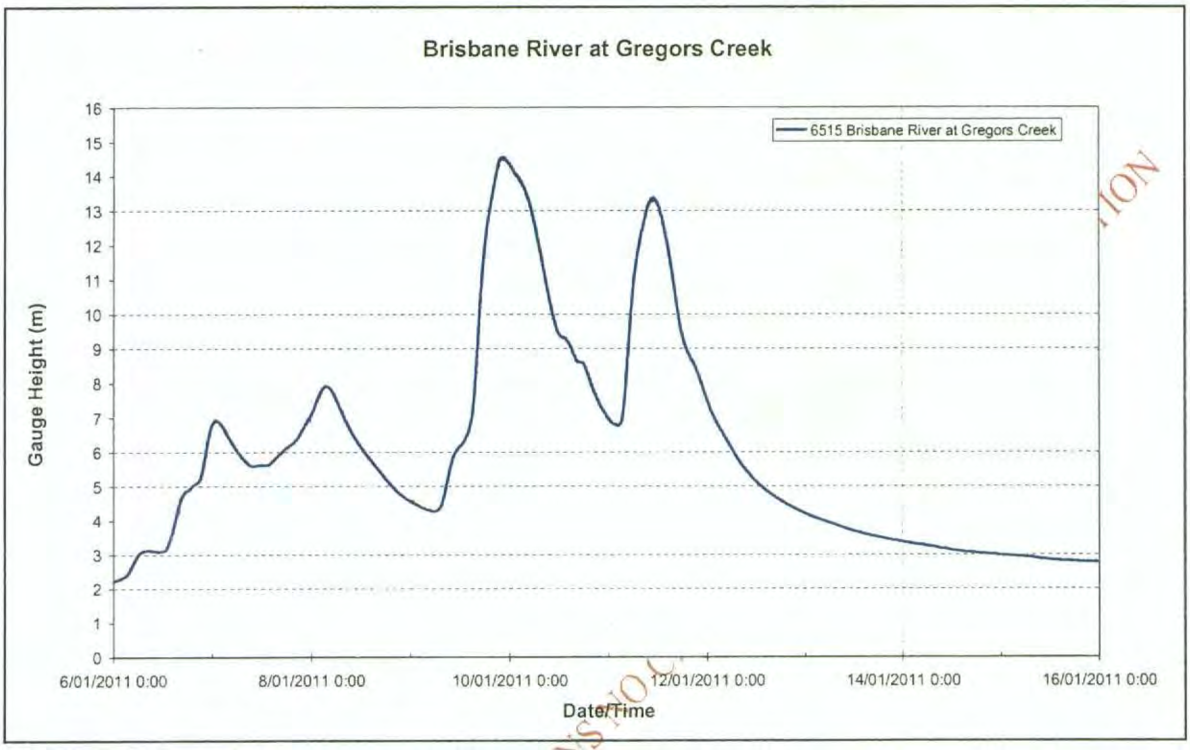

Figure 6.5.4 – Gauge height, Brisbane River at Gregors Creek

Wivenhoe Dam

There are two automatic gauges at Wivenhoe Dam. Sensor 6638 was marked as 'out of action' (OOA) for the Event. The other sensor, located around 50m upstream of the gates, matched the manual gauge board readings until around midday on Tuesday 11 January 2011. It was at this point the large gate openings caused the local water level to lower in the vicinity of the gauge. This discrepancy, which was up to 0.8m at times, was observed during this period, however, as previously discussed, gate operations were, in fact, undertaken based on accurate manual gauge board observations. The discrepancy is shown clearly in Figure 6.5.6.

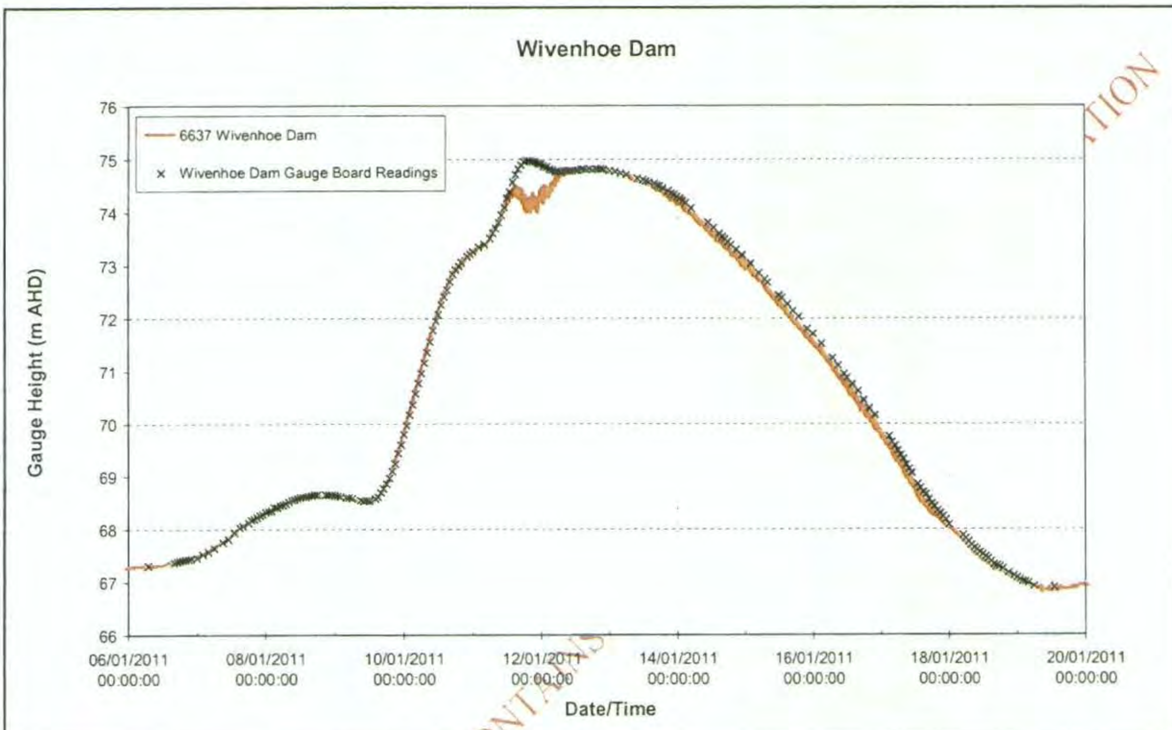

Figure 6.5.5 – Gauge height, Wivenhoe Dam

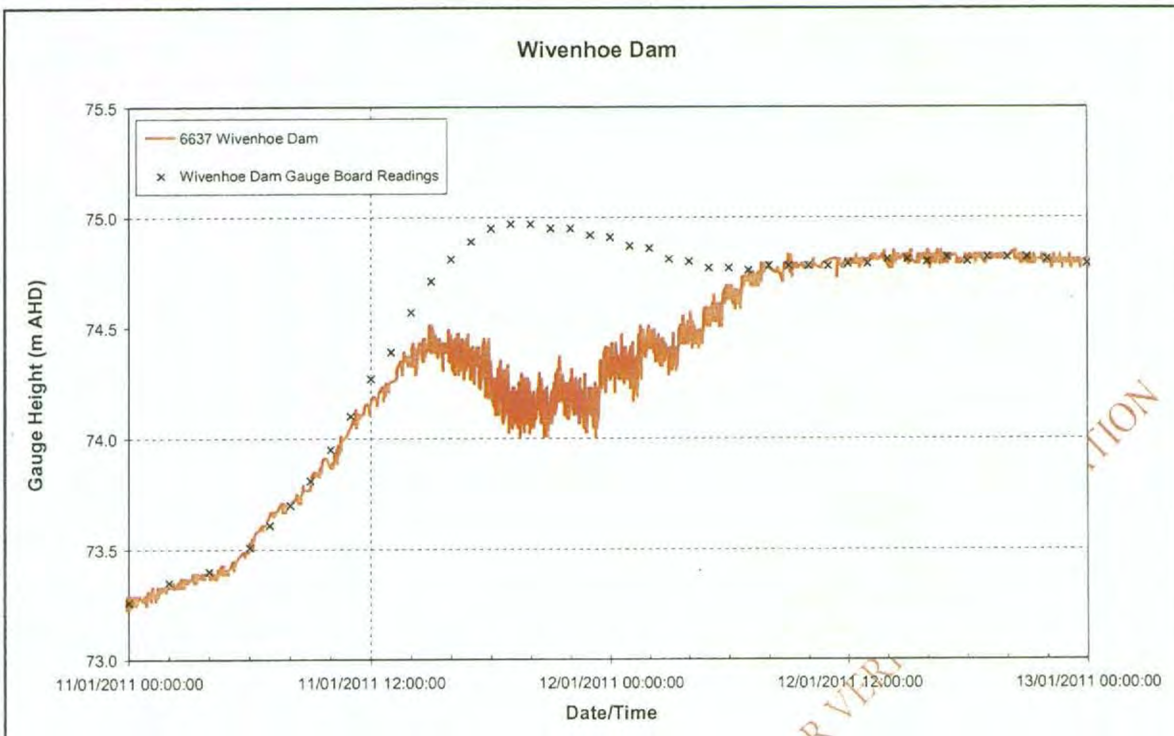

Figure 6.5.6 – Gauge height, Wivenhoe Dam

Lockyer Creek at Lyons Bridge

Lockyer Creek at Lyons Bridge is a key gauging station for determining outflows from Lockyer Creek into the Brisbane River. While the O'Reillys Weir gauge is located further down the catchment, it is influenced by backwater due to releases from Wivenhoe Dam. Therefore, readings from the O'Reillys Weir gauge during a large Event are not considered reliable. The Lyons Bridge gauge operated reliably and provided sufficiently accurate operational data for modelling purposes during the Event.

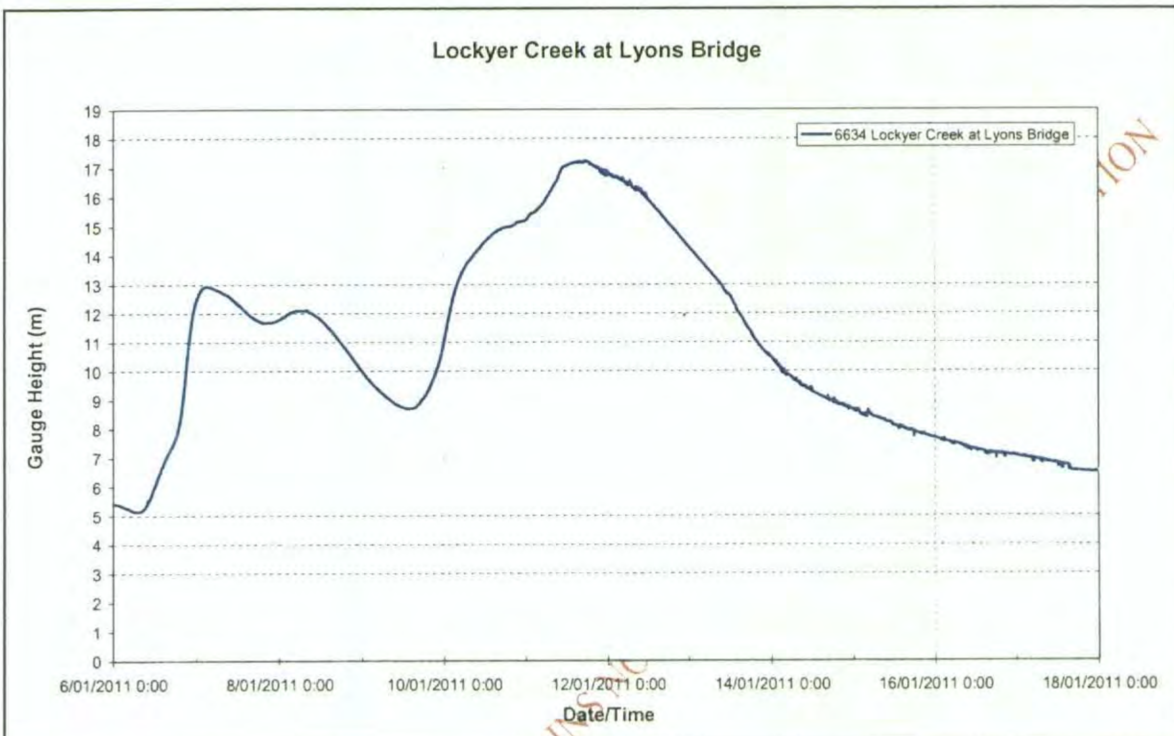

Figure 6.5.7 - Gauge height, Lockyer Creek at Lyons Bridge

Brisbane River at Savages Crossing

Savages Crossing is located just downstream from the junction of the Brisbane River and Lockyer Creek. This gauge is considered to more accurately represent the combined Lockyer and Brisbane flow than the upstream station at Lowood. This gauge operated reliably and provided sufficiently accurate operational data for modelling purposes during the Event.

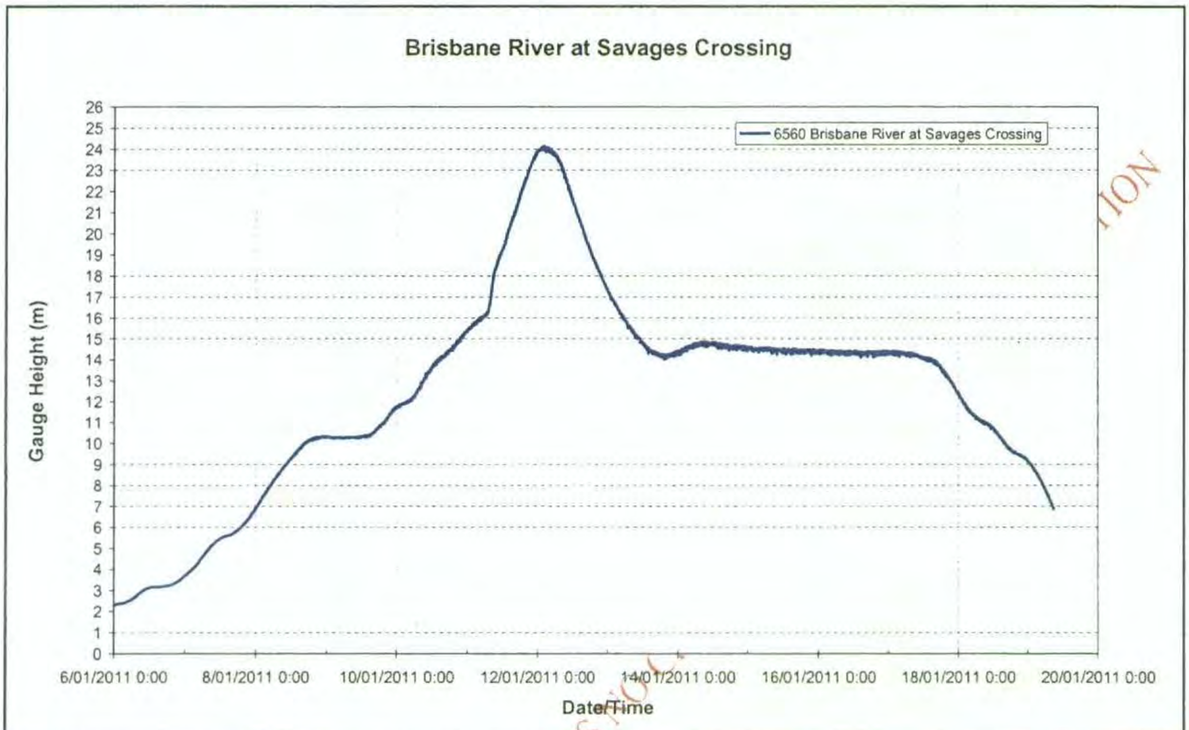

Figure 6.5.8 – Gauge height, Brisbane River at Savages Crossing

Bremer River at Walloon

Walloon is a key gauging station used to determine total outflow from the Bremer River. It operated reliably and provided sufficiently accurate operational data for modelling purposes during the Event.

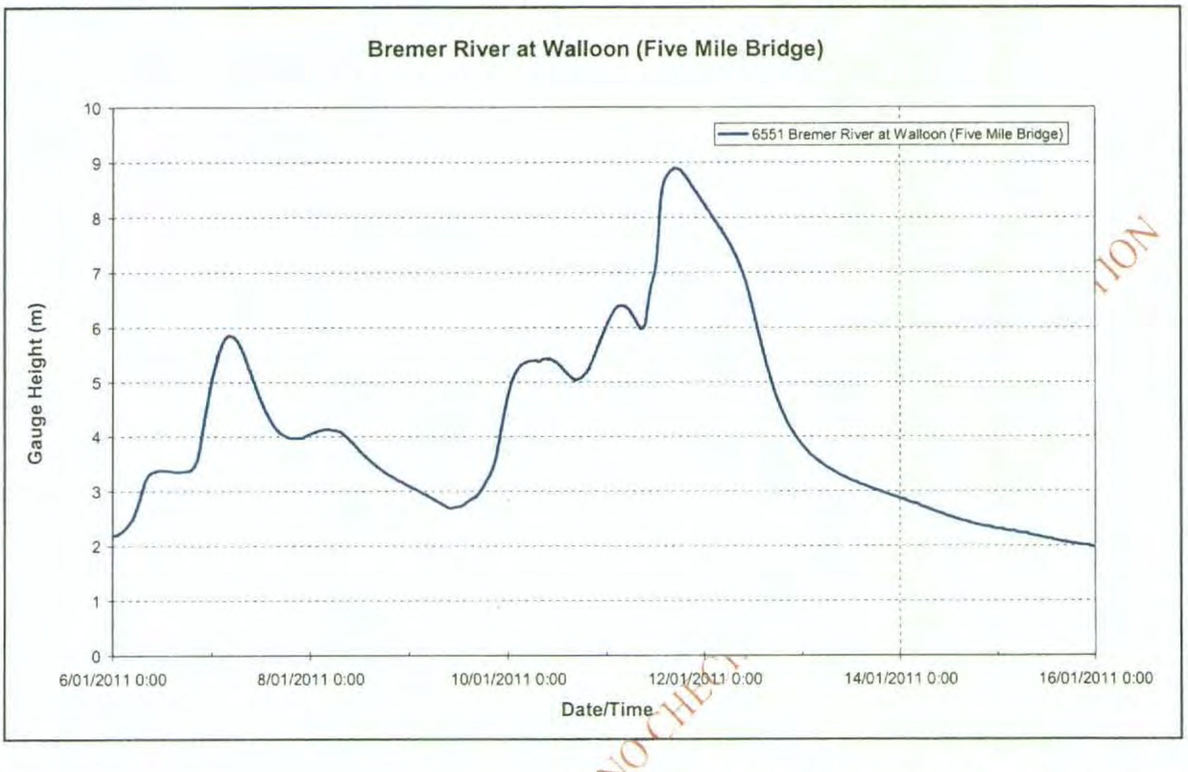

Figure 6.5.9 – Gauge height, Bremer River at Walloon

Warrill Creek at Amberley

Amberley is a key gauging station on Warrill Creek, and when combined with Walloon, it is a key gauging station used to determine total outflow from the Bremer River. This station operated reliably and provided sufficiently accurate operational data for modelling purposes during the Event.

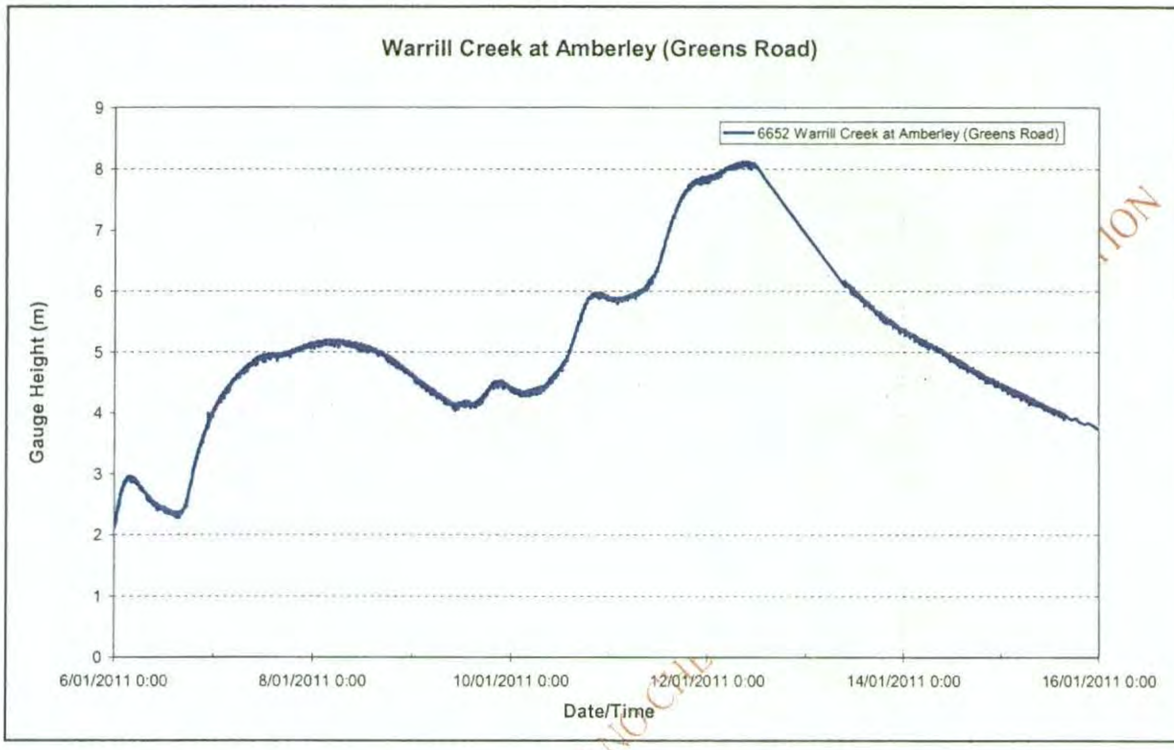

Figure 6.5.10 – Gauge height, Warrill Creek at Amberley

Brisbane River at Moggill

Moggill is the key gauging station at the junction of the Brisbane and Bremer Rivers. It represents the combined flow of these two rivers. This gauge operated reliably and provided sufficiently accurate operational data for modelling purposes during the Event.

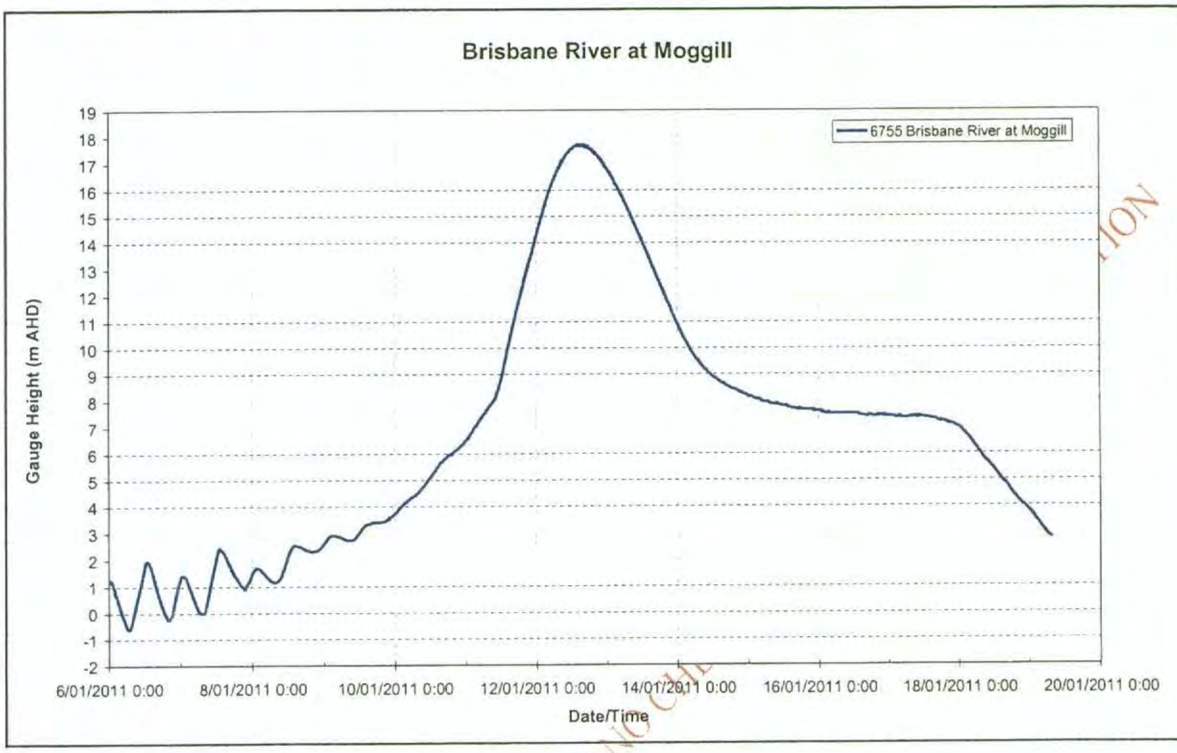

Figure 6.5.11 – Gauge height, Brisbane River at Moggill

Brisbane River at Whyte Island

The Brisbane River gauge at Whyte Island is located near to the mouth of the river and records tide levels. While tide levels do not directly impact dam operations, flood levels in the Lower Brisbane River are tide dependent and the Flood Operations Centre needs to be cognisant of the tides.

During the January 2011 Flood Event, recorded tides at Whyte Island were up to 0.5m lower than the previous week.

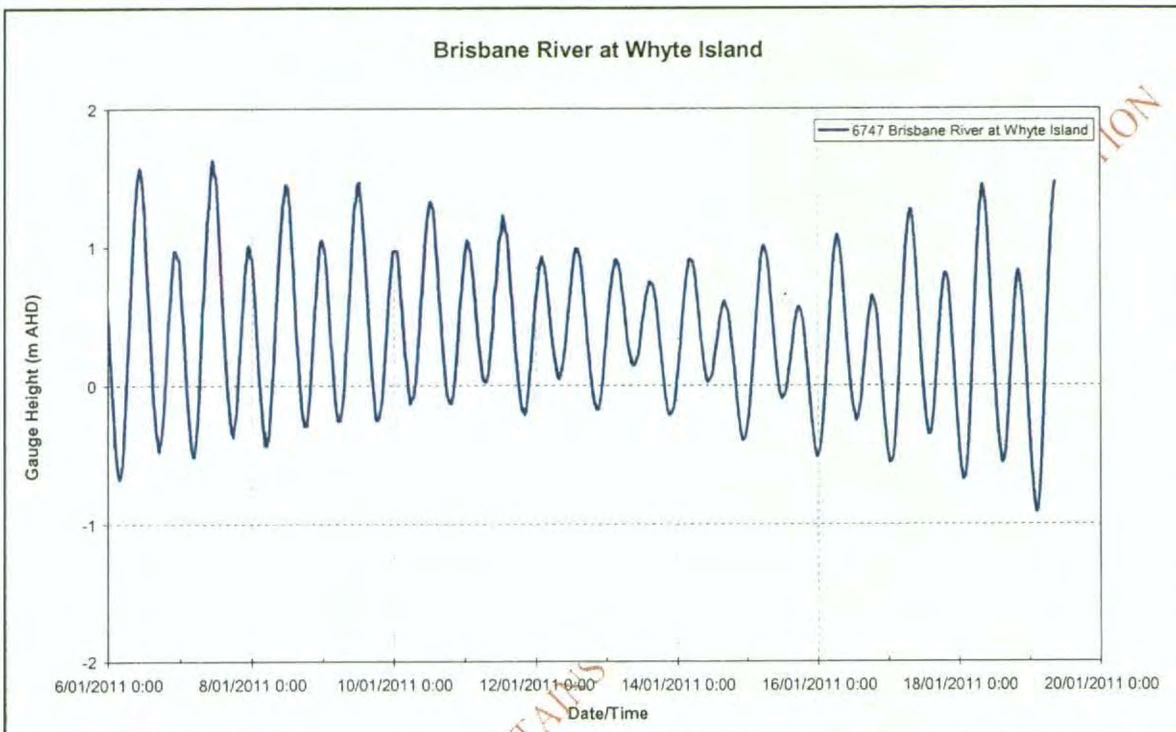

Figure 6.5.12 – Gauge height, Brisbane River at Whyte Island

6.6 Dam inflows and outflows

The inflows and outflows from Somerset and Wivenhoe Dams appear in Table 6.6.1 and are shown in more detail in Section 9 and Appendix B. Dam inflow is estimated by reverse routing. Reverse routing is calculating the rate of change of the storage and adding the Dam outflow.

Item	Unit	Somerset Dam	Wivenhoe Dam*
Inflow volume	ML	825,000	2,650,000
Outflow volume	ML	820,000	2,650,000
Inflow peaks	m3/s	5,350 on 09/01/2011 15:00 4,170 on 11/01/2011 14:00	10,100 on10/01/2011 8:00 11,600 on 11/01/2011 13:00
Outflow peaks	m3/s	1,690 on 10/01/2011 16:00 1,460 on 12/01/2011 11:00	7,460 on 11/01/2011 19:00
Peak water level	m AHD	105.11 on 12/01/2011 06:00	74.97 on 11/01/2011 19:00

* Wivenhoe Dam inflow figures include Somerset Dam outflows

Table 6.6.1 – Summary inflows and outflows for Somerset and Wivenhoe Dams

The inflow into Somerset Dam is characterised by dual peaks; the first peak on the afternoon of Sunday 9 January 2011 being higher than the second on the afternoon of Tuesday 11 January 2011 (nearly 48 hours apart). The peak of the outflow occurred late on Monday 10 January 2011 when five sluices were opened. These were quickly closed on the morning of Tuesday 11 January 2011 when Wivenhoe Dam levels began rising quickly. The maximum water level in Somerset Dam of 150.11m was reached on the morning of Wednesday 12 January 2011. This information is summarised in the following graph, Figure 6.6.2.

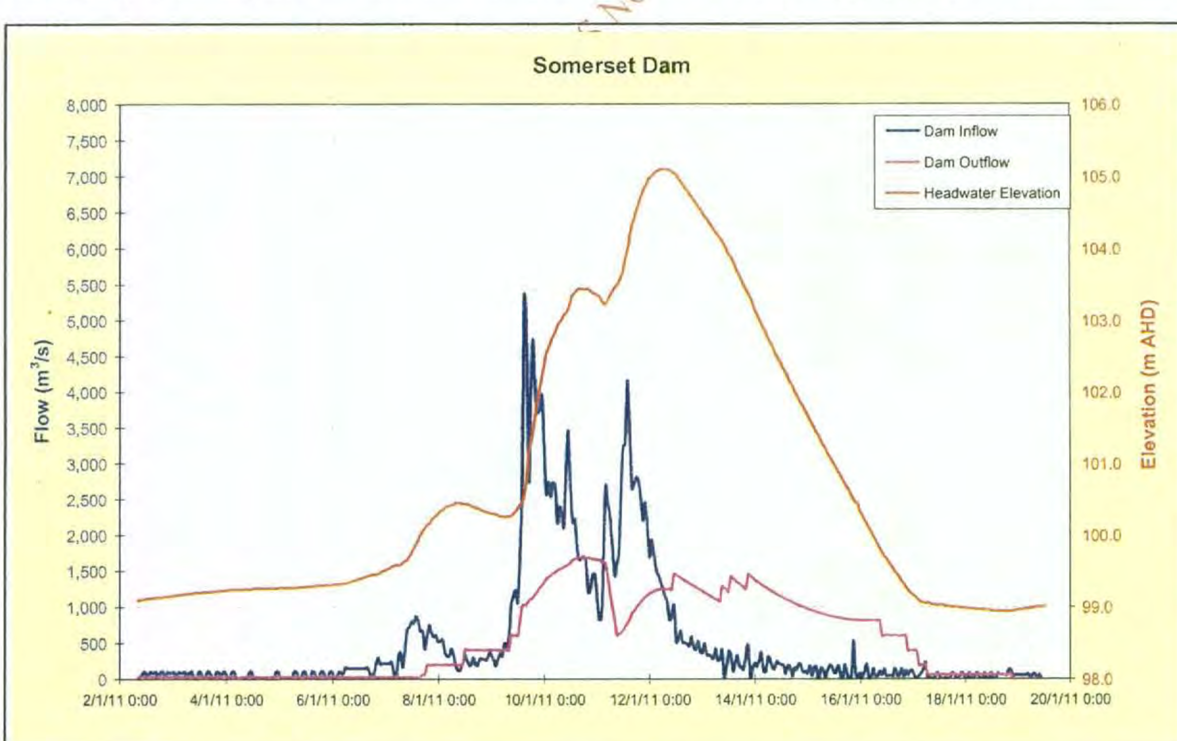

Figure 6.6.2 – Somerset Dam water levels, January 2011 Flood Event

Similar to Somerset Dam, the inflow into Wivenhoe Dam is also characterised by dual peaks. The first peak on the morning of Monday 10 January 2011 was lower than the second on the afternoon of Tuesday 11 January 2011 (30 hours apart). The peak of the outflow occurred at 19:00 on Tuesday 11 January 2011. Flow was reduced quickly later that night as the Dam water level stabilised, however it was increased again during Thursday 13 January 2011 to achieve the drainage required within seven days after the flood peak passed below Moggill. The peak water level in Wivenhoe Dam of 74.97m was reached at 19:00 on Tuesday 11 January 2011. This information is summarised in the following graph, Figure 6.6.3.

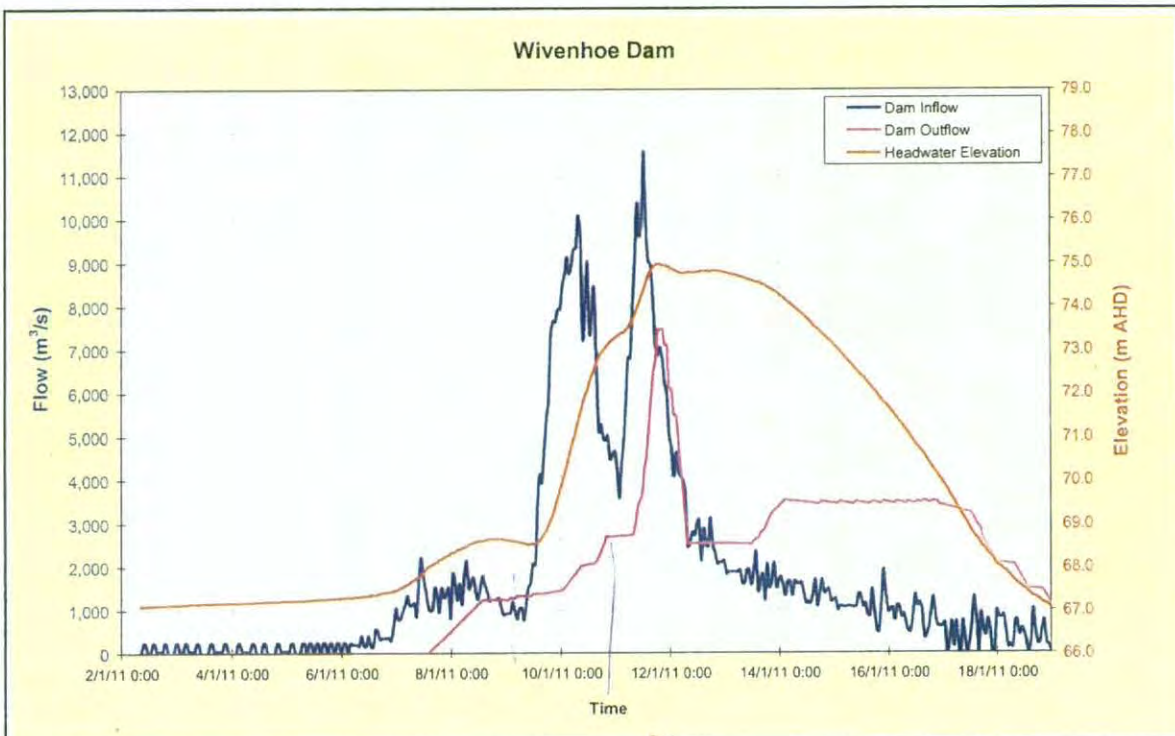

Figure 6.6.3 – Wivenhoe Dam water levels, January 2011 Flood Event

6.7 Other data sources

Other decision-making support tools examined and considered in conjunction with the modelling results include:

- Flood model results (available via BoM registered user service);
- Enviromon, the BoM replacement software for Flood-Col. This includes all available ALERT stations in South East Queensland, including a large number of non-Seqwater stations.

During the Event, detailed discussions were also held with the BoM Flood Warning Centre. These discussions centred on model results, rainfall forecast information and actual and projected Dam inflows and outflows. BoM also provided Lockyer Creek and Bremer River outflows to compare against modelled results generated by the Flood Operations Centre. Generally, Flood Operations Centre modelling correlated well with BoM modelling results.

Similar discussions were held with Brisbane City Council and the Council also provided stage damage data for consideration by the Flood Operations Centre during the Event.

In addition to the sources listed above, for comparison purposes, the DERM website (www.derm.qld.gov.au) was used to examine and check river height and flow estimations at selected gauging stations.

7

7 FLOOD MODEL VALIDITY AND PERFORMANCE

7.1 Background

A real time flood monitoring and forecasting system has been established to monitor rainfall and water levels in the Dam catchments and to provide adequate, accurate and timely information for informed decision-making. This system is described in detail in Section 5. As the real time rainfall and river height data is received in the Flood Operations Centre, the data is processed using a Real Time Flood Model (RTFM) to estimate likely Dam inflows and evaluate a range of possible inflow scenarios based on forecast and recorded rainfall in the Dam catchments.

The RTFM comprises a suite of hydrologic computer programs that use real time data to assist in the operation of the Dams during flood events. Seqwater is responsible for providing and maintaining the RTFM and for ensuring sufficient data is available to allow its proper operation during a flood event. Flood Operations Engineers use the RTFM for flood monitoring and forecasting during flood events to operate the Dams in accordance with the Manual. This is done by optimising releases of water from the Dams to minimise the impacts of flooding in accordance with the Manual's objectives and procedures.

Seqwater is continually improving the operation of the RTFM by:

- Implementing improvements based on flood event audits and reviews;
- Improving RTFM calibration as further data becomes available;
- Updating software in line with modern day standards;
- Improving the coverage and reliability of the data collection network to optimise data availability during flood events.

This Section describes the RTFM in detail and assesses the performance of the RTFM during the January 2011 Flood Event.

7.2 Model description

The current RTFM was developed in 1994 as part of the Brisbane River and Pine River Flood Study, (DNR, 1994) and consists of two integrated modules:

- FLOOD-Col;
- FLOOD-Ops.

FLOOD-Col is the data capture module whilst FLOOD-Ops is the data analysis module. The system is accessed through a Graphical User Interface (GUI) that allows the operator flexibility in managing the system. The modelling system was developed under a UNIX operating environment using OSF/Motif GFUI under the X Window system. In 2008, the system was ported to a LINUX operating environment and is currently running on a DELL PowerEdge 1800 Server. The RTFM performs the tasks outlined below.

- Automatically and continuously collects, filters and stores rainfall and water level data in real time.
- Assigns temporal and spatial distributions of actual and forecast rainfall for extension into the future;
- Evaluates the spatial and temporal distribution of antecedent catchment soil moisture conditions on a daily basis;
- Performs hydrologic routing of stream flows in an integrated environment;
- Provides estimates of storage performance and resulting downstream releases;
- Prepares summary output in textual and graphical format for storage operation and resulting downstream flood levels and flows.

As described in Section 5, the primary source of raw data for the RTFM are the rainfall and water level gauges located within and around the Dam catchments. Data collection is completely independent to data analysis within the RTFM system. Filtered data obtained from the gauges can be viewed in a textual or graphical format. Facilities for viewing groups of gauges are also available. The types of information that can be viewed or edited include height, discharge, rainfall pluviographs, rainfall hyetographs, lake levels and dam volumes.

The data analysis system and modelling within the RTFM has been developed around the concepts of Regions, Processes and Cases. These are each explained individually below.

Regions

Regions are land areas located above a stream gauging station, which can be assigned Processes depending upon the nature of the Region. For example, a sub-catchment Region is assigned a soil moisture accounting Process and a runoff-routing Process, whereas a reservoir Region is assigned only a reservoir routing Process. A Region's relationships with neighbouring Regions are defined for each Process associated with the Region. Generally, outflow from one Region is inflow into its adjoining downstream Region.

The Region database contains the following information:

- Extent and location of sub-areas within Regions and Regions within catchments;
- Connectivity of sub-areas within Regions and Regions with catchments;
- The list of Processes associated with each Region;
- Process module input definitions.

Figure 7.2.1 shows the Region layout adopted in the RTFM system.

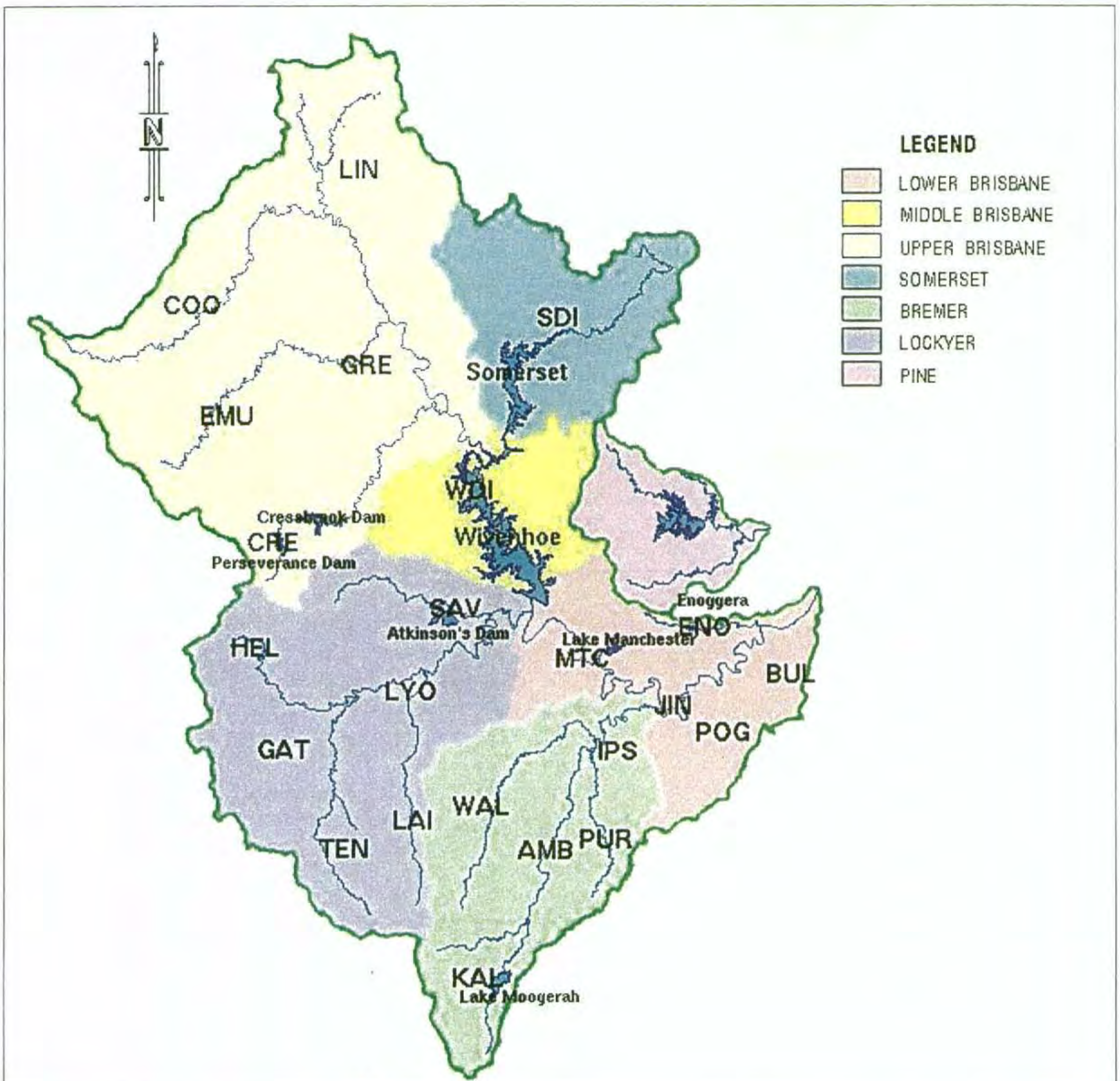

Figure 7.2.1 – RTFM Regions

Relevant statistics relating to each Region as defined in the RTFM are shown in Table 7.2.2.

Region Code	Stream gauge	AMTD (km)	Area (km^2)	Distance to outlet (km)
	Upper Brisbane River			
COO	Cooyar Creek at Damsite	12.2	980	28.1
LIN	Brisbane River at Linville	282.4	1,061	23.2
EMU	Emu Creek at Boat Mountain	9.3	913	42.1
CRE	Cressbrook Creek at Cressbrook Dam	58.6	317	15.9
GRE	Brisbane River at Gregors Creek	251.7	973	25.0
	Stanley River			
SDI	Stanley River at Somerset Dam	7.2	1,328	42.6
	Middle Brisbane River			
WDI	Brisbane River at Wivenhoe Dam	150.4	1,429	49.1
SAV	Brisbane River at Savages Crossing	130.8	728	43.7
MTC	Brisbane River at Mt Crosby Weir	90.8	358	31.3
	Lockyer Creek			
HEL	Lockyer Creek at Helidon	96.6	377	23.8
TEN	Tenthill Creek at Tenthill	14.6	465	37.7
LAI	Laidley Creek at Showground Weir	17.6	285	23.6
GAT	Lockyer Creek at Gatton	72.0	706	27.7
LYO	Lockyer Creek at Lyons Bridge	27.2	602	30.2
	Bremer River			
WAL	Bremer River at Walloon	37.2	626	30.3
KAL	Warrill Creek at Kalbar	49.7	469	21.8
AMB	Warrill Creek at Amberley	8.7	449	25.0
PUR	Purga Creek at Loamside	6.8	223	23.6
IPS	Bremer River at Ipswich	16.9	265	23.4
	Lower Brisbane River			
JIN	Brisbane River at Jindalee	49.1	390	21.0
POG	Brisbane River at Port Office Gauge	22.7	339	36.9
ENO	Enoggera Creek at Junction	0.0	82	16.4
BUL	Bulimba Creek at Junction	0.0	130	18.8

Table 7.2.2 – RTFM Region statistics

Processes

A Process is a computational model of a physical mechanism. The Processes contained in the RTFM are soil moisture accounting, runoff-routing, reservoir routing and base flow. These Processes are explained in detail below:

- **Soil Moisture Accounting**

  Soil Moisture Accounting is used to provide an indication of catchment saturation at the commencement of a flood event. Relationships have been derived which relate conceptual soil moisture storage volumes with rainfall loss rates. The RTFM contains a number of different process models that perform similar functions. For example the Soil Moisture Accounting Module consists of several different model types, which are as follows:

  - Antecedent Precipitation Index (API);
  - Residual Baseflow Index;
  - SACRAMENTO Model.

  These models are described in detail in the Brisbane River and Pine River Flood Study Report Series, (DNR, 1994), Report on Regional Loss Model Relationships, June 1994.

  During the January 2011 Flood Event, the API model was used to derive initial estimates of rainfall loss rates during the early period of the Event. These initial estimates were updates as initial stream rises were detected. This enabled the event loss rates to be closely estimated by matching model results with the actual data received from the water level gauges in the Dam catchments. Relationships derived by the Bureau of Meteorology that link API and initial loss rate were utilised during the Event. These equations are of the following form:-

  Initial Loss (Summer Period)

  - IL = 62.5 -0.4386*API

  Where:

  - IL = Initial Loss (mm)
  - API = Antecedent Precipitation Index based upon 30 day rainfalls (mm)
  - Minimum API = 5mm
  - Maximum API = 150mm

- **Runoff-routing**

  Runoff-routing is used to estimate the surface runoff from rainfall within a Region. This Process uses concentrated storages distributed over a Region, which have a non-linear storage-discharge relationship. This Process originated as WT42 but was rewritten in ANSI C for the inclusion into the RTFM. This enabled the system to use improved data structures to access data more efficiently in real time. The Process was also modified to operate in a manner that allowed separate Regions to be run as a series of linked cascading models. This allows for more effective use of spatially varying data.

  The runoff-routing Process was calibrated using ten historical flood events (up to 1994) and has been used to successfully simulate operational floods in February 1999, March 1999, February 2001, February 2010, March 2010 and October 2010. Table 7.2.3 below shows the region runoff-routing parameters that are used in the RTFM.

Region code	Kc	m
	Upper Brisbane River	
COO	43.6	0.8
LIN	20.6	0.8
EMU	37.2	0.8
CRE	34.3	0.8
GRE	20.1	0.8
	Stanley River	
SDI	60.3	0.8
	Middle Brisbane River	
WDI	108.5	0.8
SAV	40.0	0.8
MTC	47.0	0.8
	Lockyer Creek	
HEL	15.0	0.8
TEN	19.0	0.8
LAI	42.1	0.8
GAT	61.9	0.8
LYO	53.9	0.8
	Bremer River	
WAL	44.0	0.8
KAL	34.0	0.8
AMB	35.0	0.8
PUR	49.0	0.8
IPS	15.7	0.8
	Lower Brisbane River	
JIN	29.4	0.8
POG	19.3	0.8
ENO	9.1	0.8
BUL	10.5	0.8

Table 7.2.3 – Region runoff-routing parameters

- **Reservoir routing**

Reservoir routing is used to estimate the outflow from a reservoir within a Region. This Process is incorporated into the RTFM based on level pool routing algorithms. The development of this Process to account for Somerset Dam and Wivenhoe Dam was complex as it needed to fully account for the rules used to operate these dams during flood events including the requirement for conjunctive operation to allow the flood mitigation benefits of the Dams to be maximised.

The Process originally incorporated into the RTFM is an adaptation of a stand alone computer program known as WIVOPS that incorporates the flood operation objectives described in the October 2004, Version 6 of the 'Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam'. WIVOPS was further modified in May 2005 to incorporate the Stage I auxiliary spillway works as defined in the Wivenhoe Dam Alliance Report entitled, 'Design Discharges and Downstream Impacts of Wivenhoe Dam Upgrade', Report Number Q1091, June 2004.

The current operational Process used in the RTFM for reservoir routing uses Dam inflow estimates and catchment stream extracted from the FLOOD-Ops and imports this data into customised gate operation spreadsheets for use in determining appropriate gate operation strategies in accordance with the Manual. This system has been proven to work very effectively.

- **Base-flow**

Base flow is used to estimate residual stream flow that is additional to surface run-off. FLOOD-Ops only estimates surface runoff which is generally the major component of the total runoff and accurate assessment of the total runoff is required to accurately model rises in dam storage levels. The base flow component was introduced to assist in determining more accurately the total inflow volumes into the dams.

The base flow model (after Boughton) has the form:

- $\text{Base Flow}_t = ((\text{Base Flow}_{t-1} \times BR) + (BC \times Q_t)\text{^}BM))$

Where:

- Base Flow_t = Baseflow at time t (m3/s)
- BR = Base Flow Recession Constant (~0.975 or less than unity)
- Q_t = Modelled Surface Runoff at time t (m3/s)
- BC = Surface Runoff Factor (~0.002)
- BM = Exponent (~1.0)

As stated above, FLOOD-Ops only estimates surface runoff and does not calculate base flow as this is added in the gate operations spreadsheets. This should be noted when comparing output data from FLOOD-Ops to the final estimated dam inflow volumes. Base flow coefficients can be adjusted during flood events to allow matching of model results with actual data.

At the start of the January 2011 Flood Event, a residual base flow into the Dams resulting from the post Christmas flood was evident. As a result, the starting base flow used in the RTFM was relatively high and was adjusted to match the water level rises in the dams in the absence of surface runoff. As surface runoff increased during the event, the base flow component of the total runoff hydrograph decreased and by the end of the event was between 8% and 10% of the total inflow volume into the Dams. Final event estimates of base flow in volumetric terms, for the two dams were, 114,000 ML for Somerset Dam and 250,000 ML for Wivenhoe Dam out of a total event inflow volume of 2,650,000 ML. Figure 7.2.4 below shows the estimated base flow component in comparison to the total surface run-off into Wivenhoe Dam from the Upper Brisbane River.

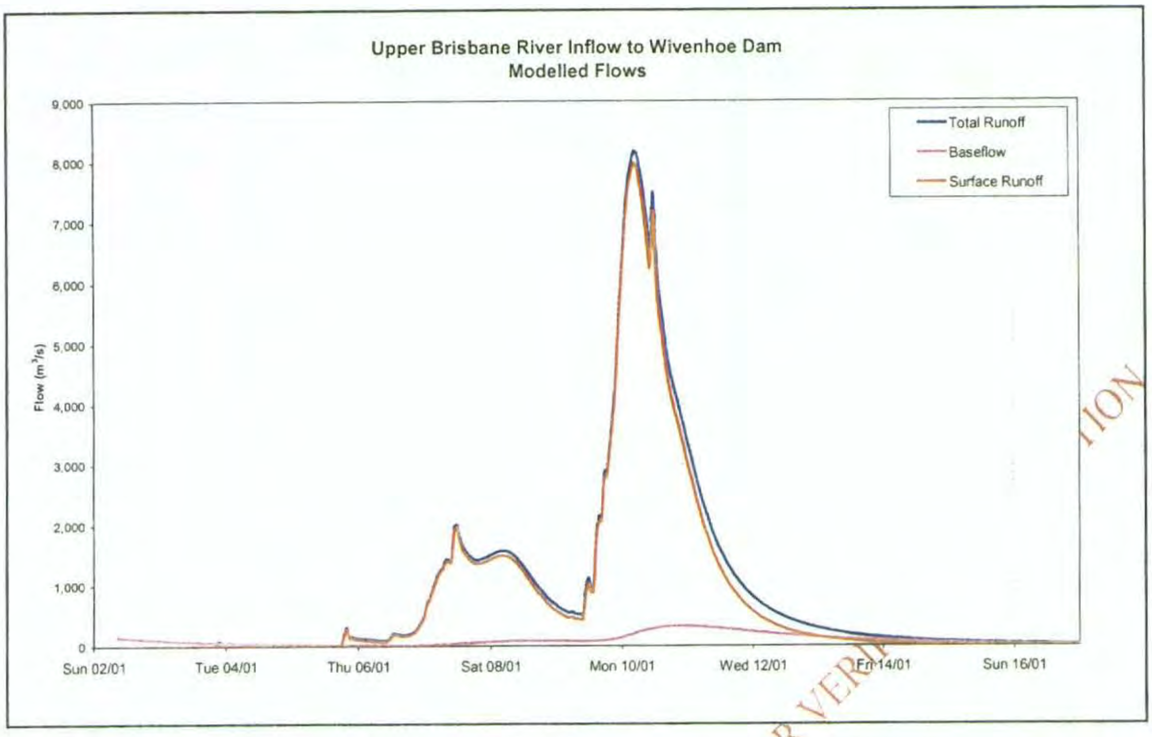

Figure 7.24 - Upper Brisbane River inflow to Wivenhoe Dam

7 FLOOD MODEL VALIDITY AND PERFORMANCE

Cases

A Case is an event-based sequence of processes applied to a number of Regions. Generally, all Regions are included in a Case, which is identified by a unique Case name. The following items are required to define a Case:

- Name and description of Case;
- Simulation start time, current time, simulation finish time and computational time step;
- Rainfall from simulation start time to the current time;
- Rainfall loss model type, required rainfall loss rates and spatial distribution;
- Forecast rainfall duration, depth, spatial and temporal distribution;
- Regions included in Case;
- Hydrologic model routing parameters;
- Reservoir start volume and operating procedure.

In determining appropriate operational strategies, reference is made within these simulation Cases to model estimates at the following locations:

- Wivenhoe Dam Inflow;
- Somerset Dam Inflow;
- Lockyer Creek at O'Reillys Weir (6569);
- Bremer River at David Trumpy Bridge (2168);
- Brisbane River at Lowood (A-6650 and B-6647);
- Brisbane River at Moggill (6755).

The output from a case provides model results that are used in flood event decision-making.

7.3 Model performance during the Event

Data

As discussed in detail in Section 5 and Section 6, there were no significant issues observed with the RTFM data collection system during the January 2011 Flood Event.

Ratings

A Rating is a unique relationship between height and flow at a water level recording station. A Rating is used to convert the recorded water level to an estimated flow rate. A full list of the ratings in the RTFM is provided in Appendix R.

Ratings are generally derived from field measurements of flow and extrapolated by a variety of techniques for flows that are beyond the range of available field measurements to allow coverage of a full range of potential gauge heights. Therefore there can be considerable uncertainty in the estimation of high flows from recorded water level data, especially at high heights such as those experienced during the current event.

During the January 2011 Flood Event actual water levels exceed the range of available field measurements at a number of gauges. This factor caused additional uncertainty to be associated with the results provided by the RTFM, but this could not be avoided. However, overall this factor did not have a major impact on Flood Event decision-making.

Soil Moisture Accounting Model

The spring and early summer rainfall totals were above average for all Regions. Flood producing rainfall was recorded in October 2010 and again throughout late November 2010 and December 2010. Four separate flood events were experienced during this period with the Boxing Day flood finishing on Sunday 2 January 2011. As a consequence of these floods, the catchments were relatively saturated at the commencement of the January 2011 Flood Event as evidenced by the estimates of initial loss shown in the table below.

The Tenthill (TEN) and Laidley (LAI) regions in the Upper Lockyer Creek catchment along with the Kalbar (KAL), Amberley (AMB) and Purga (PUR) regions in the Bremer River catchment, show the effect of isolated storm rainfalls that fell between Tuesday 4 and Wednesday 5 January 2011. The values shown in Table 7.3.1 were used as a starting point for the 'calibration' of the runoff-routing Process.

Loss rate estimates of regions – 5 January 2011

Region code	API Initial Loss (mm)	Sacramento Initial Loss (mm)	Sacramento Continuing Loss (mm/hr)
	Upper Brisbane River		
COO	28.0	26.5	3.5
LIN	22.6	13.6	3.3
EMU	30.7	25.2	2.1
CRE	33.3	29.6	3.3
GRE	29.2	23.7	3.9
	Stanley River		
SDI	22.2	12.3	2.5
	Middle Brisbane River		
WDI	23.5	31.7	2.8
SAV	34.2	37.3	3.0
MTC	33.1	33.0	3.8

Loss rate estimates of regions – 5 January 2011			
Region code	**API Initial Loss (mm)**	**Sacramento Initial Loss (mm)**	**Sacramento Continuing Loss (mm/hr)**
	Lockyer Creek		
HEL	30.4	25.0	4.0
TEN	24.1	0.0	3.5
LAI	14.8	0.0	4.3
GAT	29.3	21.8	3.6
LYO	28.8	20.9	4.2
	Bremer River		
WAL	27.8	28.1	2.9
KAL	24.1	0.0	2.0
AMB	27.6	0.0	2.0
PUR	34.3	0.0	2.1
IPS	33.4	0.0	2.0
	Lower Brisbane River		
JIN	33.5	34.0	3.8
POG	33.6	33.4	3.8
ENO	30.3	25.2	1.2
BUL	33.2	26.6	4.2

Table 7.3.1 – Region loss rate estimates at 5 January 2011

During the Event, continuing loss rates were changed to ensure the overall shape and volume of the Flood Event was being matched to an acceptable level. Given the multi-peaked nature of the hydrographs and the prolonged duration of the event, the continuing loss rates tended to reduce as the event progressed and Table 7.3.2 shows the final Event values used in the RTFM.

To continue to produce accurate modelling outputs, the final continuing loss rates adopted were substantially lower than the values initially used. This clearly indicates the increasing impact of catchment saturation over the duration of the Flood Event.

Adopted loss rate estimates of regions – January 2001 (final)		
Region code	**Initial Loss (mm)**	**Continuing Loss (mm/hr)**
	Upper Brisbane River	
COO	30	0.5
LIN	30	0.5
EMU	30	0.5
CRE	10	2.5
GRE	40	0.5
	Stanley River	
SDI	15	0.5
	Middle Brisbane River	

Adopted loss rate estimates of regions – January 2001 (final)		
Region code	**Initial Loss (mm)**	**Continuing Loss (mm/hr)**
WDI	0	2.5
SAV	5	2.5
MTC	5	2.5
	Lockyer Creek	
HEL	10	1.5
TEN	10	1.5
LAI	10	1.5
GAT	10	1.5
LYO	10	1.5
	Bremer River	
WAL	15	1.0
KAL	15	1.0
AMB	30	1.0
PUR	10	1.0
IPS	10	1.0
	Lower Brisbane River	
JIN	30	2.5
POG	30	2.5
ENO	30	2.5
BUL	30	2.5

Table 7.3.2 – Region loss rates (final) January 2011

The continuing loss rates contained in Table 7.3.2 are well within the range of those used to model historic flood events including the January 1974 event and certainly within the calibration range of the RTFM. However, while the continuing loss rate has some physical basis, it must also be understood that the continuing loss rate is also an indicator of the quality of the recorded data. The consistency of continuing loss rate estimates between events provides a positive indication that rainfall network provides adequate coverage and that stream gauge ratings are relatively reliable.

Cases

Two basic Case scenarios were examined during the event, these being:

- No Forecast Rainfall – accounted for rainfall on the ground to the time of the simulation run;
- Forecast Rainfall – included an extension of rainfall based upon Bureau of Meteorology forecasts (either QPF or SILO).

As is standard practice, during the initial phases of the Event, numerous simulations were conducted. This allows an understanding of the Event to be developed. During this period between rainfall commencing and runoff being recorded at water level gauges, the purpose of the modelling is focused on matching the rising limb of the hydrographs. Once the start of rise of the hydrograph is matched sufficiently, the focus of the modelling is on estimating the peak flow and the volume of the flood, especially for stations located above the Dams. Normally, peak flow rates and flood volumes are matched to at least within 20% of recorded values.

The No Forecast Rain and Forecast Rain scenarios are then examined to establish appropriate operational strategies within lower and upper bound model estimates. Matching of flows at all available gauging stations is attempted, with emphasis placed upon the key locations. These key locations for each catchment (with associated ALERT sensor identification numbers) are listed below:

- **Upper Brisbane River**
  Brisbane River at Gregors Creek (A) 6515 and (B) 6518
- **Middle Brisbane River**
  Brisbane River at Wivenhoe Dam Headwater (A) 6637 and (C) 6638
- **Stanley River**
  Stanley River at Woodford (A) 6706 and (B) 6703
  Stanley River at Somerset Dam Headwater (A) 6594, (B) 6591 and (C) 6592
- **Lockyer Creek**
  Lockyer Creek at Lyons Bridge (A) 6634 and (B) 6631
- **Bremer River**
  Bremer River at Walloon (A) 6551 and (B) 6743
  Warrill Creek at Amberley (A) 6652 and (B) 6654

The recorded headwater levels and gate settings at each of the Dams are also used to ensure the modelled inflows are appropriate before using projected inflows to determine future gate operations. Manually read gauge board readings obtained from the storage operators are used to validate the automatic gauge information at the Dams and are used in preference to automatic gauge information for operational decision making.

Further points to note in regard to the field stations are as follows:

- At Lyons Bridge both the (A) and (B) stations are subject to bypass flows at flow magnitudes greater than $600m^3/s$. Therefore, the recorded flows are considered to under estimate larger flood magnitudes. There is also an inconsistency between the (A) and (B) site rating curves. The (A) station was adopted in this Event;
- There is an inconsistency between the Amberley (A) and Amberley (B) site rating curves. The (A) station was adopted in this event;
- David Trumpy Bridge is a height only station as it is also impacted by tidal flows and it too is back-water affected from large flows in the Brisbane River.

During the Event, some Cases were over-written. This occurred because Cases are generally created by using the most recent Case as a base. If the Case being used as a base is not explicitly saved, it will be lost. This does not present a problem from an operational sense as historical Cases quickly become "out of date" as further rain falls in the Dam catchments. "Out of date" Cases have little bearing on current time operational decision making as they do not consider all of the rain that has fallen since the commencement of the flood event to the current time. Cases can also easily be re-created at any time during or after the flood event as all Case data is archived. Table 7.3.3 provides a list of preserved Cases developed during the Flood Event.

Run number	Run date and time	Case name	Case description
A	18:00 6/01/2011	201101061800	No Forecast Rain
B	21:00 6/01/2011	201101062100	No Forecast Rain
C	01:00 7/01/2011	201101070100	No Forecast Rain
D	18:00 7/01/2011	201101071800	No Forecast Rain
E	22:00 7/01/2011	201101072200	No Forecast Rain
Efs	22:00 7/01/2011	201101072200-72h	SILO –Forecast Rain
F	09:00 8/01/2011	201101080900	No Forecast Rain
Ffs	09:00 8/01/2011	201101080900-72h	SILO - Forecast Rain

Run number	Run date and time	Case name	Case description
G	15:00 8/01/2011	201101081500	No Forecast Rain
Gfq	15:00 8/01/2011	201101081500-72h	SILO Forecast Rain
H	09:00 9/01/2011	201101090900	No Forecast Rain
I	14:00 9/01/2011	201101091400	No Forecast Rain
J	16:00 9/01/2011	201101091600	No Forecast Rain
K	18:00 9/01/2011	201101091800	No Forecast Rain
Kfq	18:00 9/01/2011	201101091800-12h	QPF Forecast Rain
L	20:00 9/01/2011	201101092000	No Forecast Rain
Lfq	20:00 9/01/2011	201101092000-24h	QPF Forecast Rain
M	22:00 9/01/2011	201101092200	No Forecast Rain
Mfq	22:00 9/01/2011	201101092200-24h	SILO Forecast Rain
N	01:00 10/01/2011	201101100100	No Forecast Rain
O	03:00 10/01/2011	201101100300	No Forecast Rain
P	05:00 10/01/2011	201101100500	No Forecast Rain
Q	10:00 10/01/2011	201101101000	No Forecast Rain
Qfq	10:00 10/01/2011	201101101000-24hq	QPF Forecast Rain
Qfs	10:00 10/01/2011	201101101000-24hs	SILO Forecast Rain
R	13:00 10/01/2011	201101101300	No Forecast Rain
S	20:00 10/01/2011	201101102000	No Forecast Rain
T	00:00 11/01/2011	201101110000	No Forecast Rain
U	03:00 11/01/2011	201101110300	No Forecast Rain
Ufq	03:00 11/01/2011	201101110300-24h	QPF Forecast Rain
V	11:00 11/01/2011	201101111100	No Forecast Rain
W	11:00 13/01/2011	201101131100	No Forecast Rain
X	09:00 19/01/2011	201101190900	No Forecast Rain
Y	12:00 20/01/2011	201101201200	No Forecast Rain
Z	00:00 21/01/2011	201101210000-1893	No Forecast Rain

Table 7.3.3 – Preserved model runs, January 2011 Flood Event

Table 7.3.4 presents a summary of Cases associated with the periods contained in Section 2. A post-event naming convention has been developed to facilitate presentation of these model runs and the mapping of this convention to the preserved event model runs is summarised in the following Table 7.3.4.

Post-event run number	Date and time of run	Corresponding or previous event run number
2	08:00 Thu 6 Jan 2011	A
5	02:00 Fri 7 Jan 2011	C
7	09:00 Fri 7 Jan 2011	C
8	14:00 Fri 7 Jan 2011	C
10	14:00 Sat 8 Jab 2011	F
12	01:00 Sun 9 Jan 2011	G
14	08:00 Sun 9 Jan 2011	G

Post-event run number	Date and time of run	Corresponding or previous event run number
17	14:00 Sun 9 Jan 2011	I
21	19:00 Sun 9 Jan 2011	K
23	01:00 Mon 10 Jan 2011	N
26	09:00 Mon 10 Jan 2011	P
28	15:00 Mon 10 Jan 2011	R
31	20:00 Mon 10 Jan 2011	S
35	04:00 Tue 11 Jan 2011	U
37	08:00 Tue 11 Jan 2011	U
39	13:00 Tue 11 Jan 2011	V
41	19:00 Tue 11 Jan 2011	V
43	08:00 Wed 12 Jan 2011	V
45	12:00 Wed 19 Jan 2011	X

Table 7.3.4 – Model run naming convention

RTFM results

Overall, the RTFM provided sufficient information to properly support flood operations decision making. Water level estimates approximated recorded gauge water levels did not require significant scaling to match recorded lake levels. Generally there was also agreement with the flows estimated by BoM that were made available via their registered user service. An example of this is shown in Figure 7.3.5.

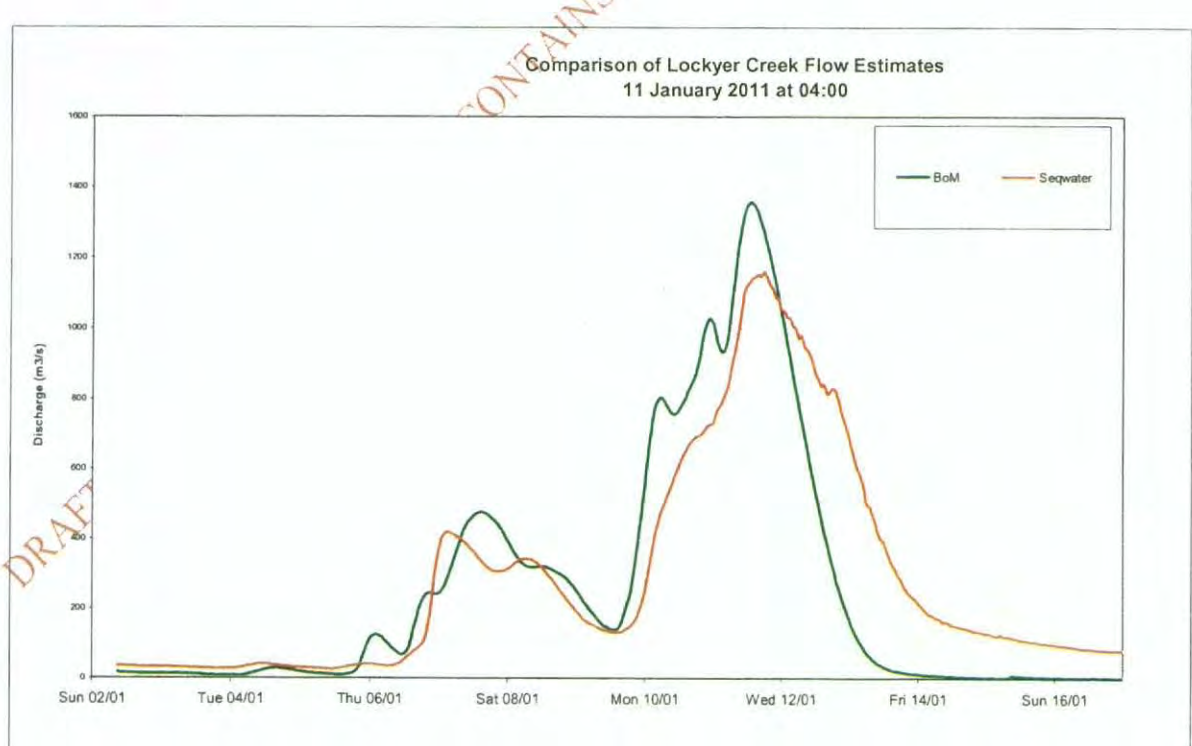

Figure 7.3.5 – Comparison of model estimates

There was correlation between the results provides between the RTFM and the results provide from the back-up RTFM system utilising the URBS models.

The model performance also reflects the robustness of the original model calibrations which were biased towards the larger historical flood events such as January 1974. It is noted that the January 2011 Event has a magnitude that requires extrapolation of the model parameters beyond that for which they were previously benchmarked. It is considered that the availability of numerous rainfall stations in the catchment most significantly contributes positively to the overall model performance.

In respect of the application of the runoff-routing models in a forecasting mode, it should be noted that the projected flows are not updated using the recorded flows to the time of the simulation but rather, the projected flows are derived from recorded rainfalls with or without a forecast rainfall extension.

Summaries of the results across the four key catchments are contained below.

- **Upper Brisbane River Catchment Model**
  The Upper Brisbane River Catchment Model performed well at all locations as evidenced by the comparisons at Gregors Creek. There was some difficulty encountered in the modelling of flows in the Upper and Middle Brisbane Rivers when trying to match the rapid lake level rise in Wivenhoe Dam that occurred on Tuesday 11 January 2011. However, this was due to an absence of data rather than a flaw in the model, as back calculations showed the intense rainfall falling during this period was not adequately captured in the available rain gauges. This issue is discussed in more detail in Section 6.

- **Stanley River Catchment Model**
  The Stanley River Catchment Model performed adequately and accurate inflow estimates into Somerset Dam were obtained from the modelling results. However, because the Woodford gauge only commands a relatively low percentage (20%) of the total catchment area of Somerset Dam, some scaling was needed to match estimated inflow volumes to recorded lake levels. This is because substantial event runoff was generated on the Jimna and D'Aguilar Ranges that flowed directly into Lake Somerset. Therefore, the flow at Woodford was not totally representative of all the contributing catchment of the Stanley River. Again, this is a data availability issue rather than a modelling issue.

- **Lockyer Creek Catchment Model**
  The Lockyer Creek Catchment Model performed well and generally matched with catchment flows estimated by BoM. The flash flooding episode experienced on the Toowoomba Range escarpment on the afternoon of Monday 10 January 2011, showed the intense rainfall falling during this period was not adequately captured in the available rain gauges.

  Two stream gauges in the Upper Lockyer Creek catchment failed during the course of the Event due to overtopping, whilst the most downstream gauge became back-water affected before it failed. Therefore, stream flow matching of the modelling results was undertaken at Glenore Grove and Lyons Bridge. For flows larger than 600m^3/s, Lyons Bridge suffers from bypass flows and therefore it tends to under estimate larger flood events. This is evident of the results contained in the following tables and was accounted for during the Event when estimating flows at Moggill. Comparisons between model results shared with BoM confirm that the peak flow in Lockyer Creek was in excess of 3,000m^3/s.

- **Bremer River and Warrill Creek Catchment Model**
  The Bremer River and Warrill Creek Catchment Model performed well and generally matched with catchment flows estimated by BoM. Some timing differences were noted, particularly on Warrill Creek. The rating of the Bremer River at Walloon was exceeded during the event and so this curve will need to be extrapolated post-event to define the peak flow at this location. Upstream stations on the Bremer River indicated good matching for the event.

Table 7.3.5 contains calibration results showing the values of peak flow and flood volume to the date and time of the model run. Timing issues result in over or under estimation of peak values and in many instances the recorded values are not necessarily peak values, but rather the latest value on the rising limb. Plots of comparisons between recorded and modelled hydrographs are presented in Appendix S.

It should be noted that the results in Table 7.3.6 are surface run-off results only and contain no baseflow. Therefore, the values shown in this table will be lower than those shown in the gate operations spreadsheets and the final modelling results.

Finally, the results shown in Table 7.3.6 are based on unverified stream height data and associated Ratings. Although the values shown in the Tables are presented to the nearest m^3/s or ML, the level of precision should be not be inferred from this level of reporting.

Run 2 - 08:00 Thursday 6 January 2011

This run was completed soon after mobilisation of the Flood Operations Centre. Rainfall commenced the pervious day with the largest falls occurring in the Upper Brisbane River and Lockyer Creek catchments.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	117	13,381	357	15,847	240	2,466
Woodford	4	1,998	8	125	3	-1,874
Lyons Bridge	44	12,257	95	4,860	52	-7,397
Walloon	38	480	116	6,426	77	5,946
Amberley	26	6,084	203	5,471	177	-612

Run 5 - 02:00 Friday 7 January 2011

This run was completed 19 hours after mobilisation of the Flood Operations Centre. Flows in the Upper Brisbane River had just peaked, whilst the Lockyer Creek and Bremer River catchments continued to rise.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	986	40,737	1,302	67,830	316	27,093
Woodford	14	2,227	44	797	30	-1,430
Lyons Bridge	412	22,230	315	14,327	-97	-7,903
Walloon	336	7,429	88	6,291	-248	-1,138
Amberley	73	8,125	124	4,893	51	-3,232

Run 7 - 09:00 Friday 7 January 2011

This run was completed 26 hours after mobilisation of the Flood Operations Centre. Warrill Creek continued to rise but all other streams had peaked and were receding.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	986	59,062	1,302	84,378	316	25,316
Woodford	14	2,394	63	1,446	49	-948
Lyons Bridge	422	32,566	447	24,429	25	-8,137
Walloon	412	16,791	89	8,449	-323	-8,342
Amberley	117	10,629	124	6,938	7	-3,691

Run 8 - 14:00 Friday 7 January 2011

This run was completed 31 hours after mobilisation of the Flood Operations Centre. Rainfall in the Upper Brisbane River and Stanley River had resulted in renewed rises at Gregors Creek, with Woodford now starting to respond.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	986	69,618	1,302	93,636	316	24,018
Woodford	43	2,792	124	2,939	81	148
Lyons Bridge	422	39,179	484	32,904	61	-6,275
Walloon	412	20,384	126	10,418	-286	-9,965
Amberley	137	12,941	130	8,730	-7	-4,212

Run 10 - 14:00 Saturday 8 January 2011

This run was completed 55 hours after mobilisation of the Flood Operations Centre. The Upper Brisbane River had peaked for a second time and was now receding. The Stanley River and Warrill Creek were also falling. Secondary peaks in Lockyer Creek and Bremer River were now falling.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	1,387	150,518	1,767	209,354	381	58,837
Woodford	79	8,356	134	7,628	55	-728
Lyons Bridge	422	67,238	485	65,809	62	-1,429
Walloon	412	30,148	181	24,936	-231	-5,212
Amberley	164	25,976	210	24,026	46	-1,950

Run 12 - 01:00 Sunday 9 January 2011

This run was completed 66 hours after mobilisation of the Flood Operations Centre. All streams appeared to be receding, although heavy rainfall falling on all catchments suggested another rise was likely to occur.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	1,387	168,163	1,767	224,123	381	55,960
Woodford	79	9,905	134	9,993	55	88
Lyons Bridge	422	76,656	485	74,942	62	-1,714
Walloon	412	32,134	251	29,399	-161	-2,734
Amberley	164	30,702	210	26,004	46	-4,697

Run 14 - 08:00 Sunday 9 January 2011

This run was completed 73 hours after mobilisation of the Flood Operations Centre. Large increases in flows were expected in the Upper Brisbane River, Stanley River and Bremer River as a result of continuing rainfall. Inflows into Somerset Dam and Wivenhoe Dam were expected to exceed 500,000 ML.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	1,387	175,953	1,767	235,715	381	59,761
Woodford	79	10,863	229	13,359	150	2,496
Lyons Bridge	422	80,713	485	79,538	62	-1,175
Walloon	412	32,737	412	38,411	0	5,674
Amberley	164	32,719	210	27,172	46	-5,547

Run 17 - 14:00 Sunday 9 January 2011

This run was completed 79 hours after mobilisation of the Flood Operations Centre. Rapid rises occurred in the Upper Brisbane River, with associated increased runoff volumes into both Somerset Dam and Wivenhoe Dam.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	1,387	190,752	1,767	265,570	381	74,818
Woodford	79	12,165	313	19,195	233	7,030
Lyons Bridge	422	83,681	485	82,959	62	-722
Walloon	412	33,088	551	48,994	139	15,906
Amberley	164	34,158	210	29,641	46	-4,517

Run 21 - 19:00 Sunday 9 January 2011

This run was completed 84 hours after mobilisation of the Flood Operations Centre. Heavy rainfall in the Upper Brisbane River and Stanley River catchments suggested peak flow rates similar to February 1999. Inflows into Somerset Dam and Wivenhoe Dam were expected to exceed 1,000,000 ML.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	5,156	243,878	6,877	350,681	1,720	106,803
Woodford	333	15,543	682	30,089	349	14,547
Lyons Bridge	422	86,218	485	86,639	62	420
Walloon	412	33,624	551	58,159	139	24,535
Amberley	164	35,441	210	31,218	46	-4,223

Run 23 - 01:00 Monday 10 January 2011

This run was completed 90 hours after mobilisation of the Flood Operations Centre. Upper Brisbane River catchment peaked at a level in excess of January 1974. Lockyer Creek and Bremer River catchments were rising again.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	7,351	392,566	7,594	504,062	243	111,496
Woodford	430	27,101	685	43,826	255	16,725
Lyons Bridge	422	90,773	485	94,213	62	3,440
Walloon	412	36,585	570	70,093	158	33,508
Amberley	164	37,275	210	33,052	46	-4,223

Run 26 - 09:00 Monday 10 January 2011

This run was completed 98 hours after mobilisation of the Flood Operations Centre. All catchments had peaked or had started to recede.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m3/s)	Flood volume (ML)	Peak flow (m3/s)	Flood volume (ML)	Peak flow (m3/s)	Flood volume (ML)
Gregors Creek	7,351	543,591	7,594	631,209	243	87,618
Woodford	820	48,307	685	58,068	-135	9,762
Lyons Bridge	548	103,946	485	106,479	-63	2,533
Walloon	412	45,320	635	86,481	223	41,160
Amberley	164	39,540	218	35,975	54	-3,566

Run 28 - 15:00 Monday 10 January 2011

This run was completed 104 hours after mobilisation of the Flood Operations Centre. Rainfall was causing rises again in the Upper Brisbane River and Lockyer Creek. Flash flooding was reported in Toowoomba and Upper Lockyer Creek. Inflows into Somerset and Wivenhoe Dams were approaching 1,500,000 ML.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	7,351	594,300	7,594	687,321	243	93,021
Woodford	820	60,211	685	66,084	-135	5,873
Lyons Bridge	661	117,298	485	116,464	-176	-833
Walloon	412	51,673	652	99,571	239	47,897
Amberley	164	42,069	590	47,022	426	4,953

Run 31 - 20:00 Monday 10 January 2011

This run was completed 109 hours after mobilisation of the Flood Operations Centre. Lockyer Creek and the Bremer River catchments were continuing to rise. Gauging stations in the Upper Lockyer Creek stopped reporting (Helidon and Gatton).

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	7,351	624,406	7,594	725,005	243	100,599
Woodford	820	60,211	685	70,357	-135	10,146
Lyons Bridge	701	129,738	485	124,839	-216	-4,898
Walloon	412	56,377	664	110,975	252	54,598
Amberley	277	46,268	590	55,414	313	9,146

Run 35 - 04:00 Tuesday 11 January 2011

This run was completed 117 hours after mobilisation of the Flood Operations Centre. Heavy rainfall overnight in the Upper Brisbane River catchment lead to renewed rises. Lockyer Creek continued to rise due to flash flooding near the escarpment during the previous afternoon. Bremer River also continued to rise.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	7,351	655,136	7,594	767,802	243	112,666
Woodford	820	73,389	685	75,235	-135	1,846
Lyons Bridge	808	151,461	591	139,841	-217	-11,620
Walloon	575	69,710	707	131,038	132	61,327
Amberley	280	53,921	590	63,642	310	9,720

Run 37 - 08:00 Tuesday 11 January 2011

This run was completed 121 hours after mobilisation of the Flood Operations Centre. Heavy rainfall adjacent to Wivenhoe Dam lead to rapid increases in lake level since 04:00. Lockyer Creek continued to rise quickly whilst the Bremer River catchment appeared steady. Inflows into Somerset Dam and Wivenhoe Dam were approaching 2,000,000ML.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	7,351	702,824	7,594	832,903	243	130,079
Woodford	820	76,158	685	78,289	-135	2,131
Lyons Bridge	944	164,264	1,096	174,591	152	10,327
Walloon	575	77,138	707	140,897	132	63,759
Amberley	288	57,916	590	67,321	303	9,405

Run 39 - 13:00 Tuesday 11 January 2011

This run was completed 126 hours after mobilisation of the Flood Operations Centre. The Upper Brisbane River catchment had peaked however, continuing heavy rainfall adjacent to Wivenhoe Dam caused further rapid increases in the lake level. Somerset Dam inflows also increased rapidly. Lockyer Creek continued to rise quickly and the Bremer River catchment also experienced substantial renewed rises.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	7,351	801,607	7,594	951,452	243	149,845
Woodford	820	82,317	844	87,121	24	4,805
Lyons Bridge	1,128	183,678	1,861	202,421	733	18,743
Walloon	1,210	90,488	903	66,984	-307	-23,504
Amberley	394	63,991	968	80,639	574	16,648

Run 41 - 19:00 Tuesday 11 January 2011

This run was completed 132 hours after mobilisation of the Flood Operations Centre. Wivenhoe Dam had peaked. Woodford was rising rapidly and Somerset Dam inflows also increased. Lockyer Creek appeared to have peaked, but the model grossly overestimated the rated flow. However, comparisons with BoM estimates indicated the modelled flows may be reasonable. The Bremer River at Walloon exceeded its rating curve, whilst Warrill Creek continued to rise.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	7,351	871,338	7,594	1,035,877	243	164,538
Woodford	1,341	108,327	844	103,130	-496	-5,198
Lyons Bridge	1,162	208,518	3,733	268,192	2,571	59,675
Walloon	1,210	116,624	1,408	94,997	198	-21,628
Amberley	622	75,667	1,138	104,382	516	28,715

Run 43 - 08:00 Wednesday 12 January 2011

This run was completed 145 hours after mobilisation of the Flood Operations Centre. All streams had peaked except for Warrill Creek.

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	7,351	923,781	7,594	1,112,372	243	188,591
Woodford	1,341	147,688	844	123,271	-496	-24,417
Lyons Bridge	1,162	257,121	4,013	435,463	2,851	178,342
Walloon	1,210	172,307	1,408	139,207	198	-33,100
Amberley	730	107,495	1,138	133,975	408	26,479

Run 45 - 12:00 Wednesday 19 January 2011

This run was completed 317 hours after mobilisation of the Flood Operations Centre. Gate operations ceased at Wivenhoe Dam. Little rain fell on the catchment in the week following the peak on Tuesday 11 January 2011. This was the final simulation run. Minor adjustments to loss parameters resulted in minor changes to the model calibration results compared to Run 43. Inflows into Somerset Dam and Wivenhoe Dam approached 2,350,000ML (excluding base flow).

Stream gauge	Estimated		Modelled		Difference	
	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)	Peak flow (m^3/s)	Flood volume (ML)
Gregors Creek	7,351	1,000,750	8,098	1,150,594	746	149,844
Woodford	1,341	169,736	844	132,950	-496	-36,786
Lyons Bridge	1,162	384,482	2,904	518,567	1,742	134,085
Walloon	1,210	198,434	1,408	158,052	198	-40,383
Amberley	736	193,908	1,138	175,781	402	-18,127

Table 7.3.6 - Model run peak flow and flood volume values

8

8 PRELIMINARY ASSESSMENT OF EVENT MAGNITUDE

8.1 Introduction

The significance of this Event can be determined by comparing rainfall, water levels and flood volumes measured during the period with historical records and then undertaking a statistical analysis of this information. Australian Rainfall and Runoff (ARR) categorises events according to their Annual Exceedance Probability (AEP), as illustrated in Figure 8.1.1. The Bureau of Meteorology adopts a flood classification system based on minor, moderate and major flood levels which are defined by BoM in conjunction with local Councils.

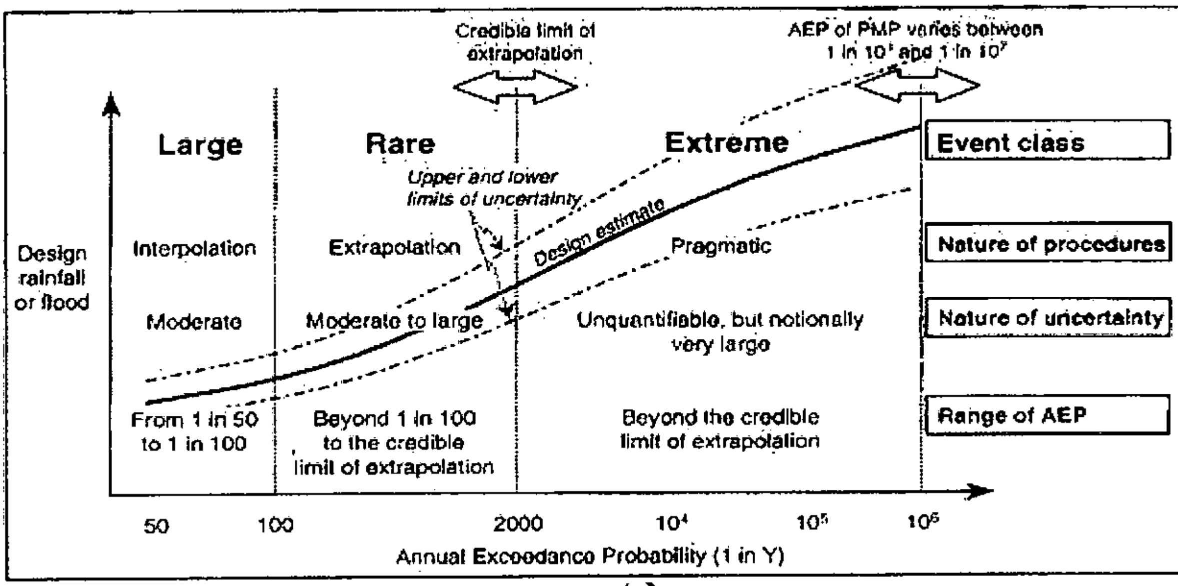

Figure 8.1.1 – Annual Exceedance Probability (AEP)

> ***It should be noted that the assessments carried out in this Section of the report are preliminary only and are based upon operational data collected during the event. Given that time constraints for preparation of the report, it is recognised that more information may become available on which to base a more rigorous assessment of the event magnitude.***

Rainfall totals and intensities can be compared with those recorded during other significant events to determine the significance of the January 2011 Event. Rainfall stations in the Brisbane catchment have good record lengths that, in some cases, are greater than 100 years and therefore provide an effective basis for analysis. The analysis of rainfall intensity rather than depth provides a good indicator of the magnitude of floods in terms of peak flows and volumes.

Water level stations generally have shorter record lengths than rainfall stations, leading to a greater level of uncertainty when comparing recorded and historic water level data to determine event significance. Automatic stations have only been in widespread use since the 1960s, so continuous water level records are generally only available for maximum periods of around 50 years.

Detailed flood frequency analysis consisting of at-station statistical analysis of flow records, requires extensive investigation based on a reassessment of station ratings to account for the current Event. This reassessment work is currently being undertaken by the Department of Environment and Resource Management (DERM) and was not available at the time of writing this Report. However, some preliminary flood frequency analysis was undertaken using available records and this information is included in this Report.

8 PRELIMINARY ASSESSMENT OF EVENT MAGNITUDE

8.2 Rainfall depth and intensity comparison

In the four weeks prior to Thursday 6 January 2011, rainfall in South East Queensland had been well above the December average. In some areas, rainfall exceeded the December average by as much as 400mm. These results can be seen in the following map (Figure 8.2.1) provided by BoM:

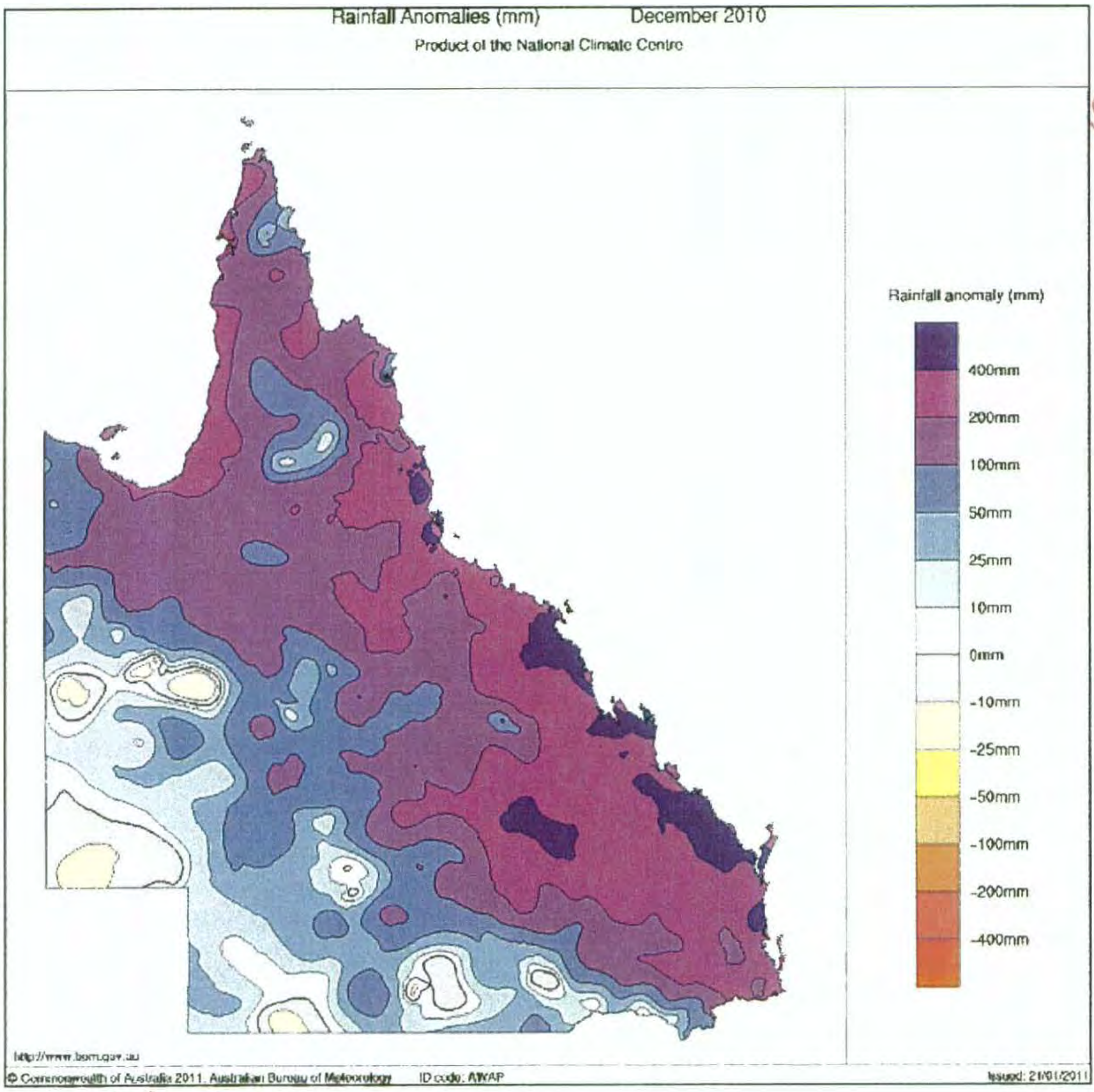

Figure 8.2.1 – Queensland Rainfall (mm), December 2010

There had already been two significant rainfall events in mid and late December 2010 which required large releases from Somerset and Wivenhoe Dams. As a result of these events and the above average rainfall that had been experienced, the Brisbane catchment was wetter than would normally be expected at this time of year and primed to generate runoff from relatively low rainfall events.

Historic comparison

Table 8.2.2 shows a comparison between the event rainfall totals from the January 1974, February 1999 and January 2011 flood events. The comparison could not include the February 1893 events as the available rainfall records are inadequate to allow a proper comparison.

The first feature to notice in Table 8.2.2 is that the duration the events vary from three days to eight days. This has implications for the runoff generating efficiency of the rainfall, as the longer the event duration, the more saturated the catchment becomes and the greater the proportion of runoff per period. This was particularly relevant for the January 2011 Flood Event as the catchment was already relatively saturated at the beginning of the Event.

Table 8.2.2 also shows that the depth of rainfall in the February 1999 flood is much less than the other two events. While the five day totals in the January 1974 and January 2011 are quite similar, the distribution of rainfall with time is quite different and this had a major impact on the volume of runoff generated during each event.

Daily catchment average rainfalls (mm) January 1974							
24 hours to	**Stanley**	**Upper**	**Lockyer**	**Bremer**	**Warrill**	**Purga**	**Lower**
24/01/1974 09:00	0	0	0	0	0	0	0
25/01/1974 09:00	129	70	57	57	44	67	89
26/01/1974 09:00	187	141	172	211	181	188	318
27/01/1974 09:00	398	290	346	465	410	428	530
28/01/1974 09:00	471	339	410	536	468	502	574
29/01/1974 09:00	479	344	412	536	470	503	577

Daily catchment average rainfalls (mm) February 1999							
24 hours to	**Stanley**	**Upper**	**Lockyer**	**Bremer**	**Warrill**	**Purga**	**Lower**
08/02/1999 09:00	0	0	0	0	0	0	0
09/02/1999 09:00	294	223	138	131	102	107	129
10/02/1999 09:00	350	245	150	145	115	119	137
11/02/1999 09:00	355	248	152	148	117	121	140
12/02/1999 09:00	355	248	153	148	117	121	141

Daily catchment average rainfalls (mm) January 2011							
24 hours to	**Stanley**	**Upper**	**Lockyer**	**Bremer**	**Warrill**	**Purga**	**Lower**
06/01/2011 09:00	0	0	0	0	0	0	0
07/01/2011 09:00	20	27	25	26	24	20	19
08/01/2011 09:00	50	64	65	61	75	43	45
09/01/2011 09:00	80	98	85	76	89	57	71
10/01/2011 09:00	129	117	90	80	92	60	76
11/01/2011 09:00	328	254	163	121	118	94	152
12/01/2011 09:00	423	371	275	182	196	163	202
13/01/2011 09:00	541	424	363	337	299	227	310

***Table 8.2.2** – Comparison of daily catchment average rainfalls (mm): January 1974, February 1999 and January 2011*

Table 8.2.3 compares the most intense periods of rainfall recorded for the January 1974, February 1999 and January 2011 flood events during various time periods, with the highest totals for each period highlighted in red. Generally, the January 2011 Event contains the highest rainfall totals of the three events.

8 PRELIMINARY ASSESSMENT OF EVENT MAGNITUDE

Duration	Rainfall totals for selected durations (mm)					
	Somerset Dam catchment			Wivenhoe Dam catchment (excluding Somerset Dam catchment)		
Hours	Jan-74	Feb-99	Jan-11	Jan-74	Feb-99	Jan-11
1	19	21	25	9	11	14
3	51	53	68	25	28	40
6	90	81	118	47	51	74
12	152	134	162	90	87	114
18	193	186	199	127	135	135
24	220	230	221	152	156	144
48	299	325	342	225	231	255
72	421	351	446	295	246	292
96	474	356	464	341	248	307
120	482	357	529	345	250	389

Table 8.2.3 – Comparison of rainfall totals for selected durations (mm), January 1974, February 1999 and January 2011

Figures 8.2.4 and 8.2.5 shows a comparison of the average hourly catchment rainfall patterns in the Somerset Dam and Wivenhoe Dam catchments during the January 1974, February 1999 and January 2011 flood events. Each of the graphs have been plotted on the same horizontal (eight days) and vertical (25mm/hr) scales to enable direct comparison.

The plots of the January 1974 and February 1999 flood events utilise all available rainfall data including daily rainfall records, while the plots of the January 2011 Flood Event only utilises the operational data collected during the Event. All three plots use the same approach of weighting the four nearest rainfall stations to estimate the average catchment rainfall for each subarea in Seqwater's URBS model. Weights were determined using the inverse distanced squared method. The catchment average rainfall is then calculated by weighting each subarea in relation to the total catchment area.

Somerset Dam catchment (Figure 8.2.4)

In the Somerset Dam catchment, the rainfall intensities in the 1974 flood were generally between 3mm/hr to 8mm/hr over the four day duration of the event. By comparison, intensities in the February 1999 flood were slightly higher but over a much shorter period. In January 2011, there are several burst of rainfall between 5mm/hr and 10mm/hr over short durations, leading up to a prolonged period of heavy rain where two periods of very intense rain were experienced (in the 12 hours ending 18:00 Sunday 9 January 2011 and the 12 hours ending 18:00 Tuesday 11 January 2011). During these periods, intensities were more than double those recorded in 1974 and 1999.

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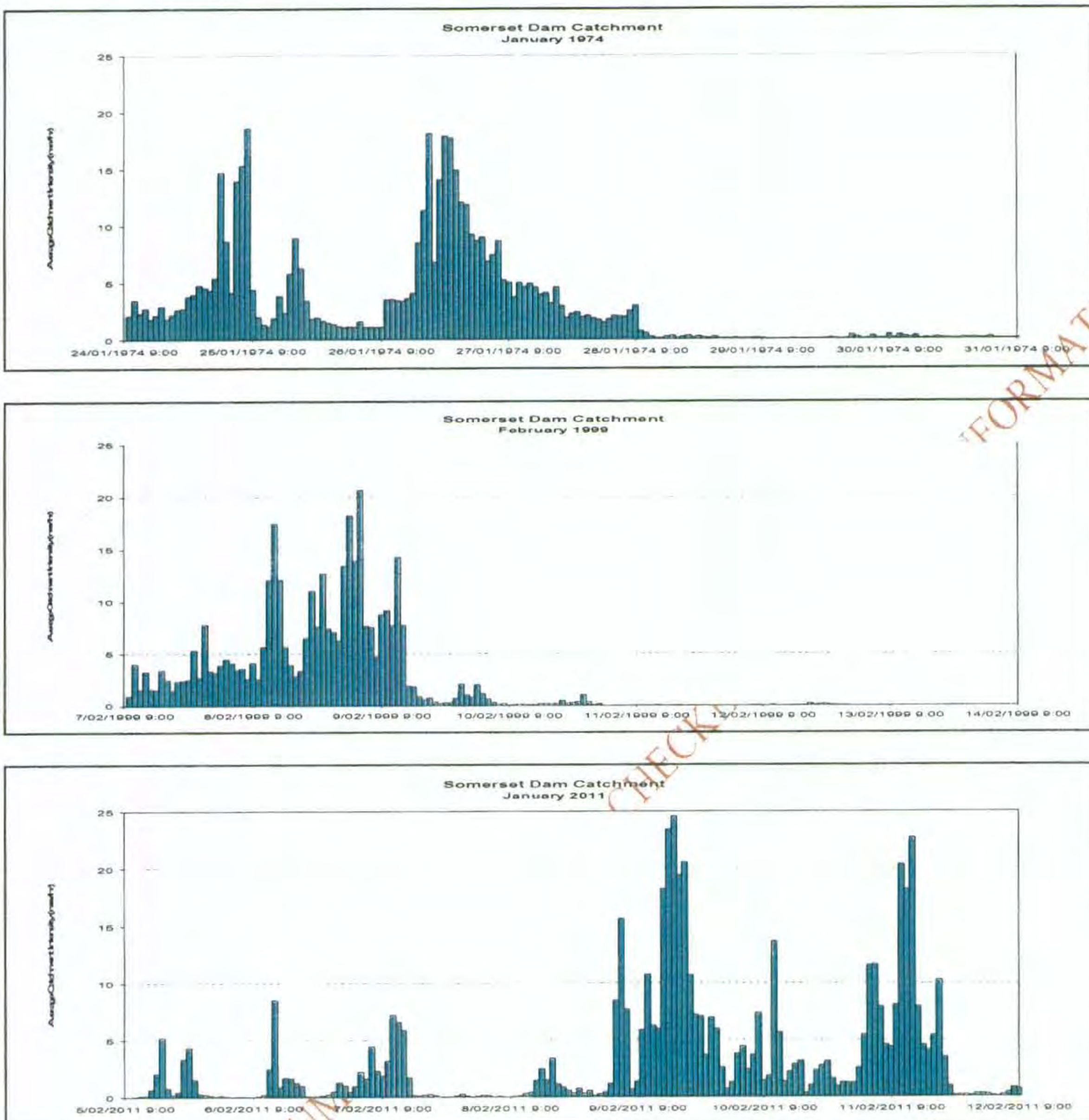

Figure 8.2.4 – Comparison of Somerset Dam catchment rainfall patterns (mm/hr): January 1974, February 1999 and January 2011

Wivenhoe Dam catchment (excluding the Somerset Dam catchment) (Figure 8.2.5)

In the Wivenhoe Dam catchment, the rainfall intensities during the 1974 flood were generally between 3mm/hr to 8mm/hr over the four day duration of the event. By comparison, intensities in the February 1999 flood were slightly higher but over a much shorter period. In January 2011, the average catchment rainfall tended to build up slowly over the first four days during which time a number of small floods were experienced. The first burst of heavy rainfall occurred in the 12 hours to 00:00 Monday 10 January 2011. This was followed by a shorter two hour burst on the afternoon of Monday 10 January 2011. The final and heaviest catchment burst occurred in the early hours of Tuesday 11 January 2011. Rainfall intensities in the January 2011 Event were nearly double those of January 1974.

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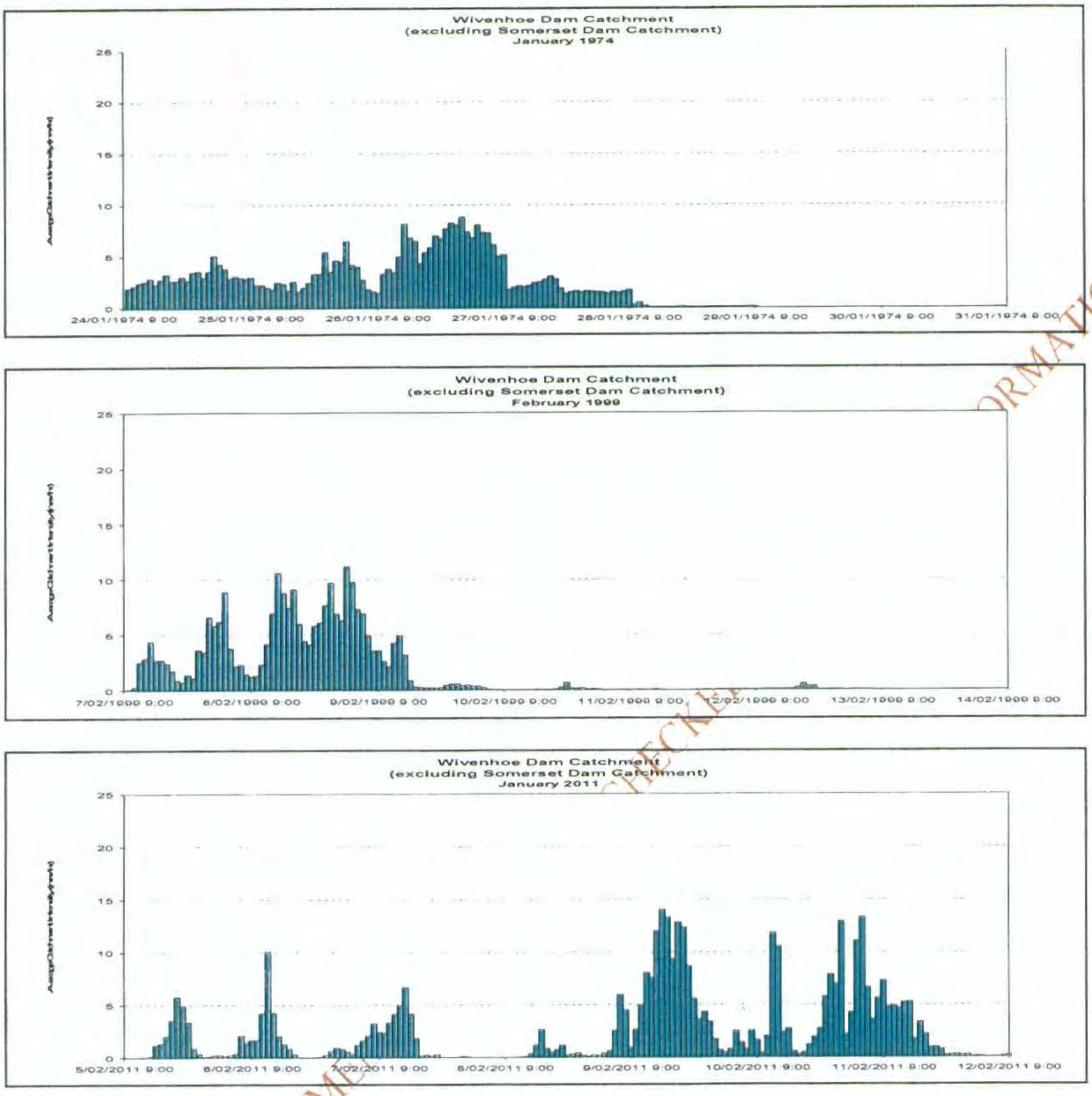

Figure 8.2.5 – Comparison of Wivenhoe Dam catchment rainfall patterns (mm/hr): January 1974, February 1999 and January 2011

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8.3 Rainfall intensity frequency duration analysis

Intensity Frequency Duration (IFD) analysis refers to the statistical analysis of rainfall intensities. Rainfall is typically described as depth in millimetres (mm) falling over a specified duration or period in hours. The rainfall rate or intensity is usually defined as the depth of rainfall per hour.

To determine the severity of a particular rainfall event, the intensity over particular periods of interest is compared with historical records to determine its frequency of occurrence. The Annual Exceedance Probability (AEP) is used to define this frequency of occurrence and is defined by BoM as "*the probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.*"

Depth and intensity may be used in IFD analysis however BoM prefers to simply use rainfall intensity (mm/h). There are two generally accepted methods for IFD analysis:

- Australian Rainfall and Runoff (IEAust 1987);
- CRC-FORGE (Hargraves, 2004 & 2005).

Appendix B contains the analysis for both of these methodologies for a range of rainfall gauges in the Dam catchments for the January 2011 Flood Event. The Australian Rainfall and Runoff (IEAust 1987) results are also available in real time within the RTFM and are used to assess the progression of flood events.

In the Brisbane River Catchment the CRC-FORGE method and Australian Rainfall and Runoff produce similar estimates for 1% AEP for durations from 24 hours to 72 hours. The CRC-FORGE method is the only IFD method used in relation to dams that provides design rainfall estimates for durations up to 120 hours.

The CRC-FORGE method is based upon a regional rainfall frequency analysis that derives rainfall depth estimates of large to rare flood events and uses the concept of an expanding region focused at the site of interest. When using CRC-FORGE, design rainfall estimates for frequent events (1 in 50 and 1 in 100 AEP) are based on pooled data from a few stations around the focal point, while design rainfall estimates at the AEP limit of extrapolation (1 in 2,000) are based on pooled rainfall data from up to several hundred stations. Before data from different sites can be pooled, maximum annual rainfalls from each site need to be standardised by dividing by an index variable. The index variable may be the mean annual maximum for the site, or rainfall of any specified AEP that is reasonable and accurately determined from a short record. An Areal Reduction Factor (ARF) is also introduced to correct the variation of rainfall intensity over a large catchment area and to convert point rainfall estimates to areal estimates.

The CRC-FORGE method was developed using daily rainfall totals. It should be noted that there is some uncertainty in the AEP estimates of the recorded rainfall produced by the CRC-FORGE method for durations less than 24 hours. The shorter durations are extrapolated using ratios calculated from Australian Rainfall and Runoff. There are experimental techniques available for investigating the AEP for the shorter duration rainfalls but time constraints associated with the preparation of this report have not allowed this to be included in the analysis. Given the focus of this IFD analysis is mostly on longer duration storms, the approach undertaken for this report is considered appropriate.

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Point IFD Analysis

For the January 2011 Event, the CRC-FORGE method was used to derive rainfall estimates for frequent to rare flood events for storm durations from 15 minutes to 120 hours, for both point and areal estimates. As discussed above there is some uncertainty associated with design rainfall estimates below 24 hour duration so there curves are shown dotted in the plots below. Point IFD analysis was carried out for each gauge in the rainfall network listed in Table 8.3.1.

ALERT	Station	Location	
ID		Latitude	Longitude
6511	Mount Pechey	-27.3170	152.0820
6514	Gregors Creek	-26.9800	152.4040
6520	Boat Mountain	-26.9789	152.2847
6523	Cressbrook Dam	-27.2650	152.1950
6529	Saint Aubins	-27.0619	151.8944
6540	Yarraman	-26.8358	151.9692
6542	Dam Site	-26.7417	152.1367
6550	Walloon	-27.6170	152.6680
6553	Rosentretters	-27.1383	152.3294
6556	Glenore Grove	-27.5242	152.4081
6559	Savages Crossing	-27.4410	152.6680
6571	Harrisville	-27.8150	152.6406
6574	Caboonbah	-27.1460	152.4900
6577	Gatton	-27.5564	152.2731
6580	Adams Bridge	-27.8294	152.5108
6583	Showground Weir	-27.6386	152.3844
6596	Crows Nest	-27.2308	152.0311
6598	Toowoomba	-27.5114	151.9536
6600	Kilcoy	-26.9481	152.5836
6604	Toogoolawah	-27.0858	152.3722
6606	Woodbine West	-27.7847	152.1497
6608	Jimna	-26.6610	152.4510
6610	Kluvers Lookout	-27.2070	152.7030
6615	Thorton	-27.8211	152.3800
6617	Little Egypt	-27.7042	152.0650
6619	Mount Castle	-27.9636	152.3756
6621	Nukinenda	-27.0567	152.1072
6623	Tarome	-27.9867	152.5008
6636	Wivenhoe Dam	-27.3550	152.5960
6643	Wivenhoe Dam Tailwater	-27.4100	152.5960
6649	Lowood	-27.4900	152.5930
6651	Amberley	-27.6780	152.6990
6680	Mount Glorious	-27.3220	152.7470
6705	Woodford	-26.9500	152.7600
6708	Devon Hills	-26.9000	152.3210
6711	Baxters Creek	-27.1958	152.8000
6714	Ferris Knob	-26.8542	152.8167
6716	Bellthorpe West	-26.8230	152.6780
6730	Jindalee	-27.5322	152.9239
6733	Rosewood	-27.6600	152.6030
6739	Washpool	-27.8290	152.7550
6748	Brisbane City Gauge	-27.4730	153.0300
6751	Mount Crosby	-27.5300	152.7980
6754	Moggill	-27.5950	152.8630
6760	North Pine Dam	-27.2650	152.9300
6763	Petrie	-27.2700	152.9750
6766	Lake Kurwongbah	-27.2500	152.9500
6769	Drapers Crossing	-27.3500	152.9167
6778	Samford	-27.3610	152.8790

Table 8.3.1 – Rainfall stations IFD analysis

Significant stations in each catchment were selected for inclusion in this section of the Report. The remainder of the IFD tables and curves for other stations are included in Appendix P.

Table 8.3.2 summarises the highest AEPs at particular stations estimated from an IFD analysis of the entire list of stations in the tables above. The table shows that for durations of more than three hours, the highest AEPs of the recorded rainfall were 1 in 500 or greater.

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January 2011 Flood Event - Highest rainfall intensities					
Duration	**ALERT ID**	**Station**	**Recorded intensity mm/hr**	**End time**	**AEP 1 in Y**
3 H	6559	Savages Crossing	70.5	09:34 11/01/2011	500 - 1000
6 H	6559	Savages Crossing	47.8	12:49 11/01/2011	> 2000
	6649	Lowood	40.0	14:04 11/01/2011	
12 H	6559	Savages Crossing	30.7	14:34 11/01/2011	> 2000
	6643	Wivenhoe Dam	29.4	16:29 11/01/2011	
	6649	Lowood	29.0	14:49 11/01/2011	
18 H	6649	Lowood	19.6	19:34 11/01/2011	> 2000
24 H	6649	Lowood	14.8	19:19 11/01/2011	> 2000
48 H	6649	Lowood	9.0	14:49 11/01/2011	> 2000
72 H	6649	Lowood	6.4	01:19 12/01/2011	1000 - 2000
96 H	6649	Lowood	4.9	01:19 12/01/2011	500 - 1000
120 H	6649	Lowood	4.0	01:04 12/01/2011	500 - 1000

Table 8.3.2 – Highest AEP rainfall intensities, January 2011 Flood Event

IFD results for significant individual stations are defined further in this section. Discussions on temporal patterns are also contained in Section 6.0. Overall, there was significant spatial variation in the rainfall intensities. Intensities were generally very high in the catchment above Somerset and Wivenhoe Dams however they were not statistically significant at stations below the Dams. It should also be noted the rainfall which caused the Lockyer Creek flash flood was not recorded in any of the Seqwater stations.

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Gregors Creek

This station is located near the Brisbane River around 49km north of Wivenhoe Dam and is close to the centre of the Wivenhoe Dam catchment. Figure 8.3.3 below shows the heaviest rainfall up to 18 hours was recorded on the afternoon of Sunday 9 January 2011. For durations less than three hours, the AEP was not particularly significant however, between 18 and 24 hours, the AEP of the rainfall was in the 1 in 100 to 1 in 200 range. By 20:00 Tuesday 11 January 2011, the longer rainfall periods up to 120 hours are consistently in the 1 in 100 to 1 in 200 range.

Duration	Recorded intensity mm/hr	End time	AEP 1 in Y
15 M	70.0	9/01/2011 15:20	< 5
30 M	52.6	9/01/2011 15:35	< 5
1 H	42.2	9/01/2011 16:05	< 5
3 H	30.4	9/01/2011 18:05	20
6 H	25.0	9/01/2011 19:05	50 - 100
12 H	16.0	9/01/2011 22:20	100 - 200
18 H	12.1	9/01/2011 23:35	100 - 200
24 H	10.0	10/01/2011 12:35	100 - 200
48 H	6.6	11/01/2011 5:05	100 - 200
72 H	4.8	11/01/2011 20:20	100 - 200
96 H	3.6	11/01/2011 20:20	50 -100
120 H	3.2	11/01/2011 20:20	100 - 200

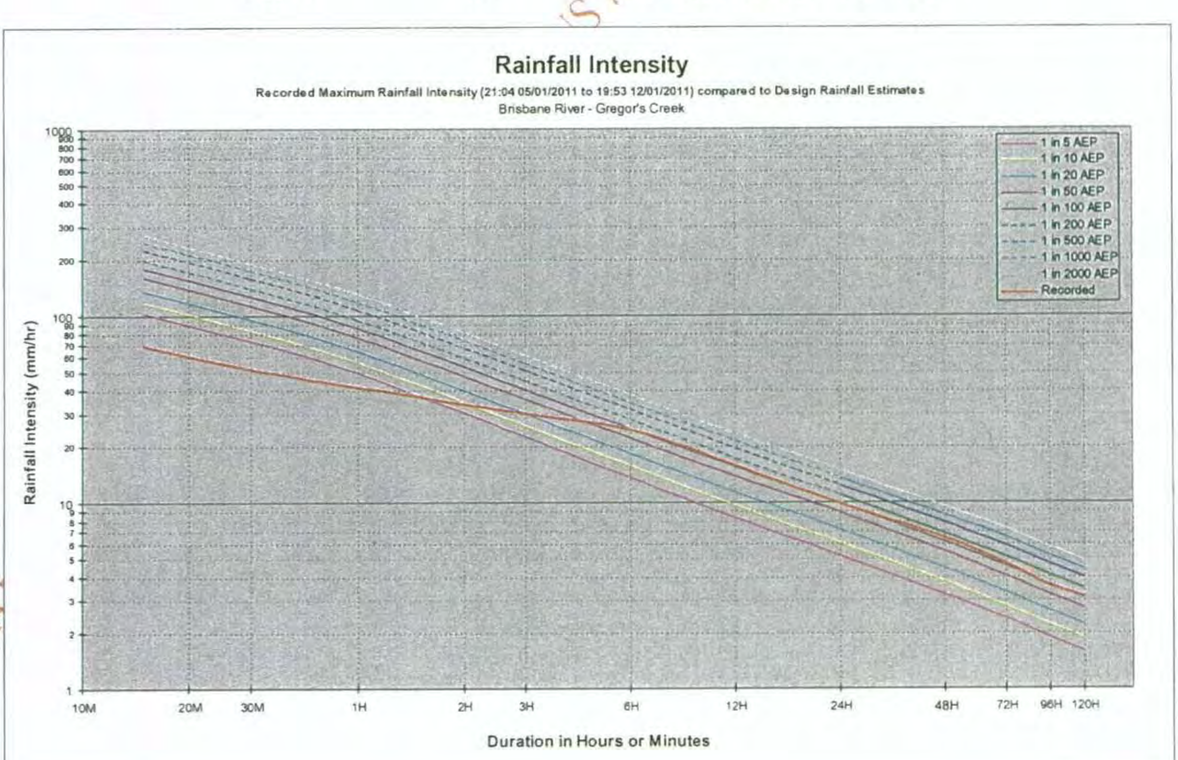

Figure 8.3.3 – Rainfall intensity. Gregors Creek

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Cooyar Creek Dam Site

This station is located within the lower reaches of Cooyar Creek, around 85km north north-west of Wivenhoe Dam, near the northern boundary of the Wivenhoe Dam catchment. Figure 8.3.4 below shows the shorter duration rainfall up to 24 hours was not statistically significant and mostly occurred in the period up to late Monday 10 January 2011 to early Tuesday 11 January 2011. By Tuesday 11 January 2011, the longer rainfall periods up to 120 hours are consistently in the 1 in 50 to 1 in 100 range.

Duration	Recorded intensity mm/hr	End time	AEP 1 in Y
15 M	60.4	10/01/2011 23:04	< 5
30 M	55.6	10/01/2011 23:19	< 5
1 H	38.2	10/01/2011 23:49	< 5
3 H	22.2	11/01/2011 0:49	< 5
6 H	16.3	11/01/2011 4:49	20
12 H	9.8	11/01/2011 5:49	20
18 H	6.9	9/01/2011 23:49	20
24 H	5.4	10/01/2011 2:04	20
48 H	5.2	11/01/2011 5:49	50 - 100
72 H	3.6	11/01/2011 14:49	50 - 100
96 H	3.0	11/01/2011 4:49	50 - 100
120 H	2.9	11/01/2011 7:34	200 - 500

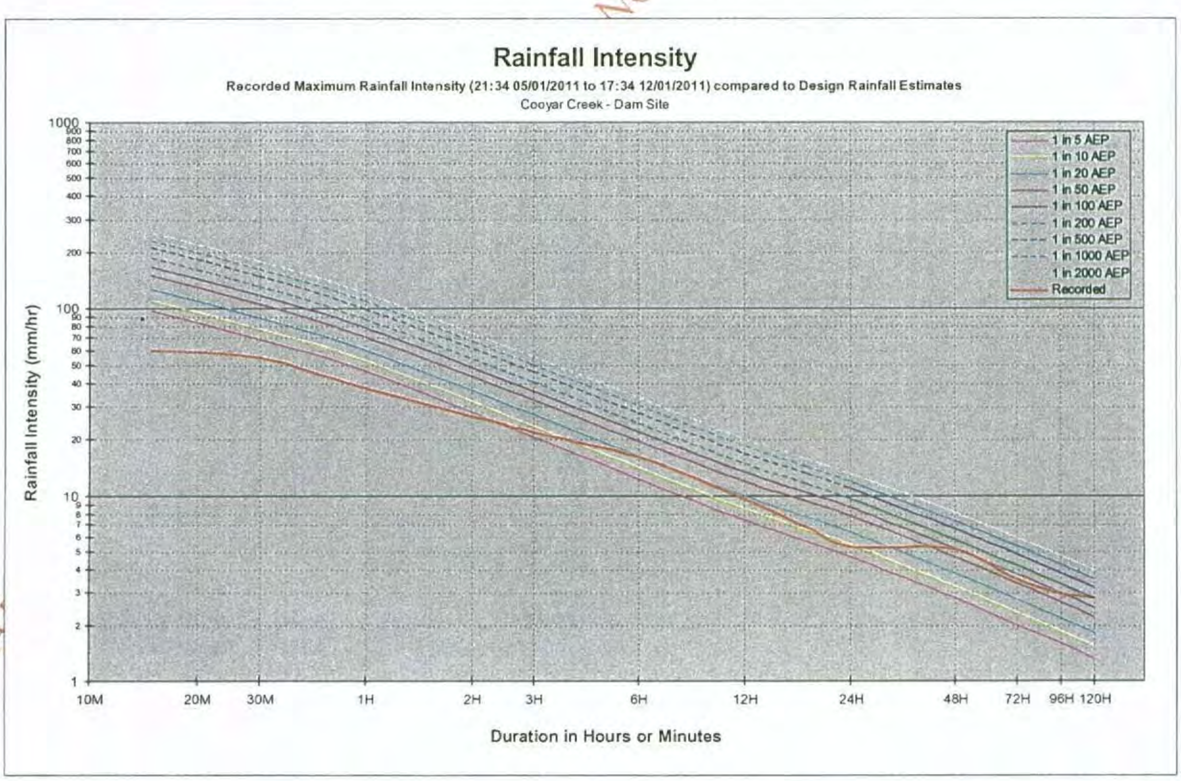

Figure 8.3.4 – Rainfall intensity, Cooyar Creek

Glenore Grove

This station is located within the lower reaches of Lockyer Creek, around 24km south west of Wivenhoe Dam. Figure 8.3.5 below shows the most intense rainfall for all durations ended in the evening of Tuesday 11 January 2011. The rainfall which fell in the afternoon of that day was up to 1 in 500 AEP and coincided with the arrival of floodwaters from the previous afternoon's heavy rainfall in the upper reaches.

Duration	Recorded intensity mm/hr	End time	AEP 1 in Y
15 M	87.2	11/01/2011 6:18	< 5
30 M	76.0	11/01/2011 6:18	< 5
1 H	54.7	11/01/2011 6:48	< 5
3 H	26.0	11/01/2011 13:48	20
6 H	21.2	11/01/2011 15:18	50 - 100
12 H	16.6	11/01/2011 15:18	200 - 500
18 H	11.2	11/01/2011 19:33	100 - 200
24 H	8.4	11/01/2011 19:48	50 - 100
48 H	5.7	11/01/2011 15:18	100 - 200
72 H	4.1	11/01/2011 19:48	100 - 200
96 H	3.1	11/01/2011 19:48	50 - 100
120 H	2.6	11/01/2011 19:48	50 - 100

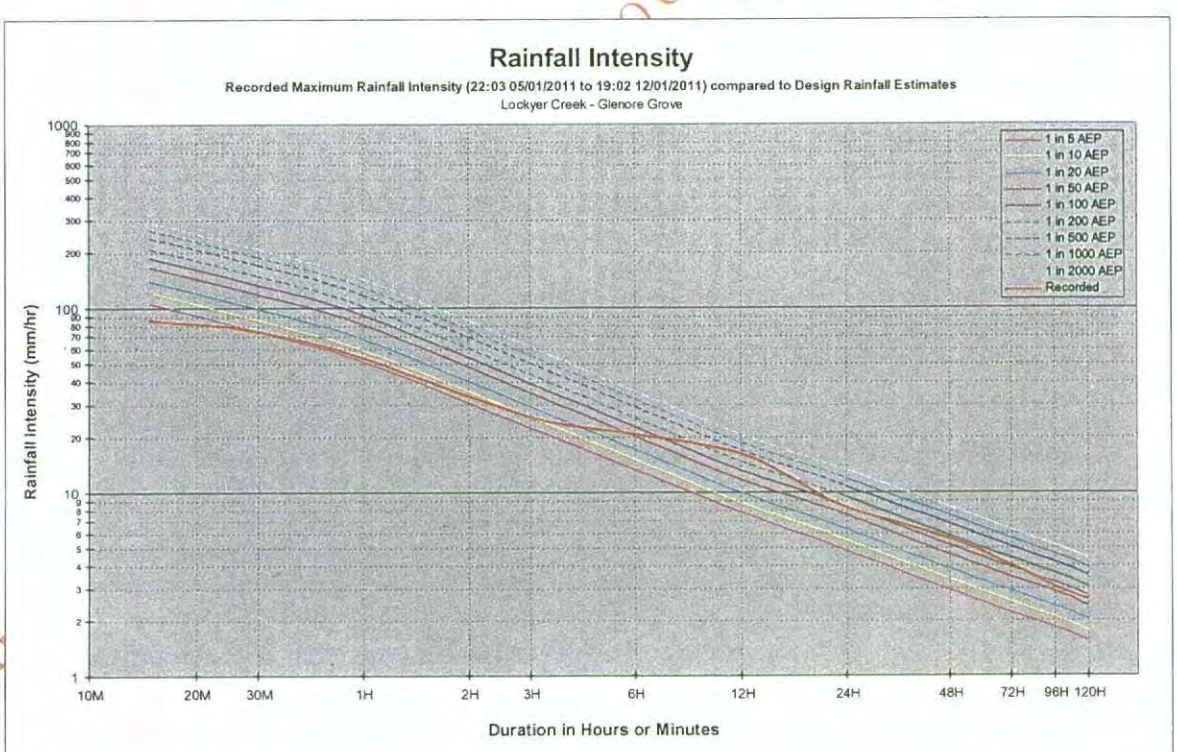

Figure 8.3.5 – Rainfall intensity, Glenore Grove

8 PRELIMINARY ASSESSMENT OF EVENT MAGNITUDE

Toowoomba

This station is located within the watershed of the Condamine River Basin and Lockyer Creek, around 66km south-west of Wivenhoe Dam. Figure 8.3.6 below shows the most intense rainfall for periods of less than 12 hours ended on the afternoon of Monday 10 January 2011. The rainfall for these durations is not particularly significant, being in the frequent to large range. However, despite its location, the rainfall at this gauge is not considered to accurately represent the rainfall which caused the flash flood in the Lockyer Valley on the afternoon of Monday 10 January 2011.

Duration	Recorded intensity mm/hr	End time	AEP 1 in Y
15 M	81.2	10/01/2011 14:04	< 5
30 M	72.8	10/01/2011 14:04	10 - 20
1 H	57.9	10/01/2011 14:04	20 - 50
3 H	22.6	10/01/2011 15:49	10 - 20
6 H	12.7	10/01/2011 17:19	5 - 10
12 H	7.3	10/01/2011 17:19	5 - 10
18 H	6.2	11/01/2011 6:19	5 - 10
24 H	5.6	10/01/2011 16:19	10 - 20
48 H	4.1	11/01/2011 11:34	20 - 50
72 H	3.0	12/01/2011 5:34	10 - 20
96 H	2.4	11/01/2011 9:49	10 - 20
120 H	2.3	11/01/2011 6:19	20 - 50

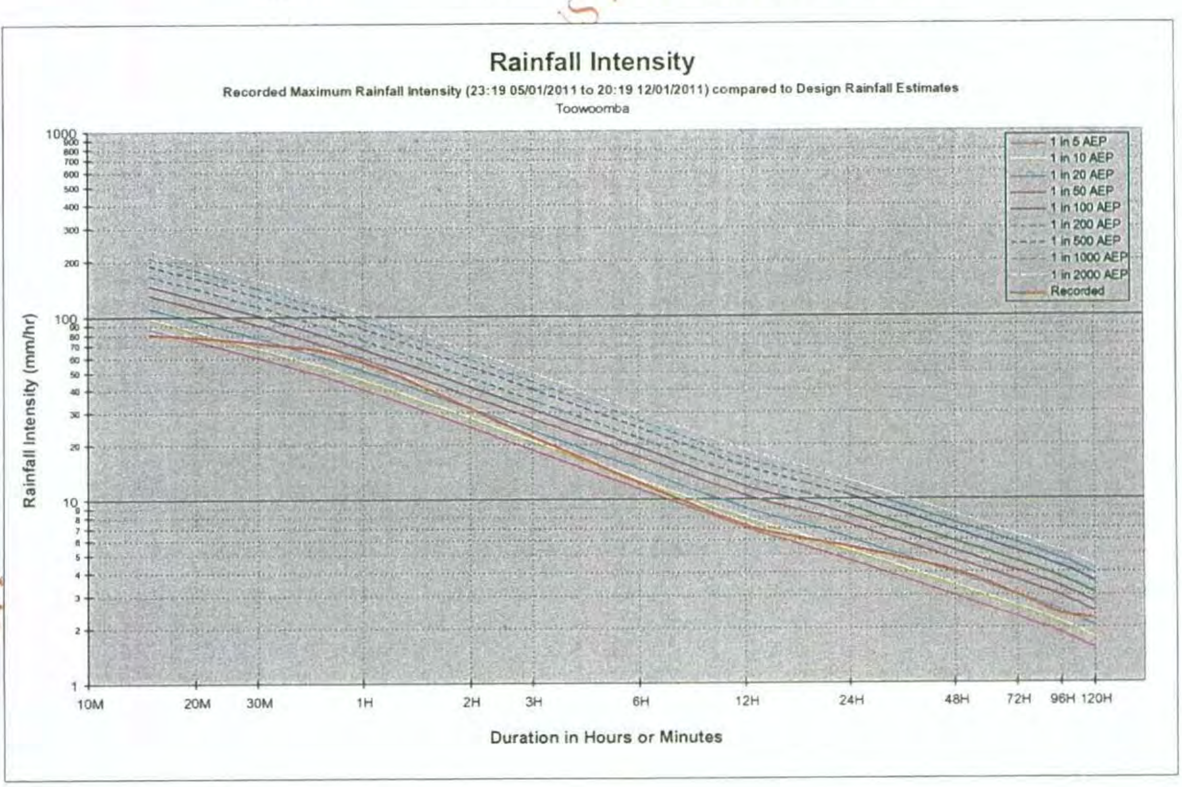

Figure 8.3.6 – Rainfall intensity, Toowoomba

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Lowood

This station is located only 8.5km south of Wivenhoe Dam, in the area which recorded some of the highest Event rainfall totals. Figure 8.3.7 below shows the rainfall at this location had AEPs for durations above 6 to 48 hours to be above 1 in 2000 and is estimated to be in the rare range. The IFD graph shows the 12 hour duration rainfall was significantly above the 1 in 2000 AEP and extended into the extreme range. The timing of the short duration rainfall should also be noted. On the afternoon of Tuesday 11 January 2011, this rainfall coincided with the arrival of floodwaters from the upper Brisbane River into Wivenhoe Dam and the arrival of the Lockyer Creek floodwaters into the Brisbane River.

Duration	Recorded intensity mm/hr	End time	AEP 1 in Y
15 M	90.4	13:34 11/01/2011	< 5
30 M	83.0	13:34 11/01/2011	5 - 10
1 H	66.3	13:49 11/01/2011	10 - 20
3 H	45.4	09:34 11/01/2011	100 - 200
6 H	40.0	14:04 11/01/2011	> 2000
12 H	29.0	14:49 11/01/2011	> 2000
18 H	19.6	19:34 11/01/2011	> 2000
24 H	14.8	19:19 11/01/2011	> 2000
48 H	9.0	14:49 11/01/2011	> 2000
72 H	6.4	01:19 12/01/2011	1000 - 2000
96 H	4.9	01:19 12/01/2011	500 - 1000
120 H	4.0	01:04 12/01/2011	500 - 1000

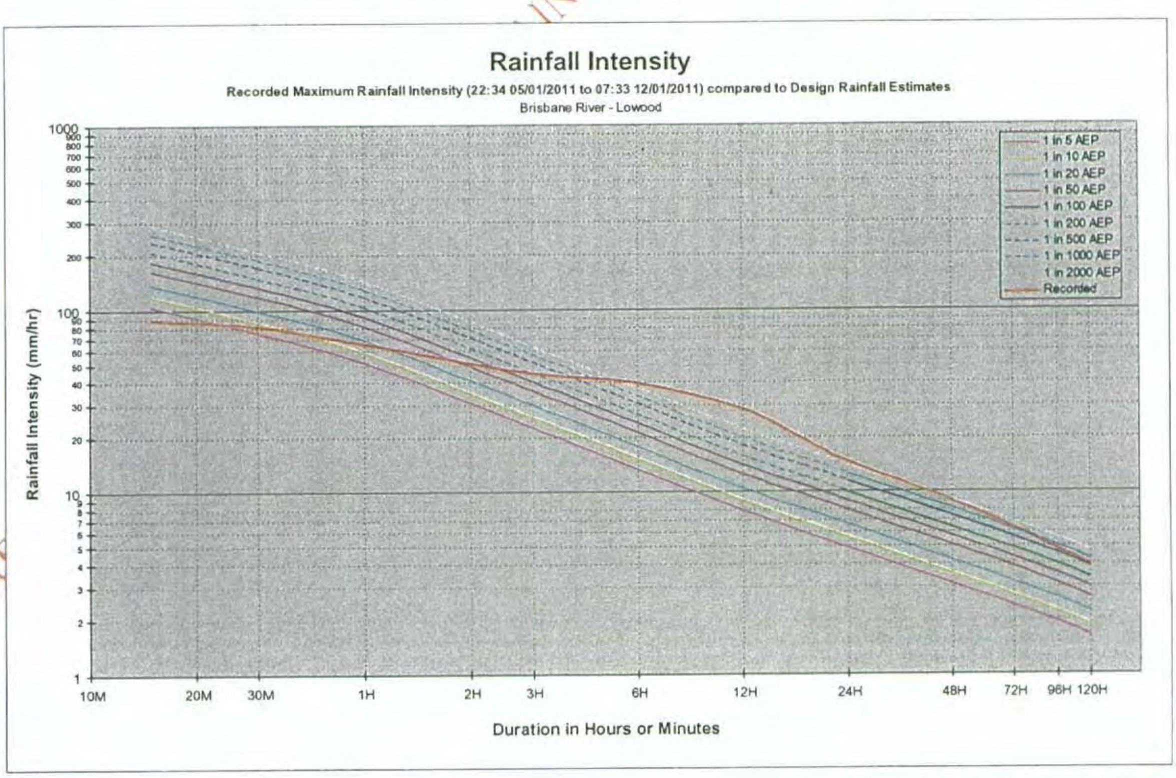

Figure 8.3.7 – Rainfall intensity, Lowood

8 PRELIMINARY ASSESSMENT OF EVENT MAGNITUDE

Bellthorpe West

This station is located in the northern part of the Stanley River catchment, around 35km north-east of Somerset Dam on the catchment boundary with the Mary River. The table in Figure 8.3.8 below highlights that for durations of between 6 and 48 hours, the AEP of the recorded rainfall was between 1 in 50 and 1 in 100. Beyond 48 hours, AEPs were between the 1 in 100 and 1 in 200 range.

Duration	Recorded intensity mm/hr	End time	AEP 1 in Y
15 M	73.2	13:49 09/01/2011	< 5
30 M	59.8	13:49 09/01/2011	< 5
1 H	49.9	14:04 09/01/2011	< 5
3 H	30.4	16:04 09/01/2011	5 - 10
6 H	30.1	19:04 09/01/2011	50 - 100
12 H	20.4	22:19 09/01/2011	50 - 100
18 H	18.0	23:04 09/01/2011	50 - 100
24 H	14.6	04:34 10/01/2011	50 - 100
48 H	10.0	05:04 11/01/2011	50 - 100
72 H	8.4	01:34 12/01/2011	100 - 200
96 H	6.7	13:19 12/01/2011	100 - 200
120 H	5.6	19:49 11/01/2011	100 - 200

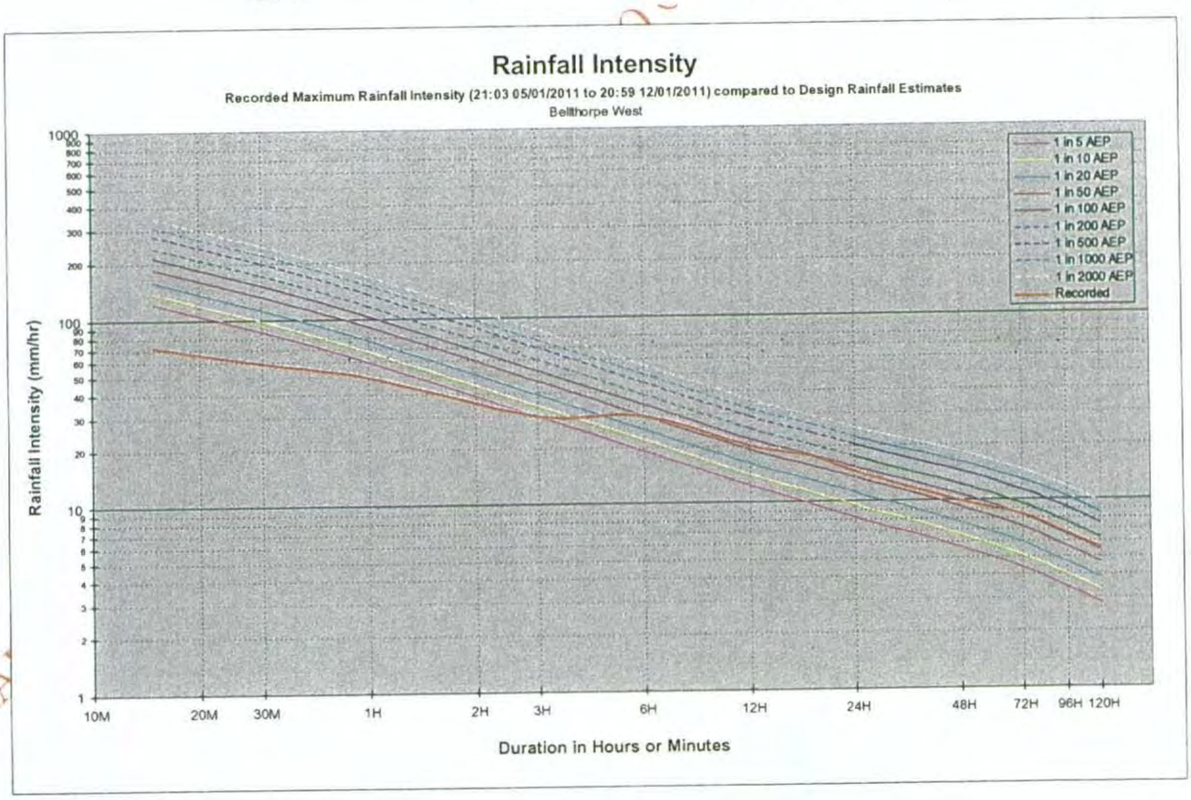

Figure 8.3.8 – Rainfall intensity, Bellthorpe West

8.4 Catchment rainfall Intensity Frequency Duration (IFD) analysis

While Point IFD analysis demonstrates the rainfall intensity in the immediate vicinity of the station, it does not indicate the significance of the rainfall over the entire catchment. The catchment average rainfall is determined by applying a weighting to each station in the network, then adding up the weighted station rainfall for each period of the analysis. Catchment IFD analysis derived using CRC-FORGE is based upon assumed idealised spatial and temporal patterns which can be quite different to the actual Event rainfall distributions.

By their nature, catchment average rainfall intensities tend to be lower than Point intensities due to the spatial variation of rainfall through the catchment with some areas recording higher rainfall than others. This is particularly true for relatively large catchments such as the total Wivenhoe Dam catchment (including Somerset Dam). However, the AEPs for the total Wivenhoe Dam catchment were between the 1 in 100 and 1 in 200 range for rainfall durations between 72 hours and 120 hours, and this fact certainly highlights the significance of the Event.

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Somerset Dam catchment

Although the catchment average rainfall intensities in this catchment were generally less intense than that in the Wivenhoe Dam catchment, AEPs for the Somerset Dam catchment in the 1 in 50 to 1 in 100 range for rainfall durations greater than 48 hours certainly highlight the significance of the Event.

Duration	Recorded intensity mm/hr	End time	AEP 1 in Y
1 H	29.8	11/01/2011 13:00	< 5
3 H	25.8	11/01/2011 13:00	< 5
6 H	20.4	9/01/2011 19:00	10-20
12 H	14.5	9/01/2011 21:00	20-50
18 H	11.8	9/01/2011 22:00	20-50
24 H	9.9	10/01/2011 4:00	20-50
48 H	8.1	11/01/2011 13:00	50-100
72 H	7.0	11/01/2011 19:00	50-100
96 H	5.5	12/01/2011 13:00	50-100
120 H	4.7	11/01/2011 21:00	50-100

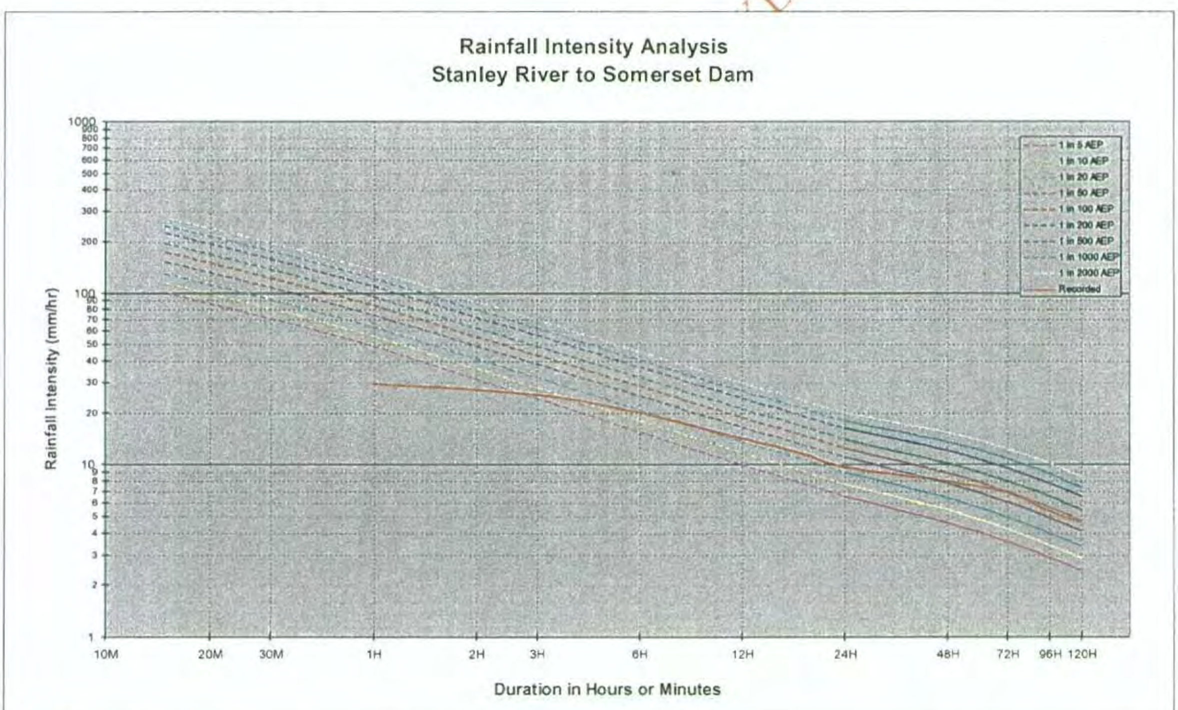

Figure 8.4.1 – Rainfall intensity, Somerset Dam

8 PRELIMINARY ASSESSMENT OF EVENT MAGNITUDE

Wivenhoe Dam catchment (including the Somerset Dam catchment)

The AEPs for the Wivenhoe Dam catchment were between the 1 in 100 and 1 in 200 range for rainfall durations between 72 hours and 120 hours.

Duration	Recorded intensity mm/hr	End time	AEP 1 in Y
1 H	17.5	9/01/2011 15:00	<5
3 H	15.0	9/01/2011 16:00	<5
6 H	13.8	9/01/2011 19:00	10-20
12 H	10.1	9/01/2011 22:00	20-50
18 H	7.9	9/01/2011 23:00	20-50
24 H	6.4	10/01/2011 4:00	20-50
48 H	5.7	11/01/2011 13:00	50-100
72 H	4.7	11/01/2011 19:00	100-200
96 H	3.6	12/01/2011 13:00	100
120 H	3.2	11/01/2011 21:00	100-200

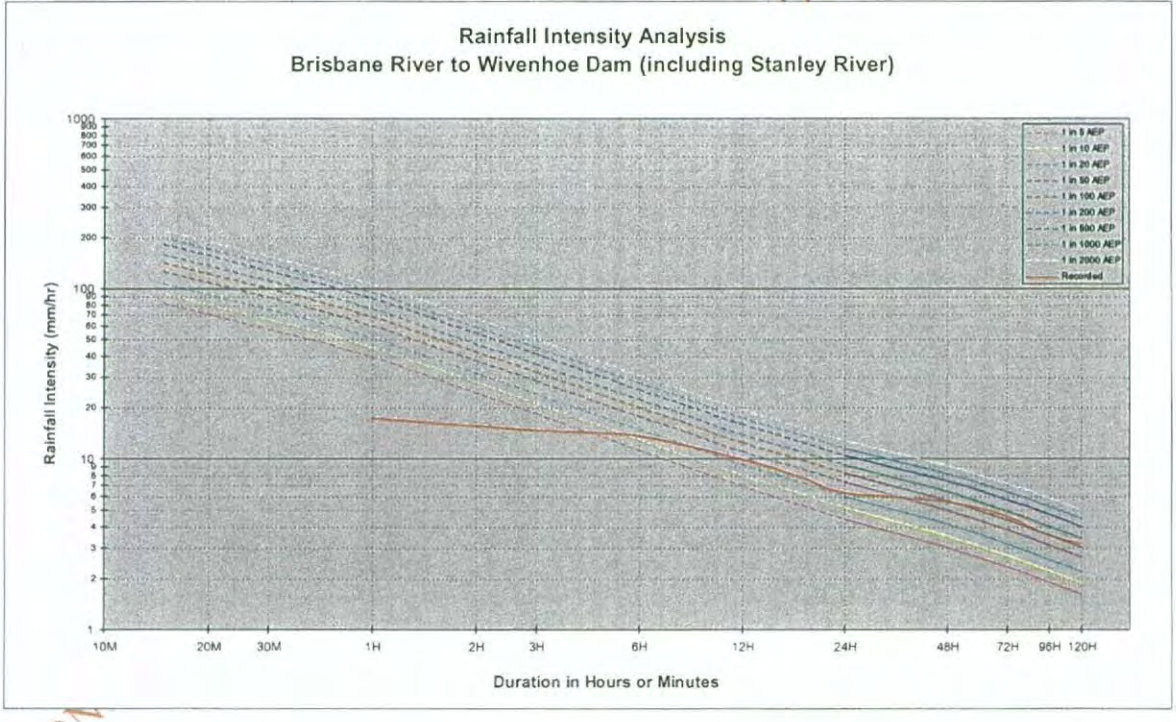

Figure 8.4.2 – Rainfall intensity, Wivenhoe Dam (including Stanley River)

8 PRELIMINARY ASSESSMENT OF EVENT MAGNITUDE

8.5 Comparison of flood volumes

While flood peaks are an important feature for the comparison of events, flood volumes are especially critical in the operation of dams. For this reason, flood volumes were compared. Table 8.5.1 below compares flood volumes across a selection of recent and historical events in the Brisbane River at the location of Wivenhoe Dam. It should be noted that these events occur over different time periods.

Dams have a significant mitigating impact and the construction dates for each Dam in the Basin is:

- Somerset Dam 1955;
- Cressbrook Dam 1982;
- Wivenhoe Dam 1985.

Table 8.5.1 shows that the volume of the January 2011 Flood Event is almost double (190%) the volume of the January 1974 flood and rivals the February 1893 flood. The volumes of pre 1968 floods are estimated from models studies of these events.

Event	Somerset Dam			Wivenhoe Dam			
	Peak elevation	Stanley River	Outflow	Peak elevation	Upper Brisbane River only	Total	Outflow
	m AHD	ML	ML	m AHD	ML	ML	ML
Feb 1893[1]		1,361,000			1,383,000	2,744,000	
Feb1931		150,000			570,000	720,000	
Mar 1955	103.47	390,000	340,000		560,000	900,000	
Jan 1968	na	540,000	380,000		440,000	820,000	
Jan 1974	106.57	620,000	450,000		960,000	1,410,000	
Jun 1983	101.58	260,000	280,000		800,000	1,080,000	470,000
Mar 1989	102.59	370,000	380,000	69.78	310,000	690,000	660,000
Apr 1989	102.69	340,000	350,000	71.45	520,000	870,000	820,000
Feb 1999	102.96	450,000	280,000	70.45	940,000	1,220,000	900,000
May 2009	99.62	110,000	110,000	62.19	125,000	235,000	0
Mar 2010	99.41	210,000	200,000	66.43	190,000	390,000	0
Oct 2010	101.37	250,000	270,000	69.61	360,000	630,000	630,000
Mid Dec 2010	100.42	150,000	140,000	67.50	220,000	360,000	330,000
Late Dec 2010	99.98	120,000	130,000	69.35	370,000	500,000	460,000
Jan 2011	105.11	825,000	820,000	74.97	1,830,000	2,650,000	2,650,000

[1] Only includes first flood and largest flood peak.

Table 8.5.1 – Recent and historical event flood volumes in the Brisbane River at Wivenhoe Dam

8 PRELIMINARY ASSESSMENT OF EVENT MAGNITUDE

8.6 Comparison of flood levels

Table 8.6.1 compares the peak water levels reached during the January 2011 Flood Event with historical floods. The flood of February 1893 is generally regarded as one of the largest on record. Estimates exist of possible larger floods occurring in 1841 and 1867 at the Brisbane Port Office gauge however, there are no records at upstream stations to enable any comparison to be undertaken.

The flood of 1974 is certainly the best documented major flood event impacting Brisbane and provides a useful comparison. The February 1999 flood was larger than the January 1974 flood in the upper Brisbane River however its impact on the urban areas of Ipswich and Brisbane was mitigated by Wivenhoe and Somerset Dams.

A number of points in the table stand out as being significant:

- The peak levels reached at stations in the upper Brisbane River above Wivenhoe Dam were the highest on record;
- Peak water levels reached in the Lockyer Creek area were the highest on record at Gatton, Glenore Grove and Lyons Bridge, easily exceeding the levels reached in the January 1974 and perhaps even the 1893 flood;
- Below Wivenhoe Dam, the level reached at Savages Crossing was around 0.36m higher than in 1974 however the peak level reached at Mt Crosby was around 0.62m lower.
- With a few exceptions, most water levels stations in the Brisbane River basin recorded peak water levels well above major flood level.

ALERT ID	STATION	Feb 1893 m	Jan 1974 m	Feb 1999 m	Jan 2011 m	Jan 2011 Flood Classification	Comments
6776	Peachester		8.43	8.72	9.04	Major	
6703	Woodford	11.73	8.60	9.00	9.44	Major	
6591	Somerset Dam		106.57	102.96	105.11		
6543	Dam Site		9.33	6.06	12.02	Major	Different sites
6718	Linville		8.90	8.93	11.04	Major	Highest on record of 47 years
6709	Devon Hills			10.80	11.25	Major	Highest on record of 24 years
6521	Boat Mountain		9.61	9.22	11.10	Major	Highest on record of 46 years
6515	Gregors Creek		13.65	14.14	14.50	Major	Highest on record of 49 years
6554	Rosentretters			4.64	6.80	Major	Impacted by Cressbrook Dam
6638	Wivenhoe Dam			70.45	74.97		Highest on record
6578	Gatton	16.33	14.63	8.50	>16	Major	May be highest on record
6584	Showground Weir			5.97	9.36	Major	
6557	Glenore Grove		14.94	10.68	15.34	Major	Highest on record of 56 years
6634	Lyons Bridge		16.54	12.55	17.31	Major	Highest on record of 56 years

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ALERT ID	STATION	Feb 1893 m	Jan 1974 m	Feb 1999 m	Jan 2011 m	Jan 2011 Flood Classification	Comments
6647	Lowood Pump Station	26.39	22.02	11.17	22.91		Different sites
6560	Savages Crossing		23.79	11.40	24.15	Major	Higher than 1974
6752	Mt Crosby Weir	32.00	26.74	12.06	26.12	Major	Lower than 1974
6581	Adams Bridge		5.29	3.18	5.05	Moderate	
6734	Rosewood		7.62	5.30	4.91	Minor	
6551	Walloon		8.70	5.66	8.90	Major	ALERT site
6572	Harrisville		6.18	4.20	5.91	Major	
6652	Amberley		10.18	5.34	8.12	Major	ALERT site
2168	Ipswich	24.50	20.70	6.40	15.96	Major	
6755	Moggill		19.95	3.53	17.72	Major	Lower than 1974
6731	Jindalee	17.90	14.10	<4.00	12.90	Major	Lower than 1974
6749	City Gauge	8.35	5.45	<1.70	4.45	Major	Lower than 1974

Table 8.6.1 – January 2011 peak water levels compared with other historical floods

Until the construction of Wivenhoe Dam was completed, BoM operated a flood warning station at Caboonbah, just below the junction of the Stanley and Brisbane Rivers, well upstream of Wivenhoe Dam. Records show levels at this station reached 22.63m in 1893 and 16.32m in 1974, with estimated peak flows of approximately 13,000m^3/s and 5,500m^3/s respectively. The estimated peak flow at this location in the January 2011 Event was at least 8,500m^3/s.

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8.7 Flood frequency analysis

The annual flood series showing the largest flood in a water year (1 October to 30 September) was extracted from the DERM website at 143007a Linville (1966-2005) and 143009a Gregors Creek (1962-2005). A Generalised Extreme Value (GEV) flood frequency analysis of these flows was undertaken, with the results shown below. This analysis is preliminary and is subject to reassessment of the rating at these sites and inclusion of post 2005 records, including records from the January 2011 Flood Event.

The two peaks at each of Linville and Gregors Creek stations associated with the January 2011 Flood Event were significantly higher than any other flood on record. Individually, the pre January 2011 peaks at both stations are considered to be significantly rarer than the AEP of the 1974 flood of 1 in 75. The probability of two new higher flood peaks occurring within 36 hours of each other as occurred during the January 2011 Flood event is considered to be appreciably uncommon and demonstrates the rarity of the January 2011 Flood Event.

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Brisbane River at Linville

Analysis of the data at Linville suggests the 1974 flood had an AEP of around 1 in 75. Given the January 2011 flood peak was more than 2 metres higher than the 1974 flood suggests the January 2011 flood peak was significantly rarer than 1 in 100 AEP.

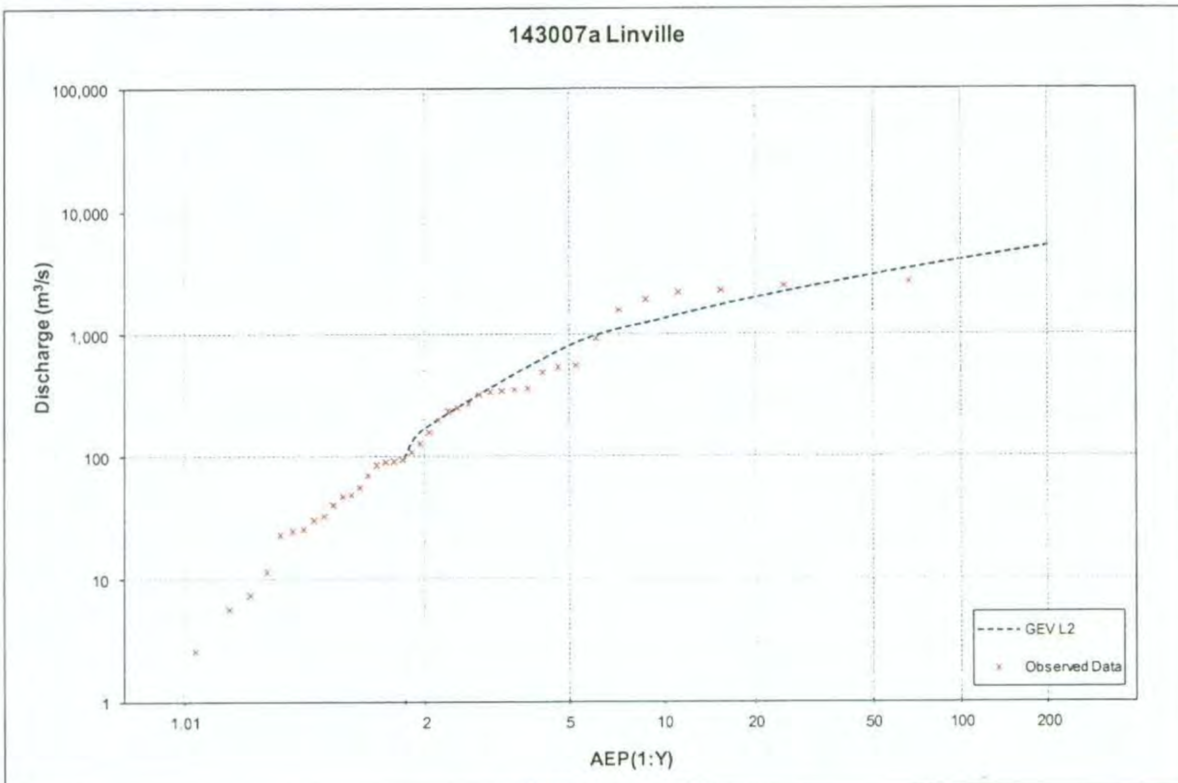

Figure 8.7.1 – Flood frequency analysis, Linville

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Brisbane River at Gregors Creek

Prior to January 2011, the largest recorded flood at Gregors Creek was the January 1974 flood which reached a gauge height of 14.14m. The flood frequency analysis suggests this flood peak had an AEP of about 1 in 75. The January 2011 flood peak at Gregors Creek was some 0.35 metres higher than 1974 suggesting an AEP rarer than 1 in 75.

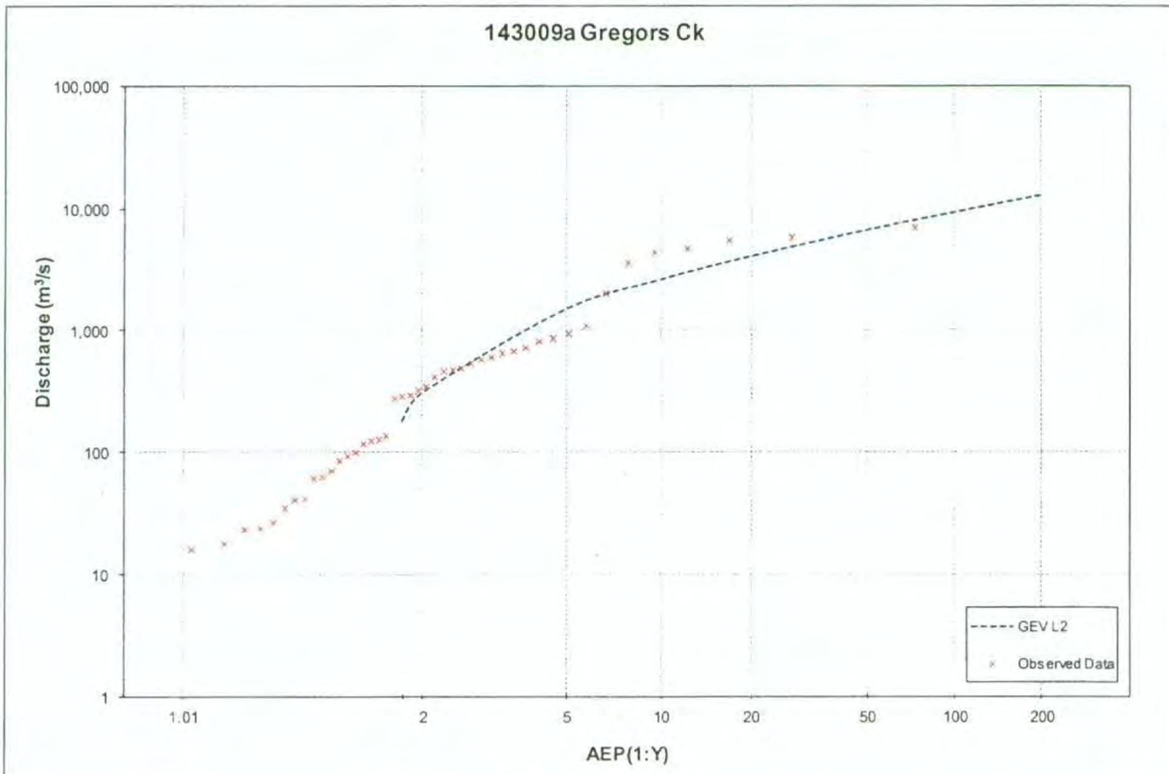

Figure 8.7.2 - Flood frequency analysis, Gregors Creek

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8.8 Design flood comparisons

Some care should be exercised when comparing actual flows and volumes with design flows and volumes. The later are based upon idealised design storms distributed in time and space combined with average catchment conditions. These circumstances are not necessarily directly comparable with actual events such as the January 2011 Flood Event. However, these design cases do provide an indicative comparison.

Somerset Dam

Seqwater undertook a review of the design flood hydrology for Somerset Dam in October 2009 (*Somerset Dam Design Flood Hydrology, Draft Report, October 2009*).

A 48-hour design storm generated a peak inflow of 5,000m^3/s and an inflow volume of around 770,000ML reaching a peak level of 105.19m in a 1 in 1,000 AEP event. This compares with the January 2011 Event that produced a similar peak inflow of about 5,000m^3/s, an inflow volume of 825,000ML and reached a peak level of 105.11m.

Wivenhoe Dam

The design flood hydrology for Wivenhoe Dam was reviewed and upgraded in 2005 (*Wivenhoe Alliance, Design Discharges and Downstream Impacts of the Wivenhoe Dam Upgrade, Q1091, 2005*) as part of the spillway augmentation. Using this report, significant comparisons with the January 2011 Event can be made.

- The report indicates the 36 hour design storm generates the highest peak inflow for all AEPs. The estimated peak inflow of the January 2011 Event was estimated to be around 12,000m^3/s, equating to an AEP of around 1 in 1,000.
- The report also indicates the first fuse would be initiated in an event with an AEP of 1 in 6,000. This is consistent with the peak water level of 74.97m which was reached during the January 2011 Event.
- The report estimated the volumes of the design inflow hydrographs for a range of durations and AEPs. For an AEP of 1 in 2,000, the design inflow volumes range from 2,000,000ML to 2,225,000ML for durations of between 48 and 120 hours. Given the January 2011 Event inflow volume to Wivenhoe Dam was estimated to be 2,650,000ML over eight days, the AEP of the flood volume is around 1 in 2,000.

The design inflow and outflows derived from the Wivenhoe Alliance report are illustrated in Figure 8.8.1 below.

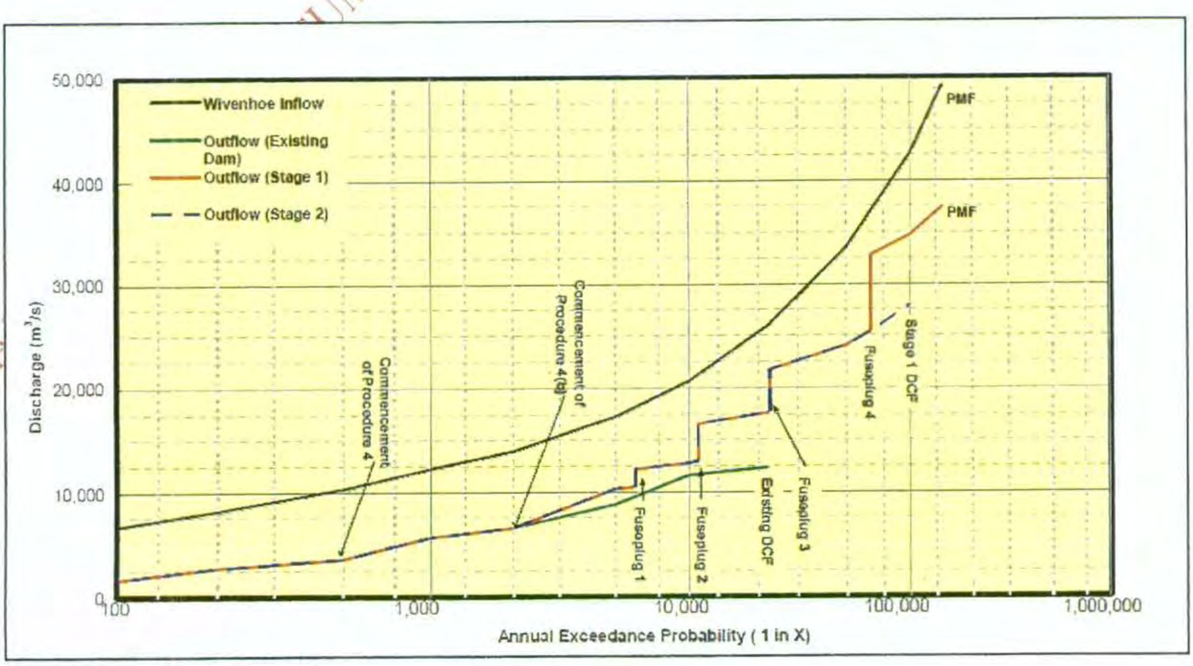

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Figure 8.8.1 – Wivenhoe Alliance report, design inflow and outflows

The 48-hour design flows for Somerset only and Upper Brisbane only flows are contained in Appendix G of the Manual. Comparison of the actual flows with the flows shown in this Appendix also indicates the Event inflows could be considered as a rare occurrence.

8 PRELIMINARY ASSESSMENT OF EVENT MAGNITUDE

8.9 Impact of intense rainfall occurring on Tuesday 11 January 2011

As discussed in Section 6, heavy, localised, intense rainfall around the Wivenhoe Lake area commenced in the early hours of Tuesday 11 January 2011 and continued into the afternoon.

This rainfall was recorded in the rain gauges to the east and south of Lake Wivenhoe, around Mt Glorious and Lowood however, it was not recorded in gauges to the north and west of Wivenhoe Dam. There is a large unmonitored area between these gauges which covers a large component of the Lake area. For modelling purposes, this area is treated as impervious and generates 100% runoff. Radar images at the time indicated rain was falling continuously in this area over the period. Rainfall totals in the 12 hours to 15:00 ranged from 410 millimetres at Mt Glorious in the eastern side of the Lake to only 32 millimetres at Rosentretters on the western side of Lake Wivenhoe.

The real time modelling undertaken with the available recorded rainfall data did not reproduce the rapid rise in Lake level recorded that afternoon. This inferred very heavy rainfall fell within and around the Wivenhoe Dam Lake area immediately upstream of the Dam. This suggestion was tested using the Seqwater URBS model using the following methodology.

The recorded Mt Glorious rainfall was transposed to a dummy station at the centre of the Lake and, for the period of heavy rainfall, scaled up the URBS model re-run and the resultant flows imported into the gate operations spreadsheet. The modelled water levels were then compared with the recorded water levels. Figure 8.9.1 below shows the impact of the scaled rainfall on the modelled upper Brisbane River inflow to Wivenhoe Dam. The peak of the inflow is both much higher and earlier with the transposed dummy rainfall station than without.

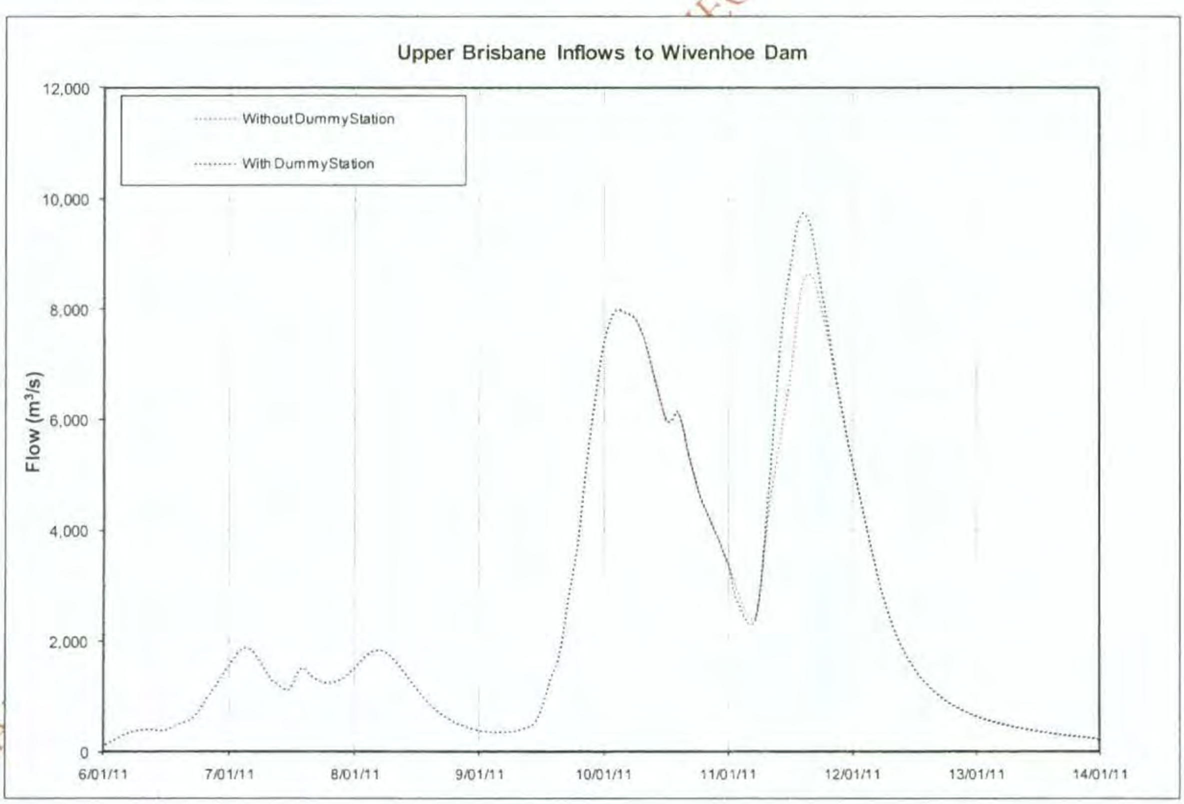

Figure 8.9.1 – Impact of scaled rainfall on the upper Brisbane River inflow to Wivenhoe Dam

The recalculated inflows with the dummy rainfall station more accurately reproduced the recorded water levels than the originally modelled inflows, as shown in Figure 8.9.2 below.

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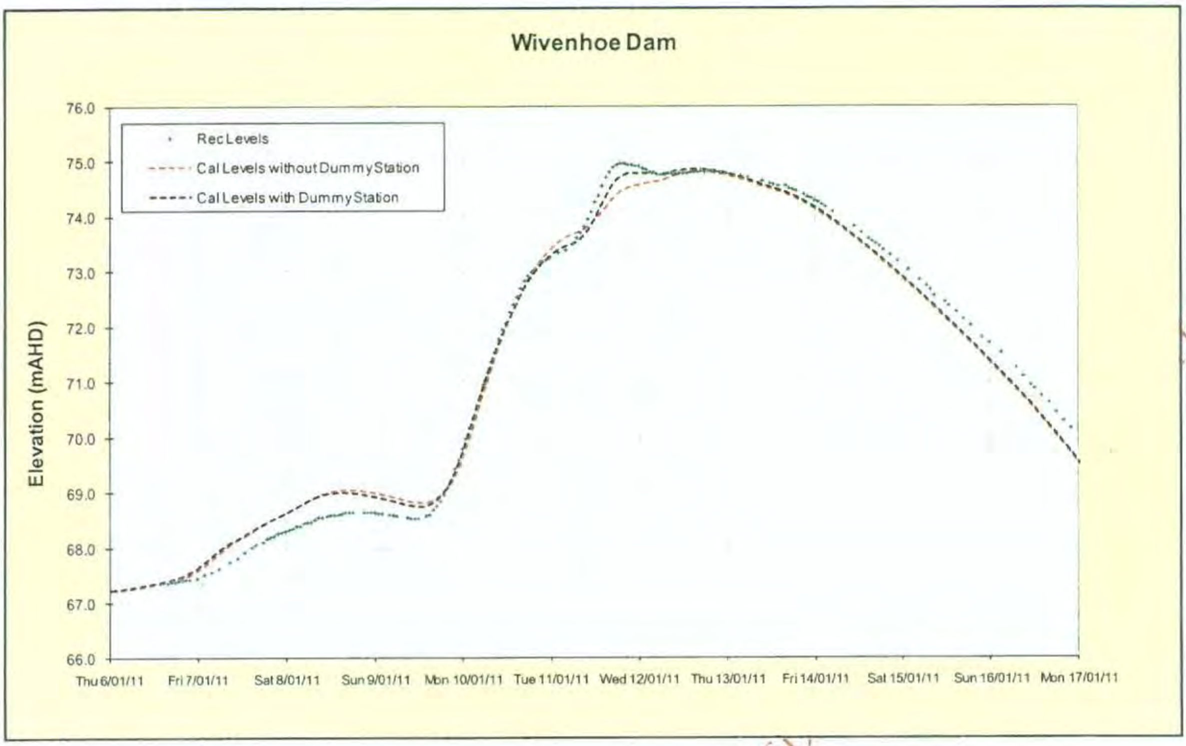

Figure 8.9.2 – Recalculated inflows to Wivenhoe Dam

In order to reproduce the recorded Wivenhoe Dam levels, it was necessary to scale the rainfall of the transposed Mt Glorious data by a factor of two for the period between 03:00 to 15:00 Tuesday 11 January 2011, indicating the significance of the heavy rainfall in the ungauged area immediately upstream of the Dam.

IFD analysis of the rainfall record at Mt Glorious shows the 12 hours to 15:00 Tuesday 11 January 2011 had an average intensity of 33.9mm/hr and was in the range 1 in 500 to 1 in 1,000 AEP, between the large and rare categories.

To model the rapid rise of the recorded Wivenhoe Dam levels between 03:00 to 15:00 on Tuesday 11 January 2011, the Mt Glorious rainfall data was repositioned to the ungauged area immediately upstream of the Dam where BoM radar indicated the centre of the heavy rainfall during that period. It was then necessary to scale this rainfall up by a factor of two to match the rapid lake level rises. This factored Mt Glorious rainfall data had an average intensity of 68mm/hr which exceeds an annual recurrence interval of 1 in 2,000 years and may be well into the extreme category. Rainfall of this intensity and duration over the Wivenhoe Dam Lake area at such a critical stage of a Flood Event was unprecedented. The resulting run-off could not be contained without transition to Strategy W4, as discussed in Section 2 and Section 10.0.

8 PRELIMINARY ASSESSMENT OF EVENT MAGNITUDE

8.10 Wivenhoe Dam and Somerset Dam flood mitigation in Brisbane City

Seqwater's Unified River Basin Simulator (URBS) hydrologic model was used to assess the flood mitigation impact of Somerset and Wivenhoe Dams on flows and water levels at the Port Office gauge in Brisbane City. This hydrologic model consists of seven linked models representing various catchments within the Basin.

During the January 2011 Event, the model overestimated the heights and flows in the lower Brisbane River due to a lack of adequate flood plain storage along the mainstream. The model was adjusted to take into account this flood plain storage and recalibrated on several floods from January 1974 to January 2011, to satisfactorily reproduce recorded heights and estimated flows at gauging stations.

It should be noted that the behaviour of the Brisbane River downstream of Wivenhoe Dam is better simulated using a hydraulic model. However, in the absence of a fully calibrated hydraulic model and being limited by time constraints, the URBS hydrologic model has been used to enable relative comparison of various scenarios. The model was run under five cases as explained in the following Table 8.10.1.

Case number	Case description
1	Actual Wivenhoe Dam outflows combined with Lockyer Creek, Bremer River and other non-controlled catchment flows from the January 2011 Flood Event.
2	Lockyer Creek, Bremer River and other non-controlled catchment flows from the January 2011 Flood Event only.
3	Actual Wivenhoe Dam outflows from the January 2011 Flood Event only.
4	Assumes Wivenhoe Dam removed and uses estimated flows in the Brisbane River at the location of Wivenhoe Dam combined with Lockyer Creek, Bremer River and other non-controlled catchment flows from the January 2011 Flood Event. This case provides an indication of the impacts of the January 2011 Flood Event at Brisbane City if Wivenhoe Dam had not been constructed.
5	Assumes both Wivenhoe Dam and Somerset Dam removed and uses estimated flows in the Brisbane River at the location of Wivenhoe Dam combined with Lockyer Creek, Bremer River and other non-controlled catchment flows from the January 2011 Flood Event. This case provides an indication of the impacts of the January 2011 Flood Event at Brisbane City if both Wivenhoe Dam and Somerset Dam had not been constructed.

Table 8.10.1 – Comparison of modelled flood scenarios

For Case 4 and Case 5, the models containing the Dams were modified to remove the impervious fractions representing the reservoir areas. In addition, the reach length factors for the drowned reaches in the post Dam models were removed as appropriate for each case.

While the model does not replicate levels in the normal tidal ranges, it does replicate the higher flood stages under tidal conditions reasonably well. For all cases, the downstream tidal conditions recorded during the Event were adopted.

The results of the model runs containing these five cases are displayed in the following graphs, Figure 8.10.2 and Figure 8.10.3. Points not in relation to these results are:

- Inflows to the river system can not be directly added together due to the storage and routing impact of the flood plain and the river channels;
- The peak height at Brisbane City (Port Office gauge) generally coincides with the highest tide of the day, in the cases investigated;
- Even if the flood flows in the Stanley River and upper Brisbane River had been contained, and there were no releases from Wivenhoe Dam (Case 2), the flows from Lockyer Creek, Bremer River and other uncontrolled catchment flows would still have exceeded the threshold of urban damages;

8 PRELIMINARY ASSESSMENT OF EVENT MAGNITUDE

- If there had not been any flows from Lockyer Creek, Bremer River and the other uncontrolled catchments, the actual releases from Wivenhoe Dam (Case 3) would have caused only minor flooding in Brisbane City;
- Without Wivenhoe Dam (Case 4), the peak flow would have been of the order of 12,000m^3/s and the peak height would have been in the order of 2.0m higher at Brisbane City;
- Without Somerset and Wivenhoe Dams (Case 5), the peak flow would have been of the order of 14,000m^3/s and the peak height would have been around 2.5m higher at the Port Office gauge.

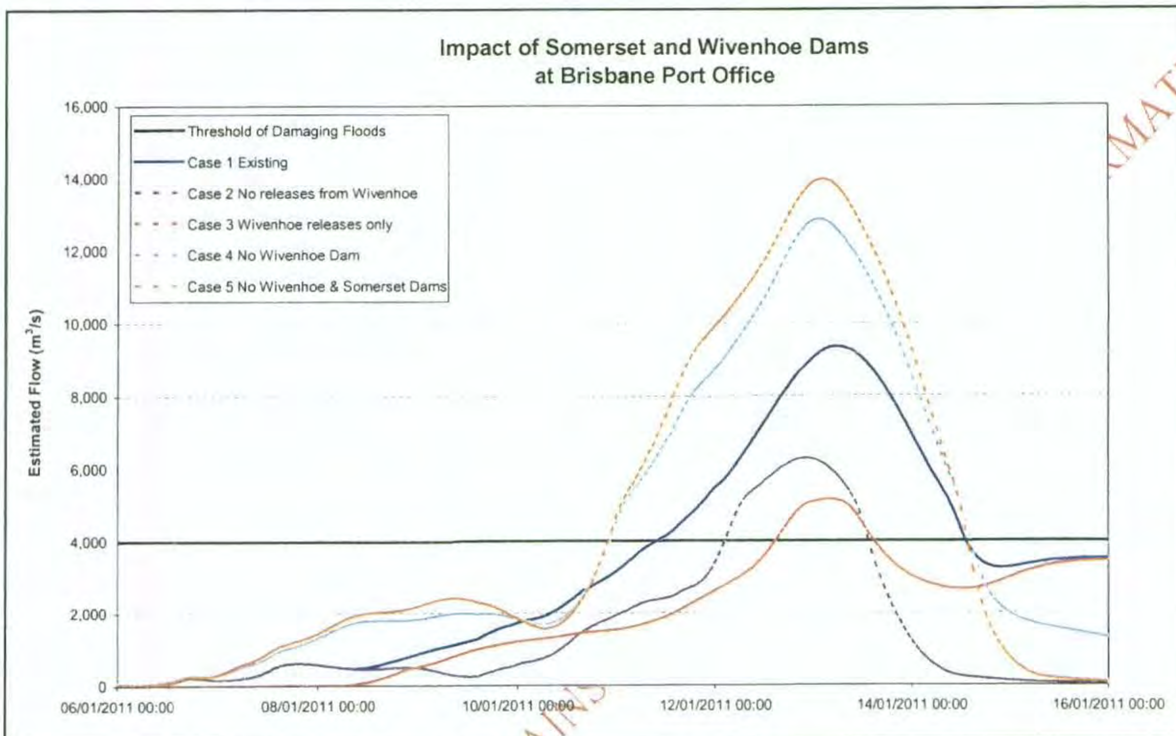

Figure 8.10.2 – Impact of Somerset and Wivenhoe Dams at Brisbane Port Office, showing estimated flow

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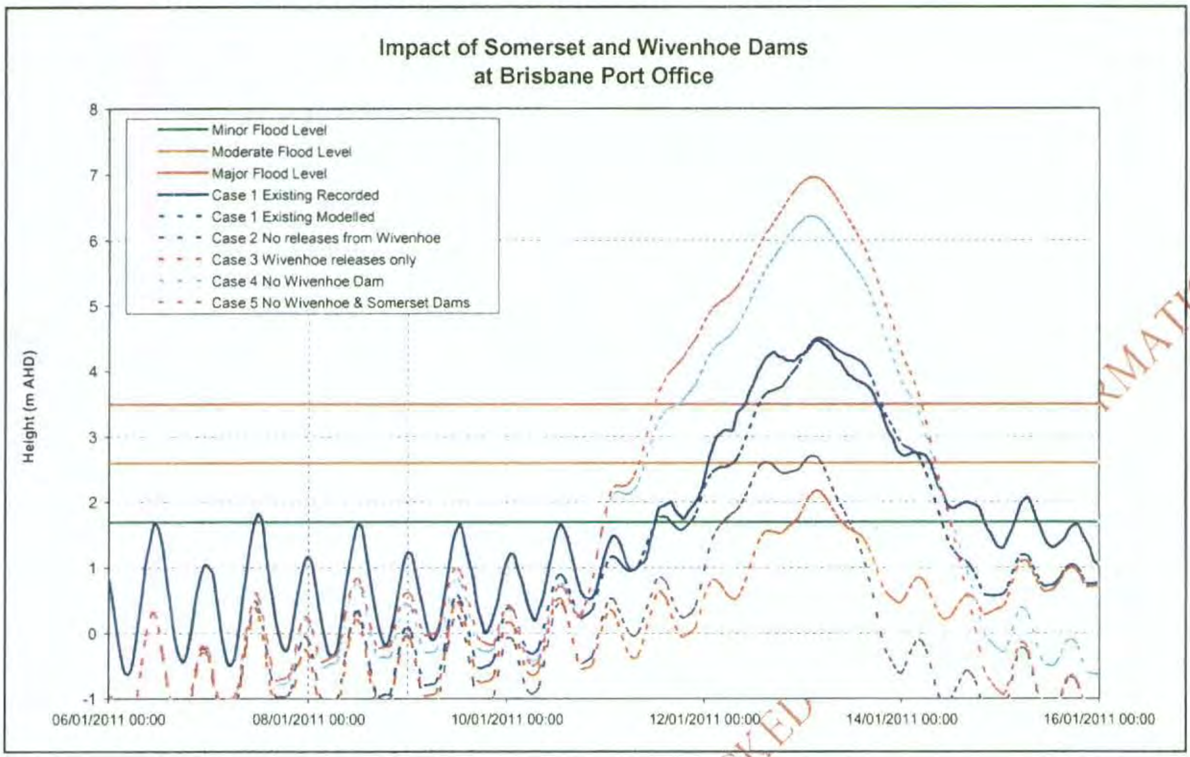

Figure 8.10.3 – Impact of Somerset and Wivenhoe Dams at Brisbane Port Office, showing peak height

The duration above selected thresholds was also extracted from the model runs as duration of flooding has an adverse impact on flood damages, with longer durations causing greater costs for the same peak flow.

The threshold of damaging floods in the lower Brisbane River is defined in the Flood Procedure Manual as 4,000m^3/s, and this has been adopted for comparative purposes. The flow of 9,500m^3/s is the estimated peak flow of the January 2011 Flood Event at the Port Office gauge.

In Cases 4 and 5, the duration of flooding at the Port Office gauge would have been much longer than actually occurred. The duration above 4,000m^3/s is appreciably longer than recorded. However, the duration of the flow above the peak of the January 2011 Flood Event would have been much as two days longer.

Table 8.10.4 shows the duration of flooding above the selected threshold for the cases investigated.

Case	Duration above flow threshold (Hours)			
	4,000 m^3/s	6,000 m^3/s	8,000 m^3/s	9,500 m^3/s
Case 1 Existing	75	48	26	0
Case 2 No releases from Wivenhoe	35	12	0	0
Case 3 Wivenhoe releases only	24	0	0	0
Case 4 No Wivenhoe Dam	88	72	55	39
Case 5 No Wivenhoe Dam or Somerset Dam	87	75	61	51

Table 8.10.4 – Duration of flooding above the flow threshold

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8.11 Conclusion

Based on the information contained in this section, the following conclusions can be made in relation to the significance of the January 2011 Flood Event.

- The rainfall intensities varied significantly in the catchment areas above the Dams, although at some locations – especially around Wivenhoe Dam - the AEP of the short duration rainfalls may be classified as extreme;
- The AEPs for the Wivenhoe Dam average catchment rainfall were between the 1 in 100 and the 1 in 200 range for durations between 72 hours and 120 hours, clearly highlighting the significance of the Event;
- When compared with historical events, flood volumes indicate the volume of the January 2011 Event is almost double that of the January 1974 flood, and rivals the February 1893 flood;
- Peak water levels at gauging stations in the Brisbane River above Wivenhoe Dam were the highest on record. In the Lockyer Valley, peak water levels exceeded the 1974 levels and may well have been larger than those of 1893;
- Preliminary flood frequency analysis of records at Linville and Gregors Creek indicated there were two peaks of similar magnitude in the January 2011 Event at both Linville and Gregors Creek. Preliminary flood frequency analysis indicates the highest peak at both stations were significantly rarer than the generally accepted AEP of the 1974 flood of 1 in 75 (approaching 1 in 100). The probability of two such flood peaks within 36 hours of each other is considered to be appreciably uncommon and demonstrates the rarity of the January 2011 Flood Event;
- A comparison of the recorded peaks, volumes and peak levels at Somerset and Wivenhoe Dams indicate the January 2011 Flood Event easily exceeds 1 in 100 AEP;
- Below Wivenhoe Dam, the flood had an AEP similar to that of the post Wivenhoe 1974 flood and may be as high as 1 in 1,000;
- Overall, the January 2011 Flood Event is considered to represent a rare event as defined by Australian Rainfall and Run-off (AR&R) in terms of rainfall, flood peaks, inflow volume and peak heights.

9

9 DAM INFLOW AND FLOOD RELEASE DETAILS

9.1 Wivenhoe Dam

Table 9.1.1 provides full details of inflows into and releases from Wivenhoe Dam for the duration of the January 2011 Flood Event. Details of the strategies used in determining these releases and how these strategies comply with the Manual are contained in Section 7 of this Report. Table 9.1.1 also shows the gate operation sequence was in accordance with the Manual over the duration of the Event.

Some points to note in relation to the table in Table 9.1.1 are:

- Inflow and flood release calculations are based on manual gauge board readings shown in the table that provide the lake level. During the Event, these manual gauge board readings were provided by the Dam operators to the Flood Operations Centre on an hourly basis. Any missed readings have been interpolated from the closest available actual readings.
- Inflow calculations are based on the rate of change of the storage and use the Dam storage curve.
- Release calculations are based on the discharge rating tables contained in the Manual.
- The table shows inflow rates and releases on the hour through the event. In some instances, gate operations may have occurred between hours or at less than one-hourly intervals. In these instances, the table shows the actual gate openings as they were at the time indicated.

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Date/time	Lake level	Storage volume	Net inflow (outflow deducted)		Hydro	Gate settings					Gate discharges					Total outflow	Total inflow	Total inflow minus Somerset outflow
						1	2	3	4	5	1	2	3	4	5			
	m AHD	ML	ML	m^3/s	m^3/s	m	m	m	m	m	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
06/01/2011 09:00	67.32	1200019	458	127	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	406	0
06/01/2011 10:00	67.33	1201119	1283	356	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	177	0
06/01/2011 11:00	67.34	1202219	458	127	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	177	0
06/01/2011 12:00	67.34	1202219	458	127	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	406	0
06/01/2011 13:00	67.35	1203319	1283	356	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	177	0
06/01/2011 14:00	67.36	1204418	458	127	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	152	0
06/01/2011 15:00	67.36	1204418	367	102	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	559	0
06/01/2011 16:00	67.37	1205518	1833	509	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	534	0
06/01/2011 17:00	67.39	1207718	1741	484	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	330	0
06/01/2011 18:00	67.40	1208817	1008	280	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	355	0
06/01/2011 19:00	67.41	1209917	1100	305	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	355	0
06/01/2011 20:00	67.42	1211017	1100	305	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	355	0
06/01/2011 21:00	67.43	1212117	1100	305	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	355	0
06/01/2011 22:00	67.44	1213216	1100	305	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	305	0
06/01/2011 23:00	67.45	1214316	916	255	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	660	0
07/01/2011 00:00	67.46	1215416	2197	610	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	1047	0
07/01/2011 01:00	67.49	1218715	3590	997	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	798	0
07/01/2011 02:00	67.52	1222047	2692	748	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	800	0
07/01/2011 03:00	67.54	1224279	2698	750	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	980	0
07/01/2011 04:00	67.57	1227627	3348	930	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	1135	0
07/01/2011 05:00	67.60	1230975	3906	1085	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	1342	100
07/01/2011 06:00	67.64	1235438	4650	1292	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	1109	0
07/01/2011 07:00	67.68	1239902	3813	1059	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	1134	0
07/01/2011 08:00	67.71	1243250	3902	1084	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	1167	0

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage volume	Net inflow (outflow deducted)		Hydro	Gate settings					Gate discharges					Total outflow	Total inflow	Total inflow minus Somerset outflow
						1	2	3	4	5	1	2	3	4	5			
	m AHD	ML	ML	m^3/s	m^3/s	m	m	m	m	m	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
07/01/2011 09:00	67.75	1247714	4023	1117	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	864	0
07/01/2011 10:00	67.78	1251110	2930	814	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	1648	389
07/01/2011 11:00	67.81	1254506	5754	1598	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	2225	970
07/01/2011 12:00	67.88	1262429	7829	2175	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	1778	528
07/01/2011 13:00	67.94	1269221	6222	1728	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	1472	11
07/01/2011 14:00	67.99	1274881	5118	1422	50	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	1139	0
07/01/2011 15:00	68.03	1279457	3920	1089	13	0.0	0.0	0.5	0.0	0.0	0	0	51	0	0	51	995	0
07/01/2011 16:00	68.06	1282901	3350	930	13	0.0	0.0	1.0	0.0	0.0	0	0	103	0	0	103	1020	0
07/01/2011 17:00	68.09	1286345	3253	904	13	0.0	0.0	1.5	0.0	0.0	0	0	154	0	0	154	1523	124
07/01/2011 18:00	68.12	1289789	4879	1355	13	0.0	0.0	2.0	0.0	0.0	0	0	205	0	0	205	1360	0
07/01/2011 19:00	68.17	1295530	4114	1143	13	0.0	0.0	2.5	0.0	0.0	0	0	255	0	0	255	958	0
07/01/2011 20:00	68.19	1297826	2486	691	13	0.0	0.0	3.0	0.0	0.0	0	0	303	0	0	303	1514	173
07/01/2011 21:00	68.22	1301270	4312	1198	13	0.0	0.0	3.5	0.0	0.0	0	0	351	0	0	351	1300	0
07/01/2011 22:00	68.26	1305878	3371	936	13	0.0	0.5	3.5	0.0	0.0	0	52	351	0	0	403	1387	85
07/01/2011 23:00	68.28	1308206	3496	971	13	0.0	0.5	3.5	0.5	0.0	0	52	352	52	0	456	1519	234
08/01/2011 00:00	68.32	1312862	3783	1051	13	0.0	1.0	3.5	0.5	0.0	0	104	352	52	0	509	818	0
08/01/2011 01:00	68.34	1315190	1067	296	13	0.0	1.0	3.5	1.0	0.0	0	104	353	104	0	561	1841	593
08/01/2011 02:00	68.35	1316354	4559	1266	13	0.5	1.0	3.5	1.0	0.0	52	104	353	104	0	614	1624	393
08/01/2011 03:00	68.41	1323339	3589	997	13	0.5	1.0	3.5	1.0	0.5	52	105	354	105	52	667	1246	36
08/01/2011 04:00	68.41	1323339	2037	566	13	0.5	1.5	3.5	1.0	0.5	52	156	354	105	52	719	1622	428
08/01/2011 05:00	68.45	1327995	3201	889	13	0.5	1.5	3.5	1.5	0.5	52	157	354	157	52	773	1135	0
08/01/2011 06:00	68.46	1329159	1258	350	13	1.0	1.5	3.5	1.5	0.5	105	157	355	157	52	825	1867	709
08/01/2011 07:00	68.48	1331487	3701	1028	13	1.0	1.5	3.5	1.5	1.0	105	157	355	157	105	879	2144	1003
08/01/2011 08:00	68.52	1336176	4509	1253	13	1.0	1.5	4.0	1.5	1.0	105	157	402	157	105	927	1515	393

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage volume	Net inflow (outflow deducted)		Hydro	Gate settings					Gate discharges					Total outflow	Total inflow	Total inflow minus Somerset outflow
						1	2	3	4	5	1	2	3	4	5			
	m AHD	ML	ML	m³/s	m³/s	m	m	m	m	m	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s
08/01/2011 09:00	68.55	1339718	2069	575	13	1.0	2.0	4.0	1.5	1.0	105	209	403	157	105	980	1649	543
08/01/2011 10:00	68.56	1340899	2361	656	13	1.0	2.0	4.0	2.0	1.0	105	209	403	209	105	1031	1755	665
08/01/2011 11:00	68.59	1344441	2558	711	13	1.5	2.0	4.0	2.0	1.0	158	209	404	209	105	1085	1399	109
08/01/2011 12:00	68.60	1345622	1082	301	13	1.5	2.0	4.0	2.0	1.5	158	209	404	209	158	1138	1260	0
08/01/2011 13:00	68.61	1346802	394	109	13	1.5	2.5	4.0	2.0	1.5	158	260	404	209	158	1189	1530	279
08/01/2011 14:00	68.61	1346802	1181	328	13	1.5	2.5	4.0	2.5	1.5	158	260	404	260	158	1239	1799	574
08/01/2011 15:00	68.63	1349164	1968	547	13	1.5	2.5	4.0	2.5	1.5	158	260	404	260	158	1240	1581	157
08/01/2011 16:00	68.64	1350345	1181	328	13	1.5	2.5	4.0	2.5	1.5	158	260	405	260	158	1241	1418	12
08/01/2011 17:00	68.65	1351525	590	164	13	1.5	2.5	4.0	2.5	1.5	158	260	405	260	158	1242	1227	0
08/01/2011 18:00	68.65	1351525	-98	-27	13	1.5	2.5	4.0	2.5	1.5	158	260	405	260	158	1242	1255	0
08/01/2011 19:00	68.65	1351525	0	0	13	1.5	2.5	4.0	2.5	1.5	158	260	405	260	158	1242	1255	0
08/01/2011 20:00	68.65	1351525	0	0	13	1.5	2.5	4.0	2.5	1.5	158	260	405	260	158	1242	1255	0
08/01/2011 21:00	68.65	1351525	0	0	13	1.5	2.5	4.0	2.5	1.5	158	260	405	260	158	1242	1282	0
08/01/2011 22:00	68.65	1351525	98	27	13	1.5	2.5	4.0	2.5	1.5	158	260	405	260	158	1242	1091	0
08/01/2011 23:00	68.65	1351525	-590	-164	13	1.5	2.5	4.0	2.5	1.5	158	260	405	260	158	1242	899	0
09/01/2011 00:00	68.64	1350345	-1279	-355	13	1.5	2.5	4.0	2.5	1.5	158	260	405	260	158	1241	926	0
09/01/2011 01:00	68.63	1349164	-1181	-328	13	1.5	2.5	4.0	2.5	1.5	158	260	404	260	158	1240	925	0
09/01/2011 02:00	68.62	1347983	-1181	-328	13	1.5	2.5	4.5	2.5	1.5	158	260	450	260	158	1286	943	0
09/01/2011 03:00	68.61	1346802	-1279	-355	13	1.5	2.5	4.5	2.5	1.5	158	260	450	260	158	1285	1189	0
09/01/2011 04:00	68.60	1345622	-394	-109	13	1.5	2.5	4.5	2.5	1.5	158	260	450	260	158	1285	970	0
09/01/2011 05:00	68.60	1345622	-1181	-328	13	2.0	2.5	4.5	2.5	1.5	209	260	450	260	158	1336	802	0
09/01/2011 06:00	68.58	1343260	-1968	-547	13	2.0	2.5	4.5	2.5	1.5	209	259	449	259	158	1335	1047	0
09/01/2011 07:00	68.57	1342080	-1082	-301	13	2.0	2.5	4.5	2.5	1.5	209	259	449	259	158	1334	1046	0
09/01/2011 08:00	68.56	1340899	-1082	-301	13	2.0	2.5	4.5	2.5	1.5	209	259	449	259	157	1334	773	0

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage volume	Net inflow (outflow deducted)		Hydro	Gate settings					Gate discharges					Total outflow	Total inflow	Total inflow minus Somerset outflow
						1	2	3	4	5	1	2	3	4	5			
	m AHD	ML	ML	m^3/s	m^3/s	m	m	m	m	m	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
09/01/2011 09:00	68.55	1339718	-2066	-574	13	2.0	2.5	4.5	2.5	1.5	209	259	449	259	157	1333	1182	0
09/01/2011 10:00	68.53	1337357	-590	-164	13	2.0	2.5	4.5	2.5	1.5	209	259	448	259	157	1332	1536	310
09/01/2011 11:00	68.54	1338538	689	191	13	2.0	2.5	4.5	2.5	1.5	209	259	448	259	157	1332	1646	438
09/01/2011 12:00	68.54	1338538	1082	301	13	2.0	2.5	4.5	2.5	2.0	209	259	448	259	209	1384	2080	891
09/01/2011 13:00	68.56	1340899	2460	683	13	2.0	2.5	4.5	2.5	2.0	209	259	449	259	209	1385	2054	882
09/01/2011 14:00	68.58	1343260	2361	656	13	2.0	2.5	4.5	2.5	2.0	209	259	449	259	209	1386	3448	2292
09/01/2011 15:00	68.61	1346802	7377	2049	13	2.0	2.5	4.5	2.5	2.0	209	260	450	260	209	1388	4136	2996
09/01/2011 16:00	68.70	1357429	9846	2735	13	2.0	2.5	4.5	2.5	2.0	210	261	452	261	210	1394	3946	2821
09/01/2011 17:00	68.77	1365725	9139	2539	13	2.0	2.5	4.5	2.5	2.0	211	262	453	262	211	1398	4733	3624
09/01/2011 18:00	68.86	1376494	11959	3322	13	2.0	2.5	4.5	2.5	2.0	212	263	455	263	212	1404	5454	4362
09/01/2011 19:00	68.97	1389656	14533	4037	13	2.0	2.5	4.5	2.5	2.0	213	264	458	264	213	1411	5848	4768
09/01/2011 20:00	69.10	1405370	15925	4424	13	2.0	2.5	4.5	2.5	2.0	214	265	461	265	214	1419	7338	6276
09/01/2011 21:00	69.24	1422345	21263	5906	13	2.0	2.5	4.5	2.5	2.0	215	267	464	267	215	1428	7659	6610
09/01/2011 22:00	69.44	1446897	22385	6218	13	2.0	2.5	4.5	2.5	2.0	217	269	468	269	217	1440	7646	6611
09/01/2011 23:00	69.60	1466712	22294	6193	13	2.0	2.5	4.5	2.5	2.0	218	271	471	271	218	1450	7935	6913
10/01/2011 00:00	69.80	1491685	23298	6472	13	2.0	2.5	4.5	2.5	2.0	220	273	475	273	220	1462	7936	6925
10/01/2011 01:00	69.97	1513125	23260	6461	13	2.0	2.5	4.5	2.5	2.0	222	275	479	275	222	1473	8449	7451
10/01/2011 02:00	70.17	1538617	25068	6963	13	2.5	2.5	4.5	2.5	2.0	277	277	483	277	223	1539	8732	7746
10/01/2011 03:00	70.36	1563055	25850	7181	13	2.5	2.5	4.5	2.5	2.5	280	280	487	280	280	1605	9133	8159
10/01/2011 04:00	70.57	1590316	27054	7515	13	2.5	3.0	4.5	2.5	2.5	282	336	491	282	282	1672	8759	7797
10/01/2011 05:00	70.77	1616520	25465	7074	13	2.5	3.0	4.5	3.0	2.5	284	338	495	338	284	1740	8933	7980
10/01/2011 06:00	70.96	1641685	25847	7180	13	2.5	3.5	4.5	3.0	2.5	286	395	499	341	286	1806	9312	8372
10/01/2011 07:00	71.16	1668426	26972	7492	13	2.5	3.5	4.5	3.5	2.5	288	398	503	398	288	1875	9351	8418
10/01/2011 08:00	71.36	1695406	26868	7463	13	3.0	3.5	4.5	3.5	2.5	346	401	507	401	290	1944	10095	9174

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage volume	Net inflow (outflow deducted)		Hydro	Gate settings					Gate discharges					Total outflow	Total inflow	Total inflow minus Somerset outflow
						1	2	3	4	5	1	2	3	4	5			
	m AHD	ML	ML	m³/s	m³/s	m	m	m	m	m	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s
10/01/2011 09:00	71.56	1722624	29297	8138	13	3.0	3.5	4.5	3.5	3.0	349	404	511	404	349	2015	9731	8820
10/01/2011 10:00	71.78	1752854	27732	7703	13	3.0	3.5	4.5	3.5	3.0	351	407	515	407	351	2031	7267	6363
10/01/2011 11:00	71.95	1776448	18801	5222	13	3.0	3.5	4.5	3.5	3.0	353	409	518	409	353	2044	8059	7165
10/01/2011 12:00	72.07	1793215	21609	6002	13	3.0	3.5	4.5	3.5	3.0	355	411	521	411	355	2053	9026	8139
10/01/2011 13:00	72.26	1819906	25055	6960	13	3.0	3.5	4.5	3.5	3.0	357	414	524	414	357	2067	7384	6504
10/01/2011 14:00	72.41	1841210	19096	5304	13	3.0	3.5	4.5	3.5	3.0	359	416	527	416	359	2077	7856	6983
10/01/2011 15:00	72.54	1859739	20755	5765	13	3.0	3.5	4.5	3.5	3.0	361	418	529	418	361	2087	8411	7544
10/01/2011 16:00	72.70	1882728	22719	6311	13	3.0	4.0	4.5	3.5	3.0	363	477	532	420	363	2155	6568	5708
10/01/2011 17:00	72.84	1902994	15842	4401	13	3.0	4.0	5.0	4.0	3.0	364	479	590	479	364	2277	5116	4262
10/01/2011 18:00	72.92	1914623	10174	2826	13	3.5	4.0	5.0	4.0	3.5	423	480	592	480	423	2399	5286	4437
10/01/2011 19:00	72.99	1924798	10347	2874	13	3.5	4.5	5.0	4.5	3.5	424	538	593	538	424	2517	4946	4102
10/01/2011 20:00	73.06	1935072	8697	2416	13	4.5	4.5	5.0	4.5	4.0	539	539	595	539	483	2695	4920	4081
10/01/2011 21:00	73.11	1942421	7963	2212	13	4.5	4.5	5.0	4.5	4.0	540	540	596	540	484	2699	5026	4189
10/01/2011 22:00	73.17	1951241	8328	2313	13	4.5	4.5	5.0	4.5	4.0	541	541	597	541	484	2705	4488	3656
10/01/2011 23:00	73.22	1958590	6372	1770	13	4.5	4.5	5.0	4.5	4.0	542	542	598	542	485	2709	4574	3745
11/01/2011 00:00	73.26	1964486	6666	1852	13	4.5	4.5	5.0	4.5	4.0	543	543	599	543	486	2713	4654	3827
11/01/2011 01:00	73.31	1971917	6940	1928	13	4.5	4.5	5.0	4.5	4.0	544	544	600	544	487	2717	4175	3349
11/01/2011 02:00	73.35	1977862	5202	1445	13	4.5	4.5	5.0	4.5	4.0	544	544	601	544	487	2721	3594	2769
11/01/2011 03:00	73.38	1982321	3096	860	13	4.5	4.5	5.0	4.5	4.0	545	545	601	545	488	2724	4388	3564
11/01/2011 04:00	73.40	1985294	5944	1651	13	4.5	4.5	5.0	4.5	4.0	545	545	602	545	488	2726	4974	4151
11/01/2011 05:00	73.46	1994211	8046	2235	13	4.5	4.5	5.0	4.5	4.0	546	546	603	546	489	2731	5866	5043
11/01/2011 06:00	73.51	2001658	11238	3122	13	4.5	4.5	5.0	4.5	4.0	547	547	604	547	490	2736	6817	5995
11/01/2011 07:00	73.61	2016681	14644	4068	13	4.5	4.5	5.0	4.5	4.0	549	549	606	549	492	2745	6802	5981
11/01/2011 08:00	73.70	2030202	14560	4044	13	4.5	4.5	5.0	4.5	4.0	551	551	608	551	493	2753	8060	7240

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage volume	Net inflow (outflow deducted)		Hydro	Gate settings					Gate discharges					Total outflow	Total inflow	Total inflow minus Somerset outflow
						1	2	3	4	5	1	2	3	4	5			
	m AHD	ML	ML	m³/s	m³/s	m	m	m	m	m	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s
11/01/2011 09:00	73.81	2046825	19060	5294	0	4.5	5.0	5.5	5.0	4.5	553	610	666	610	553	2991	9165	8346
11/01/2011 10:00	73.95	2068085	22223	6173	0	5.5	5.5	5.5	5.5	5.5	669	669	669	669	669	3347	10376	9558
11/01/2011 11:00	74.10	2091030	25305	7029	0	5.5	6.0	6.0	6.0	5.5	673	729	729	729	673	3533	9606	8789
11/01/2011 12:00	74.27	2117163	21862	6073	0	6.0	6.0	6.0	6.0	6.0	733	733	733	733	733	3667	10120	9508
11/01/2011 13:00	74.39	2135795	23231	6453	0	7.0	7.0	7.0	7.0	7.0	850	850	850	850	850	4250	11561	10950
11/01/2011 14:00	74.57	2163861	26320	7311	0	7.5	7.5	7.5	7.5	7.5	912	912	912	912	912	4562	9739	9128
11/01/2011 15:00	74.71	2185835	18638	5177	0	8.5	8.5	8.5	8.5	8.5	1033	1033	1033	1033	1033	5167	9055	8444
11/01/2011 16:00	74.81	2201636	13999	3889	0	9.5	9.5	9.5	9.5	9.5	1157	1157	1157	1157	1157	5786	8947	8337
11/01/2011 17:00	74.89	2214333	11380	3161	0	10.5	10.5	10.5	10.5	10.5	1286	1286	1286	1286	1286	6432	8196	7586
11/01/2011 18:00	74.95	2223855	6348	1763	0	11.0	11.0	11.0	11.0	11.0	1355	1355	1355	1355	1355	6774	7141	6532
11/01/2011 19:00	74.97	2227030	1323	367	0	12.0	12.0	12.0	12.0	12.0	1493	1493	1493	1493	1493	7464	6876	6267
11/01/2011 20:00	74.97	2227030	-2116	-588	0	12.0	12.0	12.0	12.0	12.0	1493	1493	1493	1493	1493	7464	7060	6451
11/01/2011 21:00	74.95	2223855	-1455	-404	0	12.0	12.0	12.0	12.0	12.0	1492	1492	1492	1492	1492	7458	6797	6189
11/01/2011 22:00	74.95	2223855	-2381	-661	0	11.5	11.5	11.5	11.5	11.5	1422	1422	1422	1422	1422	7111	6229	5622
11/01/2011 23:00	74.92	2219094	-3174	-882	0	11.5	11.5	11.5	11.5	11.5	1421	1421	1421	1421	1421	7103	5964	5357
12/01/2011 00:00	74.91	2217507	-4100	-1139	0	10.0	10.0	10.0	10.0	10.0	1224	1224	1224	1224	1224	6118	5052	4648
12/01/2011 01:00	74.87	2211158	-3836	-1065	0	10.0	10.0	10.0	10.0	10.0	1222	1222	1222	1222	1222	6109	4750	4346
12/01/2011 02:00	74.86	2209571	-4894	-1359	0	9.0	9.0	9.0	9.0	9.0	1098	1098	1098	1098	1098	5492	4096	3692
12/01/2011 03:00	74.81	2201636	-5026	-1396	0	9.0	9.0	9.0	9.0	9.0	1097	1097	1097	1097	1097	5483	4638	4234
12/01/2011 04:00	74.80	2200049	-3042	-845	0	8.0	8.0	8.0	8.0	8.0	978	978	978	978	978	4888	4190	3787
12/01/2011 05:00	74.77	2195287	-2513	-698	0	7.0	7.0	7.0	7.0	7.0	861	861	861	861	861	4304	4083	3882
12/01/2011 06:00	74.77	2195287	-794	-220	0	6.0	6.0	6.0	6.0	6.0	745	745	745	745	745	3727	3984	3783
12/01/2011 07:00	74.76	2193700	926	257	0	5.0	5.0	5.0	5.0	5.0	629	629	629	629	629	3143	3694	3493
12/01/2011 08:00	74.78	2196874	1984	551	0	3.5	4.0	5.0	4.0	3.5	449	510	629	510	449	2547	2473	2272

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage volume	Net inflow (outflow deducted)		Hydro	Gate settings					Gate discharges					Total outflow	Total inflow	Total inflow minus Somerset outflow
						1	2	3	4	5	1	2	3	4	5			
	m AHD	ML	ML	m³/s	m³/s	m	m	m	m	m	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s
12/01/2011 09:00	74.78	2196874	-265	-73	0	3.5	4.0	5.0	4.0	3.5	449	510	629	510	449	2547	2510	2441
12/01/2011 10:00	74.78	2196874	-132	-37	0	3.5	4.0	5.0	4.0	3.5	449	510	629	510	449	2547	2804	2735
12/01/2011 11:00	74.78	2196874	926	257	0	3.5	4.0	5.0	4.0	3.5	449	510	629	510	449	2547	2730	2662
12/01/2011 12:00	74.79	2198461	661	184	0	3.5	4.0	5.0	4.0	3.5	449	510	629	510	449	2547	3025	2956
12/01/2011 13:00	74.79	2198461	1719	478	0	3.5	4.0	5.0	4.0	3.5	449	510	629	510	449	2547	3098	3030
12/01/2011 14:00	74.81	2201636	1984	551	0	3.5	4.0	5.0	4.0	3.5	449	510	630	510	449	2549	2145	2076
12/01/2011 15:00	74.81	2201636	-1455	-404	0	3.5	4.0	5.0	4.0	3.5	449	510	630	510	449	2549	2880	2811
12/01/2011 16:00	74.80	2200049	1190	331	0	3.5	4.0	5.0	4.0	3.5	449	510	629	510	449	2548	2511	2443
12/01/2011 17:00	74.82	2203223	-132	-37	0	3.5	4.0	5.0	4.0	3.5	449	510	630	510	449	2550	2476	2408
12/01/2011 18:00	74.80	2200049	-265	-73	0	3.5	4.0	5.0	4.0	3.5	449	510	629	510	449	2548	3136	3067
12/01/2011 19:00	74.82	2203223	2116	588	0	3.5	4.0	5.0	4.0	3.5	449	510	630	510	449	2550	2513	2444
12/01/2011 20:00	74.82	2203223	-132	-37	0	3.5	4.0	5.0	4.0	3.5	449	510	630	510	449	2550	2329	2261
12/01/2011 21:00	74.82	2203223	-794	-220	0	3.5	4.0	5.0	4.0	3.5	449	510	630	510	449	2550	2072	2003
12/01/2011 22:00	74.81	2201636	-1719	-478	0	3.5	4.0	5.0	4.0	3.5	449	510	630	510	449	2549	2108	2039
12/01/2011 23:00	74.80	2200049	-1587	-441	0	3.5	4.0	5.0	4.0	3.5	449	510	629	510	449	2548	2107	2039
13/01/2011 00:00	74.79	2198461	-1587	-441	0	3.5	4.0	5.0	4.0	3.5	449	510	629	510	449	2547	2143	2075
13/01/2011 01:00	74.78	2196874	-1455	-404	0	3.5	4.0	5.0	4.0	3.5	449	510	629	510	449	2547	1848	1780
13/01/2011 02:00	74.77	2195287	-2514	-698	0	3.5	4.0	5.0	4.0	3.5	449	510	629	510	449	2546	1887	1818
13/01/2011 03:00	74.75	2192113	-2373	-659	0	3.5	4.0	5.0	4.0	3.5	449	509	628	509	449	2544	1891	1823
13/01/2011 04:00	74.74	2190543	-2351	-653	0	3.5	4.0	5.0	4.0	3.5	448	509	628	509	448	2544	1890	1821
13/01/2011 05:00	74.72	2187404	-2354	-654	0	3.5	4.0	5.0	4.0	3.5	448	509	628	509	448	2542	1888	1819
13/01/2011 06:00	74.71	2185835	-2354	-654	0	3.5	4.0	5.0	4.0	3.5	448	509	628	509	448	2541	1887	1819
13/01/2011 07:00	74.69	2182696	-2354	-654	0	3.5	4.0	5.0	4.0	3.5	448	508	627	508	448	2540	1922	1853
13/01/2011 08:00	74.68	2181126	-2224	-618	0	3.5	4.0	5.0	4.0	3.5	448	508	627	508	448	2539	1631	1562

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage volume	Net inflow (outflow deducted)		Hydro	Gate settings					Gate discharges					Total outflow	Total inflow	Total inflow minus Somerset outflow
						1	2	3	4	5	1	2	3	4	5			
	m AHD	ML	ML	m^3/s	m^3/s	m	m	m	m	m	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
13/01/2011 09:00	74.66	2177987	-3270	-908	0	3.5	4.0	5.0	4.0	3.5	447	508	627	508	447	2537	1629	1560
13/01/2011 10:00	74.64	2174848	-3270	-908	0	3.5	4.0	5.0	4.0	3.5	447	508	626	508	447	2536	1918	1850
13/01/2011 11:00	74.62	2171709	-2224	-618	0	3.5	4.0	5.0	4.0	3.5	447	507	626	507	447	2534	1917	1848
13/01/2011 12:00	74.61	2170139	-2224	-618	0	3.5	4.0	5.0	4.0	3.5	447	507	626	507	447	2534	1589	1520
13/01/2011 13:00	74.59	2167000	-3401	-945	0	3.5	4.5	5.0	4.0	3.5	446	567	625	507	446	2592	1938	1869
13/01/2011 14:00	74.57	2163861	-2354	-654	0	3.5	4.5	5.0	4.5	3.5	446	566	625	566	446	2650	2359	2290
13/01/2011 15:00	74.56	2162291	-1046	-291	0	4.0	4.5	5.0	4.0	3.5	506	566	625	506	446	2650	1451	1382
13/01/2011 16:00	74.55	2160722	-4316	-1199	0	4.0	4.5	5.0	4.5	4.0	506	566	625	566	506	2769	1677	1609
13/01/2011 17:00	74.51	2154444	-3930	-1092	0	4.5	4.5	5.0	4.5	4.0	565	565	624	565	506	2825	1817	1749
13/01/2011 18:00	74.50	2152874	-3627	-1008	0	4.5	4.5	5.0	4.5	4.5	565	565	624	565	565	2883	1231	1162
13/01/2011 19:00	74.46	2146663	-5950	-1653	0	4.5	5.0	5.0	5.0	4.5	564	623	623	623	564	2997	2062	1994
13/01/2011 20:00	74.43	2142006	-3364	-934	0	5.0	5.0	5.0	5.0	5.0	622	622	622	622	622	3111	1530	1461
13/01/2011 21:00	74.41	2138900	-5693	-1581	0	5.0	5.5	5.5	5.0	5.0	622	680	680	622	622	3225	1679	1611
13/01/2011 22:00	74.36	2131137	-5564	-1545	0	5.0	5.5	5.5	5.5	5.0	621	678	678	678	621	3277	2091	2022
13/01/2011 23:00	74.34	2128032	-4270	-1186	0	5.5	5.5	5.5	5.5	5.0	678	678	678	678	620	3332	1534	1466
14/01/2011 00:00	74.30	2121821	-6474	-1798	0	5.5	5.5	5.5	5.5	5.5	677	677	677	677	677	3386	1667	1667
14/01/2011 01:00	74.26	2115611	-6186	-1718	0	5.5	5.5	6.0	5.5	5.5	676	676	733	676	676	3438	1767	1767
14/01/2011 02:00	74.22	2109452	-6017	-1671	0	5.5	6.0	6.0	5.5	5.5	675	732	732	675	675	3491	1572	1572
14/01/2011 03:00	74.18	2103312	-6907	-1919	0	5.5	6.0	6.0	6.0	5.5	675	731	731	731	675	3543	1339	1339
14/01/2011 04:00	74.13	2095636	-7932	-2203	0	5.5	6.0	6.0	6.0	5.5	673	730	730	730	673	3537	1653	1653
14/01/2011 05:00	74.08	2087960	-6782	-1884	0	5.5	6.0	6.0	6.0	5.5	672	729	729	729	672	3531	1648	1648
14/01/2011 06:00	74.04	2081819	-6778	-1883	0	5.5	6.0	6.0	6.0	5.5	671	728	728	728	671	3526	1338	1338
14/01/2011 07:00	73.99	2074159	-7879	-2189	0	5.5	6.0	6.0	6.0	5.5	670	727	727	727	670	3521	1659	1659
14/01/2011 08:00	73.94	2066566	-6702	-1862	0	5.5	6.0	6.0	6.0	5.5	669	725	725	725	669	3515	1616	1616

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage volume	Net inflow (outflow deducted)		Hydro	Gate settings					Gate discharges					Total outflow	Total inflow	Total inflow minus Somerset outflow
						1	2	3	4	5	1	2	3	4	5			
	m AHD	ML	ML	m³/s	m³/s	m	m	m	m	m	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s
14/01/2011 09:00	73.90	2060492	-6834	-1898	0	5.5	6.0	6.0	6.0	5.5	668	724	724	724	668	3510	1612	1612
14/01/2011 10:00	73.85	2052899	-6834	-1898	0	5.5	6.0	6.0	6.0	5.5	667	723	723	723	667	3504	1640	1640
14/01/2011 11:00	73.81	2046825	-6713	-1865	0	5.5	6.0	6.0	6.0	5.5	666	722	722	722	666	3499	1399	1399
14/01/2011 12:00	73.76	2039232	-7563	-2101	0	5.5	6.0	6.0	6.0	5.5	665	721	721	721	665	3493	1163	1163
14/01/2011 13:00	73.71	2031704	-8390	-2331	0	5.5	6.0	6.0	6.0	5.5	664	720	720	720	664	3488	1193	1193
14/01/2011 14:00	73.65	2022690	-8261	-2295	0	5.5	6.0	6.0	6.0	5.5	663	718	718	718	663	3480	1151	1151
14/01/2011 15:00	73.60	2015179	-8388	-2330	0	5.5	6.0	6.0	6.0	5.5	662	717	717	717	662	3475	1386	1386
14/01/2011 16:00	73.54	2006165	-7518	-2088	0	5.5	6.0	6.0	6.0	5.5	660	716	716	716	660	3467	1705	1705
14/01/2011 17:00	73.50	2000156	-6346	-1763	0	5.5	6.0	6.0	6.0	5.5	659	715	715	715	659	3463	1090	1090
14/01/2011 18:00	73.45	1992725	-8541	-2372	0	5.5	6.0	6.0	6.0	5.5	658	713	713	713	658	3457	1392	1392
14/01/2011 19:00	73.39	1983807	-7431	-2064	0	6.0	6.0	6.0	6.0	5.5	712	712	712	712	657	3504	1715	1715
14/01/2011 20:00	73.35	1977862	-6440	-1789	0	6.0	6.0	6.0	6.0	5.5	711	711	711	711	656	3500	1399	1399
14/01/2011 21:00	73.30	1970431	-7562	-2101	0	6.0	6.0	6.0	6.0	5.5	710	710	710	710	655	3493	1441	1441
14/01/2011 22:00	73.25	1963000	-7390	-2053	0	6.0	6.0	6.0	6.0	5.5	708	708	708	708	654	3487	1482	1482
14/01/2011 23:00	73.20	1955650	-7220	-2006	0	6.0	6.0	6.0	6.0	5.5	707	707	707	707	653	3481	1202	1202
15/01/2011 00:00	73.15	1948301	-8207	-2280	0	6.0	6.0	6.0	6.0	5.5	706	706	706	706	651	3475	1229	1229
15/01/2011 01:00	73.09	1939481	-8087	-2246	0	6.0	6.0	6.0	6.0	5.5	704	704	704	704	650	3468	1259	1259
15/01/2011 02:00	73.04	1932132	-7951	-2209	0	6.0	6.0	6.0	6.0	5.5	703	703	703	703	649	3462	997	997
15/01/2011 03:00	72.98	1923345	-8874	-2465	0	6.0	6.0	6.0	6.0	6.0	702	702	702	702	702	3508	1087	1087
15/01/2011 04:00	72.92	1914623	-8716	-2421	0	6.0	6.0	6.0	6.0	6.0	700	700	700	700	700	3501	1078	1078
15/01/2011 05:00	72.86	1905902	-8723	-2423	0	6.0	6.0	6.0	6.0	6.0	699	699	699	699	699	3493	1071	1071
15/01/2011 06:00	72.80	1897180	-8720	-2422	0	6.0	6.0	6.0	6.0	6.0	697	697	697	697	697	3485	1079	1079
15/01/2011 07:00	72.74	1888475	-8661	-2406	0	6.0	6.0	6.0	6.0	6.0	696	696	696	696	696	3478	1085	1085
15/01/2011 08:00	72.68	1879854	-8614	-2393	0	6.0	6.0	6.0	6.0	6.0	694	694	694	694	694	3470	1075	1075

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage volume	Net inflow (outflow deducted)		Hydro	Gate settings					Gate discharges					Total outflow	Total inflow	Total inflow minus Somerset outflow
						1	2	3	4	5	1	2	3	4	5			
	m AHD	ML	ML	m^3/s	m^3/s	m	m	m	m	m	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
15/01/2011 09:00	72.62	1871234	-8621	-2395	0	6.0	6.0	6.0	6.0	6.0	693	693	693	693	693	3463	1066	1066
15/01/2011 10:00	72.56	1862613	-8629	-2397	0	6.0	6.0	6.5	6.0	6.0	691	691	744	691	691	3507	1094	1094
15/01/2011 11:00	72.50	1853992	-8689	-2414	0	6.0	6.0	6.5	6.0	6.0	689	689	742	689	689	3500	1365	1365
15/01/2011 12:00	72.44	1845471	-7685	-2135	0	6.0	6.0	6.5	6.0	6.0	688	688	740	688	688	3492	1355	1355
15/01/2011 13:00	72.39	1838369	-7693	-2137	0	6.0	6.0	6.5	6.0	6.0	687	687	739	687	687	3485	1084	1084
15/01/2011 14:00	72.33	1829848	-8645	-2401	0	6.0	6.0	6.5	6.0	6.0	685	685	737	685	685	3477	1151	1151
15/01/2011 15:00	72.27	1821326	-8375	-2326	0	6.0	6.0	6.5	6.0	6.0	684	684	735	684	684	3469	899	899
15/01/2011 16:00	72.21	1812870	-9253	-2570	0	6.0	6.0	6.5	6.0	6.0	682	682	734	682	682	3462	862	862
15/01/2011 17:00	72.14	1803043	-9357	-2599	0	6.0	6.5	6.5	6.0	6.0	680	732	732	680	680	3504	1487	1487
15/01/2011 18:00	72.08	1794619	-7260	-2017	0	6.0	6.5	6.5	6.0	6.0	679	730	730	679	679	3496	971	971
15/01/2011 19:00	72.03	1787600	-9088	-2524	0	6.0	6.5	6.5	6.0	6.0	677	729	729	677	677	3489	527	527
15/01/2011 20:00	71.95	1776448	-10662	-2962	0	6.0	6.5	6.5	6.0	6.0	675	726	726	675	675	3478	491	491
15/01/2011 21:00	71.88	1766733	-10752	-2987	0	6.0	6.5	6.5	6.0	6.0	673	724	724	673	673	3469	1154	1154
15/01/2011 22:00	71.80	1755630	-8333	-2315	0	6.0	6.5	6.5	6.5	6.0	671	722	722	722	671	3509	1943	1943
15/01/2011 23:00	71.76	1750078	-5638	-1566	0	6.0	6.5	6.5	6.5	6.0	670	721	721	721	670	3503	1406	1406
16/01/2011 00:00	71.71	1743202	-7549	-2097	0	6.0	6.5	6.5	6.5	6.0	669	719	719	719	669	3496	956	956
16/01/2011 01:00	71.65	1734971	-9145	-2540	0	6.0	6.5	6.5	6.5	6.0	667	718	718	718	667	3488	1009	1009
16/01/2011 02:00	71.58	1725368	-8924	-2479	0	6.0	6.5	6.5	6.5	6.0	665	716	716	716	665	3478	1043	1043
16/01/2011 03:00	71.52	1717137	-8766	-2435	0	6.0	6.5	6.5	6.5	6.0	664	714	714	714	664	3469	767	767
16/01/2011 04:00	71.45	1707612	-9730	-2703	0	6.5	6.5	6.5	6.5	6.0	712	712	712	712	662	3509	1093	1093
16/01/2011 05:00	71.38	1698119	-8700	-2417	0	6.5	6.5	6.5	6.5	6.0	710	710	710	710	660	3499	1080	1080
16/01/2011 06:00	71.32	1689981	-8712	-2420	0	6.5	6.5	6.5	6.5	6.0	708	708	708	708	658	3491	838	838
16/01/2011 07:00	71.25	1680488	-9550	-2653	0	6.5	6.5	6.5	6.5	6.0	706	706	706	706	657	3481	908	908
16/01/2011 08:00	71.18	1671107	-9260	-2572	0	6.5	6.5	6.5	6.5	6.0	704	704	704	704	655	3470	677	677

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage volume	Net inflow (outflow deducted)		Hydro	Gate settings					Gate discharges					Total outflow	Total inflow	Total inflow minus Somerset outflow
						1	2	3	4	5	1	2	3	4	5			
	m AHD	ML	ML	m³/s	m³/s	m	m	m	m	m	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s
16/01/2011 09:00	71.11	1661725	-10058	-2794	0	6.5	6.5	6.5	6.5	6.5	702	702	702	702	702	3509	510	510
16/01/2011 10:00	71.03	1651004	-10798	-2999	0	6.5	6.5	6.5	6.5	6.5	699	699	699	699	699	3497	488	488
16/01/2011 11:00	70.95	1640361	-10834	-3009	0	6.5	6.5	6.5	6.5	6.5	697	697	697	697	697	3486	911	911
16/01/2011 12:00	70.87	1629765	-9267	-2574	0	6.5	6.5	6.5	6.5	6.5	695	695	695	695	695	3474	1355	1355
16/01/2011 13:00	70.81	1621818	-7625	-2118	0	6.5	6.5	7.0	6.5	6.5	693	693	741	693	693	3513	1106	1106
16/01/2011 14:00	70.75	1613871	-8663	-2406	0	6.5	6.5	7.0	6.5	6.5	691	691	739	691	691	3503	1173	1173
16/01/2011 15:00	70.68	1604711	-8389	-2330	0	6.5	6.5	7.0	6.5	6.5	689	689	737	689	689	3493	1007	1007
16/01/2011 16:00	70.62	1596859	-8949	-2486	0	6.5	7.0	7.0	6.5	6.5	687	735	735	687	687	3531	360	360
16/01/2011 17:00	70.54	1586390	-11415	-3171	0	6.5	7.0	7.0	6.5	6.5	685	732	732	685	685	3518	428	428
16/01/2011 18:00	70.45	1574691	-11124	-3090	0	6.5	7.0	7.0	6.5	6.5	682	729	729	682	682	3504	602	602
16/01/2011 19:00	70.37	1564348	-10449	-2902	0	6.5	7.0	7.0	6.5	6.5	680	726	726	680	680	3491	1010	1010
16/01/2011 20:00	70.29	1554005	-8933	-2482	0	6.5	7.0	7.0	7.0	6.5	677	724	724	724	677	3525	1301	1301
16/01/2011 21:00	70.23	1546279	-8008	-2224	0	6.5	7.0	7.0	7.0	6.5	675	722	722	722	675	3515	827	827
16/01/2011 22:00	70.16	1537340	-9679	-2689	0	6.5	7.0	7.0	7.0	6.5	673	719	719	719	673	3504	634	634
16/01/2011 23:00	70.08	1527124	-10333	-2870	0	6.5	7.0	7.0	7.0	6.0	671	717	717	717	624	3445	624	624
17/01/2011 00:00	70.00	1516908	-10153	-2820	0	6.5	7.0	7.0	7.0	6.0	668	714	714	714	622	3432	632	632
17/01/2011 01:00	69.92	1506819	-10079	-2800	0	6.5	7.0	7.0	7.0	6.0	666	711	711	711	620	3419	700	700
17/01/2011 02:00	69.84	1496729	-9788	-2719	0	6.5	7.0	7.0	7.0	6.0	663	708	708	708	617	3406	0	0
17/01/2011 03:00	69.76	1486640	-12314	-3421	0	6.5	7.0	7.0	7.0	6.0	661	706	706	706	615	3393	253	253
17/01/2011 04:00	69.65	1472934	-11304	-3140	0	6.5	7.0	7.0	7.0	6.0	657	702	702	702	612	3375	724	724
17/01/2011 05:00	69.58	1464223	-9542	-2651	0	6.5	7.0	7.0	7.0	6.0	655	699	699	699	610	3363	160	160
17/01/2011 06:00	69.49	1453039	-11531	-3203	0	6.5	7.0	7.0	7.0	6.0	652	696	696	696	607	3348	734	734
17/01/2011 07:00	69.40	1441983	-9411	-2614	0	6.5	7.0	7.0	7.0	6.0	649	693	693	693	605	3333	239	239
17/01/2011 08:00	69.33	1433384	-11141	-3095	0	6.5	7.0	7.0	7.0	6.0	647	691	691	691	603	3322	0	0

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage volume	Net inflow (outflow deducted)		Hydro	Gate settings					Gate discharges					Total outflow	Total inflow	Total inflow minus Somerset outflow
						1	2	3	4	5	1	2	3	4	5			
	m AHD	ML	ML	m^3/s	m^3/s	m	m	m	m	m	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
18/01/2011 09:00	67.64	1235438	-4834	-1343	0	3.5	4.5	5.0	4.0	3.5	341	428	470	385	341	1964	775	775
18/01/2011 10:00	67.61	1232091	-4278	-1188	0	3.5	4.0	5.0	4.0	3.0	340	384	469	384	295	1872	425	425
18/01/2011 11:00	67.56	1226511	-5211	-1447	0	3.0	4.0	4.5	4.0	3.0	294	383	426	383	294	1780	570	570
18/01/2011 12:00	67.52	1222047	-4357	-1210	0	3.0	3.5	4.5	3.5	3.0	293	338	425	338	293	1688	488	488
18/01/2011 13:00	67.48	1217615	-4321	-1200	0	2.5	3.5	4.5	3.5	2.5	246	338	424	338	246	1592	243	243
18/01/2011 14:00	67.44	1213216	-4855	-1348	0	2.5	3.0	4.5	3.0	2.5	246	292	423	292	246	1499	0	0
18/01/2011 15:00	67.39	1207718	-6507	-1807	0	2.5	3.0	4.5	3.0	2.5	245	291	422	291	245	1495	247	247
18/01/2011 16:00	67.33	1201119	-4491	-1247	0	2.5	3.0	4.5	3.0	2.5	244	290	421	290	244	1490	1032	1032
18/01/2011 17:00	67.31	1198920	-1650	-458	0	2.5	3.0	4.5	3.0	2.5	244	290	420	290	244	1488	570	570
18/01/2011 18:00	67.29	1196720	-3305	-918	0	2.5	3.0	4.5	3.0	2.5	244	290	420	290	244	1487	223	223
18/01/2011 19:00	67.25	1192321	-4549	-1264	0	2.5	3.0	4.5	3.0	2.5	243	289	419	289	243	1484	231	231
18/01/2011 20:00	67.21	1187988	-4508	-1252	0	2.5	3.0	4.5	3.0	2.5	243	288	418	288	243	1480	603	603
18/01/2011 21:00	67.17	1183654	-3160	-878	0	2.5	3.0	4.5	2.5	2.5	242	288	417	242	242	1432	755	755
18/01/2011 22:00	67.15	1181488	-2437	-677	0	2.5	2.5	4.5	2.5	2.0	242	242	416	242	195	1338	235	235
18/01/2011 23:00	67.12	1178238	-3972	-1103	0	2.0	2.5	4.5	2.5	1.5	195	242	416	242	147	1241	188	188
19/01/2011 00:00	67.08	1173905	-3792	-1053	0	1.5	2.5	4.0	2.5	1.5	147	241	373	241	147	1150	46	46
19/01/2011 01:00	67.05	1170655	-3972	-1103	0	1.5	2.0	4.0	2.0	1.5	147	194	373	194	147	1055	302	302
19/01/2011 02:00	67.01	1166321	-2711	-753	0	1.0	2.0	4.0	2.0	1.0	98	194	372	194	98	956	609	609
19/01/2011 03:00	67.00	1165238	-1248	-347	0	1.0	1.5	4.0	1.5	1.0	98	146	372	146	98	860	96	96
19/01/2011 04:00	66.98	1163105	-2753	-765	0	0.5	1.5	4.0	1.5	0.5	49	146	371	146	49	762	0	0
19/01/2011 05:00	66.95	1159906	-3554	-987	0	0.5	1.0	4.0	1.0	0.5	49	98	370	98	49	664	244	244
19/01/2011 06:00	66.92	1156707	-1511	-420	0	0.0	1.0	4.0	1.0	0.0	0	98	370	98	0	565	466	466
19/01/2011 07:00	66.92	1156707	-355	-99	0	0.0	0.5	4.0	0.5	0.0	0	49	370	49	0	468	319	319
19/01/2011 08:00	66.91	1155641	-533	-148	0	0.0	0.5	3.5	0.0	0.0	0	49	327	0	0	376	228	228

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage volume	Net inflow (outflow deducted)		Hydro	Gate settings					Gate discharges					Total outflow	Total inflow	Total inflow minus Somerset outflow
						1	2	3	4	5	1	2	3	4	5			
	m AHD	ML	ML	m^3/s	m^3/s	m	m	m	m	m	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
19/01/2011 09:00	66.91	1155641	-533	-148	0	0.0	0.0	3.0	0.0	0.0	0	0	284	0	0	284	136	136

Table 9.1.1 - Wivenhoe Dam inflow and release data for the January 2011 Flood Event

A summary of the data in Table 9.1.1 is illustrated in Figure 9.1.2. The considerable flood mitigation benefits provided by Wivenhoe Dam over the duration of the Event is clearly demonstrated below.

9 DAM INFLOW AND FLOOD RELEASE DETAILS

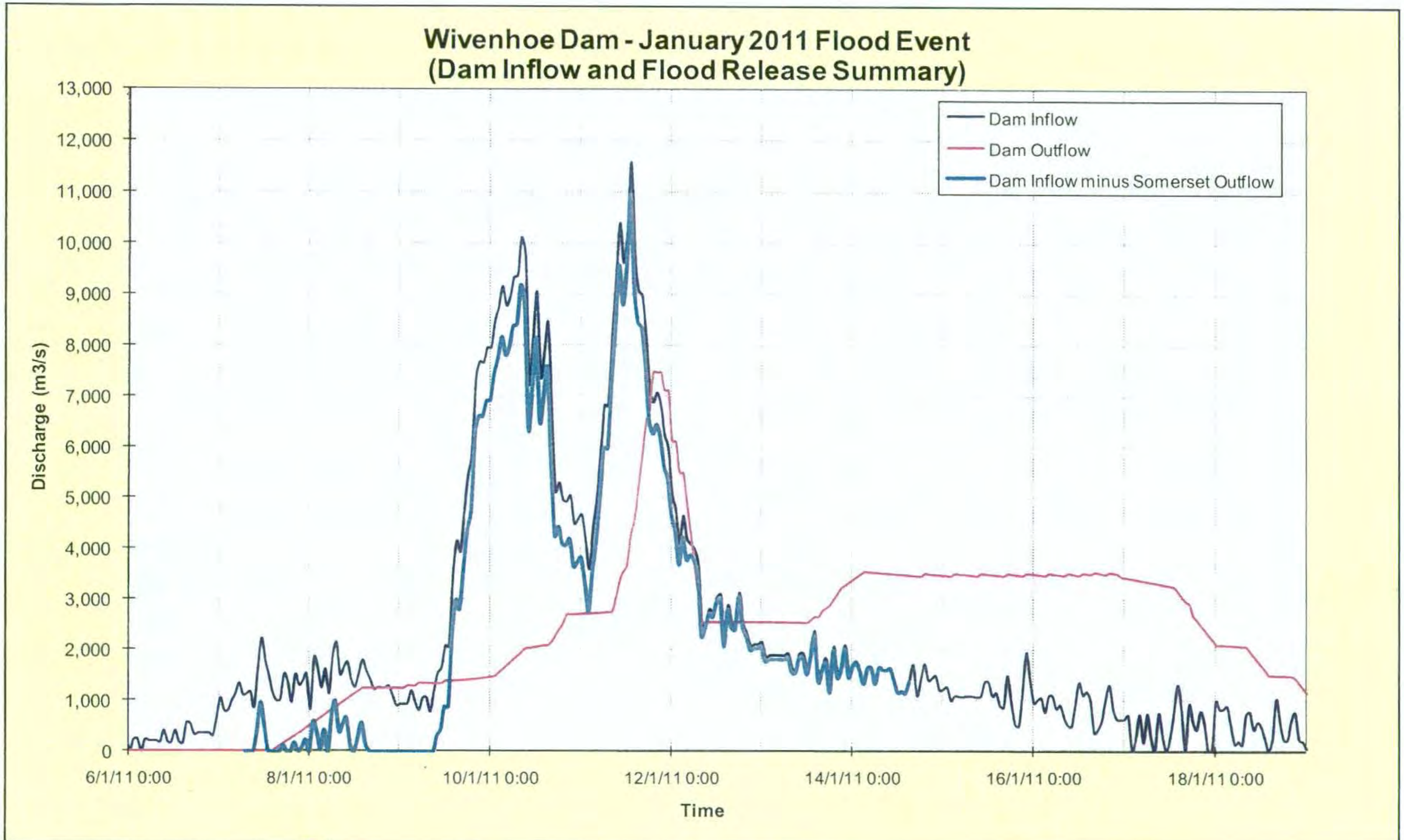


Figure 9.1.2 – Wivenhoe Dam inflow and release summary for the January 2011 Flood Event

9 DAM INFLOW AND FLOOD RELEASE DETAILS

9.2 Somerset Dam

Table 9.2.1 provides full details of inflows into and releases from Somerset Dam over the duration of the Flood Event. Details of the strategies used in determining these releases and how these strategies comply with the Manual are contained in Section 7 of this Report. Table 9.2.1 also shows the gate operation sequence was in accordance with the Manual over the duration of the Event.

Some points to note in relation to the table in Table 9.2.1 are:

- Inflow and flood release calculations are based on manual gauge board readings shown in the table that provide the lake level. During the Event, these manual gauge board readings were normally provided by the Dam operators to the Flood Operations Centre on an hourly basis. However, with prior approval from the Flood Operations Centre, during non-critical periods, the operators occasionally would miss a reading to complete higher priority site activities. In these instances, the table value has been interpolated from the closest available actual readings.
- Inflow calculations are based on the rate of change of the storage and use the Dam storage curve.
- Release calculations use the discharge rating formulae contained in the Manual.
- The table shows inflow rates and releases on the hour through the event. In some instances, gate operations may have occurred between hours or at less than one-hourly intervals. In these instances, the table shows the actual gate openings as there were at the time indicated.

Date/time	Lake level	Storage	Incremental inflow		Outflow				Inflow	
	m AHD	ML	ML	m^3/s	Tot regulators	Tot Sluices	Tot Gates	Hydro	m^3/s	m^3/s
06/01/2011 09:00:00	99.37	395716	435	121	0.5	0	8	0	35	155
06/01/2011 10:00:00	99.38	396151	435	121	0.5	0	8	0	35	155
06/01/2011 11:00:00	99.39	396587	435	121	0.5	0	8	0	35	155
06/01/2011 12:00:00	99.40	397022	435	121	0.5	0	8	0	35	155
06/01/2011 13:00:00	99.41	397457	435	121	0.5	0	8	0	35	155
06/01/2011 14:00:00	99.42	397893	435	121	0.5	0	8	0	35	156
06/01/2011 15:00:00	99.43	398328	435	121	0.5	0	8	0	35	156
06/01/2011 16:00:00	99.44	398764	472	131	0.5	0	8	0	35	166
06/01/2011 17:00:00	99.45	399199	218	60	0.5	0	8	0	35	95
06/01/2011 18:00:00	99.46	399634	-73	-20	0.5	0	8	0	35	14
06/01/2011 19:00:00	99.46	399634	181	50	0.5	0	8	0	35	85
06/01/2011 20:00:00	99.46	399634	689	191	0.5	0	8	0	35	226
06/01/2011 21:00:00	99.47	400070	948	263	0.5	0	8	0	35	298
06/01/2011 22:00:00	99.49	400941	627	174	0.5	0	8	0	35	209
06/01/2011 23:00:00	99.51	401821	669	186	0.5	0	8	0	35	220
07/01/2011 00:00:00	99.52	402267	668	186	0.5	0	8	0	35	220
07/01/2011 01:00:00	99.54	403157	668	186	0.5	0	8	0	35	220
07/01/2011 02:00:00	99.55	403603	668	186	0.5	0	8	0	35	220
07/01/2011 03:00:00	99.57	404493	742	206	0.5	0	8	0	35	241
07/01/2011 04:00:00	99.58	404939	186	52	0.5	0	8	0	35	86
07/01/2011 05:00:00	99.60	405829	-186	-52	0.5	0	8	0	35	0
07/01/2011 06:00:00	99.59	405384	1002	278	0.5	0	8	0	35	313
07/01/2011 07:00:00	99.60	405829	1225	340	0.5	0	8	0	35	375
07/01/2011 08:00:00	99.63	407165	482	134	0.5	0	8	0	35	169
07/01/2011 09:00:00	99.65	408056	1298	361	0.5	0	8	0	35	395
07/01/2011 10:00:00	99.66	408501	2339	650	0.5	0	8	0	35	684
07/01/2011 11:00:00	99.71	410728	2485	690	0.5	0	8	0	35	725
07/01/2011 12:00:00	99.76	412964	2774	770	0.5	0	8	0	35	805
07/01/2011 13:00:00	99.82	415697	2694	748	0.5	0	8	0	35	783
07/01/2011 14:00:00	99.88	418429	3038	844	0.5	0	8	0	35	879
07/01/2011 15:00:00	99.94	421162	2803	779	0.5	0	8	0	35	814
07/01/2011 16:00:00	100.01	424360	2297	638	0.5	0	8	0	35	673
07/01/2011 17:00:00	100.06	426690	2175	604	1.0	0	8	0	70	674
07/01/2011 18:00:00	100.11	429020	1282	356	1.0	0	8	0	70	426
07/01/2011 19:00:00	100.15	430885	1320	367	0.0	1	8	0	205	572
07/01/2011 20:00:00	100.17	431817	1978	549	0.0	1	8	0	206	755
07/01/2011 21:00:00	100.21	433681	1648	458	0.0	1	8	0	206	663
07/01/2011 22:00:00	100.25	435545	1395	388	0.0	1	8	0	206	593
07/01/2011 23:00:00	100.28	436976	1471	409	0.0	1	8	0	206	615

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage	Incremental inflow		Outflow			Inflow		
	m AHD	ML	ML	m³/s	Tot regulators	Tot Sluices	Tot Gates	Hydro	m³/s	m³/s
08/01/2011 00:00:00	100.31	438408	1153	320	0.0	1	8	0	206	526
08/01/2011 01:00:00	100.34	439839	1193	331	0.0	1	8	0	206	538
08/01/2011 02:00:00	100.36	440794	1272	353	0.0	1	8	0	206	560
08/01/2011 03:00:00	100.39	442225	676	188	0.0	1	8	0	206	394
08/01/2011 04:00:00	100.41	443180	437	121	0.0	1	8	0	206	328
08/01/2011 05:00:00	100.42	443657	437	121	0.0	1	8	0	206	328
08/01/2011 06:00:00	100.43	444134	795	221	0.0	1	8	0	207	427
08/01/2011 07:00:00	100.44	444611	517	144	0.0	1	8	0	207	350
08/01/2011 08:00:00	100.46	445565	-40	-11	0.0	1	8	0	207	196
08/01/2011 09:00:00	100.46	445565	-278	-77	0.0	1	8	0	207	129
08/01/2011 10:00:00	100.46	445565	-278	-77	0.0	1	8	0	207	129
08/01/2011 11:00:00	100.45	445088	80	22	0.0	1	8	0	207	229
08/01/2011 12:00:00	100.45	445088	-239	-66	0.0	2	8	0	413	347
08/01/2011 13:00:00	100.45	445088	-477	-133	0.0	2	8	0	413	281
08/01/2011 14:00:00	100.44	444611	-756	-210	0.0	2	8	0	413	203
08/01/2011 15:00:00	100.43	444134	-756	-210	0.0	2	8	0	413	203
08/01/2011 16:00:00	100.41	443180	-398	-110	0.0	2	8	0	413	302
08/01/2011 17:00:00	100.40	442702	-756	-210	0.0	2	8	0	413	203
08/01/2011 18:00:00	100.39	442225	-756	-210	0.0	2	8	0	413	203
08/01/2011 19:00:00	100.37	441271	-437	-121	0.0	2	8	0	413	291
08/01/2011 20:00:00	100.36	440794	-477	-133	0.0	2	8	0	413	280
08/01/2011 21:00:00	100.35	440317	-477	-133	0.0	2	8	0	412	280
08/01/2011 22:00:00	100.34	439839	-517	-144	0.0	2	8	0	412	269
08/01/2011 23:00:00	100.33	439362	-199	-55	0.0	2	8	0	412	357
09/01/2011 00:00:00	100.32	438885	-199	-55	0.0	2	8	0	412	357
09/01/2011 01:00:00	100.32	438885	-477	-133	0.0	2	8	0	412	280
09/01/2011 02:00:00	100.31	438408	-795	-221	0.0	2	8	0	412	191
09/01/2011 03:00:00	100.30	437931	-477	-133	0.0	2	8	0	412	280
09/01/2011 04:00:00	100.28	436976	-199	-55	0.0	2	8	0	412	357
09/01/2011 05:00:00	100.28	436976	-318	-88	0.0	2	8	0	412	324
09/01/2011 06:00:00	100.27	436499	318	88	0.0	2	8	0	412	500
09/01/2011 07:00:00	100.27	436499	159	44	0.0	2	8	0	412	456
09/01/2011 08:00:00	100.28	436976	676	188	0.0	2	8	0	412	600
09/01/2011 09:00:00	100.28	436976	1471	409	0.0	3	8	0	618	1027
09/01/2011 10:00:00	100.31	438408	1948	541	0.0	3	8	0	618	1159
09/01/2011 11:00:00	100.34	439839	2227	619	0.0	3	8	0	619	1237

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage	Incremental inflow		Outflow			Inflow		
	m AHD	ML	ML	m^3/s	Tot regulators	Tot Sluices	Tot Gates	Hydro	m^3/s	m^3/s
09/01/2011 12:00:00	100.39	442225	1624	451	0.0	3	8	0	619	1070
09/01/2011 13:00:00	100.43	444134	3050	847	0.0	4	8	0	826	1673
09/01/2011 14:00:00	100.47	446043	6159	1711	0.0	5	8	0	1034	2744
09/01/2011 15:00:00	100.57	450891	15529	4314	0.0	5	8	0	1038	5352
09/01/2011 16:00:00	100.75	459677	14602	4056	0.0	5	8	0	1052	5108
09/01/2011 17:00:00	101.14	479305	6013	1670	0.0	5	8	0	1098	2768
09/01/2011 18:00:00	101.29	487007	10402	2890	0.0	5	8	0	1121	4011
09/01/2011 19:00:00	101.43	494310	12977	3605	0.0	5	8	0	1145	4750
09/01/2011 20:00:00	101.68	507564	10237	2844	0.0	5	8	0	1193	4037
09/01/2011 21:00:00	101.89	518935	8954	2487	0.0	5	8	0	1238	3725
09/01/2011 22:00:00	102.06	528282	8964	2490	0.0	5	8	0	1277	3768
09/01/2011 23:00:00	102.22	537207	9522	2645	0.0	5	8	0	1317	3962
10/01/2011 00:00:00	102.38	546296	6927	1924	0.0	5	8	0	1359	3283
10/01/2011 01:00:00	102.54	555472	4284	1190	0.0	5	8	0	1403	2593
10/01/2011 02:00:00	102.62	560135	4775	1327	0.0	5	8	0	1426	2752
10/01/2011 03:00:00	102.70	564798	3989	1108	0.0	5	8	0	1449	2557
10/01/2011 04:00:00	102.78	569498	4566	1268	0.0	5	8	0	1473	2741
10/01/2011 05:00:00	102.84	573067	4361	1211	0.0	5	8	0	1491	2703
10/01/2011 06:00:00	102.93	578421	2387	663	0.0	5	8	0	1519	2182
10/01/2011 07:00:00	102.98	581395	3125	868	0.0	5	8	0	1535	2403
10/01/2011 08:00:00	103.02	583798	2731	759	0.0	5	8	0	1548	2306
10/01/2011 09:00:00	103.08	587437	2021	561	0.0	5	8	0	1567	2128
10/01/2011 10:00:00	103.11	589257	4647	1291	0.0	5	8	0	1577	2868
10/01/2011 11:00:00	103.16	592289	6747	1874	0.0	5	8	0	1593	3468
10/01/2011 12:00:00	103.26	598367	3979	1105	0.0	5	8	0	1627	2732
10/01/2011 13:00:00	103.36	604553	1908	530	0.0	5	8	0	1661	2191
10/01/2011 14:00:00	103.39	606410	2011	559	0.0	5	8	0	1672	2230
10/01/2011 15:00:00	103.43	608884	516	143	0.0	5	8	0	1686	1829
10/01/2011 16:00:00	103.45	610122	-103	-29	0.0	5	8	0	1693	1664
10/01/2011 17:00:00	103.45	610122	0	0	0.0	5	8	0	1693	1693
10/01/2011 18:00:00	103.45	610122	52	14	0.0	5	8	0	1693	1707
10/01/2011 19:00:00	103.45	610122	-155	-43	0.0	5	8	0	1693	1650
10/01/2011 20:00:00	103.45	610122	-1753	-487	0.0	5	8	0	1693	1206
10/01/2011 21:00:00	103.44	609503	-1650	-458	0.0	5	8	0	1689	1231
10/01/2011 22:00:00	103.40	607028	-825	-229	0.0	5	8	0	1675	1446
10/01/2011 23:00:00	103.39	606410	-773	-215	0.0	5	8	0	1672	1457
11/01/2011 00:00:00	103.37	605172	-1856	-516	0.0	5	8	0	1665	1149
11/01/2011 01:00:00	103.36	604553	-2992	-831	0.0	5	8	0	1661	830
11/01/2011 02:00:00	103.31	601460	-2871	-797	0.0	5	8	0	1644	847

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage	Incremental inflow		Outflow			Inflow		
	m AHD	ML	ML	m^3/s	Tot regulators	Tot Sluices	Tot Gates	Hydro	m^3/s	m^3/s
11/01/2011 03:00:00	103.27	598985	258	72	0.0	5	8	0	1630	1702
11/01/2011 04:00:00	103.23	596535	3851	1070	0.0	5	8	0	1617	2686
11/01/2011 05:00:00	103.28	599604	3766	1046	0.0	4	8	0	1417	2463
11/01/2011 06:00:00	103.34	603316	3815	1060	0.0	3	8	0	1220	2280
11/01/2011 07:00:00	103.40	607028	3089	858	0.0	2	8	0	1023	1881
11/01/2011 08:00:00	103.46	610740	2239	622	0.0	1	8	0	826	1448
11/01/2011 09:00:00	103.50	613215	3477	966	0.0	0	8	0	622	1588
11/01/2011 10:00:00	103.54	615741	4149	1152	0.0	0	8	0	636	1788
11/01/2011 11:00:00	103.61	620161	7098	1972	0.0	0	8	0	660	2631
11/01/2011 12:00:00	103.68	624582	9233	2565	0.0	0	8	0	684	3249
11/01/2011 13:00:00	103.83	634158	9145	2540	0.0	0	8	0	738	3278
11/01/2011 14:00:00	103.96	642535	12173	3381	0.0	0	8	0	786	4167
11/01/2011 15:00:00	104.12	652997	9800	2722	0.0	0	8	0	846	3569
11/01/2011 16:00:00	104.31	665556	6259	1739	0.0	0	8	0	921	2659
11/01/2011 17:00:00	104.41	672250	6365	1768	0.0	0	8	0	961	2729
11/01/2011 18:00:00	104.51	678957	6540	1817	0.0	0	8	0	1001	2818
11/01/2011 19:00:00	104.60	685093	6264	1740	0.0	0	8	0	1039	2779
11/01/2011 20:00:00	104.70	691910	5179	1439	0.0	0	8	0	1081	2519
11/01/2011 21:00:00	104.78	697401	3938	1094	0.0	0	8	0	1115	2208
11/01/2011 22:00:00	104.85	702259	4742	1317	0.0	0	8	0	1145	2462
11/01/2011 23:00:00	104.90	705729	3524	979	0.0	0	8	0	1167	2145
12/01/2011 00:00:00	104.98	711281	1818	505	0.0	0	8	0	1202	1707
12/01/2011 01:00:00	105.00	712669	2650	736	0.0	0	8	0	1211	1947
12/01/2011 02:00:00	105.04	715493	1765	490	0.0	0	8	0	1228	1719
12/01/2011 03:00:00	105.07	717612	1000	278	0.0	0	8	0	1242	1520
12/01/2011 04:00:00	105.09	719024	706	196	0.0	0	8	0	1251	1447
12/01/2011 05:00:00	105.10	719730	353	98	0.0	0	8	0	1255	1353
12/01/2011 06:00:00	105.11	720436	0	0	0.0	0	8	0	1260	1260
12/01/2011 07:00:00	105.11	720436	-353	-98	0.0	0	8	0	1260	1162
12/01/2011 08:00:00	105.11	720436	-647	-180	0.0	0	8	0	1260	1080
12/01/2011 09:00:00	105.10	719730	-1530	-425	0.0	0	8	0	1255	830
12/01/2011 10:00:00	105.09	719024	-1353	-376	0.0	0	8	0	1251	875
12/01/2011 11:00:00	105.06	716906	-1593	-442	0.0	1	8	0	1461	1018
12/01/2011 12:00:00	105.05	716200	-3389	-941	0.0	1	8	0	1456	515
12/01/2011 13:00:00	105.01	713375	-3184	-884	0.0	1	8	0	1438	554
12/01/2011 14:00:00	104.96	709893	-2659	-739	0.0	1	8	0	1416	677
12/01/2011 15:00:00	104.92	707117	-3181	-884	0.0	1	8	0	1398	515
12/01/2011 16:00:00	104.88	704341	-3124	-868	0.0	1	8	0	1380	513
12/01/2011 17:00:00	104.83	700871	-3120	-867	0.0	1	8	0	1359	492

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage	Incremental inflow		Outflow					Inflow
	m AHD	ML	ML	m³/s	Tot regulators	Tot Sluices	Tot Gates	Hydro	m³/s	m³/s
12/01/2011 18:00:00	104.79	698095	-3149	-875	0.0	1	8	0	1341	466
12/01/2011 19:00:00	104.74	694637	-2609	-725	0.0	1	8	0	1320	595
12/01/2011 20:00:00	104.70	691910	-3125	-868	0.0	1	8	0	1303	435
12/01/2011 21:00:00	104.66	689183	-3125	-868	0.0	1	8	0	1286	418
12/01/2011 22:00:00	104.61	685774	-2615	-727	0.0	1	8	0	1264	538
12/01/2011 23:00:00	104.57	683047	-3114	-865	0.0	1	8	0	1248	382
13/01/2011 00:00:00	104.53	680320	-3086	-857	0.0	1	8	0	1231	374
13/01/2011 01:00:00	104.48	676936	-2563	-712	0.0	1	8	0	1210	498
13/01/2011 02:00:00	104.44	674258	-3068	-852	0.0	1	8	0	1194	342
13/01/2011 03:00:00	104.40	671581	-3012	-837	0.0	1	8	0	1177	341
13/01/2011 04:00:00	104.35	668233	-3016	-838	0.0	1	8	0	1157	320
13/01/2011 05:00:00	104.31	665556	-3051	-847	0.0	1	8	0	1141	294
13/01/2011 06:00:00	104.26	662208	-2521	-700	0.0	1	8	0	1121	421
13/01/2011 07:00:00	104.22	659568	-3010	-836	0.0	1	8	0	1105	269
13/01/2011 08:00:00	104.18	656940	-2902	-806	0.0	1	8	0	1090	284
13/01/2011 09:00:00	104.13	653655	-3180	-883	0.0	2	8	0	1290	407
13/01/2011 10:00:00	104.09	651026	-4466	-1240	0.0	2	8	0	1275	34
13/01/2011 11:00:00	104.03	647084	-3936	-1093	0.0	2	8	0	1251	158
13/01/2011 12:00:00	103.96	642535	-3004	-835	0.0	2	8	0	1225	390
13/01/2011 13:00:00	103.91	639313	-3870	-1075	0.0	3	8	0	1425	350
13/01/2011 14:00:00	103.86	636091	-4656	-1293	0.0	3	8	0	1406	113
13/01/2011 15:00:00	103.79	631580	-4127	-1146	0.0	3	8	0	1380	233
13/01/2011 16:00:00	103.72	627108	-3679	-1022	0.0	3	8	0	1354	332
13/01/2011 17:00:00	103.66	623319	-4160	-1156	0.0	3	8	0	1332	176
13/01/2011 18:00:00	103.60	619530	-4090	-1136	0.0	3	8	0	1311	175
13/01/2011 19:00:00	103.53	615109	-4139	-1150	0.0	3	8	0	1286	136
13/01/2011 20:00:00	103.47	611359	-3245	-901	0.0	3	8	0	1265	363
13/01/2011 21:00:00	103.40	607028	-3562	-990	0.0	4	8	0	1458	468
13/01/2011 22:00:00	103.36	604553	-5179	-1439	0.0	4	8	0	1444	6
13/01/2011 23:00:00	103.28	599604	-4562	-1267	0.0	4	8	0	1417	150
14/01/2011 00:00:00	103.20	594715	-4193	-1165	0.0	4	8	0	1390	225
14/01/2011 01:00:00	103.13	590470	-4295	-1193	0.0	4	8	0	1367	174
14/01/2011 02:00:00	103.06	586224	-3901	-1084	0.0	4	8	0	1344	261
14/01/2011 03:00:00	102.99	581990	-3415	-949	0.0	4	8	0	1322	374
14/01/2011 04:00:00	102.93	578421	-4265	-1185	0.0	4	8	0	1303	119
14/01/2011 05:00:00	102.87	574852	-4255	-1182	0.0	4	8	0	1285	103
14/01/2011 06:00:00	102.79	570093	-3420	-950	0.0	4	8	0	1261	311
14/01/2011 07:00:00	102.73	566547	-3445	-957	0.0	4	8	0	1243	286
14/01/2011 08:00:00	102.67	563050	-3840	-1067	0.0	4	8	0	1226	159

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage	Incremental inflow		Outflow			Inflow		
	m AHD	ML	ML	m^3/s	Tot regulators	Tot Sluices	Tot Gates	Hydro	m^3/s	m^3/s
14/01/2011 09:00:00	102.61	559552	-3829	-1064	0.0	4	8	0	1208	145
14/01/2011 10:00:00	102.54	555472	-3397	-944	0.0	4	8	0	1189	245
14/01/2011 11:00:00	102.48	551999	-3418	-949	0.0	4	8	0	1172	223
14/01/2011 12:00:00	102.42	548577	-3423	-951	0.0	4	8	0	1156	205
14/01/2011 13:00:00	102.36	545155	-3375	-937	0.0	4	8	0	1140	202
14/01/2011 14:00:00	102.30	541733	-3749	-1041	0.0	4	8	0	1124	83
14/01/2011 15:00:00	102.24	538323	-3295	-915	0.0	4	8	0	1109	194
14/01/2011 16:00:00	102.17	534418	-3302	-917	0.0	4	8	0	1091	174
14/01/2011 17:00:00	102.12	531629	-3718	-1033	0.0	4	8	0	1079	46
14/01/2011 18:00:00	102.05	527724	-3256	-905	0.0	4	8	0	1062	158
14/01/2011 19:00:00	101.99	524390	-3313	-920	0.0	4	8	0	1049	128
14/01/2011 20:00:00	101.93	521117	-2955	-821	0.0	4	8	0	1035	214
14/01/2011 21:00:00	101.87	517844	-2960	-822	0.0	4	8	0	1022	199
14/01/2011 22:00:00	101.82	515116	-3289	-914	0.0	4	8	0	1011	97
14/01/2011 23:00:00	101.76	511843	-3202	-889	0.0	4	8	0	998	109
15/01/2011 00:00:00	101.70	508631	-3244	-901	0.0	4	8	0	986	85
15/01/2011 01:00:00	101.64	505430	-2849	-791	0.0	4	8	0	974	182
15/01/2011 02:00:00	101.58	502230	-3266	-907	0.0	4	8	0	962	55
15/01/2011 03:00:00	101.53	499562	-2841	-789	0.0	4	8	0	953	164
15/01/2011 04:00:00	101.46	495875	-2779	-772	0.0	4	8	0	940	168
15/01/2011 05:00:00	101.42	493789	-3566	-990	0.0	4	8	0	933	0
15/01/2011 06:00:00	101.35	490137	-2781	-773	0.0	4	8	0	921	149
15/01/2011 07:00:00	101.29	487007	-2785	-774	0.0	4	8	0	912	138
15/01/2011 08:00:00	101.24	484410	-3144	-873	0.0	4	8	0	904	30
15/01/2011 09:00:00	101.18	481347	-2807	-780	0.0	4	8	0	895	115
15/01/2011 10:00:00	101.12	478284	-2512	-698	0.0	4	8	0	886	188
15/01/2011 11:00:00	101.07	475732	-2496	-693	0.0	4	8	0	879	186
15/01/2011 12:00:00	101.02	473180	-2796	-777	0.0	4	8	0	873	96
15/01/2011 13:00:00	100.97	470661	-2786	-774	0.0	4	8	0	867	93
15/01/2011 14:00:00	100.91	467665	-2413	-670	0.0	4	8	0	860	190
15/01/2011 15:00:00	100.86	465169	-2752	-764	0.0	4	8	0	855	90
15/01/2011 16:00:00	100.81	462673	-3085	-857	0.0	4	8	0	850	0
15/01/2011 17:00:00	100.75	459677	-2313	-642	0.0	4	8	0	844	201
15/01/2011 18:00:00	100.69	456748	-2685	-746	0.0	4	8	0	839	93
15/01/2011 19:00:00	100.65	454796	-3013	-837	0.0	4	8	0	836	0
15/01/2011 20:00:00	100.58	451379	-2828	-786	0.0	4	8	0	832	46
15/01/2011 21:00:00	100.53	448938	-1048	-291	0.0	4	8	0	829	538
15/01/2011 22:00:00	100.47	446043	-2582	-717	0.0	4	8	0	827	110
15/01/2011 23:00:00	100.47	446043	-4494	-1248	0.0	4	8	0	827	0

Date/time	Lake level	Storage	Incremental inflow		Outflow			Inflow		
	m AHD	ML	ML	m^3/s	Tot regulators	Tot Sluices	Tot Gates	Hydro	m^3/s	m^3/s
16/01/2011 00:00:00	100.36	440794	-2663	-740	0.0	4	8	0	825	85
16/01/2011 01:00:00	100.30	437931	-2862	-795	0.0	4	8	0	824	29
16/01/2011 02:00:00	100.24	435079	-2559	-711	0.0	4	8	0	823	113
16/01/2011 03:00:00	100.18	432283	-2214	-615	0.0	4	8	0	822	207
16/01/2011 04:00:00	100.13	429953	-2877	-799	0.0	4	8	0	822	22
16/01/2011 05:00:00	100.08	427622	-2816	-782	0.0	4	8	0	821	39
16/01/2011 06:00:00	100.01	424360	-2429	-675	0.0	4	8	0	820	145
16/01/2011 07:00:00	99.96	422072	-2769	-769	0.0	4	8	0	819	50
16/01/2011 08:00:00	99.90	419340	-2772	-770	0.0	4	8	0	818	48
16/01/2011 09:00:00	99.84	416608	-2534	-704	0.0	4	8	0	817	113
16/01/2011 10:00:00	99.78	413875	-1979	-550	0.0	3	8	0	612	62
16/01/2011 11:00:00	99.73	411618	-1705	-473	0.0	3	8	0	612	138
16/01/2011 12:00:00	99.69	409837	-2041	-567	0.0	3	8	0	611	44
16/01/2011 13:00:00	99.65	408056	-2004	-557	0.0	3	8	0	611	54
16/01/2011 14:00:00	99.60	405829	-2006	-557	0.0	3	8	0	610	53
16/01/2011 15:00:00	99.56	404048	-2027	-563	0.0	3	8	0	610	47
16/01/2011 16:00:00	99.51	401821	-1671	-464	0.0	3	8	0	609	145
16/01/2011 17:00:00	99.47	400070	-1995	-554	0.0	3	8	0	609	55
16/01/2011 18:00:00	99.43	398328	-1996	-554	0.0	3	8	0	608	54
16/01/2011 19:00:00	99.38	396151	-1669	-464	0.0	3	8	0	608	144
16/01/2011 20:00:00	99.34	394410	-2034	-565	0.0	3	8	0	607	42
16/01/2011 21:00:00	99.30	392668	-1763	-490	0.0	3	8	0	607	117
16/01/2011 22:00:00	99.25	390491	-1238	-344	0.0	2	8	0	404	60
16/01/2011 23:00:00	99.22	389214	-1029	-286	0.0	2	8	0	404	118
17/01/2011 00:00:00	99.19	387937	-1029	-286	0.0	2	8	0	404	118
17/01/2011 01:00:00	99.17	387086	-1313	-365	0.0	2	8	0	403	39
17/01/2011 02:00:00	99.14	385809	-1383	-384	0.0	2	8	0	403	19
17/01/2011 03:00:00	99.11	384531	-568	-158	0.0	1	8	0	202	44
17/01/2011 04:00:00	99.08	383254	-426	-118	0.0	1	8	0	201	83
17/01/2011 05:00:00	99.08	383254	-213	-59	0.0	1	8	0	201	142
17/01/2011 06:00:00	99.06	382403	106	30	0.0	1	8	0	201	231
17/01/2011 07:00:00	99.07	382829	-532	-148	1.0	0	8	0	69	0
17/01/2011 08:00:00	99.06	382403	-177	-49	1.0	0	8	0	69	19
17/01/2011 09:00:00	99.05	381977	-213	-59	1.0	0	8	0	69	10
17/01/2011 10:00:00	99.05	381977	-248	-69	1.0	0	8	0	69	0
17/01/2011 11:00:00	99.04	381552	35	10	1.0	0	8	0	69	79
17/01/2011 12:00:00	99.04	381552	35	10	1.0	0	8	0	69	79
17/01/2011 13:00:00	99.04	381552	-213	-59	1.0	0	8	0	69	10
17/01/2011 14:00:00	99.04	381552	-497	-138	1.0	0	8	0	69	0

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage	Incremental inflow		Outflow					Inflow
	m AHD	ML	ML	m³/s	Tot regulators	Tot Sluices	Tot Gates	Hydro	m³/s	m³/s
17/01/2011 15:00:00	99.03	381126	-177	-49	1.0	0	8	0	69	19
17/01/2011 16:00:00	99.02	380700	-213	-59	1.0	0	8	0	69	10
17/01/2011 17:00:00	99.02	380700	-248	-69	1.0	0	8	0	69	0
17/01/2011 18:00:00	99.01	380275	35	10	1.0	0	8	0	69	78
17/01/2011 19:00:00	99.01	380275	35	10	1.0	0	8	0	69	78
17/01/2011 20:00:00	99.01	380275	-248	-69	1.0	0	8	0	69	0
17/01/2011 21:00:00	99.01	380275	-248	-69	1.0	0	8	0	69	0
17/01/2011 22:00:00	99.00	379849	35	10	1.0	0	8	0	69	78
17/01/2011 23:00:00	99.00	379849	35	10	1.0	0	8	0	69	78
18/01/2011 00:00:00	99.00	379849	-243	-68	1.0	0	8	0	69	1
18/01/2011 01:00:00	99.00	379849	-243	-68	1.0	0	8	0	69	1
18/01/2011 02:00:00	98.99	379432	69	19	1.0	0	8	0	69	88
18/01/2011 03:00:00	98.99	379432	-243	-68	1.0	0	8	0	69	1
18/01/2011 04:00:00	98.99	379432	-243	-68	1.0	0	8	0	69	1
18/01/2011 05:00:00	98.98	379016	35	10	1.0	0	8	0	69	78
18/01/2011 06:00:00	98.98	379016	35	10	1.0	0	8	0	69	78
18/01/2011 07:00:00	98.98	379016	-243	-68	1.0	0	8	0	69	1
18/01/2011 08:00:00	98.98	379016	-243	-68	1.0	0	8	0	69	1
18/01/2011 09:00:00	98.97	378599	69	19	1.0	0	8	0	69	88
18/01/2011 10:00:00	98.97	378599	-243	-68	1.0	0	8	0	69	1
18/01/2011 11:00:00	98.97	378599	-243	-68	1.0	0	8	0	69	1
18/01/2011 12:00:00	98.96	378182	69	19	1.0	0	8	0	69	88
18/01/2011 13:00:00	98.96	378182	-243	-68	1.0	0	8	0	69	1
18/01/2011 14:00:00	98.96	378182	-243	-68	1.0	0	8	0	69	1
18/01/2011 15:00:00	98.95	377766	35	10	1.0	0	8	0	69	78
18/01/2011 16:00:00	98.95	377766	0	0	1.0	0	8	0	69	69
18/01/2011 17:00:00	98.95	377766	0	0	1.0	0	8	0	69	69
18/01/2011 18:00:00	98.95	377766	0	0	1.0	0	8	0	69	69
18/01/2011 19:00:00	98.95	377766	-35	-10	1.0	0	8	0	69	59
18/01/2011 20:00:00	98.95	377766	243	68	1.0	0	8	0	69	136
18/01/2011 21:00:00	98.95	377766	208	58	1.0	0	8	0	69	126
18/01/2011 22:00:00	98.96	378182	208	58	0.0	0	8	0	0	58
18/01/2011 23:00:00	98.96	378182	208	58	0.0	0	8	0	0	58
19/01/2011 00:00:00	98.97	378599	208	58	0.0	0	8	0	0	58
19/01/2011 01:00:00	98.97	378599	208	58	0.0	0	8	0	0	58
19/01/2011 02:00:00	98.98	379016	208	58	0.0	0	8	0	0	58
19/01/2011 03:00:00	98.98	379016	208	58	0.0	0	8	0	0	58
19/01/2011 04:00:00	98.99	379432	208	58	0.0	0	8	0	0	58
19/01/2011 05:00:00	98.99	379432	243	68	0.0	0	8	0	0	68

9 DAM INFLOW AND FLOOD RELEASE DETAILS

Date/time	Lake level	Storage	Incremental inflow		Outflow			Inflow		
	m AHD	ML	ML	m^3/s	Tot regulators	Tot Sluices	Tot Gates	Hydro	m^3/s	m^3/s
19/01/2011 06:00:00	99.00	379849	-70	-19	0.0	0	8	0	0	0
19/01/2011 07:00:00	99.00	379849	248	69	0.0	0	8	0	0	69
19/01/2011 08:00:00	99.00	379849	248	69	0.0	0	8	0	0	69
19/01/2011 09:00:00	99.01	380275	-71	-20	0.0	0	8	0	0	0

Table 9.2.1 – Somerset Dam inflow and release data for the January 2011 Flood Event

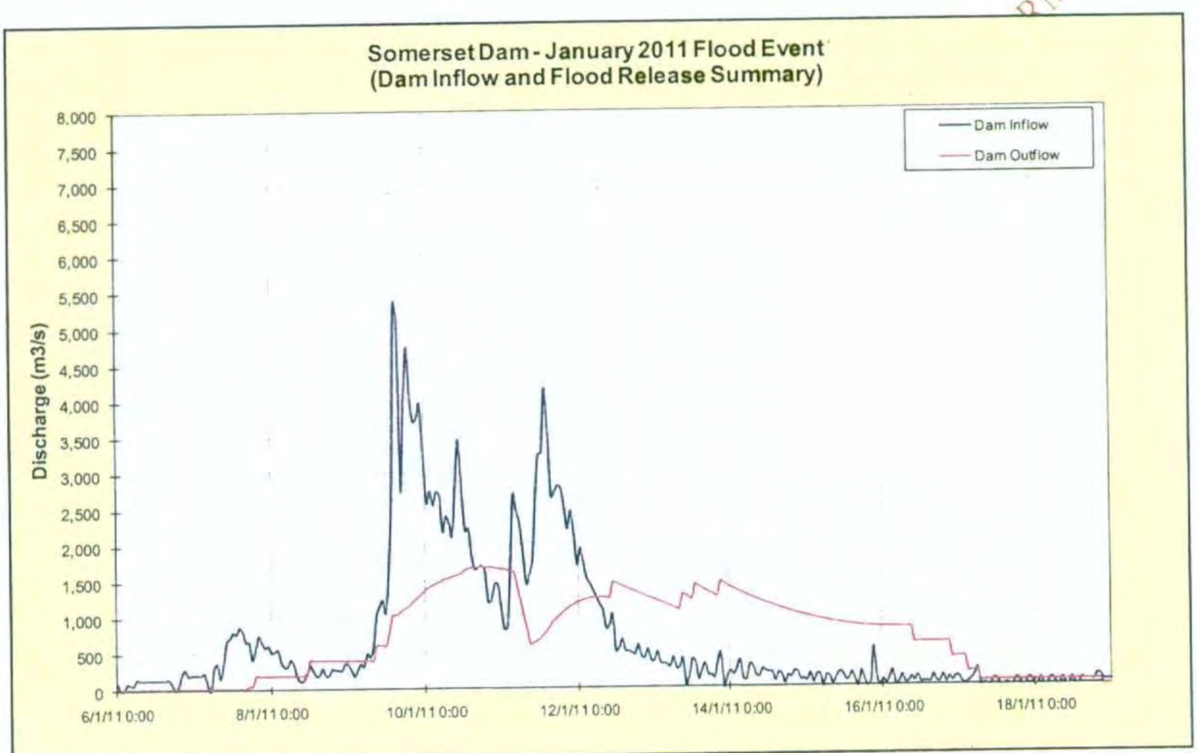


Figure 9.2.2 – Somerset Dam inflow and release summary for the January 2011 Flood Event

10

10 FLOOD MANAGEMENT STRATEGIES AND MANUAL COMPLIANCE

10.1 Wivenhoe Dam flood mitigation strategies

Wivenhoe Dam is capable of being operated in a number of ways to reduce flooding in the Brisbane River downstream of the Dam, depending on the origin, magnitude and spatial extent of the flood. Maximum overall flood mitigation effect is achieved by operating Wivenhoe Dam in conjunction with Somerset Dam.

There are four strategies (W1 to W4) used when operating Wivenhoe Dam during a flood event. These strategies are based on the Flood Objectives of the Manual. These objectives, listed in descending order of importance, are as follows:

- Ensure the structural safety of the Dams;
- Provide optimum protection of urbanised areas from inundation;
- Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;
- Retain the storage at Full Supply Level at the conclusion of the Flood Event;
- Minimise impacts to riparian flora and fauna during the drain down phase of the Flood Event.

When using any of the four strategies, consideration is always given to these objectives in this order, when making decisions on Dam releases.

The strategy chosen at any point in time depends on the actual levels in the Dams and the following predictions, which are to be made using the best forecast rainfall and stream flow information available at the time:

- Maximum storage levels in Wivenhoe and Somerset Dams;
- Peak flow rate at the Lowood Gauge (excluding Wivenhoe Dam releases);
- Peak flow rate at the Moggill Gauge (excluding Wivenhoe Dam releases).

Strategies change during a flood event as forecasts change and rain is received in the catchments. It is not possible to predict the range of strategies that will be used during the course of a flood event at the commencement of the event. Strategies are changed in response to changing rainfall forecasts and stream flow conditions to maximise the flood mitigation benefits of the Dams.

When determining Dam outflows within all strategies, peak outflow should generally not exceed peak inflow. A flowchart illustrating how to select the appropriate strategy to use at any point in time is shown in Figure 10.1.1.

10 FLOOD MANAGEMENT STRATEGIES AND MANUAL COMPLIANCE

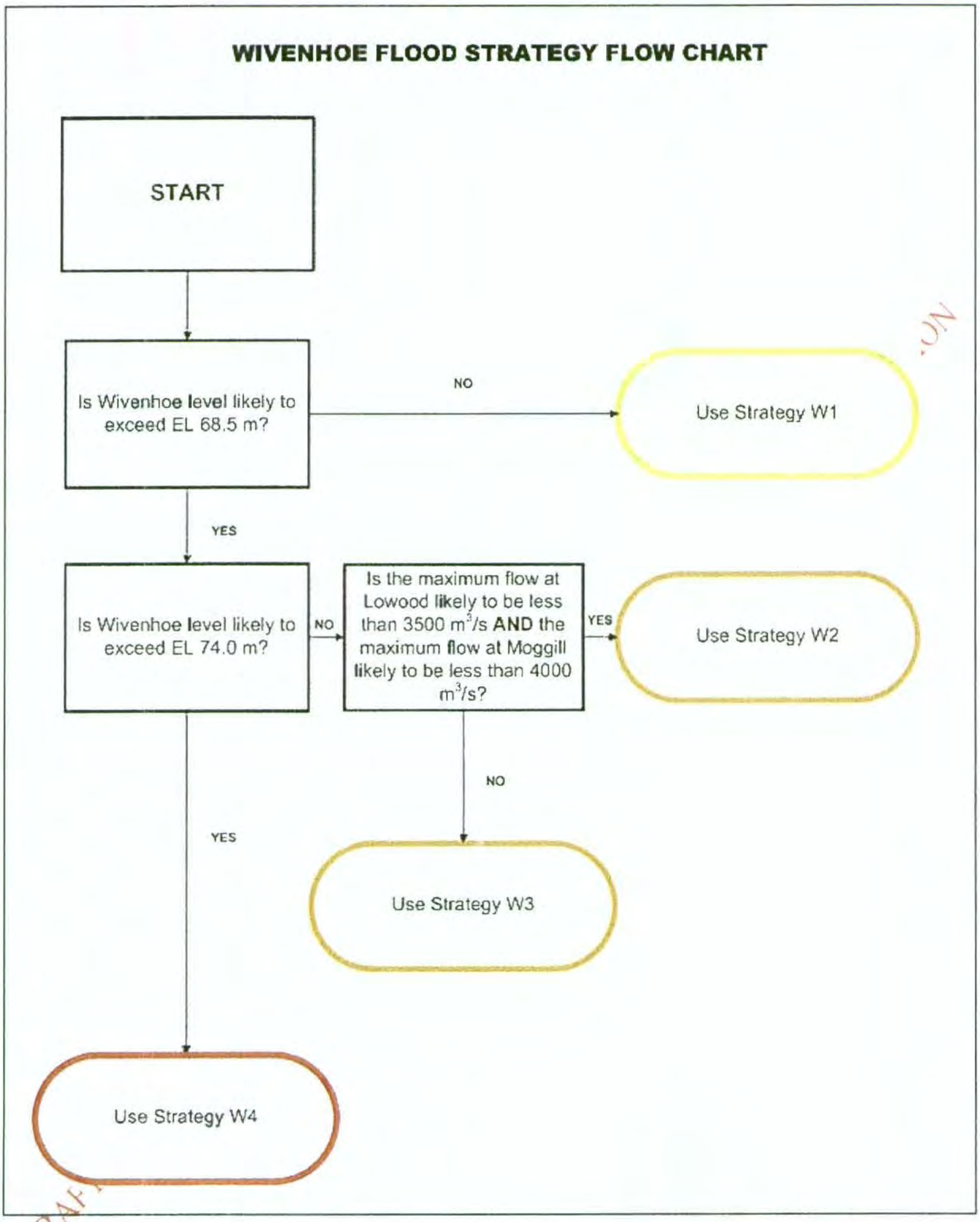


Figure 10.1.1 – Wivenhoe Dam flood strategy flow chart

10 FLOOD MANAGEMENT STRATEGIES AND MANUAL COMPLIANCE

The four Strategies (W1 to W4) used when operating Wivenhoe Dam during a flood event are summarised below.

Strategy W1 - The primary consideration is minimising disruption to downstream rural life

Conditions

- Wivenhoe storage level predicted to be less than 68.50m
- Maximum release predicted to be less than 1,900m^3/s
- The primary consideration is minimising disruption to downstream rural life

Strategy W1 intends to ensure the seven bridges between the Dam and Moggill are not submerged prematurely. The limiting condition for Strategy W1 is the submergence of Mt Crosby Weir Bridge that occurs at approximately 1,900 m^3/s.

This strategy requires a great deal of control over releases and knowledge of discharges from Lockyer Creek. In general, the releases from Wivenhoe Dam are controlled to ensure the combined flow from Lockyer Creek and Wivenhoe Dam is less than the limiting values to delay the submergence of a particular bridge.

Strategy W2 - A transition strategy where the primary consideration changes from minimising impact to downstream rural life to protecting urban areas from inundation.

Conditions

- Wivenhoe storage level predicted to be between 68.50m and 74.00m
- Maximum release predicted to be less than 3,500m3/s
- This is a transition strategy in which the primary consideration changes from minimising disruption to downstream rural life to protecting urban areas from inundation
- Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance

Strategy W2 intends to limit the flow in the Brisbane River to less than the naturally occurring peaks at Lowood and Moggill, while remaining within the upper limit of non-damaging floods at Lowood (3,500m^3/s).

Strategy W3 – The primary consideration is protecting urban areas from inundation

Conditions

- Wivenhoe storage level predicted to be between 68.50m and 74.00m
- Maximum release should not exceed 4,000m3/s
- The primary consideration is protecting urban areas from inundation
- Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance

Strategy W3 intends to limit the flow in the Brisbane River at Moggill to less than 4,000m^3/s, noting that 4,000m^3/s at Moggill is the upper limit of non-damaging floods downstream. The combined peak river flow targets for Strategy W3 are shown in the table below. In relation to these targets, it should be noted that, depending on natural flows from the Lockyer and Bremer catchments, it may not be possible to limit the flow at Moggill to below 4,000m^3/s. In these instances, the flow at Moggill is to be kept as low as possible.

Timing	Target maximum flow in the Brisbane River
Prior to the naturally occurring peak at Moggill (excluding Wivenhoe Dam releases).	The flow at Moggill is to be minimised.
After the naturally occurring peak at Moggill (excluding Wivenhoe Dam releases).	The flow at Moggill is to be lowered to 4,000m^3/s as soon as possible.

10 FLOOD MANAGEMENT STRATEGIES AND MANUAL COMPLIANCE

Strategy W4 – The primary consideration is protecting the structural safety of the Dam

Conditions

- Wivenhoe storage level predicted to exceed 74.00m
- No limit on maximum release rate
- The primary consideration is protecting the structural safety of the Dam
- Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance

Strategy W4 intends to ensure the safety of the Dam while limiting downstream impacts as much as possible. This strategy generally comes into effect when the water level in Wivenhoe Dam reaches 74.0m. However, the Senior Flood Operations Engineer may seek to invoke the discretionary powers of Section 2.8 if the earlier commencement of Strategy W4 is able to prevent a fuse plug being triggered.

Under Strategy W4, the release rate is increased as the safety of the Dam becomes the priority. The gates are generally opened until the storage level of Wivenhoe Dam begins to fall. There are no restrictions on gate opening increments or gate operating frequency once the storage level exceeds 74.0m, as the safety of the Dam is of primary concern at these storage levels.

10.2 Somerset Dam flood mitigation strategies

Somerset Dam is capable of being operated in a number of ways to regulate Stanley River floods. Somerset Dam and Wivenhoe Dam are to be operated in conjunction to optimise the flood mitigation benefits downstream of Wivenhoe Dam. Once a flood event is declared, an assessment is made of the magnitude of the flood event, including a prediction of the maximum storage levels in Somerset and Wivenhoe Dams.

Three strategies, based on the objectives of the Manual, are used when operating Somerset Dam during a flood event. The strategy selected at any point in time depends on predictions of the maximum storage levels in Somerset and Wivenhoe Dams, made using the best forecast rainfall and stream flow information available at the time.

Strategies are likely to change during a flood event as forecasts change and rain is received in the catchments. It is not possible to predict the range of strategies that will be used during the course of a flood event when the event begins. Strategies are changed in response to changing rainfall forecasts and stream flow conditions to maximise the flood mitigation benefits of the Dams.

A flowchart illustrating how to select the appropriate strategy to use at any point in time is shown in Figure 10.2.1.

10 FLOOD MANAGEMENT STRATEGIES AND MANUAL COMPLIANCE

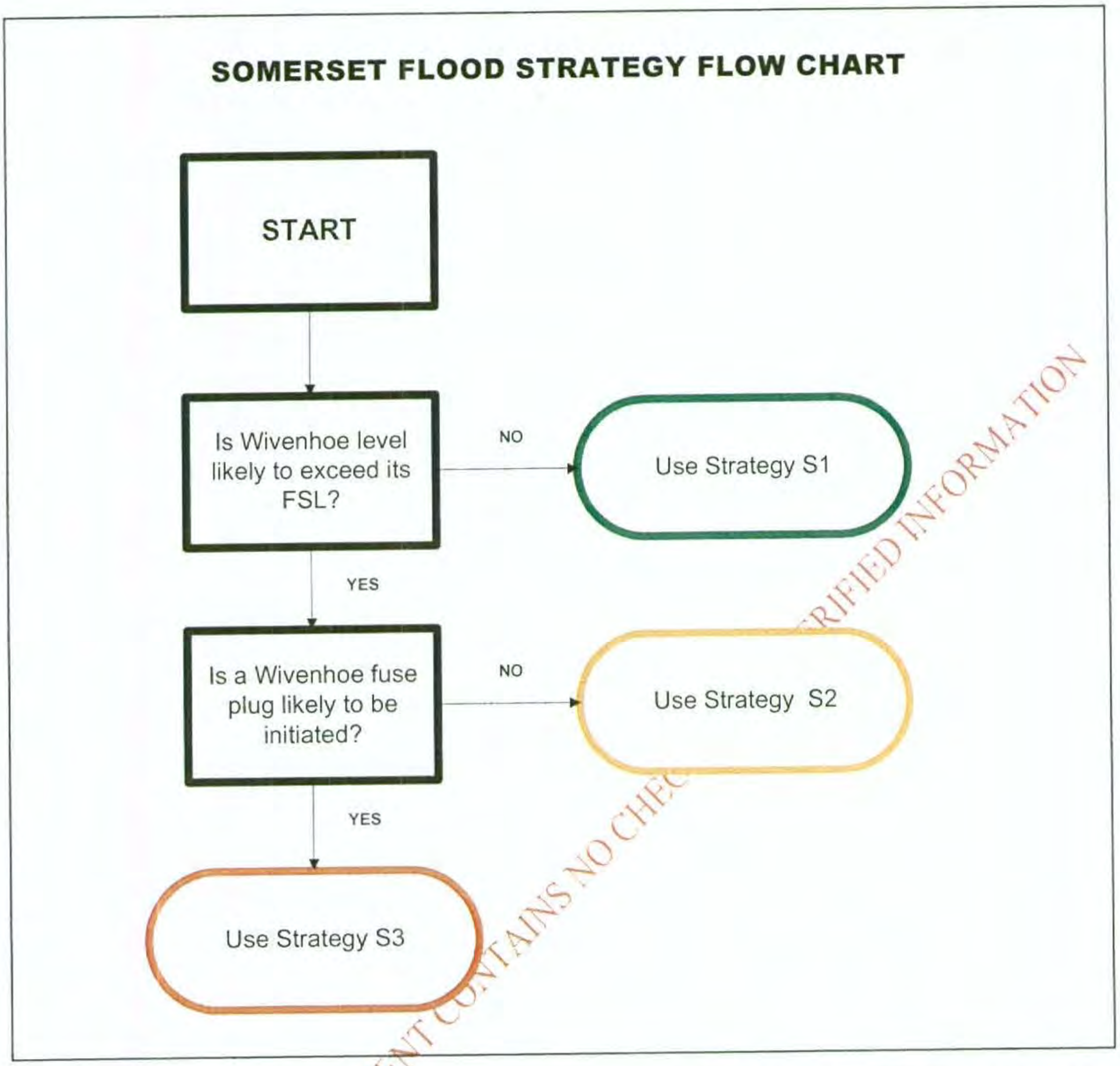


Figure 10.2.1 – Somerset Dam flood strategy flow chart

The three Strategies (S1 to S3) used when operating Somerset Dam during a flood event are summarised below.

Strategy S1 – Minimising impact on rural life upstream

Conditions

- Somerset Dam level expected to exceed 99.0m and Wivenhoe Dam not expected to reach 67.0m (FSL) during the course of the flood event

Strategy S1 intends to return the Dam to full supply level while minimising the impact on rural life upstream of the Dam. Consideration is also given to minimising the downstream environmental impacts from the release.

The crest gates at Somerset Dam are raised to enable uncontrolled discharge. The regulator valves and sluice gates are to be used to maintain the level in Somerset Dam below 102.0m (deck level of Mary Smokes Bridge). The Somerset Dam release rate is not to exceed the peak inflow into the Dam.

10 FLOOD MANAGEMENT STRATEGIES AND MANUAL COMPLIANCE

Strategy S2 – Minimise impacts below Wivenhoe Dam	
Conditions	• Somerset Dam level expected to exceed 99.0m and Wivenhoe Dam level expected to exceed 67.0m (FSL) but not exceed 75.5m (fuse plug initiation) during the course of the flood event

Strategy S2 intends to maximise the benefits of the flood storage capabilities of the Dam, while protecting the structural safety of both Dams. Table 10.2.2 contains the operating conditions and actions for Strategy S2.

Condition	Action
Wivenhoe Dam rising and Somerset level below 100.45m	• The crest gates are raised to enable uncontrolled discharge • The low-level regulators and sluices are generally kept closed
Wivenhoe Dam rising and Somerset level above 100.45m	• The crest gates are raised to enable uncontrolled discharge • Operations aim to achieve a correlation of water levels in Somerset Dam and Wivenhoe Dam, as set out in Figure 10.2.3. The operations target line shown on this graph is to generally be followed as the flood event progresses • The release rate from Somerset Dam is generally not to exceed the peak inflow into the Dam
Wivenhoe Dam falling and Somerset level above 100.45m	• The opening of the regulators and sluices generally should not cause Wivenhoe Dam to rise significantly • The release rate from Somerset Dam is generally not to exceed the peak inflow into the Dam
The flood event has emanated mainly from the Stanley River catchment without significant runoff in the Upper Brisbane River catchment	• The crest gates at Somerset Dam are raised to enable uncontrolled discharge • The regulator valves and sluice gates are to be used to maintain the level in Somerset Dam below EL 102.0 (deck level of Mary Smokes Bridge) • The release rate from Somerset Dam is generally not to exceed the peak inflow into the Dam.

Table 10.2.2 – Somerset Dam operating conditions for flood strategy S2

10 FLOOD MANAGEMENT STRATEGIES AND MANUAL COMPLIANCE

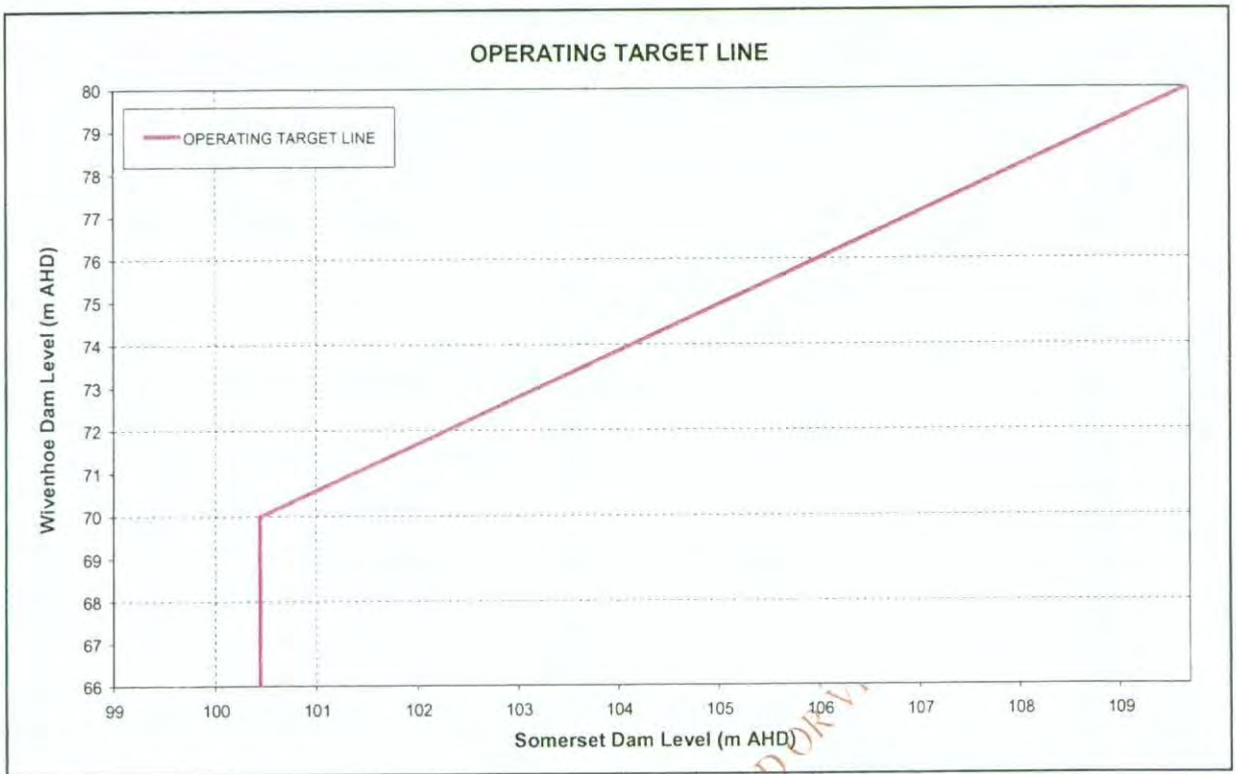


Figure 10.2.3 – Strategy S2, Wivenhoe / Somerset Operating Target Line

Notes on Figure 10.2.3:

- The Operating Target Line was selected following an optimisation study and considering the following factors:
  - Equal minimisation of flood level peaks in both Dams in relation to their associated Dam failure levels;
  - Minimisation of flows in the Brisbane River downstream of Wivenhoe Dam;
  - Consideration of the time needed at the onset of a flood event to properly assess the magnitude of the event and the likely impacts. This is to ensure the optimal strategy to maximise the flood mitigation benefits of the storages can be selected.
- The target point on the Operating Target Line at any point in time is based on the maximum storage levels in Somerset and Wivenhoe Dams, using the best forecast rainfall and stream flow information available at the time.
- Gate operations enable the progressive movement of the duty point towards the target line. It is not necessarily possible to adjust the duty point directly towards the target line in a single gate operation.

Strategy S3 - Protect the structural safety of the Dam

Conditions	• Somerset Dam level expected to exceed 99.0m and Wivenhoe Dam level expected to exceed 75.5m (fuse plug initiation) during the course of the flood event.

Strategy S3 intends to maximise the benefits of the flood storage capabilities of the Dam while protecting the structural safety of both Dams. In addition to the operating protocols used in Strategy S2 to prevent fuse plug initiation, consideration can be given to temporary departure from the operating protocols contained in this strategy under the following conditions:

- The safety of Somerset Dam is the primary consideration and cannot be compromised;
- The peak level in Somerset Dam cannot exceed 109.7m.

10 FLOOD MANAGEMENT STRATEGIES AND MANUAL COMPLIANCE

10.3 Wivenhoe Dam – Manual compliance

Table 10.3.1 summarises the strategies used in the operation of Wivenhoe Dam during the January 2011 Flood Event and provides explanations of how the use of these strategies complies with the Manual.

Period	Strategies used during the period	Explanation of strategies used during the period	Manual requirements
Commenced Thursday 06 Jan 2011 07:42 (Lake level 67.31m) Completed Friday 07 Jan 2011 02:00 (Lake level 67.52m)	Strategy W1A	• At the start of the Event, Strategy W1A was used because the Lake level was between 67.25m and 67.50m. • The strategy during this period was to ensure Colleges Crossing remained trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 175m^3/s. Because of the inflows into the Brisbane River from Lockyer Creek, there were no releases from the Dam during this period. • Based on flows recorded at Mt Crosby Weir, Colleges Crossing remained trafficable during this period. • The strategy transitioned from Strategy W1A to Strategy W1B once the Lake level exceeded 67.50m.	Use Strategy W1A when the Lake level is between 67.25m and 67.50m. [Maximum release 110m^3/s] Under Strategy W1A, the Manual requirement is to endeavour to ensure Colleges Crossing remains trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 175m^3/s. Use Strategy W1B when the Lake level is between 67.50m and 67.75m. [Maximum release 380m^3/s]
Commenced Friday 07 Jan 2011 02:00 (Lake level 67.52m) Completed Friday 07 Jan 2011 09:00 (Lake level 67.75m)	Strategy W1B	• The strategy transitioned from Strategy W1A to Strategy W1B once the Lake level exceeded 67.50m. • Based on flows recorded at Mt Crosby Weir, Colleges Crossing was inundated during this period. • The strategy during this period was to ensure Burtons Bridge remained trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 430m^3/s. Because of the inflows into the Brisbane River from Lockyer Creek, there were no releases from the Dam during this period. • Based on flows recorded at Savages Crossing, Burtons Bridge remained trafficable during this period. • The strategy transitioned from Strategy W1B to Strategy W1C once the Lake level exceeded 67.75m.	Use Strategy W1B when the Lake level is between 67.50m and 67.75m. [Maximum release 380m^3/s] Under Strategy W1B, the Manual requires that once Colleges Crossing is closed to traffic, endeavour to ensure Burtons Bridge remains trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 430m^3/s. Use Strategy W1C when the Lake level is between 67.75m and 68.00m. [Maximum release 500m^3/s]

Period	Strategies used during the period	Explanation of strategies used during the period	Manual requirements
Commenced Friday 07 Jan 2011 09:00 (Lake level 67.75m) Completed Friday 07 Jan 2011 15:00 (Lake level 68.03m)	Strategy W1C	• The strategy transitioned from Strategy W1B to Strategy W1C once the Lake level exceeded 67.75m. • The strategy during this period was to ensure Burtons Bridge remained trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 430m3/s. Once Burtons Bridge was closed to traffic, endeavour to keep Kholo Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 550m^3/s. Because of the inflows into the Brisbane River from Lockyer Creek, there were no releases from the Dam during this period. • Based on flows recorded at Savages Crossing, Burtons Bridge was inundated near the end of this period. • Based on flows recorded at Mt Crosby Weir, Kholo Bridge remained trafficable during this period. • As well as being in accordance with the Manual, delaying releases until 15:00 allowed bridges to be closed by the relevant authorities and arrangements to be made to cater for rural community isolation. The impacted rural communities had been isolated over the Christmas period and time was needed to make suitable arrangements to allow these communities to prepare for another potentially extended isolation period. • The strategy transitioned from Strategy W1C to Strategy W1D once the Lake level exceeded 68.00m.	Use Strategy W1C when the Lake level is between 67.75m and 68.00m. [Maximum release 500m^3/s] Under Strategy W1C, the Manual requirement is to endeavour to keep Burtons Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 430m^3/s. Under Strategy W1C, the Manual also requires that once Burtons Bridge is closed to traffic (occurred around 13:00 during this period) endeavour to keep Kholo Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 550m^3/s. Use Strategy W1D when the Lake level is between 68.00m and 68.25m. [Maximum release 1,900m^3/s].

Period	Strategies used during the period	Explanation of strategies used during the period	Manual requirements
Commenced Friday 07 Jan 2011 15:00 (Lake level 68.03m) Completed Friday 07 Jan 2011 22:00 (Lake level 68.26m)	Strategy W1D	• The strategy transitioned from Strategy W1C to Strategy W1D once the Lake level exceeded 68.00m. • At the start of this period, it became apparent Kholo Bridge would be inundated by natural Brisbane River flows (excluding Wivenhoe Dam releases). Based on flows recorded at Mt Crosby Weir, Kholo Bridge was inundated near the end of this period (middle of the night). Therefore, the strategy adopted was to close Kholo Bridge in daylight hours for public safety and then assume – for the purposes of Strategy W1D – that Kholo Bridge was closed to traffic. • Accordingly, the strategy during this period was to keep Mt Crosby Weir Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 1,900m^3/s. • During this period, releases were increased to 421m^3/s. Radial gates were opened continuously at Wivenhoe Dam, in accordance with the standard gate opening sequence at a rate or 0.5 metres of opening per hour. • Mt Crosby Weir Bridge remained trafficable during the period. • The strategy transitioned from Strategy W1D to Strategy W1E once the Lake level exceeded 68.25m.	Use Strategy W1D when the Lake level is between 68.00m and 68.25m. [Maximum release 1,900m^3/s] Under Strategy W1D, the Manual requires that once Kholo Bridge is closed to traffic, endeavour to keep Mt Crosby Weir Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 1,900m^3/s. Use Strategy W1E when the Lake level is between 68.25m and 68.50m. [Maximum release 1,900 m^3/s]
Commenced Friday 07 Jan 2011 22:00 (Lake level 68.26m) Completed Saturday 08 Jan 2011 08:00 (Lake level 68.26m)	Strategy W1E	• The strategy transitioned from Strategy W1D to Strategy W1E once the Lake level exceeded 68.25m. • The strategy during this period was to keep Mt Crosby Weir Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 1,900m^3/s. • During this period, releases were increased to 953m^3/s. Radial gates were opened continuously at Wivenhoe Dam, in accordance with the standard gate opening sequence at a rate or 0.5 metres of opening per hour. • Mt Crosby Weir Bridge remained trafficable during the period. • The strategy transitioned from Strategy W1E to Strategy W2 once the Lake level reached 68.50m.	Use Strategy W1E when the Lake level is between 68.25m and 68.50m. [Maximum release 1,900m^3/s] Under Strategy W1E, the Manual requirement is to endeavour to keep Mt Crosby Weir Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 1,900m^3/s. Use Strategy W2 or Strategy W3 as appropriate when the Lake level reaches 68.50m.

Period	Strategies used during the period	Explanation of strategies used during the period	Manual requirements
Saturday 08 Jan 2011 08:00 (Lake level 68.52m)	Attempt to transition to Strategy W2	• The Lake level at this time was 68.52m and the release rate from the Dam at this time was 940m^3/s. • At this time, it was not possible to satisfy Strategy W2 by limiting the flow in the Brisbane River to less than the naturally occurring peaks at Lowood and Moggill. The calculated naturally occurring peaks at Lowood and Moggill were 530m^3/s and 800m^3/s respectively, whereas the release rate from the Dam at this time was 940m^3/s. • Accordingly, it was not appropriate to switch to Strategy W2, and Strategy W3 was adopted for use at 08:00 on Saturday 8 January 2011.	The Manual states, "If the level reaches EL 68.5m in Wivenhoe Dam, switch to Strategy W2 or W3 as appropriate". Use Strategy W2 when the Lake level is predicted to be between 68.50m and 74.00m. [Maximum release 3,500m^3/s] Strategy W2 is a transition strategy in which the primary consideration changes from minimising disruption to downstream rural life to protecting urban areas from inundation. Lower level objectives are still considered under Strategy W2 when making decisions on water releases. Objectives are always considered in order of importance. The intent of Strategy W2 is to limit the flow in the Brisbane River to less than the naturally occurring peaks at Lowood and Moggill, while remaining within the upper limit of non-damaging floods at Lowood (3,500m^3/s).

Period	Strategies used during the period	Explanation of strategies used during the period	Manual requirements
Commenced Saturday 08 Jan 2011 08:00 (Lake level 68.52m) Completed Sunday 09 Jan 2011 08:00 (Lake level 68.58m)	Strategy W3	• The Lake level at the start of this period was 68.52m and the release rate from the Dam was 940m^3/s. The Lake level at the end of this period was 68.58m and the release rate from the Dam was 1,386m^3/s. The Lake level rose 60mm during this 24-hour period. • The catchment average rainfall experienced in the Wivenhoe Dam catchment (excluding the Somerset Dam catchment) during this 24-hour period was 21mm. • The latest QPF forecast available at the end of this period was for 40mm in the Dam catchments in the next 24 hours (issued at 16:00 on 8 January 2011). • At the end of this period, model results estimated the Wivenhoe Dam peak at 68.7m (excluding forecast) and 69.3m (including forecast). The estimated peak of 69.3m (including forecast) had previously been exceeded in March 1989, April 1989, February 1999, October 2010 and December 2010. On each of these occasions, no known urban damage had occurred downstream of Moggill as a result of Dam releases. • At the end of this period, model results estimate total Dam inflow at 420,000ML (excluding forecast) and 662,000ML (including forecast). The estimated total Dam inflow of 662,000ML (including forecast) on a full Dam had previously been exceeded in March 1989, April 1989 and February 1999. On each of these occasions, no known urban damage had occurred downstream of Moggill as a result of Dam releases. • Estimated peak flow at Moggill (including Wivenhoe Dam releases) was 1,720m^3/s (excluding forecast) and 2,220m^3/s (including forecast). • On the basis of the information above, the available data did not indicate there would be a need to increase releases from Wivenhoe Dam above the current modelled levels to protect urban areas from inundation, either during the current period or in the 24 hours following the current period. • The naturally occurring peak at Moggill was estimated to have occurred at 05:00 on 08 January 2011 (i.e. in the past). • Strategy W3 requires the flow at Moggill to be lowered to 4,000m^3/s as soon as possible after the naturally occurring peak at Moggill (excluding Wivenhoe Dam releases). This was already achieved. • Strategy W3 also requires consideration of lower level Manual objectives, and on the basis of this requirement, consideration during this period was given to minimising disruption to downstream rural life and endeavouring to keep Mt Crosby Weir Bridge and Fernvale Bridge trafficable.	Use Strategy W3 when the intent of Strategy W2 cannot be met and the Lake level is predicted to be between 68.50m and 74.00m. [Maximum release 4,000m^3/s] The primary consideration is protecting urban areas from inundation, however the Manual also requires lower level objectives to be considered when making decisions on water releases. Objectives are always considered in order of importance. The intent of Strategy W3 is to limit the flow in the Brisbane River at Moggill to less than 4,000m^3/s. After the naturally occurring peak at Moggill (excluding Wivenhoe Dam releases), the flow at Moggill is to be lowered to 4,000 m^3/s as soon as possible.

Period	Strategies used during the period	Explanation of strategies used during the period	Manual requirements
Commenced Sunday 09 Jan 2011 08:00 (Lake level 68.58m) Completed Sunday 09 Jan 2011 19:00 (Lake level 68.97m)	Strategy W3	• The Lake level at the start of this period was 68.58m and the release rate from the Dam was 1,386m^3/s. The Lake level at the end of this period was 68.97m and the release rate from the Dam was 1,411m^3/s. The Lake level rose 390mm during this 11-hour period. • The catchment average rainfall experienced in the Wivenhoe Dam catchment (excluding the Somerset Dam catchment) during this 24-hour period was 96mm, the bulk of which (62mm) occurred in the last five hours of the period. • The latest QPF forecast available at the end of this period was for 65mm in the Dam catchments in the next 24 hours (issued at 16:00 on 9 January 2011). • At the mid-point of this period (14:00), model results estimated Wivenhoe Dam to peak at 70.0m (excluding forecast) and 71.3m (including forecast). The estimated peak of 71.3m (including forecast) had previously been exceeded in April 1989, and on this occasion, no known urban damage had occurred downstream of Moggill as a result of Dam releases. • At the mid-point of this period (14:00), model results estimated total Dam inflow at 804,000ML (excluding forecast) and 1,108,000ML (including forecast). The estimated total Dam inflow of 1,108,000ML (including forecast) – on a full Dam – had never previously been exceeded, with the previous largest volumes being 870,000ML in April 1989 and 925,000 in February 1999. Although the inflow estimate of 1,108,000ML was based on a forecast, it resulted in an expectation that there may be a need within the next six hours to transition to a situation where minimising disruption to downstream rural life was no longer considered. This would result is the closure of all bridges between the Dam and Moggill, and the closure of Brisbane Valley Highway. • At the mid-point of this period (14:00), estimated peak flow at Moggill (including Wivenhoe Dam releases) was 1,850m^3/s (excluding forecast) and 2,590m^3/s (including forecast). • On the basis of the information above, the available data at the mid-point of this period did not indicate there would be a definite need to increase releases from Wivenhoe Dam above the current modelled levels, to protect urban areas from inundation in the six hours from 14:00. • At the end of this period, model results estimated Wivenhoe Dam to peak at 72.1m (excluding forecast) and 73.9m (including forecast). These values had never been previously exceeded. • At the end of this period, model results estimated total Dam inflow at 1,272,000ML (excluding forecast) and 1,712,000ML (including forecast). These values had never been previously exceeded. • On the basis of the estimated Wivenhoe Dam peak levels and inflow volumes from the model results undertaken towards the end of this period, the decision was made at 19:00 on 09 January 2011 to transition to a situation where minimising disruption to downstream rural life was no longer a consideration.	Use Strategy W3 when the intent of Strategy 2 cannot be met and the Lake level is predicted to be between 68.50m and 74.00m. [Maximum release 4,000m^3/s] The primary consideration is protecting urban areas from inundation, however the Manual also requires lower level objectives to be considered when making decisions on water releases. Objectives are always considered in order of importance. The intent of Strategy W3 is to limit the flow in the Brisbane River at Moggill to less than 4,000m^3/s. After the naturally occurring peak at Moggill (excluding Wivenhoe Dam releases), the flow at Moggill is to be lowered to 4,000m^3/s as soon as possible.

Period	Strategies used during the period	Explanation of strategies used during the period	Manual requirements

Commenced Tuesday 11 Jan 2011 08:00 (Lake level 73.70m)
 	
Completed Thursday 13 Jan 2011 12:00 (Lake level 74.61m)
	Strategy W4	• On the basis of the information contained in the previous table, at the start of this period it was decided to transition to Strategy W4.
		• The Lake level at the start of this period was 73.70m and the release rate from the Dam was 2,753m^3/s. The Lake level at the end of this period was 74.61m and the release rate from the Dam was 2,534m^3/s. During this period, at 19:00 on 11 January 2011, the Lake level peaked at 74.97m and the release rate peaked at 7,464m^3/s.
		• The Lake level stabilised at 20:00 on 11 January 2011 and then dropped slightly at 21:00. A decision was made at 21:00 to commence closing the gates as quickly as possible to reduce urban flood impacts. This decision was made in an attempt to minimise urban damage below Moggill, which is an objective that must be considered under Strategy W4. Gates would have been re-opened if further Lake level rises were experienced.
		• Following a decision to close the gates, it was calculated that reducing to a discharge of 2,547m^3/s from Wivenhoe Dam would:
		   ◦ Not increase the downstream flood peak;
		   ◦ Not cause the water level in Wivenhoe Dam to rise; and
		   ◦ Allow the dam to be drained back to FSL in seven days in accordance with the Manual.
		• On this basis, this target release rate was adopted.
		• At the end of this period, it was apparent the flood peak had passed and therefore the operational strategy transitioned to the drain down phase
			Use Strategy W4 when Wivenhoe Dam's storage level is likely to exceed 74.00m. [No limit on maximum release rate]
			
			The primary consideration of Strategy W4 is to protect the structural safety of the Dam, however lower level objectives are still considered in order of importance when making decisions on water releases.
			
			Under Strategy W4, gates are opened until the storage level of Wivenhoe Dam begins to fall.
			
			Drain down operations require stored floodwaters to be emptied from the Dams within seven days of the flood event peak passing through the Dams.

10 FLOOD MANAGEMENT STRATEGIES AND MANUAL COMPLIANCE

10.4 Somerset Dam – Manual compliance

The table that commences on the following page (Table 10.4.2) summarises the strategies used to operate Wivenhoe Dam during the January 2011 Flood Event, and outlines how the use of these strategies complies with the Manual.

A graph showing the track of the Wivenhoe / Somerset Operating Target Line over the course of the Event is shown at the end of the Table 10.4.3. The Dam levels tracked very close to and on the line, in the hours leading up to and following the Event peak at 19:00 on 11 January 2011. This is demonstrated in Table 10.4.1.

Date	Actual Dam level coordinates		Interaction line coordinates		Comments
10/01/2011 23:00	103.39	73.22	103.39	73.18	Moved above interaction line.
11/01/2011 00:00	103.37	73.26	103.37	73.16	
11/01/2011 01:00	103.36	73.31	103.36	73.15	
11/01/2011 02:00	103.31	73.35	103.31	73.09	
11/01/2011 03:00	103.27	73.38	103.27	73.05	
11/01/2011 04:00	103.23	73.40	103.23	73.01	
11/01/2011 05:00	103.28	73.46	103.28	73.06	
11/01/2011 06:00	103.34	73.51	103.34	73.12	
11/01/2011 07:00	103.40	73.61	103.40	73.19	
11/01/2011 08:00	103.46	73.70	103.46	73.25	
11/01/2011 09:00	103.50	73.81	103.50	73.30	
11/01/2011 10:00	103.54	73.95	103.54	73.34	
11/01/2011 11:00	103.61	74.10	103.61	73.42	
11/01/2011 12:00	103.68	74.27	103.68	73.49	
11/01/2011 13:00	103.83	74.39	103.83	73.65	
11/01/2011 14:00	103.96	74.57	103.96	73.79	
11/01/2011 15:00	104.12	74.71	104.12	73.97	
11/01/2011 16:00	104.31	74.81	104.31	74.17	
11/01/2011 17:00	104.41	74.89	104.41	74.28	
11/01/2011 18:00	104.51	74.95	104.51	74.39	
11/01/2011 19:00	104.60	74.97	104.60	74.49	Event peak.
11/01/2011 20:00	104.70	74.97	104.70	74.59	
11/01/2011 21:00	104.78	74.95	104.78	74.68	
11/01/2011 22:00	104.85	74.95	104.85	74.76	
11/01/2011 23:00	104.90	74.92	104.90	74.81	
12/01/2011 00:00	104.98	74.91	104.98	74.90	
12/01/2011 01:00	105.00	74.87	105.00	74.92	Moved below interaction line.

***Table 10.4.1** – Somerset Dam levels as tracking against the Wivenhoe / Somerset Operating Target Line for the January 2011 Flood Event*

Period	Strategies used during the period	Explanation of strategies used during the period	Manual requirements
Commenced Thursday 06 Jan 2011 07:42 (Lake level 99.34m) Completed Friday 07 Jan 2011 17:00 (Lake level 100.06m)	Strategy S2	• During this nine-hour period, the Wivenhoe Dam level was rising (67.31m at the start of the period, rising to 68.03m by the end of the period) and the Somerset Dam level was below 100.45m. • In accordance with Strategy S2, the crest gates at Somerset Dam were raised at the start of the Event to enable uncontrolled discharge, and the low-level sluices were kept closed. Some regulated releases continued from December as part of previous event drain down, (in the order of $35m^3/s$) and these continued during this period.	Use Strategy S2 when the Somerset Dam level is expected to exceed 99.0m and the Wivenhoe Dam level is expected to exceed 67.0m but not exceed 75.5m (fuse plug initiation) during the course of the event. If Wivenhoe Dam is rising and the Somerset Dam level is below 100.45m, Strategy S2 requires the crest gates to be raised, and the low-level regulators and sluices are **generally** kept closed.
Commenced Thursday 07 Jan 2011 17:00 (Lake level 100.06m) Completed Friday 08 Jan 2011 07:00 (Lake level 100.44m)	Strategy S2	• During this 15-hour period, the Wivenhoe Dam level was rising (68.03m at the start of the period, rising to 68.48m by the end of the period) and the Somerset Dam level was below 100.45m. • At 17:00, it was apparent that unless releases began at Somerset Dam, the Somerset Lake level would exceed 100.45m within 12 hours. Accordingly, one sluice gate was opened during this period to allow Dam levels to move towards the Wivenhoe/Somerset Operating Target Line.	Use Strategy S2 when the Somerset Dam level is expected to exceed 99.0m and the Wivenhoe Dam level is expected to exceed 67.0m but not exceed 75.5m (fuse plug initiation) during the course of the event. If Wivenhoe Dam is rising and the Somerset Dam level is below 100.45m, Strategy S2 requires the crest gates to be raised, and the low-level regulators and sluices are **generally** kept closed.

Period	Strategies used during the period	Explanation of strategies used during the period	Manual requirements
Commenced Friday 08 Jan 2011 07:00 (Lake level 100.06m) Completed Friday 08 Jan 2011 13:00 (Lake level 100.45m)	Strategy S2	• During this six hour period, the Wivenhoe Dam level was rising (68.48m at the start of the period, rising to 68.61m by the end of the period) and the Somerset Dam level moved above 100.45m (this occurred between 07:00 and 08:00 on 8 January 2011) and then stayed above 100.45m for the remainder of the period. • A second sluice was opened during this period to allow Dam levels to track towards the Wivenhoe/Somerset Operating Target Line.	Use Strategy S2 when the Somerset Dam level is expected to exceed 99.0m and the Wivenhoe Dam level is expected to exceed 67.0m but not exceed 75.5m (fuse plug initiation) during the course of the Event. If Wivenhoe Dam is rising and the Somerset Dam level is above 100.45m, Strategy S2 requires the crest gates to be raised, and the low-level regulators and sluices are used to **generally** allow the Wivenhoe/Somerset Operating Target Line to be followed.
Commenced Friday 08 Jan 2011 13:00 (Lake level 100.45m) Completed Friday 08 Jan 2011 17:00 (Lake level 100.40m)	Strategy S2	• During this four-hour period, the Wivenhoe Dam level was rising (68.61m at the start of the period, rising to 68.65m by the end of the period). The Somerset Dam level moved to just below 100.45m (this occurred between 13:00 and 14:00 on 8 January 2011) and then stayed below 100.45m for the remainder of the period. • At the beginning of this period, it was apparent the Somerset Lake level would exceed 100.45m within four hours. Accordingly, two sluices remained open during this period to allow Dam levels to track towards the Wivenhoe/Somerset Operating Target Line.	Use Strategy S2 when the Somerset Dam level is expected to exceed 99.0m, and the Wivenhoe Dam level is expected to exceed 67.0m but not exceed 75.5m (fuse plug initiation) during the course of the Event. If Wivenhoe Dam is rising, and the Somerset Dam level is below 100.45m, Strategy S2 requires the crest gates to be raised, and the low-level regulators and sluices are **generally** kept closed.

Period	Strategies used during the period	Explanation of strategies used during the period	Manual requirements
Commenced Friday 08 Jan 2011 17:00 (Lake level 100.40m) Completed Saturday 09 Jan 2011 10:00 (Lake level 100.31m)	Strategy S2	• During this 17-hour period, the Wivenhoe Dam level was falling (68.65m at the start of the period, falling to 68.53m by the end of the period). The Somerset Dam level remained below 100.45m. • Strategy S2 does not provide specific guidance for this situation, however Strategy S2 intends to maximise the benefits of the flood storage capabilities of the Dams. Accordingly, two sluices remained open during this period and a third sluice was opened near the end of the period as modelling results indicated rapidly increasing inflows into Somerset Dam occurring soon after the end of the period and continuing. Increasing the sluice gate release would ultimately allow Dam levels to track towards the Wivenhoe/Somerset Operating Target Line.	Use Strategy S2 when the Somerset Dam level is expected to exceed 99.0m, and the Wivenhoe Dam level is expected to exceed 67.0m but not exceed 75.5m (fuse plug initiation) during the course of the Event. Strategy S2 intends to maximise the benefits of the flood storage capabilities of the Dams.
Commenced Saturday 09 Jan 2011 10:00 (Lake level 100.31m) Completed Saturday 09 Jan 2011 13:00 (Lake level 100.43m)	Strategy S2	• During this three-hour period, the Wivenhoe Dam level was rising (68.53m at the start of the period, rising to 68.56m by the end of the period). The Somerset Dam level remained below 100.45m, but rose rapidly. • Three sluices remained open during this period, and a fourth sluice was opened near the end of the period to allow Dam levels to track towards the Wivenhoe/Somerset Operating Target Line.	Use Strategy S2 when the Somerset Dam level is expected to exceed 99.0m, and the Wivenhoe Dam level is expected to exceed 67.0m but not exceed 75.5m (fuse plug initiation) during the course of the Event. If Wivenhoe Dam is rising, and the Somerset Dam level is below 100.45m, Strategy S2 requires the crest gates to be raised, and the low-level regulators and sluices are **generally** kept closed.

Period	Strategies used during the period	Explanation of strategies used during the period	Manual requirements
Commenced Saturday 09 Jan 2011 13:00 (Lake level 100.43m) Completed Tuesday 11 Jan 2011 04:00 (Lake level 103.23m)	Strategy S2	• During this 63-hour period, the Wivenhoe Dam level was rising (68.56m at the start of the period, rising to 73.40m by the end of the period). The Somerset Dam level moved above 100.45m (this occurred between 13:00 and 14:00 on 9 January 2011) and then stayed above 100.45m for the remainder of the period. • Four sluices remained open during this period, and a fifth sluice was opened near the beginning of the period to allow Dam levels to track towards the Wivenhoe/Somerset Operating Target Line.	Use Strategy S2 when the Somerset Dam level is expected to exceed 99.0m, and the Wivenhoe Dam level is expected to exceed 67.0m but not exceed 75.5m (fuse plug initiation) during the course of the Event. If Wivenhoe Dam is rising, and the Somerset Dam level is above 100.45m, Strategy S2 requires the crest gates to be raised, and the low-level regulators and sluices are used to **generally** allow the Wivenhoe/Somerset Operating Target Line to be followed.
Commenced Tuesday 11 Jan 2011 04:00 (Lake level 103.23m) Completed Tuesday 11 Jan 2011 09:00 (Lake level 103.50m)	Strategy S2	• During this five-hour period, the Wivenhoe Dam level was rising (73.40m at the start of the period, rising to 73.81m by the end of the period). The Somerset Dam level remained above 100.45m. • During this period, all sluice gates were closed to allow Dam levels to track towards the Wivenhoe/Somerset Operating Target Line and limit rises in Wivenhoe Dam.	Use Strategy S2 when the Somerset Dam level is expected to exceed 99.0m, and the Wivenhoe Dam level is expected to exceed 67.0m but not exceed 75.5m (fuse plug initiation) during the course of the Event. If Wivenhoe Dam is rising, and the Somerset Dam level is above 100.45m, Strategy S2 requires the crest gates to be raised, and the low-level regulators and sluices are used to **generally** allow the Wivenhoe/Somerset Operating Target Line to be followed.

Period	Strategies used during the period	Explanation of strategies used during the period	Manual requirements
Commenced Tuesday 11 Jan 2011 09:00 (Lake level 103.50m) Completed Tuesday 11 Jan 2011 19:00 (Lake level 104.60m)	Strategy S2	• During this 10-hour period, the Wivenhoe Dam level was rising (73.81m at the start of the period, rising to 74.97m by the end of the period). The Somerset Dam level remained above 100.45m. • During this period, all sluice gates remained closed to allow Dam levels to track towards the Wivenhoe/Somerset Operating Target Line and limit rises in Wivenhoe Dam.	Use Strategy S2 when the Somerset Dam level is expected to exceed 99.0m, and the Wivenhoe Dam level is expected to exceed 67.0m but not exceed 75.5m (fuse plug initiation) during the course of the Event. If Wivenhoe Dam is rising, and the Somerset Dam level is above 100.45m, Strategy S2 requires the crest gates to be raised, and the low-level regulators and sluices are used to **generally** allow the Wivenhoe/Somerset Operating Target Line to be followed.
Commenced Tuesday 11 Jan 2011 19:00 (Lake level 104.60m) Completed Wednesday 12 Jan 2011 10:00 (Lake level 105.09m)	Strategy S2	• During this 15-hour period, the Wivenhoe Dam level was falling (74.97m at the start of the period, falling to 74.78m by the end of the period). The Somerset Dam level remained above 100.45m. • During this period, all sluice gates remained closed to allow Dam levels to track towards the Wivenhoe/Somerset Operating Target Line and limit rises in Wivenhoe Dam.	Use Strategy S2 when the Somerset Dam level is expected to exceed 99.0m, and the Wivenhoe Dam level is expected to exceed 67.0m, but not exceed 75.5m (fuse plug initiation) during the course of the Event. If Wivenhoe Dam is falling, and the Somerset Dam level is above 100.45m, Strategy S2 requires the crest gates to be raised, and the low-level regulators and sluices are used to **generally** not cause Wivenhoe Dam to rise significantly.

Period	Strategies used during the period	Explanation of strategies used during the period	Manual requirements
Commenced Wednesday 12 Jan 2011 10:00 (Lake level 105.09m) Completed Thursday 13 Jan 2011 12:00 (Lake level 103.96m)	Strategy S2	• During this 26-hour period, the Wivenhoe Dam level was falling (74.78m at the start of the period, falling to 74.61m by the end of the period). The Somerset Dam level remained above 100.45m. • During this period, two sluice gates were opened to allow Dam levels to track towards the Wivenhoe/Somerset Operating Target Line. The timing of these openings was calculated to ensure the Wivenhoe Lake level did not rise. • At the end of this period, it was apparent the flood peak had passed and therefore the operational strategy transitioned to the drain down phase.	Use Strategy S2 when the Somerset Dam level is expected to exceed 99.0m, and the Wivenhoe Dam level is expected to exceed 67.0m but not exceed 75.5m (fuse plug initiation) during the course of the Event. If Wivenhoe Dam is falling, and the Somerset Dam level is above 100.45m, Strategy S2 requires the crest gates to be raised, and the low-level regulators and sluices are used to **generally** not cause Wivenhoe Dam to rise significantly. Drain down operations require stored floodwaters to be emptied from the Dams within seven days of the flood event peak passing through the Dams.

Commenced Thursday 13 Jan 2011 08:00 (Lake level 103.96m)
Completed Wednesday 19 Jan 2011 12:00 (Lake level 99.02m)
	Drain down	• On the basis of the information contained in the row above, it was decided to transition to the drain down phase at the beginning of this period.
		• Considerations that impacted on the duration and timing of the drain down phase in this instance included:
		  • Causing no renewed increases in the Wivenhoe Dam Lake level;
		  • Re-opening D'Aguilar Highway and other impacted rural bridges as quickly as possible;
		  • Achieving Full Supply Levels in the Dams at the conclusion of the Event.
		• The Flood Event was concluded on Wednesday 19 January 2011 at 12:00.
			Drain down operations require stored floodwaters to be emptied from the Dams within seven days of the flood event peak passing through the Dams.

***Table 10.4.2** – Somerset Dam operating strategies for the January 2011 Flood Event, in compliance with the Manual*

11

11 EVENT COMMUNICATION

Queensland's disaster management response is provided at a local, district and State level by various, specialist agencies. This collaborative approach ensures the effective and timely coordination of information and support services state-wide.

Disaster management and hazard-specific response plans provide details of arrangements and processes to be followed at times of crisis and identify the need for all public communication to be coordinated during these critical times.

Following the flood event impacting Somerset and Wivenhoe Dams in October 2010, a Communication Protocol was developed to ensure the effective communication between local, State and Commonwealth agencies impacted by the release of floodwater from the Dams. In summary, this Protocol outlines the communication processes to be followed during flood events by the following agencies:

- Brisbane City Council;
- Ipswich City Council;
- Somerset Regional Council;
- Seqwater;
- Water Grid Manager;
- Queensland Police Service;
- Department of Community Safety;
- Department of Environment and Resource Management;
- Department of Premier and Cabinet;
- Bureau of Meteorology.

The Communication Protocol is designed to ensure consistent, harmonised information is effectively communicated to the public based on an agreed single technical report. The information in this report is used to inform communities and assist them to make decisions in the interests of public safety.

The Protocol divides the communication process into three key stages:

1. Monitoring and assessment;
2. Briefing and activation;
3. Public communications.

The application of this Communication Protocol to the January 2011 Flood Event is summarised below.

1. Monitoring and assessment

During the January 2011 Event, all flood information communicated to the public - including information about floodwater releases from Wivenhoe Dam - was based upon a continuous process of monitoring and technical assessment of the developing situation. This process is dynamic and evolves according to the event however, it generally follows a standard set of steps, as outlined below. During the January 2011 Event, the following monitoring and assessment steps were undertaken:

- Weather events and Dam levels were routinely monitored by relevant agencies via established systems and procedures.
- The Bureau of Meteorology (BoM) was the primary agency responsible for providing weather forecasts and warnings to the public.
- Councils monitored creek levels, local runoff and flash flooding within their areas of responsibility.
- Seqwater modelled implications of the inflows on the necessary floodwater release from Somerset Dam and/or Wivenhoe Dam. (The floodwater release strategy is a balance between releasing the water quickly

enough so the flood storage capacity is available if another major rain event occurs, and minimising downstream flooding impacts to people and property from the releases.)

- Seqwater calculated floodwater releases according to the Manual and provided this information to BoM and the Councils. BoM modelled the Brisbane River catchment and its river systems using this information.
- BoM participated in technical discussions with Seqwater, Brisbane City Council, Ipswich City Council and Somerset Regional Council as necessary, to share modelling results. These discussions lead to the development of a technical agreement around the flood situation, upon which public communications were based.
- Councils with the necessary resources and expertise undertook modelling, formed predictions, identified flood inundation areas and assessed impacts for their communities and shared this information with relevant parties. Councils without the necessary resources and expertise had to rely on information from other agencies to complete the impact assessment for their communities.

The Communication Protocol allows each agency to initiate public communication and engage disaster management processes as they deem appropriate. The trigger points for initiating the public communication of flood event information are defined according to an agency's responsibilities.

During the January 2011 Flood Event, local, State and Commonwealth agencies increased their frequency of communication with the community as it became apparent public impacts were likely.

Technical staff from relevant agencies held regular teleconferences to clarify and agree modelling inputs and results. In particular, regular teleconferences were held between Seqwater and BoM.

A Technical Situation Report (TSR) around the floodwater release from Wivenhoe Dam was also completed by Seqwater and provided to the Water Grid Manager and relevant local government agencies, in line with the requirements of Seqwater's Emergency Response Plan. The frequency of these reports was increased as critical periods were experienced during the Event. Appendix F contains a copy of all Technical Situation Reports issued during the Event.

2. Briefing and activation

During a flood event, if public safety is considered to be at risk, disaster management arrangements may be activated. During the January 2011 Flood Event, the following briefings were undertaken:

- The Brisbane City, Ipswich City and Somerset Regional Councils activated their Local Disaster Management Groups (LDMGs);
- LDMGs informed the relevant District Disaster Coordinators of the situation;
- The Queensland Police Service (QPS) initiated disaster management actions as provided for under the *Disaster Management Act 2003*;
- The Water Grid Manager alerted the Director-General (DG) of the Department of Community Safety (DCS), the DG of the Department of Environment and Resource Management (DERM), and the Brisbane City, Ipswich City and Somerset Regional Councils;
- The DG of the DCS informed the DG of the Department of Premier and Cabinet (DPC), the Chair of the State Disaster Management Group (SDMG) and activated the State Disaster Coordination Centre (SDCC). The DG DCS also informed the Minister for Police, Corrective Services and Emergency Services;
- The DG DERM informed the Minister for Natural Resources, Mines and Energy;
- The DG DPC informed the Premier;

- The Crisis Communications Network, chaired by DPC, was activated at the direction of the SDMG Chair to coordinate public messaging from BoM, Seqwater, the Water Grid Manager, QPS, relevant Councils and the DCS.

3. Public communications issues

The Communication Protocol developed following the October 2010 Flood Event states that each agency is responsible for publicly communicating information commensurate with their role. This can be done without prior approvals. However, during the January 2011 Flood Event, agencies shared information and operated in a fully consultative process to ensure consistent public information was provided.

The BoM, local governments and relevant State government agencies remained in frequent contact to ensure conflicting information was not released at any time during the Event. Agencies also ensured this consultation process did not cause delays in providing necessary public warnings. To ensure communication accuracy, all information provided to the public was based on information contained in technical reports.

The following agencies were responsible for the communication of specific information during the Event:

- **Bureau of Meteorology** – Concentrated on flood warnings, which were communicated broadly via the BoM website (www.bom.gov.au), other agencies and the media. Representatives from BoM also participated in media (radio, television, newspaper) interviews to provide factual information regarding observed and forecast weather conditions, rainfalls and water levels.
- **Local Governments / Local Disaster Management Groups** – Communicated the effects of weather-related events and the impact on safety for their local communities, residents, and Councils' assets. Local governments had the primary responsibility for communication within their community.
- **Water Grid Manager** – As the State's lead communication agency on floodwater release, the Water Grid Manager concentrated on publicly communicating aspects of release timings and the expected duration of the impacts. To allow these communications to occur, Seqwater operational staff ensured the supporting technical information was provided to the Water Grid Manager. The Water Grid Manager took responsibility for liaising with local government and coordinating any public communications in relation to the flood releases.
- **Seqwater** – Situation updates were provided to the Water Grid Manager, Brisbane City Council, Ipswich City Council and Somerset Regional Council on a regular basis. In addition to these operational communications, Seqwater also provided regular updates to mid-Brisbane irrigators during the event. These updates were also provided to the Water Grid Manager.

These primary communications were augmented by:

- **Queensland Police Service** – Provided specific community safety messaging during operations.
- **Department of Community Safety** – Communicated general safety matters regarding flooding.
- **Department of Premier and Cabinet (extreme events only)** – Ensured consistent messages were provided to the media and other relevant agencies.

Information was released to the public as frequently as required throughout the Event. The timing of media releases was guided by the frequency of technical reports, which ranged from once a day to once an hour during critical stages of the Event.

The Water Grid Manager's Communications Unit centrally tracked and shared all communications and liaised with the following agencies in regard to public safety messages:

- BoM;
- Seqwater;
- Councils' Media Directors;
- QPS Media Director;
- DCS Media Director.

Overall, it appears public and agency communications throughout the Event was effective and inline with the Communication Protocol developed following the October 2010 Flood Event.

12

12 REVIEW OF DATA COLLECTION SYSTEMS

12.1 Review of data collection system performance during the Event

The rainfall and stream height field stations had never been tested by a flood the size of the January 2011 Event. As would be expected in all systems of this type world-wide, some field failures did occur during the Event. Some stations were completely destroyed by the flood flows. By surveying the aftermath of the flood and its impacts along the river channels, it is easy to see how this occurred.

After the Event, 14 out of 75 rain stations, and 31 out of 71 river height stations, were not operating correctly. This is considered a good result, with the station redundancy system Seqwater has in place within the network mitigating the impacts of these failures. There were no data omissions or errors resulting from these failures which resulted in incorrect operational decisions being made. This issue is examined in Section 5.0.

One significant gap in rainfall data occurred on Tuesday 11 January 2011 during the period of intense rainfall that resulted in extreme and rapid rises in the level of Wivenhoe Dam. This very intense rainfall appeared to fall directly on the Wivenhoe Dam lake, outside the catchment rain gauges. This was a similar scenario to when the rainfall that lead to the flash flooding in Lockyer Valley occurred the previous day. This flash flooding impacted the Grantham township however, the catchment rain gauges did not record the extreme rainfall.

A solution to this issue could be to install additional rain gauges in the Brisbane Basin (a detailed examination of this issue will be undertaken in conjunction with BoM and other relevant agencies as soon as practical). However, within an area the size of the Brisbane Basin, it is not practically possible to guarantee any rain gauge network will detect all instances of very intense or extreme rainfall that could occur in the Basin area.

12.2 Future of the data collection system

The current ALERT data collection network has been operational since 1995. Overall the performance of the system in recent times has been satisfactory, with the following improvements made in recent times:

- Seqwater employed a dedicated hydrographic team to enhance and maintain the data collection network. This team continues to be supported by the RoadTek technicians who have been maintaining the network since its initial installation.
- In 2008/09, around 30 stations were upgraded with new generation ALERT Event Reporting Radio Telemetry System (ERRTS) equipment. In 2009/10, a further 55 sites were upgraded so now almost all the ERRTS equipment in the Seqwater ALERT network has now been upgraded.
- In 2008/09 and 2009/10, new rainfall stations were constructed and installed at the following locations:
  - Lindfield;
  - Westvale;
  - Hazeldean;
  - Monsildale;
  - Mt Stanley;
  - Mt Binga;
  - Blackbutt;
  - Redbank Creek.
- In 2008/09 and 2009/10, new rain/river height stations were constructed and installed at the following locations:
  - Atkinson Dam;
  - Bill Gunn Dam;
  - Lake Clarendon Dam;
  - Moogerah Dam;
  - North Pine River at Dayboro Waste Water Treatment Plant.
- In 2008/09 and 2009/10, new river height stations were installed at the following locations:
  - Kilcoy Creek downstream of Kilcoy Weir;
  - Kobble Creek at Mt Samson.

The network will undergo further upgrades and enhancements over the coming years as Seqwater looks to maximise the system's overall reliability.

13

13 REVIEW OF FLOOD OPERATIONS CENTRE MOBILISATION AND STAFFING

13.1 Duty Engineers

The four Duty Engineers approved by the Chief Executive Officer to direct the operations of Somerset and Wivenhoe Dams during flood events are:

1. Engineer 1;
2. Engineer 2;
3. Engineer 3;
4. Engineer 4.

Engineer 1, Engineer 2 and Engineer 3 are three of the most experienced and expert Engineers in the industry in relation to their knowledge of Brisbane River flood hydrology. Engineer 4 is probably the most experienced engineer in Queensland in relation to the operation and maintenance of gated dams. Resumes for these engineers are contained in Appendix N.

During the Event, the Duty Engineers worked long hours and functioned on a limited amount of sleep, particularly during the critical period of the Event between Sunday 9 January 2011 and Wednesday 12 January 2011. While these demands are expected with this work, decision making was not adversely impacted in any way during the Event. However, it is recommended the following support mechanisms are examined to determine any valuable improvements to the current system.

Number of Duty Engineers

The appropriate number of Duty Engineers required to work during an event has been widely considered and discussed over the past 15 years. From the perspective of event management continuity and coordination, a small team of very expert and experienced staff working closely together is preferred. However, this must be considered in line with the potential impact of fatigue during larger events or extended periods of operation.

From 1996 to date, engaging four Duty Engineers has proven to be effective when managing flood events impacting the Dams. There are currently also three professionally qualified engineers working within the flood officer team who gain valuable event experience that will eventually enable them to transition to the Duty Engineer role should this be deemed appropriate.

Factors that could assist in managing fatigue, and that will be examined further in conjunction with the Dam Safety Regulator at an appropriate time following the submission of this Report, are:

- The requirement to have a Duty Engineer present in the Flood Operations Centre on a 24/7 basis, during dam drain down periods when there is no rain falling or forecast and gate movements are not undertaken;
- The provision of appropriate accommodation facilities close to the Flood Operations Centre to allow effective rest and sleep when staff are required at the Centre on a 24/7 basis.

Work hours

While the work hours during the Event were long, they were not considered excessive or to be at a level that adversely impacted operational decision making. Natural disaster emergency management requires efforts above and beyond normal day-to-day operations, and the Duty Engineers fully accept and understand this is a responsibility of the position.

13 REVIEW OF FLOOD OPERATIONS CENTRE MOBILISATION AND STAFFING

13.2 Flood Officers

The nine Flood Officers that assisted in the Flood Operations Centre during the Event were:

1. Flood Officer 1;
2. Flood Officer 2;
3. Flood Officer 3;
4. Flood Officer 4;
5. Flood Officer 5;
6. Flood Officer 6;
7. Flood Officer 7;
8. Flood Officer 8;
9. Flood Officer 9.

All Officers have been trained in Flood Operations Centre duties and completed their allocated tasks efficiently, correctly and with a high degree of professionalism over the full duration of the Event.

14

14 REVIEW OF DAM SITE MOBILISATION AND STAFFING

The 13 Dam Operators that operated Somerset and Wivenhoe Dams during the Event were:

1. Dam Operator 1;
2. Dam Operator 2;
3. Dam Operator 3;
4. Dam Operator 4;
5. Dam Operator 5;
6. Dam Operator 6;
7. Dam Operator 7;
8. Dam Operator 8;
9. Dam Operator 9;
10. Dam Operator 10;
11. Dam Operator 11;
12. Dam Operator 12;
13. Dam Operator 13.

All Operators have been trained in Flood Operations Centre duties and all completed their allocated tasks efficiently, correctly and with a high degree of professionalism over the duration of the Event.

The following is a list of suggestions that will help to ensure the Dam Operators are fully supported and can continue to perform their roles with a high level of effectiveness in future events:

- Staff housing arrangements should be retained. Having trained operators living on site is critically important during extreme events of this nature to ensure the timely response to developing situations;
- Local staff members working on site during flood events need to be able to maintain contact with their family and friends to provide reassurance they are safe and secure while on duty. This is an issue that may have caused some anxiety at certain stages of the January 2011 Event and will be addressed;
- Ensuring additional electrical and mechanical trade support can be provided to the Dams during events of this nature. While there were no equipment breakdowns during this Flood Event, and while multi-level operational back-up systems are provided to release flood water if breakdowns do occur, trade support may be critically important if breakdowns do occur. Unless trade support can be sourced prior to the closure of Brisbane Valley Highway, the Dams may not be accessible in extreme events as travel to the Dams becomes difficult and at times, impossible. The ability to ensure early in the event that trade support is accessible should be examined.

15

15 REVIEW OF FLOOD MODELLING SYSTEMS

15.1 Review of system performance during the Event

The Real Time Flood Model (RTFM) and associated systems performed well during the Event as described in detail in Section 8. No system failures occurred during the Event and, generally, the systems closely modelled actual stream flow.

One difficulty was encountered during the period of intense rainfall that occurred on Tuesday 11 January 2011, when there were extreme and rapid rises in the level of Wivenhoe Dam. The very intense rainfall generally fell directly on the Wivenhoe Dam lake and outside the catchment rain gauges, which resulted in the systems not accurately modelling the rapid rises in the Dam level. This scenario was similar to the flash flooding experienced in Lockyer Valley the previous day. The flash flooding impacted the Grantham township, however the catchment rain gauges did not record the extreme rainfall, which made it impossible for the catchment models to accurately predict the Event during this period. A review of the existing data-gathering network (which discusses this issue) is contained in Section 12.

In summary, there were no operational flaws or errors detected in the existing RTFM system that adversely impacted Event decision making.

15.2 Future of the RTFM

The RTFM and software was originally developed more than 15 years ago and resides on the Linux Fedora Core Operating System. Both main software components (Flood-Col and Flood-Ops) run on the Linux PC known as NOAH and the back-up PC located in the Back-up FOC. Although there were no failures during the current Flood Event, a number of minor failures have occurred in recent times and the age of the software is a concern. The software continues to function adequately from an operational perspective, however replacement software has been under development since 2008 and is expected to be implemented and operational in 2011. Approval for the replacement system will be sought from the Dam Safety Regulator prior to implementation.

A secondary component of the original RTFM software (WIVOPS) that assisted in formulating the gate operating strategy at Wivenhoe Dam is no longer used. This software was retired in 2005 following the construction of the Dam's auxiliary spillway, comprising three fuse plugs. A number of factors were considered in this retirement process, including the age of the WIVOPS program (more than 15 years), the absence of program documentation and the complexity of the required programming changes to account for the new auxiliary spillway.

Detailed operational spreadsheets are currently used in place of WIVOPS and these worked very well during this Event (see Section 8.0 and Appendix A). WIVOPS was used as a verification tool during the Event (see Section 8.0), within the limits of its operational effectiveness. A dedicated program with similar functionality to WIVOPS has also been under development since 2010 and, when complete, will be evaluated to determine its operational role and function during an event.

Independent of the RTFM, Seqwater has developed a series of flood models for its storages, including Somerset Dam and Wivenhoe Dam. These models are linked to the BoM Enviromon data collection system and are based on URBS Models. This system provides a backup to the RTFM software in the Flood Operations Centre and was used as a verification tool during the Event. Generally, this system provided very similar modelling results to the RTFM and experienced similar difficulties to the RTFM in accurately modelling the rapid rises in the Wivenhoe Dam lake level that occurred on Tuesday 11 January 2011 as described in Section 15.1.

16

16 REVIEW OF FLOOD MANUAL PROCEDURES AND STRATEGIES

16.1 Intent of the Manual

The Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam (Revision 7) (the Manual) defines the objectives and procedures for operating the Dams during flood events.

Flood events that impact Somerset Dam and Wivenhoe Dam are caused by rainfall events that vary in intensity, duration and distribution over a catchment area exceeding 7,000km^2 above the Dams. When making decisions about releasing water from the Dams during flood events, consideration is also given to rain falling in Brisbane River catchment areas not controlled by the Dams. These catchment areas, which include the Lockyer Creek and Bremer River catchments, also cover an area in the order of 7,000km^2 and rain falling in these catchments will also vary in intensity, duration and distribution. Accordingly, the Manual must account for an infinite number of flood event scenarios.

The current level of forecasting technology does not make it possible for the Bureau of Meteorology (BoM) to provide completely accurate rainfall forecasts for the Dam catchment areas. A degree of uncertainty exists in all weather forecasts and the further forward in time forecasts are provided, the greater the degree of uncertainty.

As it is not possible to provide a specific procedure for Dam operation during every possible flood event, the Manual takes the approach of providing objectives and strategies to guide operational decision-making during a flood event. The objective followed and strategy chosen at any point in time depends on the actual water levels in the Dams as well as flood modelling predictions based on the best observed and forecast rainfall and stream flow information available at the time.

It is not possible to predict the range of objectives and strategies that will be used during the course of a flood event, before or at any time during the event, prior to the event peak. Objectives and strategies change as flood events progress, as rainfall is received in the catchment and as forecast rainfall amounts change. For small floods, objectives and strategies relate to minimising flood impacts in rural areas, while as the scale of the flood increases, the emphasis changes to protecting urban areas and maintaining the structural safety of the Dam.

16.2 Use of the Manual objectives

The primary objectives of the procedures contained in the Manual, in order of importance, are:

1. Ensure the structural safety of the Dams;
2. Provide urbanised areas with optimum protection from inundation;
3. Minimise the disruption to rural life in the valleys of the Brisbane River and Stanley River;
4. Retain the storage at Full Supply Level at the conclusion of the flood event;
5. Minimise impacts to riparian flora and fauna during the drain down phase of the flood event.

To meet these objectives, the Dams must be operated in a manner that considers the potential effects of closely spaced flood events. Accordingly, normal procedures require stored floodwaters to be emptied from the Dams within seven days of the flood event peak passing through the Dams.

Throughout the duration of this Event, the Manual objectives were always considered in order of importance, and the requirement to empty the stored floodwaters within seven days of the flood event peak passing through the Dams was also achieved.

Additionally, while ensuring the Dams are operated during flood events within the Manual objectives, Seqwater's duty of care to the public is also a primary consideration when making flood releases from the Dams. Every attempt is made to ensure public roads are closed prior to inundation by Dam outflows and that authorities are provided with enough time to prepare for community isolations and to undertake evacuations. Every attempt is also made to ensure urban damage is minimised, and that Dam outflows with the potential to contribute to urban damage are delayed until it is apparent no other options are available without risking the safety of the Dams.

Following the Event, some discussions occurred in the public arena in relation to lowering the emphasis on minimising disruption to rural life in the valleys of the Brisbane and Stanley Rivers for anything but very minor events. Due to the associated impacts to the public, changing this emphasis remains a political decision, however it is noted the Dams could be operated in this way if desired. However, changing the emphasis of the objectives would also require a change to the current version of the Manual.

16.3 Use of the Manual strategies

As discussed in detail in Section 10, a range of strategies were used during the Event, in accordance with the Manual. Having to apply the strategies during such an extremely large and rare event provided the opportunity to consider how the strategies are worded from a practical sense.

The strategies provided a good guide in responding to the full range of scenarios presented by this Event, however some situations would benefit from additional points of clarification, and these are discussed below. It should be noted however, that due to the high degree of scenario variability, improving the Manual in this regard may not be possible. Any changes to the Manual in the areas discussed below would require extensive and detailed engineering and hydrological investigations prior to any proposed changes being formally adopted.

- Under Strategy W3, it would be useful for additional guidance to be provided as to the extent to which the flow at Moggill should be minimised prior to the natural peak occurring at that location. During the Event, this requirement competed with the need to protect urban areas by not allowing Wivenhoe Dam to reach a level that invoked Strategy W4. After considering these issues during the Event, it was decided the best course of action would be to increase releases to the limit of non-damaging flows at Moggill, prior to the natural peak occurring at Moggill. This ensured the structural safety of the Dams and provided urbanised areas with optimum protection from inundation.
- Under Strategy W3, it would be useful to clarify the flow at Moggill that defines the upper limit of non-damaging floods downstream. During the Event, Brisbane City Council provided information and damage curves to the Flood Operations Centre indicating the upper limit flow at Moggill was 3,000m^3/s, whereas the Manual specifies the flow as 4,000m^3/s. This number must be agreed as it defines the intent of Strategy W3.
- Under Strategy W4, additional guidance on gate closing sequences would be useful. During the Event, a decision was made to begin closing the gates as quickly as possible, to reduce urban flood impacts once the Wivenhoe Dam level peaked. This was decided in an attempt to minimise urban damage below Moggill (an objective which must be considered under Strategy W4). Gates would have been re-opened if further lake level rises were experienced, however this scenario is not specifically addressed in the Manual.
- Under Strategy S2, additional guidance on actions to take when the Wivenhoe Dam Level is falling and the Somerset Dam Level is below 100.45m would be useful.

17

17 REVIEW OF WIVENHOE DAM FULL SUPPLY LEVEL

Following the January 2011 Flood Event, there has been significant public discussion around the appropriate Full Supply Level (FSL) of the Dams and whether the FSL should be lowered.

The FSL of Somerset Dam and Wivenhoe Dam are contained in the Moreton Resource Operations Plan (see pages 91 and 93), which was developed by the Department of Environment and Resource Management (DERM) in accordance with the *Water Act 2000*. DERM is responsible for developing and approving all resource operations plans in Queensland, and the current Moreton Resource Operations Plan was approved by Governor-in-Counsel in December 2009. It is publicly available on the DERM website (www.derm.qld.gov.au). Seqwater's Resource Operations Licence requires compliance with the relevant parts of the Moreton Resource Operations Plan, including the prescribed FSL.

The Manual states:

1. that an explicit objective is to *"retain the storage at full supply level at the conclusion of the Flood Event"*. In Section 3.5 of the Manual, it states *"as the dams are the primary urban water supply for South East Queensland, it is important that all opportunities to fill the dams are taken. There should be no reason why the dams should not be full following a Flood Event"*;
2. in Section 8.3, *"the spillway gates are not to be opened for flood control purposes prior to the reservoir level exceeding EL 67.25 which is 0.25 metres above FSL)"*.

In view of the above, Flood Operations Engineers did not set the FSL of the Dams and they are not authorised to make decisions in relation to setting or changing the FSL of the Dams at any time, either during or following Flood Events.

If a decision is to be made by DERM to permanently lower the FSL, detailed consideration will need to be given to the procedures in the Manual as the procedures assume the existing FSL.

18

18 REVIEW OF AGENCY COMMUNICATION

As discussed in Section 11, Queensland's disaster management response is provided by various disaster management groups at local, district and State levels. This collaborative approach to disaster response ensures an effective and timely coordination of information and services state-wide, whenever disaster strikes.

During the January 2011 Flood Event, a Communication Protocol (that was developed following the October 2010 Flood Event) was used to manage communications between Seqwater and the relevant local, State and Commonwealth agencies impacted by the release of floodwater from the Dams. From Seqwater's perspective, the Protocol worked well and communications were managed effectively. However, to properly assess communications, detailed feedback on the effectiveness of Seqwater communications during the Flood Event must be obtained from the following agencies:

- Brisbane City Council;
- Ipswich City Council;
- Somerset Regional Council;
- Water Grid Manager;
- Queensland Police Service;
- Department of Community Safety;
- Department of Environment and Resource Management;
- Department of Premier and Cabinet;
- Bureau of Meteorology.

To date, this process has not commenced however, this work will proceed as soon as appropriate personnel are available to undertake the necessary review.

In the interim, Seqwater has provided comment below and suggested preliminary recommendations to improve communications during flood events, based on the experiences of the January 2011 Event.

The comments and preliminary recommendations are made in accordance with the three stages in the communication process contained in the Protocol, which are:

1. Monitoring and assessment;
2. Briefing and activation;
3. Public communications.

The comments and preliminary recommendations are summarised below.

1. Monitoring and assessment

- Seqwater discussions with BoM relating to modelling result comparisons, and actual and projected Dam outflows worked well and were beneficial to both parties.
- Seqwater also provided modelling results to Brisbane City Council. It remains unclear how Council used this information or if it proved beneficial. Generally, it appears the most relevant information required by the Council was projected flood height data, and this is estimated and issued by BoM. It is recommended the provision of technical data from Seqwater to Brisbane City Council be examined further with Council, with a view to ensuring only useful data is provided to avoid any potential confusion associated with the provision of superfluous data.
- It is also recommended that investigations be undertaken to explore the benefits of a more formal arrangement with BoM in relation to the provision of rainfall forecast information during flood events. While sufficient rainfall forecasting information was available to the Flood Operations Centres during the Flood Event, and regular informal discussions were held with BoM in relation to the forecasts, there may be an opportunity to improve this process by including some appropriate procedures in the Communication Protocol.

2. Briefing and activation

Situation Reports and Technical Situation Reports were provided to relevant government agencies at regular intervals over the duration of the Event. There has not been any specific feedback received to date indicating whether this process worked well. However, as previously discussed, Seqwater will seek detailed feedback on the effectiveness of its communications with the agencies involved, with a view to implementing any suggested improvements arising from these discussions.

3. Public communications issues

There were no specific public communications made by Seqwater during the January 2011 Flood Event, as the Water Grid Manager was assigned the responsibility of being the State's lead communication agency on floodwater release information. Seqwater operational staff ensured technical information was communicated to the Water Grid Manager, as requested, to support all public communication.

It is understood the Water Grid Manager is currently reviewing the effectiveness of these processes.

19 REPORT CONCLUSIONS

Following are the significant conclusions drawn from the information contained in this Report.

The significant conclusions drawn from the information contained in this Report include:

- During the January 2011 Flood Event, Somerset Dam and Wivenhoe Dam were operated in accordance with *The Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam (Revision 7)*.
- The data collection and flood modelling systems used to support decisions made during the Event performed well and assisted informed decision-making, in accordance with the Manual.
- BoM rainfall forecasts did not support the additional release of flood water early in the Event.
- During the Event, Seqwater followed the Department of Environment and Resource Management's draft Communications Protocol which was compiled after the October 2010 flood event. This Protocol was developed to ensure effective communication between local, State and Commonwealth agencies impacted by the release of floodwater from the Dams.
- The January 2011 Flood Event was an extremely large and rare flood event. The combined effects of Somerset Dam and Wivenhoe Dam did reduce flood damages downstream however they could not fully mitigate the impacts of the Event without putting the safety of the Dams at risk.
- Studies associated with the design and operation of Wivenhoe Dam dating back to 1971, indicate a flood of the magnitude of the January 2011 Flood Event would be expected to result in urban damage below Moggill.
- The combined effects of Somerset Dam and Wivenhoe Dam provided clear and greatly significant flood mitigation benefits during the January 2011 Flood Event.

20 REPORT RECOMMENDATIONS

Following is a summary of the key recommendations contained in this report.

- In conjunction with the Bureau of Meteorology (BoM) and other relevant agencies, examine whether additional rain gauges should be installed in the Brisbane River Basin to improve the level of data recorded during flood events. It is recognised that undertaking this exercise still may not guarantee the rain gauge network will detect all instances of very intense or extreme rainfall that could occur in the Basin area.
- Given that a rare and very large flood event occurred, it is recommended a formal review of The Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam (Revision 7) (the Manual) be undertaken. This is a requirement of the Manual when an event of this nature is experienced. The issues raised in Section 16.0 should be considered in this process.
- In conjunction with BoM and other relevant agencies, it is recommended Seqwater participate in a review of the Agency Communications Protocol used during the Flood Event. This Event was the first major test of the Protocol since its development in October 2010 and therefore a full review at this time would be appropriate.

A

APPENDIX A – MODEL RESULTS

Summary of operational runs

Without forecast rainfall

RUN DATE	RUN	SOMERSET				WIVENHOE											With Wivenhoe				Without Wivenhoe			
		Current	Predicted			Current			Predicted			Total Inflow Volume	Lockyer		Bremer		Lowood		Moggill		Lowood		Moggill	
		Level	Peak Flow	Inflow Vol	Predicted Peak	Level	Peak Flow	Inflow Vol	Predicted Peak	Predicted Peak Outflow			Peak Flow	Predicted	Peak Flow	Predicted	Peak Flow	Predicted	Peak Flow	Predicted	Peak Flow	Predicted	Peak Flow	Predicted
		m AHD	m3/s	ML	m AHD	m AHD	m3/s	ML	m AHD	m3/s	dd/mm hh	ML	m3/s	dd/mm hh	m3/s	dd/mm hh	m3/s	dd/mm hh	m3/s	dd/mm hh	m3/s	dd/mm hh	m3/s	dd/mm hh
Fri 07/01/2011 02:00	5	99.59	280	46,000	99.7	67.52	1,110	158,000	68.2	1,220	08/01 23	204,000	470	07/01 19	200	07/01 07	1,430	09/01 01	1,460	09/01 14	470	07/01 22	550	08/01 06
Fri 07/01/2011 09:00	7	99.63	280	56,000	99.8	67.75	1,270	186,000	68.2	1,220	08/01 15	242,000	470	07/01 19	230	07/01 10	1,510	08/01 17	1,550	09/01 06	470	07/01 22	570	08/01 06
Fri 07/01/2011 15:00	8	99.94	790	86,000	100.3	68.03	1,790	260,000	68.4	1,240	08/01 13	346,000	530	07/01 21	260	07/01 15	1,610	08/01 17	1,660	09/01 06	530	08/01 00	660	08/01 08
Sat 08/01/2011 14:00	10	100.44	1,110	111,000	100.5	68.61	1,910	309,000	68.7	1,480	10/01 01	420,000	530	07/01 21	410	07/01 16	1,620	08/01 17	1,720	09/01 06	530	08/01 00	770	08/01 05
Sun 09/01/2011 01:00	12	100.32	1,110	128,000	100.5	68.63	1,890	329,000	68.7	1,480	10/01 01	457,000	530	07/01 21	410	07/01 16	1,620	08/01 17	1,720	09/01 06	530	08/01 00	770	08/01 05
Sun 09/01/2011 08:00	14	100.28	1,110	173,000	100.5	68.55	1,930	396,000	68.7	1,500	10/01 01	569,000	530	07/01 21	410	07/01 16	1,620	08/01 17	1,720	09/01 06	530	08/01 00	770	08/01 05
Sun 09/01/2011 14:00	17	100.47	1,700	243,000	100.7	68.58	2,860	561,000	70.0	1,490	10/01 22	804,000	530	07/01 21	410	07/01 16	1,680	11/01 03	1,850	09/01 21	530	08/01 00	770	08/01 05
Sun 09/01/2011 19:00	21	101.43	3,800	387,000	102.3	68.86	6,960	886,000	72.1	2,880	11/01 08	1,272,000	530	07/01 21	410	07/01 16	3,240	11/01 11	3,300	12/01 00	530	08/01 00	770	08/01 05
Mon 10/01/2011 01:00	23	102.51	3,910	448,000	102.9	69.97	8,050	1,020,000	72.9	2,700	11/01 07	1,468,000	620	10/01 04	410	07/01 16	3,180	11/01 08	3,240	11/01 21	620	10/01 07	820	10/01 16
Mon 10/01/2011 09:00	26	103.08	3,910	485,000	103.1	71.56	8,180	1,046,000	72.9	2,690	11/01 06	1,531,000	630	10/01 07	470	10/01 16	3,240	11/01 02	3,420	11/01 12	630	10/01 10	1,090	10/01 16
Mon 10/01/2011 15:00	28	103.43	3,910	530,000	103.4	72.54	8,180	1,178,000	73.6	2,750	11/01 12	1,708,000	780	10/01 23	870	10/01 20	3,490	11/01 02	3,910	11/01 13	780	11/01 02	1,500	10/01 20
Mon 10/01/2011 20:00	31	103.46	3,950	544,000	103.5	73.06	8,180	1,187,000	73.6	2,760	11/01 14	1,731,000	780	10/01 23	870	10/01 20	3,490	11/01 02	3,930	11/01 13	780	11/01 02	1,500	10/01 20
Tue 11/01/2011 04:00	35	103.28	3,950	570,000	103.5	73.40	8,180	1,446,000	74.1	2,970	12/01 14	2,016,000	780	11/01 21	870	10/01 20	3,570	12/01 01	4,040	11/01 14	780	12/01 00	1,500	10/01 20
Tue 11/01/2011 08:00	37	103.46	3,910	628,000	103.9	73.70	8,180	1,582,000	74.5	3,700	12/01 06	2,210,000	1,750	11/01 15	870	10/01 20	5,430	12/01 04	5,870	12/01 06	1,750	11/01 18	2,320	12/01 02
Tue 11/01/2011 13:00	39	103.91	3,910	748,000	104.8	74.39	8,590	1,758,000	75.0	5,220	12/01 03	2,506,000	3,000	11/01 16	2,120	11/01 18	8,130	11/01 19	9,180	12/01 07	3,000	11/01 19	4,410	12/01 03
Tue 11/01/2011 19:00	41	104.60	3,910	801,000	105.2	74.97	8,830	1,858,000	75.0	5,480	11/01 22	2,659,000	3,540	11/01 18	2,790	11/01 21	11,000	11/01 22	12,260	12/01 11	3,540	11/01 21	5,530	12/01 04
Wed 12/01/2011 08:00	43	104.83	3,910	803,000	105.2	74.82	8,180	1,724,000	74.7	7,300	11/01 21	2,527,000	3,540	11/01 18	2,790	11/01 21	10,830	11/01 22	12,090	12/01 11	3,540	11/01 21	5,530	12/01 04

With forecast rainfall

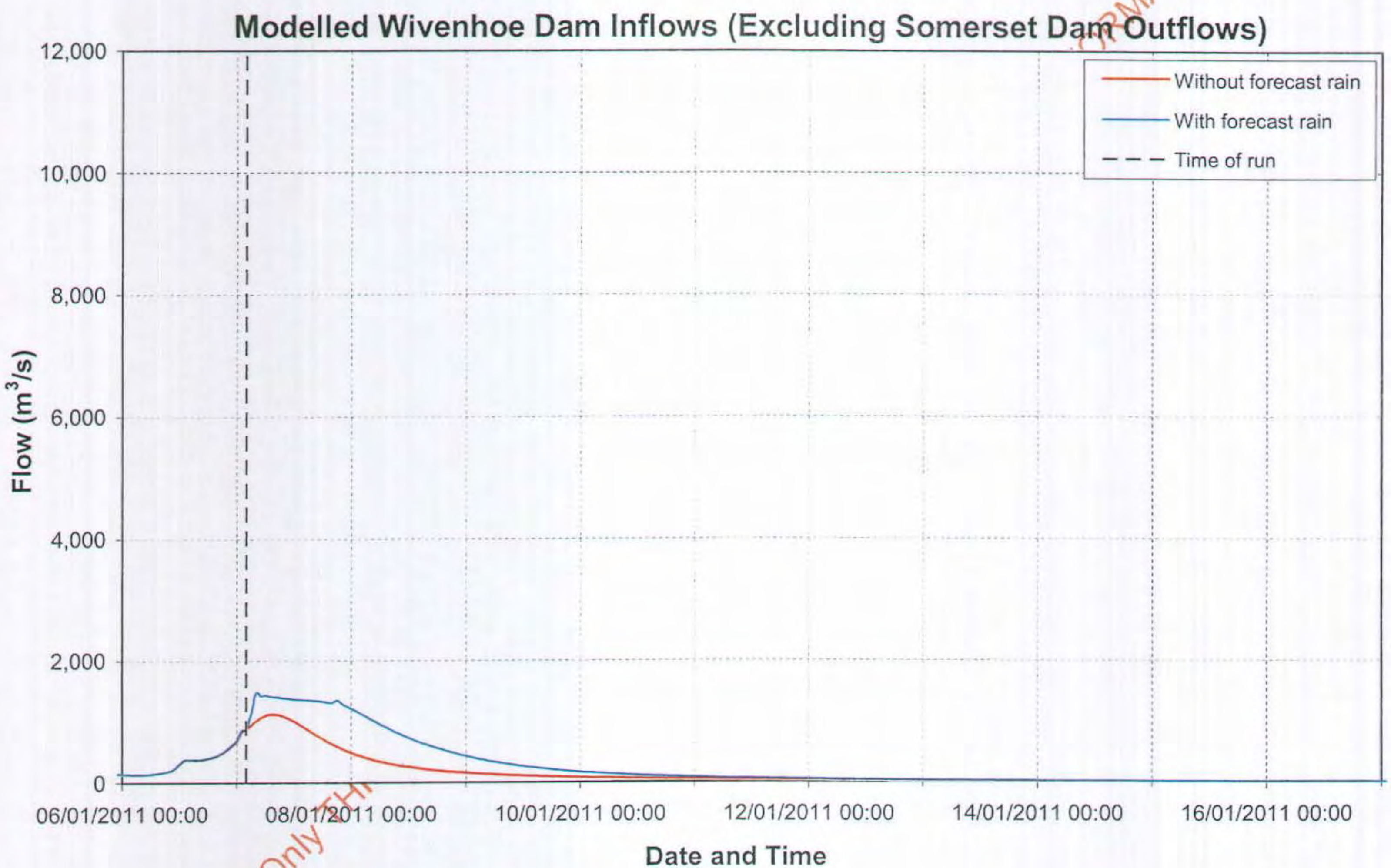
RUN DATE	RUN	SOMERSET				WIVENHOE						Total Inflow Volume	Lockyer		Bremer		With Wivenhoe				Without Wivenhoe			
		Current	Predicted			Current	Predicted										Lowood		Moggill		Lowood		Moggill	
		Level	Peak Flow	Inflow Vol	Predicted Peak	Level	Peak Flow	Inflow Vol	Predicted Peak	Predicted Peak Outflow			Peak Flow	Predicted	Peak Flow	Predicted	Peak Flow	Predicted	Peak Flow	Predicted	Peak Flow	Predicted	Peak Flow	Predicted
		m AHD	m3/s	ML	m AHD	m AHD	m3/s	ML	m AHD	m3/s	dd/mm hh	ML	m3/s	dd/mm hh	m3/s	dd/mm hh	m3/s	dd/mm hh	m3/s	dd/mm hh	m3/s	dd/mm hh	m3/s	dd/mm hh
Fri 07/01/2011 02:00	5	99.59	430	77,000	100.1	67.52	1,470	266,000	68.7	1,260	08/01 22	343,000	720	07/01 22	440	07/01 13	1,720	09/01 01	1,800	09/01 14	720	08/01 01	960	08/01 05
Fri 07/01/2011 09:00	7	99.63	500	87,000	100.2	67.75	1,650	293,000	68.5	1,250	08/01 14	380,000	670	07/01 21	390	07/01 21	1,830	08/01 17	1,960	09/01 06	670	08/01 00	970	08/01 08
Fri 07/01/2011 15:00	8	99.94	790	120,000	100.6	68.03	1,790	364,000	68.9	1,270	09/01 02	483,000	710	08/01 01	440	08/01 02	1,890	08/01 20	2,050	09/01 06	710	08/01 04	1,040	08/01 12
Sat 08/01/2011 14:00	10	100.44	1,110	165,000	100.6	68.61	1,910	497,000	69.1	1,540	10/01 01	662,000	530	07/01 21	540	09/01 04	1,940	10/01 04	2,220	09/01 15	530	08/01 00	940	09/01 10
Sun 09/01/2011 01:00	12	100.32	1,110	182,000	100.6	68.63	1,890	515,000	68.9	1,520	10/01 14	697,000	530	07/01 21	510	09/01 16	1,890	10/01 15	2,220	10/01 03	530	08/01 00	840	10/01 00
Sun 09/01/2011 08:00	14	100.28	1,110	227,000	101.0	68.55	2,320	586,000	69.3	1,560	11/01 00	814,000	530	07/01 21	490	10/01 04	1,900	11/01 00	2,220	10/01 10	530	08/01 00	780	10/01 07
Sun 09/01/2011 14:00	17	100.47	1,990	311,000	101.1	68.58	4,720	798,000	71.3	1,560	11/01 09	1,108,000	690	10/01 23	790	10/01 04	2,240	11/01 02	2,590	10/01 15	690	11/01 02	1,210	10/01 12
Sun 09/01/2011 19:00	21	101.43	3,940	482,000	103.0	68.86	8,810	1,231,000	73.9	3,070	11/01 13	1,712,000	1,250	11/01 00	1,100	10/01 09	4,160	11/01 11	4,400	12/01 00	1,250	11/01 03	1,940	10/01 17
Mon 10/01/2011 01:00	23	102.51	3,910	546,000	103.4	69.97	8,890	1,376,000	74.7	2,860	11/01 19	1,922,000	1,290	11/01 04	1,090	10/01 13	4,110	11/01 08	4,480	11/01 21	1,290	11/01 07	2,000	10/01 23
Mon 10/01/2011 09:00	26	103.08	3,910	583,000	103.5	71.56	8,180	1,401,000	74.5	2,840	12/01 04	1,985,000	1,220	11/01 12	1,310	10/01 20	4,020	11/01 15	4,680	11/01 12	1,220	11/01 15	2,090	11/01 07
Mon 10/01/2011 15:00	28	103.43	3,910	628,000	103.7	72.54	8,180	1,533,000	75.2	2,900	12/01 08	2,152,000	1,590	11/01 18	1,710	11/01 01	4,460	11/01 22	5,180	11/01 15	1,590	11/01 21	2,570	11/01 11
Mon 10/01/2011 20:00	31	103.46	3,950	601,000	103.5	73.06	8,180	1,381,000	74.3	2,820	12/01 06	1,982,000	1,060	11/01 21	1,120	11/01 06	3,870	12/01 01	4,470	11/01 15	1,060	12/01 00	1,840	11/01 12
Tue 11/01/2011 04:00	35	103.28	3,950	626,000	103.7	73.40	8,180	1,641,000	74.9	3,050	12/01 14	2,267,000	1,050	12/01 00	1,050	11/01 15	3,900	12/01 04	4,540	11/01 15	1,050	12/01 03	1,810	11/01 14
Tue 11/01/2011 08:00	37	103.46	3,910	684,000	104.2	73.70	8,180	1,776,000	75.1	3,760	12/01 11	2,460,000	2,130	12/01 04	1,210	11/01 20	5,870	12/01 07	6,540	12/01 07	2,130	12/01 07	3,000	12/01 04
Tue 11/01/2011 13:00	39	103.91	3,980	875,000	105.7	74.39	8,680	2,248,000	76.2	5,430	12/01 20	3,123,000	3,560	11/01 21	3,300	11/01 22	8,860	12/01 11	10,650	12/01 10	3,560	12/01 00	5,770	12/01 05
Tue 11/01/2011 19:00	41	104.60	3,910	928,000	105.9	74.97	8,830	2,362,000	75.2	7,520	12/01 15	3,289,000	4,020	12/01 04	3,530	12/01 02	11,530	12/01 07	13,470	12/01 11	4,020	12/01 07	6,910	12/01 04
Wed 12/01/2011 08:00	43	104.83				74.82																		

APPENDIX A – MODEL RESULTS

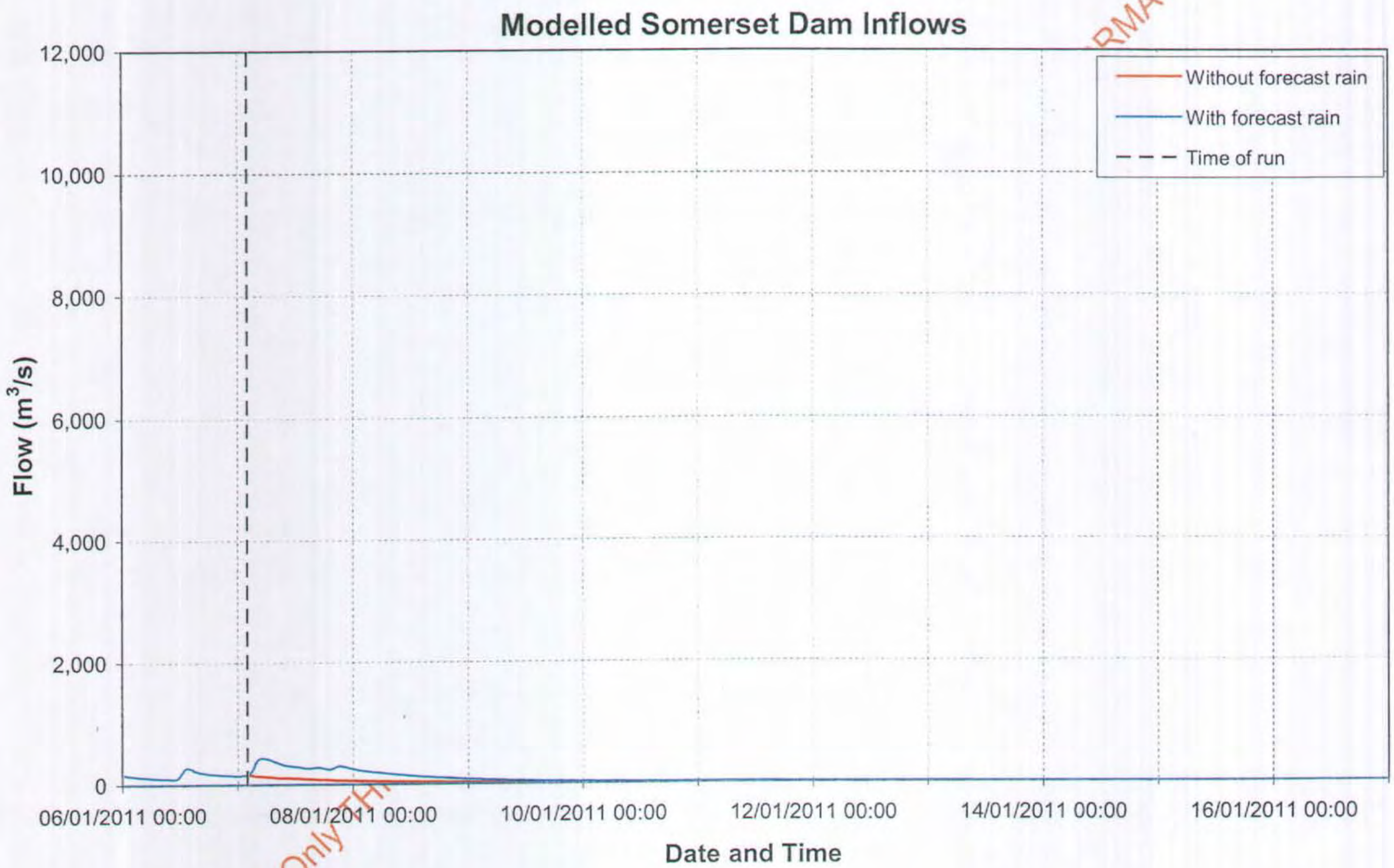
Run 5

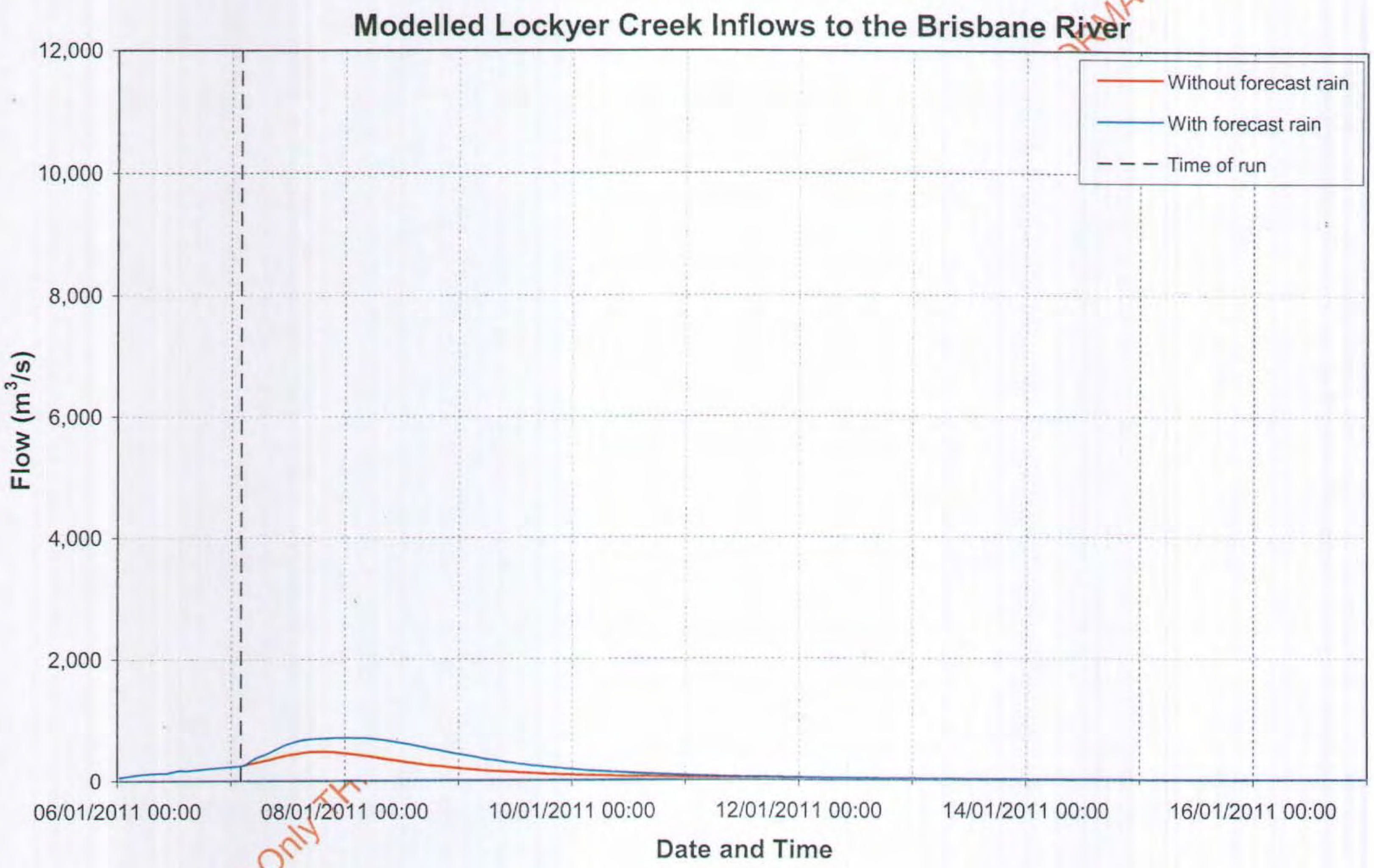
Date: Friday 7 January 2011

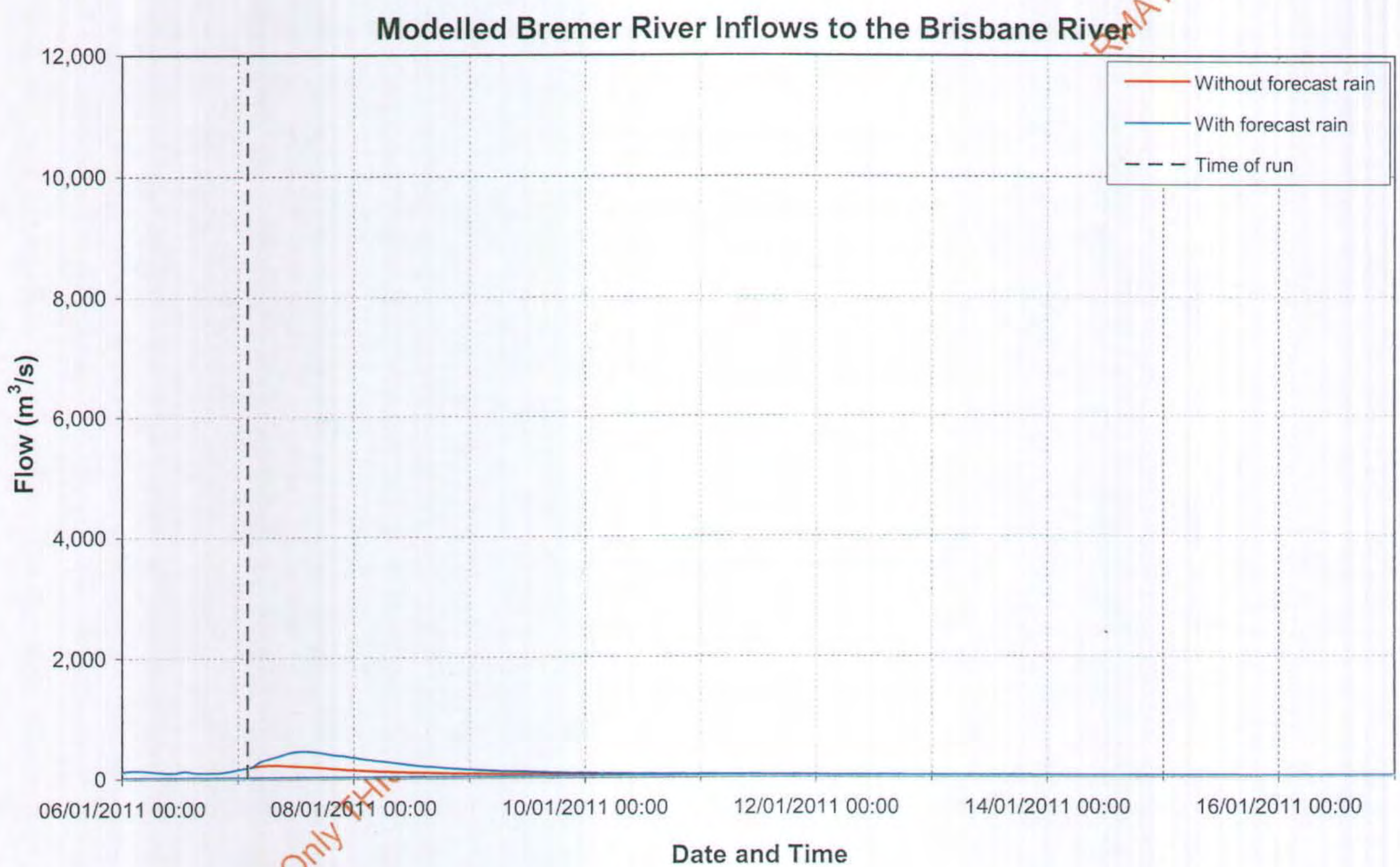
Time: 02:00


Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time
Draft Only
MATION

APPENDIX A – MODEL RESULTS

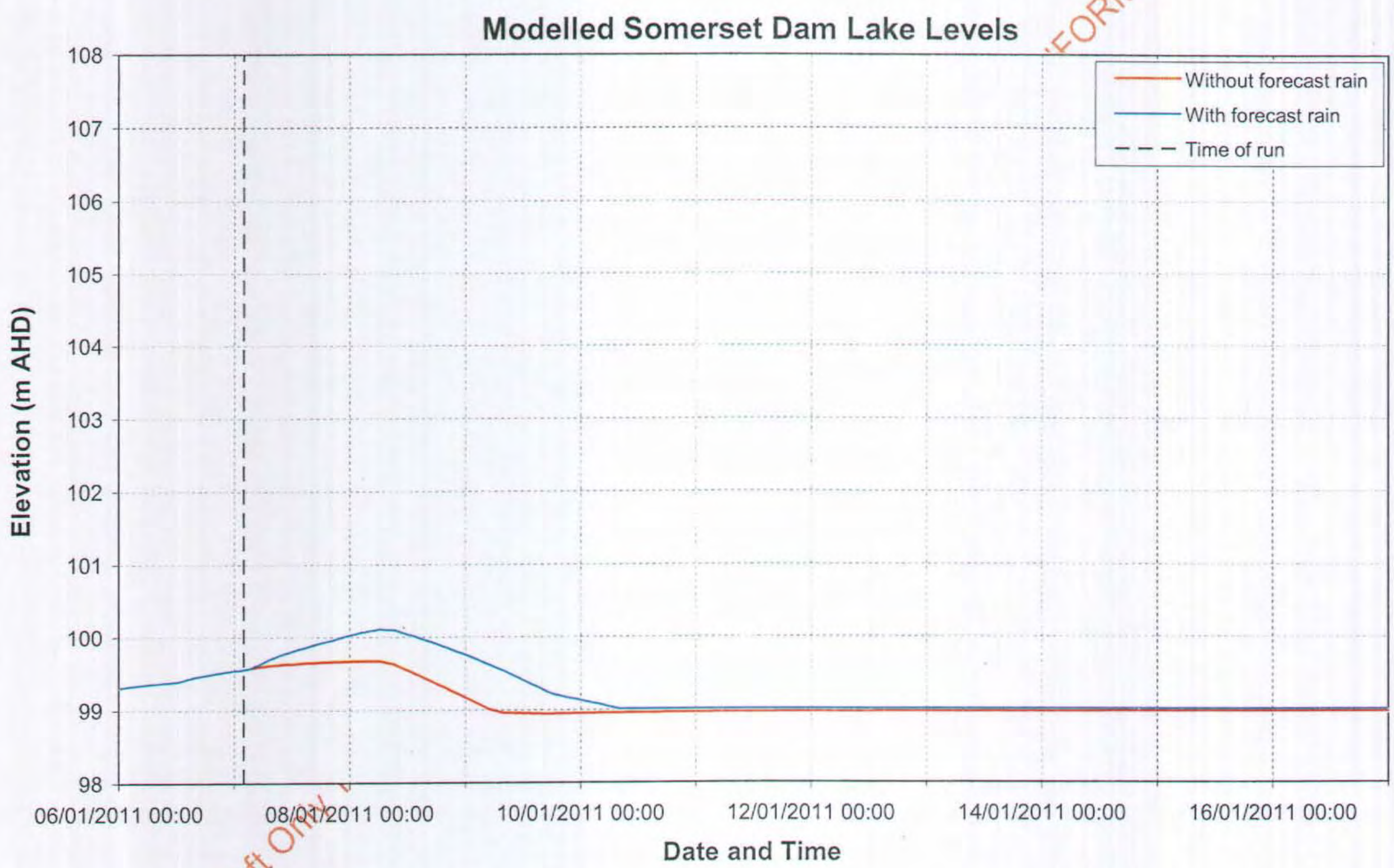


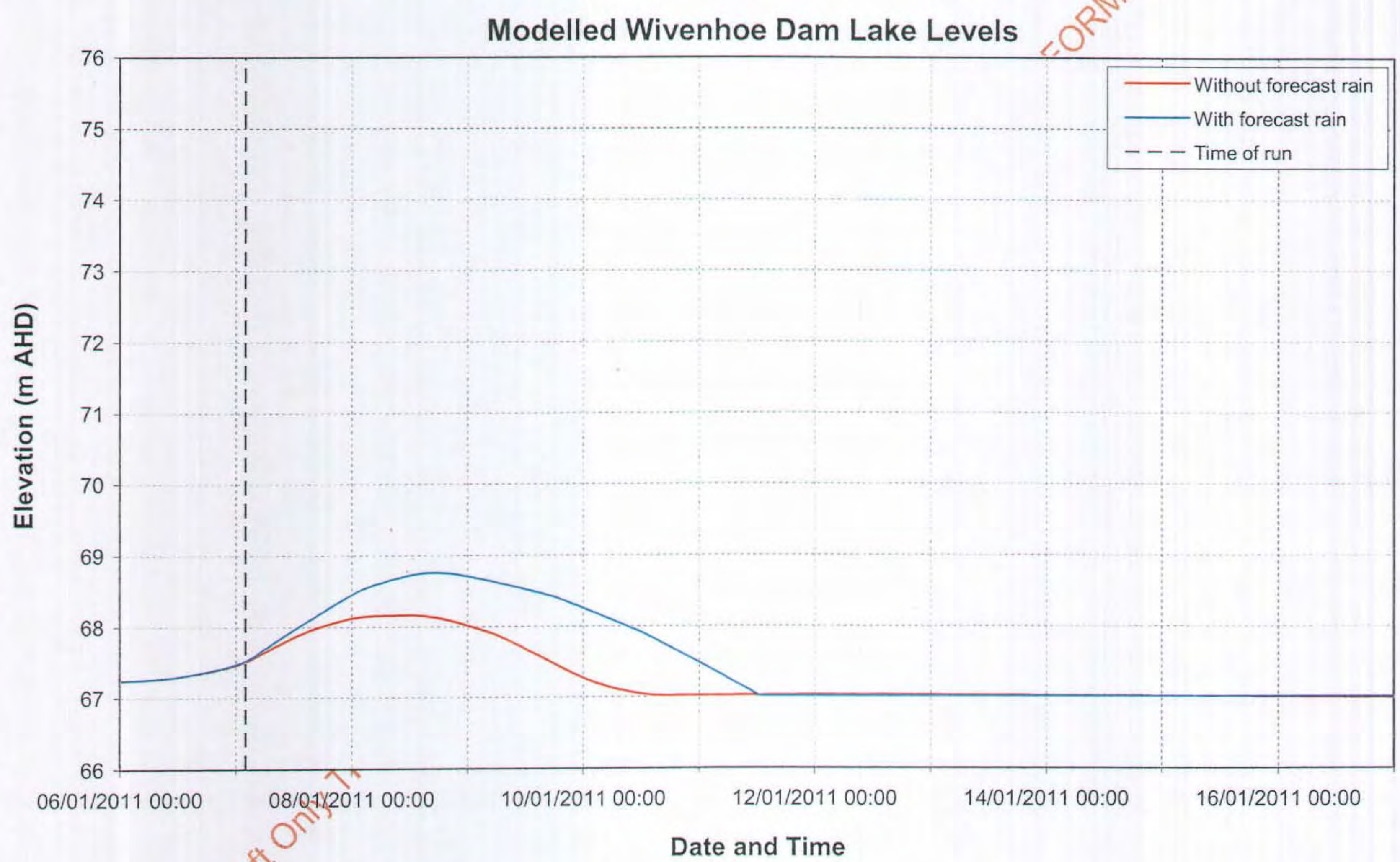

Modelled Lockyer Creek Inflows to the Brisbane River
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
Without forecast rain
With forecast rain
Time of run
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

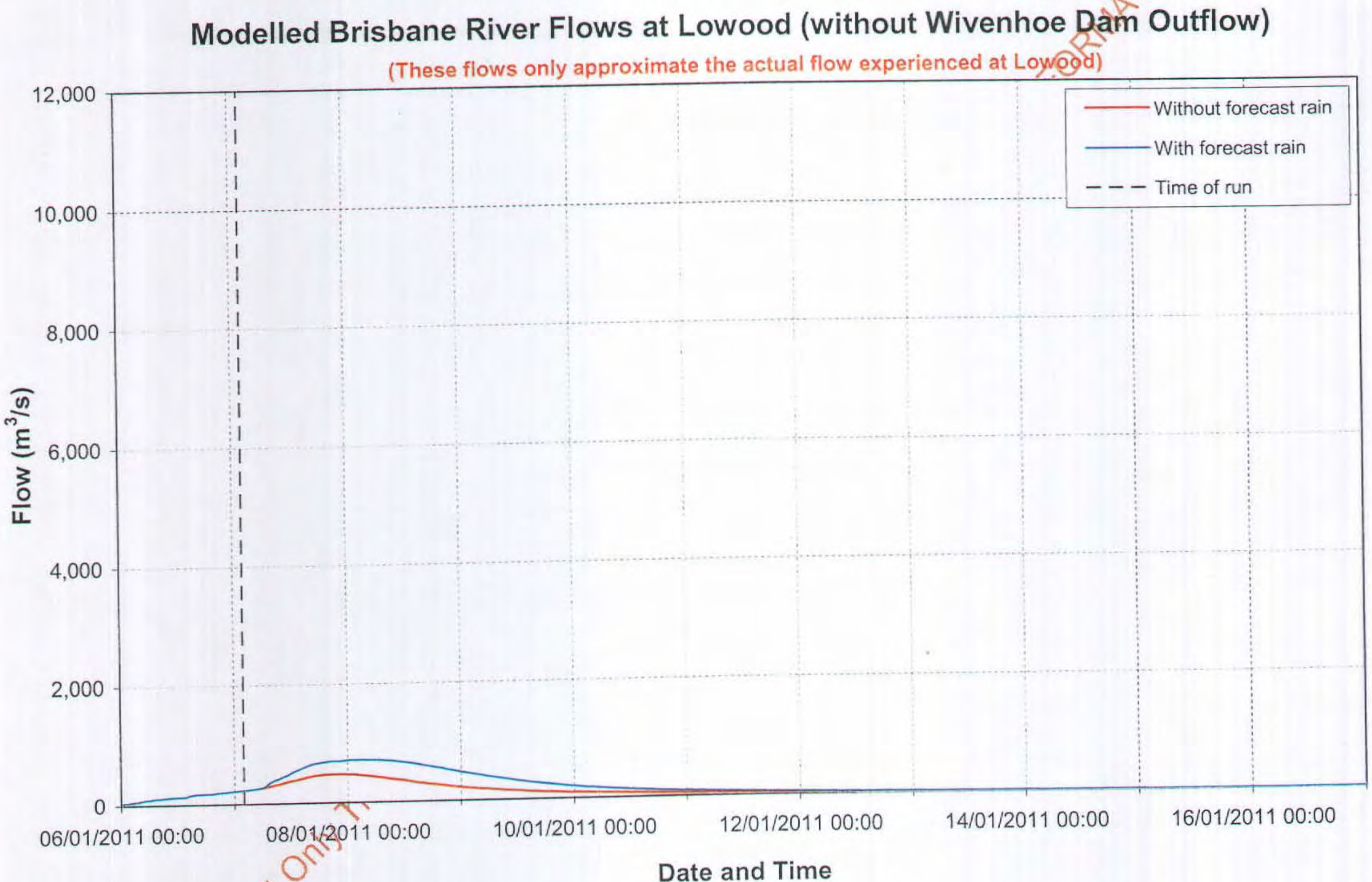


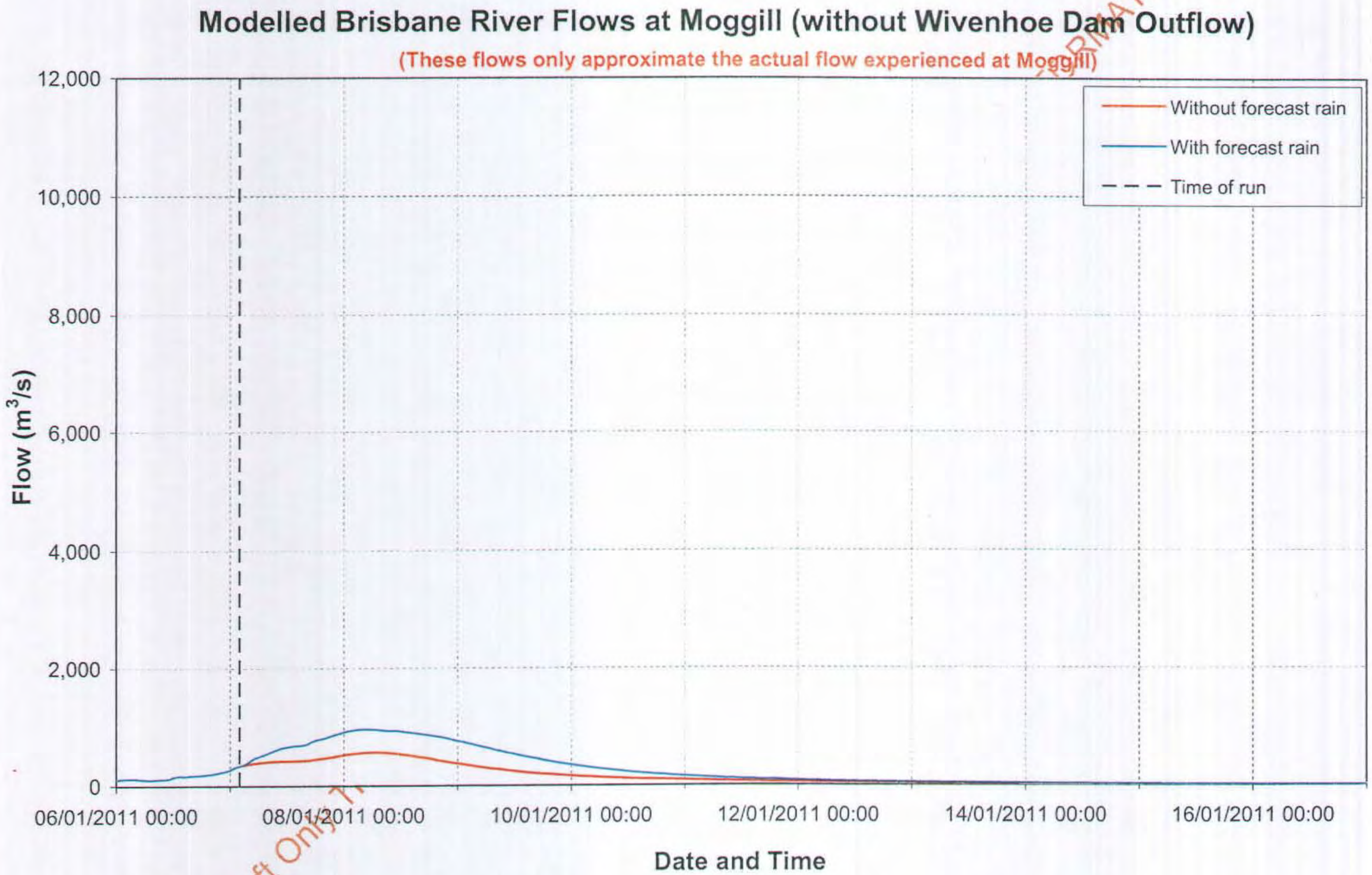
Modelled Bremer River Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

APPENDIX A – MODEL RESULTS




Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m³/s)
Without forecast rain
With forecast rain
Time of run
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



Modelled Brisbane River Flows at Moggill (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Moggill)
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time
Without forecast rain
With forecast rain
Time of run

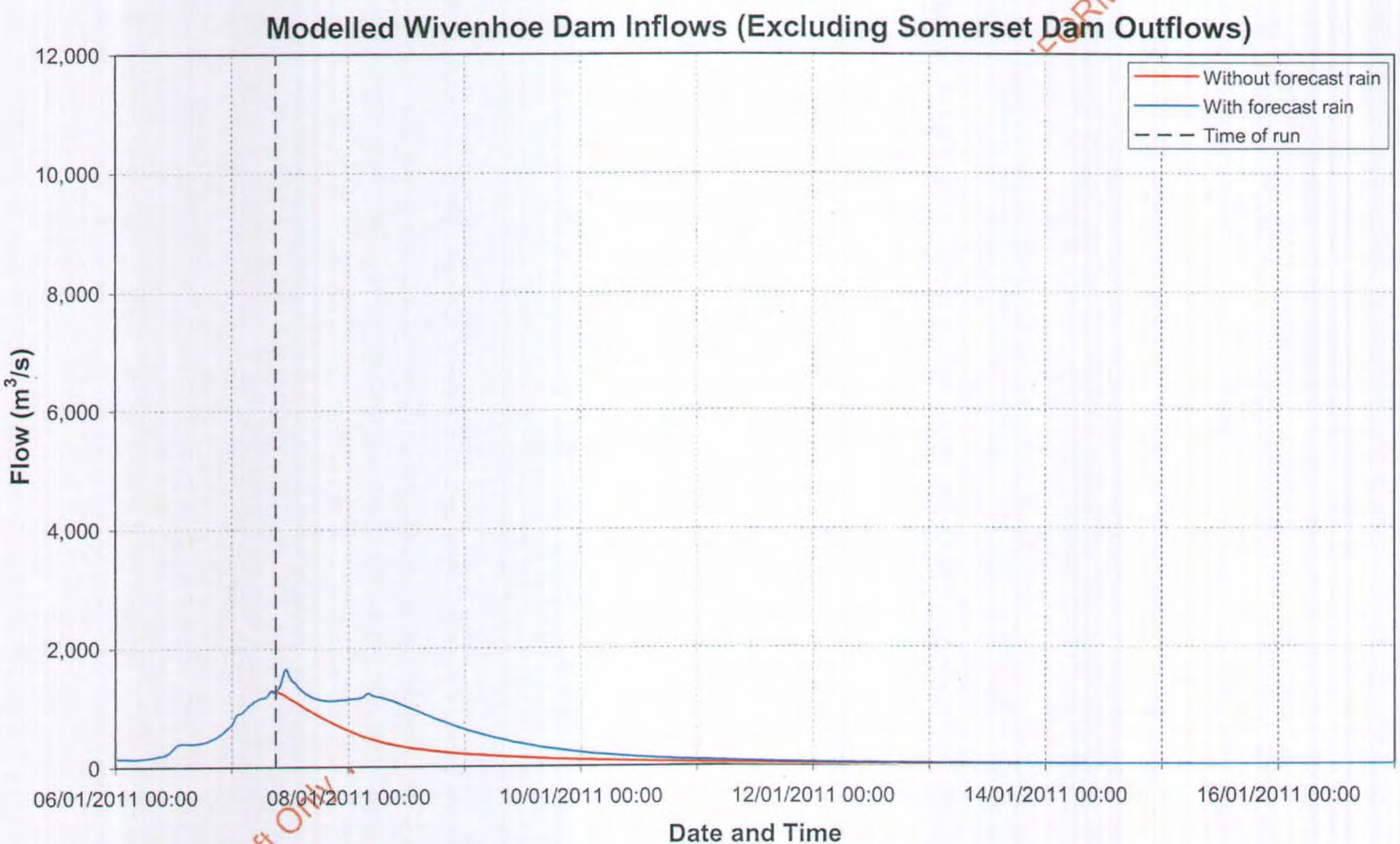
APPENDIX A – MODEL RESULTS

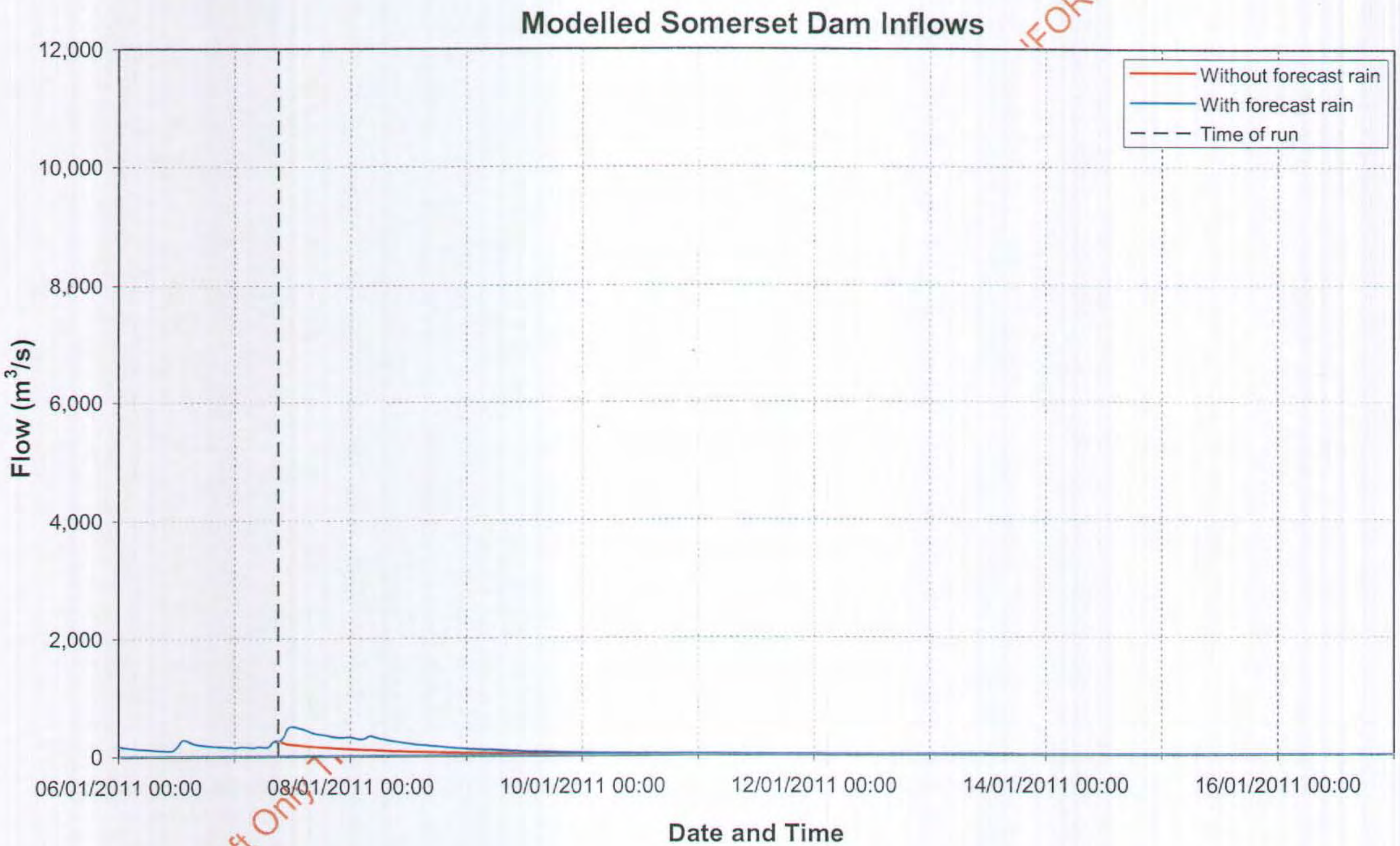
Run 7

Date: Friday 7 January 2011

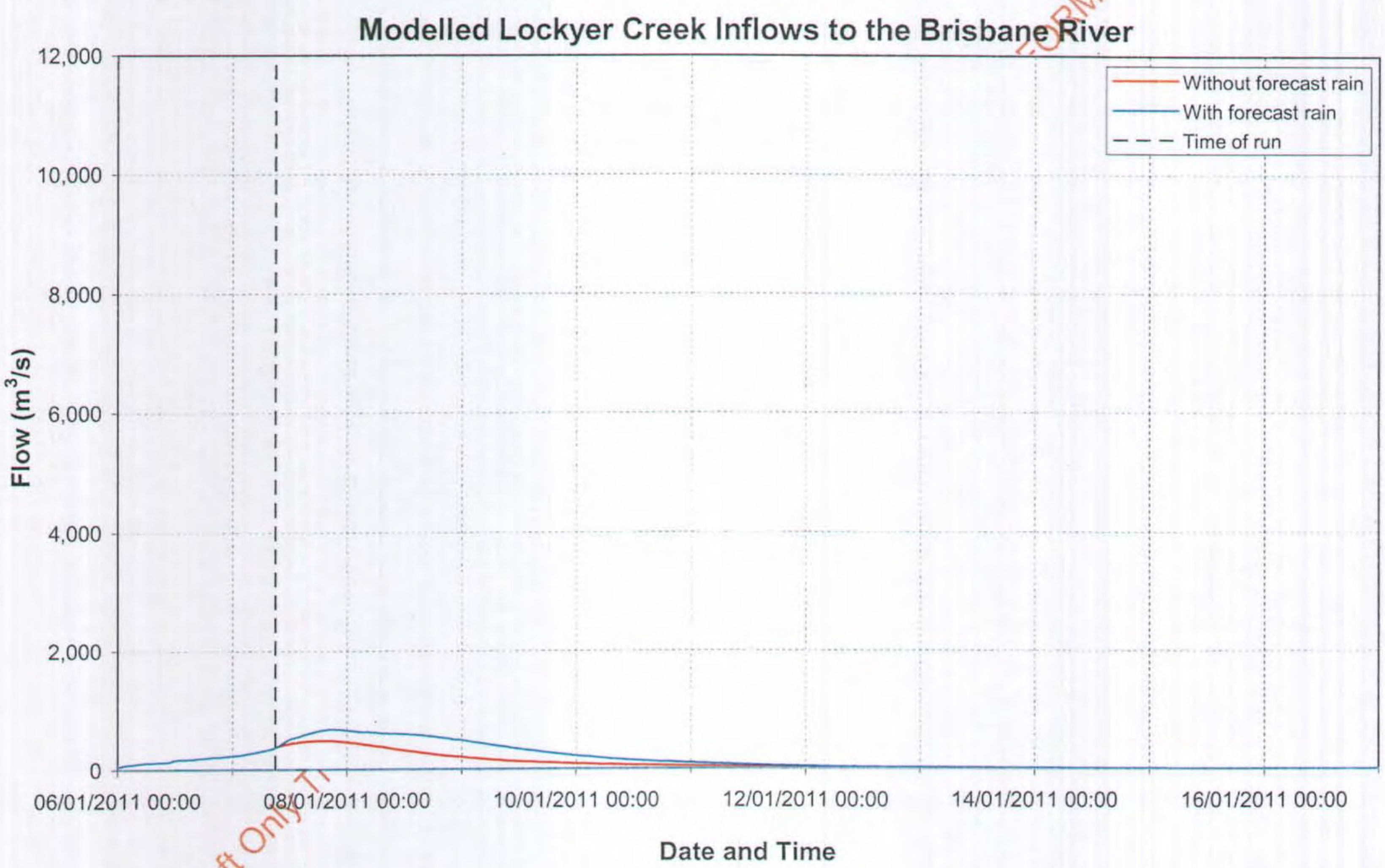
Time: 09:00

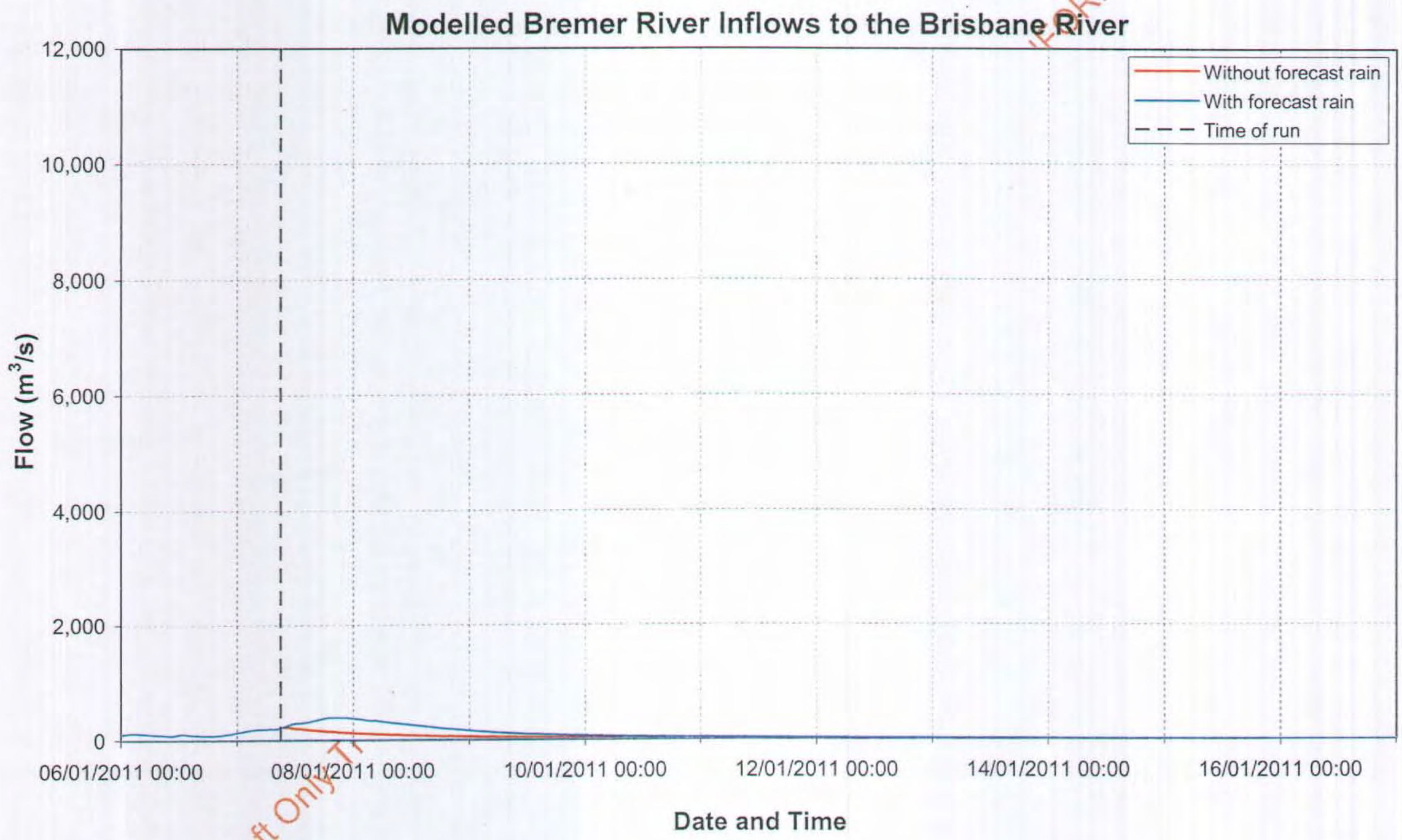
APPENDIX A – MODEL RESULTS

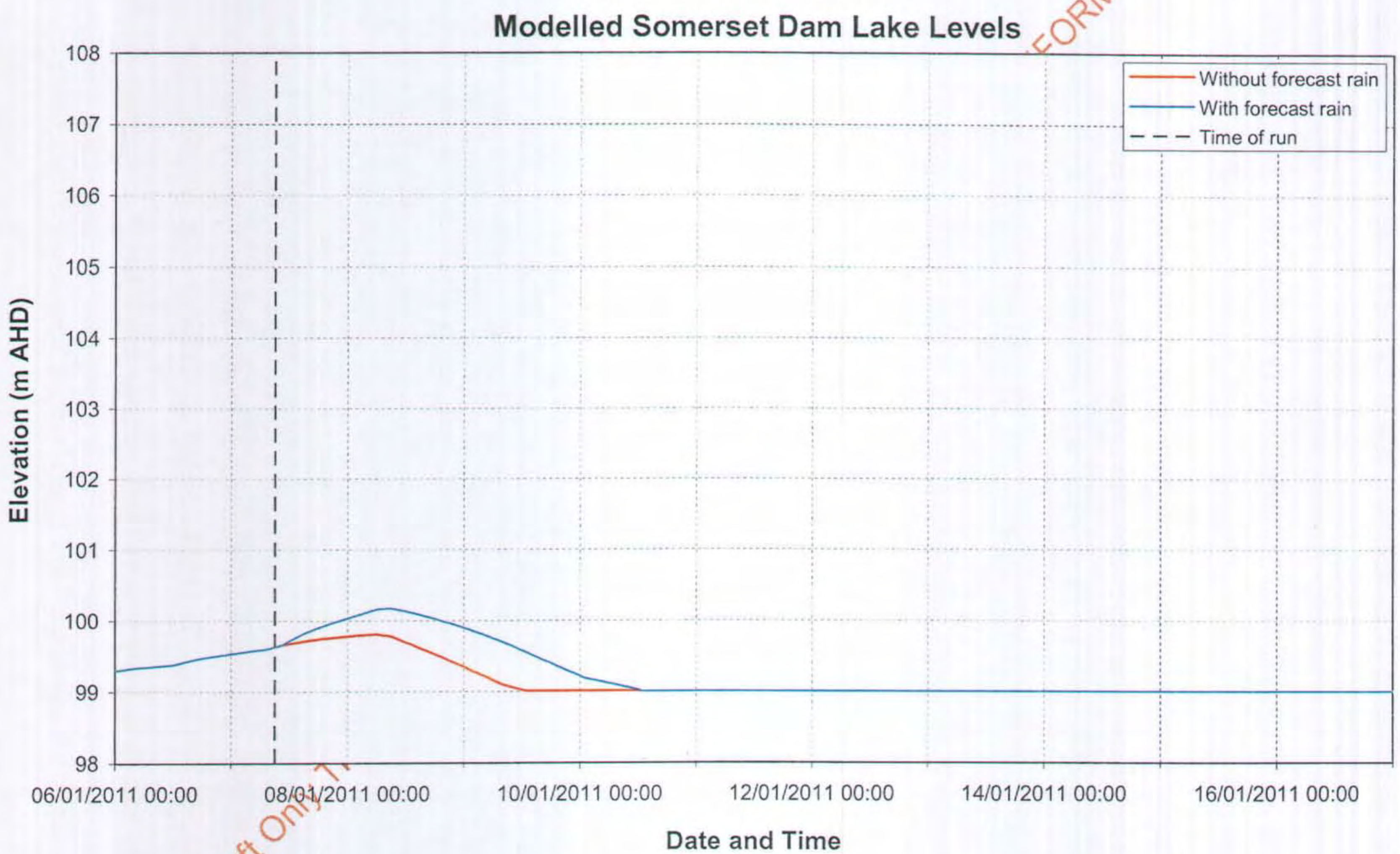



Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

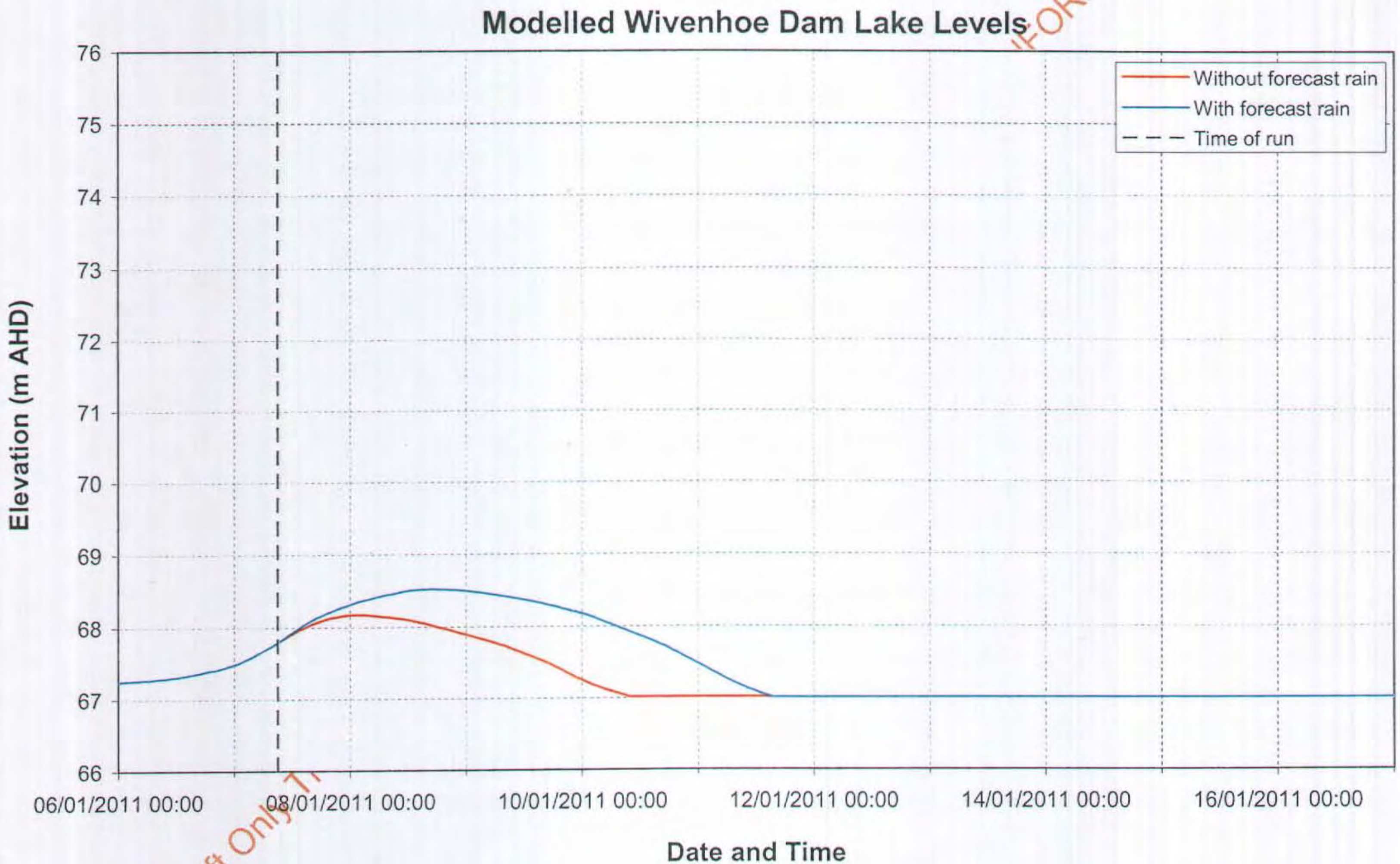
APPENDIX A – MODEL RESULTS

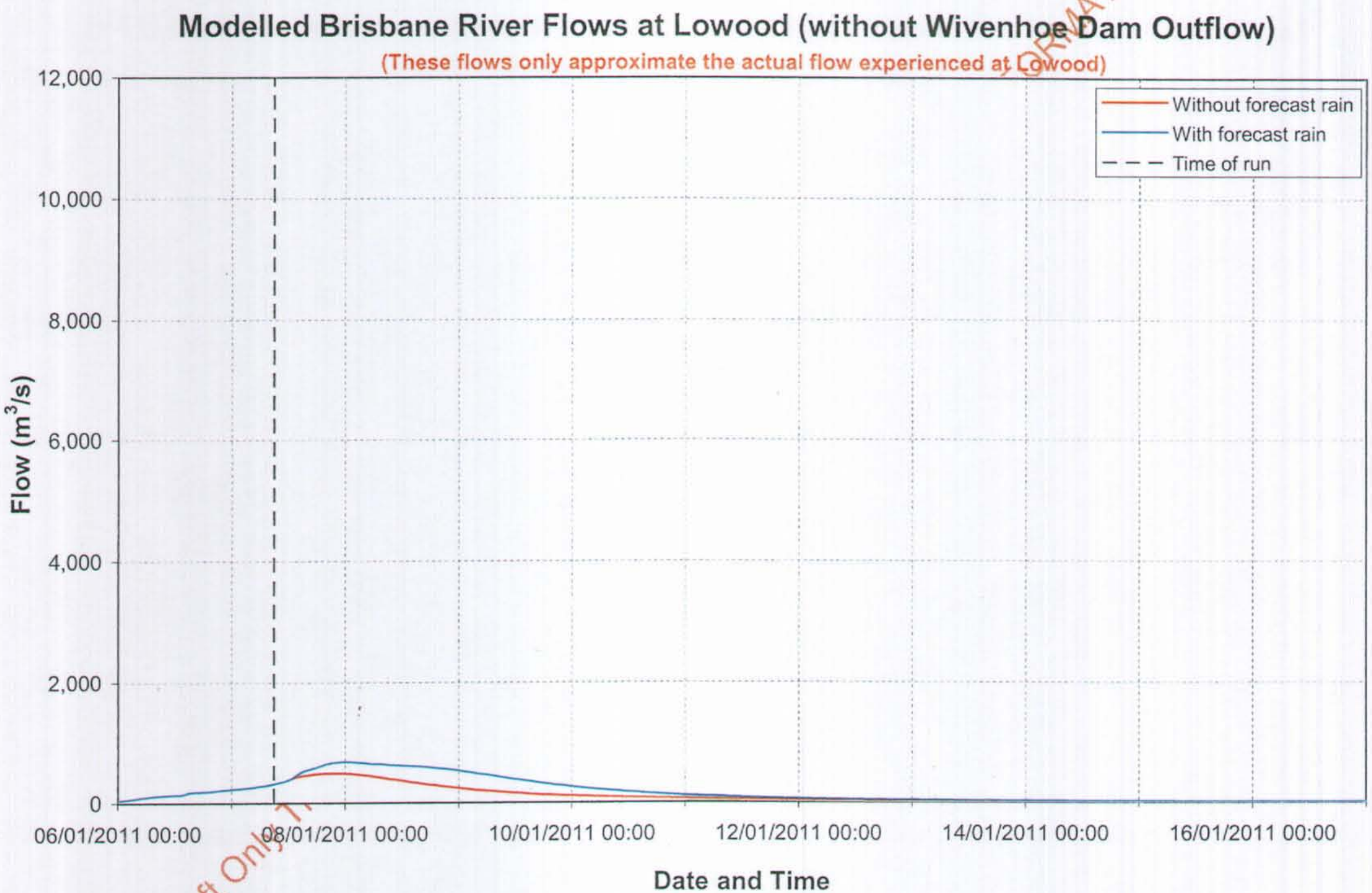



Modelled Bremer River Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m³/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

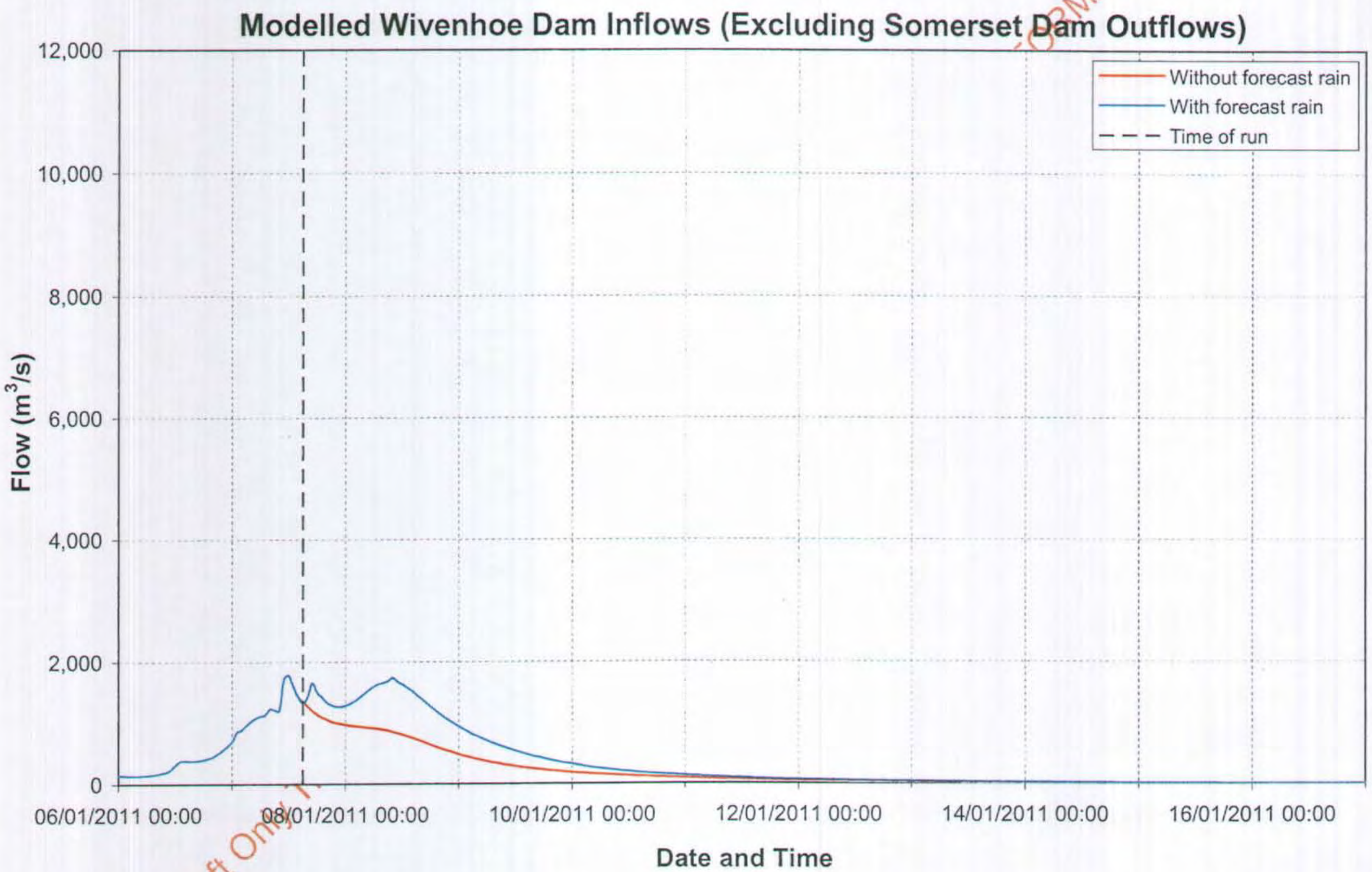

Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

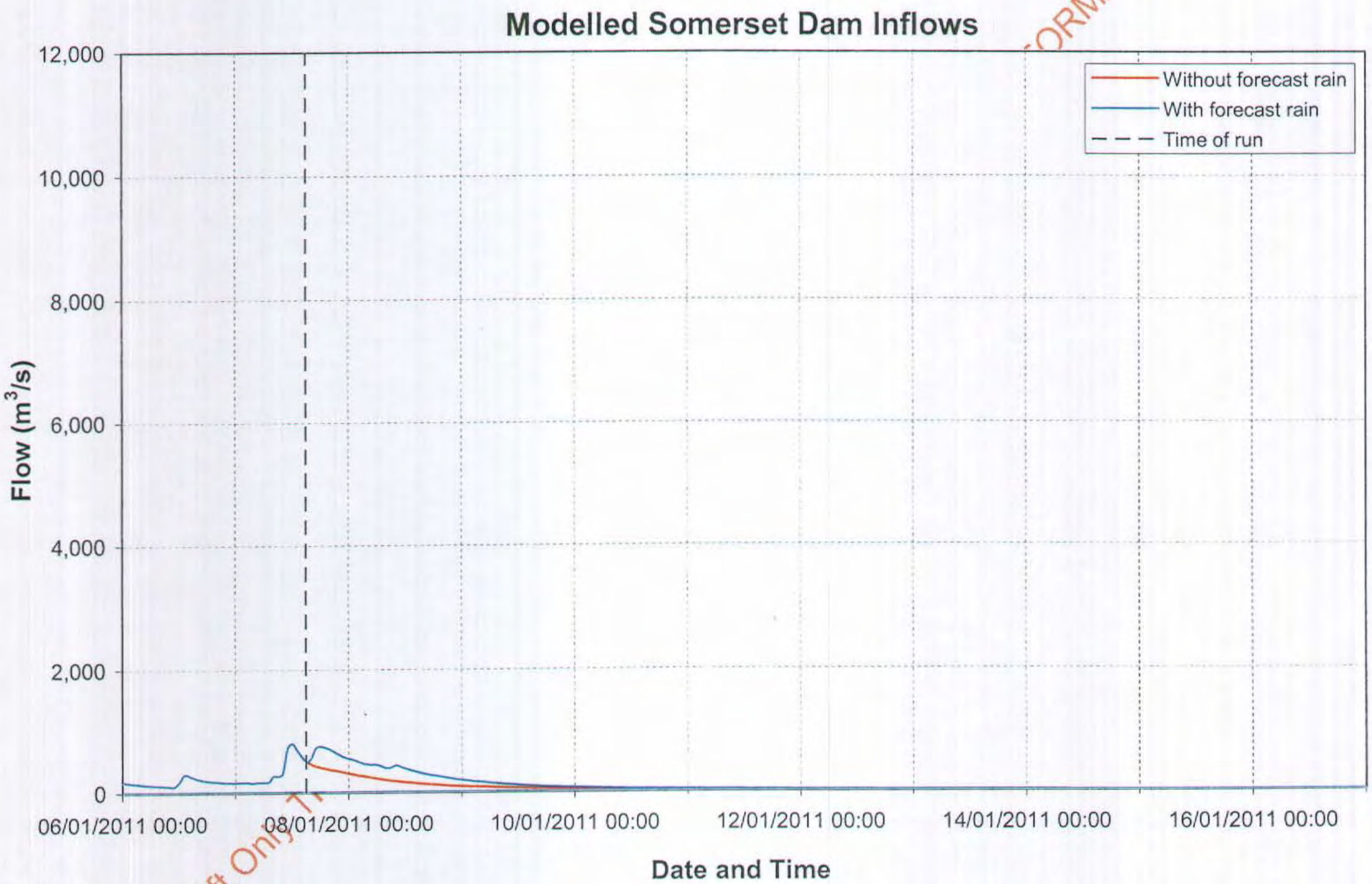
Run 8

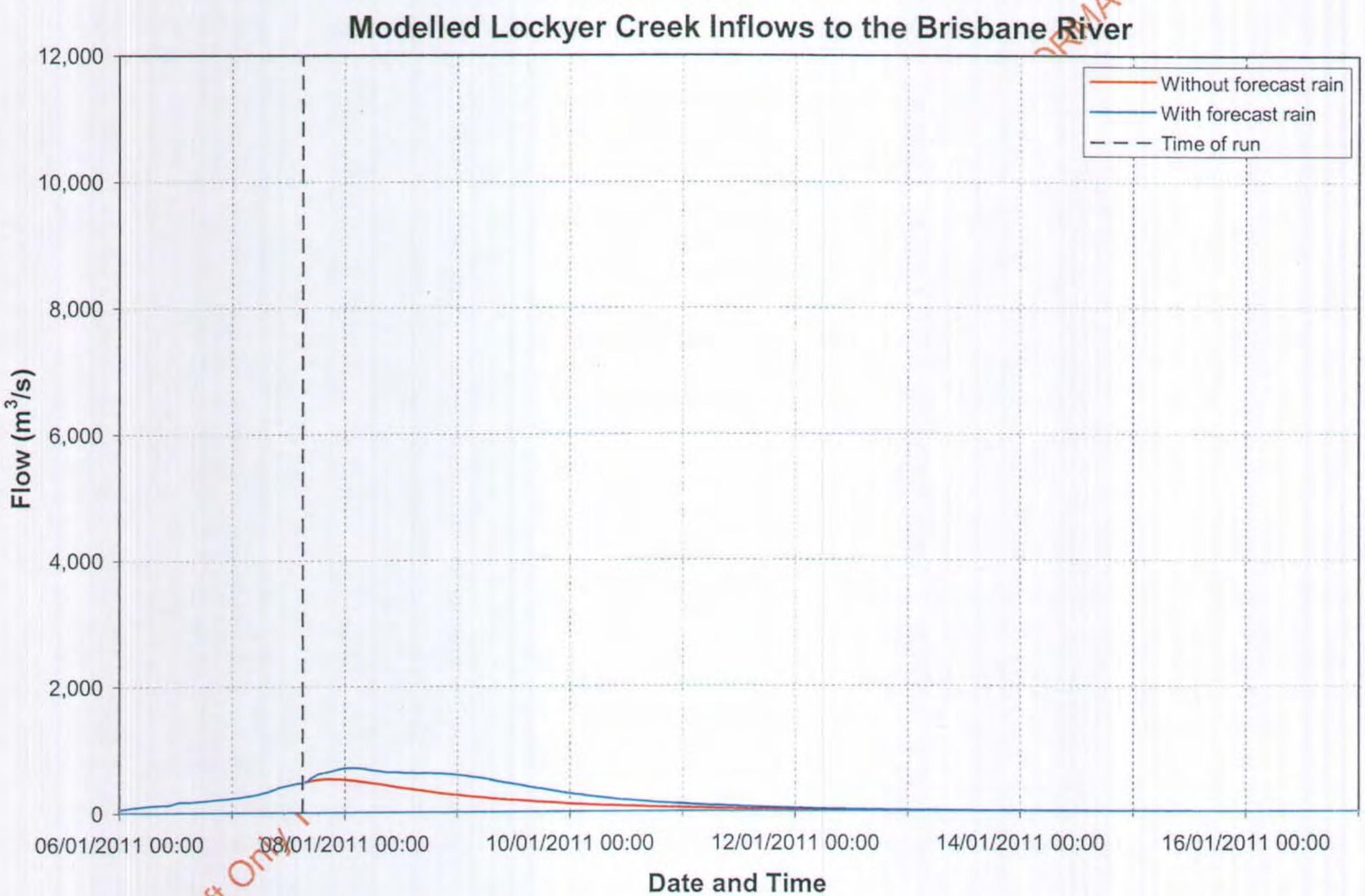
Date: Friday 7 January 2011

Time: 15:00

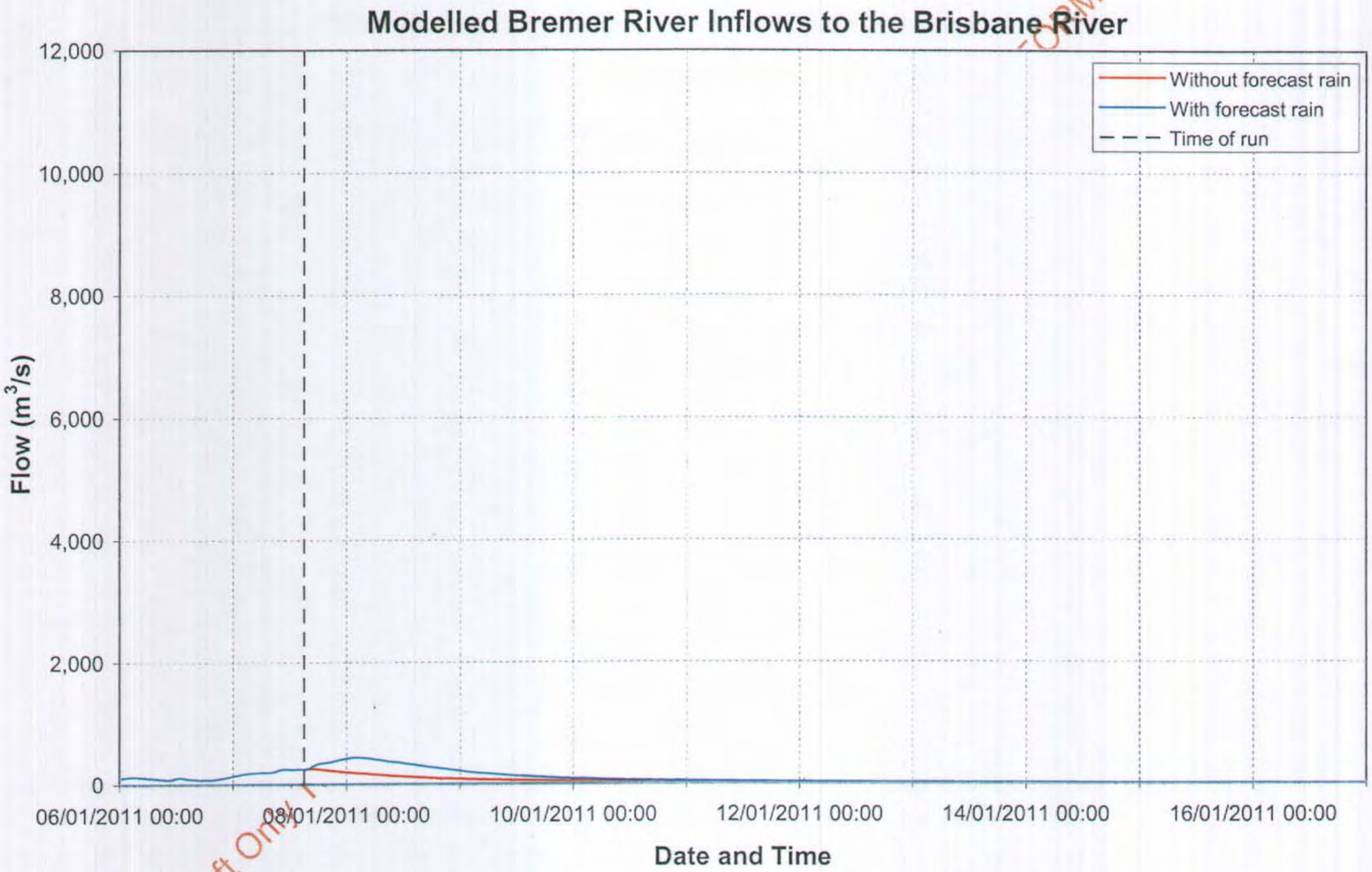

Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

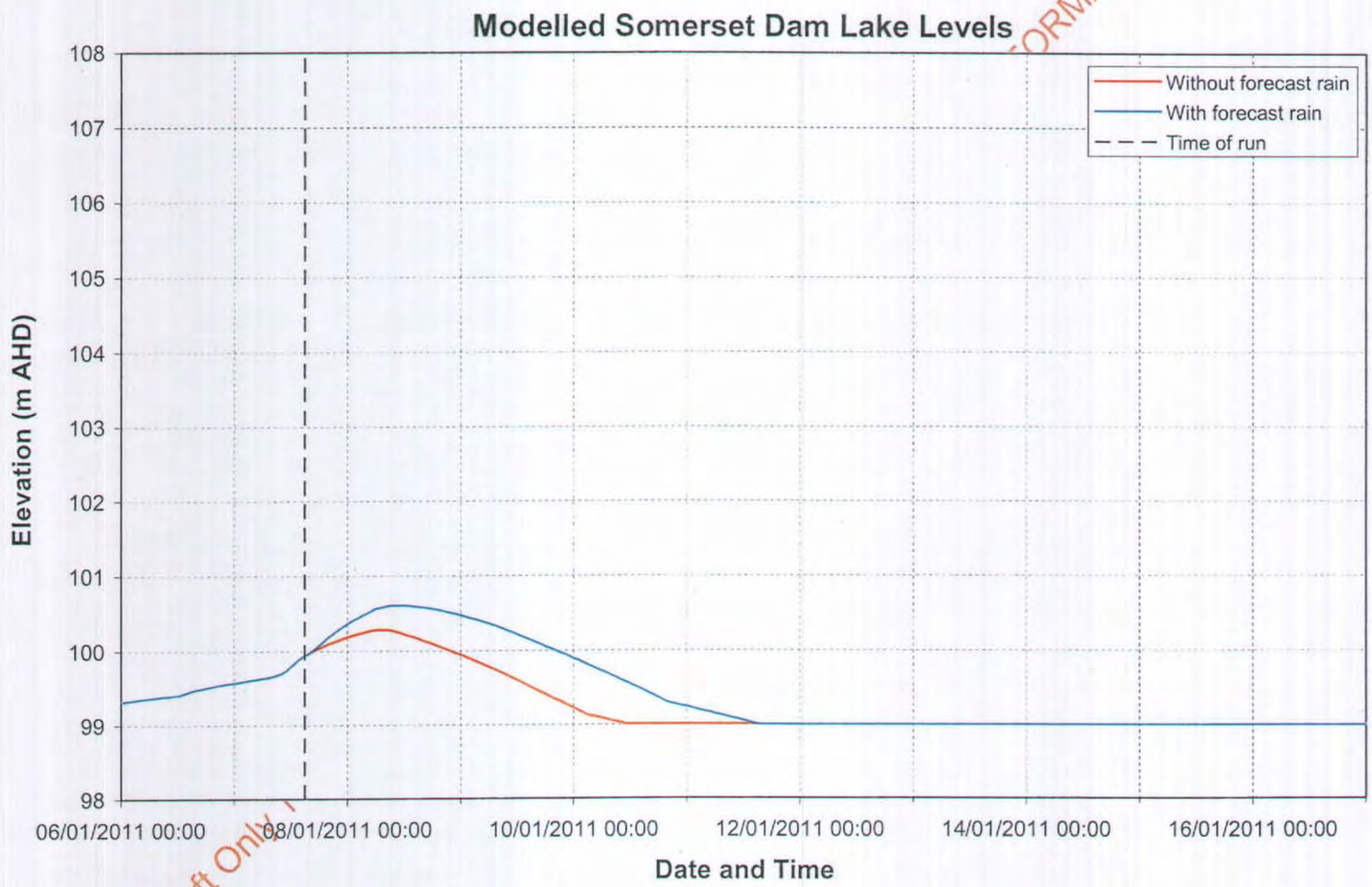
APPENDIX A – MODEL RESULTS



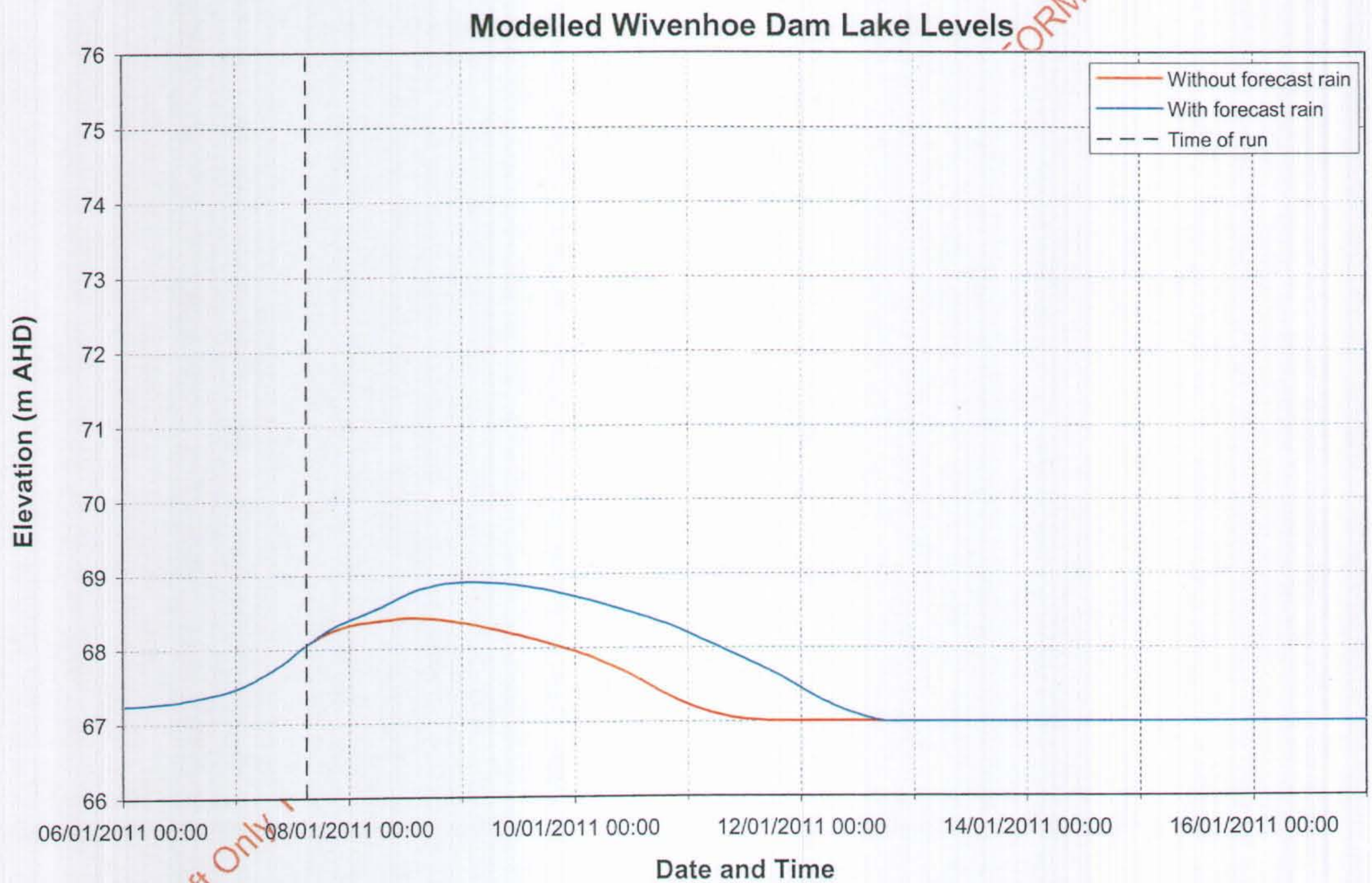


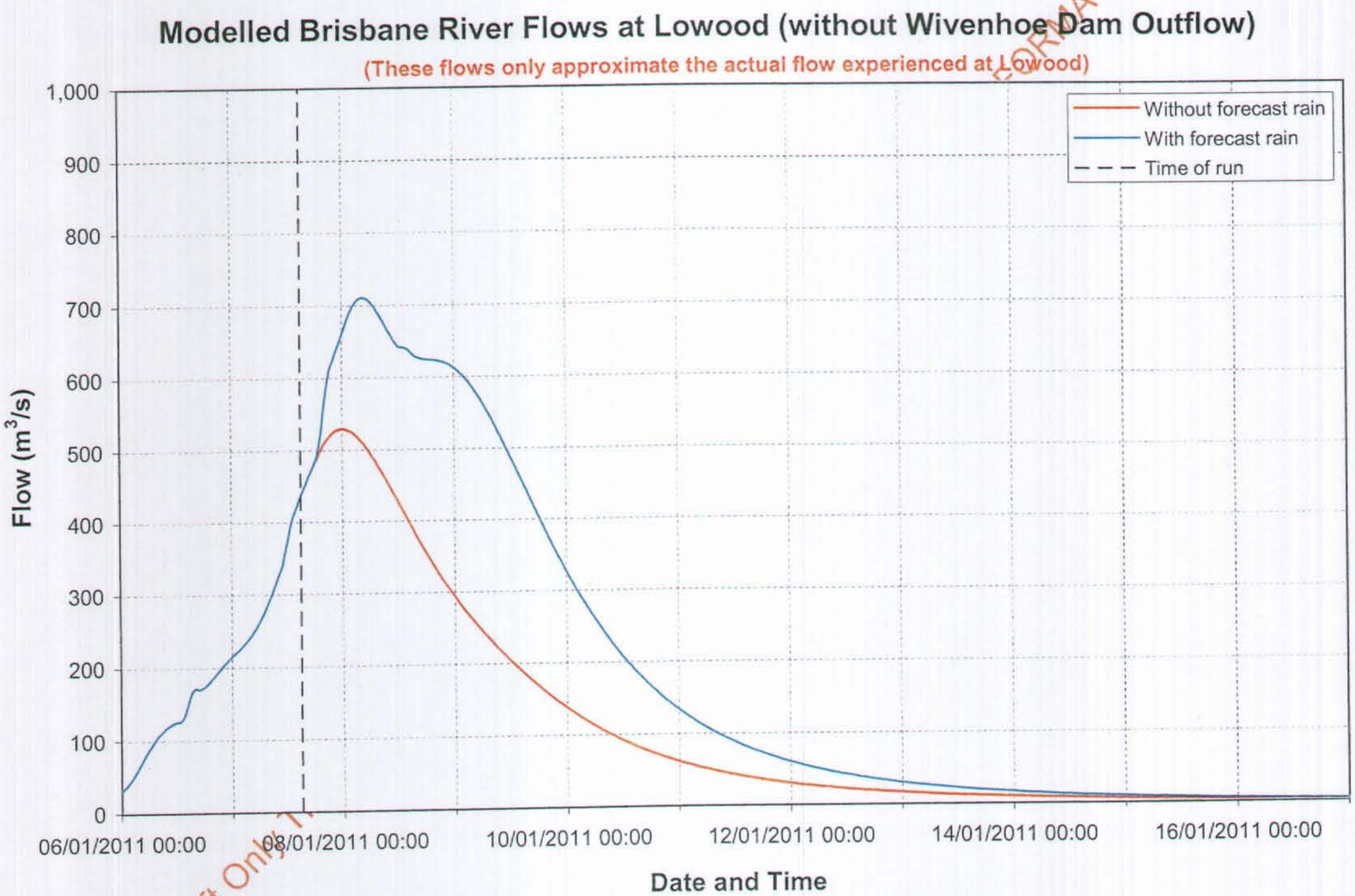
Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

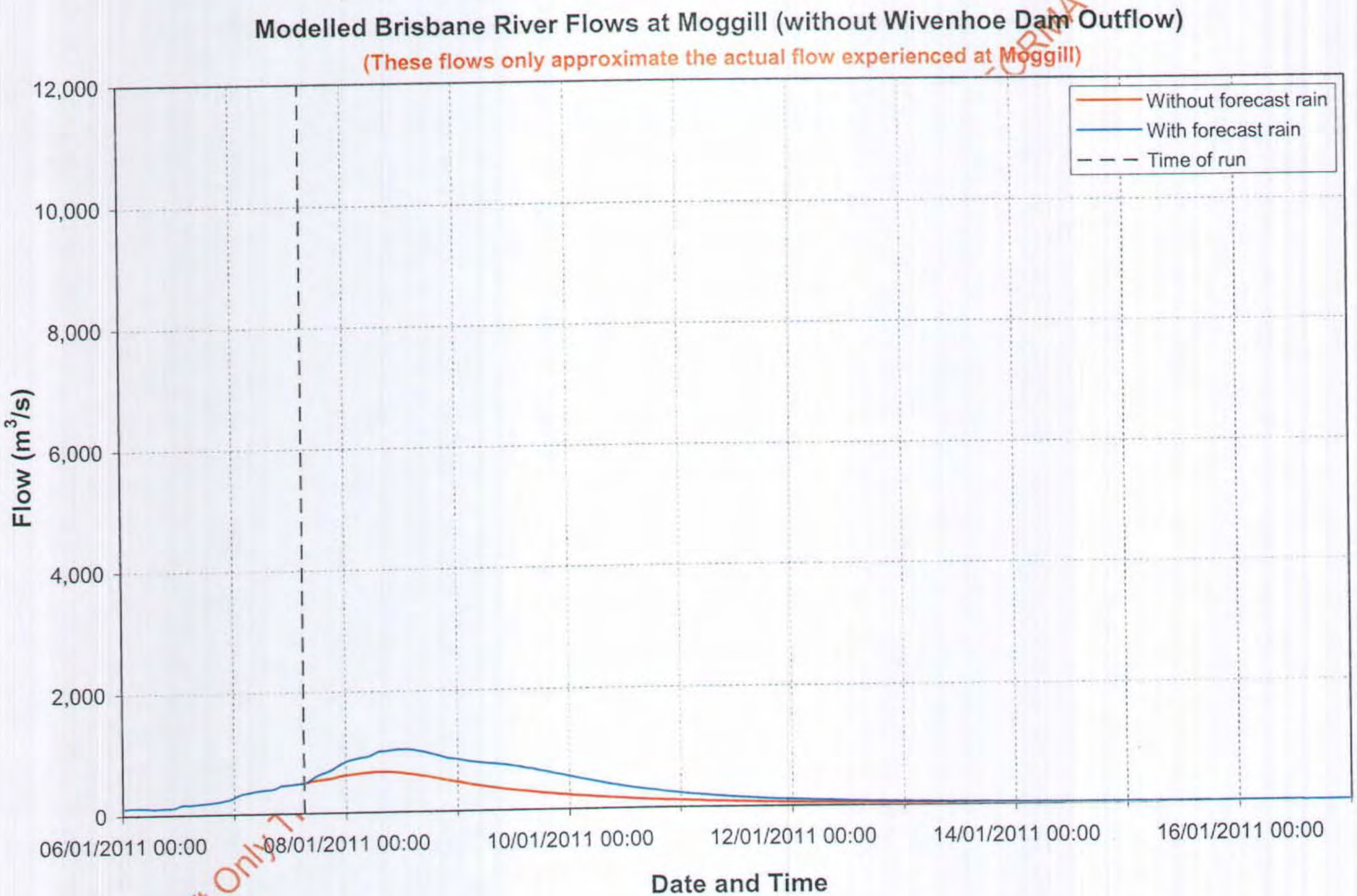

Modelled Bremer River Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Lake Levels
108
107
106
105
104
103
102
101
100
99
98
Elevation (m AHD)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time
Without forecast rain
With forecast rain
Time of run

APPENDIX A – MODEL RESULTS




Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
1,000
900
800
700
600
500
400
300
200
100
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



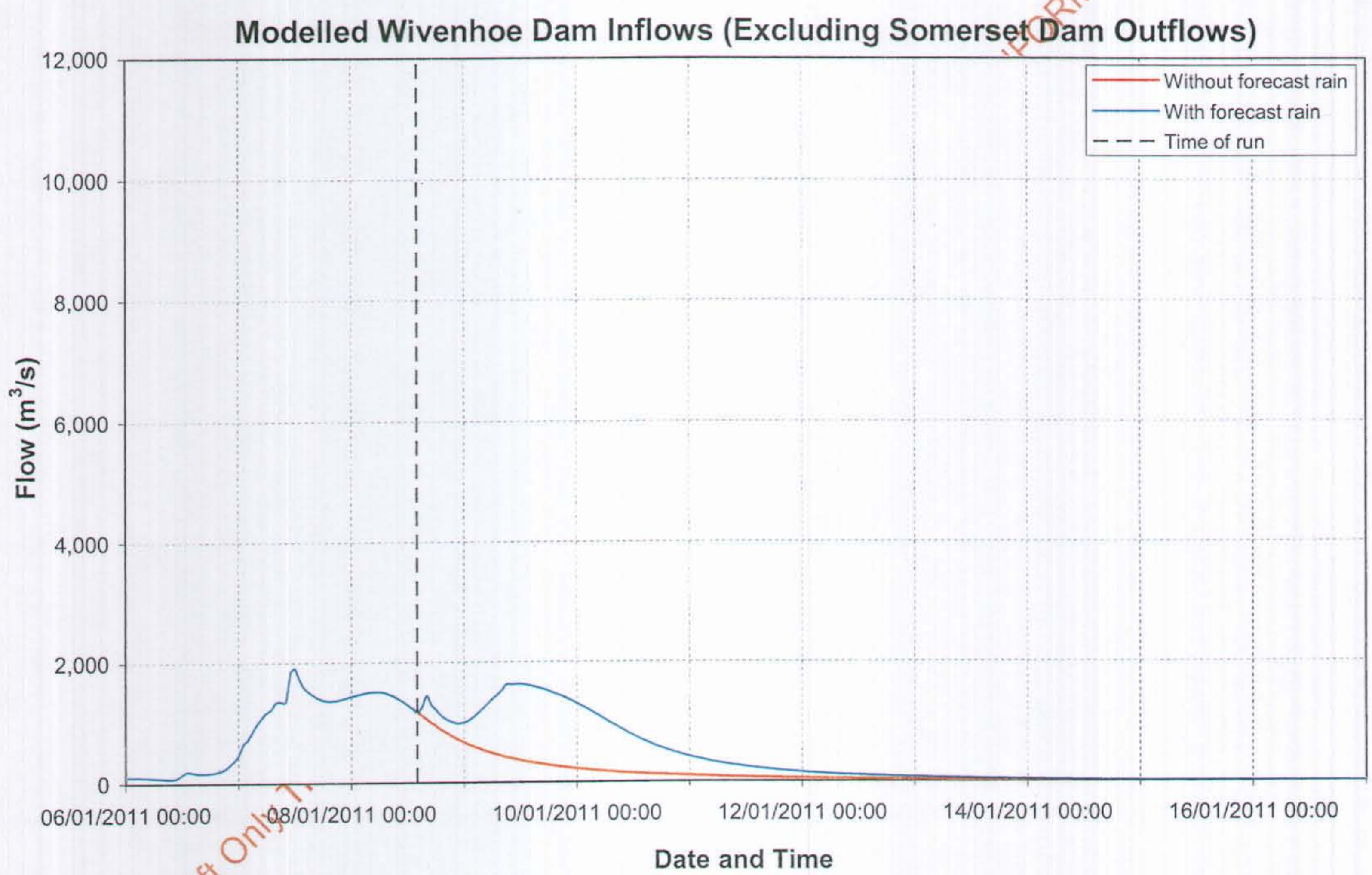
Modelled Brisbane River Flows at Moggill (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Moggill)
Without forecast rain
With forecast rain
Time of run
Flow (m^3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

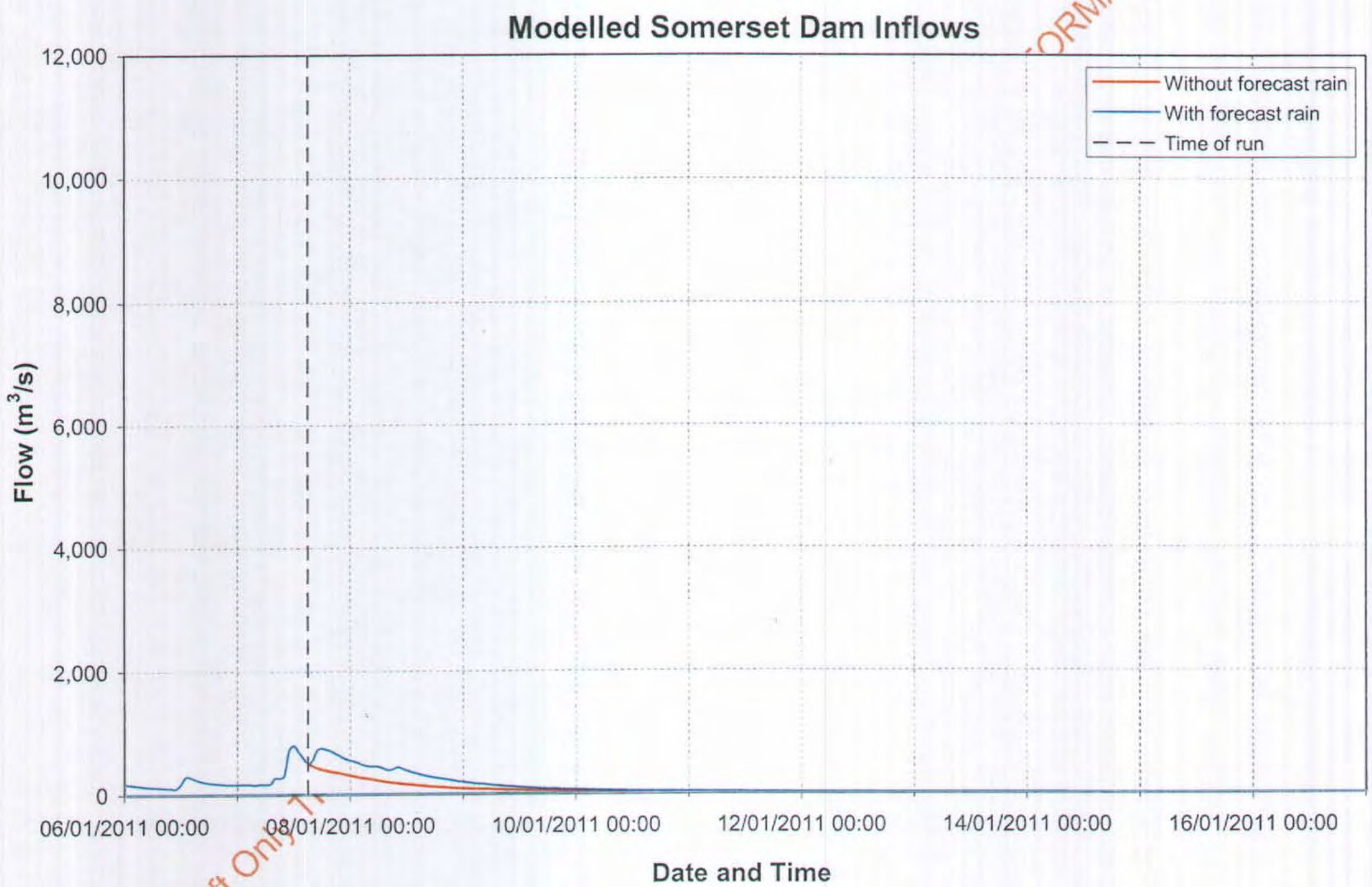
APPENDIX A – MODEL RESULTS

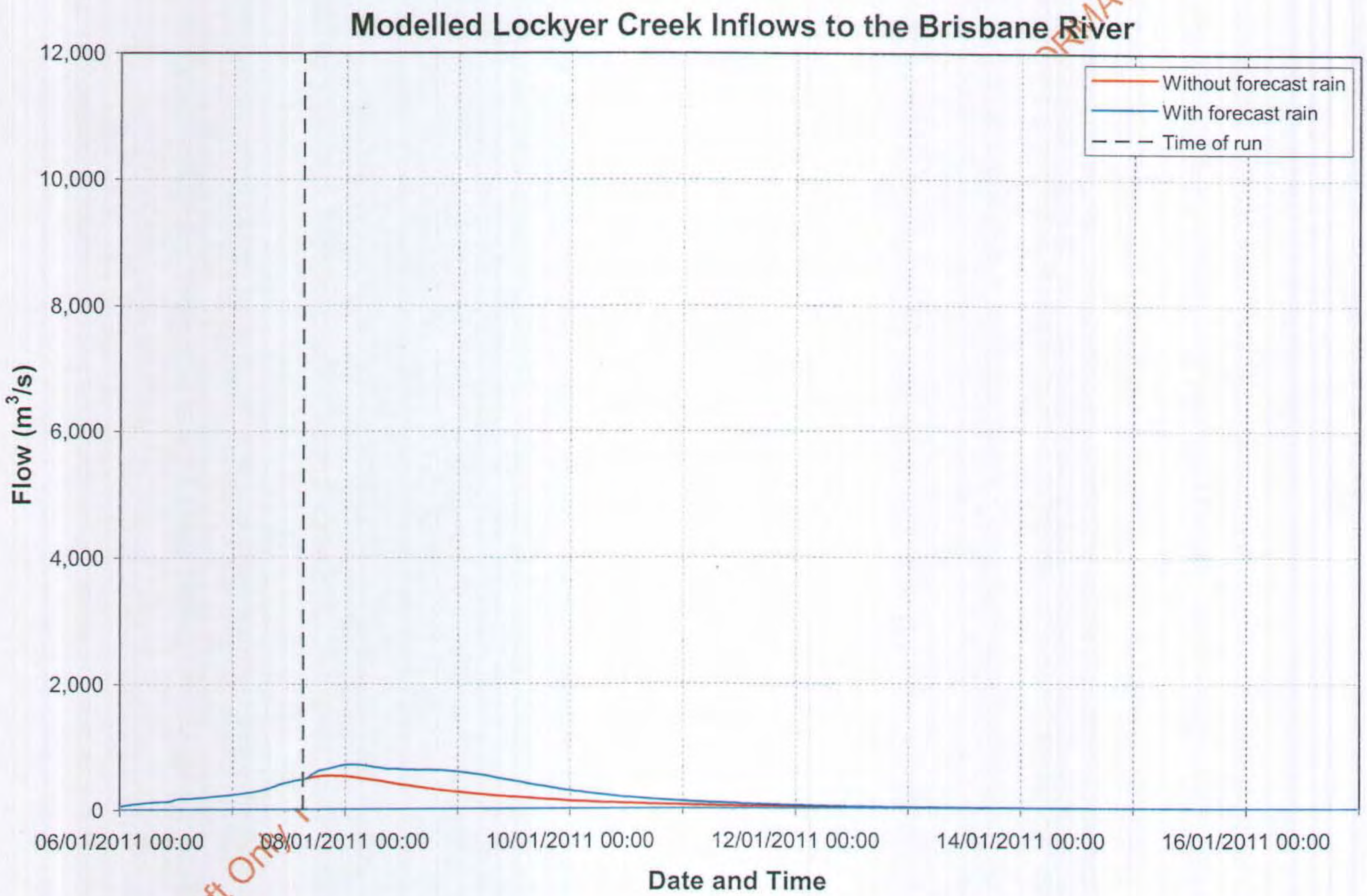
Run 10

Date: Saturday 8 January 2011

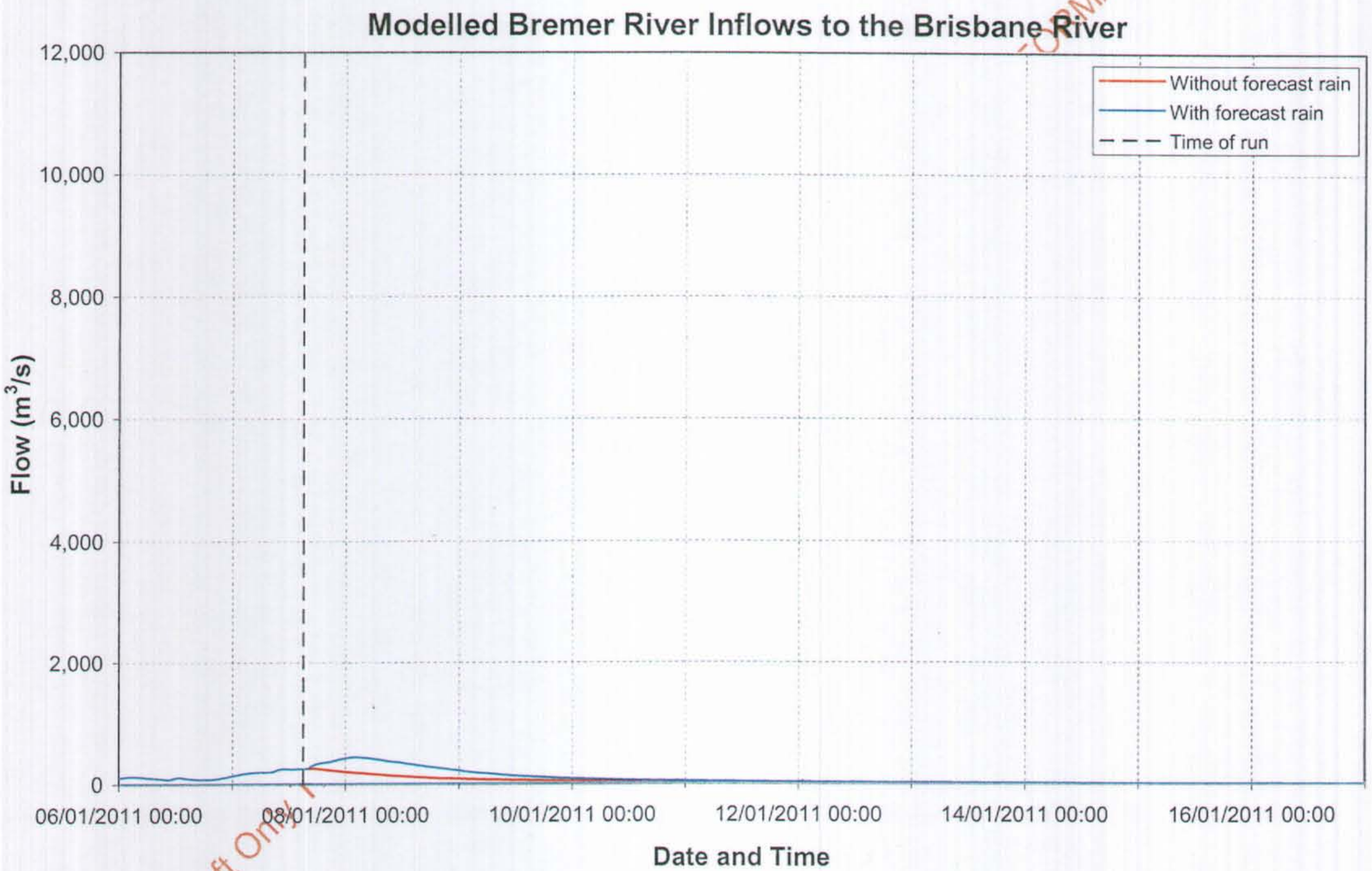
Time: 14:00

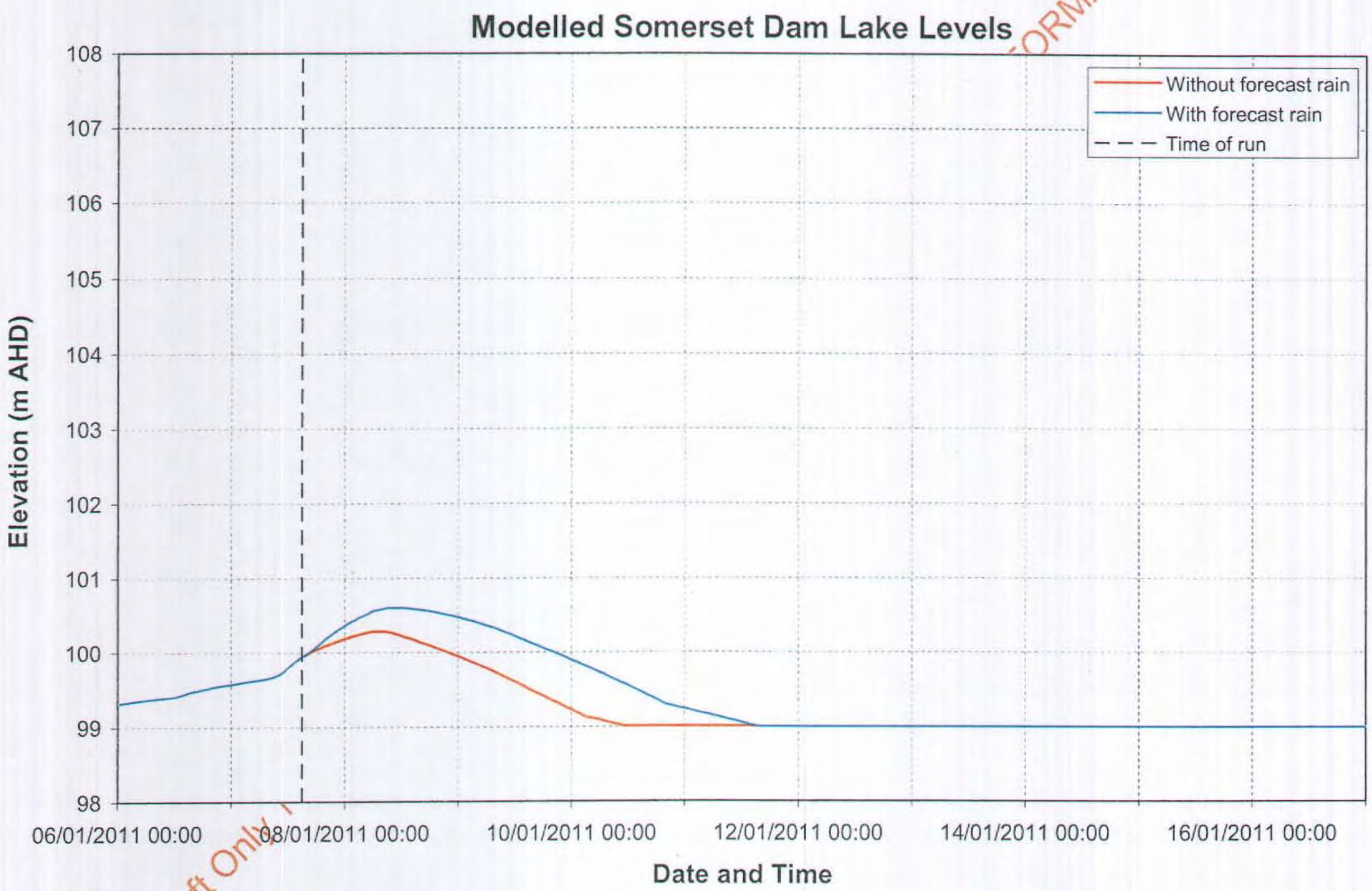

Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

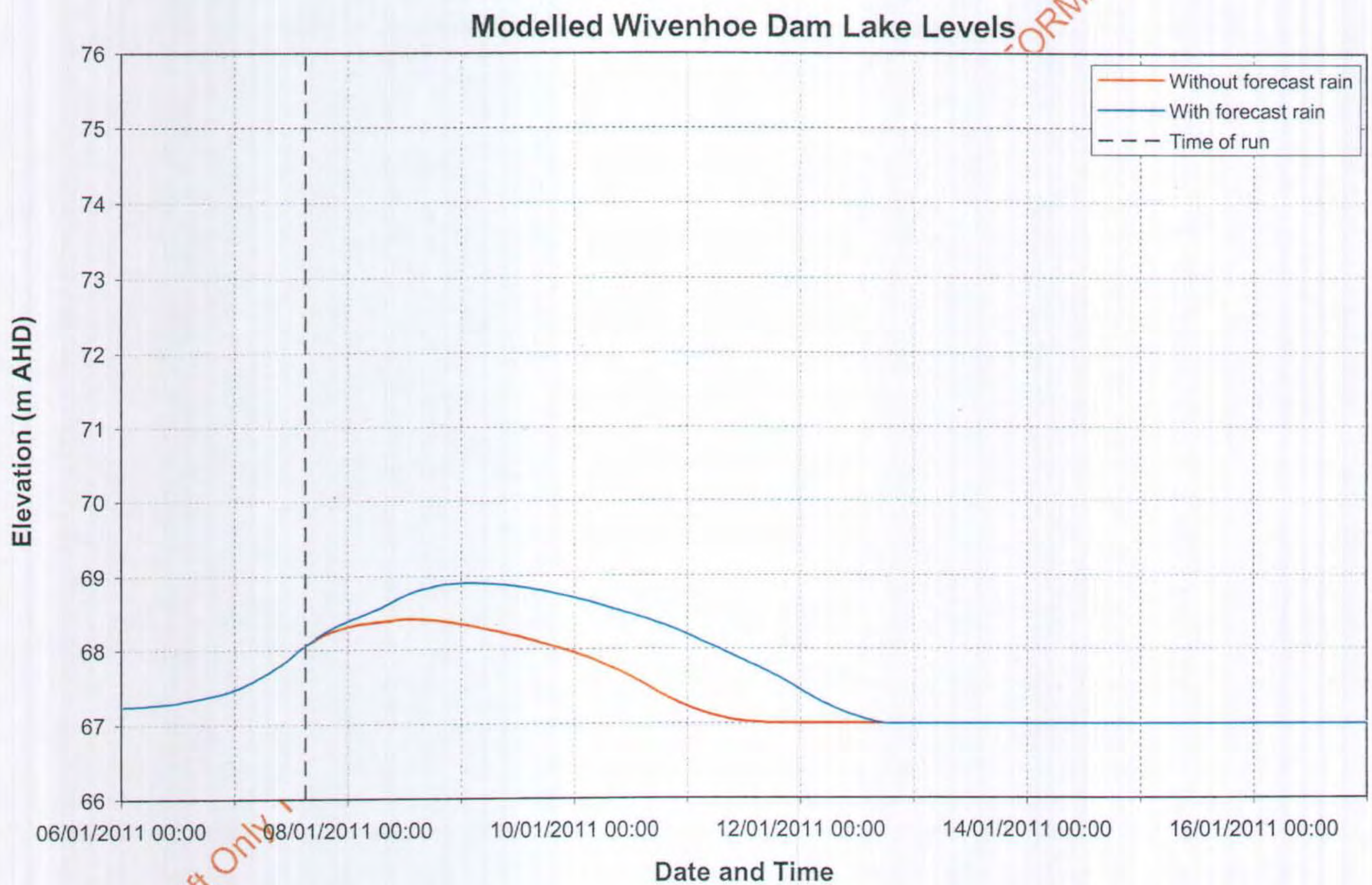

Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m³/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Lockyer Creek Inflows to the Brisbane River
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m³/s)
Without forecast rain
With forecast rain
Time of run
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

APPENDIX A – MODEL RESULTS




Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

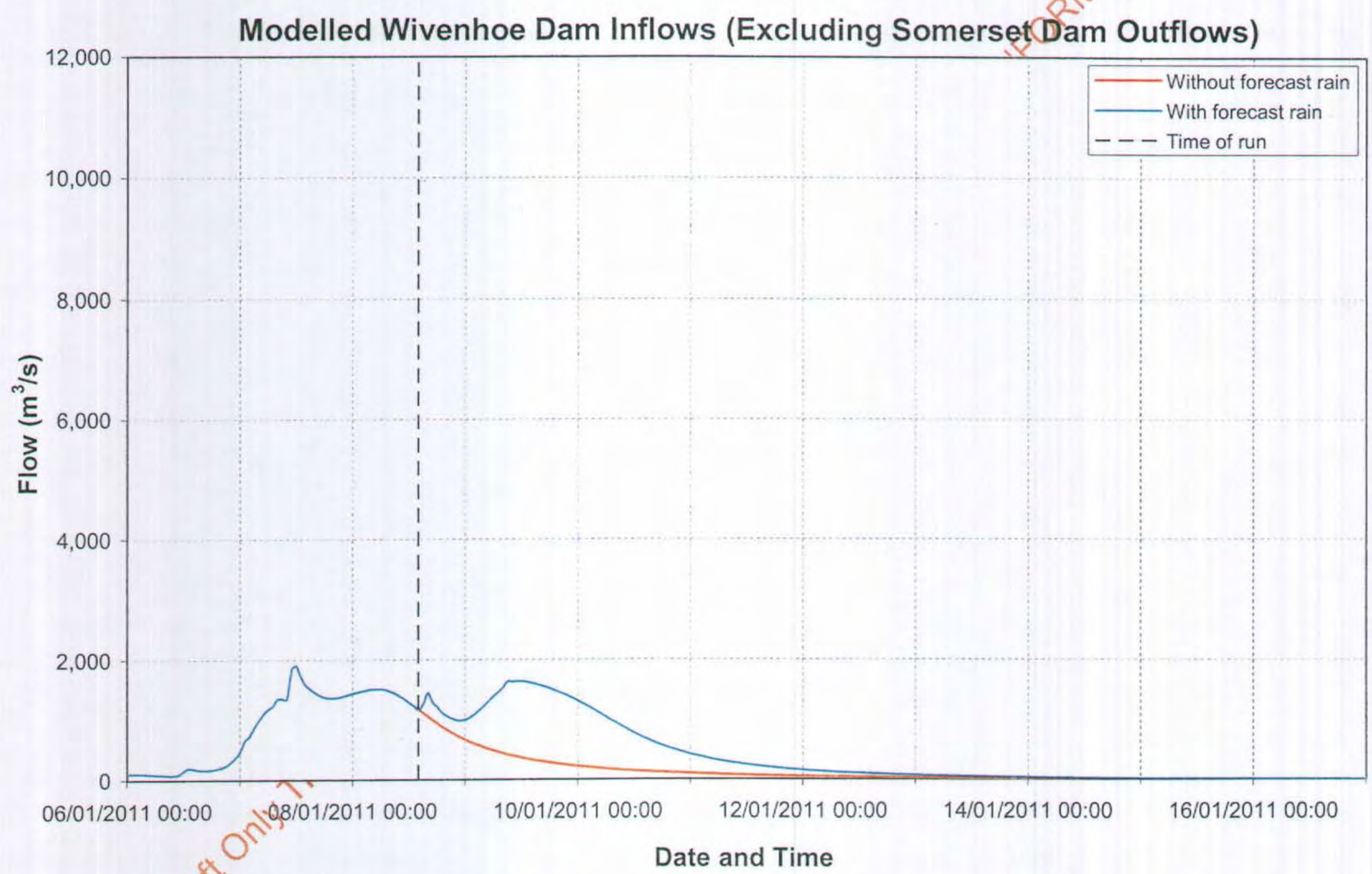

Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

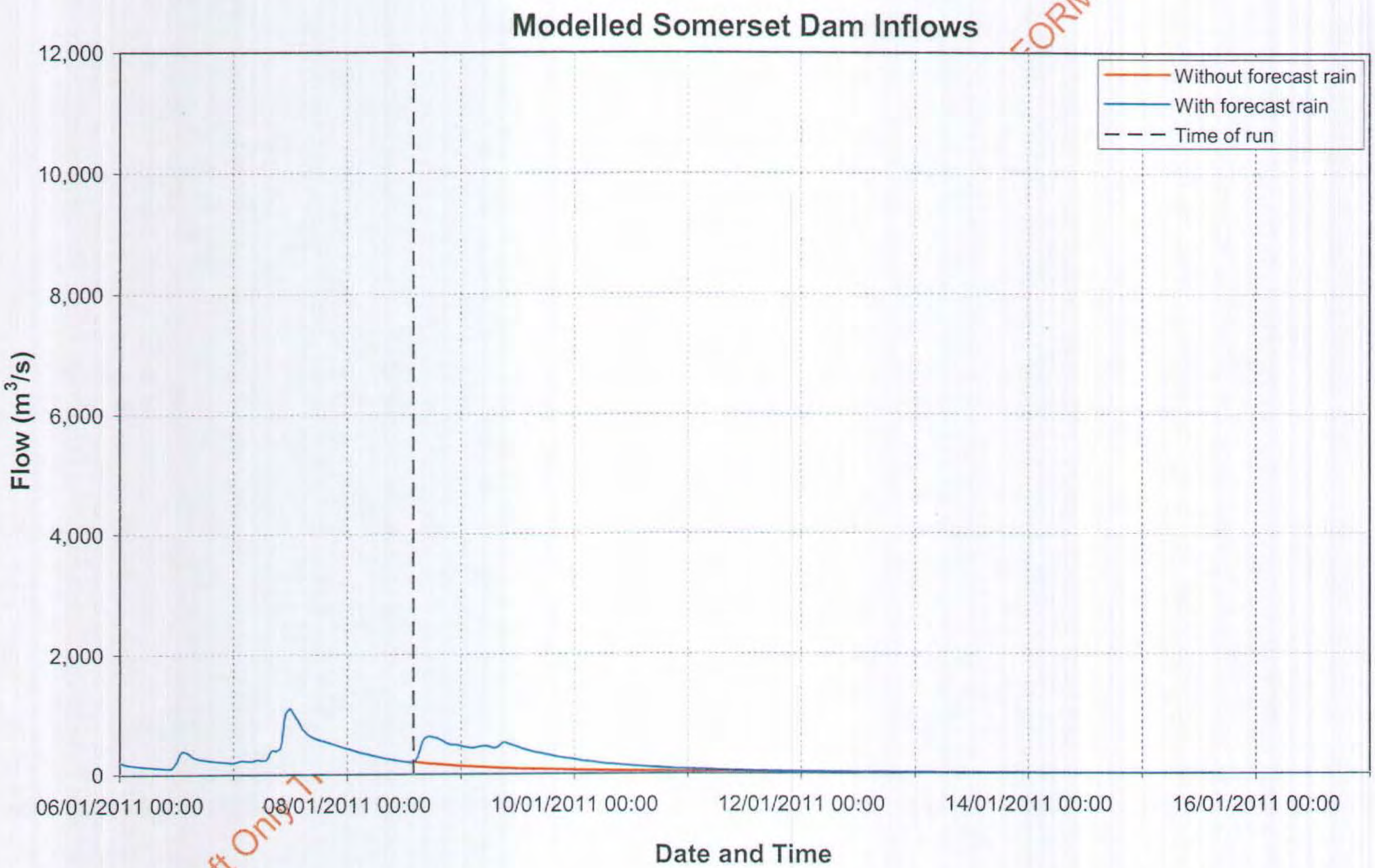
APPENDIX A – MODEL RESULTS

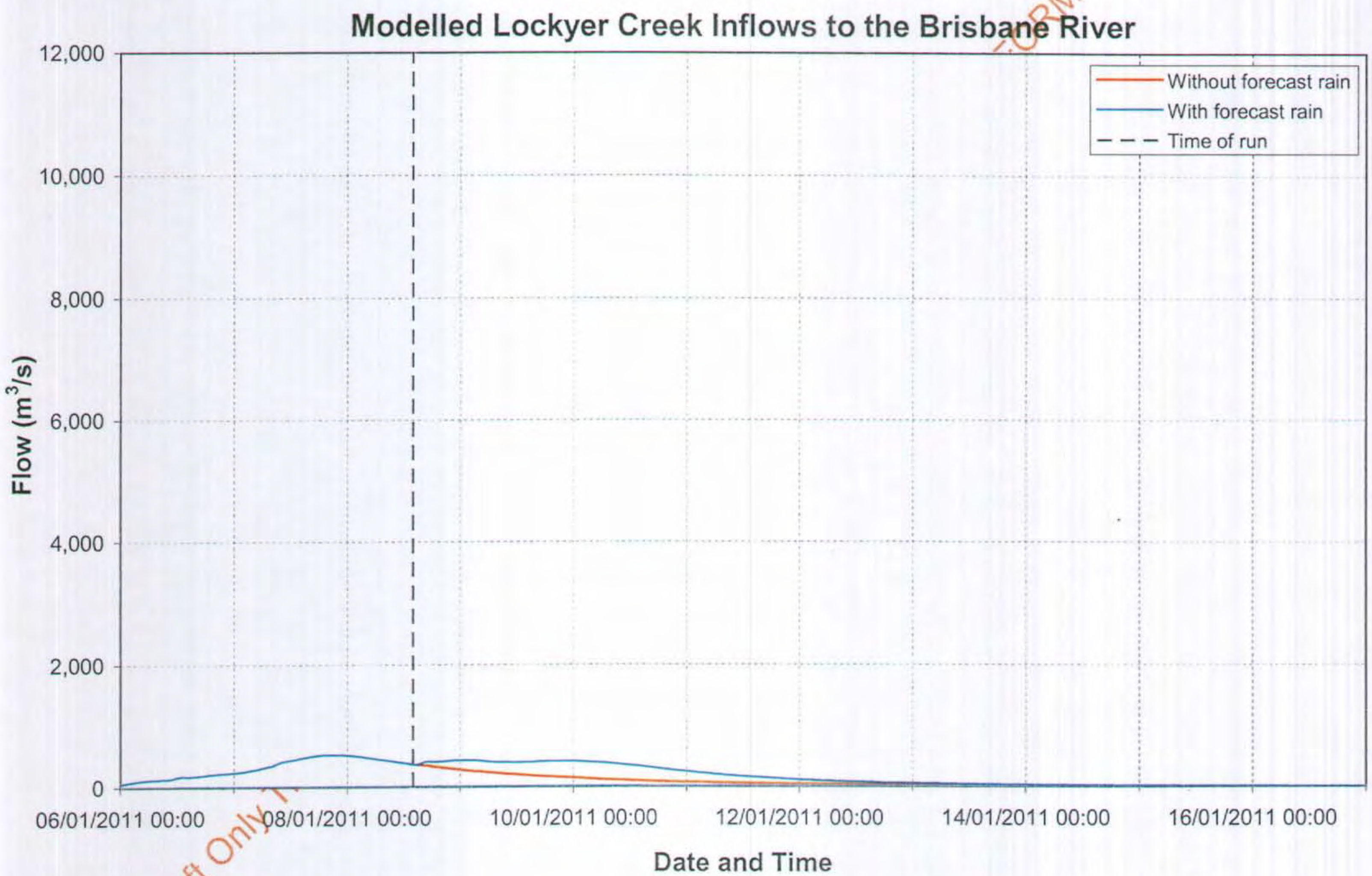
Run 10

Date: Saturday 8 January 2011

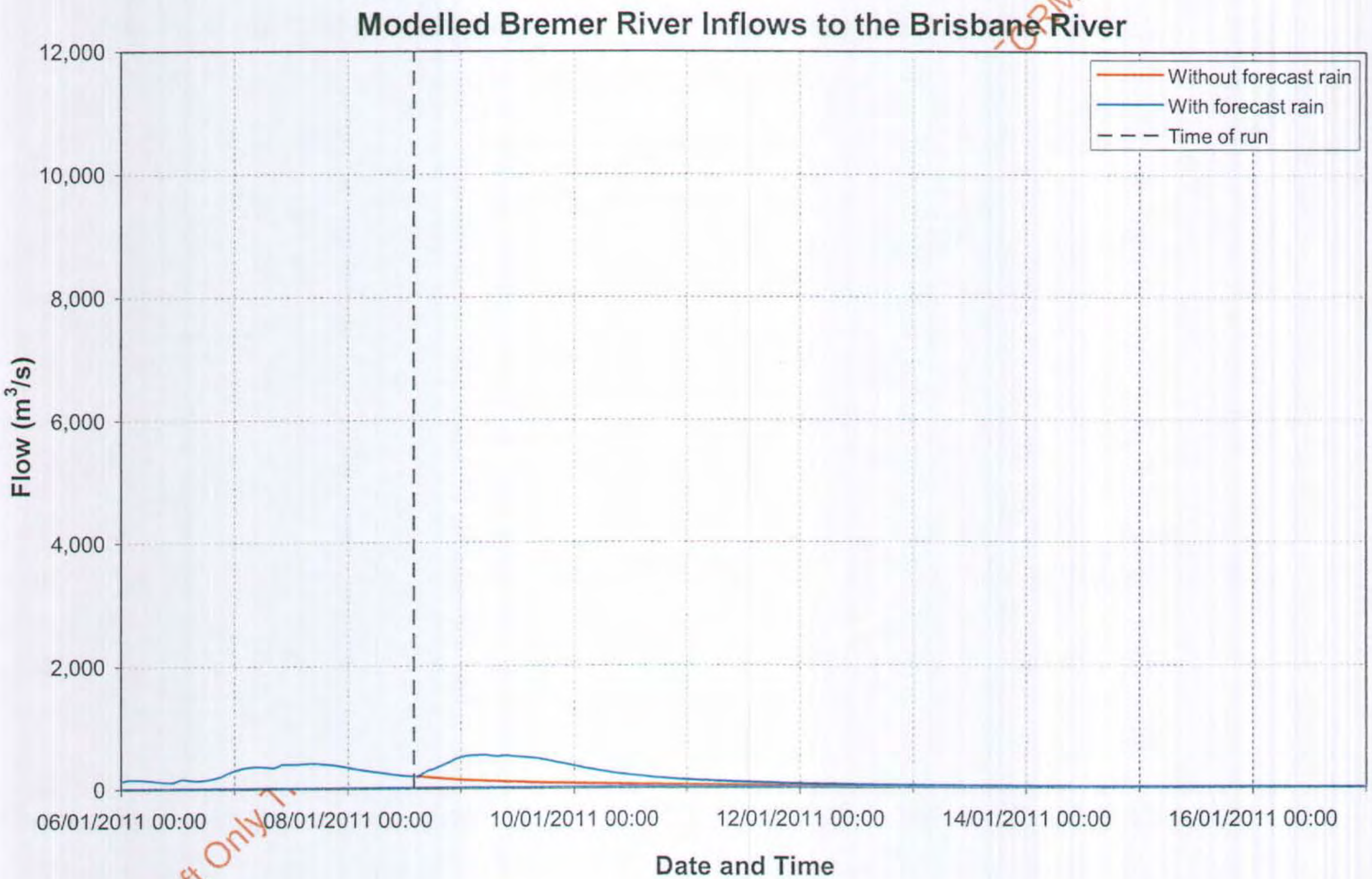
Time: 14:00

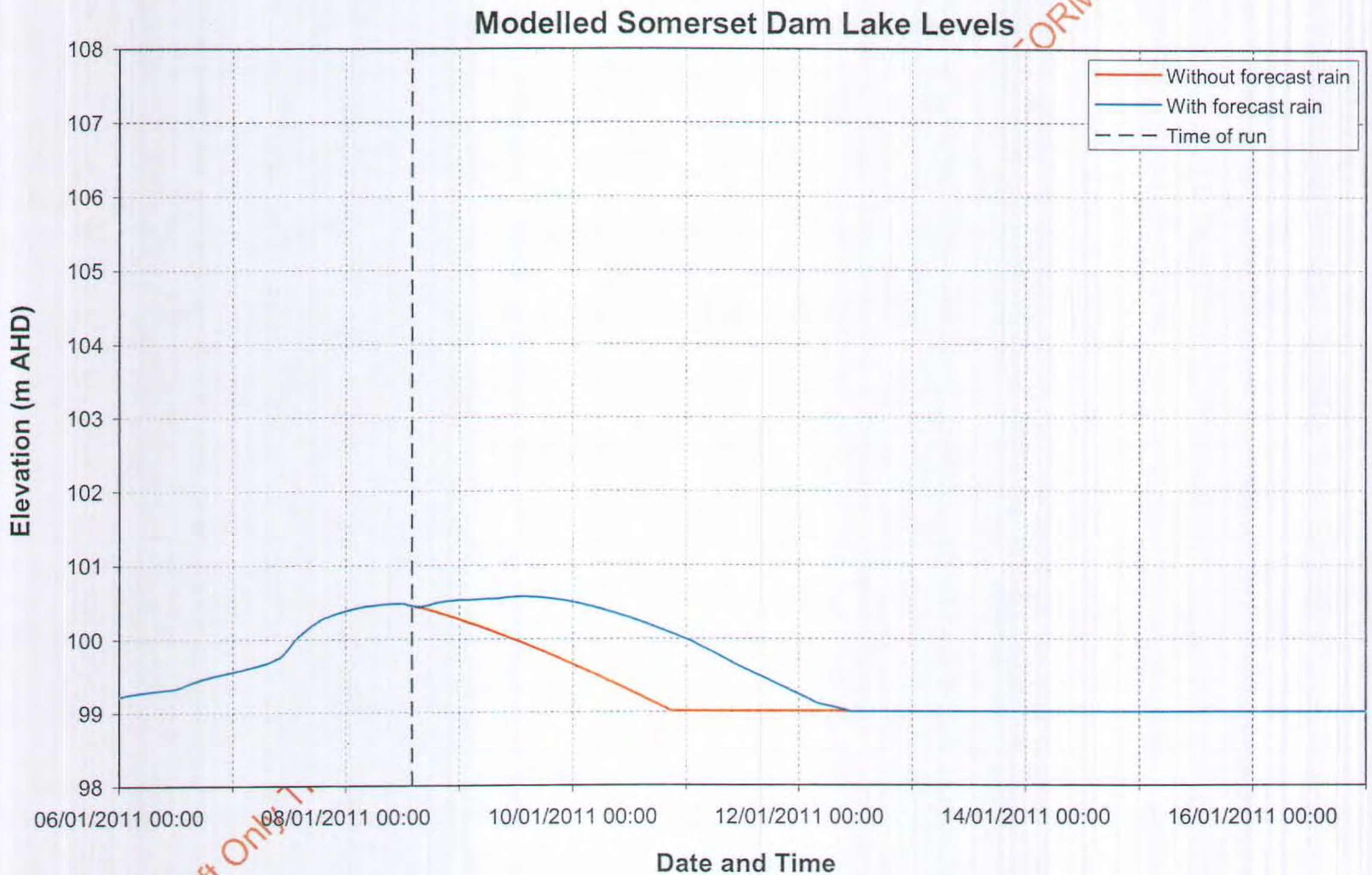

Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

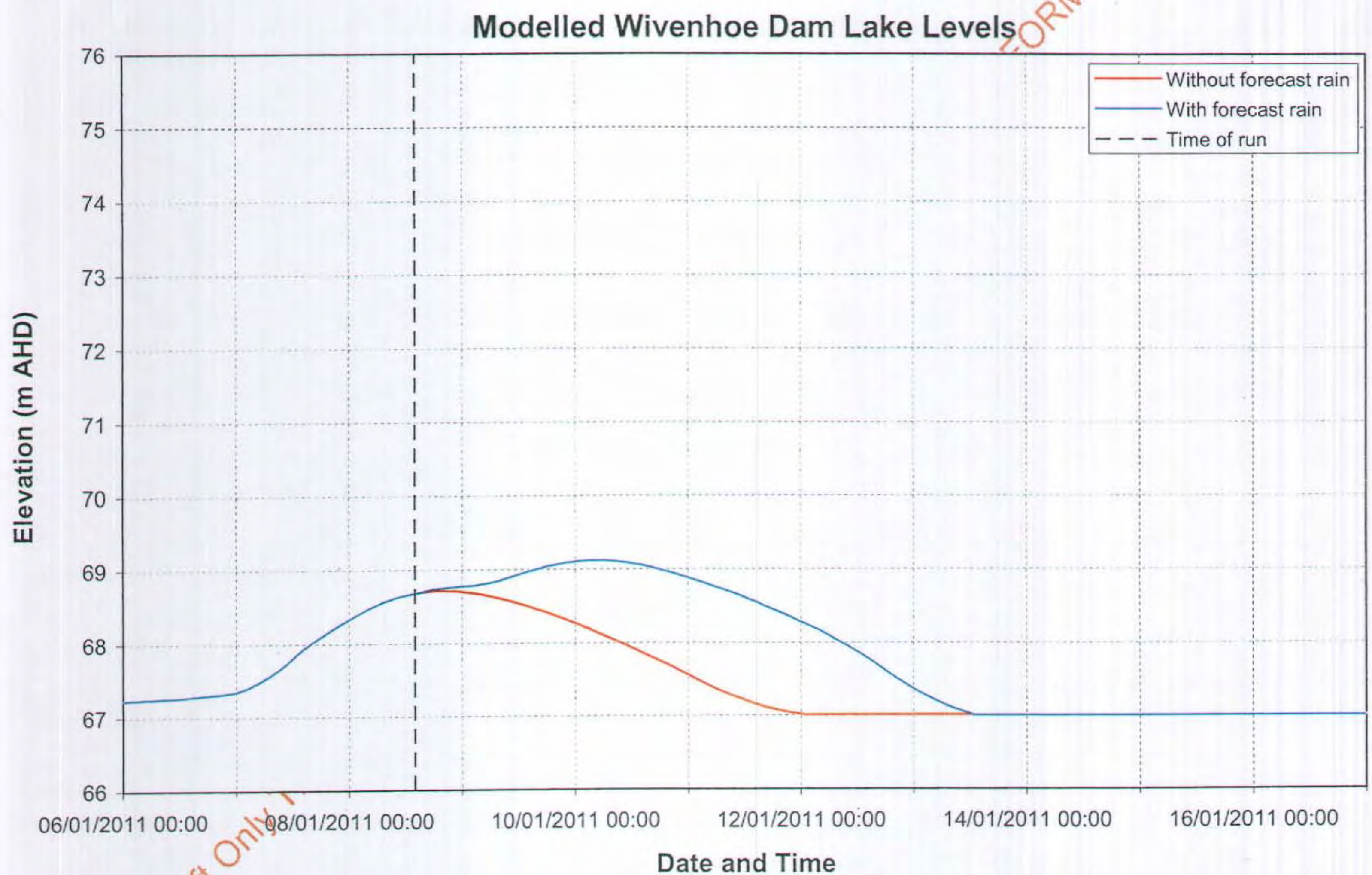


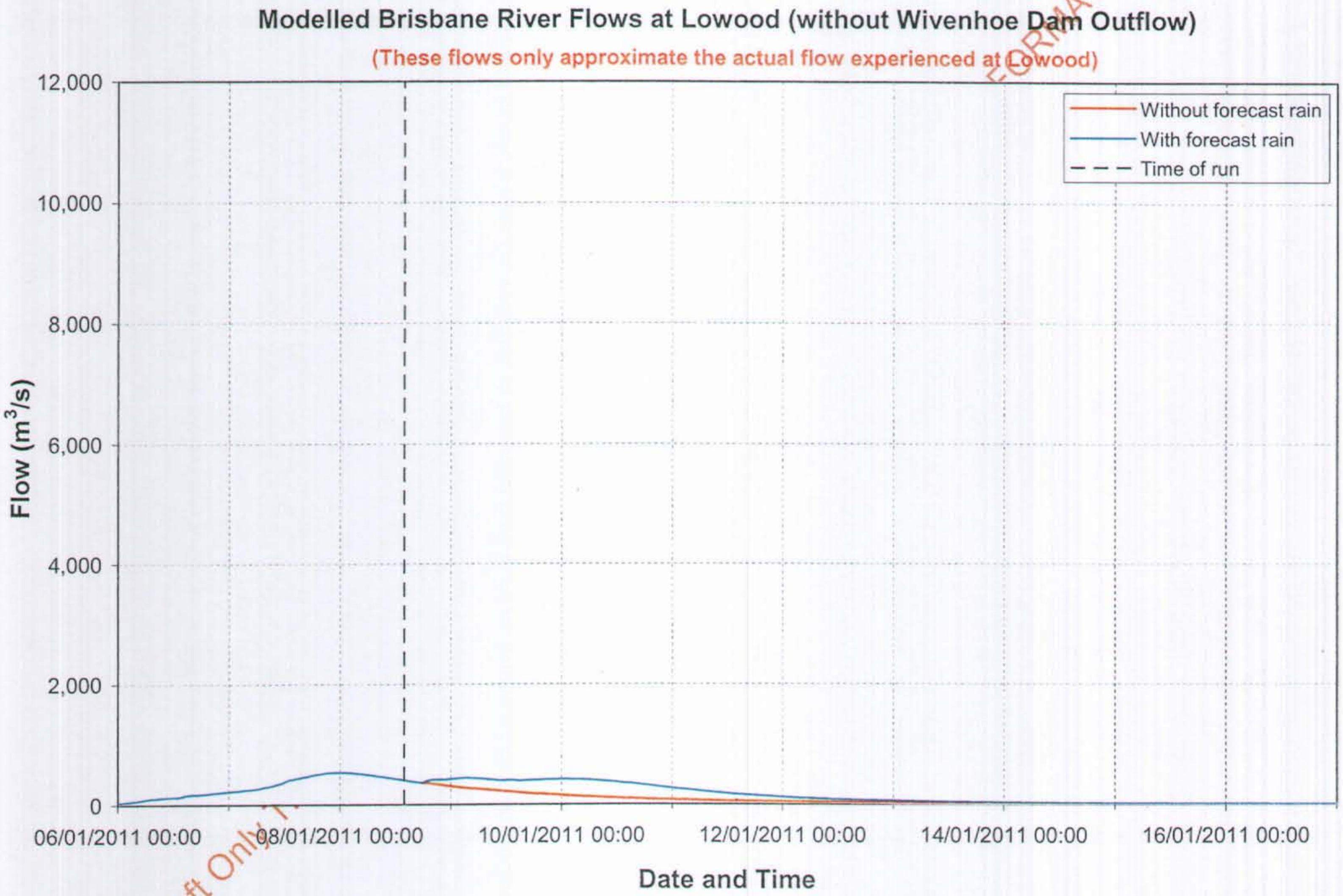
Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

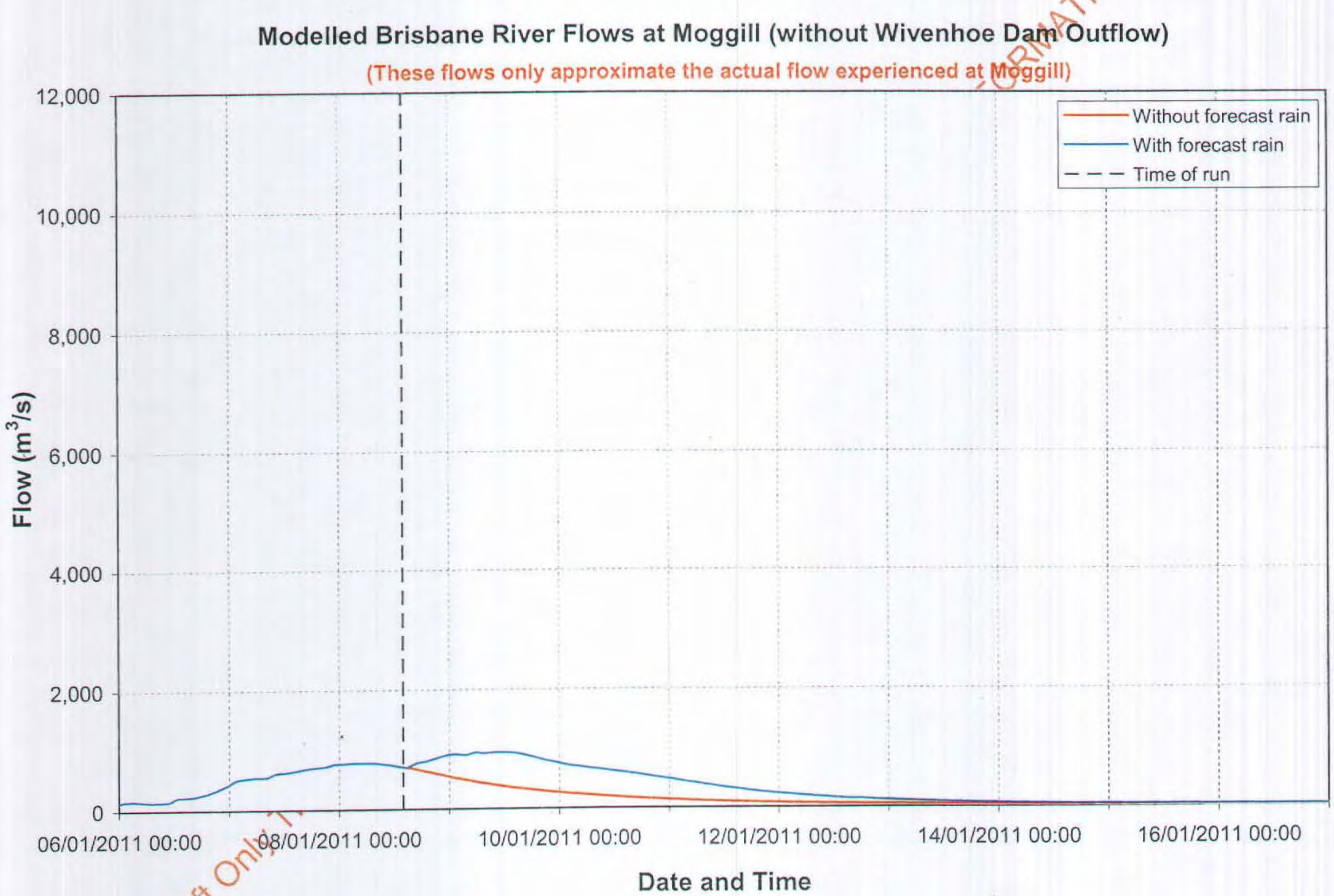

Modelled Bremer River Inflows to the Brisbane River
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
Without forecast rain
With forecast rain
Time of run
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

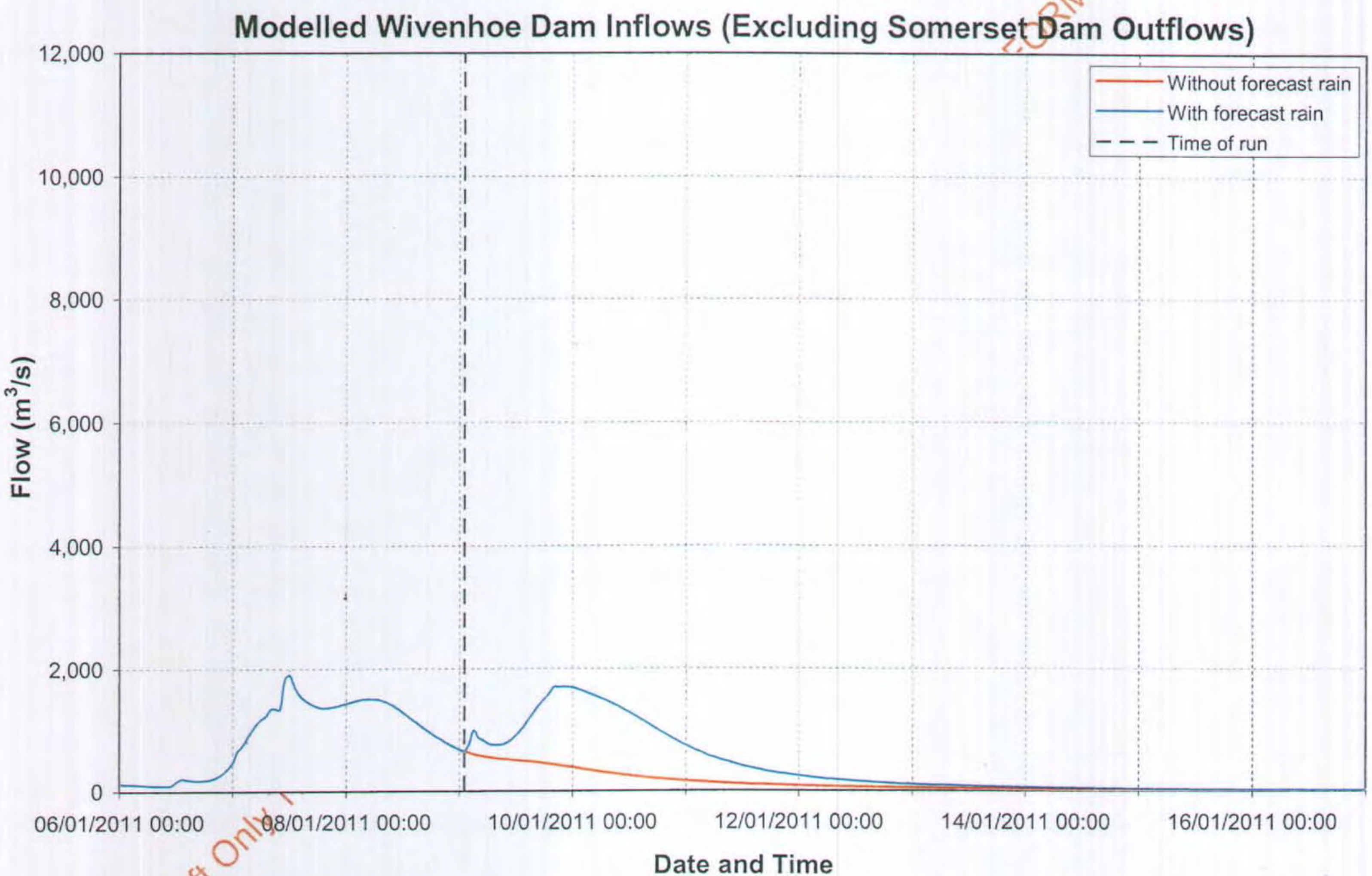

Modelled Brisbane River Flows at Moggill (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Moggill)
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

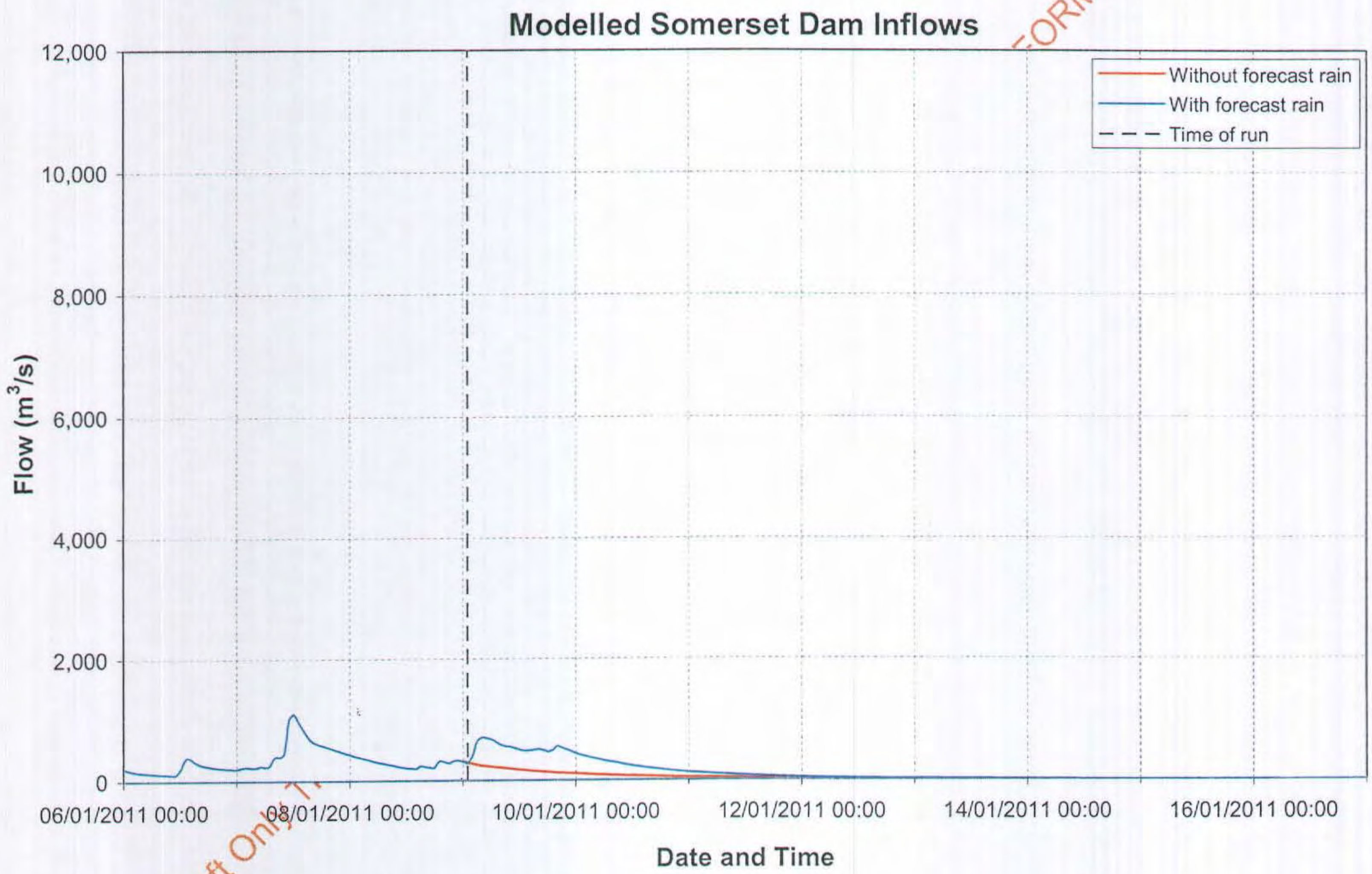
APPENDIX A – MODEL RESULTS

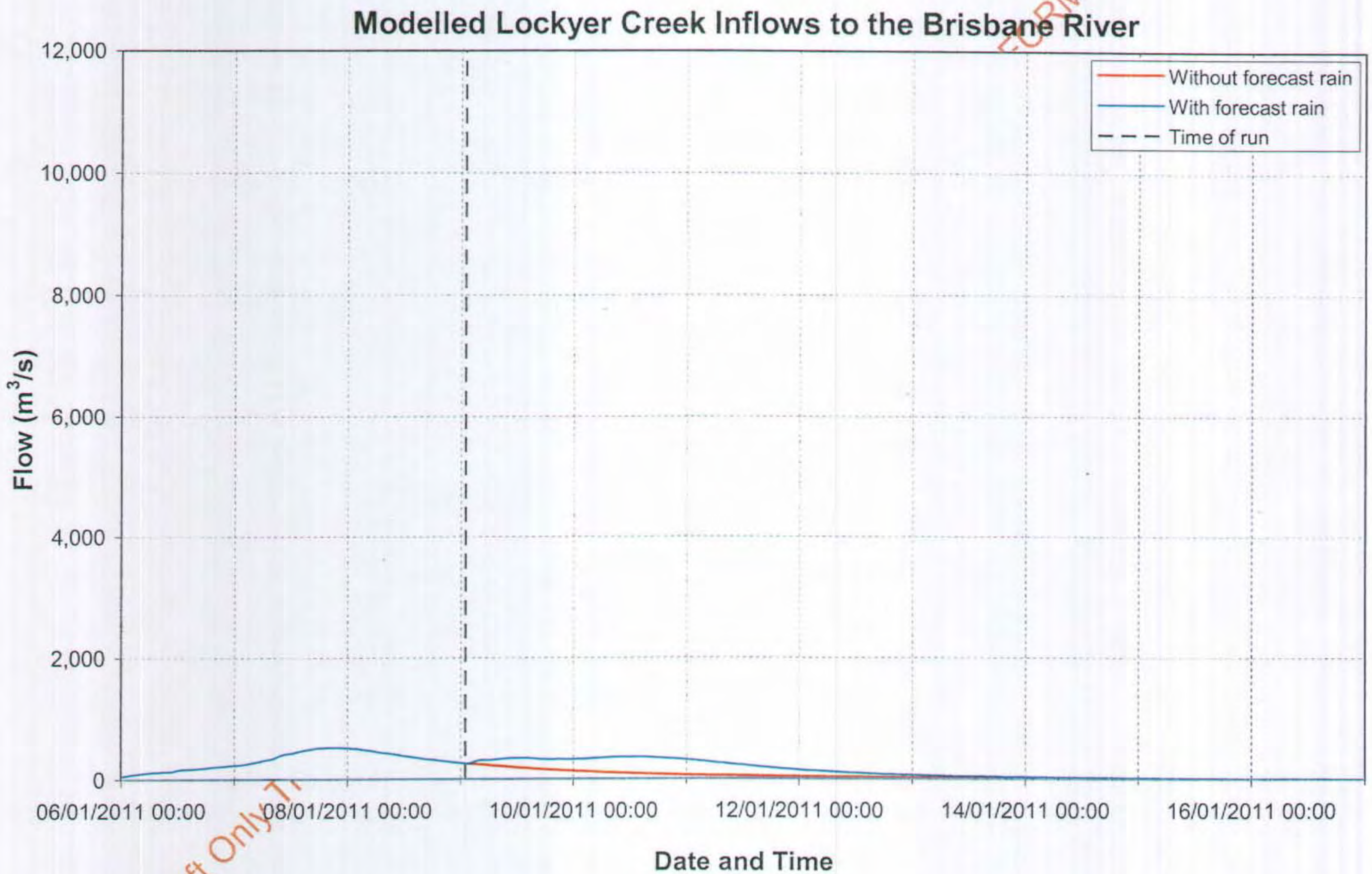
Run 12

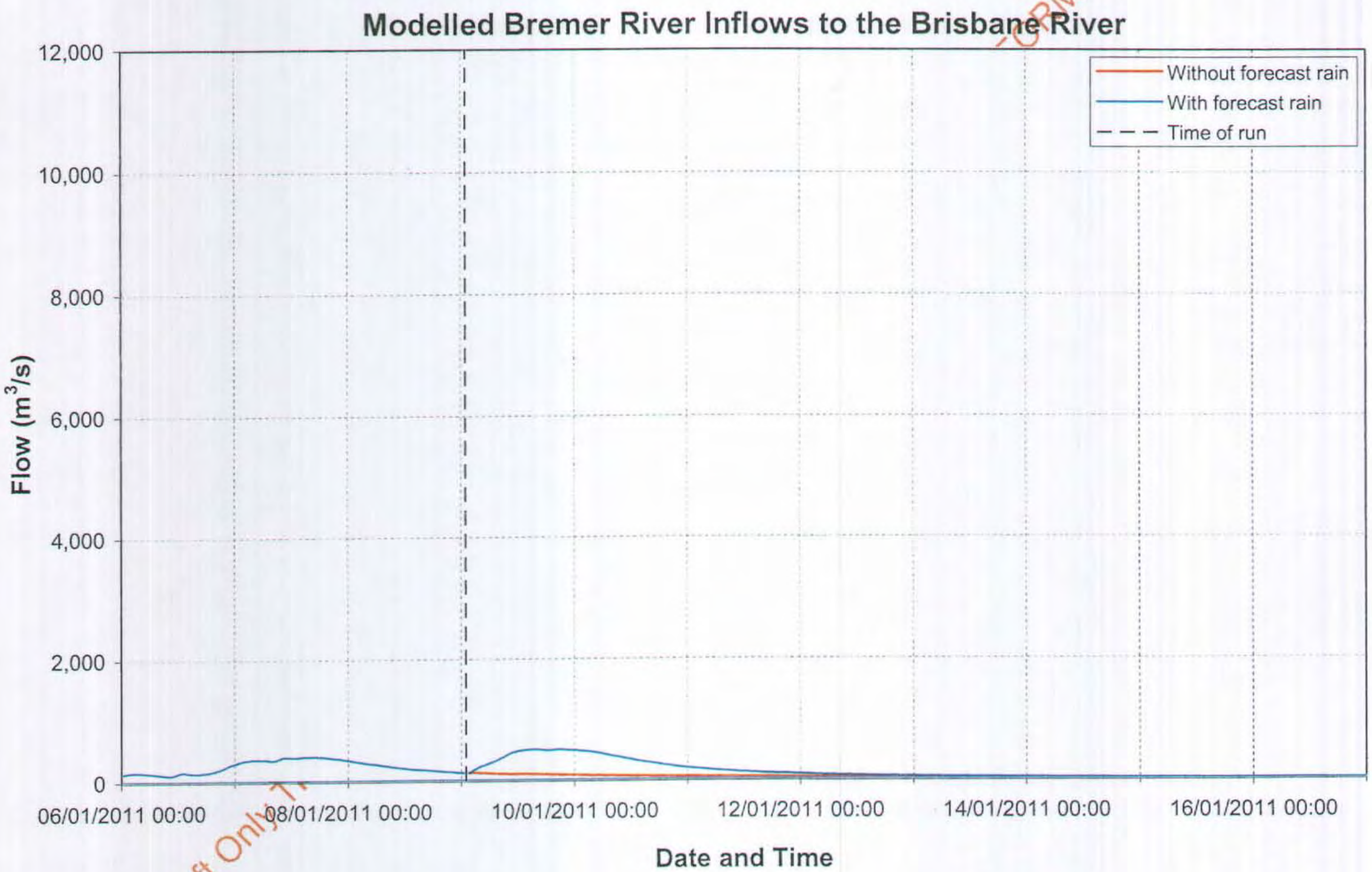
Date: Sunday 9 January 2011

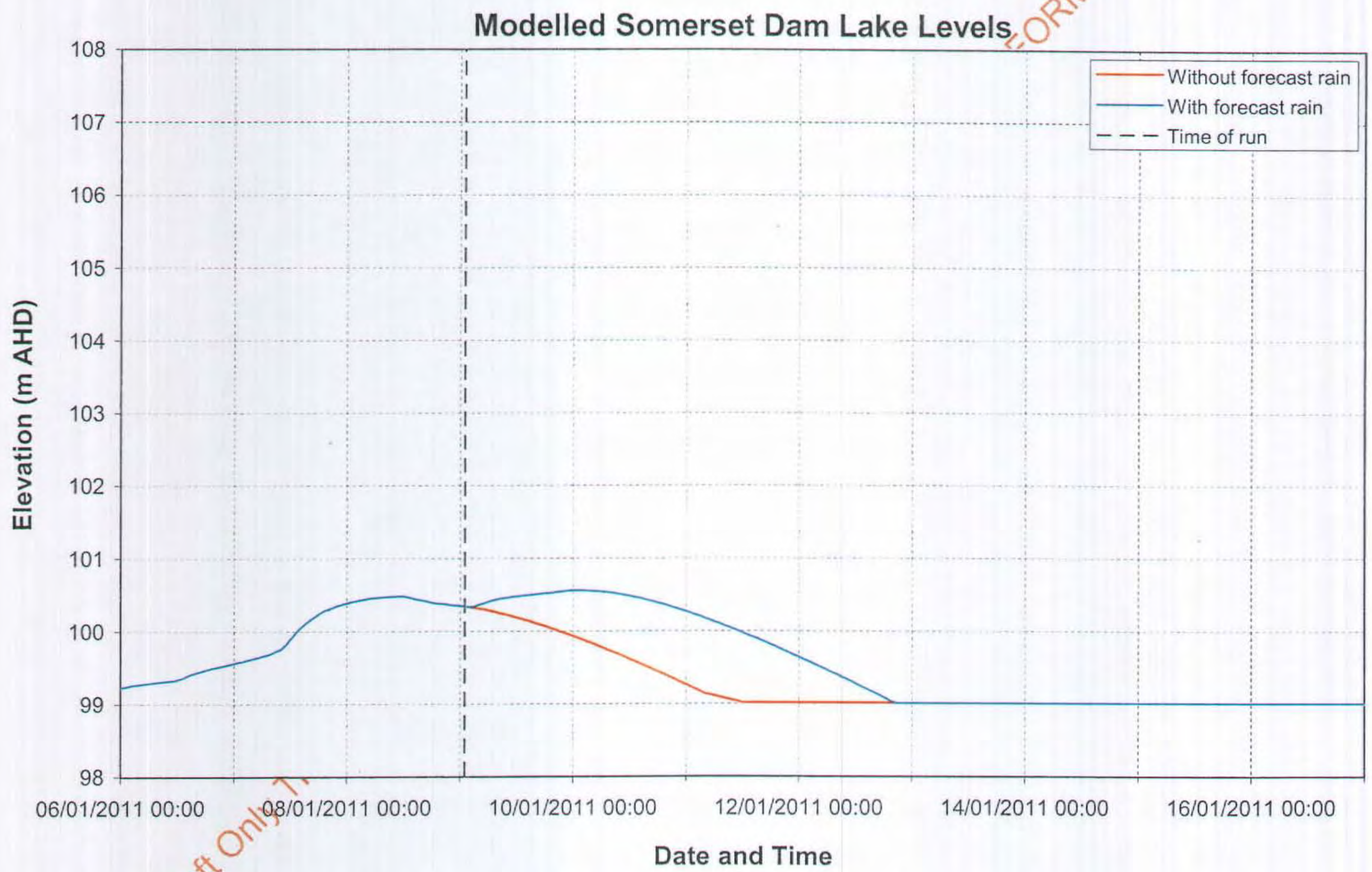
Time: 01:00

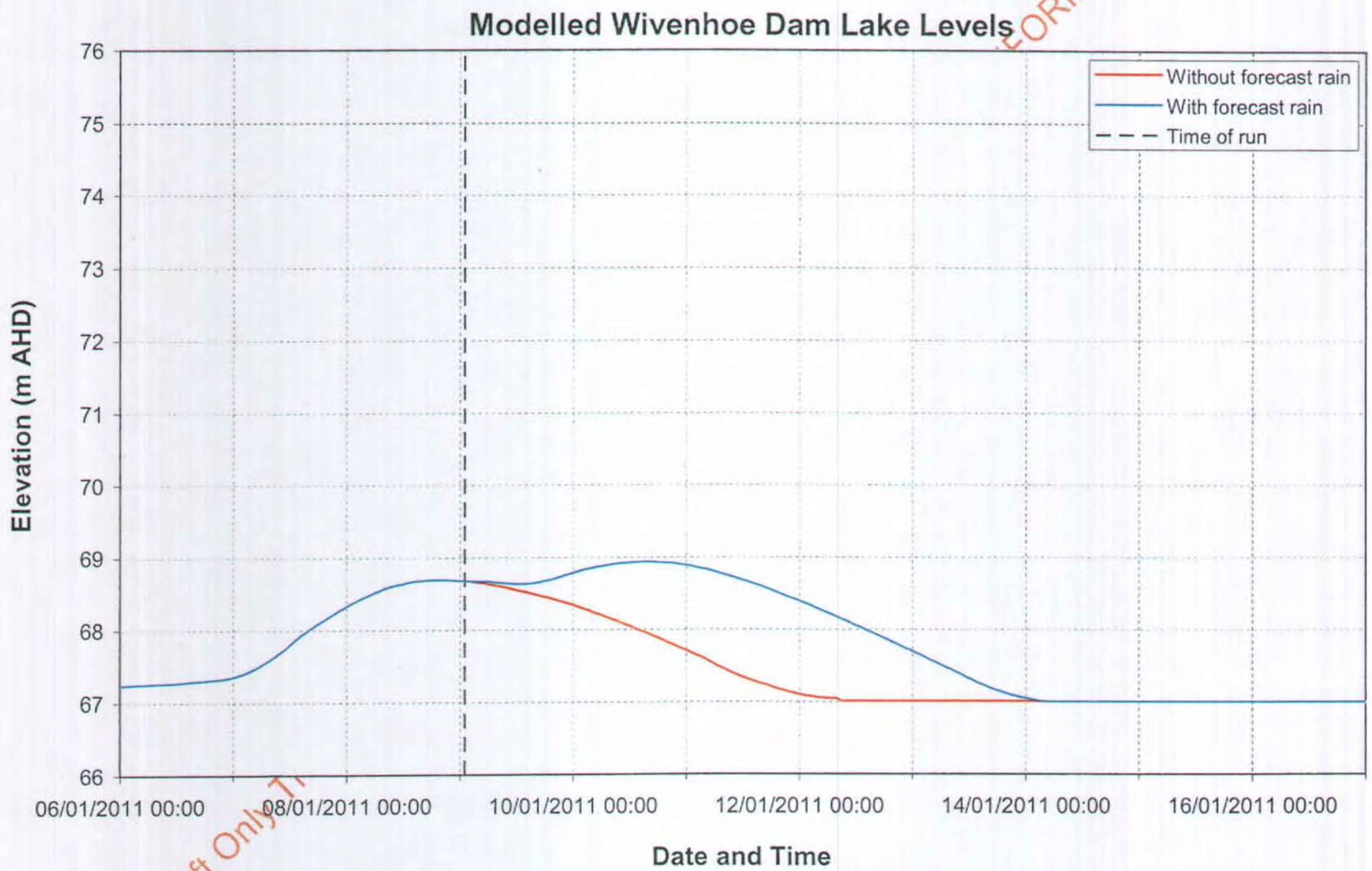

Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

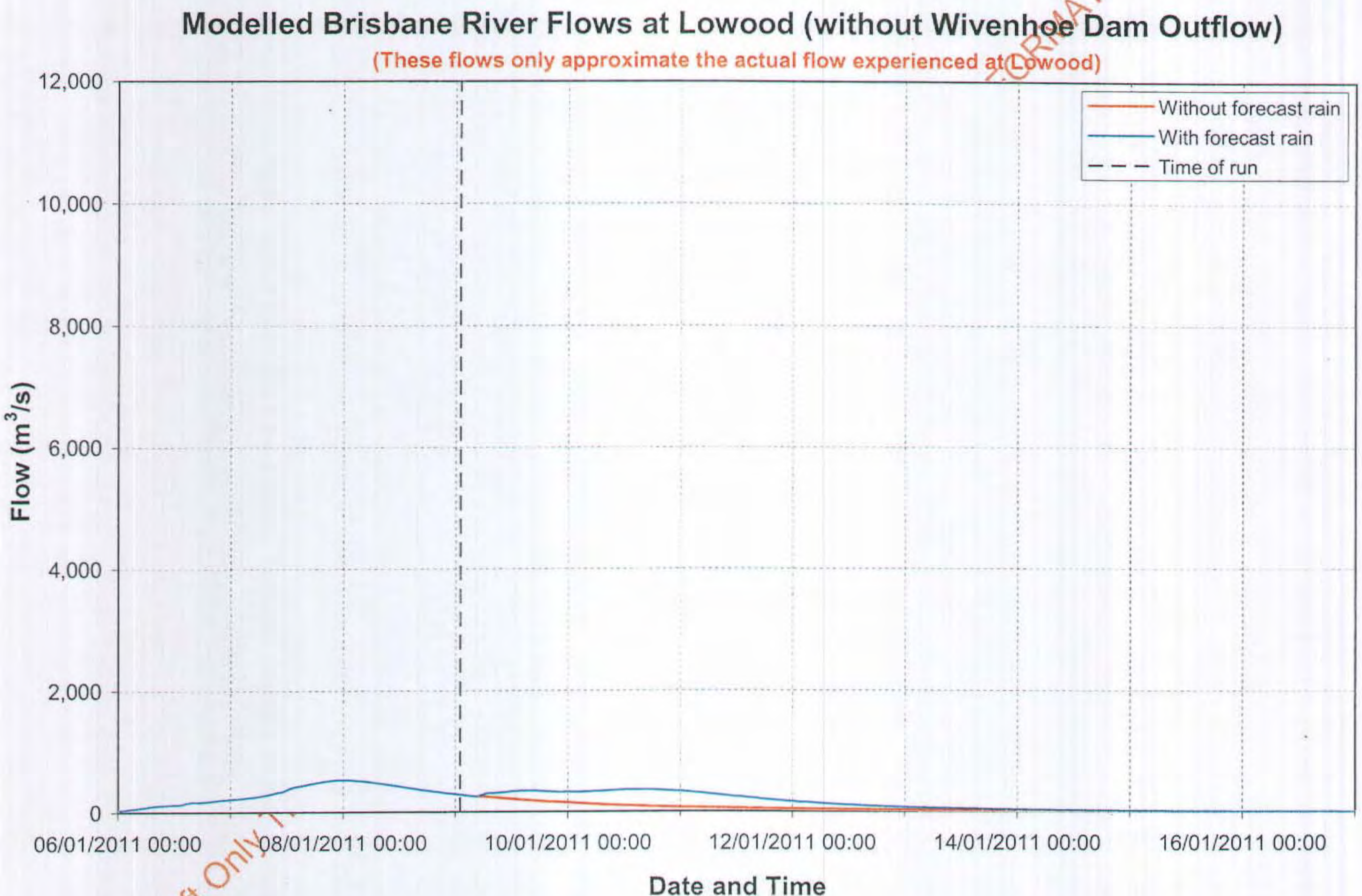

Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m³/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

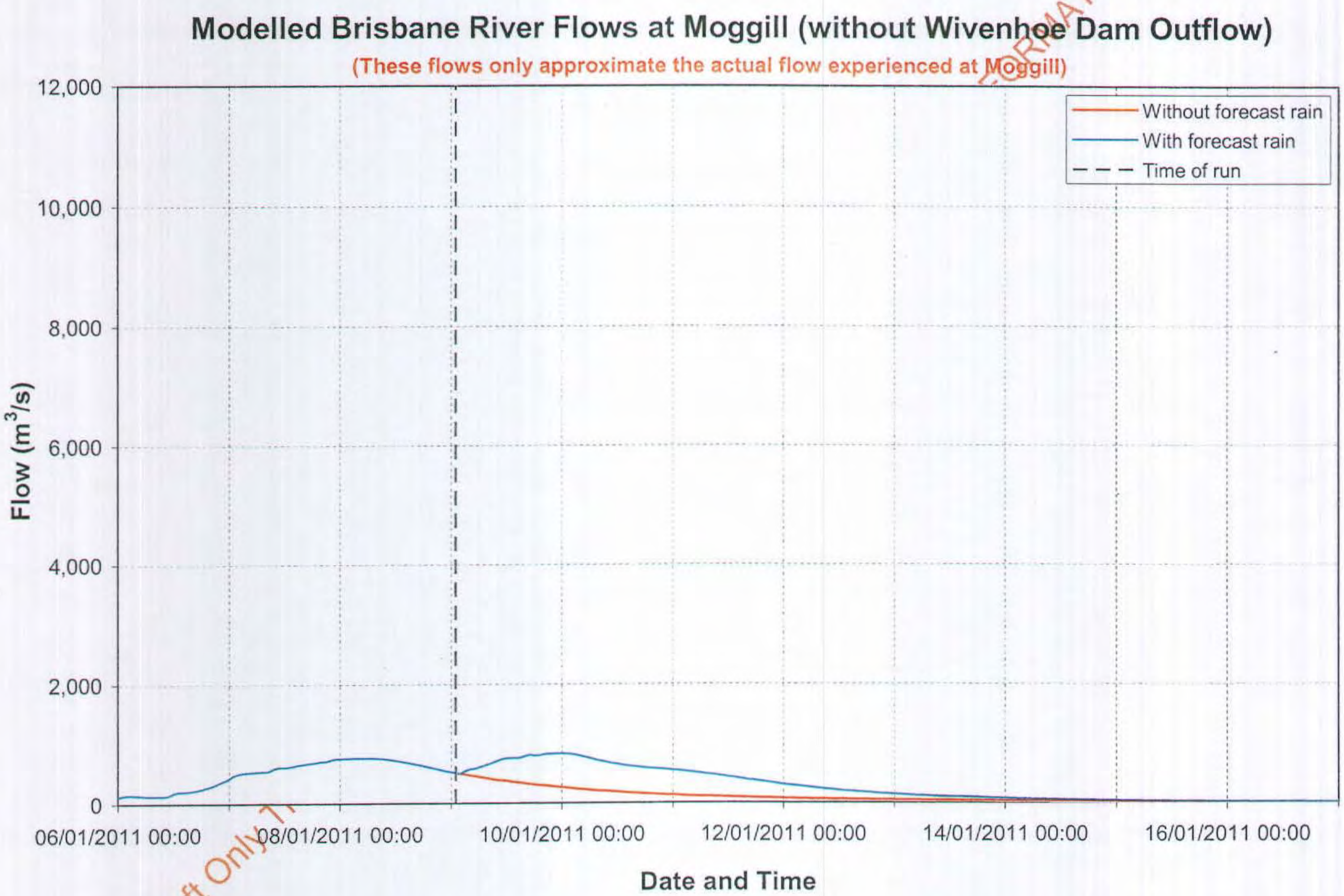

Modelled Bremer River Inflows to the Brisbane River
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
Without forecast rain
With forecast rain
Time of run
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

APPENDIX A – MODEL RESULTS



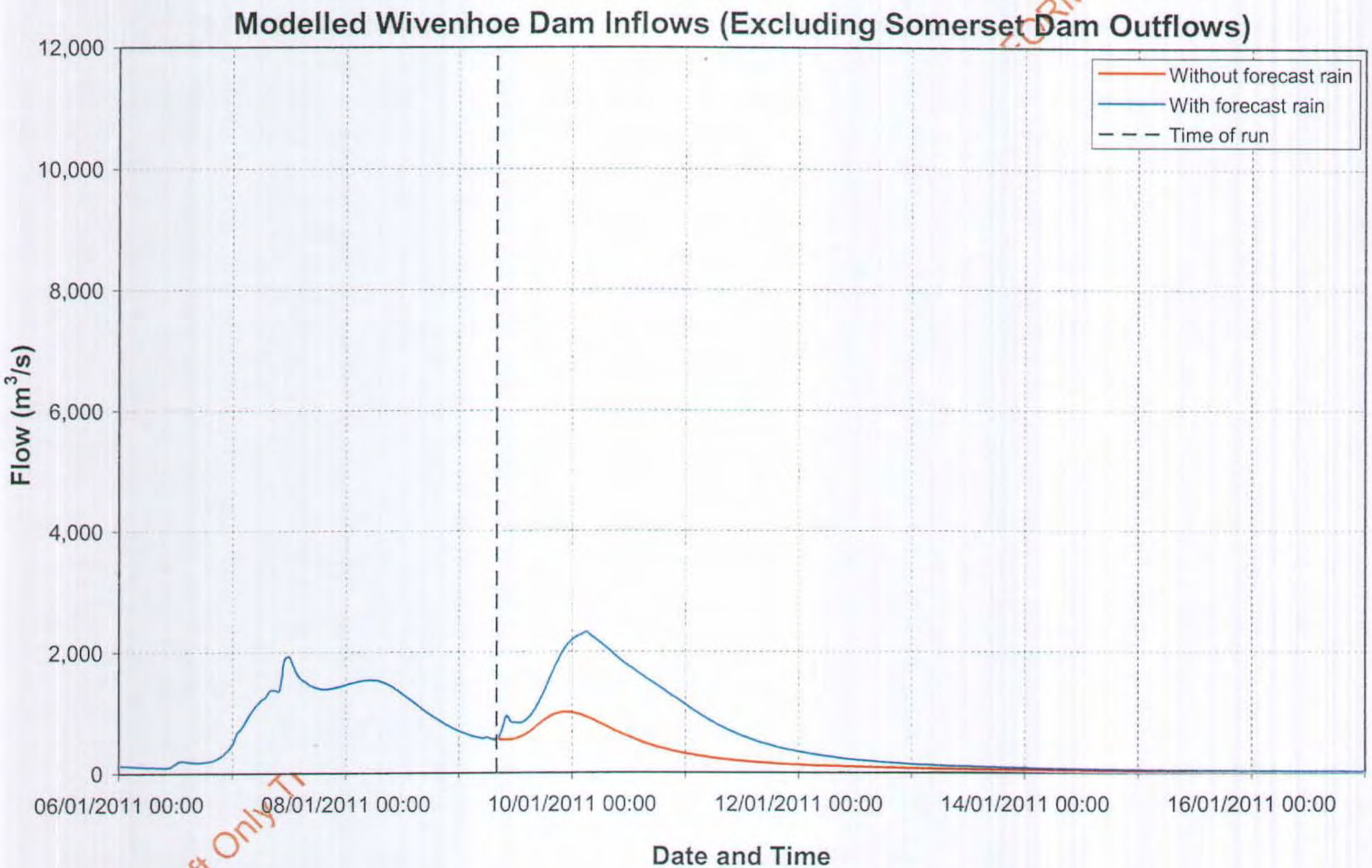

Modelled Brisbane River Flows at Moggill (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Moggill)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

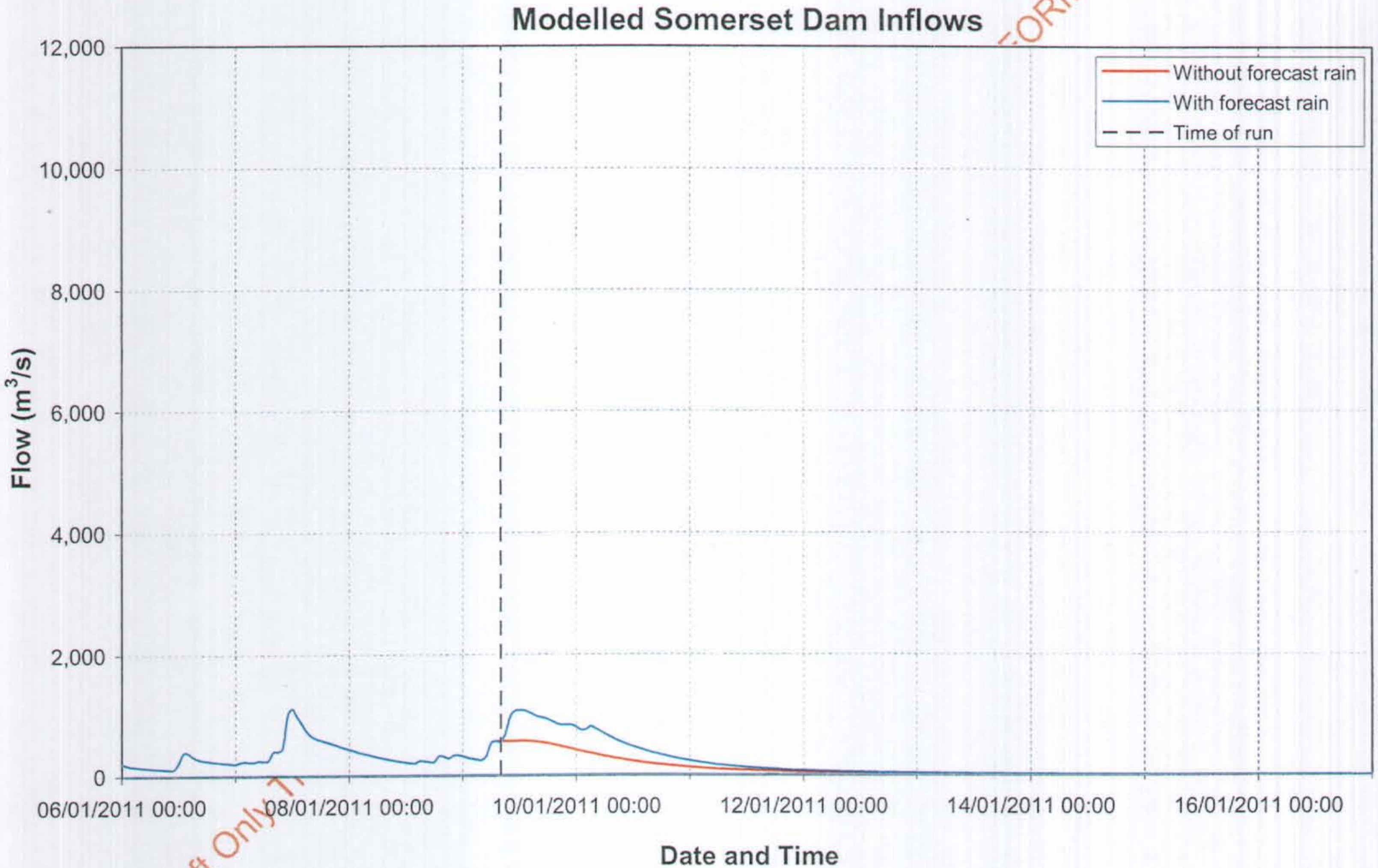
APPENDIX A – MODEL RESULTS

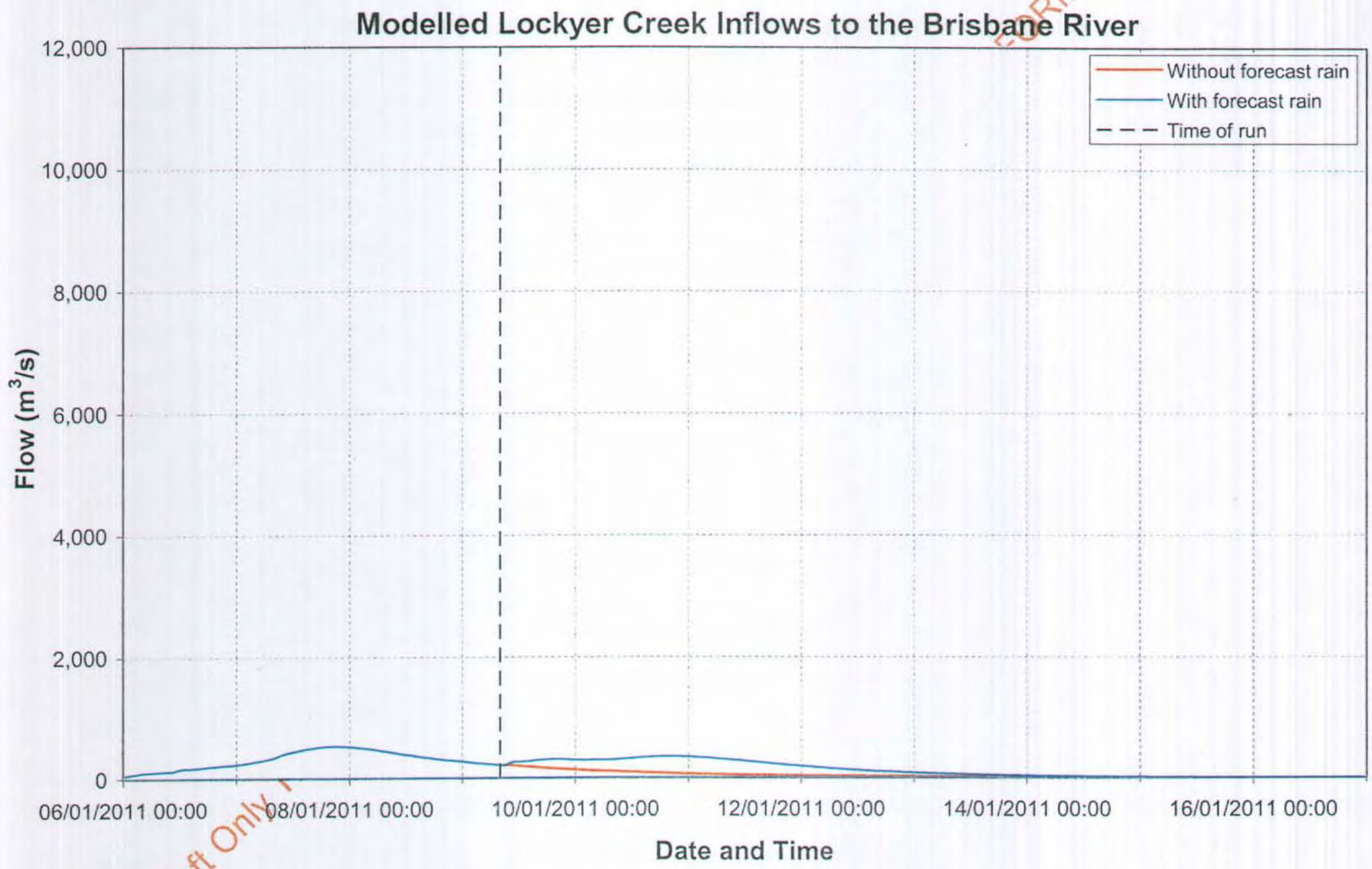
Run 14

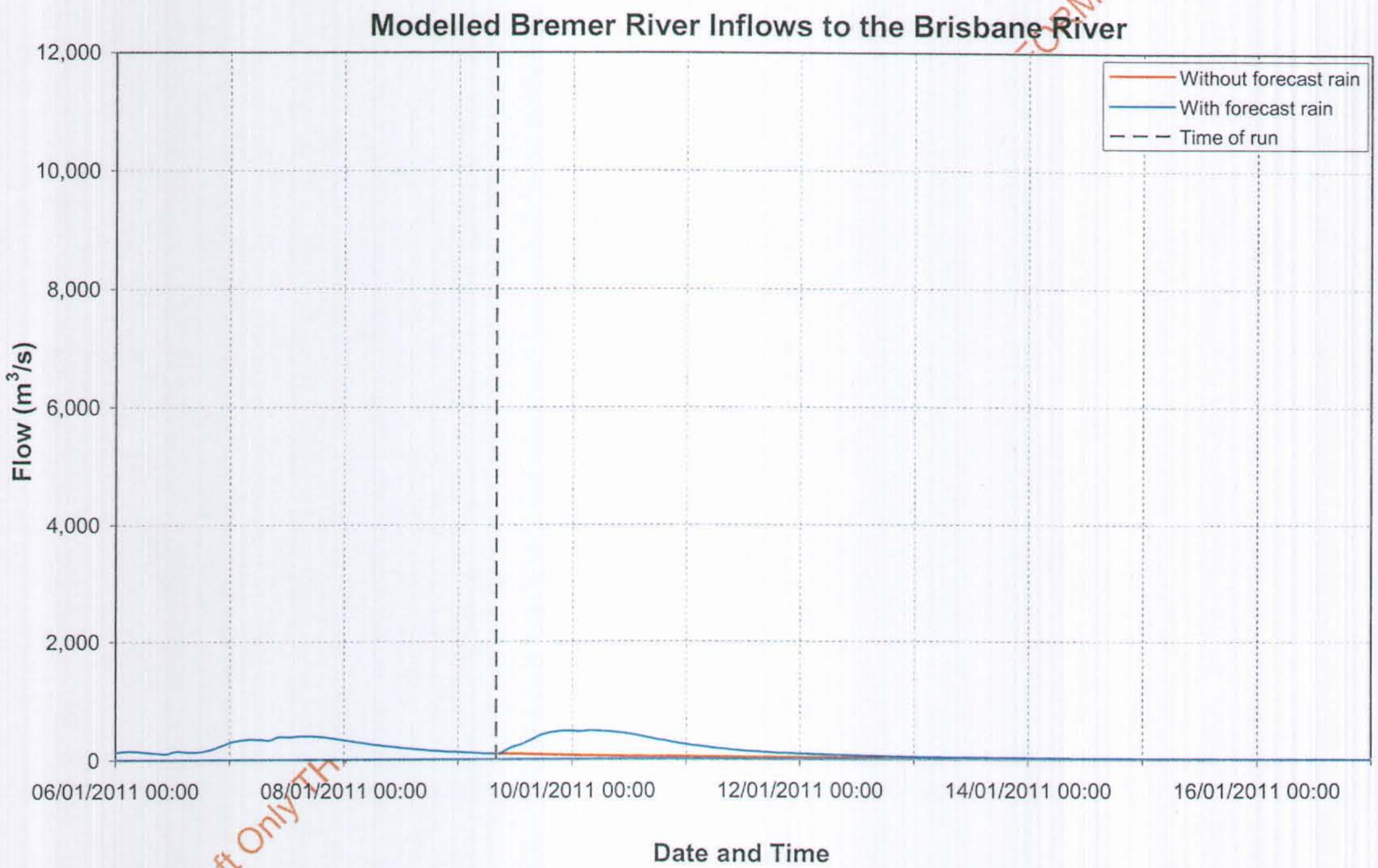
Date: Sunday 9 January 2011

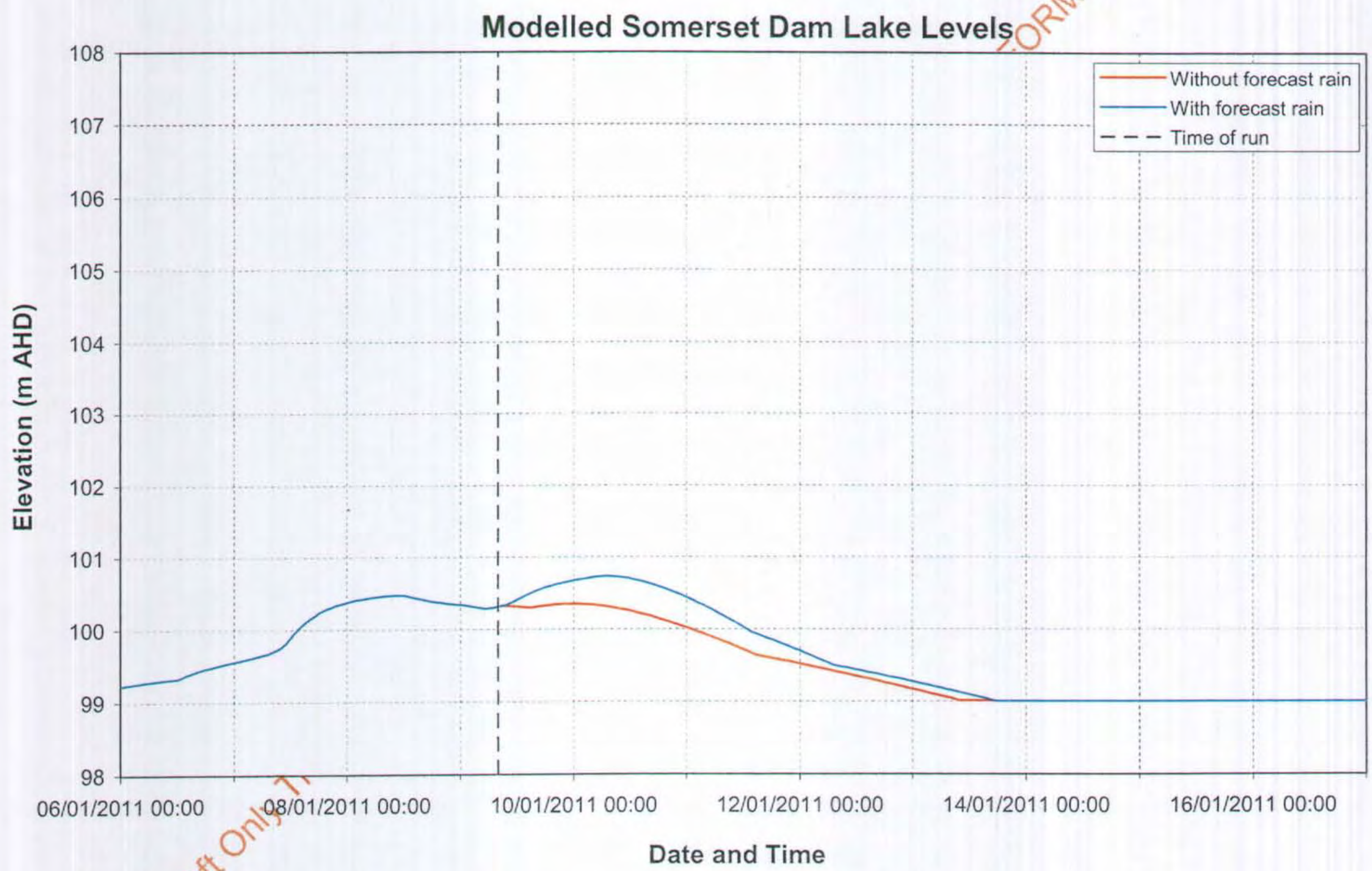
Time: 08:00

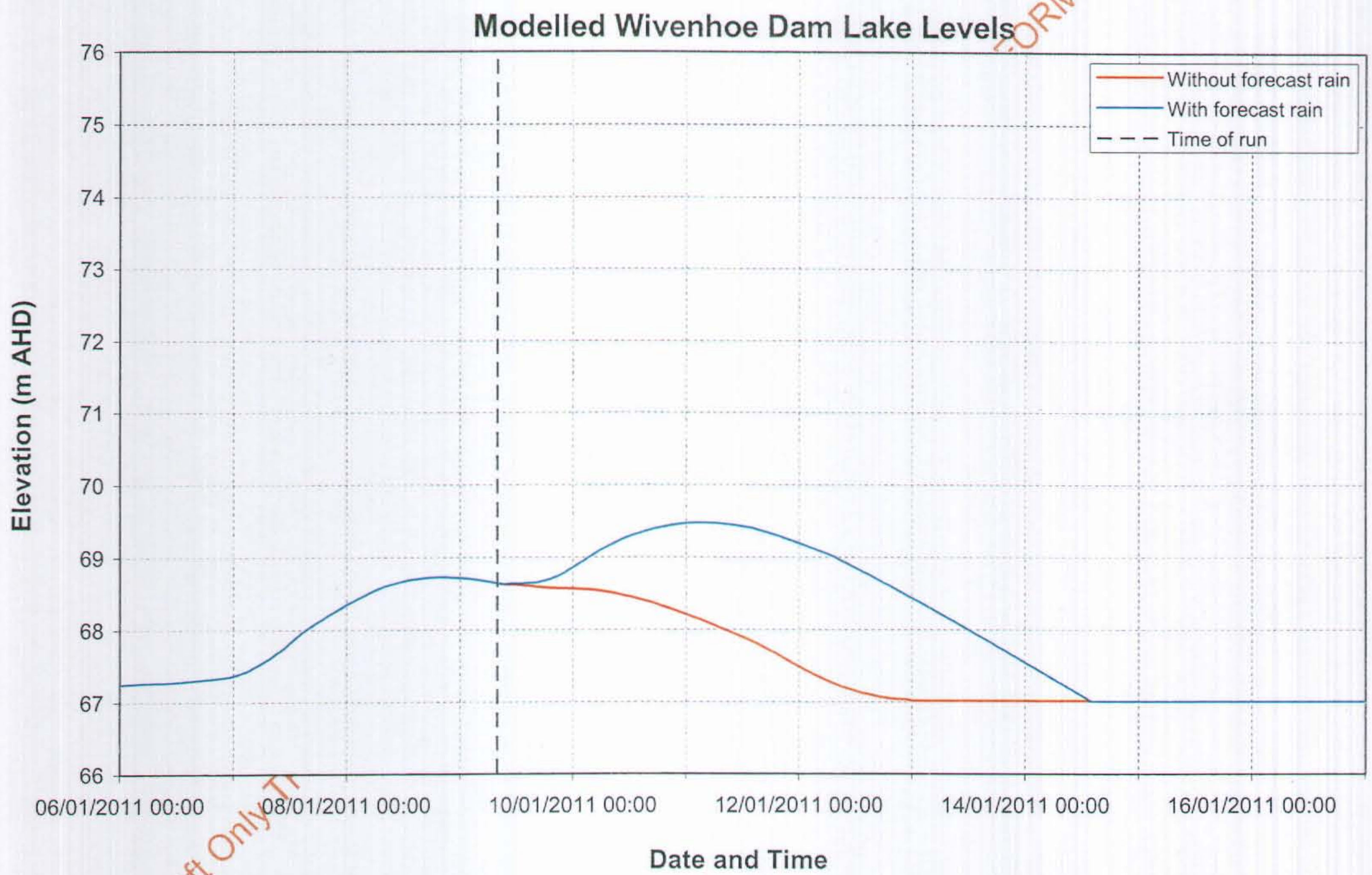

Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m³/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Bremer River Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
0
2,000
4,000
6,000
8,000
10,000
12,000
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

APPENDIX A – MODEL RESULTS

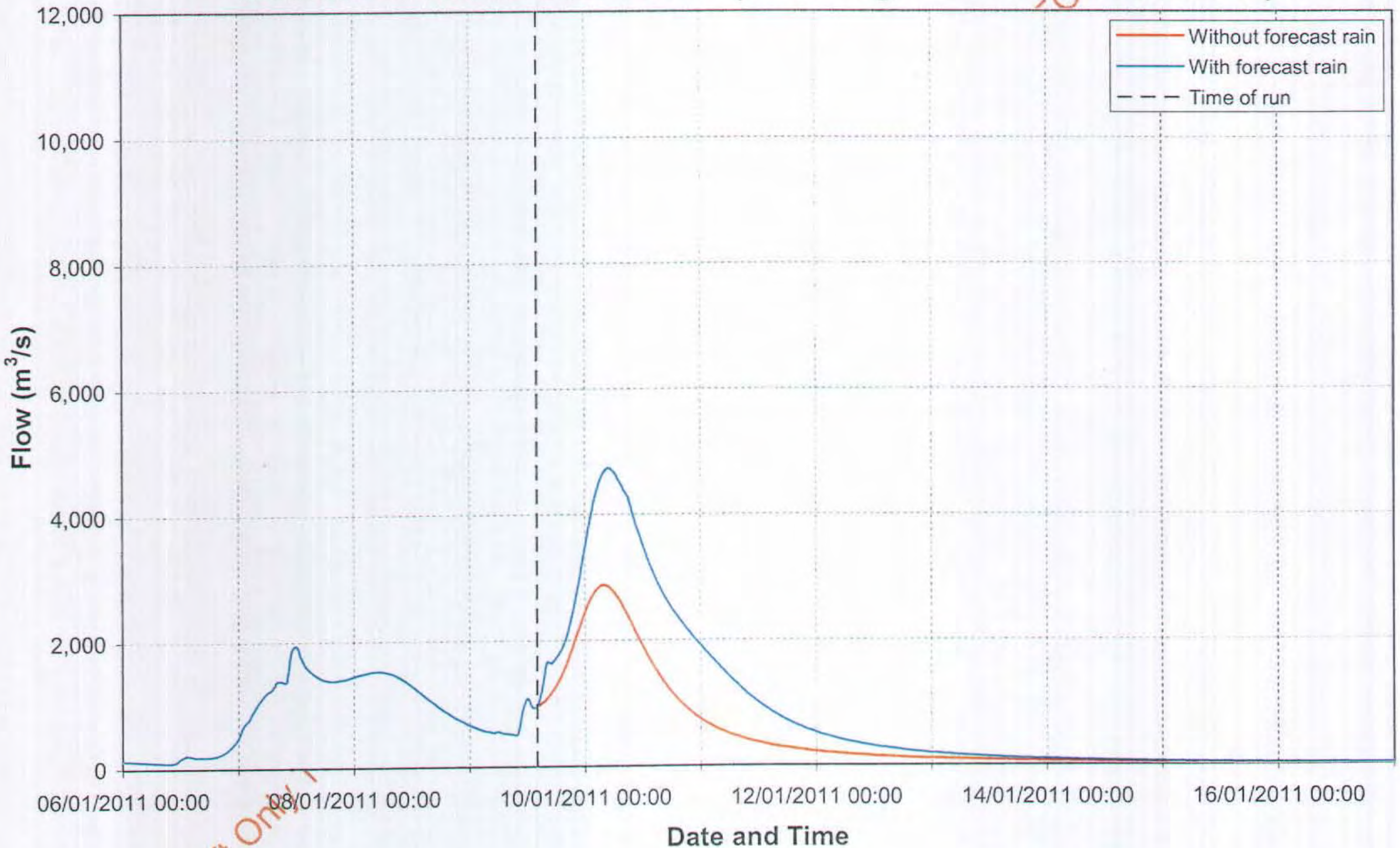
Run 17

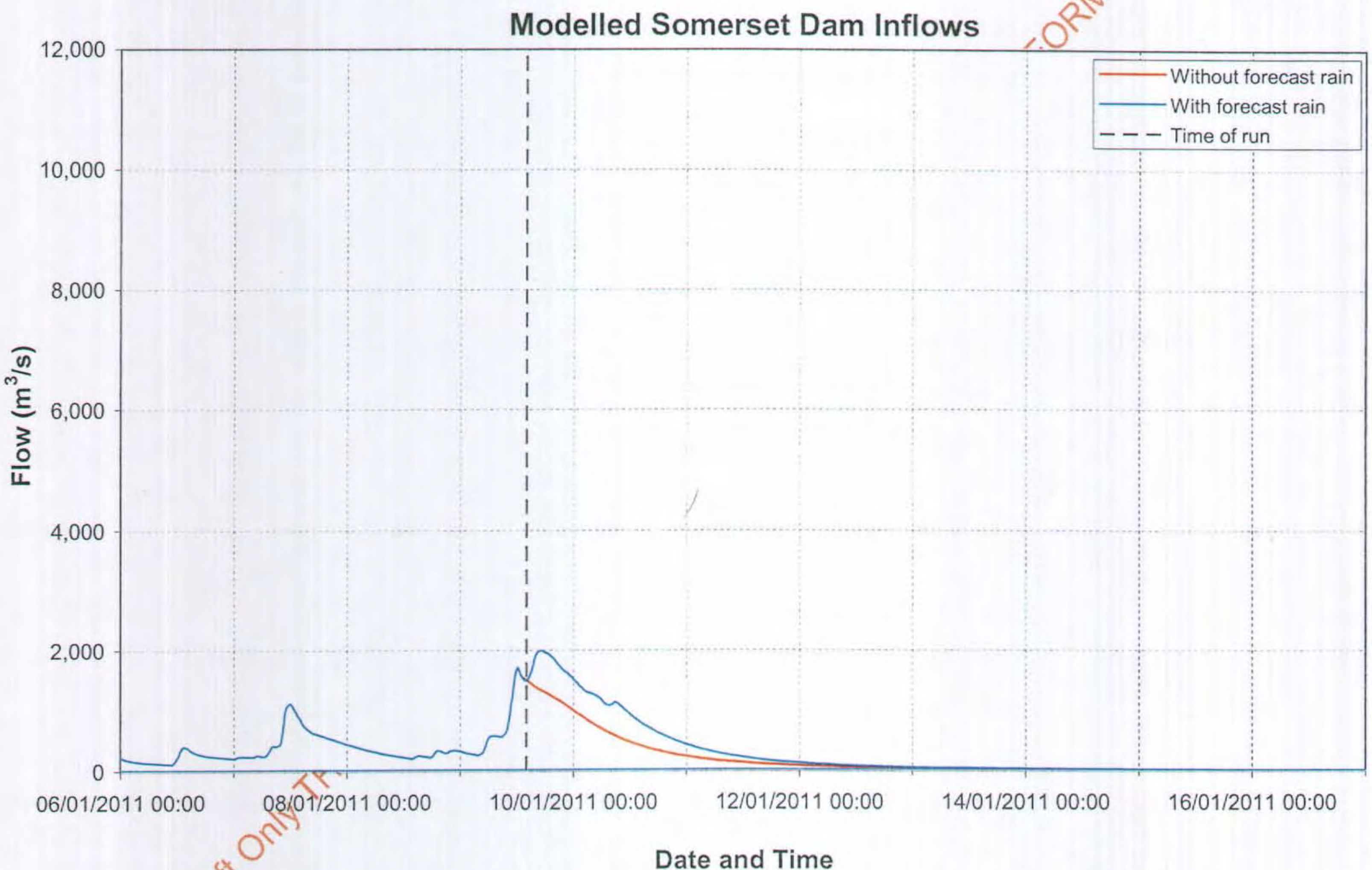
Date: Sunday 9 January 2011

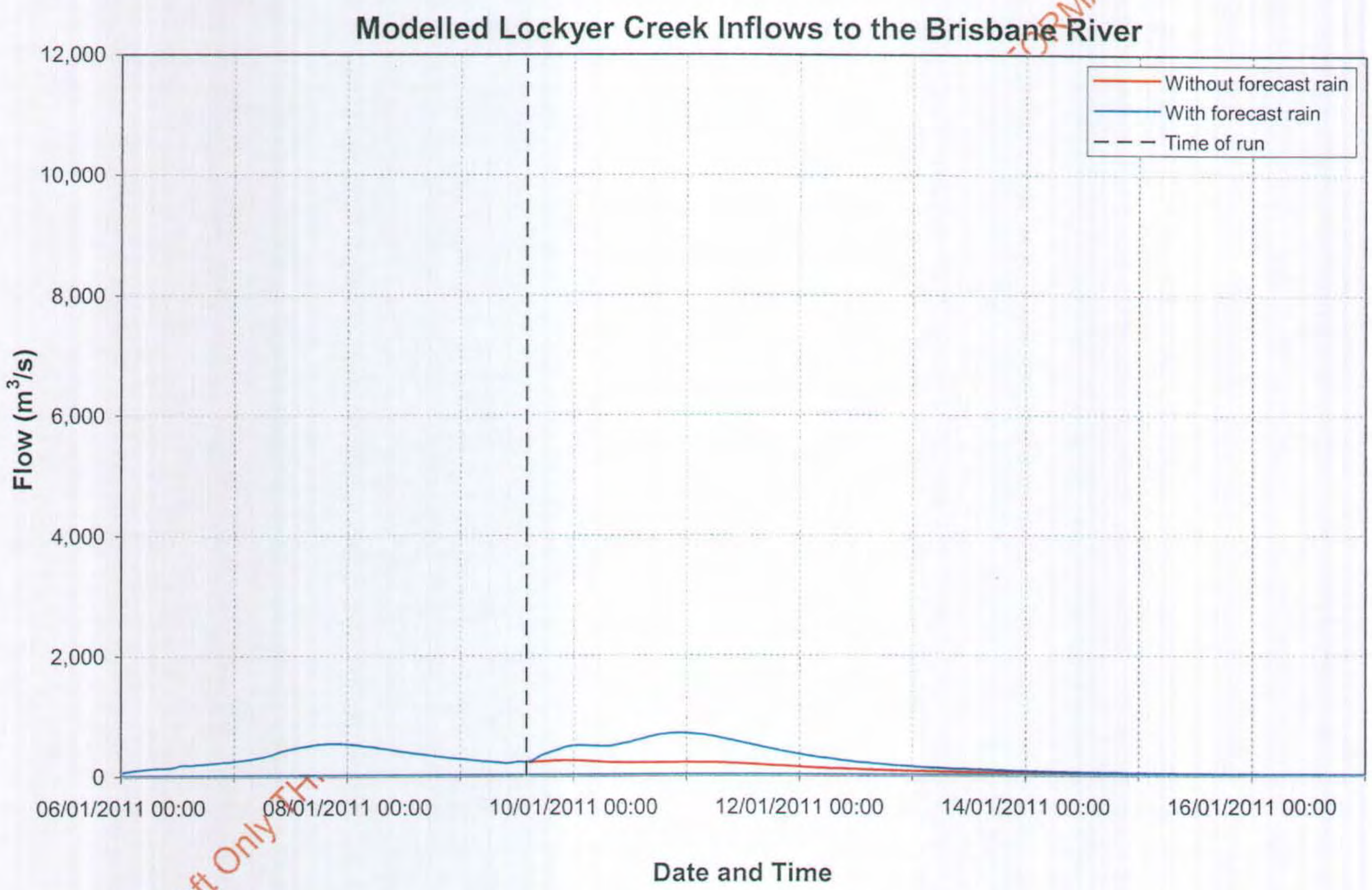
Time: 14:00

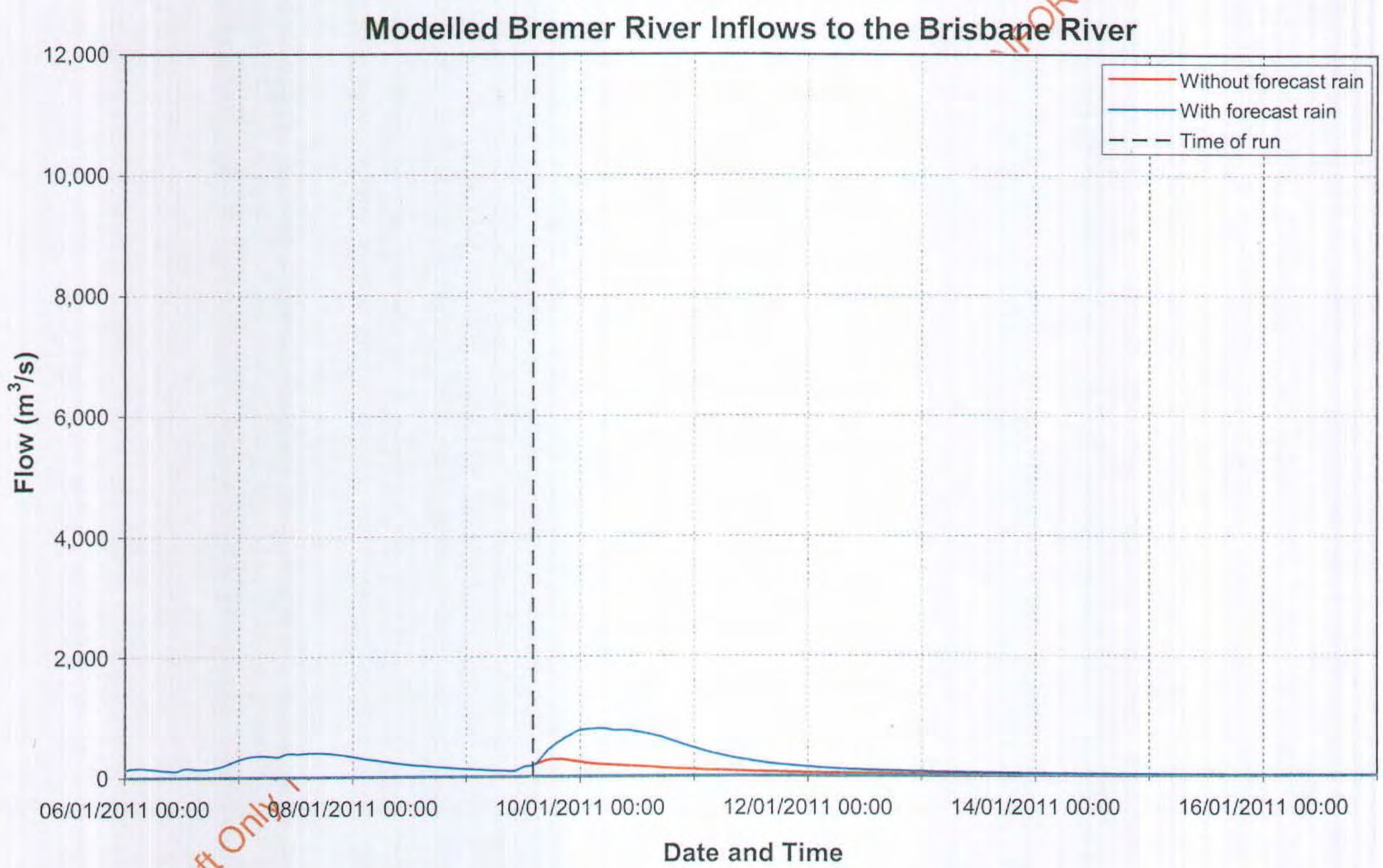
APPENDIX A – MODEL RESULTS

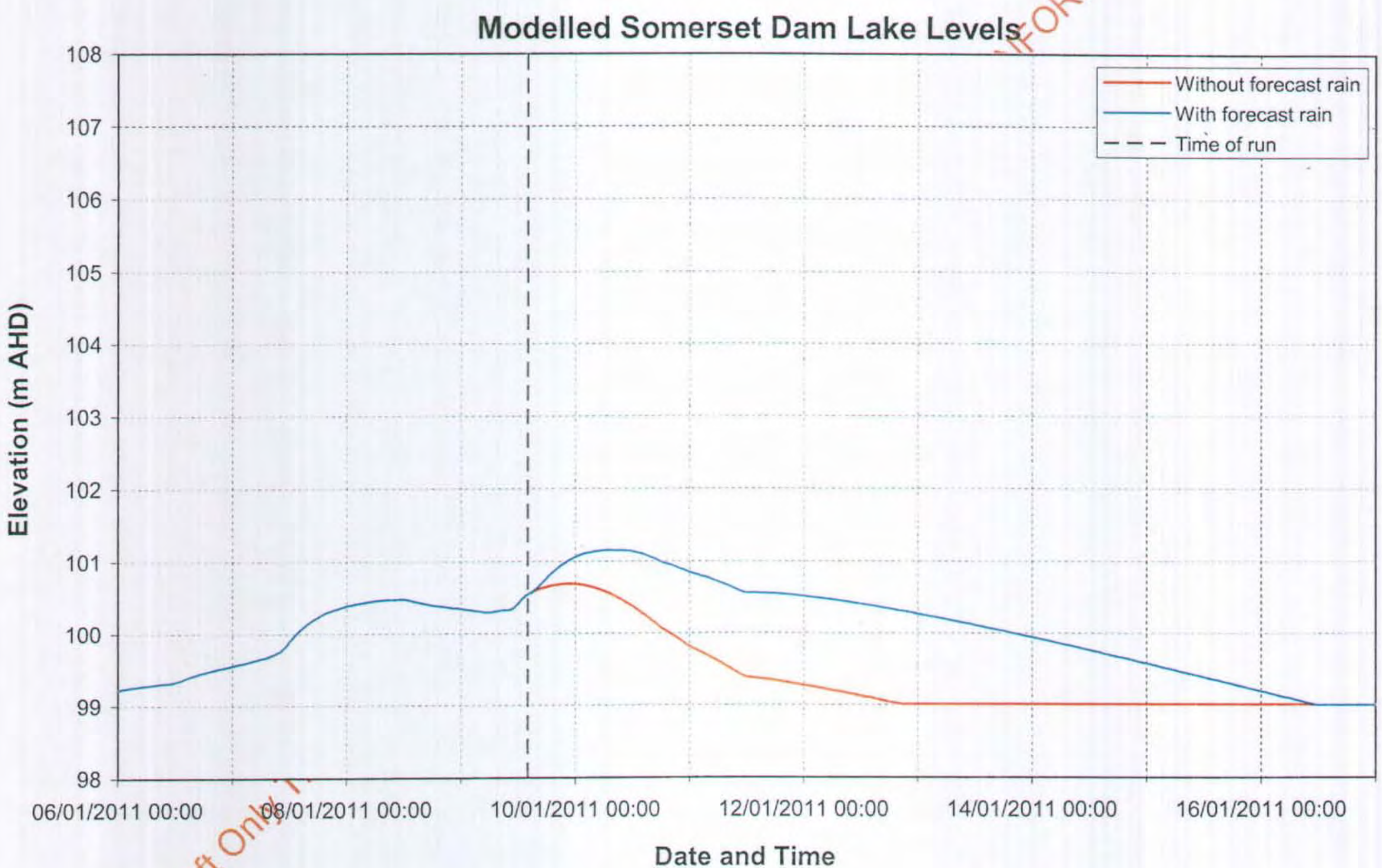
Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)

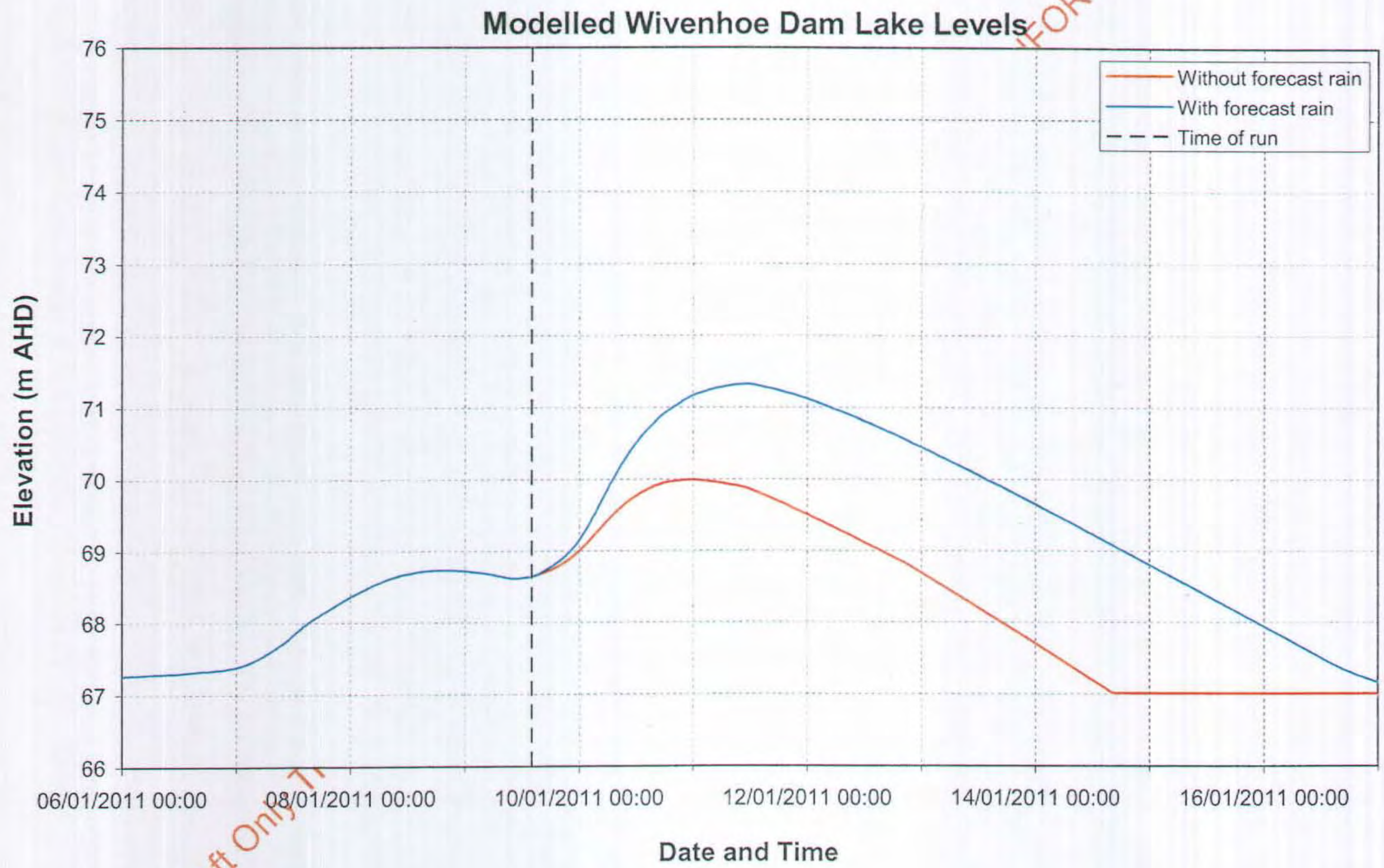


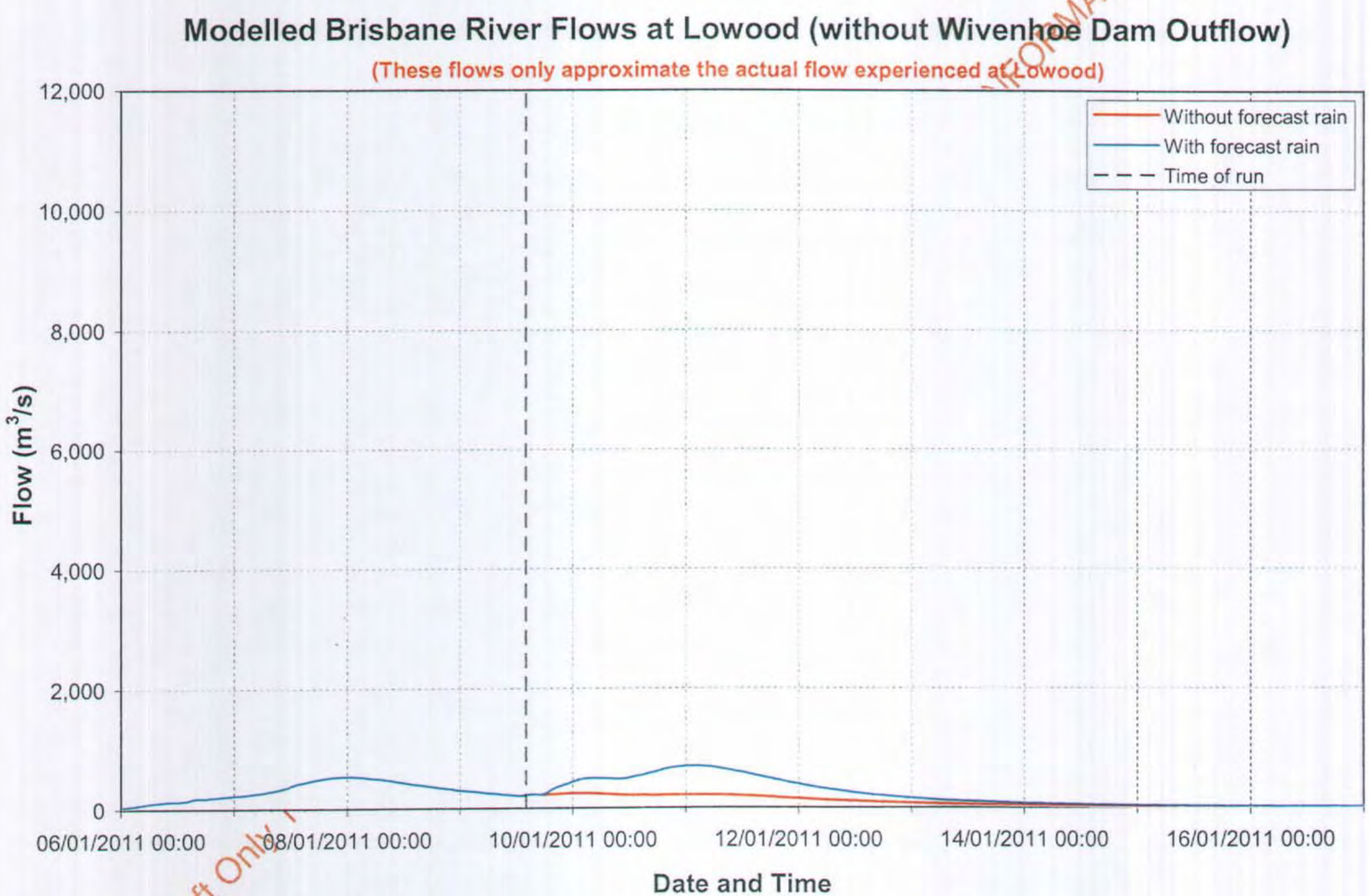

Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m^3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

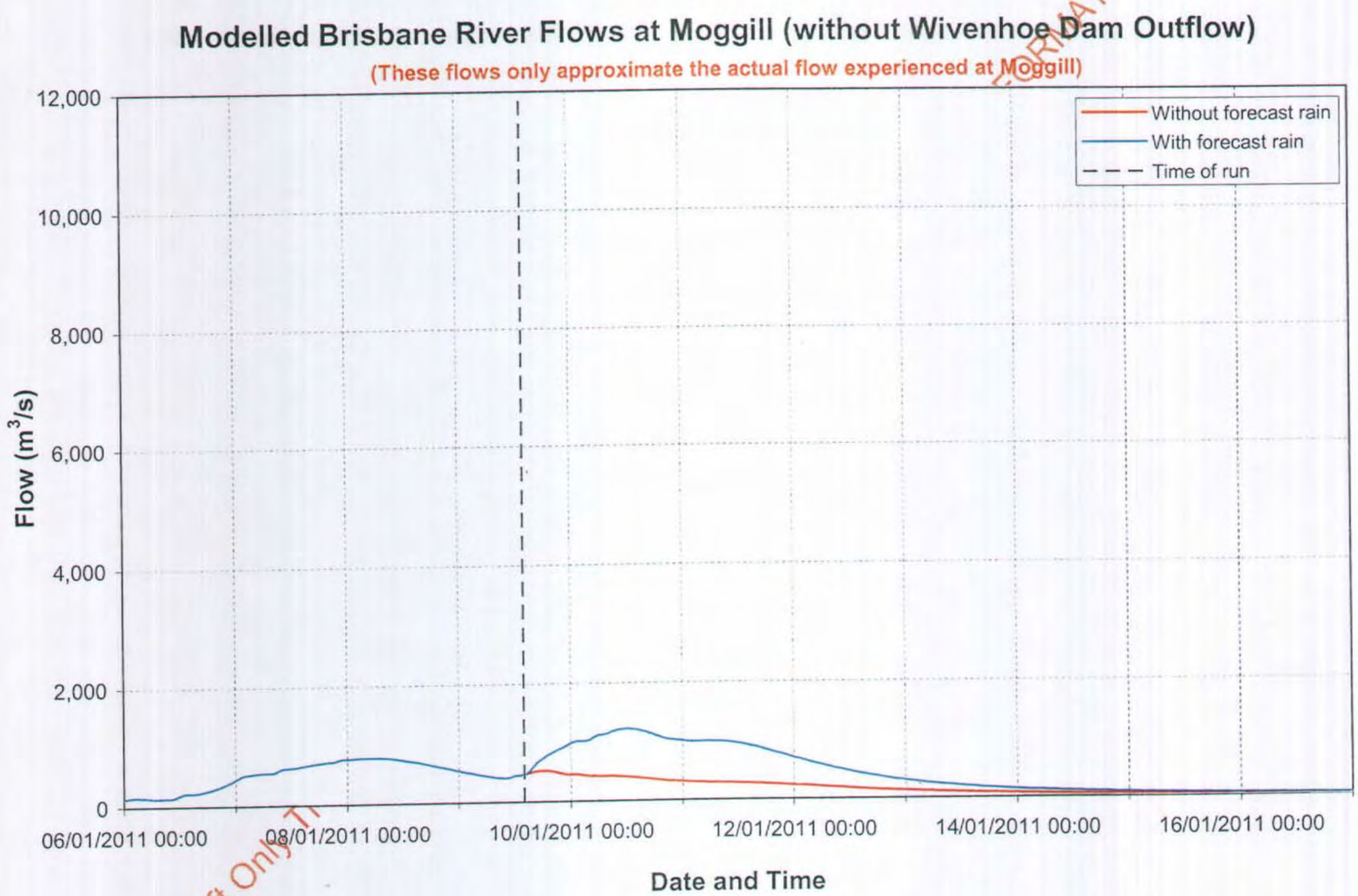

Modelled Bremer River Inflows to the Brisbane River
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
Without forecast rain
With forecast rain
Time of run
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Lake Levels
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time
Without forecast rain
With forecast rain
Time of run


Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



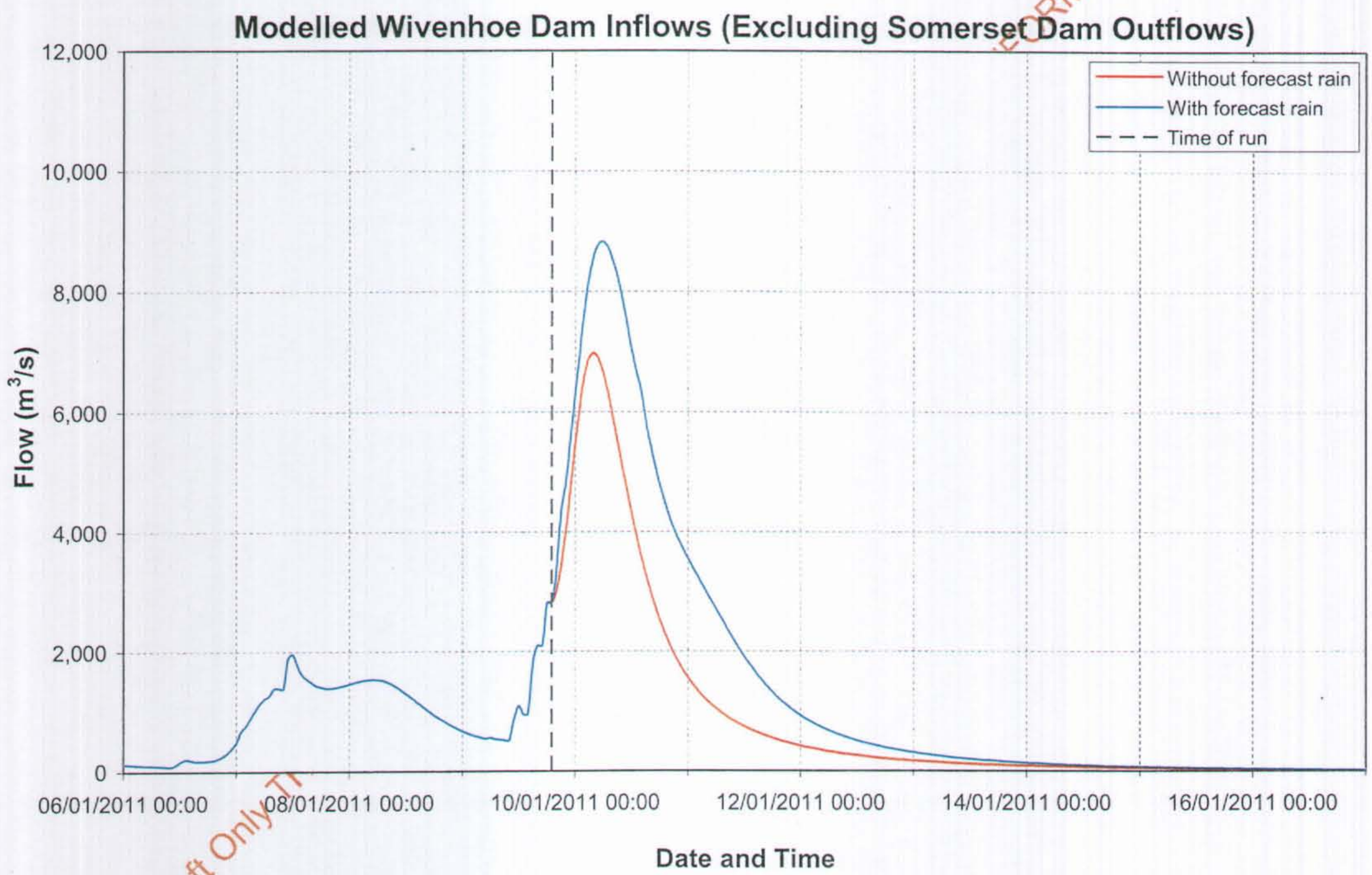
Modelled Brisbane River Flows at Moggill (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Moggill)
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

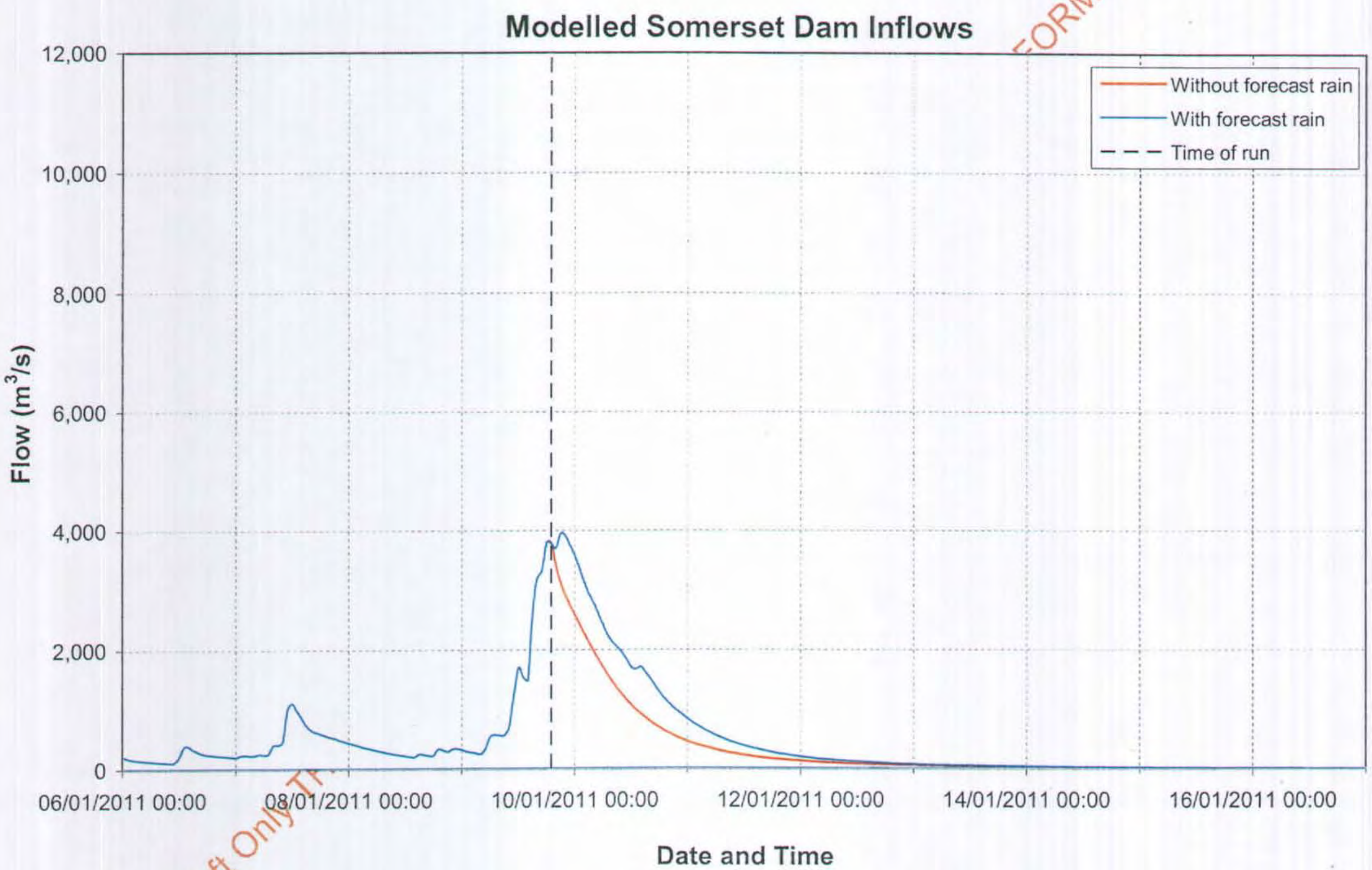
APPENDIX A – MODEL RESULTS

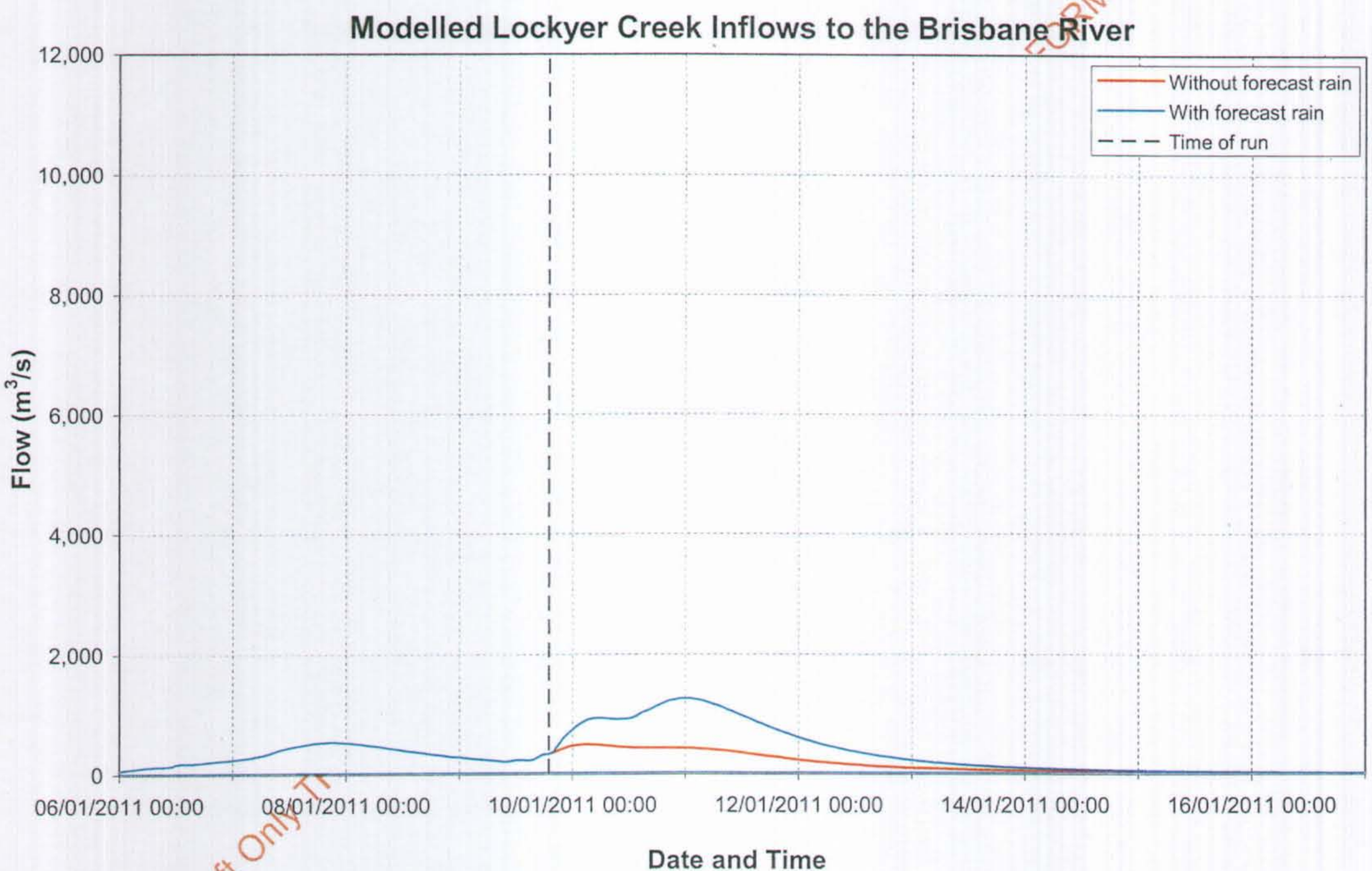
Run 21

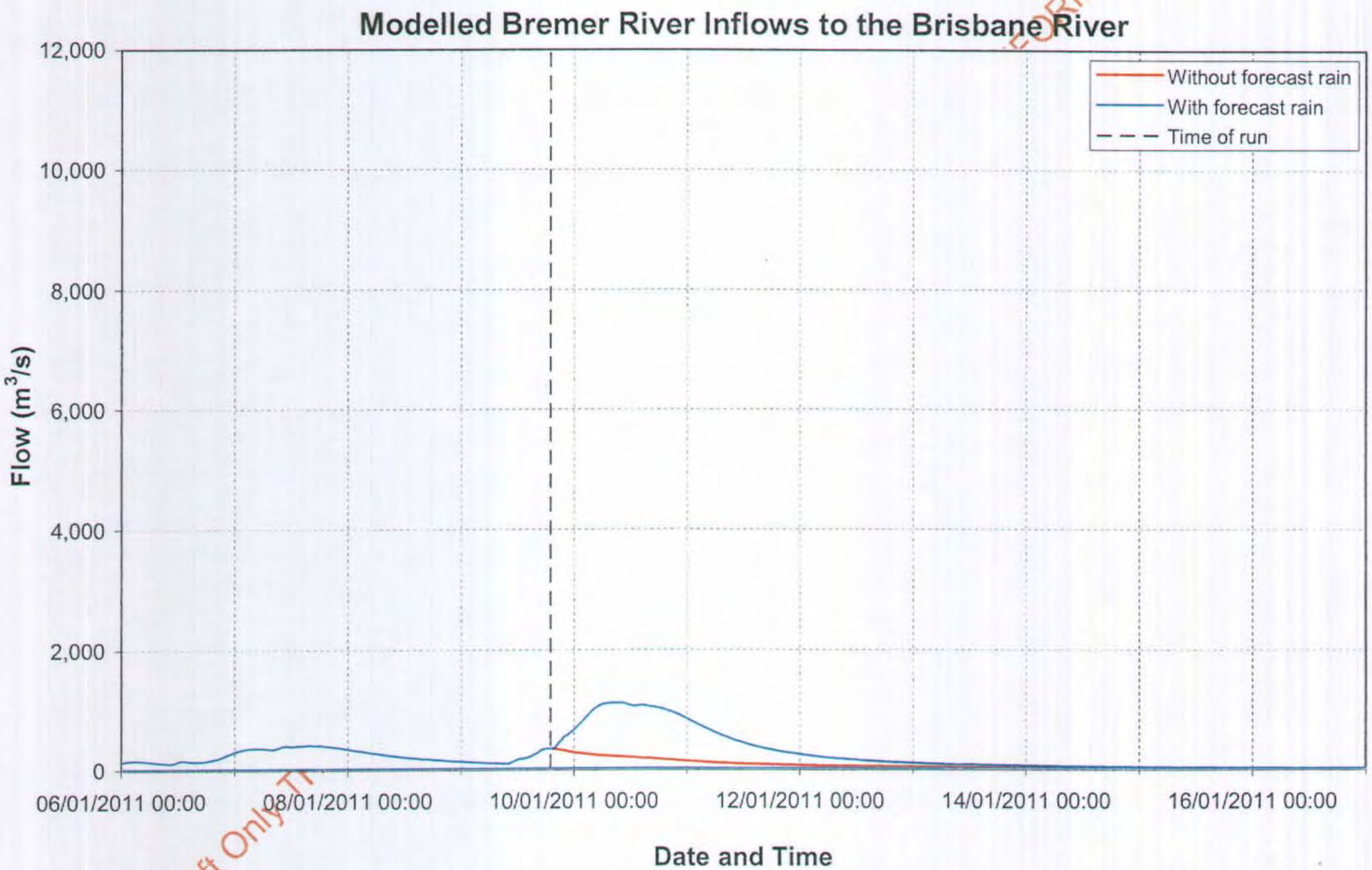
Date: Sunday 9 January 2011

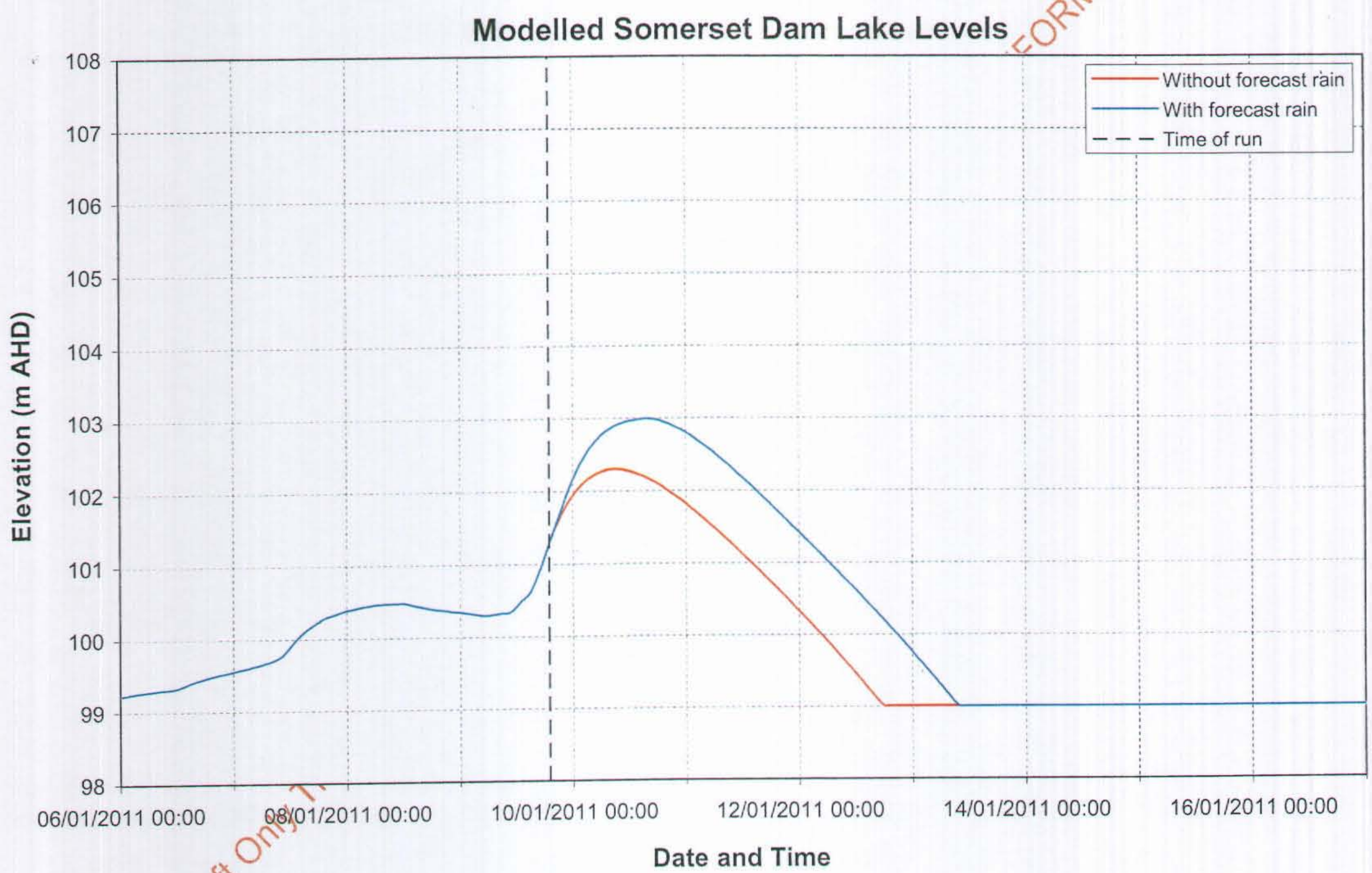
Time: 19:00

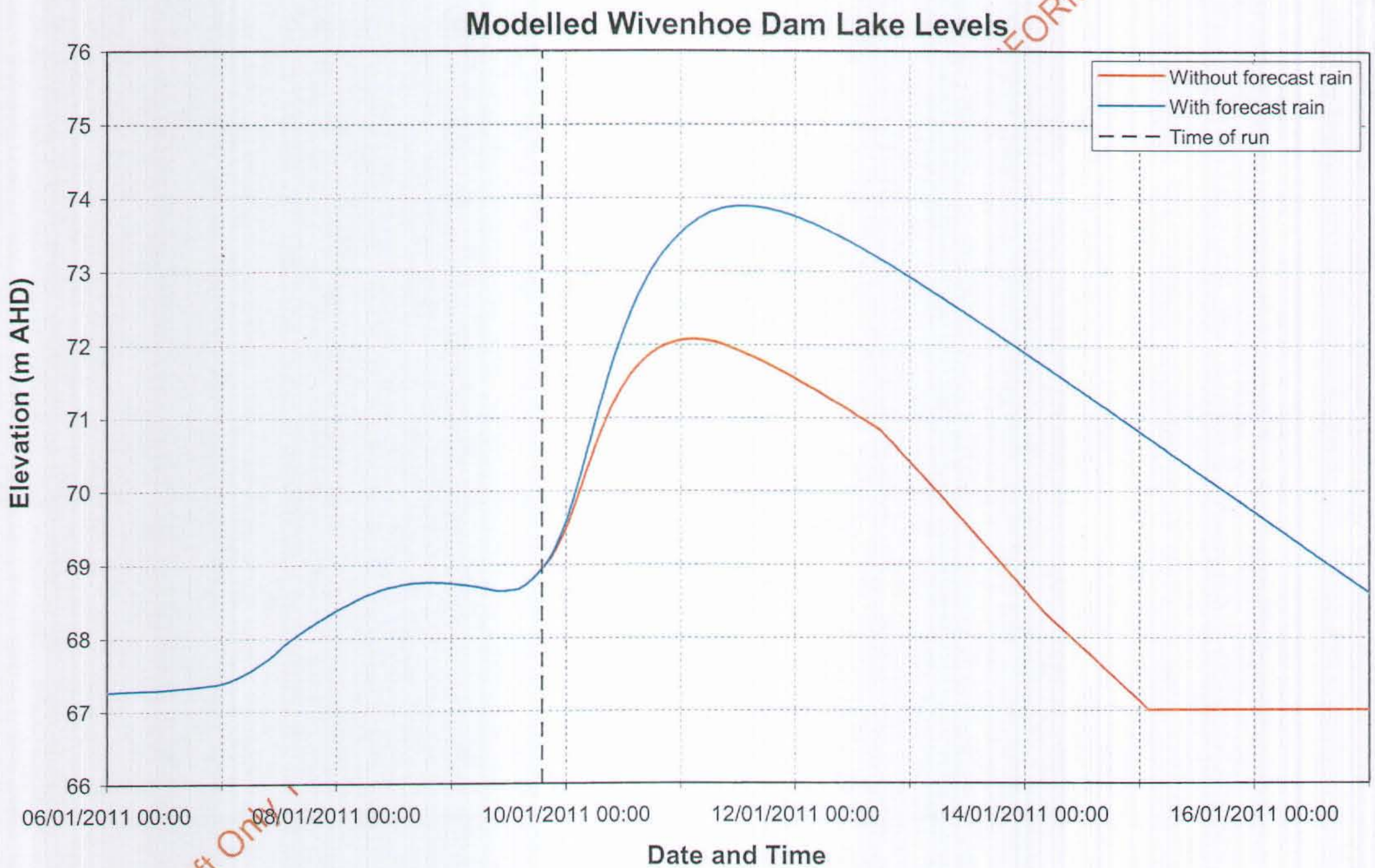

Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

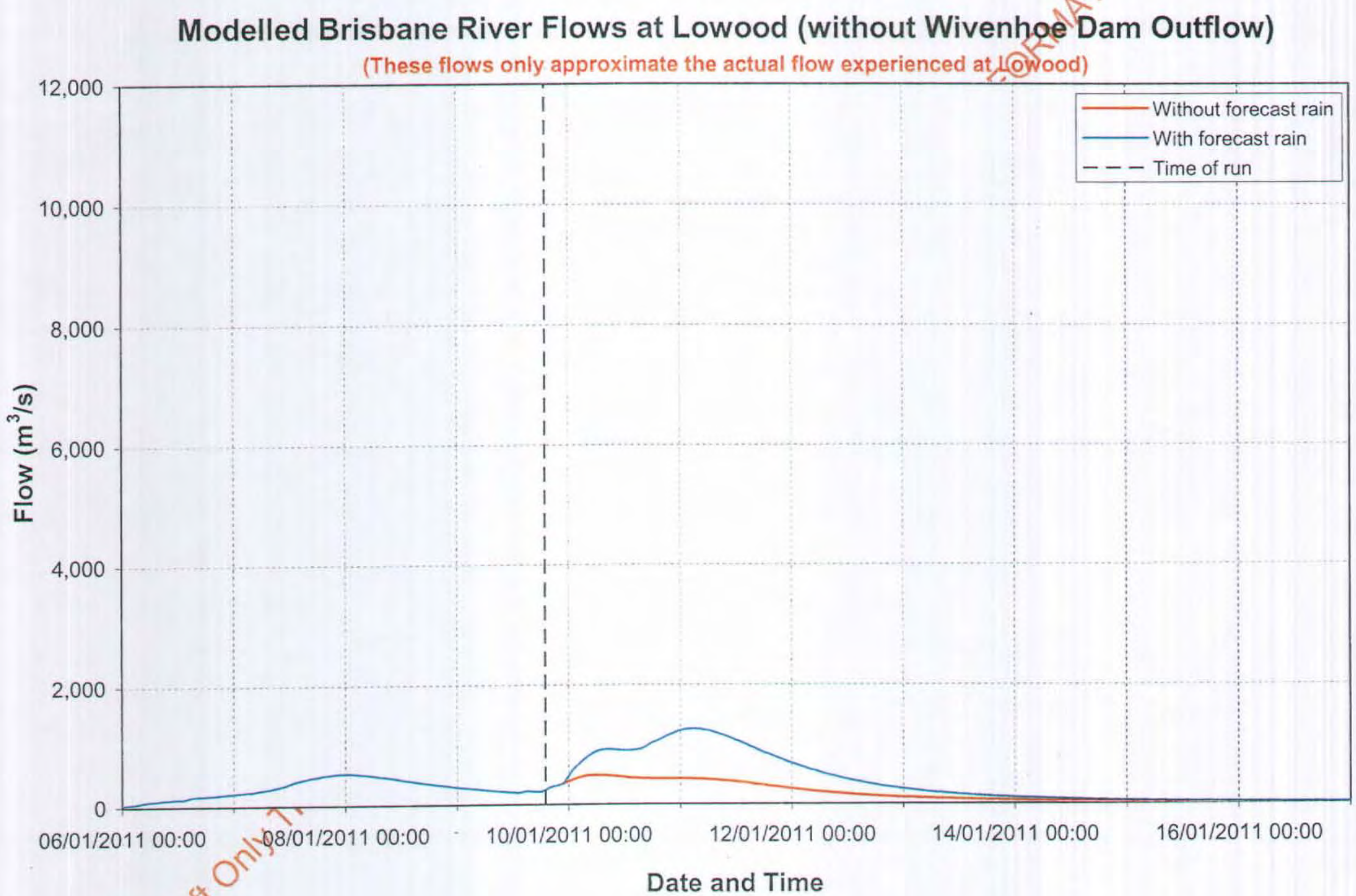

Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Bremer River Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m³/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

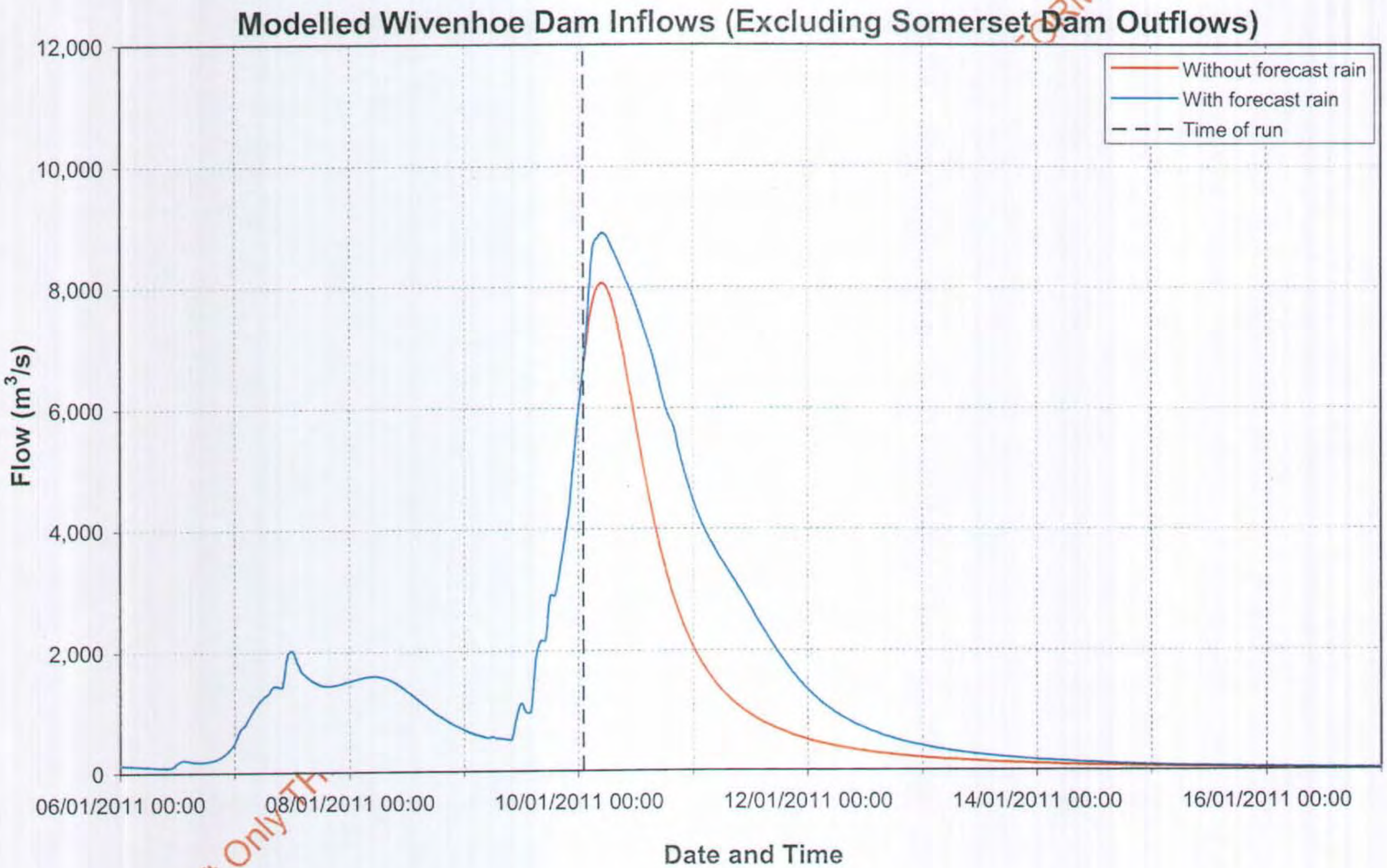

Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

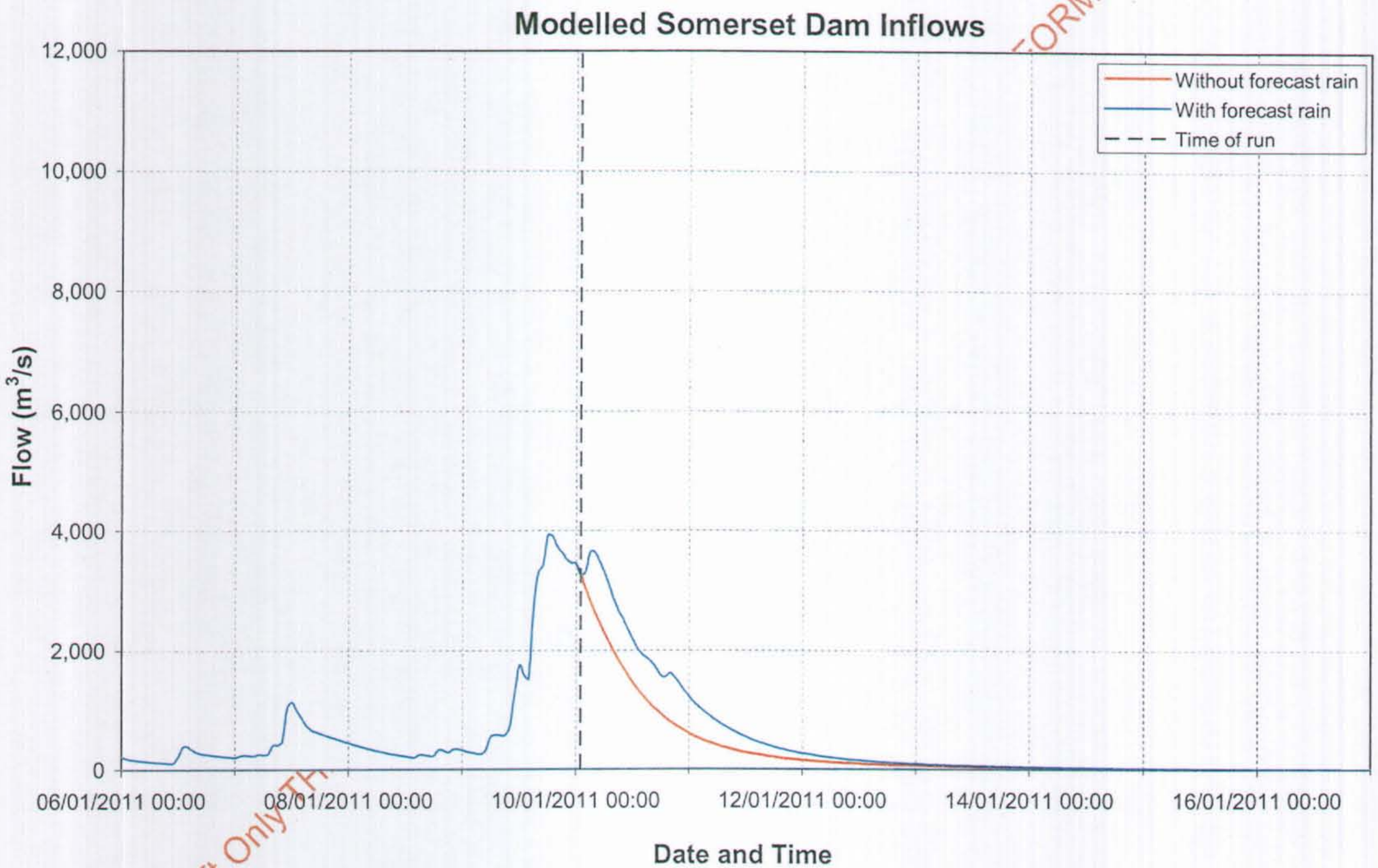
APPENDIX A – MODEL RESULTS

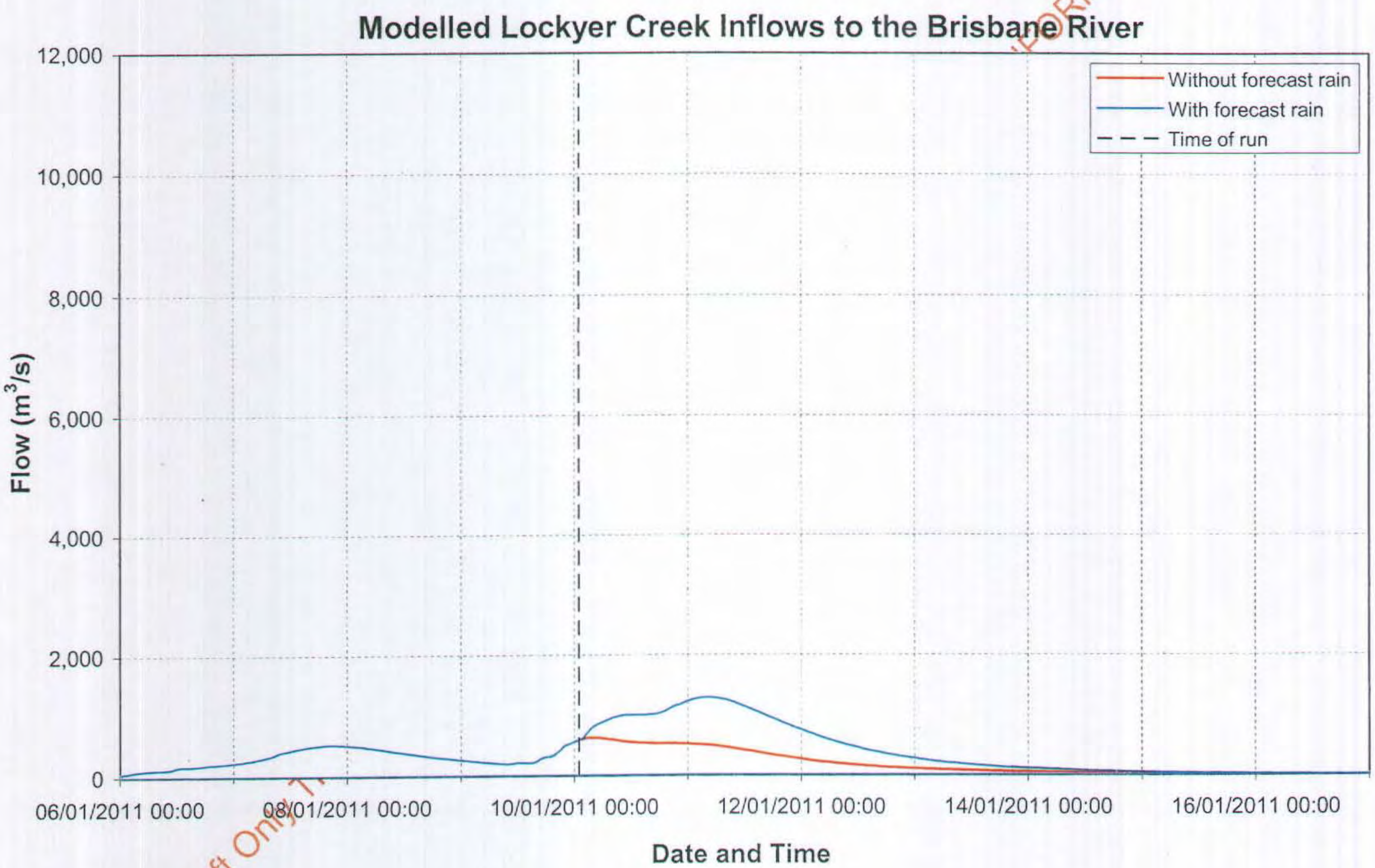
Run 23

Date: Monday 10 January 2011

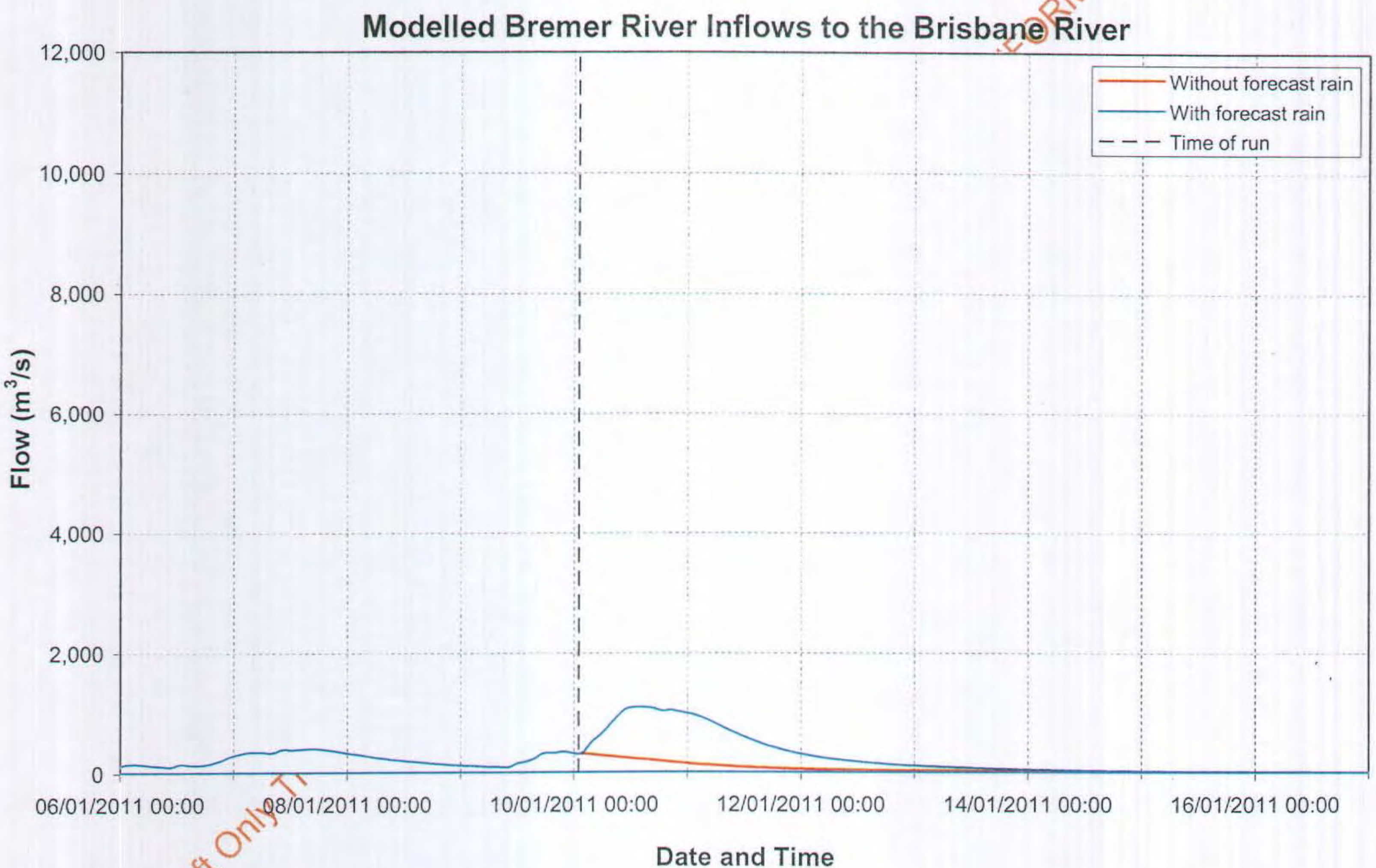
Time: 01:00

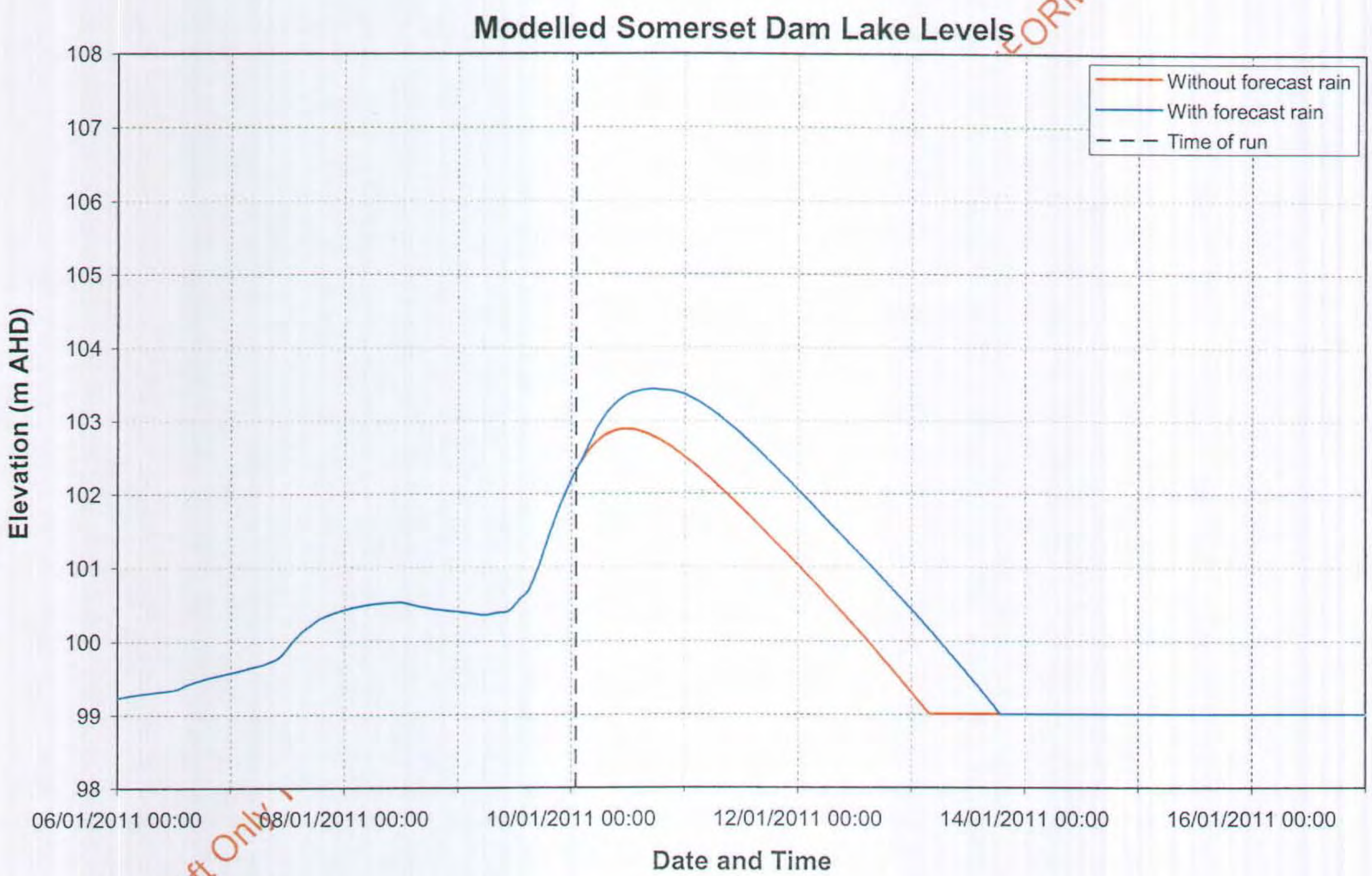

Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

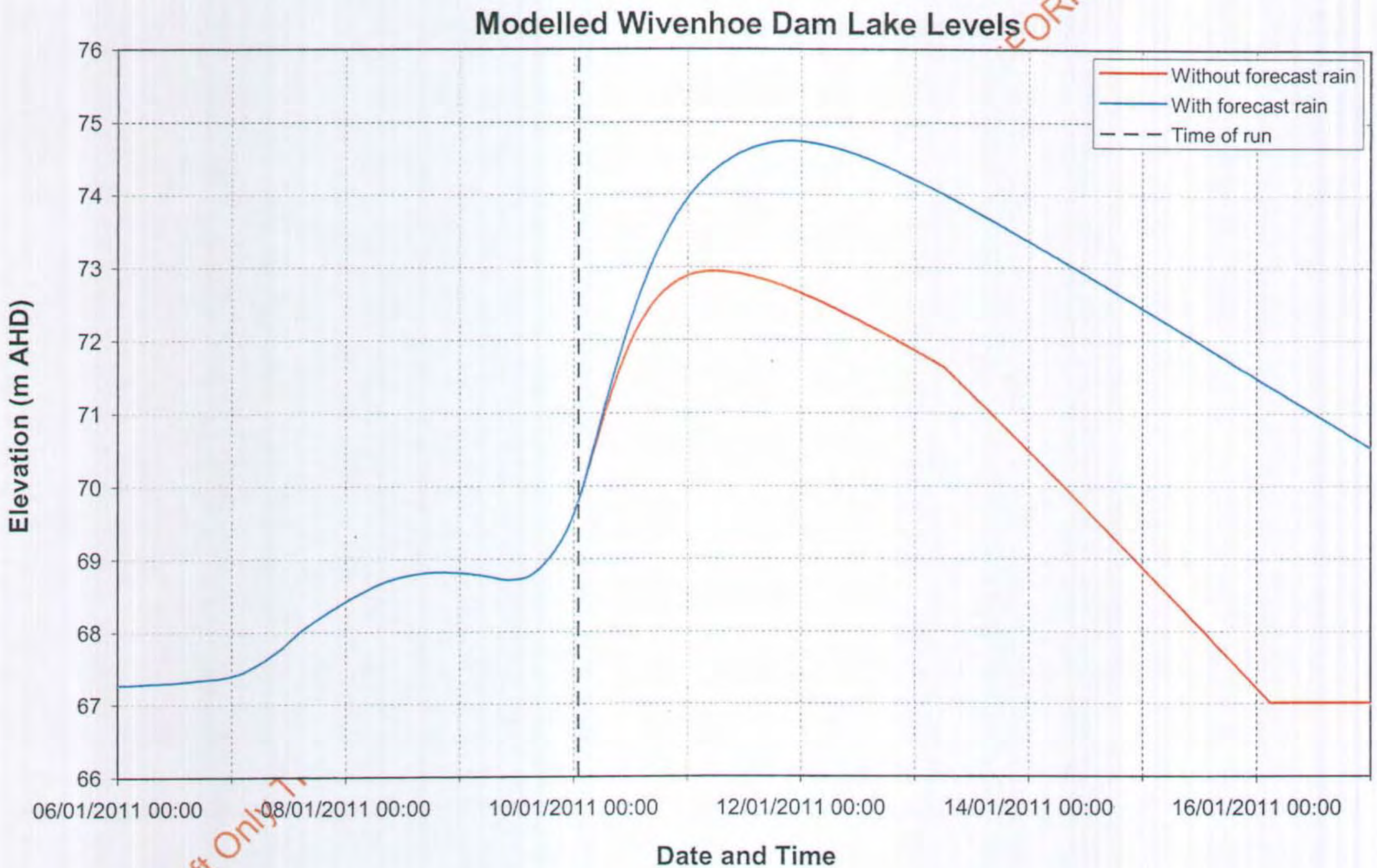

Modelled Somerset Dam Inflows
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m³/s)
Without forecast rain
With forecast rain
Time of run
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

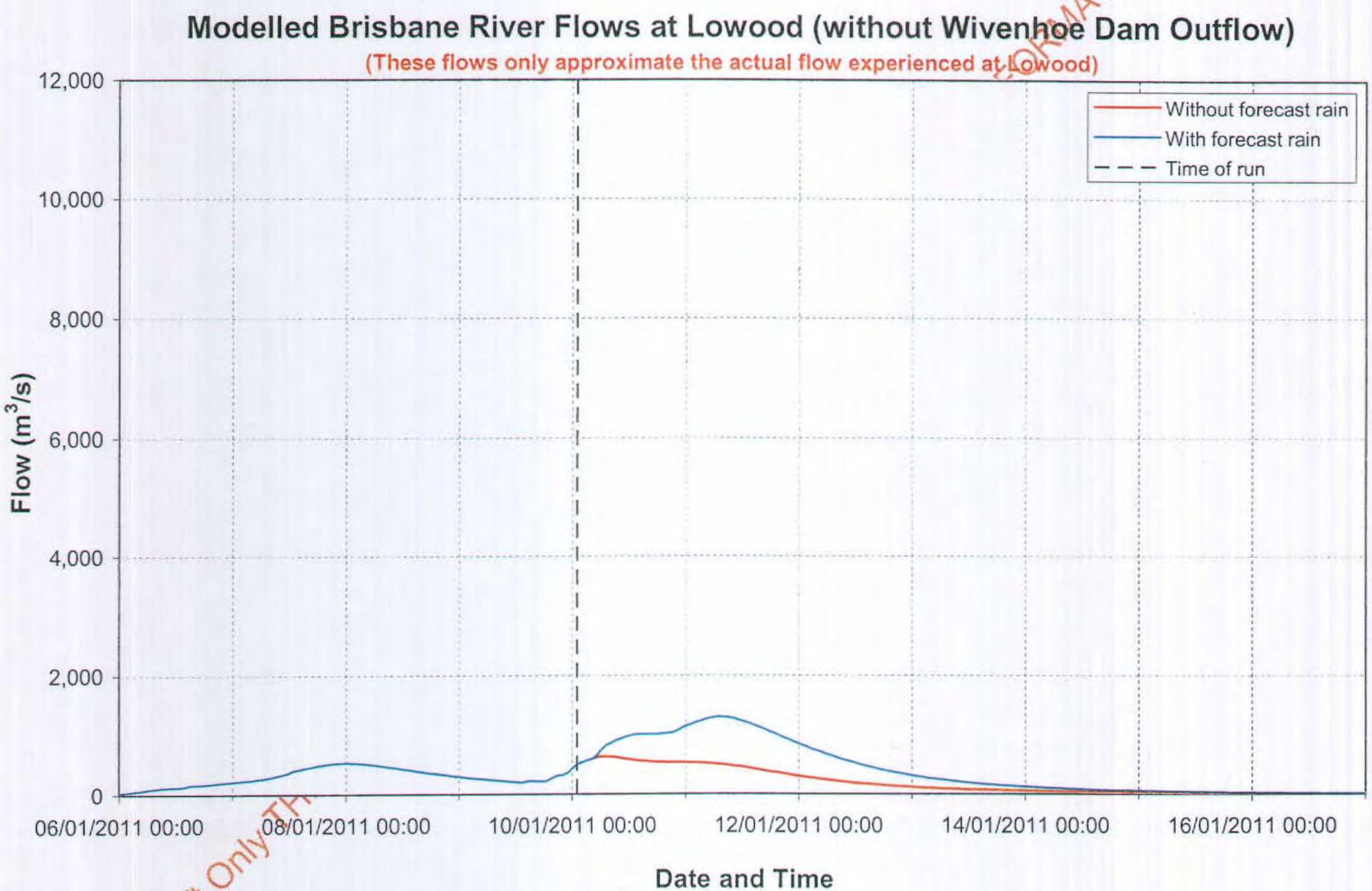

Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

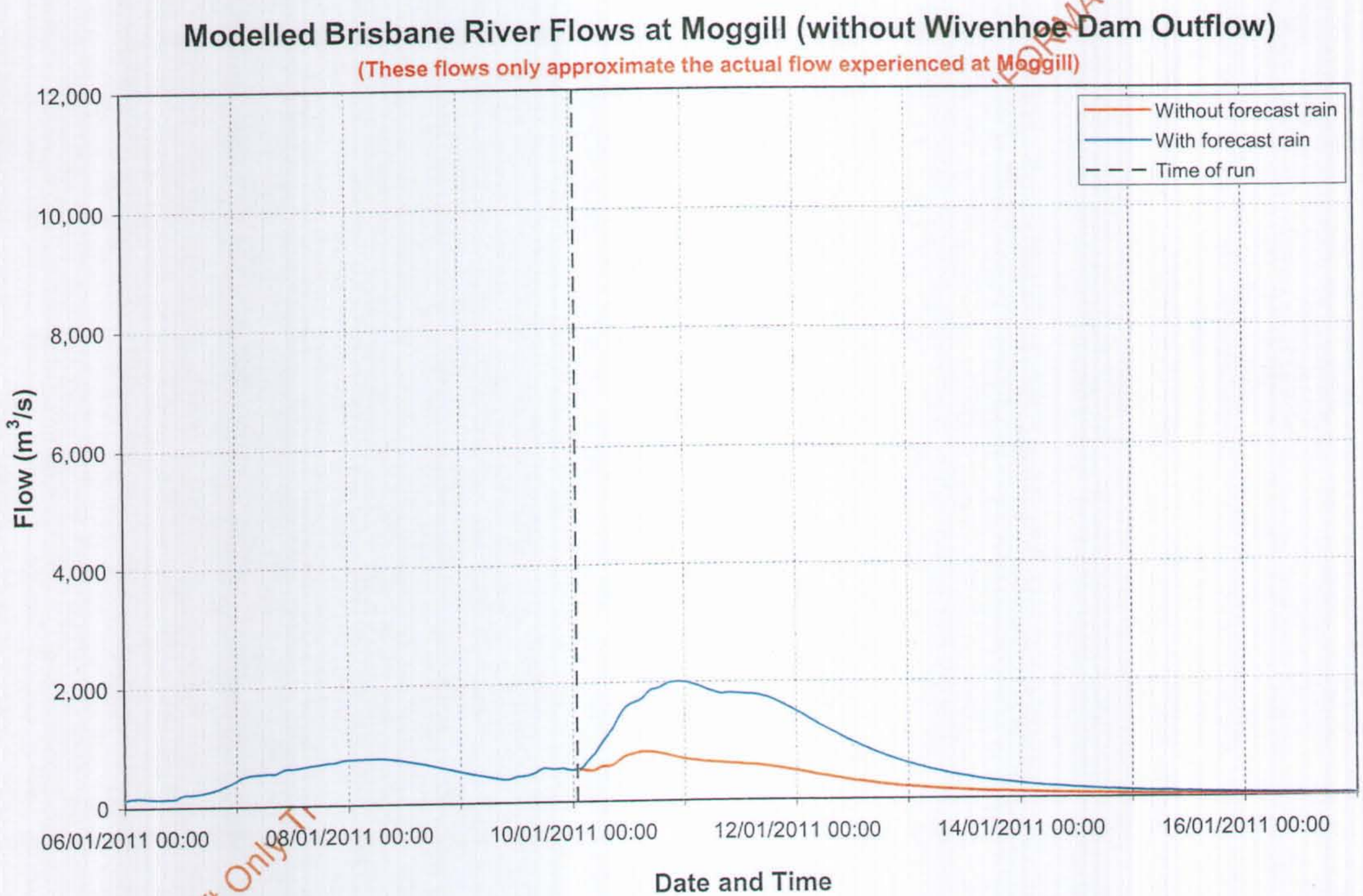
APPENDIX A – MODEL RESULTS




Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



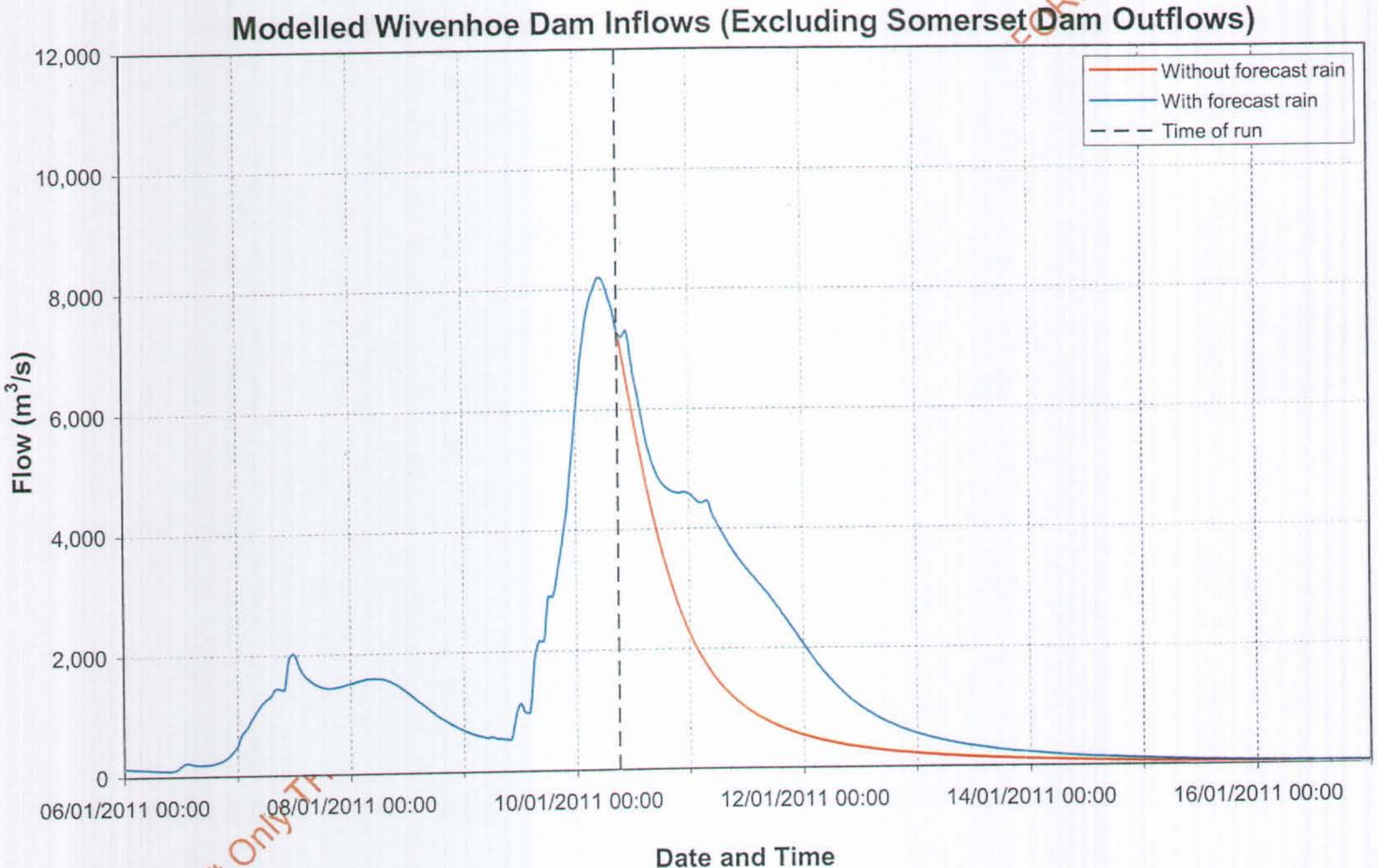
Modelled Brisbane River Flows at Moggill (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Moggill)
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m³/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time
Without forecast rain
With forecast rain
Time of run

APPENDIX A – MODEL RESULTS

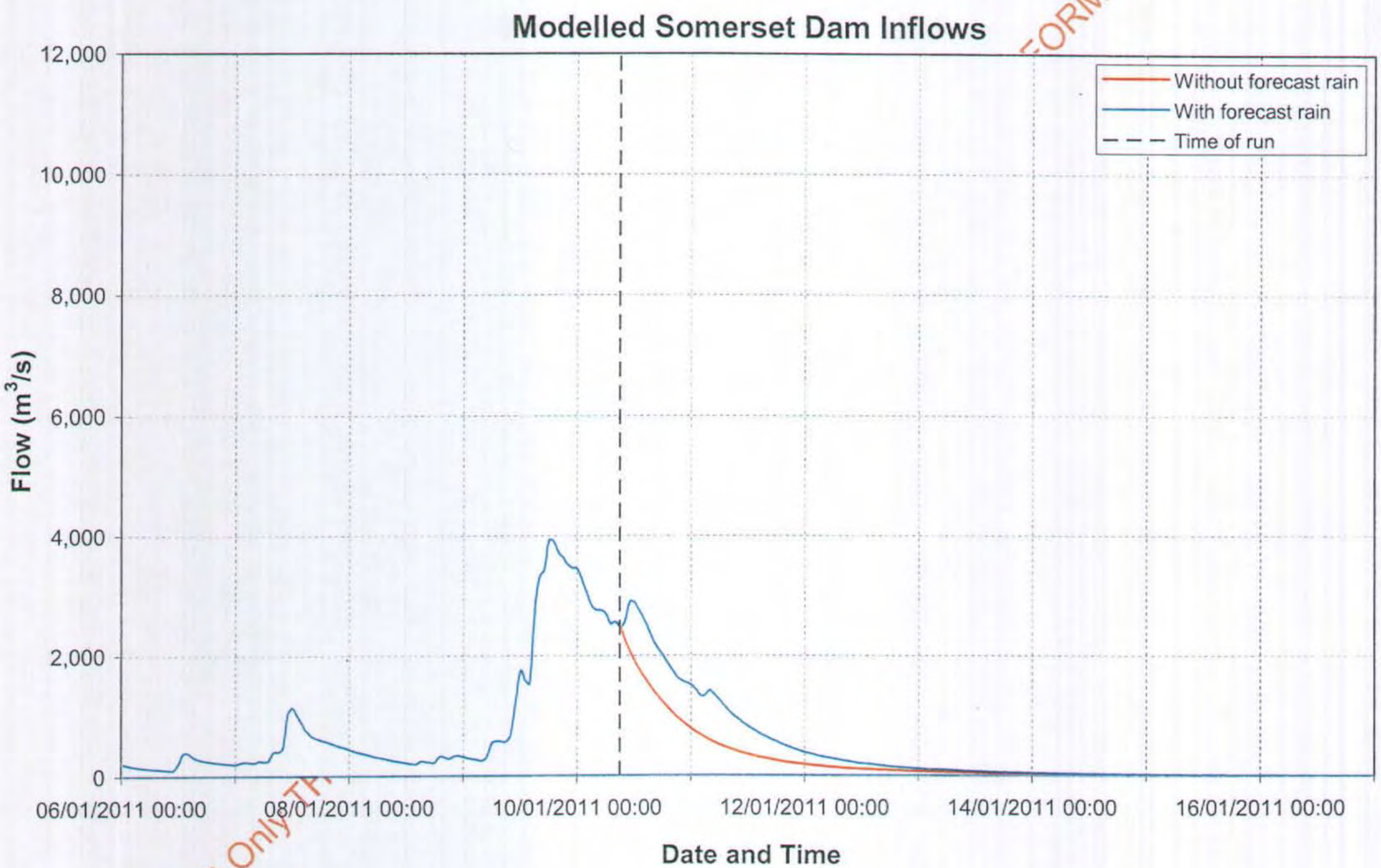
Run 26

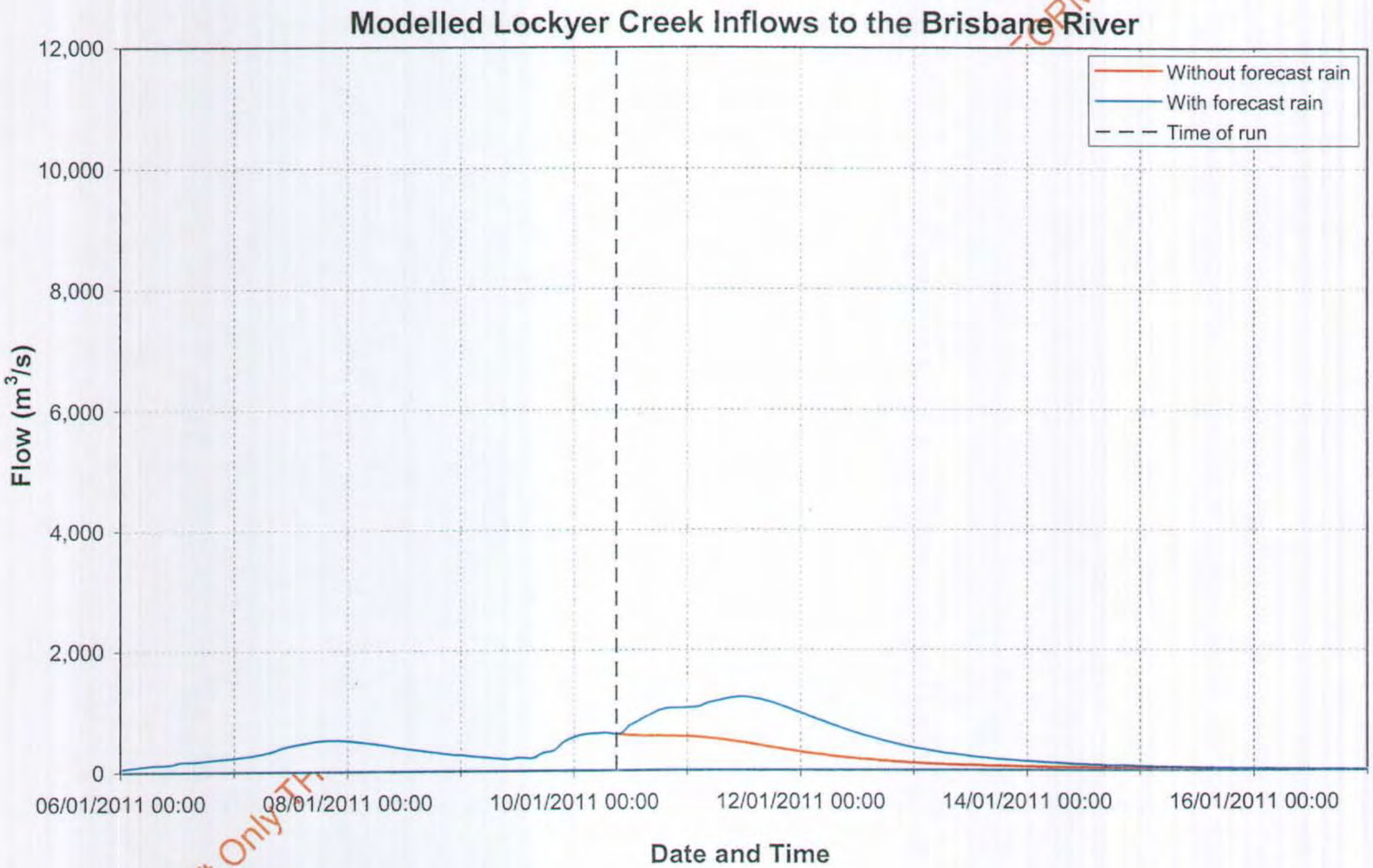
Date: Monday 10 January 2011

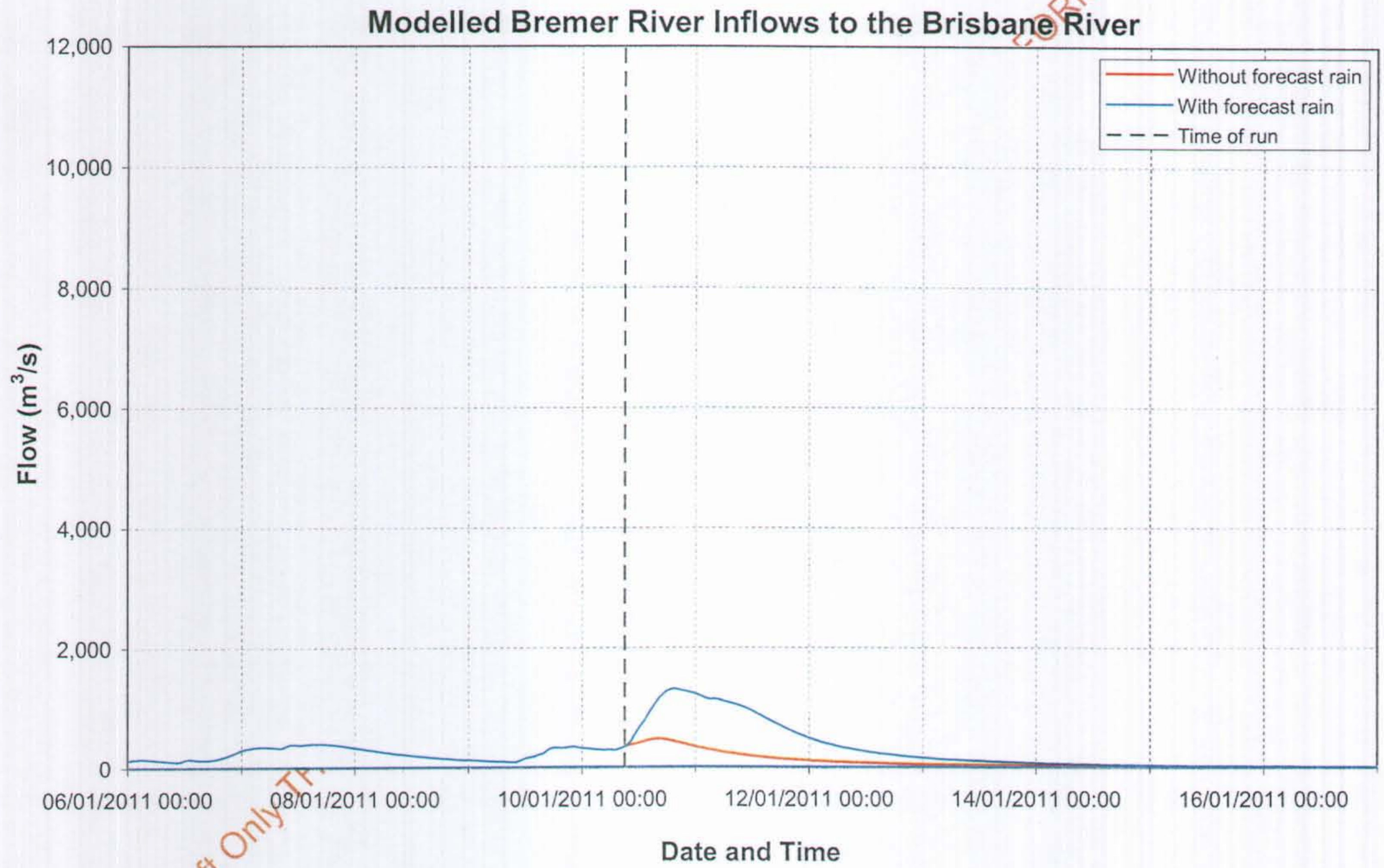
Time: 09:00

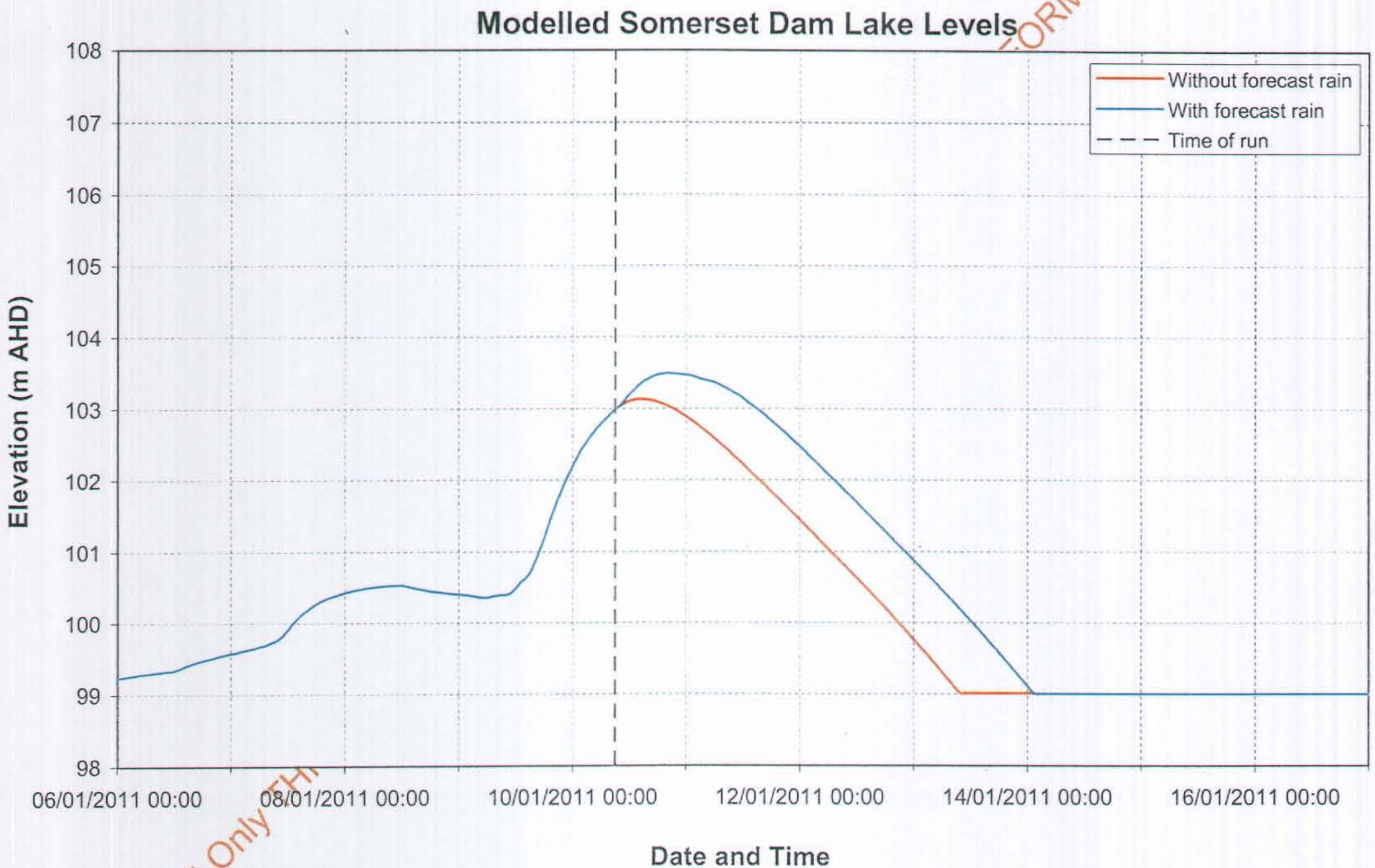


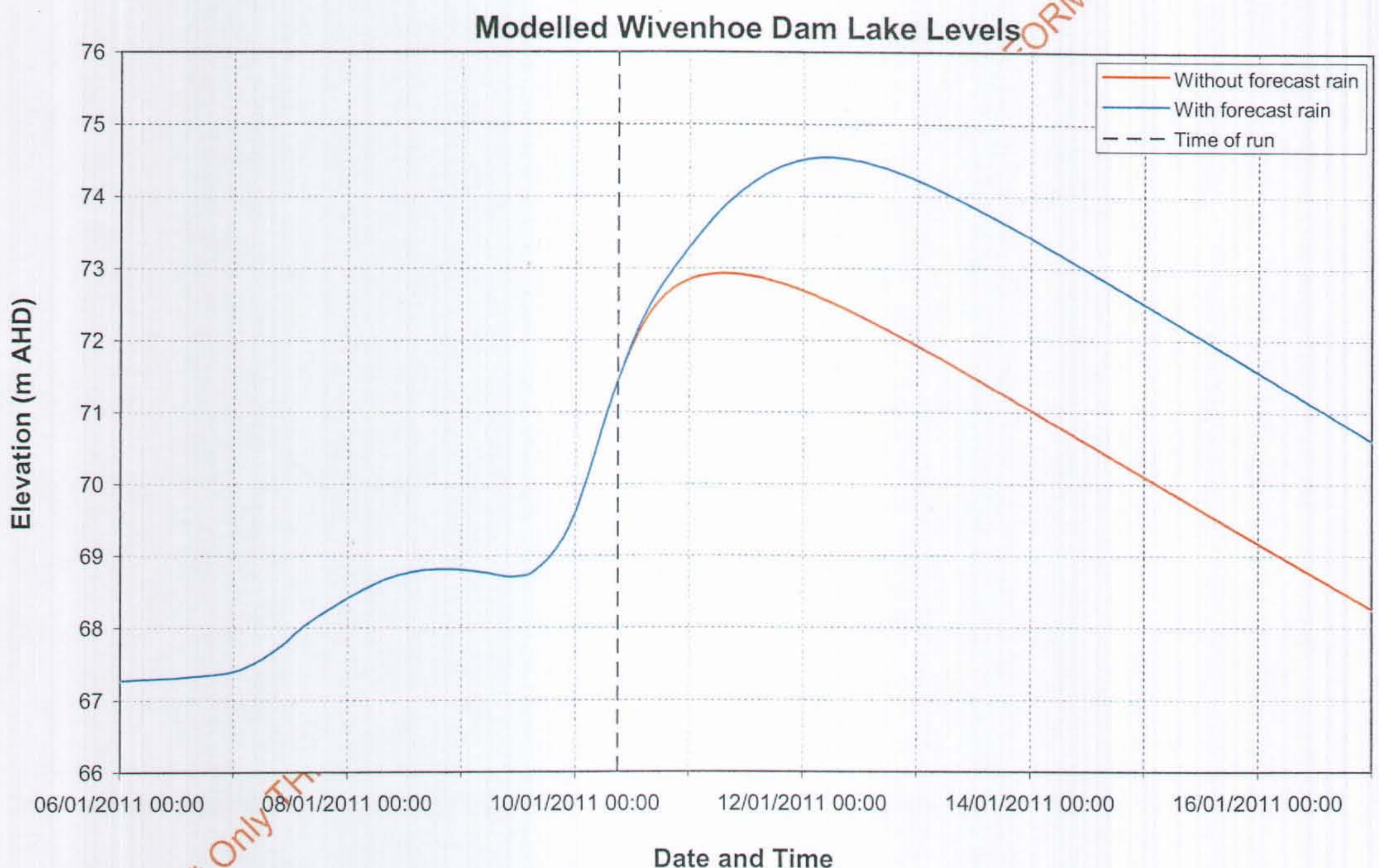
Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

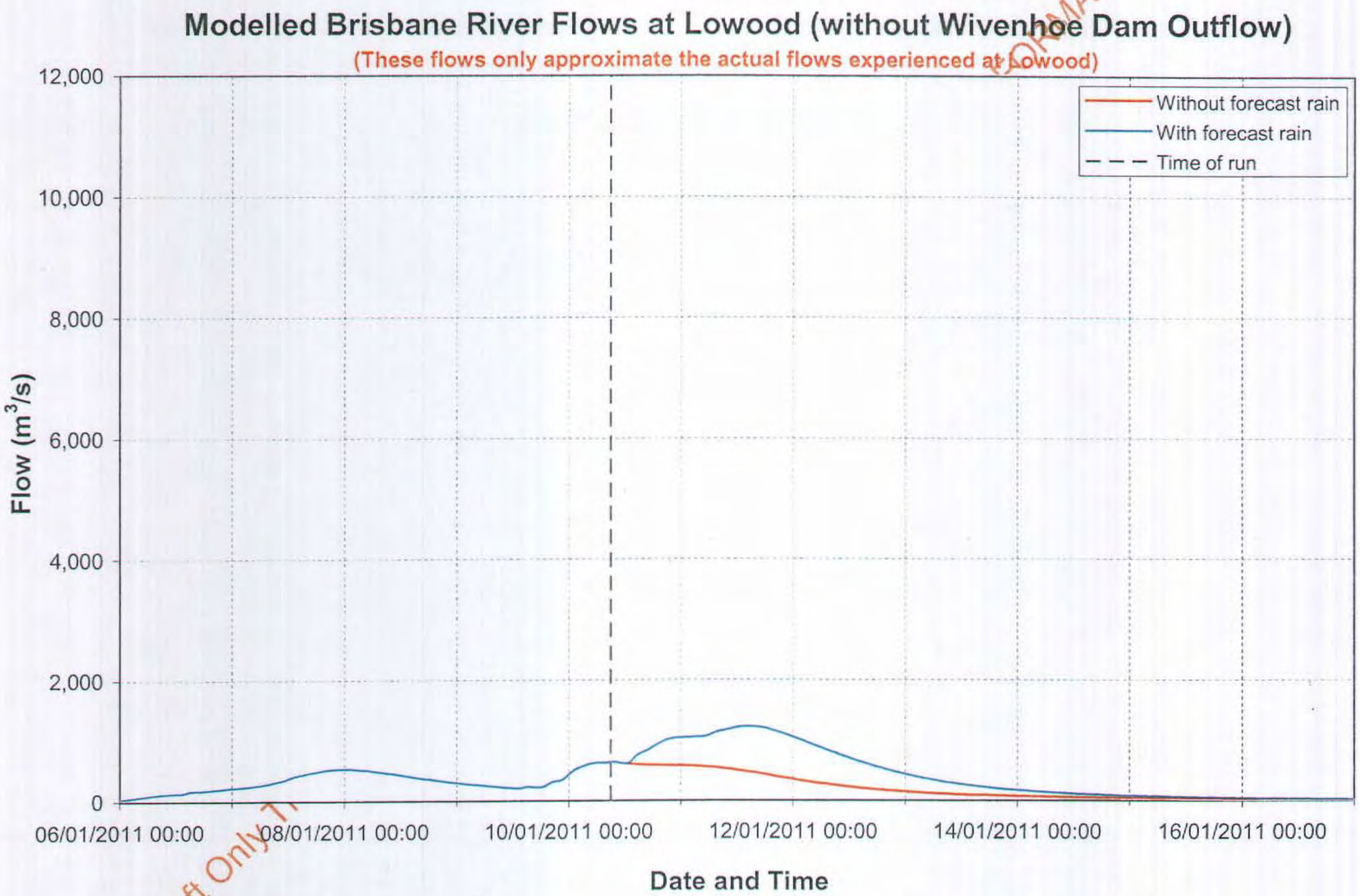

Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

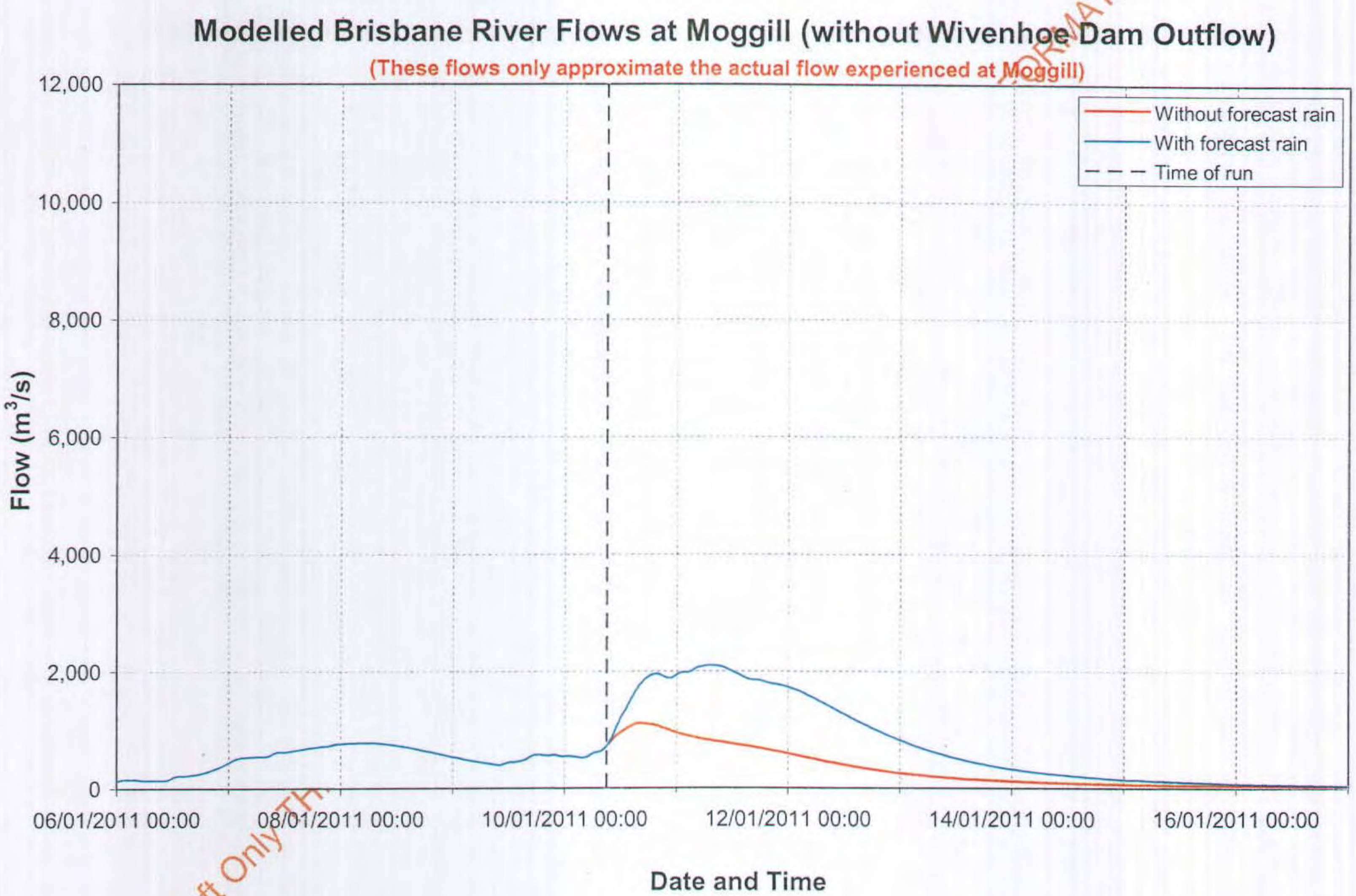

Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Bremer River Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m³/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
108
107
106
105
104
103
102
101
100
99
98
Elevation (m AHD)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flows experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

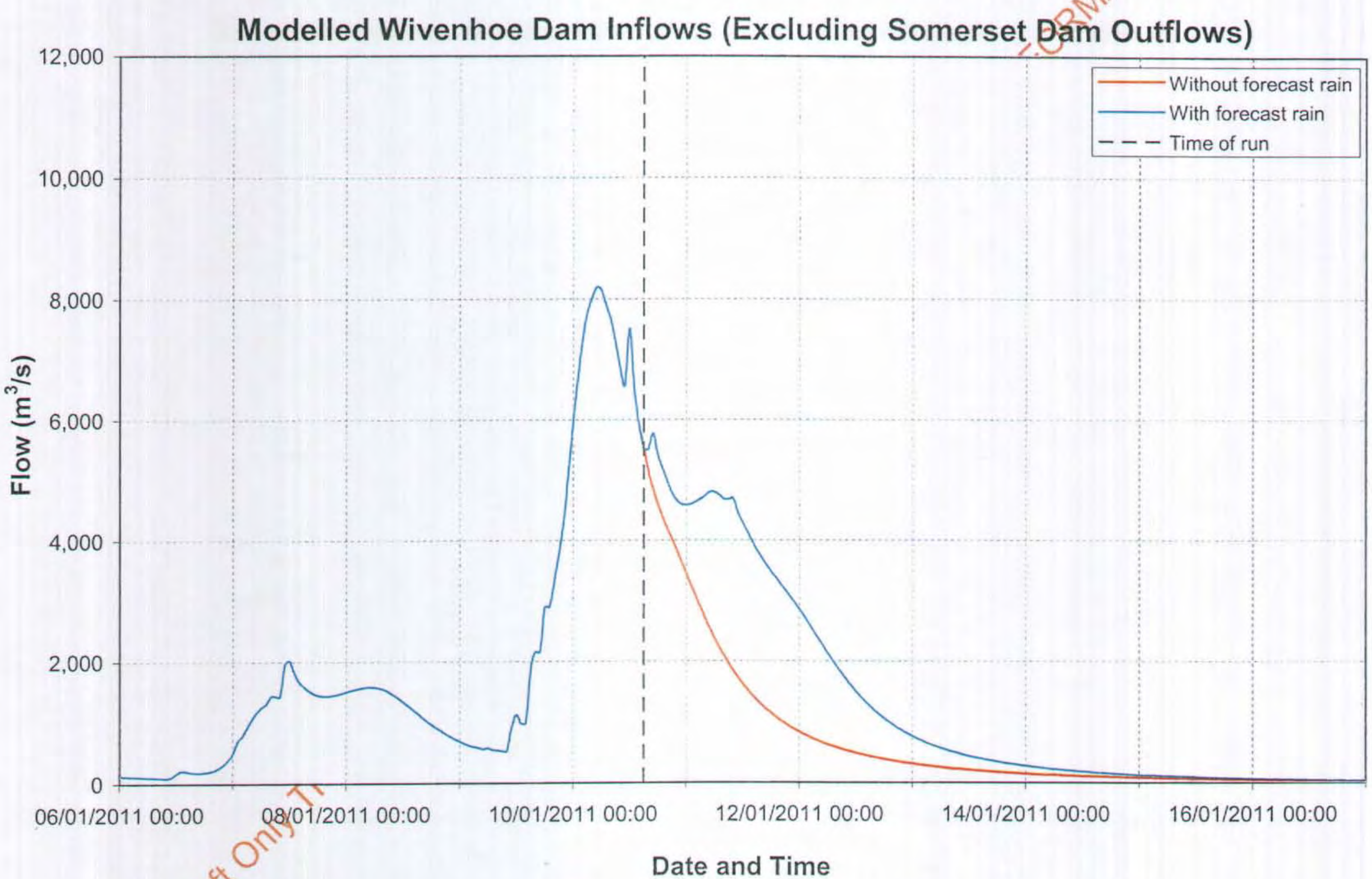

Modelled Brisbane River Flows at Moggill (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Moggill)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

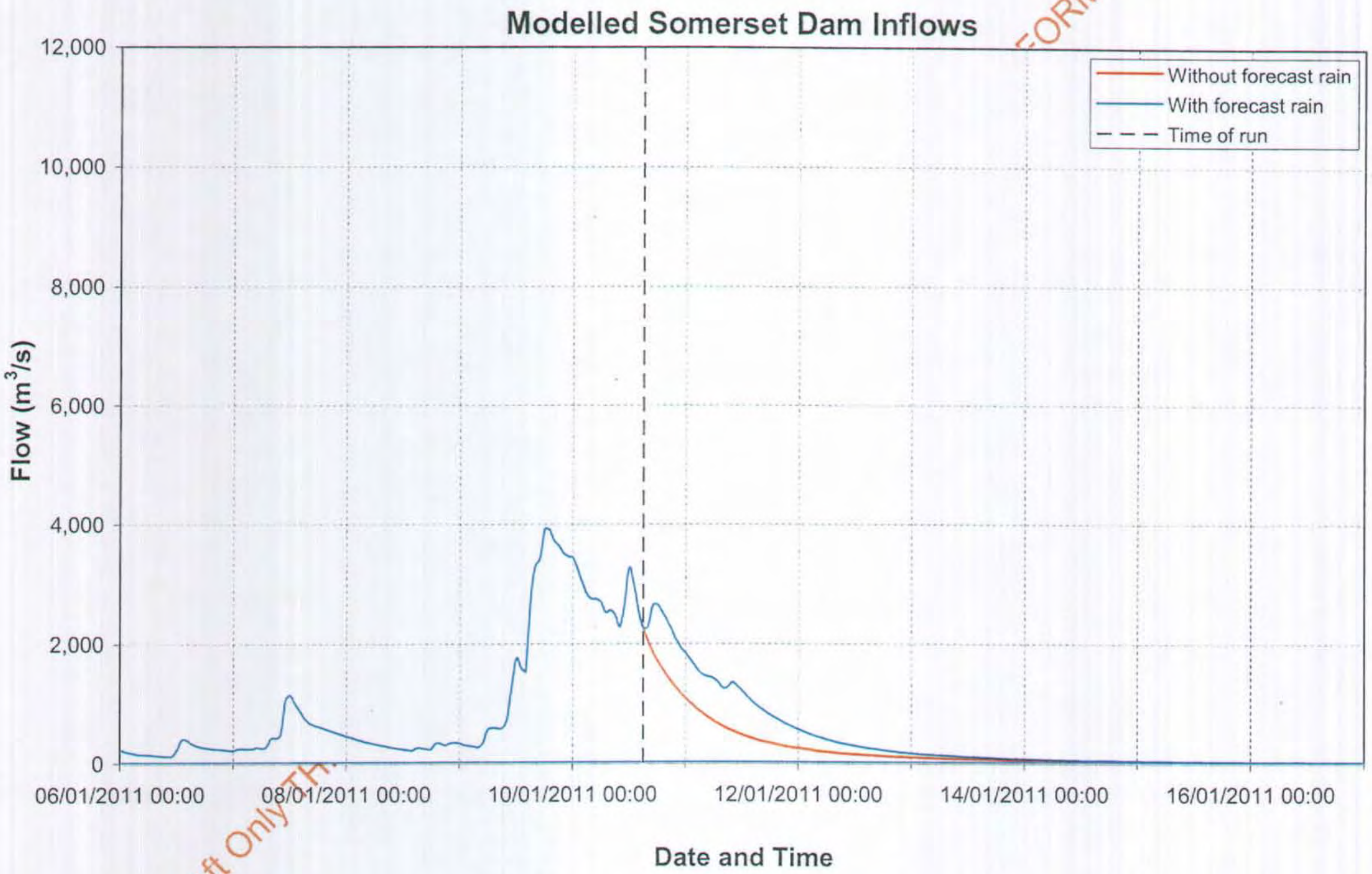
APPENDIX A – MODEL RESULTS

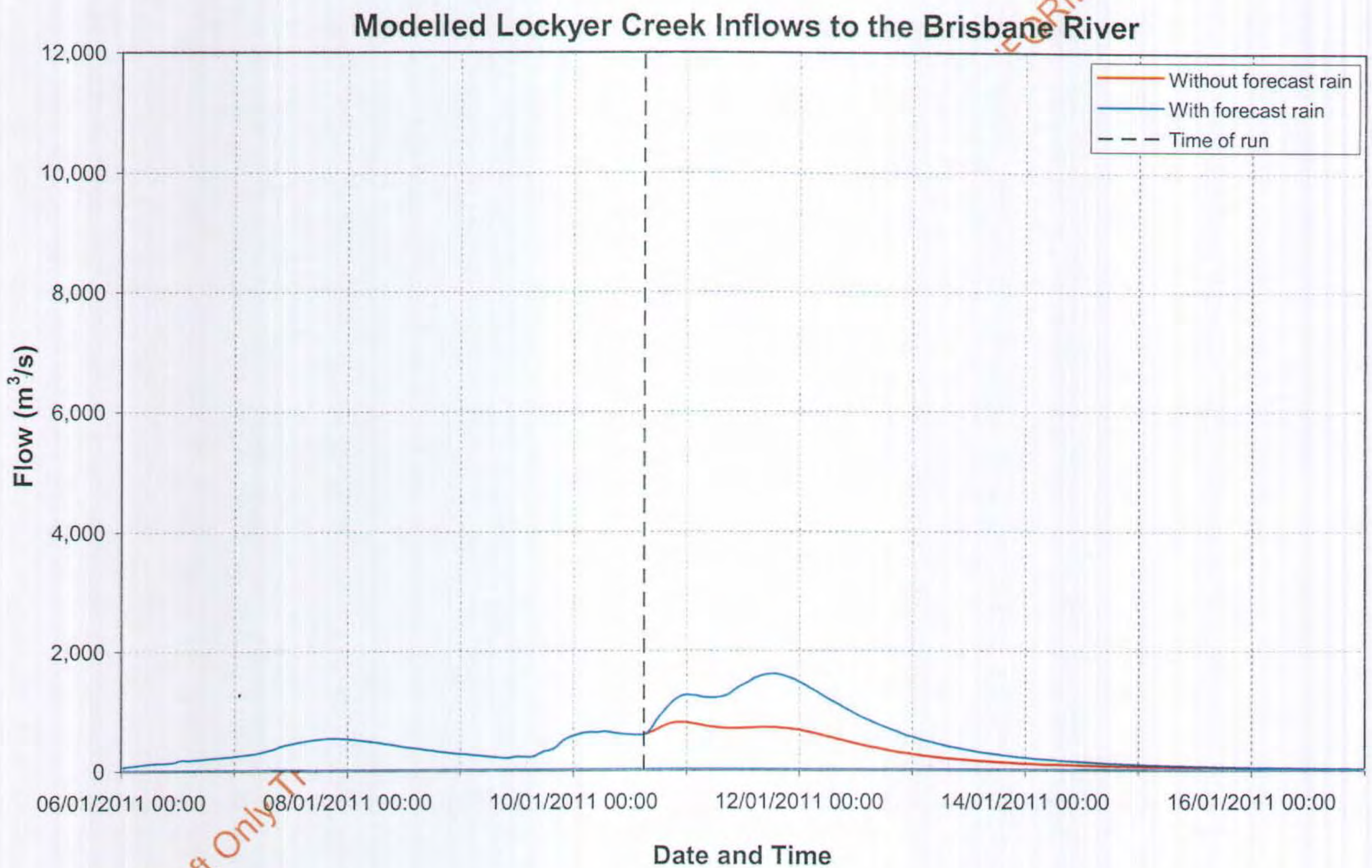
Run 28

Date: Monday 10 January 2011

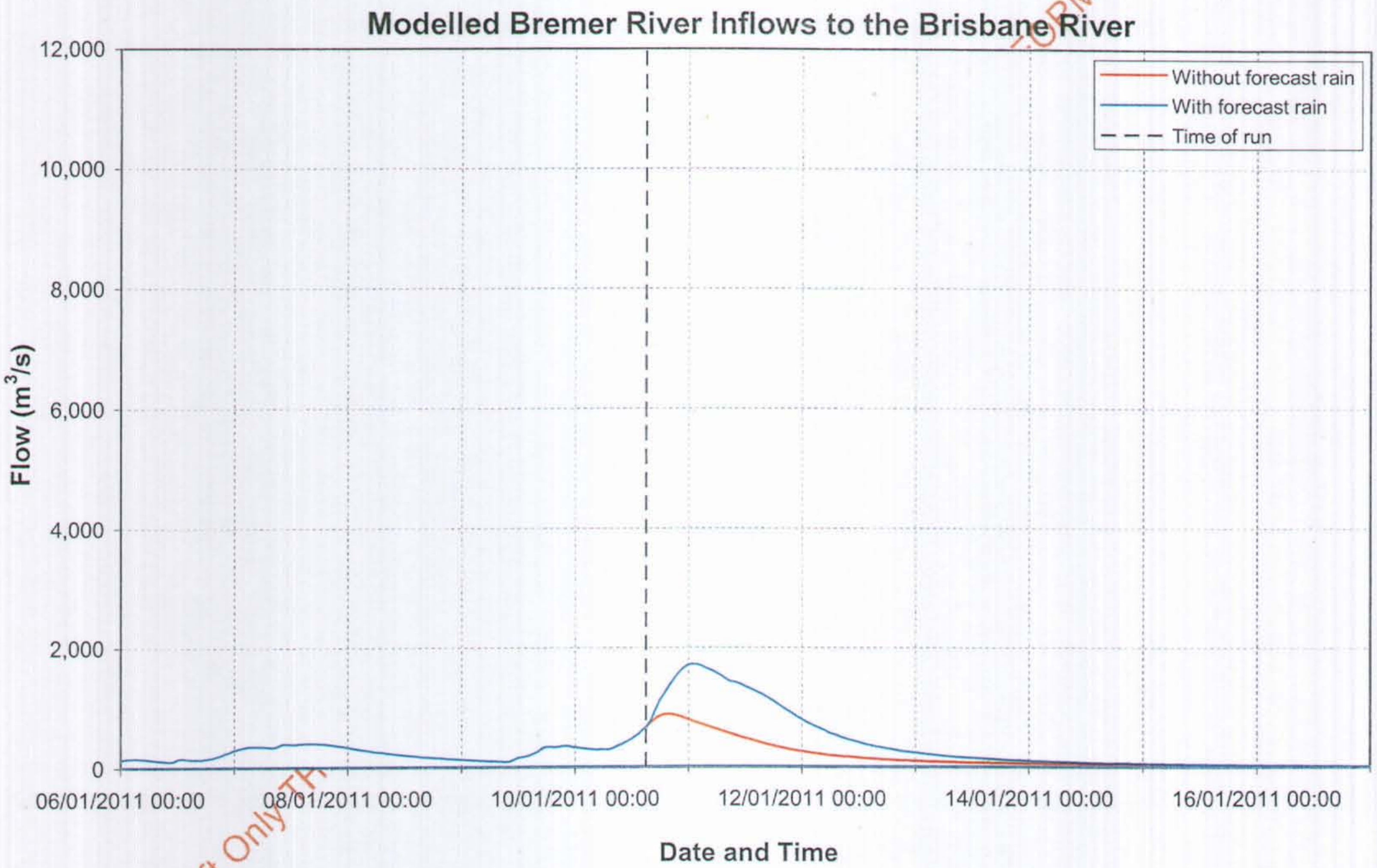
Time: 15:00


Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

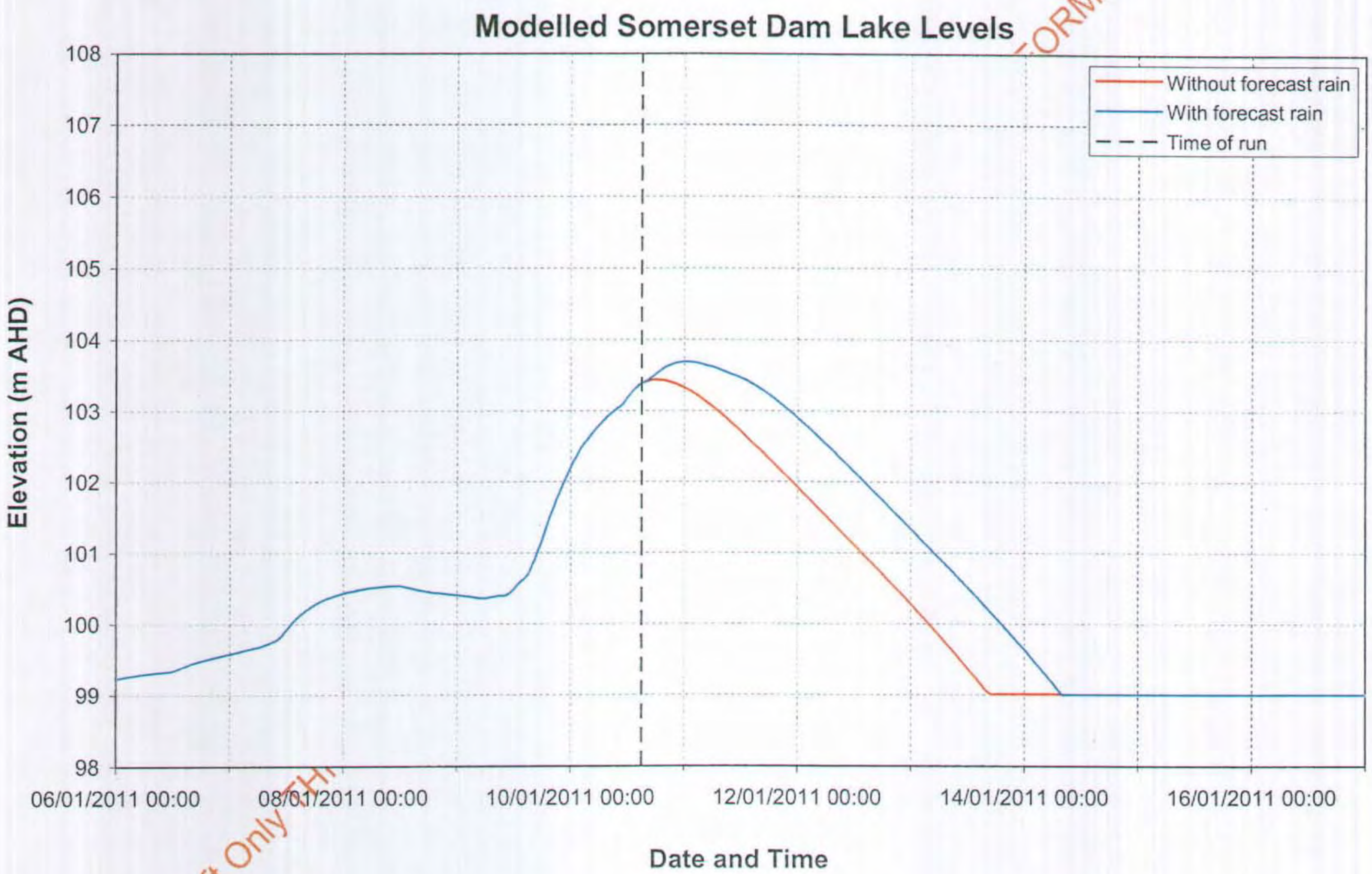

Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

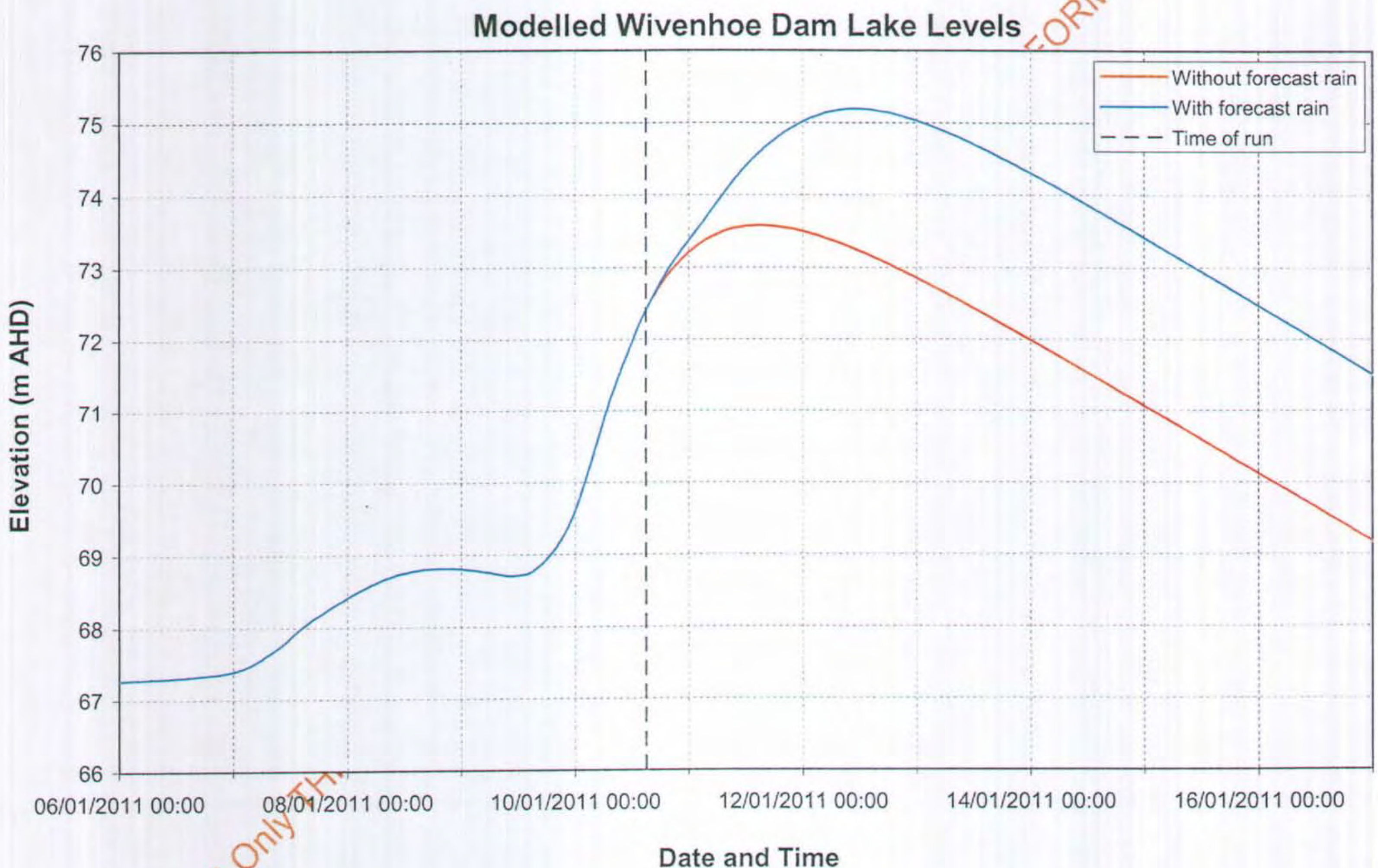


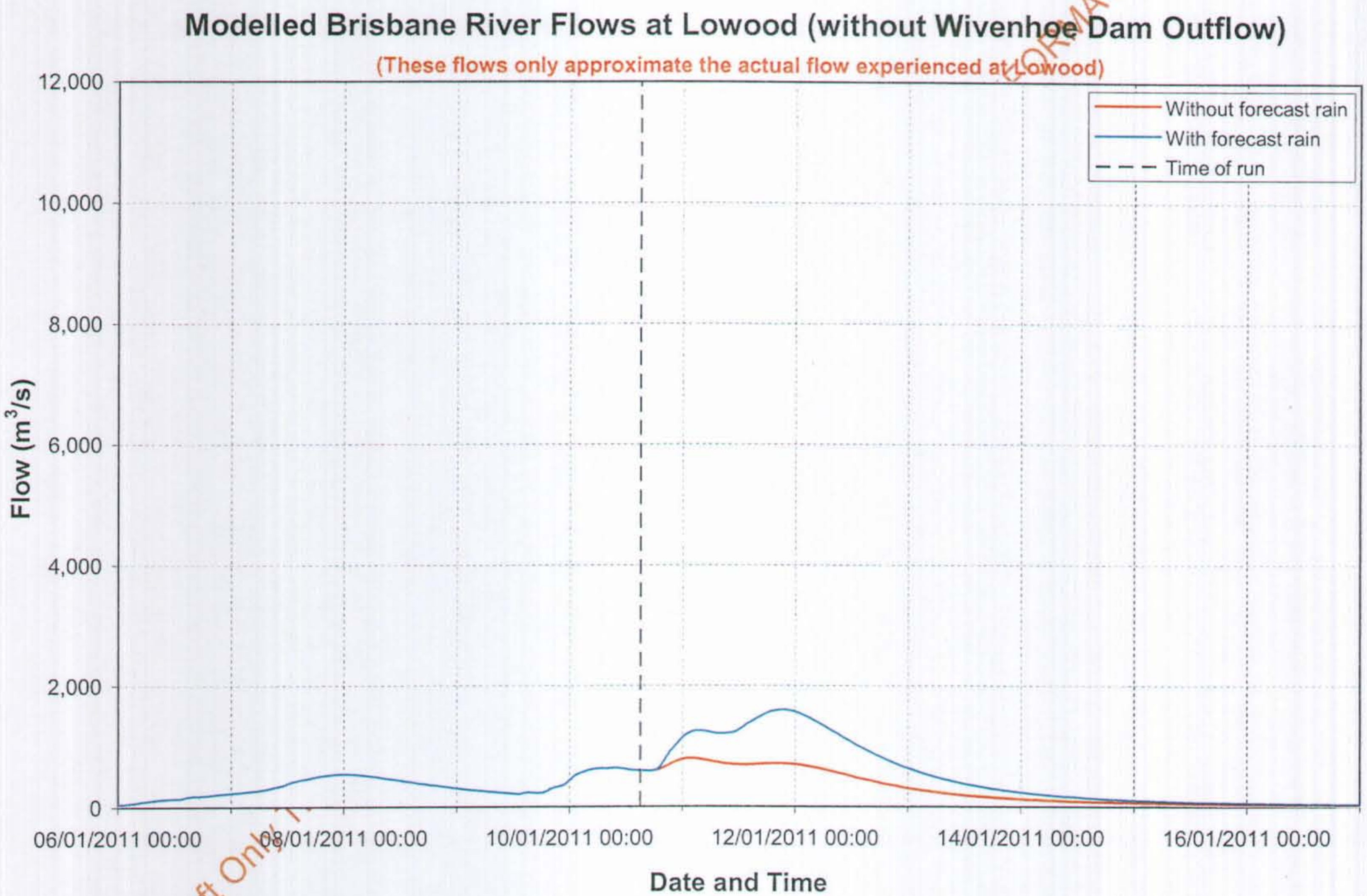
Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

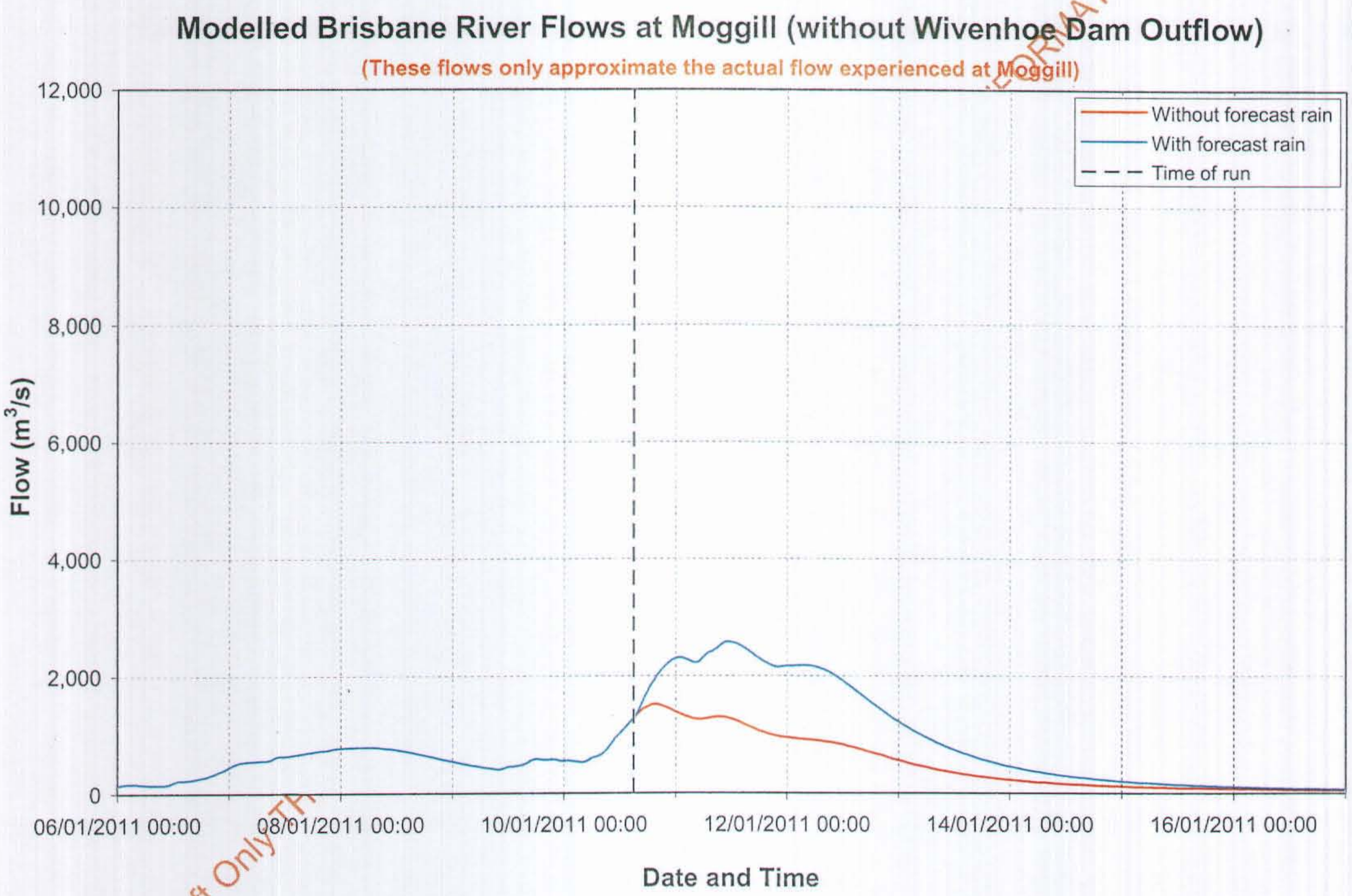

Modelled Bremer River Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

APPENDIX A – MODEL RESULTS




Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

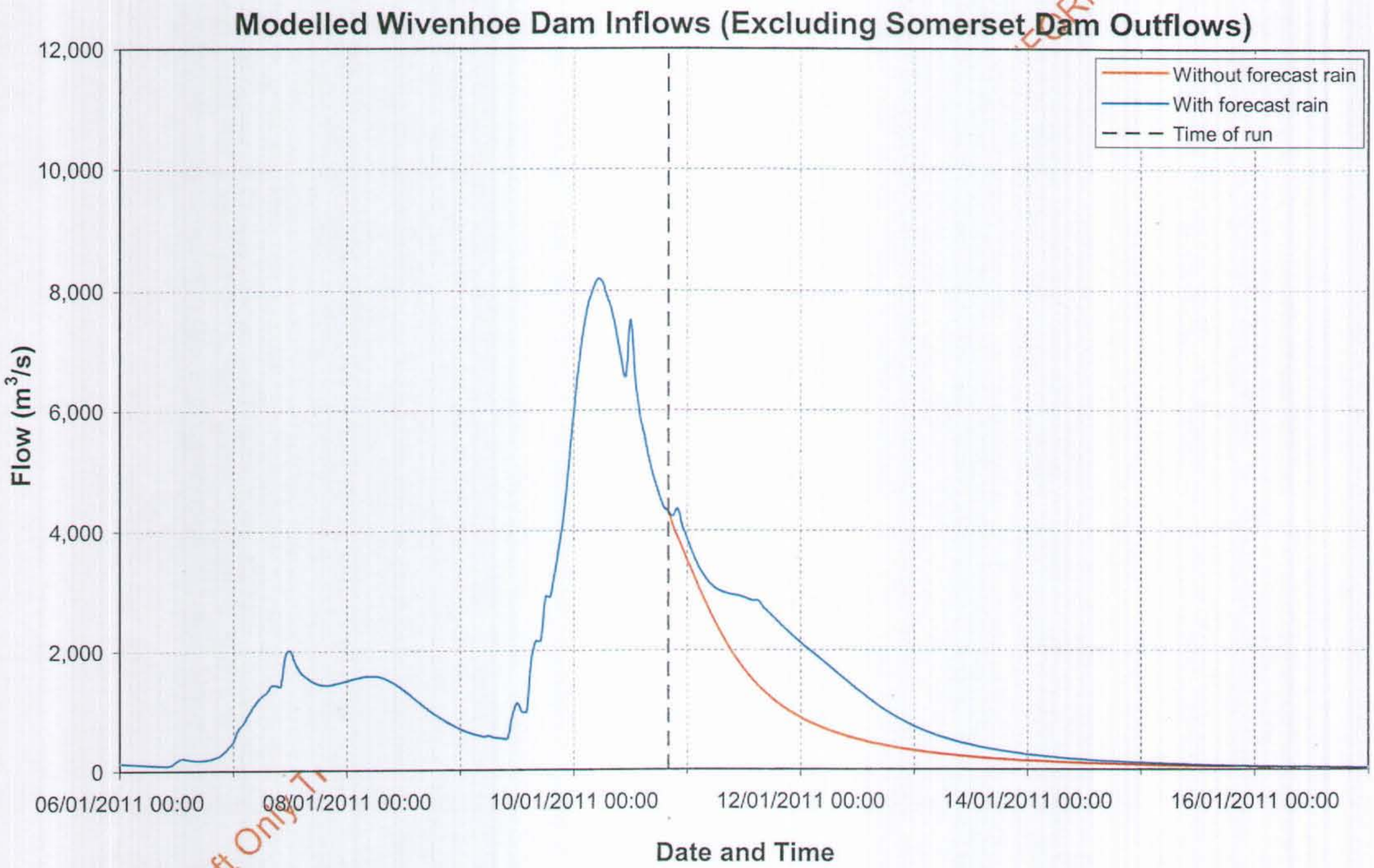

Modelled Brisbane River Flows at Moggill (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Moggill)
Without forecast rain
With forecast rain
Time of run
Flow (m^3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time
Draft Only
ATION

APPENDIX A – MODEL RESULTS

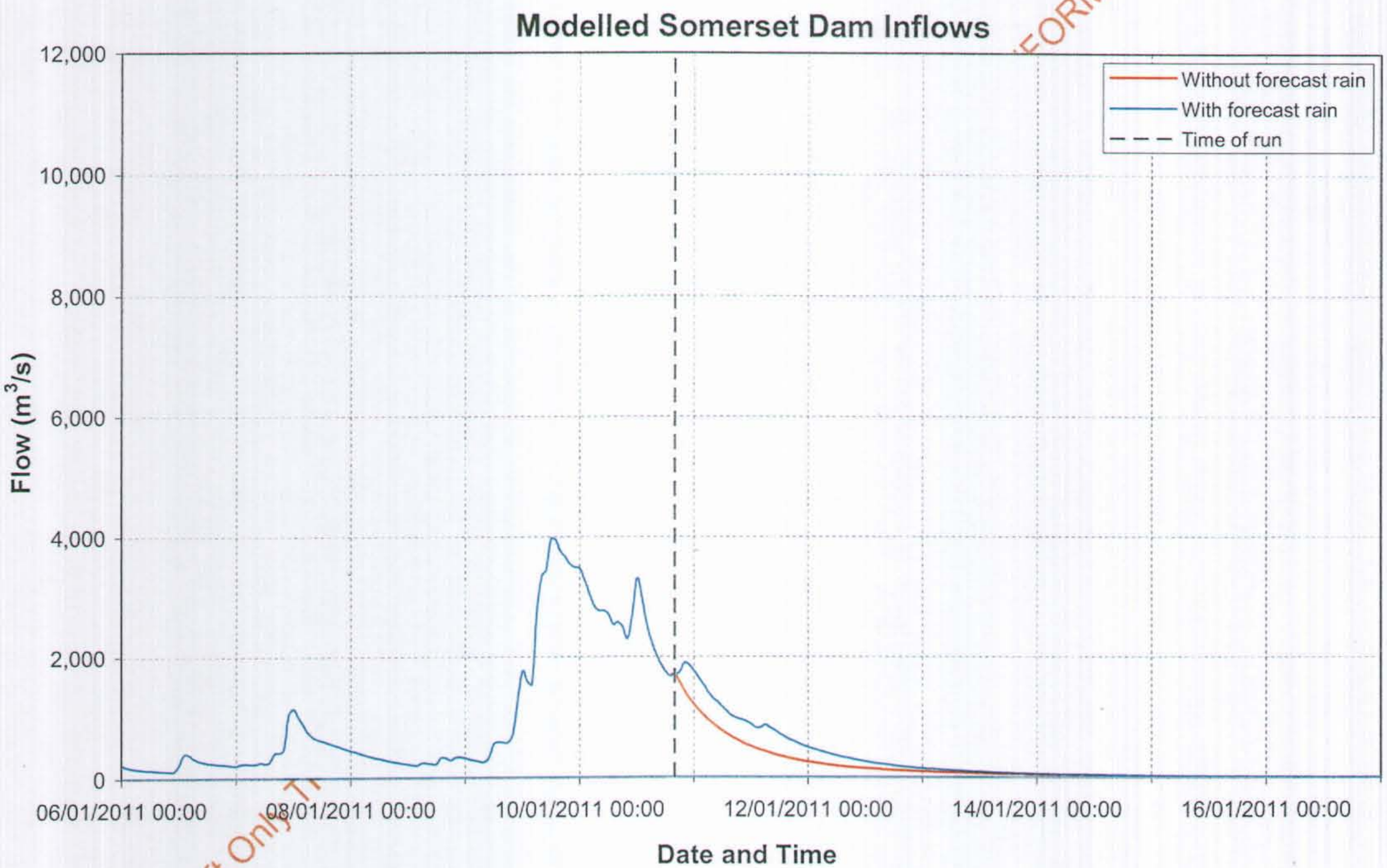
Run 31

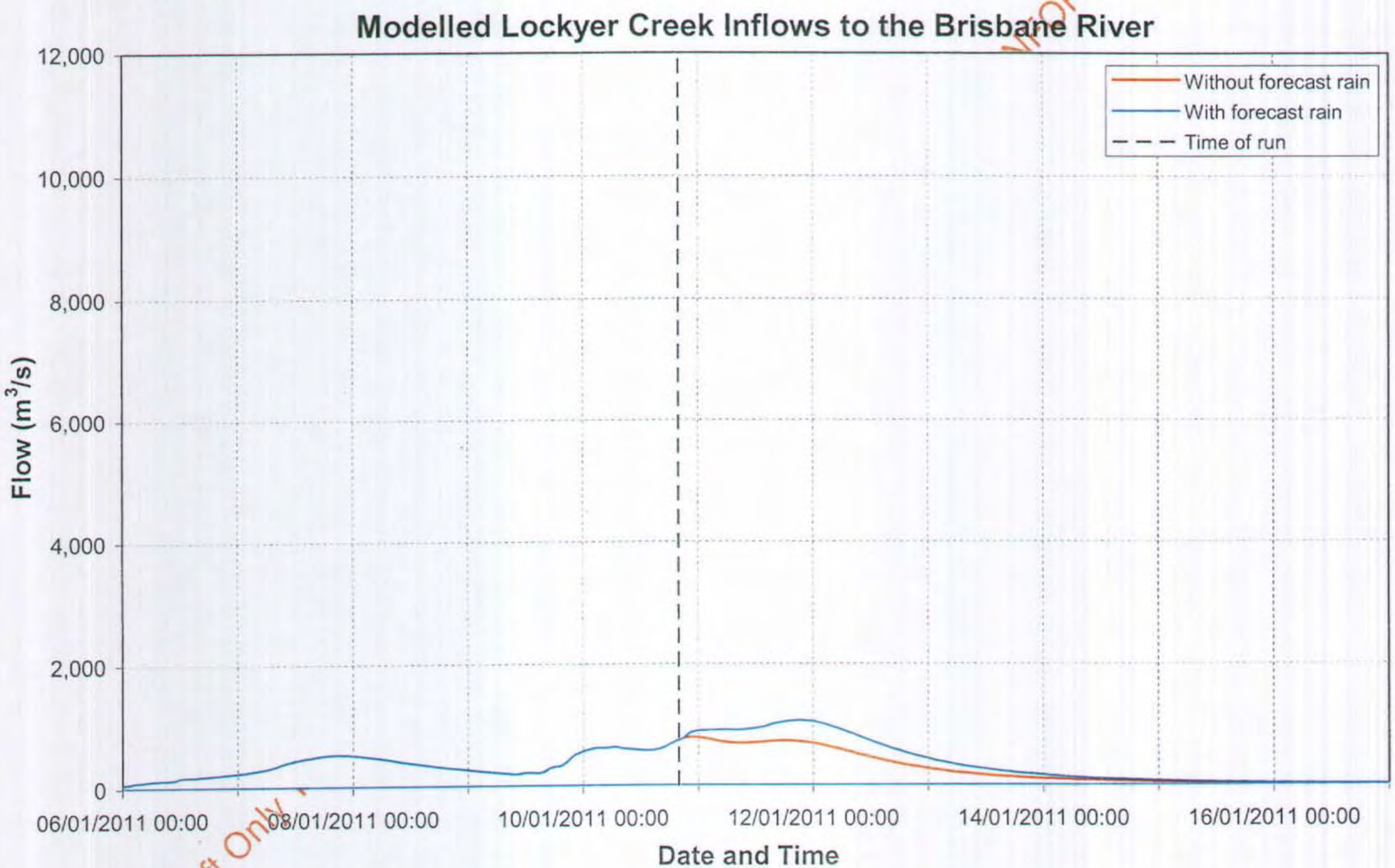
Date: Monday 10 January 2011

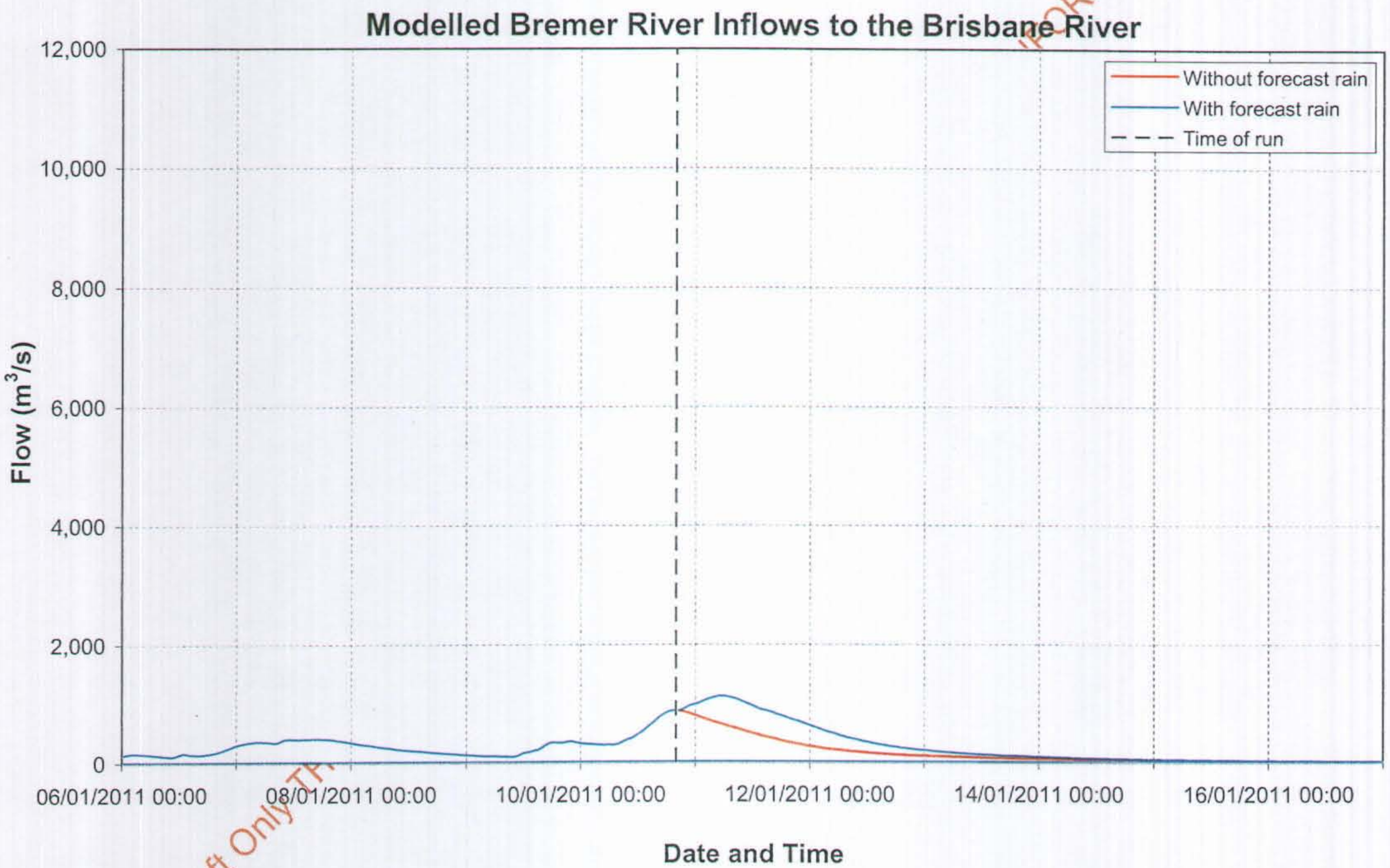
Time: 20:00

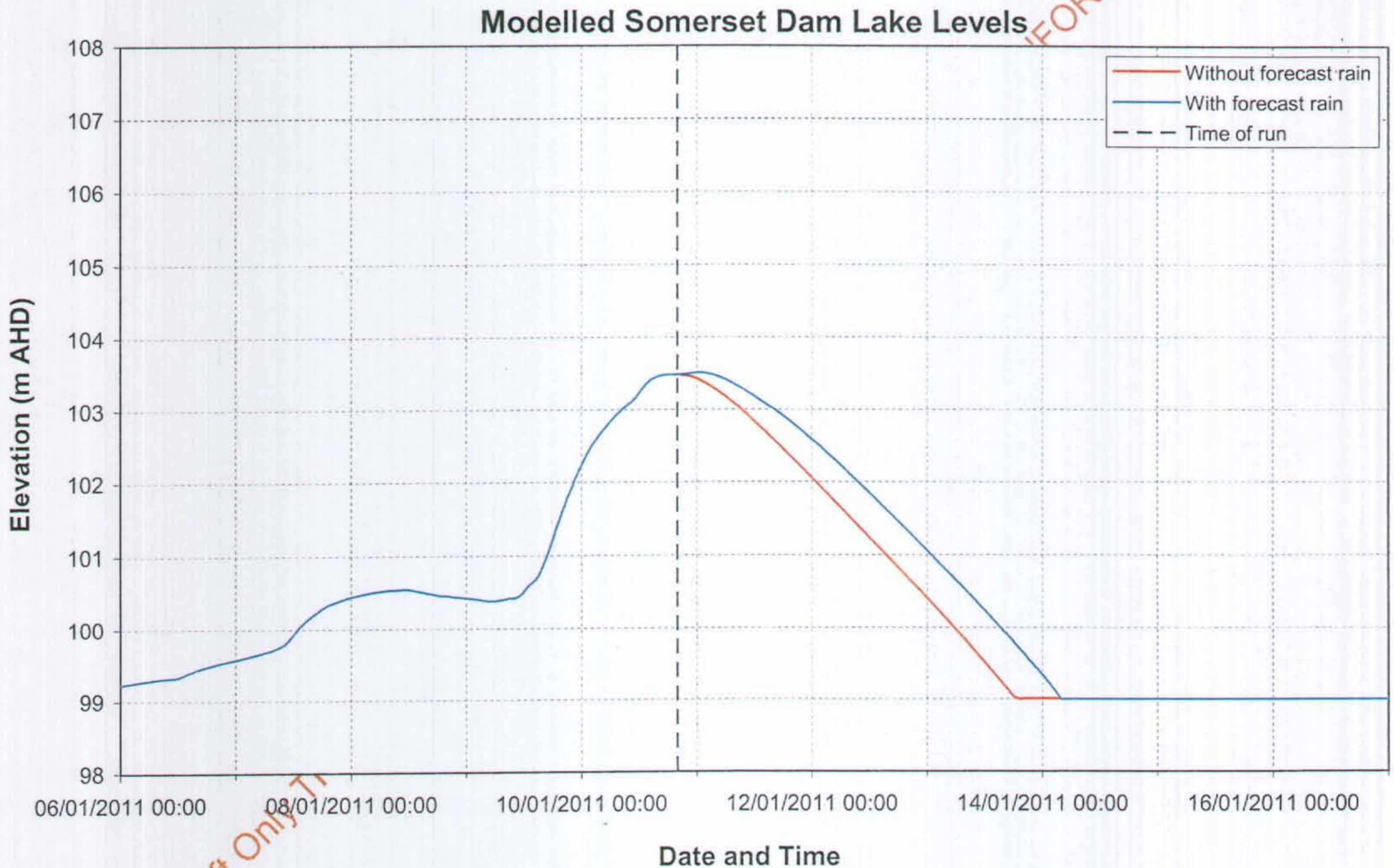

Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

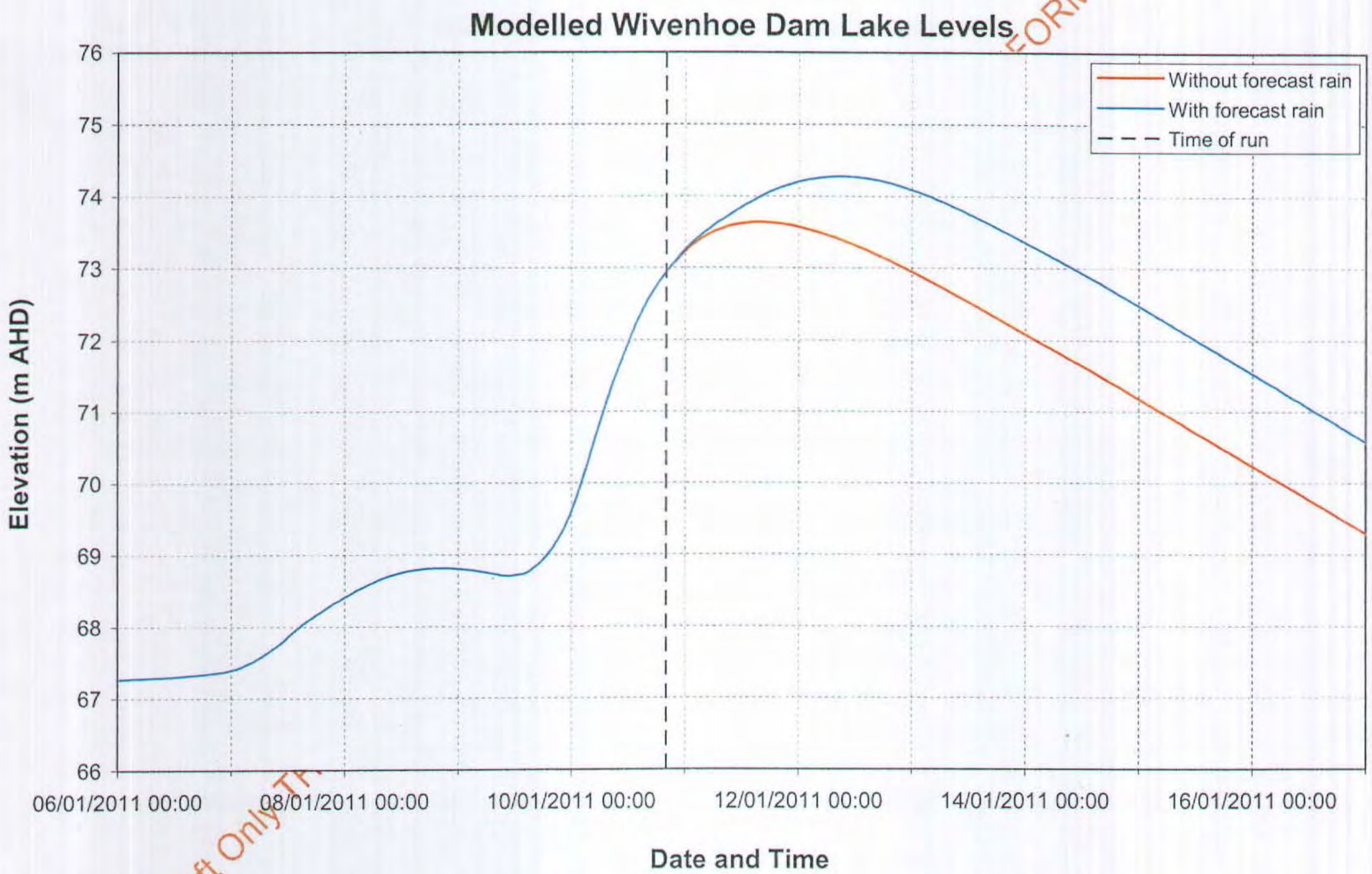
APPENDIX A – MODEL RESULTS



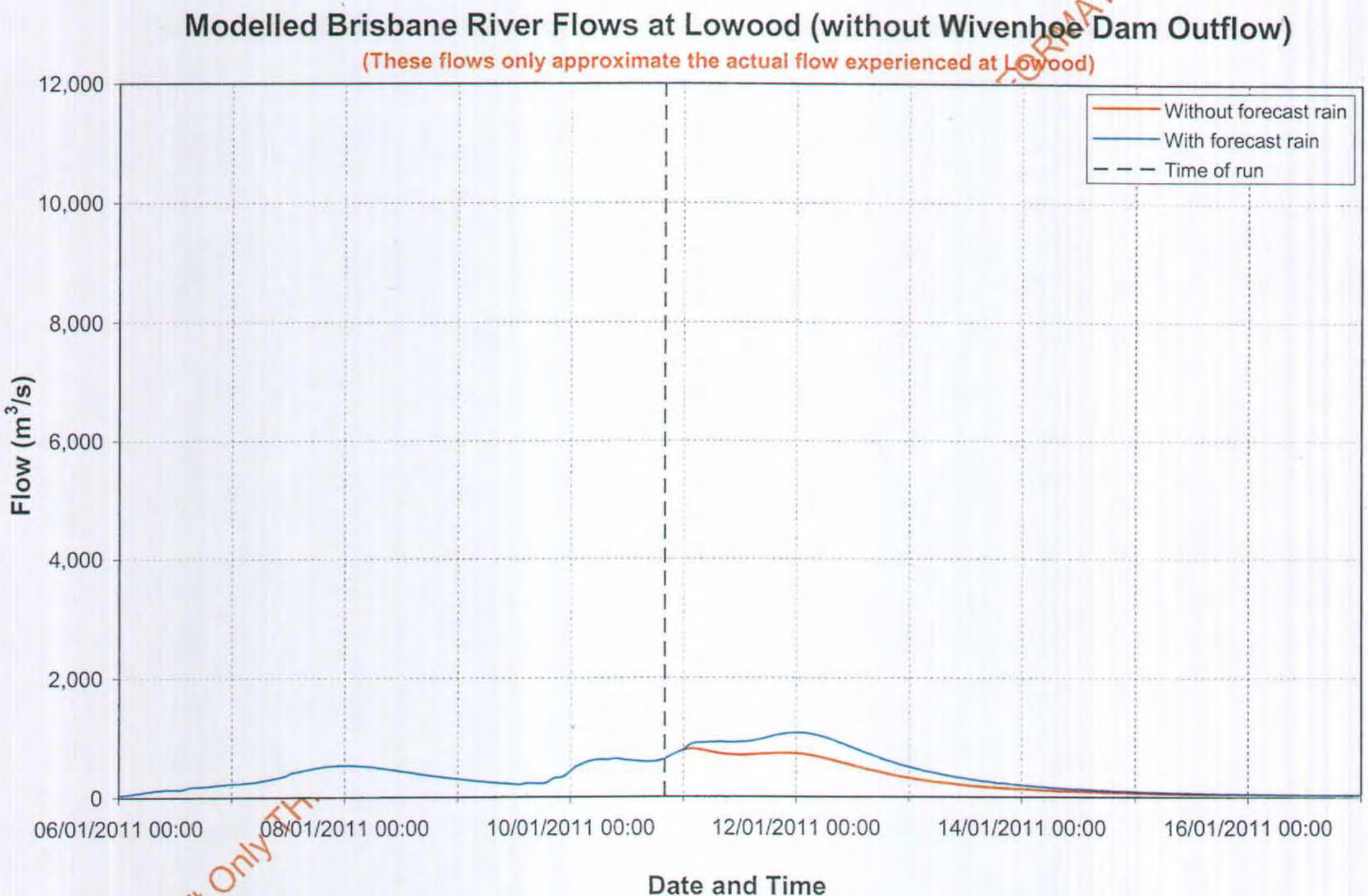

Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Bremer River Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

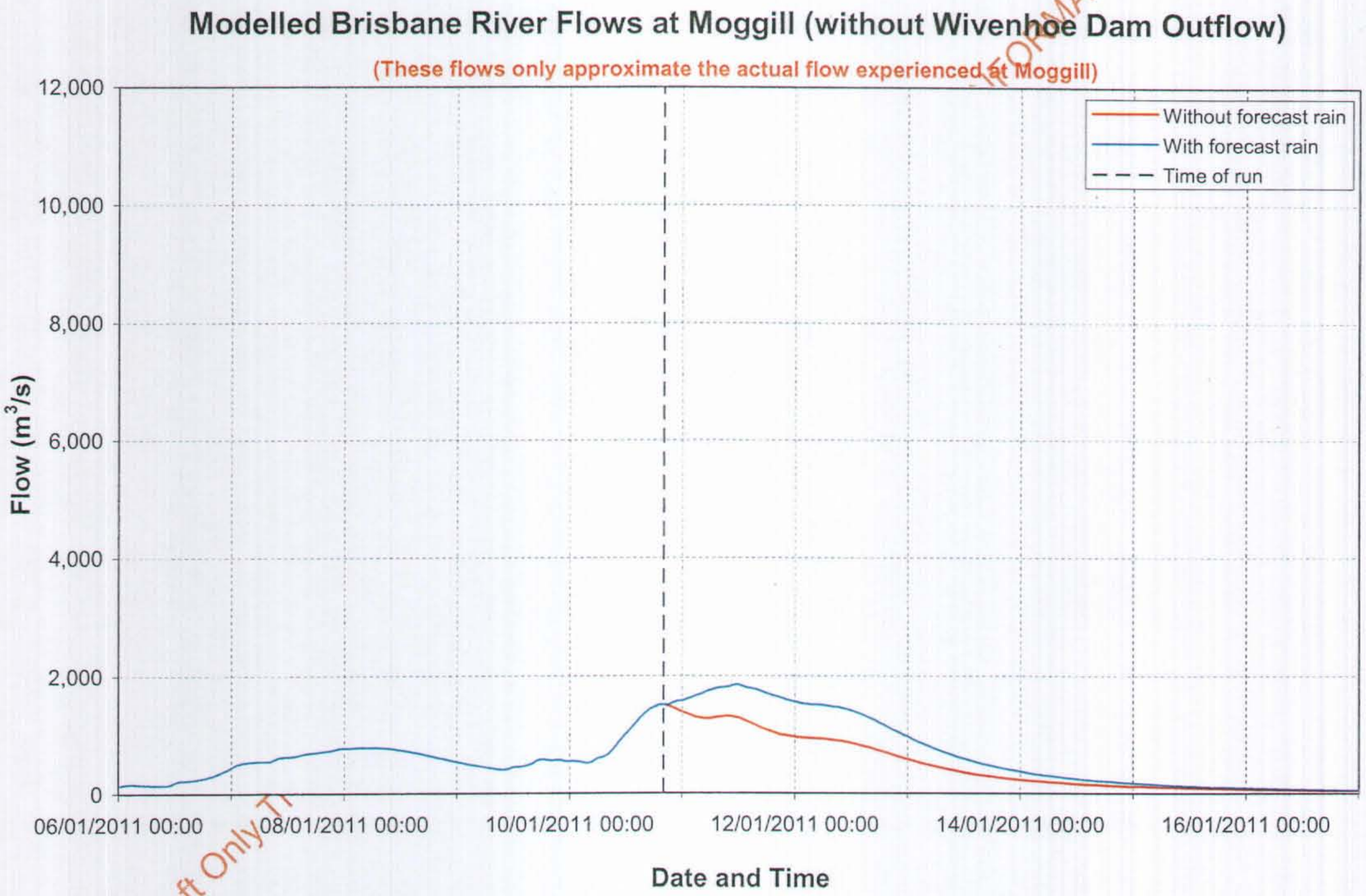

Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m³/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

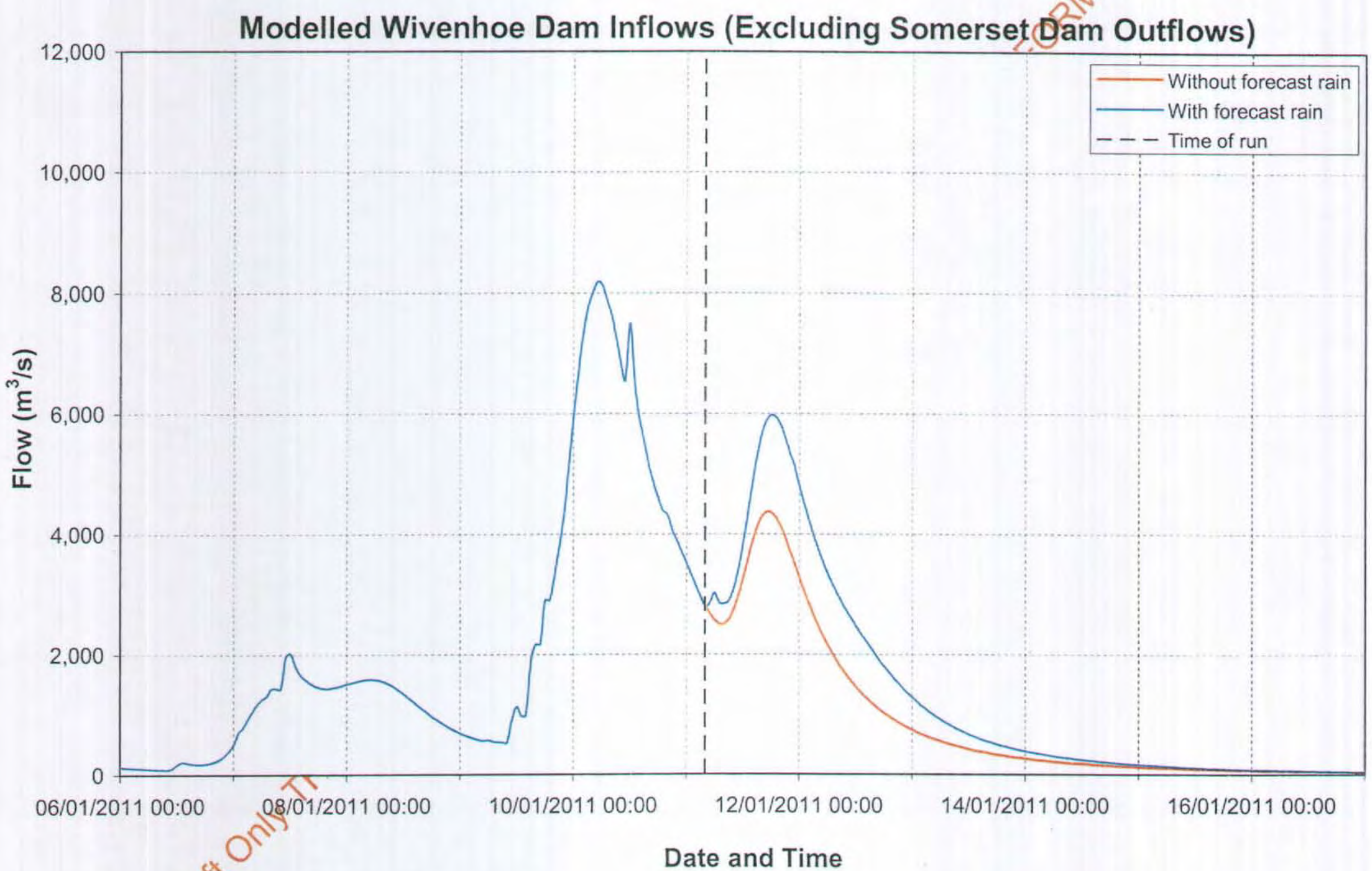

Modelled Brisbane River Flows at Moggill (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Moggill)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

APPENDIX A – MODEL RESULTS

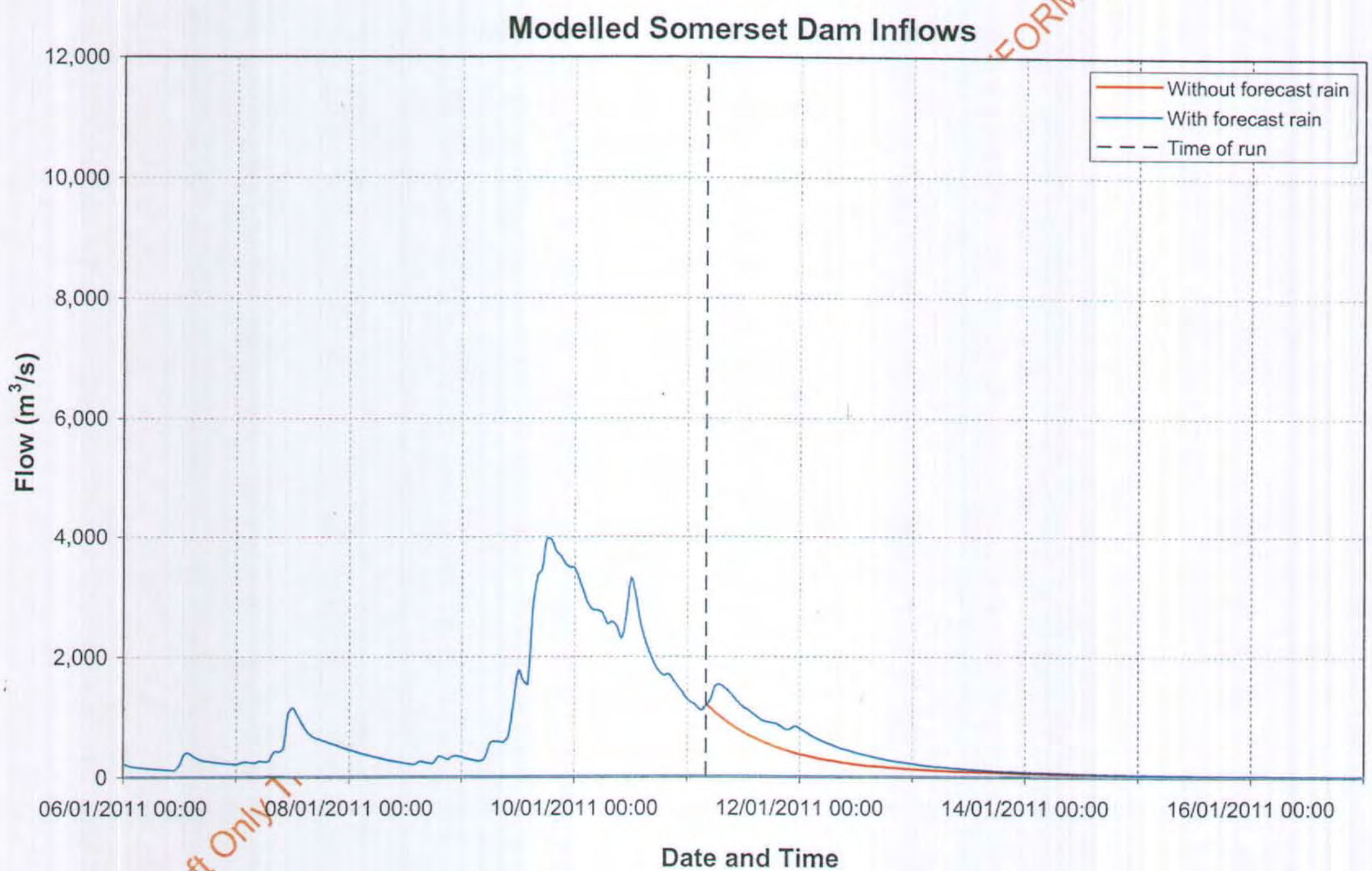
Run 35

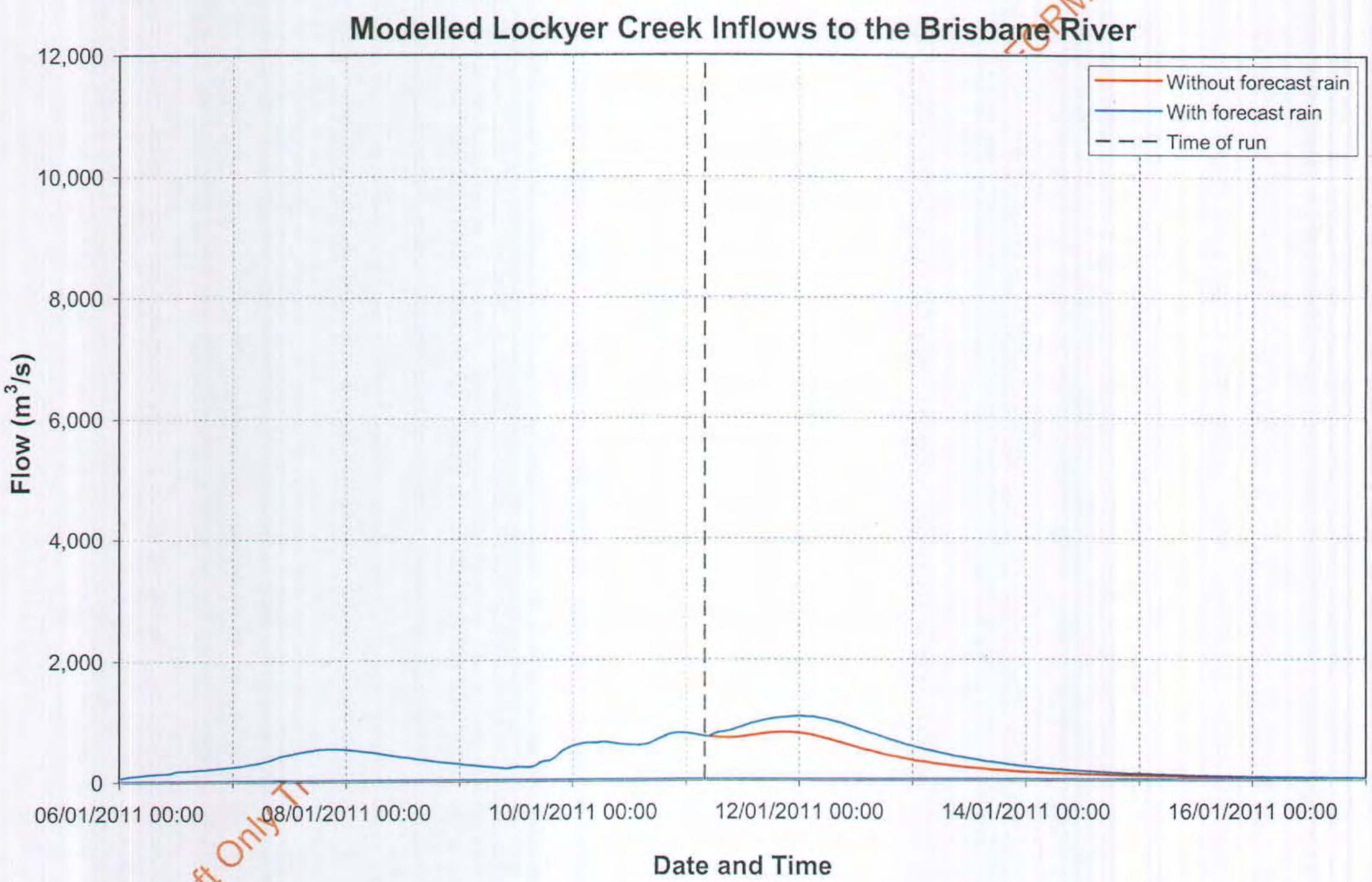
Date: Tuesday 11 January 2011

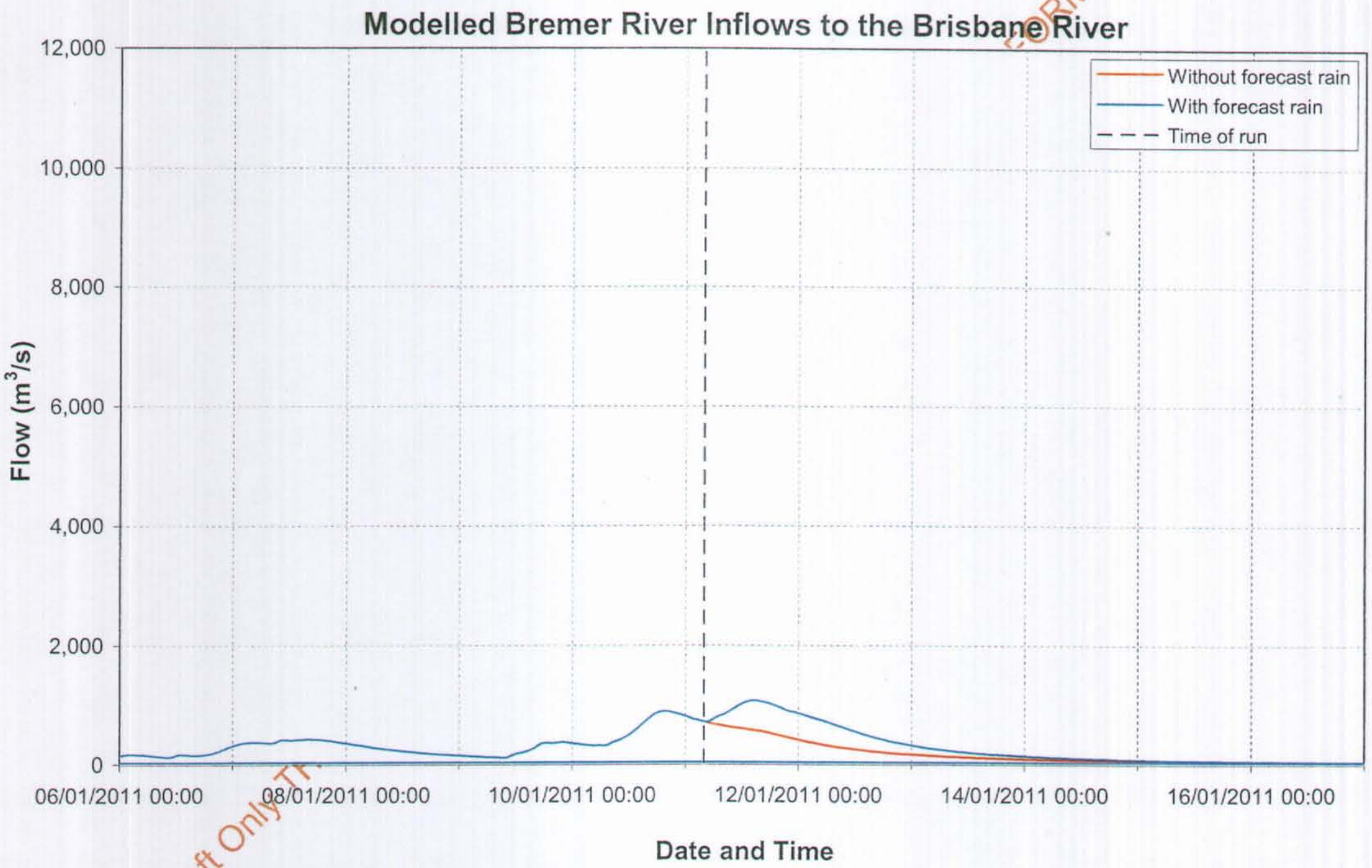
Time: 04:00

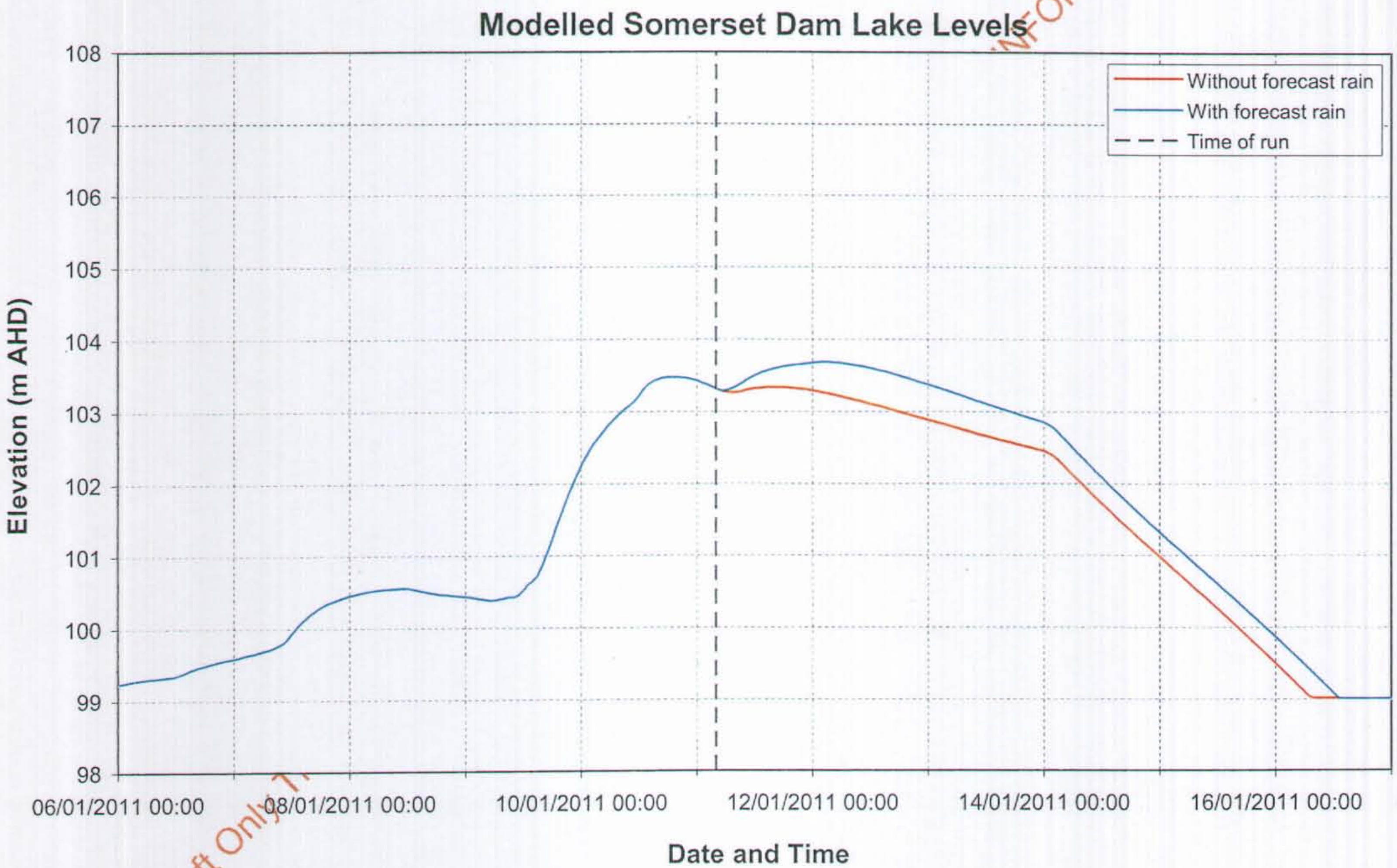


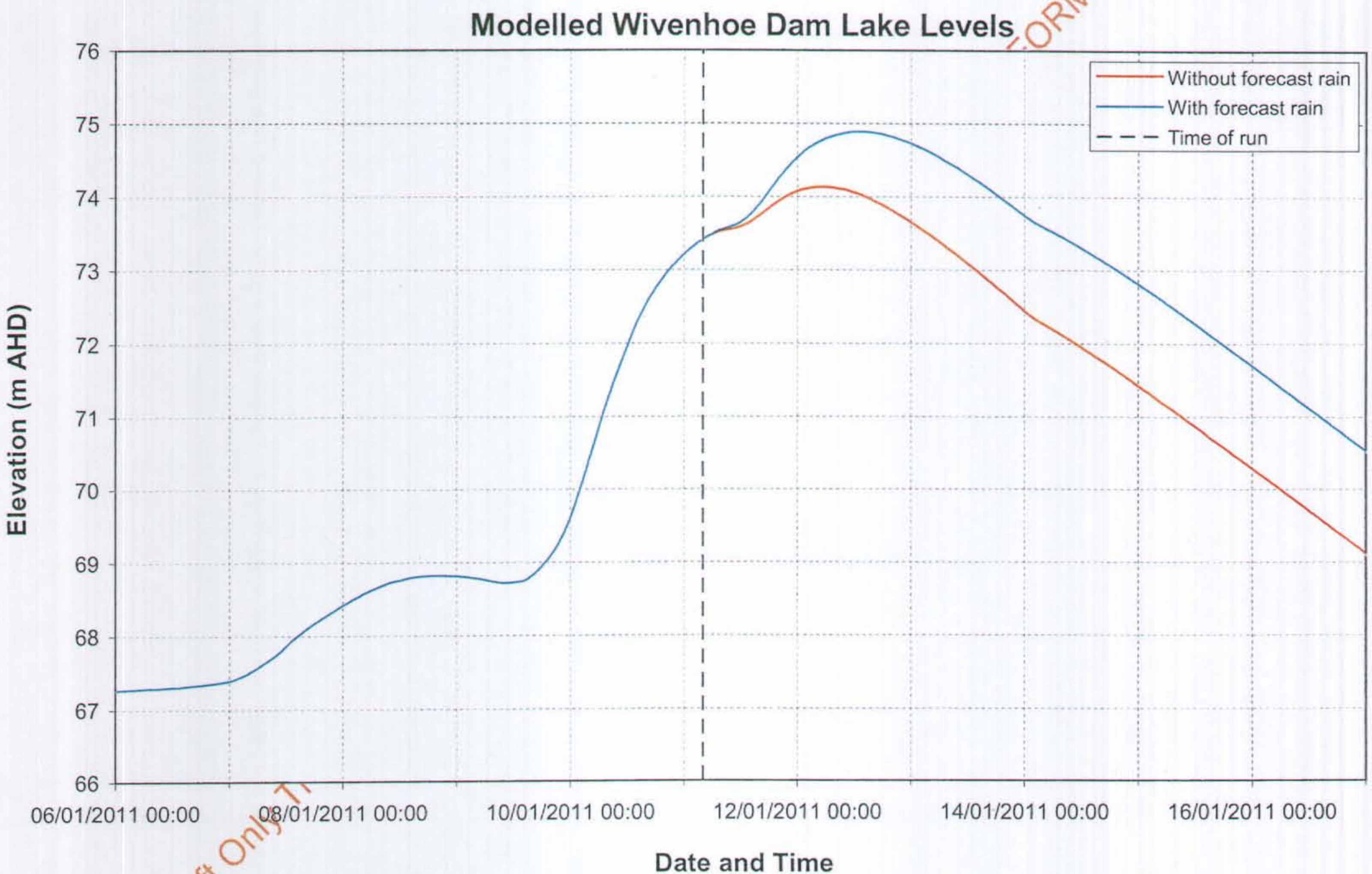
Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

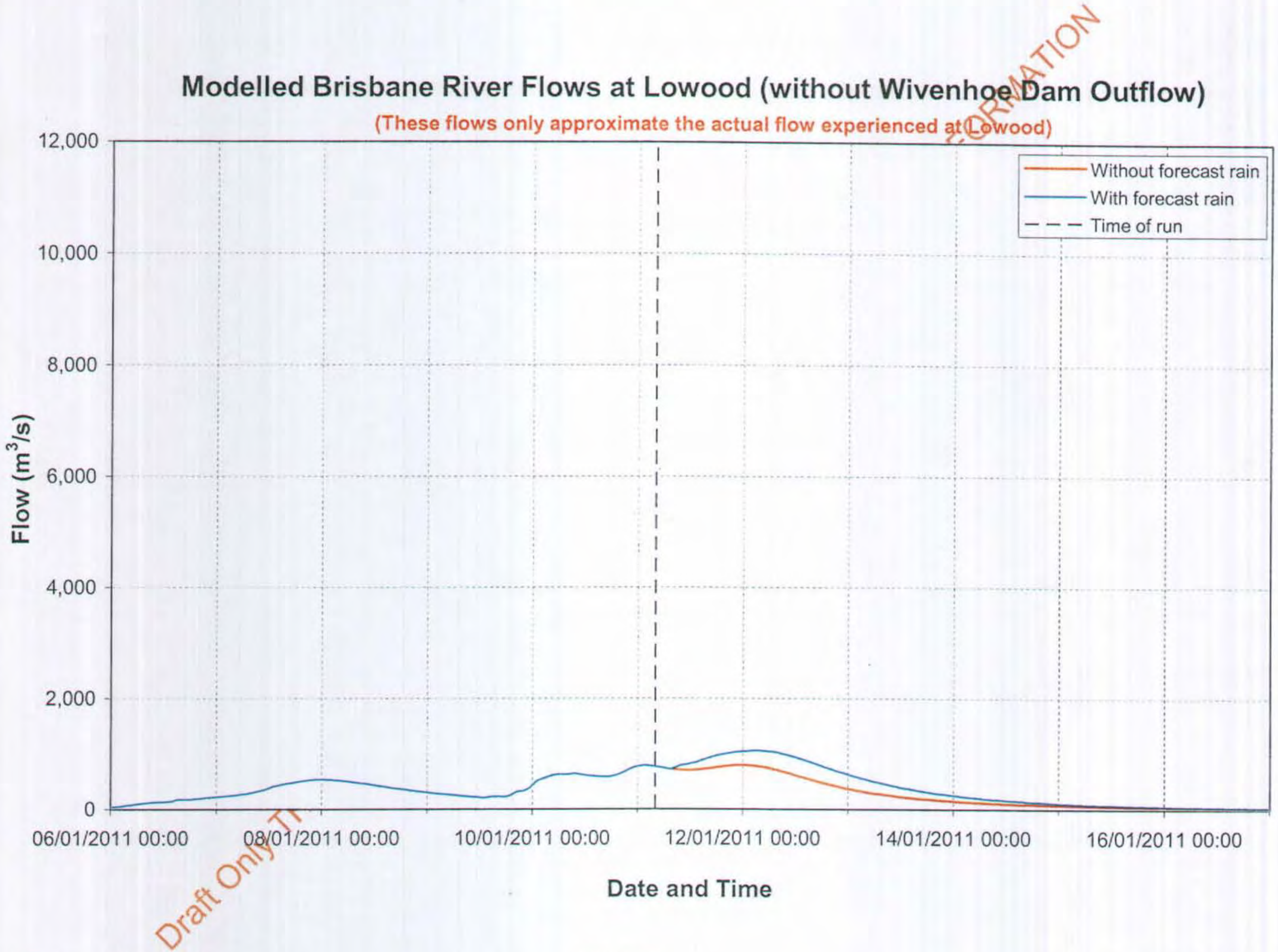

Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

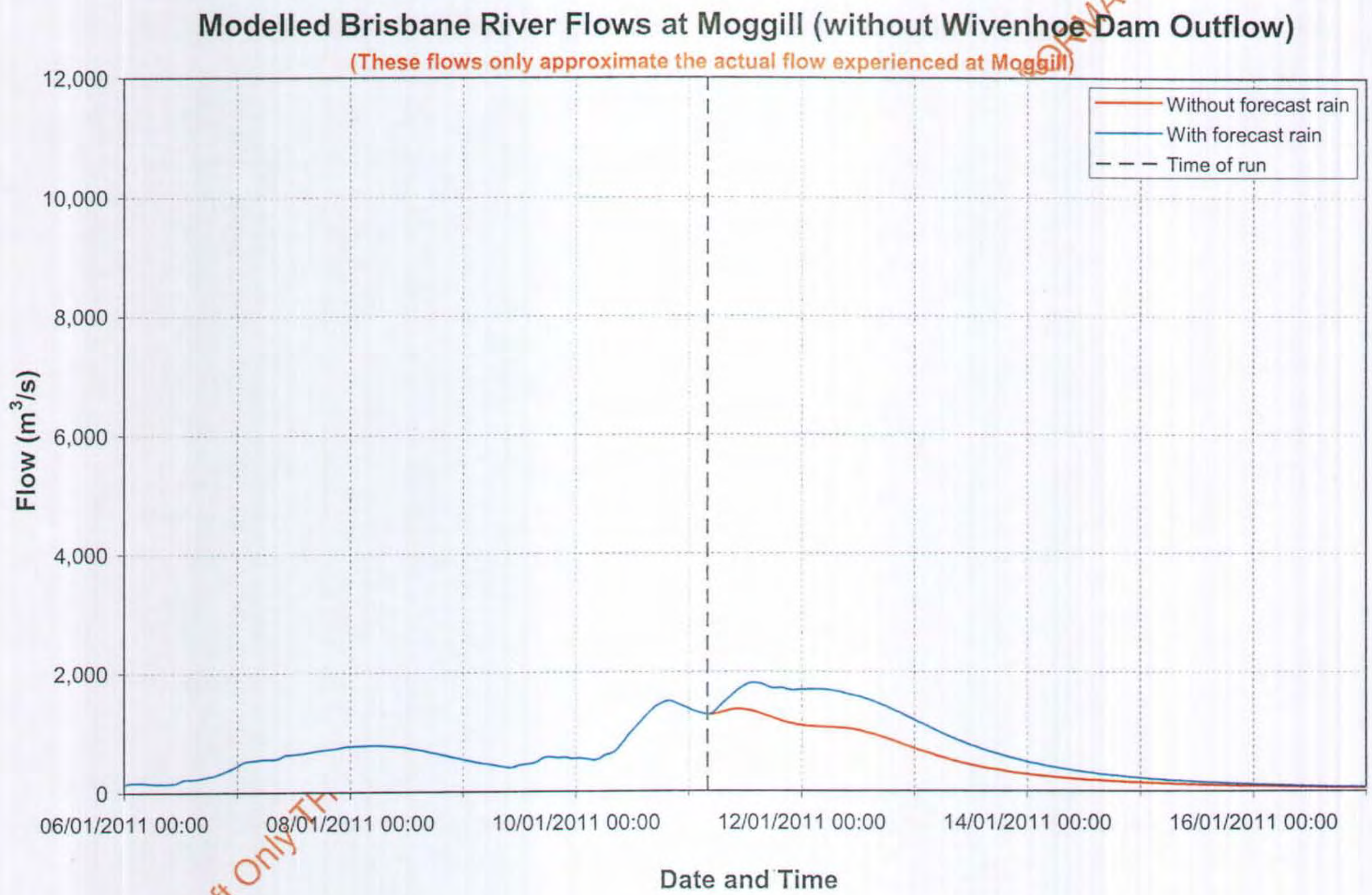

Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Bremer River Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time
INFORMATION
Draft Only

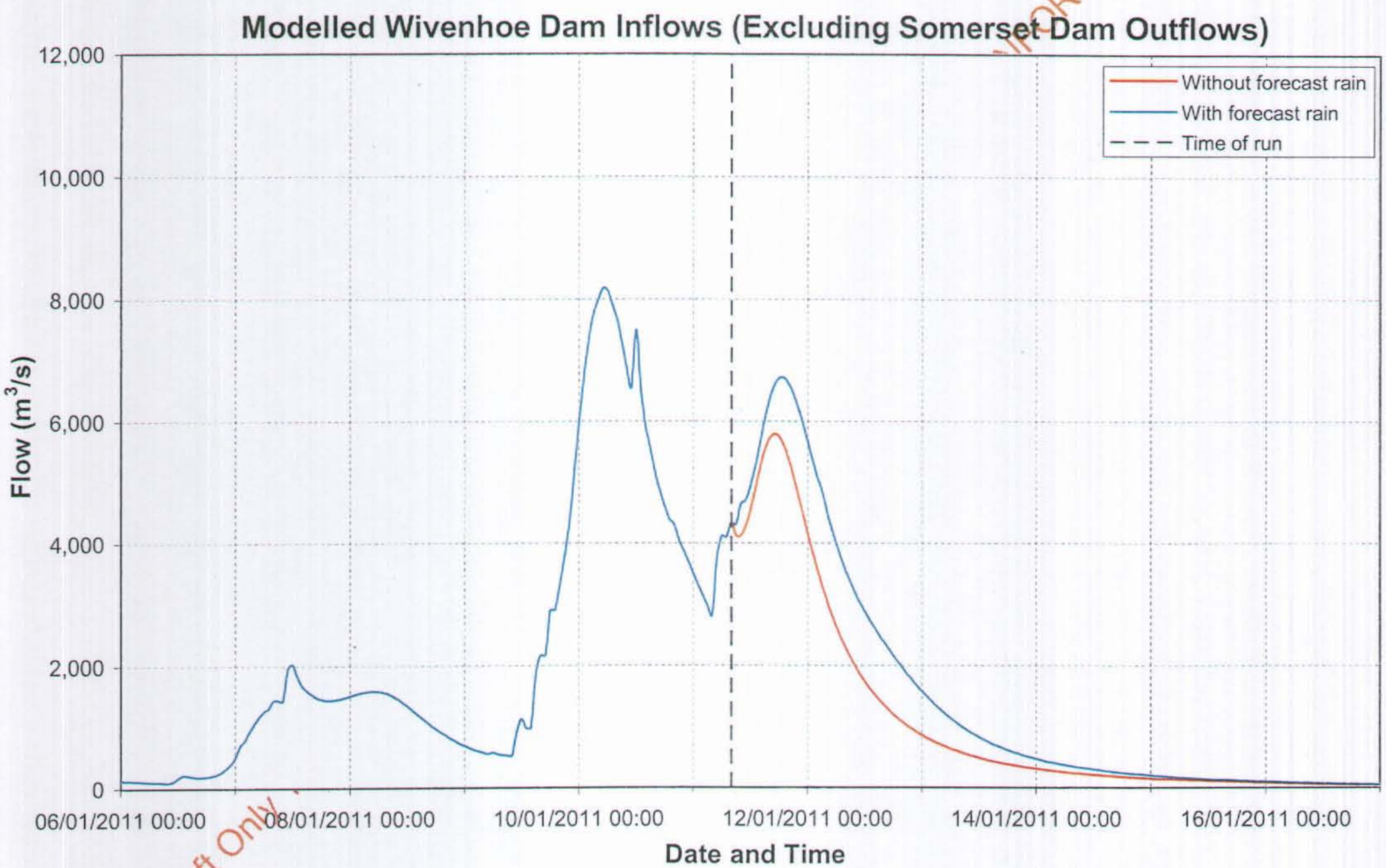

Modelled Brisbane River Flows at Moggill (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Moggill)
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

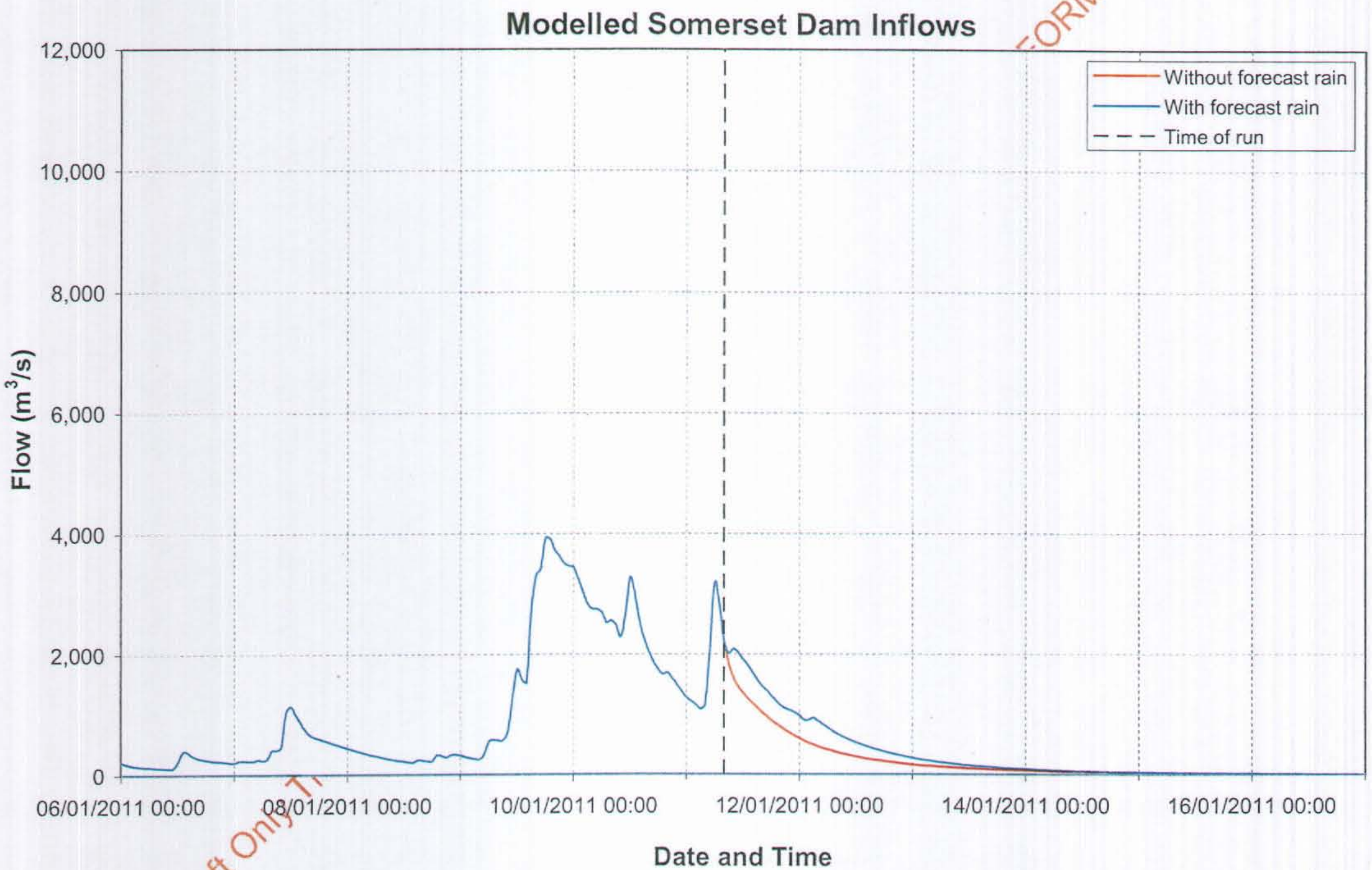
APPENDIX A – MODEL RESULTS

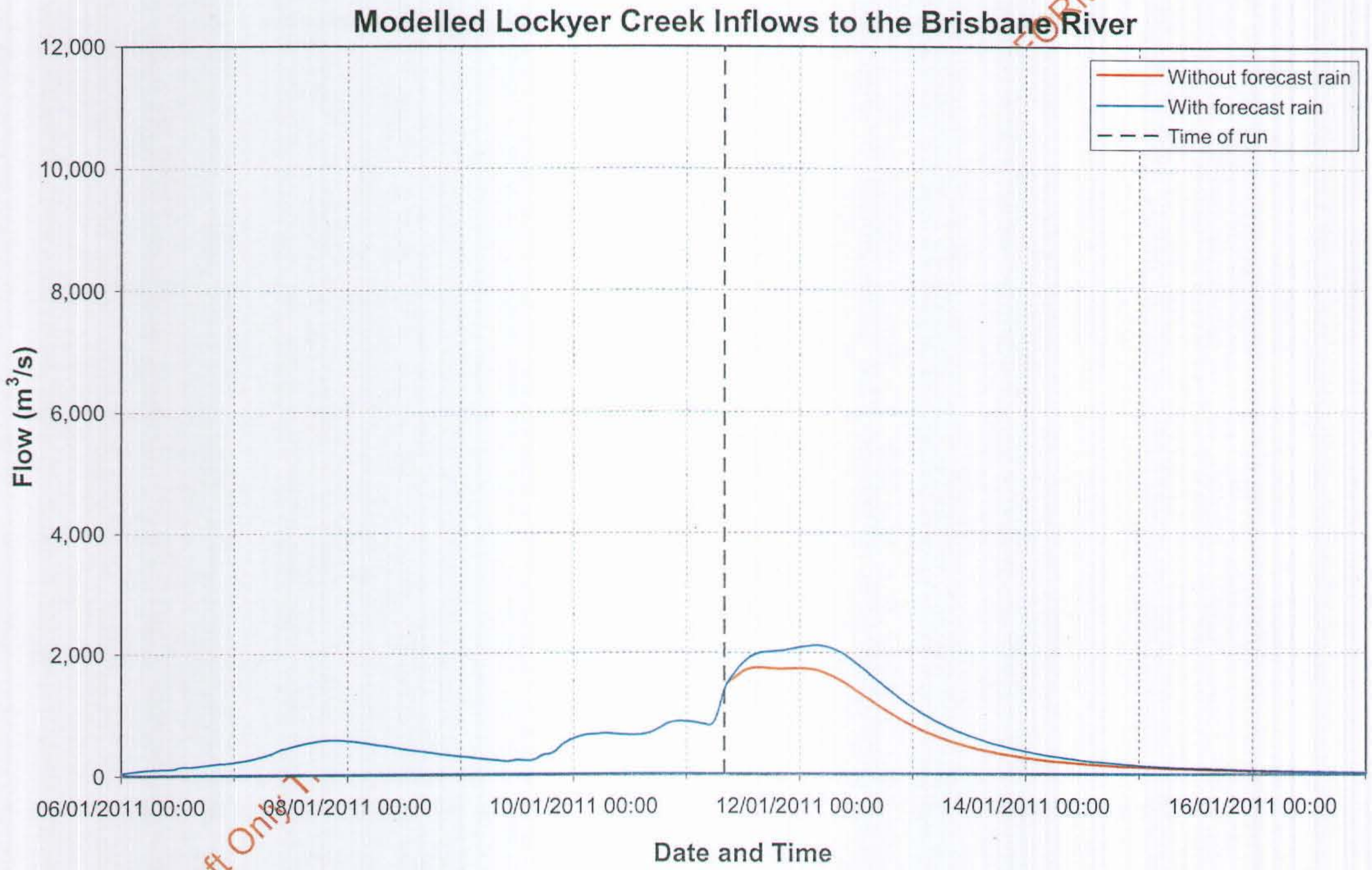
Run 37

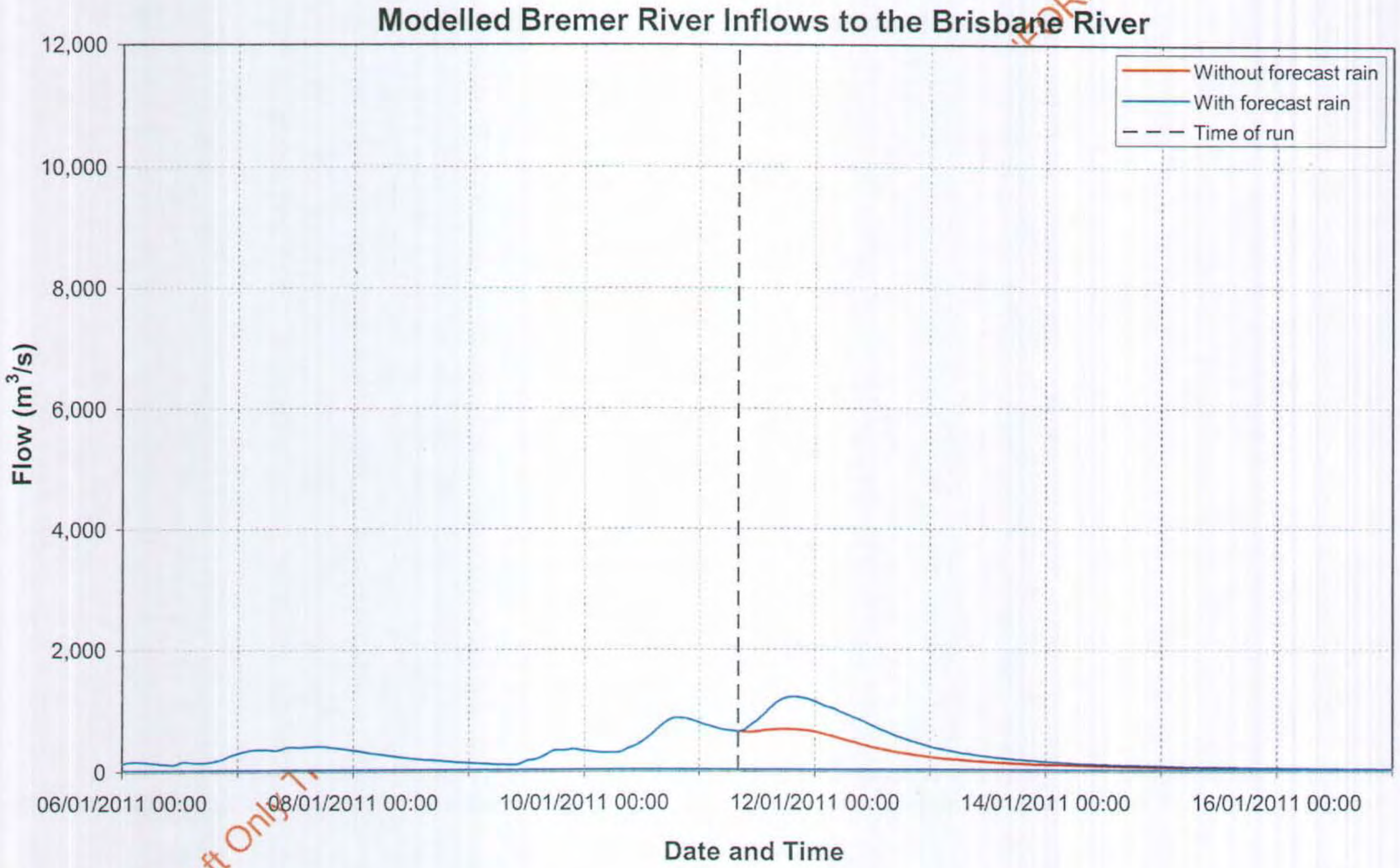
Date: Tuesday 11 January 2011

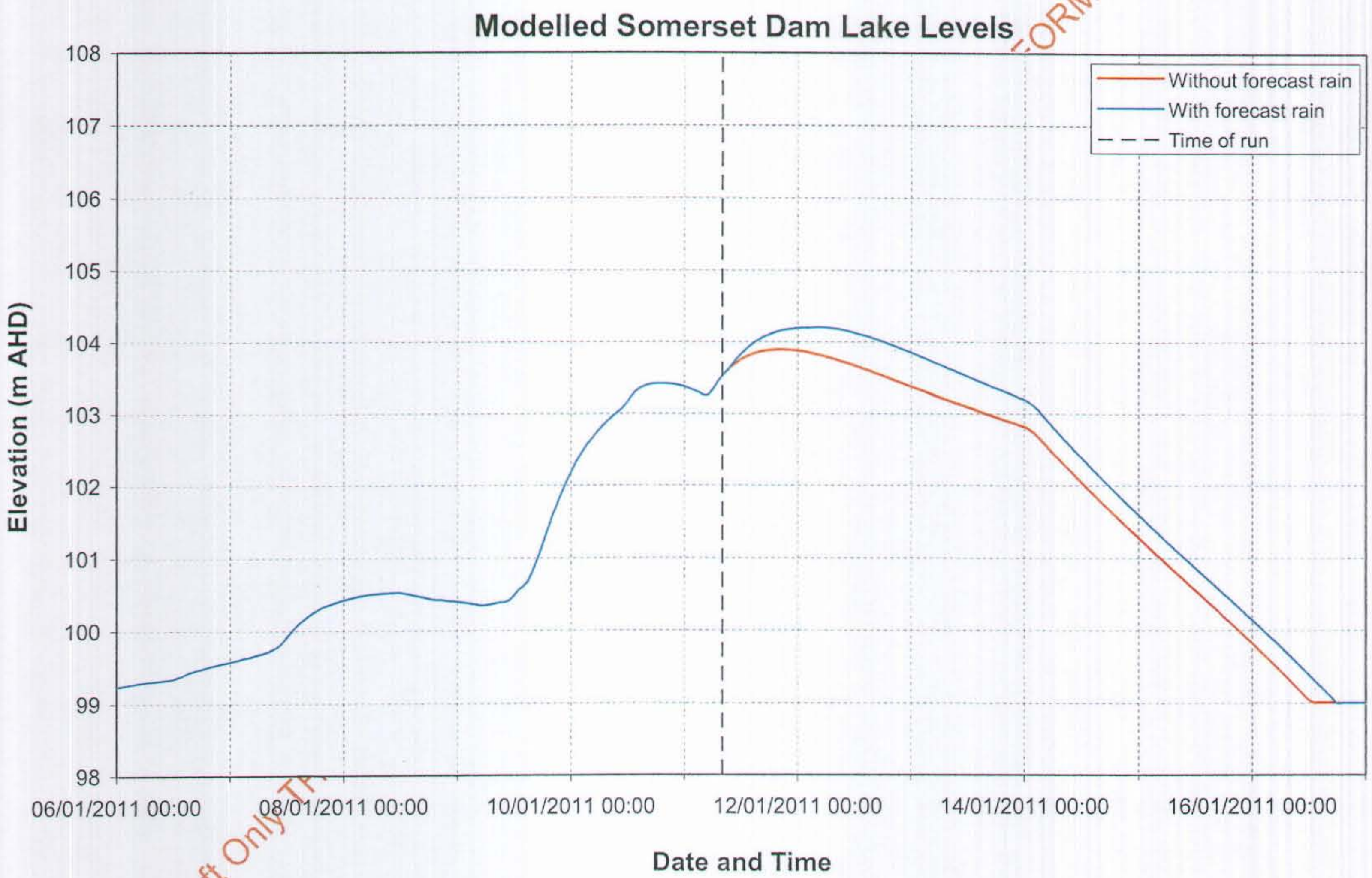
Time: 08:00

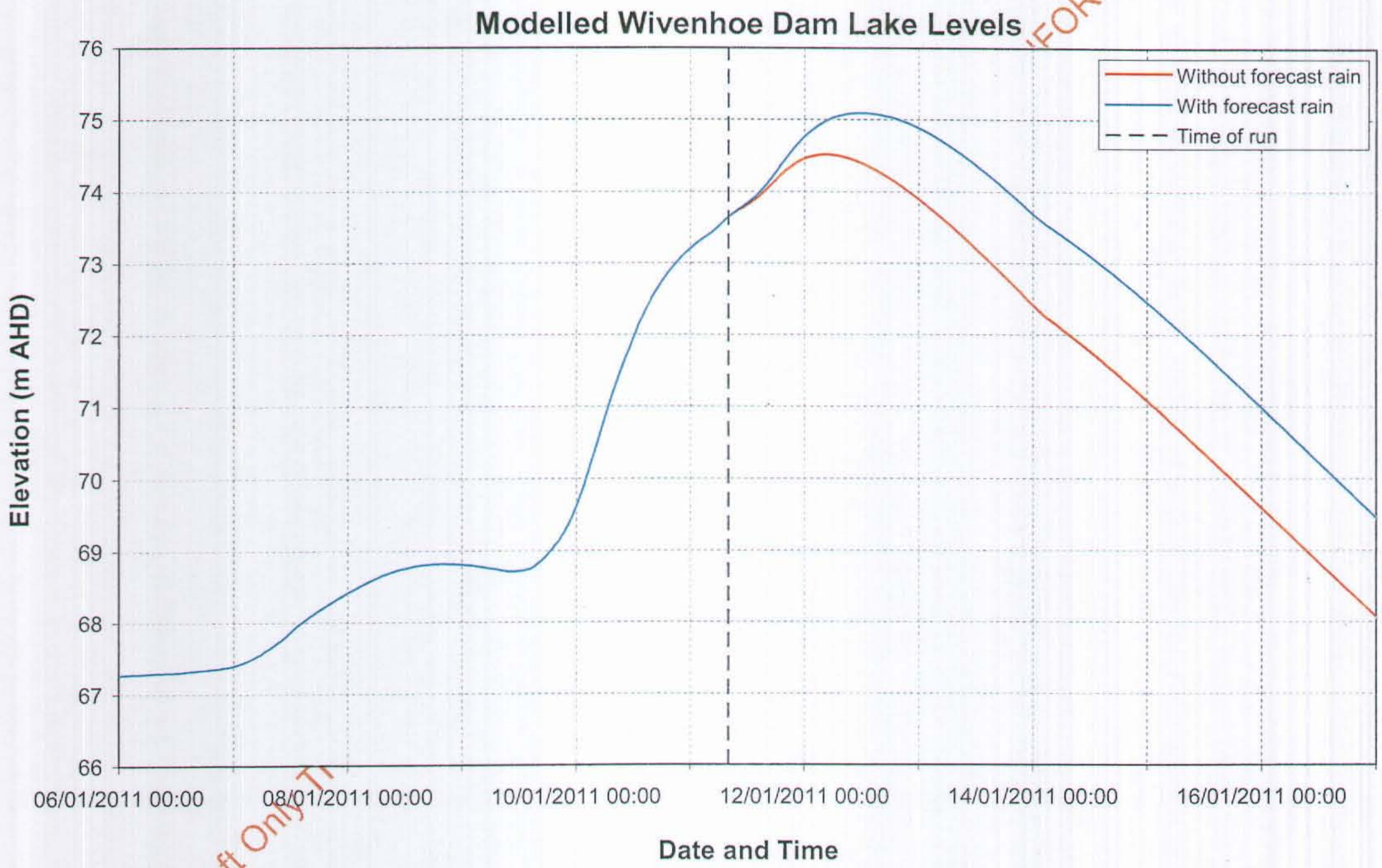

Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

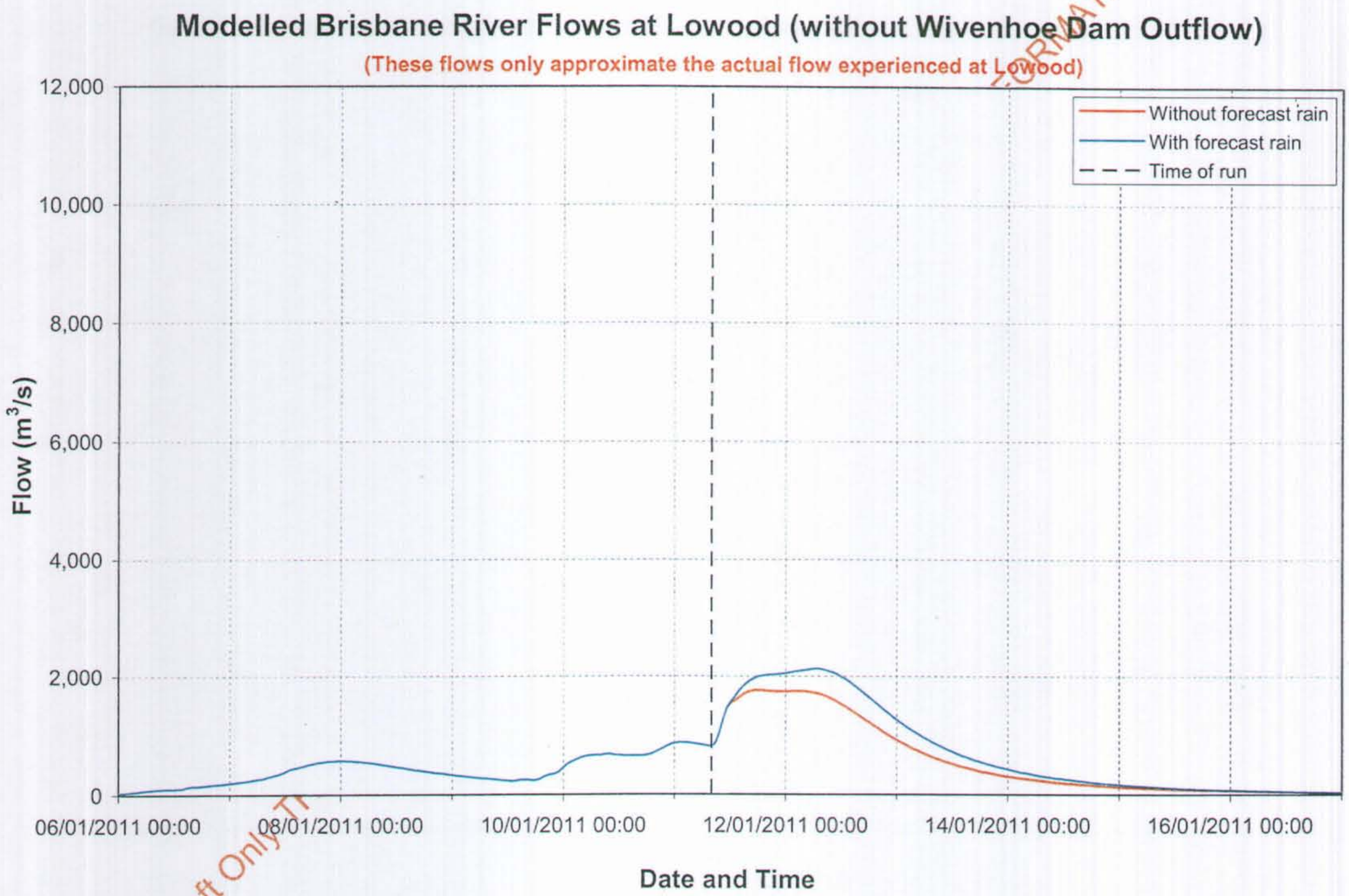

Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

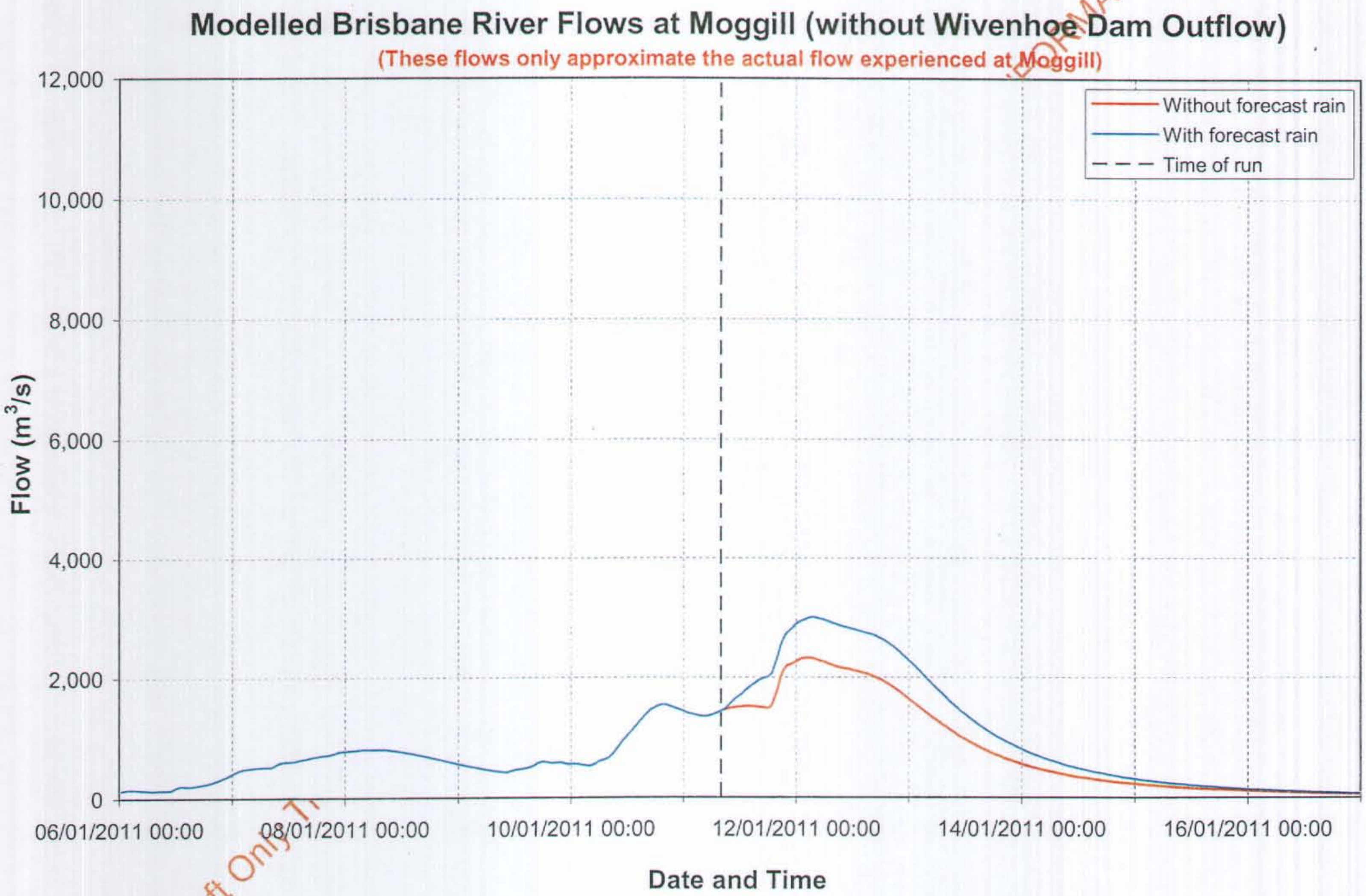

Modelled Bremer River Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
Flow (m^3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

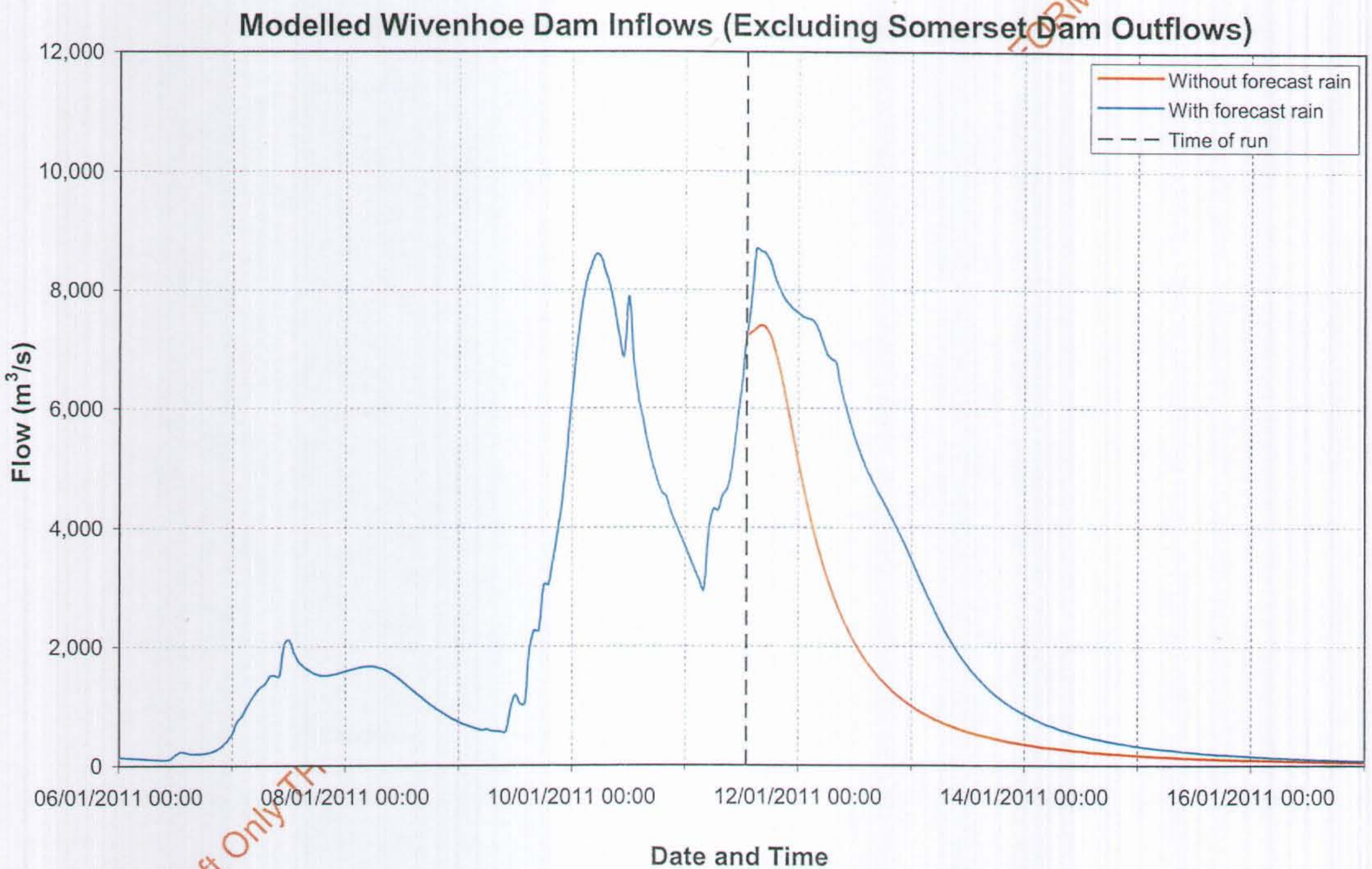

Modelled Brisbane River Flows at Moggill (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Moggill)
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

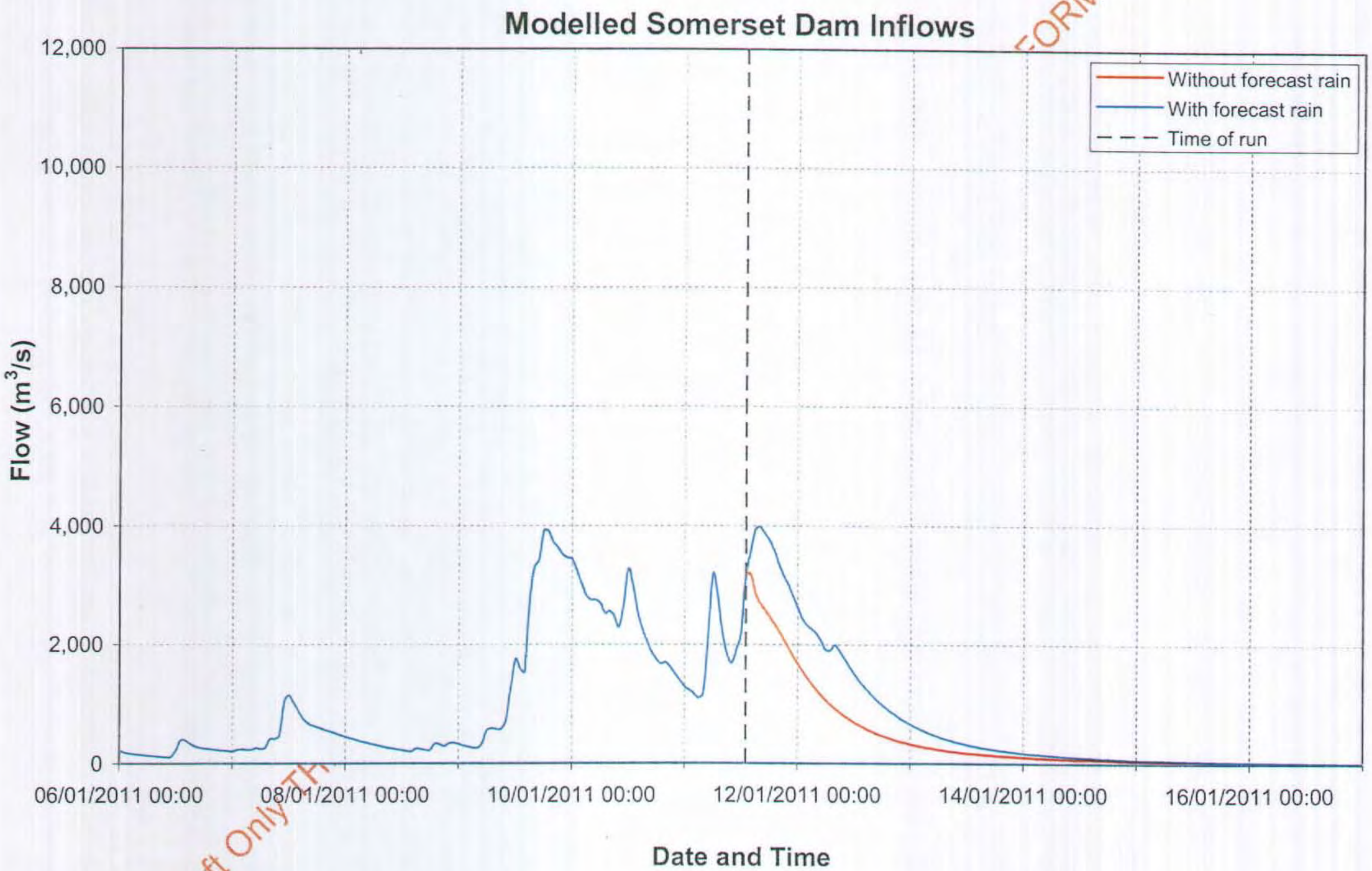
APPENDIX A – MODEL RESULTS

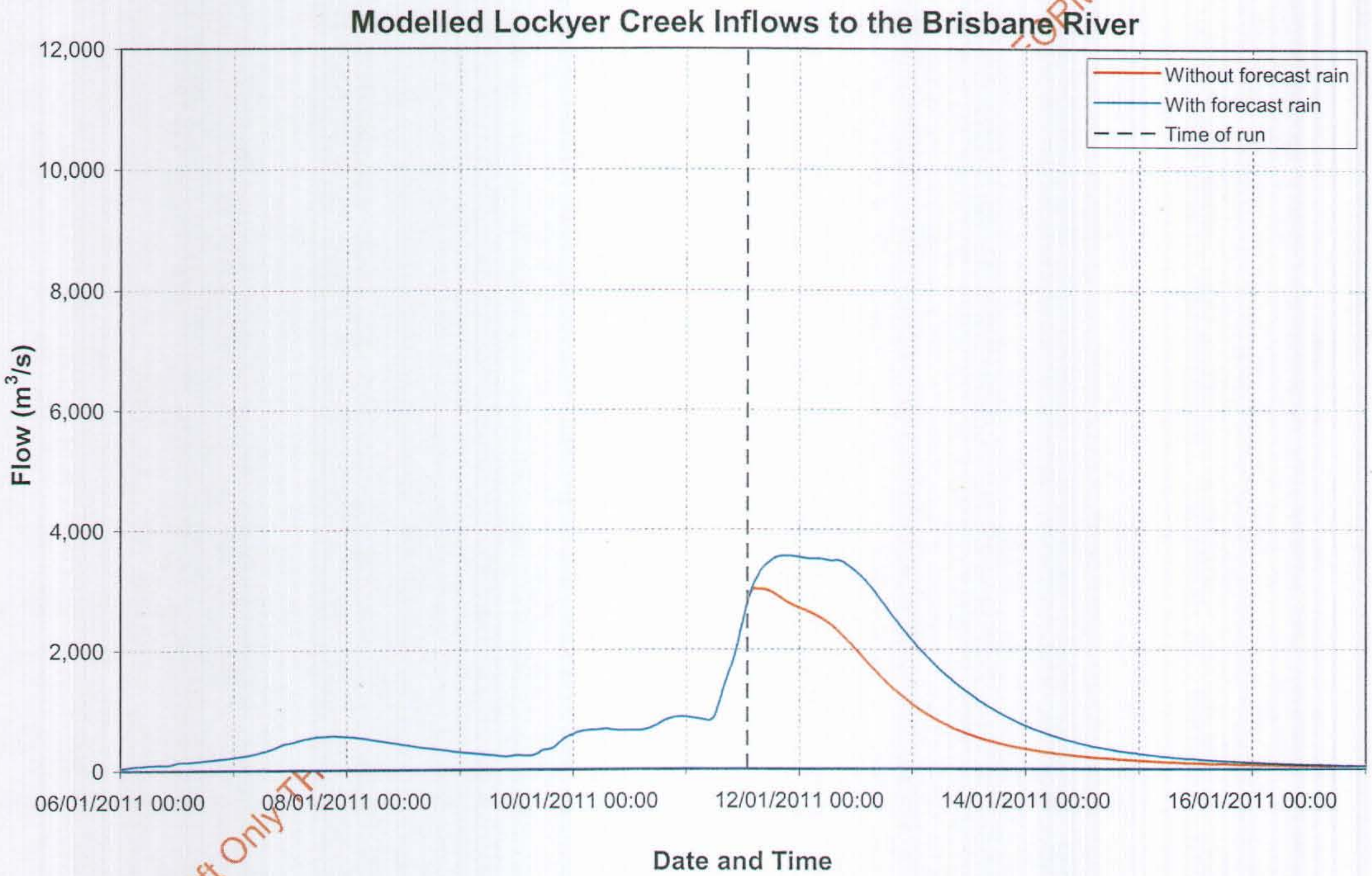
Run 39

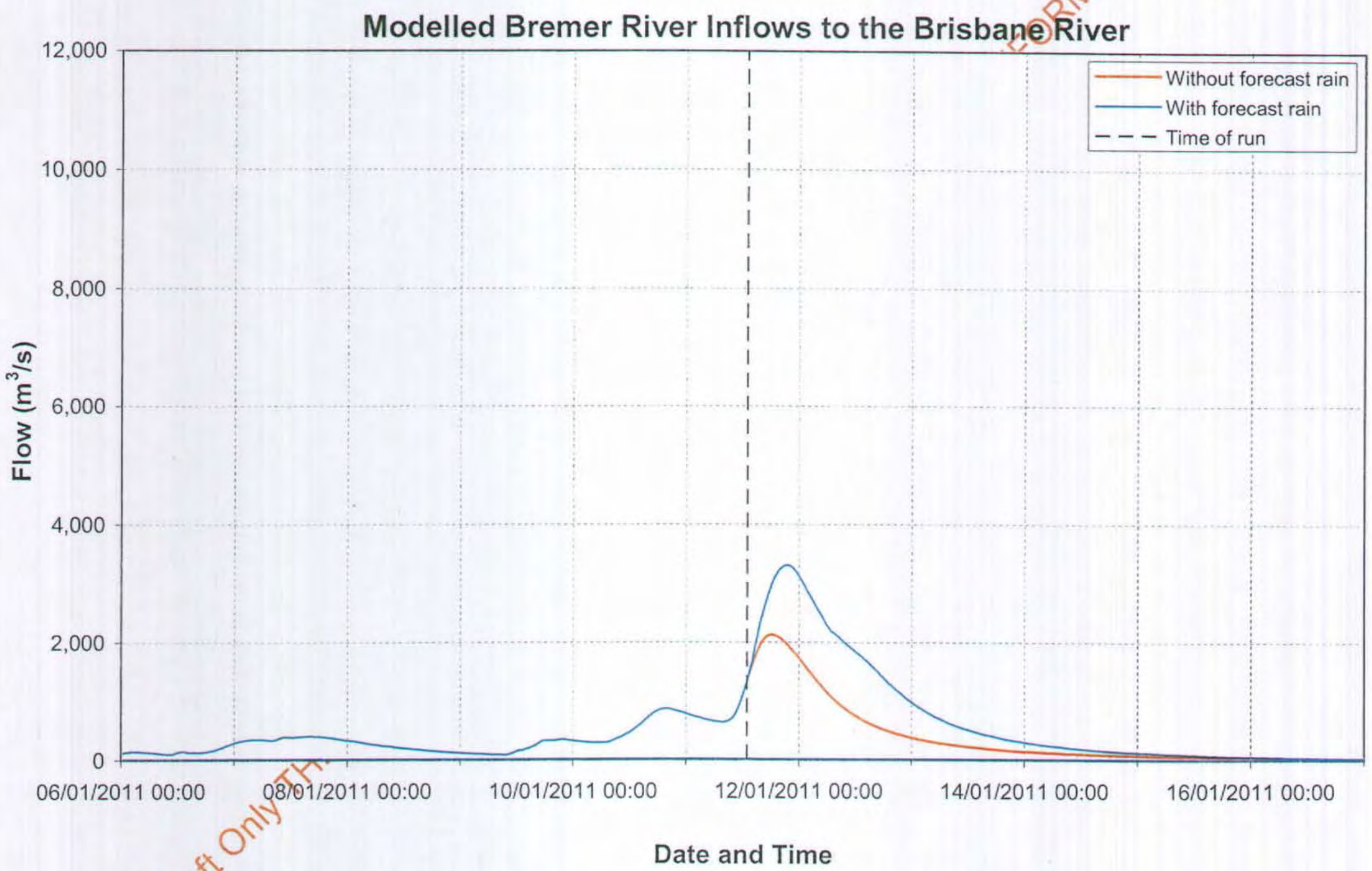
Date: Tuesday 11 January 2011

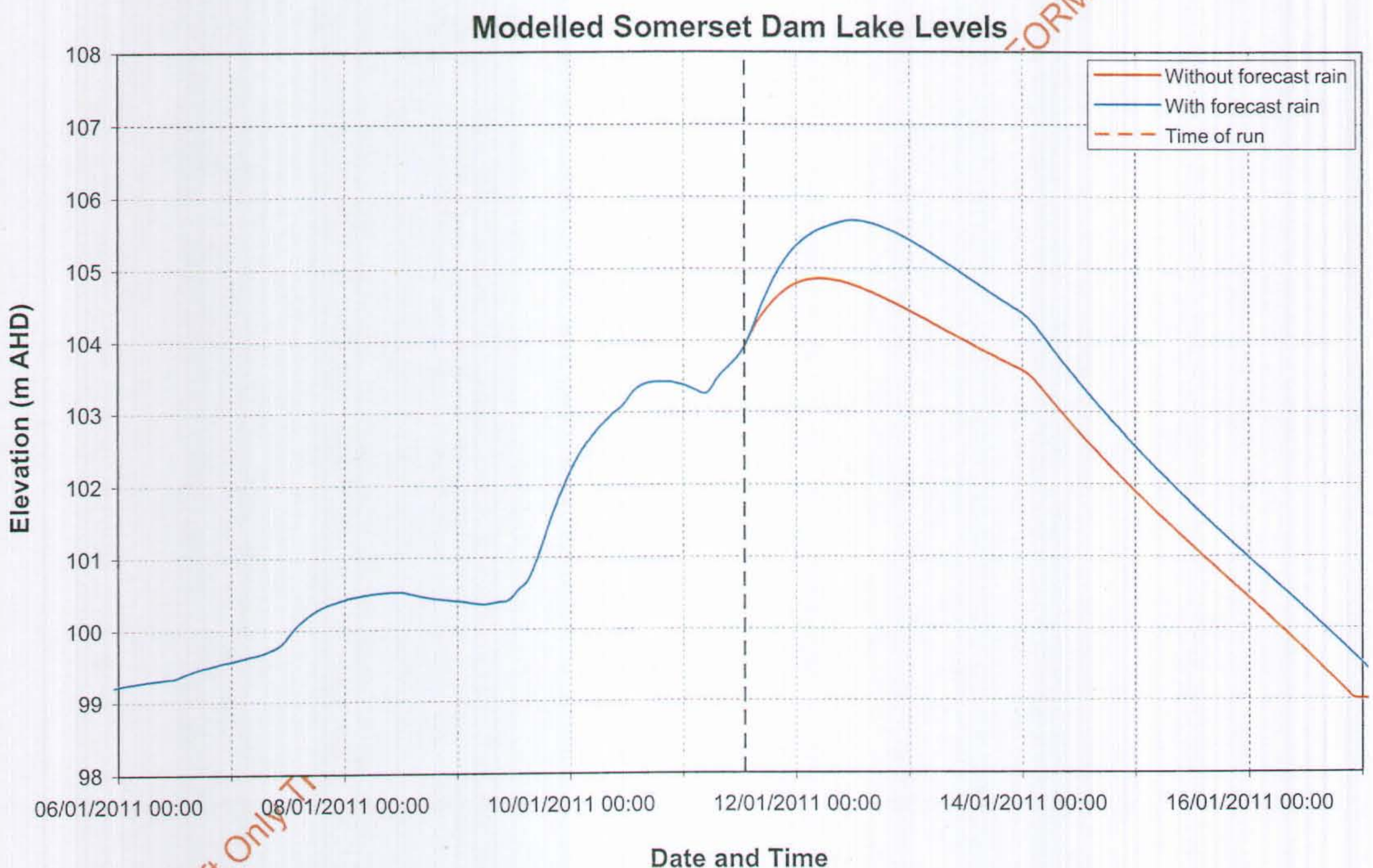
Time: 13:00

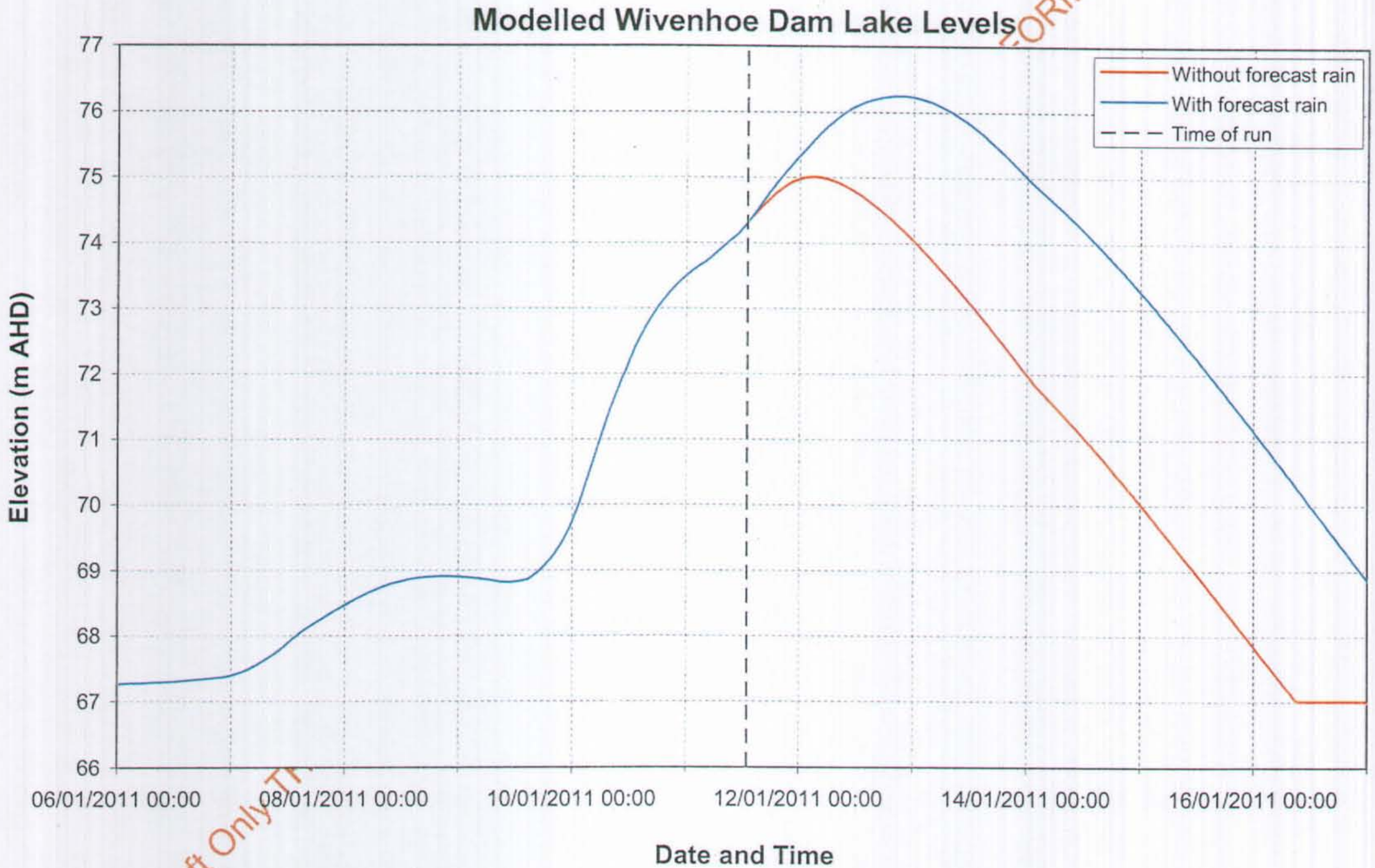

Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m³/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

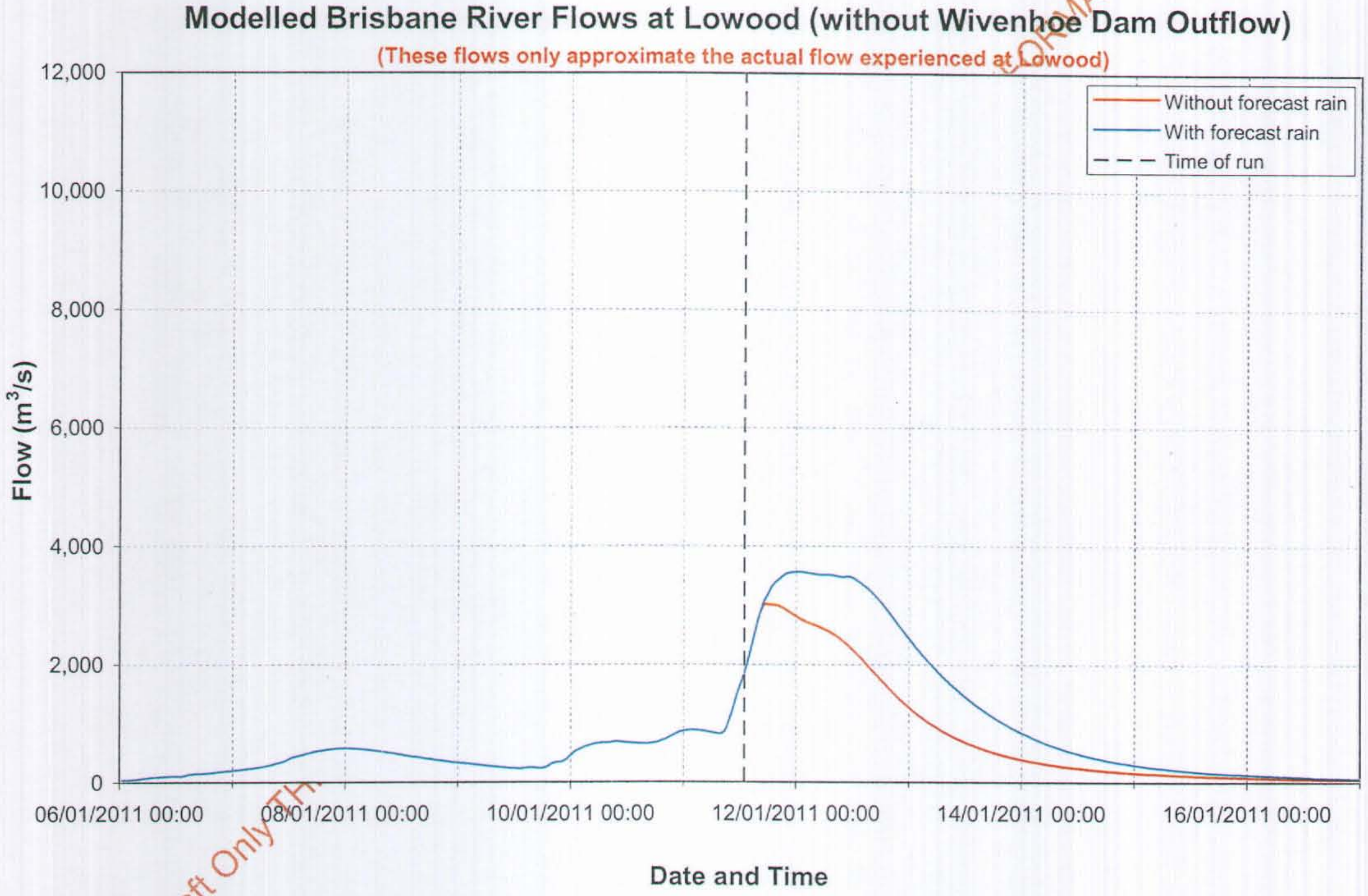

Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Bremer River Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

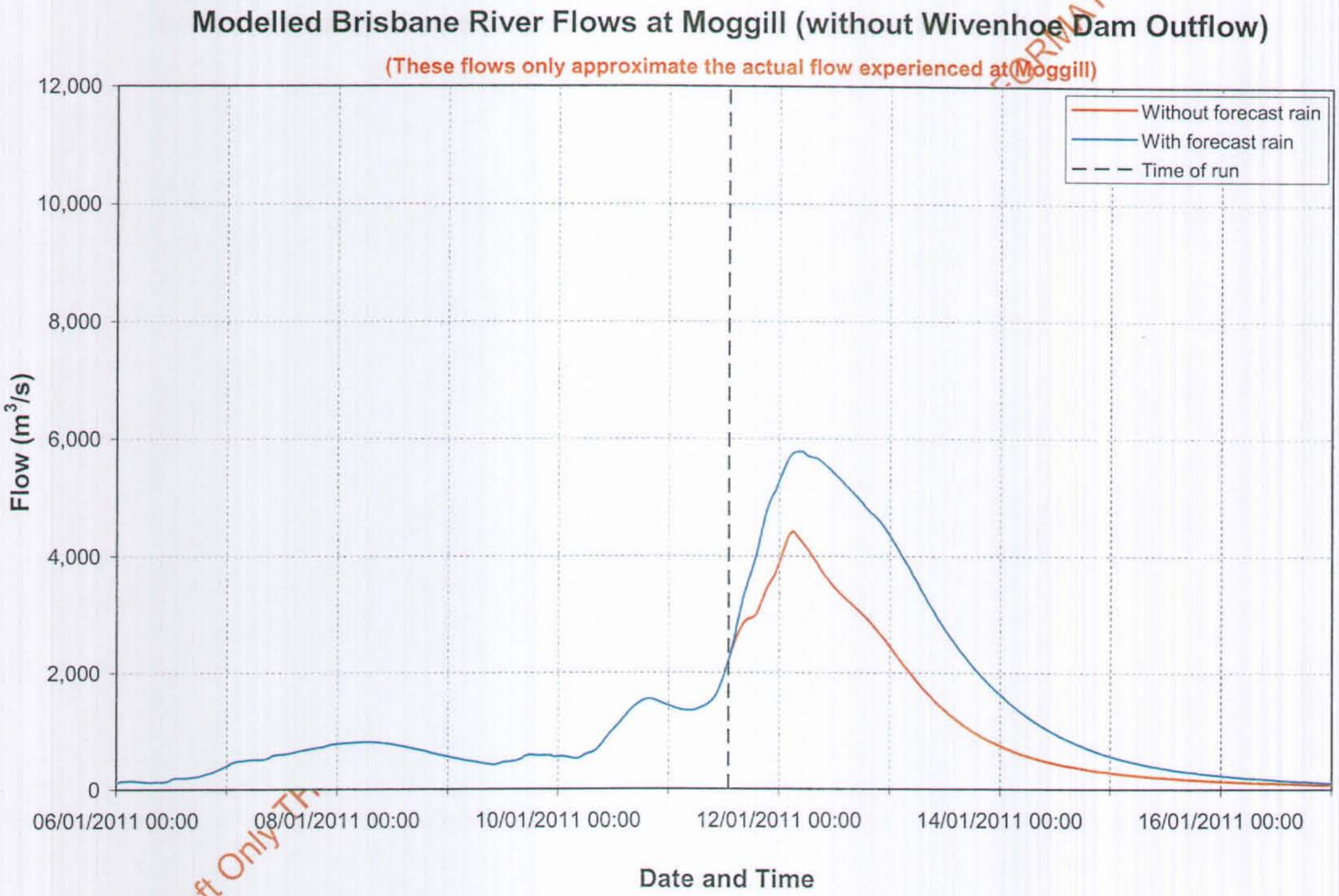

Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
77
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



Modelled Brisbane River Flows at Lowood (without Wivenhoe Dam Outflow)
(These flows only approximate the actual flow experienced at Lowood)
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

APPENDIX A – MODEL RESULTS

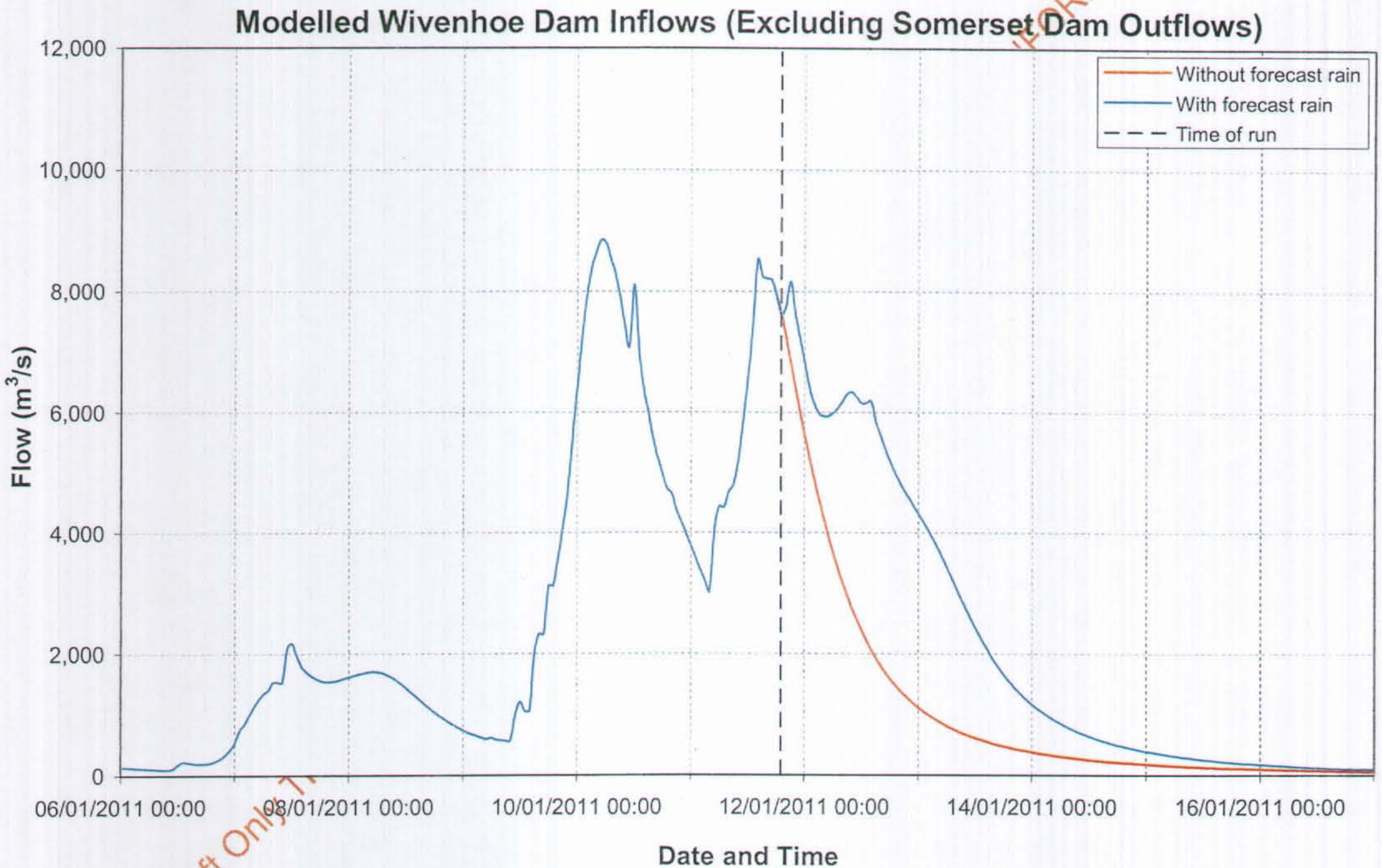


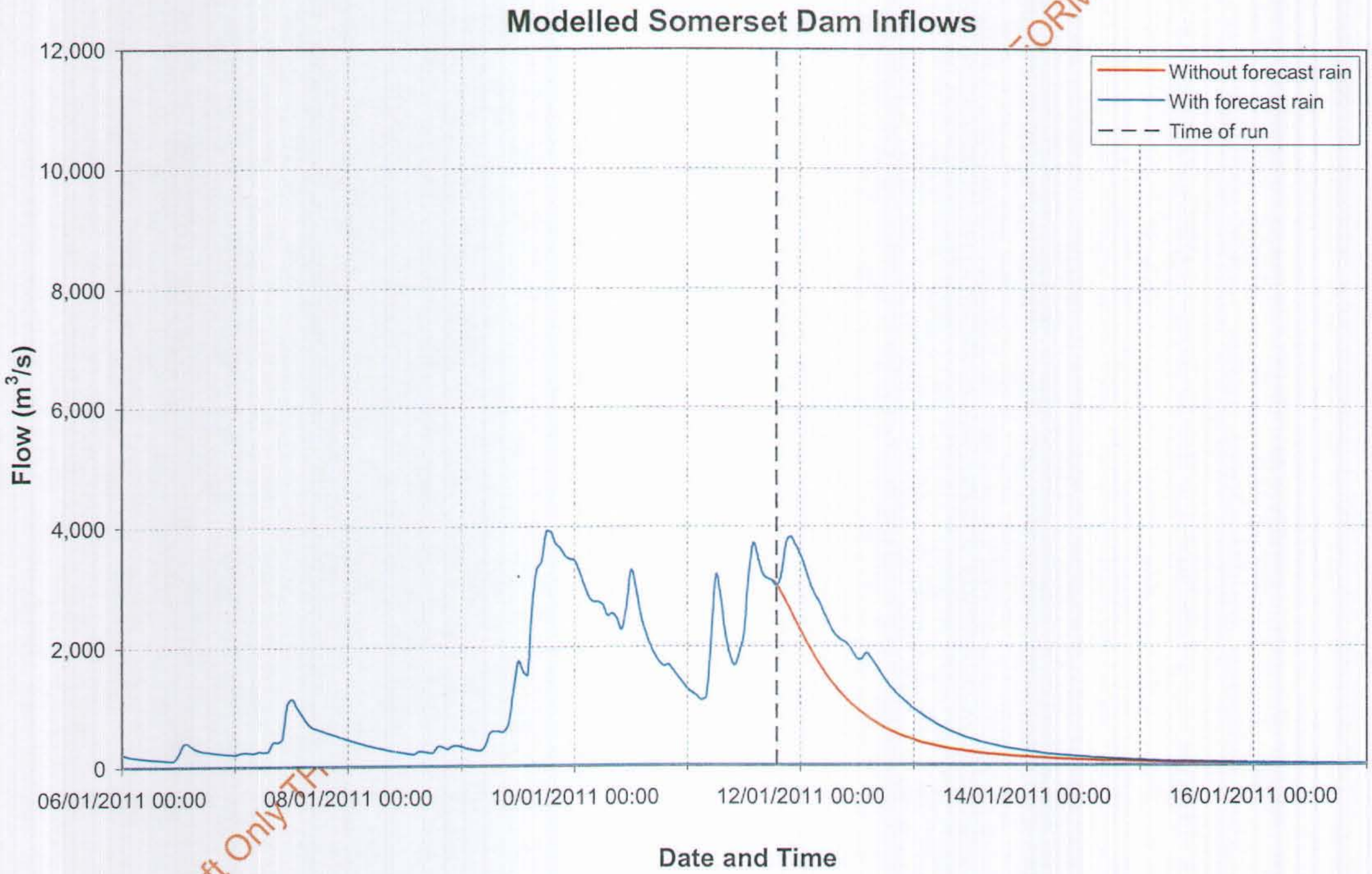
APPENDIX A – MODEL RESULTS

Run 41

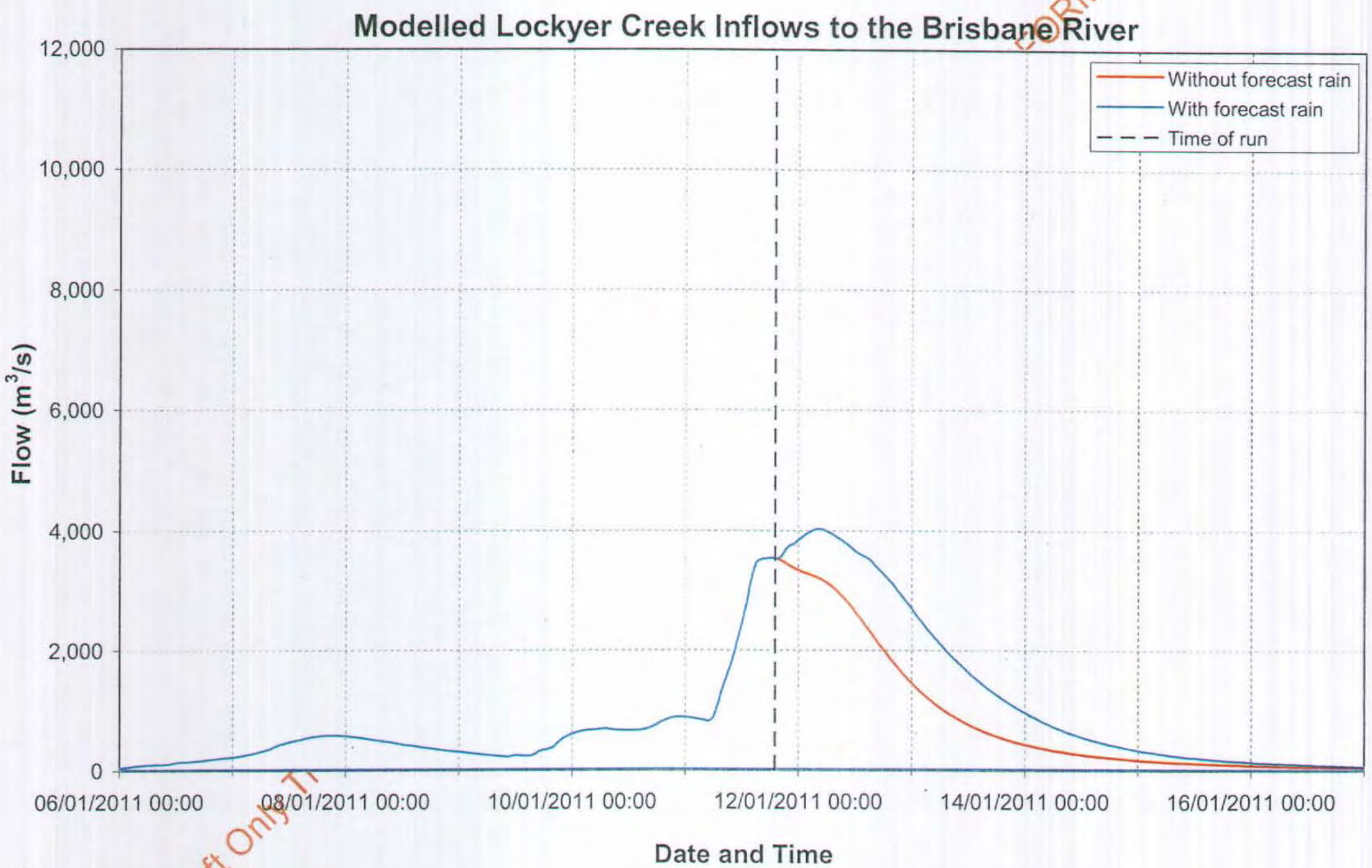
Date: Tuesday 11 January 2011

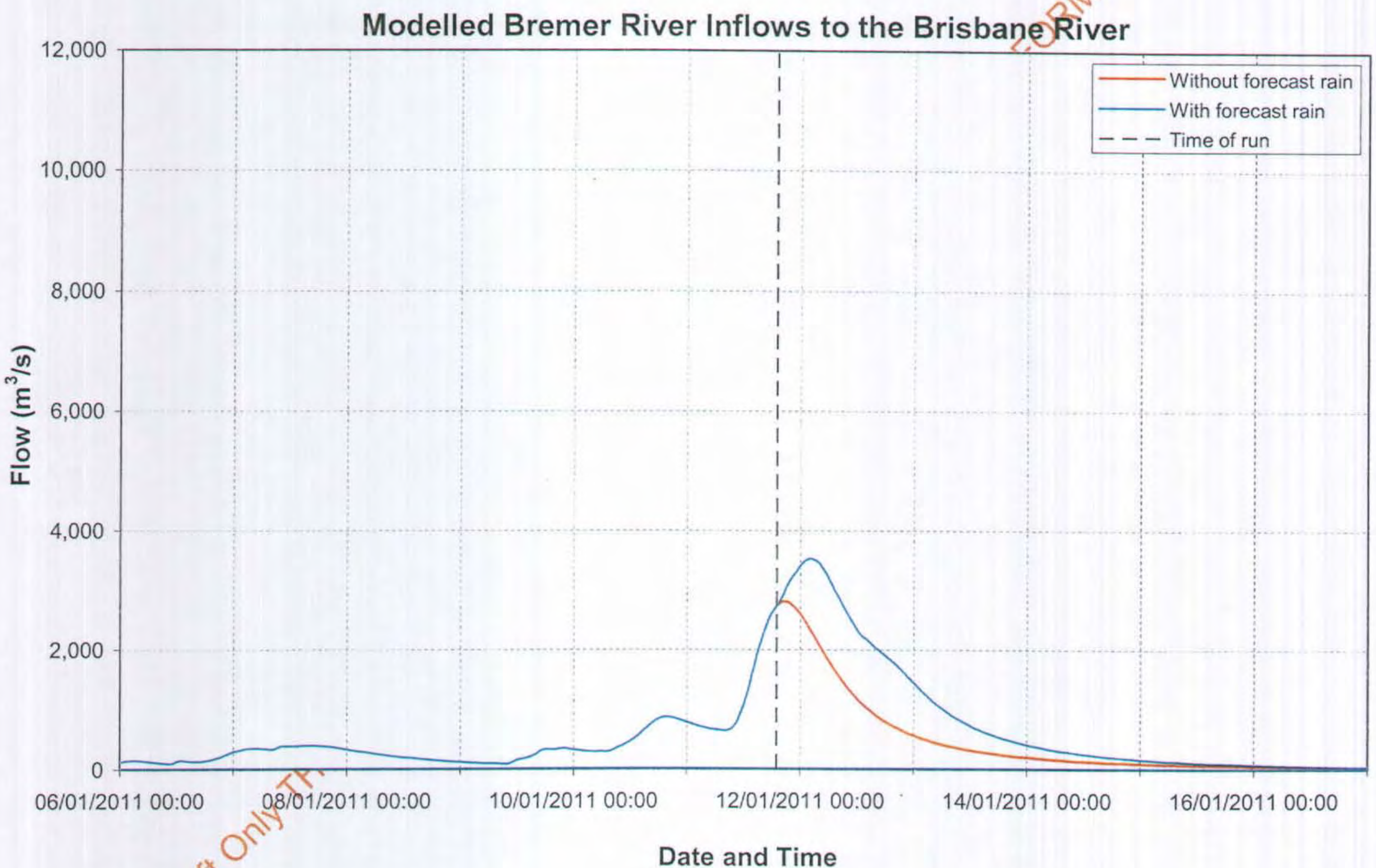
Time: 19:00

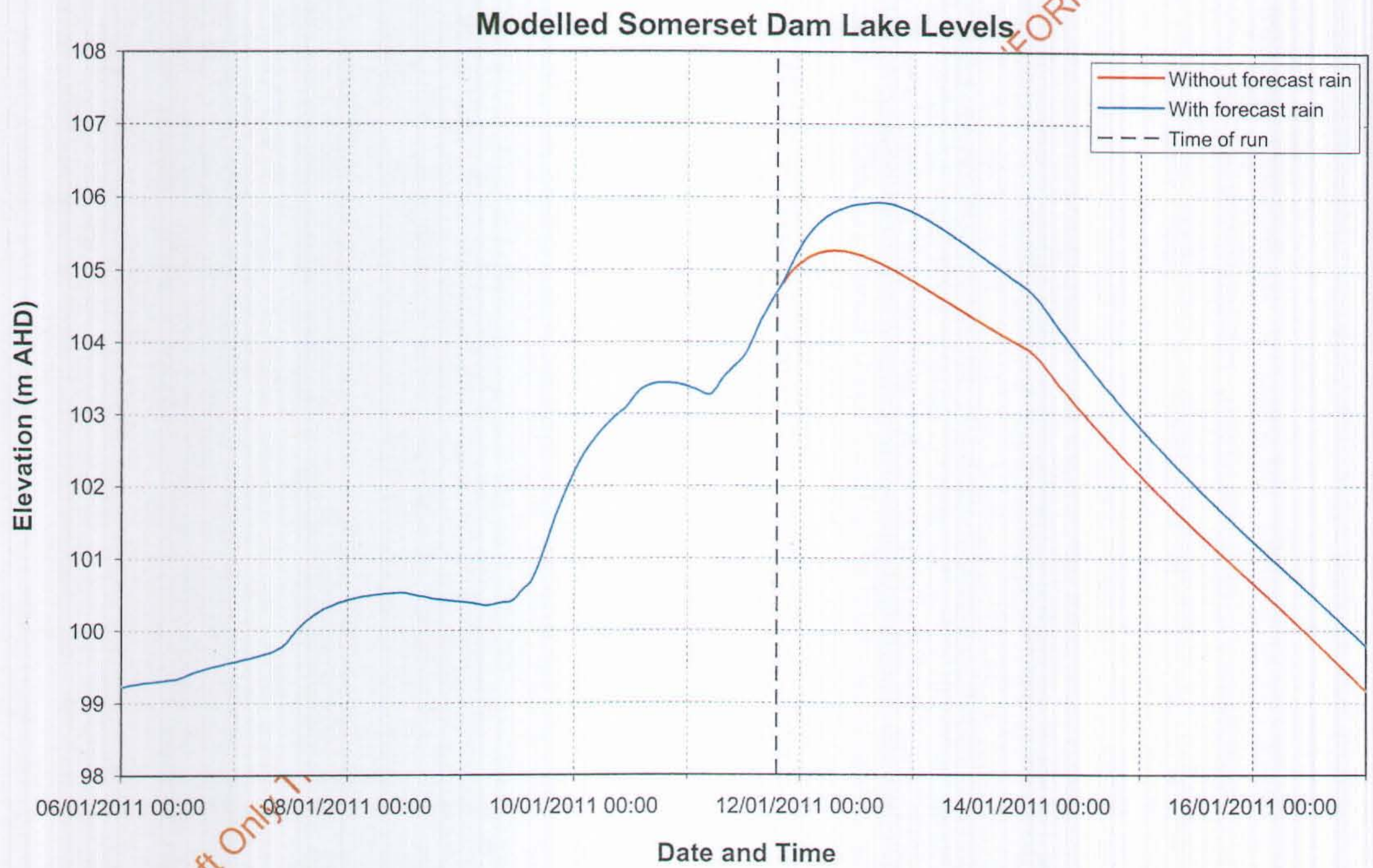

Modelled Wivenhoe Dam Inflows (Excluding Somerset Dam Outflows)
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

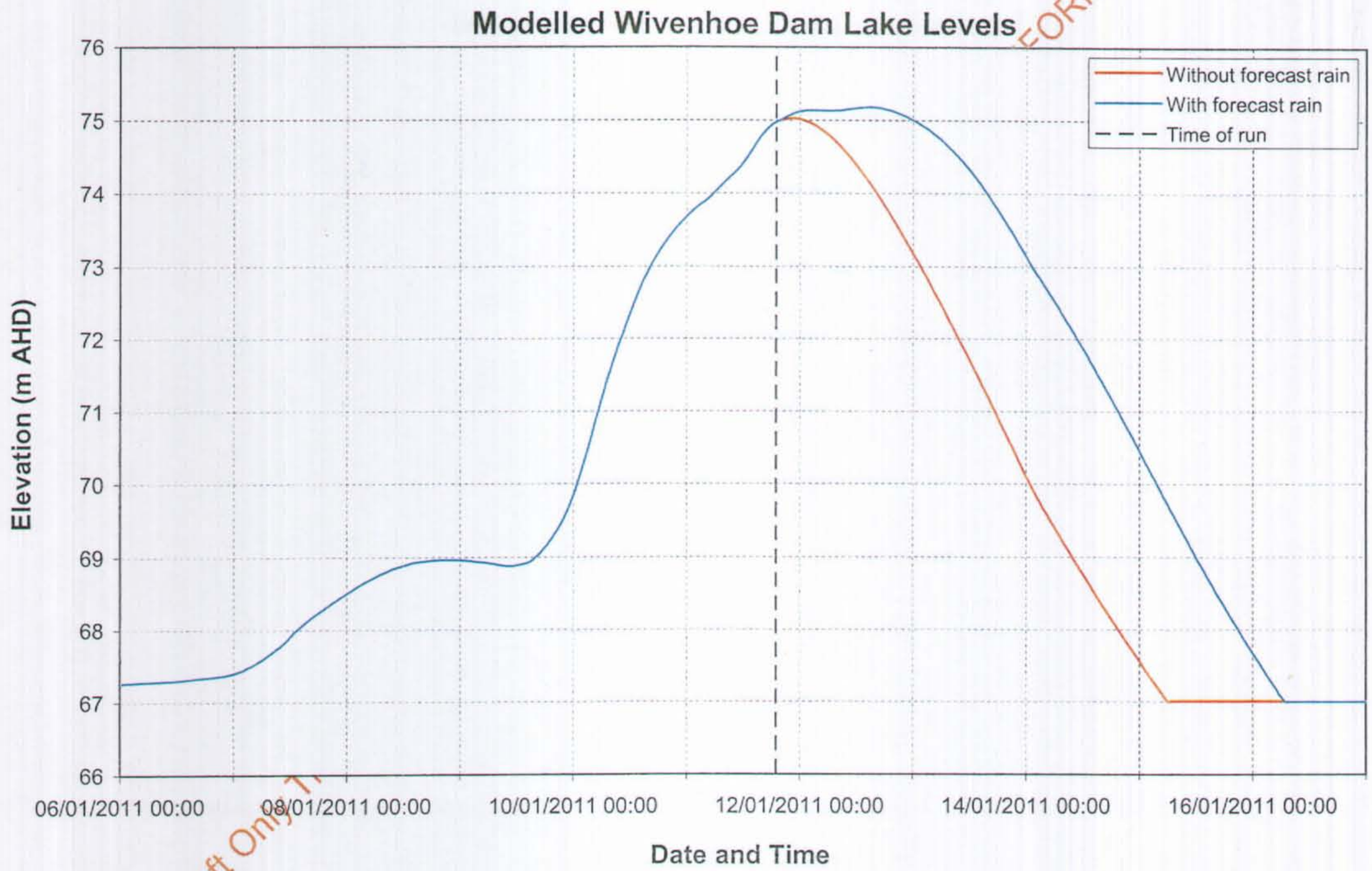


Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m³/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Lockyer Creek Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
Flow (m3/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Bremer River Inflows to the Brisbane River
Without forecast rain
With forecast rain
Time of run
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (m3/s)
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time


Modelled Somerset Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
108
107
106
105
104
103
102
101
100
99
98
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time



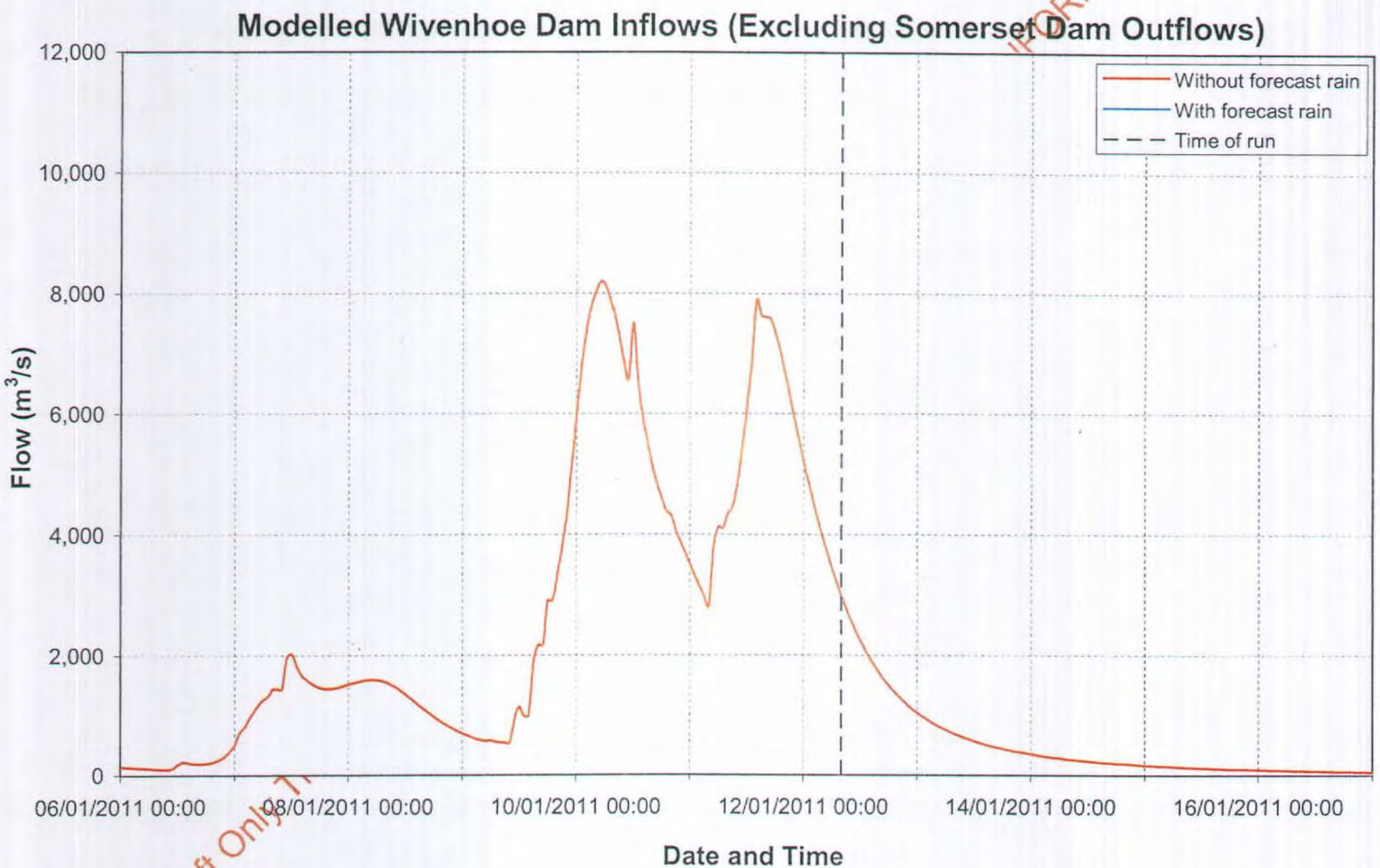
Modelled Wivenhoe Dam Lake Levels
Without forecast rain
With forecast rain
Time of run
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
66
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

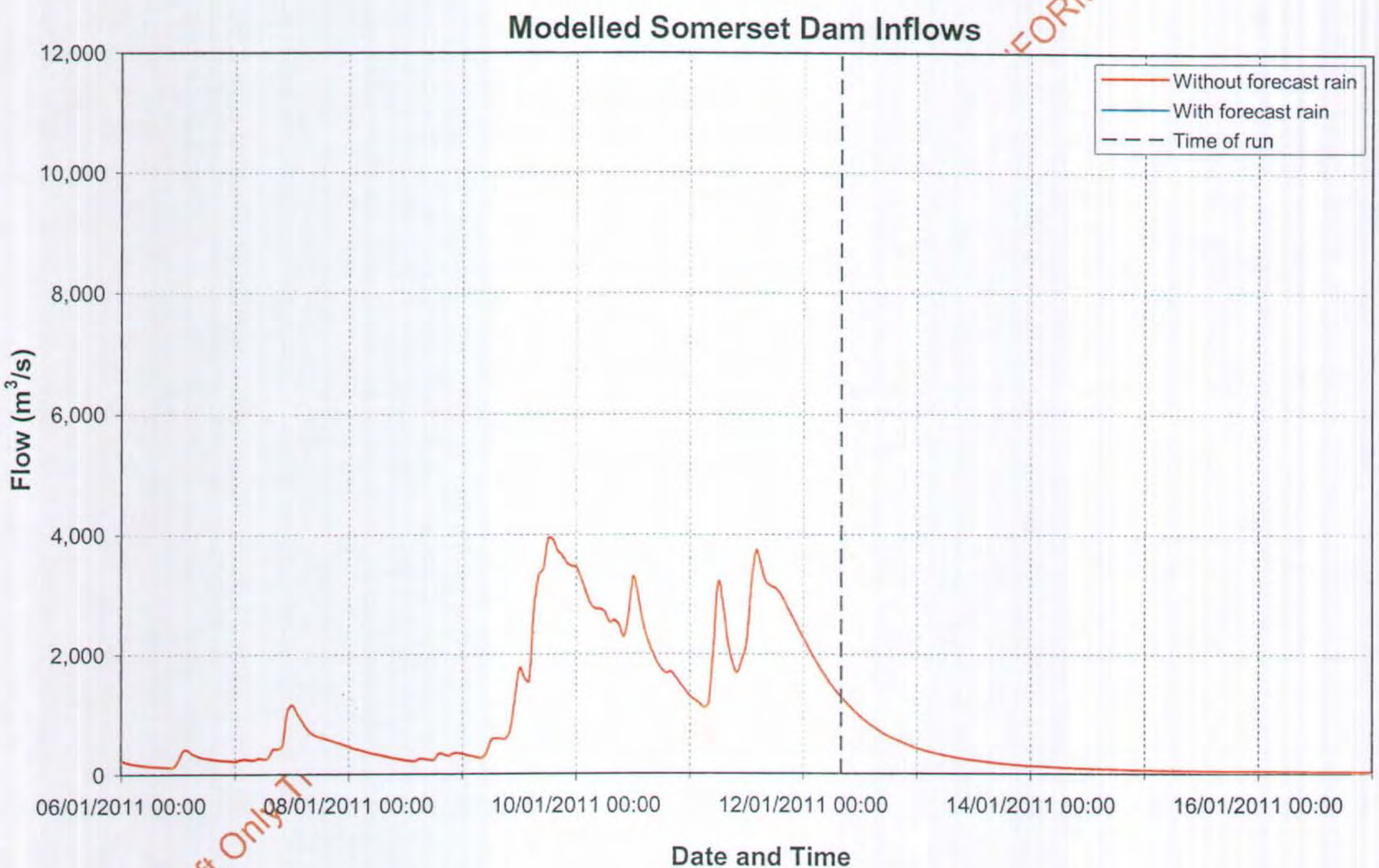
Run 43

Date: Wednesday 12 January 2011

Time: 08:00

APPENDIX A – MODEL RESULTS





Modelled Somerset Dam Inflows
Without forecast rain
With forecast rain
Time of run
Flow (m³/s)
12,000
10,000
8,000
6,000
4,000
2,000
0
06/01/2011 00:00
08/01/2011 00:00
10/01/2011 00:00
12/01/2011 00:00
14/01/2011 00:00
16/01/2011 00:00
Date and Time

APPENDIX A – MODEL RESULTS