Brisbane Flooding January 2011

An Avoidable Disaster – Supplementary Submission 2

9 June 2011

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A	Draft	MOB	4-Apr-11
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Contents

1. INTRODUCTION

This submission is considered relevant to the Queensland Floods Commission of Inquiry under Section 2(f) of the Terms of Reference (1).

Implementation of the systems operation plans for dams across the state and in particular the Wivenhoe and Somerset release strategy and an assessment of compliance with, and the suitability of the operational procedures relating to flood mitigation and dam safety.

The Original Submission (2) noted that *"Severe limitations have been imposed on the capacity to perform detailed analyses of the events as only very limited information on the actual operation of the dams was made available. Critical basic data such as gate opening strategies and release rates from both dams was only made available by SEQWater on 7th March, less than four days prior to the date for submissions. Even then only a summary of the data was provided and the raw data necessary for a complete analysis was not included. It is not possible, for instance, to determine the period for the maximum releases from Wivenhoe on the evening of Tuesday 11th. Based on the data currently provided by SEQWater the period of these releases could be anywhere between two and four hours. This information is critical to any detailed analysis of the impact on the flood in Brisbane. It is understood that an earlier submission to the Commission requested that such data be provided directly by the Commission."*

While much of the basic data is still not available a significant amount of additional information has been made available through the Commission. This supplementary submission seeks to build on the Original Submission using additional data provided. In addition the conclusions reached in the Original Submission have been reviewed to determine what changes, if any, were necessary. It is not considered that any significant changes to the Conclusions or analysis of the Original Submission are required. Additional commentary is provided in relation to two items: -

- Measurement of the lake level for Wivenhoe
- Available Flood Storage Capacity in Wivenhoe and Somerset

2. ADDITIONAL CONSIDERATIONS

1. Numerous respected hydrologists, including Max Winders and the Commission's expert Mark Babister, have noted that hydrodynamic modelling is required to adequately model the flood in Brisbane and to properly allow for the interaction of flows from Lockyer Creek and the Bremer River. No results of such modelling have been made available for consideration.

   SEQWater has also acknowledged the deficiencies in the hydrological modelling presented (Refer Section 5 of this Submission) but has continued to rely on the output from such models to justify the release strategy adopted during the flood and to reject alternate release strategies. Some idea of the potential inaccuracies in the existing hydrological modelling presented by SEQWater are apparent from the modelling included in Section 8 of the Flood Event Report (3): -

   - It completely fails to model the minor peak of 4.3 mAHD at the Brisbane City Gauge at 17:03 Wednesday 12th January.
   - It indicates a modelled peak flow of approximately 9300 cubic metres per sec at the Brisbane City Gauge at approximately 03:00 Thursday 13th January.
   - This is inconsistent with SEQWater's reporting that the peak flow at the Jindalee Bridge was **measured** as 9,800 cubic metres per sec on the **evening** of Wednesday 12th January.
   - The peak flow of approximately 9300 cubic metres per sec was modelled to result in a height of approximately 4.47 mAHD at the Brisbane City Gauge at approximately 03:00 Thursday 13th January.
   - This modelled river height of 4.47 mAHD is not consistent with a flow of 9300 cubic metres per sec from either of the rating curves for the Brisbane City Gauge provided by SEQWater especially as this peak flow would have been coincident with a measured high tide of 0.91 mAHD at Whyte Island at 03:06 Thursday 13th January.
   - The above indicates that the modelled peak flow is potentially some 12 ½ hours later than the actual peak flow and modelled river heights at the Brisbane City Gauge are at times 0.6 m in error.

   For additional discussion refer to Section 5.

2. SEQWater has provided the modelled flows from Lockyer Creek. For every period from 09:00 Friday 7th January through to 08:00 Friday 14th January these flows are substantially higher than the flows which would be determined by using the gauging station at Rifle Range Road, sometimes by a factor of two and three times. The ICA Report (4) notes that this gauging station was affected by backwater flooding from the Brisbane River and therefore that higher gauge height cannot be used to presume higher flow rates. Accurate modelling of flows from Lockyer Creek can only be resolved by the use of a hydrodynamic model. Refer to further discussion in Section 7.1.

   Accurate estimates of the flows from Lockyer Creek and the Bremer are an essential prerequisite for determination of the flooding that would have occurred in Brisbane through the adoption of alternate release strategies.

3. It is very difficult to understand the basis for operation of Somerset. The clear implication of the Somerset Strategies is that the Operators are not permitted (or are unable) to close the radial gates and will undertake major releases from Somerset to ensure that it does not reach

its originally nominated flood storage capacity. This immediately leads to a suspicion of undocumented concerns about the structural integrity of the dam and/or the radial gates.

During the peak of the releases on Tuesday 11th January, the maximum level in Somerset was 104.42 mAHD with approximately 227,748 ML of spare flood capacity. The maximum that Somerset was ever filled to during the event was 104.96 mAHD with unused flood storage capacity of 190,788 ML. SEQWater has relied on the Somerset/Wivenhoe interaction curve in Rev 7 of the Operational Manual (5) to justify not accessing this spare capacity. However there has not been any discussion of the basis for this interaction curve or justification of the three Strategies specified for Somerset.

None of the Strategies specified for Somerset in the Operational Manual allows the Operators to close the radial gates. The Strategies go further, and require that, if the level in Somerset is rising above the interaction curve, the Operators are to open the sluice gates and release more water from Somerset.

This unused flood storage volume becomes very significant since the analysis in the Original Submission (2) indicates that if 123,000 ML less was released during the peak release period, the flood height at the Brisbane City Gauge would not have exceeded the Major Flood Level of 3.5 mAHD.

Refer to further discussion in Section 8.2.

4. It may be argued that the declared flood storage capacity of both dams is still available. However the declared flood storage capacity is no longer available during the more frequent floods of the size of the January 2011 event.

   It now only becomes available during the very largest of floods due to changes in the configuration and operations of the dams such as the design selected for the Fuse Plugs on Wivenhoe and restrictions on radial gate operations at Somerset.

   Refer to additional discussion in Section 8.

5. SEQWater claim that the total inflow into Wivenhoe Dam during the Event was 2,650,000ML which is 190% of the comparable inflow from the January 1974 flood event, and comparable with the flood of 1893. However it is appears that this inflow into Wivenhoe can only be obtained if the total inflow to the dam is calculated for the whole of the period between Thursday 6th January 2011 and Wednesday 19th January 2011. This extends well beyond the actual flood.

   If the calculation is limited to the period from 09:00 Sunday 9th January, when the major inflows to the dam commenced, to 24:00 Wednesday 12th January when the inflows from the major event substantially ceased, the total inflow to Wivenhoe was around 2,033,943 ML and this includes 400,532 ML of releases from Somerset.

6. It remains an unresolved concern that the January event exceeded the trigger level for Strategy W4 and almost resulted in initiation of a Fuse Plug when the estimated AEP of the Flood Event is substantially less than 1 in 4,500 and likely to be significantly less than 1 in 500.

   Studies, carried out prior to the January Flood Event and subsequent to the installation of the Fuse Plugs, forecast that the trigger level for Strategy W4 (i.e. 74 mAHD) would have an AEP in the range of 1 in 430 to 1 in 500 and that Fuse Plug initiation would have an AEP in the range of 1 in 4,500 to 1 in 6,000. Refer GHD study for SEQWater in December 2009 (6).

   Mark Babister in paragraph 81 of his report to the Commission (7) noted *"The assessment in the SKM report that the January 2011 flood event "exceeds 1 in 100 AEP" is considered the*

most reasonable estimate based on available information until more detailed analysis can be undertaken." This is well short of an AEP of 1 in 430 to 1 in 500 and so raises a question as to why Strategy W4 was triggered.

Some of the reasons why this occurred may be apparent by reference to another SunWater study (8) which concluded that increasing the FSL from EL 67 to EL 68 or EL 69 would result in an increased probability of exceeding the trigger level for Strategy W4, an increased probability of a Fuse Plug initiation and significant increases in flows downstream of Wivenhoe.

The operation of the dam during the January Flood Event meant that Wivenhoe was operated as if there had been a defacto increase in the FSL. The dam was EL 68 before any gate releases were commenced and was at EL 68.55 at 09:00 Sunday 9th January when the significant flood event commenced evidenced by the increased inflows to the dam.

Refer to additional discussion in Section 6.

7. In the response to the Original Submission (9) Robert Ayre raised a number of concerns about the rating curve that was developed to model flows past the Brisbane City Gauge. However Figure 1 in his response indicates that the rating curve used in the Original Submission adequately matches one of SEQWater's preferred curves over the range of interest for these Submissions which is from the level of a Minor Flood at the Brisbane City Gauge of 1.7 mAHD to the peak experienced during the Flood Event of 4.46 mAHD.

   As noted in the Original Submission, the data in the Brisbane River Flood Study (10) on which the rating curve was based, modelled all flows assuming a tail water level of 0.92 mAHD equivalent to the Mean High Water Spring Tide (MHWS). The recorded high tides at Whyte Island were all less that 0.99 mAHD for the whole of the period that the Brisbane River exceeded the Minor Flood Height of 1.7 mAHD at the Brisbane City Gauge which was from 12:09 Tuesday 11th January to 20:18 Friday 14th January. Therefore the data from the Brisbane River Flood Study and the derived rating curve ought to adequately represent the flow height relationship at the Brisbane City Gauge during this period.

   While there remain obvious and acknowledged deficiencies in the calculation methods used, the order of magnitude of the calculations remains valid and in the absence of any other modelling to the contrary it remains relevant to restate the following observations of the Original Submission: -

   - If 123,000 ML was discharged earlier than 11:00 Tuesday 11th or later than 19:00 Wednesday 12th rather than during this period, the flood level at the Brisbane City Gauge would not have exceeded the Major flood level.
   - If 335,000 ML was discharged outside of the period 02:00 Tuesday 10th to 08:00 Thursday 13th rather than during the period, the flood level at the Brisbane City Gauge would not have exceeded the Moderate flood level.
   - If 623,000 ML was discharged outside of the period 13:00 Monday 10th to 21:00 Thursday 13th rather than during the period, there would not have been a flood at the Brisbane City Gauge.

   There was adequate capacity within the system to reduce the releases by this magnitude.

   Refer to additional discussion in Section 4.

3. DAM CHARACTERISTICS

The following are considered as key characteristics of the dams and have been retained from the Original Submission: -

3.1 Wivenhoe

Item No	Characteristic	Value	Capacity ML	Source
W1	Spillway Fixed Crest Level	57 mAHD	414,000	Page 19 (5)
W2	Full Supply Level (FSL)	67 mAHD	1,165,000	Page 19 (5)
W3	Minimum Level for Opening Gates	67.25 mAHD	1,192,500	Section 8.3 (5)
W4	Top of Closed Radial Gate	73 mAHD	1,926,000	Page 19 (5)
W5	Limit of land acquired by the Corporation to provide temporary flood storage	75 mAHD	2,232,000	Section 8.1 (11)
W6	1st (Central) Fuse Plug Trigger Point	75.7 mAHD	2,347,000	Page 20 (5)
W7	2nd (Right) Fuse Plug Trigger Point	76.2 mAHD	2,442,000	Page 20 (5)
W8	3rd (Left) Fuse Plug Trigger Point	76.7 mAHD	2,537,000	Page 20 (5)
W9	Evaluation Design Flood Level	77 mAHD	2,566,000	Page 19 (5)
W10	Main Embankment Crest Level	79.1 mAHD	2,953,600	Page 19 (5)
W11	Top of Wave Wall	79.9 mAHD	3,112,000	Page 19 (5)
W12	Saddle Dam	80 mAHD	3,132,000	Page 19 (5)
W13	Bottom of Radial Gates (Open)	73 mAHD	1,926,000	Page 56 (5)
W14	Top of Radial Gates (Open)	80.3 mAHD		Page 56 (5)
W15	Maximum Level during Tuesday 11th	74.51 mAHD	2,154,580	
W16	Maximum Level for period	74.85 mAHD	2,208,300	
W17	191% Capacity		2,225,605	

3.2 Somerset

Item No	Characteristic	Value	Capacity ML	Source
S1	Full Supply Level (FSL)	99 mAHD	379,800	Page 77 (5)
S2	Spillway Fixed Crest Level	100.45 mAHD	445,640	Page 77 (5)
S3	Sluice & Regulator Trigger Level	102.25 mAHD	539,000	Page 77 (5)
S4	Crest level	107.46 mAHD	900,728	Page 77 (5)
S5	Top of Deck	112.34 mAHD	1,129,800	Page 77 (5)
S6	Flood Storage		520,887	SEQWater advice to Australian 22nd Feb 2011
S7	Maximum Level during Tuesday 11th	104.42 mAHD	672,988	
S8	Maximum Level for period	104.96 mAHD	709,948	

4. BRISBANE CITY GAUGE RATING CURVES

4.1 SEQWater

SEQWater has provided two sets of graphs showing rating curves for the Brisbane City Gauge, the first in their response to the Original Submission at *"QFCI_Exhibit_20_Statement_of_Rober_Ayre_11-4-11 Response to the Submission of Michael O'Brien Witness Statement of Robert Arnold Ayre"* (9)

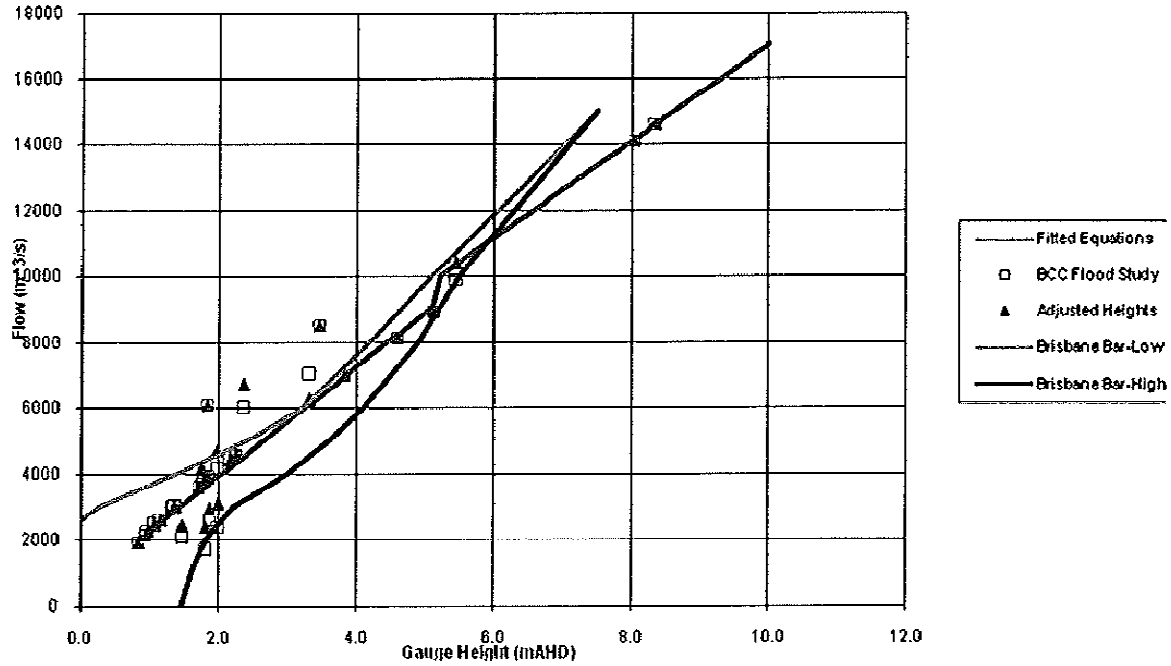
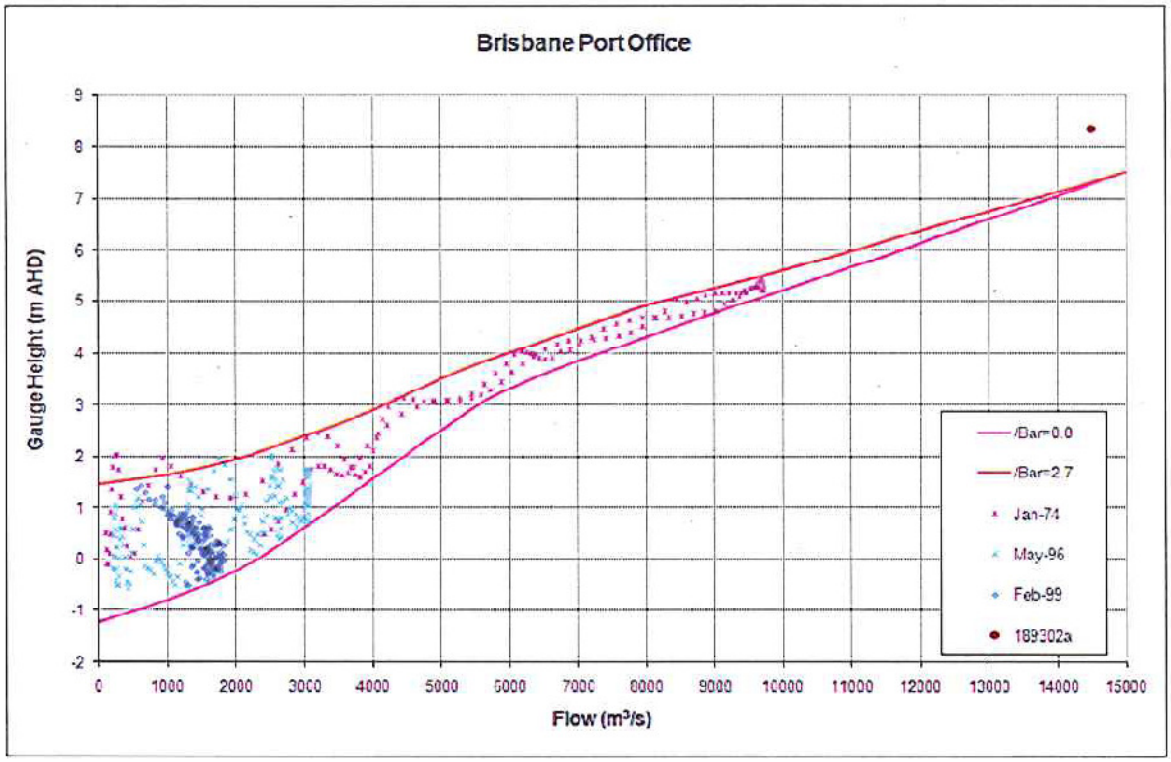


Figure 1

In the remainder of this submission this is referred to as the first graph.



The second graph showing rating curves for the Brisbane City Gauge was provided in the Second Statement of Terrence Alwyn Malone "*Seqwater_Malone_Terrence_Alwyn_2nd_11.04.11"* (12)

In the remainder of this submission this is referred to as the second graph.

These graphs appear to provide the same data but are plotted differently. The first graph (provided in Exhibit 20) merely indicates that that the rating curves are for the Brisbane Bar at Low Tide and the Brisbane Bar at High Tide, but includes no information in relation to the actual tide heights. However at paragraph 32 Robert Ayre indicates that "*These relationships are based on numerical hydraulic models of low tide and high tide at the Brisbane Bar (0.0mAHD and 2.7mAHD respectively)."*

The second graph included in the Statement of Terrence Alwyn Malone indicates that the curves are for "*Bar=0.0 and Bar=2.7".*

Tide heights at the Brisbane Bar are not generally reported in mAHD, but instead are referenced to a Prediction Datum which is 1.24 metres lower than 0.00 mAHD. A tide of 2.7 m at the Brisbane Bar is close to the Highest Astronomical Tide and therefore a tide of 2.7 mAHD at the Brisbane Bar would represent a tide of 1.24 metres above the Highest Astronomical Tide which is an unlikely reference point.

It is therefore suspected that the 0.0 mAHD and 2.7 mAHD used by Robert Ayre should instead be tide heights in metres referenced to the Brisbane Bar datum and not mAHD. This would mean that the first graph is then fully consistent with the second graph included in the Statement of Terrence Alwyn Malone. Both rating curves would therefore be for 0.0 m to 2.7 m at the Brisbane Bar or minus 1.24 mAHD to 1.46 mAHD.

4.2 Original Submission

Attachment 2 of the Original Submission (7) detailed the development of a Rating Curve for Brisbane City Gauge based primarily on data sourced from the Brisbane River Flood Study (10).

In the response to the Original Submission (7) Robert Ayre raised a number of concerns about this rating curve. However the first graph above, which includes a plot of this rating curve, demonstrates that the developed rating curve used in the Original Submission adequately matches one of SEQWater's preferred curves over the range of interest for these submissions. This range of interest is from the level of a Minor Flood at the Brisbane City Gauge which is 1.7 mAHD through to the peak experienced during the Flood Event of 4.46 mAHD.

As noted in the Original Submission, the data in the Brisbane River Flood Study (6) on which the rating curve was based, modelled all flows assuming a tail water level of 0.92 mAHD equivalent to the Mean High Water Spring Tide (MHWST). 0.92 mAHD at Whyte Island is equivalent to a tide of 2.16 m at the Brisbane Bar. It can be seen from reference to the first graph that the developed rating curve is close to the SEQWater prefer rating curve for a tide of 0 m at the Brisbane Bar.

It remains of some concern that the data taken from the Brisbane River Flood Study (6) which is said to assume a tail water level of 0.92 mAHD (i.e. 2.16 m at the Brisbane Bar) is substantially close to the SEQWater preferred rating curve for a tide of 0 m at the Brisbane Bar. This warrants further investigation of the data used in the Brisbane River Flood Study and or the SEQWater provided rating curves. But this consideration is outside the scope of this submission.

The recorded high tides at Whyte Island were all less that 0.99 mAHD for the whole of the period that the Brisbane River exceeded the Minor Flood Height of 1.7 mAHD at the Brisbane City Gauge which was from 12:09 Tuesday 11th January through to 20:18 Friday 14th January. Therefore the data from the Brisbane River Flood Study and the rating curve developed for the Original Submission ought to adequately represent the flow height relationship at the Brisbane City Gauge during this period.

At no stage during this period did the high tide at Whyte Island reach the 1.6 mAHD noted in paragraph 33 of the response by Robert Ayre (9).

High tides at Whyte Island (13) during the relevant period were: -

Date and Time	**Whyte Island (mAHD)**
02:12 Wednesday 12th Jan	0.93
13:35 Wednesday 12th Jan	0.99
03:06 Thursday 13th Jan	0.91
14:39 Thursday 13th Jan	0.75
04:04 Friday 14th Jan	0.91
15:40 Friday 14th Jan	0.59

5. ACCURACY OF SEQWATER MODELS

At point 3(i) in the second witness statement dated 11th April 2011 Terence Alwyn Malone (12) makes the point: -

> "*It should be noted that these results are based upon a hydrologic model, when a hydrodynamic model would be more appropriate and expected to give more accurate results. I do not have a working hydrodynamic model but SEQWater have commissioned SKM to get the Hydrodynamic model used by the Wivenhoe Alliance Spillway Augmentation Study working. However, the results are indicative of the relative impact of the suggested change in release strategy"*

Some idea of the potential inaccuracies by relying on the hydrologic modelling can be gained by examining the relationship between flow rates and the height at the Brisbane City Gauge shown in Figures 8.10.2 and 8.10.3 in the Flood Event Report (3) specifically Case 1 which represents the actual flood event.

Case 1 in Figure 8.10.3 completely fails to identify the minor peak of 4.3 mAHD which occurred at the Brisbane City gauge at 17:03 Wednesday 12th Jan. The modelled height at the time of the minor peak is scaled at 3.7 mAHD which represents an error of 0.6 mAHD between the actual height recorded at the Brisbane City Gauge and the modelled height at that time.

The following additional data has been scaled from Figures 8.10.2 and 8.10.3 in the Flood Event Report (3) for Case 1

- Figure 8.10.3 indicates a predicted peak height of 4.47 mAHD at 03:08 Thursday 13th January which corresponds quite closely with the recorded peak height of 4.46 mAHD at 02:57 Thursday 13th.
- Figure 8.10.2 indicates a peak flow of 9,378 m^3/sec at 05:42 Thursday 13th January which is slightly later than the actually recorded peak height which occurred at 02:57 Thursday 13th.

Based on the quote below from this witness statement (12), it is believed that 9,300 m^3/sec is the figure actually calculated from the hydrologic model flow and 9,300 m^3/sec has been used subsequently.

Again referring the rating curves provided by SEQWater and referenced in Section 4.1 above a flow of 9300 m^3/sec would be expected to result in the following heights at the Brisbane City Gauge: -

- Utilising the first graph between 4.66 mAHD and 5.2 mAHD for a tide height at the Brisbane Bar of 0.0 m and 2.7 m respectively.
- Utilising the second graph, between 4.43 mAHD and 5.0 mAHD for a tide height at the Brisbane Bar of 0.0 m and 2.7 m respectively.

This range depends on the tide height at the Brisbane Bar of 0.0 m or 2.7 m respectively (or minus 1.24 mAHD to 1.46 mAHD). Given that a high tide of 0.91 mAHD was recorded at Whyte Island at 03:06 Thursday 13th January, a flow of 9,300 m^3/sec would be expected to result in a height at the Brisbane City Gauge at towards the upper end of the above ranges of 4.43 mAHD to 5.2 mAHD. This is not the case and the hydrologic model instead provides an estimated height of 4.46 mAHD, very close to the lowest possible estimate.

At points 3(a) and 3(b) in the second witness statement dated 11th April 2011 Terence Alwyn Malone states that: -

> *A gauging or flow measurement was undertaken by a Joint Seqwater and Department of Environment and Resource Management hydrographic team on the evening of 12 January*

2011 from Jindalee Bridge, just downstream of Moggill. In practice, the peak flow at Jindalee is the same as that at Moggill. The flow measured at this location around the peak of the event was about 9,800m^3/sec.

A hydrologic model of the catchment adopting the Wivenhoe actual release hydrograph gives 9,300m^3/sec at Jindalee, which is reasonably consistent with the magnitude and timing of the measured peak

As noted above, the hydrologic model predicted a peak flow of 9,378 m^3/sec at 05:42 Thursday 13th January compared to measured peak flow of 9,800 m^3/sec at Jindalee on the evening of Wednesday 12th January. It is considered much more likely that the minor peak of 4.3 mAHD which occurred at the Brisbane City gauge at 17:03 Wednesday 12th January corresponds to peak flow at the Brisbane City Gauge. If this is correct it would indicate that the hydrologic model predicted the timing of the peak flow approximately 12 ½ hours later than it actually occurred.

In summary this indicates a number of significant deficiencies in the hydrologic model used to develop Case 1 in Figures 8.10.2 and 8.10.3 of the Flood Event Log: -

- The predicted time for the peak flow at the Brisbane City Gauge appears to be some 12 ½ hours later than it actually occurred.
- It fails to predict the minor peak at the Brisbane City Gauge and is in error by approximately 0.6 m at the time of the minor peak.
- The predicted peak height at the Brisbane City Gauge requires a tide at Whyte Island of close to minus 1.24 mAHD while it was actually closer to 0.91 mAHD. This is likely to represent an error in the predicted height at the Brisbane City Gauge of around 0.5 m.

Presumably these same deficiencies would be repeated in the output from this hydrologic model for other scenarios analysed by SEQWater.

At paragraph 33 in Robert Ayre's response to the Original Submission (9) he states that: -

It should be noted that the peak level recorded at Whyte Island, the most downstream ALERT gauge, during the January 2011 Flood Event was approximately 1.6mAHD.

I do not have access to the data for the whole period of the flood event, but none of the high tides was above 0.99 mAHD during the period of flooding in Brisbane.

6. MAGNITUDE OF FLOOD EVENT

6.1 Flood Volume

Page ii Executive Summary of the Flood Event Report (3) SEQWater states *"The volume of total inflow into Wivenhoe Dam during the Event was 2,650,000ML. This volume is almost double (190%) the comparable volume of inflow from the January 1974 flood event, and comparable with the flood of 1893."* However it is believed that this inflow into Wivenhoe can only be obtained if the total inflow to the dam is calculated for the whole of the period between Thursday 6th January 2011 and Wednesday 19th January 2011.

If the calculation is limited to the period from 09:00 Sunday 9th January, when the major inflows to the dam commenced, to 24:00 Wednesday 12th January when the inflows from the major event substantially ceased, the total inflow to Wivenhoe was around 2,033,943 ML which included 400,532 ML of releases from Somerset.

6.2 AEP of Flood

Studies, carried out prior to the January Flood Event and subsequent to the installation of the Fuse Plugs, forecast that the trigger level for Strategy W4 (i.e. 74 mAHD) would have an AEP in the range of 1 in 430 to 1 in 500 and that Fuse Plug initiation would have an AEP in the range of 1 in 4,500 to 1 in 6,000. Refer GHD study for SEQWater in December 2009 (6).

It remains an unresolved concern that the January event exceeded the trigger level for Strategy W4 and almost resulted in initiation of a Fuse Plug when the estimated AEP of the Flood Event is substantially less than 1 in 4,500 and likely to be less than 1 in 500. Mark Babister in paragraph 81 of his report to the Commission (7) noted *"The assessment in the SKM report that the January 2011 flood event "exceeds 1 in 100 AEP"* is considered the most reasonable estimate based on available information until more detailed analysis can be undertaken."

Some of the reasons why this occurred may be apparent by reference to another SunWater study investigating the potential increase in the FSL from EL 67 to EL 68 or EL 69 (8). This study indicated that there would be an increased probability of exceeding the trigger level for Strategy W4, an increased probability of a Fuse Plug initiation and significant increases in flows downstream of Wivenhoe resulting from an increase in the FSL e.g.: -

- A 45% increase in downstream flows in the 96hr Q200 for a FSL of EL 68.
- A 68% increase in downstream flows in the 120hr Q100 downstream flows for a FSL of EL 69.

The operation of the dam during the January Flood Event meant that Wivenhoe was operated as if there had been a defacto increase in the FSL. The dam was EL 68 before any gate releases were commenced and was at EL 68.55 at 09:00 Sunday 9th January when the major inflows to the dam from the significant flood event commenced.

7. MODELLING OF IMPACT OF WIVENHOE RELEASES

Section 7.3 of the original submission referred to the SEQWater assessment of the impact of releases from Wivenhoe on flows at the Brisbane City Gauge in Section 8 of the Flood Event Report (3).

It was noted that despite the number of cases examined, SEQWater had made no assessment of the actual contribution of the releases from Wivenhoe to the peak of the flood, but simply looked at Wivenhoe releases alone and compared it with the actual flood.

In addition it was noted that it would be important to understand the impact that very high releases from Wivenhoe on Tuesday 11th had on the incoming flows from Lockyer Creek and the Bremer River.

It was also pointed out that overestimation of the flows past the City Gauge would reduce the apparent contribution to the flood from releases from Wivenhoe and conversely underestimation of the flows at the City Gauge would increase the apparent contribution of releases from Wivenhoe.

It was suggested that the Commission could consider the following: -

To make a proper assessment of the contribution of the releases from Wivenhoe to the flood in Brisbane it is essential to make an assessment of the flows past the Brisbane City Gauge during the event.

SEQWater has not made an assessment of the contribution of the releases from Wivenhoe to the actual flood in Brisbane.

SEQWater has now provided additional information to the Flood Commission of Inquiry, made publicly available on March 9th 2011, which would enable an analysis of SEQWater's calculated flows in the Bremer River and Lockyer Creek for the cases reported by SEQWater. This data is included in the spreadsheet attached to the witness statements entitled
"*Sunwater_Schedule_1_to_Statement_of_Rob_Ayre.xls"*

7.1 Lockyer Creek

The table below compares the flows modelled by SEQWater for Lockyer Creek against the recorded stream heights and implied flows provided by DERM for the Rifle Range gauge 143210B on Lockyer Creek (14). The Rifle Ridge gauge indicates the total flows from Lockyer Creek.

Date and Time	SEQWater Modelled Flow	DERM provided flows	SEQWater / DERM
	m^3/sec	m^3/sec	%
09:00 Fri 07 Jan	393	363	108%
10:00 Fri 07 Jan	427	359	119%
11:00 Fri 07 Jan	447	353	127%
12:00 Fri 07 Jan	466	347	135%
13:00 Fri 07 Jan	486	338	144%
14:00 Fri 07 Jan	505	330	153%
15:00 Fri 07 Jan	522	320	163%
16:00 Fri 07 Jan	538	311	173%
17:00 Fri 07 Jan	551	303	182%

Date and Time	SEQWater Modelled Flow	DERM provided flows	SEQWater / DERM
	m^3/sec	m^3/sec	%
21:00 Mon 10 Jan	862	713	121%
22:00 Mon 10 Jan	875	721	121%
23:00 Mon 10 Jan	879	728	121%
00:00 Tue 11 Jan	874	736	119%
01:00 Tue 11 Jan	863	740	117%
02:00 Tue 11 Jan	850	767	111%
03:00 Tue 11 Jan	837	786	106%
04:00 Tue 11 Jan	824	813	101%
05:00 Tue 11 Jan	814	888	92%

Date and Time	SEQWater Modelled Flow	DERM provided flows	SEQWater / DERM
	m^3/sec	m^3/sec	%
18:00 Fri 07 Jan	562	295	190%
19:00 Fri 07 Jan	570	290	197%
20:00 Fri 07 Jan	574	284	202%
21:00 Fri 07 Jan	576	282	204%
22:00 Fri 07 Jan	574	280	205%
23:00 Fri 07 Jan	571	280	204%
00:00 Sat 08 Jan	565	281	201%
01:00 Sat 08 Jan	557	283	197%
02:00 Sat 08 Jan	548	288	191%
03:00 Sat 08 Jan	538	293	184%
04:00 Sat 08 Jan	527	297	177%
05:00 Sat 08 Jan	516	300	172%
06:00 Sat 08 Jan	504	303	166%
07:00 Sat 08 Jan	491	305	161%
08:00 Sat 08 Jan	479	306	156%
09:00 Sat 08 Jan	466	305	153%
10:00 Sat 08 Jan	453	303	150%
11:00 Sat 08 Jan	441	299	148%
12:00 Sat 08 Jan	428	293	146%
13:00 Sat 08 Jan	416	286	145%
14:00 Sat 08 Jan	404	278	146%
15:00 Sat 08 Jan	393	269	146%
16:00 Sat 08 Jan	382	259	148%
17:00 Sat 08 Jan	371	249	149%
18:00 Sat 08 Jan	361	239	151%
19:00 Sat 08 Jan	351	233	151%
20:00 Sat 08 Jan	341	217	157%
21:00 Sat 08 Jan	331	207	160%
22:00 Sat 08 Jan	322	196	164%
23:00 Sat 08 Jan	312	190	165%
00:00 Sun 09 Jan	304	185	164%
01:00 Sun 09 Jan	295	180	164%
02:00 Sun 09 Jan	287	176	163%
03:00 Sun 09 Jan	278	171	162%
04:00 Sun 09 Jan	270	168	161%
05:00 Sun 09 Jan	262	164	160%
06:00 Sun 09 Jan	255	161	159%
07:00 Sun 09 Jan	247	158	157%
08:00 Sun 09 Jan	240	155	155%
09:00 Sun 09 Jan	232	152	153%
10:00 Sun 09 Jan	225	150	150%
11:00 Sun 09 Jan	235	148	159%
12:00 Sun 09 Jan	248	146	170%
13:00 Sun 09 Jan	245	145	169%

Date and Time	SEQWater Modelled Flow	DERM provided flows	SEQWater / DERM
	m^3/sec	m^3/sec	%
06:00 Tue 11 Jan	889	981	91%
07:00 Tue 11 Jan	1115	1072	104%
08:00 Tue 11 Jan	1387	1174	118%
09:00 Tue 11 Jan	1616	1254	129%
10:00 Tue 11 Jan	1842	1356	136%
11:00 Tue 11 Jan	2146	N/A	N/A
12:00 Tue 11 Jan	2465	N/A	N/A
13:00 Tue 11 Jan	2789	N/A	N/A
14:00 Tue 11 Jan	3196	N/A	N/A
15:00 Tue 11 Jan	3461	N/A	N/A
16:00 Tue 11 Jan	3516	N/A	N/A
17:00 Tue 11 Jan	3533	N/A	N/A
18:00 Tue 11 Jan	3542	N/A	N/A
19:00 Tue 11 Jan	3532	N/A	N/A
20:00 Tue 11 Jan	3501	N/A	N/A
21:00 Tue 11 Jan	3457	N/A	N/A
22:00 Tue 11 Jan	3410	N/A	N/A
23:00 Tue 11 Jan	3365	N/A	N/A
00:00 Wed 12 Jan	3327	N/A	N/A
01:00 Wed 12 Jan	3295	N/A	N/A
02:00 Wed 12 Jan	3266	N/A	N/A
03:00 Wed 12 Jan	3237	N/A	N/A
04:00 Wed 12 Jan	3204	N/A	N/A
05:00 Wed 12 Jan	3165	N/A	N/A
06:00 Wed 12 Jan	3118	N/A	N/A
07:00 Wed 12 Jan	3061	N/A	N/A
08:00 Wed 12 Jan	2994	N/A	N/A
09:00 Wed 12 Jan	2917	N/A	N/A
10:00 Wed 12 Jan	2832	1364	208%
11:00 Wed 12 Jan	2740	1349	203%
12:00 Wed 12 Jan	2641	1327	199%
13:00 Wed 12 Jan	2539	1298	196%
14:00 Wed 12 Jan	2433	1276	191%
15:00 Wed 12 Jan	2326	1241	187%
16:00 Wed 12 Jan	2219	1214	183%
17:00 Wed 12 Jan	2113	1187	178%
18:00 Wed 12 Jan	2009	1161	173%
19:00 Wed 12 Jan	1907	1116	171%
20:00 Wed 12 Jan	1808	1085	167%
21:00 Wed 12 Jan	1713	1025	167%
22:00 Wed 12 Jan	1622	968	167%
23:00 Wed 12 Jan	1535	899	171%
00:00 Thu 13 Jan	1451	819	177%
01:00 Thu 13 Jan	1372	775	177%

Date and Time	SEQWater Modelled Flow	DERM provided flows	SEQWater / DERM
	m^3/sec	m^3/sec	%
14:00 Sun 09 Jan	240	143	167%
15:00 Sun 09 Jan	238	143	166%
16:00 Sun 09 Jan	262	144	182%
17:00 Sun 09 Jan	310	147	211%
18:00 Sun 09 Jan	336	151	223%
19:00 Sun 09 Jan	347	156	223%
20:00 Sun 09 Jan	381	161	236%
21:00 Sun 09 Jan	453	169	268%
22:00 Sun 09 Jan	521	177	295%
23:00 Sun 09 Jan	562	186	302%
00:00 Mon 10 Jan	595	203	293%
01:00 Mon 10 Jan	624	235	265%
02:00 Mon 10 Jan	646	274	235%
03:00 Mon 10 Jan	659	318	207%
04:00 Mon 10 Jan	664	356	186%
05:00 Mon 10 Jan	665	388	171%
06:00 Mon 10 Jan	677	418	162%
07:00 Mon 10 Jan	682	446	153%
08:00 Mon 10 Jan	671	472	142%
09:00 Mon 10 Jan	664	498	133%
10:00 Mon 10 Jan	657	525	125%
11:00 Mon 10 Jan	653	552	118%
12:00 Mon 10 Jan	651	577	113%
13:00 Mon 10 Jan	652	602	108%
14:00 Mon 10 Jan	655	622	105%
15:00 Mon 10 Jan	664	646	103%
16:00 Mon 10 Jan	684	665	103%
17:00 Mon 10 Jan	716	682	105%
18:00 Mon 10 Jan	757	693	109%
19:00 Mon 10 Jan	799	702	114%
20:00 Mon 10 Jan	836	707	118%

Date and Time	SEQWater Modelled Flow	DERM provided flows	SEQWater / DERM
	m^3/sec	m^3/sec	%
02:00 Thu 13 Jan	1298	744	174%
03:00 Thu 13 Jan	1227	710	173%
04:00 Thu 13 Jan	1160	679	171%
05:00 Thu 13 Jan	1097	647	169%
06:00 Thu 13 Jan	1038	615	169%
07:00 Thu 13 Jan	982	584	168%
08:00 Thu 13 Jan	930	555	168%
09:00 Thu 13 Jan	881	523	168%
10:00 Thu 13 Jan	835	505	165%
11:00 Thu 13 Jan	791	467	170%
12:00 Thu 13 Jan	751	440	171%
13:00 Thu 13 Jan	713	417	171%
14:00 Thu 13 Jan	677	396	171%
15:00 Thu 13 Jan	643	373	172%
16:00 Thu 13 Jan	612	351	174%
17:00 Thu 13 Jan	582	330	177%
18:00 Thu 13 Jan	554	310	179%
19:00 Thu 13 Jan	528	291	182%
20:00 Thu 13 Jan	504	273	185%
21:00 Thu 13 Jan	481	273	176%
22:00 Thu 13 Jan	459	245	187%
23:00 Thu 13 Jan	439	233	189%
00:00 Fri 14 Jan	420	222	189%
01:00 Fri 14 Jan	402	211	190%
02:00 Fri 14 Jan	385	201	191%
03:00 Fri 14 Jan	369	192	192%
04:00 Fri 14 Jan	354	187	189%
05:00 Fri 14 Jan	339	183	185%
06:00 Fri 14 Jan	326	180	181%
07:00 Fri 14 Jan	313	177	177%
08:00 Fri 14 Jan	301	175	172%

The gauge at Rifle Range was not recording during the period 11:00 Tuesday 11th through till 09:00 Wednesday 12th during the period of highest flows from Wivenhoe.

For the whole period above, the flows modelled by SEQWater exceed the flows determined by DERM from the stream height, sometimes by more than a factor of two.

Additionally, since the original submission the report prepared on behalf of the Insurance Council Australia (4) has been released which noted on page iii: -

> *As the flood travelled further downstream, backwater effects from the Brisbane River associated with the releases from Wivenhoe Dam came into play and affected water levels. Flood behaviour in the lower reaches of Lockyer Creek and the Bremer River was complicated by "normal" floods associated with flows in these waterways attempting to flow into the Brisbane River whilst backwater flood flows from the Brisbane River were moving*

upstream. The interaction of these two flood events will have increased water levels along the lower reaches of these tributary waterways.

And in Section 8.5.2 of the ICA Report (4) noted: -

> *In the early hours of Tuesday morning 11 January, water levels at Rifle Range Road started to rise again, in response to backflow from the Brisbane River flowing up Lockyer Creek. This backflow was caused by releases from Wivenhoe Dam, especially the significant increase in release (to 7,450 m3/s) that is thought to have commenced around 0300-0600 hours on Tuesday 11 January.*

It is therefore likely that the highest stream gauge heights are due to these backwater flows and that the stream rating curve utilised by DERM would overestimate the actual stream flows during these periods. At the times of the highest stream levels the flows modelled by SEQWater are already between 136% and 208% of the flows that have been calculated by DERM.

SEQWater would therefore appear to have substantially overestimated the actual flows from Lockyer Creek during the peak of the flood. Overestimation of the flows from Lockyer Creek will underestimate the impact that releases from Wivenhoe had on the flows and levels in the Brisbane downstream.

It is therefore important for an independent expert assessment of the impact of releases from Wivenhoe on flows and levels downstream in Brisbane.

7.2 Bremer River

No data has been obtained from DERM to allow a similar comparison of the flows modelled by SEQWater against the recorded stream heights and implied flows.

An independent assessment is required to determine the contribution of the releases from Wivenhoe to the actual flood in Brisbane.

8. CHANGES IN FLOOD STORAGE CAPACITY

While it can be claimed that there has been no loss in flood storage capacity, it is disingenuous, as it does not consider the significant change in the downstream impact on communities when the quoted flood storage volumes are accessed.

The table below compares releases from both dams, at the claimed flood storage volumes, now and when the dams were constructed.

	Releases As Constructed (m^3/sec)	**Releases Now (m^3/sec)**
Wivenhoe (utilising 1,450,000 ML in flood storage)		
all radial gates closed	930	Not Permitted
all radial gates open 5.4 metres	3670	Not Permitted
all radial gates fully open	11,715	22,215
Somerset (utilising 520,887 ML in flood storage)		
	Nil	2,512

8.1 Wivenhoe

Prior to the installation of the Fuse Plugs the water level in the dam would be at EL 77 if it was retaining the quoted 1,450,000 ML in flood storage. At this level, the lake was above the top of the closed radial gates which are at EL 73.

Therefore prior to the installation of the Fuse Plugs, the dam had to be releasing water and the releases would have been one of the following: -

- With all the radial gates closed (i.e. all the water discharging over the gates) - 930 cubic metres per sec, or
- With all the radial gates open 5.4 metres (i.e. all the water discharging under the gates) - 3670 cubic metres per sec, or
- With all the radial gates fully open – 11,715 cubic metres per sec.

In the original design configuration, the dam could be overtopped by the revised criteria for the Maximum Probable Flood and consequently fail. This was deemed so unsafe that it was necessary to increase the release capacity of the dam. Installation of the current fuse plugs was only one of the many possible options considered at the time.

However, the selection of the current Fuse Plug option meant that releases from the dam substantially increased under all circumstances when the dam level was above EL 74.

Now at EL 77, the Operational Manual requires that all radial gates are fully open and all Fuse Plugs will be breached. Releases from the dam will now total 22,215 cubic metres per sec. Calculated releases from the Fuse Plug Spillways are based on the table presented on page 57 of the Operational Manual (5).

8.2 Somerset

Somerset temporary flood storage capacity is claimed to be 520,887 ML in addition to the 379,849 ML below FSL giving a total capacity of 900,736 ML. There are several different numbers quoted, including different numbers from SEQWater which initially quoted 524,000 ML of flood storage capacity. However the Office of the Hon Stephen Robertson MP Minister for Energy and Water Utilities confirmed 520,887ML as the temporary flood storage capacity of Somerset on 22nd February this year.

When Somerset Dam was first operational it could retain water to EL 107.46 and held this 520,887 ML of flood waters behind the wall. The Crest Gates, sluices and regulator valves could all be closed and there would be no releases from the dam. However all current Strategies for the operation of Somerset (2) appear to require the Crest Gates to be open and the level of 107.46 mAHD would not be achieved without significant outflows.

While Somerset can still be filled to EL 107.46 and it can therefore be claimed to have the same flood storage volume, the difference now is that under the Operational Manual (5) the Crest Gates, and perhaps also the sluice gates, must be open. In this case the dam would be releasing at a minimum rate of 2,512 cubic metres per sec.

During the peak of the releases on Tuesday 11th January, the maximum level in Somerset was 104.42 mAHD with approximately 227,748 ML of spare flood capacity. The maximum that Somerset was ever filled to during the event was 104.96 mAHD with unused flood storage capacity of 190,788 ML. SEQWater has always relied on the Somerset/Wivenhoe interaction curve in Rev 7 of the Manual of Operational Procedures (2) to justify not using this spare capacity during the period. But there has not been any discussion about the basis for this interaction curve or justification of the three Strategies specified for Somerset.

The whole operation of Somerset and the way the Strategies are written seem very unusual.

Under the Strategies there are no circumstances under which it is permitted to close the radial gates on Somerset. The Strategies go further and require that if the level in Somerset is rising above the interaction curve the sluice gates are to be opened to release more water form Somerset. In the logic adopted by SEQWater this does not mean that you are unable to ultimately still store 520,887 ML as Flood Storage in Somerset and so the flood storage capacity remains unchanged. However, in reality a much larger flood is now required to utilise this flood storage capacity – recognising that the Operators will be releasing the water at the maximum possible rate.

The reasons for adopting this approach do not seem to have been released by the Commission but the clear implication is that the Operators are desperately scared of filling Somerset to its initial capacity. The Operators will initiate the maximum possible releases to prevent it reaching that level and there is no way that they will close the radial gates. It would appear therefore that there are undocumented concerns about the structural integrity of Somerset and/or the radial gates.

It may be argued that the declared flood storage capacity of both dams is still available. However the declared flood storage capacity is no longer available during the more frequent floods of the size of the January 2011 event.

It now only becomes available during the very largest of floods due to changes in the configuration and operations of the dams such as the design selected for the Fuse Plugs on Wivenhoe and restrictions on radial gate operations at Somerset.

9. DISCREPANCY IN DAM LEVELS

9.1 Wivenhoe

Levels in Wivenhoe for the original submission were sourced from Brisbane River at Wivenhoe Dam Station Number: 540177 (15). It has not been possible to definitely determine the relationship between this Station Number 540177 and gauges 6637 and 6638 referred to in the Flood Event Report (3).

Section 9.3 of the original submission (2) noted the reported discrepancies between the two electronic gauges and the manual gauge board indicating levels in Wivenhoe. Refer also to Section 6 page 85 of the Flood Event Report (3) where SEQWater state: -

The manual read gauge board used during this event is located on the outside of wing wall of the spillway approach. There are two automatic gauges at Wivenhoe Dam. Sensor 6638 was marked as OOA for the Event. The other sensor 6637, located around 50m upstream of the gates, matched the manual gauge board readings until around midday on Tuesday 11 January 2011.

There are a number of inconsistencies regarding these gauges throughout the remainder of Flood Event Report (3). Despite all three readings matching until midday on Tuesday, Table 5.2.6 of the Flood Event Report (3) records both electronic gauges as being recorded out of action prior to midday Tuesday 11th.

- Gauge 6637 was recorded as Out of Action from 10:00 on 11 Jan 2011, two hours prior to the readings diverging, and
- Gauge 6638 was recorded as Out of Action from 11:00 on 10 Jan 2011, 25 hours prior to the readings diverging.

Figure 6.5.5 of the Flood Event Report (3) shows a plot of the Manual Gauge Board readings for the level in Wivenhoe compared with sensor 6637. Sensor 6637 continues to read through the whole of the event but the disparity from the gauge readings is obvious.

Appendix Q of the Flood Event Report (3), Recorded Height Hydrographs, provides additional plots for sensor 6637, 6638 and the manual gauge board. However in this plot no readings are provided for sensor 6637 beyond midafternoon Tuesday 11th while sensor 6638 continues to provide data.

Appendix M of the Flood Event Report (3), Flood Event Log, records other agencies were not notified of the failure of the Wivenhoe ALERT gauge until 2:19 PM on Tuesday 11th.

The trace shown for sensor 6637 is similar to the trace obtained from Station Number 540177 and it is assumed that these readings are from the same gauge.

9.1.1 Sequence of Events

Item No	Date and Time	Event
1	11:00 Monday 10th Jan	Gauge 6638 was recorded as Out of Action
2	10:00 Tuesday 11th Jan	Gauge 6637 was recorded as Out of Action
3	12:00 Tuesday 11th Jan	Gauges 6637 and 6638 first deviate from Manual Gauge Board
4		Gauges 6637 and 6638 continue to provide data for the whole

Item No	Date and Time	Event
		of the event
5	14:19 Tuesday 11th Jan	Other agencies first notified of the failure of the Wivenhoe ALERT gauge

9.1.2 Impact of Releases from Splityard Creek

In the submission from Tarong Energy (16) it is noted that 5,262 ML of water was released from Splityard Creek Dam into Wivenhoe during the period 11:09 Tuesday 11th January to 19:00 Tuesday 11th January 2011. Apparently SEQWater were unaware of these releases at the time and while the quantities are not significant, SEQWater have not allowed for these inflows to Wivenhoe in any of the analysis provided in the Flood Event Report (3).

Tarong Energy also note *"the potential discrepancy between Wivenhoe Dam levels recorded at the station, versus those recorded by SEQWater at the dam wall"*

9.2 Somerset

Discrepancies are also indicated between sensors 6591, 6594, 6795 and the manual gauge board on Somerset Dam in Appendix Q of the Flood Event Report (3). No reasons for the discrepancies are addressed in the remainder of the Flood Event Report (3).

10. NOTES

1. As per the original submission (2), the words Operator and SEQWater are used interchangeably in this supplementary submission. There has been no attempt to understand the actual legal structure defining the relationship between the beneficial owners of the assets and any relationships they may have with other parties who may provide services to the owners such as design, construction, maintenance or operating services. The terms Operator and SEQWater are therefore shorthand for the legally responsible entity for the provision of the required services at the particular time.

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12. ABBREVIATIONS

ARI	Average Recurrence Interval
AEP	Annual Exceedance Probability
BoM	Bureau of Meteorology
cumecs	cubic metres per sec, 1000 litres per sec
DERM	Department of Environment and Resource Management (Qld)
EL	Elevation
FSL	Full Supply Level
FOC	Flood Operations Centre
mAHD	metres Australian Height Datum
m^3/sec	cubic metres per sec, 1000 litres per sec
ML	mega litres, 10^6 litres, million litres
ML/d	mega litres per day
MHWS	Mean High Water Spring Tide
Operator	Refer to Section 9
SEQWater	Refer to Section 9
TCE	Target Cost Estimate

ATTACHMENT 1

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