A series of model runs for 4,500 cumecs, 5,000 cumecs, 5,500 cumecs and 6000 cumecs might be analysed to see if a combination gate-plug flow plus fuse plug flow would constitute less of a threat to inundation of the floodplain downstream of Wivenhoe.

Reports on the operation of the gates during fuse plug flows contemplate removing the gates from any play in the control of the flows.

The concern has been expressed that the fuse plug flows are uncontrolled. If it is practicable, partial closing of the gates during fuse plug flows would bring a measure of control to the total outflows that would not be available if the gates were completely opened.

If, say, the Dam water level rose to 75.7m AHD:

1. The level 1 fuse plug flow of 1600 cumecs would shortly thereafter be released;
2. The gates could be partially closed, say, so that the top of the gates are at 76m AHD;
3. The gate opening would then be 4 metres approx – see Ref C, page 56, '***Top and Bottom Gate Levels for Various Gate Openings'***;
4. The release through each gate would be 528 cumecs – see Ref C, page 55, '***Individual Radial Gate - Rating Table'*** ;
5. The release rate from all gates would be 2640 cumecs approx;
6. The total release rate, gates and fuse plug would be 4240 cumecs; and
7. Thus the gates would need to be opened a little more to provide 4500 cumecs,

Thus controlling flow to 4500 cumecs as part of a fuse plug release appears to be feasible at a Wivenhoe Dam water level of 75.7m AHD, engineering factors permitting. Controlling the flow to 5000 cumecs and to higher releases also appears feasible at this water level.

If then, say:

1. the W4 decision was taken to keep releases to 4,000 cumecs, from the time that the decision was made to invoke the W4 Strategy, that is, at 0800 hours on Tuesday 11 January 2011;
2. The size of the cap of the actual gate-plug flow that occurred in that Flood Event (above the 4000 cumecs level, from 1300 hours on 11 January to 0500 hours on 12 January 2011), was approx 34,000 cumec hours (see **REF B**, pages 158-9);
3. The additional releases effected before this period (from 0800 to 1300 hours on 11 January 2011) would have been approx 4,000 cumec hours (see **REF B**, pages 158-9);
4. The volume therefore that would need to be absorbed by additional storage in the Dam was approx [34,000 – 4,000 =] 30,000 cumec hours, or 108,000ML;
5. The peak water level reached in Wivenhoe Dam with the actual gate plug flow of 7500 cusecs was 74.97m AHD, say 75m AHD; and
6. 108,000 ML above this level would raise the water level to approx 75.66m AHD (see Ref C, page 53).

Under this application of the Strategy W4, the first Fuse Plug may not have been initiated during the January 2011 Flood Event, and the releases out of Wivenhoe Dam may not have exceeded 4000 cumecs.

This analysis is using some hindsight.

A methodology that may assist the operators to this result without hindsight is set out in Figure 4.

It appears that when the second fuse plug is initiated, controlled flow at release rates below 8000 cumecs may not be feasible.

It is not apparent that any option that relied on fuse plug releases was investigated.

FIGURE 4: ALTERNATIVE RELEASE RULE FOR STRATEGY W4, WIVENHOE DAM

4000 cumecs → →→
[or 4500, or 5000, if lower flows do not keep predicted WD Water levels below 76.2m AHD]

Aim: Minimise the peak flood level at Moggill that keeps WD Water level below the Trigger Level, 76.2m AHD, for the Second Fuse Plug

08.00	13.00		05.00			
Tuesday 11 January 2011			Wednesday 12 January 2011			

REF B has failed to analyse the availability of such an option, once SEQWater realized the situation that had been generated at the end of the Strategy W3 period.

The apparent determination not to rely on the first fuse plug may betray a absence of any confidence in the fuse plug option, and an attitude that equated of the fuse plug option with a high risk of dam failure or dambreak.

This author certainly agrees with any such risk assessment.

This author has designed rockfill dams for overtopping, and has researched the recordings of rockfill dams having been overtopped from around the world. This author would design and redesign such a dam, in this Dam‘s situation, **not to be overtopped by the PMF, as was the original design criterion for Wivenhoe Dam.**

SEQWater, however, have established such a fuse plug system into the Wivenhoe Dam, and would be expected to at least consider using the fuse plug mechanism before sending a 7500 cumec _gate-plug' flood down the Brisbane River.

An unexplained fear of the fuse plug option appears to have prevented even a consideration of this option.

RECOMMENDATION 2: That an analysis, using and building upon the Alternate W4 Strategy suggested by Figure 4, be undertaken by the Commission using an independent third party authority.

Conclusions re Strategy

The operational focus of SEQWater, during the January 2011 Flood Event, appears to switch very quickly from an _avoid inundation' objective during the W3 Strategy to an _avoid fuse plug operation' objective in the W4 Strategy.

There does not appear to have been any consideration, during either the W3 or the W4 Strategies, to options that followed a _minimise inundation' objective.

As a result, it appears that SEQWater may not have carried out analyses that might have identified, for SEQWater, options that may have avoided any release flows from Wivenhoe Dam in excess of 4000 cumecs.

These options appear to have been available at relevant times, whether in the operation was in the Strategy W3 or the Strategy W4 decision-making regime

OVERALL RATING OF SDWD AS A FLOOD MITIGATION SYSTEM

General

In the first submission made to the Commission of Inquiry [–**REF A**‘], a proposal was outlined for a system of auditing flood mitigation schemes, leading to a rating of each such scheme against the following hierarchy of system descriptors:

1. **Ad hoc** – the system is piecemeal, without organisational involvement;

2. **Planned** – the system is planned but not implemented;

3. **Managed** – the system is being implemented, but without alignment, consistency, consolidation and/or balance;

4. **Integrated** – the system is holistic, but is in need of improvement; and,

5. **Optimised** – all aspects of the system are under continuous improvement and are open to updating, upgrading and innovation.

A preliminary rating of the **SDWD** flood mitigation regime, operated by SEQWater within the Brisbane Valley, is offered below.

It is submitted that the **SDWD** system may be assessed at 1.9, that is, at the 40% point of the scale [1.5 to 2.5] for the rating, ‗**PLANNED**‘.

It is further submitted that deficiencies in the planning of the system are tending to undermine, for critical flood events, the capacity of the operating system to achieve a higher rating as an effective flood mitigation regime.

Comments in support of this preliminary rating are offered below.

Planning

Strengths. The following aspects may show strength in planning for the **SDWD** system for mitigating floods flowing into Somerset and Wivenhoe Dams, accepting the accuracy of some statements made by SEQWater about itself:

1. The Manual for Operating the **SDWD**, complete with Operational Target Line, Strategy options, provisions for discretionary variations, and guidance for decision-making;
2. A Communications Protocol at draft stage;
3. Staffing arrangements;
    a. for 24/7 operations upon the trigger of a Flood Event; and
    b. for streamgauging exercises during moderate and major flooding;
4. Redundancy arrangement for power; and
5. Completed calibrations of particular hydrologic models.

Improvements. The Planning regime for mitigating floods passing through the **SDWD** may benefit from actions to address the following:

1. Coverage of rainfall stations appears to be insufficient, deficient or non-existent in significant parts of the catchments feeding the **SDWD** infrastructure, and in catchments feeding flood flows outside of the **SDWD** infrastructure;
2. Operability of streamgauging stations may be at risk during the major flood events for which their operation is most critical;
3. Measurement of water levels at Wivenhoe Dam near and at the peak of the Dam water levels may be contradictory and confused;
4. Insufficient priority may be being given to obtaining flood flow measurements to improve the rating range of principal flood gauging stations. For example, the

primary Gregor Creek station was rated during the January 2011 Flood Event but only to a 30% rating ratio;

5. A hydraulic model capable of providing forecasts of floods downstream of Wivenhoe is not available;
6. The hydrologic modeling currently serving this purpose if performing poorly, and may have caused a credibility issue with the flood community the next time that severe flooding warnings are issued downstream of the Wivenhoe Dam;
7. Confusion exists as to whether the _no inundation' flow at Moggil is 3500 cumecs or 4000 cumecs;
8. Flooding maps may not have been on hand for decision-making during the Flood Event;
9. Staffing of the operations function may be insufficient for three day flood events or longer, exercising technical control over **SDWD**, North Pine Dam and other dam and dam related infrastructure; and
10. Too many functions, important to the optimum functioning of an operations centre in critical times, had to fall back upon redundancy provisions and make-piece alternatives, including power, communications, and computing capabilities.

Further, an additional Strategy, between W3 and W4, may be advisable. It could be specifically devoted to the objective of minimizing inundation downstream of Wivenhoe.

This new Strategy might be triggered by an assessment that the objective of avoiding inundation was no longer feasible. It would also need a trigger, to determine when this new Strategy needed to be terminated because the flood mitigation purpose of the **SDWD** needed thereafter had to be surrendered to the objective of preventing Dam failure.

Managing the Scheme.

It is proposed that deficiencies in the Planning for the flood mitigation function of the **SDWD** system may be preventing the system improving to a level of _**MANAGED**" on the rating scheme for assessing systems proposed by Ref A.

The strategies for flood mitigation for the benefits of homes subject to inundation, and the decision-making applying these strategies, may be conflicted with and/or misaligned to the flood mitigation purpose.

REF B appears to refuse to acknowledge any of the problems that are within the current public debate, not even to dismiss these problems. Regrettably, **REF B** has opted instead to avoid the issues.

Two significant aspects to **REF B** that may demonstrate this avoidance are:

1. The failure to conduct and report any analysis that proves or dismisses the charge that the flood was avoidable. SEQWater was in the best position, objectively, to carry out this necessary analysis. Accordingly, it is submitted, SEQWater can not reasonably be trusted with the analysis, because of a perceived interest in one of the outcomes from such an analysis. An attitude of curiosity for any insufficiencies in existing methods and thinking is not apparent in **REF B** – a defensive approach appears to have been adopted;
2. A statement in the Executive Summary of **REF B,** page iii**,** (Quote):

   "…Had the rainfall on Tuesday 11 January 11 largely fallen in catchments downstream 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 a loss of the mitigation effects that were provided by the Dam."

   Was it the rains fault that we had a flood?

The most serious deficiency in the management of the **SDWD** may be a lack of ethics in the public information provided on the scheme. This failure of ethics may originate, it is

submitted, in the way that the characteristics of the **SDWD** are advertised to the public in probability terms.

This submission advocates the position that rare floods should be presented factually to the public, in terms of percentages of the current estimate of the **PMF**.

In modern governance, there is an unequivocal right of the public to know the facts, including the quality of any estimates of the facts.

Allowing a place for those who have a genuine preference for the use of probabilities, probabilities must also be expressed according to an ethic, this submission proposes, particularly when it impinges on public safety.

This ethic, as it happens, has been described by professionals who have been advancing notions of credibility limits criticized by this author, albeit in the context of paleofloods (Quote):

> ***"…Uncertainties associated with the descriptions of flood flow exceedance probabilities are likely to be substantial and an important attribute for the characterization of extreme floods. Flood characterization should include a "best estimate" of the annual exceedance probability of floods of different magnitudes and a description of the uncertainty in such results. Such uncertainties need to be honestly represented and considered throughout the risk assessment process."***[Ref H]

The information that is going to the public about the Wivenhoe Dam appears only to be the estimate of the annual exceedance probability of the **PMF,** without an honest representation‘ of the uncertainty in this single figure, it is submitted. Often AEP is expressed in terms of years, thousands and hundreds of thousands of years.

The continuing flow of words referring to a ‗1in6,000' AEP event, or ‗1in22,000 flood', the 1in100,000 design flood or similar, **do not carry** the uncertainty reminder that may properly be required for the information to be ethically presented, it is submitted.

This submission proposes that the uncertainty of the **PMF** value as a probability figure needs to be described. If the uncertainty is to be honestly represented to the appropriate standard of professional ethics for informing the public about probability estimates, providing information on the confidence limits is an unavoidable obligation.

The **PMF** for the Wivenhoe Dam, on an analysis sighted by the author during employment in the State Public Service, had a 95% confidence range of 8,000 cumecs to 300,000 cumecs.

It is proposed in this submission that descriptions of the **PMF** for Wivenhoe of

49,000 [95%:8000→300,000] cumecs

is an honest representation of the 49,000 **PMF** figure as a probability figure.

It is honest because it shows the true quality of what is being proposed as the ―best estimate".

It is submitted that the public is entitled to be given the honest indication that the ―best estimate" of **PMF** and its AEP, notwithstanding that, even if it is the ―best", it is not very good.

Regrettably, this does not appear to be happening with respect to information about Wivenhoe Dam.

For rare floods less than the **PMF**, it is submitted, honest representations are also required for the **SDWD** to merit a rating of ‗**MANAGED**'.

Thus the diagram in Ref I, ***Figure 2: Probability Log Plot of Design Inflows, Wivenhoe Dam'*** is unsatisfactory as a broadcast of information about the rare and extreme inflows estimated for Wivenhoe Dam, for several reasons:

1. The uncertainty limits have been reduced from 95% to 75% - sometimes 50% confidence limits are used by hydrologists who may be embarrassed by the meaninglessness that 95% confidence limits impose upon the ~~"b~~est estimate";
2. Dashed lines have been used for the confidence limits – actually, these lines are not hard to see, but other reports such as Ref I use faint dots that reproduce poorly; and
3. The Upper Confidence line is terminated at an AEP of 10^{-4}, and is not continued to show the Upper 75% Confidence Limit of the **PMF** just past the 10^{-5} vertical.

This diagram does allow (with a little extrapolation of the Upper Confidence Limit) an honest representation of the 1in22,000 AEP flow. This flow is expressed only as 25,700 cumecs in Ref G, but, as best can be read of Ref I, it could be represented as:

1in22K AEP Flow ≈25,700 [75%: 20,000→80,000] cumecs

The diagram also allows the range of the AEP of the flow, 25,700 cumecs, to be described, as

AEP of 25,700 cumecs ≈ 1in22K [75%:1in6K→1in80K]

Ref I, reporting upon the hydrology of another Dam in South East Queensland, may include a demonstration as to how quickly the approximate nature of these AEP figures can be left behind, where the range of AEP for the **PMF** is given as 1in183,000 to 1in18,300,000 [Ref I, page 21].

It is submitted that the practice of plotting the **PMF** on probability paper, and then drawing a line from the ~~"b~~est estimate" of the 1in100 AEP event to the **PMF,** so as to estimate the AEP of rare floods, is an application of GEOMETRY, not an application of PROBABILITY THEORY.

This should be stated to the public.

Representing such a plot as a product of PROBABILITY THEORY misrepresents the true nature of the method, it is submitted. The degree of misrepresentation may be fairly described as ‗gross'.

If GEOMETRY is the basis for scaling floods below the PMF, it is logical and honest to express these scaled-off floods in geometric terms. The descriptor, say,

[x% of the current estimate of **PMF**]

has this measure of honesty.

If the approach instead is to choose a frequency distribution curve, sometimes by eye, through the probability plots of the historical flows, that intersect the probability assigned to the **PMF**, close to the **PMF** value, is this the application of PROBABILITY THEORY or is it a form of CURVATURE GEOMETRY?

If it is seen to be probability, then the description of rare floods needs to again describe the uncertainty in the estimated flow for that AEP. The uncertainty needs to be described, it is submitted, without diminution of that uncertainty by omission, reduction, termination or light shading of the 95% confidence limits. The public interest demands a full and honest description of the state of knowledge about the flooding situation that is faced, it is proposed.

It is submitted that only credible science should be used in any technical analysis. To engage in technical analysis of hydrology and dam design, using non-credible science, may only bring the profession into disrepute, it is further submitted, including a loss of public confidence in government and its instrumentalities responsible for water management.

Such disrepute appears to be an emerging outcome from the January 2011 Flood.

CONCLUSIONS

The following submissions by SEQWater in REF B should be dismissed by the Commission of Inquiry:

1. That the cause of the flooding was the rain or the inaccuracy of the rainfall forecasts provided by the Bureau of Meteorology
2. That the data collection and flood modeling systems overall performed sufficient for the purpose of an effective flood mitigation regime
3. That the January 2011 Flood Event has an AEP of 1in100 to 1in 1000
4. That a flood of the size of the January 2011 Flood Event would be expected to cause the damage that the January 2011 flood actually caused
5. The sufficiency of the staffing for major flood events simultaneously mobilizing flood mitigation operations for multiple major dams

The Commission should conduct independent analyses to test the positions that:

1. Outflows from Wivenhoe Dam, 4000 cumecs or less, could have handled the January 2011 Flood Event
2. The Flood Event could have been mitigated to the 4000 cumec limit or less in both the W3 and the W4 Strategies
3. The benefits of adding a new strategy to the Operational Strategies currently listed for the Wivenhoe Dam, one that had the single objective of minimizing inundation downstream of the SDWD
4. The AEP of the January 2011 Flood Event upstream of Wivenhoe, based on volumes of inflows, using techniques that allow the extension of the record, or that make allowance for the records that exist, of historic floods back to 1893
5. The AEP of the January 2011 Flood Event upstream of Ipswich and of Brisbane, based on volumes of inflows and /or flood heights, using techniques that allow the extension of the record, or that make allowance for the records that exist, of historic floods back to 1893 and, if possible, back to 1841

The Commission should make inquiry into:

1. The source and accuracy of the forecasts of Wivenhoe Dam water level contained in the Situation Reports and in the Technical Situation Reports
2. The factors that contributed to the purported ‗rapid rise' in water levels in Wivenhoe Dam rising to the peak water level
3. The sources for any concerns, held by any registered professional engineers within SEQWater or other stakeholder State Government organisations, for employment of the fuse plugs currently installed into the walls of Wivenhoe Dam
4. The sufficiency of staffing, accommodation, capacities for communications and support for the operators at central locations and at Dam sites during major flooding lasting 7 days
5. The source and basis for the opinion that Somerset Dam can cope, without failure, with more than 2 metres of outflow overtopping the Dam wall
6. The real needs of the SDWD for data collection and modeling / forecasting systems that will be operable during very large floods up to the PMF (including facilities for stream measurements for rating priority streamgauging stations such as at Gregor Creek
7. The pressures, if any, that were brought to bear on experts within the Bureau of Meteorology and on other specialist professionals in the State Public Servants or consultancies for the State Public Service during the introduction and implementation of the practice of assignment of probabilities to PMFs
8. Which individual experts, not organisations, in the relevant field in Australia, if any, have ever recommended the assignment of probabilities to the PMF for the purposes of dam design or for purposes other than **comparative studies, not absolute decisions**, on matters such as cost benefit analyses of alternatives for controlling floods, and **relative impacts, not absolute impacts**, of factors upon technical estimates of precipitation
9. The legitimacy of claims that methods used to establish the ‗probability' of rare floods is based on probability theory rather than drafting by eye on probability paper

10. The legitimacy of the basis for claims that estimates of 1in2000 AEP in Queensland are within a reasonably defined 'limit of credibility'
11. Any misrepresentations, errors and / or poorly defined concepts in the practices and writings of SEQWater, Bureau of Meteorology, AR&R and / or ANCOLD regarding the assignment of probabilities to large dams, including the statement in Ref J, page 27, for which Deputy Commissioner Cummins appears to be a co-author, that estimates of the probability for PMP were

    'previously recommended by Kennedy and Hart (1984)'

12. The information that should be given to the public so as to properly inform the public about the protection afforded to the public by Wivenhoe Dam and other major rockfill dams that can be overtopped by current estimates of the PMF.
13. The likely response by the public in the Brisbane River valley on the next occasion of a major flood when SEQWater provide warnings of flood heights in excess of the 1974 flood heights

[redacted]