Somerset-Wivenhoe Interaction Study

Terry Malone & John Tibaldi

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ABREVIATIONS

AFC	Acceptable Flood Capacity
AEP	Annual Exceedance Probability
DCF	Dam Crest Flood
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PMPDF	Probable Maximum Precipitation Design Flood

1.0 INTRODUCTION

To maximise the combined flood mitigation benefits of Wivenhoe and Somerset dams, the operation of the dams during floods is interdependent. This report examines this interdependency and recommends an operational procedure to maximise the overall flood mitigation benefits of the dams, while preserving as much as possible the safety of the dams. To determine the optimal flood mitigation strategy, a Somerset-Wivenhoe Operating Target Line is used to examine the relationship between the levels in the two dams during a flood event.

The existing Operating Target Line requires review because it does not properly account for the raising of Wivenhoe Dam (Wivenhoe Wave Wall now AHD 80.0 metres AHD) and construction of an Auxiliary Spillway that occurred in 2005. It also does not properly account for the revised failure level of Somerset Dam (Somerset Failure Level now 109.7 AHD) or for scenarios associated with floods centred on the Somerset Catchment.

This Operating Target Line is optimised for the following two competing objectives:

- Dam flood level peaks in both dams are to be equally minimised in relation to their associated dam failure levels.
- Flows in the Brisbane River downstream of Wivenhoe Dam are to be minimised.

When selecting the optimum Target Line, consideration must also be given to the time needed at the onset of a Flood Event to properly assess the magnitude of the event and the likely impacts. Such assessment is critical in ensuring that the required strategies are followed in the management of the event. Commencing a release strategy without such assessment may not result in maximising the Flood Mitigation benefits of the storages.

2.0 METHODOLOGY

The following methodology was used in the investigation of the Somerset-Wivenhoe Operating Target Line:

- The latest available design flows for the Brisbane River to Wivenhoe Dam and for Stanley River to Somerset Dam were checked, verified and collated.
- The existing operations spreadsheet was modified to reflect both the revised critical levels (see Section 2.1) and the updated operations strategies for both dams. The spreadsheet was then checked and verified against a range of flood events.
- A range of flood events were examined against a range of trial Target Lines. Dam flood level peaks and flows in the Brisbane River downstream of Wivenhoe Dam were calculated and graphed for each trial.
- Flood Events relating to both Wivenhoe centred floods and for Somerset centred floods were investigated.
- All results were analysed and an optimum Target Line was selected based on 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, so that the likely optimal strategy to maximise the Flood Mitigation benefits of the storages can be selected.

2.1 CRITICAL LEVELS

The Somerset-Wivenhoe Operating Target Line is influenced by the critical levels in each dam. These critical levels are shown in the following tables, with all levels shown in relation to Australian Height Datum.

Table 2-1: Critical Levels for Somerset Dam

Item	Elevation m AHD
Full Supply Level	99.00
Spillway Fixed Crest	100.45
Current Sluice Trigger Level	102.25
Main Dam Crest	107.46
Maximum Allowable Flood Level	109.70
Top of Deck	112.34

In the current Flood Manual, the maximum allowable flood level was taken to be the elevation of the main dam crest of EL 107.46 m AHD. A study undertaken by NSW Commerce (NSW Commerce 2005) determined that the failure level at the *"Change of Slope"* in the upper abutment monoliths is EL 109.7 m AHD.

The change in maximum allowable flood level has significant implications for the slope of the operating target line and associated target levels.

Table 2-2: Critical Levels for Wivenhoe Dam

Item	Elevation m AHD
Spillway Fixed Crest	57.00
Full Supply Level	67.00
Gate Trigger Level	67.50
Upper Limit of W1 Operating Strategy	68.50
Top of Closed Gate	73.00
Upper Limit of W2 & W3 Operating Strategy	74.00
Main Embankment Crest	79.10
Top of Wave Wall	79.90
Saddle Dam Embankment Level	80.00

2.2 HISTORICAL OPERATING LEVELS

Somerset Dam was completed in 1953 while Wivenhoe dam was not completed until 1986. There are only a limited number of historical events which may be used for testing and comparison of gate operating levels. These are events that have occurred since 1986.

The table below, shows the levels at which sluices were commenced to be operated in historical events. The levels are shown for general information and no firm conclusions can be drawn from them.

Table 2-3: Historical Sluice Opening Levels

Event	First Sluice Opening m AHD
Jan-74*	101.60
Jan-76*	100.29
Jun-83*	100.90
Early Apr 89	99.30
Late Apr 89	99.56
Feb-92	100.74
Feb-99	102.57
Apr-09	99.39

*Wivenhoe dam not constructed.

2.3 CURRENT SOMERSET-WIVENHOE OPERATING TARGET LINE

The Somerset-Wivenhoe Operating Target Line is shown in Figure 2-1.

The maximum allowable water level in Somerset Dam was taken to be EL 107.46 m AHD. This level was previously understood to be the failure level for Somerset Dam. Following detailed engineering assessments, this level was revised in 2005 and the failure level for Somerset Dam is now understood to be EL 109.7 m AHD.

The operation of the sluices in Somerset Dam was dependent on the position at the time i.e. below the operating target line sluices were opened; above the operating target line sluices were closed.

The level of EL 102.25 m AHD, the level at which the sluice gates operations for Somerset Dam commence under the current Operating Target Line, was based on the commencement of flooding of the Mary Smokes Bridge in the upstream reaches of the Somerset Reservoir.

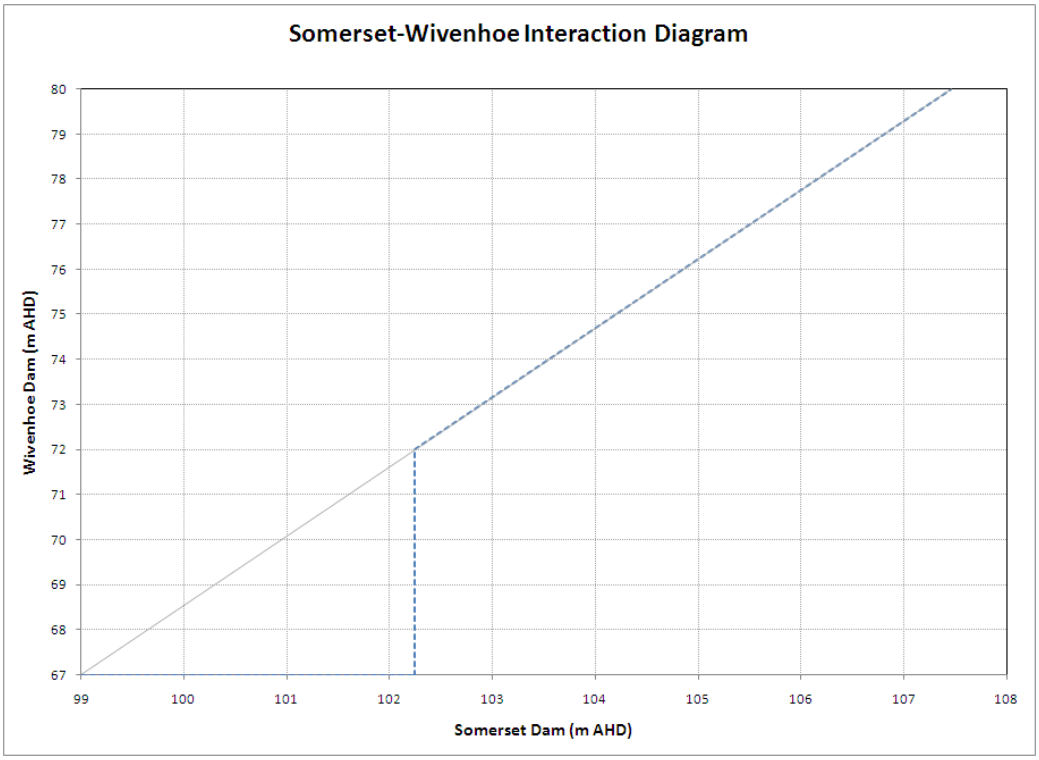

Figure 2-1: Current Somerset-Wivenhoe Operating Target Line

3.0 DESIGN HYDROLOGY

This study utilises the latest available flood hydrology for Somerset and Wivenhoe Dams. As part of the Wivenhoe upgrade, the Wivenhoe Alliance updated the design flood hydrology for the Wivenhoe catchment in September 2005 (Wivenhoe Alliance 2005). The Alliance also reviewed the Somerset Dam flood hydrology in 2004 (Wivenhoe Alliance 2004).

In September 2009, Seqwater commenced a review of the flood capacity of Somerset Dam. At the time of this investigation, the study had not been completed and only preliminary design flood estimates were available.

For Somerset Dam, there are differences between the design inflow hydrographs generated by the Wivenhoe Alliance in 2004 and those generated by Seqwater in 2009. Similar differences might also be expected in the current set of Wivenhoe design inflows.

Given the age of the models, the occurrence of significant floods events since this time and the differences in the Somerset design estimates, the flood models should be revised and the calibration revisited. This will occur in 2010 and the Somerset-Wivenhoe Operating Target Line will be investigated again at that time.

3.1 WIVENHOE DAM FLOOD HYDROLOGY

The design floods adopted by the Wivenhoe Alliance in 2005 utilised the calibrated WT42 models derived by the Department of Natural Resources in 1993 (DNR 1993). Since the 1993 study, the design rainfall methodology was significantly updated and the Alliance study included the latest estimates. As a result, the design floods were significantly higher than the 1993 estimates.

The study concluded that the 48 hour storm produced the highest outflows and results of the study are summarised in Figure 3-1.

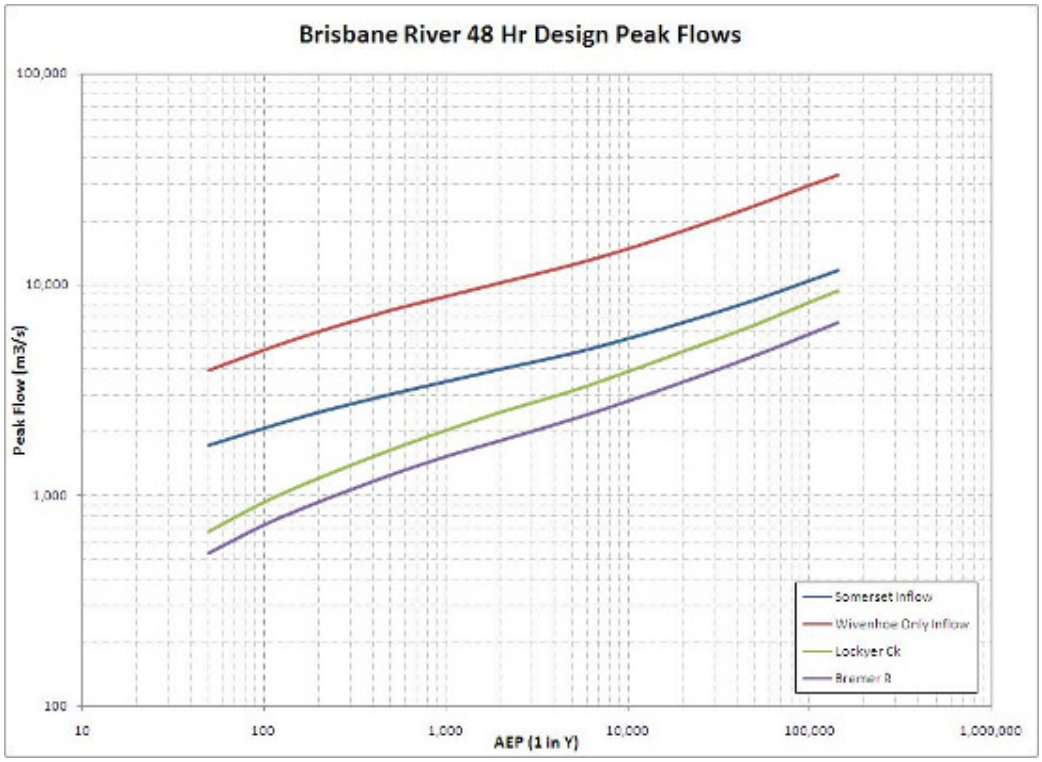

Figure 3-1: Brisbane River Peak Flow Estimates

Specifically for Wivenhoe Dam, the study concluded that:

- The AEP of the PMP is 1 in 143,000.
- The 36 hour storm produces the highest inflow peak for all AEPs.
- The 48 hour storm produces the highest peak outflow for the 1 in 200, 1 in 500, 1 in 5,000 and 1 in 10,000 AEP event for the existing dam. The 72 hour event produces the highest outflow peak for the 1 in1,000 and 1 in 2,000 AEP events for under the Stage 1 (now existing) spillway arrangements.
- The spillway augmentation does not impact upon design flows up to the 1 in 2,000 AEP event. This is substantially larger than the 1974 flood.
- Under the existing spillway arrangement, the DCF is approximately 1 in 100,000 AEP.

Individual design flood hydrographs derived by the Alliance for the Stanley River to Somerset Dam, the upper Brisbane River to Wivenhoe Dam (excluding the Stanley River), Lockyer Creek and the Bremer River are given in Appendix A. These flows have been adopted for assessment the operating target line for Wivenhoe centred floods.

3.2 SOMERSET DAM FLOOD HYDROLOGY

As the Somerset catchment is substantially smaller than the Wivenhoe catchment, design rainfalls and resultant flows are substantially higher than the Wivenhoe centred flood estimates. Additionally, the AEP of the PMP for the catchment is significantly higher i.e. 1 in 750,000.

The Wivenhoe Alliance also determined design flood estimates for the Stanley River to Somerset Dam (Wivenhoe Alliance 2004). The adopted design rainfalls and the resultant peak inflows are shown in Table 4-3. The studies utilised the WT42 models calibrated in the earlier DNR study. The FloodRoute program, developed by the NSW Department of Commerce, was used to route the flows through the storage to determine maximum discharges and water levels.

Table 3-1: Wivenhoe Alliance Design Rainfalls and Peak Inflows for Somerset Dam

AEP (1 in Y)	24 Hour		36 Hour		48 Hour		72 Hour	
	Rainfall (mm)	Peak Inflow (m3/s)	Rainfall (mm)	Peak Inflow (m3/s)	Rainfall (mm)	Peak Inflow (m3/s)	Rainfall (mm)	Peak Inflow (m3/s)
100	360	5,250	425	4,666	475	3,921	545	3,855
10,000	760	13,071	895	11,558	1,015	9,726	1,195	10,369
1,000,000	1,180	21,676	1,400	18,520	1,590	16,008	1,930	18,064

The current investigation of design flows for the Stanley River to Somerset Dam (Seqwater 2009d) adopted an URBS model of the catchment and calibrated to a series of floods including several events post 1993 floods not used in the original WT42 model calibration. As shown in Figure 3-2, the design inflows in both the Alliance and Seqwater studies are, not surprisingly, significantly higher the 1993 DNR study.

The relatively minor differences between the Alliance and Seqwater studies could be attributed to model and loss differences.

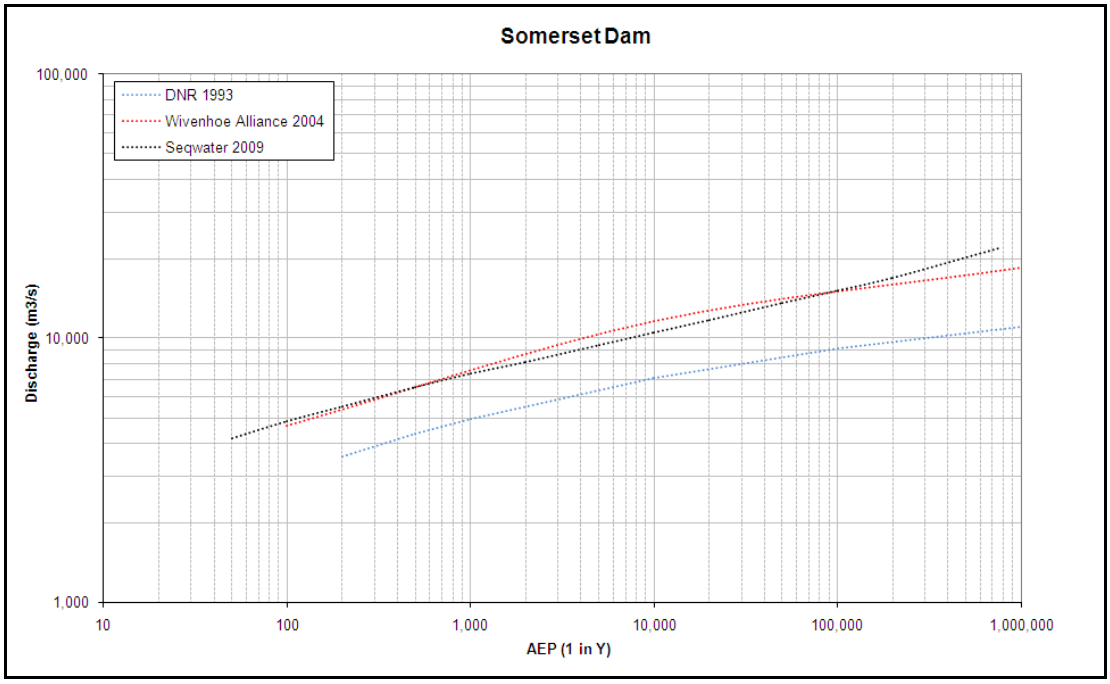

Figure 3-2: Stanley River to Somerset Dam Design Flows

4.0 INTERACTION INVESTIGATIONS

The investigation of a Somerset-Wivenhoe Operating Target Line involved routing the design floods through the dams using the operations spreadsheet. This spreadsheet has been developed and modified by various users in recent years. The latest version, Version 4A, was modified by Peter Allen, DERM, as part of this study to ensure it matched with current operating strategies for both dams. The modifications were verified as part of the investigation process.

The inputs into the operations spreadsheet are the design flows generated either during the Alliance study or during the latest Somerset Dam study. The spreadsheet allows the user to modify the starting level of the dam (usually assumed to be FSL) and the critical levels which define the Operating Target Line.

Output from the spreadsheet includes:

- Interaction diagram showing the relative levels between Somerset and Wivenhoe along with the Operating Target Line;
- Inflow and outflow from, and peak water level in, Somerset Dam, and;
- Inflow and outflow from, and peak water level in, Wivenhoe Dam, and;
- Flows in the lower Brisbane River downstream of Wivenhoe Dam.
- Summary tables of peak flows and levels.

Several Operating Target Line scenarios were considered. These are listed as follows:

- Somerset Dam sluice operating levels of EL 102.25, EL 100.45 and EL 99.0
- Wivenhoe Dam target operating levels of EL 67.0 and EL 68.5.

The corresponding operating target lines considered in the investigation are shown in Figure 4-1.

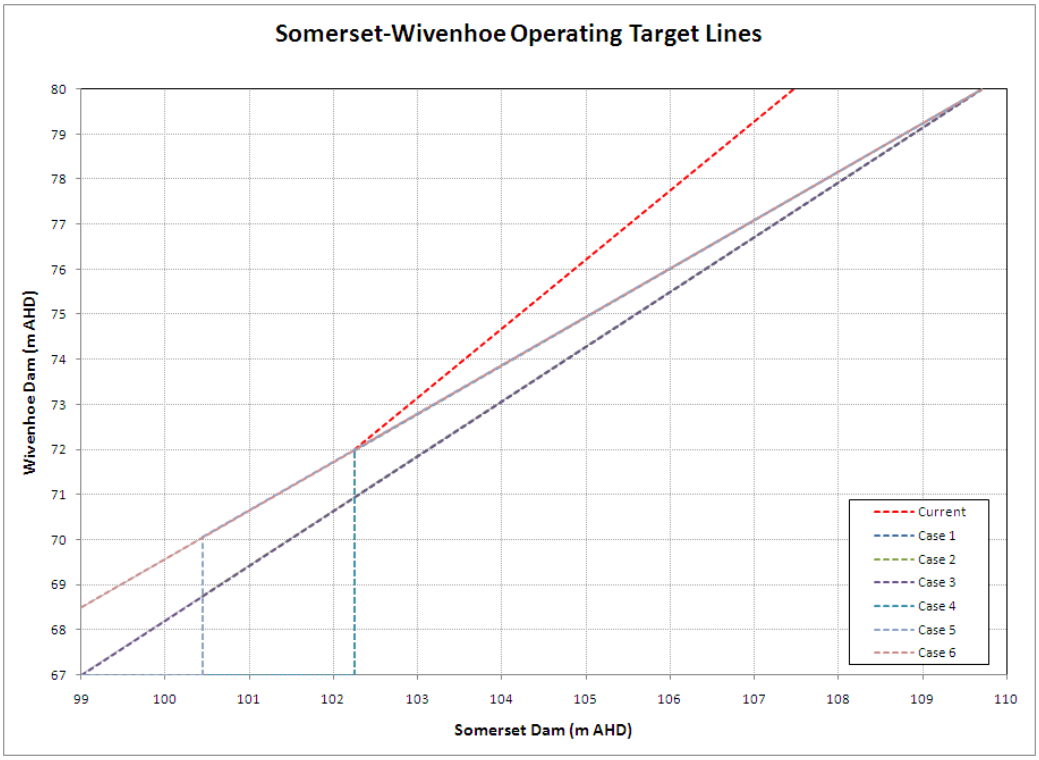

Figure 4-1: Trial Operating Target Lines

TRIAL OPERATING TARGET LINE CASE SUMMARY			
	LINE ORIGIN	**LINE CHANGE POINT**	**LINE END POINT**
Case 1	67.0, 102.25	71.0, 102.25	80.0, 109.7
Case 2	67.0, 100.45	68.75, 100.45	80.0, 109.7
Case 3	67.0, 99.0	-	80.0, 109.7
Case 4	68.5, 102.25	72.0, 102.25	80.0, 109.7
Case 5	68.5, 100.45	70.0, 100.45	80.0, 109.7
Case 6	68.5, 99.0	-	80.0, 109.7

Cases 3 and 6 which commence sluice operation at the Somerset Dam FSL (EL 99.0 m AHD), are not considered feasible options because they provide no time at the onset of a Flood Event to properly assess the magnitude of the event and the likely impacts. Such an approach is unlikely to maximise the Flood Mitigation benefits of the storages in all by the very rare events i.e. events in the order of 1 in 100 000. Accordingly Cases 3 and 6 have not been considered any further.

4.1 WIVENHOE CENTRED FLOODS

A range of AEPs from 1 in 100 up to the PMPDF (1 in 143,000) was investigated in assessing the four selected trial Operating Target Lines for Wivenhoe centred floods.

Peak water levels and flows for selected locations are shown below while more detail results are contained in Appendix B. Note the instability in the recession of the hydrographs at Lowood and Moggill in the 1 in 1,000 flood.

4.1.1 Somerset Peak Water Level

For events up to the 1 in 10,000, Case 5 which has the Somerset sluices opened at EL 100.45 results in lower peak water levels than the other Cases. This is not surprising as under this scenario flood water is released earlier from Somerset Dam.

In the extreme events, there is little difference in the peak water levels achieved under each operating scenario as shown in the table below.

Table 4-1: Somerset Dam Peak Water Levels

AEP	Case 1	Case 2	Case 4	Case 5
100	102.69	102.11	102.69	101.15
1,000	103.64	103.75	103.51	103.28
10,000	105.91	105.94	105.75	105.72
100,000	109.33	109.23	109.33	109.23
143,000	110.17	110.12	110.17	110.05

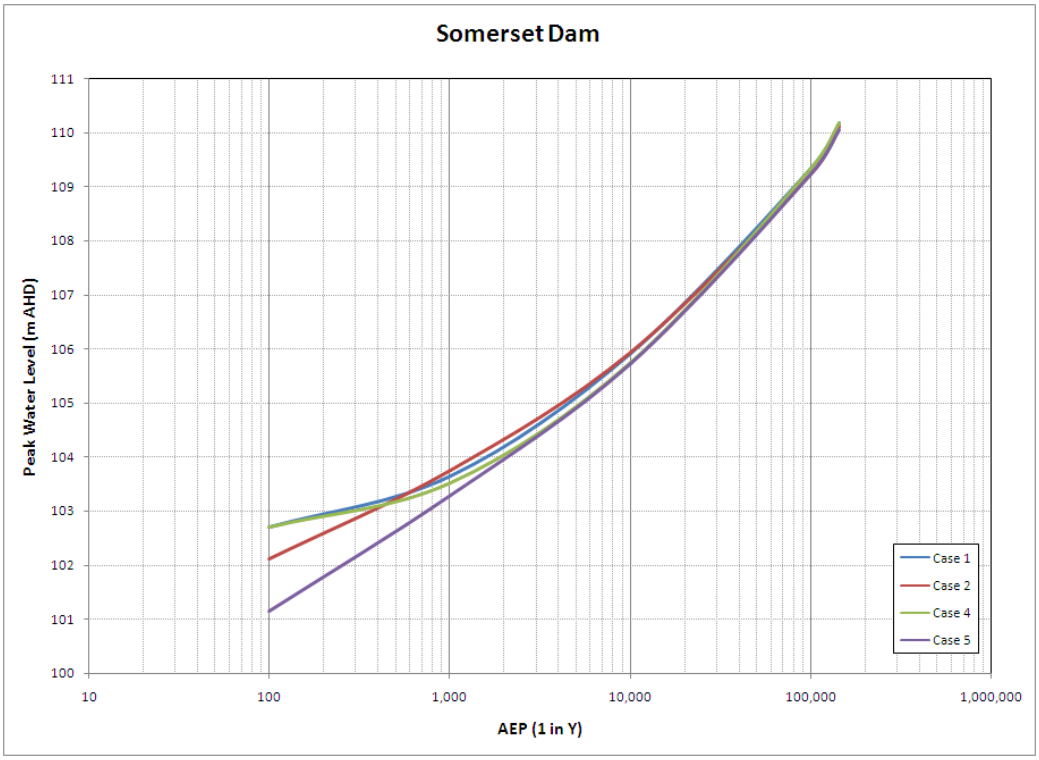

Figure 4-2: Somerset Dam Peak Water Levels

4.1.2 Wivenhoe Peak Water Level

Case 2, which has the Somerset sluices opened at EL 100.45, results in the lowest peak water level in Wivenhoe Dam up to the 1 in 1,000 flood. Beyond this AEP, differences in peak water levels are very small.

Table 4-2: Wivenhoe Dam Peak Water Levels

AEP	Case 1	Case 2	Case 4	Case 5
100	72.35	72.15	72.48	72.44
1,000	74.70	74.59	74.77	74.66
10,000	76.21	76.20	76.20	76.21
100,000	79.15	79.12	79.15	79.12
143,000	80.17	80.14	80.17	80.15

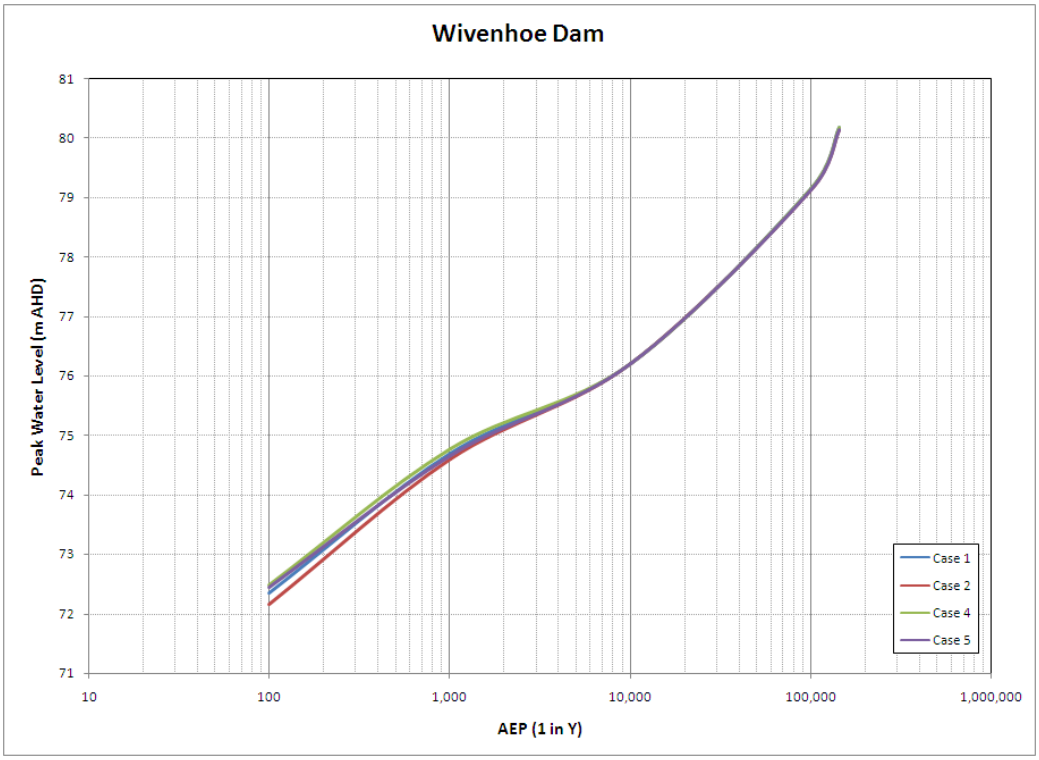

Figure 4-3: Wivenhoe Dam Peak Water Levels

4.1.3 Lowood Peak Flows

At Lowood, there is generally an insignificant difference in the peak flows between the different operating cases. Case 2, which has the Somerset sluices opened at EL 100.45, results in marginally lower peak flows up to the 1 in 1,000.

Table 4-3: Lowood Peak Flows

AEP	Case 1	Case 2	Case 4	Case 5
100	2,877	2,784	2,937	2,999
1,000	7,535	7,207	7,844	7,534
10,000	20,216	20,159	20,238	20,200
100,000	35,301	35,243	35,301	35,243
143,000	39,066	38,996	39,066	39,018

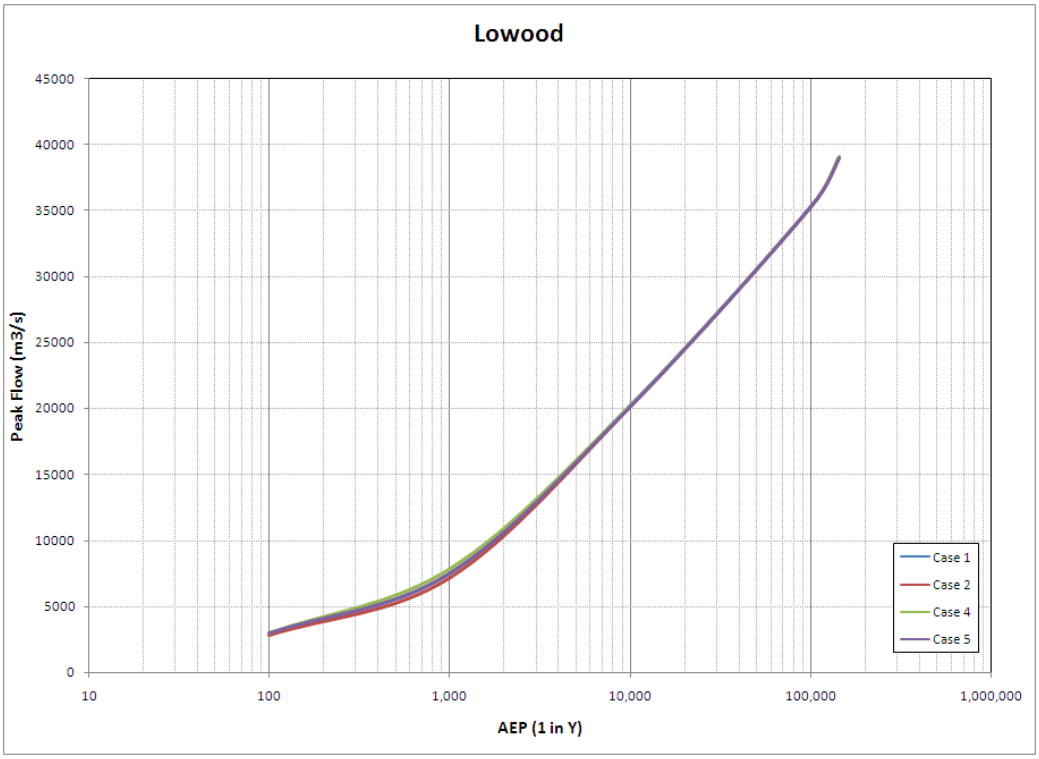

Figure 4-4: Lowood Peak Flows

4.1.4 Moggill Peak Flows

Similarly to Lowood, there is generally an insignificant difference in the peak flows at Moggill between the different operating cases. Case 2, which has the Somerset sluices opened at EL 100.45, results in marginally lower peak flows up to the 1 in 1,000.

Table 4-4: Moggill Peak Flows

AEP	Case 1	Case 2	Case 4	Case 5
100	3,075	3,002	3,123	3,220
1,000	7,963	7,630	8,258	7,961
10,000	21,209	21,085	21,274	21,186
100,000	36,963	36,906	36,963	36,906
143,000	40,868	40,796	40,868	40,823

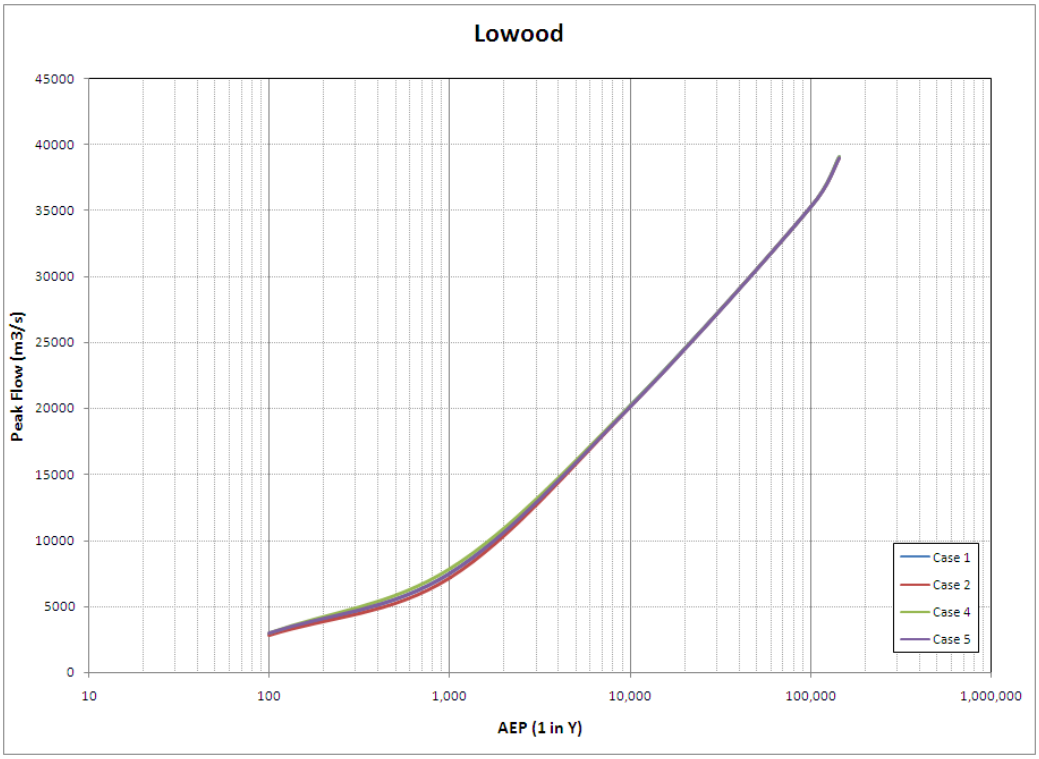

Figure 4-5: Moggill Peak Flows

4.2 SOMERSET CENTRED FLOODS

As noted earlier, the Somerset centred floods generate high peak inflows and flood volumes than the corresponding Wivenhoe centred floods. The behaviour of Somerset Dam has been checked using recent design flood estimates (Seqwater 2009).

It has been assumed that co-incident flooding of 1 in 100 in upper Brisbane, Lockyer and Bremer. However, this is not critical in the assessment of the peak water levels in Somerset as the opening of the sluices and the peak water levels in Somerset is dominated by the early rising limb of the Somerset inflows and not by the peak of the Wivenhoe inflows.

The results of this section of the study in Table 4-5 and Figure 4-6 show that opening the Somerset sluice gates has a demonstrable reduction on the peak water levels over the entire range of floods.

Table 4-5: Somerset Dam Peak Water Levels

AEP	Sluices Open @ EL 100.45 m AHD	Sluices Open @ EL 102.25 m AHD
100	103.59	102.93
1,000	105.75	105.51
10,000	108.34	108.20
20,000	109.15	109.02
50,000	110.21	110.05
100,000	111.03	110.91

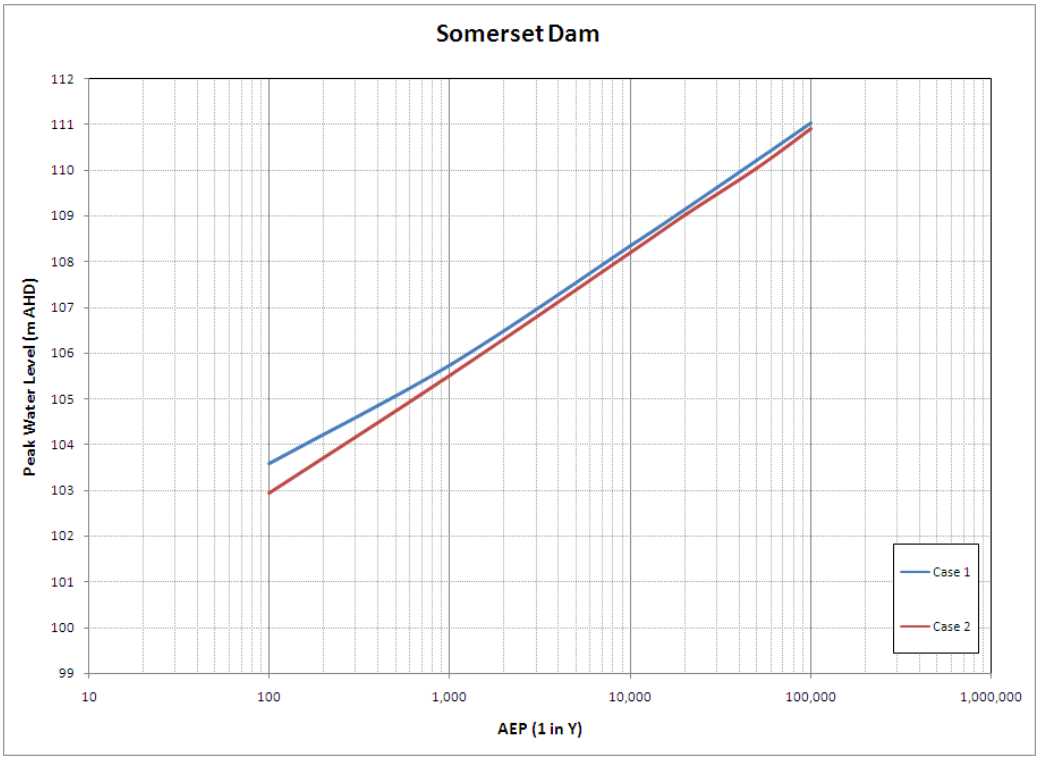

Figure 4-6: Somerset Dam Peak Water Levels

5.0 CONCLUSIONS

- At Lowood and Moggill, there is generally an insignificant difference in the peak flows between the different operating cases. Accordingly this is not a major consideration in case comparison or selection between the considered cases.

- The reduction of the sluice operating level in Somerset Dam for EL 102.25 to EL 100.45 provides the following benefits:

    - A lower peak water level in the dam itself.

    - Lower flood levels in upstream areas around Kilcoy.

    - Improvement in the flood immunity of Somerset Dam in extreme events.

    - Lower peak water levels in Wivenhoe Dam up to the 1 in 1,000 flood (beyond this AEP, the reduction in peak water levels is very small).

  All of these factors support the selection of either Case 2 or Case 5 as the preferred operating option.

- When comparing Cases 2 and 5, Case 5 provides the best results overall when considering resultant peak water levels in Somerset and Wivenhoe Dams. For events up to the 1 in 10000 in particular, Case 5 improves the flood immunity of Somerset Dam, while having little impact on the safety of Wivenhoe Dam.

6.0 RECOMMENDATIONS

It is recommended that the Case 5 Operating Target Line, shown in Figure 6-1, be adopted for the operation of Somerset and Wivenhoe Dams.

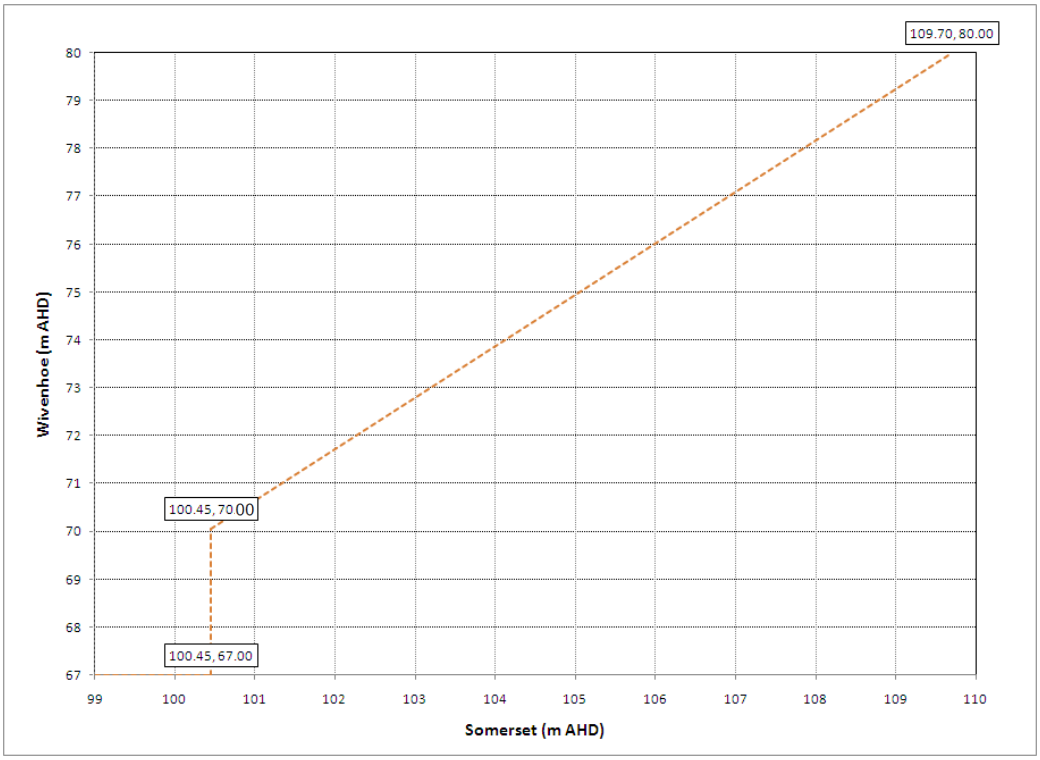

Figure 6-1: Recommended Operating Target Line

References

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(Seqwater 2009b) Seqwater, *Emergency Action Plan for Wivenhoe Dam,* Oct 2009.

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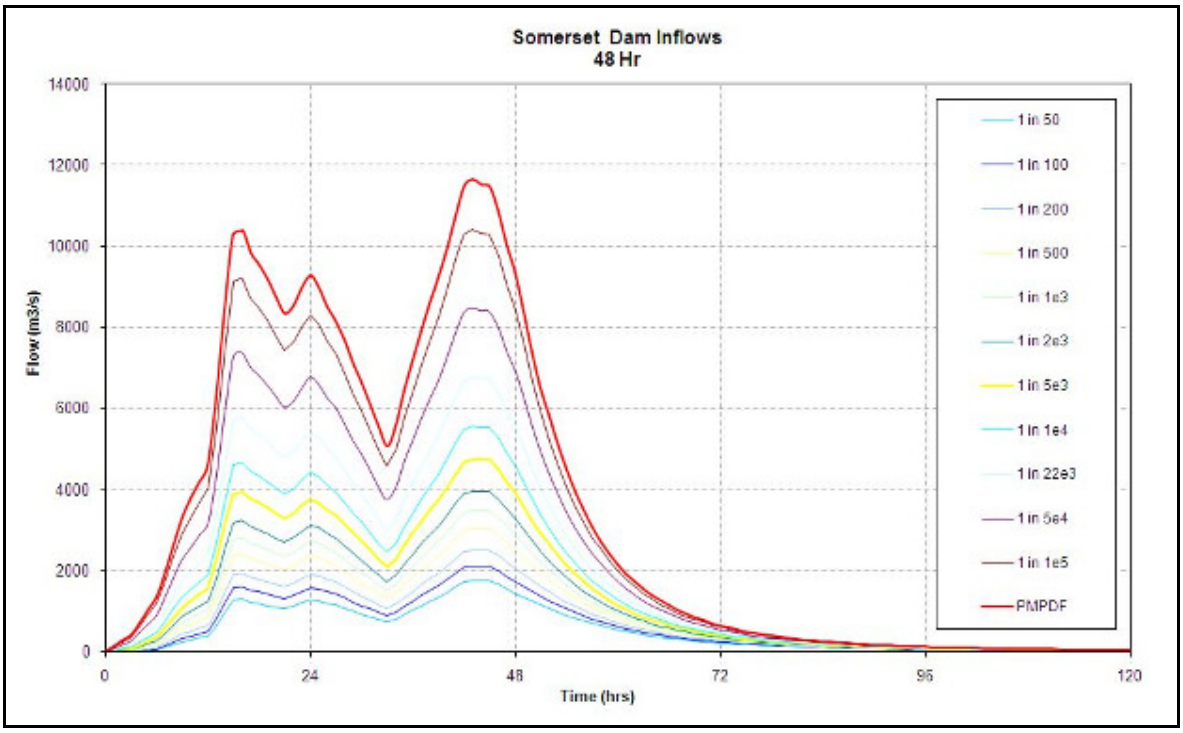
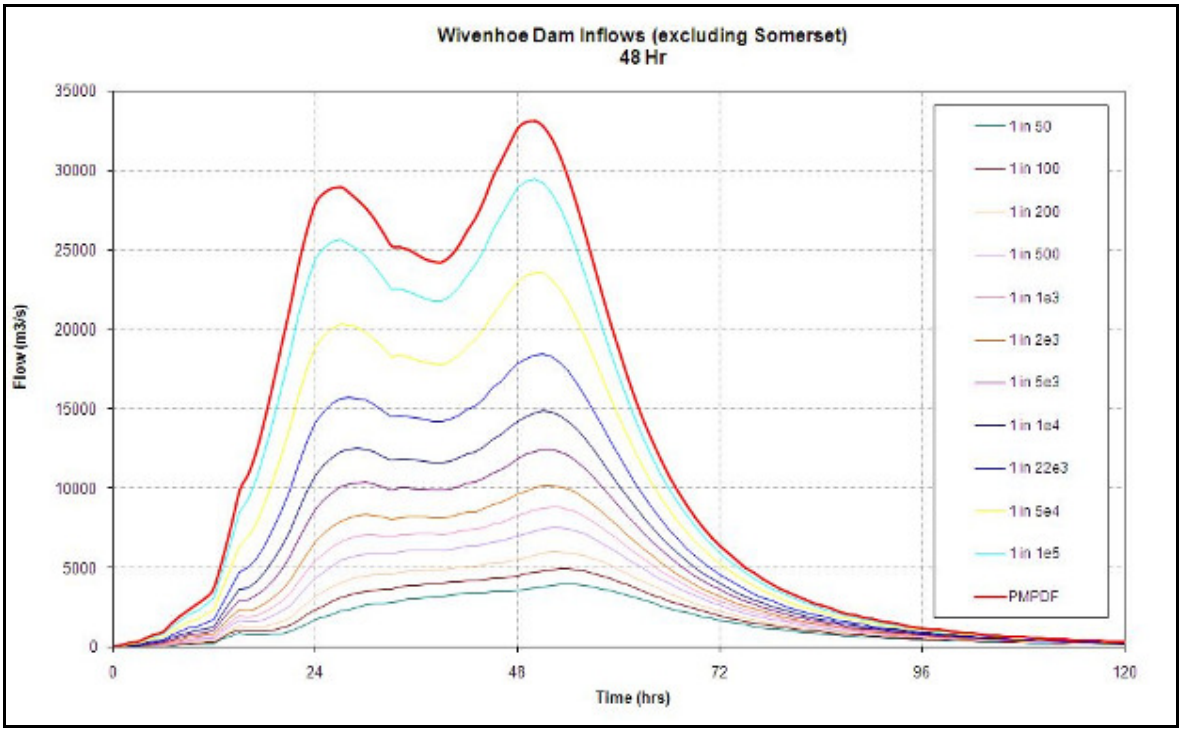
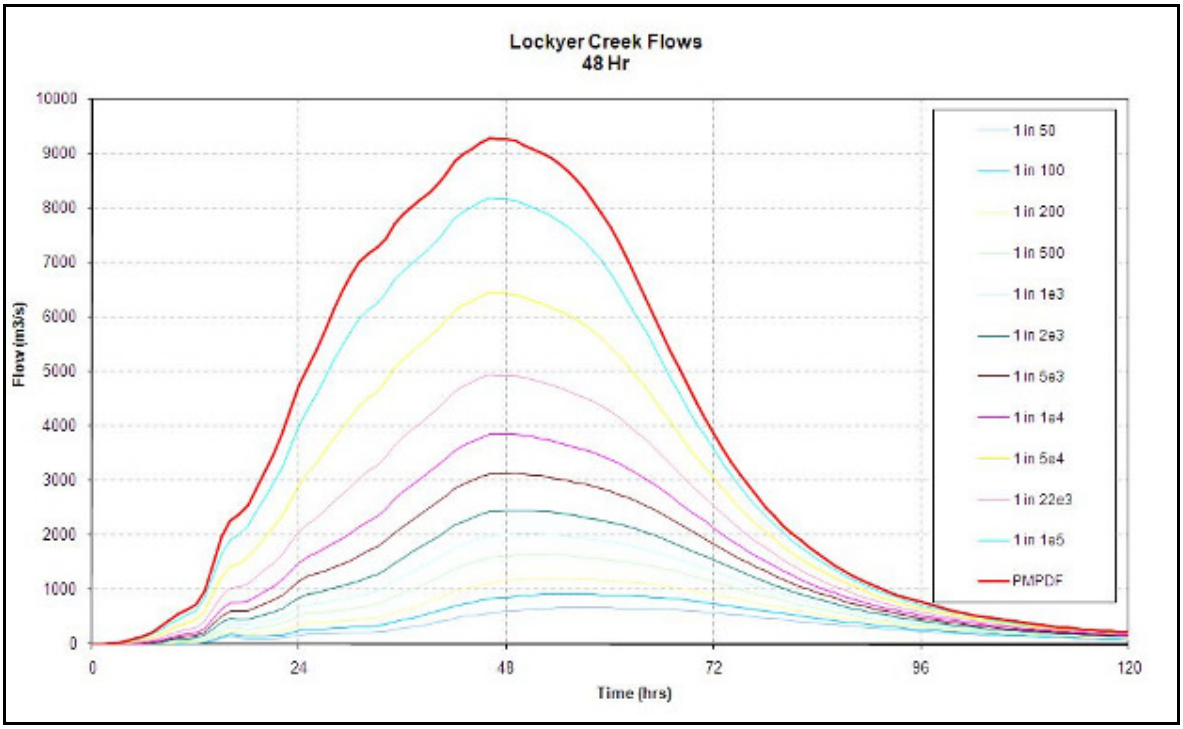
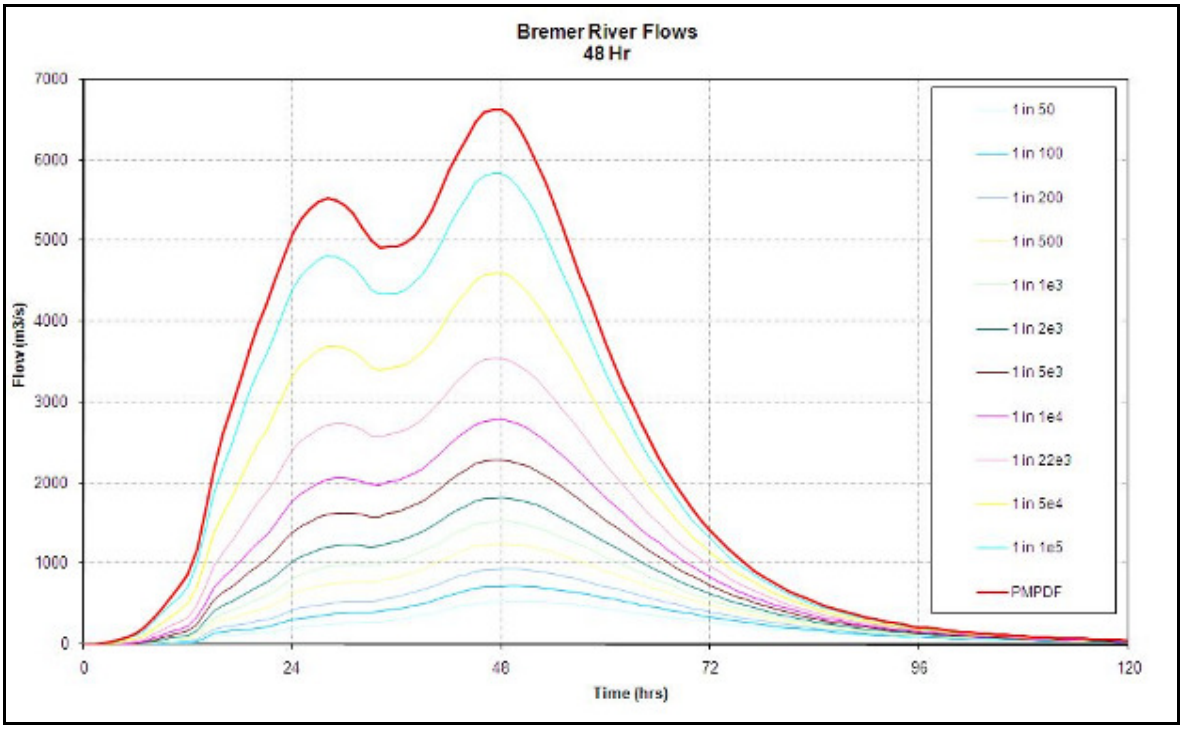
Appendix A

Wivenhoe Centred Design Flows

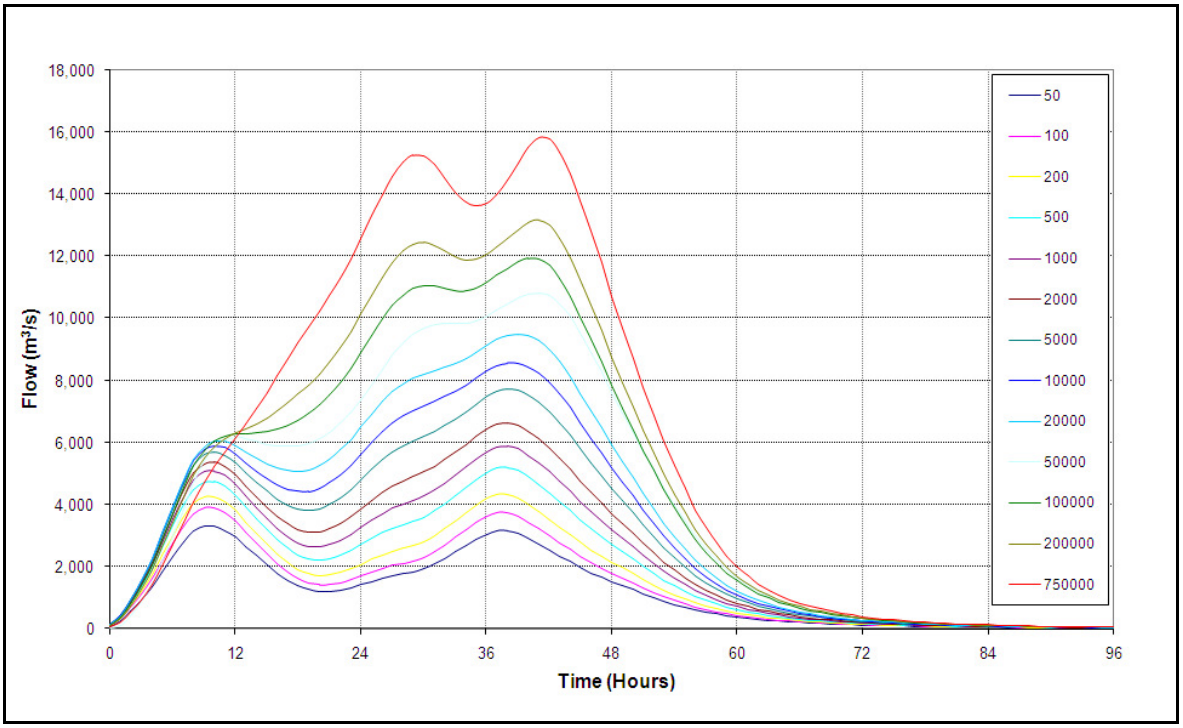





Lockyer Creek Flows
48 Hr
Flow (m3/s)
Time (hrs)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
0
24
48
72
96
120
1 in 50
1 in 100
1 in 200
1 in 500
1 in 1e3
1 in 2e3
1 in 5e3
1 in 1e4
1 in 5e4
1 in 22e3
1 in 1e5
PMPDF


Bremer River Flows
48 Hr
Flow (m3/s)
Time (hrs)
0
1000
2000
3000
4000
5000
6000
7000
0
24
48
72
96
120
1 in 50
1 in 100
1 in 200
1 in 500
1 in 1e3
1 in 2e3
1 in 5e3
1 in 1e4
1 in 22e3
1 in 5e4
1 in 1e5
PMPDF

Somerset Centred Design Flows

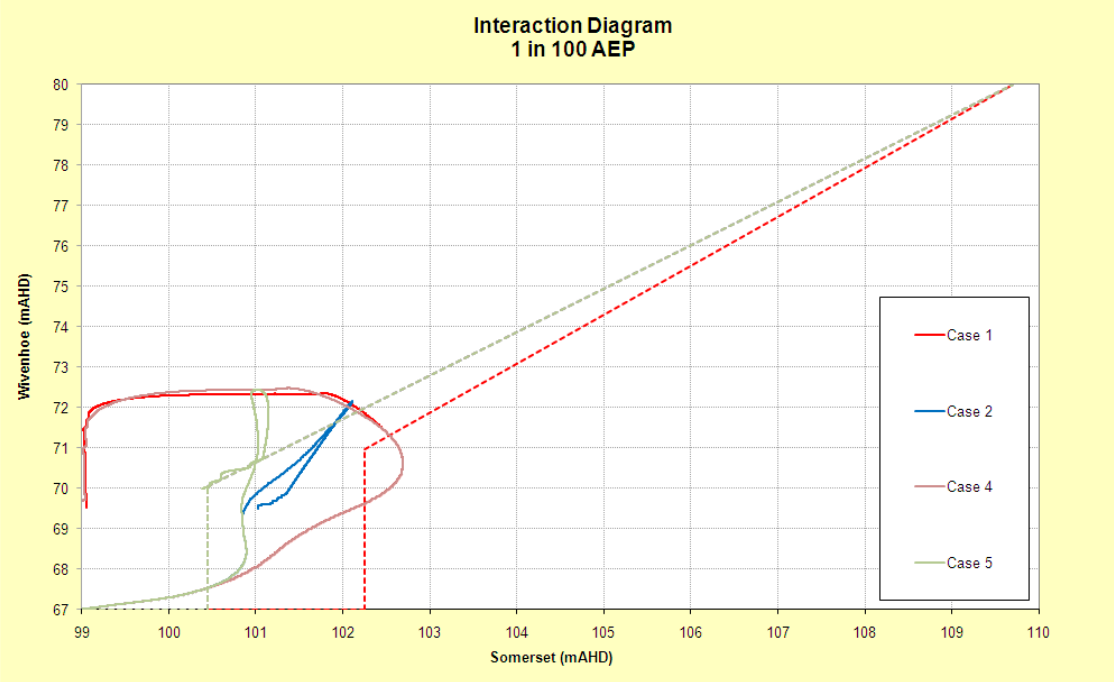


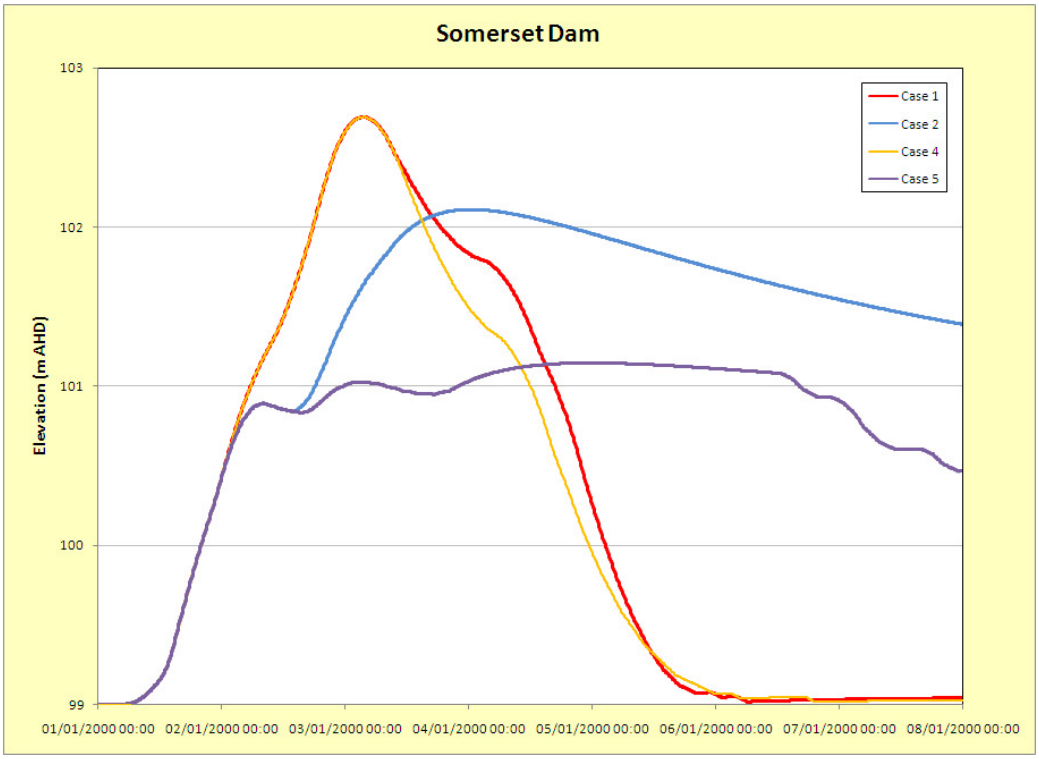
Appendix B

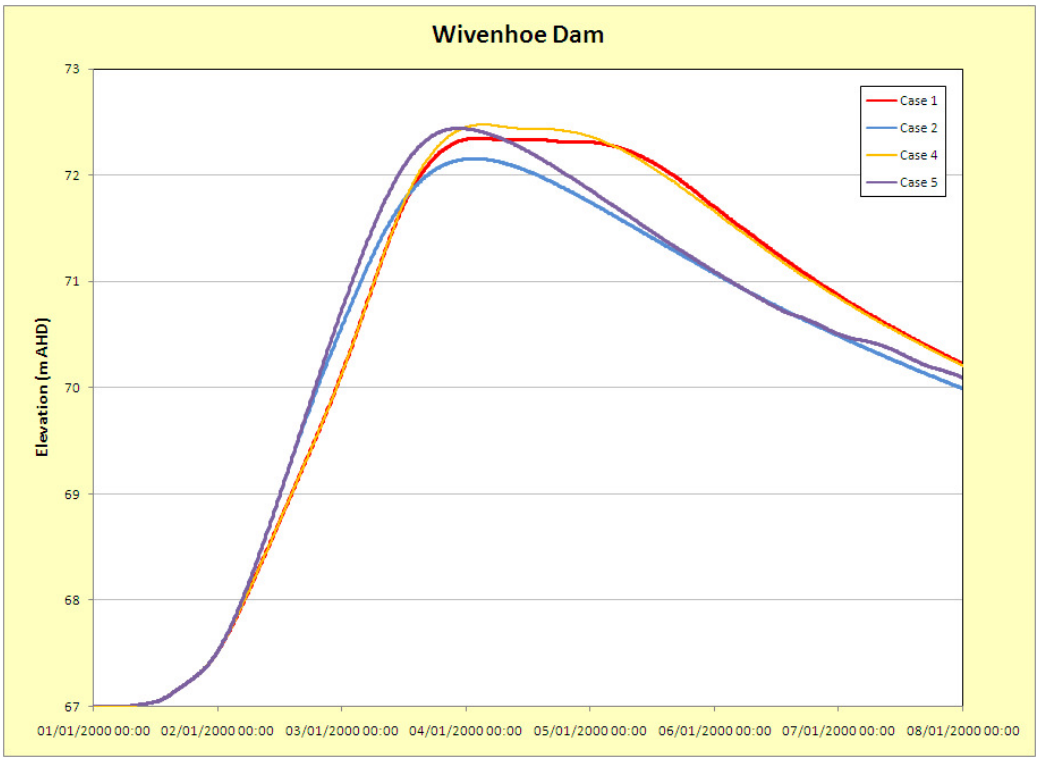
Wivenhoe Centred Results

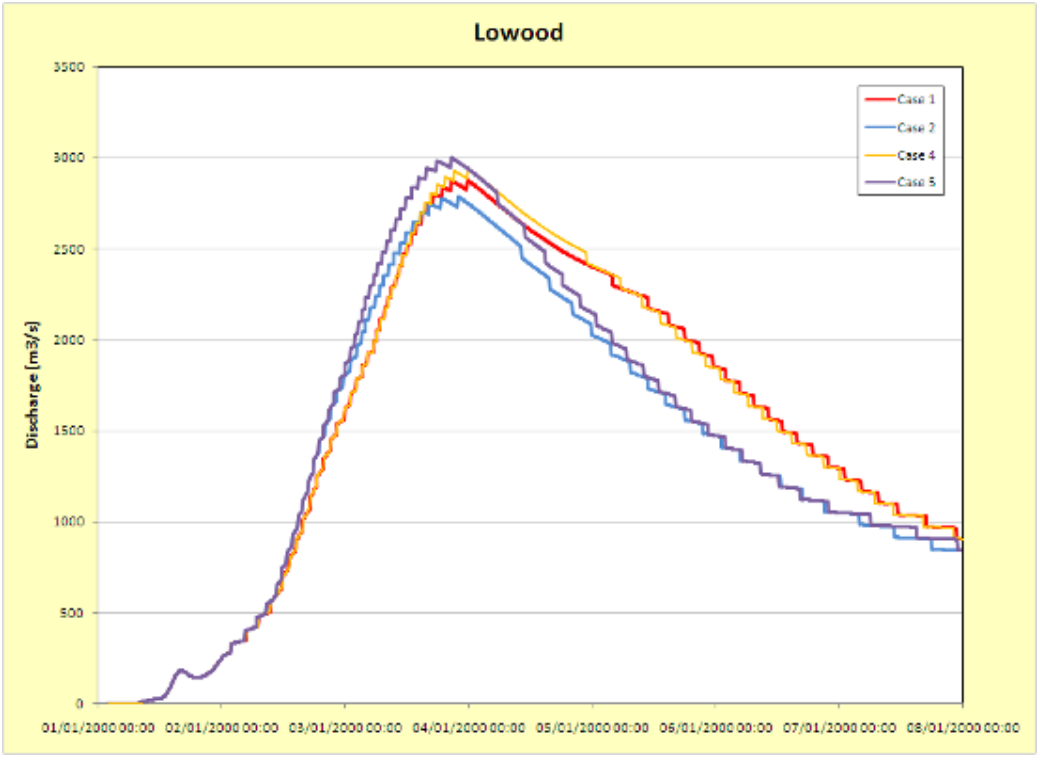
1 in 100 AEP

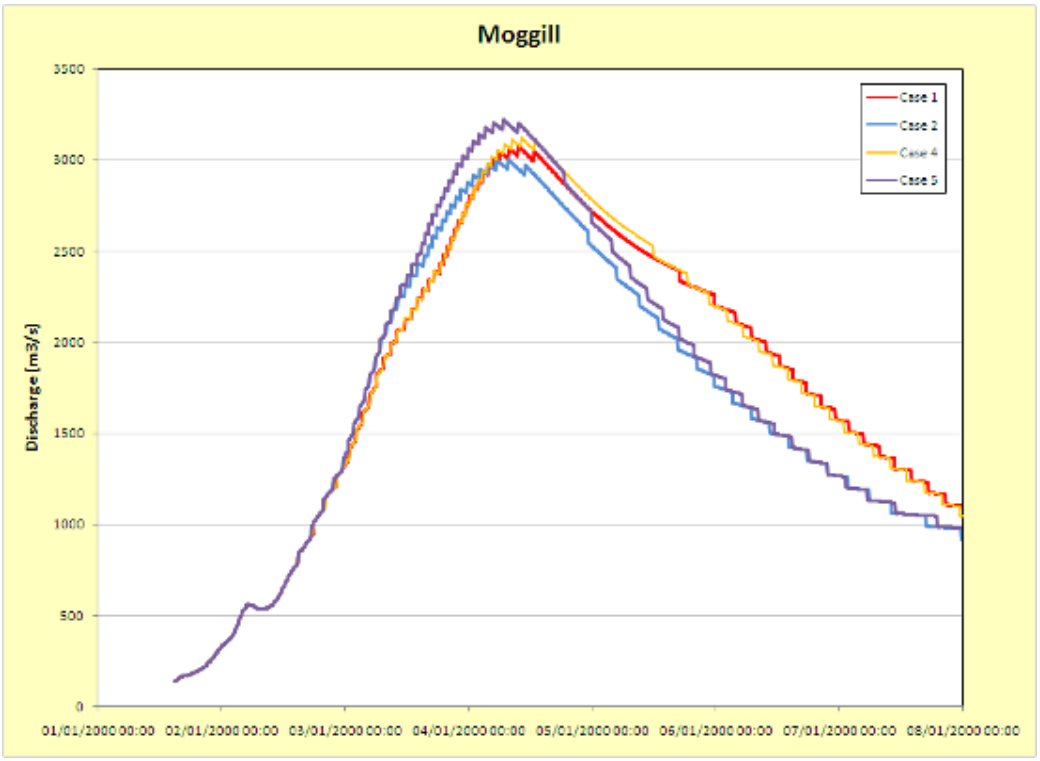
Item	Unit	Wivenhoe Operating Level			
		67.0 m AHD		68.5 m AHD	
		Somerset Operating Level		Somerset Operating Level	
		102.25	100.45	102.25	100.45
		Case 1	Case 2	Case 4	Case 5
Somerset Peak Elevation	m AHD	102.69	102.11	102.69	101.15
Wivenhoe Peak Elevation	m AHD	72.35	72.15	72.48	72.44
Lowood Peak Flow	m3/s	2,877	2,784	2,937	2,999
Moggill Peak Flow	m3/s	3,075	3,002	3,123	3,220




Somerset Dam
Elevation (m AHD)
103
102
101
100
99
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

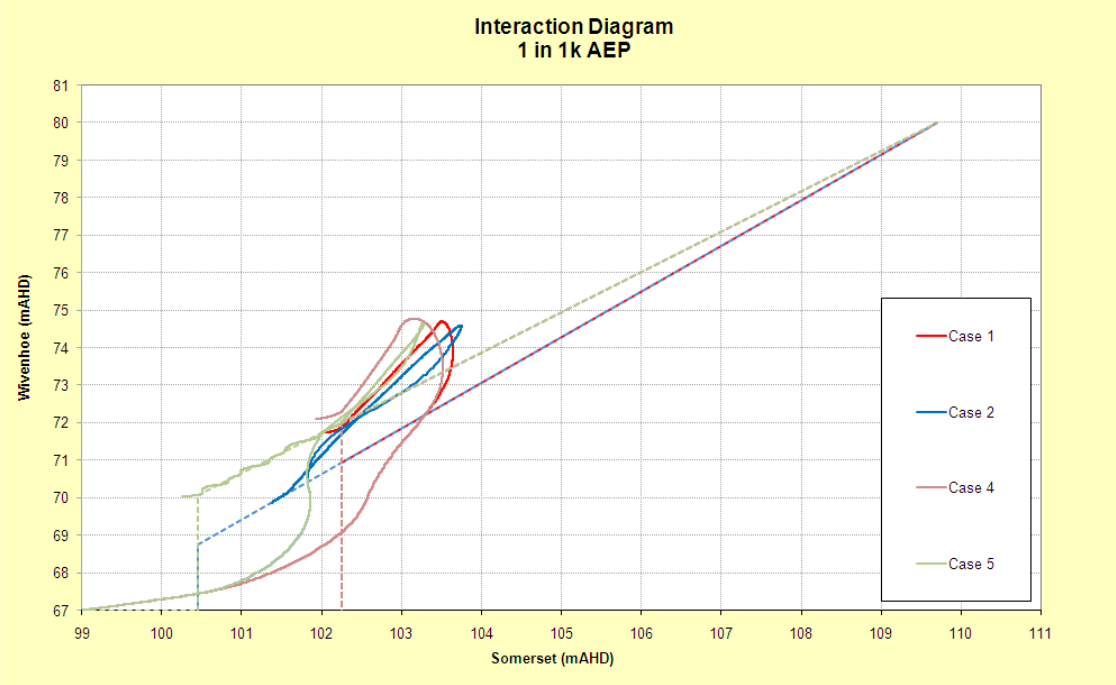

Wivenhoe Dam
Elevation (m AHD)
73
72
71
70
69
68
67
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

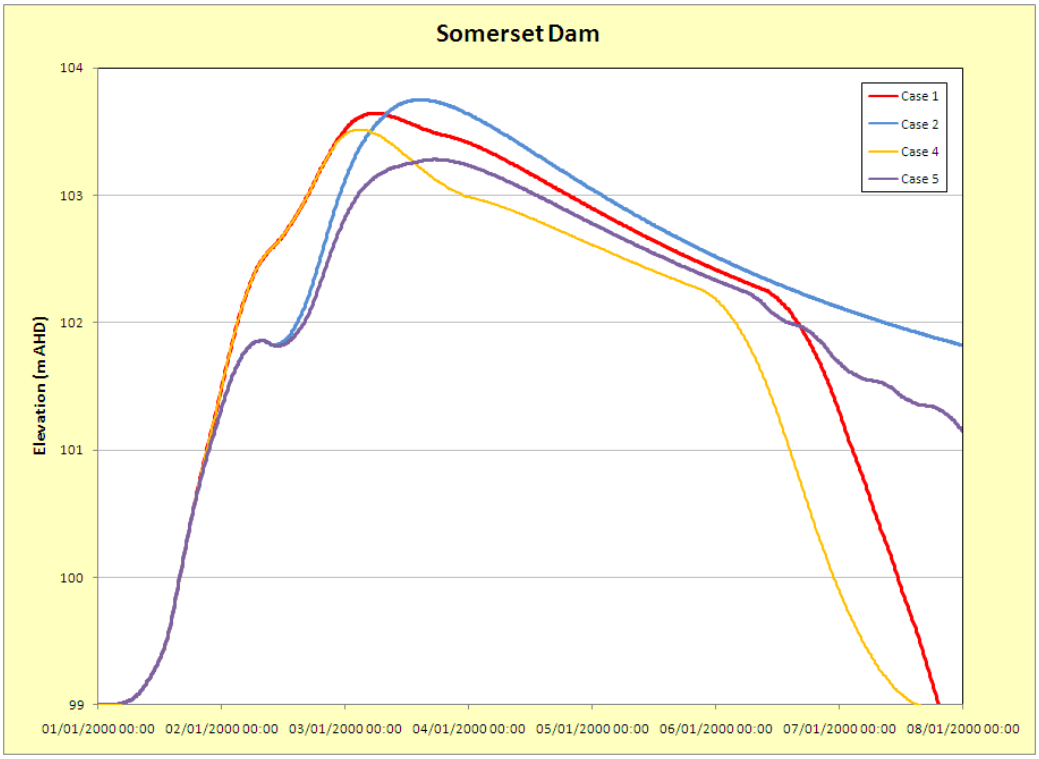

Lowood
Discharge [m3/s]
3500
3000
2500
2000
1500
1000
500
0
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

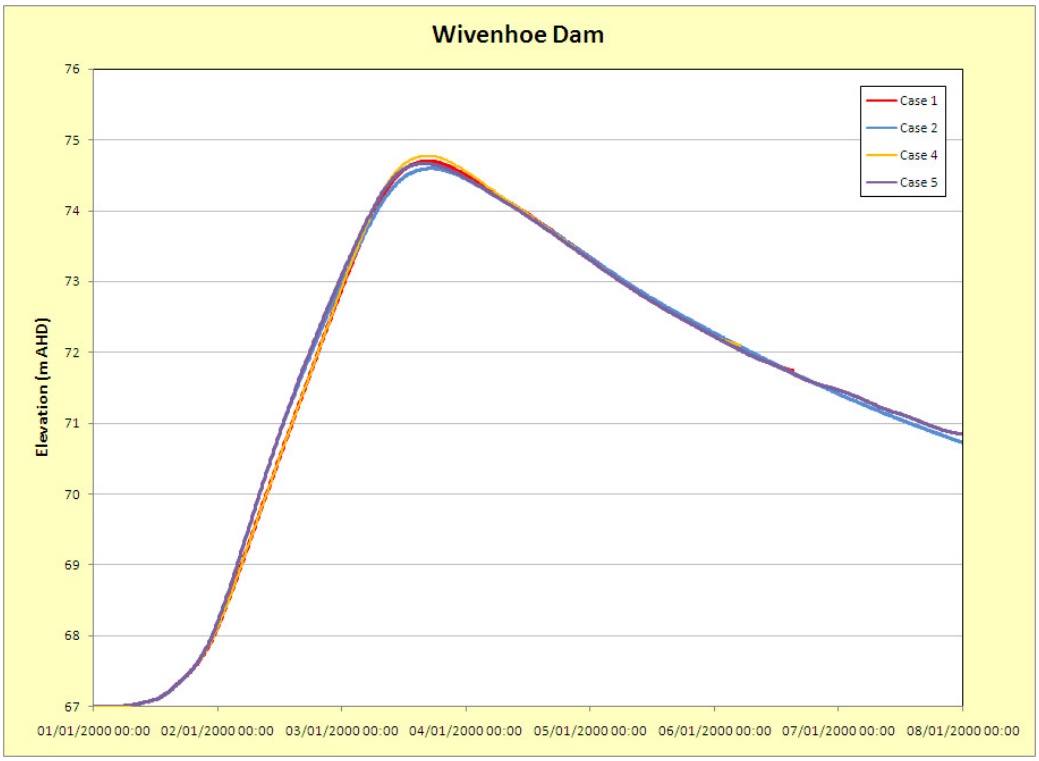

Moggill
Discharge [m3/s]
3500
3000
2500
2000
1500
1000
500
0
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

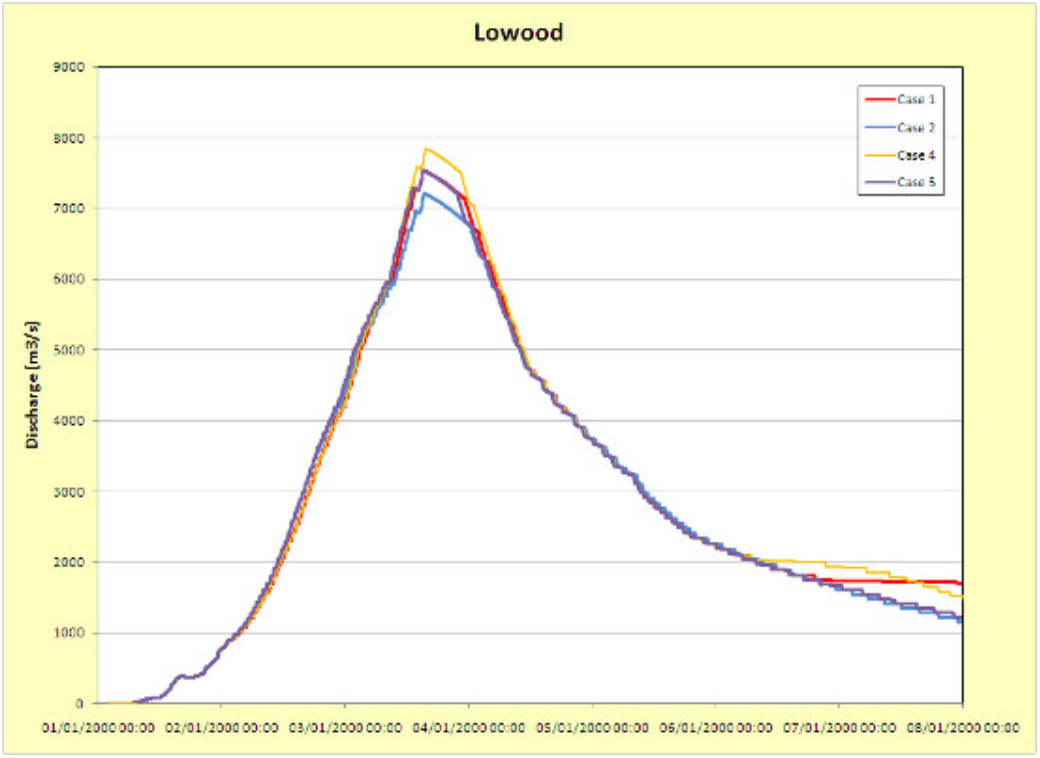
1 in 1,000 AEP

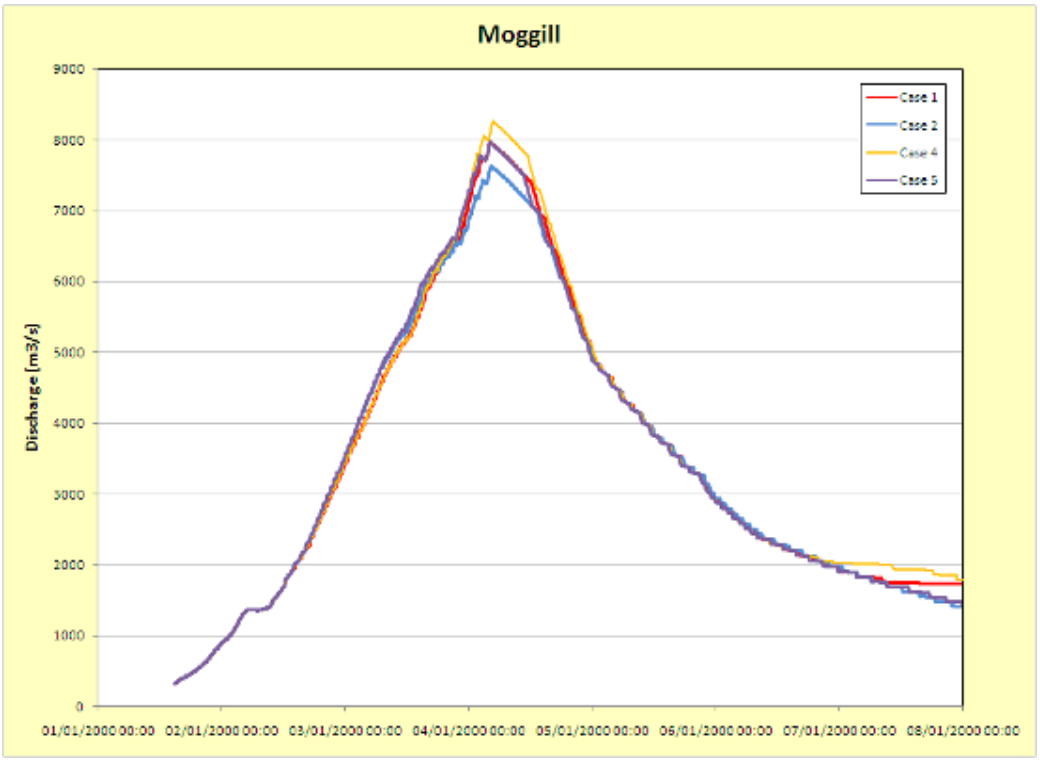
Item	Unit	Wivenhoe Operating Level			
		67.0 m AHD		68.5 m AHD	
		Somerset Operating Level		Somerset Operating Level	
		102.25	100.45	102.25	100.45
		Case 1	Case 2	Case 4	Case 5
Somerset Peak Elevation	m AHD	103.64	103.75	103.51	103.28
Wivenhoe Peak Elevation	m AHD	74.70	74.59	74.77	74.66
Lowood Peak Flow	m3/s	7,535	7,207	7,844	7,534
Moggill Peak Flow	m3/s	7,963	7,630	8,258	7,961




Somerset Dam
Elevation (m AHD)
104
103
102
101
100
99
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

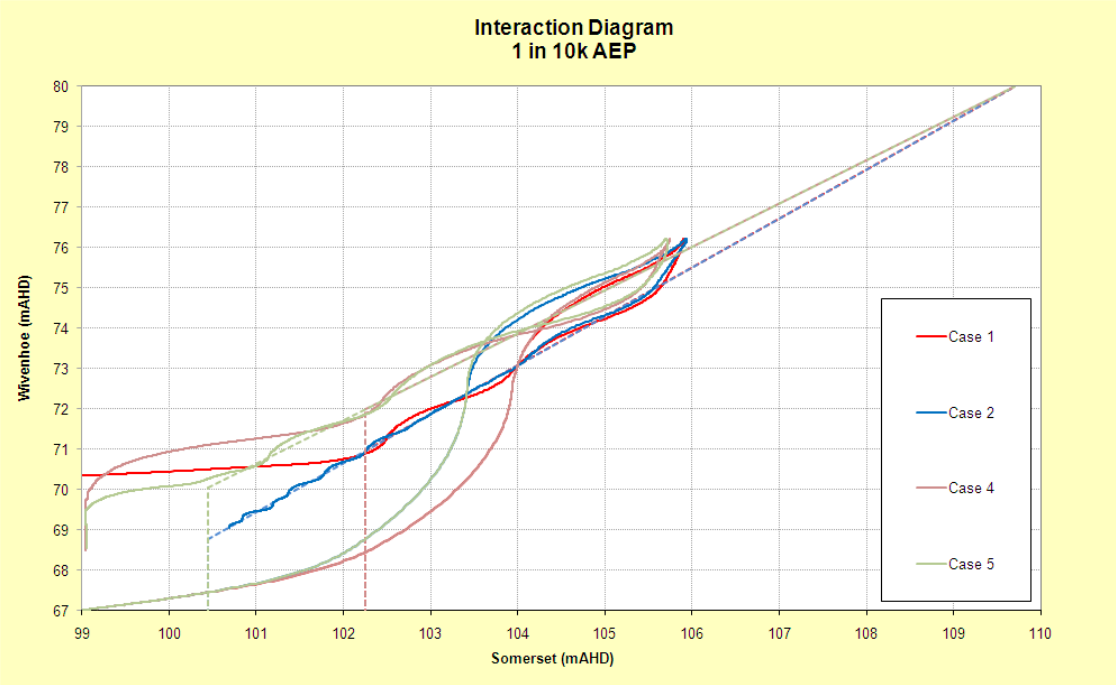

Wivenhoe Dam
Elevation (m AHD)
76
75
74
73
72
71
70
69
68
67
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

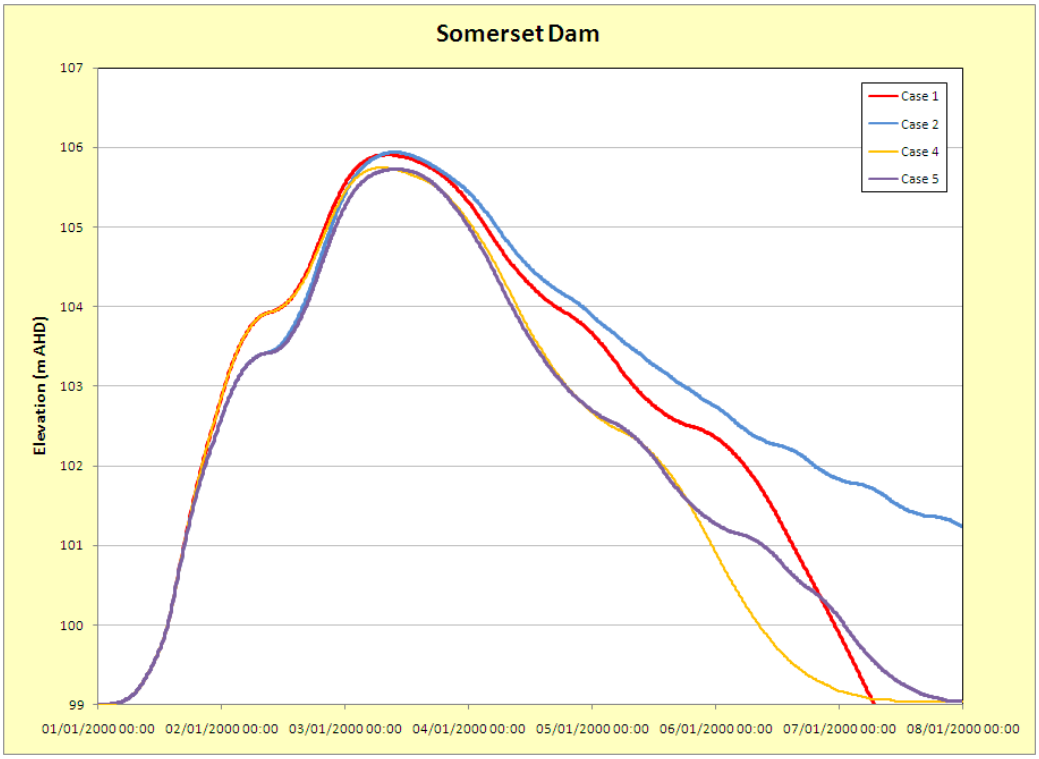

Lowood
Discharge [m3/s]
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

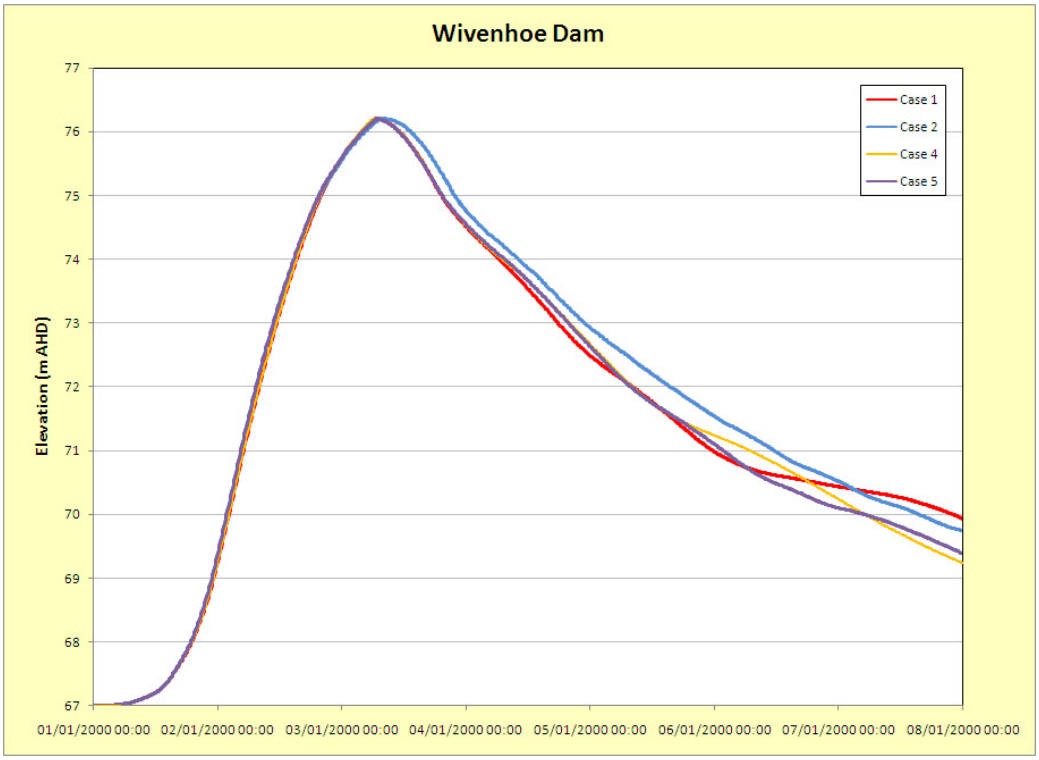

Moggill
Discharge [m3/s]
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

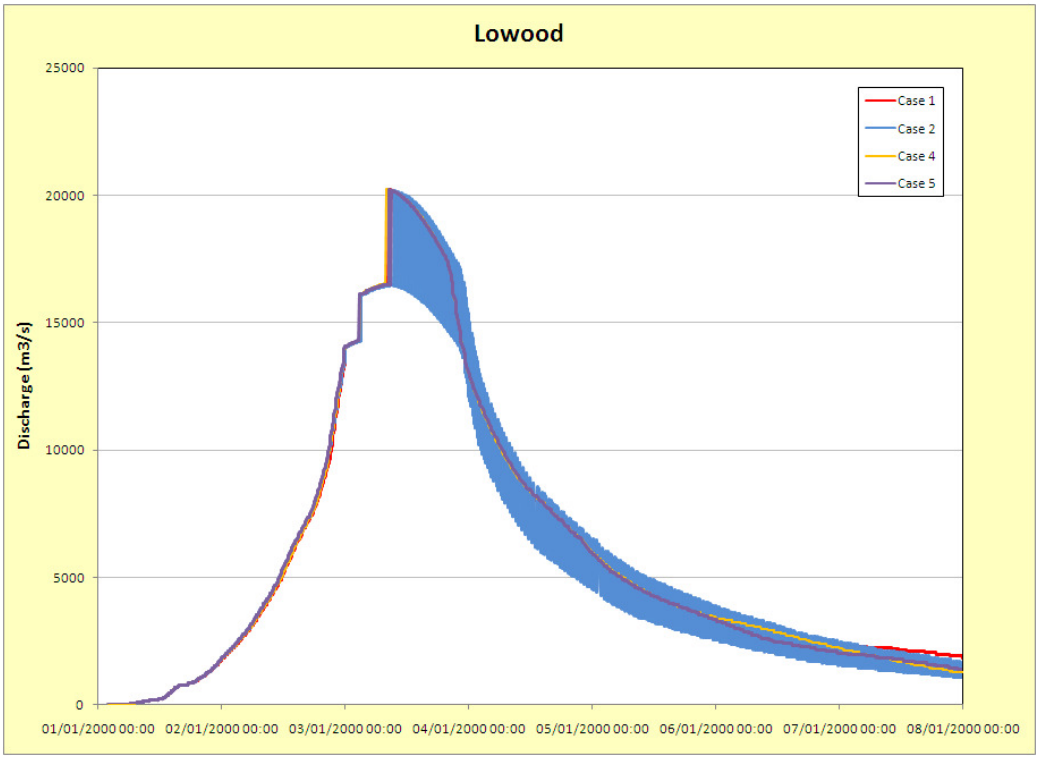
1 in 10,000 AEP

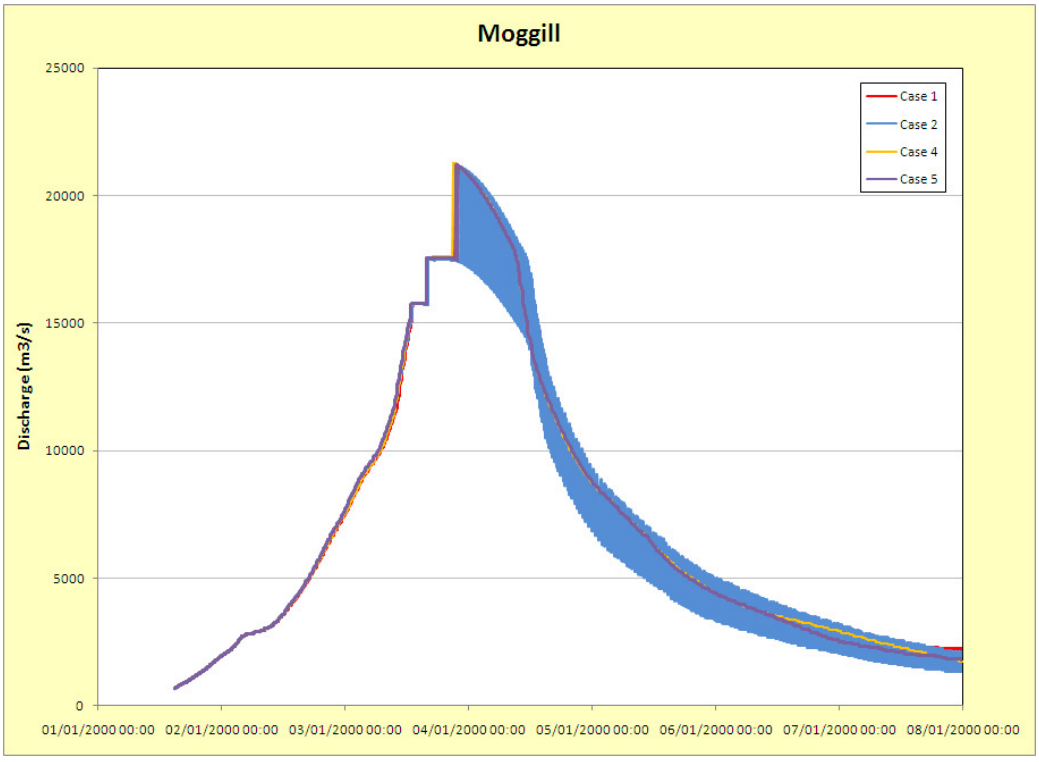
Item	Unit	Wivenhoe Operating Level			
		67.0 m AHD		68.5 m AHD	
		Somerset Operating Level		Somerset Operating Level	
		102.25	100.45	102.25	100.45
		Case 1	Case 2	Case 4	Case 5
Somerset Peak Elevation	m AHD	105.91	105.94	105.75	105.72
Wivenhoe Peak Elevation	m AHD	76.21	76.20	76.20	76.21
Lowood Peak Flow	m3/s	20,216	20,159	20,238	20,200
Moggill Peak Flow	m3/s	21,209	21,085	21,274	21,186




Somerset Dam
Elevation (m AHD)
107
106
105
104
103
102
101
100
99
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

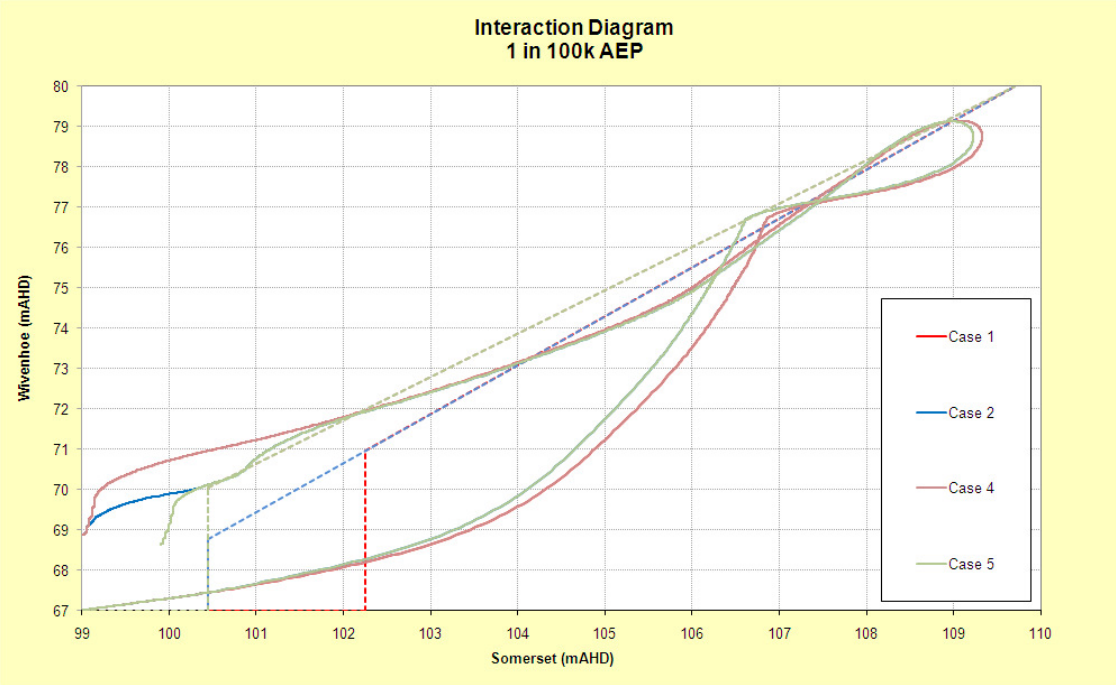

Wivenhoe Dam
Elevation (m AHD)
77
76
75
74
73
72
71
70
69
68
67
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

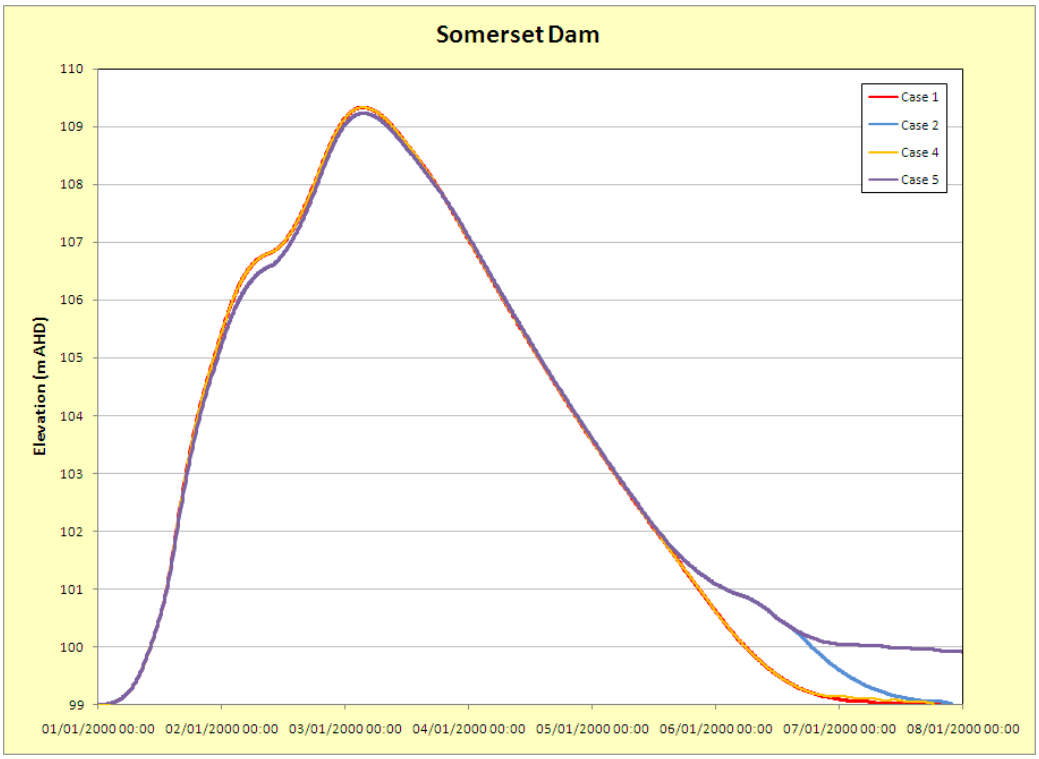

Lowood
Discharge (m3/s)
25000
20000
15000
10000
5000
0
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

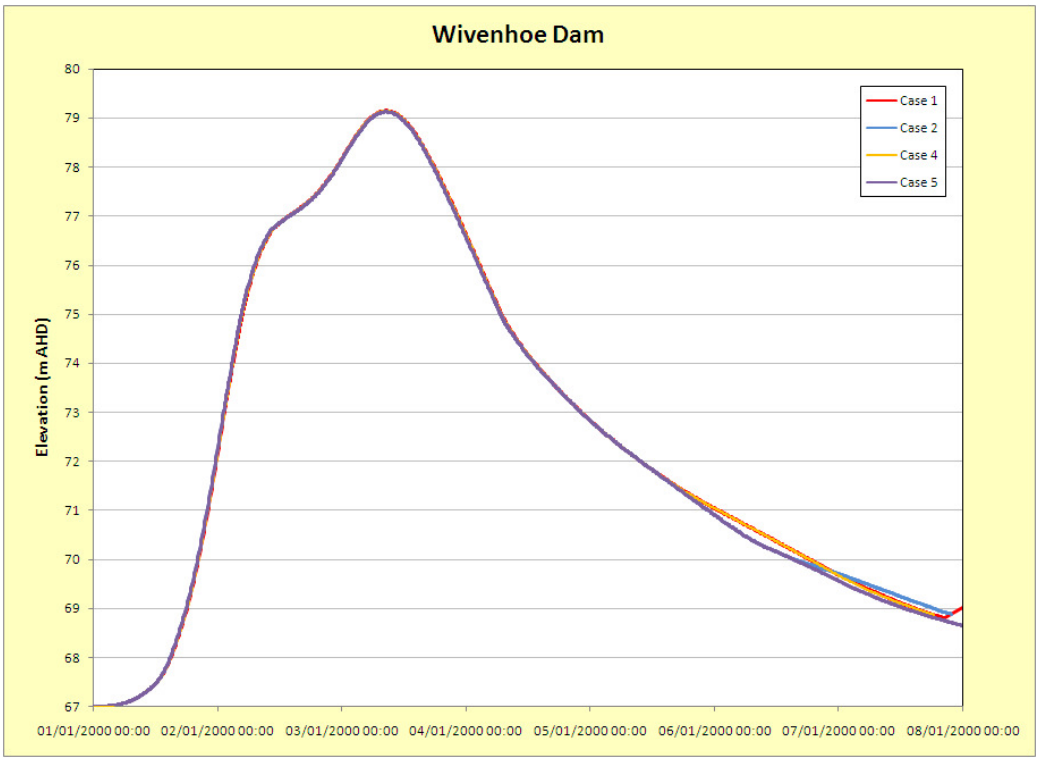

Moggill
Discharge (m3/s)
25000
20000
15000
10000
5000
0
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

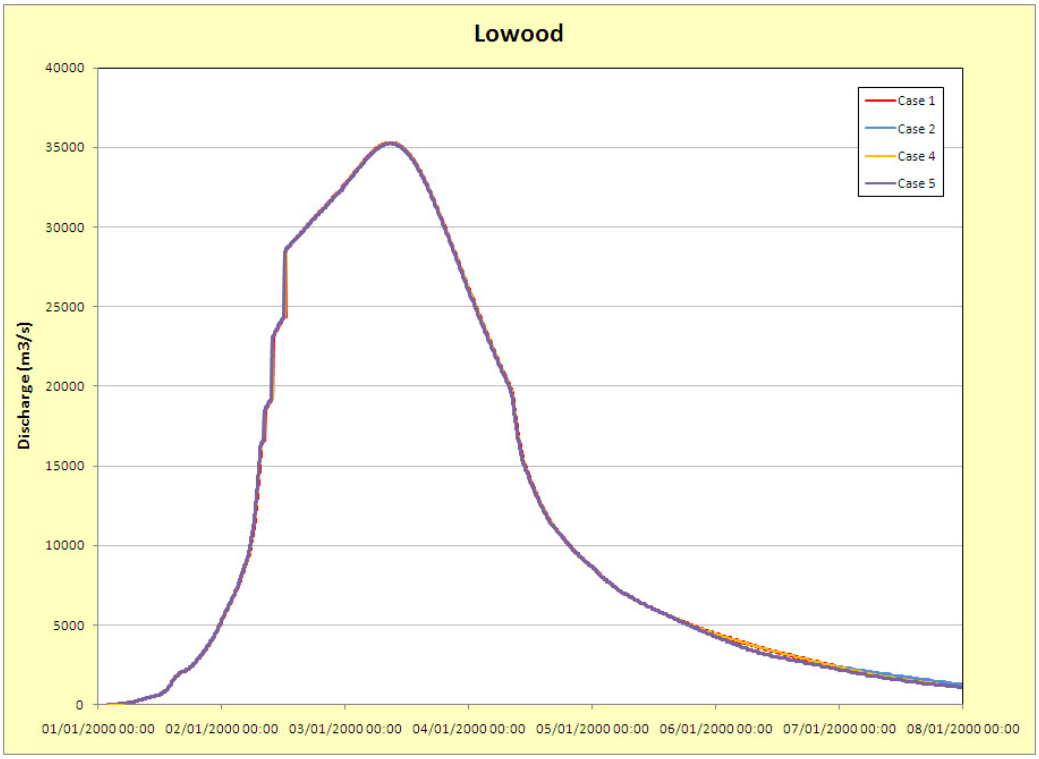
1 in 100,000 AEP

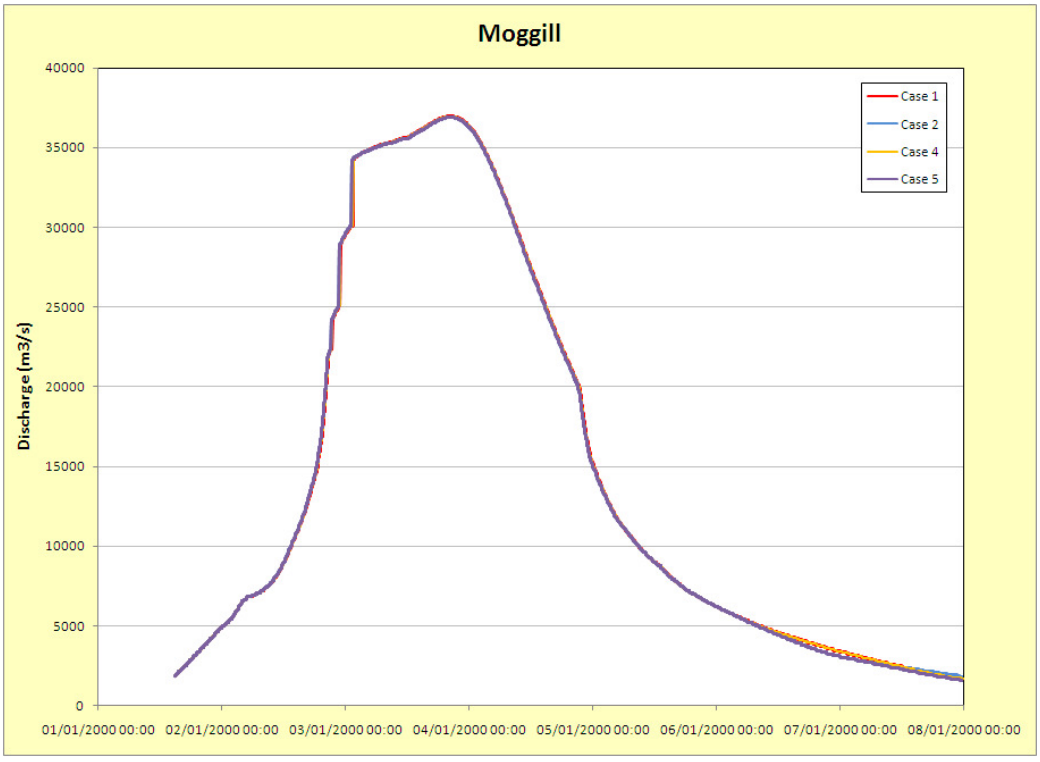
Item	Unit	Wivenhoe Operating Level			
		67.0 m AHD		68.5 m AHD	
		Somerset Operating Level		Somerset Operating Level	
		102.25	100.45	102.25	100.45
		Case 1	Case 2	Case 4	Case 5
Somerset Peak Elevation	m AHD	109.33	109.23	109.33	109.23
Wivenhoe Peak Elevation	m AHD	79.15	79.12	79.15	79.12
Lowood Peak Flow	m3/s	35,301	35,243	35,301	35,243
Moggill Peak Flow	m3/s	36,963	36,906	36,963	36,906




Somerset Dam
Elevation (m AHD)
110
109
108
107
106
105
104
103
102
101
100
99
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00
Case 1
Case 2
Case 4
Case 5

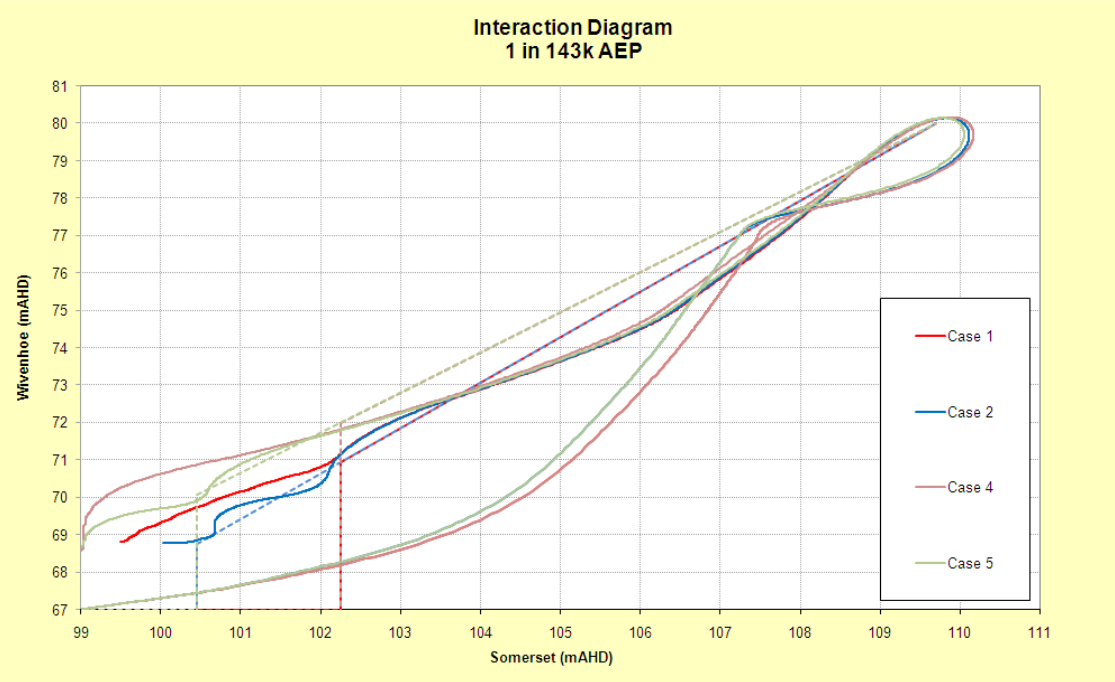

Wivenhoe Dam
Elevation (m AHD)
80
79
78
77
76
75
74
73
72
71
70
69
68
67
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00
Case 1
Case 2
Case 4
Case 5

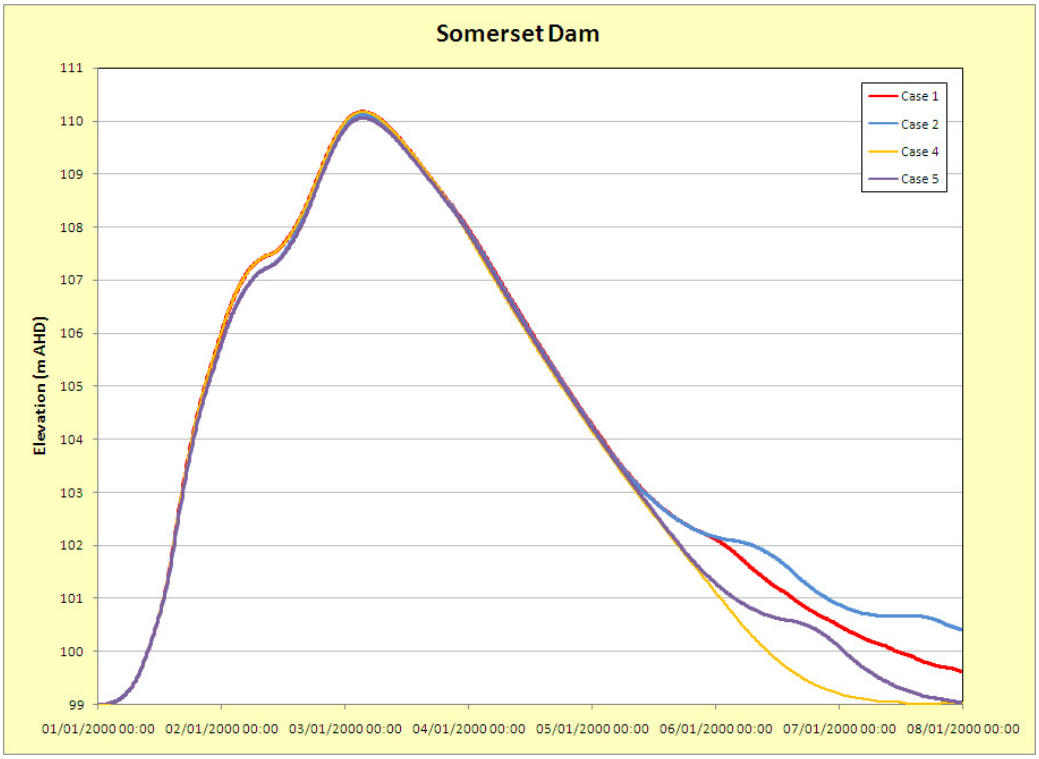

Lowood
Discharge (m3/s)
40000
35000
30000
25000
20000
15000
10000
5000
0
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

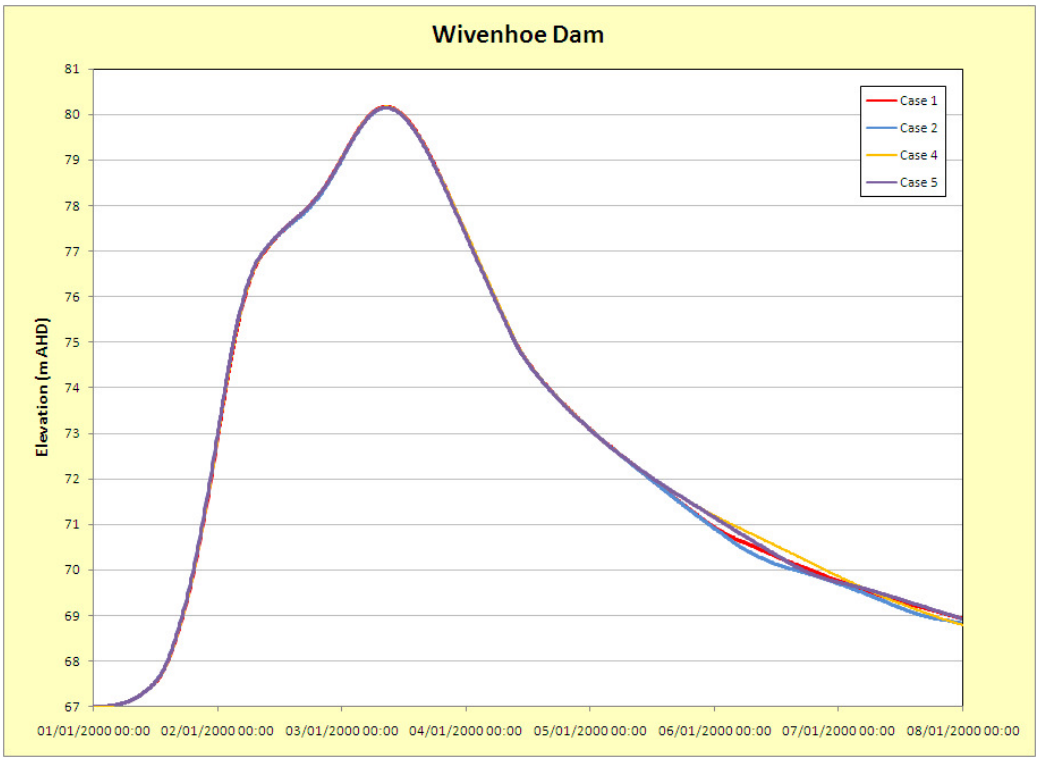

Moggill
Discharge (m3/s)
40000
35000
30000
25000
20000
15000
10000
5000
0
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

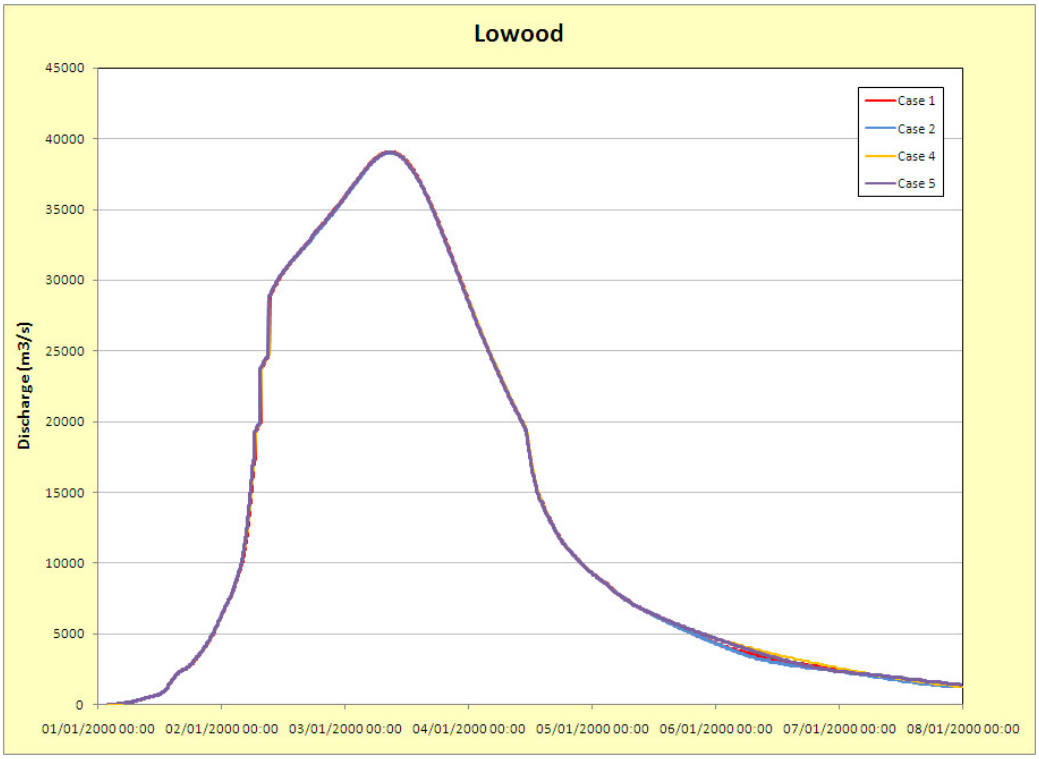
1 in 143,000 AEP

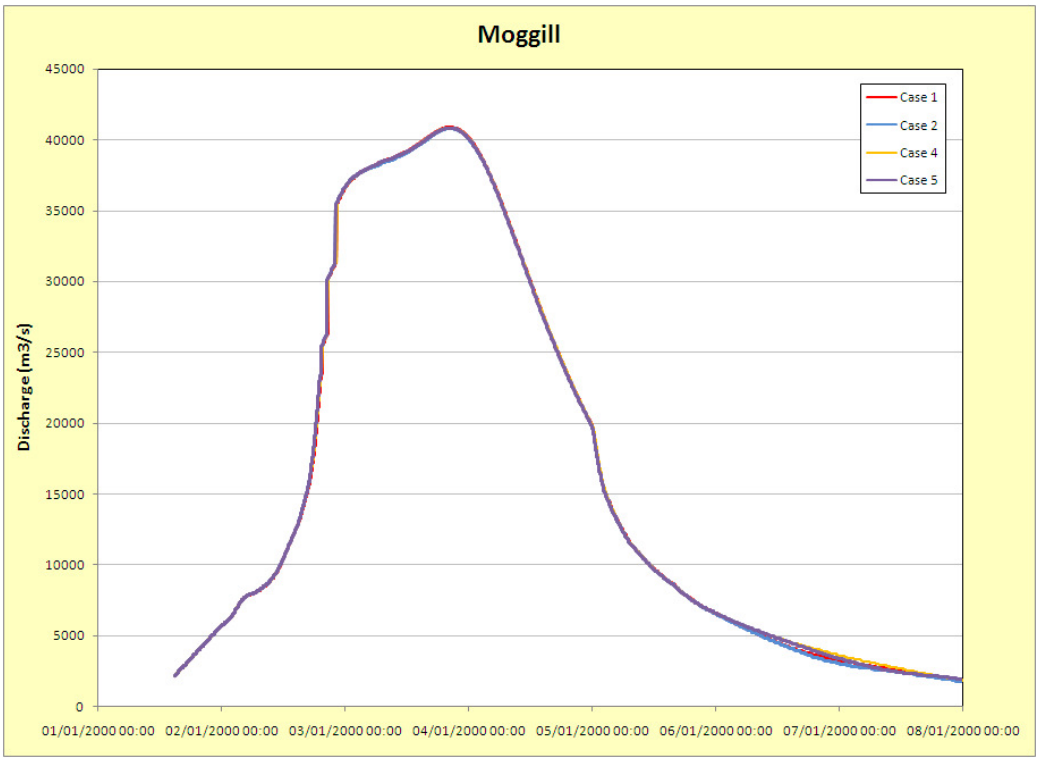
Item	Unit	Wivenhoe Operating Level			
		67.0 m AHD		68.5 m AHD	
		Somerset Operating Level		Somerset Operating Level	
		102.25	100.45	102.25	100.45
		Case 1	Case 2	Case 4	Case 5
Somerset Peak Elevation	m AHD	110.17	110.12	110.17	110.05
Wivenhoe Peak Elevation	m AHD	80.17	80.14	80.17	80.15
Lowood Peak Flow	m3/s	39,066	38,996	39,066	39,018
Moggill Peak Flow	m3/s	40,868	40,796	40,868	40,823




Somerset Dam
Elevation (m AHD)
111
110
109
108
107
106
105
104
103
102
101
100
99
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00


Wivenhoe Dam
Elevation (m AHD)
81
80
79
78
77
76
75
74
73
72
71
70
69
68
67
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00


Lowood
Discharge (m3/s)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

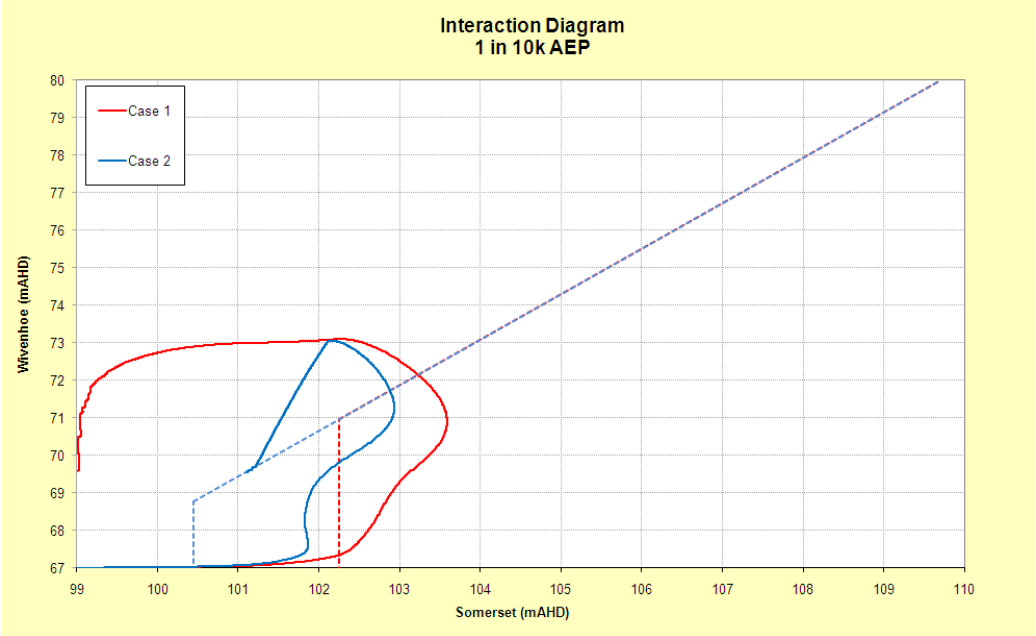

Moggill
Discharge (m3/s)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

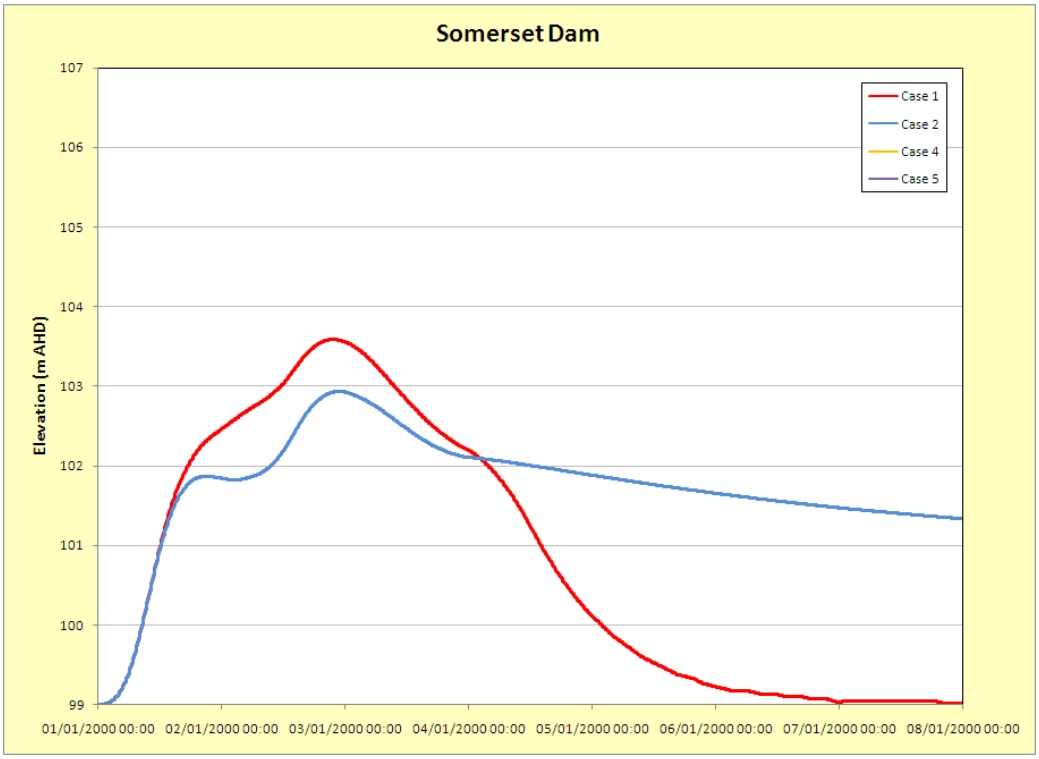
Appendix C

Somerset Centred Results

1 in 100 AEP

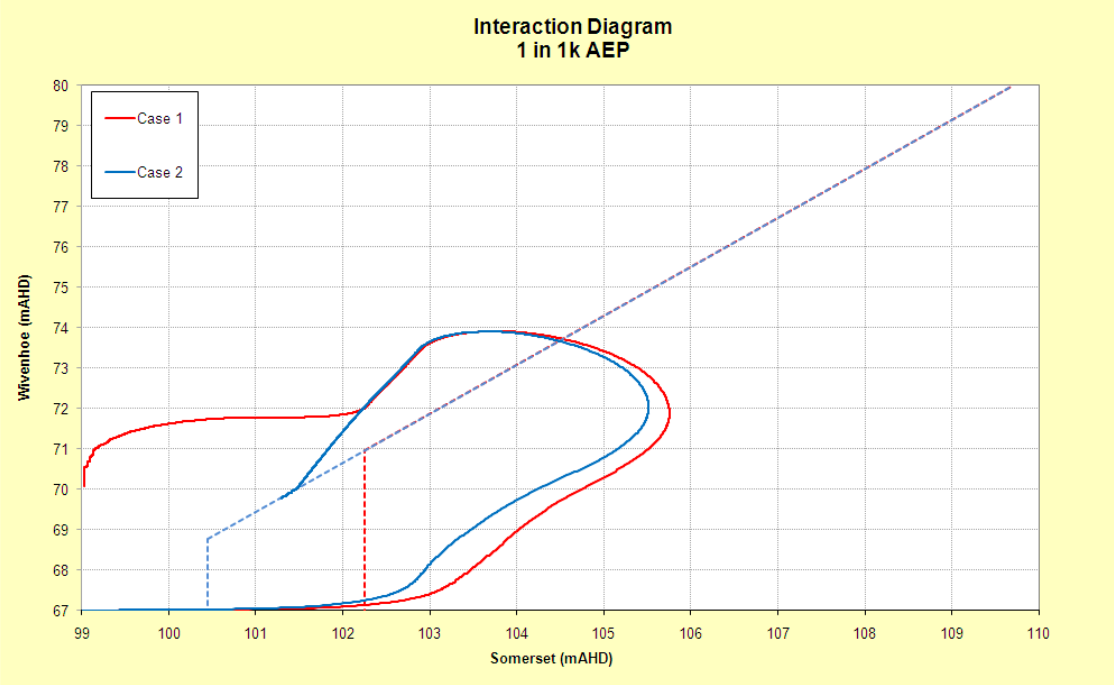
Item	Unit	Wivenhoe Operating Level	
		67.0 m AHD	
		Somerset Operating Level	
		102.25	100.45
		Case 1	Case 2
Somerset Peak Elevation	m AHD	103.59	102.93

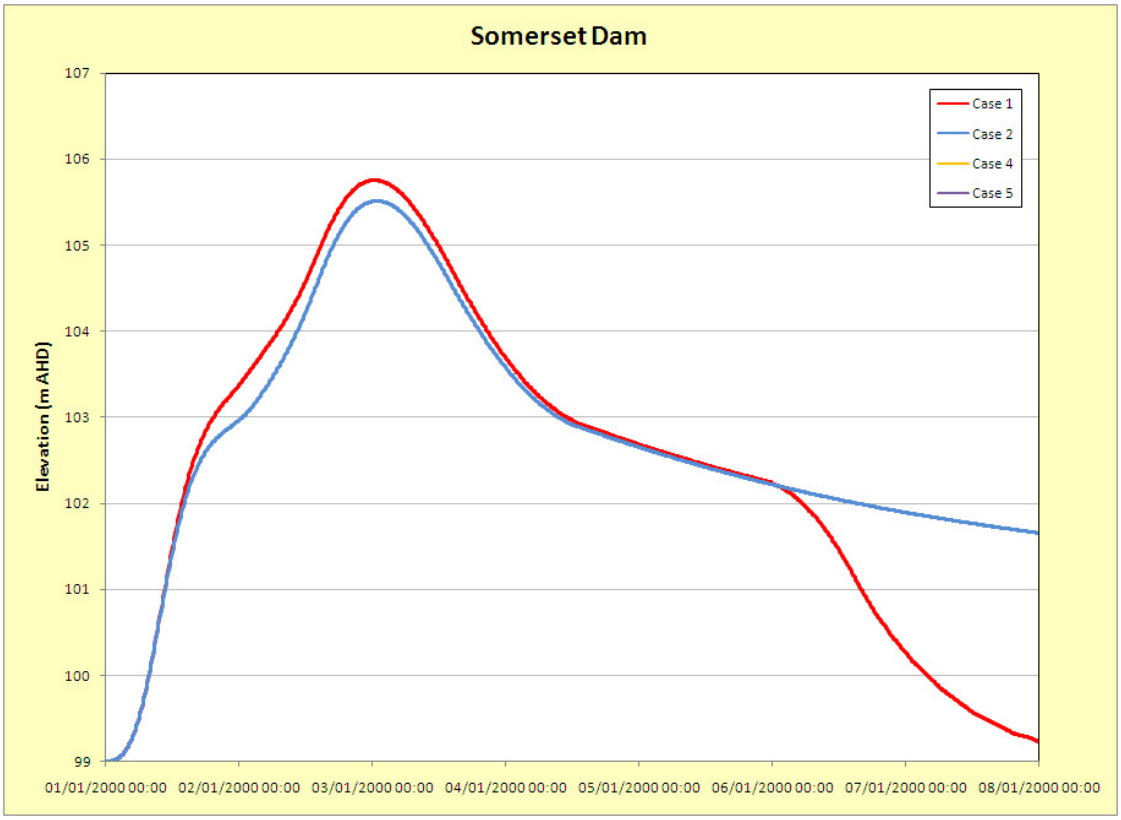



Somerset Dam
Elevation (m AHD)
107
106
105
104
103
102
101
100
99
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

1 in 1,000 AEP

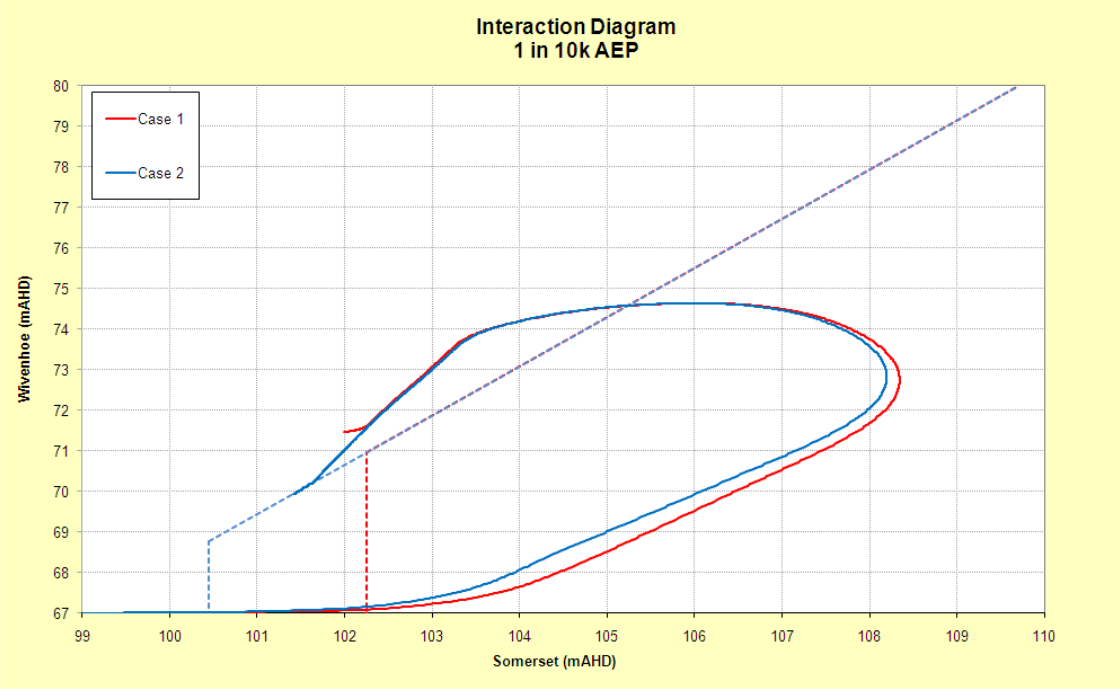
Item	Unit	Wivenhoe Operating Level	
		67.0 m AHD	
		Somerset Operating Level	
		102.25	100.45
		Case 1	Case 2
Somerset Peak Elevation	m AHD	105.75	105.51

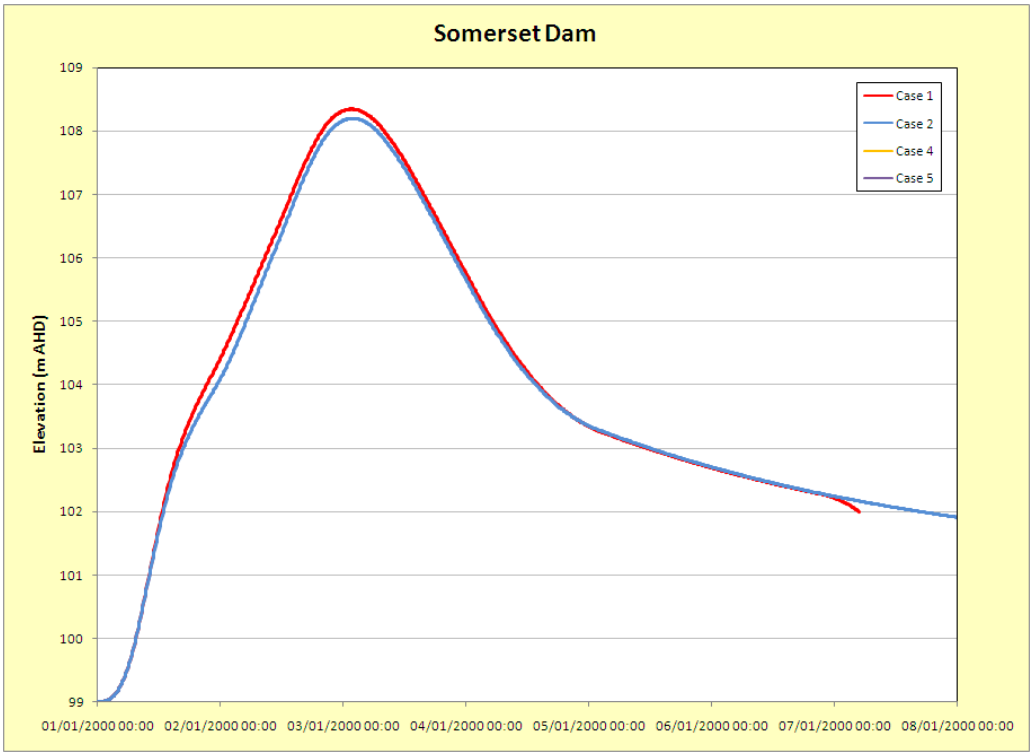



Somerset Dam
Elevation (m AHD)
107
106
105
104
103
102
101
100
99
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00
Case 1
Case 2
Case 4
Case 5

1 in 10,000 AEP

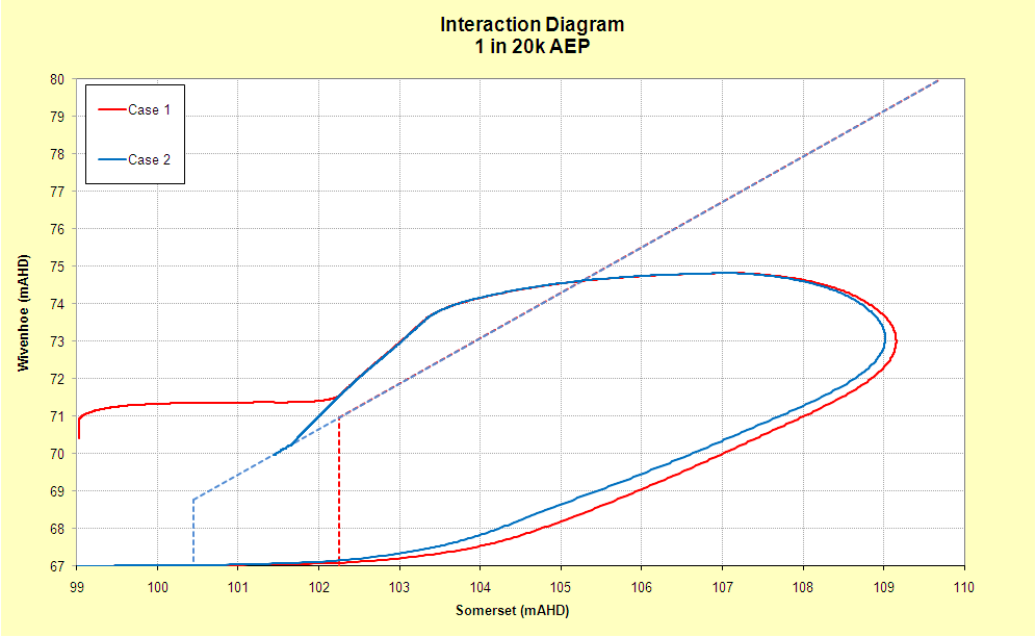
Item	Unit	Wivenhoe Operating Level	
		67.0 m AHD	
		Somerset Operating Level	
		102.25	100.45
		Case 1	Case 2
Somerset Peak Elevation	m AHD	108.34	108.20

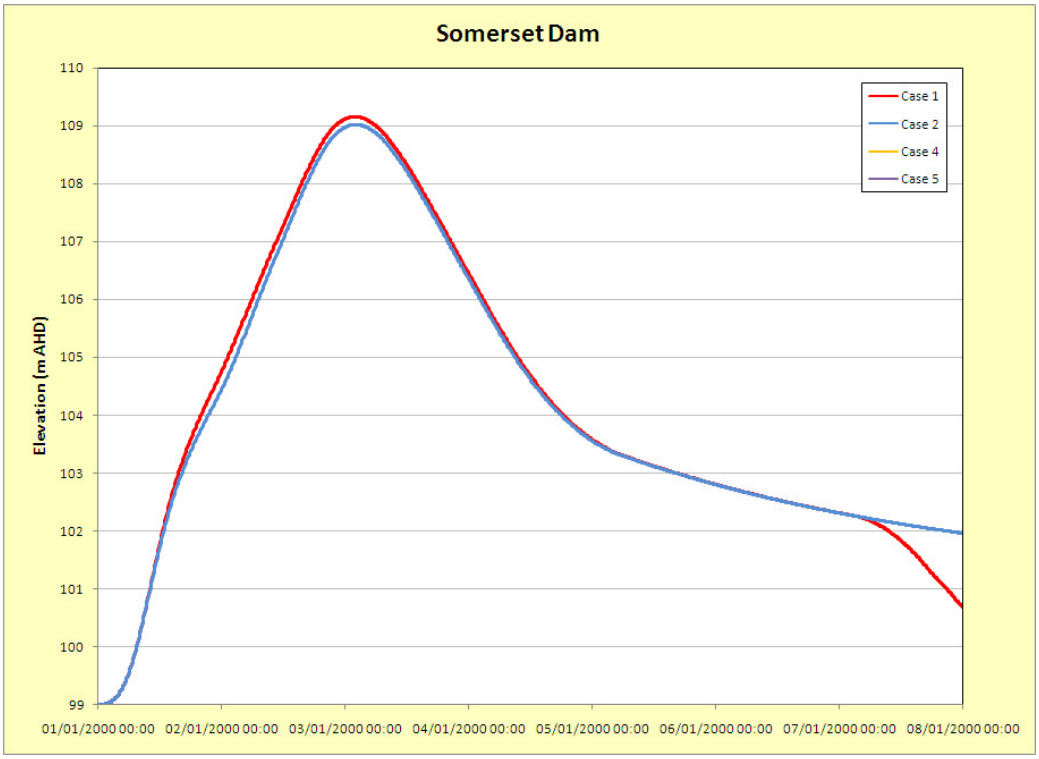



Somerset Dam
Elevation (m AHD)
109
108
107
106
105
104
103
102
101
100
99
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00
Case 1
Case 2
Case 4
Case 5

1 in 20,000 AEP

Item	Unit	Wivenhoe Operating Level	
		67.0 m AHD	
		Somerset Operating Level	
		102.25	100.45
		Case 1	Case 2
Somerset Peak Elevation	m AHD	109.15	109.02




Somerset Dam
Elevation (m AHD)
110
109
108
107
106
105
104
103
102
101
100
99
Case 1
Case 2
Case 4
Case 5
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

1 in 50,000 AEP

Item	Unit	Wivenhoe Operating Level	
		67.0 m AHD	
		Somerset Operating Level	
		102.25	100.45
		Case 1	Case 2
Somerset Peak Elevation	m AHD	110.21	110.05