Wivenhoe - Somerset Flood Manual Review - Meeting

Meeting | Insert | Format Text

Cancel Meeting | Calendar | Forward | Actions | Appointment | Scheduling Assistant | Tracking | Show | Add or Remove Attendees | Message to Attendees | Meeting Workspace | Address Book | Check Names | Responses | Attendees | Show As: Busy | Reminder: None | Recurrence | Time Zones | Categorize | Private | High Importance | Low Importance | Options | Spelling | Proofing

2 attendees accepted, 0 tentatively accepted, 0 declined.
This appointment occurs in the past.

Send Update

To... 'Allen Peter' [redacted] 'Ayre, Rob' [redacted] 'John Ruffini' [redacted]; Terry Malone; Rob Drury; Barton Maher

Subject: Wivenhoe - Somerset Flood Manual Review

Location: Floor 3 - Mineral House (subject to confirmation with Peter Allen) Rooms...

Start time: Fri 6/11/2009 2:00 PM ☐ All day event

End time: Fri 6/11/2009 3:30 PM

To discuss updated draft and associated report distributed on 30 October.

QFCI

Date: 15/4/11

Exhibit Number: 62

In Shared Folder: Calendar

Last modified by John Tibaldi on 6/11/2009

Start | Inbox - Microsoft Outlook | 2 Reminders | FW: Flood Manual Revie... | Manual Review | Adobe Reader | Notice of seventh Meetin... | Microsoft Excel | Wivenhoe - Somerset...

Notes on Wivenhoe Somerset Flood Manual Updates- Enterprise Vault Archived Item - Windows Internet Explorer

http://seq-vaultsite.seqwater.com.au/EnterpriseVault/ViewMessage.asp?VaultId=1E0A83DBBB9ABE5488D382S706S2368391110000SEQ-VaultSite&SavesetId=201005040000000~200911040003530000~Z~415D4809081A1BA7DADC740D3E4A7E21

Wivenhoe Somerset Flood M... | RE: Wivenhoe Somerset Flo... | Notes on Wivenhoe Som...

From John Tibaldi

To 'Allen Peter'; 'John Ruffini [redacted]; Rob Drury; 'Ayre, Rob'; Terry Malone; Barton Maher

Date Wednesday, 4 November 2009 10:03:53 AM

Cc Jim Pruss

Subject Notes on Wivenhoe Somerset Flood Manual Updates

Explanatory Notes for 2009 Revision.doc (44 KB HTML) image001.png (7 KB HTML)

All

I have drafted up some summary notes to explain the changes to the Manual (see attached). I though these may be useful for future reference and may also assist Peter in explaining the changes for the approval process. Perhaps we can discuss these at the meeting on Friday if anyone would like any changes or additions.

John Tibaldi
Dam Safety Manager
Queensland Bulk Water Supply Authority *trading as* Seqwater

cid:image001.png@01C8F22C.8A7

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Local intranet | 100%

Start | Inbox - Microsoft Outlook | 2 Reminders | FW: Flood Manual Revie... | Manual Review | Notice of seventh Meetin... | Microsoft Excel | Wivenhoe - Somerset Flo... | Notes on Wivenhoe S...

MANUAL

OF

OPERATIONAL PROCEDURES

FOR

FLOOD EVENTS

AT

WIVENHOE DAM

AND

SOMERSET DAM

Revision 7
September 2009

Revision No.	Date	Amendment Details
0	27 October 1968	Original Issue
1	6 October 1992	Complete revision and re-issue
2	13 November 1997	Complete revision and re-issue
3	24 August 1998	Change to page 23
4	6 September 2002	Complete revision and re-issue
5	4 October 2004	Complete revision
6	20 December 2004	Miscellaneous amendments and re-issue
7	September 2009	Complete Revision

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Preface

Given their potential significant impact on downstream populations, it is imperative that Wivenhoe and Somerset Dams be operated during flood events in accordance with clearly defined procedures to minimise impacts to life and property. This manual outlines these procedures and is an approved Flood Mitigation Manual under Water Supply Act 2008.

The Manual in its current form was developed in 1992 and the basis of this document was a manual written in 1968 covering flood operations at Somerset Dam (Wivenhoe Dam was completed in 1984). Six revisions of the Manual have occurred since 1992 to account for updates to the Flood Alert Network and the Real Time Flood Models, the construction of an Auxiliary Spillway at Wivenhoe Dam in 2005 and to account for institutional and legislative changes.

The primary objectives of the procedures contained in this Manual are essentially the same as those contained in previous Manual versions. These objectives in order of importance are:

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

In meeting these objectives, the dams must be operated to account for the potential effects of closely spaced Flood Events. Accordingly, normal procedures require stored floodwaters to be emptied from the dams within seven days of the flood event peak passing through the dams.

Wivenhoe Dam and Somerset Dam are operated in conjunction so as to maximise the overall flood mitigation capabilities of the two dams. The procedures outlined in this Manual are based on the operation of the dams in tandem.

1.2 Meaning of Terms

In this Manual, save where a contrary definition appears -

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

"AEP" means annual exceedance probability, the probability of a specified event being exceeded in any year.

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

“AHD” means Australian Height Datum;

“Chairperson” means the Chairperson of Seqwater;

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

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

“Dams” means dams to which this Manual applies, that is Wivenhoe Dam and Somerset Dam;

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

“Duty Flood Operations Engineer” means the Senior Flood Operations Engineer or Flood Operations Engineer rostered on duty to be in charge of Flood Operations at the dams;

“EL” means elevation in metres Australian Height Datum;

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

“Flood Operations Centre” means the Centre used during by Flood Operations Engineers to manage Flood Events;

“Flood Operations Engineer” means a person designated to direct flood operations at the dams in accordance with Section 2.3 of this Manual;

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

“Gauge” when referred to in (m) means river level referenced to AHD, and when referred to in (m^3/s) means flow rate in cubic metres per second;

“Manual” or “Manual of Operational Procedures for Flood Events at Wivenhoe Dam and Somerset Dam” means the current version of this Manual;

“Power Station” means the Wivenhoe pumped storage hydro-electric power station associated with Wivenhoe Dam and Split-Yard Creek Dam;

“Senior Flood Operations Engineer” means a person designated in accordance with Section 2.2 of this Manual under whose general direction the procedures in this Manual must be carried out;

“Seqwater” means the Queensland Bulk Water Supply Authority trading as Seqwater.

1.3 Purpose of Manual

The purpose of this Manual is to define procedures for the operation of Wivenhoe Dam and Somerset Dam to reduce, so far as practicable, the effects of flooding associated with the dams. This is achieved by the proper control and regulation in time of the flood release infrastructure at the dams, with due regard to the safety of the dam structures.

The procedures in this Manual have been developed on the basis that the community is to be protected to the maximum extent practical against flood hazards recognising the limitations on being able to:

- Obtain accurate forecasts of rainfall during flood events;
- Accurately estimate flood run-off within the dam catchments;
- Identify all potential flood hazards and their likelihood;
- Remove or reduce community vulnerability to flood hazards;
- Effectively respond to flooding;
- Provide resources in a cost effective manner.

1.4 Legal Authority

This manual has been prepared as a Flood Mitigation Manual in accordance with Chapter 4 Part 2 of the Act.

1.5 Application and Effect

The procedures in this Manual apply to the operation of Wivenhoe Dam and Somerset Dam for the purpose of flood mitigation, and operation in accordance with the manual shall give the protection from liability provided by Section 374 of the Act.

1.6 Date of Effect

The procedures in this Manual shall have effect on and from the date on which this version of the Manual is approved by gazette notice.

The Manual shall remain in force for the period of approval as determined by the Chief Executive. This approval may be for a period of up to five years.

Before the approval of the Manual expires, Seqwater must review and if necessary update the Manual and submit a copy to the chief executive for approval.

1.7 Observance of Manual

This Manual contains the operational procedures for Wivenhoe Dam and Somerset Dam for the purposes of flood mitigation and must be used for the operation of the dams during flood events.

1.8 Provision for Variations to Manual

If Seqwater is of the opinion that this Manual should be amended, altered or varied, it must submit for approval as soon as practical, an appropriate request to the Chief Executive, setting out the circumstances and the exact nature of the amendment, alteration or variation sought. The Chief Executive may accept, reject or modify the request prior to approval.

1.9 Distribution of Manual

Seqwater must regard the manual as a Controlled Document and ensure that only controlled manuals are used in the direction of flood mitigation activities. Agencies having copies of controlled hardcopies of the Manual are listed in Appendix A. Seqwater must maintain a Register of Contact Persons for issued controlled hardcopies of the Manual and must ensure that each issued document is updated whenever amendments or changes are approved.

2 DIRECTION OF OPERATIONS

2.1 Statutory Operation

Pursuant to the provisions of the Act, Seqwater is responsible for operating and maintaining the dams in accordance with this Manual in order to retain the protection from liability afforded by the Act. Operators, employees, agents, and contractors working for Seqwater must also comply with this Manual to obtain the protection of the Act.

2.2 Operational Arrangements

For the purposes of operation of the dams during Flood Events, Seqwater must ensure that:

- Sufficient numbers of suitably qualified personnel are available to operate the dams if a Flood Event occurs.
- Sufficient numbers of suitably qualified personnel are available to operate the Flood Operations Centre if a Flood Event occurs
- A Duty Flood Operations Engineer is on call at all times. The Duty Flood Operations Engineer must constantly review weather forecasts and catchment rainfall and must declare a Flood Event if the water level of either Wivenhoe or Somerset Dam is expected to exceed Full Supply Level as a result of prevailing or predicted weather conditions.
- A Senior Flood Operations Engineer is designated to be in the charge of Flood Operations at all times during a Flood Event.
- Release of water at the dams during Flood Events is carried out under the direction of the Duty Flood Operations Engineer.
- All practical attempts are made to liaise with the Chairperson and the Chief Executive if the release of water from the Dams during a Flood Event is likely to endanger life or property.

2.3 Designation and Responsibilities of Senior Flood Operations Engineer

Seqwater must nominate one or more suitably qualified and experienced persons to undertake the role of Senior Flood Operations Engineer. If approved by the Chief Executive, these persons can be authorised in the Schedule of Authorities (see Section 2.6). When rostered on duty during a Flood Event, the responsibilities of the Senior Flood Engineer are as follows:

- Set the overall strategy for management of the Flood Event in accordance with the objectives of this Manual.
- Provide instructions to site staff to make releases of water from the Dams during Flood Events that are in accordance with this Manual.

- Apply reasonable discretion in managing a Flood Event as described in Section 2.8.

Seqwater must ensure that an adequate number of Senior Flood Operations Engineers are available to manage all Flood Events.

2.4 Designation and Responsibilities of Flood Operations Engineer

Seqwater must nominate one or more suitably qualified and experienced persons to undertake the role of Flood Operations Engineer. If approved by the Chief Executive, these persons can be authorised in the Schedule of Authorities (see Section 2.6). When rostered on duty during a Flood Event, the responsibilities of the Flood Engineer are as follows:

- Direct the operation of the dams during a flood event in accordance with the general strategy determined by the Senior Flood Operations Engineer.
- Follow any direction from the Senior Flood Operations Engineer in relation to applying reasonable discretion in managing a Flood Event as described in Section 2.8. Unless otherwise directed, a Flood Operations Engineer is to follow this Manual in managing Flood Events and is not to apply reasonable discretion unless directed by the Senior Flood Operations Engineer or the Chief Executive.
- Provide instructions to site staff to make releases of water from the Dams during Flood Events that are in accordance with this Manual.

Seqwater must ensure that an adequate number of Flood Operations Engineers are available to manage all Flood Events. Seqwater must also ensure that an adequate number of suitably qualified and experienced persons are available to assist the Flood Operations Engineers during all Floods Events.

2.5 Qualifications and Experience of Engineers

Qualifications

All engineers referred to in Sections 2.2 and 2.3 must hold a Certificate of Registration as a Registered Professional Engineer of Queensland and must hold appropriate engineering qualifications to the satisfaction of the Chief Executive.

Experience

All engineers referred to in Sections 2.2 and 2.3 must, to the satisfaction of the Chief Executive, have:

(1) Knowledge of design principles related to the structural, geotechnical and hydraulic design of large dams, and

(2) At least a total of five years of suitable experience and demonstrated expertise in at least two of the following areas:

- Investigation, design or construction of major dams;
- Operation and maintenance of major dams;
- Hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology;
- Applied hydrology with particular reference to flood forecasting and/or flood forecasting systems.

2.6 Schedule of Authorities

Seqwater must maintain a Schedule of Authorities containing a list of the Senior Flood Operations Engineers and Flood Operations Engineers approved by the Chief Executive to direct flood operations at the dams during floods. A copy of the Schedule of Authority must be provided to the Chief Executive by 30 September of each year.

Seqwater shall nominate suitably qualified and experienced engineers for registration in the Schedule of Authorities as the need arises. Each new nomination must include a validated statement of qualifications and experience as required by the Chief Executive. Seqwater must obtain the approval for all nominations from the Chief Executive prior to their inclusion in the Schedule of Authorities.

If, in the event of unforseen and emergency situations, no Senior Flood Operations Engineer or no Flood Operations Engineer is available from the Schedule of Authorities to manage a Flood Event, Seqwater must temporarily appoint a suitable person or persons and immediately seek ratification from the Chief Executive.

2.7 Training

Seqwater must ensure that operational personnel required for flood operations activities receive adequate training in the various activities involved in flood control operation as required by the Chief Executive.

2.8 Reasonable Discretion

If in the opinion of the Senior Flood Operations Engineer, it is necessary to depart from the procedures set out in this Manual to meet the flood mitigation objectives set out in Section 3, the Senior Flood Operations Engineer is authorised to adopt such other procedures as considered necessary subject to the following:

- Before exercising discretion under this Section of the Manual with respect to flood mitigation operations, the Senior Flood Operations Engineer must make a reasonable attempt to consult with both the Chairperson and Chief Executive.

- The Chief Executive would normally authorise any departures from the Manual. However if the Chief Executive cannot be contacted within a reasonable time, departures from the Manual can be authorised by the Chairperson.

- If both the Chairperson and the Chief Executive cannot be contacted within a reasonable time, the Senior Flood Operations Engineer may proceed with the procedures considered necessary and report such action at the earliest opportunity to the Chairperson and Chief Executive.

2.9 Report

Seqwater must prepare a report after each Flood Event. The report must contain details of the procedures used, the reasons therefore and other pertinent information. Seqwater must forward the report to the Chief Executive within six weeks of the completion of the Flood Event.

3 FLOOD MITIGATION OBJECTIVES

3.1 General

To meet the purpose of the flood operational procedures in this Manual, the following objectives, listed in descending order of importance, are as follows:

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

In meeting these objectives, the dams must be operated to account for the potential effects of closely spaced Flood Events. Accordingly, normal procedures require stored floodwaters to be emptied from the dams within seven days of the flood event peak passing through the dams.

Additionally, the auxiliary spillway constructed at Wivenhoe Dam in 2005 incorporates fuse plugs. Triggering of a fuse plug will increase floods levels downstream. Where possible, gate operations at both Wivenhoe and Somerset dams should be formulated to prevent operation of the fuse plug. This potential scenario is possible only when the forecast peak water level for Wivenhoe Dam just exceeds the trigger level for the fuse plug and sufficient time is available to alter releases.

3.2 Structural Safety of Dams

The structural safety of the dams must be the first consideration in the operation of the dams for the purpose of flood mitigation.

Wivenhoe Dam

The structural safety of Wivenhoe Dam is of paramount importance. Structural failure of Wivenhoe Dam would have catastrophic consequences. Wivenhoe Dam is predominantly a central core rockfill dam. Such dams are not resistant to overtopping and are susceptible to breaching should such an event occur. Overtopping is considered a major threat to the security of Wivenhoe Dam. Wivenhoe Dam is overtopped by an event with a 1 in 100,000 AEP.

Somerset Dam

The structural safety of Somerset Dam also is of paramount importance. Failure of Somerset Dam could have catastrophic consequences. Whilst Wivenhoe Dam has the capacity to mitigate the flood effects of such a failure in the absence of any other flooding, if the failure were to occur during major flooding, Wivenhoe Dam could be overtopped and destroyed also.

Somerset Dam is a mass concrete dam. Such dams can withstand limited overtopping without damage. Failure of such structures is rare but when they do occur, they occur suddenly without warning, creating very severe and destructive flood waves. Although Somerset Dam is overtopped by an event with a 1 in 5,000 AEP, it is expected that the dam could withstand at least 2.2 metres of overtopping without failure. This equates to an event centred on the Somerset Dam catchment with a 1 in 20,000 AEP.

Extreme Floods and Closely Spaced Large Floods

As indicated in the previous section, techniques for estimating extreme floods show that floods are possible which would overtop both dams. In the case of Wivenhoe Dam such an overtopping would most likely result in the destruction of the dam. Such events however require several days of intense rainfall to produce the necessary runoff.

Historical records show that there is a significant probability of two or more flood producing storms occurring in the Brisbane River system within a short time of each other. Therefore, unless determined otherwise by the Senior Flood Operations Engineer in accordance with Section 2.8, the aim during a Flood Event should be to empty stored floodwaters within seven days after the flood peak has passed through the dams. In a very large flood, this time frame may not be achievable because of downstream flood conditions and it may be necessary to extend the emptying period by several days.

The discharges from the dams should be regulated so as to have little impact on the urban reaches of the Brisbane River, taking into account inflows into the river downstream of the dams. However the seven day drainage requirement may result in submergence of some bridges. Regardless, the level of flooding as a result of emptying stored floodwaters after the peak has passed is to be less than the flood peak unless accelerated release is necessary to reduce the risk of overtopping.

3.3 Inundation of Urban Areas

The prime purpose of incorporating flood mitigation measures into Wivenhoe Dam and Somerset Dam is to reduce flooding in the urban areas of the flood plains below Wivenhoe Dam. The peak flows of floods emanating from the upper catchments of Brisbane and Stanley Rivers can be reduced by controlling flood releases from the dams, while taking into account flooding derived from the lower Brisbane River catchments.

3.4 Disruption to Rural Areas

While the dams are being used for flood mitigation purposes, bridges and areas upstream of the dams may be temporarily inundated. Downstream of the dam, bridges and lower river terraces will be submerged. The operation of the dams should not prolong this inundation unnecessarily.

Disruption to navigation in the Brisbane River is also a consideration when considering disruption to rural areas downstream of the dam. This consideration is secondary however to considerations associated with reducing bridge inundation.

3.5 Retain the storage at Full Supply Level at the Conclusion of the Flood Event

As the dams are the primary urban water supply for South East Queensland, it is important that all opportunities to fill the dams are taken. There should be no reason why the dams should not be full following a Flood Event.

3.6 Minimising Impacts to Riparian Flora and Fauna

During the drain down phase, consideration is to be given to minimising the impacts on riparian flora and fauna. In particular, strategies aimed at reducing fish deaths in the vicinity of the dam walls are to be instigated, provided such procedures do not adversely impact on other flood mitigation objectives.

Additionally, when determining the time interval between successive gate closures consideration should also be given to reducing potential bank slumping. Rapid draw down of stream levels where banks are saturated should be avoided if this can be managed within the other flood mitigation objectives.

4 FLOOD CLASSIFICATION

For the reference purposes of this Manual, four magnitudes of flooding are classified as follows:

Minor Flooding

Causes inconvenience. Low-lying areas next to watercourses are inundated which may require the removal of stock and equipment. Minor roads may be closed and low-level bridges submerged.

Moderate Flooding

In addition to the impacts experienced during Minor Flooding, the evacuation of some houses may be required. Main traffic routes may be impacted. The area of inundation is substantial in rural areas requiring the removal of stock.

Major Flooding

In addition to the impacts experienced during Moderate Flooding, extensive rural areas and/or urban areas are inundated. Properties and towns are likely to be isolated and major traffic routes likely to be closed. Evacuation of people from flood affected areas may be required. The 1974 flood that impacted on the Ipswich and Brisbane areas is classified as a major flood.

Extreme Flooding

This causes flooding impacts equal to or in excess of levels previously experienced. In addition to the impacts experienced during Major Floods, the general evacuation of people from significant populated areas is likely to be required.

It should be noted that a flood may not cause the same category of flooding along its entire length and the relevant agencies shall have regard to this when flooding is predicted. The classifications of minor, moderate and major flooding are based on the Bureau of Meteorology Standard Flood Classifications for Australia.

The current classifications for key reference gauges in the Brisbane River are given in Appendix B.

5 FLOOD MONITORING AND FORECASTING SYSTEM

5.1 General

A real time flood monitoring and forecasting system has been established in the dam catchments. This system employs radio telemetry to collect, transmit and receive rainfall and stream flow information. The system consists of more than 100 field stations that automatically record rainfall and/or river heights at selected locations in the dam catchments. Some of the field stations are owned by Seqwater with the remainder belonging to other agencies.

The rainfall and river height data is transmitted to Seqwater's Flood Operations Centre in real time. Once received in the Flood Operations Centre, the data is processed using a Real Time Flood Model (RTFM) to estimate likely dam inflows and evaluate a range of possible inflow scenarios based on forecast and potential rainfall in the dam catchments. The RTFM is a suite of hydrologic and hydraulic computer programs that utilise the real time data to assist in the operation of the dams during flood events. Seqwater is responsible for providing and maintaining the RTFM and for ensuring that sufficient data is available to allow proper operation of the RTFM during a Flood Event.

5.2 Operation

The Senior Flood Operations and Flood Operations Engineers use the RTFM for flood monitoring and forecasting during flood events to operate the dams in accordance with this Manual. This is done by optimising releases of water from the dams to minimise the impacts of flooding in accordance with the objectives and procedures contained in this Manual.

Seqwater is responsible for improving the operation of the RTFM over time by using the following processes:

- Implementing improvements based on Flood Event audits and reviews.
- Improving RTFM calibration as further data becomes available.
- Updating software in line with modern day standards.
- Improving the coverage and reliability of the data collection network to optimise data availability during Flood Events.
- Recommendations by Senior Flood Operations Engineers.

A regular process of internal audit and management review must be maintained by Seqwater to achieve these improvements.

Seqwater must also maintain a log of the performance of the data collection network. The log must include all revised field calibrations and changes to the number, type and locations of gauges. Senior Flood Operations and Flood Operations Engineers are to be notified of all significant changes to the Log.

Seqwater must also maintain a log of the performance of the RTFM. Any faults to the computer hardware or software are to be noted and promptly and appropriately attend to.

5.3 Storage of Documentation

The performance of any flood monitoring and forecasting system is reliant on accurate historical data over a long period of time. Seqwater must ensure that all available data and other documentation is appropriately collected and catalogued for future use.

5.4 Key Reference Gauges

Key field station locations have been identified for reference purposes when flood information is exchanged between authorities or given to the public. Should it be deemed desirable to relocate field stations from these locations or vary flood classification levels, agreement must first be obtained between Seqwater, Bureau of Meteorology and the Local Government within whose boundaries the locations are situated.

Gauge boards that can be read manually must be maintained by Seqwater as part of the equipment of each key field station. Where possible and practical during Flood events, Seqwater is to have procedures in place for manual reading of these gauge boards in the event of failure of field stations.

5.5 Reference Gauge Values

Other agencies such as the Bureau of Meteorology, Brisbane City Council and Ipswich City Council have direct access to the information from field stations for flood assessment purposes. The consultation between agencies is a very important part of the assessment and prediction of flood flows and heights.

Seqwater must ensure that information relevant to the calibration of its field stations is shared with these agencies.

6 COMMUNICATIONS

6.1 Communications between Staff

Seqwater is responsible for providing and maintaining equipment to allow adequate channels of communication to exist at all times between the Seqwater Flood Operations Centre and site staff at Wivenhoe and Somerset Dams.

6.2 Dissemination of Information

Agencies other than Seqwater have responsibilities for formal flood predictions, the interpretation of flood information and advice to the public associated with Flood Events. Adequate and timely information is to be supplied to agencies responsible for the operation of facilities affected by flooding and for providing warnings and information to the public. Agency information requirements are generally as shown in Table 6.1.

The Senior Flood Operations and Flood Operations Engineers must supply information to each of these agencies during Flood Events. The contact information for these Agencies and communication procedures is contained in the Emergency Action Plans for the dams and each agency is to receive updated controlled copies of these documents.

Seqwater must liaise and consult with these agencies with a view to ensuring all information relative to the flood event is consistent and used in accordance with agreed responsibilities.

AGENCY INFORMATION REQUIREMENTS

Agency	Activity	Information Required from Flood Operations Centre	Trigger
Bureau of Meteorology	Issue of flood warnings for Brisbane River basin	Actual and projected discharges from Wivenhoe Dam Actual and projected discharges from Somerset Dam	Initial gate operations and thereafter at intervals to suit forecasting requirements
Department of Environment and Resource Management	Review of flood operations and discretionary powers	Actual and predicted lake levels and discharges	
Somerset Regional Council	Flood level information upstream of Somerset Dam and upstream and downstream of Wivenhoe Dam	Actual and predicted lake levels, Somerset Dam and actual and predicted lake levels and discharges, Wivenhoe Dam	Somerset Dam water level predicted to exceed EL 102 m AHD and initial Wivenhoe Dam gate operation
Ipswich City Council	Flood level information for Ipswich City area	Nil (information obtained from BOM)	
Brisbane City Council	Flood level information for Brisbane City area	Nil (information obtained from BOM)	

6.3 Release of Information to the Public

Seqwater is responsible for the issue of information regarding storage conditions and current and proposed releases from the dams to the public and the media.

The Bureau of Meteorology has responsibility for issuing flood warnings.

The Emergency Services Response Authorities, under the Disaster Management Act 2003, have responsibility for the preparation of a local counter disaster plan and the interpretation of flood forecast information for inclusion in their local flood warnings prepared under the flood sub plan of the counter disaster plan.

7 REVIEW

7.1 Introduction

With the passage of time neither the technical assumptions nor the physical conditions on which this Manual is based may remain unchanged. It is also recognised that the relevance of the Manual may change with changing circumstances. It is important therefore, that the Manual contain operational procedures which cause the assumptions and conditions upon which they are based, to be checked and reviewed regularly.

This process must involve all personnel involved in the management of Flood Events, to ensure that changes of personnel do not result in a diminished understanding of the basic principles upon which the operational procedures are based. Variations to the Manual may be made in accordance with provisions in Section 1.8.

7.2 Personnel Training

Seqwater must report to the Chief Executive by 30 September each year on the training and state of preparedness of operations personnel.

7.3 Monitoring and Forecasting System and Communication Networks

Seqwater must provide a report to the Chief Executive by 30 September each year on the state of the Flood Monitoring and Forecasting System and Communication Networks. The report must assess following in terms of hardware, software and personnel:

- Adequacy of the communication and data gathering facilities.
- Reliability of the system over the previous period.
- Reliability of the system under prolonged flood conditions.
- Accuracy of forecasting flood flows and heights.
- The overall state of preparedness of the system.

Seqwater must take any action considered necessary for the proper functioning and improvement of this system.

7.4 Operational Review

After each significant flood event, Seqwater must report to the Chief Executive on the effectiveness of the operational procedures contained in this manual. This report must be submitted within six weeks of any flood event that requires mobilisation of the Flood Operations Centre.

7.5 Five Yearly Review

Prior to the expiry of the approval period, Seqwater must review the Manual pursuant to provisions of the Act. The review is to take into account the continued suitability of the communication network and the flood monitoring and forecasting system, as well as hydrological and hydraulic engineering assessments of the operational procedures.

8 WIVENHOE DAM FLOOD OPERATIONS

8.1 Introduction

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

The reservoir volume above FSL of EL 67.0 is available as temporary flood storage. How much of the available flood storage compartment is utilised, will depend on the initial reservoir level below FSL, the magnitude of the flood being regulated and the procedures adopted.

Splityard Creek Dam is part of the overall Wivenhoe Area Project and it forms the upper pumped storage for hydro power generation. Splityard Creek Dam impounds a volume of 28,700 ML at FSL (EL 166.5). This volume can be emptied into Lake Wivenhoe within 12 hours and this water can affect the level in Wivenhoe Dam by up to 300mm when Wivenhoe Dam is close to FSL. Operation of the power station and release of water from Splityard Creek Dam to Lake Wivenhoe is outside the control of Seqwater, but should be considered when assessing the various trigger levels of Wivenhoe Dam.

8.2 Flood Release Infrastructure

Radial Gates and an Auxiliary Spillway are the primary infrastructure used to release water during flood events at Wivenhoe Dam. The arrangement of the Radial Gates is shown in the diagram below:

In addition to the five radial gates, the auxiliary spillway was constructed in 2005 as part of an upgrade to improve flood adequacy of this storage. The auxiliary spillway consists of a three bay fuse plug spillway at the right abutment. In association with other works constructed at the dam, this gives the dam crest flood an AEP of approximately 1 in 100,000. Another one bay fuse plug spillway may be constructed at Saddle Dam Two in the future.

Pertinent information about the auxiliary spillway, including the initiation level for the specific bays is given in the following table.

AUXILIARY SPILLWAY - FUSE PLUG DETAILS

[redacted]

* Storage Level is as per that measured at the Headwater Gauge. Initiation of Fuse Plug is expected to occur when the Lake Water Level exceeds the Lake Level at Fuse Plug Pilot Channel by 0.10 - 0.15 m

[+] Includes 0.03m of drawdown from the Fuse Plug Pilot Channel Invert to the Lake Water Level

[++] Includes 0.08m of drawdown from the Fuse Plug Pilot Channel Invert to the Lake Water Level

The arrangement of the Auxiliary Spillway is shown in the diagram below.

[redacted]

8.3 Initial Flood Control Action

Once a Flood Event is declared, an assessment is to be made of the magnitude of the Flood Event, including:

- A prediction of the maximum storage levels in Wivenhoe and Somerset Dams.
- A prediction of the peak flow rate at the Lowood Gauge excluding Wivenhoe Dam releases.
- A prediction of the peak flow rate at the Moggill Gauge excluding Wivenhoe Dam releases.

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

8.4 Flood Operations Strategies

There are four strategies (W1 to W4) used when operating Wivenhoe Dam during a flood event as outlined below. These strategies are based on the Flood Objectives of this manual. As outlined in Section 3, the objectives, listed in descending order of importance, are as follows:

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

Within any strategy, consideration is always given to these objectives in this order, when making decisions on dam releases.

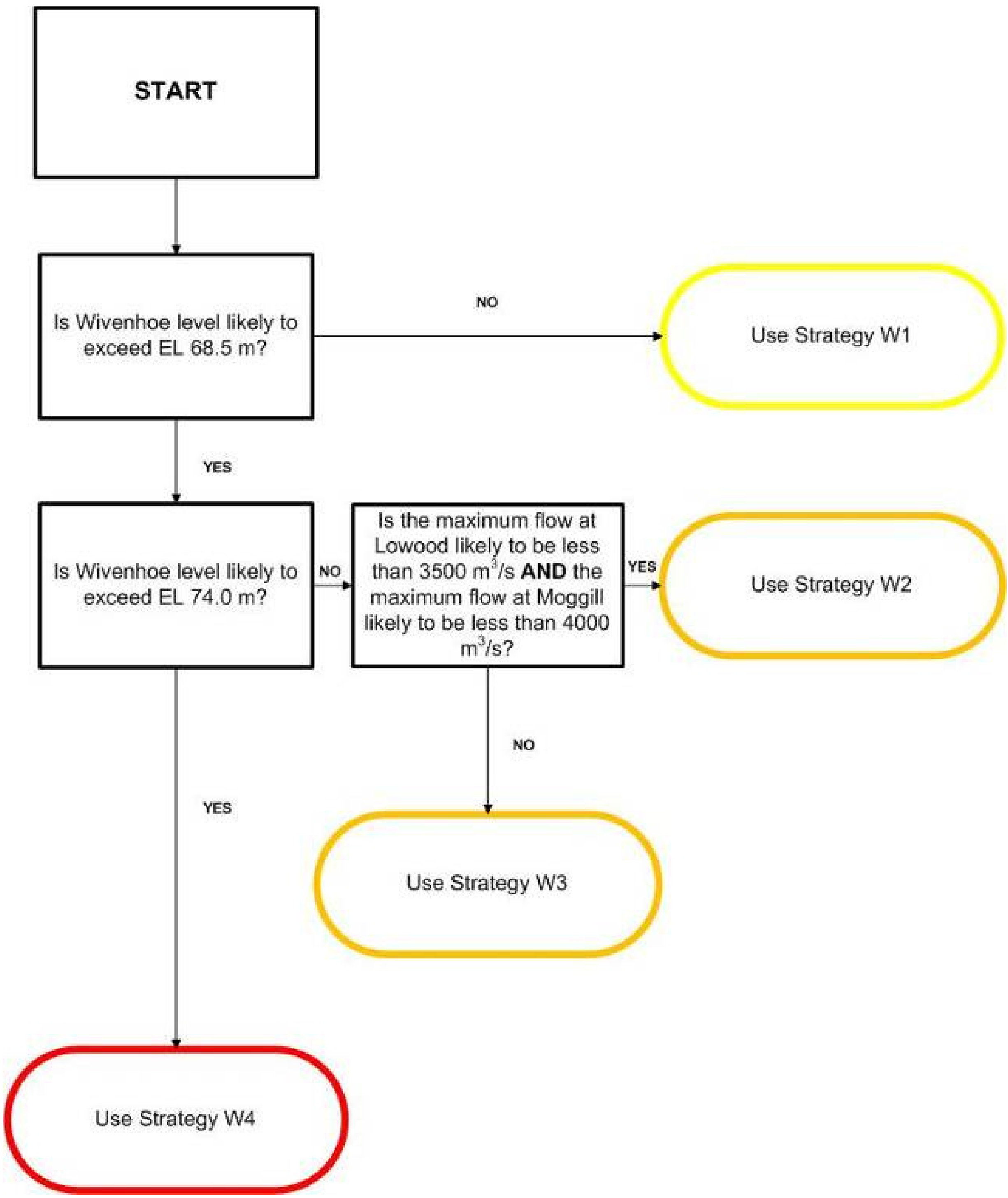
The strategy chosen at any point in time will depend on the actual levels in the dams and the following predictions, which are to be made using the best forecast rainfall and stream flow information available at the time:

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

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

When determining dam outflows within all strategies, peak outflow should generally no exceed peak inflow. A flowchart showing how best to select the appropriate strategy to use at any point in time is shown below:

WIVENHOE FLOOD STRATEGY FLOW CHART



Strategy W1 - The Primary Consideration is Minimising Disruption to Downstream Rural Life

Conditions	• **Wivenhoe Storage Level predicted to be less than 68.50 m AHD** • **Maximum release predicted to be less than 1,900 m^3/s** • **The primary consideration is minimising disruption to downstream rural life**

The intent of Strategy W1 is to not to submerge the bridges downstream of the dam prematurely. The limiting condition for Strategy W1 is the submergence of Mt Crosby Weir Bridge that occurs at approximately 1,900 m^3/s.

* Note: Colleges Crossing is affected by tides

For situations where flood rains are occurring on the catchment upstream of Wivenhoe Dam and only minor rainfall is occurring downstream of the dam, releases are to be regulated to limit, as much as appropriate in the circumstances, downstream flooding.

The following strategies require a great deal of control over releases and knowledge of discharges from Lockyer Creek. In general, the releases from Wivenhoe Dam are controlled such that the combined flow from Lockyer Creek and Wivenhoe Dam is less than the limiting values to delay the submergence of particular bridges. The diagram above shows the location of the impacted bridges and the approximate river flow rate at which they are closed to traffic.

Strategy W1A Twin Bridges, Savages Crossing and Colleges Crossing

Lake Level greater than 67.25 m AHD
[Maximum Release 110 m^3/s]

Firstly, endeavour to maintain Twin Bridges trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 50 m^3/s.

Once Twin Bridges is closed to traffic, endeavour to maintain Savages Crossing trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 110 m^3/s.

Once Savages Crossing is closed to traffic, endeavour to maintain College's Crossing trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 175 m^3/s. Note that College's Crossing can be impacted by tidal influences.

When the flood event subsides, all gates are to be closed when the dam achieves FSL in accordance with Section 8.5.

Strategy W1B College's Crossing and Burtons Bridge

Lake Level greater than 67.50 m AHD
[Maximum Release 380 m^3/s]

No consideration is given to maintaining Twin Bridges or Savages Crossing open.

Endeavour to maintain College's Crossing trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 175 m^3/s.

Once College's Crossing is closed to traffic, endeavour to maintain Burtons Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 430 m^3/s.

<u>Strategy W1C</u> Burtons Bridge and Kholo Bridge

Lake Level greater than 67.75 m AHD
[Maximum Release 500 m^3/s]

No consideration is given to maintaining College's Crossing open.

Endeavour to maintain Burtons Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 430 m^3/s.

Once Burtons Bridge is closed to traffic, endeavour to maintain Kholo Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 550 m^3/s.

<u>Strategy W1D</u> Kholo Bridge and Mt Crosby Weir Bridge

Lake Level greater than 68.00 m AHD
[Maximum Release 1900 m^3/s]

No consideration is given to maintaining Burtons Bridge open.

Endeavour to maintain Kholo Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 550 m^3/s.

Once Kholo Bridge is closed to traffic, endeavour to maintain Mt Crosby Weir Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 1900 m^3/s.

<u>Strategy W1E</u> Mt Crosby Weir Bridge and Fernvale Bridge

Lake Level greater than 68.25 m AHD
[Maximum Release 1900 m^3/s]

No consideration is given to maintaining Kholo Bridge open.

Endeavour to maintain Mt Crosby Weir Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 1900 m^3/s.

Once Mt Crosby Weir Bridge is closed to traffic, endeavour to maintain Fernvale Bridge trafficable by limiting the combined flows from Wivenhoe Dam and Lockyer Creek to a maximum of 2000 m^3/s.

If the level reaches EL 68.5 m AHD in Wivenhoe Dam, switch to Strategy W2 or W3 as appropriate.

Strategy W2 - Strategy W2 is a Transition Strategy where the primary consideration changes from Minimising Impact to Downstream Rural Life to Protecting Urban Areas from Inundation.

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

The intent of Strategy W2 is limit the flow in the Brisbane River to less than the naturally occurring peaks at Lowood and Moggill, while remaining within the upper limit of non-damaging floods at Lowood (3,500 m^3/s). In these instances, the combined peak river flows should not exceed those shown in the following table:

LOCATION	TARGET MAXIMUM FLOW IN THE BRISBANE RIVER
Lowood	The lesser of: • the natural peak flow at Lowood excluding Wivenhoe Dam releases, and; • 3,500m^3/s.
Moggill	The lesser of: • the natural peak flow at Moggill excluding Wivenhoe Dam releases, and; • 4,000m^3/s.

Strategy W3 – The primary consideration is Protecting Urban Areas from Inundation

Conditions	• **Wivenhoe Storage Level predicted to be between 68.50 and 74.00 m AHD** • **Maximum Release should not exceed 4,000 m^3/s** • **The primary consideration is protecting urban areas from inundation** • **Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance**

The intent of Strategy W3 is to limit the flow in the Brisbane River at Moggill to less than 4000 m^3/s, noting that 4000 m^3/s at Moggill is the upper limit of non-damaging floods downstream. The combined peak river flow targets for Strategy W3 are shown in the following table. In relation to these targets, it should be noted that depending on natural flows from the Lockyer and Bremer catchments, it may not be possible to limit the flow at Moggill to below 4000 m^3/s. In these instances, the flow at Moggill is to be kept as low as possible.

TIMING	**TARGET MAXIMUM FLOW IN THE BRISBANE RIVER**
Prior to the naturally occurring peak at Moggill (excluding Wivenhoe Dam releases).	The flow at Moggill is to be minimised.
After the naturally occurring peak at Moggill (excluding Wivenhoe Dam releases).	The flow at Moggill is to be lowered to 4,000m^3/s as soon as possible.

Strategy W4 – The primary consideration is Protecting the Structural Safety of the Dam

Conditions	• **Wivenhoe Storage Level predicted to exceed 74.00m AHD.** • **No limit on Maximum Release rate** • **The primary consideration is protecting the structural safety of the dam** • **Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance**

The intent of Strategy W4 is to ensure the safety of the dam while limiting downstream impacts as much as possible.

This strategy normally comes into effect when the water level in Wivenhoe Dam reaches 74.0 m AHD. However the Senior Flood Operations Engineer may seek to invoke the discretionary powers of Section 2.8 if earlier commencement is able to prevent triggering of a fuse plug.

Under Strategy W4 the release rate is increased as the safety of the dam becomes the priority. Opening of the gates is to occur generally in accordance with the requirements of Section 8.6, until the storage level of Wivenhoe Dam begins to fall.

There are no restrictions on gate opening increments or gate operating frequency once the storage level exceeds 74.0 AHD, as the safety of the dam is of primary concern at these storage levels. However the impact of rapidly increasing discharge from Wivenhoe Dam on downstream reaches should be considered when determining gate opening sequences.

Strategy W4A – No Fuse Plug Initiation Expected

Lake Level between 74.0 and 75.5 m AHD
[No Maximum Release]

Strategy 4A applies while all indications of the peak flood level in Wivenhoe Dam are that it will be insufficient to trigger operation of the first bay of the fuse plug by reaching 75.5 m AHD.

Gate openings are generally to occur at the minimum intervals and sequences as specified in Section 8.6 until the storage level of Wivenhoe Dam begins to fall. However, to protect the safety of the dam, minimum opening intervals can be reduced and gate opening sequences can be modified.

Strategy W4B – Fuse Plug Initiation Possible

Lake Level greater than 75.5 m AHD
[No Maximum Release]

Strategy W4B applies once indications are the peak flood level in Wivenhoe Dam may exceed EL75.5 and trigger the fuse plug under normal operations. Two scenarios are possible under this strategy. The first scenario is where it may be possible to prevent fuse plug initiation by early opening of the gates. The second scenario is where fuse plug initiation cannot be avoided. The actions associated with these scenarios are contained in the following table:

[redacted]

8.5 Gate Closing Strategies

In general, gate closing commences when the level in Wivenhoe Dam begins to fall and is generally to occur in the reverse order to opening. The final gate closure should occur when the lake level has returned to Full Supply Level. The following requirements must be considered when determining gate closure sequences:

- Where possible, total releases during closure should not produce greater flood levels downstream than occurred during the flood event.
- The maximum discharge from the dam during closure should generally be less than the peak inflow into Wivenhoe Dam experienced during the event. The discharge from Wivenhoe Dam includes discharge from triggered fuse plugs, gates, regulator cone dispersion valve and hydro release.
- If, at the time the lake level in Wivenhoe Dam begins to fall, the combined flow at Lowood is in excess of 3,500 m^3/s then the combined flow at Lowood is to be reduced to 3,500 m^3/s as quickly as practicable.
- The aim should always be to empty stored floodwaters stored above EL 67.0m within seven days after the flood peak has passed through the dams. However, provided a favourable weather outlook is available, this requirement can be relaxed for the volume between EL 67.0m and EL 67.5m, to obtain positive environmental outcomes.
- If the flood storage compartments of Wivenhoe Dam and Somerset Dam can be emptied within seven days, the maximum flow in the Brisbane River at Lowood should not exceed 3,500 m^3/s.
- To minimise the stranding of fish downstream of the dam, final closure sequences should consider Seqwater policies relating to fish protection at the dam.

There may be a need to take into account base flow when determining final gate closure. This may mean that the lake level temporarily falls below Full Supply Level to provide for a full dam at the end of the Flood Event.

8.6 Gate Operation Sequences

Radial Gate Opening Operations

When dam outflows are less than 4,000 m^3/s, rapid opening of the radial gates can cause undesirable rapid rises in downstream river levels. Accordingly, when dam outflows are less than 4,000 m^3/s, the aim in opening radial gates is to operate the gates one at a time at intervals that will minimise adverse impacts on the river system. The table below shows the target minimum intervals for gate operations in these circumstances. These gate opening constraints are to be overridden if the gates are at risk of being overtopped or the safety of the dam is at risk.

TARGET MINIMUM INTERVALS FOR RADIAL GATE OPERATIONS (DOWNSTREAM RIVER FLOWS < 4000 m^3/s)

OPERATION	TIME INTERVAL BETWEEN SUCCESSIVE OPERATIONS (mins)
Radial Gate opening of 500 mm	10

When dam outflows exceed 4,000 m^3/s, the impact of rapid gate openings on downstream water levels is reduced due to the already elevated river levels. Under these circumstances, the safety of the dam will generally be of primary concern and therefore there are no restrictions on gate operating intervals in these circumstances.

Under extreme circumstances, the mechanical capability of the radial gate operating system provides the facility to open each radial gate more than five metres within a one hour period. Accordingly, unless a mechanical breakdown is experienced, physical gate opening capability in unlikely to be a constraint in meeting projected outflow targets.

Radial Gate Closing Operations

When dam outflows are less than 4,000 m^3/s, rapid closure of the radial gates can cause adverse impacts to the river system. Accordingly, when dam outflows are less than 4,000 m^3/s, the aim in closing radial gates is to operate the gates one at a time at intervals that will minimise adverse impacts on the river system as outlined in the table below.

TARGET MINIMUM INTERVALS FOR RADIAL GATE OPERATIONS

OPERATION	TIME INTERVAL BETWEEN SUCCESSIVE OPERATIONS (mins)
Radial Gate closure of 500 mm	20

When dam outflows exceed 4,000 m^3/s, the impact of rapid gate closings is reduced due to the already elevated river levels. However, given that the safety of the dam is unlikely to be at risk if decisions are made to close radial gates, the target of operating the gates one at a time in accordance with the time interval shown in the above table remains.

Rapid closure of more than one gate at a time should only be used when time is critical and there is a requirement to correct a malfunction to preserve storage or to rapidly reduce downstream flooding.

When determining gate closure sequences, consideration should be given to following the calculated natural recession of the flood in the river to ensure that the recession impacts are not greater than those that would have been experienced had the dam not been constructed.

Protection of the Spillway Walls

The flip bucket spillway is designed to control the discharge from the reservoir and to dissipate the energy of the discharge. The flip throws the discharge clear of the concrete spillway structures and into a plunge pool where the energy is dissipated by turbulence. Under non-symmetric flow conditions or when Gates 1 and 5 are not operating, the discharge jet may impinge on the walls of the plunge pool. As these walls have been excavated into erodible sandstone rock, this impingement may cause non-predictable erosion. Upstream migration of this erosion is to be avoided. This can be achieved by operating Gates 1 and 5 to deflect the discharge away from the walls of the plunge pool.

Therefore in operating the spillway, the principles to be observed in order of priority are:

(i) The discharge jet into the plunge pool is not to impinge on the right or left walls of the plunge pool.

(ii) The flow in the spillway is to be symmetrical.

Normal Gate Operation Sequences

Under normal operation, only one gate is to be opened at any one time and the sequences shown in the table below are to be adopted. Variations are allowed at any time to protect the structural safety of the dam.

It should also be noted that:

- Gates are numbered 1 to 5 from the left bank looking downstream
- Flow in spillway to be as symmetrical as possible.

RADIAL GATE OPENING SEQUENCES

[redacted]

[redacted]

[redacted]

During the initial opening or final closure sequences of gate operations it is permissible to replace the discharge through a gate by the immediate opening of a regulator valve (or the reverse operation). This allows for greater control of low flows.

Gate Failure or Malfunction Procedures

Gate operating procedures in the event of equipment failure are contained in Appendix G. If one or more gates are inoperable during the course of the flood event, the gate openings of the remaining gates are to be adjusted to provide the required discharge from the dam. These adjustments should ensure that:

- The impact of the flow on the sidewalls of the plunge pool should be minimised, and
- The flow in the spillway is as symmetrical as practicable.

Radial Gate Turbulence Considerations

Unless in the process of lifting the gates clear of the flow, the bottom edge of the radial gates must always be at least 500 millimetres below the release flow surface. Having the bottom edge of the gates closer to the release flow surface than 500 millimetres may cause unusual turbulence that could adversely impact on the gates. This procedure has never been undertaken in practice and should be observed closely when being undertaken. Variations to the procedure are allowed to protect the structural safety of the dam.

Lowering Radial Gates that have been lifted Clear of the Release Flow

When lowering radial gates that have been lifted clear of the release flow, the bottom edge of the gates must be lowered at least 500 millimetres into the flow. Lowering gates into the release flow less than this amount may cause unusual turbulence that could adversely impact on the gates. This procedure has never been undertaken in practice and should be observed closely when being undertaken. Variations to the procedure are allowed to protect the structural safety of the dam.

8.7 Modification to Flood Operating Procedures if a Fuse Plug Triggers

Where the operation of a fuse plug spillway bay has been triggered, the flood operation procedures are to be modified such that:

- The discharge from the triggered fuse plug is to be taken into account when determining total flood releases from the dam;
- The gates are to be operated, to the extent possible, so that the same discharge restrictions apply as would have if the fuse plug embankment was intact.

8.8 Modification to Flood Operating Procedures if a subsequent flood event occurs prior to the reconstruction of Triggered Fuse Plugs

Where the operation of any or all of the fuse plug spillway bays has been triggered and a flood event occurs before the fuse plug can be reinstated, the flood operation procedures are to be modified such that:

- The discharge from the triggered fuse plug is to be taken into account when determining total flood releases from the dam;
- The gates are to be operated, to the extent possible, so that the same discharge restrictions apply as would have if the fuse plug embankment was intact.
- Discharge from the Auxiliary Spillway will occur before the Gate Trigger Level of EL 67.25 m AHD. This flow should be taken into account when applying the flood operation strategies relevant to the low level bridge crossings.

9 SOMERSET DAM FLOOD OPERATIONS

9.1 Introduction

Somerset Dam is capable of being operated in a number of ways to regulate Stanley River floods. Somerset Dam and Wivenhoe Dam are to be operated in conjunction to optimise the flood mitigation benefits downstream of Wivenhoe Dam. The arrangement of the Somerset Dam Radial Gates, Sluice Gates and Regulator Valves is shown in the diagram below:

[redacted]

9.2 Initial Flood Control Action

Once a Flood Event is declared, all radial gates are to be fully opened and all sluice gates and regulator valves are to be fully closed. An assessment is to be made of the magnitude of the Flood Event, including a prediction of the maximum storage levels in Wivenhoe and Somerset Dams.

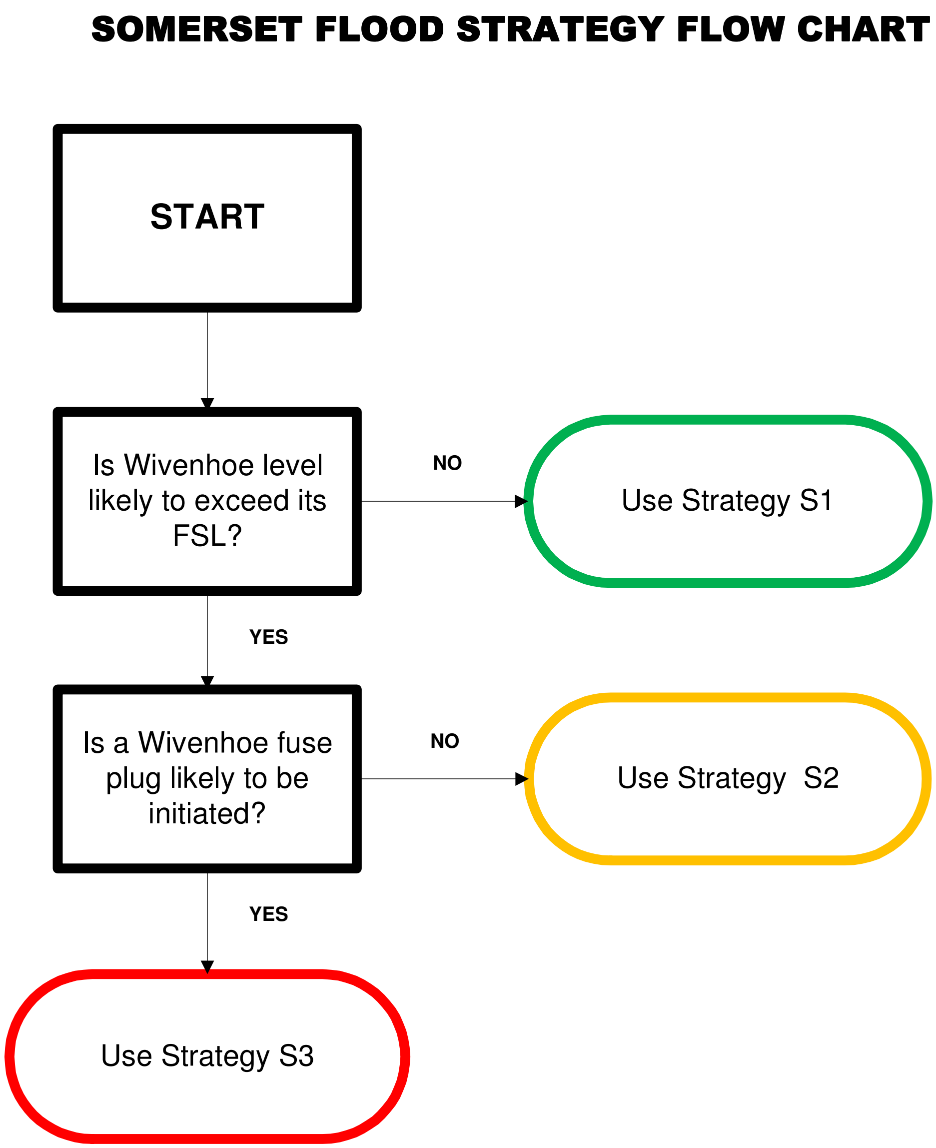
9.3 Flood Operations Strategies

There are three strategies used when operating Somerset Dam during a flood event as outlined below. These strategies are based on the Flood Objectives of this manual. The strategy chosen at any point in time will depend on predictions of the maximum storage levels in Wivenhoe and Somerset Dams which are to be made using the best forecast rainfall and stream flow information available at the time.

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

When calculating the impacts of flood releases from Somerset Dam, the gate opening sequences outlined in Section 9.5 should be used to determine likely outflow rates from the dam.

A flowchart showing how best to select the appropriate strategy to use at any point in time is shown below:



Strategy S1 – Minimising Impact on Rural Life Upstream

Conditions	• **Somerset Dam Level expected to exceed EL 99.0 and Wivenhoe Dam not expected to reach EL 67.0 (FSL) during the course of the Flood Event**

The intent of this strategy is to return the dam to full supply level while minimising the impact on rural life upstream of the dam. Consideration is also given to minimising the downstream environmental impacts from the release.

The crest gates at Somerset Dam are raised to enable uncontrolled discharge. The Regulator Valves and Sluice gates are to be used to maintain the level in Somerset dam below EL 102.0 (deck level of Mary Smokes Bridge). The release rate from Somerset dam is not to exceed the peak inflow into the dam.

Strategy S2 – Minimise Impacts below Wivenhoe Dam

Conditions	• **Somerset Dam Level expected to exceed EL 99.0 and Wivenhoe Dam level expected to exceed EL 67.0 (FSL) but not exceed EL 75.5 (fuse plug initiation) during the course of the Flood Event.**

The intent of this strategy is to maximise the benefits of the flood storage capabilities of the dam while protecting the structural safety of both dams. The table below contains the operating conditions and actions for Strategy S2.

[redacted]

[redacted]

Notes:

- The Operating Target Line was selected following an optimisation study. The 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.
- The levels of 109.70 m AHD and 80.00 m AHD represent the likely failure level for Somerset Dam and the level at the top of the Wivenhoe Dam Wave Wall respectively.

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

Strategy S3 - Protect the Structural Safety of the Dam

Conditions	• **Somerset Dam Level expected to exceed EL 99.0 and Wivenhoe Dam level expected to exceed EL 75.5 (fuse plug initiation) during the course of the Flood Event.**

The intent of this strategy is to maximise the benefits of the flood storage capabilities of the dam while protecting the structural safety of both dams.

In addition to the operating protocols used in Strategy S2, to prevent fuse plug initiation, consideration can be given to temporary departure from the operating protocols contained in this strategy under the following conditions:

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

9.4 Gate Closing Strategies

In general, gate closing commences when the level in Somerset Dam begins to fall and is generally to occur in the reverse order to opening. The final gate closure should occur when the lake level has returned to Full Supply Level. The following requirements must be considered when determining gate closure sequences:

- Unless determined otherwise by the Senior Flood Operations Engineer in accordance with Section 2.8, the aim should be to empty stored floodwaters within seven days after the flood peak has passed through the dams.
- To minimise the stranding of fish downstream of the dam, final closure sequences should consider Seqwater policies relating to fish protection at the dam.

There may be a need to take into account base flow when determining final gate closure. This may mean that the lake level temporarily falls below Full Supply Level to provide for a full dam at the end of the Flood Event.

9.5 Gate Operation Sequences

Intervals between Operations

Releases from Somerset Dam flow directly into Wivenhoe Dam and therefore the downstream river impact considerations associated with radial gate operations at Wivenhoe Dam, do not directly apply to Somerset Dam. However, the following minimum intervals should generally be observed whilst opening and closing regulators, sluices and crest gates at Somerset Dam for flood mitigation purposes. These intervals have been chosen to minimise any adverse impacts caused by lake level rises above the junction of the Stanley and Brisbane Rivers.

MINIMUM INTERVALS FOR NORMAL GATE OPERATIONS

ITEM	OPENING	CLOSING
Regulator Valves	30 mins	60 mins
Sluice Gates (Dam level < EL 100.45)	120 mins	180 mins
Sluice Gates (Dam level > EL 100.45)	60 mins	60 mins
Crest Gates	Gates are normally open	-

Regulator Valve Considerations

During the initial opening or final closure sequences of gate operations it is permissible to replace the discharge through a sluice gate by the immediate opening of one or more regulator valves (or the reverse operation). This allows for greater control of low flows and enables a smooth transition on opening and closing sequences.

It must also be noted that the Regulator Valves are not to be operated when the tail water level below Somerset Dam is above the invert of the valves (68.60 m AHD). Operating the valves under these circumstances can damage the valves. This requirement can be ignored if the structural safety of the dam is at risk.

10 EMERGENCY FLOOD OPERATIONS

10.1 Introduction

While every care has been exercised in the design and construction of the dams, there still remains a low risk that the dams may develop an emergency condition either through flood events or other causes. Vigilance is required to recognise emergency flood conditions such as:

- Occurrence of a much larger flood than the discharge capacity of the dam;
- Occurrence of a series of large storms in a short period;
- Failure of one or more gates during a flood.
- Development of a piping failure through the embankment of Wivenhoe Dam;
- Damage to the dams by earthquake;
- Damage to the dams as an act of war or terrorism;

Responses to these conditions are included in Emergency Action Plans for the dams.

10.2 Overtopping of Dams

Whatever the circumstances, every endeavour must be made to prevent overtopping of Wivenhoe Dam by the progressive opening of operative spillway gates. The Auxiliary Spillway constructed at the dam in 2005 gives the dam crest flood an AEP of approximately 1 in 100,000. Another one bay fuse plug spillway may be constructed at Saddle Dam Two in the future, thereby increasing this immunity.

Somerset Dam should not be overtopped by flood water, but if Wivenhoe Dam is threatened by overtopping, the release of water from Somerset Dam is to be reduced at the risk of overtopping Somerset Dam in order to prevent the overtopping of Wivenhoe Dam.

10.3 Communications Failure

If communications are lost between the Flood Operations Centre and either dam, the officers in charge at each dam are to adopt the procedures set out below.

Wivenhoe Dam Emergency Procedure

In the event of communications loss with the Flood Operations Centre, the Dam Supervisor at Wivenhoe Dam is to assume responsibility for flood releases from the Dam. Once it has been established that communications have been lost, the Dam Supervisor at Wivenhoe Dam is to:-

- Take all practicable measures to restore communications and periodically check the lines of communication for any change;
- Follow the procedures set out below to determine the relevant magnitude and duration of releases from Wivenhoe Dam;
- Log all actions in the Event Log;
- Ensure the dam is at full supply level at the end of the event;
- Remain in the general vicinity of the dam while on duty.

Minimum gate openings are to be as set in the following table:

[redacted]

[redacted]

The minimum intervals between the opening and closing of the radial gates are shown in the table below. This requirement can be ignored to achieve the minimum openings in the table above when the dam level is greater than EL 74.0 or to protect the structural safety of the dam.

ITEM	MINIMUM OPENING INTERVAL	MINIMUM CLOSING INTERVAL
Radial Gates (Dam Level < EL 74.0)	10 mins	20 mins
Radial Gates (Dam Level > EL 74.0)	No Minimum	10 mins

Under extreme circumstances, the mechanical capability of the gate operating system allows the facility to open each radial gate more than five metres within a one hour period. Accordingly, unless a mechanical breakdown is experienced, physical gate opening capability in unlikely to be a constraint in meeting projected outflow targets. However in a loss of communications scenario, when extreme rises in lake level are being experienced, dam operators will have difficulty in continually matching minimum gate settings to lake level. Accordingly, in these circumstances when the dam level exceeds 74.0 AHD, it is permissible to estimate target dam levels one hour in advance, based on lake level rises in the previous hour and undertake gate operations on this basis.

In the event of a gate becoming jammed shut the remaining gates are to be operated to provide the required release. In the event of one or more gates becoming jammed in the partially or fully open position, the remaining gates are to be operated to provide the remaining required release. The gate rating table shown below along with the discharges contained in the tables above are to be used in these calculations.

The bulkhead gate is not to be used without the specific direction of the Duty Engineer. Under loss of communication circumstances, it is only to be used to prevent a situation occurring which could endanger the safety of the dam.

At the end of the event, the full supply level of the storage is to be achieved.

Somerset Dam Emergency Procedure

In the event of communications loss with the Flood Operations Centre, the Dam Supervisor at Somerset Dam is to assume responsibility for flood releases from the Dam. Once it has been established that communications have been lost, the Dam Supervisor at Somerset Dam is to:-

- Take all practicable measures to restore communications and periodically check the lines of communication for any change;
- Follow the procedures set out below to determine the relevant magnitude and duration of releases from Somerset Dam;
- Log all actions in the Event Log;
- Ensure the dam is at full supply level at the end of the event;
- Remain in the general vicinity of the dam while on duty.

The actions to be undertaken are:

- The radial gates are to be kept raised to allow uncontrolled discharge.
- The regulators are not to be used if the tail water level exceeds EL 68.60 and are generally kept closed. The only exception to this is if the regulators are used to prevent overtopping of the dam.
- The sluice gates are to be managed in accordance with the following procedures:
    - **Case 1 -** the level in Somerset Dam is below EL 100.45 **and** the level in Wivenhoe Dam is below EL 70.0 and falling; or
    - **Case 2 -** the level in Somerset Dam is above EL 100.45.

  These procedures are described below.

Case 1 Procedure (Level in Somerset Dam is below EL 100.45 and the level in Wivenhoe Dam is below EL 70.00 and falling)

If communications with Wivenhoe Dam are lost, the level in Wivenhoe Dam is to be assumed as the level shown on gauge boards located downstream of Somerset Dam.

Sluice gates are to be opened progressively at intervals of not less than 120 minutes, provided the number of open sluice gates does not exceed that shown in the following table based.

[redacted]

If the level in Wivenhoe Dam begins to rise at any time during this procedure, sluice gates are to be progressively closed in accordance with the following table. Additionally, once a sluice gate has been opened in accordance with this procedure, it must remain open for 180 minutes before being closed.

LOSS OF COMMUNICATIONS
CASE 1 PROCEDURE - TIMING GATE MOVEMENTS

GATE	OPENING INTERVAL	CLOSING INTERVAL
Regulators	Generally kept closed	Generally kept closed
Sluice Gate	120 mins	180 mins
Radial Gate	Gates to remain open	Gates to remain open

<u>Case 2 Procedure (Level in Somerset Dam is above EL 100.45)</u>

If communications with Wivenhoe Dam are lost, the level in Wivenhoe Dam is to be assumed as the level shown on the gauge boards located downstream of Somerset Dam.

The sluices gates are to be operated in accordance with the following graph:

[redacted]

Sluices are progressively closed at one hour intervals if operating above the Operating Target Line and progressively opened at one hour intervals if operating below the Operating Target Line. The aim is always to follow the Operating Target Line as closely as possible.

10.4 Equipment Failure

In the event of equipment failure the action to be taken is indicated in Appendix E for Wivenhoe Dam and Appendix F for Somerset Dam.

APPENDIX A
AGENCIES HOLDING CONTROLLED COPIES OF THIS MANUAL

Agency	Responsible Person	Location
Seqwater	Dam Safety and Source Operations Manager	Brisbane
Seqwater	Principal Engineer Dam Safety	Ipswich
Seqwater	Storage Supervisor	Wivenhoe Dam
Seqwater	Storage Supervisor	Somerset Dam
Seqwater	Operations Coordinator	Central
Seqwater	Senior Flood Operations Engineer	Flood Operations Centre, Brisbane
Department of Environment and Natural Resources	Director Dam Safety	Brisbane
Department of Emergency Services	Duty Officer – Disaster Management Service	Brisbane
Somerset Regional Council	Local Disaster Response Coordinator	Esk
Ipswich City Council	Local Disaster Response Coordinator	Ipswich
Brisbane City Council	Local Disaster Response Coordinator	Brisbane
Emergency Management Queensland	Regional Director, Brisbane District	Brisbane

APPENDIX B
KEY REFERENCE GAUGES

Location	Gauge Zero	1974 Gauge Height	Minor Flood		Moderate Flood		Major Flood	
			Gauge Height	Flow	Gauge Height	Flow	Gauge Height	Flow
	m AHD	m	m	m^3/s	m	m^3/s	m	m^3/s
Stanley River at Somerset Dam	0.00	106.57	103.0		105.0		106.0	
Brisbane River at Lowood	23.68	22.02	8.0	1,000	15.0	3,300	20.0	6,000
Brisbane River at Lowood	22.74	-	8.6		15.9		21.2	
Brisbane River at Savages Crossing	18.43	23.79	9.0		16.0		21.0	
Brisbane River at Mt Crosby	0.00	26.74	11.0		13.0		21.0	
Bremer River at Ipswich	0.00	20.70	7.0		9.0		11.7	
Brisbane River at Moggill	0.00	19.95	10.0	4,000	13.0	5,000	15.5	6,500
Brisbane River at Jindalee Bridge	0.00	14.10	6.0		8.0		10.0	
Brisbane River at City Gauge	0.00	5.45	1.7		2.6		3.5	

Flows are approximate only and gauge heights are tide dependent in the lower reaches.

APPENDIX C
WIVENHOE DAM TECHNICAL DATA

[redacted]

[redacted]

(1) This is the maximum discharge of an individual spillway bay or regulator. Total discharge is calculated by adding the contributions of each gate or regulator. There are two (2) regulators to five (5) spillway bays.

(2) This assumes that all gates and sluices are closed. Discharges through the spillway have to be added to the above figures to calculate the actual inflow into the reservoir.

(3) The temporary storage above normal Full Supply Level of EL 67.0.

(4) The first fuse plug is designed to trigger at EL75.7. Above this level, fuse plug flows from Table E.3 need to be added to give the full outflow.

[redacted]

[redacted]

* Flow impacted by bridge deck.

[redacted]

WIVENHOE DAM AUXILIARY SPILLWAY RATING TABLE

[redacted]

APPENDIX D
SOMERSET DAM TECHNICAL DATA

[redacted]

[redacted]

(1) This is the maximum discharge of an individual gate or regulator. Total discharge is calculated by adding the contributions of each gate or regulator.

APPENDIX E
WIVENHOE DAM GATE OPERATION CONSIDERATIONS

SPILLWAY OPERATION PRINCIPLES

The radial gates are sequentially numbered from 1 to 5 from left to right looking in the downstream direction. Plans of the dam and spillway are contained in Appendix H.

The flip bucket spillway is designed to control the discharge from the reservoir and to dissipate the energy of the discharge. The flip throws the discharge clear of the concrete structures into a plunge pool where the energy is dissipated by turbulence. Under non-symmetric flow conditions, or when gates 1 and 5 are not operating, the discharge jet may impinge on the walls of the plunge pool, which has been excavated into erodible sandstone rock, and cause non-predictable erosion. Upstream migration of this erosion is to be avoided. The wing walls adjacent to the flip bucket deflect the discharge away from the walls of the plunge pool when gates 1 and 5 are operated.

Therefore in operating the spillway, the principles to be observed are, in order of priority:

(i) The discharge jet into the plunge pool is not to impinge on the right or left walls of the plunge pool.

(ii) The flow in the spillway is to be generally symmetrical.

The main purpose of gating the spillway is to exercise maximum possible control over the flow in the Brisbane River insofar as river flows in excess of 4,000 m^3/s cause damage to urban areas downstream. The gates also allow the routing of much larger floods with substantial flood mitigation being achieved.

RADIAL GATE OPERATION PRINCIPLES

Each radial gate consists of a cylindrical upstream skin-plate segment that is attached to the radial arms. The cylindrical axis is horizontal. Each gate rotates about two spherical trunnion bearings that are on this axis.

The position of the gate is controlled by hydraulically driven winches that are located on the piers beside the gates. Wire ropes are attached to the downstream face of the skin plate through a pulley system. The hydraulic motors work off a common pressure manifold and under perfectly matched conditions, will give an equal lifting force to each side of the gate. This system does not sense rope travel and will take up slack rope. It cannot prevent or correct skewing of the skin plate segment between the piers. If skewing occurs, skids will come into contact with the side seal plates to limit movement.

It is not possible to operate a winch independently of the other winch attached to the gate.

When the hydraulic motors are not energised, the gates are held in position by spring loaded friction brakes on the winches. There are two brake bands per winch and each band is capable of supporting half the weight of the gate. One winch can support the total weight of a gate on both its brake bands but not on one.

While the radial gates have been designed to withstand overtopping, it should be avoided if possible. The reservoir levels and the structural state of the radial gates when in the closed position are as follows:

Reservoir Level m AHD	Radial Gate Stress Condition with Gate Closed
73	Normal
77	33% Overstress
79	Critical

Once overtopped, the gates become inoperable when the lifting tackle is fouled by debris from the overflow. The gates remain structurally secure until the reservoir level exceeds EL 77. The ability to control floods however may be lost.

FREE FALL OF THE RADIAL GATES

Under no circumstances are the radial gates allowed to free fall. The lower skin plate sections are overstressed if a freefall of 60 mm is arrested by the seal plate on the spillway.

If a gate becomes stuck in an open position, attempts are to be made to free the gate by applying positive lifting forces. Under no circumstances are the winches to be unloaded and the direct weight of the gates used to yield the obstruction.

OPERATION IN HIGH WIND

Other than in periods of mitigation of medium and major floods, the gates are not to be raised or lowered when clear of water, during periods of high winds. The gates can however, be held on the brakes in any position in the presence of high wind.

The term "high wind" means any wind that causes twisting or movement of the gate. While a precise figure cannot be placed on these velocities, further experience over time may allow a figure to be determined.

This limitation is required to prevent the gate from twisting from skew on one side to skew on the other side. While the gate is being raised or lowered, skewing cannot be prevented by the hydraulic lifting system and any impact forces encountered may damage the gate.

MAINTENANCE CONSIDERATIONS

No more than one gate is to be inoperable at any one time for maintenance. The maintenance is to be scheduled so that the spillway bay can be cleared of obstructions in a reasonable time to allow its use in the event of major flooding.

BULKHEAD GATE OPERATING LIMITATIONS

The bulkhead gate can be used to control discharge in an emergency situation where a radial gate is inoperable. It is transported to, and lowered upstream of the inoperable radial gate by means of the gantry crane. The following conditions apply:

(a) The bulkhead gate can always be lowered with any type of underflow; and

(b) It is not possible to raise the bulkhead gate once it has been lowered past certain levels depending on upstream conditions without there being a pool of water between it and the radial gate.

It is thus possible to preserve storage by effectively closing the spillway even with one radial gate inoperable. It will not be possible to raise the bulkhead gate until the radial gate behind has been repaired and is again storing water between the bulkhead gate and itself.

The bulkhead gate is not to be used for flood regulation until the reservoir level is falling and not likely to rise within the period needed to repair the inoperable radial gate.

The spillway gantry crane is to be used to raise and lower the bulkhead gate. The crane operates at two speeds, 1.5 and 3.0 m/min. When within the bulkhead gate guides, the bulkhead gate is to be moved only at 1.5 m/min.

BULKHEAD GATE OVERTOPPING

In the event that the bulkhead gate is overtopped (reservoir level exceeds EL 69 when bulkhead gate is closed), it cannot be removed unless a pool of water fills the space between it and the radial gate behind. The closed bulkhead becomes critically stressed when the reservoir level overtops it to EL 71.4.

It is not possible to engage the lifting tackle while overtopping is occurring. While there is any risk that the bulkhead gate may be overtopped, the lifting gear is to be left engaged so that the gate can be raised once the downstream radial gate becomes operable.

BULKHEAD GATE DISCHARGE REGULATION

This procedure should only be used if the safety of the dam is at direct risk.

In the event that a radial gate is inoperable in a partially open position, the bulkhead gate can be used for flow regulation provided that the lower lip of the radial gate is clear of the underflow jet.

Where a pool exists between the bulkhead gate and a radial gate under flow conditions, the bulkhead gate will be subjected to additional pull-down and possibly subjected to vortex-induced vibrations. When this condition occurs, the bulkhead gate is to be lowered to dewater the pool. The bulkhead gate can then be adjusted to regulate the flow provided the underflow jet remains below the lower lip of the radial gate.

INOPERABLE RADIAL GATES

In the event of a major flood, where the full discharge capacity of the four operable radial gates is required, these gates are to be used to their full capacity to protect the embankment from overtopping. Under certain abnormal conditions, it may not be possible to operate one gate. The following guidelines are to be adopted.

(a) Gate 3 Inoperable

Gates 2 and 4 are to be used to regulate flood discharges, until the discharge impinges on the walls of the plunge pool. Gates 1 and 5 are then to be opened sufficiently to deflect the discharge into the plunge pool.

The bottoms of gates 1 and 5 are to be maintained at or below those of gates 2 and 4 respectively.

(b) Either Gate 2 or 4 Inoperable

Normal gate operating procedures are to be adopted, except that only the operable gate 2 or 4 is available for flood regulation beyond 500 m^3/s and not both.

(c) Either Gate 1 or 5 Inoperable

Normal gate operating procedures are to be adopted until the discharge impinges on the walls of the plunge pool. Thereafter the operable gate 1 or 5 is to be used in lieu of using the radial gate adjacent to the inoperable gate. The other radial gates are to be used in the normal way to control discharge.

EQUIPMENT MALFUNCTION

Normal gate operation is by means of two electric hydraulic pumps supplied by external mains supply electric power, with pump number 1 connected to gates 1 and 2 and the penstock gate, while pump number 2 is connected to gates 3, 4 and 5.

Normal gate operation may not be possible in the event of equipment malfunctions during the passing of a flood. The procedures to be followed under various possible events are outlined below.

Failure of External Electric Power

A diesel electric generator is used to provide a power supply. The generator supplies sufficient power to operate the gates normally.

Failure of One Electric Hydraulic Pump

In the event that one electric hydraulic pump fails, the connecting valves between pumps are to be switched such that both sets of hydraulic lines are connected to the operable pump, thus permitting operation of all 5 gates, one gate at a time.

Failure of Two Electric Hydraulic Pumps

In the event that both electric hydraulic pumps fail, either the mobile or fixed emergency diesel hydraulic pump is to be used to operate the gates, one gate at a time.

Rupture of Hydraulic Lines

Depending on location and severity, a hydraulic line rupture may cause a radial gate to become inoperable. Accordingly any ruptures to the hydraulic lines are to be repaired as soon as practical. Depending on the location of the rupture, it may be possible to use the mobile emergency diesel hydraulic pump to operate the impacted gate.

Contamination of Winch Brakes

Oil contamination of the winch brakes will reduce their holding capacity and possibly allow the gate to fall. The brake bands are to be inspected regularly and cleaned immediately if any contamination is observed.

Fouling of Radial Gate Lifting Tackle

The lifting tackle consists of blocks, wire ropes and winch drums. If the gate is overtopped, debris may be collected on the wire ropes that may in turn foul the blocks or the winch drums. This may result in jamming of the wire rope or in uneven lifting, both of which may cause the gate to jam.

Fouling of Side Skids

The side skids have been designed to limit the side-sway and skew of the radial gates during operation. Under ideal conditions, the skids should not be in contact with the side seal plates.

If the winches are lifting the gates unevenly or in a skewed position, the lifting gear should be adjusted if possible.

APPENDIX F
SOMERSET DAM AUXILIARY EQUIPMENT

DISCHARGE REGULATION

The normal operating procedure for Somerset Dam in the event of a flood requires the spillway gates to be raised to provide an uncontrolled spillway followed by opening of the low level outlets some time later. Plans of the dam and spillway are contained in Appendix I.

EMERGENCY POWER SUPPLY

In the event of a power failure at Somerset Dam, both a fixed and a mobile diesel generator are available to operate the regulators, sluice gates and radial gates. The fixed generator can also power the crane. A mobile auxiliary generator is also available for emergency operation of the regulators and gates.

FAILURE OF SPILLWAY GATES MACHINERY

If a spillway gate cannot be raised due to failure of the lifting machinery, the gantry crane may be attached to the gate and the gate can be raised using the gantry crane.

FAILURE OF SLUICE GATE MACHINERY

In the event of a sluice gate being jammed in the open position or the lifting machinery failing, the coaster gate at the dam can be lowered over the inlet to the sluice to preserve the water supply storage.

APPENDIX G
HYDROLOGIC INVESTIGATIONS

The design hydrology for the Manual is based on the design hydrology undertaken in September 2005 in conjunction with the flood discharge capacity upgrade of Wivenhoe Dam. This work was undertaken by the Wivenhoe Alliance, the group responsible for undertaking the upgrade work. (Wivenhoe Alliance, Design Discharges and Downstream Impacts of the Wivenhoe Dam Upgrade Q1091, Sep 2005)

Floods in the Brisbane River catchment above Wivenhoe Dam can originate in either the Stanley River or upper Brisbane River catchment or both. Both of the dams are capable of being operated in a number of ways, each of which will reduce the flow downstream. Indicative inflows for the dams for 48 hour storm events (the critical duration for Wivenhoe Dam) are shown in the graph below. Full results containing inflows for a range of storm events and durations are contained in the Alliance reports.

[redacted]

APPENDIX H
WIVENHOE DAM
PLANS, MAPS AND PHOTOGRAPH

Somerset-Wivenhoe Interaction Study

Terry Malone & John Tibaldi

October 2009

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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.

[redacted]

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.

[redacted]

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	24 Hour		36 Hour		48 Hour		72 Hour	
(1 in Y)	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

[redacted]

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

[redacted]

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

[redacted]

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.

[redacted]

Figure 6-1: Recommended Operating Target Line

References

(DNR 1993) Department of Natural Resources, *Brisbane River Flood Hydrology Report, Design Flood Estimation for Somerset and Wivenhoe Dam,* Main Report, Volume I, Mar 1993.

(NRW 2007) Department of Natural Resources and Water, *Guidelines for the Acceptable Flood Capacity of Dams,* February 2007

(Seqwater 2009a) Seqwater, *Emergency Action Plan for Somerset Dam,* Oct 2009.

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

(Seqwater 2009c) Seqwater, *Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam*, (Draft), Oct 2009.

(Seqwater 2009d) Seqwater, *Somerset Dam – Design Flood Hydrology*, (Draft), Oct 2009.

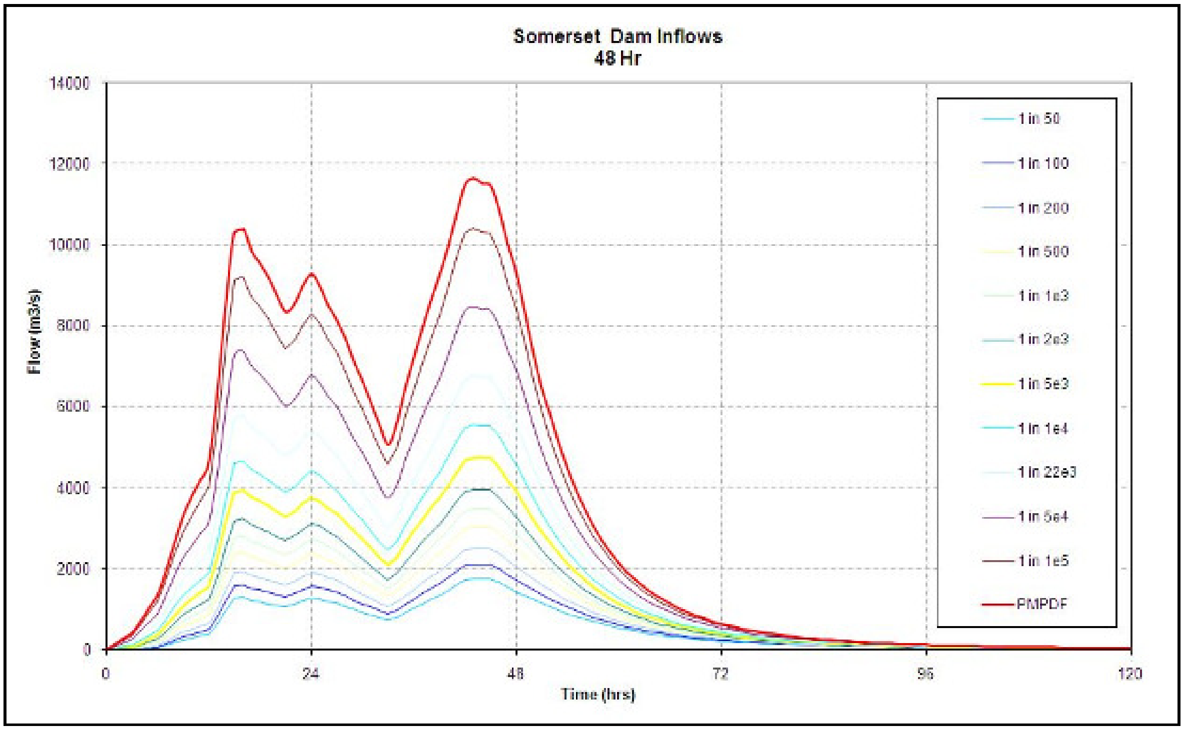
(NSW Commerce 2005) NSW Department of Commerce, *Somerset Dam – Stability of Abutment Monoliths,* Report No DC 05099, May 2005.

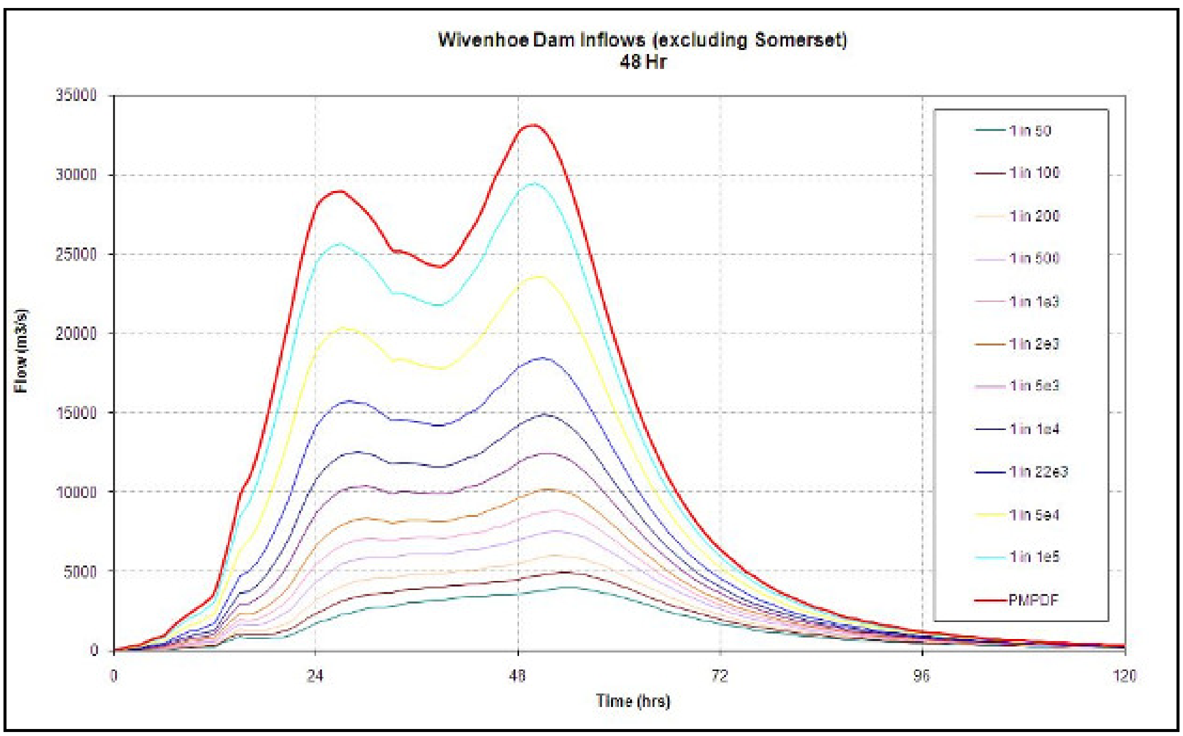
(Wivenhoe Alliance 2004) Wivenhoe Alliance, *Somerset Dam – Maximum Flood Level Estimates for Various Gate Operation Scenarios,* Q1091, Feb 2004.

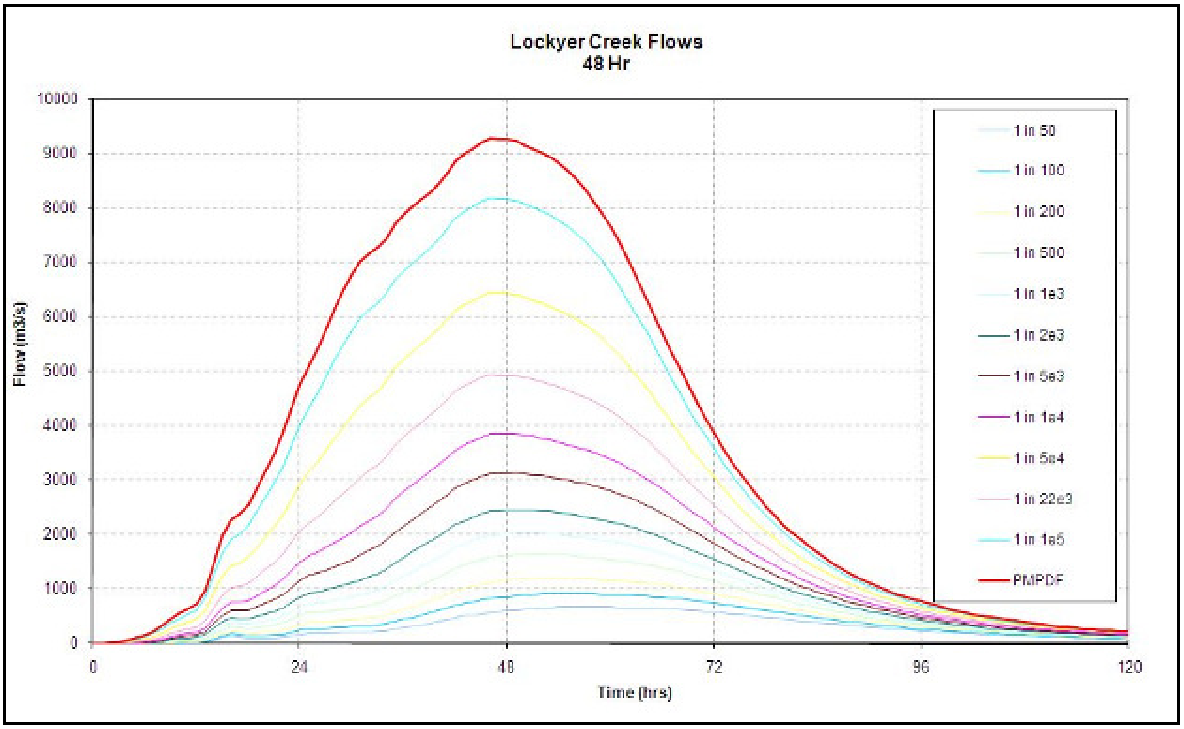
(Wivenhoe Alliance 2005) Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Dam Upgrade,* Q1091, Sep 2005.

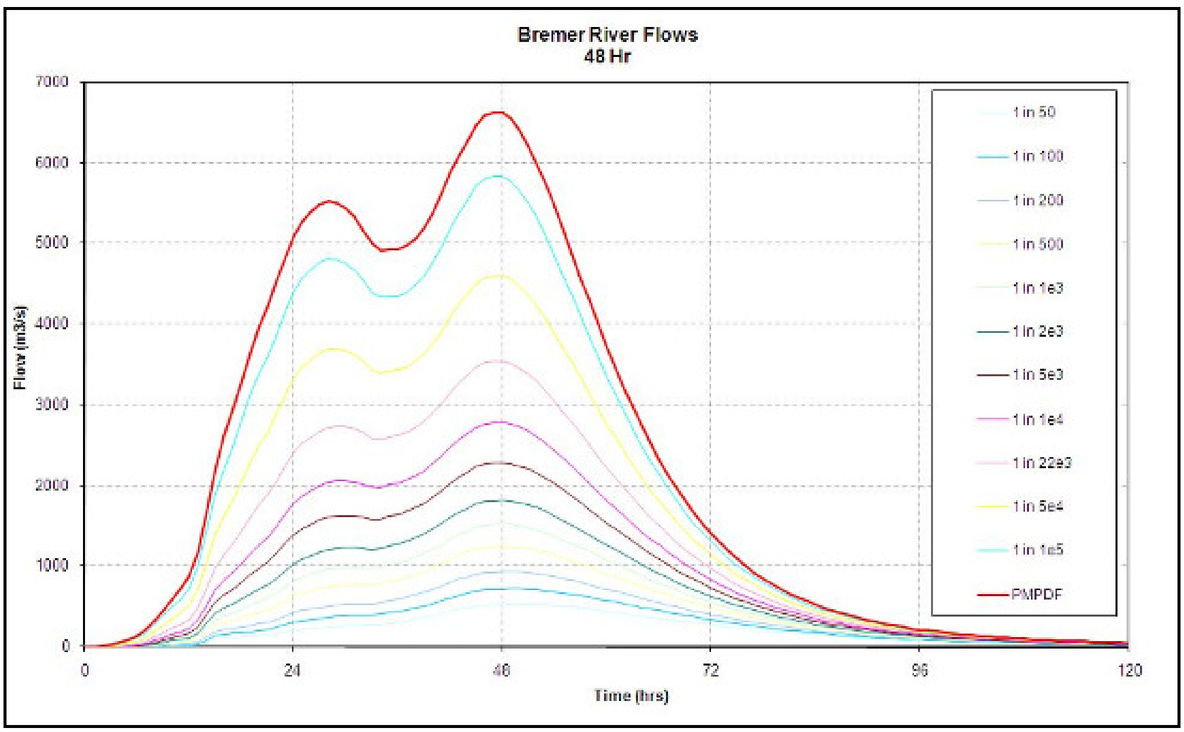
Appendix A

Wivenhoe Centred Design Flows

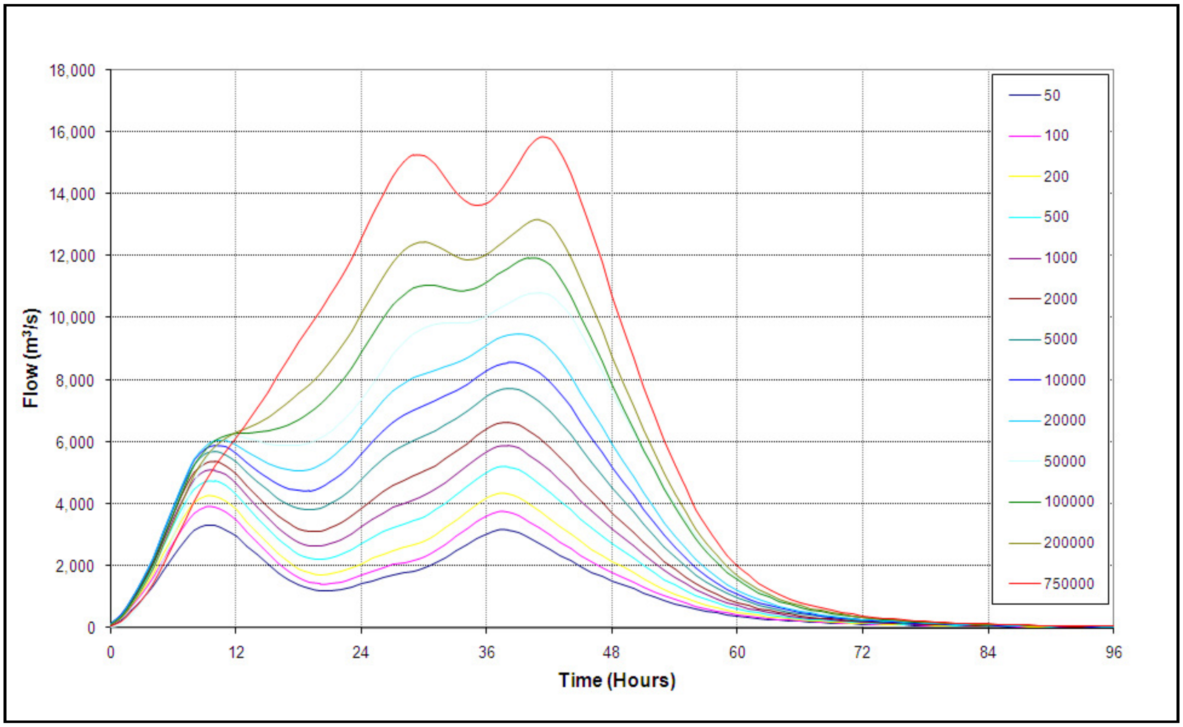





Lockyer Creek Flows
48 Hr
Flow (m3/s)
Time (hrs)
1 in 50
1 in 100
1 in 200
1 in 500
1 in 1e3
1 in 2e3
1 in 5e3
1 in 1e4
1 in 5e4
1 in 22e3
1 in 1e5
PMPDF


Bremer River Flows
48 Hr
Flow (m3/s)
Time (hrs)
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



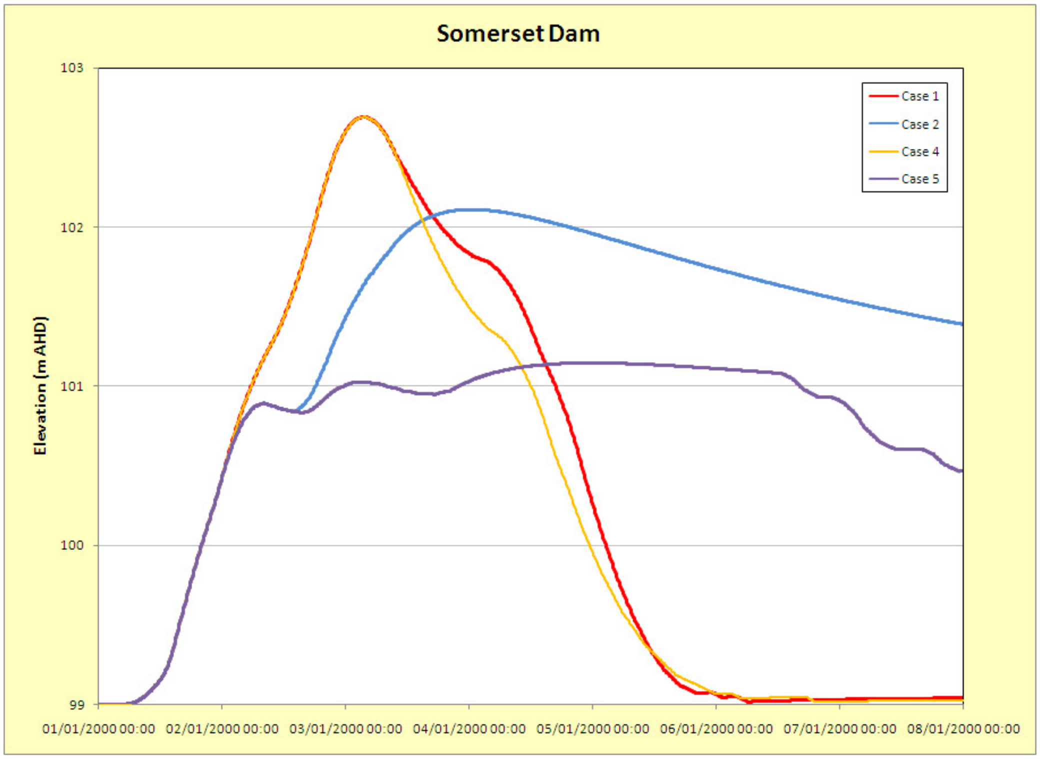
Appendix B

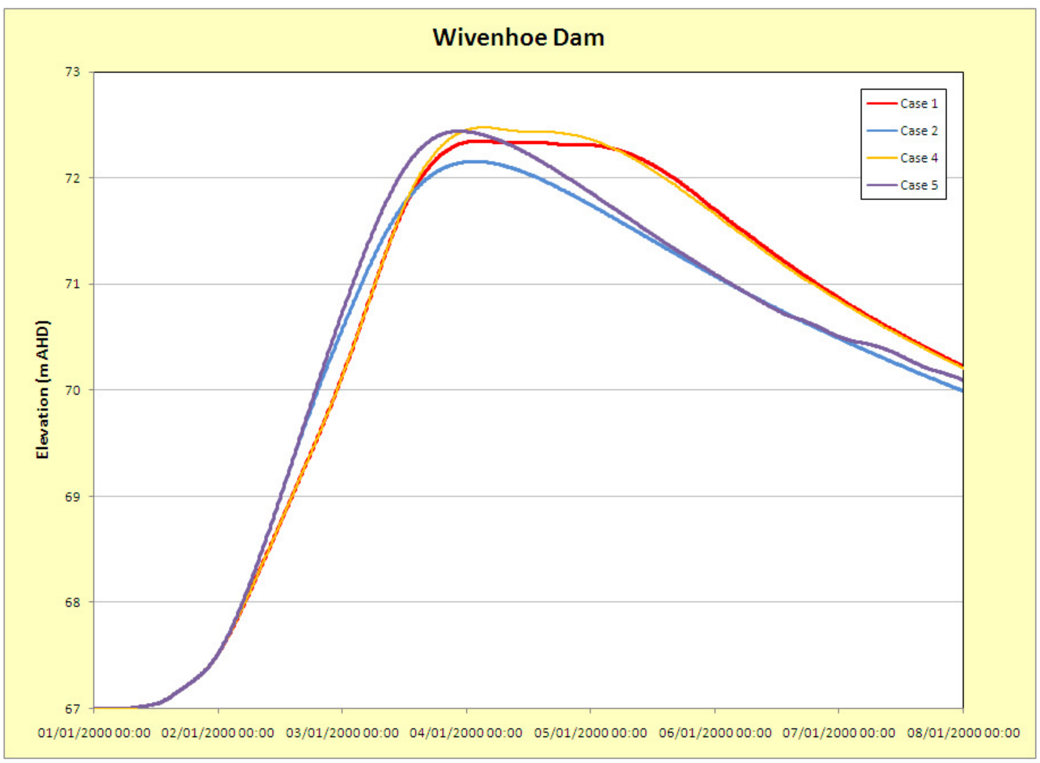
Wivenhoe Centred Results

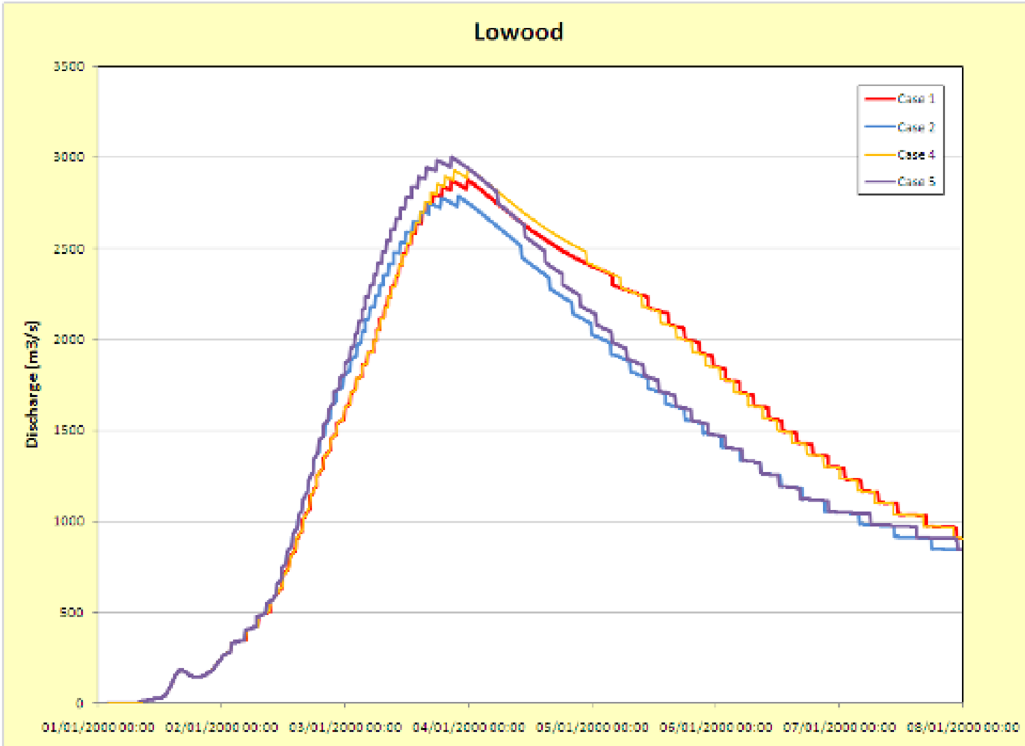
1 in 100 AEP

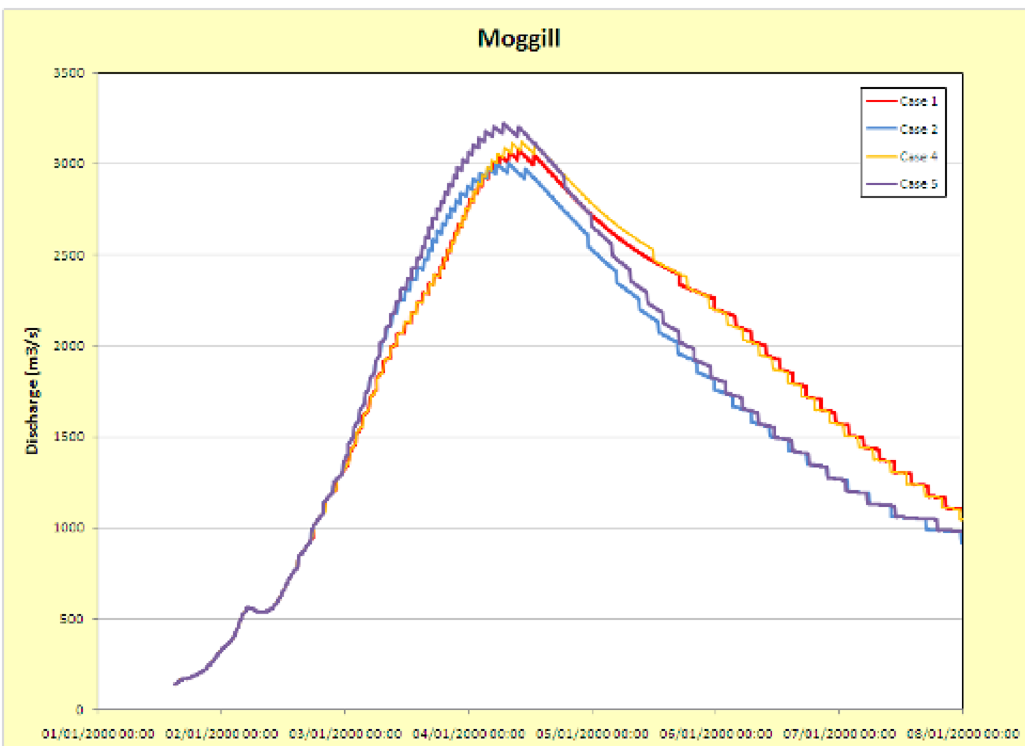
Item	Unit	Wivenhoe Operating Level			
		67.0 m AHD		68.5 m AHD	
		Somerset Operating Level		Somerset Operating Level	
		102.25	100.45	102.25	100.45
		Case 1	Case 2	Case 4	Case 5
Somerset Peak Elevation	m AHD	102.69	102.11	102.69	101.15
Wivenhoe Peak Elevation	m AHD	72.35	72.15	72.48	72.44
Lowood Peak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

[redacted]


Somerset Dam
Elevation (m AHD)
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)
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

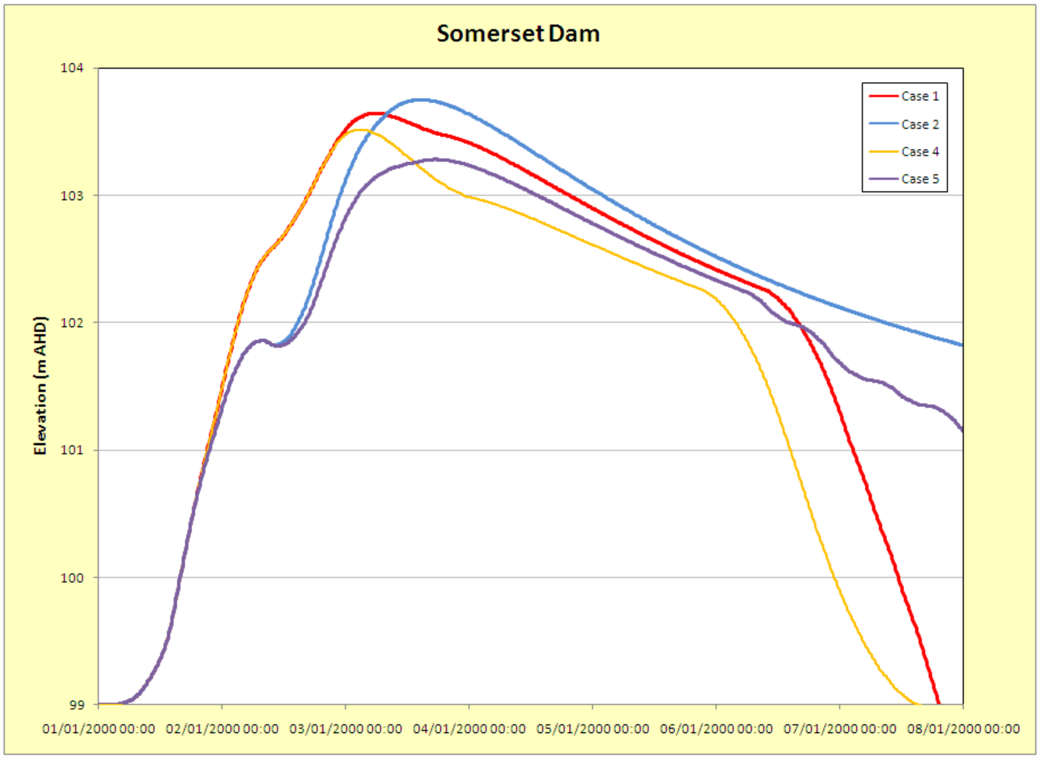

Lowood
Discharge (m3/s)
3500
3000
2500
2000
1500
1000
500
0
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00
Case 1
Case 2
Case 4
Case 5

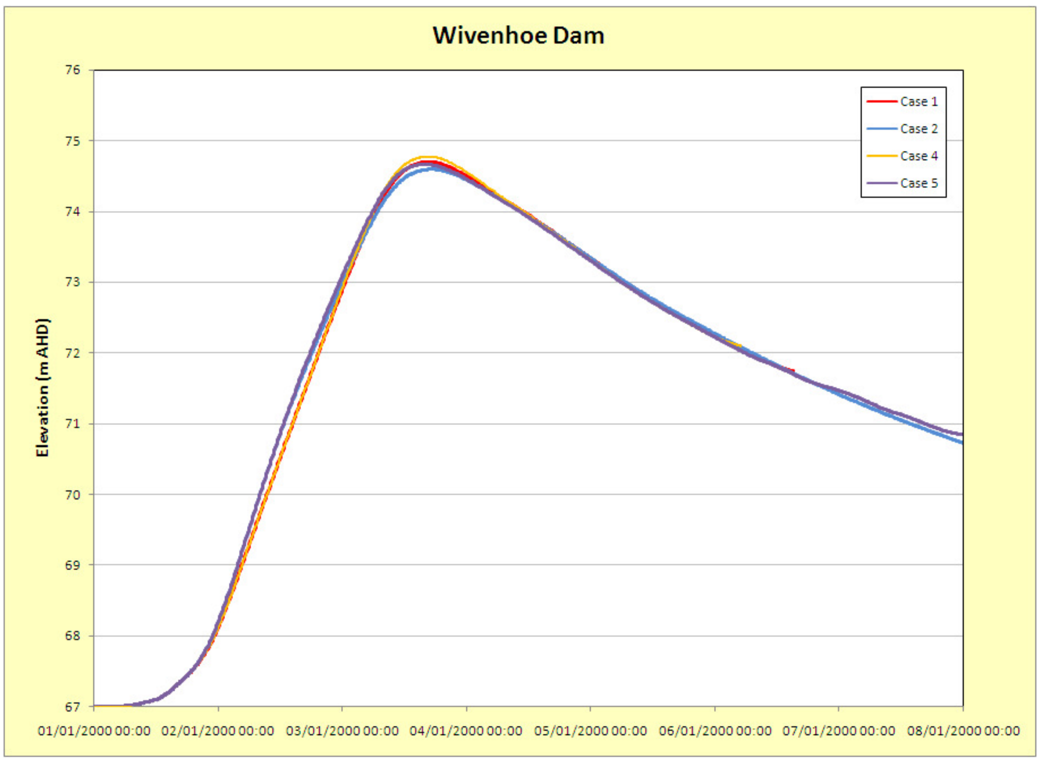

Moggill
Discharge (m3/s)
3500
3000
2500
2000
1500
1000
500
0
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00
Case 1
Case 2
Case 4
Case 5

1 in 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

[redacted]


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
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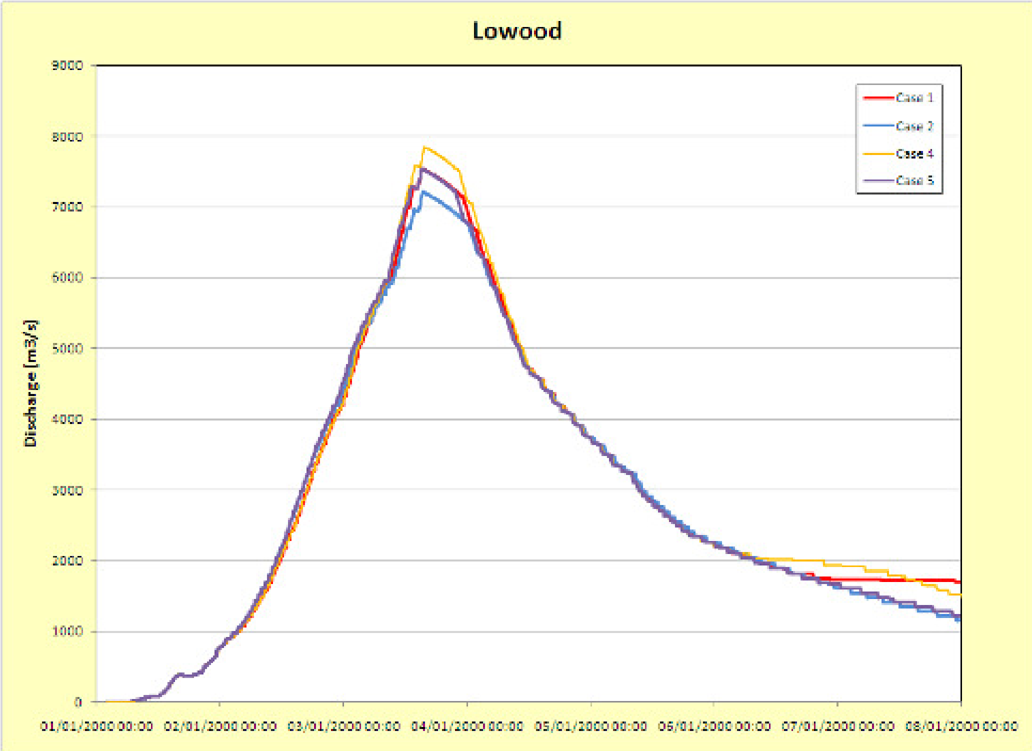
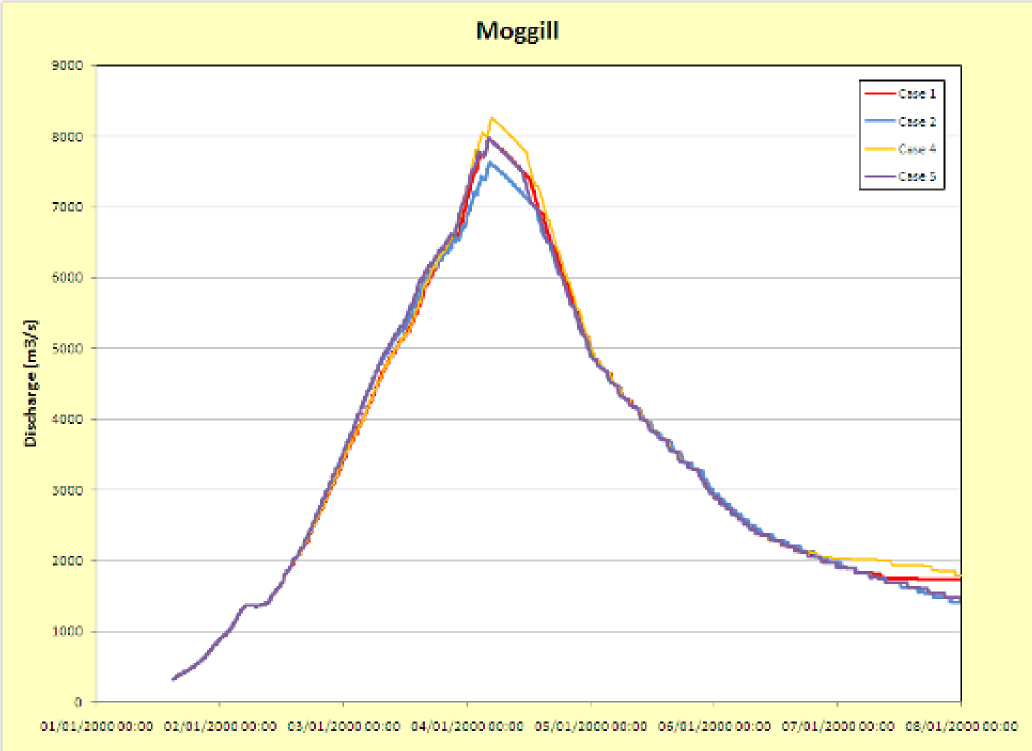
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00

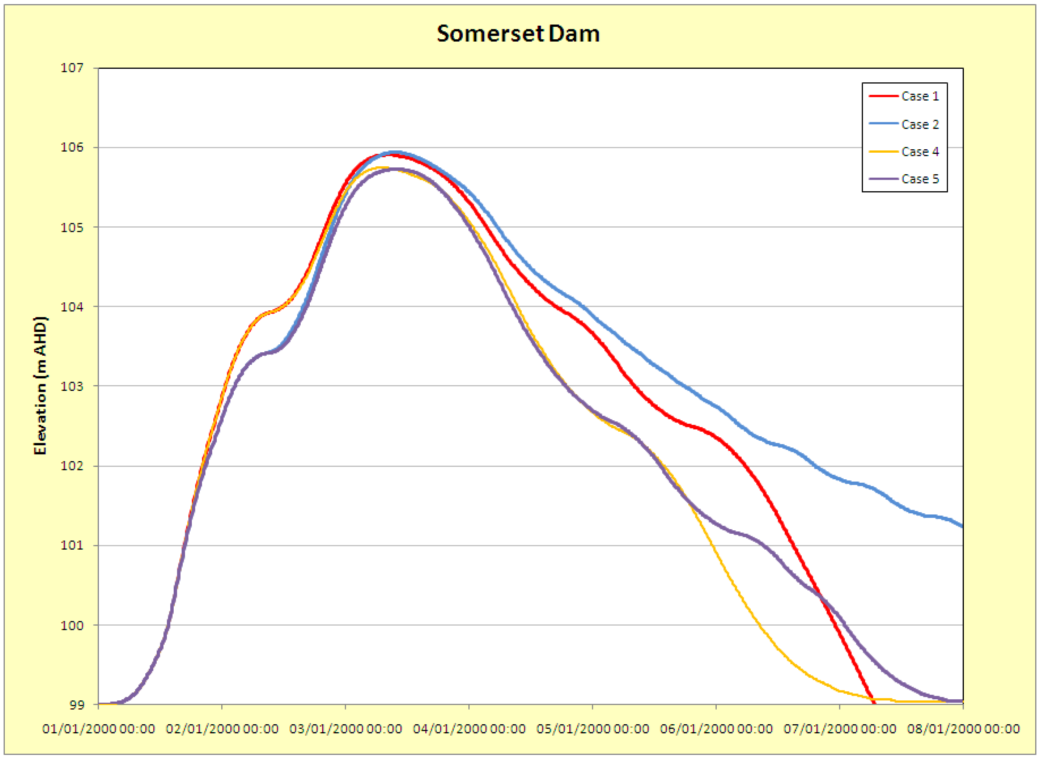

Lowood
Discharge (m3/s)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00
Case 1
Case 2
Case 4
Case 5

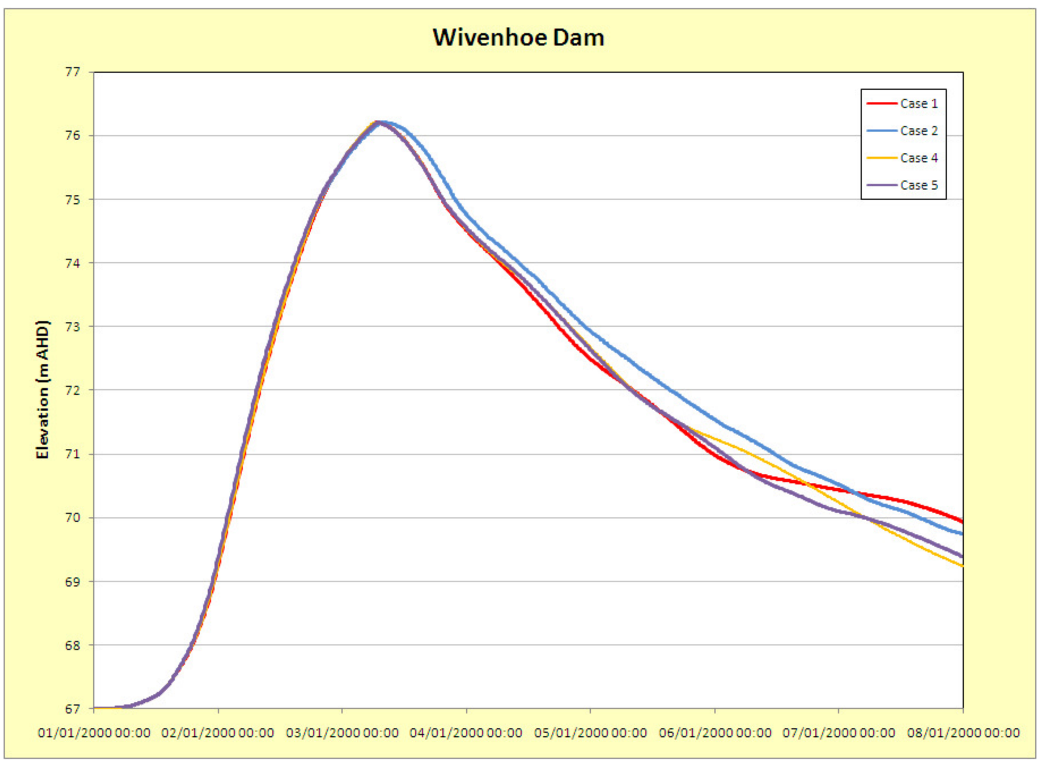

Moggill
Discharge (m3/s)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00
Case 1
Case 2
Case 4
Case 5

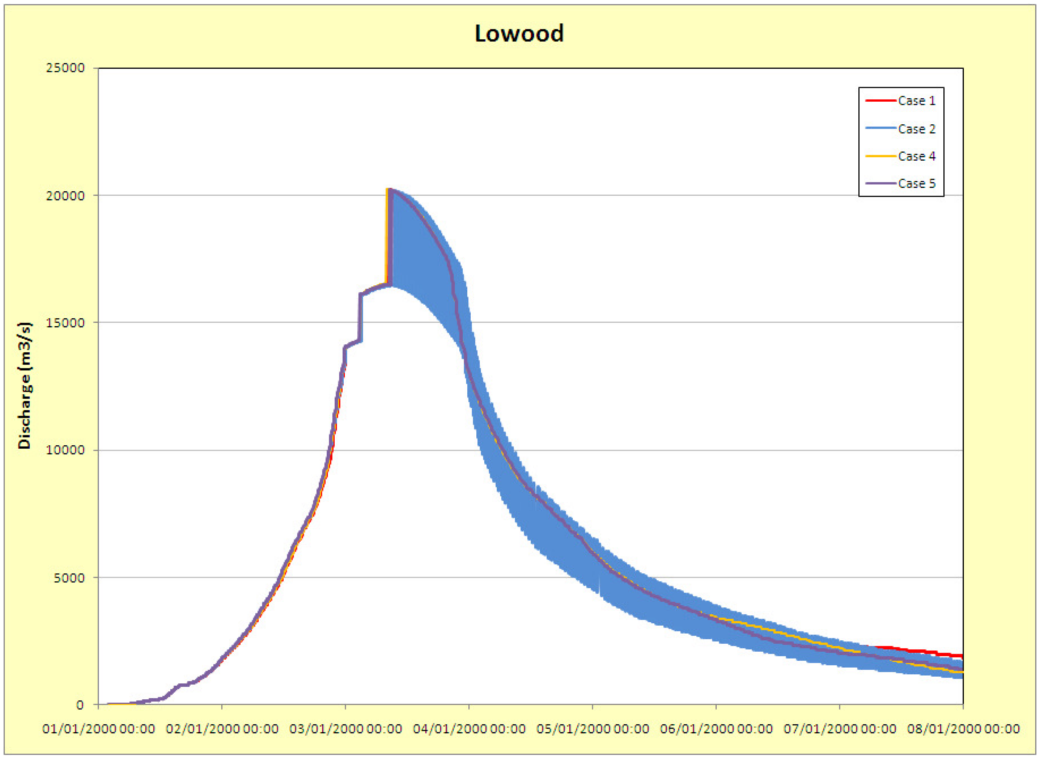
1 in 10,000 AEP

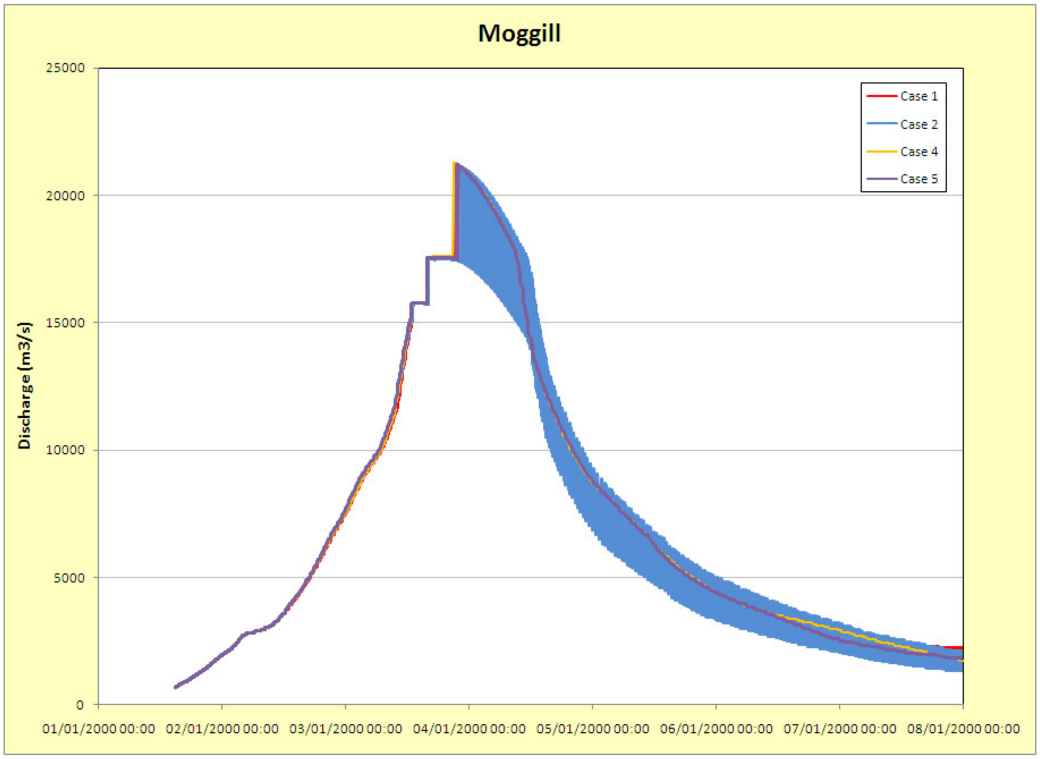
Item	Unit	Wivenhoe Operating Level			
		67.0 m AHD		68.5 m AHD	
		Somerset Operating Level		Somerset Operating Level	
		102.25	100.45	102.25	100.45
		Case 1	Case 2	Case 4	Case 5
Somerset Peak Elevation	m AHD	105.91	105.94	105.75	105.72
Wivenhoe Peak Elevation	m AHD	76.21	76.20	76.20	76.21
Lowood Peak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

[redacted]


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


Wivenhoe Dam
Elevation (m AHD)
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

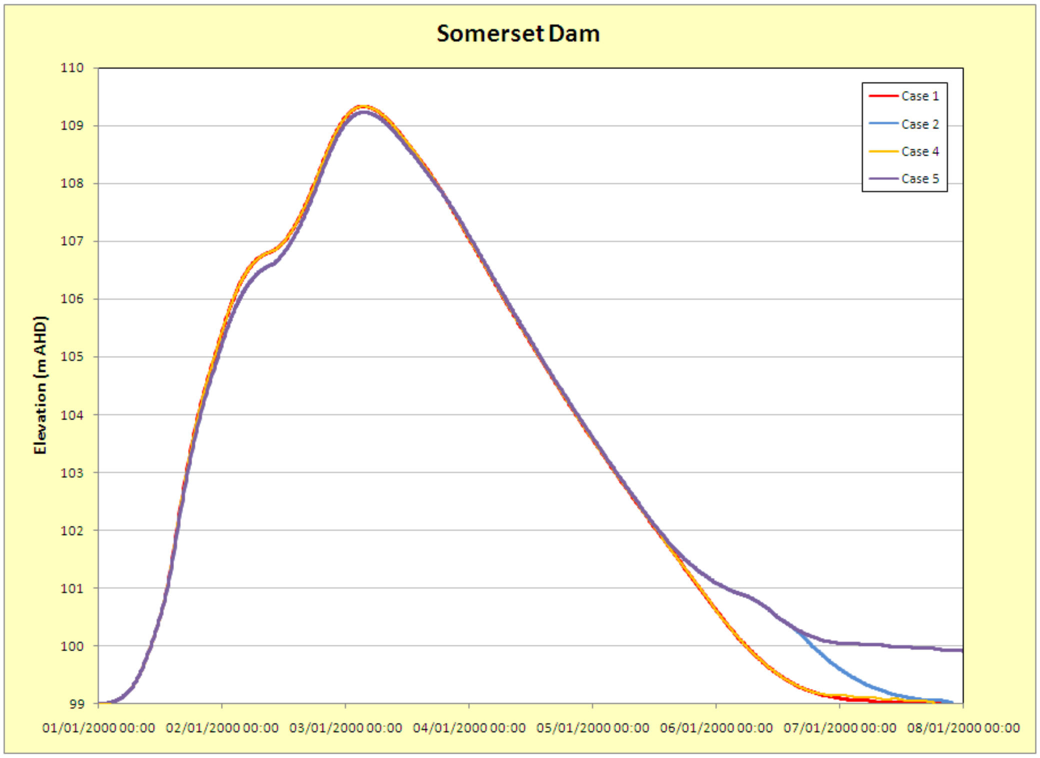

Lowood
Discharge (m3/s)
25000
20000
15000
10000
5000
0
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00
Case 1
Case 2
Case 4
Case 5

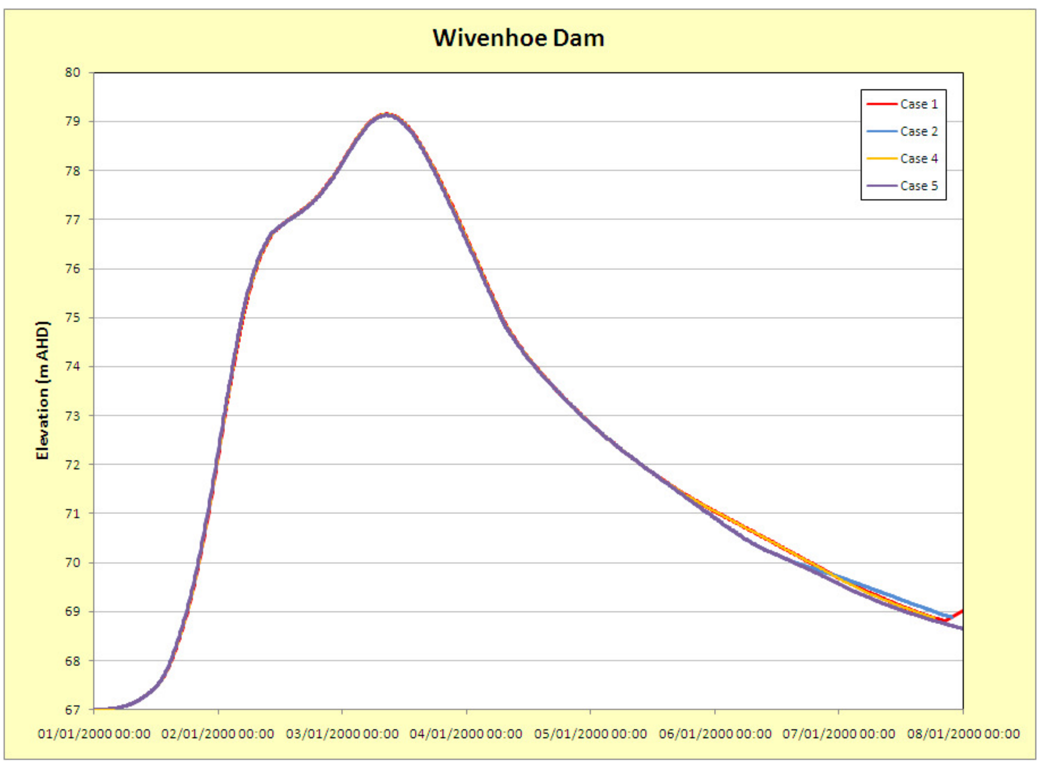

Moggill
Discharge (m3/s)
25000
20000
15000
10000
5000
0
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00
Case 1
Case 2
Case 4
Case 5

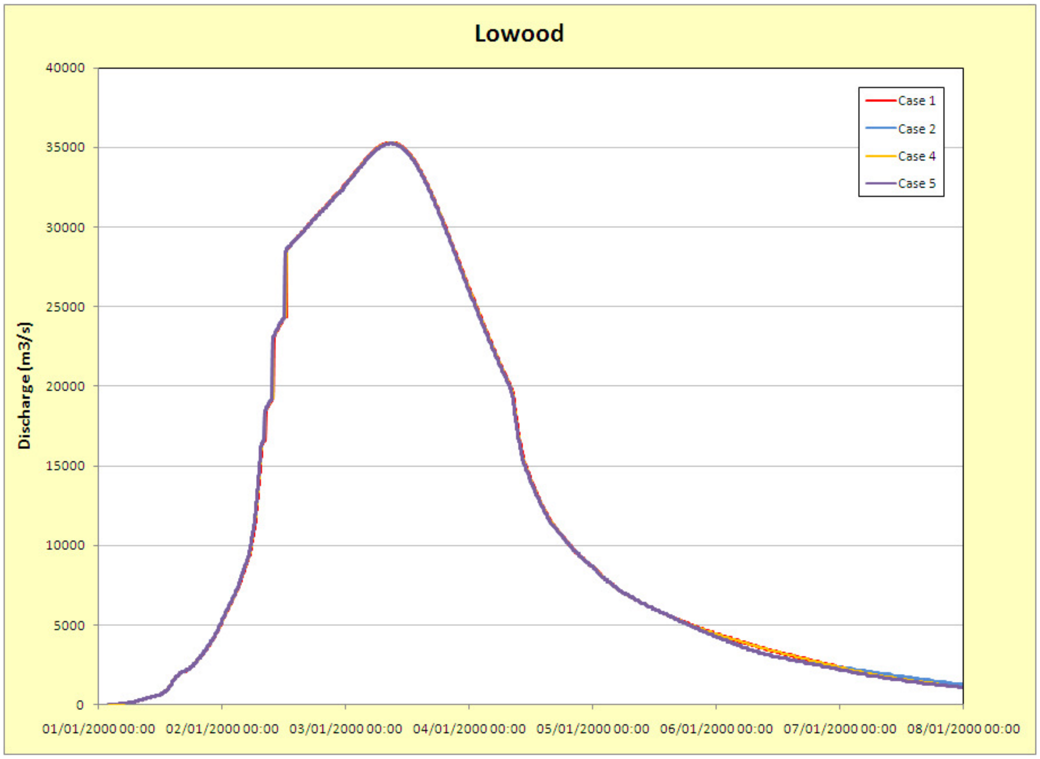
1 in 100,000 AEP

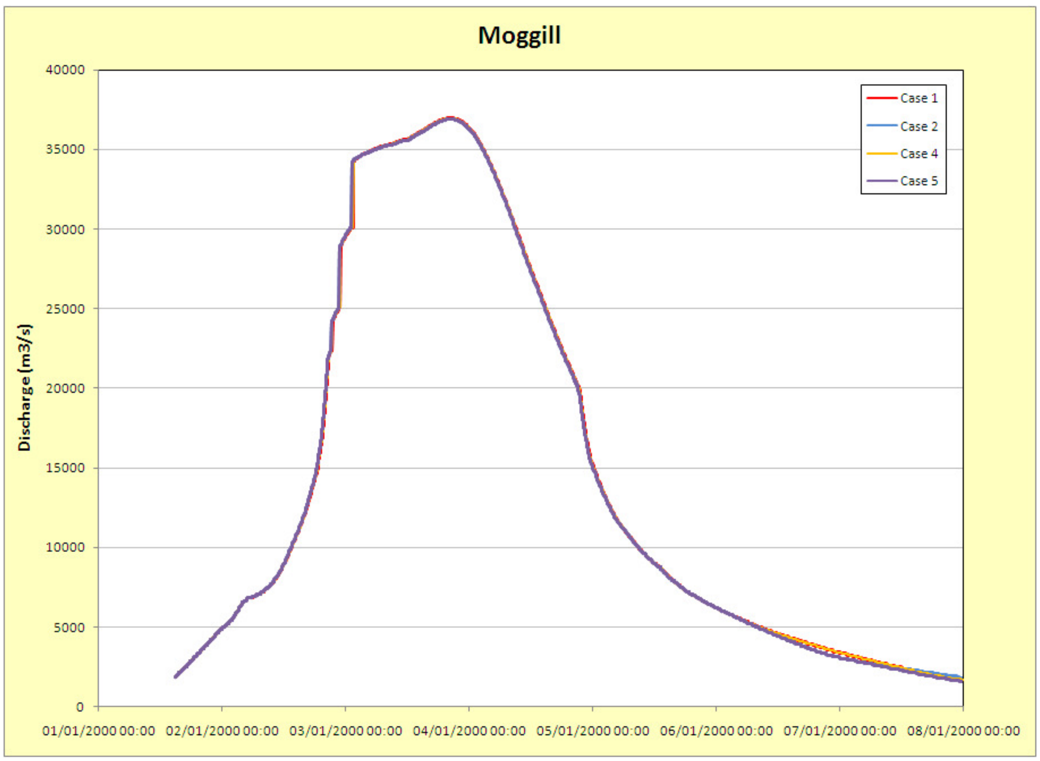
Item	Unit	Wivenhoe Operating Level			
		67.0 m AHD		68.5 m AHD	
		Somerset Operating Level		Somerset Operating Level	
		102.25	100.45	102.25	100.45
		Case 1	Case 2	Case 4	Case 5
Somerset Peak Elevation	m AHD	109.33	109.23	109.33	109.23
Wivenhoe Peak Elevation	m AHD	79.15	79.12	79.15	79.12
Lowood Peak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

[redacted]


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

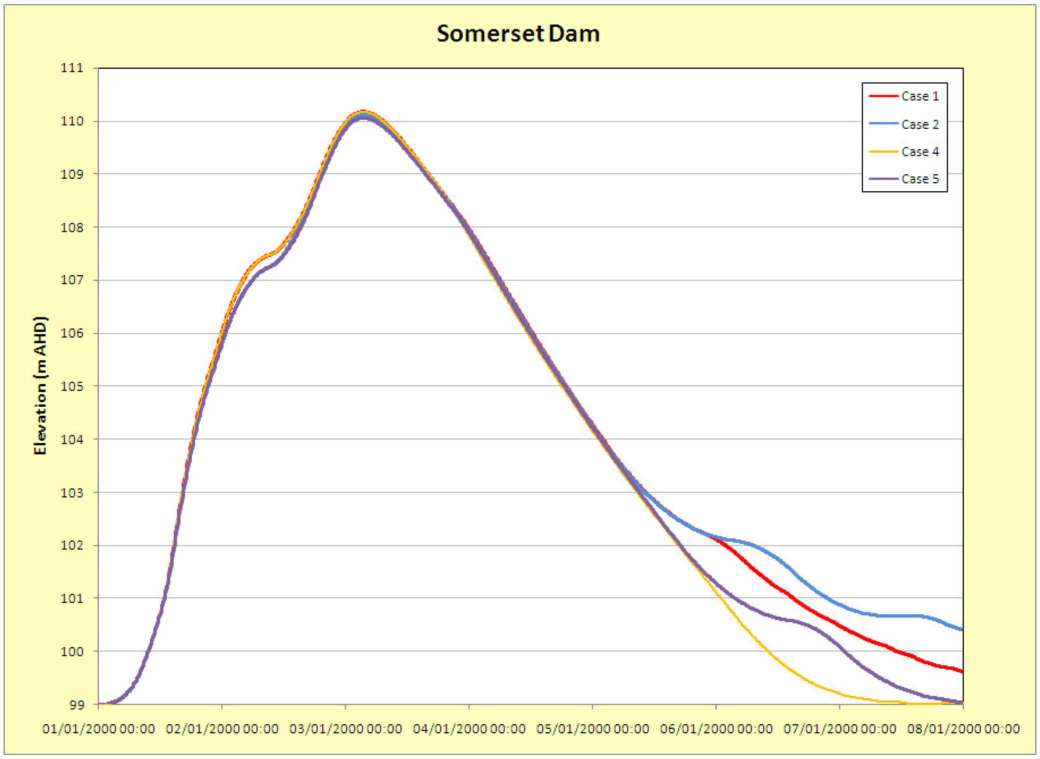

Lowood
Discharge (m3/s)
40000
35000
30000
25000
20000
15000
10000
5000
0
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00
Case 1
Case 2
Case 4
Case 5

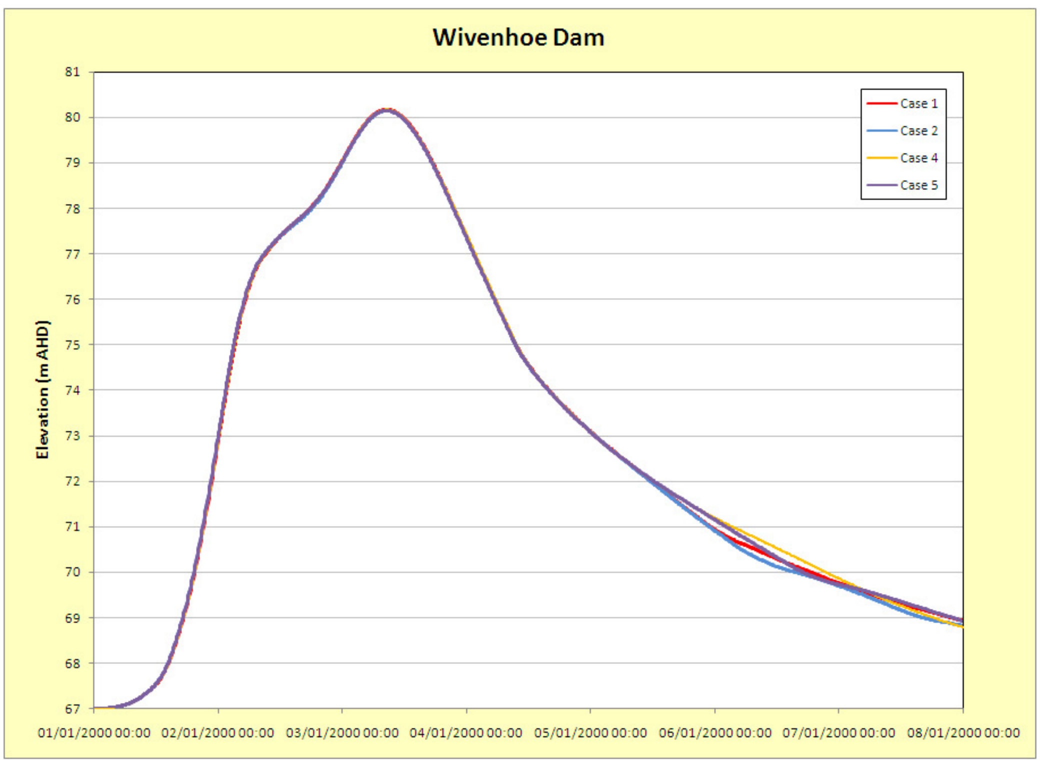

Moggill
Discharge (m3/s)
40000
35000
30000
25000
20000
15000
10000
5000
0
01/01/2000 00:00
02/01/2000 00:00
03/01/2000 00:00
04/01/2000 00:00
05/01/2000 00:00
06/01/2000 00:00
07/01/2000 00:00
08/01/2000 00:00
Case 1
Case 2
Case 4
Case 5

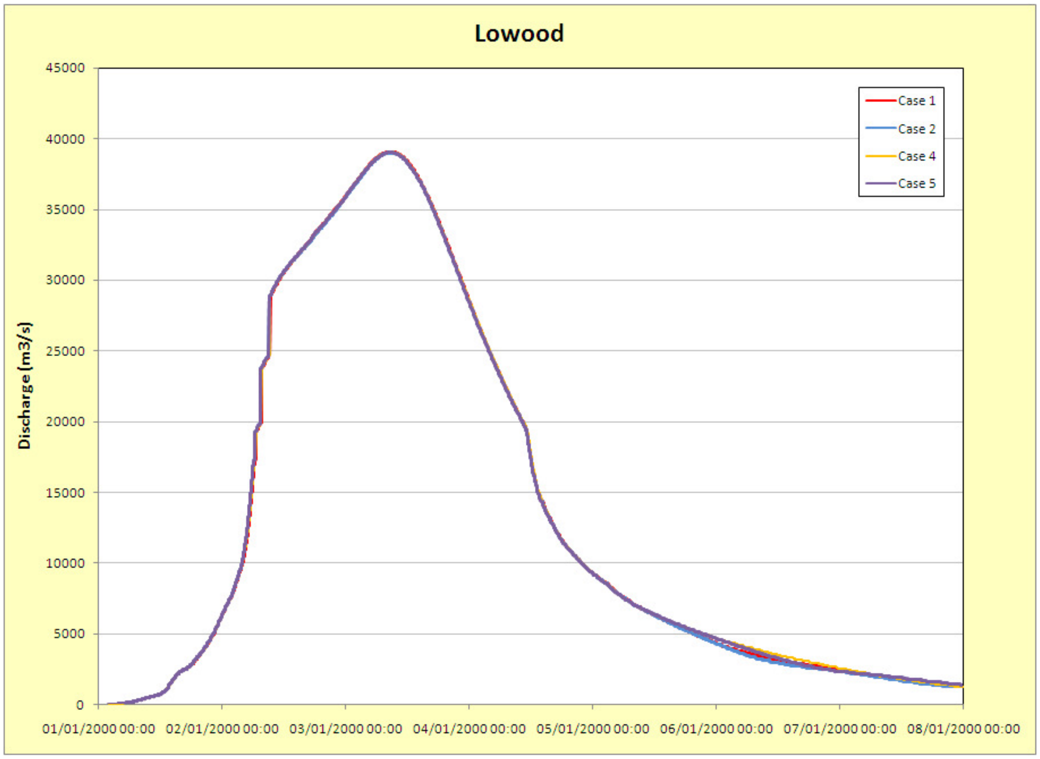
1 in 143,000 AEP

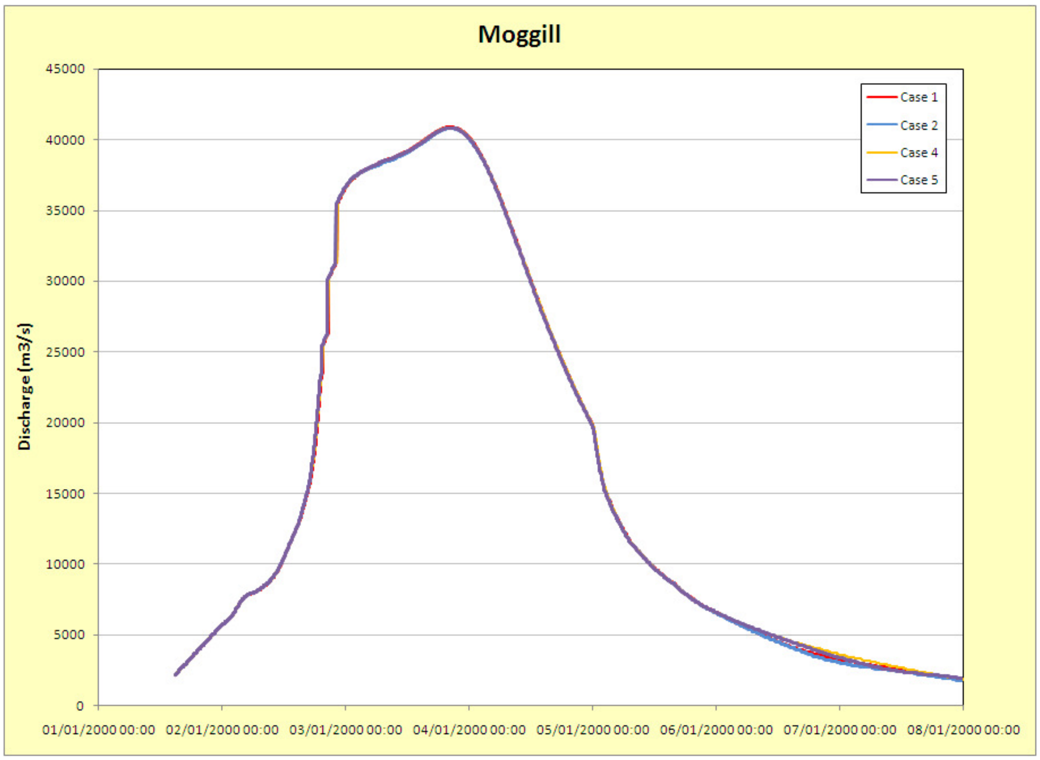
Item	Unit	Wivenhoe Operating Level			
		67.0 m AHD		68.5 m AHD	
		Somerset Operating Level		Somerset Operating Level	
		102.25	100.45	102.25	100.45
		Case 1	Case 2	Case 4	Case 5
Somerset Peak Elevation	m AHD	110.17	110.12	110.17	110.05
Wivenhoe Peak Elevation	m AHD	80.17	80.14	80.17	80.15
Lowood Peak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

[redacted]


Somerset Dam
Case 1
Case 2
Case 4
Case 5
Elevation (m AHD)
111
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


Wivenhoe Dam
Case 1
Case 2
Case 4
Case 5
Elevation (m AHD)
81
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


Lowood
Discharge (m3/s)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
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


Moggill
Discharge (m3/s)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
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

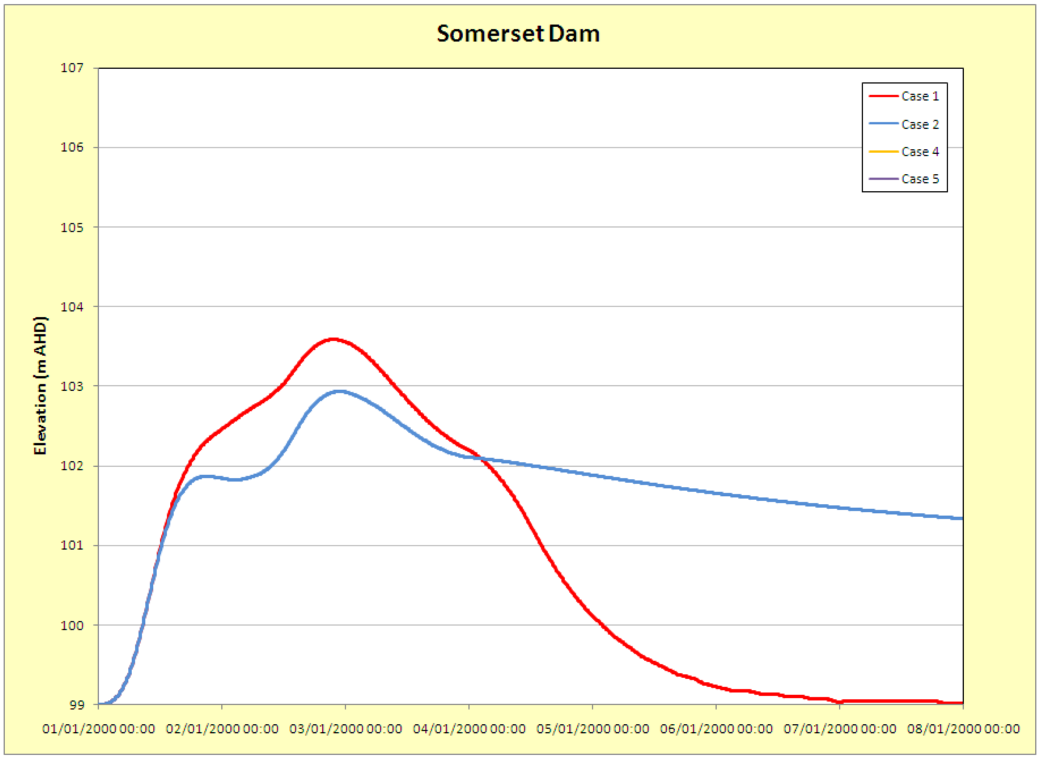
Appendix C

Somerset Centred Results

1 in 100 AEP

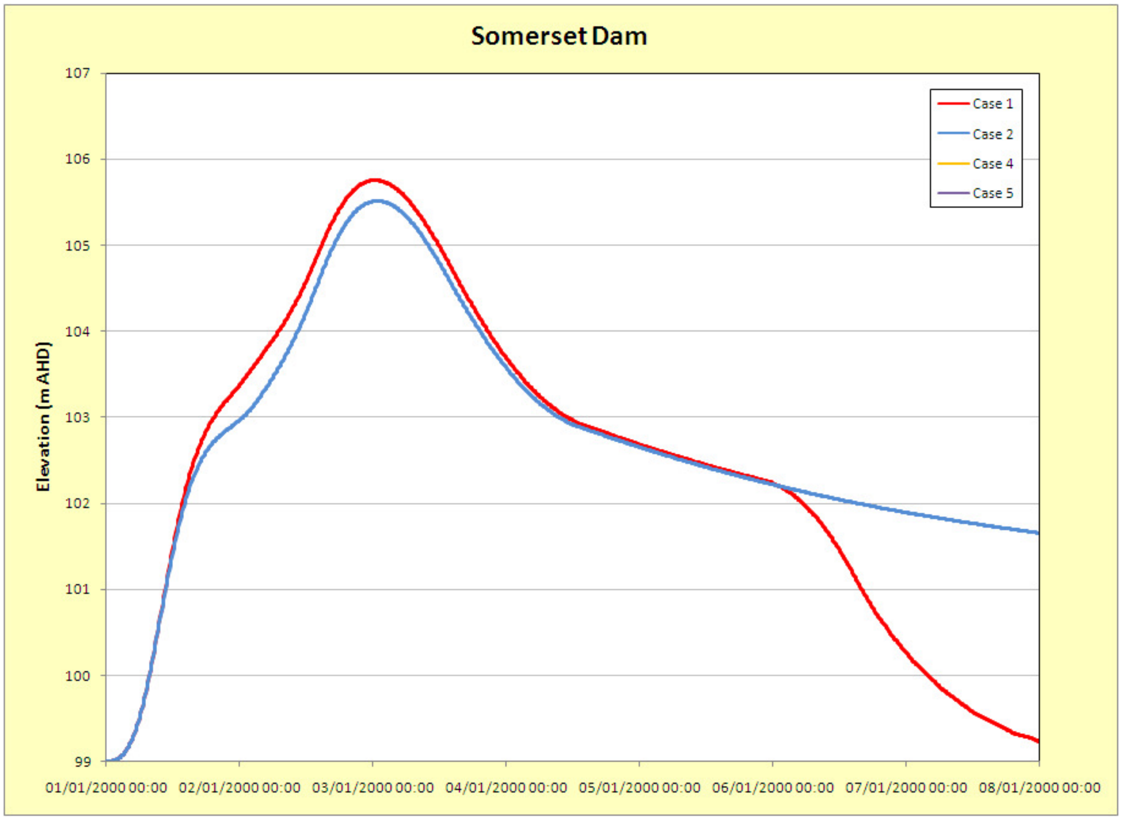
Item	Unit	Wivenhoe Operating Level 67.0 m AHD	
		Somerset Operating Level	
		102.25	100.45
		Case 1	Case 2
Somerset Peak Elevation	m AHD	103.59	102.93

[redacted]


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

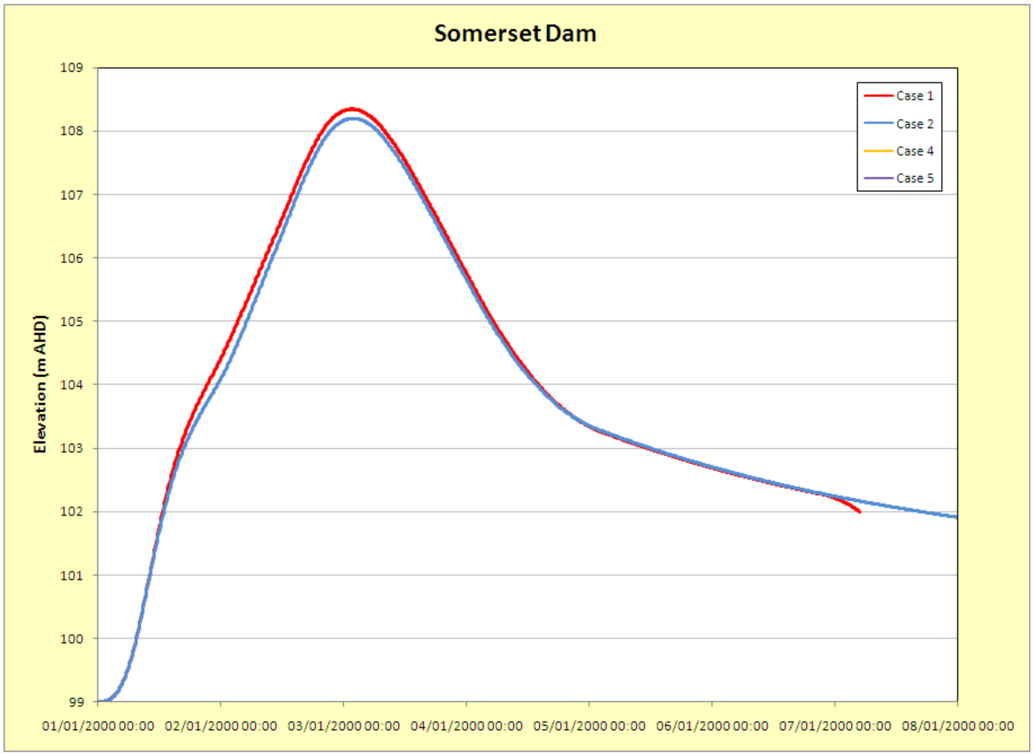
1 in 1,000 AEP

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

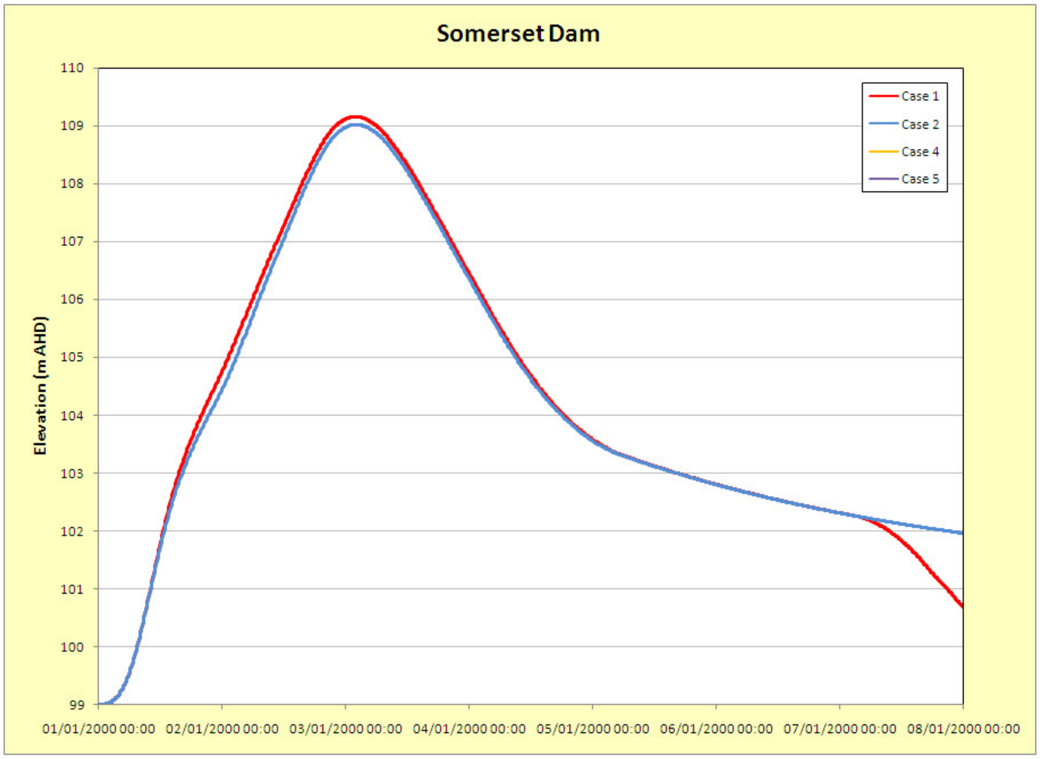
Item	Unit	Wivenhoe Operating Level	
		67.0 m AHD	
		Somerset Operating Level	
		102.25	100.45
		Case 1	Case 2
Somerset Peak Elevation	m AHD	108.34	108.20


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

[redacted]


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

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

[redacted]

MANUAL OF OPERATIONAL PROCEDURES FOR FLOOD MITIGATION AT WIVENHOE DAM AND SOMERSET DAM

NOTES ON NOVEMBER 2009 REVISION

INTRODUCTION

Seqwater has recently completed a comprehensive review and revision of the Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam. This work was very extensive and has resulted in a major rewrite of the Manual. Changes to the Manual can be grouped into four broad categories, which are:

- Administrative Issues.
- Improved Operational Descriptions.
- Review of Manual Objectives.
- Technical Amendments.

Changes within these categories are explained in detail below.

ADMINISTRATIVE ISSUES

Numerous reference changes to the manual were needed to account for the new water management institutional arrangements that were introduced by the Government in 2008. These reference changes resulted from the following:

- Change in relevant legislation to the Water Supply (Safety and Reliability) Act 2008.
- Change in relevant regulatory agency to the Department of Environment and Resource Management.
- Change in dam owner to the Queensland Bulk Water Supply Authority trading as Seqwater.
- Change in Agencies requiring information and holding controlled copies of the Manual in accordance with the Local Government Amalgamations of 2008.

None of these reference changes resulted in any change in operational procedure from the previous version of the Manual.

IMPROVED OPERATIONAL DESCRIPTIONS

Flood Events impacting on Wivenhoe and Somerset dams are caused by actual rainfall events that can vary in intensity, duration and distribution over a catchment area in excess of 10000 square kilometres. Accordingly, there is an infinite number of Flood Event scenarios that the Manual needs to account for. Previously, the operational approach taken in the Manual was procedural in nature. However, given the infinite scenarios to be catered for, it was obviously not possible for the Manual to contain a specific procedure relating to every possible flood event scenario. Therefore, following extensive discussion with both the Regulator and the Flood Operations Engineers and also taking into account the experience of previous flood events, a more practical approach was introduced.

The new approach does not change the original operational intent contained in the previous Manual, but does allow the optimisation of flood mitigation benefits, depending on the understanding of the magnitude of the flood event at any point in time. The approach provides strategies and objectives to guide flood operational decision making. The strategy chosen at any point in time will depend on the actual levels in the dams and the following predictions, which are to be made using the best forecast rainfall and stream flow information available at the time:

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

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

Flowcharts have been provided in the updated Manual to assist in Strategy selection. Additionally improved detail was provided within each strategy to clarify the intent of the Manual. This improved detail was wholly consistent with the intent and objectives of the previous version. Finally, additional detail was provided to cater for the following scenarios that were not covered in the previous version:

- **Potential to avoid a fuse plug initiation at Wivenhoe Dam by either initiating an early release of water from Wivenhoe Dam or by holding water back in Somerset Dam.** Neither action is allowed to adversely impact on the safety of the dams. In practice, the possibility of such a situation arising is considered extremely unlikely and will only occur if the event is well understood (i.e. no significant further rain is forecast for the event) and the peak flood level in Wivenhoe roughly corresponds to a fuse plug initiation level. However, it was thought that the situation should be covered off in the Manual for completeness.

- **Somerset Dam exceeds full supply level, while Wivenhoe Dam does not.** This scenario is of minor to insignificant risk, because it does not result in releases of water from Wivenhoe Dam. However, the situation was encountered in May 2009 and it was again thought that the situation should be covered off in the Manual for completeness.

REVIEW OF MANUAL OBJECTIVES

The Flood Mitigation Objectives contained in the previous version of the Manual in order of importance were:

- Ensure the structural safety of the dams;
- Provide optimum protection of urbanised areas from inundation;
- Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;
- Minimise disruption and impact upon Wivenhoe Power Station;
- Minimise disruption to navigation in the Brisbane River.

Following investigations, it was determined that decisions made during flood events have never given consideration to either minimising disruption and impact upon Wivenhoe Power Station or minimising disruption to navigation in the Brisbane River.

The Wivenhoe Power Station is not adversely impacted to any degree until the Dam Levels exceed EL 74.0 AHD. At these levels, the primary consideration is only the structural safety of the dam and minimising disruption to the power station is not a consideration.

Similarly, at the stage in a flood event where Wivenhoe Dam outflows potentially disrupt navigation in the Brisbane River, the higher level flood objectives dominate decision making processes. Additionally, it is not currently possible to derive a sensible relationship between releases from Wivenhoe Dam and disruption to navigation in the Brisbane River. Recent experience showed that one of the primary disruption mechanisms associated with the Brisbane River navigation is the cancellation of the public transport "CityCat" services. Such cancellations occurred in May 2009, when releases were not being made from Wivenhoe Dam. It is understood that the cancellations at this time were a function of factors associated with debris entering the river system downstream of the dam. Presently, it is not considered possible to incorporate such factors in flood release decision making processes.

Regardless of the difficulties, to provide recognition that in some circumstances considerations of disruption to navigation may be required, the updated Manual allows disruption to navigation in the Brisbane River to be taken into account when considering disruption to rural areas downstream of the dam. The updated manual states however that consideration of navigation is generally secondary to considerations associated with reducing bridge inundation downstream of Wivenhoe Dam.

With consideration to these changes, the Flood Mitigation Objectives contained in the updated version of the Manual in order of importance are:

- Ensure the structural safety of the dams;

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

The first three objectives are unchanged from the previous version, while the last two objectives were added to reflect current operating practice. Naturally, at the end of an event, a primary objective is to ensure that the dams are at full supply levels. Additionally in the drain down phase of the event, there has always been an objective to minimise impacts to riparian flora and fauna, particularly critical species such as lung fish.

TECHNICAL AMMENDMENTS

To maximise the combined flood mitigation benefits of Wivenhoe and Somerset dams, the operation of the dams during floods is interdependent. To determine the optimal flood mitigation strategy, a Somerset-Wivenhoe Operating Target Line is used as a guide to optimise flood mitigation benefits, while protecting the structural safety of the dams.

The existing Somerset-Wivenhoe Operating Target Line required review because it did not properly account for the raising of Wivenhoe Dam and construction of an Auxiliary Spillway that occurred in 2005. It also did not properly account for the revised failure level of Somerset Dam or for scenarios associated with floods centred on the Somerset Catchment.

A report was prepared to examine these issues in detail and the results of this report are the basis for the bulk of the technical amendments contained in the updated manual, particularly in relation to changes to the Somerset-Wivenhoe Operating Target Line. The report is entitled "Somerset-Wivenhoe Interaction Study (October 2009)". This report should be read to understand the nature and reasons for these amendments.

The other significant technical amendment related to the simplification of the loss of communications procedures. The Wivenhoe Dam minimum gate opening sequence was simplified by providing opening increments in steps of either 50 or 100 millimetres. This made the sequence easier to follow for dam operators and had very little change on dam outflows. The other change to the table was made to correct an inconsistency that allowed dam outflows of greater than 4000 m^3/s at dam levels less that EL 74.0 m AHD. This was considered to be an error in the previous manual as it is inconsistent with the flood manual objectives. Wivenhoe gate opening sequences were also made consistent between "normal communications" and "loss of communications" procedures.

The Somerset Dam Loss of Communication procedure was also simplified to provide straightforward sluice opening and closing procedures in accordance with the Somerset-Wivenhoe Operating Target Line. The simplified procedure was extensively modelled and was found to consistently provide better results in terms of optimising the flood mitigation benefits of the two dams. This modelling is contained in the Somerset-Wivenhoe Interaction Study (October 2009).

Approval of Updated Wivenhoe/Somerset Flood Mitigation Manual- Enterprise Vault Archived Item - Windows Internet Explorer

http://seq-vaultsite.seqwater.com.au/EnterpriseVault/ViewMessage.asp?VaultId=1E0A83DBBB9ABE54B8D38257065236839111000SEQ-VaultSite&SavesetId=201005070000000~200911061128020000~Z~414DC3AF9ED958DA625512D0FFA3A631

Wivenhoe Somerset Flood M... | RE: Wivenhoe Somerset Flo... | Notes on Wivenhoe Somerse... | Approval of Updated Wiv...

Approval of Updated Wivenhoe/Somerset Flood Mitigation Manual

From John Tibaldi **Date** Friday, 6 November 2009 9:28:02 PM
To Jim Pruss; Peter Borrows; Rob Drury
Cc
Subject Approval of Updated Wivenhoe/Somerset Flood Mitigation Manual

image001.png (7 KB HTML) Let - W&S Flood Manual - 02.doc (30 KB HTML) Explanatory Notes for 2009 Revision.doc (44 KB HTML)

Jim/Peter/Rob

Following another meeting this afternoon involving the Duty Flood Engineers and three engineers from the Regulator, Peter Allen has agreed in principle to gazette the current draft of the flood manual. It was generally agreed that the updated Manual is a significant improvement on the current version in a number of areas and that it has rectified several technical inconsistencies. The process for gazettal is now as follows:

- Peter Allen is leaving for ANCOLD tomorrow, but will proof read the current draft next week and undertake any final editing at ANCOLD in conjunction with myself (there won't be any significant changes, possibly just some format and presentation changes).
- The draft should be finalised on Monday 16 November. On that day I will email the final draft of the Manual, along with the Explanatory Notes, the final draft of the Wivenhoe Somerset Interaction Study Report and the covering letter to yourselves. Once you are happy with the documentation, Peter B needs to sign the covering letter and submit all documents to Peter A.
- If you want to review the documents prior to next week, the covering letter and Explanatory Notes are attached. The Manual (previous version and latest draft) and Interaction Study Report can be found on "G:\Operations\Dam Safety Management\Ipswich\Flood Manuals\Wivenhoe and Somerset". As a result of the meeting today, I will have to make a few technical amendments to both the draft Manual and Interaction Study next week, but these won't change the final recommendations and are minor in nature. If you have any queries on the required technical amendments, or the documents themselves, please give me a ring.

If you wish to make some changes or additions to the draft Manual once you have read the draft documents, that won't be a problem. However with the aim in mind of having the new Manual gazetted prior to the next flood event, it would be helpful (but not essential) to let me know about these before the end of next week, so that they can be included and discussed with Peter A as part of the final editing process.

John Tibaldi
Dam Safety Manager
Queensland Bulk Water Supply Authority *trading as* Seqwater

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Ph [redacted]
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PO Box 2437, North Ipswich QLD 4305
Website | www.seqwater.com.au

Done | Local intranet | 100%

Start | Inbox - Microsoft Outlook | 2 Reminders | FW: Flood Manual Revie... | Manual Review | Microsoft Word | Microsoft Excel | Approval of Updated ...

When contacting Seqwater please ask for John Tibaldi
Telephone: [redacted]
Reference: 09-000047

3 November 2009

Mr Peter Allen
Director Dam Safety (Water Supply)
Department of Natural Resources and Water
PO Box 2454
BRISBANE QLD 4001

Dear Mr Allen

MANUAL OF OPERATIONAL PROCEDURES FOR FLOOD MITIGATION AT WIVENHOE DAM AND SOMERSET DAM

As you are aware, Seqwater has recently completed a comprehensive review and revision of the Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam. This work has been very extensive and has resulted in a major rewrite of the existing Manual. Your assistance with this work is acknowledged and I would like to thank you for your input.

Now that the revision is complete, I request that you approve the updated Manual by gazette notice, in accordance with the provisions of Chapter 4 (Part 2) of the Water Supply (Safety and Reliability) Act 2008. Copies of the updated Manual are attached, both in electronic and hardcopy format. Also attached is a copy of the Somerset – Wivenhoe Interaction Study, that was the basis of the technical changes in the updated Manual; and a short paper that summarizes the changes made to the Manual.

I trust the information provided is in accordance with your requirements and I ask that you contact me on [redacted], should any issues arise that impact on the requested approval.

Yours faithfully

Peter Borrows
CEO
QLD Bulk Water Supply Authority *trading as* Seqwater

Att:

- Summary of Manual changes.
- Revised Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam, November 2009 (Hardcopy and electronic format).
- Somerset – Wivenhoe Interaction Study (October 2009).