Allens Arthur Robinson

Queensland Floods Commission of Inquiry

Opening Submission by Queensland Bulk Water Supply Authority trading as Seqwater

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A Preliminary

1. The Queensland Floods Commission of Inquiry was announced on 17 January 2011.

2. The Terms of Reference[1] require the Commission to make full and careful inquiry in an open and independent manner with respect to the following matters:

   (a) the preparation and planning by federal, state and local governments, emergency services and the community for the 2010/2011 floods in Queensland;

   (b) the performance of private insurers in meeting their claims responsibilities;

   (c) all aspects of the response to the 2010/2011 flood events, particularly measures taken to inform the community and measures to protect life and private and public property, including:

      (i) immediate management, response and recovery;

      (ii) resourcing, overall coordination and deployment of personnel and equipment;

      (iii) adequacy of equipment and communications systems; and

      (iv) the adequacy of the community's response;

   (d) the measures to manage the supply of essential services such as power, water and communications during the 2010/2011 flood events;

   (e) adequacy of forecasts and early warning systems particularly as they related to the flooding events in Toowoomba, and the Lockyer and Brisbane Valleys;

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

   (g) all aspects of land use planning through local and regional planning systems to minimise infrastructure and property impacts from floods.

   (h) in undertaking its inquiries, the Commission is required to:

      (i) take into account the regional and geographic differences across affected communities;

      (ii) seek public submissions and hold public hearings in affected communities.

3. On 11 February 2011, the Commission called for:

   (a) written submissions relating to issues of flood preparedness relevant to next summer's wet season (particularly dam operations, early warning systems and responses), such submissions to be received by the Commission by 5.00pm on 11 March 2011;

[1] See Queensland Government Gazette No. 12 dated 17 January 2011.

(b) written submissions relating to any other matters in the Inquiry's terms of reference, such submissions to be received by the Commission by 5.00pm on 4 April 2011.

4. This document is the opening submission of Seqwater in respect of the issues of flood preparedness relevant to next summer's wet season.

5. This submission is provided now, in accordance with the Commission's published timetable, to assist the Commission:

(a) commence its investigations into the matters the subject of the Inquiry;

(b) understand in a preliminary way:

(i) Seqwater's role in the matters included in the Terms of Reference;

(ii) the regulatory framework within which Seqwater operates;

(iii) the January 2011 Flood Event at Somerset, Wivenhoe and North Pine Dams; and

(iv) some possible recommendations the Commission might consider in respect of flood-preparedness for next summer's wet season.

6. Seqwater intends to deliver a further submission by 4 April 2011.

7. Seqwater is committed to assisting the Commission carry out its investigations and will provide such further submissions, documents and assistance as the Commission requires.

8. In this submission, capitalised terms have the meaning set out in Annexure A.

B Executive Summary

Preliminary

9. Seqwater is South East Queensland's bulk water supply provider.

10. Seqwater provides integrated management of catchments, water storages, dams and treatment services to provide quality water for the region.

11. Within the portfolio of assets Seqwater owns, operates and manages are 25 dams[2] (including Somerset, Wivenhoe and North Pine Dams), 47 weirs and 46 water treatment plants.

12. The dams fulfil a number of important roles for the community including the provision of:

    (a) water for urban, industrial and irrigation use;

    (b) flood mitigation;

    (c) hydroelectric power generation; and

    (d) facilities for community recreation.

13. Wivenhoe and Somerset Dams contain dedicated flood mitigation storage designed to provide flood mitigation benefits to areas potentially affected by flood flows along the Brisbane River below Wivenhoe Dam. The ability to store catchment runoff from rain events only arises in respect of rain which falls in the catchment *above* the dams. The area of the catchment above the dams is approximately 7,000 square kilometres.

14. Around 6,500 square kilometres (approximately 50%) of the Brisbane River catchment is *below* Wivenhoe and Somerset Dams. This includes the Lockyer Creek and Bremer River catchments.

15. Seqwater's North Pine Dam operates in the separate Pine Rivers catchment and is designed for drinking water storage only. It was not designed for flood mitigation.

16. Given their potential significant impact on downstream populations, it is imperative Somerset, Wivenhoe and North Pine Dams are operated during flood events in accordance with clearly defined procedures to minimise impacts to life and property.

17. Separate manuals containing these procedures for Wivenhoe and Somerset Dams (***the Wivenhoe Manual***) and North Pine Dam (***the North Pine Manual***) have been approved under Queensland dam safety legislation.

18. The Manuals provide the objectives and strategies to guide operational decision making during flood events. This ensures any releases of water made from the dams during flood events are made in accordance with a hierarchy of objectives.

19. The objectives in the Wivenhoe Manual, in order of importance, are:

    (a) ensure the structural safety of the dams;

    (b) provide optimum protection of urbanised areas from inundation;

[2] See paragraph 51(a) of this submission.

(c) minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;

(d) retain the storage at full supply level at the conclusion of the flood event; and

(e) minimise impacts to riparian flora and fauna during the drain down phase of flood event.

20. While the Wivenhoe Manual provides objectives and strategies to guide operational decision-making, it is not possible to provide a specific procedure for dam operation for every possible flood event. The objective followed and strategy chosen at any point in time during the event depends on the real-time water levels in the dams, as well as flood modelling predictions based on the best observed rainfall, forecast rainfall and stream flow information available.

21. Given the Lockyer Creek and Bremer River catchments drain into the Brisbane River below Wivenhoe Dam, several Wivenhoe Manual strategies require the flow from the Lockyer Creek and the Bremer River to be considered when releasing water from Wivenhoe Dam. This is done by measuring the flow of water (in cubic metres per second, ie m^3/s (***cumecs***)) at a gauging station known as "Moggill". This station is located downstream of where the Lockyer Creek and Bremer River join the Brisbane River. The Wivenhoe Manual notes that a flow of 4,000 cumecs at Moggill is the upper limit of non-damaging floods in urban areas downstream of the dams.

22. The balancing of the different flows from these separate systems requires expertise and experience in managing flood events. As a result, all decisions taken under the Manuals are made by experienced engineers, approved by the Dam Safety Regulator. Seqwater operates the Flood Operations Centre which is staffed throughout declared flood events.[3]

The January 2011 Flood Event

23. In the 28 days prior to Thursday 6 January 2011, rainfall in South East Queensland had been well above the December average and three separate flood events had occurred. Flood releases were made from Wivenhoe Dam on most of these days.[4]

24. As a result, the catchments were near saturation and primed to generate runoff.

25. Commencing on Thursday, 6 January 2011, further rain fell across South East Queensland. At this time, notwithstanding the rainfall received over the previous month, virtually all of Wivenhoe and Somerset Dams' dedicated flood mitigation storage volume was available for use.

26. Rain continued to fall until Wednesday, 12 January 2011.

27. This rainfall resulted in:

(a) inflows into Wivenhoe and Somerset Dams almost double the 1974 flood volume, with flows received at Wivenhoe Dam characterised as two distinct flood peaks separated by about 30 hours; and

[3] Seqwater, '*Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*', November 2009, p39.

[4] Seqwater, '*Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*', November 2009, p31.

(b) the highest ever recorded inflows into North Pine Dam and the largest flood ever recorded in the Pine Rivers catchment.

28. Seqwater managed the flood events:

(a) at the Wivenhoe and Somerset Dams, in accordance with the Wivenhoe Manual, for the period Thursday, 6 January 2011 until Wednesday, 19 January 2011; and

(b) at the North Pine Dam, in accordance with the North Pine Manual, for the period Thursday, 6 January 2011 to Friday, 14 January 2011 (collectively the ***January 2011 Flood Event***).

29. The Wivenhoe Manual and the North Pine Manual require Seqwater to prepare a report on each flood event within 6 weeks of the conclusion of the event.

30. Seqwater has prepared these technical flood event reports in respect of the separate flood events which impacted Wivenhoe and Somerset Dams and North Pine Dam, and they have been submitted to the Dam Safety Regulator, and copies have been provided to the Commission.

Magnitude of the event

31. The January 2011 Flood Event which impacted Wivenhoe and Somerset Dams:

(a) was unprecedented in the history of the dams and rivals the largest floods in the recorded flood history of the region;

(b) on the currently available information, can be categorised as *large* (Annual Exceedence Probability (***AEP***) of 1 in 100 years) to *rare* (AEP of 1 in 2,000 years);[5]

(c) resulted in a volume of total inflow into Wivenhoe Dam of 2,650,000 ML. This volume is almost double (190%) the comparable volume of inflow from the January 1974 event (Wivenhoe Dam was constructed in 1984), and is comparable with the flood of 1893;

(d) the maximum inflow rate at the first peak at Wivenhoe Dam is estimated to be around 200% of the comparable flow rate calculated from the January 1974 event;

(e) the maximum inflow rate at the second peak at Wivenhoe Dam is estimated to be approximately 230% of the comparable flow rate from the January 1974 event;

(f) at some individual rainfall stations within the Brisbane River catchment, rainfall estimates beyond the credible limit of extrapolation (AEP of 1 in 2,000) were recorded during the event for durations between 6 hours and 48 hours;

(g) resulted in major flood levels being recorded at gauges in the Brisbane River catchment above Wivenhoe Dam and in many cases produced the highest levels ever recorded; and

(h) resulted in major flood levels being recorded at gauges in the Lockyer Creek, and significant flooding in the Bremer River during the same event.

[5] According to The Institution of Engineers Australia (Engineers Australia) national guidelines for the estimation of design flood characteristics (AR&R).

32. The January 2011 Flood Event which affected North Pine Dam:

(a) resulted in total inflow into North Pine Dam of 202,000 ML or 94% of the total dam storage volume;

(b) on the currently available information, can be categorised as *rare* (AEP of greater than 1 in 100) and potentially with an AEP in the order of 1 in 200;

(c) the maximum inflow rate of 3,480 cumecs is more than double the largest previous flow rate into North Pine Dam ever recorded; and

(d) is the largest flow to have been recorded in the North Pine River since records commenced in 1916.

Releases of water were in compliance with flood mitigation manuals

33. Given the magnitude of the January 2011 Flood Event, it was necessary for Seqwater to release water from each of Somerset, Wivenhoe and North Pine Dams.

34. In doing so, Seqwater acted carefully and in compliance with the terms of the approved flood mitigation manuals which outline the operational procedures to be followed during flood events.

35. By observing the operational procedures contained in the flood mitigation manuals, Seqwater does not incur civil liability for an act done, or omission made, honestly and without negligence in observing the procedures.[6]

36. There is no foundation in suggestions which have been made to the effect that Seqwater ought to have released more water from Wivenhoe Dam earlier in the event or released too much water from Wivenhoe Dam late in the event. In line with the Wivenhoe Manual, releases of water from Wivenhoe Dam early in the event took into account the significant flood flows from the Lockyer Creek and Bremer River, and sought to keep the combined flow below the urban damage threshold at Moggill. Dam outflows that would cause urban inundation were delayed for as long as possible, until it became apparent no other option was available without risking the safety of Wivenhoe Dam.

37. The claims are also made with the benefit of hindsight and are based on the incorrect assumption that perfection exists in the forecasting of rainfall events. While Seqwater understands Bureau of Meteorology (***BoM***) forecasts are derived using the best available meteorological practice, during the critical period between Saturday, 8 January 2011 and Tuesday 11 January 2011, actual daily rainfall was between 160% to 340% of the best available quantitative forecast for the dam catchment.[7]

Damage in urban areas was unavoidable

38. Given the magnitude of the January 2011 Flood Event, damage to urban areas downstream of the dams was unavoidable.

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[6] Section 374 of the Water Supply Act.

[7] Seqwater, '*Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*', November 2009, p55.

39. Even if no releases of water had been made from Wivenhoe Dam, damage in downstream urban areas would have occurred in any event from the volume of flows from the Lockyer Creek and the Bremer River.

Dams provided clear flood mitigation benefits

Wivenhoe and Somerset Dams

40. Irrespective of any effect that water released from Wivenhoe Dam during the January 2011 Flood Event may have had downstream, it would be wrong to conclude that Wivenhoe Dam "caused" the flooding in the urban areas downstream of the dams. The presence of Wivenhoe and Somerset Dams and the operation of them provided clear mitigation benefits which prevented significant additional urban damage being suffered. In this regard:

    (a) The peak of the outflow from Wivenhoe Dam was approximately 40% lower than the peak of the inflow, meaning that just below the Dam, the maximum hourly flow rate in the Brisbane River was reduced by around 40%.

    (b) The peak flood height measured at the Port Office gauge near the Brisbane CBD was 4.45m. It has been estimated that this peak height would have been approximately 2.0m higher without the mitigating effects of Wivenhoe Dam.

    (c) Based on the available damage curves[8], this projected reduction in the flood peak height resulted in:

        (i) significant reductions in the potential for the loss of life;

        (ii) monetary savings in regard to property damages in the order of up to $5 billion;

        (iii) 14,000 fewer properties being impacted.

41. The flood mitigation benefits provided by Wivenhoe and Somerset Dams can be seen from the Figure 1. By way of explanation:

    (a) The dark blue line indicates the flow of water (expressed in cumecs) into Wivenhoe Dam. The speed of the flow is measured against the left axis. The two distinct flood peaks are apparent.

    (b) The light blue line indicates the flow of water (expressed in cumecs) released from Wivenhoe Dam. The significantly reduced rate at which water was released from the dam (compared to the rate at which water flowed into the dam – the dark blue line) is apparent.

    (c) The red line indicates the height of the water in Wivenhoe Dam during the January 2011 Flood Event (measured against the right axis of the Figure 1).

[8] Source: Flood Damage Tables – River PMF tab; made available to Flood Operations Centre by Brisbane City Council.

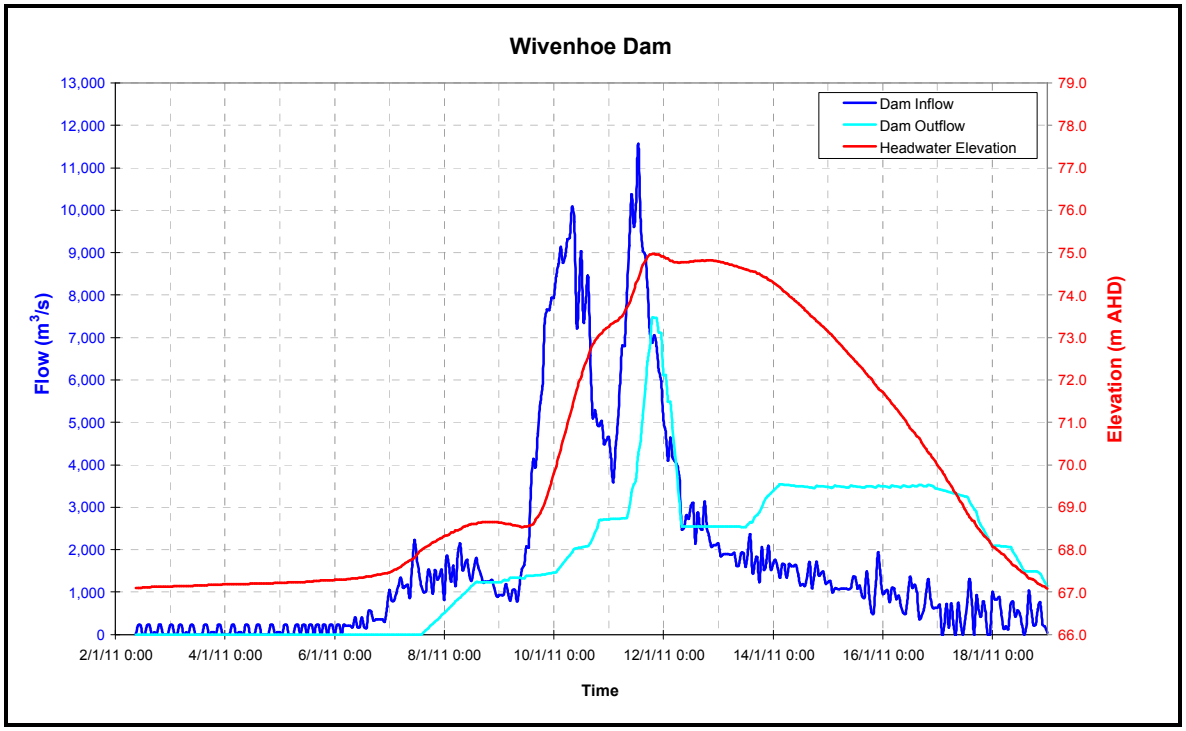

Figure 1: Wivenhoe Dam Inflow and Release Summary for the January 2011 Flood Event.

(Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p 96.)

42. The flood mitigation benefits provided by Wivenhoe and Somerset Dams are also demonstrated by Figure 2 below. By way of explanation:

(a) the threshold of damaging floods as contained in the Wivenhoe Manual is identified by the black line at 4,000 cumecs. It has been assumed for the purposes of Figure 2 that the peak flow in the Brisbane River at the Port Office gauge is approximately the same as that at Moggill gauge;

(b) the dark blue line is the estimated flow rate during the January 2011 Flood Event;

(c) the purple line is that part of the estimated flow rate during the January 2011 Flood Event which is attributable to flows from the Lockyer Creek, Bremer River and flows downstream of Wivenhoe Dam excluding releases from Wivenhoe Dam. As is evident, the flood damage threshold was exceeded by these flows alone;

(d) the red line is that part of the estimated flow rate during the January 2011 Flood Event which is attributable to flows from water released from Wivenhoe Dam. As is evident, the contribution of such flows to the overall flood event was less than the flows attributable to the Lockyer Creek, Bremer River and flows downstream of Wivenhoe Dam;

(e) the light blue line demonstrates the likely flows which would have been suffered had Wivenhoe Dam not existed. The significant reduction in the estimated flow rate in the flood event is apparent; and

(f) the orange line demonstrates the likely flows which would have been suffered had Wivenhoe and Somerset Dams not existed. The significant reduction in the estimated flow rate in the flood event is apparent.[9]

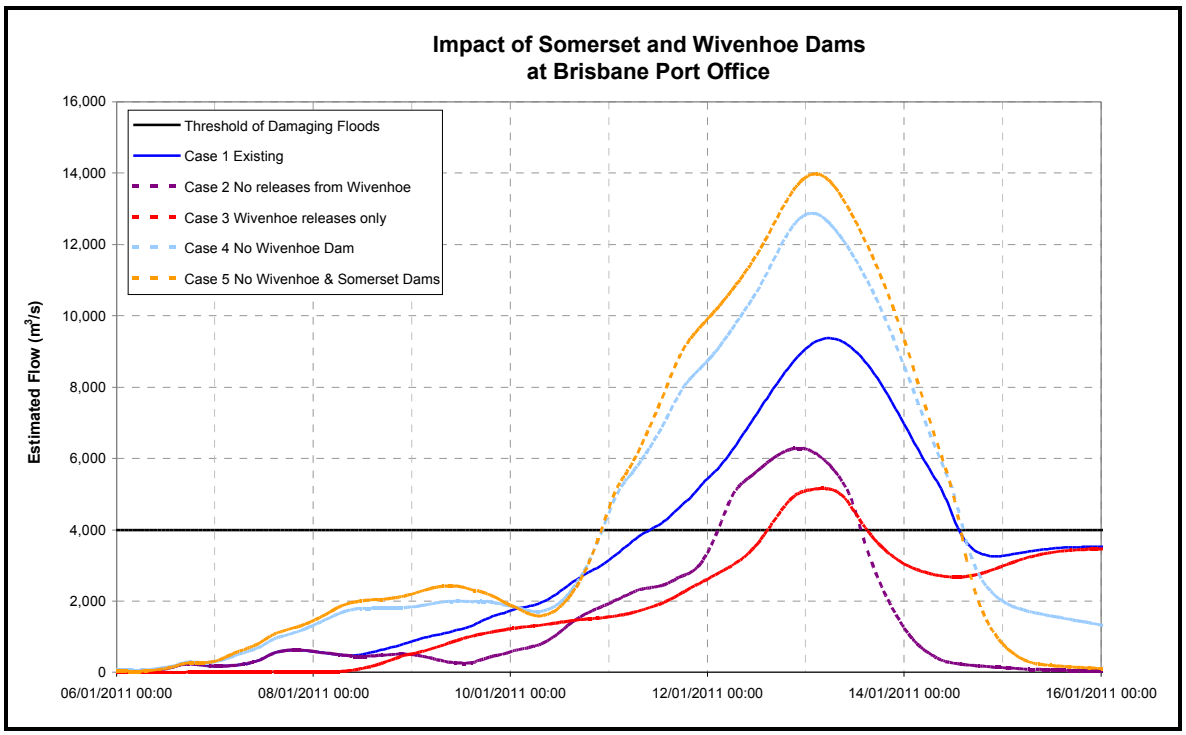

Figure 2: Impact of Somerset and Wivenhoe Dams at Brisbane Port Office.

(Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p 149.)

North Pine Dam

43. Notwithstanding that the North Pine Dam is not designed as a dedicated flood mitigation storage, the storage reduced peak outflows to a maximum of 82% of inflow rate[10].

44. The flood mitigation benefits provided by the North Pine Dam can be seen from the Figure 3. By way of explanation:

(a) the solid dark blue line indicates the outflow of water (expressed in cumecs). The peak outflow can be observed at only 82% of the peak inflow, represented by the dashed blue line.

(b) average catchment rainfall is depicted in the red column graph as millimetres per hour.

[9] Note: inflows comprising the red line (Wivenhoe releases only) and the purple line (flows from the Lockyer Creek, Bremer River and flows downstream of Wivenhoe Dam) cannot be directly added together to equal the blue line, due to the storage and routing impact of the floodplain and the river channels.

[10] Seqwater, *January 2001 Flood Event Report on the operation of North Pine Dam*, 11 March 2011.

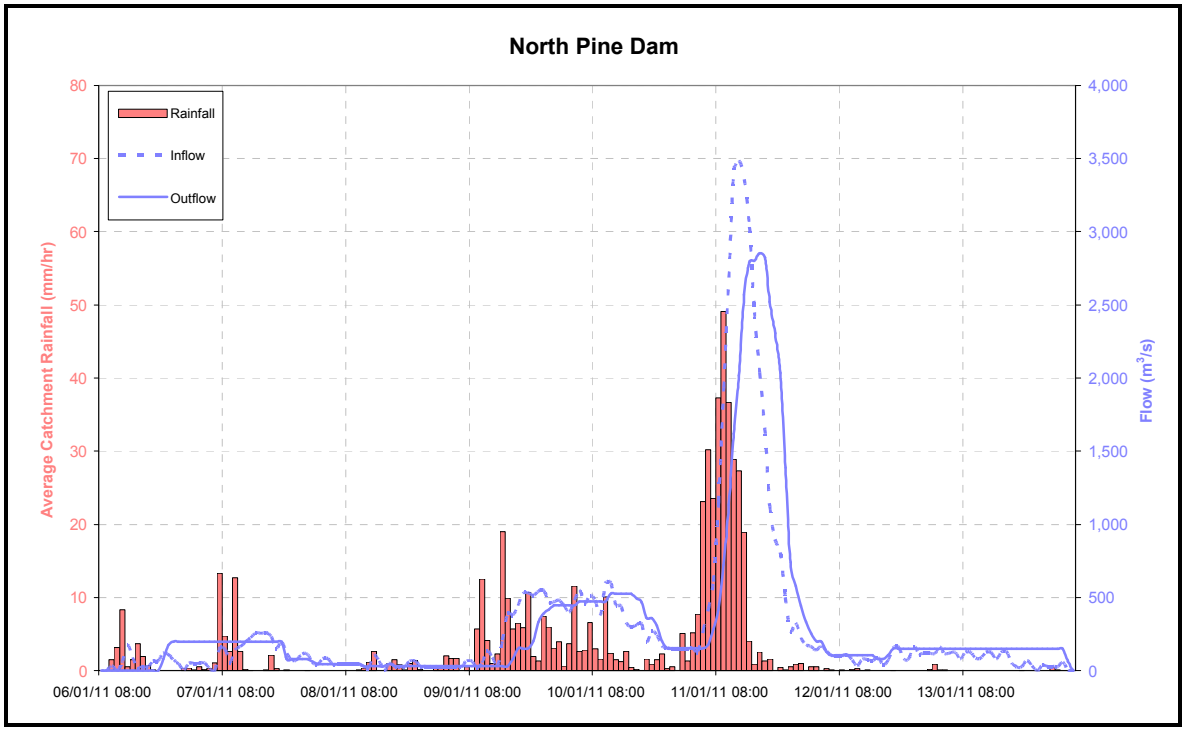

Figure 3: North Pine Dam – January 2011 Flood Event and Inflow and Outflow.

(Source: Seqwater: *January 2011 – January 2011 Flood Event Report on the operation of North Pine Dam*, 11 March 2011, p iii.)

Drinking water was maintained

45. Despite the magnitude of the January 2011 Flood Event, Seqwater maintained drinking water supplies to South East Queensland throughout the entirety of the event, other than for a small number of residents serviced by the Lowood treatment plant. Given the scale of the natural disaster, this was a very significant achievement. It was able to be achieved, in large part, because of:

    (a) Seqwater's management of the integrated asset portfolio it maintains (including water storages, dams and water treatment plants); and

    (b) the existence of the Grid (which is explained in Section C1).

Flood preparedness for next summer

46. Seqwater provides recommendations for the Commission to consider in respect of flood preparedness for next summer's wet season in Section E of this submission.

47. When considering these recommendations, Seqwater respectfully requests that the Commission note the following:

    (a) the January 2011 Flood Event has been categorised for Wivenhoe Dam as between *large* and *rare*, and for North Pine Dam as *rare*;

    (b) the Brisbane River catchment is approximately 13,500 square kilometres. Rainfall events vary in intensity, duration and distribution over the catchment. The damaging impacts suffered in the January 2011 Flood Event may have been

significantly different if the intensity, duration and distribution of the rainfall had been different; and

(c) the existence and operation of Wivenhoe and Somerset Dams cannot prevent all flooding in urban areas downstream of the dams. This is because:

(i) only rain which falls *upstream* of Wivenhoe and Somerset flows into those dams. In practical terms, this equates to approximately 50% of the catchment. The other (approximately) 50% of the catchment (including the Lockyer Creek and Bremer River) has no flood mitigation measures; and

(ii) major floods may be encountered where protection of urbanised areas is not possible. Wivenhoe Dam was designed in the knowledge of this and the objectives of the Wivenhoe Manual accommodate these circumstances. The January 2011 Flood Event was such an event.

C Introduction

C1 Seqwater and its role in the Water Grid

48. Seqwater is a statutory authority.[11]

49. Since 1 July 2008, Seqwater has owned and operated, amongst other things, the catchment, storage, dam and treatment bulk water assets in South East Queensland.

50. Prior to Seqwater's establishment in 2007, bulk water source, transport and treatment assets in South East Queensland were owned by 25 different entities, servicing 17 retail businesses based on local government boundaries.[12]

51. By way of overview, Seqwater owns, operates and manages:

    (a) 25 dams[13] and 47 weirs across South East Queensland, which provide for the catchment and storage of bulk water. These assets include:

        (i) Wivenhoe, Somerset and North Pine Dams, which are located inland of Brisbane;

        (ii) Hinze Dam in the Gold Coast hinterland;

        (iii) Baroon Pocket Dam near Maleny on the Sunshine Coast; and

    (b) 46 water treatment plants, which provide drinking water supplies to South East Queensland.

52. As explained in **Section C2**, a particular benefit of consolidating the ownership of these assets is that Seqwater is able to provide integrated management of catchments, water storages, dams and treatment services to provide quality water for South East Queensland.

53. A full list of the dams, weirs and water treatment plants currently owned, operated and managed by Seqwater is contained in **Annexure 2**.

54. Seqwater also provides water to smaller communities in the region not connected to the Grid and supplies raw water to 1,344 rural irrigator customers in the Upper Mary, Logan River, Warrill Valley, Central Lockyer, Lower Lockyer and Central Brisbane schemes.

55. It is important to note at the outset that Seqwater does *not* own (or have an entitlement to) any significant volume of the water it catches, stores and treats.[14] Predominantly, the water is owned by the Grid Manager (see below). As a result, decisions that impact upon

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[11] Seqwater was established in late 2007 by the *South East Queensland Water (Restructuring) Act 2007* – see section 6.

[12] See *Explanatory Notes South East Queensland Water (Restructuring) Bill 2007*, page 2.

[13] Wyaralong Dam is presently owned by Queensland Water Infrastructure Pty Ltd, and will be transferred to Seqwater on 1 July 2011.

[14] Under the relevant Resource Operations Plans (explained later) Seqwater holds entitlements to an insignificant (around 1%) volume of water for distribution losses, dam site amenities and unallocated water. Further, approximately 98% of Seqwater's revenue is derived from grid service charges paid by the South East Queensland Grid Manager (explained later) for the provision of declared water services. The grid service charges are determined by the Price Regulator, being the Minister for Environment and Resource Management.

the entitlement of the Grid Manager to the water stored by Seqwater, requires consultation with, and approval by, the Grid Manager.

56. To understand the importance of this issue, it is necessary to understand the South East Queensland Water Grid (***Grid***) and the roles of the entities which are partners in it.

57. The Grid is an infrastructure network connecting South East Queensland's water storages, dams and treatment plants, from Noosa to Coolangatta and west to the Lockyer Valley. In practical terms, the Grid enables (by a network of treatment facilities and two-way pipes) some movement of drinking water around South East Queensland.

58. The establishment of the Grid was a significant reform of the Queensland Government in response to the prolonged drought conditions affecting South East Queensland.

59. The infrastructure partners in the Grid (who work collaboratively with Seqwater) comprise:

(a) LinkWater:[15] LinkWater manages, operates and maintains the Grid's bulk drinking water *pipeline* network and related infrastructure;

(b) WaterSecure:[16] WaterSecure owns the Western Corridor Recycled Water Scheme (which includes plants at Bundamba, Gibson Island and Luggage Point which purify wastewater) and the Gold Coast Desalination Plant. The Commission should note that on 5 December 2010, the Queensland Government announced that, with effect from 1 July 2011, WaterSecure will be merged with Seqwater to comprise one bulk water supply authority.[17]

60. The other partner in the Grid, who works collaboratively with Seqwater, LinkWater and WaterSecure, is the Grid Manager.[18] The Grid Manager:

(a) manages the strategic operation of the Grid to ensure water security and quality in a cost effective way;

(b) owns the urban water entitlements for South East Queensland (that is, the right to be supplied water from the bulk water storages operated by Seqwater);

(c) purchases services to store, treat, produce and transport bulk water from Seqwater, LinkWater and WaterSecure;

(d) sells water to customers.[19]

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[15] LinkWater is also a statutory authority established by the *South East Queensland Water (Restructuring) Act 2007* – see section 6.

[16] WaterSecure is also a statutory authority established by the *South East Queensland Water (Restructuring) Act 2007* – see section 6.

[17] The merger is designed to provide a more streamlined and cost-efficient method of delivering bulk water and purified recycled water – see *Joint Statement: Treasurer and Minister for Employment and Economic Development The Honourable Andrew Fraser Minister for Natural Resources, Mines and Energy and Minister for Trade The Honourable Stephen Robertson; Sunday, December 05, 2010; Water reforms save money for householders.*

[18] The SEQ Water Grid Manager is also a statutory authority established by the *South East Queensland Water (Restructuring) Act 2007* – see section 6.

[19] SEQ Water Grid Manager, *annual report 2009 – 2010* p 4-5.

61. Initially, customers of the Grid Manager were local government-owned water businesses, councils and government-owned power stations. From July 2010, three distribution and retailer businesses were formed around three geographical areas. These are:

    (a) Queensland Urban Utilities, which is the distribution and retail business for the Brisbane, Scenic Rim, Ipswich, Somerset and Lockyer Valley areas;

    (b) Allconnex Water, which is the distribution and retail business for the Gold Coast, Logan and Redlands areas;

    (c) Unity Water, which is the distribution and retail business for the Sunshine Coast and Moreton Bay areas.[20]

62. Although it is simple to describe the practical operation of the Grid, there is a suite of statutory provisions and contractual arrangements which underpin the interaction of the various partners in the Grid. Seqwater can provide copies of its contractual arrangements with other Grid partners, if the Commission considers it necessary to have regard to those arrangements.

63. To assist in understanding the Grid, Figure 4 below depicts the interaction between the Grid partners.

[20] Each of these retailing businesses are statutory authorities established under the *South-East Queensland Water (Distribution and Retail Restructuring) and Other Legislation Amendment Act 2010*.

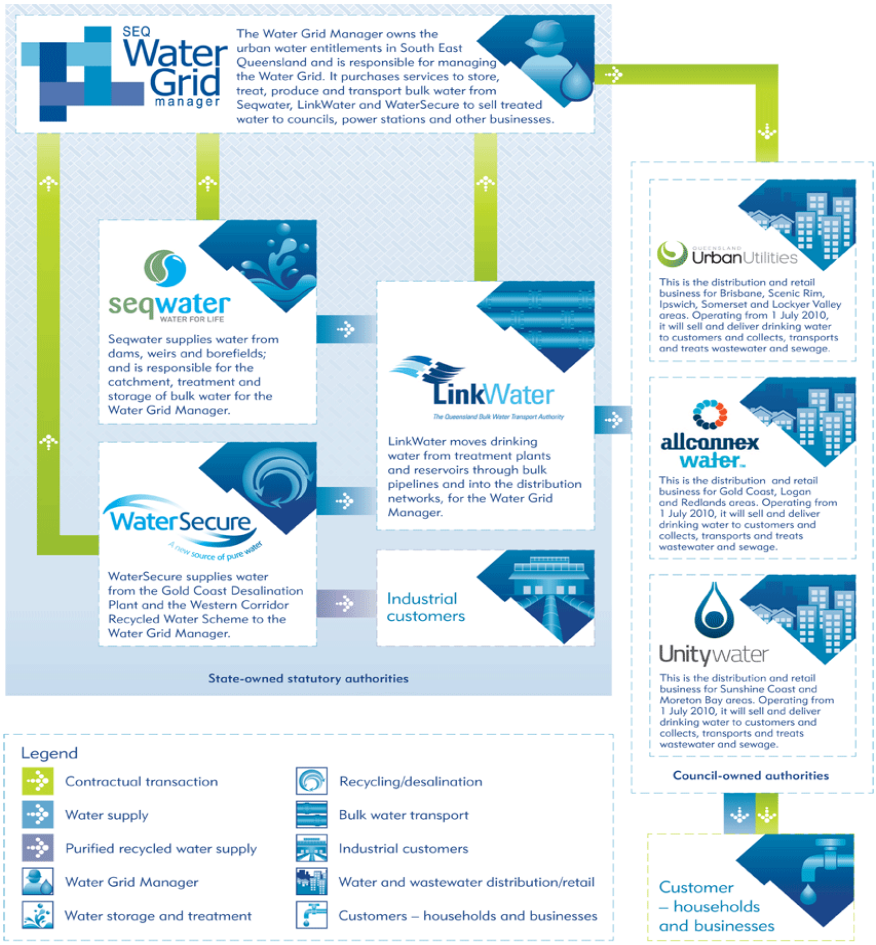

Figure 4: Diagram of the South East Queensland Water Grid.

(Source: Seqwater website.)

64. The Grid, and the partners in it, fall within the administration of the Department of Environment and Resource Management (***DERM***).

65. While the Grid (through its partners) operates to provide water to South East Queensland, DERM and the Queensland Water Commission (***QWC***)[21] (a statutory body), are responsible for (amongst other things) devising long term strategies and policies in respect of sustainable and secure water supply.

66. By way of a brief overview, QWC's main functions are to do the following for the South East Queensland region:

    (a) advise the Minister on matters relating to water supply and demand management for water;

    (b) advise the Minister on the delivery of desired levels of service objectives (which are explained in **Section C3**);

[21] QWC was established in June 2006 under the Water Act – see section 342. Under section 343, the QWC represents the State.

(c) facilitate and implement regional water security programs; and

(d) ensure compliance with the programs and with water restrictions imposed by QWC.[22]

67. The role of QWC is explained in more detail in the **Section C3**.

C2 Seqwater's role

68. The significance of Seqwater's role is immediately apparent from the depth of Seqwater's asset portfolio, the functions it is charged with and the nature of tasks outlined above.

69. Seqwater is well resourced (both financially and in respect of human resources), well managed and well governed and is achieving its objectives. In this regard, Seqwater refers the Commission to Seqwater's Annual Reports issued since the establishment of Seqwater, copies of which are provided in **Attachment 1**.

70. Seqwater's Strategic Plan 2010-11 to 2014-15 (**Attachment 2**), which is approved by the Minister, identifies two key goals within Seqwater's regulatory framework:

(a) in partnership with other Grid entities, to provide urban consumers with reliable water of a quality that meets or exceeds the Australian Drinking Water Guidelines (2004) as required by contract, regulation and best practice; and

(b) in order to ensure the current and future viability of the primary water sources of South East Queensland, Seqwater will effectively research and manage the water catchments to maximise water quality while also:

(i) providing for flood mitigation;

(ii) fostering rural productivity;

(iii) providing places of recreation;

(iv) enhancing biodiversity; and

(v) providing amenity for the people of South East Queensland.

71. Seqwater has adopted a sustainable 'productive catchment' vision for the integrated management of its assets and is focused on ensuring sustainable water quality for the South East Queensland region. The blend of Seqwater's asset portfolio enables sustainable planning and decision making to occur by balancing longer term catchment improvements against shorter term treatment plant upgrades. Seqwater recognises that this whole-of-catchment approach is vital to protecting human health. This commitment is in line with the approach prescribed by the National Health and Medical Research Council through the Australian Drinking Water Guidelines (2004). According to these Guidelines, drinking water quality is most effectively managed through a preventative multi-barrier approach, encompassing all steps in drinking water production.

72. Seqwater also recognises that best practice management of water quality across all steps of the treatment process is necessary to ensure the maximum sustainable value from Seqwater's integrated assets and services is achieved.

[22] See section 345 of the Water Act.

73. In addition to improved water quality, the benefits of this integrated approach to catchment-sourced water management also includes improved water quantity of water supply, improved community confidence, increased operational management and incident response, and the ability to anticipate and respond to regional growth and climate change.

74. The January 2011 Flood Event has highlighted the value of improved communication and access to information between water treatment plant operations and catchment and dam operations. This allows better management of water treatment, in particular raw water quality events, that might lead to downstream risks to the treatment plants.

75. During the January 2011 Flood Event, Seqwater's water treatment plant operators had immediate access to dam release strategies and dam release volumes, allowing the timing and impacts of releases to be assessed. Access to flood model predictions on river level and flows also enabled pre-emptive and proactive preparations to be made at water treatment plants and recreation sites across the region.

76. While significant attention during the Commission's deliberations will rightly be focused upon flood releases from Seqwater's dams, it is important the Commission notes that throughout the January 2011 Flood Event in South East Queensland, drinking water was maintained at all times to the people of South East Queensland other than a small number of residents serviced by the Lowood treatment plant. Given the scale of the natural disaster, this was a very significant achievement. It was able to be achieved, in large part, because of:

    (a) Seqwater's management of the integrated asset portfolio it maintains (including water storages and water treatment plants); and

    (b) the existence of the Grid.

77. In its subsequent submissions, Seqwater will provide the Commission with further details outlining the steps taken by Seqwater and other partners in the Grid in maintaining drinking water for the region during the January 2011 Flood Event (a matter relevant to paragraph 2(d) of the Terms of Reference) and Seqwater's management of its wider asset portfolio during the event.

C3 The regulatory framework governing Seqwater's operations

78. The regulatory framework which applies to Seqwater's operations is complex. However, an understanding of the framework is important.

79. In **Annexures 3, 4 and 5** Seqwater has identified the key regulatory instruments (and the relevant sections within them) which will likely be of assistance to the Commission. In doing so, Seqwater has not identified the regulatory instruments which apply in respect of water quality, as those matters will be included in subsequent submissions.

80. For ease of reference, the analysis has been broken into three categories:

    (a) Seqwater's powers and functions – see **Annexure 3**;

    (b) water planning and supply – see **Annexure 4**;

    (c) dam safety and flood mitigation – see **Annexure 5**.

81. Based upon the analysis in **Annexures 3, 4 and 5**, the following key observations can be made.

82. Seqwater holds a Resource Operations Licence (***ROL***) for Somerset, Wivenhoe and North Pine dams.[23] Seqwater's ROL is **Attachment 3**.

83. It is an offence to contravene a condition of a ROL.[24]

84. The conditions of Seqwater's ROL oblige Seqwater to comply with the operating requirements and supply arrangements set out in the Moreton ROP. The Moreton ROP is a statutory instrument issued under the Water Act.

85. The Moreton ROP is **Attachment 4**.

86. The operating requirements for Wivenhoe and Somerset Dams are contained in section 72 and Attachment 5 of the Moreton ROP.

87. The operating requirements for North Pine Dam are contained in section 97 and Attachment 6 of the Moreton ROP.

88. In line with these requirements, Seqwater must not release water from Somerset, Wivenhoe and North Pine Dams other than to supply downstream demand.[25] The vast majority of this downstream demand emanates from the Grid Manager.[26]

89. On its face, this restriction may prevent releases for flood mitigation purposes.[27]

90. However, Seqwater holds an approved interim program which, amongst other things, permits flood mitigation releases from Somerset, Wivenhoe and North Pine Dams once the level of the dams exceeds their Full Supply Levels (***FSL***).[28] The FSLs of Somerset, Wivenhoe and North Pine Dams are contained in the Moreton ROP.[29]

91. Under the dam safety legislation in Queensland,[30] Somerset, Wivenhoe and North Pine Dams are governed by approved manuals of operational procedures for flood mitigation.[31]

92. The manuals have been developed over many years with the input of qualified engineers and leading experts in the field. The history of the development of the manuals is contained in **Annexure 6**.

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[23] The ROL is held under the Water Act.

[24] Section 875 of the Water Act

[25] In respect of Mount Crosby Weir (downstream of Wivenhoe and Somerset), there is also an approval to release an insignificant amount of water each day (see sections 72(3) and 75 of the Moreton ROP).

[26] See the list of water entitlements contained in Attachment 8 to the Moreton ROP.

[27] Although Attachments 5 and 6 of the ROP do refer to "flood manuals " in respect of discharge characteristics.

[28] The interim program was approved under section of the Moreton ROP. By virtue of that section, the interim program prevails over the terms of the Moreton ROP. As explained in Section E, the interim approved program was revised in February 2011 to permit a temporary reduction in the lake level of Wivenhoe Dam to 75% of FSL.

[29] See Attachments 5 and 6 to the Moreton ROP.

[30] See the *Water Supply (Safety and Reliability) Act 2008*.

[31] Seqwater has already provided copies of the Wivenhoe Manual and North Pine Manual to the Commission.

93. The manuals govern the manner in which flood mitigation releases are made from Somerset, Wivenhoe and North Pine Dams. In this regard, the manuals do not apply until a Flood Event has been declared by the Duty Flood Operations Engineer, which occurs when the Duty Flood Operations Engineer expects the water level in the dams to exceed FSL and flood releases to be necessary.

94. By observing the operational procedures contained in the flood mitigation manuals, Seqwater does not incur civil liability for an act done, or omission made, honestly and without negligence in observing the procedures.[32]

95. Importantly, at the conclusion of the Flood Event, the dams are to be retained at FSL.[33]

96. In addition to holding approved flood mitigation manuals, Somerset, Wivenhoe and North Pine Dams comply with dam safety guidelines which require the dams to have sufficient flood discharge capacity to pass the Acceptable Flood Capacity without failure of the dams.[34]

C4 Seqwater's dam management – water storage, flood mitigation and other matters

97. There are four key roles that are performed by dams owned and operated by Seqwater. These are:

(a) Water storage

Dams enable the harvesting and storage of river flows to provide water supply to the community. Typically dams have outlet structures which allow water to be drawn from the various storage levels in order to source the best water quality. Releases are then made from the dam to either the river or piped to water treatment plants.

(b) Flood mitigation

Flood mitigation, at its most basic level, is capturing water and releasing it at a slower rate to minimise river levels downstream of the dam.

Flood mitigation by use of a dam and upstream reservoir, is the temporary storage of flood flows within the reservoir and discharging the flood flows to the downstream creek/river system in a controlled manner. The benefits of flood mitigation include:

(i) a reduction in peak discharge from the dam to the downstream creek/river system as compared to the peak discharge that would naturally occur without the dam in place; and

(ii) a delay in flood release to the downstream system, where an initial flood volume is temporarily stored (hours to days depending on flood magnitude) prior to opening flood gates, thereby allowing the peak

[32] Provided it acted honestly and without negligence - section 374 of the Water Supply Act.

[33] See section 3.1 of the manuals.

[34] See the discussion in **Annexure 7**.

discharges in other downstream creeks and rivers to pass prior to the release of the discharge out of the dam.

While all dams to some extent provide flood mitigation (because water must flow into them before proceeding downstream), few dams in Queensland are specifically designed to provide flood mitigation to areas downstream of the dam.

(c) Hydroelectricity generation

Hydroelectricity generation is the use of the potential energy of the water stored in dams by transforming it into kinetic energy that can be used to generate electricity. It is the most widely used form of renewable energy that produces no direct waste.

(d) Recreation

Seqwater is responsible for the ongoing management and maintenance of the recreation facilities at its water and catchment assets. Seqwater has recognised the important role that recreation plays for the community of South East Queensland. However, the use of assets for recreational purposes is secondary to Seqwater's main function of water supply and treatment. Recreational pursuits must be managed in a sustainable and environmentally responsible manner to ensure Seqwater's core responsibilities and accountabilities are not adversely impacted. There is ongoing public demand for use of lakes and the surrounding land for recreation and this demand is increasing as the South East Queensland population continues to increase.

98. Seqwater owns and operates 25 referable dams[35] in South East Queensland.

99. The failure of any one of Seqwater's dams can have significant consequences ranging from loss of life or injury, to economic loss and damage to property and the environment, and to loss of critical water supplies.

100. Seqwater has an excellent dam safety record that is based on a Dam Safety Management Program developed to ensure the safety of Seqwater's dams. These systems are described in Seqwater's Dam Safety Management Program, a copy of which is **Attachment 5**.

101. Potential hazards that impact the safety of Seqwater's dams and that are managed by Seqwater's Dam Safety Management Program include:

(a) flood;

(b) earthquake;

(c) potential design or construction flaws currently unknown;

(d) deterioration of dam infrastructure over time;

(e) interference with dam infrastructure by an external influence.

102. These potential hazards are managed by robust dam safety systems for staff training, dam safety documentation, dam surveillance and inspection, dam safety review and dam operations and maintenance.

[35] As defined in the Water Supply Act.

103. Seqwater owns four gated spillway dams and 21 uncontrolled spillway dams.

104. Gated spillway dams must be operated during flood events to protect the safety of the dam.

105. Of these, Wivenhoe and Somerset Dams have been designed to provide flood mitigation. North Pine and Leslie Harrison Dams have not been designed to provide for flood mitigation.

106. Seqwater also owns four uncontrolled spillway dams that have been designed to provide flood mitigation. These dams are Enoggera, Gold Creek, Hinze and Maroon Dams. Further technical detail in relation to these dams is contained in Annexure 7.

107. Details of these dams are contained in the following tables:

Table 1: Table of Gated Spillway Dams with Flood Compartments.

Source: Seqwater.

Gated Spillway Dams designed for flood mitigation			
Dam Name	**Full Supply Volume (ML)**	**Flood Compartment Volume (ML)**	**Dam Catchment Area (km^2)**
Somerset	379,849	524,000	1,340
Wivenhoe	1,165,238	1,420,000 [36]	7,020

Table 2: Table of Gated Spillway Dams with Flood Compartments.

Source: Seqwater.

Gated Spillway Dams not designed for flood mitigation			
Dam Name	**Full Supply Volume (ML)**	**Flood Compartment Volume (ML)**	**Dam Catchment Area (km^2)**
Leslie Harrison	24,868	N/A	87
North Pine	214,302	N/A	348

Table 3: Table of Uncontrolled Spillway Dams with Flood Compartments.

Source: Seqwater.

Uncontrolled Spillway Dams designed to provide flood mitigation			
Dam Name	**Full Supply Volume (ML)**	**Flood Compartment Volume (ML)**	**Dam Catchment Area (km^2)**
Enoggera	4,567	3,703ML	33
Gold Creek	1,421	640 (lowered storage level)	11
Hinze	161,073	79,000 (1 in 100)	207
Maroon	44,319	42,031	106

[36] This number is often represented as 1,450,000 ML as this was the figure that was announced and subsequently popularised at the time of the completion of the construction of the Wivenhoe Dam.

Table 4: Table of Uncontrolled Spillway Dams with Flood Compartments.

Source: Seqwater.

Uncontrolled Spillway Dams not designed for flood mitigation			
Dam Name	**Full Supply Volume (ML)**	**Flood Compartment Volume (ML)**	**Dam Catchment Area (km^2)**
Atkinson	30,488	N/A	33
Baroon Pocket	61,000	N/A	67
Bill Gunn	6,947	N/A	3
Borumba	45,952	N/A	465
Bromelton	8,210	N/A	1
Cedar Pocket	735	N/A	18
Clarendon	24,276	N/A	3
Cooloolabin	13,800	N/A	8
Ewen Maddock	16,587	N/A	21
Lake Macdonald	8,018	N/A	49
Lake Manchester	26,409	N/A	74
Little Nerang	6,705	N/A	35
Moogerah	83,765	N/A	228
Nindooinbah	322	N/A	<1
Poona	655	N/A	<1
Sideling Creek	14,370	N/A	53
Wappa	4,694	N/A	72

108. The approaches taken by Seqwater in operating gated spillway dams and uncontrolled spillway dams during flood events are described below.

Gated Spillway Dams

109. Given their potential significant impact on downstream populations, it is imperative that Seqwater's four gated spillway dams are operated during flood events in accordance with clearly defined procedures to minimise impacts to life and property. Seqwater has developed and maintains a detailed manual of procedures that describes the responsibilities of Seqwater personnel for flood event preparation, mobilisation and operation in relation to its gated spillway dams. This manual is titled the Seqwater Flood Procedure Manual. A copy is **Attachment 6**.

110. The Seqwater Flood Procedure Manual is an internal document. It refers to and implements the approved manuals of operational procedures for flood mitigation which are referred to above.[37]

111. Seqwater operates and maintains a Flood Operations Centre which manage flood events in accordance with the approved manuals of operational procedures for flood mitigation

[37] The approved manuals are the Wivenhoe Manual and the North Pine Manual.

which are referred to above[38]. Details of the Flood Operations Centre are contained in Chapter 4 of the Wivenhoe Flood Report.

112. The Seqwater Executive Management Team uses an Expert Panel to ensure the approved manuals of operational procedures for flood mitigation are kept current. This provides the necessary assurance that any updates or changes to the manuals will be suitable for use in supporting critical decision making during major flood events. The Expert Panel can access the following membership:

(a) Seqwater (Dam Safety Manager);

(b) Seqwater (Principal Hydrologist);

(c) DERM (Dam Safety Regulator);

(d) DERM (Principal Hydrologist);

(e) Bureau of Meteorology (Principal Hydrologist Flood Warning);

(f) Brisbane City Council (Principal Hydrologist);

(g) SunWater (Principal Hydrologist); and

(h) Independent Expert/s (as required).

113. Meetings of the Expert Panel are convened by Seqwater's Dam Safety Manager as required. This occurs following major flood events and if any manual or system changes are proposed.

Uncontrolled Spillway Dams

114. Seqwater owns 21 uncontrolled spillway dams. During flood events, these dams fill and overflow from a spillway, with Seqwater having no facility to regulate or change these outflows.

115. Uncontrolled spillway dams do not have associated approved manuals of operational procedures for flood mitigation as it is not possible to in any way influence flood releases from these dams during flood events.

116. Seqwater's primary responsibility during such events is to monitor the safety of the dams and provide dam outflow information to the emergency agencies including the BoM and the Local Authority responsible for the area impacted by the dam outflow.

117. Seqwater's 21 uncontrolled spillway dams generally contain earth and rockfill structures that cannot withstand overtopping without damage or risk of failure. The exceptions to this are Little Nerang Dam and Moogerah Dam that can withstand some limited overtopping without risk. The structural safety of the dams is paramount as failure of a dam could have catastrophic consequences due to the magnitude of the flood damage which would be caused downstream. Seqwater ensures that its dam spillways are kept clear and well maintained and ready for flood outflows at all times and that a Dam Supervisor is available to monitor flood releases as required.

[38] Seqwater has already provided copies of the Wivenhoe Manual and North Pine Manual to the Commission.

118. Seqwater has access to a number of data collection systems, providing real time rainfall and stream height data. There are approximately 350 rain gauges and 250 water level gauges in South East Queensland which operate as event reporting radio telemetry stations. Approximately one-third of this network is owned by Seqwater with the remainder owned by the BoM and the various City and Regional Councils across the area. Other real time data sources available to Seqwater include:

(a) rainfall and water level data from about 30 stations is obtained via polled telephone telemetry;

(b) manual observations, particularly of water level at dams;

(c) radar images and corrected radar fields made available from the BoM; and

(d) numerical weather prediction maps made available from the BoM.

119. Using this available real time data, Seqwater uses hydrologic models to estimate outflows from its dams and in key stream locations relevant to the dams.

120. During flood events, Seqwater runs these models to provide estimates of actual and projected (based on rainfall forecasts) stream flows in real time. These estimates are calculated for the following purposes:

(a) supporting operational decision making at Wivenhoe, Somerset, North Pine and Leslie Harrison dams during flood events;

(b) calculating the potential magnitude of flood events in advance for emergency action planning purposes; and

(c) providing information to Local Disaster Management Groups on likely and predicted outflows from Seqwater dams if requested.

121. Seqwater has also developed and maintains procedures that describe the responsibilities of Seqwater personnel for flood event preparation, mobilisation and operation, in relation to its uncontrolled spillway dams. These are contained in Seqwater's Flood Procedure Manual referred to above.

122. In addition to the above, Seqwater complies with a draft Communication Protocol developed by DERM to ensure effective communication between local, State and Commonwealth agencies impacted by the release of floodwaters from Wivenhoe and Somerset Dams. Further information on the protocol is provided in Chapter 11 of the Wivenhoe Flood Report.

C5 Overview of Wivenhoe and Somerset Dams and their flood mitigation capacity

123. As an earth and rock fill dam, Wivenhoe Dam is not designed to be overtopped.

124. As a mass concrete dam, Somerset Dam is designed to only withstand limited overtopping.

125. Overtopping carries with it the risk of "failure", which is

(a) the physical collapse of all or part of the dam; or

(b) the uncontrolled release of any of the dam's contents.[39]

126. As a result, Wivenhoe and Somerset Dams contain infrastructure which release water during flood events.

127. 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 Figure 5.

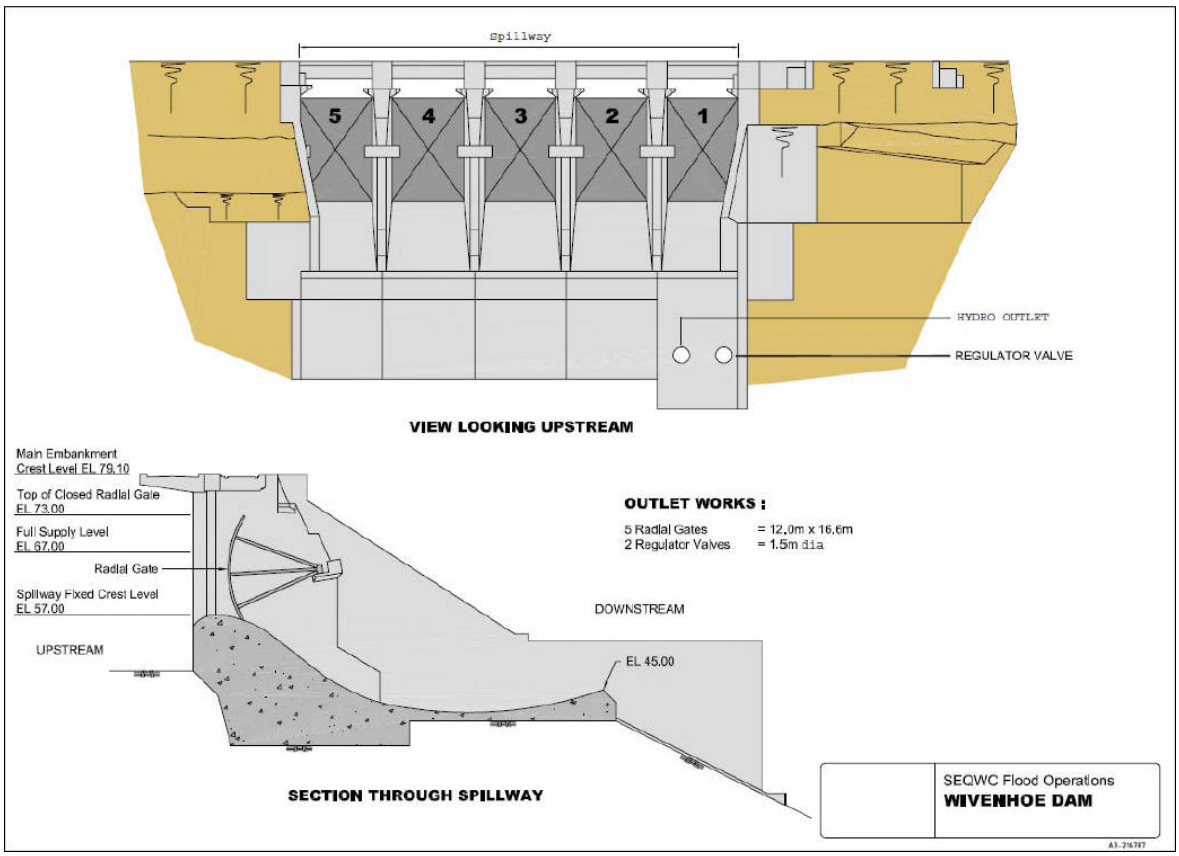

Figure 5: Cross Sections of Wivenhoe Dam.

(Source: Seqwater, *Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam, November 2009*, p 19.)

128. Radial gates, sluice gates and regulator valves are the primary infrastructure used to release water during flood events at Somerset Dam. The arrangement of this infrastructure is shown in the figure below.

[39] Schedule 3, Water Supply Act

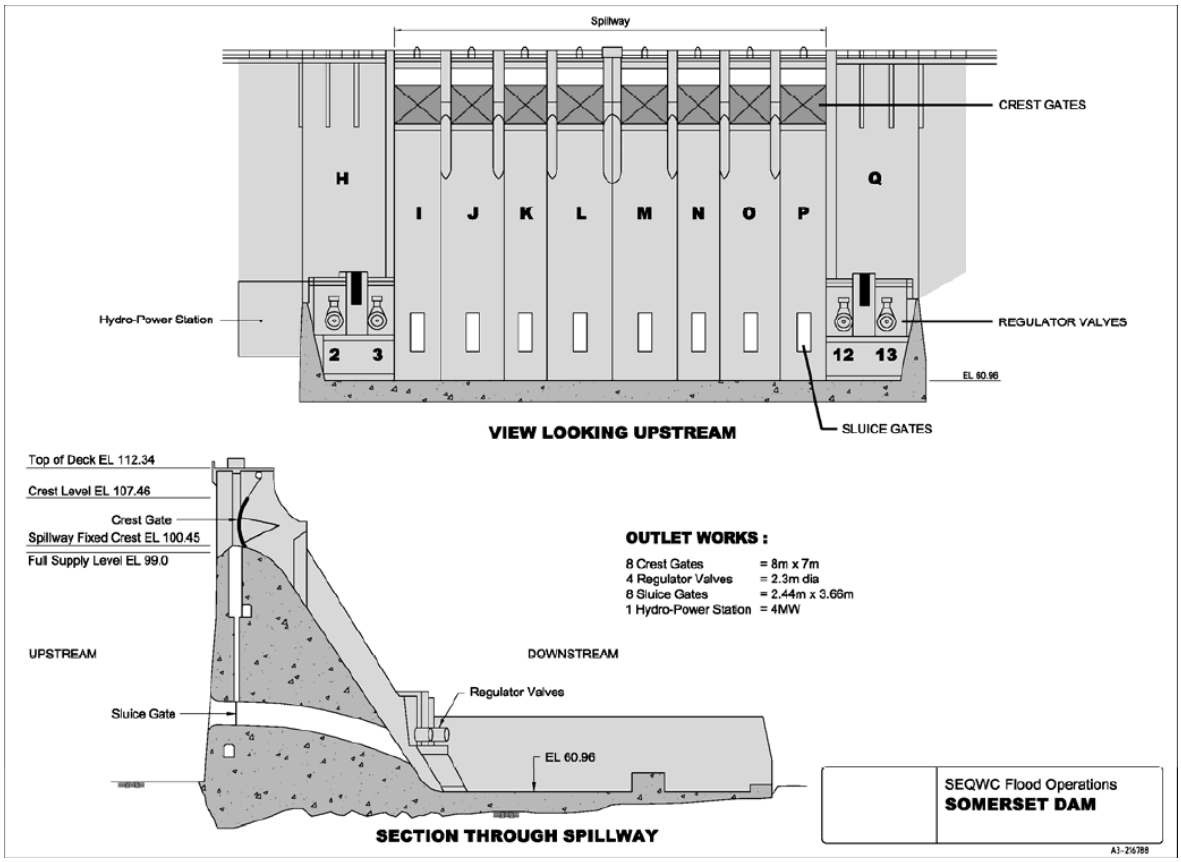

Figure 6: Cross Sections of Somerset Dam.

(Source: Seqwater, *Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*, November 2009, p 77.)

129. The capacities of Wivenhoe and Somerset Dams are detailed in the table below.[40] The table identifies drinking water capacity and flood mitigation capacity, both at an elevation level and in volume.

[40] The megalitre volume for storage capacity is only available to the nearest 0.5 metre for Wivenhoe and Somerset Dams.

Table 5: Storage Capacity of Wivenhoe and Somerset Dams.

Source: Seqwater, 'Somerset Dam Design Flood Hydrology' (Draft Report), October 2009. Seqwater, 'Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam', November 2009. Department of Primary Industries, 'Wivenhoe Dam Design Report – Volume 1 – Text' , September, 1995.

	Somerset Dam	**Wivenhoe Dam**
FSL (EL)	99.00 m[41]	67.00 m[42]
FSL (ML)	379,800 ML[43]	1,165,000 ML[44]
Dam Crest Level (EL)	107.46 m[45]	79.1 m[46]
Flood Mitigation Capacity above FSL (ML)	524,200 ML[47]	1,420,000 ML[48]
Dam Failure Level (EL)	109.7 m[49]	80 m[50]
AEP (Dam Failure Flood)	1 in 100,000	1 in 100,000 AEP [51]
AEP of the PMP	1 in 750,000 [52]	1 in 143,000 AEP

[41] Seqwater, '*Somerset Dam Design Flood Hydrology*' (Draft Report), October 2009, p13.

[42] Seqwater, '*Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*', November 2009, p19.

[43] Seqwater, '*Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*', November 2009, p58.

[44] Seqwater, '*Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*', November 2009, p52.

[45] Seqwater, '*Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*', November 2009, p 59.

[46] EL 77 was the original Maximum Flood Level of Wivenhoe Dam. Department of Primary Industries, '*Wivenhoe Dam Design Report – Volume 1 – Text*' – September, 1995.

[47] Seqwater, '*Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*', November 2009, p59.

[48] Seqwater, '*Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*', November 2009, p53.

[49] Seqwater, '*Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*', November 2009, p40.

[50] Seqwater, '*Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*', November 2009, p40.

[51] Wivenhoe Alliance, Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091, September 2005, p 9.

[52] Seqwater, (Draft) '*Somerset Dam Design Flood Hydrology*', October 2009, p i to ii.

130. By way of explanation of the above table:

(a) Wivenhoe Dam:

(i) has a Full Supply Level of 1,165,000 ML. This is the drinking water storage compartment of Wivenhoe. This Full Supply Level is achieved when the water in the lake reaches EL 67.0m. The Full Supply Level at this elevation level was first identified in 1971 by the Co-ordinator General, when the dam was designed.[53] Subsequent reports have affirmed the Full Supply Level at EL67.0m[54], which is the level contained in the Moreton ROP;

(ii) in addition, was designed with a flood storage compartment of 1,420,000 ML. The failure level of the dam in the original design was EL 79.1m and temporary works were installed during construction of the dam to raise this level to EL 79.7m. In 2005, permanent works including the construction of a new wave wall on the crest of the dam were completed to raise the failure level of the dam to EL 80.0m. Once all radial gates are fully open at about EL 75.7m, the Dam operators have no control over Dam outflow if the Dam level continues to rise towards the dam failure level;

(iii) can pass a flood with an Annual Exceedence Probability (which is the probability of a specified event being reached or exceeded in any one year) (***AEP***) of 1 in 100,000;[55]

(iv) planned future Stage 2 upgrade works to be completed by 2035, including the Reconstruction of Saddle Dam 2 as a fuse plug spillway, are proposed such that Wivenhoe Dam can accommodate the Probable Maximum Flood (***PMF***), which is the worst flood statistically estimated for the catchment.[56]

(b) Somerset Dam:

(i) has a designed dedicated flood mitigation capacity of approximately 524,000 ML at its dam crest level of EL 107.45 m;

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[53] See "Report on Proposed Dam on the Brisbane River at Middle Creek or alternatively Wivenhoe and Flood Mitigation" Co-Ordinator General dated June 1971 page S7;

[54] South East Queensland Water Board, Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam (1992), p24; South East Queensland Water Board, Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam (1997), p 20.; South East Queensland Water Corporation Limited, Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam (2002), p20; South East Queensland Water Corporation Limited, Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam (2004), p24; Seqwater, (for Queensland Water Commission and Queensland Department of Natural Resources and Water), Provision of contingency storage in Wivenhoe and Somerset Dams (March 2007), p14-15; Seqwater, Wivenhoe Dam Five Year Comprehensive Dam Safety Inspection Report, (September 2010), p 4.

[55] Source: Wivenhoe Alliance, Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091, September 2005, p 9.

[56] Seqwater (for Queensland Water Commission and Queensland Department of Natural Resources and Water), *Provision of contingency storage in Wivenhoe and Somerset Dams* (March 2007), p 16.

(ii) can pass a flood with an AEP of approximately 1 in 100,000 with all gates operational.[57]

131. In order to assist the Commission, in **Annexure 7** Seqwater provides further technical information in respect of the design of Wivenhoe and Somerset Dams.

C6 Wivenhoe Manual Objectives and Strategies

132. The Wivenhoe Manual provides the objectives and strategies to guide operational decision making during flood events. This ensures that any releases of water are made in accordance with a hierarchy of objectives. In order of importance, these objectives are:

(a) ensure the structural safety of the dams;

(b) provide optimum protection of urbanised areas from inundation;

(c) minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;

(d) retain the storage at FSL at the conclusion of the flood event;

(e) minimise impacts to riparian flora and fauna during the drain down phase of flood event.

133. While the Wivenhoe Manual provides objectives and strategies to guide operational decision-making, it is not possible to provide a specific procedure for dam operation for every possible flood event. The objective followed and strategy chosen at any point in time must depend on the real-time water levels in the dams, as well as flood modelling predictions based on the best observed rainfall, forecast rainfall and stream flow information available.

134. In view of the complexity of the tasks involved in making operational decision making during flood events, all decisions taken under are made by experienced engineers, approved by the Dam Safety Regulator.

135. During flood events, Wivenhoe and Somerset Dams are to be operated in conjunction to optimise the total flood mitigation benefits of the storages.[58]

136. By way of brief overview, the strategies contained in the Wivenhoe Manual are summarised below dealing with the Wivenhoe strategies first and the Somerset strategies second.

Wivenhoe Dam Operating Strategies

Table 6: Table of Wivenhoe Dam Flood Mitigation Strategy W1.

Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p 24.

Strategy W1 - The primary consideration is minimising disruption to downstream rural life	
Conditions	• Wivenhoe storage level predicted to be less than 68.50m

[57] Seqwater, (Draft) '*Somerset Dam Design Flood Hydrology*', October 2009, p i to ii.

[58] Seqwater, '*Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*', November 2009.

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

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

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

Table 7: Table of Wivenhoe Dam Flood Mitigation Strategy W2

Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p 27.

Strategy W2 - A transition strategy where the primary consideration changes from minimising impact to downstream rural life to protecting urban areas from inundation.	
Conditions	• Wivenhoe storage level predicted to be between 68.50m and 74.00m • Maximum release predicted to be less than 3,500m^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

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

Table 8: Table of Wivenhoe Dam Flood Mitigation Strategy W3

Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p 28.

Strategy W3 – The primary consideration is protecting urban areas from inundation	
Conditions	• Wivenhoe storage level predicted to be between 68.50m and 74.00m • Maximum release should not exceed 4,000m^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

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

Table 9: Table of Wivenhoe Dam Combined Peak River Flow Targets for Flood Mitigation Strategy W3

Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p 28.

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.

Table 10: Table of Wivenhoe Dam Combined Peak River Flow Targets for Flood Mitigation Strategy W4

Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p 29.

Strategy W4 – The primary consideration is protecting the structural safety of the Dam	
Conditions	• Wivenhoe storage level predicted to exceed 74.00m • No limit on maximum release rate • The primary consideration is protecting the structural safety of the Dam • Lower level objectives are still considered when making decisions on water releases. Objectives are always considered in order of importance

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

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

Somerset Dam Operating Strategies

Table 11: Table of Somerset Dam Flood Mitigation Strategy S1

Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p 39.

Strategy S1 – Minimising impact on rural life upstream	
Conditions	• Somerset Dam level expected to exceed 99.0m and Wivenhoe Dam not expected to reach 67.0m (FSL) during the course of the flood event

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

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

Table 12: Table of Somerset Dam Flood Mitigation Strategy S2

Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p 39.

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

145. Strategy S2 intends 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.

Table 13: Table of Somerset Dam Operating Conditions and Actions for Strategy S2

Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p 39 - 40.

Condition	Action
Wivenhoe Dam rising and Somerset Dam level below 100.45m	• The crest gates are raised to enable uncontrolled discharge • The low-level regulators and sluices are generally kept closed
Wivenhoe Dam rising and Somerset Dam level above 100.45m	• The crest gates are raised to enable uncontrolled discharge • Operations aim to achieve a correlation of water levels in Somerset Dam and Wivenhoe Dam, as set out in Figure 10.2.2. The Operating Target Line shown on this graph is to generally be followed as the flood event progresses

Condition	Action
	• The release rate from Somerset Dam is generally not to exceed the peak inflow into the Dam
Wivenhoe Dam falling and Somerset Dam level above 100.45m	• The opening of the regulators and sluices generally should not cause Wivenhoe Dam to rise significantly • The release rate from Somerset Dam is generally not to exceed the peak inflow into the Dam
The flood event has emanated mainly from the Stanley River catchment without significant runoff in the Upper Brisbane River catchment	• The crest gates at Somerset Dam are raised to enable uncontrolled discharge • The regulator valves and sluice gates are to be used to maintain the level in Somerset Dam below 102.0m (deck level of Mary Smokes Bridge) • The release rate from Somerset Dam is generally not to exceed the peak inflow into the Dam.

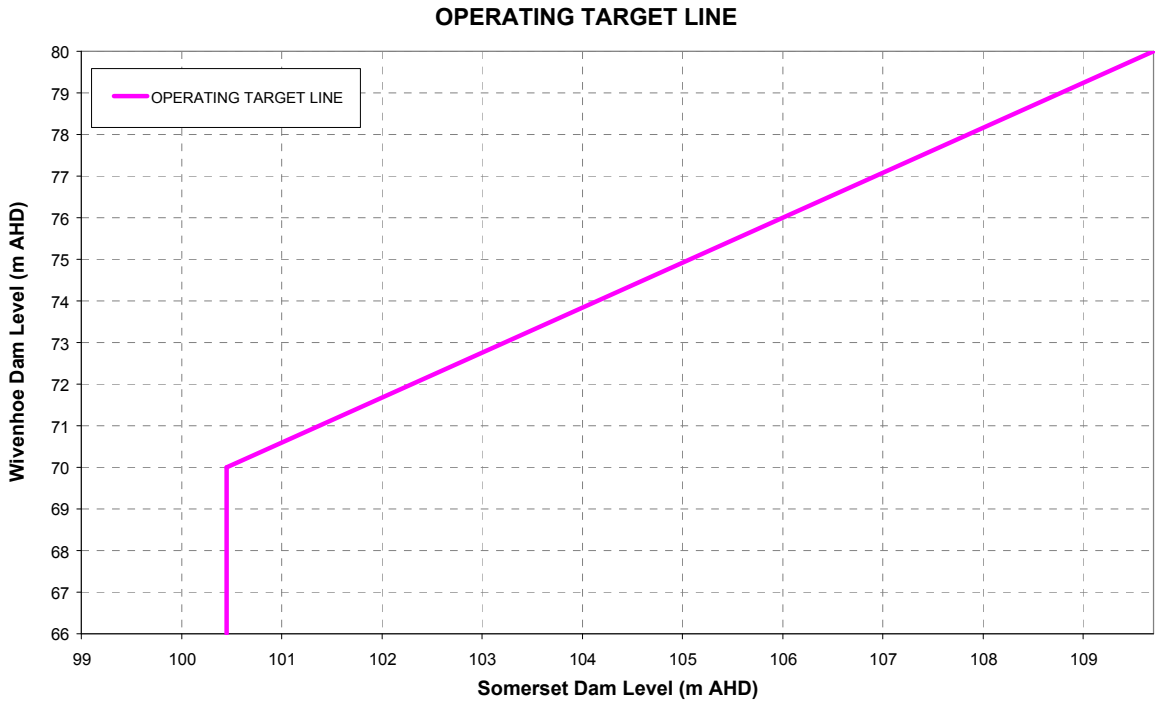

Figure 7: Operating Target Line of Wivenhoe and Somerset Dams.

(Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p 7.).[59]

[59] The Operating Target Line was selected following an optimisation study and considering the following factors:

- Equal minimisation of flood level peaks in both Dams in relation to their associated Dam failure levels;
- Minimisation of flows in the Brisbane River downstream of Wivenhoe Dam;

Table 14: Table of Somerset Dam Flood Mitigation Strategy S3

Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p 41.

Strategy S3 - Protect the structural safety of the Dam	
Conditions	• Somerset Dam level expected to exceed 99.0m and Wivenhoe Dam level expected to exceed the fuse plug initiation level during the course of the flood event.

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

(a) The safety of Somerset Dam is the primary consideration and cannot be compromised;

(b) The peak level in Somerset Dam cannot exceed 109.7m.

C7 Overview of North Pine Dam and why it is different to Wivenhoe and Somerset Dams

147. North Pine Dam is located on the North Pine River approximately 2 km upstream of its confluence with the South Pine River.[60]

148. North Pine Dam was completed in 1976. It has an FSL of EL 39.60 m or approximately 214,000 ML for drinking water supply to South East Queensland.[61]

149. North Pine Dam was not designed to provide flood mitigation.

150. North Pine Dam is also not designed to be overtopped and as a result, North Pine Dam contains infrastructure which releases water during flood events.

151. Radial gates are the primary infrastructure used to release water during flood events at North Pine Dam. The arrangement of this infrastructure is shown in the Figure 8 below.

- Consideration of the time needed at the onset of a flood event to properly assess the magnitude of the event and the likely impacts. This is to ensure the optimal strategy to maximise the flood mitigation benefits of the storages can be selected.

The target point on the Operating Target Line at any point in time is based on the maximum storage levels in Wivenhoe and Somerset Dams, using the best forecast rainfall and stream flow information available at the time.

Gate operations enable the progressive movement of the duty point towards the target line. It is not necessarily possible to adjust the duty point directly towards the target line in a single gate operation.

[60] SunWater, *Final Report North Pine Dam Design Flood Hydrology* (October 2007), p4.

[61] SunWater, *Final Report North Pine Dam Design Flood Hydrology* (October 2007), p4; Seqwater, *North Pine Dam Emergency Action Plan* (September 2010), p5.

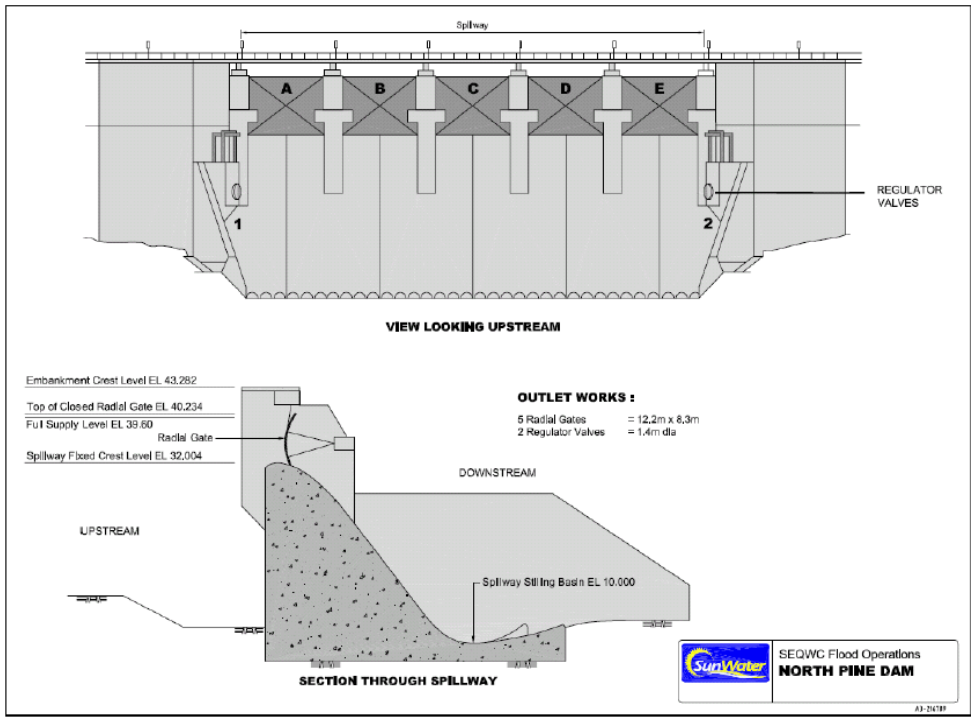

Figure 8 Cross Sections of North Pine Dam.

(Source: Seqwater, *Manual of Operational Procedures for Flood Mitigation at North Pine Dam, Revision 5, August 2010*, p 18.)

C8 North Pine Dam Manual Objectives

152. The North Pine Manual provides the objectives to guide operational decision making during flood events.

153. In order of importance these objectives are:

(a) ensure the structural safety of the dam;

(b) minimise disruption to the community in areas downstream of the dam;

(c) retain the storage at full supply level at the conclusion of the flood event; and

(d) minimise impacts to riparian flora and fauna during the drain down phase of flood event.

154. North Pine Dam is not designed for flood mitigation, and once the dam is full ensuring the structural safety of the dam is paramount. Accordingly, the flood operation strategy is to pass any significant flood through the reservoir, while ensuring that peak outflow generally does not exceed peak inflow and aiming to empty stored floodwaters as quickly as possible.[62]

155. As the size of the North Pine catchment is very different to the catchments of the Wivenhoe and Somerset Dams, the North Pine Manual expressly permits the pre-release of water to reduce the risk of the dam overtopping.[63]

[62] North Pine Manual p 19.

[63] Seqwater, *Manual of Operational Procedures for Flood Mitigation at North Pine Dam* (August 2010), Revision 5, p 19.

D The January 2011 Flood Event in South East Queensland

D1 Detailed analysis of the January 2011 Flood Event

156. As required by the Wivenhoe Manual and North Pine Manual, Seqwater has prepared two reports in respect of the January 2011 Flood Event.

157. Seqwater has already provided the Commission with a copy of the Wivenhoe Flood Report. The report focuses on the January 2011 Flood Event which commenced in the Brisbane River catchment at 7.42am on 6 January 2011 and ended at 12pm on 19 January 2011.

158. The Wivenhoe Flood Report has been independently peer reviewed. The reports from these independent peer reviewers are shown as **Attachment 29**. Seqwater will make further submissions to the Commission in respect of those peer reviews shortly.

159. Accompanying this submission is a copy of the North Pine Flood Report. The report focuses upon the January 2011 Flood Event which commenced in the Pine River catchment at 8.00am on 6 January 2011 and ended at 5.00am on 14 January 2011.

160. Seqwater relies on the contents of the Wivenhoe Flood Report and the North Pine Flood Report for the purposes of this submission.

161. Together, the reports provide the Commission with Seqwater's detailed analysis of the January 2011 Flood Event affecting Somerset, Wivenhoe and North Pine Dams.

162. Seqwater is prepared to provide such further information, data or elaboration as the Commission may require.

D2 Conclusions to be drawn in respect of the January 2011 Flood Event

163. In view of the Commission's first task to deliver an interim report containing recommendations on flood preparedness relevant to next summer's wet season, Seqwater submits that there are a number of conclusions the Commission should reach in respect of the January 2011 Flood Event. These are dealt with in categories below.

The extent of the protection offered by Wivenhoe and Somerset Dams

164. The existence and operation of Wivenhoe and Somerset Dams cannot prevent flooding in Brisbane.

165. This is so for a number of reasons.

166. *First*, each Flood Event is different. The Brisbane River catchment is approximately 13,500 square kilometres. Rainfall events vary in intensity, duration and distribution over the catchment.

167. Only rain which falls *upstream* of Wivenhoe and Somerset flows into the impoundments. In practical terms, this equates to approximately 50% of the Brisbane River catchment.

168. A map of much of the South East Queensland is shown in Figure 9. The Commission will note that only floodwaters in the "Stanley catchment" flow into Somerset Dam, and only floodwaters in the "Upper Brisbane catchment" flow into the Wivenhoe Dam. Only the northern section of the "Pine catchment" flows into the North Pine Dam.

169. As can be seen from the map below, the other (approximately) 50% of the Brisbane River catchment in South East Queensland has no flood mitigation measures – see the "Lockyer catchment", "Bremer catchment", "Mid-Brisbane catchment" and "Lower Brisbane catchment" all of which drain into the Brisbane River below Wivenhoe and Somerset Dams. This is particularly relevant in respect of the January 2011 Flood Event, where flows from the Lockyer Creek, Bremer River, Mid-Brisbane catchment and Lower Brisbane catchment *alone* would have caused damaging flooding in Brisbane.

Figure 9: Map of South East Queensland River Catchments

(Source: Healthy Waterways website.)

170. *Secondly*, depending upon the size of the flood event, it may be necessary to release floodwaters from Wivenhoe Dam in a controlled manner.

171. As discussed in Section C6 above, the Manual provides the objectives and strategies to guide operational decision making during Flood Events. This ensures that any releases made are in accordance with a hierarchy of objectives. In order of importance, these objectives are:

(a) ensure the structural safety of the dams;

(b) provide optimum protection of urbanised areas from inundation;

(c) minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers;

(d) retain the storage at full supply level at the conclusion of the flood event;

(e) minimise impacts to riparian flora and fauna during the drain down phase of flood event.

172. It is immediately apparent from these objectives that major flood events upstream of Wivenhoe and Somerset Dams may be encountered where protection of urbanised areas is not possible and the focus of releases of water from Wivenhoe must be upon maintaining the structural safety of the dam (and thereby avoiding the catastrophic consequences which would likely flow should the dam suffer structural failure). Wivenhoe Dam was designed in the knowledge of this and the objectives of the Wivenhoe Manual accommodate these circumstances. The January 2011 Flood Event was just such a flood event (as explained below).

Size and scale of the January 2011 Flood Event

173. The available recorded data shows the January 2011 Flood Event was unprecedented in the history of Wivenhoe and Somerset Dams and rivals the largest floods in the recorded flood history of the region.

174. The Institution of Engineers Australia (Engineers Australia) national guidelines for the estimation of design flood characteristics (AR&R) categorise the January 2011 Flood Event as a *large* (Annual Exceedence Probability [AEP] of 1 in 100) to *rare* (AEP of 1 in 2,000) event.

175. The flood level classifications adopted by the BoM also define the January 2011 Flood Event as a major flood.

176. Relevant statistics that demonstrate this are:

(a) At some individual rainfall stations within the Brisbane River catchment, rainfall estimates beyond the credible limit of extrapolation (AEP of 1 in 2,000) were recorded for durations between 6 hours and 48 hours during the event. [64]

(b) Rainfall recorded in the catchment area above Wivenhoe Dam indicates the catchment average rainfall intensity for the 72-hour period to Tuesday 11 January 2011 at 19:00 had an AEP between 1 in 100 and 1 in 200.[65]

[64] Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p ii.

(c) The catchment average rainfall intensity for the 120-hour period to Tuesday, 11 January 2011 at 19:00 also had an AEP between 1 in 100 and 1 in 200.[66]

(d) On the morning of Tuesday 11 January 2011, water levels in Wivenhoe Dam began rising rapidly in response to very heavy localised rainfall on and close to the Wivenhoe Dam lake area. At the time, the BoM radar indicated this rain was located in an area not containing real time rain gauges. Post flood analysis suggests the rainfall required to reproduce this rise could exceed an AEP of 1 in 2,000 and may be well into the extreme category. Rainfall of this intensity and duration over the Wivenhoe Dam lake area at such a critical stage of a Flood Event was unprecedented.[67] To assist in understanding the location and intensity of the rainfall during the January 2011 Flood Event, Seqwater's computer systems have generated an animation of the rainfall event. The animation is **Attachment 7**.

(e) The volume of total inflow into Wivenhoe Dam during the January 2011 Flood Event was 2,650,000 ML. This volume is almost double (190%) the comparable volume of inflow from the January 1974 flood event, and is comparable with the flood of 1893.[68]

(f) The inflow into Wivenhoe Dam during the January 2011 Flood Event was characterised by two distinct flood peaks, with each peak separated by about 30 hours. The maximum flow rate at the first peak is estimated to be around 200% of the comparable flow rate calculated from the January 1974 event, while the maximum flow rate at the second peak is estimated to be approximately 230% of the comparable flow rate from the January 1974 event.[69]

(g) The peak water levels recorded at gauges in the Brisbane River catchment above Wivenhoe Dam during the January 2011 Flood Event exceeded the major flood level and in many cases produced the highest levels ever recorded. This situation was repeated in Lockyer Creek that enters the Brisbane River downstream of Wivenhoe Dam.[70]

Flood mitigation benefits

Wivenhoe and Somerset Dams

177. Notwithstanding the size and scale of the January 2011 Flood Event, the existence and operation of Wivenhoe and Somerset Dams had a major effect on reducing flood damage in areas downstream of the dams. These benefits include the following:

(a) *First*, the Figure 10 below demonstrates the significant mitigation benefits of Wivenhoe Dam during this January 2011 Flood Event. The peak of the outflow

[65] Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p ii.

[66] Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p ii.

[67] Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p ii.

[68] Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p ii.

[69] Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p iii.

[70] Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p iii.

from the Wivenhoe Dam was approximately 40% lower than the peak of the inflow, meaning that just below the Dam, the maximum hourly flow rate in the Brisbane River was reduced by around 40%.

(b) *Secondly*, Figure 10 below demonstrates that without the mitigating effects of Wivenhoe Dam, the peak flood height measured at the Port Office gauge near the Brisbane CBD would have been approximately 2.0m higher than the peak of 4.45m which was experienced. The same figure demonstrates that damaging flooding would have occurred in urbanised areas from flows from the Lockyer Creek and Bremer River *alone*.

(c) *Thirdly*, based on the current damage curves, these projected reductions in the flood peak height resulted in:

(i) significant reductions in the potential for the loss of life;

(ii) monetary savings in regard to property damages in the order of up to $5 billion, as it is estimated up to 14,000 more properties would have been impacted by the January 2011 Flood Event (*Source: Flood Damage Tables – River PMF tab; provided to Seqwater by Brisbane City Council*).

178. The flood mitigation benefits provided by Wivenhoe and Somerset Dams can be seen from the following figure. By way of explanation:

(a) The dark blue line indicates the flow of water (expressed in cumecs) into Wivenhoe Dam. The speed of the flow is measured against the left axis. The two distinct flood peaks are apparent.

(b) The light blue line indicates the flow of water (expressed in cumecs) released from Wivenhoe Dam. The significantly reduced rate at which water was released from the dam (compared to the rate at which water flowed into the dam – the dark blue line) is apparent.

(c) The red line indicates the height of the water in Wivenhoe Dam during the January 2011 Flood Event (measured against the right axis of Figure 10).

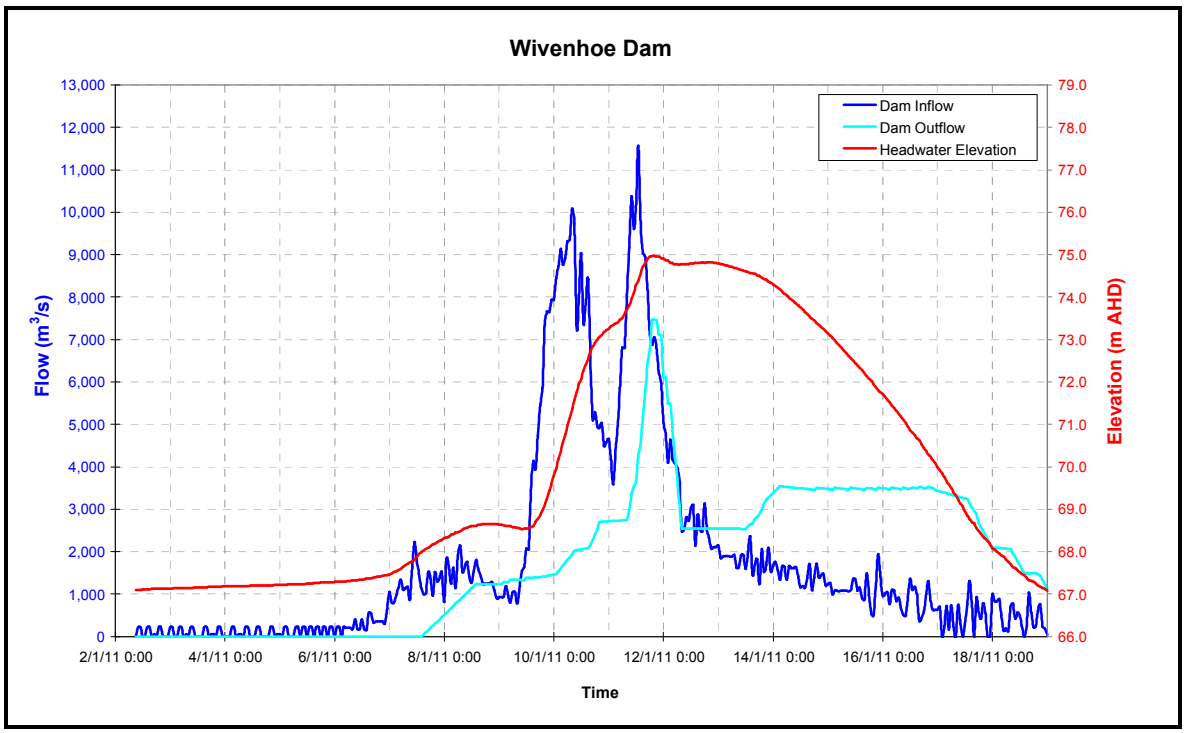

Figure 10: Wivenhoe Dam Inflow and Release Summary for the January 2011 Flood Event.

(Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Sam and Wivenhoe Dam*, 2 March 2011, p 96.)

179. The flood mitigation benefits provided by Wivenhoe and Somerset Dams are also demonstrated by Figure 11 below. By way of explanation:

(a) the threshold of damaging floods is identified by the black line at 4,000 cumecs. For the purposes of Figure 11, it has been assumed that the peak flow in the Brisbane River at the Port Office gauge is approximately the same as that at Moggill gauge;

(b) the blue line is the estimated flow rate during the January 2011 Flood Event;

(c) the purple line is that part of the estimated flow rate during the January 2011 Flood Event which is attributable to flows from the Lockyer Creek, Bremer River and flows downstream of Wivenhoe Dam excluding releases from Wivenhoe Dam. As is evident, the threshold of the damaging flood threshold was exceeded by these flows alone;

(d) the red line is that part of the estimated flow rate during the January 2011 Flood Event which is attributable to flows from water released from Wivenhoe Dam. As is evident, the contribution of such flows to the overall flood event was less than the flows attributable to the Lockyer Creek, Bremer River and flows downstream of Wivenhoe Dam;

(e) the light blue line demonstrates the likely estimated flows which would have been suffered had Wivenhoe Dam not existed. The significant reduction in the estimated flow rate in the flood event is apparent;

(f) the orange line demonstrates the likely estimated flows which would have been suffered had Wivenhoe and Somerset Dams not existed. The significant reduction in the estimated flow rate in the flood event is apparent; and

(g) inflows comprising the red line (Wivenhoe releases only) and the purple line (flows from the Lockyer Creek, Bremer River and flows downstream of Wivenhoe Dam) cannot be directly added together to equal the blue line, due to the storage and routing impact of the floodplain and the river channels.

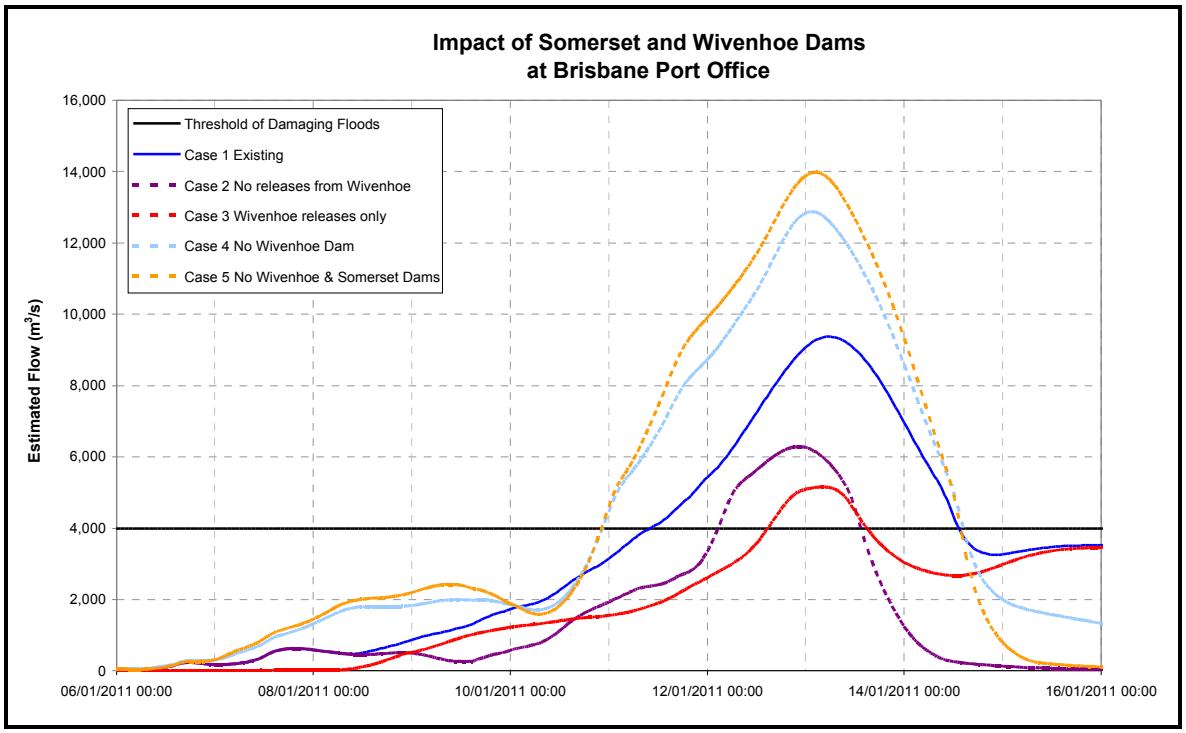

Figure 11: Impact of Somerset and Wivenhoe Dams at Brisbane Port Office.

(Source: Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p 149.)

North Pine Dam

180. Notwithstanding that the North Pine Dam is not designed for flood mitigation, the storage reduced peak outflows to a maximum of 82% of inflow rate[71].

181. The flood mitigation benefits provided by the North Pine Dam can be seen in Figure 12. By way of explanation:

(a) the solid dark blue line indicates the outflow of water (expressed in cumecs). The peak outflow can be observed at only 82% of the peak inflow, represented by the dashed blue line.

[71] Seqwater, *January 2001 Flood Event Report on the operation of North Pine Dam*, 11 March 2011.

(b) average catchment rainfall is depicted in the red column graph as millimetres per hour (mm/hr).

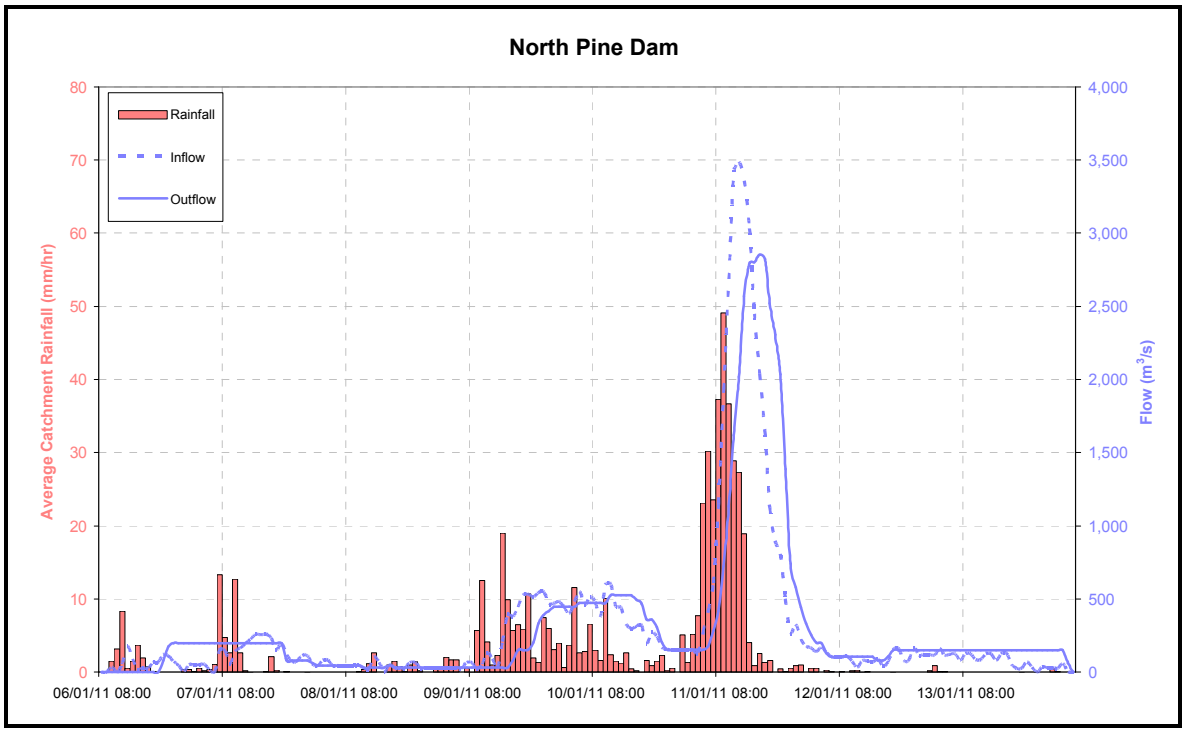

Figure 12: North Pine Dam – January 2011 Flood Event and Inflow and Outflow.

(Source: Seqwater, *January 2011 Flood Event Report on the operation of North Pine Dam*, 2 March 2011, p 46)

Operation of Wivenhoe and Somerset Dams

182. Following the January 2011 Flood Event, it has been suggested that Seqwater's operation of Wivenhoe and Somerset Dams caused or contributed to flooding in urban areas below the dams.

183. Questions have been raised whether:

(a) Seqwater should have reduced the volume of water in Wivenhoe Dam prior to the January 2011 Flood Event (below FSL) to increase the available flood mitigation capacity;

(b) Seqwater did not release enough water during the early stages of the January 2011 Flood Event; and

(c) Seqwater released too much water in the later stages of the January 2011 Flood Event.

184. However, an understanding of the size and magnitude of the January 2011 Flood Event, the extent to which forecasts underestimated actual rainfall and the regulatory environment within which Seqwater operates, demonstrate these claims are without foundation for the reasons explained below.

185. On the question of whether Seqwater should have reduced the volume of water in Wivenhoe Dam prior to the January 2011 Flood Event (below FSL) to increase the available flood mitigation capacity, Seqwater notes:

(a) *First*, nothing in the meteorological material Seqwater received in the lead up to the 2011 wet season suggested an event of the magnitude of the January 2011 Flood Event would occur.

(b) *Secondly*, in any event, the Wivenhoe Dam provides significant flood mitigation capacity (1,420,000 ML) above its existing FSL. At the commencement of the January 2011 Flood Event, virtually all of this flood mitigation capacity was available.[72] To obtain any appreciable additional flood mitigation benefit, a significant reduction in FSL would be required (an indicative volume of around 250,000 ML was nominated, subject to further investigation). There was no suggestion at the time that the Grid Manager, as the owner of the water entitlements and as one of the entities principally responsible for water security affected by such a reduction in FSL, was agreeable to such a volume of drinking water being discarded.

(c) *Thirdly*, the FSL for Wivenhoe Dam is contained in the Moreton ROP, having been initially identified in the design report when Wivenhoe Dam was being designed. It is a matter for the State to alter the FSL in the Moreton ROP[73], but it is noted that the State will often seek advice or recommendations from the QWC, the Grid Manager and Seqwater before effecting any such amendments.

(d) *Fourthly*, unless the FSL in the Moreton ROP was changed, Seqwater was not able to release water from Wivenhoe Dam below FSL in advance of the January 2011 Flood Event as to do so would have contravened Seqwater's Resource Operations Licence.

186. On the question of the timing and volume of releases, Seqwater notes that the Wivenhoe Manual sets out the objectives and strategies to guide operational decision making during Flood Events.

187. The Wivenhoe Flood Report (in section 10, and in the summary in section 2) identifies the steps taken by Seqwater throughout the January 2011 Flood Event. The explanation provided in those sections demonstrates that operational decisions were carefully considered and made in accordance with the Manual.

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[72] The release from Wivenhoe Dam associated with the rainfall prior to the January 2011 Flood Event was completed at 09:00 on 2 January 2011. The lake level in Wivenhoe Dam at this time was 67.10m or 0.15m below the gate opening trigger level.[72] At this level, 16,250ML of inflow is needed before the trigger level (to reopen the gates) is reached. Following the closure of the gates, the Dam continued to release over 4,000ML per day to account for base flow into the dam from the previous flood event, with the expectation being that the dam would slowly fall below FSL in the days following 2 January 2011. However, due to rainfall and further dam inflows, the lake level rose steadily after 2 January 2011 and was above gate trigger level at the commencement of the January 2011 Flood Event. However, in accordance with Strategy W1 and the intent of that Strategy, releases did not immediately commence to ensure that bridges downstream of the dam were not prematurely submerged.

[73] Refer to subdivision 2 of Part 4 of Chapter 2 of the *Water Act 2000*.

188. Seqwater has commissioned independent peer reviews of Seqwater's operational decisions made during the event. The peer reviews are **Attachments 28**. Seqwater will make further submissions to the Commission in respect of those peer reviews shortly.

189. Four key observations can be made about the decisions taken by Seqwater:

(a) Rainfall forecasts in the early stage of the January 2011 Flood Event did not support flood releases being made from Wivenhoe Dam greater than those that occurred;

(b) In line with the Wivenhoe Manual, releases of water from Wivenhoe Dam early in the event took into account the significant flood flows from the Lockyer Creek and Bremer River, and sought to keep the combined flow below the urban damage threshold at Moggill. Dam outflows which would cause urban inundation were delayed for as long as possible until it became apparent no other option was available without risking the safety of Wivenhoe Dam.

(c) Rainfall forecasts issued between Thursday, 6 January 2011 and 10:00am on Tuesday, 11 January 2011 did not support an increase in flood releases above that undertaken. In accordance with the Manual, Seqwater continued to control flows to minimise urban impacts for as long as possible, while there was the possibility that widespread flooding could be avoided. To have increased releases in the later stages of the January 2011 Flood Event (prior to the morning of Tuesday 11 January 2011) had the potential to create further urban damage downstream of the dams, due to the possible southward movement of the prevailing weather system.[74]

(d) However, the extreme intense rainfall that fell on and close to Wivenhoe Dam on the morning of Tuesday 11 January 2011 (which was not forecast) meant it was no longer possible to constrain outflows from the Dam without risking the safety of the Dam. The volume of water released from Wivenhoe Dam was consistent with the Manual.[75]

190. It is also important to note the following:

(a) Two distinct flood peaks entered Wivenhoe Dam during the January 2011 Flood Event. The first flood into Wivenhoe Dam, in the early hours of Monday 10 January 2011, was similar in nature and magnitude to the comparable flood flows of the January 1974 event. The combined mitigation effect of Wivenhoe and Somerset Dams ensured this first flood did not result in urban damage below Moggill, however achieving this result did cause significant filling of the Dams' flood storage compartments.[76]

[74] Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p iii.

[75] Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, Chapter 10.

[76] Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p iii.

(b) For clarity, if increased releases had been made during the first flood peak:

(i) the dam would have been releasing water at a flow rate that would cause urban damage downstream of the dam; and

(ii) if the unpredicted intense rainfall that subsequently occurred had fallen downstream of Wivenhoe Dam, such releases would have placed urban areas at an increased risk of flooding.

(c) The second flood, some 30 hours later, on Tuesday 11 January 2011, was also similar in nature and magnitude to the comparable flood flows of the January 1974 event. Rainfall that occurred directly on and near the Wivenhoe Dam lake area contributed to the second flood. Post flood analysis suggests the intensity of this rainfall could have exceeded an AEP of 1 in 2,000 and may be well into the extreme category.[77]

(d) The effects of this intense rainfall, at a critical stage of the January 2011 Flood Event, was exacerbated by the fact that it fell on and near the Wivenhoe Dam lake area, thereby immediately raising the lake level. This reduced available mitigation options (as opposed to if the rain had fallen in other parts of the catchment and taken time to flow into the lake).[78]

(e) The flood compartments of the Dams were filled to a high level by the first flood and there was not sufficient time to release this water prior to the second flood arriving. Accordingly, the second flood could not be completely contained without risking the safety of the Dams.[79]

(f) BoM quantitative forecasts for the dam catchments issued over key days of the event underestimated daily actual catchment rainfall by between 160% to 340%.[80]

191. The questions being raised are raised with the benefit of hindsight and they incorrectly assume perfection exists in the forecasting of rainfall events. Whilst Seqwater understands BoM forecasts are derived using the best available meteorological practice, the Wivenhoe Flood Report demonstrates that the forecasts are not sufficiently accurate to be used as the basis for making decisions on releasing flood water from the dams.

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[77] Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011, p iii.

[78] Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011.

[79] Seqwater, *January 2011 Flood Event Report on the operation of Somerset Dam and Wivenhoe Dam*, 2 March 2011.

[80] By way of example:

(a) in five 24-hour forecasts issued by the BoM in the critical part of the January 2011 Flood Event (from 4pm Saturday 8 January 2011 to 10am Tuesday 11 January 2011), the quantitative precipitation forecasts underestimated rainfall by an average discrepancy of 225%; and

(b) in two 24-hour forecasts issued by the BoM between 10am Tuesday 11 January 2011 and 4pm Tuesday 11 January 2011, the quantitative precipitation forecasts overestimated rainfall by an average discrepancy of 270%.

E Flood preparedness for next wet season

192. The Commission is required to deliver an interim report by 1 August 2011 on matters associated with flood preparedness to enable early recommendations to be implemented before next summer's wet season.[81]

193. Seqwater respectfully requests that the Commission note that in the Wivenhoe Flood Report and the North Pine Flood Report, Seqwater has identified a number of operational matters arising from the January 2011 Flood Event which warrant further consideration (see section 20 of the Wivenhoe Flood Report and section 12 of the North Pine Flood Report). Seqwater will be progressing these matters.

194. It is obviously not feasible before next summer's wet season to implement long term infrastructure options which the Commission might ultimately consider necessary to further mitigate against future flood events in South East Queensland. These options might include:

(a) raising the Wivenhoe Dam crest to provide greater flood mitigation capacity;

(b) building higher bridges in the Brisbane Valley so that greater releases of water can be made earlier in flood events without inundating the bridges; and

(c) retarding flows in parts of the Bremer River and Lockyer Creek.

195. There are however two matters which the Commission might consider in the context of next summer's wet season and the submissions which follow are designed to assist the Commission in its consideration of those matters, namely, reductions in FSL of Wivenhoe Dam, and releases from Wivenhoe Dam based on forecasts but in advance of rain falling.

Reductions in the Full Supply Level of Wivenhoe Dam

196. On 25 October 2010, the Minister sought advice from the Grid Manager about whether the then water security position provided an opportunity for a temporary reduction in the volume of water stored in key dams, including Wivenhoe and North Pine, as a means of reducing the severity, frequency and duration of flooding in downstream areas.[82]

197. The Minister's request was made in the context of anticipated major inflows occurring over the coming wet season, and the fact that key Grid storages were, at that time, at 100% of drinking water storage capacity at the commencement of the traditional wet season.

198. In relation to the Wivenhoe Dam, the Minister's request noted that significant inconvenience and isolation had been caused for residents in some downstream areas as a result of then recent releases. The Minister specifically sought confirmation from the Grid Manager that the options to be presented to him "*would not significantly impact upon our current water security position, measured as the probability of needing to reintroduce Medium Level Restrictions over the next five to ten years*".

[81] Paragraph 3 of the Terms of Reference.

[82] The letter is **Attachment 8**.

199. The Grid Manager in turn sought advice from Seqwater in order to develop the requested options. Seqwater undertook a preliminary assessment of options for a temporary reduction in Full Supply Level which was provided to the Grid Manager on 10 November 2010. Following subsequent discussions between the Grid Manager and Seqwater, the final preliminary assessment was provided to the Grid Manager on 2 December 2010. The assessment identified that for minor floods, similar in scale to the October 2010 event, reducing the volume stored in Wivenhoe Dam by 5% or 10% would have minimal impacts on flood effects downstream.

200. Seqwater considered the option of pre-releasing water from Wivenhoe Dam in anticipation of a flood event but determined it not to be a viable option for a number of reasons, including the risk of rains occurring in the catchments below the dam over the period of pre-releases that could potentially worsen downstream flood impacts. Seqwater indicated that it had contacted the Queensland Director of Dams Safety, who confirmed the assessment that minor reductions in the stored volume of Wivenhoe Dam would have minimal impact on floods downstream and concurred with the risks involved in any pre-release of significant volumes of water from dams prior to a flood event.

201. In relation to large flood events causing a flow of greater than 3,500 cumecs at Moggill, Seqwater advised that reductions in dam in the volume in Wivenhoe Dam in the order of at least 250,000 ML would be needed to provide significant reduction in water level peaks experienced in the relevant areas. Additionally, reductions in the FSL of this order would not necessarily guarantee reductions in urban flood levels, as the effectiveness of Wivenhoe Dam in reducing urban flood levels is directly dependent on the distribution of rainfall in the Brisbane River catchment during a flood event and the space in between individual flood events.

202. The Grid Manager subsequently advised the Minister on 24 December 2010[83] that Seqwater had advised the Grid Manager that releasing water to below Full Supply Level may provide some benefits in terms of reduced community and operational impacts during minor inflow events, such as had occurred over the prior month; however, for medium and major flood events, Seqwater considers that pre-emptive releases will provide negligible benefits.

203. The Grid Manager advised Seqwater that, from a water security perspective, it had no in-principle objection to minor releases from Wivenhoe, Somerset and North Pine Dams to minimise the operational and community impact of gate releases. Specifically, the Grid Manager provided advice to the Minister that it had no objection in relation to Wivenhoe and Somerset Dams being drawn down to 95% of their combined FSL, and North Pine Dam being drawn down to 97.5% of its FSL. The Grid Manager assessed the water security implications of releases to those lower levels to be negligible, as having no impact on the ability of the Grid to meet the risk criteria specified in the System Operating Plan or its ability to meet supply obligations to Grid Customers. Further, from a water security perspective, the Queensland Water Commission had confirmed that it did not have any objections to the potential releases. Those releases were noted to be intended to apply for

[83] The advice is **Attachment 9**.

the current wet season only, taken into account the level of the storages and the rainfall forecasts for the coming months.

204. In the 25 days leading up to the January 2011 Flood Event, three separate flood events impacted Wivenhoe and Somerset Dams. Flood releases were made from Wivenhoe Dam on all but five of those days.

205. Less that four days separated the end of Event 3 and the commencement of the January 2011 Flood Event.

206. Following the January 2011 Flood Event, the Minister, the QWC, DERM, the Grid Manager and Seqwater considered the possible temporary reduction in the water stored in Wivenhoe Dam to 75% of FSL for the current wet season.

207. As part of this consideration:

(a) the Grid Manager confirmed that it had no objection, from a water security perspective, to the temporary reduction. The Grid Manager noted that if a permanent consideration was to be considered "*this may have an impact on … desired levels of service objectives*" and that Seqwater should engage with the QWC;[84]

(b) At the request of the Minister, Seqwater carried out a preliminary assessment into the impact that such a reduction (and others) would have on downstream discharges for major flood events. The analysis was intended only to provide an order of magnitude assessment and noted that the actual flood reduction achievable was dependent on the characteristics of the specific event.[85] The assessment confirmed that a reduction to 75% of FSL would provide appreciable flood mitigation benefits.[86] By way of example, the assessment indicated that the reduction to 75% of FSL would have likely reduced the peak flow out of Wivenhoe Dam during the January 2011 Flood Event by 24%. Of course, given the attenuation of water in the lower reaches of the Brisbane River, it is not possible for Seqwater to determine whether the impact will be as appreciable in those lower reaches. The Commission should note that if this 24% reduction had occurred, the resultant (reduced) flow rate in the January 2011 Flood Event would still have resulted in damaging floods in Brisbane. In this regard, Seqwater refers the Commission to **Attachment 28**, which contains aerial photographs of Brisbane identifying the lateral effect of the January 2011 Flood Events and alternative scenarios of 50% and 75% FSL prepared collaboratively by DERM and Brisbane City Council with input from Seqwater. The lateral impacts in the alternate scenarios are not significantly different. The Commission should note that these aerials photographs do not identify the depth of water impacting the affected properties;[87]

[84] Letter from the Grid Manager to Seqwater dated 9 February 2011 – see **Attachment 10**.

[85] Letter from Seqwater to John Bradley, Director General, DERM dated 7 February 2011 – see **Attachment 11**.

[86] Letter from Seqwater to John Bradley, Director General, DERM dated 10 February 2011 – see **Attachment 12**.

[87] The model used to calculate the depth of water impacting affecting properties is owned and operated by the Brisbane City Council and Seqwater understands that this model is being updated

(c) the QWC subsequently confirmed that it had no objection to the temporary reduction to 75% but that any permanent reduction would need to be considered critically as it would have an impact on supply, may result in the need for new infrastructure being brought forward and there could be an impact on future bulk water through an increase in operational costs.[88]

208. Following these considerations, on 13 February 2011, the Minister announced that the water level in Wivenhoe Dam was to be temporarily reduced to 75% of FSL for the remainder of the wet season.

209. Amendments to the Moreton ROP and Seqwater's interim program were necessary to facilitate these releases.[89]

210. Seqwater subsequently commenced additional releases from Wivenhoe Dam on 20 February 2011 in order to lower the water storage level in accordance with the Minister's announcement and the level in Wivenhoe Dam reached 76.5% of FSL on 2 March 2011.

211. The Commission may consider a recommendation which implements a similar approach next wet season or more permanently. If the Commission is to consider such a recommendation, Seqwater makes the following observations.

212. *First*, any reduction (temporary or permanent) in the storage level in Wivenhoe will only be effective to increase flood mitigation if the relevant rain event falls in the catchments above Wivenhoe and Somerset. No increased flood mitigation benefits will be obtained from a reduction in Wivenhoe lake levels if the rain event falls in the other (approximate) 50% of the Brisbane River catchment. Notably, the rainfall during the January 2011 Flood Event did not fall in the city area with sufficient intensity and duration to cause local creeks to break their banks or cause localised flooding as happened in 1974.

213. *Secondly*, the January 2011 Flood Event was a large to rare event (that is, an AEP of 1 in 100 to 1 in 2000 years).

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[88] Letter from the QWC to Seqwater dated 14 February 2011 – **Attachment 13**.

[89] The following changes were implemented:

(a) the Chief Executive of DERM submitted an amendment to the Moreton ROP to the Governor in Council to amend the ROP;

(b) the proposed amendment to the ROP sought to insert a new clause 13(6A) to permit a resource operations licence holder with an approved interim program to submit a revised interim program to the Chief Executive for consideration under clause 13(7) of the ROP;

(c) the Governor in Council approved the proposed amendment to the ROP on 14 February 2011, which took effect on the same day;

(d) Seqwater submitted a Revised Interim Program to DERM pursuant to the new clause 13(6A) of the ROP on 17 February 2011, for consideration by the Chief Executive of DERM under clause 13(7) of the ROP; and

(e) the Chief Executive approved the Revised Interim Program without conditions on 17 February 2011 pursuant to clause 13(7)(a) of the ROP.

The amended Moreton ROP and the Revised Interim Program are **Attachments 4 and 14**.

214. *Thirdly*, the Commission might consider whether such reductions should only be triggered where published long range meteorological forecasts indicate predicted above average rainfall for the Brisbane River catchment, noting the imprecise nature of weather forecasts that have been detailed in this submission.

215. *Fourthly*, any reduction (temporary or permanent) would require the water security issues to be considered by the Grid Manager, QWC and the State. As indicated above, permanent reductions would require the QWC to critically consider water supply (including pricing) issues and, consistently with QWC's role, to advise the Minister in respect of the water supply issues. Seqwater is willing to contribute to the advice provided by QWC by providing further modelling analysis of the flood mitigation benefits associated with reduced lake levels.

216. *Fifthly*, a permanent reduction in FSL (as opposed to a temporary reduction in lake level) would require the Wivenhoe flood mitigation manual to be revised as the strategies outlined in the manual assume an FSL of 67.0M (or 100%). Seqwater notes that the FSL of Wivenhoe Dam was identified in 1971 when the dam was designed, and has been adopted since that time. Most recently it has been incorporated into the Moreton ROP. The development of the Wivenhoe Manual has been predicated upon FSL being at 67.0m[90].

217. *Sixthly*, a permanent reduction in FSL may result in a recalculation of the probability of flood damage to areas downstream of Wivenhoe Dam, including some parts of the Brisbane, Ipswich and Somerset local government areas. Any such recalculation may result in the introduction of new flood mapping for the downstream areas and impacts on building approval codes for affected areas. Similarly, if FSL is not permanently fixed due to seasonal variations in the FSL level, this may result in uncertainty in determining whether particular downstream areas are in fact 'flood prone' and accordingly are suitable for development.

Releases from Wivenhoe Dam based on forecasts but in advance of rain falling

218. It has been suggested that Seqwater could pre-emptively release water from Wivenhoe when heavy rain is forecast for the catchments. This so called "pre-release" strategy has, as its foundation, reliance upon meteorological forecasts (say 3 and 5 day forecasts).

219. Seqwater submits that a pre-release strategy is not appropriate for at least two reasons.

220. *First*, as the discussion in Section D demonstrates, meteorological forecasts are not sufficiently accurate to be used as the basis for making decisions on releasing flood water from the dams. If pre-releases are made, and the rain event becomes situated below Wivenhoe Dam:

[90] South East Queensland Water Board, Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam (1992), p24; South East Queensland Water Board, Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam (1997), p 20.; South East Queensland Water Corporation Limited, Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam (2002), p20; South East Queensland Water Corporation Limited, Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam (2004), p24; Seqwater, (for Queensland Water Commission and Queensland Department of Natural Resources and Water), Provision of contingency storage in Wivenhoe and Somerset Dams (March 2007), p14-15; Seqwater, Wivenhoe Dam Five Year Comprehensive Dam Safety Inspection Report, (September 2010), p 4.

(a) artificial flooding may arise in areas below the dam (noting that it ordinarily takes 36 hours for water released from Wivenhoe Dam to reach the city reaches of the Brisbane River); and

(b) water will have been lost from the storage.

221. *Secondly*, a pre-release strategy would likely result in disruption to downstream rural life for longer periods of time. Seqwater notes that the intent of Strategy W1 in the Wivenhoe Manual is to not submerge the bridges downstream of the dam prematurely.[91]

[91] See the Wivenhoe Manual at page 24.

Annexure 1

Glossary

In this submission the following terms are defined as below:

"***Acceptable Flood Capacity***" means the overall flood discharge capacity required of a dam determined in accordance with the DERM AFC Guidelines including freeboard as relevant, which is required to pass the critical duration storm event without causing a failure of the dam.

"***AEP***" means Annual Exceedence Probability, the probability of a specified event being reached or exceeded in anyone year. This may be expressed as a ratio (e.g. 1 in Y) or a percentage;

"***AHD***" means Australian Height Datum;

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

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

"***ANCOLD***" means the Australian National Committee on Large Dams;

"***ANSI***" means the American National Standards Institute;

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

"***BoM***" means the Bureau of Meteorology;

"***Cumecs***" means a rate of water flow measured in cubic metre of water per second or 1,000 litres of water per second;

"***Chairperson***" means the Chairperson of Seqwater;

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

"***Dams***" means Somerset Dam, Wivenhoe Dam and North Pine Dam;

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

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

"***DERM***" means the Department of Environment and Resource Management;

"***DERM AFC Guidelines***" means Guidelines on Acceptable Flood Capacity for Dams, February 2007;

"***DERM Failure Assessment Guidelines***" means Guidelines for Failure Impact Assessment of Water Dams, June 2010;

"***DERM Safety Guidelines***" means Queensland Dams Safety Management Guidelines, February 2002;

"***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 office location used by Flood Operations Engineers during a flood event to manage the event;

"***Flood Operations Engineer***" means a person designated to direct flood operations at the Dams in accordance with Section 2.4 of the Manual;

"***Flood Operations Engineers***" means the collective group of persons who individually have designation as either a Flood Operations Engineer or a Senior Flood Operations Engineer;

"***Flood Operations Manager***" means the Senior Flood Operations Engineer or Flood Operations Engineer designated responsibility for the overall management of the Flood Operations Centre leading up to or during a flood event;

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

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

"***Grid***" means the South East Queensland Water Grid;

"***Grid Manager***" means the South East Queensland Water Grid Manager;

"***January 2011 Flood Event***" means, in the case of the Wivenhoe and Somerset Dams, the flood event which commenced on 6 January 2011 and concluded on 19 January 2011, and in the case of North Pine Dam, the flood event which commenced on 6 January 2011 and concluded on 14 January 2011.

"***LinkWater***" means the Queensland Bulk Water Transport Authority trading as LinkWater;

"***LOS***" means the desired levels of service objectives detailed in the RWSP;

"***Manuals***" means the Wivenhoe Manual and the North Pine Manual;

"***Minister***" means the Minister for Environment and Resource Management;

"***Moreton ROP***" means the Moreton Resource Operations Plan, which is a statutory instrument issued under the Water Act.

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

"***NP Flood Report***" means the January 2011 Flood Event Report on the Operation of North Pine Dam dated 11 March 2011;

"***North Pine Manual***" means the "*Manual of Operational Procedures for Flood Mitigation at North Pine Dam*" (Revision 5);

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

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

"***PAR***" means Population At Risk as defined by the Water Supply Act;

"***PMF***" or "***Probable Maximum Flood***" means the flood resulting from the PMP and, where applicable, snowmelt, coupled with the worst flood producing catchment conditions that can be realistically expected in the prevailing catchment meteorological conditions;

"***PMP***" or "***Probable Maximum Precipitation***" means the theoretical greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year, with no allowance made for long term climactic trends;

"***Protocol***" means draft Communication Protocol prepared by DERM to ensure information is effectively communicated to the public during flood events impacting Somerset Dam and Wivenhoe Dam;

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

"***QWC***" means the Queensland Water Commission;

"***ROL***" means Resource Operations Licence issued under the Water Act;

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

"***RWSP***" means the Regional Water Security Program;

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

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

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

"***SOP***" means the System Operating Plan made by QWC;

"***Water Act***" means *Water Act 2000* (Qld);

"***WaterSecure***" means the Queensland Manufactured Water Authority trading as WaterSecure;

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

"***Wivenhoe Flood Report***" means the January 2011 Flood Event Report on the Operation of Somerset Dam and Wivenhoe Dam dated 2 March 2011;

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

"***WRP***" means Water Resource Plans, which are subordinate legislation to the Water Act.

Annexure 2

List of dams, weirs and treatment plants owned and operated by Seqwater

Asset Site Description	
Lagoon	
	Bigfoot Lagoon
	Herring Lagoon
	Kilcoy Off Stream Storage
	Moodlu Quarry Off Stream Storage
	Seven Mile Lagoon
	Woodford Off Stream Storage
Dam	
	Atkinson Dam
	Baroon Pocket Dam
	Bill Gunn Dam
	Borumba Dam
	Bromelton Dam
	Cedar Pocket Dam
	Clarendon Dam
	Cooloolabin Dam
	Enoggera Dam
	Ewen Maddock Dam
	Gold Creek Dam
	Hinze Dam
	Lake Kurwongbah (Sideling Creek) Dam
	Lake MacDonald Dam
	Lake Manchester Dam
	Leslie Harrison Dam
	Little Nerang Dam
	Maroon Dam
	Moogerah Dam
	Nindooinbah Dam
	North Pine Dam
	Poona Dam
	Somerset Dam
	Wappa Dam
	Wivenhoe Dam
Sewage Treatment Plant	
	Lumley Hill STP
	Somerset Dam STP

Asset Site Description	
Weir	
	Albert River Weir
	Aratula Weir
	Beaudesert Intake Weir
	Brightvale Weir
	Bromelton Weir
	Buaraba Creek Weir
	Caboolture River Weir
	Carpendale Weir
	Cedar Grove Weir
	Churchbank Weir
	Clarendon Weir
	Crowley Vale Weir
	Dayboro Road Pump Station Weir
	Flagstone Creek Weir
	Gatton Weir
	Glenore Grove Weir
	Grantham Weir
	Imbil Weir
	Jimna Weir
	Jordan 1 Weir
	Jordan 2 Weir
	Kents Lagoon Diversion Weir
	Kentville Weir
	Kilcoy Weir
	Kings Lane Weir
	Laidley Creek Diversion Weir
	Lower Flagstone Creek Weir
	Lower Tenthill Creek Weir
	Ma Ma Creek Weir
	Maleny Weir
	Maroochy Intake Weir
	Mount Crosby Weir
	Mulgowie Weir
	O'Reilly's Weir
	Potters Weir
	Railway Weir
	Rathdowney Weir
	Redbank Creek Weir
	Sandy Creek Weir
	Showgrounds Weir
	Sippels Weir

	Asset Site Description
	South Maclean Weir
	Tenthill Creek Weir
	Upper Warrill Diversion Weir
	Waraba Creek Weir
	Warrill Creek Diversion Weir
	Warroolaba Creek Diversion Weir
	West Branch Warrill Diversion Weir
	Wilson Weir
	Woodford Weir
	Yabba Creek Weir
Water Treatment Plant	
	Albert River WTP
	Algester WTP
	Amity Point WTP
	Aratula WTP
	Atkinson Dam (Recreation) WTP
	Atkinson Dam WTP
	Banksia Beach WTP
	Beaudesert WTP
	Borumba Dam WTP
	Caboolture WTP
	Canungra WTP
	Capalaba WTP
	Chandler WTP
	Dayboro WTP
	Dunwich WTP
	Enoggera WTP
	Esk WTP
	Ewen Maddock WTP
	Forest Lake WTP
	Hinze Dam WTP
	Image Flat WTP
	Jimna WTP
	Kalbar WTP
	Kenilworth WTP
	Kilcoy (Somerset) WTP
	Kilcoy WTP
	Kirkleagh (Recreation) WTP
	Kooralbyn WTP
	Lake MacDonald (Noosa) WTP
	Landers Shute WTP
	Linville WTP

	Asset Site Description
	Lowood WTP
	Maleny WTP
	Maroon Dam WTP
	Molendinar WTP
	Moogerah Dam WTP
	Mount Crosby East Bank WTP
	Mount Crosby West Bank WTP
	Mudgeeraba WTP
	North Pine WTP
	North Stradbroke Island WTP
	Petrie WTP
	Point Lookout WTP
	Rathdowney WTP
	Runcorn WTP
	Somerset Dam Township WTP
	South Maclean WTP
	Sunnybank WTP
	Toogoolawah WTP
	Wivenhoe Dam (Recreation) WTP
	Woodford WTP
	Woorim WTP

Annexure 3

Regulatory framework – Seqwater's powers and functions

1. Seqwater was established under the *South East Queensland Water (Restructuring) Act* 2007.

2. The Commission should note:

   (a) Seqwater's functions are broad. They include:

      (i) carrying out water activities and other ancillary activities;

      (ii) supplying water services and other ancillary services;

      (iii) supplying other services relating to the water industry, including:

         (A) engineering services;

         (B) services for operating or maintaining infrastructure;

         (C) business management services;

         (D) energy generation; and

         (E) scientific services;

      (iv) developing water supply works;

      (v) improving the supply, delivery and quality of water, including by way of:

         (A) riverine area protection;

         (B) soil erosion control;

         (C) land degradation treatment and prevention;

         (D) nutrient management; and

         (E) vegetation management;

      (vi) using or managing the entity's land in ways that benefit the community, including for recreational purposes;

      (vii) anything else likely to complement or enhance a function mentioned above; and

      (viii) another function conferred under legislation;[92]

   (b) Seqwater has all of the powers of an individual;[93]

   (c) Seqwater is not a body corporate;[94]

[92] See section 9 of the *South East Queensland Water (Restructuring) Act 2007*.

[93] See section 7 of the *South East Queensland Water (Restructuring) Act 2007*.

[94] See section 6(2) of the *South East Queensland Water (Restructuring) Act 2007*.

(d) Seqwater does not represent the State[95], although the State is the successor at law at the end of 99 years;[96]

(e) Seqwater must carry out is functions as a commercial enterprise;[97]

(f) Seqwater operates through a board, chief executive officer and senior employees;[98]

(g) Seqwater's responsible Minister may, in exceptional circumstances, give the board a written direction;[99]

(h) Seqwater must perform its functions in accordance with the *Financial Accountability Act* 2009 and the *Statutory Bodies Financial Arrangements Act* 1982.[100]

[95] See section 6(3) of the *South East Queensland Water (Restructuring) Act 2007*.

[96] See section 64 of the *South East Queensland Water (Restructuring) Act 2007*.

[97] See section 11 of the *South East Queensland Water (Restructuring) Act 2007*.

[98] See Chapter 2 Parts 2 & 3 of the *South East Queensland Water (Restructuring) Act 2007*.

[99] See section 61 of the *South East Queensland Water (Restructuring) Act 2007*.

[100] See section 34 of the *South East Queensland Water (Restructuring) Act 2007*.

Annexure 4

Regulatory framework – Water planning and supply

Overview

1. The relevant Act is the *Water Act 2000* (***Water Act***).

2. The Water Act establishes a regulatory regime for:

   (a) water planning; and

   (b) water supply,

   to provide for the sustainable management of water in Queensland.

3. Under the Act, for each region, there is a hierarchy of plans and instruments which are applicable to Seqwater.

4. The hierarchy of these plans and instruments for South East Queensland is explained below.

5. *First*, there is a Regional Water Security Program (***RWSP***). The RWSP is issued by the Minister following advice from the QWC.[101] The RWSP must make provision for:

   (a) the desired levels of service (***LOS***) objectives for the region;

   (b) water supply works for achieving the desired LOS objectives;

   (c) demand management for water in SEQ; and

   (d) the extent to which implementation of the levels would involve modifying existing water supply works or building new works;

   (e) assessing the costs and pricing implications of the issues mentioned in paragraphs (c) and (d) above; and

   (f) the preferred ways of sharing the costs.[102]

6. By way of background, LOS objectives provide a basis for establishing a secure water supply. The objectives define:

   (a) the desirable maximum frequency, duration and severity of water restrictions;

   (b) the average amount of water per capita that must be supplied in normal times.

7. The LOS objectives are used to determine the volume of water that can be supplied from the water storages and other supplies (that is, the Grid) within South East Queensland, on average, every year. This is the LOS system yield. The LOS system yield is used, together with the projected demands, to ensure that supply and demand initiatives are put in place to meet future water needs.

[101] See sections 360I – 360M of the Water Act.

[102] See section 360M(2) of the Water Act.

8. The published LOS objectives make clear the assumptions made by water supply planners and for investment decisions by the community at large.

9. A copy of the RWSP for South East Queensland is **Attachment 15**.

10. In addition to the RWSP, the QWC has also issued the South East Queensland Water Strategy (see **Attachment 16**). This strategy was required to be produced under the South East Queensland Regional Plan 2009-2031, and will be the basis upon which the QWC provides future advice to the Minister in respect of the RWSP.[103]

11. QWC must ensure that the RWSP is complied with.[104]

12. *Secondly*, there is the Water Resource Plan (***WRP***).[105]

13. WRPs are subordinate legislation to the Water Act and provide a framework for the allocation and management of water in a specified area by:

    (a) defining the availability of water in the relevant area;

    (b) providing a framework for sustainably managing and taking that water;

    (c) identifying priorities and mechanisms for dealing with future water requirements; and

    (d) providing a framework for reversing, where practicable, degradation that has occurred in natural ecosystems.

14. Water availability is mainly reflected as entitlements, which are specified following rigorous environmental, hydrologic, social and economic assessment processes.

15. In South East Queensland, there are four WRPs. These are the Moreton WRP, the Logan Basin WRP, the Gold Coast WRP and the Mary Basin WRP.

16. It is likely the most relevant of these for Seqwater, in the context of the Commission's investigations, is the Moreton WRP. This is because Somerset, Wivenhoe and North Pine Dams are within the Moreton WRP. A copy is shown as **Attachment 17**.

17. *Thirdly*, there is the Resource Operations Plan (***ROP***).[106]

18. ROPs are also subordinate legislation to the Water Act.

19. ROPs implement WRPs by management rules and arrangements necessary to satisfy the WRPs' objectives and outcomes. They establish rules for monitoring, water sharing and water trading, and processes for dealing with unallocated water, within a single catchment. In addition, they establish tradeable water allocations.

20. Importantly, in respect of dams, ROPs contain:

    (a) the FSL;

    (b) the minimum operating levels;

---

[103] See page 19, second paragraph of the South East Queensland Water Strategy.

[104] See section 360R of the Water Act.

[105] See generally sections 38-58 of the Water Act.

[106] See generally sections 95-106 of the Water Act.

(c) the circumstances in which water can be released. In general, releases are only authorised for:

(i) environment flows (maintaining the environment of the river downstream from the dam);

(ii) supplying downstream demand (in the case of South East Queensland, this is to supply the Grid Manager with water);

(iii) maintaining downstream storage levels in downstream dams.

21. Again, in South East Queensland there are four ROPs. These are the Moreton ROP, the Logan Basin ROP, the Gold Coast ROP and the draft Mary Basin ROP.

22. It is likely the most relevant of these for Seqwater, in the context of the Commission's investigations, is the Moreton ROP. A copy is shown as **Attachment 4**.

23. *Fourthly*, there is the Resource Operations Licence (***ROL***).[107]

24. This is the instrument which authorises the licence holder to interfere with the flow of water as detailed in the ROP to the extent necessary to operate the licence holders' infrastructure.

25. Seqwater holds ROLs for the various ROPs in South East Queensland.

26. Again, the relevant ROL is the one held by Seqwater for the Moreton ROP. The ROL held by Seqwater for Somerset, Wivenhoe and North Pine Dams is **Attachment 3**.

27. Importantly, it is an offence under section 813 of the Water Act to contravene a condition of a ROL.

28. *Fifthly*, there is the System Operating Plan (***SOP***).

29. The SOP must be made by QWC.[108]

30. The SOP facilitates the achievement of the LOS objectives.[109]

31. The SOP must state, among other things, each of the following:

(a) the plan area for the plan;

(b) the entities to which the plan applies;

(c) the water supply works for the plan area;

(d) the maximum volume the Grid Manager may enter into contracts to sell;

(e) the desired LOS objectives for South East Queensland; and

(f) other obligations imposed on the entities under the plan.[110]

32. The plan must also be consistent with any Water Resource Plan (explained below) applying to the plan area for the SOP.[111]

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[107] See generally sections 107-119D of the Water Act.

[108] See section 360V of the Water Act.

[109] See section 360V of the Water Act.

[110] See section 360W of the Water Act.

33. The QWC must publish the plan and give a copy to each entity to which the plan applies.[112]

34. The South East Queensland SOP is **Attachment 18**.

35. Seqwater is obliged to provide information to the Grid Manager under the South East Queensland SOP, but otherwise the South East Queensland SOP does not apply to Seqwater (rather it generally applies to the Grid Manager).[113]

36. The above discussion can be represented diagrammatically as follows:

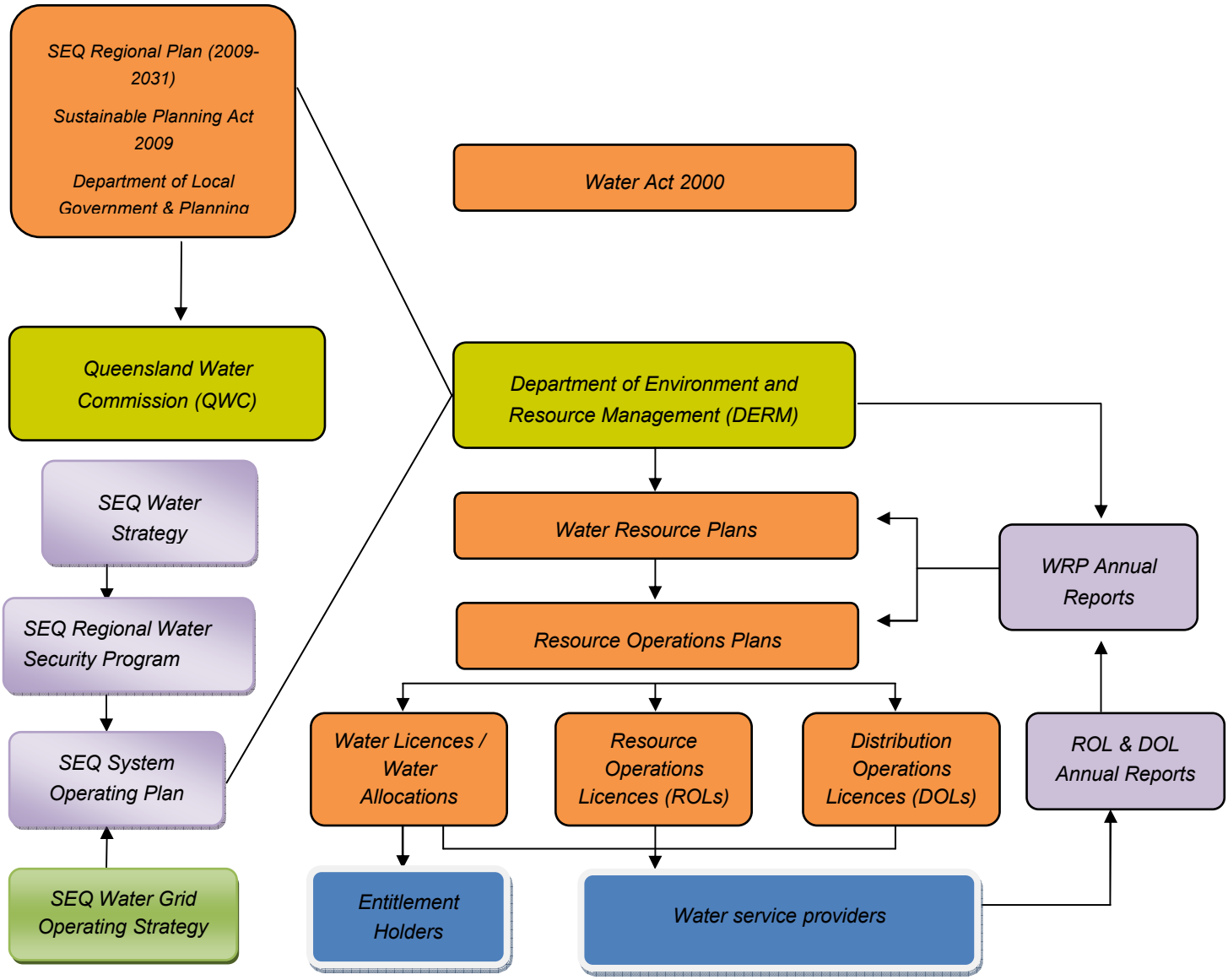

Figure 13 (Annexure 4): Regularly framework for Water Planning and Supply in South East Queensland.

(Source: Seqwater.)

[111] See section 360W(2) of the Water Act.

[112] See section 360Y of the Water Act.

[113] See section 360ZA of the Water Act and section 4.1 of the SOP.

Application to Seqwater

37. The Commission will note that under the conditions of Seqwater's ROLs, Seqwater must comply with the operating arrangements and supply requirements detailed in Chapters 5 and 6 of the Moreton ROP.

38. Chapter 5 of the Moreton ROP contains operational and environmental management rules for Wivenhoe and Somerset Dams. Section 72 provides:

"***Operating levels for infrastructure***

(1) *The operating levels for the infrastructure in the Central Brisbane River and Stanley River water supply schemes are specified in Attachment 5, Table 1, Table 2 and Table 3.*

(2) *The resource operations licence holder must not release or supply water from any infrastructure is at or below its minimum operating level.*

(3) ***The resource operations licence holder must not release water from any infrastructure unless the release is necessary to –***

(a) ***meet minimum flow rates in section 75 [8.64ML/day from Mt Crosby weir except where critical water sharing arrangement are in force]; or***

(b) ***supply downstream demand.*** (emphasis added)

39. The operating levels (including the FSL and minimum operating levels) referred to in Section 72 are detailed in Attachment 5 to the Moreton ROP.

40. Chapter 6 of the Moreton ROP contains operational and environmental management rules for North Pine Dam. Section 97 provides:

"***Operating levels for infrastructure***

(1) *The operating levels for the infrastructure in the Pine Valley Supply Scheme are specified in Attachment 6, Table 1.*

(2) *The resource operations licence holder must not release or supply water from any infrastructure is at or below its minimum operating level.*

(3) ***The resource operations licence holder must not release water from any infrastructure unless the release is necessary to supply downstream demand and is made in accordance with this plan.*** (emphasis added)

41. The operating levels (including the FSL and minimum operating levels) referred to in Section 97 are detailed in Attachment 6 to the Moreton ROP.

42. In each case, the "downstream demand" referred to is largely the demand from the Grid Manager (see the list of water entitlements in Attachment 8 to the Moreton ROP).

43. For the above reasons, it is therefore an offence for Seqwater to release water from Somerset, Wivenhoe and North Pine Dams for a purpose other than supplying downstream demand (save for the minor release permitted under section 72(3)(a)).

44. On the face of these provisions, releases for flood mitigation purposes may also not be permitted.

45. However, section 13 of the Moreton ROP permits Seqwater to submit an interim program, which, if approved by the Chief Executive, prevails over the ROP.

46. Seqwater submitted an interim program to the Chief Executive in 2010 which permits flood mitigation releases. The interim program and the approval of it is **Attachment 14**.

47. In the event of a non-compliance with the rules contained in the ROP, Seqwater is required to provide the Chief Executive with:

    (a) an operational report with details of the incident within one business day of becoming aware of a non-compliance; or

    (b) where the non-compliance was due to an emergency, an emergency report.[114]

[114] See sections 166-167 of the Moreton ROP.

Annexure 5

Regulatory framework – Dam Safety and Flood Mitigation

1. The Water Supply Act regulates (amongst other things) dam safety, including dam failure risk assessment and flood mitigation plans.

Dam Safety

2. Dealing first with dam failure safety assessment, under the Water Supply Act, Somerset, Wivenhoe and North Pine dams are "referable dams" meaning the chief executive can:

   (a) apply safety conditions on each of these dams; and

   (b) in the event that there is a danger of dam failure, issue directives to prevent the failure of the dam or minimise its impact (s.358 Water Supply Act).

3. Three guidelines with statutory force apply to the management of dams in Queensland. The relevant guidelines are:

   (a) the 'Queensland Dam Safety Management Guidelines', February, 2002 (***DERM Safety Guidelines***) – **Attachment 19**;

   (b) the 'Guidelines for Failure Impact Assessment of Water Dams', June, 2010 (***DERM Failure Assessment Guidelines***) – **Attachment 20**; and

   (c) the 'Guidelines on Acceptable Flood Capacity for Dams', February, 2007 (***DERM AFC Guidelines***) – **Attachment 21**.

4. Each of the above guidelines interrelate with each other.

5. The statutory regulation of dams has been shifted from the Water Act to the Water Supply Act.

6. Pursuant to s.589 of the Water Supply Act[115], guidelines issued under the Water Act (i.e. the DERM Safety Guidelines and DERM AFC Guidelines) continue to have effect until such time new guidelines are issued pursuant to the Water Supply Act.

DERM Safety Guidelines

7. The Chief Executive may apply safety conditions to referrable dams[116].

8. Each of Wivenhoe, Somerset and North Pine dams are referable dams and are subject to dam safety conditions.

9. When deciding the safety conditions for a dam, the Chief Executive must have regard to the guidelines, if any, made by the Chief Executive for applying safety conditions to a referable dam (s.354(2), Water Supply Act).

10. Consequently, the Chief Executive must have regard to the DERM Safety Guidelines prior to conditioning a referable dam.

[115] s.598 commenced on 1 July 2008

[116] s.353, Water Supply Act and previously Water Act.

11. The current DERM Safety Guidelines were issued under the Water Act.

12. The purpose of the DERM Safety Guidelines is to describe practices dealing with the construction and management of referable dams and assist dam owners to safely manage their dams and protect the community from dam failure.[117]

DERM Failure Assessment Guidelines

13. A 'failure impact assessment' of a dam is required in certain circumstances.[118]

14. Each of Wivenhoe, Somerset and North Pine Dams have required a failure impact assessment and have a 'Category 2' failure impact rating.[119]

15. A failure impact assessment is the process under the Water Supply Act (and Water Act previously) to determine the number of people whose safety could be at risk should the dam fail (the 'population at risk' (***PAR***)).[120]

16. The Water Supply Act defines the 'failure' of a referable dam to mean:

    (a) the physical collapse of all or part of the dam; or

    (b) the uncontrolled release of any of the dam's contents.[121]

17. The results of the assessment are used to determine whether a dam is referrable and the failure impact rating of a dam.[122]

18. There are two failure impact ratings, 'Category 1' and 'Category 2'.

19. A Category 1 impact rating is given to dams with a PAR of 2 to 100 persons in the event of a dam failure.[123]

20. A Category 2 impact rating is given to dams with a PAR of more than 100 persons in the event of a dam failure.[124]

21. In June 2007, the Queensland Department of Natural Resources and Water (now DERM) performed a safety audit of each of Wivenhoe, Somerset and North Pine Dams.

22. The purpose of the audit was to review compliance against the:

    (a) Development Permit Safety Conditions;

    (b) DERM Safety Guidelines; and

    (c) the ANCOLD Dam Safety Management Guidelines (2003).[125]

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[117] DERM Safety Guidelines, page 1.

[118] s.343, Water Supply Act; previously s.483 Water Act.

[119] Queensland Department of Natural Resources and Water, *SEQWater Water Services Dam Safety Audit*, (June 2007), p 5.

[120] DERM Failure Assessment Guidelines, p3.

[121] Schedule 3, Water Supply Act

[122] DERM Failure Assessment Guidelines, p3.

[123] s346, Water Supply Act.

[124] s346, Water Supply Act.

[125] Queensland Department of Natural Resources and Water, *SEQWater Water Services Dam Safety Audit*, (June 2007), p 1.

23. The safety audit relevantly concluded that:

    (a) a very effective maintenance program appeared to be in place;[126]

    (b) staff are well trained and supported with documentation and resources;[127]

    (c) industry best practice was being followed in the approach to risk assessment;[128]

    (d) the Standard Operating Procedures conformed with the DERM Safety Guidelines;[129]

    (e) overall emergency documentation and preparedness were considered to be of a very high standard;[130] and

    (f) no major Dam Safety Condition non-conformances were identified amongst the recommendations and suggested opportunities for improvement.[131]

24. In 2010, a five yearly comprehensive dam safety inspection report was prepared in respect of Wivenhoe Dam,[132] Somerset Dam[133] and North Pine Dam.[134]

25. The comprehensive inspection must incorporate a review of the dam safety standards of the existing dam against current standards, a review of the adequacy of the dam safety documentation for the dam and reviews of the status on recommended actions from previous inspections.[135]

26. Relevantly, the 2010 comprehensive dam safety reviews determined that:

[126] Queensland Department of Natural Resources and Water, *SEQWater Water Services Dam Safety Audit*, (June 2007), p 1.

[127] Queensland Department of Natural Resources and Water, *SEQWater Water Services Dam Safety Audit*, (June 2007), p 1.

[128] Queensland Department of Natural Resources and Water, *SEQWater Water Services Dam Safety Audit*, (June 2007), p 2.

[129] Queensland Department of Natural Resources and Water, *SEQWater Water Services Dam Safety Audit*, (June 2007), p 2.

[130] Queensland Department of Natural Resources and Water, *SEQWater Water Services Dam Safety Audit*, (June 2007), p 2.

[131] Queensland Department of Natural Resources and Water, *SEQWater Water Services Dam Safety Audit*, (June 2007), p 2.

[132] Seqwater, *Wivenhoe Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010).

[133] Seqwater, *Somerset Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010).

[134] Hydro Tasmania Consulting, *North Pine Dam Five Yearly Comprehensive Dam Safety Inspection*, (23 July 2010).

[135] Seqwater, *Wivenhoe Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010), p 1.

Table 15 (Annexure 5): Table of Five Year Comprehensive Dam Safety Inspection Reports' Conclusions.

Source: Seqwater, *Wivenhoe Dam Five Year Comprehensive Dam Safety Inspection Report*, September 2010. Seqwater, *Somerset Dam Five Year Comprehensive Dam Safety Inspection Report*, September 2010. Hydro Tasmania Consulting, *North Pine Dam Five Yearly Comprehensive Dam Safety Inspection*, 23 July 2010.

Dam	Conclusion
Wivenhoe Dam	• Wivenhoe Dam is generally in very good condition.[136] • There are no outstanding design issues that require investigation at the present time.[137] • No issues were identified as a result of the comprehensive review of the instrumentation data.[138] • Seqwater now has a robust system in place for ensuring routine inspections are undertaken daily.[139] • There are no outstanding items critical to the safety of the dam.[140]
Somerset Dam	• Somerset Dam is generally in very good condition.[141] • There are no significant outstanding design issues that require investigation at the present time.[142] • No issues were identified as a result of the comprehensive review of instrumentation data.[143] • Seqwater now has a robust system in place for ensuring routine inspections are undertaken daily.[144] • There are no outstanding items critical to the safety of the dam.[145]
North Pine Dam	• North Pine Dam is generally in a satisfactory condition.[146]

[136] Seqwater, *Wivenhoe Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010), p 3.

[137] Seqwater, *Wivenhoe Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010), p 3.

[138] Seqwater, *Wivenhoe Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010), p 3.

[139] Seqwater, *Wivenhoe Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010), p 15.

[140] Seqwater, *Wivenhoe Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010), p 19.

[141] Seqwater, *Somerset Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010), p 3.

[142] Seqwater, *Somerset Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010), p 3.

[143] Seqwater, *Somerset Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010), p 3.

[144] Seqwater, *Somerset Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010), p 15.

[145] Seqwater, *Somerset Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010), p 17.

[146] Hydro Tasmania Consulting, *North Pine Dam Five Yearly Comprehensive Dam Safety Inspection*, (23 July 2010), p v.

DERM AFC Guidelines

27. The DERM AFC Guidelines apply to referable dams. As detailed above, Wivenhoe, Somerset and North Pine Dams are referable dams.

28. All referable dams are required to have sufficient flood discharge capacity to pass the following:

    (a) the Acceptable Flood Capacity without failure of the dam; and

    (b) a Spillway Design Flood without any damage to the dam.[147]

29. 'Acceptable Flood Capacity' means 'the overall flood discharge capacity required of a dam determined in accordance with [the DERM AFC Guidelines] including freeboard as relevant, which is required to pass the critical duration storm event without causing a failure of the dam'.[148]

30. 'Spillway Design Flood' means 'the flood event which can be routed through the dam (with appropriate allowance for freeboard due to wind and wave effects) without any damage to individual sections of the dam".[149]

31. The DERM AFC Guidelines are based on a range of Australian National Committee on Large Dams (***ANCOLD***) and other guidelines, in particular:

    (a) *Selection of Acceptable Flood Capacity for Dams* (ANCOLD);

    (b) *Assessment of the Consequences of Dam Failure* (ANCOLD);

    (c) *Risk Assessment* (ANCOLD); and

    (d) *Guide to Flood Estimation* (AR&R 1999, Nathan, RJ and Weinmann, PE).[150]

32. Where the DERM AFC Guidelines do not specifically address an issue the relevant sections of the referenced ANCOLD guidelines apply.[151]

33. However, it is important to remember that compliance with ANCOLD guidelines is not mandatory; this is recognised by the ANCOLD guidelines themselves. For example the ANCOLD *Selection of Acceptable Flood Capacity for Dams* guidelines state:

    "It must be remembered they are guidelines only to what is considered current acceptable practice and allow owners and practitioners flexibility to exercise professional judgment in all aspects. Indeed, without the application of such judgment, the procedures themselves could lead to results that have serious shortcomings."[152].

    and:

[147] DERM AFC Guidelines, p4.

[148] DERM AFC Guidelines, p19.

[149] DERM AFC Guidelines, p21.

[150] DERM AFC Guidelines, p4.

[151] DERM AFC Guidelines, p4.

[152] ANCOLD, *Selection of Acceptable Flood Capacity for Dams,* Forward, page i.

"It is important to note that the risk procedure does not provide a specific solution for an acceptable flood capacity (AFC) and spillway provisions. Instead, it provides options for consideration, and parallel with traditional standards within the total asset risk management context."[153]

34. The DERM AFC Guidelines detail the:

(a) available methods for determining the required flood discharge capacity for referable dams;

(b) procedures to be followed when applying the methods;

(c) reporting requirements when reporting the results of the investigations to the Chief Executive of DERM; and

(d) timeframe for any necessary dam safety upgrades.

35. The DERM AFC Guidelines relevantly provide that:

"Owners of existing referable dams, which cannot safely discharge the Acceptable Flood Capacity, will be required to upgrade the spillway capacity of their dams. The timing of any necessary upgrade works for the dam is dependent on the proportion of the Acceptable Flood Capacity able to be safely passed by the existing dam. The timing will have to at least satisfy the schedule presented in Table 3."

36. Table 3 is extracted here.

Table 16 (Annexure 5): DERM AFC Guidelines Schedule for Dam Safety Upgrades.

Source: ANCOLD, *Selection of Acceptable Flood Capacity for Dams*, p 18.

Tranche	Required minimum flood discharge capacity	Date by which the required minimum flood capacity is to be in place for existing dams
1	25% of AFC or 1:500 AEP flood event (whichever is the bigger flood)	These dams must be upgraded as soon as possible[1]
2	50% of AFC or 1:2000 AEP flood event (whichever is the bigger flood)	1 October 2015 [2,3]
3	75% of AFC	1 October 2025 [2,3]
4	100% of AFC	1 October 2035 [2,3]

Table 3: Schedule for Dam Safety Upgrades

37. The flood capacity of Wivenhoe and Somerset Dams are detailed in the following table.

[153] ANCOLD, *Selection of Acceptable Flood Capacity for Dams,* page 1

Table 17 (Annexure 5) Program of upgrades of Seqwater assets

(Source: Seqwater)

Dam	% of Required Flood Capacity	Upgrade required by
Hinze Dam[154]	Less than 50%	2015
Lake Macdonald Dam	Less than 50%	2015
Maroon Dam	Less than 50%	2015
Moogerah Dam	Less than 50%	2015
Baroon Pocket Dam	Between 50 and 75%	2025
Borumba Dam	Between 50 and 75%	2025
Ewen Maddock Dam[155]	Between 50 and 75%	2025
Leslie Harrison Dam	Between 50 and 75%	2025
Little Nerang Dam	Between 50 and 75%	2025
Sidling Creek Dam	Between 50 and 75%	2025
Somerset Dam	Between 50 and 75%	2025
Atkinson Dam	Greater than 75%	2035
North Pine Dam[156]	Greater than 75%	2035
Wivenhoe Dam	Greater than 75%	2035

38. In relation to the following Table, megalitre volume for storage capacity is only available to the nearest 0.5 metre for Wivenhoe and Somerset Dams.

Flood Mitigation

39. Part 2 of Chapter 4 of the Water Supply Act regulates flood mitigation.

40. Relevantly:

(a) a regulation may nominate dam owners required to prepare a manual of operational procedures for flood mitigation for the dam (a ***flood mitigation manual***);[157]

(b) the chief executive approves flood mitigation manuals by gazette notice;[158] and

[154] Works are nearing completion.

[155] Works are planned to ensure the dam achieves 75% of AFC prior to 2015.

[156] A detailed study is to be conducted following the January 2011 Flood Event, as explained in the North Pine Flood Event Report.

[157] Section 370 of the Water Supply Act.

[158] Section 371 of the Water Supply Act.

(c) the chief executive may require the amendment of the existing flood mitigation manual.[159]

41. Seqwater's Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam (the ***Wivenhoe and Somerset Flood Manual***) was developed in 1992, before the commencement of the Water Supply Act. The basis of the Wivenhoe and Somerset Flood Manual was a manual written in 1968 to cover flood operations at Somerset Dam (Wivenhoe dam was completed in 1984). Six revisions of the Wivenhoe and Somerset Flood Manual have occurred since 1992. The Wivenhoe and Somerset Flood Manual was gazetted on 22 January 2010. The history of the development of the manual in contained in **Annexure 6**. As can be seen from that analysis, leading experts have been involved in the development of the Wivenhoe Manual.

42. A flood mitigation manual has also been approved for the North Pine Dam. The Manual for Operational Procedures for Flood Mitigation at North Pine Dam was gazetted on 17 December 2010.

43. Section 613 of the Water Supply Act provides that a flood mitigation manual approved under the previous s.497 of the Water Act and in force before the commencement of the Water Supply Act, which the Flood Manual was, is taken to be a flood mitigation manual approved under s.371 of the Water Supply Act. Accordingly, the Wivenhoe and Somerset Flood Manual is an approved flood mitigation manual under the Water Supply Act.

44. Section 374 of the Water Supply Act provides that:

> "*(1) The chief executive or a member of the council does not incur civil liability for an act done, or omission made, honestly and without negligence under this part.*
>
> *(2) An owner of a dam who observes the operational procedures in a flood mitigation manual, approved by the chief executive, for the dam does not incur civil liability for an act done, or omission made, honestly and without negligence in observing the procedures.*
>
> *(3) If subsection (1) or (2) prevents civil liability attaching to a person, the liability attaches instead to the State.*
>
> *(4) In this section—*
>
> ***owner**, of a dam, includes—*
>
> *(a) the operator of the dam; or*
>
> *(b) a director of the owner or operator of the dam; or*
>
> *(c) an employee of the owner or operator of the dam; or*
>
> *(d) an agent of the owner or operator of the dam."*

45. Additionally, Section 49 of the Water Supply Act provides that:

> "(1) A service provider, owner of land, operator of water infrastructure, operator of relevant water infrastructure or lessee of a service provider or operator of water infrastructure (each ***an affected party***) is not liable for an event or circumstance beyond the control of the affected party.
>
> (2) Subsection (1)—

[159] Section 372 of the Water Supply Act.

(a) applies only if, in relation to the event or circumstance, the affected party acted reasonably and without negligence; and

(b) does not affect, or in any way limit, the liability of an affected party for negligence.

(3) In this section—

an event or circumstance includes—

(a) the escape of water from water infrastructure or works; and

(b) flooding upstream or downstream of water infrastructure or works; and

(c) contamination, or the quality, of water, including manufactured water flowing, or released, from water infrastructure, relevant water infrastructure or works.

manufactured water means water, including desalinated or recycled water or any substance resulting from the production of desalinated or recycled water, from any source.

relevant water infrastructure means infrastructure that is—

(a) infrastructure the subject of—

(i) a water supply emergency declaration or water supply emergency regulation; or

(ii) works to be undertaken, including works included in a program of works approved by the Governor in Council, under the *State Development and Public Works Organisation Act 1971*; and

(b) a prescribed project under the *State Development and Public Works Organisation Act 1971*; and

(c) infrastructure the Minister declares in a gazette notice to be relevant water infrastructure for the purposes of this section."

Annexure 6

Development of the Flood Mitigation Manuals for the Somerset, Wivenhoe and North Pine Dams

46. Seqwater's *Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam, Revision 7, November 2009* (***Wivenhoe Manual***) was approved by the Chief Executive of the Department of Environmental and Resource Management (***DERM***) on 22 December 2009 as a flood mitigation manual under the *Water Supply (Safety and Reliability) Act 2008* (***Water Supply Act***)[160].

47. Seqwater's *Manual of Operational Procedures for Flood Mitigation at North Pine Dam, Revision 5, August 2010* (***North Pine Manual***) was approved by the Chief Executive of the DERM on 6 December 2010 as a flood mitigation manual under the Water Supply Act[161].

48. The Wivenhoe Manual and North Pine Manual have been developed over time to accord with changes to:

    (a) the relevant legislation;

    (b) available flood event data and models for rainfall estimation and design floods; and

    (c) the physical infrastructure itself, including the installation of an Automated Local Evaluation in Real Time (ALERT) rainfall and water level monitoring system in the early 1990s, subsequent upgrades to the ALERT system and the upgrade of Wivenhoe Dam in 2005.

49. As shown in the following Table, the Wivenhoe Manual and North Pine Manual have been revised seven and five times respectively.

50. The first revisions of both manuals were approved in 1992 following the construction of Wivenhoe Dam and reviews of existing design flood modelling.

51. Since then, the Wivenhoe Manual has governed the operational procedures for flood mitigation for the Somerset and Wivenhoe Dams in tandem "to maximise the combined flood mitigation benefits of [the dams]"[162].

52. This Annexure describes the development of the Wivenhoe Manual and North Pine Manual since 2004 until the most recent approvals noted above. A description of the development of the manuals prior to 2004 can be provided on the request of the Commission.

[160] *Approval of Flood Mitigation Manual Notice (No 1) 2010* in Queensland Government Gazette, No. 15, p127 (Friday 22 January 2010)

[161] *Approval of Flood Mitigation Manual Notice (No 2) 2010* in Queensland Government Gazette, No. 114, 01102 (Friday 17 December 2010)

[162] Seqwater, *Somerset-Wivenhoe Interaction Study* (October 2009)

Table 18 (Annexure 6): Dates of Wivenhoe Manual Revisions.

Source: Seqwater.

Wivenhoe Manual			
Issue	**Doc. Date**	**Gazette Date**	**Reference**
0	27.10.68	-	**-**
1	06.10.92	-	**-**
2	13.11.97	-	**-**
3	24.08.98	-	***Wivenhoe Revision 3***
4	06.09.02	16.10.02	***Wivenhoe Revision 4***
5	04.10.04	27.10.04	***Wivenhoe Revision 5***
6	20.12.04	02.02.05	***Wivenhoe Revision 6***
7	00.11.09	22.12.09	***Wivenhoe Manual***

Table 19 (Annexure 6) Dates of North Pine Manual Revisions.

Source: Seqwater.

North Pine Manual			
Issue	**Doc. Date**	**Gazette Date**	**Reference**
0	10.12.86	-	**-**
1	06.10.92	-	**-**
2	13.11.97	-	***North Pine Revision 2***
3	26.07.02	18.09.02	***North Pine Revision 3***
4	05.09.07	13.09.07	***North Pine Revision 4***
5	00.08.10	06.12.10	***North Pine Manual***

2004 and 2007 Revisions

Relevant Regulatory Provisions

53. The *South East Queensland Water Board (Reform Facilitation) Act 1999*:

    (a) facilitated the transfer of Wivenhoe, Somerset and North Pine Dams from the South East Queensland Water Board (***Water Board***) to Seqwater Corporation Limited (***Seqwater Corp***), a company wholly owned by the State and relevant local governments; and

    (b) moved sections relevant to flood mitigation from the *South East Queensland Water Board Act 1979* (***Water Board Act***) to the *Water Resources Act 1989* (***WRA***)[163].

54. Wivenhoe Revision 3 and North Pine Revision 2, prepared under the Water Board Act, were taken to be approved under the WRA[164].

55. Following the introduction of the *Water Act 2000* (***Water Act***), the flood mitigation sections were moved from the WRA to the Water Act. Under the Water Act:

    (a) dam owners, as nominated by regulation, were required to:

        (i) prepare a flood mitigation manual for the Chief Executive's approval[165]; and

        (ii) review and update the manual as necessary before it expired and seek the Chief Executive's approval for any updated manual[166];

    (b) the Chief Executive could:

        (i) approve a flood mitigation manual for up to 5 years[167];

        (ii) require a dam owner to amend an existing flood mitigation manual[168]; and

        (iii) get advice from an advisory council before approving a flood mitigation manual or amendment[169]; and

    (c) a dam owner, its directors, employees and agents who observed the procedures in an approved flood mitigation manual were protected from civil liability for an act done or omission made honestly and without negligence[170].

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[163] *South East Queensland Water Board (Reform Facilitation) Act 1999,* s13 (which inserted new Part 10A into the *Water Resources Act 1989*). Under the WRA, (a) the Minister could establish a technical advisory committee (s215C) to prepare a flood mitigation manual for each of the Water Board's reservoirs (to become Seqwater Corp's)(s215D), (b) the Minister could approve the flood mitigation manual or an amendment thereto by gazette notice (s215F); and Seqwater Corp's directors, employees and agents were protected from civil liability for an act done or omission made honestly and without negligence in observing the procedures in the flood mitigation manual (s215G)

[164] *Water Resources Act 1989,* s215Y(2)

[165] *Water Act 2000,* ss496, s497(1)

[166] *ibid.,* s499

[167] *ibid.,* s497(3)

[168] *ibid.,* s498

56. Wivenhoe Revision 3 and North Pine Revision 2 were taken to be approved under the Water Act[171].

57. Subsequently, in relation to Wivenhoe and Somerset Dams, the Chief Executive approved:

    (a) Wivenhoe Revision 4 on 16 October 2002 for a five year period[172].

    (b) Wivenhoe Revision 5 on 27 October 2004 for a five year period[173]; and (shortly thereafter)

    (c) Wivenhoe Revision 6 on 2 February 2005 for a five year period (i.e. until 2 February 2010 unless otherwise amended)[174].

58. In relation to North Pine Dam, the Chief Executive approved:

    (a) North Pine Revision 3 on 18 September 2002 for a five year period (i.e. until 18 September 2007 unless otherwise amended)[175]; and

    (b) North Pine Revision 4 on 13 September 2007 for a five year period[176] (i.e. until 13 September 2012 unless otherwise amended).

Technical Developments

59. The flood event in 1999 was the first event managed following installation of the ALERT system, the effectiveness of which was subsequently analysed[177]. North Pine Revision 3 and Wivenhoe Revision 4 were subsequently prepared.

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[169] *ibid.,* ss497(4), 498(4)

[170] *ibid.,* s500(2)-(4); Explanatory Notes to *Water Bill 2000* stated: "Clause 500 provides that an owner of a flood mitigation dam shall not be civilly liable for actions taken or omissions made by the owner honestly and without negligence in operating a dam in accordance with approved procedures. This carries on a provision that existed under the *South East Queensland Water Board Act 1979*. Essentially the provision requires that the operator of the approved flood management storage must have and comply with Ministerial approved manuals as to how the storage is operated. Where releases from the storage may result in some damage downstream (for example, damage to a bridge) the operator is not liable. The provisions for the storage as nominated in the schedule to the Bill are not matters that the service providers undertake as part of their normal commercial operations. Rather, they are things the operator undertakes to fulfil a broader public purpose, for example, control releases and undertake certain reporting and coordinating activities with local governments about release from the storage. The Bill provides that if the service provider operates the storage according to the approved manual, and acts honestly and without negligence, the service provider will not be liable. Liability will attach to the State instead" (p7)

[171] *Water Act 2000*, s1071

[172] *Approval of Flood Mitigation Manual Notice (No 1) 2002* in Queensland Government Gazette, No. 41, p641 (22 October 2002)

[173] *Approval of Flood Mitigation Manual Notice (No 1) 2004* in Queensland Government Gazette, No. 54, p754 (5 November 2004)

[174] *Approval of Flood Mitigation Manual Notice (No 1) 2005* in Queensland Government Gazette, No. 40, p617 (25 February 2005)

[175] *Approval of Flood Mitigation Manual Notice (No 2) 2002* in Queensland Government Gazette, No. 41, p641 (22 October 2002)

[176] *Approval of Flood Mitigation Manual Notice (No 1) 2007* in Queensland Government Gazette, No. 28, p504 (28 September 2007)

[177] Department of Natural Resources, State Water Projects (September 1999), *Report to South East Queensland Water Board on Flood Events of February and March 1999 at Somerset Dam, Wivenhoe Dam and North Pine Dam;* Sunwater

60. In 2001, Seqwater Corp commissioned Gutteridge Haskins and Davey Pty Ltd (***GHD***) to carry out a preliminary engineering assessment on options to upgrade the flood capacity at Wivenhoe Dam (***2001 Investigation***)[178].

61. Subsequently in 2003, Seqwater Corp sought proposals for involvement in, and subsequently formed, an alliance to consider the options included the 2001 Investigation and eventually deliver the upgrade. The 'Wivenhoe Alliance' comprised:

    (a) Leighton Contractors (construction and project management);

    (b) NSW Department of Commerce, Dams & Civil Section (dam design);

    (c) Coffey Geosciences (geotechnical design and hydrology); and

    (d) MWH (environmental assessment and stakeholder management).

62. Following the evaluation of the options by the Wivenhoe Alliance[179], Seqwater Corp decided to upgrade the flood discharge capacity of Wivenhoe Dam by constructing two auxiliary spillways consisting of a secondary, three-bay fuse plug on the right abutment (Stage 1) and a tertiary, one bay fuse plug at Saddle Dam 2 (Stage 2)(***Upgrade***).

63. In 2007, Seqwater Corp commissioned SunWater Engineering Services to revise the design hydrology for North Pine Dam (***2007 Review***)[180]:

Key Amendments

64. A copy of the Wivenhoe Revision 5 is at **Attachment 22.**

65. Wivenhoe Revision 5 amended the operational procedures for flood mitigation to:

    (a) facilitate the Stage 1 Upgrade at Wivenhoe Dam; and

    (b) accord with developments in flood modelling.

66. The preface to Revision 5 confirms that the substantive amendments from Wivenhoe Revision 4 were to include operational procedures for Wivenhoe Dam during the construction phase of the Stage 1 Upgrade:

> "*The primary objectives have not varied from those defined in the previous manual. These remain ensuring safety of the dams, their ability to deal with extreme and closely spaced floods, and protection of urban areas. The basic operational procedures have also essentially remained the same. Wivenhoe Dam and Somerset Dam are operated in*

(February 2001), *Report on Flood Event of February 2001 at Somerset Dam, Wivenhoe Dam and North Pine Dam*. Seqwater Corporation; See also ANCOLD (1991), *Real time flood management of the Brisbane River and Pine River Dams during the February 1999 flood*

[178] See ANCOLD (2001) *Flood Passing Capacity Upgrade Considerations for Wivenhoe Dam*, paper presented at the 2001 ANCOLD Conference on Dams

[179] Wivenhoe Alliance (26 June 2003), *Option Selection Report, Phase 1 for Wivenhoe Dam Spillway Augmentation*; See also Wivenhoe Alliance (25 February 2004), *Somerset Dam – Maximum Flood Level Estimates for Various Gate Operation Scenarios*; Wivenhoe Alliance (February 2004), *Design Discharges and Downstream Impacts of Wivenhoe Dam Upgrade: report number Q1091*; Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Dam Upgrade* (September 2005); ANCOLD (2001), *Flood Passing Capacity Upgrade Considerations for Wivenhoe Dam*, paper presented at the 2001 ANCOLD Conference on Dams; ANCOLD (2004), *Wivenhoe Dam Flood Security Upgrade*, paper presented at ANCOLD/NZSOLD Conference 2004

[180] Sunwater (October 2007), *Final Report North Pine Dam Design Flood Hydrology.* Seqwater Corporation

> *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.*
>
> *The changes to the 2002 version of the manual have arisen out of the spillway upgrade process for Wivenhoe Dam with the addition of the three bay right abutment fuse plug spillway. The changes enable Wivenhoe Dam to pass a 1:100,000 AEP flood event. The manual covers the provisions introduced to cover flood operations of the dams during the construction period for the spillway upgrade and for flood operations after theses provisions become operational*"[181].

67. A copy of the Wivenhoe Revision 6 is at **Attachment 23.**

68. Wivenhoe Revision 6 included additional details regarding the fuse plugs but no other substantive amendments.

69. A copy of North Pine Revision 4 is at **Attachment 24.**

70. The amendments in the North Pine Revision 4 following the 2007 Review were "minor". The preface of North Pine Revision 4 states "The operational effectiveness of the system has led to some flexibility in the operating procedures being identified. Some minor changes to the procedures have been incorporated…as a consequence".

[181] Wivenhoe Revision 5, p5

Current Flood Manuals – 2009 & 2010

Relevant Regulatory Provisions

71. The Queensland Bulk Water Supply Authority (***Seqwater***) was established on 16 November 2007 under the *South East Queensland Water (Restructuring) Act 2007* (***Restructuring Act***). The Restructuring Act also facilitated the transfer of the Wivenhoe, Somerset and North Pine Dams from Seqwater Corp to Seqwater.

72. From 1 July 2008, the flood mitigation sections in the Water Act were relocated to the Water Supply Act[182].

73. Wivenhoe Revision 6 and North Pine Revision 4 were taken to be approved under the Water Supply Act[183].

74. Subsequently, the Chief Executive approved:

    (a) Wivenhoe Manual on 22 December 2009 for a five year period (i.e. until 22 December 2014 unless otherwise amended)[184]; and

    (b) North Pine Manual on 6 December 2010 for a five year period (i.e. until 6 December 2015 unless amended otherwise)[185].

Technical Developments

75. As part of the Stage 1 Upgrade to Wivenhoe Dam, the Wivenhoe Alliance:

    (a) reviewed the existing spillway design and construction[186]; and

    (b) updated the design flood hydrology[187],

    for the Wivenhoe catchment.

76. In *Design Discharges and Downstream Impacts of the Wivenhoe Dam Upgrade* (September 2005)(***2005 Report***), the Wivenhoe Alliance also considered whether gate operating procedures contained in Wivenhoe Revision 6 ought to change following the completion of the Stage 1 Upgrade. The 2005 Report concluded the procedures would "remain generally unchanged" however proposed changes:

    (a) to include procedures to prevent a fuse plug from initiating; and

    (b) for circumstances when communication with the flood centre is lost.

77. A similar review of the design flood hydrology was completed in relation to Somerset Dam in 2004[188].

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[182] *Water Supply (Safety and Reliability) Act 2008*, ss370-374

[183] *ibid*., s613

[184] *Approval of Flood Mitigation Manual Notice (No 1) 2010* in Queensland Government Gazette, No. 15, p127 (Friday 22 January 2010)

[185] *Approval of Flood Mitigation Manual Notice (No 2) 2010* in Queensland Government Gazette, No. 114, 01102 (Friday 17 December 2010)

[186] Wivenhoe Alliance (December 2005), *Wivenhoe Dam Spillway Augmentation, Volume 10 – Existing Spillway Design and Construction Report*

[187] Wivenhoe Alliance (September 2005), *Design Discharges and Downstream Impacts of the Wivenhoe Dam Upgrade*

78. Stage 1 of the Upgrade was completed in late 2005.

79. Seqwater Corp was involved in the *Brisbane Valley Flood Damage Minimisation Study* instigated by the BCC in 2005. The Technical Steering Committee for the study included representatives of Seqwater Corp, BoM, Department of Natural Resources and Water (***DNRW***), SunWater and the Brisbane City, Ipswich, Esk, Kilcoy and Laidley councils. The study confirmed the appropriateness of the flood design models adopted in North Pine Revision 4 and Wivenhoe Revision 6[189].

80. A subsequent safety audit of the dams in 2007 by DNRW also stated that the operational procedures in North Pine Revision 4 and Wivenhoe Revision 6 were "concisely written, backed up with modelling tools & training with reliable links to field personnel and catchment monitoring"[190].

81. In light of the prolonged drought in South East Queensland, Seqwater in conjunction with DNRW, investigated whether raising the full supply levels at Wivenhoe Dam or Somerset Dam could provide contingency storage as part of the *South East Queensland Regional Water Supply Strategy*[191]. The options were compared with other storage options in the region and it was recommended that[192]:

    (a) raising of the full supply level of Somerset Dam be discounted as an option; and

    (b) the provisions of contingency storage in Wivenhoe Dam be investigated further in the future[193].

82. In 2009, Seqwater's Executive Management Team resolved to convene a 'Flood Modelling and Flood Operations Expert Panel' to review North Pine Revision 4 and Wivenhoe Revision 6 (***Expert Panel***). The members of the Expert Panel include representatives from Seqwater, BOM, BCC, Sunwater (being the flood centre operator) and the DERM, including the Dam Safety Regulator. The first meeting of the Expert Panel was held on 8 May 2009[194].

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[188] Wivenhoe Alliance (February 2004), *Somerset Dam – Maximum Flood Level Estimates for Various Gate Operation Scenarios*; see also NSW Department of Commerce (May 2005), *Somerset Dam, Stability of Abutment Monoliths, Report No DC05099*. Seqwater Corporation

[189] WRM Water & Environment (27 October 2006), *Brisbane Valley Flood Damage Minimisation Study, Brisbane City Flood Damage Assessment*. Brisbane City Council, City Design.

[190] Department of Natural Resources and Water (June 2007), *Seqwater Water Services Dam Safety Audit*, p2

[191] Seqwater (March 2007), *Provision of contingency storage in Wivenhoe and Somerset Dams*. Queensland Water Commission and Department of Natural Resources and Water; See also Sunwater, (December 2007), *Assessment of Wivenhoe Dam Full Supply Level on Flood Impacts: Report*. Seqwater; GHD (December 2009), *Report for Wivenhoe Dam Full Supply Level Review, Technical Assessment of Raising Potential.* Seqwater.

[192] *ibid*., p59

[193] See GHD (December 2009), *Report for Wivenhoe Dam Full Supply Level Review, Technical Assessment of Raising Potential*. Seqwater. NB: A review of "the operation of the Brisbane River system to optimise the water supply yield and balance flood storage and water supply storage volume requirements" is allocated a 'medium-term' timeframe under the Queensland Water Commission (2010), *South East Queensland Water Strategy*, p143

[194] Seqwater, *Minutes of Meeting of Flood Modelling and Flood Operations Expert Panel, Wivenhoe, Somerset and North Pine Dams* (Friday 8 May 2009)

83. Later in 2009, the appropriateness of the procedures in Wivenhoe Revision 6 following the Stage 1 Upgrade were assessed against the latest available design flow data (***2009 Interaction Study***)[195]. The 2009 Interaction Study is at **Attachment 25**.

84. The review of North Pine Revision 4 and Wivenhoe Revision 6 also benefited from the analysis of data collected during flood events in 2009[196]. Further, the preparation of the North Pine Manual benefited from an analysis of flood events in February and March 2010[197].

85. In 2010, Seqwater prepared a number of documents to support the operational procedures contained in the Wivenhoe Manual and North Pine Manual, including:

(a) Seqwater, *Flood Procedure Manual for Wivenhoe Dam, Somerset Dam, North Pine Dam, Leslie Harrison Dam, Uncontrolled Spillway Dams, Revision 0* (January 2010); and

(b) Seqwater, *Flood Operations Preparedness Report, Wivenhoe, Somerset and North Pine Dam* (October 2010).

Key Amendments

86. A copy of the Wivenhoe Manual is at **Attachment 26.**

87. The Wivenhoe Manual amended the operational procedures for flood mitigation to accord with:

(a) the introduction of the Water Supply Act; and

(b) the new operational capabilities of Wivenhoe Dam following the Stage 1 Upgrade based on the 2005 Report and 2009 Interaction Study.

87.2 The following explanatory notes summarise the changes contained in the Wivenhoe Manual:

> "*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***

[195] Seqwater (October 2009), *Somerset-Wivenhoe Interaction Study.*

[196] Sunwater (August 2009), *Final Report Seqwater Flood Event Report 2009*. Seqwater

[197] SunWater (March 2010), *Flood Events at Wivenhoe, Somerset and North Pine Dams for February and March 2010: final report.* Seqwater

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 AMENDMENTS

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 [sic]. *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)".

88. A copy of the North Pine Manual is at **Attachment 27.**

89. The North Pine Manual was amended to reflect the Water Supply Act and re-ordered the flood mitigation objectives. The following explanatory notes summarise those amendments:

> *"Seqwater has recently completed a comprehensive review of the Manual of Operational Procedures for Flood Mitigation at North Pine Dam. This work has resulted in a number of*

revisions to the Manual. Changes to the Manual can be grouped into two broad categories, which are:

- *Administrative Issues.*
- *Review of Manual Objectives.*

Changes within these two categories are explained in detail below. Unlike the recent review of the Wivenhoe Dam and Somerset Dam Manual, no technical amendments or improvements to operational descriptions were considered necessary as a result of the review.

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.

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 dam;*
- *Minimise disruption to urban and rural life in the valleys of the North Pine River and its major tributaries; and*
- *Retain storage at the full supply level.*

As a result of the review process, the Flood Mitigation Objectives contained in the updated version of the Manual in order of importance are:

- *Ensure the structural safety of the dam;*
- *Minimise disruption to the community in areas downstream of the dam;*
- *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 essentially unchanged from the previous version, with only updated wording that is consistent with the Wivenhoe Dam and Somerset Dam Manual. The last objective has been added to reflect current operating practice. During 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".

Annexure 7

Technical Information in respect of Wivenhoe , Somerset and some other dams

Wivenhoe Dam

Figure 14 (Annexure 7): Photograph of Wivenhoe Spillway Gates.

(Source: Seqwater.)

Background

1. Wivenhoe Dam has a catchment area of about 7,048 km^2.[198]

2. As originally constructed, Wivenhoe Dam is 56 m high, zoned earth and rock embankment with a concrete spillway (crest level EL 57), controlled by 5 radial gates, each 12.0m wide

[198] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 11.

by 16.0m high. Two saddle dam embankments are located on the left side of the reservoir. The Brisbane Valley Highway was relocated to pass over the dam wall.[199]

3. The Co-ordinator General's Department carried out preliminary investigations to determine the major design parameters for Wivenhoe Dam.[200]

4. The Co-ordinator General's recommendations regarding reservoir levels were[201]:

   (a) FSL at EL 67m;

   (b) Maximum Flood Level at EL 77m; and

   (c) Reservoir Resumption Level at EL 75m.

5. The dam was designed by the Queensland Water Resources Commission. A design report was complied by the then Department of Primary Industries for the South East Queensland Water Board.[202]

6. The Dam was constructed by a series of contracts between 1977 and 1985, supervised by the Queensland Water Resources Commission.[203]

7. Wivenhoe Dam has four main functions by providing:

   (a) A storage of 1.165 GL at FSL (EL 67) providing safe drinking water supply for Brisbane and surrounding areas;

   (b) Flood mitigation of the Brisbane River with a dedicated flood storage volume of approximately 1.45 GL, at EL 77.0 m;

   (c) The lower pool Split Yard Pumped Hydro-Electric power station, which has a 500 ML generating capacity; and

   (d) a recreation area.[204]

Wivenhoe Dam Upgrade

8. The original spillway capacity of Wivenhoe Dam had an AEP of 1 in 22,000 for the Dam Crest Flood.[205]

9. The 'Wivenhoe Alliance' was formed by Seqwater to improve the flood security of the dam with a long term goal of providing for PMF.[206]

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[199] Seqwater (for Queensland Water Commission and Queensland Department of Natural Resources and Water), *Provision of contingency storage in Wivenhoe and Somerset Dams* (March 2007), p 15.

[200] Department of Primary Industries, '*Wivenhoe Dam Design Report – Volume 1 – Text*' – September, 1995 , p 5.

[201] Department of Primary Industries, '*Wivenhoe Dam Design Report – Volume 1 – Text*' – September, 1995 , p 5.

[202] Seqwater (for Queensland Water Commission and Queensland Department of Natural Resources and Water), *Provision of contingency storage in Wivenhoe and Somerset Dams* (March 2007), p 15.

[203] Seqwater (for Queensland Water Commission and Queensland Department of Natural Resources and Water), *Provision of contingency storage in Wivenhoe and Somerset Dams* (March 2007), p 15.

[204] GHD, South East Queensland Water Corporation Limited, '*Report for Wivenhoe Dam Full Supply Level Review – Technical Assessment of Raising Potential*', December, 2009, p4.

[205] Seqwater (for Queensland Water Commission and Queensland Department of Natural Resources and Water), *Provision of contingency storage in Wivenhoe and Somerset Dams* (March 2007), p 15.

10. The following outcomes were adopted for the design of the upgrade works:

    (a) to allow for Wivenhoe Dam to safely pass the latest estimate of the PMF;

    (b) to preserve the flood mitigation benefits of Wivenhoe and Somerset dams for more frequent flood events;

    (c) to ensure the outflows are less than inflows for all flood events;

    (d) to limit the frequency of operation of the auxiliary spillway to reduce downstream damage; and

    (e) to minimise the cost of the upgrade.[207]

11. The 'Wivenhoe Alliance, Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091, September 2005' determined that "[t]he proposed auxiliary spillways allow SEQWater to satisfy all of the above conditions."[208]

12. Investigation studies concluded that a two-stage upgrade program (outlined below) would provide a cost-effective risk reduction program.[209]

13. Stage 1 Upgrade Works included:

    (a) Construction of a new secondary spillway on the right abutment that would enable the dam to handle an inflow flood with an AEP of 1 in 100,000 at a maximum flood level of EL 80m. The spillway is controlled by three fuse plug embankments.

    (b) Upgrading the embankment crest to retain a maximum flood level of EL 80m with nil freeboard; and

    (c) Upgrading of associated structures as appropriate, including protection of the main spillway gates and bridge and strengthening of the spillway gravity structure.[210]

14. Stage 2 Upgrade Works included:

    (a) Reconstruction of Saddle Dam 2 as a fuse plug spillway such that Wivenhoe Dam can accommodate PMF.[211]

15. Stage 1 upgrade works were completed by late 2005. Accordingly, the dam currently has an AEP of 1 in 100,000.

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[206] Seqwater (for Queensland Water Commission and Queensland Department of Natural Resources and Water), *Provision of contingency storage in Wivenhoe and Somerset Dams* (March 2007), p 15.

[207] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 12.

[208] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 12.

[209] Seqwater (for Queensland Water Commission and Queensland Department of Natural Resources and Water), *Provision of contingency storage in Wivenhoe and Somerset Dams* (March 2007), p 15.

[210] Seqwater (for Queensland Water Commission and Queensland Department of Natural Resources and Water), *Provision of contingency storage in Wivenhoe and Somerset Dams* (March 2007), p 16.

[211] Seqwater (for Queensland Water Commission and Queensland Department of Natural Resources and Water), *Provision of contingency storage in Wivenhoe and Somerset Dams* (March 2007), p 16.

16. Relevantly, the 'Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005' also determined that:

(a) The PMF inflow to the dam (including Somerset outflows) is estimated at 49,200 m^3/s, which corresponds to a critical storm duration of 36 hours. The PMF outflow is estimated at 37,600 m^3/s[212]; and

(b) The PMF inflow and outflow is sensitive to temporal patterns. The adopted pattern produced an inflow peak that is higher than the mean and median produced using the historical patterns. PMF outflow is not very sensitive to downstream flows or the lateral erosion rates of the fuse plugs.[213]

What is a Fuse Plug?

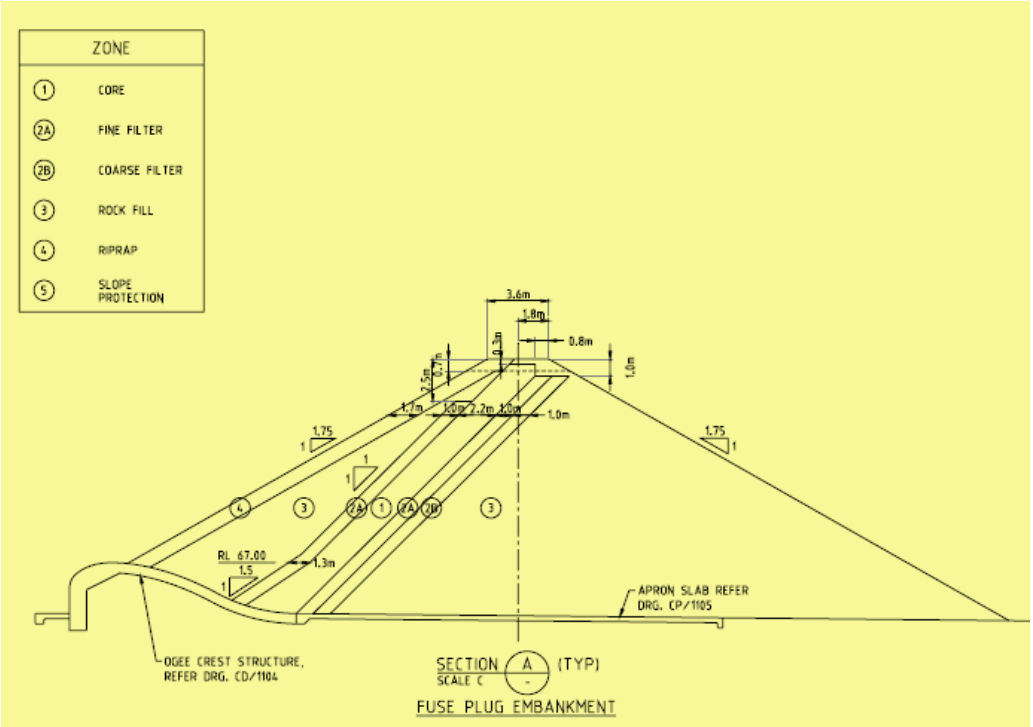

Figure 15 (Annexure 7): Typical Fuse Plug Embankment Cross Section.

(Source: Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 15)

17. A fuse plug is effectively a zoned earth and rock fill embankment that is constructed on a non-erosive sill or weir.[214]

[212] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 52.

[213] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 52.

[214] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 14.

18. The embankment is designed to erode in a controlled manner when the lake water level reaches a pre-determined level. Below this level, the embankment impounds water in the same manner as a typical zoned earth and rock fill embankment.[215]

19. The upstream face of the embankment consists of a riprap layer to protect against wave action. Consecutive layers consist of coarse rock followed by a coarse filter and then the impermeable clay core that are laid on a similar slope to the riprap.[216]

20. Downstream of the sloping clay core are more layers of filters that lie on compacted rock fill, which extends to the downstream slope of the embankment.[217]

21. The controlled erosion is initiated at a low point, or pilot channel located in the embankment crest. [218]

22. A narrow vertical slot of coarse filter is located immediately downstream of the pilot channel that extends to the downstream slope of the dam and replaces the compacted rock fill.[219]

23. As the lake water level rises above the pilot channel crest to a depth of about 0.1 m, fast flowing water starts to erode the coarse filter in the vertical slot, which removes the material supporting the sloping clay core eventually causing it to collapse.

24. The material adjacent to the slot is then exposed to the fast flowing water initiating lateral erosion.[220]

Design of the Fuse Plugs

25. The DERM AFC Guidelines specify that unless a case for a contrary view is adequately made, where fuse plugs or fuse gates are relied upon to pass the Acceptable Flood Capacity, they should be appropriately designed, constructed and maintained in order to fulfil their required function in accordance with the following:

    (a) initial triggering of the fuse element is not to occur for floods having greater probability than 0.2 per cent AEP;

    (b) failure of successive fuse plugs or fuse gates is to be progressive, predictable and designed to minimise the impact on downstream Population at Risk (PAR); and

[215] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 14.

[216] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 14.

[217] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 14.

[218] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 15.

[219] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 15.

[220] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 15.

(c) the potential downstream impacts of fuse plug or fuse gate triggering at representative locations of PAR are to be identified and documented as part of the Acceptable Flood Capacity report.[221]

26. The DERM AFC Guidelines additionally state that, unless varied by the above, the design of fuse plugs are to comply with the provisions of US Department of the Interior (USBR 1987), *Guidelines for Using Fuse-plug Embankments in Auxiliary Spillways*.[222]

27. Each of the above requirements are satisfied by the Wivenhoe fuse plug spillway, in particular:

(a) A 0.2% AEP trigger level equates to an AEP of approximately 1 in 500. The initiation of the first fuse plug at Wivenhoe occurs at an AEP of about 1 in 6,000.[223] Consequently, this requirement is satisfied;

(b) A full analysis of the downstream impacts of the fuse plugs is detailed in the 'Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005', report. Further information is detailed below. However, the downstream impacts are small, flows from the fuse plugs on the right abutment (i.e. fuse plugs 1 to 3) increase peak water levels by only 0.7m to 1.1m at Savages Crossing, and by 0.3 m to 0.5 m at Moggill Gauge[224]; and

(c) The Wivenhoe fuse plugs comply with the US Department of the Interior (USBR 1987), *Guidelines for Using Fuse-plug Embankments in Auxiliary Spillways*.

28. The New South Wales Public Works and Services, extrapolated the results of the abovementioned studies to design a 15 m high fuse plug embankments at Warragamba Dam in Sydney.[225]

29. The analysis undertaken for Warragamba Dam was used to select the material and estimate the lateral erosion rates for the fuse plugs at Wivenhoe Dam.[226]

Wivenhoe Fuse Plugs

30. Stage 1 of the Wivenhoe upgrade resulted in the construction of three right bank fuse plugs. Stage 2 works consist of the construction of single bay fuse plug at Saddle Dam 2 to be considered at the next comprehensive dam safety review due in 2017.[227]

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[221] DERM AFC Guidelines, p5.

[222] DERM AFC Guidelines, p5.

[223] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005.

[224] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 53.

[225] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 16.

[226] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 16.

[227] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 13-14.

31. The Table below provides relevant details of the three existing fuse plugs and the proposed Saddle Dam 2 fuse plug.

Table 3.1 Fuse Plug Spillway Details, Wivenhoe Dam

Auxiliary Spillway Location	Spillway Crest Control Type	Spillway Crest Width (m)	Spillway Crest Level (m AHD)	Fuse Plug Pilot Channel Crest Level (m AHD)
Right Bank				
Fuse plug 1	Ogee	33	67	75.7
Fuse plug 2	Ogee	64.5	67	76.2
Fuse plug 3	Ogee	65.5	67	76.7
Saddle Dam 2				
Fuse plug 4	Ogee	100	67	78.3

Figure 16 (Annexure 7) Wivenhoe Dam Fuse Plug Spillway Details.

(Source: Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Update Q109*1, September 2005, p 14.)

32. As detailed above, the 'spillway crest level' is EL 67 m (i.e. FSL). This means after a fuse plug is triggered, the fuse plug bay erodes to a level of EL 67 m. Consequently, following an initiation event, the auxiliary spillway will operate every time the water in the dam exceeds FSL.

33. Fuse plug embankments can generally be reconstructed within three months of an initiation event provided designs are in place and sufficient material is available.[228]

34. As the initiation of the first fuse plug occurs at an AEP of about of 1 in 6,000, it is not practicable to stockpile material for such a rare event.[229]

35. To ensure sufficient material is available at the time of an initiation event, Seqwater will identify sources of replacement material, should it be needed, as part of the Dam Safety Inspections undertaken every 10 to 15 years.[230]

[228] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 16.

[229] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 16

[230] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 16.

Spillway Discharges at Fuse Plug Initiation

Table 5.1 Peak Outflows and Maximum Lake Levels at Fuse Plug Initiation, Wivenhoe Dam

Fuse Plug No. Initiated	Approx. Inflow AEP (1 in X Years)	Peak Outflow (m^3/s)			Lake Water Level at Fuse Plug Initiation (m AHD)
		Gated Spillway	Total Right Abutment (RA) Spillway	Saddle Dam 2 (SD2) Spillway	
1	6,000	10,600	1,650	0	75.80
2	11,500	11,200	5,400	0	76.33
3	22,500	11,900	9,900	0	76.88
4 (SD2)	65,000	13,100	12,200	7,550	78.40

Figure 17 (Annexure 7): Peak out Flows and Maximise Lake Levels of Fuse Plug Initiation, Wivenhoe Dam.

(Source: Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Update Q109*1, September 2005, p 23.)

36. The above Table shows lake water levels and discharges from the various spillways when each fuse plug initiates.[231]

37. The approximate flood (inflow) AEP at which the fuse plugs initiate are also shown. It has been assumed that a depth averaged water level of 0.1m over the fuse plug pilot channel crest is required to initiate the fuse plug.[232]

38. Spillway chute losses of 0.03m and 0.08 m have been assumed for bay 2 and bay 3 on the right abutment respectively. These losses were determined from the 3D CFD modelling of the spillway undertaken by Worley (2004).[233]

[231] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 23.

[232] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 23.

[233] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 23.

39. Relevantly, in relation to the above Table:

(a) The first fuse plug initiates at an AEP of about 1 in 6,000. This is an exceptionally rare initiation level in comparison to auxiliary spillway retrofits of other large dams in Australia. For instance, the initiation of the first fuse plug at Warragamba Dam in Sydney is at an AEP of 1 in 750;[234]

(b) The discharge through each fuse plug bay increases incrementally as the flood AEP reduces, as shown by the difference between right abutment discharges at each initiation point[235];

(c) The first fuse plug breach increases downstream flows by about 1,650 m^3/s within about 20 to 30 minutes. The second fuse plug breach increases flows by 3,600 m^3/s within about 30 to 40 minutes and the third by 4,000 m^3/s in about the same time. The final proposed Stage 2 fuse plug at Saddle Dam 2 increases downstream flows by 7,400 m^3/s in about an hour;[236]

(d) The total peak outflow rate for the right abutment spillway never exceeds the peak outflow rate of the gated spillway. The peak outflow rate for fuse plug 1 is approximately one tenth of the peak outflow rate for the gated spillway.

[234] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 24.

[235] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 24.

[236] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 24.

Design Discharges

Table 5.2 Design Inflows and Outflows for Existing, Stage 1 and Stage 2 Wivenhoe Upgrade

Event (1in X)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)		
		Existing	Stage 1	Stage 2
200	8,200	2,800	2,800	2,800
500	10,300	3,700	3,700	3,700
1,000	12,300	5,700	5,700	5,700
2,000	14,000	6,600	6,600	6,600
5,000	17,300	8,900	10,400 [c]	10,400 [c]
10,000	20,600	11,700	12,900	12,900
22,000 [a]	25,900	12,400 [a]	17,700	17,700
50,000	33,500	- [b]	24,100	24,100
100,000	42,600	- [b]	28,100 [a]	34,900
PMF	49,200	- [b]	- [b]	37,400 [a]

[a] Dam Crest Flood [b] Overtops dam wall [c] Increases due to changes to Procedure 4.

Figure 18 (Annexure 7): Design Inflows and Outflows for Wivenhoe Dam Pre-Upgrade, Post-Stage Upgrade, Post-Stage 2 Upgrade.

(Source: Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Update Q109*1, September 2005, p 24. Note: References to 'Existing' are those levels of Wivenhoe Dam prior to the State 1 Upgrade which has already occurred.)

40. The above Table shows design inflows and outflows for Wivenhoe Dam prior to the Stage 1 upgrade (described as 'Existing' above) and the Stage 1 and Stage 2 dam upgrades, for design floods ranging from the 1 in 200 AEP to the PMF.[237]

[237] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 24.

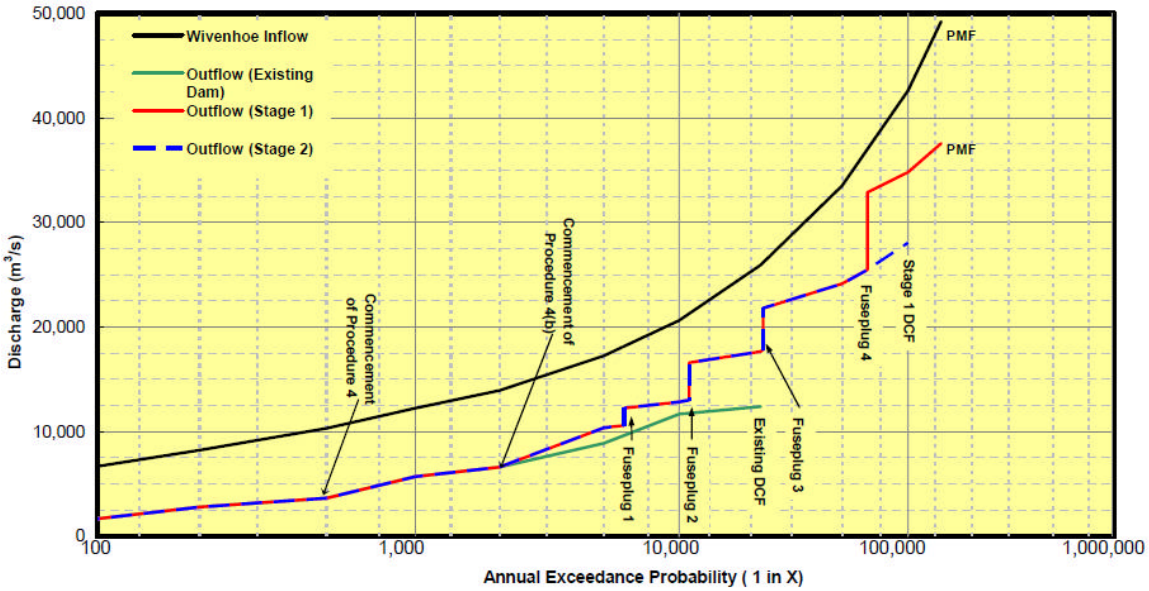

Figure 5.1 Inflow and Outflow Annual Series Flood Frequency Curves for the Existing, Stage 1 and Stage 2 Upgrades, Wivenhoe Dam.

Figure 19 (Annexure 7): Inflow and Outflow Annual Series Flood Frequency Curves for Wivenhoe Dam Pre-Upgrade, Post-Stage 1 Upgrade and Post-Stage 2 Upgrade.

(Source: Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Update Q109*1, September 2005, p 25. Note: References to 'Existing' are those levels of Wivenhoe Dam prior to the State 1 Upgrade which has already occurred.)

The above graph shows the inflow and outflow annual series flood frequency curves over the range of floods analysed. Peak inflows represent the sum of inflows from the upper Brisbane River catchment and outflows from Somerset Dam.[238]

41. Relevantly, in relation to the above Table and Graph:

(a) The 36-hour storm produces the highest inflow peak for all floods;[239]

(b) The 48-hour storm produces the highest outflow peak for the 1 in 200, 1 in 500, 1 in 5,000 and 1 in 10,000 AEP events for the dam upgrade and the 1 in 5,000 AEP event for the dam prior to upgrade.[240]

(c) The 72-hour event produces the highest outflow peak for the 1 in 1,000 and 1 in 2,000 AEP events for both the pre-upgrade and post-dam upgrade.[241]

[238] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 24.

[239] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 25.

[240] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 25.

[241] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 25.

(d) The 36-hour storm produces the highest outflow peak for events more extreme than the 1 in 10,000 AEP event for both the pre-upgrade and post-dam upgrade;[242]

(e) Both Wivenhoe and Somerset Dams have a significant impact on design flood outflow peaks. Somerset Dam alone reduces the PMF inflow peak to Wivenhoe Dam by over 6,000 m^3/s. Combined Stage 1 and Stage 2 works reduce the PMF peak outflow by a further 11,800 m^3/s[243];

(f) The pre-upgrade dam was designed for a maximum flood level of 77 m AHD, which is the top of the existing clay core and filters.[244] The pre-upgrade dam had an increased risk of failure above this level.[245] The flood AEP at this level is about 1 in 10,000[246];

(g) The proposed works do not change outflows for flood events up to the 1 in 2,000 AEP event. This is substantially higher than the 1974 flood, which had an AEP of about 1 in 100 at the dam[247]; and

(h) The rapid increases in outflows in the annual series frequency curves represent the initiation of the fuse plugs.[248]

[242]

[243] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 25.

[244] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 25.

[245] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 25.

[246] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 25.

[247] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 25.

[248] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 25.

Wivenhoe Dam Inflow and Outflow Comparison

42. A design objective of the auxiliary spillway was to ensure outflows from the dam do not exceed inflows for any conceivable flood.[249]

43. To assess this objective, the models were run for all storm durations and all design AEP scenarios. The results of the analysis are detailed below.[250]

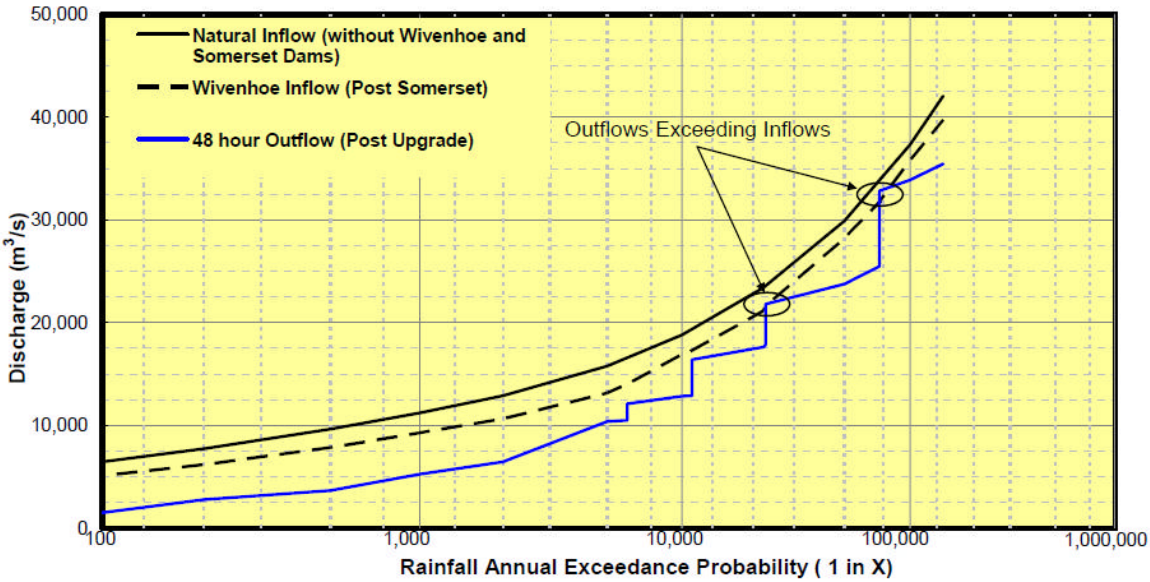

Figure 5.2 Flood Frequency Curves for Pre-Dams Flow, Wivenhoe Inflow (Including Somerset Outflow) and Wivenhoe Outflow (Post Upgrade), 48-hour duration event.

Figure 20 (Annexure 7): Flood Frequency Curves for Pre-Dams Flow, Wivenhoe inflow (including Somerset Outflow) and Wivenhoe Outflow (post upgrade). 48 hour Duration Event.

(Source: Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Update Q109*1, September 2005, p 25. Note: References to 'Existing' are those levels of Wivenhoe Dam prior to the State 1 Upgrade which has already occurred.)

44. The above graph shows flood frequency curves for the Wivenhoe Dam natural (pre Somerset) inflow and Wivenhoe Dam (post Somerset) inflow and Wivenhoe Dam (post upgrade) outflow for the 48 hour duration event.[251]

45. The 48 hour storm duration was selected for comparison between inflows and outflows because this duration produces the smallest difference between flood inflows and outflows.[252]

[249] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 26.

[250] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 26.

[251] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 26.

[252] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 26.

46. Relevantly, in relation to the above Graph:

(a) Somerset Dam alone significantly reduces design flood flows of this duration for all AEP scenarios (shown by the difference in flows between the solid and dashed lines).[253]

(b) Wivenhoe Dam (post upgrade) has a further Impact on design flows (shown by the difference in flows between the dashed line and the solid blue line).[254]

(c) For the floods that just initiate fuse plug 3 and fuse plug 4, the outflows marginally exceed the Wivenhoe Inflows but are substantially lower that the pre-Somerset Dam design flows, thereby satisfying one of the design objectives (i.e. to ensure that outflows are less than inflows for all flood events).[255]

Downstream Impact of Fuse Plug Flows

47. The Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, Report determined that:

Flows from the fuse plugs on the right abutment spillway (ie. fuse plugs 1 to 3) increase peak water levels by 0.7 m to 1.1 m at Savages Crossing and by 0.3 m to 0.5 m at Moggill Gauge;

(a) Flows from fuse plug 4 (Saddle Dam 2 spillway) increase peak water levels by almost 1.5 m at Savages Crossing and by 0.6m at Moggill Gauge;

(b) This increase translates to only a small increase in flood extent upstream of Savages Crossing;

(c) The rate of water level rise downstream of Savages Crossing is not significantly affected by the fuse plug flows; and

(d) It appears that the rapid increase in flows from all fuse plug flows is mitigated by the large floodplain storage upstream of Savages Crossing.

[253] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 26.

[254] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 26.

[255] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 27.

Table 8.2 Brisbane River Flood Peak Travel Times From Commencement of the 36hour Duration Storm, Pre and Post Fuse Plug Flows

Location	Fuse Plug 1		Fuse Plug 2		Fuse Plug 3		Fuse Plug 4 (Saddle Dam 2)	
	Before	After	Before	After	Before	After	Before	After
Wivenhoe Dam	53.0	53.0	54.0	51.5	53.5	52.5	53.5	53.5
Savages Crossing (Fernvale)	60.0	60.5	58.0	57.5	56.5	55.5	55.5	55.0
Mt Crosby Weir	70.5	69.5	68.5	67.0	65.5	64.0	61.5	61.0
Moggill Gauge	76.5	76.0	75.5	75.0	73.0	72.5	70.0	69.0
Port Office Gauge	88.0	88.0	88.0	87.5	86.5	87.0	84.0	82.5

Figure 21 (Annexure 7): Brisbane River Flood Peak Travel Times for Commencement of the 36 hour Duration Storm, Pre and Post Fuse Plug Flows.

(Source: Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Update Q109*1, September 2005, p 51.)

48. The above Table shows the travel time of the flood peak from the commencement of the 36 hour storm event to various locations along the Brisbane River for flood events immediately prior to and just after fuse plug flows occur.[256]

49. Relevantly, in relation to the above Table:

(a) The flood peak travel times from Wivenhoe Dam to Savages Crossing (Fernvale) vary from about 7 hours prior to the initiation of fuse plug 1 to 1.5 hours following the initiation of fuse plug 4[257];

(b) The flood peak travel times from Wivenhoe Dam to Moggill Gauge vary from 23.5 hours prior to the initiation of fuse plug 1 to 15.5 hours following the initiation of fuse plug 4[258]; and

(c) The fuse plug flows do not significantly alter the flood peak travel times, only the volume of flow.[259]

[256] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 51.

[257] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 51.

[258] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 51.

[259] Wivenhoe Alliance, *Design Discharges and Downstream Impacts of the Wivenhoe Upgrade Q1091*, September 2005, p 51.

Somerset Dam

Figure 22 (Annexure 7): Photograph of Somerset Dam dated 28 October 2004.

(Source: Seqwater.)

Background

50. Somerset Dam is a 47 m high concrete gravity dam on the Stanley River upstream of Wivenhoe Dam.[260]

51. The dam was constructed in two stages. Construction commenced in 1935, however, it was suspended in 1942 due to the impact of the Second World War. In 1948, work recommenced and the dam was completed in 1953.[261]

52. The dam has a catchment area of 1,330 km^2 and is fitted with both Radial Gates and Sluice Gates.[262]

53. Somerset Dam is dual purpose dam providing water supply to Brisbane and adjacent local authorities and flood mitigation benefits from the Brisbane and Ipswich areas.[263]

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[260] Seqwater (for Queensland Water Commission and Queensland Department of Natural Resources and Water), *Provision of contingency storage in Wivenhoe and Somerset Dams* (March 2007), p 46.

[261] SMEC, *SEQWater Somerset Dam Crack Investigation*, (July 2008), p 3.

[262] Seqwater, (Draft) '*Somerset Dam Design Flood Hydrology*', October 2009, p13.

54. At FSL of EL 99 m Somerset Dam holds 379,800 ML.[264]

55. At its dam crest level of EL 107.45 m, Somerset Dam has a flood mitigation capacity of approximately 524,000 ML.[265]

Structural Integrity of Somerset Dam

56. Questions have been raised in the public domain as to whether Somerset Dam is structurally sound, particularly due to concerns regarding a well developed crack on the downstream side of the dam that is visible on the downstream face and within the upper gallery of the dam.

57. The cracking in Somerset Dam was addressed in Somerset Dam's comprehensive dam safety review.[266]

58. The review relevantly states:

> "There is considerable horizontal cracking exposed in the upper gallery walls. The main cracks are located on the downstream side of the gallery wall, one about 0.4 metres above floor level and the other 1.6 metres to 1.8 metres above floor level.
>
> The latter crack extends for most of the length of the gallery and appears to be at the same level as a construction joint in the downstream face of the dam. This crack has been investigated in a series of reports, the most recent being in 2008 by SMEC in a report entitled "Somerset Dam – Crack Investigation".
>
> Generally, the reports conclude that the cracking in the Upper gallery is not of structural concern, but that the current monitoring program should continue so that a further investigation trigger can be initiated should the crack begin to significantly change in nature over time".[267]
>
> [Emphasis added]

59. Accordingly, there is no merit in the question that has been raised.

Seqwater's Uncontrolled Spillway Dams With Flood Compartments

60. Seqwater owns four uncontrolled spillway dams that have designed flood storage compartments. These dams are Enoggera Dam, Gold Creek Dam, Hinze Dam and Maroon Dam. Details of these flood storage compartment arrangements are contained below.

Enoggera Dam

61. The spillway of Enoggera Dam comprises a mass gravity uncontrolled ogee section with a crest level of RL 80.47 m and two uncontrolled sluices at the Full Supply Level of RL 74.37 m AHD. The more frequent floods are moderated using the orifice controlled outflow from the sluices by storing the flood hydrograph up to the level of the ogee gravity section

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[263] Seqwater (for Queensland Water Commission and Queensland Department of Natural Resources and Water), *Provision of contingency storage in Wivenhoe and Somerset Dams* (March 2007), p 46.

[264] Seqwater, 'Somerset Dam Design Flood Hydrology' (Draft Report), October 2009, p13; Seqwater, 'Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam', November 2009, p58.

[265] [4] Seqwater, '*Manual of Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam*', November 2009, p59 and p 40; Seqwater, 'Somerset Dam Design Flood Hydrology' (Draft Report), October 2009, p ii.

[266] Seqwater, *Somerset Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010).

[267] Seqwater, *Somerset Dam Five Year Comprehensive Dam Safety Inspection Report*, (September 2010), p7.

and passing the outflow through the sluices peaking at approximate "bank full" flow for the downstream portion of Enoggera Creek. This operation minimises flooding damage in urban areas. For floods greater than about the 1 in 100 year AEP event, the excess flow is passed via the ogee crest overflow spillway to ensure the safety of the dam. The crest level of the embankment section of Enoggera Dam is at RL 84.25 m AHD.

Gold Creek

62. The spillway has been refurbished by the addition of a three metre wide by three metre deep slot with a downstream gated outlet that provides the ability to lower the dam Full Supply Level from 95.75m AHD to 92.75m AHD with a reduced storage capacity of 800 Megalitres. Accordingly, Seqwater lowered the dam Full Supply Level to 92.75 metres in 2009, following a Comprehensive Inspection of the dam and consultation with the Queensland Dam Safety Regulator. This was done to maximise the flood mitigation benefits of the dam and ensure that the dam's spillway can safely pass extreme floods. The dam has been reported to support platypus and other native wildlife therefore further lowering of the dam Full Supply Level cannot not be undertaken without a detailed Environmental Impact Assessment.

Hinze Dam

63. The recently completed Hinze Dam upgrade project is a $395 million investment in flood mitigation and securing water supply. Work undertaken included raising the dam wall 15 metres and upgrading the spillway. The upgraded Hinze Dam provides additional water storage capacity and significantly reduce the flooding risk for more than 4500 existing properties in the lower Nerang River catchment area. The upgrade was designed and constructed with a two-level spillway to maximise safety and minimise downstream flooding impacts. This design ensures permanent passive flood mitigation measures are in place, providing safe and consistent performance in any flood event. The significant points to note in relation to the flood mitigation benefits of the upgrade are:

(a) The number of houses potentially affected by a 1 in 100 year flood event has been reduced by almost 75%.

(b) The peak flood outflow in a 1 in 100 year flood event has been reduced by 50% - from 1,100m3 per second to 550m3 per second.

(c) The storage capacity of the dam has nearly doubled, from 161,000 megalitres ML to 309,700 ML.

Maroon Dam

64. The purpose of Maroon Dam is to supply regulated irrigation and urban water to Burnett Creek and the Logan River and to provide flood mitigation for areas downstream. The Maroon Dam full supply level is 207.14m AHD and the spillway level is 217.51m AHD. The spillway is unlined rock outlet channel with a concrete control structure. The spillway is only expected to operate for floods greater than about the 1 in 1000 year AEP event. The crest level of the embankment section of Maroon Dam is at RL 219.78 m AHD.