Submission to the Queensland Floods Commission of Inquiry

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Much of my activity as a hydrologist is set out in the accompanying paper "Flood Operational Manuals" but, in brief, I was on the staff of the Stanley River Works Board / Co-ordinator Generals Department from 1944 to 1955, the Irrigation Commission for six months before being lured in 1955 to Brisbane City Council because it seemed certain that Somerset Dam, on completion, would be transferred to it and the Chief Engineer of the Water Supply and Sewerage Department wanted someone who knew the dam and could operate it. When the finally finished dam was transferred to the Council in 1959 I was made the controller. In the beginning and up to 1974 no computers were available so all calculations had to be done by hand, which forced the use of empirical methods. I expanded the rain gauge network in the Brisbane Valley, including pluviometers, installed more flood gauges in the metropolitan reaches of the driver and took every opportunity to involve my small staff of engineers in the operations whenever there were minor or moderate floods to be dealt with and there were many during my 27 year tenancy. The citizens of Brisbane were hardly aware of any change in the river due to the mitigation effect of the dam in these circumstances but the residents of the valley necessarily had their low level bridges submerged, crops and irrigation pumps flooded and were not amused.

We operated the dam successfully during the 1974 flood and I will come to this later because it has a bearing on the February 2011 flood. My team then analysed the 1974 flood and developed the diagram of flood height envelopes printed on the backs of each copy of the twenty three flood maps covering the whole tidal sections of the Brisbane River. I wrote the "Flood Profiles and Flood Frequencies' section in Part 3 of "Brisbane River Flood Investigations—Final Report—Cities Commission, November, 1975" which sets out the contributions made by the various bodies involved in the development of the flood maps, for which group I acted as general advisor and co-ordinator. I remained as operator of the dam for twenty seven years until I retired,

Enough of my experience and now to the Inquiry's terms of reference.

The Manual

I have carefully studied the current Manual and I cannot see any point where the operators departed from its terms and instructions during the events of January and February 2011. As I have stated before the present Manual is much more specific on a whole range of points than the earliest version but, otherwise, covers the same principles of operation. Incidentally there is an error on the first page of the Manual.

Performance of the operators

I am satisfied that the operators carried out a magnificent professional job in the most difficult of circumstances and which resulted in the best available outcome. At this stage I must revert to a consideration of the previous floods for which adequate data were .available. Apart from his seminal paper on the rainfall pattern of the first major 1893 flood, A.T.Brunt, Senior Metrologist at the Queensland Regional Office of the Bureau of Metrology, examined all storm pattens of major floods in the Brisbane River from 1897 to 1955 and concluded that each was associated with a one-off event such as a cyclone, with no suggestion of late rain on the catchment. The 1974 storm had a different pattern. Cyclone Wanda was involved but passed and disintergrated to the north of the Brisbane River catchment but, in the Met Bureau terminology, dragged the intertropical convergence, popularly known as the monsoon trough, down over South East Queensland where it oscillated for some days shedding copious amounts of rain in the process. Fortunately the heaviest rain started in the southern end of the catchment and worked northwards leaving the last heavy dollop of rain on the Upper Brisbane River catchment. This fortunate rainfall distribution firstly allowed the runoff from the southern tributaries to "get away early", leaving the Upper Brisbane flood hydrograph to dominate the resultant flood peak in Brisbane and, secondly, placing Somerset Dam in the best position to mitigate the flood as far as the flood pondage available at the dam was able. Incidentally we had only a metre to spare at the end of the process.

In my time at the Stanley River Works Board I had never heard any discussion on the possible effect of late rain on the catchment after the mitigated main flood has started down the river but any consideration probably had taken place up to ten years before I appeared on the scene. When I assumed control of the dam I became acutely aware of the possibility but hoped that I would never encounter it but I nearly did in 1974 without realising it at the time due to poor, almost non existent, communications. This brings me back to the January 2011 flood where the phenomenon of late rain on the catchment occurred in a major way. In effect the operators had to face three separate storms with no forewarning. The first storm mainly, on the upper catchment, could easily have been contained by itself but they were then struck, without any possible warning, with the Lockyer Creek disaster involving not only a record flood in the creek but a gigantic flood twice as high as any previously observed. On the same day as the Lockyer Creek event 24 hour falls up to 250 mm were registered in the catchment of Wivenhoe Dam in the area from Somerset Dam southwards and extending into the unregulated catchment south of Wivenhoe. This was followed on the next day by similar heavy falls both above Wivenhoe and extending southwards into tributaries of the Brisbane River. The gates of Wivenhoe Dam were closed in conformity with the Manual to prevent as much water as possible originating in the regulated catchment of Wivenhoe Dam from adding to the Lockyer Creek flow as it entered the Brisbane River a short distance downstream from Wivenhoe Dam. To the Lockyer contribution was added the runoff of the storm to the south of Wivenhoe but the inflow to the dam from the regulated catchment was so great that the dam's flood storage was filled and threatened to overflow the dam so, once again in conformity with the Manual to prevent damage to the dam, the gates had to be opened to match the discharge with the inflow with the result that water had to be discharged on to the peak of the Brisbane River flood, a rough estimate suggesting that this added something like 1 000 cumecs to the river out of the 11 000 cumecs recorded at

Savages Crossing, the first flood gauge downstream of Wivenhoe Dam. In terms of the flood level at Brisbane this is a significant increase but there was no alternative. By the same token it makes nonsense of the claim published in the media that the release of water from Wivenhoe Dam formed 80 percent of the peak flood flow in Brisbane.

A further factor that shows the divergence of the February 2011 flood from the formerly considered regular flood pattern is the shape of the hydrograph as it progressed down the Brisbane River. In all the previously recorded floods, starting from 1898, the hydrographs were similar in the "well rounded shape" of the 1974 recordings. In the 2011 case the hydrographs were much slimmer, no doubt due to the very sharp peaked flood from Lockyer Creek but the interesting feature never previously recorded was the progressive reduction in height of the 2011 hydrographs as the flood peak progressed down the river from Savages Crossing where it was higher than the 1974 flood. By the time the flood peak reached Mt Crosby the 2011 was lower than 1974 with the trend progressing to Jindalee and Brisbane. This was the reason that the first forecast of a six metre flood for Central Brisbane was progressively lowered as the flood peak moved downstream. This behaviour was due to the valley storage effect. A flood hydrograph is a complicated affair. As a flood progresses downstream tributaries keep adding water to it but, at the same time, the front part is progressively carved away to supply the water that inundates the countryside as rising flood progresses downstream with the result that the flood peak normally travels in the Brisbane River from Savages Crossing to at least Moggill at a stately five kilometres per hour while the water velocity measured in the river is very much higher.

Had more flood pondage had been available at Wivenhoe Dam in February 2011 it would not have been necessary to discharge water on to the peak of the Brisbane River flood with the consequent saving in flood damage.

As for the 2011/2012 wet season---. If the practice of reducing the water supply levels of the two dams as in February /March 2011 is again carried out then extra flood pondage will be available in the event of flood higher than 2011. Thee is, however, a cautionary tale that must be told. During the Queen's first visit to Australia in 1954 a cyclone travelling down the Queensland coast seemed certain to strike the Somerset Dam catchment and cause a significant flood. Instead it continued parallel to the coast and suddenly wheeled inland over Tweed Heads and devastated the Northern Rivers district of New South Wales. The Somerset catchment received only about twelve millimetres of rain and if water had been discharged from the dam in anticipation of a flood the water supply system would have been in difficulties. There is also the factor I mentioned in the attached statement. More headworks flood storage, which is a popular idea at the moment, requires an increased rate of discharge of water after a large flood to keep within the time limit for emptying the storages as set out in the Manual. This will have an important effect on the clearing of flood water from the already known areas of difficulty which showed up in the December/January floods but it must always be remembered that the factor of the decreasing increment of increasing returns applies to flood mitigation installations. This factor was well understood by the Special Committee of the Bureau of Industry in its 1934 Report.

When a decision is finally made following the recommendations that the present Inquiry may make and followed inevitably by further investigations and much political debate, we will have a facility of defined size for flood mitigation with certain capabilities and limitations, staffed by qualified experts, to meet future, larger storms and it will have to be operated as best possible to deal with whatever mature inflects upon us. Inevitably there will come a flood larger than the capabilities of the system and which could have been mitigated more successfully if more flood pondage had been available!

G Cossins
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Flood Operational Manuals

During the 1974 flood in the Brisbane River the Lord Mayor of Brisbane, on the very mistaken urging of a senior public servant but against the advice of the officers of Brisbane City Council in charge of the operation of Somerset dam for flood mitigation purposes, ordered the gates of the dam to be closed during the emptying phase of the flood mitigation operations after the peak of the flood had passed sufficiently down steam as described in my paper "1974: The Gates Of Somerset Dam". This was done in the mistaken belief that it would allow flood levels to fall more rapidly and give people the earliest opportunity to inspect the damage to their properties. This concern is deeply rooted in the psyche of the community and is clearly understood by the mayors of local authorities during the draining phase of flood waters,

In order to clarify the areas of responsibly in such circumstances the Brisbane and Area Water Board Act 1974—1984 was amended to provide for a "Manual Of Operational Procedures For Flood Mitigation" to be developed for the Brisbane major water supply dams, i.e., Somerset, North Pine and Wivenhoe, all of which are equipped with controllable flood gates but only the gates for Somerset and Wivenhoe are utilised for the purpose of flood mitigation. The Act also specified that once a Manual has been approved and issued by the Minister of the Crown charged with the administration of the Act it has the power of law. All Manuals contained the provision that the owners of the dams could make arrangements with persons for the operation of a dam subject to the condition that the operation be carried out under the general direction of a suitably qualified and experienced engineer. This provision obviated future political intervention in an important area where the exercise of technical expertise is essential for safe operations as opposed to the popular misconceptions so dear to the general community.

In 1983 a Manual was prepared for North Pine Dam and a separate Manual for Somerset Dam during the construction of Wivenhoe Dam, these being the first moves in this respect. A committee of engineers was formed to frame the necessary manuals, the chairman and secretary being drawn from the Co-ordinator Generals Department with representatives from the Water Resources Commission, the Local Governent Department, the Bureau of Meteorology and myself from the Water Supply and Sewerage Department of Brisbane City Council. While most of the Committee members had considerable hydrological experience I was the only one with any experience of operating a flood mitigation dam, i.e. Somerset Dam, during the 1974 flood. At that time Somerset Dam was the only one in Australia with combined water supply and controllable flood mitigation functions. It was later joined by Wivenhoe Dam with similar functions. In spite of the technical papers I had written after the 1974 flood the 1983 Committee members did not fully understand the principles involved in flood mitigation operations as this is a very narrow specialised matter which only a few hydrologists would normally encounter. Nevertheless the principles involved in the operation of a flood mitigation dam were clearly understood by J.B.Henderson, the Government Hydraulic Engineer, in his 1896 report on the means of mitigating the effects of an 1893 type of record flood He did not propose a flood mitigation dam as he realised the cost would obviously be

excessive By observation of flood debris he estimated the peak flow in Brisbane at 400 000 cusecs (cubic feet per second) and this was supported by more careful observations during the 1898 flood. On the other hand Colonel Pennycuick, called in to review the matter in 1899, recommended a purely flood mitigation dam at the Middle Creek site on the Brisbane River a short distance upstream of the present Wivenhoe Dam on the basis of a Brisbane peak flow of 240 000 cusecs derived from his experience in India as set out on page 3 of his 1999 Report on Scheme for the Abatement of Floods in the Brisbane River. His detailed costing showed the project to be well beyond the financial capacity of the community. In any case the unreliable telephone system then available would have made operational control a nightmare. South East Queensland then plunged into the record Federation Drought and the major attention switched quickly to water supply.

The earliest reference I have found to a proposal for a combined water supply and flood mitigation dam was by Henty Plantagenet Somerset after whom the dam is named. From his house, "Caboonbah" on the Brisbane River a short distance downstream from its junction with the Stanley River, he observed the rapid rise of the 1893 flood and sent a warning telegram to Brisbane. He became a staunch advocate of a combined water supply and flood mitigation dam at the present Somerset site and in1906 he took the Engineer of the Brisbane Board of Works, John Kemp, to the site and continued to promote the proposal vigorously. The dam is names after him. Commissioned by the Brisbane Board of Water Works, the distinguished American Engineer, Allen Hazen examined the Somerset site in 1907 and was impressed with its potential but his brief was strictly for urban water supply and he made no reference to flood mitigation. In the middle 1920s the Metropolitan Water Supply and Sewerage Board had the contours of the present Lake Somerset surveyed and proposed to build a water supply dam at the site (with a hopelessly inadequate side spillway) but the Board had no flood mitigation mandate and the subject had suddenly become a talking point, particularly after a mild flood in 1927 which followed many years of drought. The situation was resolved by the 1928 Royal Commission conducted by Gordon Gutteridge, into the Brisbane water supply system, which commended the construction of a combined water supply and flood mitigation dam at either the Stanley River (Somerset) site or at the Middle Creek site on the Brisbane River. He set the ratio of flood pondage to water supply storage for the Somerset site at 64/36 and the ratio for the Middle Creek site at 67/33 on the basis of a peak 1893 flood in Brisbane being reduced from 460 000 cusecs (cubic feet per second) to 200 000 cusecs .

The functions of the Metropolitan Board were transferred in 1928 to Brisbane City Council which already had flood mitigation powers. The Council's newly appointed Engineer for Water Supply and Sewerage, W.E. Bush, investigated the hydrology of the Somerset site in some detail in 1930 on the basis of the 1893 triple floods by the hydrological method common at the time which he described on pages 24 to 34 of his 1930 report and on the basis of a Brisbane 1893 flood peak of 400 000 cusecs, the calculations being carried out by a recently graduated engineer W, Nicol who, much later, was attached to my Investigation Section. In his 1930 report Bush recommended the building of a combined dam at the Somerset site, very much to the dimensions of the present dam and with ratio of 51/49 of flood pondage to water supply storage. He also recommended a flood mitigation only dam be built at the

Middle Creek site. The Great 1930s Depression had just started and the financial situation ruled out the Council's construction hopes.

In 1933 a Special Committee of the Bureau of Industry was established to make a more thorough re-examination of the overall water supply and flood mitigation problem. It was chaired by the Director of the Bureau, J.B. Bridgen, an economist, with the hydrological studies very largely influenced by W.H.R.Nimmo, an expert on dams and, at that time, Australia's leading hydrologist. D. Fison, of the Department of Harbours and Marine studied the effects of river improvements on flood levels in Brisbane. The Special Committee thoroughly re-examined the Royal Commission's findings and examined the two suggested flood mitigation dam sites using the then recently published unit graph method of hydrological analysis. This was applied to the 1893 flood, which involved two record floods a fortnight apart with a smaller flood in between and with an adopted a peak Brisbane flood flow of 350 000 cusecs. Special attention was given to the problems of emptying the flood compartments of the dams between each flood and some consideration was given to the effect that the emptying flows might have on the long drawn out drainage of low lying areas, particularly in Brisbane and Ipswich. After an economic analysis the Committee showed clearly in its 1934 Report that the development of the Somerset site would be more economical than the alternative Middle Creek site. Construction at the Somerset site started in 1935 with William (later Dr) Nimmo as Chief Engineer, the full supply level being set at the old Somerset Dam level grid standard of RL 314.4 feet with a flood to water supply ratio of about 50/50. The grid was established by the Metropolitan Water Supply and Sewerage Board for the 1920s survey of the storage basin, being a compromise between the railway datum at Esk and at Kilcoy which differed by 16 feet. When I joined the staff of the Stanley River Works Board in 1944 as a new civil engineering graduate I carried out many hydrological studies of the effect of Somerset Dam on both droughts and floods as a result of which I recommended the raising of the nominal full supply level to a round value of RL 315 feet mainly for ease of description. This was the first move towards setting the ratio of flood pondage to water supply storage in the dam to the present ratio of 60/40.

In 1953,at the request of the Stanley River Works Board of which he was the chairman, the Co-ordinator General, Sir John Kemp, directed his Engineering Department to carry out a study of the future water supply requirements of the areas dependent on Somerset Dam, i.e. Brisbane, Ipswich and Redcliffe. This matter had not been revised since the report of the Special Committee in 1934 in which time the water consumption per capita had risen considerably but the estimated population had not risen as rapidly as previously estimated. (When Dr. Nimmo, the Chief Engineer of the Stanley River Works Board, was appointed Irrigation Commissioner in 1949 the Board's engineering staff was incorporated into the Co-ordinator General's Department). As E.M.Shepherd, now Deputy Chief Engineer (Hydraulics), and myself were the only hydrologists on the staff the job automatically fell to us. We had worked together in this fashion before on the Tully Falls and Barron Falls hydro-electric projects as well as the Burdekin River Irrigation, Hydro-Electric and Flood Mitigation Project with me doing all the hydrological calculations of water yields and flood flows as well as the capital cost estimates for the proposed Burdekin Falls Dam and hydro-electric plant under Mick's direction. On the basis of the updated data on rapidly increasing per capita water consumption and new estimates of future population growth we carried out a very thorough study of the revised water yield that

would be available from Somerset Dam during a critical drought to determine when the next stage headworks amplification would be necessary and also a detailed revision of the economics of the flood mitigation function of the dam based on estimates of flood damage at different levels prepared by Dr Colin Clark, an economist, the Director of the Bureau of Industry. On this basis we recommended firstly, that the full supply level of Somerset Dam be raised by five feet to RL 320 (still below the fixed spillway crest level of RL 325) as the first stage of amplifying urban water supply storage. This set the present 60/40 ratio for the dam, bearing in mind that the dam was designed to be stable with two feet of water over the non spillway section. Secondly, we recommended the North Pine dam be developed as the next source of water supply amplification to be followed by the Middle Creek dam site on the Brisbane River. This report was approved by the Chief Engineer, James Holt, (a little later to become Co-ordinator General) and also by the then Co-ordinator General, Sir John Kemp, but no immediate action was taken because the future Operating Authority for Somerset Dam had not yet been decided with construction on the dam still continuing.

In 1958,with the completion of Somerset finally in sight, James (later Sir James) Holt, now Co-ordinator General, proposed the formation of an overall board to control the water supply and sewerage of virtually all of South East Queensland along the lines of the then Sydney Water Supply, Sewerage and Drainage Board. This was violently opposed by Brisbane City Council so a mediation group of the Co-ordinator General, the Town Clerk of Brisbane and the Director of Local Government recommended the status quo be retained with the dam to be transferred to Brisbane and for Brisbane to continue to make bulk supplies of water available to adjacent local authorities. The Water Supply Planning Committee was then established to make recommendations to both the Co-ordinator General and to Brisbane City Council for the amplification of water supplies for both the city and the adjacent local authorities. The Committee members were the Chief Engineer and Manager of the Brisbane City Council's Water Supply and Sewerage Department, Gordon Cowling, as chairman, Edward (Mick) Shepherd, the Deputy Chief Engineer of the Co-ordinator Generals Department, and Don King-Scott, the Chief Engineer of the Local Government Engineering Department. I acted as secretary and submitted all reports and recommendations to the Committee. The first matters considered by the Committee were the recommendations that Mick Shepherd and I had made in 1954. These were adopted and were agreed to by both principle parties so that the 60/40 ratio for Somerset Dam was officially adopted in 1958. The completed Somerset Dam was transferred to Brisbane City Council on 1st July 1959 and the Council then made preparations for building North Pine Dam which had already been investigated in considerable detail by the Local Government Department's Engineering Branch.

In only a few years the population growth in Brisbane and the surrounding local authorities became so rapid and covered such an extensive area that it was obvious that the scope of the Water Supply Committee was becoming inadequate to handle the problem. My proposal for a broad extension of the scope of the Committee was adopted and recommended onwards. The original Committee was expanded by the Government into the Moreton Regional Water Advisory Committee by the addition to the former Committee of the Co-ordinator General as Chairman, together with the Commissioner for Irrigation and Water Supply and a representative appointed by the interested local authorities. They, in turn, appointed a senior Consulting Engineer to

oversee their interests. The new Committee rapidly decided that the next source of water for the Brisbane conurbation lay between Wivenhoe Dam and Wolffdene Dam on the Albert River which had already been investigated in detail by the Department of Local Government. The Co-ordinator Generals Department had already shown the Wivenhoe site to be more economical than the earlier favoured Middle Creek site a short distance upstream due to the rapid post World War II development of economical earth moving equipment available for the building of earth /rock filled dams even though Wivenhoe Dam is several times as long as the formerly proposed concrete Middle Creek Dam. The basic detailed investigations and cost estimates for the alternative dams for purely water supply purposes were so close that the decision rested on the cost of the necessary treatment plants and trunk delivery mains for each proposal. This task fell to me as Brisbane City Council was the only the one of the group with the necessary experience to deal with the large installations required and, in fact, I was requested at the decisive meeting of the expanded Committee to submit the cases. Wivenhoe Dam was clearly the more economical on this overall basis and was consequently adopted by the Committee with the noting that Wivenhoe Dam could also be built to a larger size to provide additional flood mitigation for the Brisbane Valley and urban areas. On the Co-ordinator General's 1971 recommendation Cabinet resolved that Wivenhoe Dam be built next for the water supply of Brisbane to be followed, as required, by Wolffdene Dam. Although I was not conversant with the formal decision it was obvious that Wivenhoe would be built as a dual purpose dam.

In 1983 while Wivenhoe Dam was being designed I was called to a discussion with a senior engineer of the Co-ordinator General's Department and a senior hydrologist of the Water Resources Commission (formerly the Irrigation Commission). They were suggesting that the two dams should be owned and operated independently by different bodies. They obviously had little understanding of the operation of flood mitigation dams and in fact did not realise that both Somerset and Wivenhoe Dams must necessarily be operated as a unit. I therefore gave them a detailed explanation of the process required during a flood of keeping the flood pondages empty in the early part of the flood so as to be able to store the whole flow of their catchments up to the limit of their storage capacities and so prevent that water from being adding to the peak of the flood originating from the unregulated catchment downstream of the dams As I have said above I was amazed that all the papers I had written about the subject, particularly after the 1974 flood, had made so little impression. In any case I had come prepared to the 1983 Manual Committee with a programme which I had already discussed with my experienced Council colleagues, Jack Clerke and Ken Hegerty, both of whom were involved in the operation of Somerset Dam in the 1974 flood and also in the lengthy subsequent hydrological studies of the flood. In the circumstances the other committee members readily fell in with my suggestions. They were not passive onlookers however but required detailed explanations before agreeing to the draft provisions subsequently adopted for the Manual's Table of Contents for Somerset Dam in the period before the completion of Wivenhoe Dam. This manual obviously had to be superseded when Wivenhoe came into operation in 1986 as the two dams, being on the same river system, have to be operated in conjunction to achieve optimum flood mitigation. A second Committee, again with representatives from the same organisations as above, convened to recommend the necessary changes, was well aware of this factor as clearly set out in Appendix "H" of the 1986 Manual. The material of Appendix "I" was prepared by the Water Resources

Commission, the designers of Wivenhoe Dam. In 1986 Somerset, Wivenhoe (just completed) and North Pine Dams were transferred to the Brisbane and Area Water Board,

The 1983 Committee also made some small changes to the 1983 version of the separate manual for North Pine Dam embodying the same principles as the Somerset manual but with much of the detailed Appendices being supplied by the Department of Local Government, the designers of the dam. This manual was adopted, with only minor amendments, in 1986 upon the transfer of the dam to the Brisbane and Area Water Board. Although equipped with spillway gates North Pine Dam does not have a flood mitigation function.

A revision of both Manuals was carried out in 1990 by another Committee drawn from most of the organisations as before but the personnel had changed with some less experienced members. In this instance I represented the then owners of the dams, Brisbane and Area Water Board, as its consultant. The inexperienced committee members soon became bogged down in semantics to the extent that the Board's Secretary became disturbed from reading the meeting minutes and asked me to report on whether the Committee had lost its way. In a long report I advised that this was the case but I heard no more as the Board at that stage discontinued my consultancy and, in fact, the Board was undergoing a reorganisation. The revised Manuals were not adopted until 1992 but the delay was probably due to the reorganisation of the Board.

The Act requires the Manual to be revised every five years. The latest revision, No 7, was carried out in 2009, the dams having been vested in Queensland Bulk Water Supply Authority (trading as Seqwater) in 2007. The latest manuals follow the same basis as the first manuals but are very much more specific in the definitions and the instructions for the operation of the dams and, in particular, limit the emptying time after a flood to seven days with qualifications (Section 3.2, page 10) compared with Section 4.4 of the 1986 Manual which stated "as quickly as would be consistent with the other major operating principles". If it is decided to increase the flood pondage of the system it will be necessary to re-examine this factor as there may well be problems with the drainage of low lying areas because the necessary increased river flow during the dam empting period would, inevitably, leave some areas with unacceptable levels of flood water for the whole period of emptying the storages and might will have an impact on any proposals for acquiring flood prone properties. This will also affect Ipswich with possibly greater depths of water than Brisbane.

Care must be taken not to tie down the operators with a complicated set of rules intended to cover all possible contingencies. This would make the task of the controllers unbearable.

G Cossins February 2011