CULGOA BALONNE MINOR WATER USERS ASSOCIATION

Angledool Station
Lightning Ridge NSW 2834
29 November 2005

Ms Maureen Weeks
Committee Secretary
Senate Rural & Regional Affairs & Transport
Committee
Parliament House
Canberra ACT 2600

Dear Madam

Our Association of floodplain Landholders wishes to bring to the Committee's attention the grossly inequitable situation that exists in the Lower Balonne Floodplain with regard to the use of the water resource.

Successive Queensland Governments since the early 1980's have made no attempt to use the precautionary principle in establishing rules for extracting water, and have ignored the advice of expert scientists in the field of river and floodplain health, to create what is potentially the worst environmental disaster in inland Australia.

The stage has been reached where the question needs to be asked as to whether a reason can be found to allow humans to dominate and destroy nature in the manner that is happening in this area.

Through the National Water Initiative structures are being put in place to establish and protect the property rights of irrigators and provide compensation if these rights are diminished through certain actions. No thought has ever been given to the rights of floodplain landholders from whom this water has been taken and made available to irrigators. This must change and more attention paid to the protection of rivers and floodplains for the production and environmental benefits that accrue to the communities dependent on them.

The landholders on the Lower Balonne Floodplain are basically seeking two things:

- restoration of stock and domestic water to the end of the system
- restoration of the flooding regime necessary for the health and productivity of the floodplains.

Two explanation papers and two submissions are attached which cover the issues. In particular we would direct the Committee's attention to the submission from the NSW Government in March 2004 in response to the Draft Water Resource Plan for the Condamine & Balonne.

It is our hope that the Commonwealth Government can take a deciding role in an issue that to date has been totally avoided by politicians and put in the 'too hard basket'. The 'greed is good' syndrome has been the underpinning for the 'development' that has occurred. It is time restore some equity for floodplain landholders and the environment.

Yours sincerely

R H Treweeke
President CBMWUA

Emailed to Committee 30 November 2005

WATER ISSUES IN THE LOWER CONDAMINE-BALONNE SYSTEM

Access to the water resources of the Condamine-Balonne river system has been a contentious issue for over three decades.

The entire system covers about 14% of the Murray-Darling Basin and drains an area on the western and southern fall of the Great Dividing Range from Killarney in the east to north of Mitchell in the north west of the catchment. The two major streams, the Condamine and the Maranoa come together in Beardmore Dam just above St George and then before reaching the New South Wales border divide into the effluent streams of the Culgoa, Ballandool, Bokhara and Narran rivers. In New South Wales the Birrie splits from the Bokhara before joining the Culgoa before it enters the Barwon River upstream of Bourke. The Narran terminates in the Narran Lakes. This dividing of the rivers south of St George, and particularly south of Dirranbandi, has created a vast floodplain of some 1.2 million hectares that in the past experienced periodic floods of varying size and duration making it a particularly suitable area for grazing sheep and cattle, and once the water holding capacity of the self mulching grey soils became better understood, for broadacre dryland farming as well.

In many river systems flooding is regarded as a natural disaster because of the damage that is caused by swift flowing floodwaters. On the floodplain of the Lower Balonne floods are welcomed because they are an integral part of a natural wetting and drying process that leads to a highly productive, though variable over time, environment. This 'beneficial inundation' was recognized legislatively by inclusion in the Queensland Water Act in the 1980's.

Flows in the streams reflect the variable rainfall in the catchment and in most years only occur for a few months. Irrigation development in the St George and Dirranbandi districts first commenced in a small way in the 1950's and 60's but the lack of permanent flows was a barrier until the concept of large on-farm storages became a reality. Water could be pumped into the storages when the rivers flowed and applied to the irrigated crops when required. This strategy became known as 'water harvesting'.

The first large scale irrigation project in the Lower Balonne was the Queensland Government sponsored St George Irrigation Area, made possible by the construction of Beardmore Dam with a capacity of 82000 megalitres (ML). This commenced operating in the early 1970's and the decade of the 80's and 90's witnessed the explosion in the downstream irrigation industry based on the concept of 'water harvesting'.

While the use of annual 'average' figures tend to hide the variability in systems such as the Condamine-Balonne, they are useful for demonstrating certain aspects of the development debate that has arisen. The total storage capacity constructed on farms in the Lower Balonne amounts to some 1513 gigalitres (GL), which exceeds the annual average flow of the system past St George by about 200 GL. This situation has arisen because water-harvesting licences in Queensland do not have annual volumetric limits attached and investment in storage has reflected the open-ended nature of the licences.

Another factor influencing this immense investment in storage has been the 'bunding' of floodplain country so that so-called 'common law' rights to divert water from the floodplain into storages could be exercised, in addition to the water extracted from the rivers through the water harvesting licences. An embargo was placed on the issuing of water harvesting licences in 1992 (NSW ceased issuing licences on these streams in 1982) and water taken under the 'bunding' strategy is a way around this embargo leading to about half the water put into storages on the floodplain being done under this heading. See Table 1 of Lower Balonne Floodplain Fact Sheet.

The irrigation development that has happened in the past twenty years has seen an enormous shift in wealth from the lower floodplain, largely in New South Wales, from the grazing and farming industries, to the irrigation industry in Queensland. The ecological survival of the floodplain and its economic productivity is derived from the flooding regime.

The situation on the Lower Balonne is a classic example of development done with no thought given by Governments as to the long-term impacts and no account taken of the needs of the system as a whole. Decision making was done in a fragmented way right along the Condamine-Balonne with no thought given to the ecological outcomes or the negative economic impacts on other industries.

In August 2004 the Queensland Government legislated a Water Resource Plan containing the future management structure and rules. Even after its own appointed Scientific Panel reported that *"…there will be significant long term degradation of the Lower Balonne floodplain and of the Narran Lakes in particular once the system experiences the water extraction that is possible with the present infrastructure. We see a long period of decline, with the full impacts not necessarily being fully obvious within the 40 year time scale of this assessment, due to the background high flow variability"*[1], it has not proposed anything in the Plan that will substantially reduce the amount of extraction from the system.

Even the Queensland Department of Natural Resources in its submission on the impacts of the development to the end of 2001 compared to the pre-development or 'natural' case found that: *"The total flow in the median event (at Brenda Station on the*

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[1] Prof Peter Cullen, Dr Richard Marchant & Dr Russell Mein: Review of Science Underpinning the Assessment of the Ecological Conditions of the Lower Balonne System" Para 5.1.5. P 34: Report to the Queensland Government, January 2003

Culgoa River) would be reduced to only 3 per cent of pre-development median event."[2] And further: *"The effect of the development is to reduce the major flood events' to change the moderate events into minor events and to eliminate the minor events."*[3] This was demonstrated starkly by a flow event in January 2004 which did not get out of the banks of any of the streams when up to 80000ha of flooding could have been expected from the history of past events of a similar size.

A Ministerial Advisory Council (MAC) to the Queensland Minister for Natural Resources & Mines has been formed to provide advice on aspects of the Resource Operations Planning (ROP) for the Water Resource Plan. This Council has places for NSW interests. NSW landholders and the NSW Government, (through previous Minister Craig Knowles and current Minister Ian Macdonald) made representations to the Queensland Minister seeking the appointment of an independent Chair for this important advisory body. The reason for this is that the majority of the Council members are landholders and irrigators having an economic interest in the outcomes of the ROP and in these circumstances good corporate governance requires a person who is independent both geographically and financially. The Water Resource Plan legislation stipulates a very close reporting relationship between the Chair of the Council and the Minister therefore it is a matter of public policy that there should be an independent Chair for the Council.

The Queensland Minister has appointed Mrs Leith Boully, a landholder and irrigator as Chair of the MAC and as a consequence NSW & Q'ld non-irrigator members of the MAC have chosen not to participate in its deliberations. They are in a minority on the MAC and are not prepared to waste their time when they have no chance of influencing the outcomes, nor wish to be 'used' by being portrayed as having concurred in the outcomes of the MAC's deliberations.

The Queensland Government has not responded to the damning submission by the NSW Government to the Draft WRP in March 2004.

Rory Treweeke
Chairman
Culgoa Balonne-Minor Water Users Association
November, 2005

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[2] Queensland Department of Natural Resources & Mines: "Submission to the Review of Science Underpinning the Assessment of the Ecological Condition of the Lower Balonne System" September 2002: P 12.
[3] Ibid.

Submission from Culgoa Balonne Minor Water Users Association
In response to Draft Water Resource Plan

EXECUTIVE SUMMARY

1. The draft WRP does nothing to redress the inequities in water sharing that have arisen during the past twenty years as the result of 'open ended' development in the Lower Balonne, leaving the environment and floodplain graziers/farmers severely disadvantaged.

2. By setting a CAP on extractions related only to the storage capacity that has been built on the Lower Balonne, with the only restraint on the Chief Executive being "not to increase amount of water taken" (S 16(1)), locks in the status quo and tacitly approves the current situation.

3. The draft WRP ignores all the warnings in the Cullen Review, notably that: **"there will be significant long term degradation of the Lower Balonne floodplain and of the Narran Lakes in particular once the system experiences the water extraction that is possible with the present infrastructure".**

4. It may well be argued that the draft WRP does not comply with the definition of "sustainable management" contained in S 10 of the Water Act.

5. The January 2004 flow event demonstrated that the extractive capacity in the Lower Balonne is capable of reducing a medium sized flood to an 'in bank' flow, and that the event management 'concessions' proposed in SS 37-40 are a waste of time.

6. Licensing of what have been known as A & B type extractions of water from the floodplain should not proceed as per the proposed Division 5 and in particular S 47. The rationale behind these 'types' of extractions was to defeat the embargo placed on the issuing of licences in 1994 in the Lower Balonne. Water should not be extracted from the floodplain – see Prof Peter Cullen's comments quoted in The Land of 04/03/04 P 9.

7. While event management is logical for the Condamine/Balonne/Maranoa system, downstream landholders need to be satisfied that the information upon which event management decisions are made is based on accurate gauging upstream of Beardmore, and that the Decision Support Tool (DST) has relevance throughout the Lower Balonne including the floodplain in NSW.

SUBMISSION

The members of the CBMWUA submit that the draft plan does nothing to rectify the inequities in water resource allocation that have taken place in the past twenty years. The plan assumes the current situation is acceptable by confirming the status quo in favour of extractors as against the beneficial flooding needed by floodplain landholders and environmental requirements for the floodplain. The setting of a CAP on extractions solely in terms of S 16 (1) "not to increase amount of water taken" is clear evidence of this.

1. The Association believes that the proposal to manage the water resource in the Lower Balonne through event management (as recommended by the Cullen Review Panel)[4] is a positive step, but there needs to be a far greater restitution of water to riparian and floodplain landholders than is envisaged in the draft plan.
2. In Defining a Healthy Working River in the Lower Balonne the Panel said: "Experience elsewhere in the MDB has indicated that the *floodplain, floodplain wetlands* and in particular *the terminal wetlands* are the first elements of the river system to be damaged by changes to flow regimes. Consequently, we make the assumption that ensuring an appropriate flow regime is provided to maintain *the floodplain and its wetlands,* the flow regime will most probably maintain a healthy working river."[5] (Italics added) However as the recent (January 2004) event has demonstrated that assumption may not be valid, as it is possible to get a flow into the Narran lakes without the river going over its banks and therefore no water going onto the floodplain. (Whether that flow was effective in achieving the aims re bird breeding is yet to be proved.)
3. And the condition of the floodplain is clearly of concern to the Panel as they state in the next paragraph to the one quoted above: "The Panel is concerned that the possible level of extraction *will exacerbate damage to the Lower Balonne floodplain.* We believe a loss of productivity in the grasslands is evident from landholder observation, and we anticipate a loss of the area supporting tree vegetation and its replacement with

[4] Review of Science Underpinning the Assessment of the Ecological Condition of the Lower Balonne System: Report to the Queensland Government : Independent Scientific Review Panel: Prof Peter Cullen, Dr Richard Marchant & Dr Russell Mein, January 2003 P 4
[5] Ibid. P 38

grassland over the longer time frame. Further studies are needed to identify wetting regimes that might avoid this possible decline."[6] (Italics added)

4. However the Panel then state a view that contains an inconsistency with the observed behaviour of the Narran. "The Panel is of the view that the dominant consideration in the Lower Balonne system is to ensure the Narran lakes receive an appropriate flow regime to maintain the vegetation and bird communities. If this is achieved, *the flow regime in the Narran River will be adequate to maintain the river and distributory channels in good condition."*[7] (Italics added) In this the Panel seem to be assuming that any flow into the Narran lakes will be good for the Narran floodplain but this is not necessarily the case as demonstrated by.
5. It is interesting to note that event management was also supported by the recommendations of the Technical Advisory Panel to the Condamine-Balonne WAMP with some specific examples:[8]
    - 1. flow events during summer (Sep.-Mar.), when riverine productivity is highest and the natural 'wet' season occurs, are to be given greater conservation priority than flows occurring during winter (Apr.-Aug) **(e.g. the Jan 2004 event)**
    - 2. flow events of any given magnitude are to be given greater conservation priority if they have not occurred for a relatively long period of time, i.e. relative to the normal periodicity of such flow events **(e.g. the Jan 2004 event)**
    - 3. any modification of the shape of the hydrograph of flow events, e.g. via water harvesting, should not result in an excessive rate of decline in water levels **(which happened in the Jan 2004 event)**
6. Unless there is a restoration of a balance between extraction and water left in the system, the economic imbalance that has been created by the licensing of upstream extractors will get worse, and there will be a marked deterioration in the ecological health of the floodplain in the future. Scientific studies are showing this to be case already where Martin Thoms says in relation to the Lower Balonne floodplain: "The magnitude, frequency and duration of flooding events have all been reduced. The construction of levees and water storages has also reduced the reactive floodplain surface area. The presented data show the impacts of these changes on the potential supply of dissolved organic carbon from the floodplain surface during periods of inundation. Annual reductions of up to 1293 tonnes of dissolved organic carbon supply were noted and reductions were especially significant for floods with an average recurrence interval of 2 years or less. Some small flood events no longer facilitate the potential supply of dissolved organic carbon from the

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[6] Ibid P 38
[7] Ibid. P 38
[8] Condamine-Balonne WAMP Environmental Flows Technical Report P 74

floodplain to the river channel because of water-resources and floodplain developments." [9]

7. In terms of plant productivity on the flood plain it has also been shown that: "…plant productivity peaks at moderate flood frequencies."[10]
8. These findings confirm the observations of floodplain landholders that extractions upstream are creating and will continue to create negative ecological impacts on the floodplain.
9. The January 2004 flow event in the system was proof of the extractive capacity of the irrigation industry to turn what should have been a moderate to minor flood event (of the type referred to in the research quoted above) into a totally within bank flow in the lower parts of the system. It fully confirms the concerns expressed by the Independent Scientific Review Panel (Cullen Report):
   - "The Panel supports the contention of the CRC for Freshwater Ecology that **there will be significant long term degradation of the Lower Balonne floodplain and of the Narran Lakes in particular once the system experiences the water extraction that is possible with the present infrastructure.** We see a long period of decline, with the full impacts not necessarily being fully obvious within the 40 year time scale of this assessment, due to the background high flow variability" (Emphasis added)[11]
   - On P2 of the of the Proposal submitted from the Lower Balonne Community Reference Group it was stated:[12] "Some members of the CRG acknowledge that the proposed measures go someway towards addressing their concerns about beneficial flooding in the low to medium events, **but do not believe that they will be adequate.** (Emphasis added) The experience of the January flow event fully confirms that their concerns are valid.

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[9] Martin C. Thoms (Co-operative Research Centre for Freshwater Ecology, University of Canberra): "Floodplain-river ecosystems: lateral connections and the implications of human interference" in *Geomorphology 56 (2003) pp335-349*

[10] N. C Sims & M. C. Thoms (Co-operative Research Centre for Freshwater Ecology, University of Canberra): "What happens when flood plains wet themselves: vegetation response to inundation on the lower Balonne flood plain" P 202. From the proceedings of an international symposium held at Alice Springs, September 2002 on *The Structure, Function and Management Implications of Fluvial Sedimentary Systems.*

[11] Prof Peter Cullen, Dr Richard Marchant & Dr Russell Mein: "Review of Science Underpinning the Assessment of the Ecological Condition of the Lower Balonne System" Para 5.1.5. P 34: Report to the Queensland Government, January 2003

[12] Lower Balonne Community Reference Group: PROPOSAL: 03/09/03

- An indication of the impact of development on downstream flows can be seen from the DNR & M's submission to the Cullen Review Panel.[13] (See Attachment A)

In light of this evidence this Association submits that the draft WRP does not comply with the definition of "**sustainable management"** contained in S 10 of the Water Act 2000, and specifically with Sub-section 2 which states that " 'sustainable management is management that-

(a) allows for the allocation and use of water for the physical, economic and social well being of the people of Queensland and Australia **within limits that can be sustained indefinitely;** and

(b) **protects the biological diversity and health of natural ecosystems; ' "** (emphases added)

In addition the Association submits that the draft WRP cannot, in its present form comply with S 11 of the Water Act 2000 which sets out the "**principles of ecologically sustainable development"** which must be adhered to in terms of S 10(2) (c) (ii) of the Act.
We would also submit that the operational portions of the WRP are inconsistent with its own **Outcomes** set out in S 8, and in particular sub-sections (d) "to minimize any adverse effect on individual enterprises" and (h) "to achieve ecological outcomes consistent with maintaining a healthy riverine environment, **floodplains** and wetlands, including, for example, maintaining-------…." Followed by nine (9) subsections of specific examples, with the Narran Lakes and the national parks of the Culgoa floodplains completing the list at (ix).

10. The event management rules proposed in the Draft Plan (SS 37-40) do not ameliorate the effects of the extractive capacity available in the system. It is the understanding of downstream landholders that the proposed changes to extraction rates contained in these sections are the maximum concessions water extractors are willing to make on a voluntary basis and any further reductions would prompt claims for compensation from the Government.

Unless a fundamental change is made to broaden the options available under the plan, which now provides priority to extractors, the draft plan is unacceptable to downstream landholders as the current inequities will continue. This fundamental change would require that instead of the water harvesters having priority to extract water on all flows, in half of the flows in the system (over a complete range of flow sizes) priority would be given to the floodplain to halt its deterioration in both ecological and economic terms.

7. Members of this Association submit that the proposed granting of licences to formally recognise 'A' & 'B' type extractions (SS 44-46) will legalize what in effect have been back-door means of circumventing the embargo on the issuing of further water harvesting licences in the Lower Balonne since 1994, and are totally opposed to this proposal.

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[13] Qld Department of Natural Resources & Mines: "Submission to the Review of the Science Underpinning the Assessment of the Ecological Condition of the Lower Balonne System" September 2002: P 12

Cullen Review: This contains one factual error where on P 4 it states "Human activities have been having impacts on the ecology of the Lower Balonne since the various bifurcation weirs were constructed to divert water from the Culgoa to the various distributory channels *to spread floodwaters across the floodplain."* (Italicized for emphasis) These bifurcations were installed to direct the compensation flow water following the completion of Beardmore Dam. They only operate to change the distribution of water up to a maximum flow of 1200ML, after which they drown out and have nor further effect. This level of flow is below any flood levels and constitutes purely an in stream flow.

Additional information on wetland requirements

1. Overview

There is about 1,284,202 ha of wetland mapped in the Condamine-Balonne catchment (8.1% of the catchment) and most of this was the Lower Balonne floodplain (Kingsford *et al.* 1999). The Condamine-Balonne catchment had the highest percentage of wetlands of any catchment in the Murray-Darling Basin (20.4%). 18,790 ha is reserved (1.8% of wetlands). Floodplains were the most extensive wetland (1,266,258 ha), followed by freshwater lakes (16,872 ha) and saline lakes (1,071 ha). More than 50% of this wetland area is in NSW (739,643 ha) compared with Queensland (544,559 ha) although most of the catchment is in Queensland (13,761,147 ha) compared to NSW (2,598,570 ha).

Scientific knowledge has clearly established that water resource development detrimentally affects the ecological values of wetland reserves dependent on river flows. As the agency responsible for biodiversity conservation in New South Wales, DEC is responsible for ensuring the sustainable management of wetland reserves under its jurisdiction as well as the protection of native fauna and flora.

In meeting its obligations to protect and conserve Aboriginal cultural heritage, DEC relies strongly on advice of Aboriginal communities. Aboriginal communities have an important cultural connection with Narran Lakes in particular, as well as the Culgoa floodplain. This connection with the river systems is fundamentally based on their biodiversity and productivity.

DEC is also responsible, on behalf of the Australian Government, for management of Ramsar listed wetlands and other lands considered nationally or internationally significant in NSW, where these are in National Parks and Nature Reserves. This entails administrative, management and legislative responsibilities for DEC, on behalf of NSW and the Australian Governments as well as international bodies. Briefly these responsibilities cover:

The Ramsar Convention

DEC is responsible for administering the Ramsar Convention in NSW. The main aim of the Convention is to ensure the conservation and wise use of wetlands in recognition of the important role they play in maintaining key ecological processes and providing economic (and other) benefits to society. Listing commits both the Australian and State Governments to the implementation of planning that promotes the conservation, ecological character and long-term sustainable use of such sites.

Migratory Bird Agreements

Australia is a signatory to two international bilateral agreements that protect migratory birds and their habitats, the Japan-Australia (JAMBA) and China-Australia (CAMBA) Migratory Bird Agreements. These agreements acknowledge that a number of migratory species are in danger of extinction through loss of habitat and that international cooperation is essential for their long term protection. Australia has committed to preserving and enhancing the habitats used by migratory birds listed under these agreements.

The Australian Heritage Commission Act 1975

DEC is also charged with managing a site that is listed on the Register of the National Estate for both its significant natural and cultural heritage values. While this Act does not bind the State, cooperative arrangements for the management of National Estate sites have been established via the Intergovernmental Agreement on the Environment.

2. The Reserves

Culgoa National Park was dedicated in 1996 and has an area of 22,430 ha. It adjoins Culgoa Floodplain National Park covering 42,800 ha in Queensland. Culgoa National Park is centred on the Culgoa River, a distributary of the Condamine-Balonne Rivers system and an important tributary of the Darling River. It protects a large area of floodplain. It is of **national significance** because it received from the World Wide Fund for Nature the *New Reserve of the Year Award* for the best addition to Australia's conservation reserves in 1997. The Park is of **state significance** because:

- it samples the Culgoa floodplain ecosystem, which is one of the most ecologically rich floodplain environments remaining in semi-arid NSW;
- it reserves large and important tracts of floodplain woodlands, native grasslands, brigalow / gidgee woodlands and chenopod shrublands and is one of the few reserves in NSW to contain these vegetation types;
- it provides habitat for the endangered bustard and a number of vulnerable species, as well as habitat for a large number of species of regional conservation significance;
- it contains many Aboriginal sites including extensive archaeological deposits with a high potential to add to knowledge about Aboriginal use of north western NSW;
- it is of considerable traditional and contemporary cultural significance to the Morowari Aboriginal people;
- it conserves European heritage associated with pastoral activities in north western NSW during the 19th and 20th centuries;
- it provides opportunities for informative and enjoyable nature tourism within an inland riverine environment; it provides opportunities for research into factors influencing a north western floodplain ecosystem which promotes a greater understanding of these environments.

Narran Lake Nature Reserve was dedicated in 1988 and has an area of 5,538 ha. Recent additions double the area under management control of DEC. These lands cover part of a large terminal wetland of the Narran River, a distributary of the Condamine-Balonne Rivers system. The reserve is of **international and national significance** as an area of extensive, frequently available, breeding and feeding habitat in a natural condition for a large number of waterbird species, including one of Australia's largest ibis rookeries, and waders protected under international agreements. It is listed as a site under the Ramsar Convention, thereby receiving world recognition as a wetland of international importance. It satisfies three criteria for listing:

- it is a particularly good representative example of a natural or near-natural wetland characteristic of the Darling Riverine Plains biogeographical area;
- it is of special value as a habitat of plants and animals at a critical stage of their biological life cycle; and
- it regularly supports 1% of the individuals in a population of one species or subspecies of waterfowl.

In addition:

- it has habitat for the conservation of migratory species listed under the JAMBA and CAMBA international agreements with Japan and China respectively.
- it is on the Register of the National Estate

The Reserve is of **state significance** because:

- it contains a distinctive suite of important Aboriginal sites including extensive archaeological deposits with high potential to add to knowledge about Aboriginal use of north-western NSW;
- it is part of an area of very high Aboriginal cultural significance as an important meeting place and ceremonial site for several tribal groups and the place of convergence of a number of dreaming paths;
- it provides habitat for a number of waterbird species listed under the NSW Threatened Species Act 1995, such as the Brolga, Freckled Duck, Blue-billed Duck, Magpie Goose, Black-necked Stork and Black-tailed Godwit, and at least eight species of conservation concern in western NSW;
- it contains important vegetation communities, two plant species listed under the NSW TSC Act 1995 and eleven plants species of regional conservation significance; and
- it supports populations of a number of mammal species which have disappeared from many areas of their former range in western NSW

In addition, the riparian zone of the Narran River provides essential habitat for major migrations of bird and mammal species, allowing them to escape regional droughts. Smaller scale migrations occur across the floodplain connecting lower fertility country with the highly productive soils and habitats produced by flooding patterns.

3. Impacts of increased diversions on floodplain values

River regulation and diversions of water from a river change flow patterns. The biodiversity has adapted to and been shaped by those flow patterns. Attributes impacted include volume (reduced), frequency (reduced), duration (reduced), seasonality (shifted) and variability (reduced). Variability is a coarse measure of the combined impacts of the other attributes. All of these in some way determine species number, distribution and abundance either directly by providing feeding and breeding habitat or indirectly through mobilising nutrients that drive the food chains which make these systems so productive.

Unfortunately it takes many years for the impacts of the changes to be detected because until recently we have had to rely on highly visible indicators. For example, changes to the way rivers like the Gwydir, Macquarie and Lachlan were managed are still having negative impacts on biodiversity 40 years later. These river systems also have terminal or near terminal wetlands which is where some of the most visible assets (colonial waterbird breeding; river red gum / coolibah health) first show signs of stress as a result of changes to flow patterns. From this experience it is expected that most of the values provided by Narran Lake will be lost when reductions in volumes and frequencies of flooding approach 60% of natural (ie. the impacts are triggered much earlier). Narran Lake may be even more sensitive with the stands of river red gum in the Nature Reserve already close to ecological tolerances under natural flow regimes. Any reduction will see this component of the wetlands gradually disappear and with it the nesting habitat for several species.

For lignum, the other major breeding habitat, the ecological tolerances are greater. However, there is evidence that the duration of flow events is now close to the minimum required for successful fledging of young. Both recent major breeding events by ibis in 1996 and 1998 were completed with only a week to ten days to spare, contrasting with previous major events where there was several weeks' tolerance. The likely pattern is that we will begin to see more breeding events abandoned because of premature shortening of flow events due to extraction upstream. The natural triggers to commence breeding will remain but will not be supported by actual flows in the river system. In addition, the spell between breeding opportunities will widen.

Furthermore, a gradual deterioration in the quality of breeding habitat will occur, leading eventually to the situation where even if a suitable flow occurred, the habitat could not support breeding by some species.

Changes to flow patterns usually accompany alienation of parts of the floodplain, further exacerbating the impacts on biodiversity by reducing connections between water and nutrients which together drive the floodplain ecosystems. Similar but less spectacular impacts will happen on both the Narran and Culgoa floodplains and their riparian lands.

The sum of these changes in turn impact on traditional and contemporary cultural values.

4. Flow requirements for Narran Lakes, Narran floodplain and Culgoa floodplain

Narran Lake, as a terminal wetland system, relies primarily on volume and season of flooding to realise its range of values. When filled, breeding habitat is guaranteed for eight months and feeding habitat for 24 months. Volume determines the overall production from a flow event eg. the number of Ibis that fledge young successfully. Duration becomes important when there is insufficient water to fill the wetland. It can determine whether breeding habitat is provided for long enough to allow completion. All species require minimum period for successful breeding. Flows that do not fill Narran Lake provide other functions such as maintaining the vigour of core lignum and river red gum breeding habitats.

Narran Lake is distinguished by the range of habitats and the frequency of flooding in a wetland of its type. It also provides(d) in combination with the Macquarie Marshes and Gwydir Wetlands an almost permanent resource for waterbirds. These wetlands are close geographically but have catchments well apart, allowing highly mobile species such as waterbirds to utilise variable rainfall patterns very efficiently.

The Narran and Culgoa floodplains respond to all flood attributes. The amount of floodplain inundated is a function of the height of any given flood. Duration and volume determine the extent to which food chains can develop, frequency determines population viability, all in combination with seasonality determine variability which in turn determines biological diversity of the river channel, floodplain and surrounding uplands. For example, germination of floodplain eucalypts requires one flood pattern while establishment requires another. The more frequent the floods, the better the growth rates, the better the habitat provided for other elements of biodiversity.

New South Wales Government

response to the

Consultation Draft
Water Resource (Condamine and Balonne) Plan
2003

May 2004

(Version for Crest and Binding)

Contents

1. Summary

The NSW Government has significant issues with the draft Water Resource Plan for the Condamine and Balonne rivers. The process by which the plan was developed and elements of the plan itself are not consistent with the requirements, objectives or tenor of COAG Inter-governmental Agreements on Water.

Key issues are summarised here under two broad areas of concern:

The process of Plan development

- ***Membership and operation of the Lower Balonne Community Advisory Group***
  - perceived conflict of interest and lack of independence of LBCRG Chair/Facilitator
  - biased towards Queensland irrigation interests
  - NSW landholders claim to have been outnumbered and "outconsensused"
  - NSW Agencies not engaged until the draft Plan was released, despite the NSW government being an affected landholder
  - no agreed decision-making process underpinned by agreed vision and outcomes to be achieved
- ***Ability to make informed decisions on the Plan***
  - the Plan was released without any assessment of what the Plan rules would deliver
  - the Plan was released without any indication of whether Plan objectives were already compromised by existing development levels
  - NSW Agencies waited for 2 months to receive necessary data to assess the Plan
- ***Cullen review and use of it***
  - the outcomes of the Cullen et al review were not subject to review or endorsement by contributors
  - the Plan has not taken a precautionary approach despite Cullen et al advising that the river system would deteriorate when *current* development levels were fully exercised
  - the Cullen Review did not adequately consider the evidence from other river systems within Australia or internationally that clearly demonstrate the long term impacts
- ***Socio-economic considerations***
  - complete disregard for socio-economic impacts from current levels of development
  - no socio-economic assessment of the Plan provisions

The intent and content of the Plan

- ***Principles and objectives***
  - do not include the Precautionary Principle
  - should place ecological health as an overriding principle and objective
  - inconsistency between economic and ecological outcomes and objectives
  - no defined or agreed hierarchy to objectives to support resolution of disagreements
- ***Environmental flow provisions***
  - were acknowledged to be at a level acceptable [no compensation demands] to the Qld irrigation community and are not based on environmental needs
  - do not fully reflect the recommendations of the Cullen et al review
  - lack of data on floodplain wetting requirements should lead to a precautionary approach to water use not one of "use it and monitor the impacts"
  - no consideration of migratory, spawning, recruitment and general habitat and fish passage requirements of native fish, including listed threatened species, populations and ecological communities in NSW

- ***MDB Cap on diversions***
  - 10 years post ratification of the MDB Cap and the Plan still fails to set a diversion limit. Despite a Moratorium announced in 2000, development has continued and is now 5 times that of 1994 levels.
  - Cap compliance is based wholly on models that are acknowledged by Queensland to be deficient

Conclusions

- The planning process has failed to provide appropriate and equitable engagement of all affected communities, resulting in a draft WRP strongly biased towards the interests of Queensland irrigators.
- The draft WRP has failed to fully address scientific uncertainty and has selectively interpreted the Cullen et al "Review of the Science".
- The draft WRP has failed to reverse, to any significant extent (if at all), the drastic impacts that water resource development has had, and will continue to have, on the flow dependent ecological and economic assets in NSW.
- The draft WRP is completely unacceptable to New South Wales.

2. Introduction to this submission

This submission on the ***draft Water Resource (Condamine and Balonne) Plan 2003*** (draft WRP) is made by the NSW government on behalf of the community of NSW. It is a whole-of-government response and has been drafted by officers of relevant NSW government agencies, these being:

- Department of Infrastructure, Planning and Natural Resources (DIPNR)
- Department of Environment and Conservation (DEC),
- NSW Fisheries, and
- NSW Agriculture.

The submission draws on published information, technical briefings and data provided by the Queensland Department of Natural Resources, Mines and Energy (DNRME), and the Lower Balonne Community Reference Group (CRG). The effort made by the DNRME and CRG to provide this information and to facilitate understanding of the draft WRP is appreciated.

The following sections elaborate on the key issues that NSW has with the draft WRP:

- the failure of the planning process to provide appropriate and equitable engagement of all affected communities, thereby resulting in a draft WRP strongly biased towards the interests of Queensland irrigators;
- the failure to fully address scientific uncertainty and deliberate misuse of the Cullen et al "Review of the Science";
- the absolute failure of the draft WRP to reverse to any significant extent (if at all) the drastic impacts water resource development has had and will have on the flow dependent ecological and economic assets in NSW.

3. Process for development of the draft Water Resource Plan

3.1. NSW role during previous water planning activities for the Condamine-Balonne

In June 1995, when the Murray-Darling Basin Ministerial Council agreed to a Cap on diversions, the Queensland government argued, successfully, to establish the Cap for their rivers after an independently audited Water Allocation Management Planning (WAMP) process had been completed. This planning process commenced in 1996 and delivered a draft WAMP in June 2000, which was subsequently abandoned in lieu of this new Water Resource Plan process.

A cross-section of NSW government agency staff and NSW landholders were formally engaged in the Plan development phase of the WAMP process, through membership of the various technical and community advisory panels that were established by the Queensland Government.

3.2. Issues with the membership of the community reference group

In contrast to the WAMP process, whereby NSW community members, as well as agency representatives, had input by way of the Community Reference Group and Technical Advisory Panel, there was little opportunity for NSW input to the WRP. This is despite the fact that the NSW Government is the major landholder in the region, owning a Nature Reserve, a National Park and the entire Western Division under the Western Lands Act, all of which are directly affected by outcomes of the WRP. The handful of NSW landholder representatives on the CRG were outnumbered by better resourced, better informed Queensland irrigators. There was no engagement of NSW government agencies, and, most importantly, no opportunity to "reality check" the CRG proposals before they were incorporated into the draft WRP.

NSW landholder representation on the Lower Balonne Community Reference Group (LBCRG), established to provide formal advice to the Queensland Minister, was an afterthought. NSW landholders were not engaged until after the Cullen et al review had been completed, limiting their ability to have input to the development of that document. The NSW government was not engaged until the draft WRP was released in late 2003 for public comment.

The key issues NSW has with the membership of the CRG are:

- Perceived conflict of interest of LBCRG Chair/Facilitator, Mrs Leith Boully. With irrigation property in the Dirranbandi region, Ms Boully has a vested interest in the outcomes of the Water Resource Plan.
- NSW landholders comprised only 4 of the 22 positions on the LBCRG. These representatives have claimed to have been continually outnumbered and "outconsensused".
- Irrigation interests were over-represented on the LBCRG, comprising 11 of the 22 positions. Graziers from both Queensland and NSW have written to NSW Minister Knowles seeking his support for a more equitable means of contributing to the development of a Water Resource Plan.
- Exclusion of NSW agency staff from meetings of the LBCRG, leaving NSW landholder representatives without technical support.

While the WRP process was to deliver a "community" plan underpinned by the available science, the process was flawed in a number of respects and, as a result, has not delivered a balanced plan.

4. Science underpinning the draft Plan

NSW commends the Queensland Government's intention to underpin the plan with the best available science. Various NSW government agencies and landholders provided input to the review conducted by Cullen, Marchant and Mein[1]. Their report is a useful review and its conclusions are reflective of the state of knowledge about the ecological condition and relationships of the lower Balonne distributary system at that time.

* **Note** that the flow event that occurred in the Lower Balonne in January of this year (2004) provided the first opportunity to assess the impact of the current level of development on river flows and floodplain inundation. The following is taken from an initial analysis provided in **Attachment 1**.

- The flow events of February-March 1981, March 1988 and March 1994 all followed long periods of no flow (the 1981 being the longest) and are similar to the January 2004 event. The volume of water entering NSW, as a proportion of the total flow at St George, was 44% for 1981, 45% for 1988 and 48% for 1994. In contrast**, the cross-border flow from the Jan 2004 was only 20% of the total at St George**. Preliminary Landsat 5 image analyses, comparing the 1988 and 2004 events, indicate that this 50% reduction in total flow and greater attenuation of flow peaks, resulted **in a reduction to floodplain inundation of 73% in Queensland and 88% in NSW**.

It is the view of the NSW government, that both NSW and Queensland government agencies should work together to provide a detailed analysis of both the impacts of development and the rules of the draft WRP on the Lower Balonne rivers and connected floodplain. To not do so would be an abrogation of responsibility that government has to the community it serves.

4.1. Development of the Cullen, Marchant and Mein review

When submissions to the review of the science in the Lower Balonne were requested, the link between the review and the subsequent development of a Water Resource Plan for the Condamine-Balonne system was not clearly conveyed. As the peak intergovernmental body established by the respective state Premiers to give effect to the Border Catchments Memorandum of Understanding, the Border Catchments Ministerial Forum should have been formally involved in the oversight of the Cullen, Marchant and Mein review.

[1] Cullen, P., Marchant, R. and Mein, R. (2003a) Review of Science Underpinning the Assessment of Ecological Condition of the Lower Balonne System. Report to the Queensland Government by the Independent Scientific Review Panel.

In addition, contributors to the review were not given the opportunity to check or endorse the interpretation of the information they provided. This has resulted in a misinterpretation by Cullen, Marchant and Mein of some information provided to them, which has led to the development of rules in the WRP that while attempt to support the recommendations of the Cullen review, will fail to meet the real environmental needs. This is elaborated on in Section 6 of this document.

The Cullen et al review inadequately considered evidence of elsewhere in the Murray-Darling Basin and elsewhere in the world and the clear impacts of water resource development in the environment and floodplains.

4.2. Interpretation and use of the Cullen, Marchant and Mein review

It is not clear how the draft Plan addresses all the key findings, qualifications and recommendations of this review. In particular, the draft Plan appears to be driven by a favourable interpretation of the statement:

"The rivers and wetlands of the Lower Balonne system are presently in a reasonable ecological condition, but this condition is expected to deteriorate if the present capacity to extract water from the system should actually be exercised"[2]

Scant attention has been paid to the limited data this assessment is based on, nor the repeated cautionary statements about future health or evidence from elsewhere. The NSW government agencies agree with and emphasise the Summary Statement made by Cullen, Marchant and Mein:

"The Panel supports the contention of the CRC for Freshwater Ecology that there will be significant long term degradation of the Lower Balonne floodplain and of the Narran lakes in particular once the system experiences the water extraction that is possible with the present infrastructure. We see a long period of decline, with the full impacts not necessarily being fully obvious within the 40 year time scale of this assessment, due to the background high flow variability".[3]

As the recent flow event (January 2004) demonstrated (refer to preliminary analyses in **Attachments 1** and **2**), this extractive capacity is being exercised, now.

4.3. Development in the Lower Balonne and impacts on the flow regime

Analyses conducted by DIPNR staff using recorded flow data, IQQM output files and development data supplied by DNRME and remote sensing techniques, indicate:

- the current capacity of on-farm storage for the Condamine-Balonne is 19 times that which existed in 1988, 5 times the 1994 capacity (the Cap benchmark year) and 3 times the 1996 capacity (the year the WAMP commenced);
- a dramatic decline in recorded cross border flows since 1972, with the proportion of the St George annual flow getting to NSW being 32% less over 1989 - 2003 than during 1972 – 1988, with this impact being greatest in the Culgoa;
- a 50% reduction in the average and a 74% reduction in the median annual cross border flow between the modelled "pre-development" and "2000 moratorium" development scenarios;
- a 50% reduction in the frequency of beneficial flooding events and reduced magnitude of remaining events;
- a doubling of the period between ecologically significant events; and,
- the total loss of *minor* to *small* flood events, as demonstrated by IQQM data and analysis of the January 2004 event [the cross border flow from the January event was at least 50% less than historic events, resulting in an 80% reduction of the area flooded in NSW].

[2] Cullen et al, 2003a, p.4
[3] Cullen et al, 2003a, p.34

The full reports of these analyses are attached (**Attachment 1** and **Attachment 2**).

4.4. A complete failure to consider the Precautionary principle

In all other river systems where impacts of this magnitude (described above) have occurred, irreversible ecological impacts have followed.

NSW believes that the draft WRP, based on advice from the CRG, has ignored the lessons from other systems.

- It fails to address the cautionary statements in Cullen et al (2003a) about the lack of data to adequately assess current ecological condition and warnings about probable future degradation.
- Whilst modelling shows the environmental flow rules will improve the flow regime to the Narran Lakes, it is doubtful that this will be sufficient to prevent degradation. The error bands around the modelling (see Section 8), as well as the limited understanding of ecological relationships, suggests that a much more precautionary approach is required with the modelling errors favouring the river, rather than the irrigators.
- The provisions to reduce access by 10% during specified events to maintain flood benefits have not been modelled and NSW doubts that they can be modelled or operationalised with the current modelling tools. The 10% cut back in access will do little to reduce the current impact on beneficial flooding. It is likely that the inability to resource an "event management" approach will favour irrigators over the river.
- The payback provisions reinforce the NSW view that the concessions made for environmental flows are driven by economic considerations, rather than ecological understanding.
- It is unacceptable that the draft Plan defers any consideration of significant claw-back of current extractions for at least 5 years.

The following statement from Cullen et al supports the NSW view:

"The panel notes that experiences elsewhere have shown that that it is technically and politically much more difficult to restore degraded systems than to prevent degradation in the first place. We therefore urge a conservative approach with immediate action to provide the required wetting regime with ongoing monitoring and assessment".[4]

NSW believes the assessment of the draft CRG proposal by Cullen et al[5] was based on modelled data, that has now been demonstrated by QDNRME to be of questionable quality. Again NSW believes an overly optimistic interpretation was adopted by the CRG of this rapid review, with no attention paid to the cautionary advice.

"*This watering strategy seems appropriate to provide protection for the Narran lakes until further information becomes available. We have not seen the modelling showing its impact on the Culgoa floodplain wetting, and the relevant agencies still need to specify appropriate wetting regimes to protect these other ecological assets. The report does not specifically consider the impacts on the Darling River or the channels of the LB floodplain but we believe they will be advantaged by the proposed regime.*"[6]

It is the NSW view that the Cullen et al reviews have been misrepresented and the scientific assessment of the draft proposals need to be subject to more informed scrutiny before the draft WRP is finalised.

[4] Cullen et al, 2003a, p9

[5] Cullen, P., Marchant, R. and Mein, R. (2003b) Comments on community response to wetting regimes for the Narran Lakes. Report to the Queensland Government by the Independent Scientific Review Panel.

[6] Cullen et al, 2003b, p2

5. Concerns with Plan principles and objectives

5.1. Compliance with national initiatives

The process by which the plan was developed and elements of the plan itself are not consistent with the requirements, objectives or tenor of COAG Inter-governmental Agreements on Water that have been agreed to in the past and/or are currently being negotiated. In particular:

- the process for the plan's development was not consistent with 4(d) of the 1994 COAG agreement - *that the environmental requirements, wherever possible, will be determined on the best scientific information available and have regard to the inter-temporal and inter-spatial water needs required to maintain the health and viability of river systems and groundwater basins*;
- the outcomes of the plan are not consistent with 4(f) of the 1994 COAG agreement - *where significant future irrigation activity or dam construction is contemplated, appropriate assessments would be undertaken to, inter alia, allow natural resource managers to satisfy themselves that the environmental requirements of the river systems would be adequately met before any harvesting of the water resource occurs*;
- the process and outcomes of the plan are not consistent with a publicly stated core objective of the National Water Initiative – *to ensure ecosystem health by implementing regimes to protect environmental assets at a whole-of-basin, aquifer or catchment scale*; and
- the process and outcomes of the plan are not consistent with a direction of negotiations for the National Water Initiative with respect to water plans, including – *that socio-economic analysis be undertaken and that this include a consideration of impacts on water users and the environment, downstream of or not in the plan area or outside the jurisdiction be considered, and that systems with high conservation values be managed to protect and enhance these values*.

5.2. Principles and objectives of the draft WRP

It is noted in the draft plan that one of the main purposes of the plan (i.e. s.2(e)) is: *"to provide a framework for reversing, where practicable, degradation that has occurred in natural ecosystems, including, for example, stressed rivers"*.

Section 8(h) states that an outcome of the plan is: *"to achieve ecological outcomes consistent with maintaining a healthy riverine environment, floodplains, wetlands"*.

However, this is in contrast to the outcomes in s.8(a) of the plan which include, *"to make water available to sustain current levels of, and to support future growth in, economic activity in the plan area"*.

The draft WRP has not specifically outlined the key ecological outcomes it wishes to achieve and how these are to be achieved through the flow rules proposed. There is no information provided on the natural flow regime and flow requirements of the riverine ecology of the draft WRP study area. The overview report to the plan only references ecological condition information from a review by the Scientific Advisory Panel which refers to four ecological assets within the study area and their current condition. It is difficult to determine if the rules proposed in the draft plan are likely to sustain the current condition of these ecological assets or further degrade them, as no quantitative information is provided on either the natural flow regime, current usage or draft plan usage levels.

The draft WRP does not provide a clear description of how the performance indicators proposed in ss.9-11 were derived and why the range of 66-133% of pre-development versus current flow pattern is considered an appropriate measure.

The Overview Report on the draft WRP also notes in section 2.3 that the Resource Operations Plan (ROP) will define, for each part of the plan area, the water sharing and environmental flow rules that will be applied in the day-to-day management of stream flows and water infrastructure in order to ensure that the WRP outcomes are achieved. However, there are no specified ecological outcomes for the environmental flow rules proposed in the WRP on which the ROP can be based. For example, there are no quantitative or qualitative targets set for the flow rules to achieve in-stream, floodplain and wetland outcomes except for Narran Lakes bird breeding events.

One positive aspect of the draft WRP is that the ROP is to include provisions relating to the monitoring of riverine habitats by the water resource operators in conjunction with local agencies and the community. Such a program is encouraged as the basis for determining whether the flow rules are achieving ecological outcomes (when defined) and to identify other flow requirements for the full range of riverine habitats.

However, with respect to the WRP principles and objectives:

- It is the NSW view that the resource has been overallocated in Queensland and that significant clawback is required to avert ecological collapse. It is naive to assume that the ecological health of the system can be conserved whilst the plan makes water available to "sustain current levels of, and to support future growth in, economic activity in the plan area".
- It is the NSW view that the plan should present the outcome "to achieve ecological outcomes consistent with maintaining a healthy riverine environment, floodplains and wetlands" as the overarching principle of the plan, with other outcomes only being achievable as long as they do not compromise the ecological health of the system. Indeed this has been the basis for continued delay by Queensland in meeting the MDBMC Cap.
- If approved in its current form, there can be no confidence that ecological health considerations would drive any significant change to resource allocation at future reviews. Such considerations have been of less importance than the economic development of the Queensland irrigation industry to date, and the plan's provisions will allow this to continue.

6. Event-based management and environmental provisions in the Plan

6.1. Comments regarding event-based management

NSW supports the concept of event-based flow management to share water equitably among competing users in river systems like the Condamine-Balonne. However, the application of the concept in this case is limited to very specific environmental targets under even more specific conditions with no supporting information on the expected impact on any user, including the environment.

Essentially, this narrowly applied concept picks winners and losers within the environment – the winners are those assets, usually highly visible, about which we know something and therefore value. The losers are those features still largely hidden by and contributing to complexity and variability, which may provide important functions in maintaining river systems.

Further arbitrary choices, informed by limited knowledge of the Condamine-Balonne system and ignoring evidence from elsewhere, are then made to select optimal times for watering the chosen assets and the volumes required to achieve the anticipated response. The result of this approach is a very narrow focus on what needs to be protected and assumes a relatively simple connection between variables. Abundant evidence from elsewhere shows that such an approach results in ecological collapse, not through intent but through ignorance.[7] [8] [9] Ignorance will not be a plausible excuse for the Narran Lakes system.

There also appears to be the following assumptions:

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[7] Kingsford, R.T. and Thomas, R.F. (1995) The Macquarie Marshes in arid Australia and their waterbirds – a 50-year history of decline. *Environ. Manag.* **19**: 867-878.

[8] Kingsford, R.T. and Johnson, W.J. (1998) Impact of water diversions on colonially-nesting waterbirds in the Macquarie Marshes of arid Australia. *Colonial Waterbirds* **21**: 159-170.

[9] Kingsford, R.T. and Thomas, R.F. (in press). Destruction of wetlands and waterbird populations by dams and irrigation on the Murrumbidgee River in arid Australia. *Environmental Management* (in press)

- that the current shares of water between all users are more or less appropriate; and,
- that better management of flows will deliver a river system that supports the full range of ecological assets in current or improved condition, a sustainable irrigation industry and therefore sustainable rural communities.

These assumptions are highly risky hypotheses for which there is no supporting evidence from any other equivalent river system. Rather, there are numerous examples of river systems with similar volumes extracted that are experiencing or facing ecological collapse. The main tool advocated for restoring these rivers is to increase the volumes available for the environment, as is occurring as part of the Living Murray Initiative.

The concept that **water foregone by irrigation users under specified conditions will be paid back during high flows** raises two points:

1. Water foregone, for both biodiversity and grazing productivity, by the environment to irrigators cannot be paid back. The environment is asked to bear the losses. Again the assumption that current (2000) shares between all water users is appropriate underpins this approach. Clearly, the evidence from other river systems with equivalent extractive capacity to that in the Condamine-Balonne demonstrates that the shares are not sustainable.
2. Such simplistic rules suggest that high-flow events are of lesser value than small and medium sized events. It also results in no "net gain" to the environment in terms of overall water sharing between the environment and water users as water that is left in the river in low-medium flow events, is then taken in higher flow events. The pay-back method proposed will also result in decreases in the ecological value of large flood events in NSW.

6.2. Issues with the WRP flow provisions for Narran Lakes

6.2.1. Narran filling flows

While the recognition given to the Narran Lakes is commendable, NSW remains concerned that the draft WRP will continue the expected decline in ecological health of this internationally important terminal wetland, as foreshadowed by Cullen et al "*if the present capacity to extract water from the system should actually be exercised*."[1]

Cullen et al. are "*of the view that the dominant consideration in the Lower Balonne system is to ensure the Narran lakes receives an appropriate flow regime to maintain the vegetation and bird communities. If this is achieved, the flow regime in the Narran River will be adequate to maintain the river and distributary channels in good condition*."[10] They go on to state "*An interim finding by the Review panel, to be reviewed once the ecological study of the Narran lakes is completed, is that the Narran lakes need to be flooded on average once every 3.5 years if its ecological values are to be maintained. This estimate is based on the NSW NP&WS submission that degradation will occur if volume and frequency of flooding is reduced below 60% of pre-development*."[11]

Given the influence of the Cullen et al recommendations on the draft WRP, it is important to understand clearly what the 60% figure represents. The submission by the NSW National Parks and Wildlife Service provided a different context to the one used by Cullen et al. In discussing evidence from other river systems with terminal wetlands and subjected to a longer history of regulation (Macquarie, Gwydir, Lachlan), the NPWS submission concluded that "**from this experience it is expected that many of the values provided by Narran Lake will be lost when reductions in volumes and frequencies of flooding approach 60% of natural (ie. the impacts are triggered**

[10] Cullen et al (2003a) p38
[11] Cullen et al (2003a) p40

much earlier). Narran Lake may be even more sensitive with the stands of river red gum in the Nature Reserve already close to ecological tolerances under natural flow regimes."[12]

The critically important difference is that the original NPWS submission associates loss of ecological values at the 60% level while Cullen et al equate it to maintenance of ecological values.

Section 39 of the draft WRP allows for limited reductions in water harvesting during conditional flows that modelling predicts would have filled the Narran Lakes Ramsar site (ie. Back and Clear Lakes) under the pre-development flow pattern. (It is not clear how these flows differ from medium flow events unless the intention in Cls 39 (2) and (3) was to fill the entire Narran Lakes system.) The implied conditions assume flows into Narran Lakes Ramsar site are only useful during bird breeding periods, that bird breeding periods are during the winter months and that the Ramsar site is largely independent of the remainder of the Narran Lakes system. Furthermore, any flows foregone by extractive users under these conditions are to be paid back under other high flow events. This approach is seriously flawed and drastically undermines the intent of the draft WRP. Comment is provided for each element.

6.2.2. Only flows for waterbird breeding are important

A distinction must be made between flows that support successful bird breeding and flows that maintain other components of ecological character. Clearly, the Narran Lakes receive a variety of flows, of which only some result in breeding attempts by the highly visible colonial nesting species. The role of other flows is unclear but almost certainly they are critical for maintaining habitat quality in the medium to long term.[13] [14] [15] Basic principles of sound ecological management include a cautious approach to change with the burden of proof resting on resource exploiters to demonstrate to the broader community minimal or acceptable impacts. NSW does not accept the proposition that, due to lack of suitable data, no action should be taken for five years given the extractive capacity currently within the Condamine – Balonne system and comparable river systems with a longer history of that extraction.

6.2.3. Breeding is during the winter months

The draft WRP refers to the months April to August as those when bird breeding occurs. Breeding by the colonial nesting (ibis, spoonbill, cormorants, egrets) and other waterbird species occurs in response to floods but appears influenced by a number of other variables, many of which are unknown. Each species responds to different stages of the flooding cycle. What is clear is that floods can occur at any time of the year in the Narran Lakes even though late summer / autumn is the most likely. Since reliable records have been kept, breeding events have occurred in all months of the year. The least successful month is July, when some nesting attempts have been abandoned presumably due to influences of cold weather on food availability and comfort of chicks. The largest breeding event in recent times, and the third largest recorded straw-necked ibis breeding event ever in Australia, commenced in January 1996, peaked in March and concluded in April. This event was recorded and published, with the reference provided to all scoping / background studies on Narran.[16] A further significant event occurred in 1998/9 with peak breeding activity occurring between September to November inclusive.

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[12] NPWS (2002) NSW National Parks and Wildlife Service Submission to *Science underpinning the assessment of the ecological condition of the Lower Balonne River system.*

[13] Jenkins, K.M. and Boulton, A.J. (1998) Community dynamics of invertebrates emerging from reflooded lake sediments: flood pulse and aeolian influences. *International Journal of Ecology and Environmental Sciences* **24**: 179-192.

[14] Jenkins, K.M. and Boulton, A.J. (2003) Connectivity in a dryland river: short-term aquatic microinvertebrate recruitment following floodplain inundation. *Ecology* **84(10)**: 2708-2723

[15] Bunn, S.E., Davies, P.M. (1999) Aquatic food webs in turbid, arid zone rivers: preliminary data from Cooper Creek, western Queensland. In: *A free-flowing River: The Ecology of the Paroo River*, 67-76, NSW National Parks and Wildlife Service, Sydney.

[16] Ley, A.J. (1998) Waterbirds at Narran Lake Nature Reserve, New South Wales, in 1996. *Aust. Bird Watcher* **17**: 219-233

6.2.4. The Narran Lakes Ramsar site is independent of Narran Lake proper

The different tenures between the Ramsar site (Nature Reserve), the main Narran Lake and floodplain land in between (privately held leasehold land) result in biased observations and emphasis on the ecological importance of elements of the Narran Lakes system. Tenure also determined the current boundary of the Ramsar site, making it an administrative artefact rather than an ecological entity. There is no question that the entire Narran Lakes system is worthy of Ramsar listing but for it to occur requires the active consent of the leaseholder. Thus for the draft WRP to assign different importance to the Nature Reserve because of its Ramsar status suggests a non-ecological reason.

Breeding success for species that use Narran Lakes is closely linked to size of flood ie. volume and height of water.[8] The bigger the flood, the more of the Narran Lakes system and associated floodplain is available feeding habitat. The closeness of the feeding habitat to the nesting sites provides greater certainty of success. Therefore, any reduction in volumes entering the Narran Lakes must have an impact on waterbird breeding success.

The limited evidence from the whole Narran system demonstrates that not only does the main Narran Lake provide an important addition to the breeding habitat available with the Ramsar site, but it also provides persistent non-breeding habitat for a large number of waterbird species and individuals.[17] [18] The observed patterns of flooding and subsequent waterbird use conform very closely to models derived from other wetland systems in inland Australia.[19] [20] [21] These models emphasise the importance of wetlands, such as Narran Lake, in ensuring the persistence of waterbird populations long after flooding has stimulated breeding.

The diversity of habitats within the Narran Lakes system is the key to its overall significance. Managing one part to the exclusion of others ignores the obvious interdependencies. This weakness has been highlighted to a degree by Cullen et al.[5] However, what is not discussed is the reliance by the colonial nesting waterbirds on water levels. Water levels at nest construction and egg laying are critical. Adult birds will abandon nests if levels drop too rapidly, a likely scenario if flows are targeted at the Nature Reserve alone and not the whole Narran system. Water can only be maintained at more or less stable levels by either persistent inflows of sufficient volumes over at least a three to four week period into the Nature Reserve, or by filling of the entire Narran system. Without filling the entire system, water levels within the Nature Reserve will drop rapidly as the water drains into the main lake. From Cullen et al filling of the entire system is likely to happen only about 42% of the pre-development case, thereby increasing significantly the chances of rapidly falling water levels and subsequent abandonment of nests. The ameliorative measures proposed in the draft WRP of restricting extractive access to 90% of capacity for 10 days seem of doubtful merit. Images of dead and dying ibis chicks, as occurred in the Booligal wetlands on the Lachlan River in 1984 are powerful motivators of public sentiment.

6.3. Issues concerning Culgoa floodplain

It is not clear how the draft WRP will provide wetting regimes that protect the floodplain National Parks. While work has not been done by agencies in either State to identify the specific watering requirements of assets within floodplain Parks, the observations and experience of graziers in this region do provide equivalent knowledge. It is clear that reserves on the floodplain eventually lose their

[17] Brooker, M.G. (1993) Aerial counts of waterbirds on Narran Lake, New South Wales. *Aust. Bird Watcher* **15**: 13-18

[18] Ley, A.J. (2000) Aerial surveys of waterbirds at Narran Lakes, New South Wales, December 1998 – June 1999. Unpublished report to NSW National Parks and Wildlife Service, Dubbo.

[19] Maher, M.T. and Braithwaite, L.W. (1992) Patterns of waterbird use in wetlands of the Paroo, a river system of inland Australia. *Rangeland J.* **14**: 128-142

[20] Halse, S.A., Pearson, G.B. and Kay, W.R. (1998) Arid zone networks in space and time: Waterbird use of Lake Gregory in north-western Australia. *Int. J. Ecol. Environ. Sci.* **24**: 207-222.

[21] Roshier, D.A., Robertson, A.I. and Kingsford, R.T. (2002) Responses of waterbirds to flooding in an arid region of Australia and implications for conservation. *Biol. Conserv.* **106**: 399-411

aquatic values when the water is denied (eg Yanga Nature Reserve on the Murrumbidgee River).[22] While there are management differences between a grazing enterprise based on domestic livestock and nature conservation, in floodplain environments both rely ultimately on adequate flow regimes for productivity and profitability. Graziers already report reduced productivity from reduced wetting frequencies, supported by comparative observations of upstream gauge heights and corresponding spread of flows on the floodplain between pre- and post-irrigation developments. These observations are consistent with other river valleys.

Additional information is appended (**Appendix A**).

6.4. Failure to recognise fish and aquatic habitat requirements

It is clear from a review of the draft WRP that the flow requirements of native fish have not been considered in the formulation of the flow rules and performance indicators. This was also confirmed in discussions with the DNRME who advised that a paper on flow requirements for fish was presented to the Scientific Review Panel, but was not provided to the CRG.

The flow events proposed are based on the requirements for downstream stock and domestic users, some medium flow event floodplain wetting and bird breeding events in the Narran Lakes only. There is no consideration of the migratory, spawning, recruitment and general habitat and fish passage requirements of native fish in the formulation of these flow rules.

The flow requirements of native threatened fish species in NSW receiving waters are different and complex and generally require the reinstatement of the components of a natural flow regime including consideration of the frequency, timing, extent, volume and duration of flows within a river from daily flows through to minor, moderate and major flow events.

Additional information on threatened aquatic species and their flow requirements is appended (**Appendix B**).

Each flow has differing impacts on the ecology of the river and this is not recognised in the WRP. The environmental flow rules proposed are simplistic event-based rules that do not address the complexity of natural flow regimes in ensuring the sustainability and recovery of these threatened species. The event-based rules focus on one-off outcomes for the environment, with no recognition of the needs of the river ecology year-round.

While floodplain wetting is targeted at Narran Lakes and Culgoa as a specific rule, there has been no consideration of the floodplain wetting requirements for the sustainable management of the Lower Balonne wetland complex. Such events are critical as triggers for spawning, recruitment and movement of fish within the receiving waters of NSW. Harvesting is likely to significantly reduce the frequency, timing, extent, volume and duration of flood events in NSW, thus limiting the ability for wetland replenishment and floodplain inundation to the detriment of the recovery of the species, populations and community listed in **Appendix B**.

From this assessment, NSW can only conclude that the draft WRP will not contribute to the recovery of threatened fish species, populations and aquatic ecological community of the Lower Darling, and may in fact lead to further degradation of the endangered aquatic community of the Lower Darling in NSW receiving waters.

7. Issues with Cap accounting and compliance

A Cap for the Condamine-Balonne has yet to be determined and, even though a development embargo was imposed in 2000, growth in use has been continuous and excessive since 1993/4, the Cap benchmark year adopted by NSW, Victoria and South Australia.

It is not the intention of this submission to revisit the deficiencies and failures of the previous WAMP process. However a review of submissions made at that time would clearly demonstrate nothing has

[22] Kingsford R.T. and Thomas R.F. (in press)

occurred with the new WRP process to address the legitimate concerns raised previously, particularly by NSW landholders and government agencies. In fact, nearly four years on, there is more development, even less commitment to any "clawback", greater entrenchment of unsustainable levels of extractions and a proposal to "legitimise" overland flow harvesting – all only offset by environmental flow rules of doubtful benefit, based more on minimising the impact on irrigators, than on science.

DNRME has not provided modelled data on extractions, however, growth since 1993/94 has been significant (see IAG reports). For example, data supplied to the MDBC by the Queensland government shows that **on-farm storage capacity is now 5 times that which was reported for 1993/94 and has trebled since the WAMP process began in 1996**. To put this into context, the mean annual flow across the NSW-Queensland border is 1,219 GL under "natural" conditions and 612 GL under developed conditions. The total on-farm storage capacity in the Lower Balonne is 1,513 GL.

The draft WRP proposes a cap on the issuing of further water licences above the average amount of water authorised, but does not define the cap in volumetric form in relation to current and future levels of activation of development. There are also very limited strategies outlined in the WRP to define and manage current levels of water use. For example, annual estimates of water availability are made and then management rules are only reviewed if the actual water extractions exceed the annual estimate. Such a management strategy does not constitute a Cap in volumetric diversions or an appropriate management regime to ensure that the current ecological condition of the Lower Balonne is sustained into the future. There are no proposed growth-in-use strategies that fairly and equitably peg back water use across the range of water licence holders if the annual estimate of extraction is exceeded.

Whilst there is a commitment to 5% cutback in extraction rates on the Lower Balonne, apparently to offset development of inactive entitlement, this is deferred for 5 years (s33).

With respect to compliance with the MDBMC Cap:

- NSW believes Queensland must set a volumetric Cap for the Condamine-Balonne. In previous submissions NSW has recommended the June 1994 level of development as the benchmark. As an *interim* Cap target for the WRP, this would be appropriate. The WRP must specify an acceptable timeframe to bring diversions back to this level. For example the 5% cut in diversion rates in the Lower Balonne, should be implemented immediately at the commencement of the plan, with further reductions specified for each year, thereafter to clawback current diversions AND offset licence activation, until the 1993/94 level is assessed to have been reached.
- The draft WRP must also commit to further cutbacks, if future research findings demonstrate that the Cap target levels are still ecologically unsustainable.

8. Issues concerning reliance of Plan implementation on modelling

Since the release of the draft WRP, there was a minor flood event in January 2004 that has allowed some assessment of the real impact of current development on flows and floodplain inundation, particularly of an event following prolonged drought.

On 27-28 April 2004, DNRME presented its analysis of the 2004 event to the CRG. Even after recalibrating the model to the 1981 event, the model "predicted" a significantly different hydrograph to the observed on the distributary streams, particularly for the Culgoa River and Briarie Creek. On their own admission, the DNRME IQQM overestimates downstream flows of events following long parching of the river and floodplain and underestimates the extractions. In its current form IQQM is not adequate to support "real time" event management, nor to model event management rules.

Whilst NSW believes event management is a commendable aspiration, we are not confident that the rules in the draft WRP can be implemented with the current modelling tools.

We are particularly concerned that the assessment of the "Narran Lakes filling flow events" rules, is seriously flawed by the modelling errors. For example, as demonstrated by DNRME, the model outputs used for their analysis were based on a model version that was not well calibrated to flood events following prolonged drought. It is expected that a recalibrated model would demonstrate longer "spell" periods between events and smaller magnitude of the post drought events.

DIPNR analyses of the modelled data also suggests that losses upstream of the lakes have been significantly underestimated. Reworking these data with higher loss rates and realistic losses from the lakes (evaporation and infiltration) also expands the "spell" periods and results in "drier" lake conditions (under both pre-development and post-development scenarios) than reported by DNRME.

Any significant underestimation of lake storage volumes would also result in the model producing a "wetter" filling regime than really exists. There has been no independent review of new survey data revising storage volumes of Back, Clear and Narran Lakes despite significant differences between old and new figures, and therefore in the modelled performance of the environmental flow rules.

9. Socio economic considerations

There are several elements of the draft WRP that are of concern to the NSW government because of the impacts upon agriculture, rural industries and regional communities that depend upon overland and channel flows originating in Queensland.

9.1. Lack of water security for NSW users

The NSW river and floodplain systems of the Culgoa, Narran, and Bokhara are highly dependent upon Queensland rainfall and the subsequent channel and overland flow this generates. Development in the Queensland section of the Condamine-Balonne has changed the hydraulic characteristics (including volume and frequency) of flow across the border particularly in the crucial summer months. Productivity of the adjoining NSW floodplain and security for the NSW water users has been disrupted as a result.

The *Water Act 2000 (QLD)* outlines matters the Minister must consider when preparing a draft water resource plan (section 47). These include:

- "*national, State and regional objectives and priorities for promoting sustainable development*"; and
- "*the effects the draft plan will have on water not covered by the draft plan*".

NSW does not believe that the needs of the Culgoa, Bokhara or Narran regions were adequately identified or considered in developing the draft WRP. There was also no consideration of the downstream impacts on water availability in these regions. The draft WRP has not acknowledged the significant equity issues for water users in NSW nor actively addressed their needs.

9.2. Lack of socio-economic impact assessments

No formal, expert socio-economic assessment of the impacts of the draft Water Resource Plan for the Condamine-Balonne River appear to have been undertaken, in particular of the impacts on NSW water users. The only two assessments that have been done did not assess impacts in NSW.[23] [24]

Prasad and Close (2000) concluded the economic and environmental impacts of development in the Condamine and other border rivers were not significant in the Lower Darling and Murray, because the total flow impact of changes in water resource development in Queensland is small this far down the system due to the effect of losses and other flow contributions. The report ignored impacts on water users in the NSW section of the lower Balonne system which includes the Culgoa, Bokhara, and Narran rivers. These users include floodplain graziers, stock and domestic users, Darling River

[23] Prasad, A. & Close, A., 2000, Economic and environmental impacts of development on the Condamine, Moonie and Border Rivers in Queensland on the Murray and Lower Darling Rivers, MDBC Technical Report 2000/6, Murray Darling Basin Commission, Canberra, Aust.

[24] Price Waterhouse Coopers. 2000. Socio-Economic Impact Assessment. Condamine-Balonne WAMP. A report prepared for the Balonne Community Advancement Committee.

irrigators and tourism and recreation industries. These users are the most adversely affected by the current level of extractions and the draft Water Resource Plan for the Condamine-Balonne.

The other socio-economic impact assessment was done by Price Waterhouse Coopers (2000) on an earlier draft Condamine-Balonne Water Allocation Plan (WAMP). This report only detailed the impacts of the plan on the productive areas in Queensland and ignored NSW. Queensland subsequently undertook a new planning process resulting in the development of the draft WRP.

The COAG Water Reform Framework 1994 requires assessment of the economic, social and environmental implications of water management plans. In addition, the *Water Act 2000 (QLD)* entrenches several concepts for water management including:

- **Section 10** Sustainable management – "that allows for the allocation and use of water for the physical, economic and social well being of the people of Queensland *and Australia* within limits that can be sustained indefinitely";
- **Section 11** Ecologically sustainable development – including 'decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations."

NSW does not feel that the social and economic impacts on affected NSW water users were explicitly and clearly considered when making decisions regarding resource access within the Condamine-Balonne system. This would appear to be contrary to the intent of the *Water Act 2000 (QLD)* and the principles of ecologically sustainable development upheld by COAG.

Additional information about the socio-economic significance of the Condamine-Balonne catchment for NSW is attached (**Appendix C**).

9.3. Removal of Compensation Flow provisions

NSW is concerned that the provisions of the Compensation Flow (a cross-border arrangement that has been in place since the mid 1970's to compensate downstream stock and domestic users for water captured in Beardmore Dam), have been removed ahead of the outcomes of a pre-existing project sponsored by the Border Rivers Commission. This project, which has cross-jurisdictional support, should be finalised prior to any termination of the current Compensation Flow arrangements.

10. Conclusions

- The planning process has failed to provide appropriate and equitable engagement of all affected communities, thereby resulting in a draft WRP strongly biased towards the interests of Queensland irrigators.
- The draft WRP has failed to fully address scientific uncertainty and has selectively interpreted the Cullen et al "Review of the Science".
- The draft WRP has failed to reverse, to any significant extent (if at all), the drastic impacts that water resource development has had, and will continue to have, on the flow dependent ecological and economic assets in NSW.
- The draft WRP is completely unacceptable to New South Wales.

11. Attachments and Appendices

Attachment 1. River flow and floodplain inundation impacts of current water resource development in the Condamine-Balonne. Prepared by DIPNR. 2004

Attachment 2. Assessment of pre and post development flooding on the Lower Condamine-Balonne floodplain. Prepared by DIPNR. 2004

Appendix A. Ecological assessment of the draft WRP for the Condamine and Balonne rivers. Prepared by NSW Department of Environment and Conservation. 2004

Appendix B. Supporting information on fish and aquatic habitat requirements. Prepared by NSW Fisheries. 2004

Appendix C. The socio-economic significance of the Condamine-Balonne catchment for New South Wales. Prepared by NSW Agriculture. 2004

Supporting information on Fish and Aquatic Habitat requirements

- The NSW Government is responsible for ensuring that the principles of the NSW Interim River Flow Objectives (RFOs) are addressed in the development of environmental flow rules for water resource management in, or affecting, NSW. The RFOs are aimed at addressing the flow requirements of aquatic ecosystems. However, it is equally important to understand the life history and flow requirements of 'fish' (where known) when establishing environmental flow rules to ensure that such rules are not detrimental to the conservation of fish species. A description of the RFOs and their benefits to native fish is provided in **Annexure 1**.

- The NSW Government is also responsible for ensuring that the requirements of both current and future listed threatened species, populations, ecological communities, critical habitats and threatening processes (listed under the *Fisheries Management Act 1994 (NSW)*), and the requirements of associated Recovery Plans and Threat Abatement Plans are considered and incorporated into water resource planning processes.

- The NSW receiving waters downstream from the Draft Condamine-Balonne Water Resources Plan area are habitat for several threatened species, populations and an endangered ecological community listed under the *Fisheries Management Act 1994*. These are summarised in **Table 1** below.

Table 1: Threatened species, populations and ecological community listed under the *Fisheries Management Act 1994* (NSW) occurring in NSW receiving waters downstream of the draft WRP study area.

Listing	Status under the *Fisheries Management Act 1994*	Flow Requirements & Impacts of Flow Regulation (extracts from the recommendations of the NSW Independent Fisheries Scientific Committee)
Aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River (area listed includes the main channel and tributaries of the Barwon-Darling River from Mungindi to Wentworth, the Culgoa and Narran Rivers and their tributaries south of the Qld border)	Endangered community	• Require – naturally variable and unpredictable patterns of high and low flows in natural riverine systems comprising deep channels, pools, benches, braided channels, terminal wetland complexes and floodplain habitats, gravel beds and riffles. Several fish species require floodplain inundation for spawning success. • Regulation – in-stream barriers and regulated water delivery has altered the natural flow regime and habitat complexity of these rivers, reduced fish passage availability and breeding

		success. Alterations to flooding and wetland regimes have further affected river productivity.
Western population of the olive perchlet (*Ambassis agassizii*)	Endangered population	• Require – slow-flowing or still waters near over-hanging vegetation or snags • Regulation – has resulted in rapid fluctuations in water levels reducing reproduction and spawning success and limiting preferred habitat availability.
Western population of the purple-spotted gudgeon (*Mogurnda adspersa*)	Endangered population	• Require – slow-flowing or still waters of rivers, creeks and billabongs • Regulation – has resulted in fluctuations in water levels leading to impacts on reproduction, recruitment and habitat availability, particularly loss of aquatic plants
Silver perch (*Bidyanus bidyanus*)	Vulnerable species	• Require – fast-flowing, open waters, especially rapids and races. Adults migrate upstream in spring and summer to spawn. • Regulation – construction of in-stream barriers which have altered natural flow patterns, prevented upstream migration and eliminated spawning triggers (ie flood events) and caused the loss of rapids and races.
River snail (*Notopala sublineata*)	Endangered species	• Require - flowing rivers where bacteria and biofilms on which it depends for food occur on hard surfaces in free-flowing waters • Regulation has reduced the occurrence of natural flows and supply of bacteria and biofilms.

- These aquatic threatened species, populations and ecological community require natural flow variability to complete key lifecycle stages, in particular, spawning and recruitment.

- **Table 2** illustrates how the NSW River Flow Objectives meet the flow requirements for these species.

Table 2: Current and potential listings of threatened species in nsw regulated streams and their flow requirements in relation to the nsw interim river flow objectives (ref - Morris *et al* 2001).

SPECIES	RIVER FLOW OBJECTIVE 3. Freshes and high flows.				RIVER FLOW OBJECTIVE 4. Inundation patterns.	RIVER FLOW OBJECTIVE 6. Variability
	Magnitude	Frequency	Duration	Timing		
Silver perch Bidyanus bidyanus Status: T Occurrence: M, Mu, MC, L, G, N	Ensure over-bank flows as well as minor freshes.	Minimum 1 in every 5 to 10 years		Spring, when temp. ≥23º	Overbank flooding can assist in successful spawning and recruitment of this species	Ensure 50-100mm short term fluctuations during spring & summer for dispersal and food production
River snail Notopala sublineata Status: T Occurrence: Mu, M, L, CW, N						Ensure frequent moderate fluctuations to achieve wetted and dried perimeter cycles
Purple-spotted gudgeon Mogurnda adspersa Status: T(P) Occurrence: M, Mu, L, MC, N, G	Ensure velocity sufficient to achieve bed scouring.			Spring, when temp. ≥20º	Ensure refreshment of wetlands at least annually.	
Olive perchlet Ambassis agassizii Status: PT(P) Occurrence: Mu, L, MC, N, G				Spring, when temp. ≥25º	Ensure refreshment of backwaters, depth ~ 1m with no flow	
Golden Perch Macquaria ambigua Status: PT Occurrence: M, Mu, L, MC, N, G	Ensure over-bank flows to achieve floodplain inundation	Minimum 1 in every 3 to 5 years	Min. 3 weeks	Spring & summer when temp. ≥23º	Overbank flooding can assist in successful recruitment of this species	Ensure frequent moderate fluctuations to aid spawning, dispersal and food production
Freshwater catfish Tandanus tandanus Status: PT Occurrence: M, Mu, L, MC, N, G	Ensure sufficient to refresh wetlands.			When temp. ≥24º	Ensure refreshment of wetlands at least annually.	

Table 2 (cont.)

SPECIES	OBJECTIVE 7. Rates of rise & fall.	OBJECTIVE 9. In-stream structures.	OBJECTIVE 10. Quality of releases
Silver perch Bidyanus bidyanus Status: T Occurrence: M, Mu, MC, L, G, N		Ensure periodic 'drown-out' of barriers and/or fishway operational flows.	Temp. ≥23° in spring.
River snail Notopala sublineata Status: T Occurrence: Mu, M, L, CW, N			
Purple-spotted gudgeon Mogurnda adspersa Status: T(P) Occurrence: M, Mu, L, MC, N, G	Minimise rate of falls in spring to prevent exposure of egg mass and adverse impacts on in-stream vegetation.		Temp. ≥20° .
Olive perchlet Ambassis agassizii Status: PT(P) Occurrence: Mu, L, MC, N, G			Temp ≥ 25°C between Nov-Dec
Golden Perch Macquaria ambigua Status: PT Occurrence: M, Mu, L, MC, N, G		Ensure periodic 'drown-out' of barriers and/or fishway operational flows.	Temp. ≥23° in spring.
Freshwater catfish Tandanus tandanus Status: PT Occurrence: M, Mu, L, MC, N, G, H	Minimise rate of falls in spring to maintain stable levels over nest sites.		Temp. ≥24° in spring.

NOTE:

- **Flow objectives 1, 2, 5, 8 & 12 – not addressed as they were considered irrelevant to regulated streams.**
- STATUS CODES:
  - T = Threatened,
  - T(P) = Threatened population,
  - PT = Potentially Threatened,
  - Pr = Protected,
  - I = Indicator species
- CATCHMENT CODES:
  - M = Murray
  - Mu = Murrumbidgee,
  - MC = Macquarie-Cudgegong,

L = Lachlan,
G = Gwydir,
N = Namoi,
H = Hunter

Annexure 1 – River Flow Objectives and Benefits to Native Fish

Over the past 10-15 years a wealth of information has been gathered on the effects on fish populations of alterations in river flows (Morris *et al.* 2001, Young 2001, Harris and Gehrke 1997). Even before then, there was good information that species like golden perch spawned during rises in river level. Since then, we have learned that juvenile fish migrate back upstream in large numbers, sometimes triggered by relatively small rises in river level. Higher flows enable fish to move upstream and colonise new habitats. Reduced flows that have lost their natural variability, because of release patterns from dams and water harvesting, appear to provide better conditions for carp and lead to reduced diversity of native fish. Species whose numbers are most affected by the loss of natural flow patterns include Murray cod, golden perch, western carp gudgeons, bony herring, striped gudgeons, and perhaps silver perch. Many native species show some effect of river regulation on the size-structure of their populations in the form of reduced recruitment or slower growth rates. It comes as no surprise then that changes in river flows have reduced the resilience of fish communities to invasion by alien fish species. Overseas experience shows that environmental flows can successfully rehabilitate fish communities, suggesting that similar benefits can be expected from enhanced river flows in New South Wales. However, although knowledge of the effects of flow alteration has expanded in recent years, ways to reverse the effects have not expanded at a similar rate.

Environmental flows need to focus on the flow requirements for river ecosystems, adopting the principle that what is good for the river is good for native fish. This approach requires an understanding of current and natural flow conditions, for which data are readily available for many rivers. Thus, flow requirements of individual species may be needed only to fine-tune environmental flows instead of driving them in an unachievable way. Healthy fish communities require a diversity of habitat and river flows that provide conditions suitable for each species during their life cycle. Thus, long-lived species such as Murray cod and golden perch may not need ideal conditions for their needs as frequently as shorter-lived species such as pygmy perch or hardyheads. For this reason, river flows need to mimic natural conditions as closely as possible to provide the conditions that formed the local ecosystem, which in turn will support the species that occur naturally in a given river. The RFOs for NSW provide generic flow targets to be implemented in individual rivers, which will in turn provide habitat and flow conditions that are more conducive to healthy fish communities dominated by native species. The attached table summarises the anticipated benefits of the RFOs for native fish.

As improved river flows are implemented, on-going monitoring will be required to determine whether the flow objectives are being met, and whether the anticipated environmental benefits to fish and other organisms are being achieved.

References

Harris, J.H and Gehrke, P.C. (1997) *Fish and Rivers in Stress: The NSW Rivers Survey*. NSW Fisheries and the Cooperative Research Centre for Freshwater Ecology, Cronulla, 298 pp.

Morris, S.A., Pollard, D.A., Gehrke, P.C. and J.J. Pogonoski, (2001) *Threatened and potentially threatened freshwater fishes of coastal New South Wales and the Murray-Darling Basin*. Report to Fisheries Action Program and World Wide Fund for Nature, NSW Fisheries Final Report Series, Cronulla, 166 pp.

Young, W.J. (Ed) (2001) *Rivers as Ecological Systems: The Murrray Darling Basin*. Murray Darling Basin Commission, Canberra, 325 pp.

NSW River Flow Objectives	**Benefits to Native Fish**
1. Protect water levels in natural river pools and wetlands during periods of no flow.	This objective provides habitat refuges during dry conditions, and protects these habitats from unnaturally severe or prolonged dry periods. Refuge habitats allow fish to survive dry periods to breed and repopulate other habitats when rivers resume flow. Natural drying of wetlands can help to eliminate carp from habitats where they can become prolific.
2. Protect natural low flows.	As for 1. Excessive water use during low flows can eliminate flow altogether, resulting in greater stress on fish populations than would naturally occur under similar conditions. Loss of low flows may disrupt fish movements within the drainage network, or disrupt the production of fish food resources (most Australian freshwater fish consume benthic invertebrates).
3. Protect or restore a proportion of freshes and high flows.	Freshes provide triggers for fish migration and/or breeding, and reconnect water bodies that have become isolated during low flows, allowing new habitats to be recolonised. Freshes also encourage riparian and aquatic vegetation, which improves habitat diversity for fish and increases food availability. High flows rejuvenate river systems by flushing organic material and sediment from channels, wetlands and floodplains, dispersing poor quality water, maintaining channel form, promoting food production, and triggering fish migration and/or breeding.
4. Maintain or restore the natural inundation patterns and distribution of flood waters supporting natural wetland and floodplain ecosystems.	Inundation of wetlands and floodplains provides habitat and food for young fish, and creates refuges from predators and strong flows in deeper channels. In some areas, fish can only migrate between river and floodplains by moving over inundated floodplain habitats.
5. Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary streams.	Excessively long dry periods in temporary streams deny fish access to feeding, breeding and refuge habitats that they would have periodic access to under natural conditions. Excessive wetting of these habitats often provides favourable conditions for carp, which may then compete with native species and degrade the habitat. Trout survival can also be enhanced by higher than normal summer flows.
6. Maintain or mimic natural flow variability in all streams.	Not all fish breed at the same time, or under the same conditions. Mimicking natural variability ensures that appropriate conditions for different species will occur in space and time. Flow variability also helps maintain habitat diversity to meet the needs of different species. Carp tend to become abundant where natural flow variability is suppressed.
7. Maintain the rates of rise and fall of river heights within natural bounds.	Rapid falls in river level due to operation of weirs or heavy pumping can damage river habitats by causing erosion and bank slumping. If water levels fall too quickly, migrating fish may become stranded and die in corridor habitats connecting more permanent waters or stream edge habitats. Fish may be stimulated to breed by rising water levels, but rapid flood recession may cause eggs laid around the stream banks or flood fringe to dry before they can hatch. Alternatively, rapid falls in water level may mean there is not be enough food for those larvae that do hatch.
8. Maintain groundwaters within natural levels, and variability, critical to surface flows or ecosystems.	Groundwater seepage into stream channels maintains streamflow in many cases. Reductions in groundwater levels will therefore cause streams to dry prematurely. Saline groundwater is heavier than freshwater, and often lacks oxygen. When saline groundwater enters river channels during low flow periods, it can persist in the bottom of the channel and prevent fish gaining access to habitats that they would otherwise use. If the water becomes mixed, the low oxygen availability and salt concentrations can sometimes cause fish kills. Preventing saline groundwater

	from entering rivers is important to avoid these problems.
9. Minimise the impact of in-stream structures.	Fish migrations are prevented by regulators, block banks, weirs, causeways and dams, which can cause local extinctions upstream of these barriers. Effects of barriers can be reduced or avoided by removing unnecessary weirs, by building appropriate fishways or bypass channels, or by providing flows to drown-out the barrier often enough for fish to move upstream. These structures also prevent access to large areas of habitat. The timing and duration of periods of weir or barrier drown-out should match the frequency and timing of flow conditions which allow natural fish movements.
10. Minimise downstream water quality impacts of storage releases.	Water released from the bottom of dams is often of very poor quality or reduced temperature compared to the receiving downstream reaches or too cold, so that native fish avoid sections of rivers affected by dam releases, or may suffer direct mortality or reduced growth rates, or fail to breed. This can prevent spawning of warm water species, causing localised extinctions. Effective strategies to improve the quality of water released from dams will provide hundreds of kilometres of suitable habitat for fish.
11. Ensure management of river flows provides the necessary means to address contingent environmental and water quality events.	If all of the above flow issues are addressed, there will still be a need for environmental flows, either as minimum flows or as pulsed flow events in some rivers. This objective allows for additional environmental water needs to maintain healthy, functioning river ecosystems for fish and other organisms.
12. Maintain or rehabilitate estuarine processes and habitats	Freshwater inflows can affect the tidal pool and extent of estuarine ecosystems. Many aquatic fauna species have adapted to the varying range of salt and freshwater inflows in rivers and will move between these habitats to complete life history processes (e.g. Australian bass, prawns, mullet).

The socio-economic significance of the Condamine-Balonne catchment for New South Wales

There are four major areas of economic activity in New South Wales that are dependent on flows in the Condamine and Balonne rivers, these are:

- Graziers utilizing the vast pasture lands stretching north of the Barwon River to Queensland on the Culgoa, Bokhara and Narran flood plains;
- Irrigators located along the Darling River below Bourke;
- Riparian water users along Culgoa, Bokhara and Narran rivers; and
- Recreation and tourism industries dependent on these unique ecosystems, including Narran Lakes and Culgoa National Park.

The Culgoa floodplain is an important agricultural production area for NSW. The recent Australian Bureau of Statistics (ABS) census shows the two main agriculture industries, sheep and beef cattle, in Walgett and Brewarrina statistical local areas (SLAs) contribute around $73.5 million to the NSW economy. ABS shows that there are roughly 1.53 million hectares in Walgett and Brewarrina SLAs of native grazing pasture lands that directly benefit from flood waters coming down the Condamine and Balonne rivers. These floods are critical in producing feed for a large number of beef cattle and sheep in the region.

The beef industry in this area is quite significant. The total number of cattle for both of these areas is around 134,519 (ABS, 2001). The value of beef production is $ 31.5 million. Sheep and Wool production is also a significant industry in this area. The total number of sheep for this area is around 1.4 million. The value of sheep production is $ 31 million for wool and $11.53 million for meat.

Most of the cattle and sheep farmers also use water from these rivers for stock and domestic purposes. Thus the flow from the Condamine and Balonne rivers in to Culgoa, Bokhara, and Narran rivers is important for the survival of the cattle and sheep industry in this area.

The contribution of Condamine and Balonne rivers to Darling River flows is also valuable for a large number of farmers located along the river below the Culgoa junction upstream of Bourke to Menindee lakes. There are 80 active irrigators who irrigate about 10,500 hectares in this area[14]. The predominant irrigation activity along this section of the river is cotton production based mainly on flood/furrow irrigation systems. Other commodities produced include peanuts, winter cereals, table grapes, citrus and melons. As the Barwon-Darling region experiences the lowest and most unreliable rainfall for any irrigation region in NSW, and at times inflows from the Culgoa are the only source of water, the continuation of these flows are critical to the survival of Darling River irrigators.

Industries impacted by reduced flow into Narran Lake and its dependent floodplain include grazing, opportunity cropping and tourism. All of these industries are dependent upon sufficient channel water and beneficial flooding for productivity and amenity purposes.

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[14] DWR (2002) Barwon-Darling Facts and Figures – Flow and Extraction Statistics. Produced for the Barwon-Darling River Management Committee by the Department and Land and Water Conservation, Far West Region, Dubbo. May 2002.

ASSESSMENT OF
PRE AND POST DEVELOPMENT
FLOODING ON THE
LOWER CONDAMINE-BALONNE
FLOODPLAIN

Department of Infrastructure Planning and Natural Resources

5 May 2004

Summary

**This report documents a rapid assessment of the impact of water resource development on beneficial flooding in the lower Balonne floodplain.
Five classes of flood events, from major to minor floods, were defined and pre and post development IQQM data, supplied by the Department of Natural Resources, Mines and Energy, were analysed to assess the modelled impact on these events.**

The analysis shows that for the 1922-1995 simulation period, the magnitude of almost all events was seriously reduced, with all minor and some small flood events eliminated entirely. The overall number of events reduced by over 50% (62 down to 30) and, as a consequence, the average period between these events expanded. Under pre development conditions there was only one occasion when there was no flooding in a four year period, now there are six.

Areas that were flooded on a frequent basis now only receive an occasional flood, thus having significant impacts on flood dependent species and economic activity.

The pre-development flow data is effectively "natural "conditions so the long-existing development associated with Beardmore Dam and in the upstream reaches is not included. Thus the pre-development flows at St George may be significantly greater than the recorded data.

The flow data used in the analysis was applicable to the Queensland moratorium development conditions. Doubts have been raised within the Department of Natural Resources and Mines as to the accuracy of the event flow data. However, to date, this data has not been reviewed.

The flow rules contained in the Draft Water Resource Plan are not considered to have a significant impact on the flooding results, although this issue requires a comprehensive study to determine the magnitude of the impacts.

Introduction

A Natural Resource Management Strategy project in 1995 consisted of a consultancy by Mottell Pty Ltd (Land and Water Management Consultants). The consultancy included a comprehensive survey of landholders, which amongst other issues identified the frequency and benefits of natural flooding for landholders on the Condamine-Balonne distributary system. The report attempted to quantify the benefits of different sized flooding events. This report has been used as background information to determine a flood classification system.

From the information contained in this report and the obvious differences in landholder responses, it is evident that flooding is dependent on a large variety of inputs. A flood that produced major flooding on one property did not necessarily produce a similarly described outcome on another.

Unfortunately information is not yet available on the flood inundation patterns for a variety of different sized floods. As in most flat floodplains where a large proportion of flood flow is carried outside of a relatively small river channel, flood heights and areas of inundation are dependent on a number of factors including peak flowrate, period above a threshold flow value, volume of the flow event, duration of flows, antecedent wetness of the floodplain and rainfall during a flood event. Without comprehensive and sophisticated hydraulic modelling of the area, it is impossible to develop an accurate picture of the total flooding regime. In this void of information the department has attempted to develop a simple flood classification system that can be used to demonstrate the scope of the impacts of reduction in flooding due to the development within the floodplain.

One of the underlying assumptions that has been used is that short duration events with a high peak flowrate at St George but not a large volume will proportionally flood more in the upper reaches, reduce the volume on the floodplain and not produce significant flooding in the lower reaches. Conversely an event with a smaller peak flow at St George but a large volume will translate some of that water into the lower reaches and provide flooding to the downstream areas.

Commence to Flood

The Draft Water Resource Plan suggests that flooding commences when the flow at St George exceeds 20 000 ML/d. This is the flowrate suggested at Section 138 (2) (a) of the plan. It has been assumed that this peak flow at St George would not produce flooding in New South Wales, with only localised flooding near St George.

The Mottell report suggests that under pre-development conditions, flooding in New South Wales commences when peak flows at St George are in excess of 30 000 ML/d. Using the model data, a flow of 30 000 ML/d at St George will produce a consolidated peak flow (see below) at the border of between 12 000 ML/d and about 23 000 ML/d.

For the current analysis, it was subjectively decided that New South Wales would only receive significant flooding when the consolidated border peak flow was in excess of 25 000 ML/d, which corresponds to a St George peak flowrate of between 30 000 ML/d and 45 000 ML/d. Because of the errors in the border consolidated process this should provide a conservative estimate (ie underestimate) of the occurrences of marginal flood events.

The choice of a threshold of 25 000 ML/d at the border for commencement of flooding provides only a common standard about which to compare flooding under the pre and post development scenarios. Because it is comparative, the choice of a single threshold should provide a valid comparison.

Consolidated Border Flows

The change in flooding in New South Wales between pre and post development conditions is largely a result of water extractions between St George and the border. Hence the trigger for determining the difference in flooding is the flow rate at the border.

There are different times of travel along the different effluent streams from St George to the border. The peak flow rates at the border from a common source flow at St George will occur on different days in each stream, ie the peak in the Culgoa will not be on the same day as in the Narran. However to get a common reference point, all the flows for the same day have been added to get a single consolidated border flow. This will underestimate the real peak flow rate across the border but the difference should not be significant.

It will provide an averaging effect taking into account uncertainty about the flow thresholds when flooding commences and the difference between streams in flood behaviour. Without estimates of flooding regimes and areas of inundation for a variety of flood peaks and volumes, it can only be an approximation of the border flows that initiate flooding.

Flood Classification

Earlier Queensland Department of Primary Industry work classified flood events as small, medium and large based on peak flowrate thresholds at St George of 30 000, 120 000, and 220 000 ML/d.

The Mottell report suggested five classifications, they being major, large, medium, small and minor. This classification had its origins more in the description of the flood by landholders in terms of the areas of inundation than a scientific basis. The estimates for percentage of the floodplain inundated were 100% for major, 99% for large, 77% for medium, 44% for small and 14% for a minor flood. The lack of a large number of documented events and objective measurements for the flood classifications makes this a subjective assessment criteria.

Without an objective criteria it is difficult to categorise a flood by a single criteria. A flood with a high peak flowrate may be a large flood for upstream landholders but may recede to a minor or non-flood in the lower reaches. Conversely a relatively low flowrate associated with a large volume may inundate large areas in the lower reaches without large flood spread in the upper reaches. Similarly, rainfall during flooding and the occurrence of a flood shortly before the subject flood will substantially alter the perception of the classification of a particular flood.

To determine the effect of development on the changes to flooding and subsequent economic and environmental benefits, it is essential to have a criteria on which to base a comparison. For this reason the classification described below is based on subjective assessments of the parameters that could be used to describe a flood. The two parameters that are easily available from modelled data are flood peak flowrate at the border and the volume that is in some way contributing to potential flooding.

Based on the Mottell report and the spread of floods throughout the assessment period of 1922 to 1995 the following classifications were constructed. Due to the lack of data the parameter ranges are open to debate, but they do provide a common base to compare changes.

Appendix 1 lists the flow events that were considered as potential flood events. The Flood volumes were calculated generally when the flow exceeded about 1 000 ML/d, but this was varied depending on the size of the event and the occurrence of a preceding or succeeding flow. The Volumes involved in the leading and trailing shoulders are relatively insignificant in terms of adding substantially to the event volume.

Events were not considered as floods unless the peak flow at the border equalled or exceeded 25 000 ML/d. There were 62 events that are potential flooding events, in some events there are two distinct flood peaks, but because of the proximity of the peaks it is appropriate that they be considered as one event.

Major Flood:

Where the peak at the border is greater than 120 000 ML/d and the total volume is greater than 2000 GL. This corresponded to a peak at St George of between 185 000 ML/d in 1983 (triple peaks of 185/172/157 000 ML/d) and 243 000 ML/d in 1950). Under natural conditions only the: July 1950, Feb 1954, Feb 1956 and 1983 floods would qualify. These are known landmark floods that would be expected to inundate all/almost all of the floodplain area. Of the 62 events 6% are considered as major ie 4 in 73 years.

Large Flood :

Where the peak at the border is greater than 100 000 ML/d and the total volume is greater than 1000 GL. Under natural conditions the; 1942, Dec 1950, July 1954, 1959, 1988 and 1990 floods would qualify. These floods could have been expected to inundate sections of the floodplain to its maximum extent, with all sections having significant inundation. Of the 62 events 10% are considered as large ie 6 in 73 years

Medium Flood :

Where the peak at the border is between 75 000 and 100 000 ML/d and the total volume is greater than 750 GL. Under natural conditions the: 1932, Oct 1954, July 1956, April 1963, 1970, 1971, 1976, 1977, Dec 1983, and Aug 1984, floods would qualify (the 1976 flood is considered as medium as there were two peaks close together of 72 and 71 GL/d with a total volume of 2413 GL). These floods could have been expected to inundate sections of the floodplain to a large extent, but some areas would remain dry. Of the 62 events 14% are considered as medium ie 10 in 73 years

Small Flood :

Where the peak at the border is between 50 000 and 75 000 ML/d and the total volume is greater than 500 GL. These floods could have been expected to inundate sections of the floodplain to a moderate extent, but large areas would remain dry. Of the 62 events 24% are considered as small ie 15 in 73 years

Minor Flood :

Where the peak at the border is between 25 000 and 50 000 ML/d and the total volume is greater than 200 GL. These floods could have been expected to inundate limited sections of the floodplain to a moderate extent, but sections and large areas would remain dry. Some minor floods because of their volume and duration could inundate significantly large areas. Of the 62 events 44% are considered as minor ie 27 in 73 years

Other Flow Events

There may be other flow events, such as in 1952 when there the total flow volume was over 500 GL, but the peaks were only 19 000 and 23 000 ML/d. There may have been flooding from these flows.

Appendix 2 **illustrates the distribution of flood events from 1922 to 1995 and the modelled change in the peak flow under pre-development and post-development (Moratorium) conditions. The magnitude of all events (except 2) is reduced.**

Analysis

Statistics

Table 1 **summarises the number of events in each class for the pre and post development conditions.**

Table 1**: Number of events 1922 - 1995**

Classification	Pre-development Number	Post-development Number
Major	4	2
Large	6	3
Medium	10	6
Small	15	7
Minor	27	12
Total	62	30

There were 32 events that were reduced from an event providing flooding benefit to only providing in-channel flows.

Appendix 3 **illustrates these changes.**

- **all 27 of the pre-development "minor" flood events have been eliminated, as have 5 of the 15 "small" events,**
- **of the 10 other "small" events all but 1 have been reduced to "minor" events,**
- **none of the 10 "medium" events have been eliminated, but 3 have been reduced to "minor", 4 reduced to "small", 2 are still in the "medium" class and 1 increases to "large",**
- **2 of the 6 of the "large" events are reduced to "small", 3 to "medium" and 1 is unchanged,**
- **finally, 1 of the 4 "major" events is reduced to "medium", 1 to "large" and 2 are unchanged.**

Table 2 **shows the longest periods without flooding for pre and post developed conditions and the size of the flood either side.**

Table 2**: Lapse time between events**

	Pre-development			Post-development		
Period Rank (1=longest)	Duration Days	Size of flood at start	Size of flood at end	Duration Days	Size of flood at start	Size of flood at end
1	2821	Medium '63	Medium '70	3985		Minor '32

2	1435	Medium '77	Small '81	2821	Minor '63	Small '70
3	1344	Small '29	Medium '32	1834	Small '42	Minor '47
4	1330	Large '90	Minor '93	1561	Minor '32	Minor '37
5	1303	Medium '84	Small '88	1496	Small '59	Minor '63
6	1117	Minor '43	Minor '46	1471	Minor '37	Minor '41

The longest period without flooding under pre-development conditions was April 1963 to December 1970 ie 7 years 8 months. Under developed conditions the longest period is at least 10 years 11 months (January 1922 to December 1932).

The average duration between flooding increases substantially and the floods that break the period are generally smaller.

The total volume that contributes to flooding over the period shows a large reduction under the developed conditions. Under pre-developed conditions approximately 68 500 000 ML flowed during the flooding events of which 17 600 000 ML was in the largest 4 floods, compared with 33 500 000 ML under the developed condition (14 700 000 ML in the largest 4).

Area of *Inundation*

NOTE: This section on area of inundation is included purely to provide an indication of the area that landholders consider will be impacted by the current development.

The Mottell study reported on the area of inundation (in NSW and in Queensland) for each category of flood. The information is anecdotal and without the raw data it is difficult to determine the applicability of it in a generalised flood classification process and quantification of areas. A more appropriate method would the assessment of a large number of different sized events and flooding conditions. This information is not available and unlikely to be for some time as it can only be accurately undertaken using satellite imagery, so historical events prior to the early 1980's must go unanalysed.

Table 3 **has been produced from the data in the first Mottell report (June 1995), it has been used to enable a comparison of flooded areas in NSW for pre and post development scenarios. While the absolute size of the areas may be in error, it enables a quantification of the differences.**

Table 3**: Area inundated in NSW for different sized floods**

Area in Thousands of hectares	Major Flood	Large Flood	Medium Flood	Small Flood	Minor Flood

Birrie	**126**	**97**	**72**	**71**	**20**
Bokhara	**103**	**71**	**39**	**34**	**7**
Culgoa	**355**	**132**	**68**	**60**	**29**
Narran	**362**	**359**	**280**	**159**	**49**
Total	**946**	**659**	**459**	**324**	**105**

Assuming that these areas are an approximation of the mid range for each classification these estimates have been used to determine the flooded areas for each flood. There are some inherent errors associated with this type of assumption, due to the antecedent wetness of the floodplain, averaging factors and the subjective assessment by landholders.

Appendix 1 **shows the areas of inundation for each flood and the cumulative total for all floods under pre and post development conditions.**

Financial Benefits of Flooding

NOTE: As is the case with Section 5.1, this section on financial implications is included purely to provide in indication of the cash flow that non-irrigating landholders consider will be involved by the current development.

This section is not intended to provide an economic assessment of the impact of irrigation development on the non-irrigation community. The economic and social cost assessment requires a comprehensive study using much more data than is available at present. The costs of reduction of property values, financial viability and security and the reduction in the number of families that can be supported on a reduced income are acknowledged but cannot be quantified.

The Mottell report attempted to value the financial productivity of flooding on the floodplain. In this instance, it categorised the flooding into three categories: large, medium and small. For the purposes of this analysis the classification will use interpolation to use the five categories identified above.

The report was presented in July 1995. For simplicity, the values in the report were converted to current day values using the CPI index published by Australian Bureau of Statistics. In 1995 the CPI in June 1995 was 116.2 and 142.8 in December 2003. The gross margin benefits derived in 1995 were multiplied by 1.229 (142.8/116.2) to approximate current values.

It identified two main areas generating benefits:

1. Additional Grazing

The most obvious benefit is the increased grazing opportunity from the additional feed produced. The benefits were estimated by comparison of the stocking rate under non-flood conditions and after flooding. Flooding has a persistence effect with grazing benefits lasting for up to three years following a flood. However, to avoid overlap effects when succeeding flooding occurs within this persistence window, and for ease of calculation, the benefits of flooding in only one year will be considered for each flood. This will provide a conservative (ie low) estimate of benefits.

2. Cropping Opportunities

The residual moisture following a flood can be utilised by planting opportunity crops. The crops use the remaining moisture and are in a position to survive and benefit from small amounts of rainfall during the growing period.

Table 4: **Benefits identified in the Mottell report, converted to current values.**

Flood Category	Stock benefits $ mill	Cropping benefits[5] $ mill	Total benefits $ mill
Major[1]	9.9	11.3	21.2
Large[2]	6.4	*7.3*	13.7
Medium[3]	*3.0*	*3.4*	6.4
Small[3]	*1.0*	*1.1*	2.1
Minor[4]	0.5	*0.6*	1.1

Notes:
Italicised figures are estimated interpolations/extrapolations.

1. **The Major flood estimates used 1990 data which is categorised above as large, but for conservatism is regarded as providing benefits on an infrequent scale and is considered as major here.**
2. **The large flood estimates used 1988 data, which is categorised above as large.**
3. **Estimated interpolated values**
4. **The minor flood benefits use the 1989 flood, which was categorised as minor.**
5. **The cropping benefits are poorly defined in the report and apart from the major flood all values are extrapolated using the ratios of the stock benefits.**

The above benefits are likely to be gross understatements of the real benefits. By way of example, the recent 2004 event, under pre-development conditions, would have been a minor flood. Ministerial representations from one landholder suggested that he had potentially "lost" about $ 500 000 from lost anticipated stocking and cropping opportunities.

Conclusions

Statistics

The changes to flooding patterns have seriously reduced the magnitude of almost all floods. All the minor flood events that were the most frequent events have been eliminated as flood events. Even some small flood events have been reduced to the extent that they now do not provide any flooding benefits. There are now six occasions when flooding would not occur for four years or more. Under natural conditions there was only one occasion when there was no flooding in a four-year period.

Appendix 1 **shows that areas flooded on a frequent basis now receive only an occasional flood. This change in the flooding frequency may have a serious impact on the floodplain and river ecology, for example decline in plant species that are not extremely drought tolerant and reduced recruitment of native fish.**

Area of Inundation

The magnitude of the changes to the flooding regime will certainly reduce the area that would now be classified as "wetland". Areas that were flooded reasonably frequently will now receive only an occasional flooding

Financial Benefits of Flooding

A focussed socio-economic study is required to determine the impacts of the reduction in flooding on incomes, viability and wider impacts on the communities in the area.

Undoubtedly the current development will jeopardise the financial viability of some properties and reduce the income in the community by a significant amount.

Annual Flow Volumes

Appendix 4 **shows the annual flow volumes at the border under natural and developed conditions. The average annual cross border flow has been reduced by 50%, whilst the median has been reduced by 74%.**

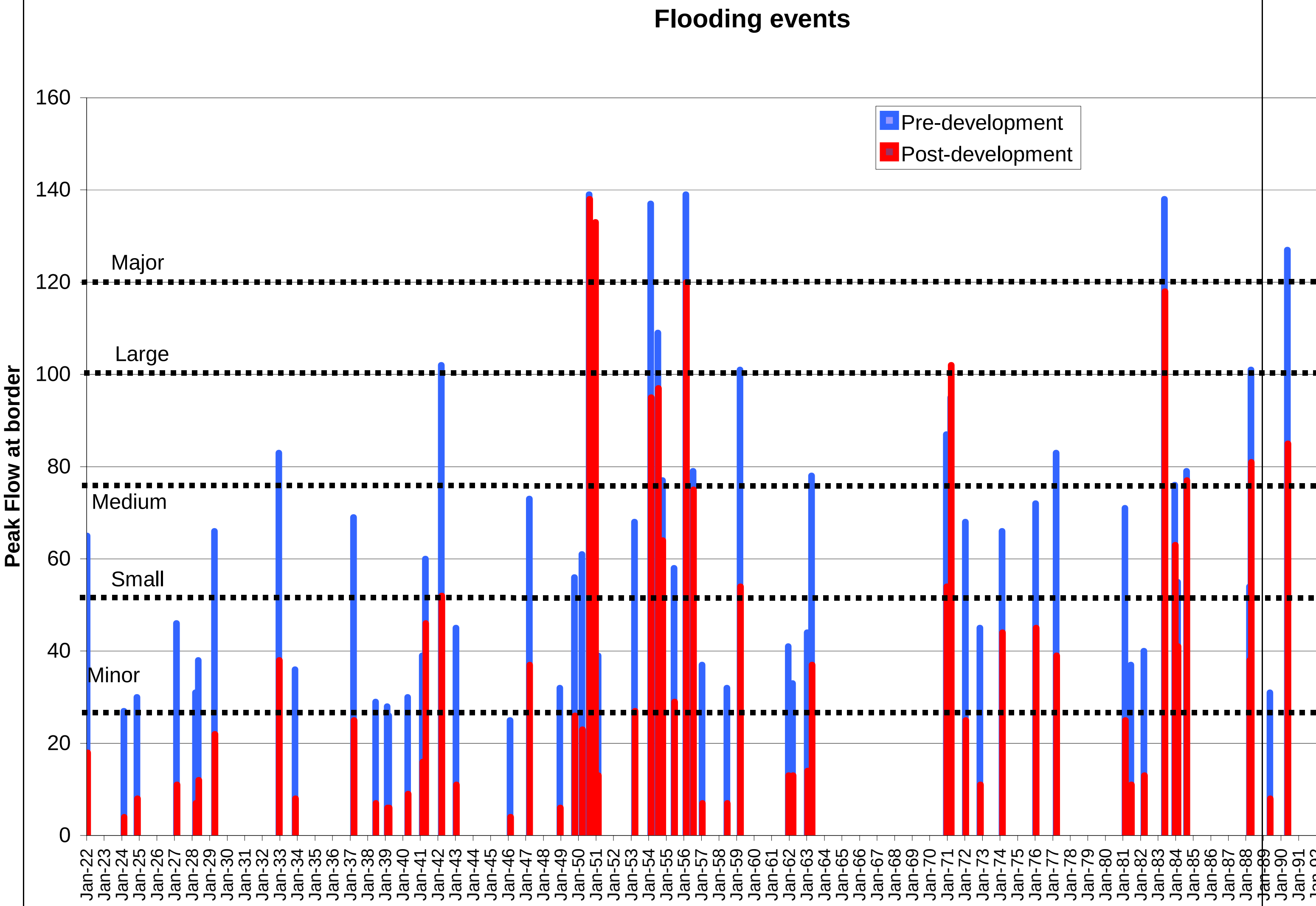
References

Mottell Pty Ltd (1995) *Flood Plain Resources Study Lower Balonne Flood Plain in New South Wales*. **July 1995.**

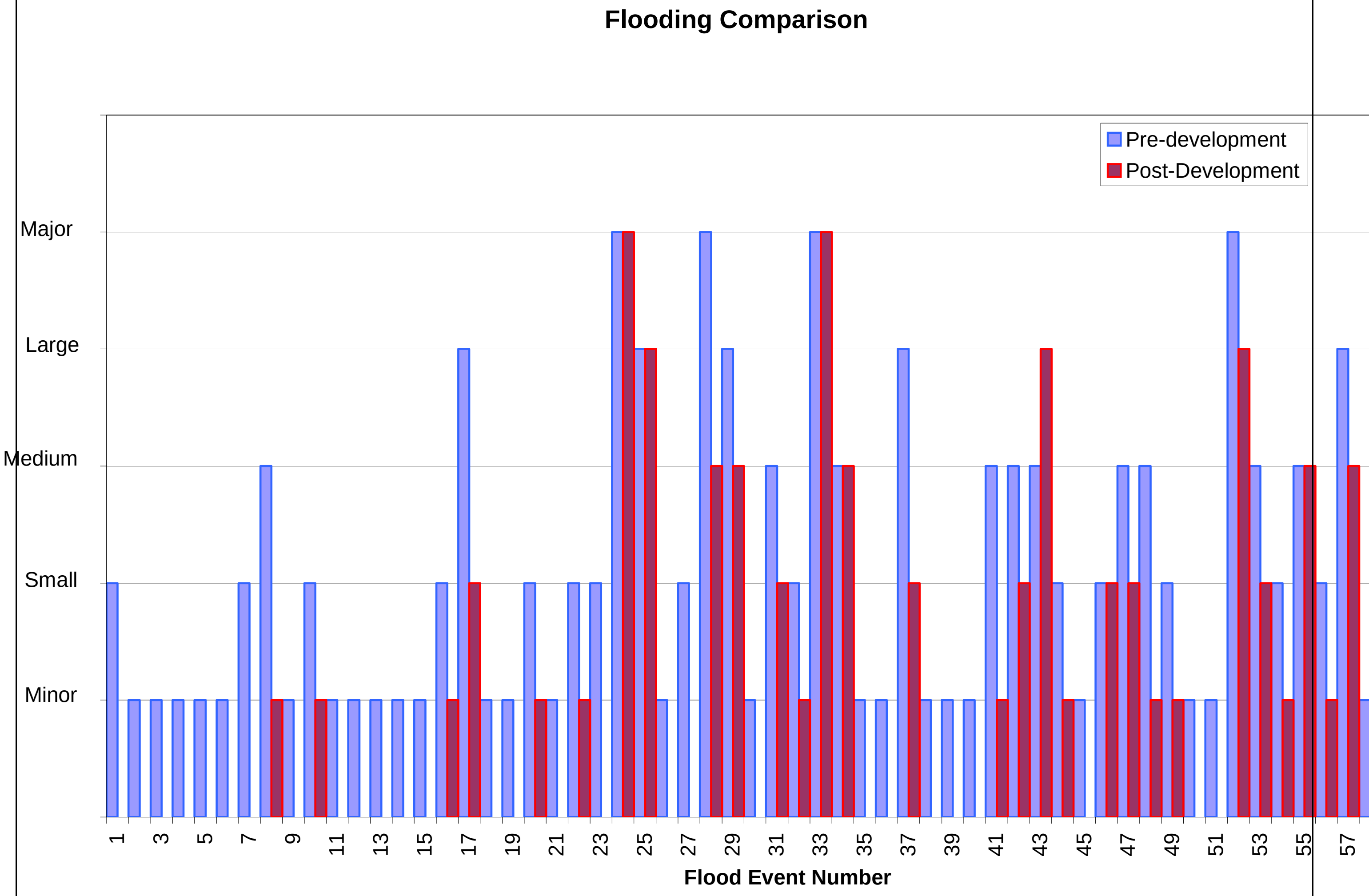
APPENDIX 1 – Analysis of events pre and post development

		NATURAL @ BORDER					DEVELOPED @ BORDER				
No	Date	Period between floods Days	Peak GL/d ('000 ML/d)	Volume GL ('000 ML/d)	Flood	Area Flooded '000 ha	Period between floods Days	Peak GL/d ('000 ML/d)	Volume GL ('000 ML/d)	Flood	Area Flooded '000 ha
1	21-Jan-22		65	735	Small	324		18	217		
2	29-Feb-24	769	27	725	Minor	105		4	188		
3	24-Nov-24	269	30	598	Minor	105		8	209		
4	22-Feb-27	820	46	653	Minor	105		11	161		
5	14-Mar-28	386	31	543	Minor	105		7	140		
6	05-May-28	52	38	388	Minor	105		12	156		
7	15-Apr-29	345	66	826	Small	324		22	278		
8	19-Dec-32	1344	83	968	Medium	459	3985	38	427	Minor	105
9	24-Nov-33	340	36	672	Minor	105		8	162		
10	29-Mar-37	1221	69	766	Small	324	1561	25	286	Minor	105
11	10-Jun-38	438	29	303	Minor	105		7	81		
12	11-Feb-39	246	28	322	Minor	105		6	70		
13	31-Mar-39	48	26	404	Minor	105		6	96		
14	02-Apr-40	368	30	863	Minor	105		9	222		
15	04-Feb-41	308	39	1045	Minor	105		16	354		
16	08-Apr-41	63	60	936	Small	324	1471	46	579	Minor	105
17	03-Mar-42	329	102	1172	Large	659	329	52	553	Small	324
18	21-Jan-43	324	45	690	Minor	105		11	181		
19	11-Feb-46	1117	25	432	Minor	105		4	75		
20	11-Mar-47	393	73	964	Small	324	1834	37	366	Minor	105
21	25-Dec-48	655	32	745	Minor	105		6	166		
22	28-Oct-49	307	56	575	Small	324	962	26	244	Minor	105
23	07-Mar-50	130	61	892	Small	324		23	311		
24	08-Aug-50	154	139	2811	Major	946	284	138	2400	Major	946
25	07-Dec-50	121	127	1794	Large	659	121	133	1579	Large	659
26	28-Feb-51	83	39	529	Minor	105		13	173		
27	05-Mar-53	736	68	733	Small	324		27	286		
28	28-Feb-54	360	137	2170	Major	946	1179	95	1265	Medium	459
29	30-Jul-54	152	109	1326	Large	659	152	97	1186	Medium	459
30	30-Aug-54	31	29	353	Minor	105		22	258		
31	30-Oct-54	61	77	915	Medium	459	92	64	703	Small	324
32	09-Jun-55	222	58	724	Small	324	222	29	419	Minor	105
33	10-Feb-56	246	139	6658	Major	946	246	120	5856	Major	946
34	10-Jul-56	151	79	1437	Medium	459	151	75	1377	Medium	459
35	13-Jan-57	187	37	483	Minor	105		7	97		
36	28-Jun-58	531	32	379	Minor	105		7	88		
37	05-Mar-59	250	101	1326	Large	659	968	54	728	Small	324
38	30-Dec-61	1031	41	1321	Minor	105		13	455		
39	25-Mar-62	85	33	470	Minor	105		13	216		
40	27-Jan-63	308	44	496	Minor	105		14	153		
41	09-Apr-63	72	78	1013	Medium	459	1496	37	494	Minor	105
42	29-Dec-70	2821	87	1654	Medium	459	2821	54	720	Small	324
43	01-Mar-71	62	95	2474	Medium	459	62	102	2036	Large	659
44	09-Jan-72	314	68	995	Small	324	314	25	377	Minor	105
45	21-Nov-72	317	45	650	Minor	105		11	181		
46	13-Feb-74	449	66	1192	Small	324	766	44	523	Small	324
47	15-Jan-76	701	72	2413	Medium	459	701	45	1297	Small	324
48	23-Mar-77	433	83	833	Medium	459	433	39	410	Minor	105
49	25-Feb-81	1435	71	903	Small	324	1435	25	317	Minor	105
50	13-Jun-81	108	37	344	Minor	105		11	136		
51	15-Mar-82	275	40	654	Minor	105		13	225		
52	20-May-83	431	138	5620	Major	946	814	118	4437	Large	659
53	10-Dec-83	204	76	974	Medium	459	204	63	748	Small	324
54	14-Feb-84	66	55	610	Small	324	66	41	424	Minor	105
55	15-Aug-84	183	79	1446	Medium	459	183	77	1294	Medium	459
56	10-Mar-88	1303	54	802	Small	324	1303	38	326	Minor	105
57	30-Apr-88	51	101	1966	Large	659	51	81	1227	Medium	459
58	10-May-89	375	31	763	Minor	105		8	213		
59	01-May-90	356	127	1531	Large	659	731	85	975	Medium	459
60	21-Dec-93	1330	32	319	Minor	105		6	58		
61	22-Mar-94	91	53	787	Small	324		19	267		
62	09-Dec-95	627	37	496	Minor	105		6	82		
	TOTAL			**68581**		**20023**			**39528**		**10151**

APPENDIX 2


Flooding events
Pre-development
Post-development
Peak Flow at border
Major
Large
Medium
Small
Minor
0
20
40
60
80
100
120
140
160

APPENDIX 3



Flooding Comparison
Pre-development
Post-Development
Major
Large
Medium
Small
Minor
1
3
5
7
9
11
13
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17
19
21
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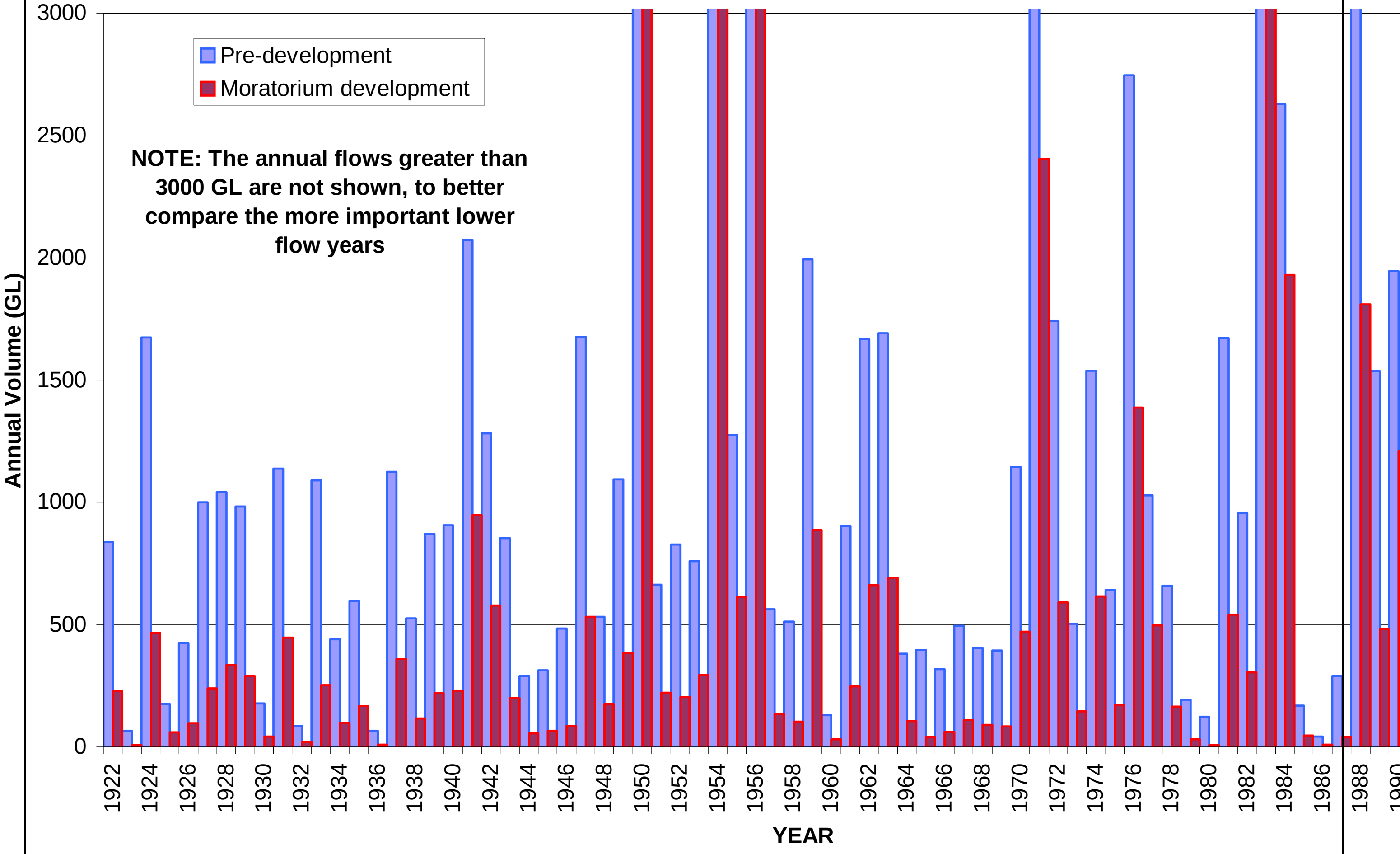
55
57
Flood Event Number

APPENDIX 4

Modelled annual cross border flows under "pre-development" and "moratorium" conditions



Department of Infrastructure, Planning and Natural Resources
–––– Far West Region ––––

River flow and floodplain inundation impacts of current water resource development in the lower Condamine-Balonne.

FINAL VERSION

23 April 2004

Acknowledgments

This report was compiled by Peter Terrill. Valuable input was provided by Derek Everson (hydrology records), Geoff Horn (satellite image analyses) and Marita Woods (preparation of figures).

River flow and floodplain inundation impacts of current water resource development in the lower Condamine-Balonne.

Executive Summary

An analysis of the historic flow record from 1971 to present was undertaken to assess the impact of irrigation development in Queensland on flows and floodplain inundation in the lower Balonne distributary system in New South Wales.

The January 2004 event resulted in much reduced flow peaks, total volumes and flooding in NSW than previous events of similar magnitude. Flows entering NSW in the 7 events up to 1997, averaged 53.5% of the volume measured at St George, whereas only 20% of the 2004 event crossed the border.

Satellite image analysis showed the extent of flooding in New South Wales was 88% less in 2004, compared with that produced by a similar event in 1988.

The annual flow data shows a declining trend in the share of water to NSW, with the mean share dropping from 75% of the total flow at St George over 1972-88 to 51% over the following 15 years. The declining trend is worse for the Culgoa.

The analysis supports conclusions that the future health of the river and floodplain ecosystems, as well as the economic prosperity of the NSW landholders, will continue to decline. It will take much more than the minimal environmental flow provisions specified in the draft Water Resource Plan for the Condamine and Balonne Rivers to restore key components of the hydrological regime and reverse this decline.

1.0 Introduction

Staff of the NSW Department of Infrastructure, Planning and Natural Resources (DIPNR) have compared several flood events and trends in annual flows to assess the impact of current development on flows and floodplain inundation associated with the cross border Condamine-Balonne distributary channels, the Narran, Bokhara, Birrie and Culgoa Rivers.

The analysis will assist in assessing Queensland's *Condamine and Balonne Draft Water Resource Plan* (DNRM, 2003), which includes event sharing rules designed to mitigate some of these impacts.

2.0 Methods

The hydrographic record from the St George stream gauging station was examined to identify events with similar flow and antecedent conditions to the January 2004 event. Several events were considered, including:

- December 1971 – January 1972
- December 1975 – January 1976
- February – March 1981
- March 1982
- February – March 1988
- March 1994, and
- February 1997

For each event, peak discharge, duration and total volumes were compared for:
GS 422201E – Discharge over Jack Taylor Weir at St George
GS 422012 – Narran River at Angledool (d/s of New Angledool weir)
GS 422014 – Bokhara River at Goodooga
GS 422013 Birrie River at Goodooga
GS 422015 – Culgoa River at Brenda

Additionally, the relative difference between the figures for the past events and the 2004 event were assessed.

To assess changes in flood inundation extent and patterns, the 1988 event was chosen for more detailed analysis because of the availability of comparable satellite imagery, there being none available for the earlier events.

The total annual flow for each of the stations was also compared from 1972 to 2003 inclusive.

3.0 Results

The results of the analysis are presented as a number of tables and figures. These are attached (**Appendix 1**, **Appendix 2 and Appendix 3**) and are described below.

<u>Appendix 1</u>

Tables 1a to 7b compile the key flow parameters for each event and compare them with the 2004 event. The relevant tables are:

Tables 1a, 1b and **1c ––** February 1997 event compared with the Jan 2004 event.

Tables 2a and **2b ––** March 1994 event compared with the Jan 2004 event.

Tables 3a and **3b ––** March 1988 event compared with the Jan 2004 event.

Tables 4a and **4b ––** March 1982 event compared with the Jan 2004 event.

Tables 5a and **5b ––** February 1981 event compared with the Jan 2004 event.

Tables 6a and **6b ––** January 1976 event compared with the Jan 2004 event.

Tables 7a and **7b ––** January 1972 event compared with the Jan 2004 event.

Table 8: Summary of changes to peak flow and total volume for each of the above flood events.

Table 9 presents the results of the satellite image analysis. It compares areas of inundation and development for NSW and Queensland for the Mar 1988 and Jan 2004 events.

Table 10 is the annual flow data for the 5 stations for the period 1972-2003 inclusive. It presents the annual flow at the NSW stations, individually and collectively, as a percentage of the total annual flow at St George. The graph in **Figure 3** is generated from these data.

Table 11 summarises the annual flow volumes for 4 **dry** year sequences - 1972 - 2003

Table 12 summarises the annual flow volumes for 4 **wet** year sequences - 1972 - 2003

Table 13 summarises the annual flow volumes **all** years – 1972-2003

Table 14 is the relative split between the four NSW stations of the total annual cross border flow for each year from 1972-2003 period.

Table 15 provides a summary of the average distribution of cross border flows for the first 17 years, the next 15 years and all 32 years from 1972 to 2003.

Appendix 2

Figure 1 illustrates the hydrographs for six events of similar magnitude at St George. Mean daily discharge at St George is plotted for each event against the time, relative to the peak.

Figure 2 graphs the proportion of the total volume at St George that reached NSW for each event – the total volume being the some of the volumes at each of the 4 NSW gauging stations.

Figure 3 compares the proportion of the flow to NSW with annual flows at St George for the period 1972 to 2003. The data prior to 1972 is incomplete and the analysis it does not include 2004 flows, ie the recent event used in other comparisons.

The subsequent figures provide more detailed comparison of the 1988 and 2004 events.

Figures 4 and **5** illustrate the antecedent conditions over the 365 days prior to the commencement of the 1988 and 2004 events. Basically both followed dry periods although this was more extended for the 2004 event. There was a small fresh, peaking around 7,000ML/d about 10 weeks prior to the March 1988 event. However, there was no flow for the 9 months prior to the January 2004 event. Despite this difference, a check of the Landsat "thumbnails" prior to these events indicates that the floodplain was dry and that subsequent flooding was due to overbank flows and not prior events or localised rainfall.

Figures 6 to **9** compare the 1988 and 2004 hydrographs at St George to the corresponding events at the downstream gauging stations.

Figure 10 compares the 1988 and 2004 hydrographs at St George to the sum of the flows at all four NSW stations, ie the total flow into NSW.

Figure 11 illustrates the growth in on farm storage since 1988 (data provided by MDBC).

Appendix 3

Figure 12 is the Landsat 5 image for the 1988 event captured on 26 March 1988, 22 days after the peak at St George.

Figure 13 is the Landsat 5 image for the 2004 event captured on 19 February 2004, 28 days after the peak at St George.

Figure 14 is the flood inundation and storage layers derived from the 1988 satellite image.

Figure 15 is the flood inundation and storage layers derived from 2004 satellite image.

4.0 Discussion

Despite gaps and inaccuracies in the hydrographic record, the results do illustrate the significant impact of water resource development on flows and flooding in the lower Condamine-Balonne.

Events similar to the January 2004 event

Eight similar events were analysed (Tables 1a to 8 and Figures 1 and 2).

The January 2004 event followed a seven year gap in events of this size. **Tables 1a to 7b** compare each of these events to the January 2004 event. **Table 8** illustrates the changes to **peak discharge** and **volumes** of the flow as the event moves down the system. For example, the cross-border flow for the 7 events to 1997 ranged from 44% to 75% (average 53.5%) of the total discharge at St George, whilst only 20% of the 2004 event entered NSW.

Peak discharge and total volume was depressed in each NSW distributary. However, the impact is greatest on the Culgoa, which historically takes about 60% of the flow entering NSW (**Table 14**). Up to 1997, the peak was 12-21% (average 17%) of that at St George but in 2004 was only 5%. Similarly, up to 1997, the volume reaching Brenda was 24-42% (average 31.6%) of the volume at St George but in 2004 was only 10%. This is a reduction of about 70%, in both indicators, for the 2004 event.

The Narran River, which historically takes about 20% of the NSW flow, sees a 32% reduction in the peak and 55% reduction in total volume for the 2004 event compared to previous events of similar magnitude.

No attempt has been made to rigorously analyse changes in **duration** of events. As illustrated by **Tables 1a** to **7a,** the duration of events at St George ranged from 27 to 64 days, while the average duration of each event across the NSW stations ranged from about 31 to 57 days. Of interest is a comparison of the relativity between average duration of flow in NSW compared to duration at St George. For all events up to 1997, the average duration of flow in NSW was 72% to 112% of the duration at St George. However, for the 2004 event it was 162%, reflecting the relatively short duration of the event at St George, possibly due to upstream extractions. (see **Figure 1**)

The 1988 event compared to the 2004 event

The above dramatic declines in flow peaks and volumes entering NSW are consistent with the assessed change in floodplain inundation (**Table 9**). The total inundated area (NSW and QLD) declined from nearly 320,000Ha in 1988 to about 60,000Ha in 2004, about an 80% decline. The biggest decline was in NSW (88%).

While part of this decline could be attributed to differences in the shape of the hydrograph, as well as antecedent conditions and local rainfall, the change in the relative magnitude of peaks and total flow would account for most of the impact.

An analysis of the data from **Table 3a** and **Table 8**, show that, from the 1988 to the 2004 event, the peak flows dropped from 2-12% (average 6.25%) to 2-5% (average 3.75%) of the St George peak and the volume at each NSW station dropped from 3-26% (average 11.5%) to 2-10% (average 5.25%) of the volume at St George. These correlate to 40% and 54% reductions respectively. Again the largest contribution is the Culgoa with its peak and volume relative to those at St George dropping by about 60%.

Comparing annual volumes

A comparison of annual flows for the period 1972-2003 assists in identifying trends that may or may not be evident (or can be confidently concluded given the data deficiencies) in the above analyses of individual events. (see **Tables 10-15** and **Figure 3**)

Although 32 years is not a long data set, 4 episodes of wet years followed by very dry years is evident (**Figure 3**). 2001-2003 is the last of these dry sequences. As could be expected, the flow to NSW as a percentage of the St George annual volume, is less in these dry years, and this share appears to be declining. As illustrated in **Table 11** the collective flow across the 4 NSW gauging stations declined from 89% of the total (3-year) flow at St George in 1978-80 to just 24% in 2002-03 – a relative reduction of 73%.

Although a greater proportion of flow in the wetter years crosses the border, as **Table 12** illustrates there is still a significant decline in this share. The NSW 3-year total flow was 91% of the flow at St George over 1975-77, but only 46% over 1996-98 – a relative reduction of 49%.

Over all 32 years, comparing the first 17 years (1972-88) to the next 15 years (1989-2003) further confirms this trend in share of flow to NSW – from 75% to 51% (**Table 13**). NSW has received 32% less water for the past 15 years compared to the share received from 1972 to 1988. The table shows this reduction occurs across each of the NSW rivers. However, as with the analysis of individual events, the share of annual flow volumes has decline most markedly in the Culgoa, down from 45% to 27% of the St George volumes – a 40% reduction in the last 15 years.

This is reflected in the comparison of relative shares of the cross border flow in **Tables 14** and **15**. Although the Culgoa still receives over half the water that enters NSW, its share has declined from 59% over 1972-88 to 54% over the last 15 years. The Bokhara has also declined while the relative shares to the Narran and Birrie have increased.

5.0 Conclusion

This analysis confirms the claims made over many years by NSW landholders that less and less water is getting across the border. The relative share of individual flood events with peaks around 60,000ML/d at St George have declined from an average of over 50% up to 1997 to only 20% in the 2004 event. This decline is also reflected in peak attenuation and reduction in beneficial flooding. A comparison of the 1988 event with the 2004 event shows that a 54% drop in the relative share of the volume results in an 88% reduction in the flooded area in NSW – some 140,000Ha.

The declining trend is clear from the annual flow volumes. As could be expected, a lower proportion of the flow crosses the border in low flow years than in high flow years. However, on average NSW received 32% less water in the last 15 years compared to the first 17 years for the period 1972-2003.

The declining trend mirrors the increasing trend in capacity of on-farm storages (**Figure 11**) and one can only conclude, that unless there is a major clawback in water diversions in Queensland, the future trend will be similar to that observed with the recent January 2004 event.

Department of Infrastructure, Planning and Natural Resources
–––– Far West Region ––––

River flow and floodplain inundation impacts of current water resource development in the lower Condamine-Balonne.

Appendix 1

Tables 1a - 15

FINAL VERSION

23 April 2004

Table 1a: Comparing Feb 1997 with 2004 event

Event / Statistic	**St George**	**Narran R. @ New Angledool**	**Bokhara R. @ Goodooga**	**Birrie R. @ Goodooga**	**Culgoa R. @ Brenda**	**Total X border**
	GS422201E	**GS422012**	**GS422014**	**GS422013**	**GS422015**	
January 2004						
Flow Peak (date)	22/1/04	2/2/04	3/2/04	3/2/04	7/2/04	
Flow Peak (ML/d)	65822	3295	1031	1683	3110	
Flow Duration (days)	27	44	44	44	43	
Flow Volume (GL)	524	32	11	14	50	107
Relative distr. of total volume (%)	100	6	2	3	10	20
February 1997						
Flow Peak (Date)	20/2/97	5/3/97	9/3/97	9/3/97	11/3/97	
Flow Peak (ML/d)	58596	5320	1411	2912	10277	
Flow Duration (days)	31	27	31	31	37	
Flow Volume (GL)	558	71	24	28	211	334
Relative distr. of total volume (%)	100	13	4	5	38	60
Difference in peak 1997 - 2004 (%)	+12	-38	-27	-42	-70	
Difference in volume 1997 - 2004 (%)	-6	-55	-54	-50	-76	-68

Table 1b: Events with peak discharge >1000ML/d in the 12 months prior to Jan 2004

Peak @ St George (ML/day)	Date	Time to next event# (Days)	Total time to Jan 2004 event (Days)
17442	20/4/03	277	
1011	20/12/01	486	763
# Lapse time calculated peak to peak			

Table 1c: Events with peak discharge >1000ML/d in the period prior to Feb 1997

Peak @ St George (ML/day)	Date	Time to next event# (Days)	Total time to Feb 1997 event (Days)
1294	11/6/96	254	
128019	21/5/96	21	275
8573	7/2/96	104	379
160669	20/1/96	18	397
# Lapse time calculated peak to peak			

Table 2a: Comparing March 1994 with 2004 event

Event / Statistic	St George	Narran R. @ New Angledool	Bokhara R. @ Goodooga	Birrie R. @ Goodooga	Culgoa R. @ Brenda	Total X border
	GS422201E	**GS422012**	**GS422014**	**GS422013**	**GS422015**	
January 2004						
Flow Peak (date)	22/1/04	2/2/04	3/2/04	3/2/04	7/2/04	
Flow Peak (ML/d)	65822	3295	1031	1683	3110	
Flow Duration (days)	27	44	44	44	43	
Flow Volume (GL)	524	32	11	14	50	107
Relative distr. of total volume (%)	100	6	2	3	10	20
March 1994						
Flow Peak (Date)	14/3/94	30/3/94	31/3/94	1/4/94	31/3/94	
Flow Peak (ML/d)	65211	5825	274	2515	13630	
Flow Duration (days)	64	65	17	65	81	
Flow Volume (GL)	843	125	2	39	238	404
Relative distr. of total volume (%)	100	15	0.2	5	28	48
Difference in peak 1994 - 2004 (%)	+1	-43	+276	-33	-77	
Difference in volume 1994 - 2004 (%)	-38	-74	+450	-64	-79	-74

Table 2b: Events with peak discharge >1000ML/d in the period prior to March 1994

Peak @ St George (ML/day)	Date	Time to next event# (Days)	Total time to Mar 1994 event (Days)
4468	29/12/93	75	
45203	14/12/94	15	90
8090	5/3/92	649	739
# Lapse time calculated peak to peak			

Table 3a: Comparing 1988 with 2004 event

Event / Statistic	**St George**	**Narran R. @ New Angledool**	**Bokhara R. @ Goodooga**	**Birrie R. @ Goodooga**	**Culgoa R. @ Brenda**	**Total X border**
	GS422201E	**GS422012**	**GS422014**	**GS422013**	**GS422015**	
January 2004						
Flow Peak (date)	22/1/04	2/2/04	3/2/04	3/2/04	7/2/04	
Flow Peak (ML/d)	65822	3295	1031	1683	3110	
Flow Duration (days)	27	44	44	44	43	
Flow Volume (GL)	524	32	11	14	50	107
Relative distr. of total volume (%)	100	6	2	3	10	20
March 1988						
Flow Peak (Date)	4/3/88	15/3/88	17/3/88	17/3/88	17/3/88	
Flow Peak (ML/d)	71133	4971	1488	3180	8185	
Flow Duration (days)	47	35	55	29	38	
Flow Volume (GL)	595	69	16	27	153	265
Relative distr. of total volume (%)	100	12	3	5	26	45
Difference in peak 1988 - 2004 (%)	-7	-34	-31	-47	-62	
Difference in volume 1988 - 2004 (%)	-12	-54	-31	-48	-67	-60

Table 3b: Events with peak discharge >1000ML/d in the 12 months prior to March 1988

Peak @ St George (ML/day)	Date	Time to next event# (Days)	Total time to Mar 1988 event (Days)
6795	13/12/87	82	
3732	13/12/85	730	812

Lapse time calculated peak to peak

Table 4a: Comparing 1982 with 2004 event

Event / Statistic	**St George**	**Narran R. @ New Angledool**	**Bokhara R. @ Goodooga**	**Birrie R. @ Goodooga**	**Culgoa R. @ Brenda**	**Total X border**
	GS422201E	**GS422012**	**GS422014**	**GS422013**	**GS422015**	
January 2004						
Flow Peak (date)	22/1/04	2/2/04	3/2/04	3/2/04	7/2/04	
Flow Peak (ML/d)	65822	3295	1031	1683	3110	
Flow Duration (days)	27	44	44	44	43	
Flow Volume (GL)	524	32	11	14	50	107
Relative distr. of total volume (%)	100	6	2	3	10	20
Mar-April 1982						
Flow Peak (Date)	7/3/82	23/3/82	24/3/82	24/3/82	29/3/82	
Flow Peak (ML/d)	82175	5642	2360	4054	12456	
Flow Duration (days)	55	52	53	51	47	
Flow Volume (GL)	630	117	31	62	266	476
Relative distr. of total volume (%)	100	19	5	10	42	75
Difference in peak 1982 - 2004 (%)	-20	-42	-56	-58	-75	
Difference in volume 1982 - 2004 (%)	-17	-73	-66	-77	-81	-78

Table 4b: Events with peak discharge >1000ML/d in the 12 months prior to March 1982

Peak @ St George (ML/day)	Date	Time to next event# (Days)	Total time to Mar 1982 event (Days)
19067	25/1/82	41	
7520	4/1/82	21	62
8634	17/12/81	18	80
2880	10/11/81	37	117
2597	7/8/81	95	212

54320	6/6/81	62	274
11338	14/4/81	53	327
74286	22/2/81	51	378
# Lapse time calculated peak to peak			

Table 5a: Comparing 1981 with 2004 event

Event / Statistic	**St George**	**Narran R. @ New Angledool**	**Bokhara R. @ Goodooga**	**Birrie R. @ Goodooga**	**Culgoa R. @ Brenda**	**Total X border**
	GS422201E	**GS422012**	**GS422014**	**GS422013**	**GS422015**	
January 2004						
Flow Peak (date)	22/1/04	2/2/04	3/2/04	3/2/04	7/2/04	
Flow Peak (ML/d)	65822	3295	1031	1683	3110	
Flow Duration (days)	27	44	44	44	43	
Flow Volume (GL)	524	32	11	14	50	107
Relative distr. of total volume (%)	100	6	2	3	10	20
Feb-March 1981						
Flow Peak (Date)	22/2/81	5/3/81	7/3/81	7/3/81	7/3/81	
Flow Peak (ML/d)	74286	5189	1590	2933	8685	
Flow Duration (days)	46	54	49	50	54	
Flow Volume (GL)	535	59	19	29	126	233
Relative distr. of total volume (%)	100	11	4	5	24	44
Difference in peak 1981 - 2004 (%)	-11	-37	-35	-43	-64	
Difference in volume 1981 - 2004 (%)	-2	-46	-42	-52	-60	-54

Table 5b: Events with peak discharge >1000ML/d in the 12 months prior to Feb 1981

Peak @ St George (ML/day)	Date	Time to next event# (Days)	Total time to Feb 1981 event (Days)
3284	4/7/79	599	
9276	12/3/79	114	713

Lapse time calculated peak to peak

Table 6a: Comparing 1975/76 with 2004 event

Event / Statistic	**St George**	**Narran R. @ New Angledool**	**Bokhara R. @ Goodooga**	**Birrie R. @ Goodooga**	**Culgoa R. @ Brenda**	**Total X border**
	GS422201E	**GS422012**	**GS422014**	**GS422013**	**GS422015**	
January 2004						
Flow Peak (date)	22/1/04	2/2/04	3/2/04	3/2/04	7/2/04	
Flow Peak (ML/d)	65822	3295	1031	1683	3110	
Flow Duration (days)	27	44	44	44	43	
Flow Volume (GL)	524	32	11	14	50	107
Relative distr. of total volume (%)	100	6	2	3	10	20
Dec 75-Jan 1976						
Flow Peak (Date)	10/1/76	21/1/76	23/1/76	21/1/76*	24/1/76	
Flow Peak (ML/d)	77537	5790	2293	3472	15175	
Flow Duration (days)	42	25	27	32	37	
Flow Volume (GL)	844	95	31	27	262	415
Relative distr. of total volume (%)	100	11	4	3	31	49
Difference in peak 1976 - 2004 (%)	-15	-43	-55	-52	-80	
Difference in volume 1976 - 2004 (%)	-38	-66	-66	-48	-81	-74

* Data missing for Birrie GS

Table 6b: Events with peak discharge >1000ML/d in the 12 months prior to Jan 1976

Peak @ St George (ML/day)	Date	Time to next event# (Days)	Total time to Jan 1976 event (Days)
3514	23/11/75	48	
4432	6/11/75	17	65
3450	13/9/75	54	119
2790	14/4/75	152	271
8393	30/3/75	15	286
12378	2/3/75	28	314

18955	16/1/75	45	359
# Lapse time calculated peak to peak			

Table 7a: Comparing 1971/72 with 2004 event

Event / Statistic	**St George**	**Narran R. @ New Angledool**	**Bokhara R. @ Goodooga**	**Birrie R. @ Goodooga**	**Culgoa R. @ Brenda**	**Total X border**
	GS422201E	**GS422012**	**GS422014**	**GS422013**	**GS422015**	
January 2004						
Flow Peak (date)	22/1/04	2/2/04	3/2/04	3/2/04	7/2/04	
Flow Peak (ML/d)	65822	3295	1031	1683	3110	
Flow Duration (days)	27	44	44	44	43	
Flow Volume (GL)	524	32	11	14	50	107
Relative distr. of total volume (%)	100	6	2	3	10	20
Dec 71-Jan 1972						
Flow Peak (Date)	1/1/72	21/1/72	22/1/72	22/1/72	21/1/72	
Flow Peak (ML/d)	97952	6317	3629	4924	20741	
Flow Duration (days)	56	55	39	48	53	
Flow Volume (GL)	1066	126	41	62	343	572
Relative distr. of total volume (%)	100	12	4	6	32	54
Difference in peak 1972 - 2004 (%)	-33	-48	-72	-66	-85	
Difference in volume 1972 - 2004 (%)	-51	-75	-73	-77	-85	-81

Table 7b: Events with peak discharge >1000ML/d in the 12 months prior to Jan 1972

Peak @ St George (ML/day)	Date	Time to next event# (Days)	Total time to Jan 1972 event (Days)
1866	18/10/71	75	
117883	23/2/71	237	312
43460	6/1/71	48	360
102490	20/12/70	17	377
# Lapse time calculated peak to peak			

Table 8: Summary of changes to peak flow and total volume for selected flood events – 1972-2004

Event	**St George (JTW) - GS422201E**		**Narran R. @ New Angledool - GS422012**		**Bokhara R. @ Goodooga - GS422014**		**Birrie R. @ Goodooga - GS422013**		**Culgoa R. @ Brenda - GS422015**		**Total NSW volume rel to JTW (%)**
	Flow Peak (ML/d)	Flow Volume (GL)	Relative to JTW		Relative to JTW		Relative to JTW		Relative to JTW		
			Peak (%)	Volume (%)	Peak (%)	Volume (%)	Peak (%)	Volume (%)	Peak (%)	Volume (%)	
January 2004	65822	524	5	6	2	2	3	3	5	10	20
February 1997	58596	558	9	13	2	4	5	5	18	38	60
March 1994	65211	843	9	15	0.4	0.2	4	5	21	28	48
March 1988	71133	595	7	12	2	3	4	5	12	26	45
Mar-April 1982	82175	630	7	19	3	5	5	10	15	42	75
Feb-March 1981	74286	535	7	11	2	4	4	5	12	24	44
Dec 75-Jan 1976	77537	844	7	11	3	4	4	3	20	31	49
Dec 71-Jan 1972	97952	1066	6	12	4	4	5	6	21	32	54

Table 9: Results of remote sensing analysis – 1988 and 2004 events

	Location	Flooded area (Ha)	Storages (Ha)	Total inundation (Ha)
26 March 1988 image analysis	QLD	153 687	1 365	155 052
	NSW	160 182	2 614	162 796
	Total	**313 869**	**3 979**	**317 848**
19 February 2004 image analysis	QLD	31 376	11 097	42 473
	NSW	17 794	2 108	19 902
	Total	**49 170**	**13 205**	**62 375**
Change in areas 1988 - 2004	QLD	- 80%	+ 713%	- 73%
	NSW	- 89%	- 19%	- 88%
	Total	**- 84%**	**+ 232%**	**- 80%**

<u>Notes:</u>

1. The analysis used Landsat 5 images captured on the 26 March 1988 (22 days post peak at St George) and 19 Feb 2004 (29 days post peak at St George.)
2. The analysis only differentiated areas greater than 4 x 25m Pixels (0.25 Ha) in order to avoid localised noise in the dataset.
3. The Flooded area was calculated from the soil wetness index (Landsat band 5 minus Landsat band 2).
4. The Storage area was calculated from the water reflectance index (Landsat band 2 minus Landsat band 4).
5. Once generated, the two indexes were used in the following manner:
    - Flooding area = (Soil Wetness Index - Water Reflectance Index) < 60
    - Storage area = (Water Reflectance Index - Soil Wetness Index) < 60

6. It should be noted that the selection of these thresholds is based on a visual analysis of the imagery, and was consistent with date.
7. The difference between the two classes (Flooded area and Storages) is mainly related to water depth, with the deeper water areas (namely rivers, storages and swamps/lakes) separable on this characteristic. Shallow water such as overbank flow or bunding, will be identified as flooding, as the water tends to be shallower, hence spectrally dissimilar to the deeper storages.

Table 10: Annual flow volumes for St George and NSW stations – 1972-2003

	St George GS 422201E	Narran GS 422 012		Bokhara GS 422014		Birrie GS 422013		Culgoa GS 422015		NSW	
	Annual flow	Annual flow	%	Annual flow	%	Annual flow	%	Annual flow	%	Annual flow	%
YEAR	GL	GL	% of St George	GL	% of St George	GL	% of St George	GL	% of St George	GL	% of St George
1972	1454	218	15	53	4	89	6	579	40	939	65
1973	382	55	14	1	0	5	1	305	80	365	96
1974	1506	340	23	199	13	252	17	915	61	1705	113
1975	609	113	19	30	5	33	5	280	46	456	75
1976	2194	540	25	110	5	98	4	1622	74	2370	108
1977	1004	141	14	57	6	86	9	341	34	626	62
1978	595	117	20	46	8	51	9	267	45	480	81
1979	131	15	12	10	8	14	11	47	36	86	66
1980	44	3	8	0	0	1	3	7	16	12	27
1981	1172	158	13	60	5	87	7	417	36	722	62
1982	847	168	20	36	4	62	7	414	49	680	80
1983	7385	759	10	506	7	761	10	2767	37	4794	65
1984	2573	377	15	197	8	291	11	1175	46	2040	79
1985	107	9	8	4	4	3	3	30	28	46	43
1986	24	0	0	0	0	0	0	11	46	11	46
1987	95	6	7	3	3	2	2	16	17	27	29
1988	3030	430	14	187	6	248	8	1116	37	1981	65
1989	1307	254	19	62	5	61	5	465	36	841	64
1990	2011	295	15	158	8	230	11	805	40	1488	74
1991	151	10	7	1	1	2	1	51	33	64	42
1992	105	7	7	0	0	6	6	4	4	17	17
1993	270	26	10	0	0	1	0	34	12	61	22
1994	857	127	15	2	0	40	5	243	28	412	48
1995	503	69	14	0	0	7	1	112	22	188	37
1996	3614	387	11	34	1	220	6	929	26	1570	43
1997	951	136	14	45	5	52	5	298	31	531	56
1998	1764	236	13	99	6	137	8	359	20	831	47
1999	986	148	15	46	5	62	6	184	19	439	45
2000	433	45	10	21	5	24	5	63	15	153	35
2001	44	0	0	0	0	0	0	1	3	2	3
2002	41	4	9	3	8	3	7	2	4	12	28
2003	89	3	4	4	5	5	6	14	15	27	30

Table 11: Dry years' annual flow volumes for St George and NSW stations – 1972-2003

3-year dry sequence	St George GS 422201E	Narran GS 422 012		Bokhara GS 422014		Birrie GS 422013		Culgoa GS 422015		NSW	
	Total flow	Total flow	%	Total flow	%	Total flow	%	Total flow	%	Total flow	%
1978-80	652	135	21	56	9	66	10	321	49	578	89
1985-87	226	15	7	7	3	5	2	57	25	84	37
1991-93	526	43	8	1	0.2	9	2	89	17	142	27
2001-03	174	7	4	7	4	8	5	17	10	41	24

Table 12: Wet years' annual flow volumes for St George and NSW stations – 1972-2003

3-year wet sequence	St George GS 422201E	Narran GS 422 012		Bokhara GS 422014		Birrie GS 422013		Culgoa GS 422015		NSW	
	Total flow	Total flow	%	Total flow	%	Total flow	%	Total flow	%	Total flow	%
1975-77	0	434	21	422014	5	422013	6	422015	59	0	91
1982-84	0	434	12	422014	7	422013	10	422015	40	0	70
1988-90	0	868	15	844028	6	844026	8	844030	38	0	68
1996-98	0	1736	12	1688056	3	1688052	6	1688060	25	0	46

Table 13: All years' annual flow volumes for St George and NSW stations – 1972-2003

Period	St George GS 422201E	Narran GS 422 012		Bokhara GS 422014		Birrie GS 422013		Culgoa GS 422015		NSW	
	Total flow	Total flow	%	Total flow	%	Total flow	%	Total flow	%	Total flow	%
1972-88	0	434	15	422014	6	422013	9	422015	45	0	75
1989-03	0	434	13	422014	4	422013	6	422015	27	0	51
1972-03	0	868	14	844028	5	844026	8	844030	38	0	66

Table 14: Distribution of annual flow volumes in NSW – 1972-2003

	Total Flow to NSW	Narran		Bokhara		Birrie		Culgoa	
Year	**GL**	**GL**	%	**GL**	%	**GL**	%	**GL**	%
1972	939	218	23	53	6	89	10	579	62
1973	365	55	15	1	0	5	1	305	83
1974	1705	340	20	199	12	252	15	915	54
1975	456	113	25	30	7	33	7	280	62
1976	2370	540	23	110	5	98	4	1622	68
1977	626	141	23	57	9	86	14	341	55
1978	480	117	24	46	10	51	11	267	56
1979	86	15	18	10	12	14	16	47	54
1980	12	3	28	0	2	1	9	7	61
1981	722	158	22	60	8	87	12	417	58
1982	680	168	25	36	5	62	9	414	61
1983	4794	759	16	506	11	761	16	2767	58
1984	2040	377	18	197	10	291	14	1175	58
1985	46	9	19	4	9	3	7	30	65
1986	11	0	1	0	0	0	0	11	99
1987	27	6	23	3	11	2	7	16	59
1988	1981	430	22	187	9	248	13	1116	56
1989	841	254	30	62	7	61	7	465	55
1990	1488	295	20	158	11	230	15	805	54
1991	64	10	16	1	2	2	3	51	80
1992	17	7	40	0	0	6	36	4	24
1993	61	26	43	0	0	1	1	34	55
1994	412	127	31	2	1	40	10	243	59
1995	188	69	37	0	0	7	4	112	60
1996	1570	387	25	34	2	220	14	929	59
1997	531	136	26	45	9	52	10	298	56
1998	831	236	28	99	12	137	16	359	43
1999	439	148	34	46	10	62	14	184	42
2000	153	45	29	21	14	24	16	63	42
2001	2	0	0	0	2	0	0	1	98
2002	12	4	32	3	27	3	26	2	15
2003	27	3	13	4	16	5	19	14	52

Table 15: Average share of the cross border flow – 1972-2003

Period	**NSW**	**Narran**		**Bokhara**		**Birrie**		**Culgoa**	
	GL	*GL*	%	**GL**	%	**GL**	%	**GL**	%
1972-1988	17340	3449	20	1499	9	2083	12	10309	59
1989-2003	6636	1747	26	475	7	850	13	3564	54
All years	23976	5196	22	1974	8	2933	12	13873	58

Department of Infrastructure, Planning and Natural Resources
---- Far West Region ----

River flow and floodplain inundation impacts of current water resource development in the lower Condamine-Balonne.

Appendix 2

Figures 1 - 11

FINAL VERSION

23 April 2004

APPENDIX 2 - Figures

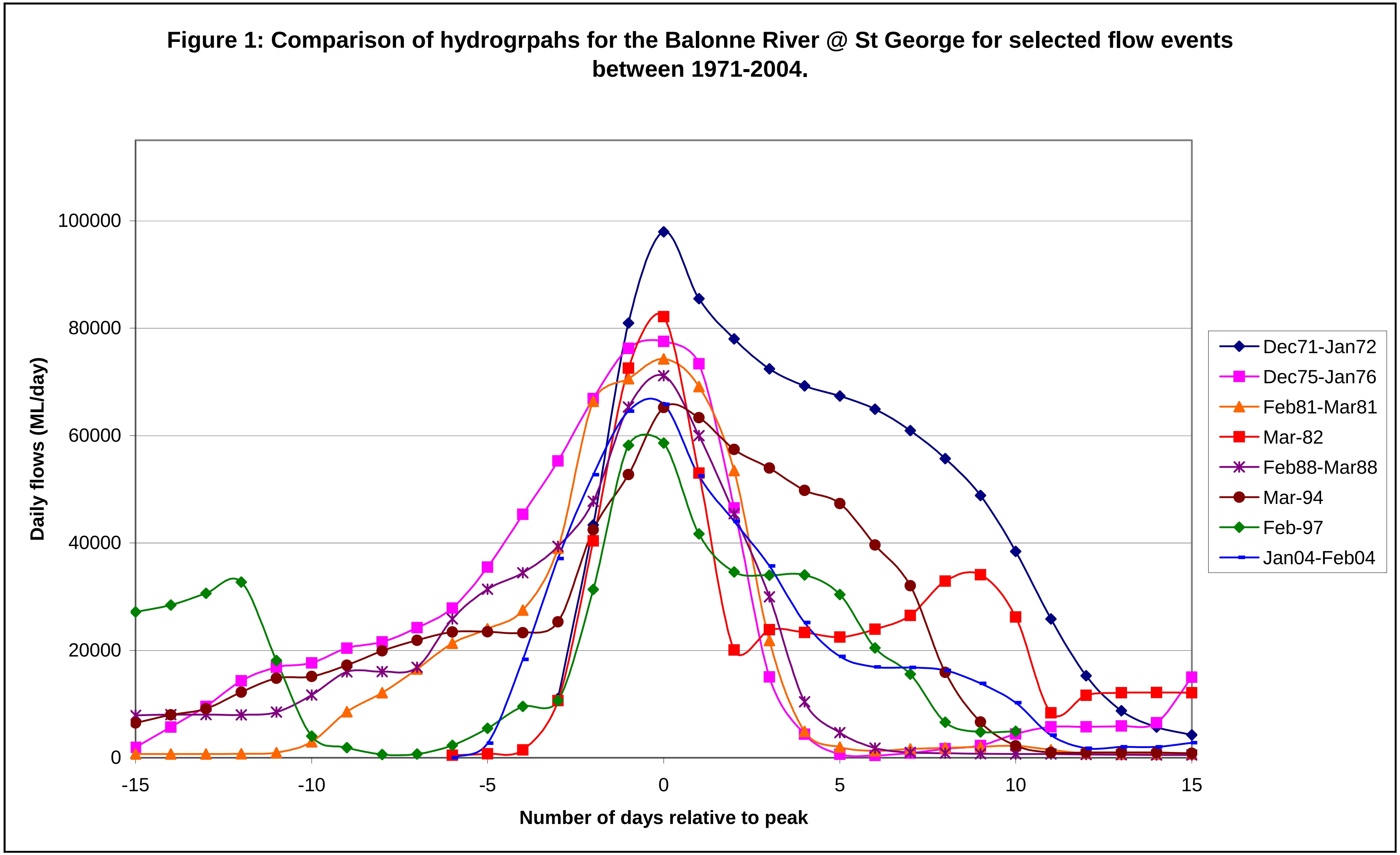
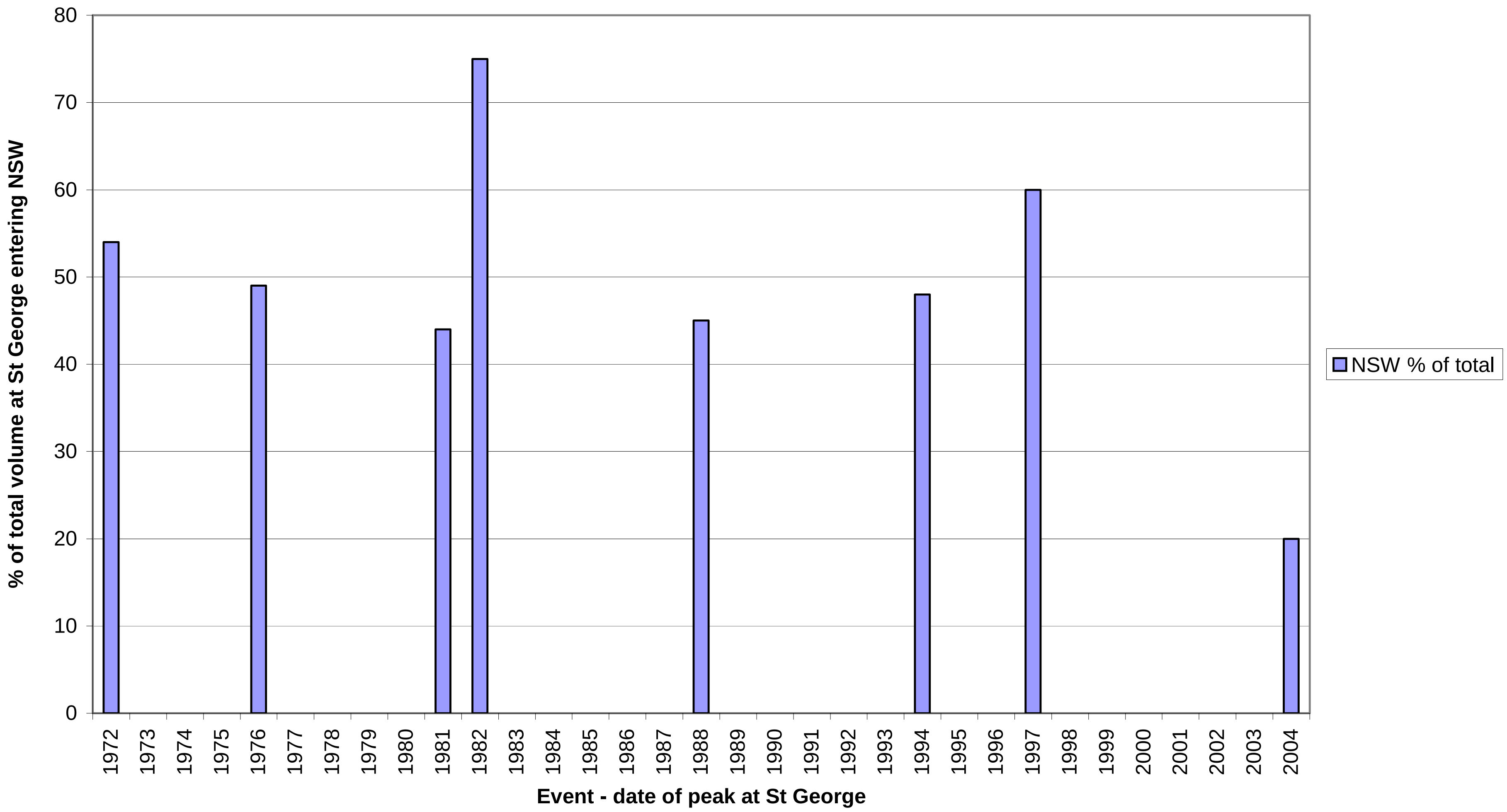


Figure 2: Comparing events similar to Jan 2004



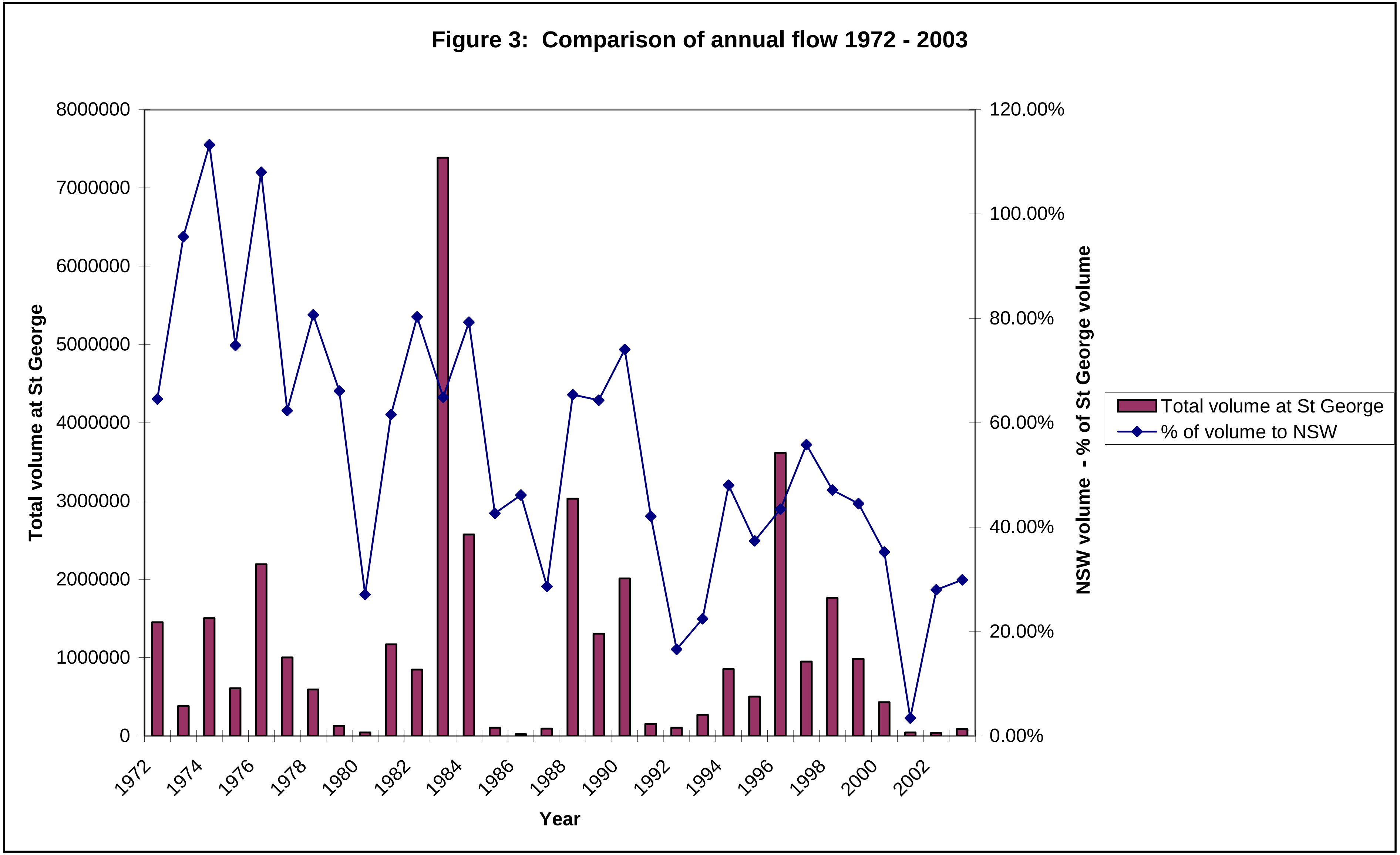


Figure 3: Comparison of annual flow 1972 - 2003
Total volume at St George
NSW volume - % of St George volume
Year
8000000
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
120.00%
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
Total volume at St George
% of volume to NSW

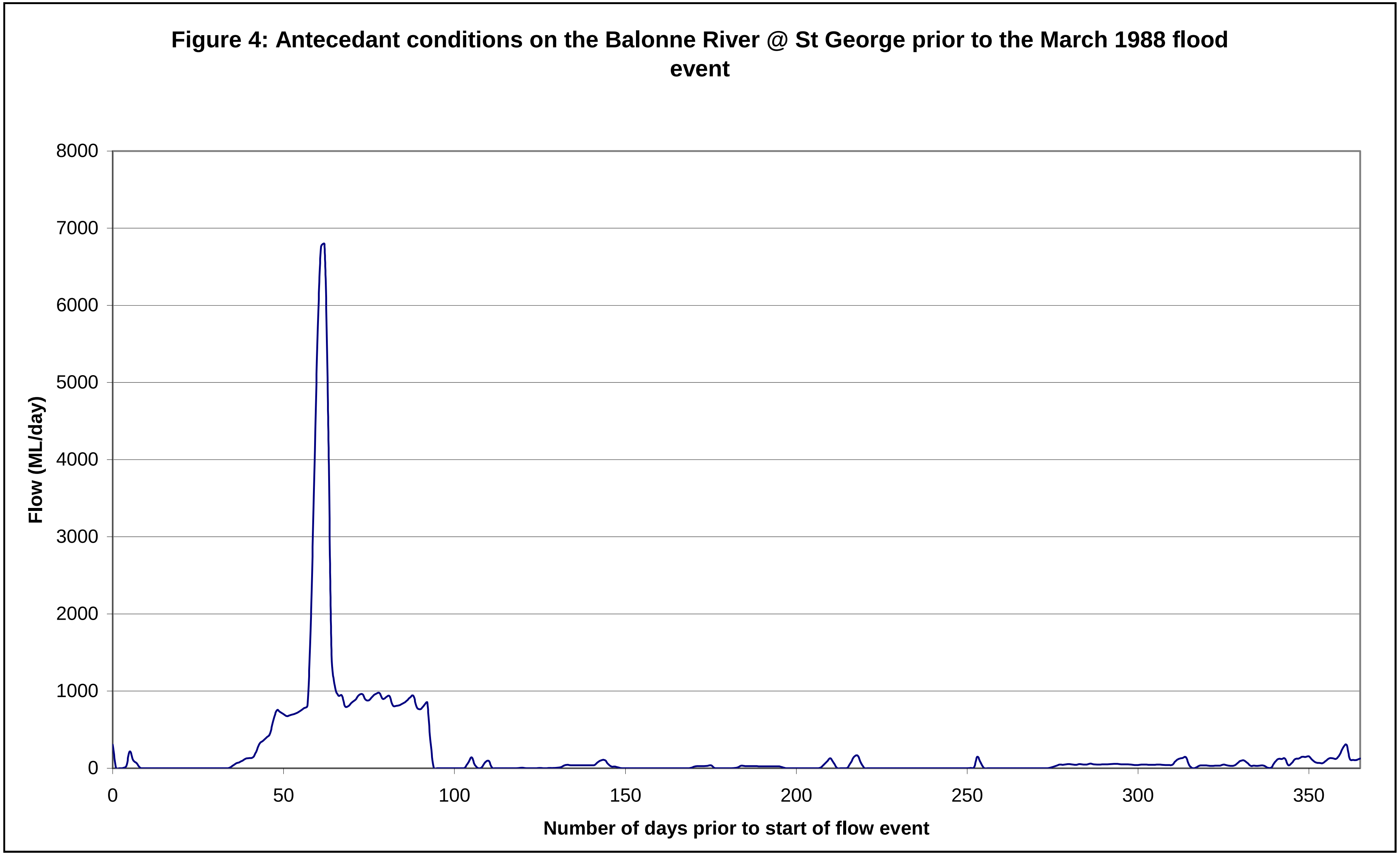


Figure 4: Antecedant conditions on the Balonne River @ St George prior to the March 1988 flood event
8000
7000
6000
5000
4000
3000
2000
1000
0
Flow (ML/day)
0
50
100
150
200
250
300
350
Number of days prior to start of flow event

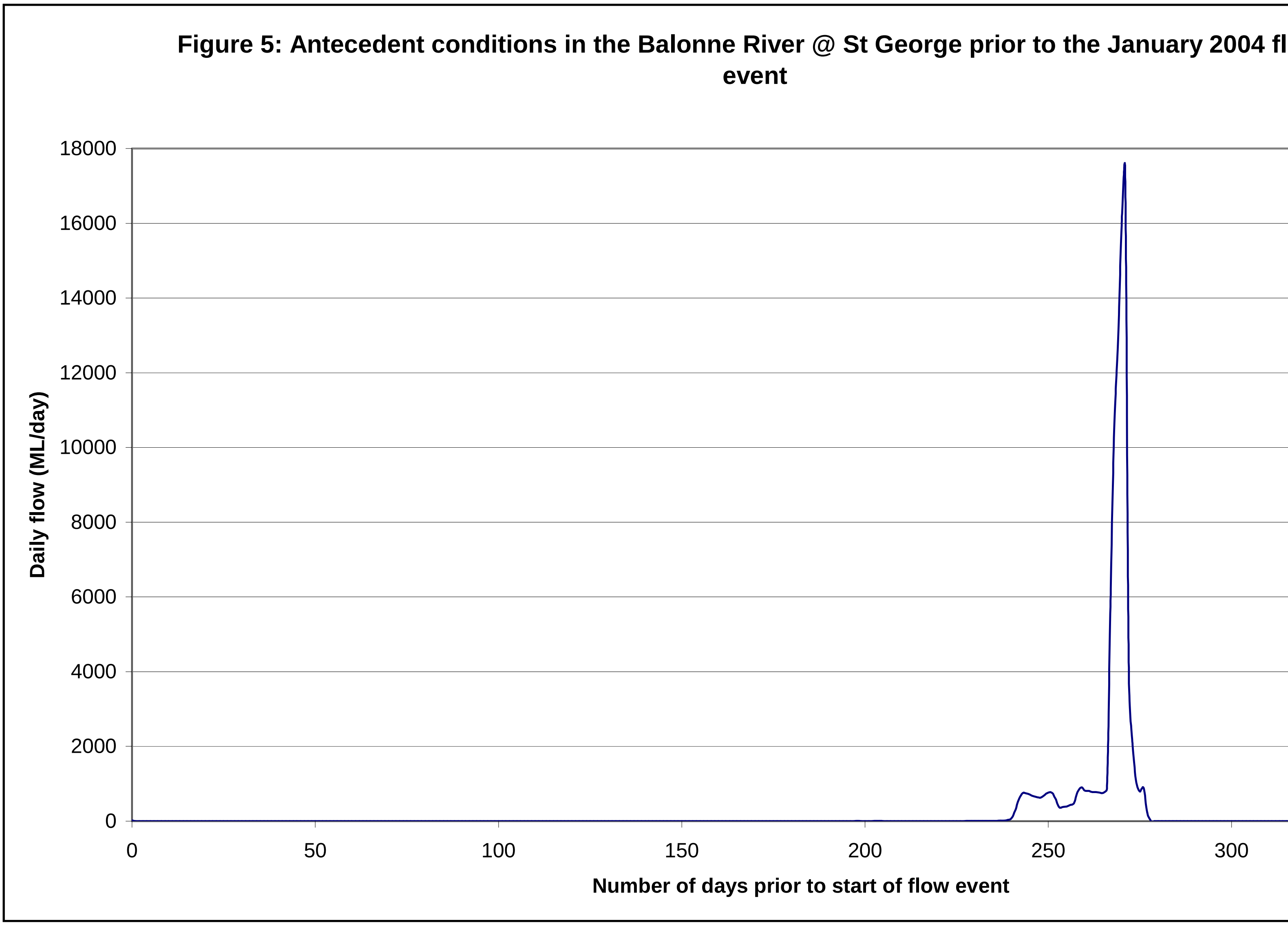


Figure 5: Antecedent conditions in the Balonne River @ St George prior to the January 2004 fl
event
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Daily flow (ML/day)
0
50
100
150
200
250
300
Number of days prior to start of flow event

Figure 6: Comparison of the hydrograph for the Balonne River @ St George with the Narran Riv Angledool (422030) for the 1988 and 2004 flow event

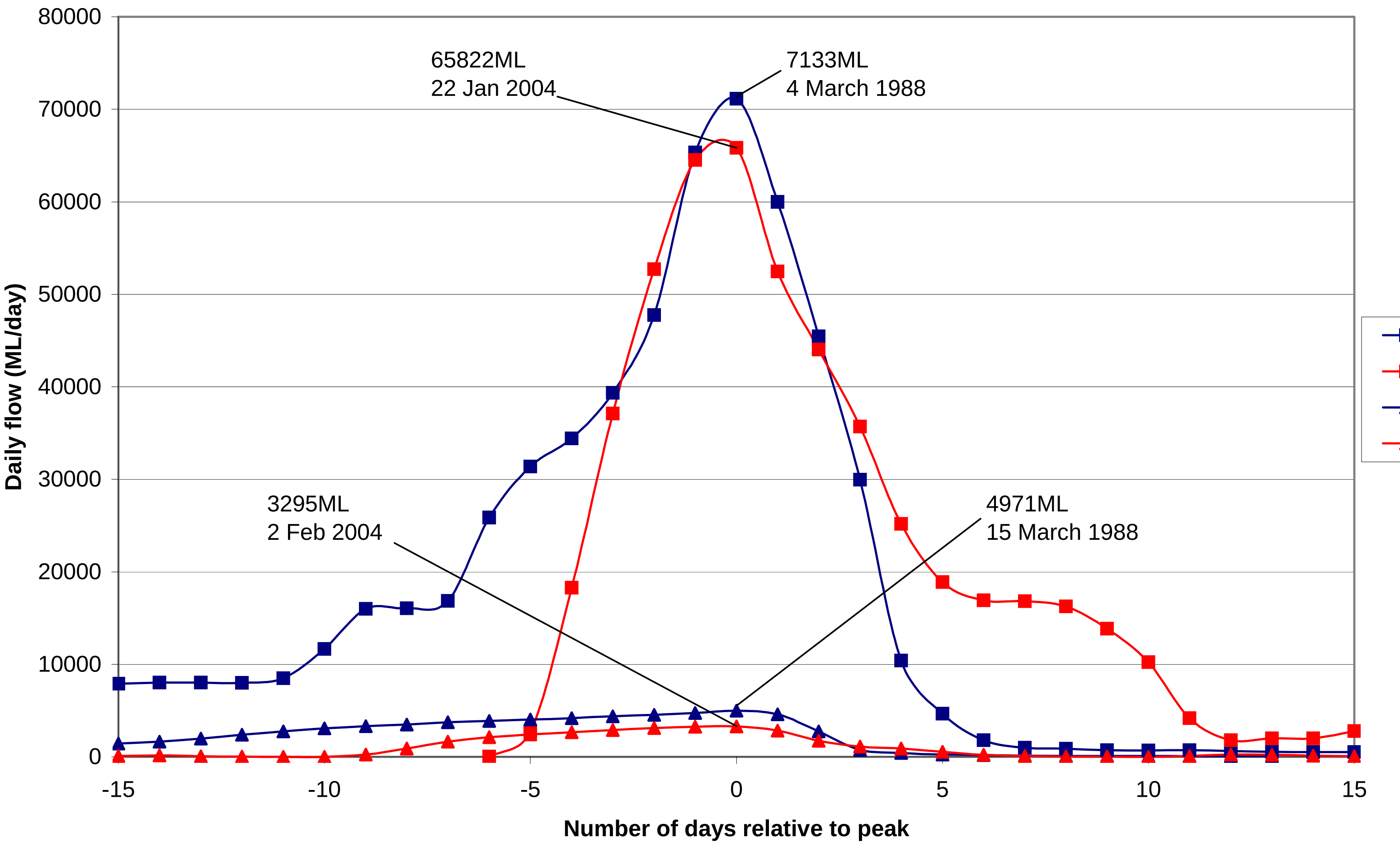


Figure 7: Comparison of the hydrograph for the Balonne River @ St George with the Bokhara R @ Goodooga (422014) for the 1988 and 2004 flow event

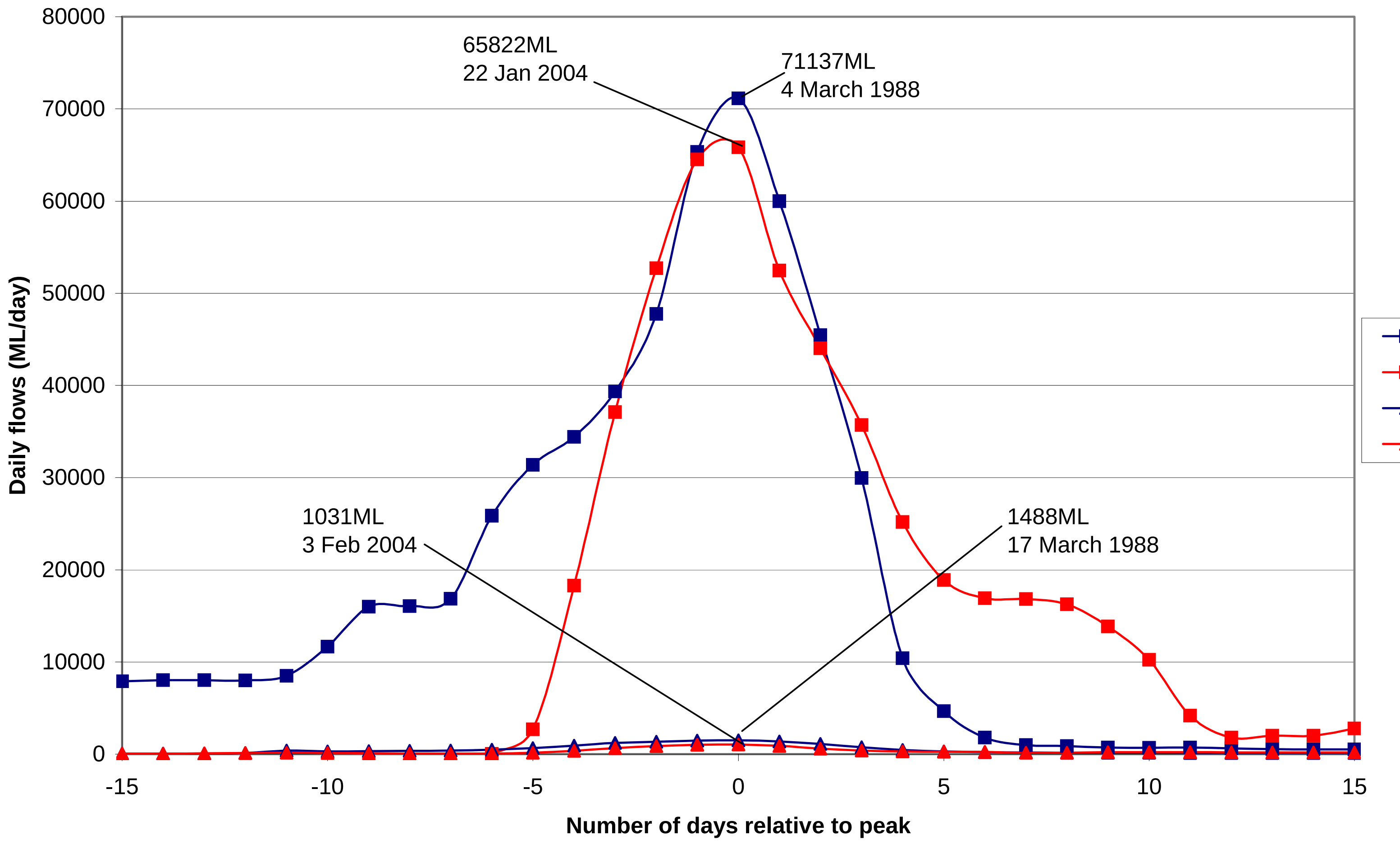


Figure 8: Comparison of the hydrograph for the Balonne River @ St George with the Birrie Rive Goodooga (422013) for the 1988 and 2004 flow event

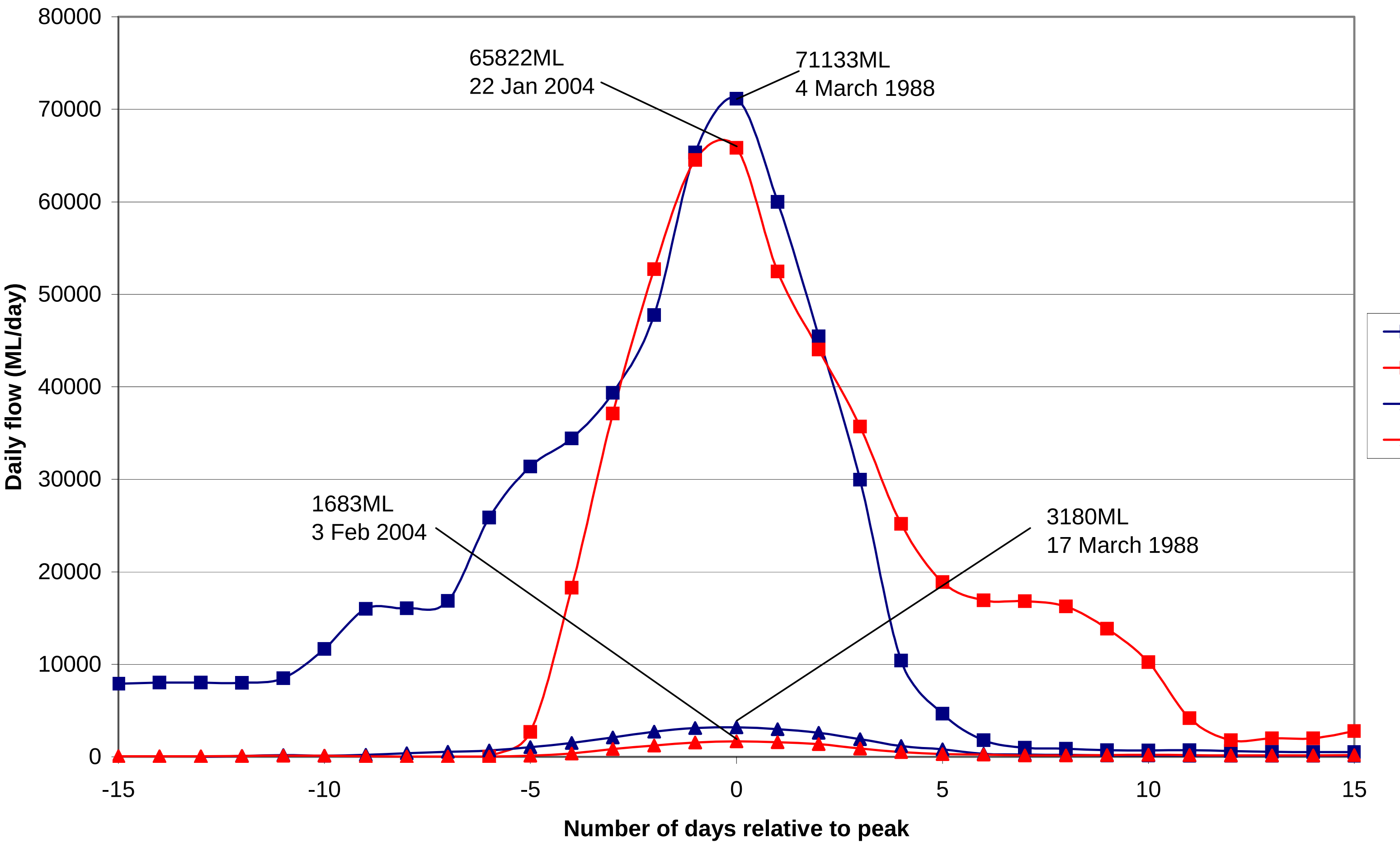


Figure 9: Comparison of the hydrograph for the Balonne River @ St George with the Culgoa Riv Brenda (422015) for the 1988 and 2004 flow event

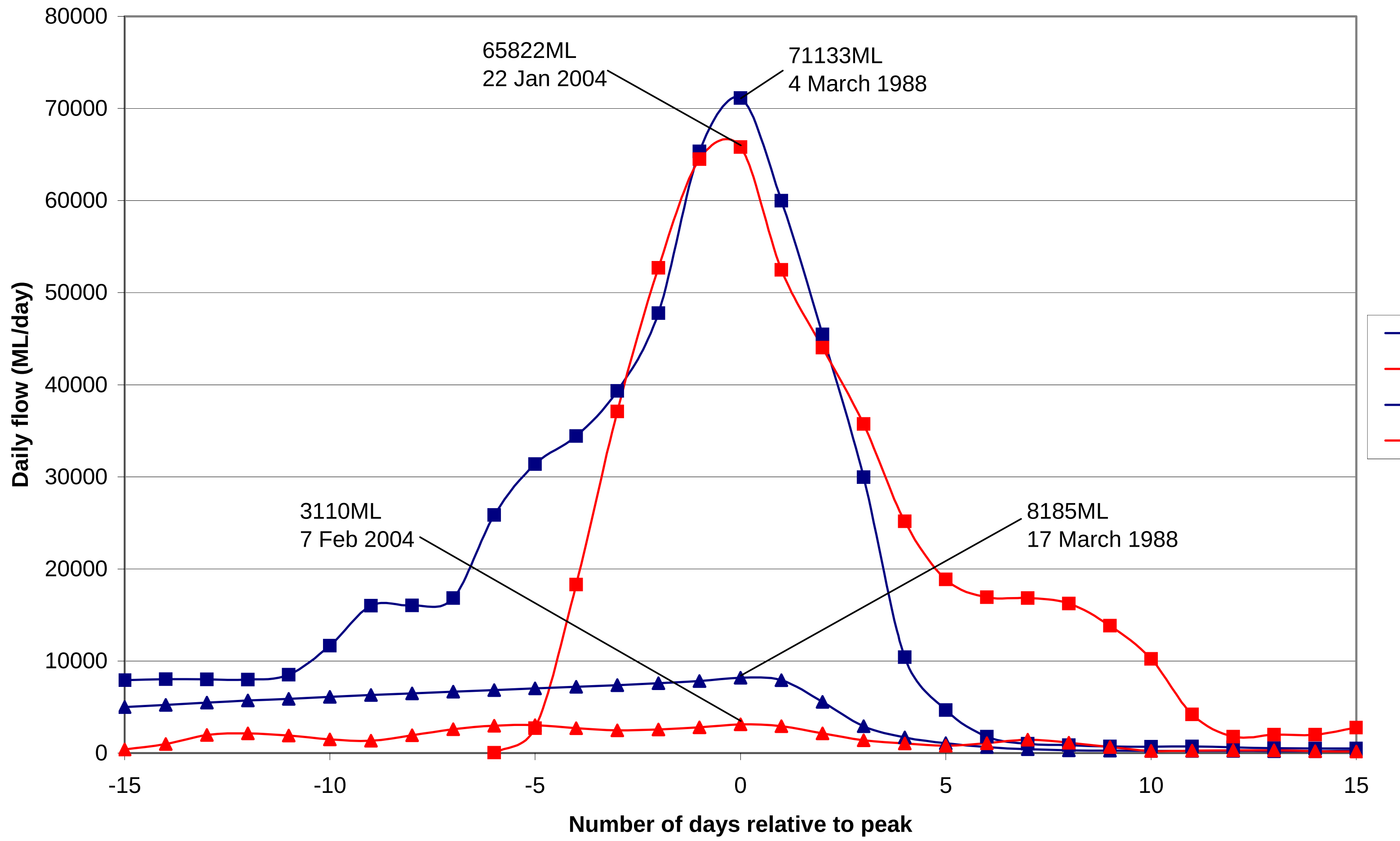


Figure 10: Comparison of hydrographs for the Balonne River @ St George with the cumulativ hydrograph for cross border flows for the 1988 and 2004 flow events

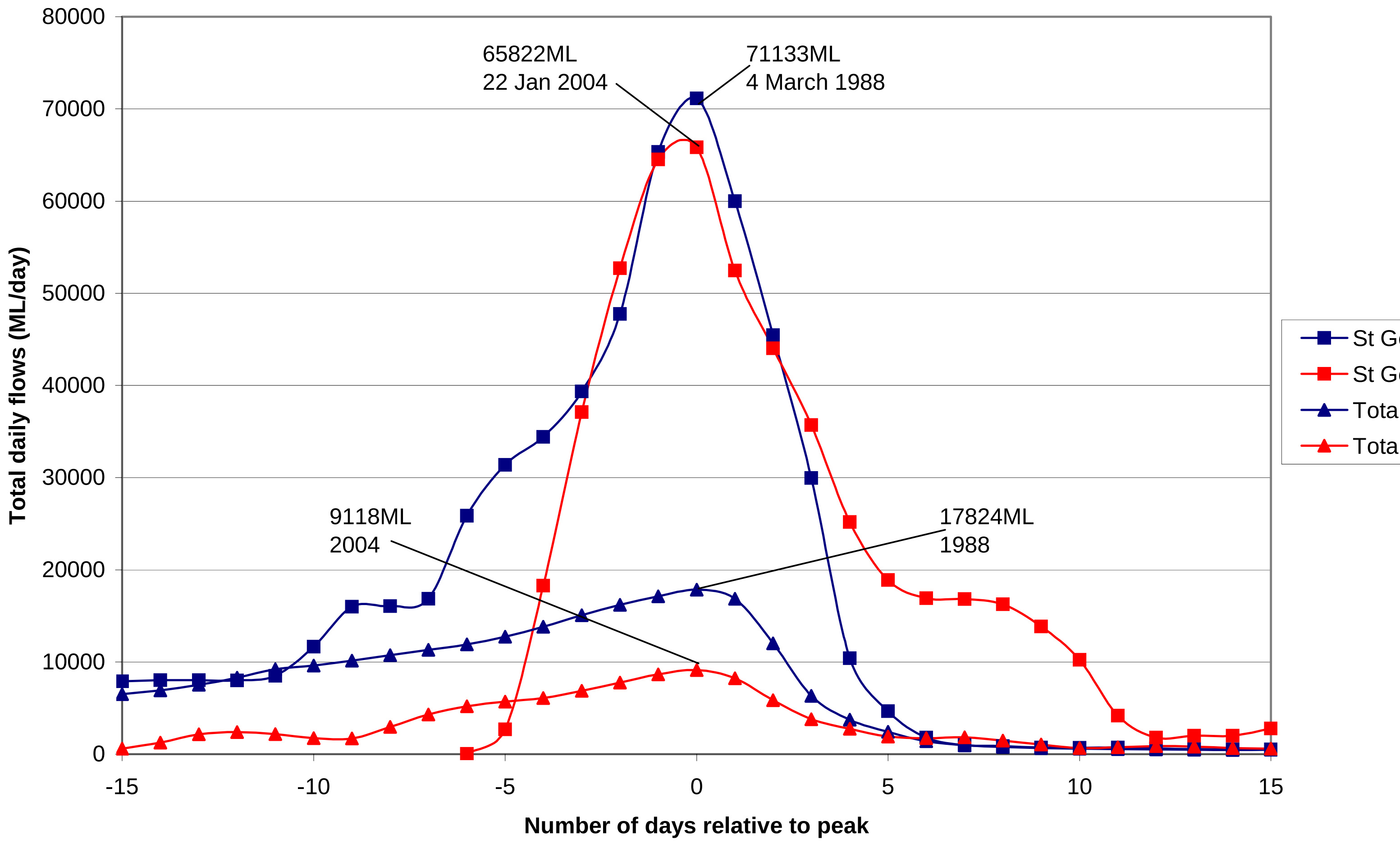


Figure 11: Capacity of on-farm storages in the Condamine-Balonne (including floodplain harver storages in the Upper Condamine)