Flooding Issues Questions and Responses Relating to the Decommissioning of Lake Mokoan December 2008

QUESTION 1.

It has been constantly stated by the Minister and Government agencies that the Nillahcootie/Mokoan system was not constructed with flood mitigation included as part of its objectives. This is clearly not true as there is much historical evidence refuting this statement (See attached references). The older residents of Benalla and District confirm that the installation of Nillahcootie, along with its original operating rules, was always meant to contribute to the mitigation of flooding. The passage of time has also cemented the acceptance by the community, and probably in a legal sense, that any flood mitigating advantages due to the existence of the 'System' is the right of the community to retain. Why is this not accepted by Government?

The primary function of the system has been to provide storage to meet irrigation demands in the Goulburn valley and stock, domestic and town requirements throughout the Broken Valley. The ability to transfer water out of Lake Nillahcootie to Lake Mokoan provided some flood mitigation benefits downstream of Lake Nillahcootie. This was recognised but not quantified in the 1963 Parliamentary Public Works Committee report that recommended the construction of both Winton Swamp Storage (Lake Mokoan) and Lake Nillahcootie. The Nillahcootie Flood Study has been commissioned to quantify the flood mitigation benefits of the lake.

QUESTION 2.

Lake Nillahcootie was designed to REGULATE the flows of the Broken River for both water harvesting (to Lake Mokoan) and for flood mitigation if operated as designed. A close examination of the storage records indicates that for a large proportion of the time these objectives were met between 1971 and 1990 whilst the weir was being operated to maintain air space during winter and spring. This evidence is confirmed by more senior local residents. Why can an alternative to the complete decommissioning of Lake Mokoan not be adopted which would retain the potential to operate Nillahcootie to regulate flows?

Lake Mokoan and Lake Nillahcootie were designed to work in tandem. The system was duly operated to achieve water harvesting objectives, and in doing so, potentially provided some flood mitigation benefits downstream as a result of available air space in Lake Nillahcootie.

The storage records confirm that water was transferred from Lake Nillahcootie to Lake Mokoan at appropriate times. However they do not quantify any resultant flood mitigation benefits to Benalla. Such benefits must include consideration of the storage level at Lake Nillahcootie immediately before the flood, as well as the amount of inflows into the Lake.

The answers to Q36 give a realistic reflection/quantitative measure of the impacts of changes to the operating rules (pre and post 1992) for known flood events at Benalla. The results show that the changes have no impact on the flood risk at Benalla for a repeat of the four largest floods since lake Nillahcootie was constructed The four floods and their average return intervals are as follows:

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- May 1974 (1 in 14 year flood)
- September 1975 (1 in 7 year flood)
- July 1981 (1 in 10 year flood)
- October 1993 (1 in 100 year flood)

The decision to decommission Lake Mokoan was made after considering a number of alternatives involving numerous modifications. The assessment of these alternatives showed that none were acceptable (see answer to Q 14).

QUESTION 3.
The Flow Regime Fact Sheet GBCMA July 2006 devalues the flood mitigation benefits of Lake Nillahcootie as it states that the catchment to Nillahcootie only commands 29% of the catchment to Benalla. But there are two separate catchments converging at Benalla (64% Broken, 36% Hollands) and it is the timing of the convergence which has a very great influence on the peak flows through Benalla and downstream. We are not convinced that this factor has been sufficiently taken into account in the flood mitigation influence of Nillahcootie. A delay in the timing of the peak flow from Nillahcootie of even a couple of hours, as mentioned in the Fact Sheet, would have great influence on the accumulative effect at Benalla. We ask that Government undertake a reappraisal of the use of Nillahcootie as a flood mitigation structure for various flood re-occurrence intervals?

The modelling undertaken as part of the Lake Nillahcootie Flood Study took into account the relative timing of the convergence of flows at Benalla and the contribution of all sub-catchments for various rainfall patterns.

The analysis took into account various initial storage levels for a range of flood events to determine any impacts at Benalla.

An appraisal of the effectiveness of Lake Nillahcootie as a flood mitigation storage has been included in the answer to Q's 7 & 36.

QUESTION 4.
It is agreed that the decommissioning will not increase flood levels over the Broken River flood plain above the current flood risk because the management rules of Lake Nillahcootie make no provision to regulate flows. This is misleading as the average person in the street would have no idea that the operating rules had been changed.

After 1992, because of water quality issues at Lake Mokoan, water was retained in Lake Nillahcootie rather than diverted to Lake Mokoan, and operational rules were modified to improve security levels for summer water supplies in the Broken Valley. This meant that the reservoir needed to be filled earlier to achieve the expected reliability of supply. The change in operating rules preceded the intention to decommission Lake Mokoan.

The response to Q 36 clarifies that changes to the operating rules have not changed flooding impacts at Benalla.

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QUESTION 5.

It is a fact that Mokoan filled relatively rapidly immediately following its construction. This in itself is testament to the effectiveness of the operation of Nillahcootie as a stream regulating structure and hence the flood mitigation benefits as a consequence are firmly established. The SR&WSC report "Floodplain Management Study — June 1984", compiled after ten years of effective operation of the system, based upon rainfall records and river gauging stations, confirms the flood benefits to Benalla and must be beyond reproach. Why has this study been disregarded or given such low recognition?

Lake Mokoan filled because conditions were right to divert flows. However, from streamflow records, the filling did not provide any flood protection to Benalla at the time as no significant flood-producing rainfalls occurred.

The SR&WSC "Benalla Floodplain Management Study" was released in 1984, and was based on then available streamflow records and other data. After the 1993 flood the available data was reassessed taking into account the additional flow record. This resulted in a 1993 peak flow of 1250 m^3/s (1,080 ML/d) being adopted as the 1 in 100 flood event, rather than the earlier (1984) adopted flow of 850 m^3/s (73,440 ML/d).

The 1984 study estimated that Lake Nillahcootie reduced the peak flow of large floods at Benalla by 7% compared to natural conditions (no storage), assuming that the storage was full at the start of each flood. The Lake Nillahcootie Flood Study has in fact determined that lake Nillahcootie, even when full, has the impact of reducing flood levels by 23 cm in a 1 in 100 year flood event, an 11% reduction in peak flow.

QUESTION 6.

According to G-MW records during the 1993 flood event the flow into Lake Nillahcootie peaked at 50,000 Ml/day. The maximum rate of flow spilling from Nillahcootie during that event was 33,000 Ml/day. This flood mitigation effect occurred even, as we understand, when the pondage was full or near full prior to that rainfall event. In other words an additional 17,000 Ml/day of peak flow was saved from passing down the Broken during that event which, combined with the retardation effect that occurred in the raising of the water level in the pondage to the toe of the secondary spillway, has got to be significant. How much more significant would the reduction in the peak, and the retardation effect, have been had the weir been half full to start with? In the case of lesser flood events the degree of impact must be even more significant as is implied in the 'Fact Sheet'.

The Lake Nillahcootie flood study investigated the effects that the storage has on reducing peak flows at Benalla. The results confirm that the maximum flood mitigation impacts of Lake Nillahcootie occur immediately downstream of the dam wall and diminish as the flood peak travels downstream. The results also confirm that the peak flow at Benalla is significantly influenced mainly by the catchment downstream of Lake Nillahcootie and the Holland Creek catchment.

The study does show that if Lake Nillahcootie is at 75% full or less prior to a flood event, there is some benefit in reduced flood levels at Benalla. The benefit varies from 7 to 11 cm at Benalla for the full range of flood events.

It should be noted however that the physical configuration of the outlet structures and the spillway,

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together with downstream river capacity constraints and pre-existing high downstream tributary flows effectively render it impossible to hold the Nillahcootie storage at or below 75% full in advance of anything but small flood events.

Refer to the answer to Q 36 for a more detailed explanation why any change to the operating rules does not have an impact at Benalla.

QUESTION 7.
It has been contended by G-MW that any gain in the reduction of a peak flow caused by holding Nillahcootie at a low level would become insignificant by the time it reached Benalla due to the dissipation effect of its travel over such a distance. We contend that in the case of rain falling above Nillahcootie only, when the balance of the catchment was not saturated, this would be the case. However, records show that all the major floods in the Broken system occurred when the rainfall events were widespread and therefore that portion of the catchment below Nillahcootie would be generating high flows at the same time. Most of the creeks entering the Broken River below Nillahcootie are steep and, because of the soil type, forestry activity and cleared land, would sometimes have a very high run-off coefficient. Therefore the magnitude of a peak flow at Nillahcootie would surely be retained, most likely increased, all the way to Benalla and beyond. Have the calculations given sufficient weight to this probability?

Yes. The hydrologic modelling in the Lake Nillahcootie flood study made provision for how rainfall is distributed spatially over the catchment and how it varies with time. The model also took into account the runoff generated from the rainfall and the way runoff behaves. The model has been calibrated and validated on known flood events

The flow at Benalla is an aggregate of all runoff generated in the catchment upstream, having regard for the differing travel times. Runoff from the uppermost parts of the catchment takes longer to reach Benalla than runoff from the lower parts.

The study found that, because of the different travel times involved, flows passing from Lake Nillahcootie do not contribute significantly to the peak flow at Benalla. This is because the peak flow from Lake Nillahcootie arrives at Benalla well after flows from other locations.

QUESTION 8.
It has been stated that the release rate from Nillahcootie has been restricted to about half of the designed rate due to the flooding of agricultural land which was proven to occur when the designed release rate was used. The River capacity is known to be very restricted in the Lima/Yin Barun region due to sand deposits which emanated from the Moonie Creek over the years when the pine plantations were being established in that catchment. It is not disputed that the designed release rate has been impaired and it is recognised that the available time span in which Lake Nillahcootie could be maintained with a significant air space is reduced accordingly. BUT the storage graphs made available to us for the period following construction until the early 1990s indicate that the maintenance of an effective air space for significant periods of time was possible and proved effective. We have not had the opportunity to examine detailed storage/flow charts for this period other than the four years presented to the Shepparton meeting in September last year. Could the detailed yearly charts be tabled and a

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reassessment be made of the percentage of time in which a reasonable air space was in existence, over the winter/spring periods, for the years when Nillahcootie was being managed under the original operating rules?

Detailed yearly charts have now been tabled to the group. Examination of the records will enable an assessment to be made when reasonable airspace was in existence.

The Lake Nillahcootie flood study has made an assessment of flood impacts for a range of floods as well as an analysis of how the different operating rules could have affected airspace at Lake Nillahcootie (see answer to Q 36).

QUESTION 9.

It has never been contended by the B&DFAG that the DIVERSION CHANNEL in itself has any significant influence on flood levels downstream regardless of whether it is in operation at the time of a flood or not. The ability to divert water to an off-river storage (Mokoan) in order to create air space in Nillahcootie during winter and spring is, however, considered significant.

The issue of effectiveness of airspace has been addressed in responses to questions 6 & 36.

QUESTION 10.

In respect to the GHD Report 2005 it has now been made quite clear that this study did not consider any aspects of flood mitigation related to the operation of Nillahcootie and neither was it commissioned to do so. The study was very restricted and confined to aspects of Lake Mokoan and the proposed wetlands. There is no definitive independent study of all flooding ramifications of a full decommissioning. There does not appear to be any consideration of the combined convergence of unregulated water from Nillahcootie joining the waters released by the opening of the Mokoan embankment. We contend that the increase of water levels below Mokoan, because of the combined uncontrolled flows, will be greatly increased in both magnitude and duration. There are many people who can attest to this based upon their own observations prior Mokoan/Nillahcootie. Will Government commission a full independent flood study to be undertaken for the whole Broken Valley which includes these combined aspects.

The GHD Report 2005 considered the impact of 1 in 5 year, 1 in 10 year, 1 in 50 year, 1 in 100 year and 1 in 1000 year Mokoan outflow events on a coincident 1993 flood at Casey's Weir.

In response to questions raised at the presentation of the Hydrology Report at Shepparton in September 2007, additional work has been carried out by GHD and the Lake Nillahcootie flood study has analysed the impacts of Lake Nillahcootie on flooding at Benalla.

The additional work by GHD has analysed the impacts of the October 1993 flood on water levels downstream of Lake Mokoan resulting from the full decommissioning of Lake Mokoan as this is the largest flood of record in living memory and was found to be a 1 in 100 year flood event. The results show that outflows from the proposed 10 m breach will only increase levels in the outlet channel immediately downstream of Lake Mokoan by 20 mm and, at the downstream end of the outlet channel near Caseys Weir the increase will be only 10 mm.

The outflows will also be contained within the existing channel with no issues caused by increased

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flow duration and while there is historic evidence of flooding adjacent to the channel in October 1993, this is a result of backwater flooding from the Broken River.

Given the large volume of water coming down the Broken River from Benalla, these flows would be entirely dissipated below Caseys Weir with no increased flood levels.

As the impacts of decommissioning Lake Mokoan on Broken Creek are minor, a regional flood study for the whole broken valley is not warranted.

QUESTION 11.
Referring to the GHD report again, now that it has been released to the public, it has become obvious that the basic limited nature of the data used to formulate its conclusions did not take into account either local knowledge of historic flow data nor a broad enough reference over both time and geography to rainfall and flow data pertinent to the area. Will the Government commission the extension of the GHD study to include more reliable and broader basic data including the observations made by senior locals?

A further extension was undertaken by GHD to analyse the 1993 flood event which was found to be representative of a 1 in 100 year event for the Lake Mokoan catchment.

It should be noted that continuous rainfall records for the area weren't available. Therefore detailed storage records held by G-MW have been used to create an inflow hydrograph. The impacts of the proposed 10m breach in the wall, including downstream flood levels and increases in flood levels for the future wetland, have been provided in the answer to Q10.

QUESTION 12.
It should be noted that the Thales (ADI) Ammunition Factory is located in a floodplain adjacent to the Mokoan outlet channel and could very possibly be adversely affected by increased flood levels which will be present after the full decommissioning has taken place. The factory site was chosen after the construction of the Lake Mokoan embankment and the flood protection it represented would probably have influenced it's siting. What, if any, consideration has been given to this concern

The additional work undertaken by GHD has determined that the greatest increase expected is a rise in flood level downstream along the outlet channel is no more than 2 cm immediately downstream of the breached embankment and 1 cm at the site for a 1 in 100 year flood. This is not considered significant.

Thales management have been briefed on the outcomes of the further GHD assessment. Further briefings will be undertaken as part of the de-commissioning process.

QUESTION 13.
It has come to our attention that the Building Permit requirements for the Shepparton municipality may have been amended requiring higher floor levels for buildings within the flood plain due to the decommissioning of Lake Mokoan. This is unconfirmed. If this is so it is

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obvious that our concerns are well founded and we have not been advised accordingly. Is this factual information and if so what other action is the Government intending to overcome the expected increases in flood levels? Subsequent to the writing of this a letter from Shepparton Planning indicates this information to be incorrect?

Building requirements within Shepparton Mooroopna floodplain areas were revised in August 2002 following a comprehensive floodplain management study. Compared with requirements determined in 1984, the finished floor height requirements could now be either higher or lower depending on location. The revised floor heights had nothing to do with the decommissioning of Lake Mokoan.

QUESTION 14.

AN ALTERNATIVE. If Lake Mokoan were left as it is and only partially filled (say 20-25%) it would reduce the evaporation dramatically in proportion to the surface area. If deemed absolutely necessary a small "Wetland' could easily and cheaply be established with a small low level embankment near the existing full suppl level either filled from a local catchment or from the diversion channel when required. Has the Government given any consideration to this simple, effective and cheaper VIRTUAL DECOMMISSIONING?

Other advantages:

a. Quicker turnover of water would virtually eliminate algae
b. Minimum reduction of 'natural flows'
a. All future options retained if other offsets proved inadequate
d. Mokoan downstream landholders retain full flood protection
e. Embankment integrity increased beyond any doubt
f. Downstream irrigators would be appeased
g. All flood issues would evaporate (providing original Nillahcootie operating rules were reinstated
h. An enormous saving of public monies which could be diverted to the improvement of the irrigation distribution system
i. Positive environmental outcomes

Disadvantages:

a. Return of original Winton Swamp wetland not achievable
b. Some reduction in the incidence of environmental flooding remains
c. Current operating costs probably remain
d. Infrastructure for Mokoan upstream water users still required

An exhaustive review of all alternatives to decommissioning was undertaken in 2007. This was in response to a proposal submitted by the Justice for the Broken irrigator group early in that year. The review was undertaken by leading consultants in the areas of water resources and water storage design and construction.

DSE engaged independent consultants SKM, URS and GHD to undertake aspects of the review relating to their expertise.

The key review finding is that "modified" storage alternatives are not a sustainable solution because they would all cost more to construct, have higher operating costs and result in significant reduction in water savings for the environment.

The review reports and other relevant document are all publicly available and posted on the Lake Mokoan website.

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QUESTION 15.
What are the corresponding flow rate increases for level increases at Caseys of 0.01, 0.04, 0.08?

The question relates to a clarification of flood level increases at Casey Weir as a result of decommissioning Lake Mokoan. In their 2005 *Works Decommissioning Concept Study* GHD listed in their conclusions:
"5. Removing the inlet channel could result in increases in flood levels at Casey Weir of between 0.08 m and 0.04 m
6. Increases in peak water levels in the outlet channel for a range of flood events in the Mokoan catchment with the preferred outlet (i.e. 10 m breach with outlet) arrangements combined with the 1993 flood level at Casey Weir are in the order of 0.01 m."

A rise of 0.01 m at Caseys Weir would increase Broken River flows at by 7 m^3/s. It is the maximum increase in the flood level resulting from a 1 in 100 year (October 1993) flood event on the Broken River plus the peak outflow from the Lake Mokoan Outlet Channel from a 1 in 100 year storm event on the Mokoan catchment with the 10m breach in place at the Winton Swamp outlet.

The other two flood level increases relate to the additional flows along Broken River as a result of diversions of up to the maximum design capacity of 28 m^3/s into Lake Mokoan no longer occurring. This would mean additional flows along Holland Creek and Broken River.

For a 1 in 5 year event the additional flow would increase the flood level at Casey Weir by 0.08 m. For a 1 in 100 year event the additional flow would increase the flood level by 0.04m.

It should be noted that these estimates are conservative as they make no allowance for attenuation of flows.

QUESTION 16.
Does the modelling recognise pre 1969 floods?

The modelling referred to relates to a hydrology study on Lake Mokoan undertaken by GHD in 2005.

The modelling does not specifically recognise pre 1969 floods. However, design storm rainfall data used to estimate relevant flows in the study was based on all major storm events up to circa 1987 as this data has been used to prepare data incorporated into the design storm information in Australian Rainfall and Runoff 1999. The methodologies and rainfall data presented in AR&R form the nationally accepted standard for flood risk management decisions and associated land use planning and infrastructure decisions.

Suitable information on flows in the Lake Mokoan catchment was required for model calibration. The data was only available since the Lake was constructed. Even then only reservoir level data was available and not flow data into the Lake.

Calibration required recorded hourly rainfall records as well as recorded hourly flows and/or changes in storage levels. Other information, where it existed, was based on daily records, and was therefore

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unsuitable for calibration.

QUESTION 17.
Are correlations with earlier Murray floods relevant and necessary?

The fact that flooding along the Murray has occurred does not necessarily mean that flooding will also have occurred near Benalla. It is concluded that the correlations are not relevant or necessary.

QUESTION 18.
Does the modelling recognise precedent conditions in 1956 flood which are reportedly higher than post 1969 events?

GHD reviewed rainfall data for 1956 for Benalla and Wangaratta and found that monthly rainfalls were above average for the majority of months that year. This indicates that runoff in 1956 would have been greater than under more normal conditions.

As indicated in the response to Q 16 there was insufficient data on the 1956 flood to be utilised for calibrating the model, although the design rainfall data used to simulate flood flows for a range of floods took into account the full rainfall record.

Notwithstanding this, it should be recognised that the 1993 flood event is the highest event recorded in the Benalla area.

QUESTION 19.
Does a reported 1956 discharge from Winton Wetland of 200m wide x 1m deep make sense?

An examination of the topography of the Winton wetland shows it to be relatively flat and considerably wider than 200 metres, without a well defined depression. The following figures are based on an analysis of the topography at Winton Swamp in the vicinity of the current Mokoan embankment:

If max waterway depth is 1.0 m, then approx waterway width is 1,300 m
If average depth is 1.0 m then waterway width is greater than 1,340 m
If waterway width is 200 m, approx waterway maximum depth is 0.24 m
If waterway width is 200 m, then average waterway depth is less than 0.08 m

It would therefore appear that reported waterway configuration could not occur and that the depth estimate of 1.0 m for the 1956 event exceeds what is more likely to have occurred. As such, it is difficult to establish the accuracy of the observation.

QUESTION 20.
What assumptions are made in the modelling?

The key assumptions detailed in the GHD modelling were:

- Wetlands full at commencement of storm
- Inlet channel not operating (i.e. no channel inflow)
- Breach in embankment wall at level of 161.14 m AHD

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QUESTION 21.
What is the expected change in frequency of future flooding events in Benalla, post Mokoan?

From the results of the Lake Nillahcootie flood study, no changes in the frequency of flooding at Benalla would be expected. Climate is the major variable.

QUESTION 22.
Were G-MW negligent in not operating Mokoan Inlet Channel in 1993?

No. G-MW was not negligent in not operating the Mokoan Inlet Channel during the 1993 flood event. It did not operate the diversion channel because of operational constraints. During the 1993 flood, the inlet channel downstream of Holland Creek regulator ran full, not because of Holland Creek overflows but from local drainage flows entering the channel along its length, from the 4 mile Creek and from overflows from Kennedy Creek. Also at the time of the 1993 flood, Lake Mokoan was already above the then agreed maximum operating level for the storage.

More importantly, the BRCC and SES flood response plans in 1993, and still today, do not recognise any role for the Mokoan Inlet Channel during flood events. There was not and is not any expectation in agreed flood management arrangements that G-MW will or should operate the channel for flood mitigation.

QUESTION 23.
How many model runs were undertaken?

At least 150 hydrologic and hydraulic model runs were undertaken, excluding numerous model runs undertaken in the calibration process. Runs of the hydraulic models undertaken to produce results involved the combination of six storm durations for each average recurrence interval event (five in total) for each of the possible scenarios (two breach lengths and two outlet options). There were also at least 30 RORB hydrologic model runs.

QUESTION 24.
What were the confidence limits around the model outputs?

Confidence limits were not determined for the results determined as part of the study. The results presented represent best estimates based on procedures / analysis undertaken in accordance with accepted guidelines, ie Australian Rainfall and Runoff 1999. The 1 in 1000 year event modelling was undertaken to give some indication of a worse situation than the 1 in 100 year event.

QUESTION 25.
What coincident events have been assumed in the modelling?

The range of flood events for Lake Mokoan (from 1 in 5 year to 1 in 1000 year flood) were all modelled assuming that the flood level at the downstream end of the outlet channel (at Caseys Weir) was at the peak of the 1993 flood event along Broken River.

QUESTION 26.
What further work could be done to address community concerns re quality of data and assumptions?

Community concerns were raised at the presentation at Shepparton in September 2007. Following this, the consultants (GHD) undertook additional work including a further analysis of historic rainfall and flood data and a comprehensive analysis of the impacts that could arise from a repeat of the October 1993 event with the proposed Winton Wetlands arrangements in place.

All available rainfall information (both official and local) has been considered in the further analysis.

It is concluded that the assumptions, approach and modelling undertaken have been appropriate for the purpose of the study given that acceptable practices were followed in accordance with the national guidelines (Australian Rainfall and Runoff 1999).

QUESTION 27.
How have the uncertainties raised in the above points been addressed in the methodology adopted by GHD?

The question is answered by the responses above. GHD has used the best information available and applied analysis generally in accordance with guidelines without bias.

QUESTION 28.
What is the expected change in Nillahcootie spill magnitude and frequency, post Mokoan?

Given that weather conditions in Australia are highly variable and not predictable, quantification of future spills and magnitudes is impossible. However post Mokoan, Lake Nillahcootie is expected to fill and empty to a greater degree than when Mokoan was operational. In general terms as a result of the changed operational conditions, Lake Nillahcootie storage levels are likely to increase slightly from June to December and to decrease slightly from January to May.

Because Lake Nillahcootie will be the only storage available to supply Broken system demands in the future, this lake will always finish the irrigation season at a lower level than is has in the past. Accordingly the lake will always commence the higher inflow winter/spring period with more airspace available to capture or retard flood events

QUESTION 29.
Does G-MW have a moral responsibility to protect Benalla from flooding?

G-MW operates its assets in accordance with its obligations under the *Water Act* 1989 and its Statement of Obligations made under the section 4I of the *Water Industry Act* 1994. The Statement of Obligations requires G-MW when performing its functions and providing its services to collaborate with other public bodies and government agencies to take account of regional needs. Also G-MW is required to manage its assets in ways which minimise detrimental social, economic or environmental effects and where its activities may affect a catchment management strategy participate in the development of that strategy. G-MW complies with these obligations and always endeavours to operate its assets in ways that do not worsen flooding.

QUESTION 30.
What flood attenuation was provided by Nillahcootie in 1993?

The attenuation provided by Lake Nillahcootie was 17,000 ML/d immediately downstream of the reservoir even though the reservoir was full at the time. Results from the Lake Nillahcootie flood study

show that this attenuation had an impact of reducing the peak flow at Benalla by 23 cm compared to a situation if the lake did not exist.

QUESTION 31.
What role did the secondary spillway play in 1993?

The peak outflow in 1993 was 33,000 ML/d which is well below the flow at which the secondary spillway operates (77,000 ML/d). Hence it played no role.

QUESTION 32.
What other hydrology studies have been commissioned?

Hydrologic Studies as part of the Decommissioning include:

- Works Decommissioning Concept Study – Report on Hydrology and Downstream Hydraulics, Oct 2005 (GHD for G-MW)
- Lake Mokoan Hydrology – Response to Community Concerns, Draft 30/7/08 (GHD for G-MW)
- Lake Nillahcootie Flood Study, 2008 (Cardno Lawson Treloar for BRCC)
- Lake Mokoan Inlet Channel Investigations in progress (GHD for G-MW)
- Mokoan Inlet Channel Closure – Impacts on Broken River and Holland Creek Hydraulics, May 2005 (EarthTech for GB CMA)

Earlier Studies

- Benalla Floodplain Management Study, 2002 (Willing & Partners for City of Benalla)
- Benalla FPM Study, 1984 (SRWSC)

QUESTION 33.
Is there a GBCMA review report of the GHD report?

No. The GBCMA provided minor editorials on a draft report directly to G-MW.

QUESTION 34.
What can be reasonably said in relation to flooding risks arising from future climate change?

The climate change models generally indicate a warmer and drier climate for Victoria with reduced catchment yield but are poor at predicting any changes in rainfall patterns at this stage. Hence there are currently no strong indicators as to whether flooding risks will increase or decrease in the future.

QUESTION 35
What are the impacts of decommissioning on flows downstream of Casey's Weir?

The GHD study shows negligible impact at Casey's Weir with an increase of 0.01 m in a 1 in 100 flood event due to outflows from Winton Swamp. Closer to Shepparton increase in flood heights will be even less due to attenuation of flows provided by the wide floodplain areas along the Broken River and flows departing into the Broken Creek system.

QUESTION 36.

What is the change in flooding impact in Benalla based on pre and post 1992 operating rules of Lake Nillahcootie? (ie height on gauge, number of houses flooded)

The only way to determine any impacts of flooding at Benalla due to changes to the operating rules post 1992 was to examine storage level conditions prior to known flood events under the two operating rules. The flood events selected were those which occurred in May 1974, September 1975, July 1981 and October 1993 for which sufficient data was available.

The consultants used a mix of detailed assessment of historic records and modelling to assess the changes in storage levels in both Lake Nillahcootie and Lake Mokoan under the two operating rules. Releases of water from Lake Nillahcootie were governed by a number of factors including:

- Water levels in Lake Mokoan and Lake Nillahcootie
- Flows in Hollands Creek and Broken River
- The capacity of the diversion channel to Lake Mokoan.

The consultants found that both sets of operating rules would have resulted in the same level of Lake Nillahcootie at the start of each event. Therefore there would be absolutely no additional adverse impact at Benalla.

Responses to the compiled questions have been provided to Council by Goulburn Murray Water, Goulburn Broken Catchment Management Authority and the Department of Sustainability and Environment.