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Memo

To:	Damian Wells, Mark Johnston	**From:**	Julian Skipworth and Ben Tate
Organisation:	North Central CMA, Central Goldfields Shire	**Date:**	31/05/2013
Job Title:	Carisbrook Flood and Drainage Management Plan		
Subject:	Response to AECOM Independent Review Document		

Dear Damian and Mark,

Thank you for the opportunity to respond to the independent review conducted by AECOM. Please find our response below to the key conclusions made in the document. It is suggested that should a response be required to any of the other minor queries within the review, these could be discussed separately at a round table meeting if it is required.

(1) The hydrologic model does not appear to reflect recorded conditions very well, with significant differences between recorded and modelled flow (up to 80%), especially for the January 2011 event.

It was acknowledged in the report that a poor calibration was achieved at the Clunes gauging station and it was explained that an improved calibration at Clunes resulted in a poorer fit at Tullaroop Reservoir. As Clunes is located further up the catchment it was decided to focus on the calibration at Tullaroop Reservoir which is located a short distance upstream of Carisbrook and thus of more importance. An excellent calibration was achieved at the Tullaroop Reservoir gauge for both calibration events with a close fit achieved with respect to peak flow, volume and timing.

It was also explained in the report that the calibration was made difficult by very poor gauge data during the calibration events. The McCallums Creek gauge was damaged in both events and data was unavailable for those periods. The data record at the two Clunes gauges showed poor quality data at the peak of both calibration events. The highest quality gauge data for the calibration events occurred at the Tullaroop Reservoir gauge and that location was the focus of the RORB hydrologic model calibration.

The excellent hydraulic calibration achieved in both the September 2010 and January 2011 events in the hydraulic modelling also indicates that the flows determined in the hydrological modelling were appropriate for these calibration events.

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(2) There is significant uncertainty in the design flow estimates (in the order of ±40% change in flows due to the selection of design losses alone).

The selection of design losses was challenging as explained in the report and the losses clearly have a significant impact on the design flows. This is not unique to Carisbrook, the determination of design parameters is indeed a challenging task in all studies, and can have significant impact on the adopted design flows. This is further complicated in cases where flood frequency analysis cannot be performed due to lack of available gauge data as is the case at Carisbrook.

Due to the difficulties in determining appropriate losses a significant amount of sensitivity testing was conducted using a range of losses in order to determine the most appropriate values. Typically design flows would be scaled to flows determined by flood frequency analysis however this was not performed in this instance due to the lack of data at the relevant gauging stations.

There is certainly a level of uncertainty in the selection of losses and resultant design flows and this was acknowledged in the report however extensive sensitivity testing was undertaken to determine the most appropriate values given the limited available data. Furthermore the design flow estimates have been reviewed by the DEPI technical review panel (which includes highly respected experts in this field), and was given approval with positive feedback. Water Technology has undertaken these types of studies in ungauged catchments across Victoria many times and is experienced in design hydrology estimation.

(3) The potential impact of climate change on increased rainfall intensities will increase 100 year ARI flows by up to 70%, which will result in an increase in the frequency of breakout flows from Tullaroop Creek through Carisbrook.

The climate change scenarios with a 32% increase in rainfall intensity have a significant impact on flows at Carisbrook particularly in the more frequent events. In frequent events the initial loss takes away a significant proportion from surface water excess, so with climate change the additional rainfall volume adds proportionally more volume to the surface water excess generated as compared to the rarer events. In the 100 year ARI event the peak flow at Carisbrook increases from 882 to 1,567 m^3/s, a percentage increase of 78%. Note that the percentage increases in the tables have been calculated incorrectly and will be updated. The actual flows are correct, but there was an incorrect reference in Excel which calculated an error in the percentage increases. Regardless, it is apparent that the impact of climate change is significant in this case.

(4) The report states that the modelled flood levels were "slightly lower" than the recorded flood levels for the January 2011 flood event. The concern with this statement is the inconsistency with the results of the RORB model calibration, which states that the modelled flows are up to 80% higher than the recorded flows for the same event.

As discussed above the "80% higher than recorded flows" refers to the calibration at the Clunes gauge which has a poor data record, is located a considerable distance up the catchment and was not the focus of the RORB calibration. The calibration at Tullaroop Reservoir, which is located a short distance upstream of Carisbrook, was excellent and demonstrated a very good fit to recorded flows.

(5) The Manning's 'n' roughness value for the main bluestone drains was changed for the design runs. It is unusual to modify parameters such as the Manning's roughness following calibration of a model.

The design modelling aimed to model current conditions while the calibration modelling aimed to replicate conditions at the time of these events, this is not unusual and is standard practice. The roughness was also altered at the upstream side of the road bridge where an area of dense vegetation and debris was cleared following the January 2011 event. These changes were agreed with the technical steering committee and were considered appropriate in the peer review arranged by DEPI.

(6) **Modelling shows that a 13% increase in flow from the September 2010 peak of 779 m3/s to the 100 year ARI design peak of 882 m3/s results in breaching of the banks of the creek and inundation of Carisbrook. This shows that flooding of Carisbrook is very sensitive to the peak flow estimate for the 100 year ARI flood event in Tullaroop Creek, and a small reduction in flows or flood levels may prevent the break out**.

This is correct – testing has indicated that the breakout across the Pyrenees Highway begins to occur with a combined flow in Tullaroop and McCallums Creek of approximately 825-850 m^3/s. As discussed previously due care and industry leading best practise has been applied in the estimation of design flows to ensure that the design flood mapping derived is reasonable.

(7) Construction of Options A or B will protect some properties from local flooding but will not protect from flooding in Carisbrook due to breakout flows from Tullaroop Creek.

This is incorrect. Both Options A and B include vegetation works which have been shown to lower flood levels by 0.25m in McCallums Creek, preventing the large breakout through town and as a result protecting a number of properties from inundation in the 1% AEP event. It is correct to say however, that larger events can occur and will result in overtopping of the Pyrenees Highway flooding the town, and Options A and B will not protect against these larger floods.

(8) The focus of the preferred mitigation option is 'protection' from flooding of the local catchments. The proposed Western Levee will not reduce flood levels in Tullaroop Creek or prevent flooding of Carisbrook caused by the break out of flow from Tullaroop Creek.

This is correct to an extent although as explained above both Option A and Option B include vegetation works which have been shown to reduce flooding from Tullaroop/McCallums Creek. In terms of cost though, it is clear that the majority of the costs of Option A and B are directed towards mitigating against local catchment flows. This was a major issue for the community and was the preferred direction of the steering committee. Other options to protect from the main waterways including levees and "floodways" were assessed and modelled however these measures were not supported by the steering committee.

(9) Maintenance of the waterways is not considered to be a sustainable mitigation option that will protect the town from flooding. The 0.25m reduction in flood levels achieved by changing modelling factors cannot be translated into a technical specification that can be implemented and maintained. The sensitivity of the breakout to this reduction in levels for the 100 year ARI flood event has not been explored or explained sufficiently to give confidence that it can be achieved with physical works, and there is no guarantee that it will be adequately maintained. We believe that these works will assist in reducing flood levels in Tullaroop Creek and should be undertaken if possible, but should not be relied on to provide flood protection for Carisbrook.

Modelling identified that a 0.25m reduction in flood levels may be achievable through a reduction in roughness of the dense vegetation adjacent to Tullaroop and McCallum Creeks. This was achieved by reducing the roughness value in this area from 0.08 to 0.06 (not 0.04 as described in the AECOM document) as described in Section 8.1 of the report. A reduction to 0.04 as mentioned in Section 6.1.3 was a typographical error and should have read 0.06.

It is acknowledged in the report that this reduction in roughness is difficult to translate into a technical specification and "on ground" vegetation thinning however there has been extensive discussions between stakeholders around what this change in vegetation may involve. The issue of ongoing responsibility for the maintenance of these works is a challenging one and at present has not been resolved. Stakeholders have been waiting on the outcome of a parliamentary response to the ENRIC report which should provide some clarity regarding this issue.

It should also be noted that both the community and steering committee were in strong support for this option from the outset of the project. Alternative measures to protect from the major waterways such as levees were investigated and modelled but were not supported by the steering committee.

(10) The increased construction cost of the preferred option (Option A, $1,651,373) over option B ($742,252) needs to be considered in terms of the increased benefits of Option A over Option B.

Option A is clearly much more expensive than Option B and provides little additional benefit in terms of flood risk. This information was presented to the steering committee but they chose to support Option B due to concerns around diverting flow into McCallums Creek. We were transparent about this in both our recommendations to the steering committee at numerous meetings and in the draft and final reports.

Water Technology's role in this project is to advise the steering committee on technical matters. We have presented the facts, been very clear and upfront in all our communications, and have made a recommendation which was not supported by the steering committee. Our report reflects this but respects the decision of the steering committee in the determination of preferred option.

If you require any clarification of the above response please don't hesitate to contact Ben Tate on (03) 8526 0800.

Regards

Water Technology Pty Ltd

Ben Tate – Principal Engineer