Rienco Consulting

Providing Specialist Services in the Fields of Hydrology and Hydraulics

Review of Flood Related Matters Proposed Temporary School Site at Old Kings School Oval, 24 O'Connell Street & 3 Marist Place, Parramatta NSW

for Eco Logical Australia Pty Ltd

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Report title:

Review of Flood Related Matters
Proposed Temporary School Site at Old Kings School Oval, 24 O'Connell Street & 3 Marist Place, Parramatta NSW

Prepared for:

Eco Logical Australia Pty Ltd

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Table of Contents

Tables

Figures

Appendices

1 INTRODUCTION

1.1 BACKGROUND

We understand that the Department of Education (DOE) needs to decant 1,000 students from Parramatta Public School to temporary demountable accommodation on the Old Kings School oval (the site). We understand that the temporary use of the site will allow construction to commence on the Parramatta Public School, and once construction is completed the students will move back to their new school and the Demountables will be removed. The Application is therefore for a temporary use of the site for (nominally) 12 months.

A Development Application (DA) has been lodged with the City of Parramatta (City) and was to be determined by the Sydney West Central Planning Panel (Panel).

It is understood that there has been on-going discussions between the DOE and the City relating to the appropriateness of the DA given the site's flood risks and the proposed use as a school for young children (Kindergarten to Year 6). Further, there have been a range of reports addressing flood risk which present conflicting opinions about the appropriateness of the development. Consequently the flood risk issues associated with the DA remain in contention.

Although the DOE has attempted to address the flood risk concerns that had been raised, on 28 March 2017 the City advised that they did not support the DA and considered *"the proposed sensitive land use should not be supported in a flood area. Whilst we acknowledge the detailed work that has gone into mitigation, it does not overcome the in principle concern".*

Subsequent to this decision, Bewsher Consulting was commissioned on 7th April 2017 by the DOE. Bewsher's report has been prepared in response to the DOE's request for Bewsher to undertake *"an expert and independent review*" of the flood risk issues associated with the DA, and was issued as a final report on 10th April 2017. Notwithstanding the Bewsher report recommending approval of the DA (with some minor modifications to the FEMP), on 12th April 2017 the Sydney West Central Planning Panel determined the DA by way of refusal.

Given the above state of affairs, the Department of Planning and Environment (DPE) has had the matter referred to it from the Local Approvals Panel for Parramatta Council. As the applicant is a crown authority, the matter has been referred to the Minister for Planning for determination.

As the DPE is assisting the Minister in relation to his consideration of the proposal, the DPE are seeking further independent flood advice on this matter. To this end, DPE have approached Eco Logical Australia (ELA) for the provision of such advice. ELA have sub-consulted Rienco Consulting to provide the required advice.

1.2 PURPOSE OF THIS REPORT

Rienco Consulting has been engaged to carry out the following:

1. Carry out a site inspection to review the location of the proposed temporary facilities and the proposed development and mitigation measures.
2. Review the key information submitted with the DA, principally produced by Northrop Engineers, being:
    a. *Flood Emergency Management Plan*

   b. *Flood Assessment - Demountables for Temporary O'Connell Street Primary School, 24 O'Connell Street Parramatta – Flooding Considerations and Risk Management*.

3. Review the Parramatta City Assessing Officers review of the submitted DA documents.
4. Review the Bewsher Consulting Review, which was commissioned by the DOE after Parramatta advised they would not support the application, to review the reasonableness of Parramatta Council's position and the adequacy of the submitted information with the DA.
5. Read and consider OEH's comments submitted to Parramatta Council with the DA.
6. Read and consider the determination (refusal) by Sydney West Central Planning Panel.
7. Provide a written report, constituting our opinion based on the reviewer's experience and knowledge of sound flood risk management practice in NSW. The report will provide, after extensive consideration of the applicable matters, conclusions that address:
   a. Our opinion of the flood hazard affecting the site.
   b. Our opinion of the flood risk affecting the site and the occupants.
   c. Key Flood Characteristics and Considerations
   d. Impacts on Flood Behaviour and Structural Stability of Buildings
8. Based on the above, provide advice to DPE as to either approve or not approve the proposed development, with regard to flood-related matters.

1.3 DOCUMENTS REVIEWED AS PART OF THIS REPORT

The following is a list of documents reviewed and considered during the preparation of this report:

a) Letter titled *Demountables for Temporary O'Connell Street Primary School, 24 O'Connell Street Parramatta – Flooding Considerations and Risk Management* dated 16th March 2017 by Northrop Engineers. Henceforth referred to in this report as the Northrop Letter.

b) Report titled *Flood Emergency Management Plan* dated 16th March 2017 by Northrop Engineers. Henceforth referred to in this report as the Northrop FEMP.

c) Report titled *Independent Review of Flood Risks* dated 10th April 2017 by Bewsher Consulting. Henceforth referred to in this report as the Bewsher Report.

d) Letter titled *Additional comments in response to Bewsher 10 04 2017* dated 11th April 2017 by Mr Paul Clark, City of Parramatta Council.

e) Letter titled *Determination and Statement of Reasons* dated 12th April 2017 by Sydney West Central Planning Panel. Henceforth referred to in this report as the Determination.

f) Letter titled *Record of Final Briefing Meeting* dated 12th April 2017 by Sydney West Central Planning Panel. Henceforth referred to in this report as the Record of Final Briefing.

g) Proposed development plans by ESE Architects dated January 2017. Henceforth referred to in this report as the proposed development plans.

1.4 EXPERIENCE OF THE AUTHOR

The author is a civil engineer with over 20 years' experience in hydrologic and hydraulic investigations. The author is a Chartered Professional Engineer and Member of the Institute of Engineers, and a Member of the College of Civil Engineers, Institute of Engineers, Australia. The author is registered on the National Engineers Register (NER)

The author is the Managing Director of Rienco Consulting, a regionally-based consulting firm dedicated to the specialist fields of hydrology and hydraulics. The author has performed similar flood, climate change and coastal hazard related assessments for major Part 3A urban developments across NSW and abroad. The full CV of the author is appended to this report.

1.5 LIMITATIONS AND ASSUMPTIONS

This report has been strictly prepared for the purposes stated in this report for exclusive use by the client. No other warranty, expressed or implied, is made as to the advice included in this report. This study specifically focuses on a review of flood behaviour at the subject site, given current conditions and the information provided by the client. This study does not address flood behaviour for other sites within the overall catchment.

2 REVIEW OF THE ORIGINAL APPLICATION

2.1 SUMMARY OF THE PROPOSED DEVELOPMENT

The subject site is located to the south of the redevelopment of the Old Kings School on Lot 6 (DP 1182647). The 'site' is effectively an old school oval. It is bounded on the south by the Parramatta River, to the wets by O'Connell Street, to the east by Marist Place and to the north by an existing school site.

Figure 2.1-1 describes the subject site, and shows the proposed location of the demountable buildings (in grey). The 1% AEP flood extent and depths are also shown as blue shading (via the legend).

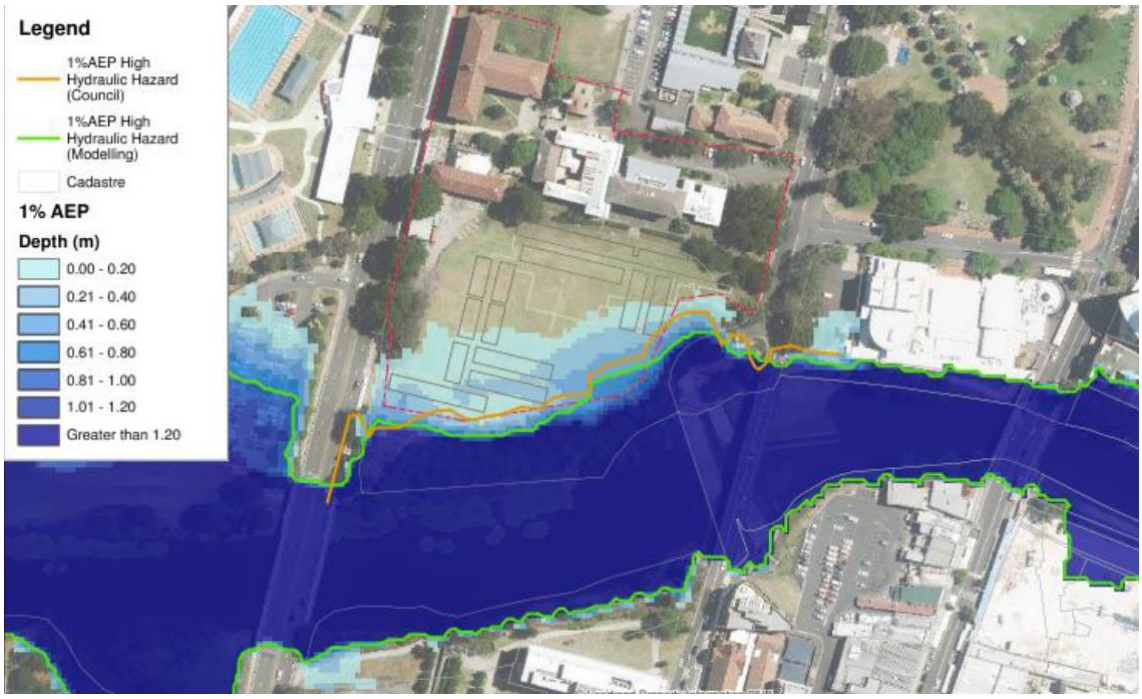

Figure 2.1-1 Subject Site and 1% AEP Flood Affectation

Note: Image extracted from Bewsher, but prepared by Northrop.

The DA seeks approval for:

- Ground preparation works (no excavation work below 100mm);
- Installation and use of demountable units to facilitate the operation of a temporary school for 1000 students including:
    - 41 demountable units to accommodate classrooms;
    - A demountable unit to accommodate a canteen;
    - A demountable unit to accommodate a library;
    - A demountable unit to accommodate accessible toilets/showers;
    - 2 demountable units to accommodate an administration office;
    - Lighting (attached to demountable units);
    - Covered walkways between demountable units;
    - Standard school signage
    - A covered outdoor learning area (2,661.38m²) (COLA);

  - Temporary security fence; and
- Kiss and drop zone on Marist Place; and
- Student access and main entry via Marist Place; and
- Construction vehicle access from O'Connell Street; and
- Several emergency and maintenance access gates along the O'Connell Street and
- Parramatta River frontages; and
- Full decommissioning of the temporary demountable school once the new O'Connell Street School is ready for occupation.

The last item above could well be the most relevant component of the application. The DA is seeking consent for the temporary use of the land. In our view, a view shared by Northrop and Bewsher, the temporary nature of the land use has a significant bearing on the flood risk at the site and related to the land use. This is described further in this report.

2.2 REVIEW OF THE NORTHROP LETTER

Northrop Consulting Engineers were engaged to undertake the flooding assessment and proposed response methodology for the application. A letter was been prepared for submission to the City of Parramatta to describe the existing flood behaviour at the site, and how the management of flood risk was incorporated into the development.

The letter describes in detail how the proposed development provides for the flood controls outlined in the Parramatta Development Control Plan 2011. Further, it also describes some additional measures that were also incorporated into the proposal.

The letter concludes that as a result of the inclusion of the nominated measures, and the nature of the proposal (i.e. temporary), Northrop consider the intent of the DCP has been satisfied.

2.3 REVIEW OF THE NORTHROP FLOOD EMERGENCY MANAGEMENT PLAN

Northrop Consulting Engineers have prepared a Flood Emergency Management Plan (FEMP) for the proposed demountable classrooms at Temporary O'Connell Street Primary School (the subject site). Northrop state that the purpose of this FEMP is to promote a satisfactory awareness of expected flood behaviour and risks, identify measures to become flood prepared, and recommend a course of action during and after flood events.

This FEMP was based on flood information obtained from the City of Parramatta through a Flood Enquiry Application and subsequent correspondence with Council officers. An XP-STORM model using the TUFLOW hydraulic engine was also built for the 1%AEP and PMF events to allow Northrop compare velocity profiles and behaviour at all locations across the subject site.

Importantly, correspondence with WHS officers from the Department of Education was been undertaken regarding the DoE's standard emergency management protocols and evacuation drills for the site. Further, dialogue with St Patricks Catholic church has also been considered to obtain their approval for refuge on their property.

The FEMP describes the full range of options available to occupants of the site during times of major to extreme flooding. The FEMP considers an evacuation (or muster) area, two evacuation routes to habitable buildings, and on-site refuge if and when required. The report notes that the majority of the evacuation assembly area is above the 1% AEP peak flood level.

2.4 THE BEWSHER REPORT

Bewsher were engaged by the DoE to on 7th April 2017, to undertake *"an expert and independent review"* of the flood risk issues associated with the Application. The Bewsher report is comprehensive and it is our considered view that the Bewsher report can be relied upon to form a view on the development proposal and the veracity of the submitted application.

Bewsher, with the recommendation of some minor inclusions to the FEMP, are entirely supportive of the development proposal. The Bewsher findings are discussed in more detail in **Section 3.1** of this report.

3 REVIEW OF PARRAMATTA COUNCIL'S CONCERNS

3.1 REVIEW OF PARRAMATTA COUNCIL'S ASSESSMENT REPORT

Council authored an assessment report taking into consideration the proposed development and submitted information with the DA (principally the Northrop letter and Northrop FEMP). We have not seen the original assessment report, but Council's flood-related comments were extracted from this report by Bewsher.

We have produced **Table 3.1-1** below, which is the extracted Council issues from the Bewsher report, the exert opinion of Bewsher (dated 10th April 2017), and our opinion after due consideration of the issues.

Table 3.1-1 – Review of Flood-Related Issues from Councils Assessment Report

Assessment Comment by the City	Response by Bewsher	Response by Rienco
"The covered outdoor learning area (COLA) would be at 8m AHD and as such would not meet the freeboard".	The COLA is an outdoor area protected by a roof. It has a concrete floor and no walls. It is not a habitable area (based on the definitions in the Floodplain Development Manual). It does not require a FPL or a freeboard.	We agree with the response by Bewsher.
"The Probable Maximum Flood (PMF) is approx. 13m AHD (4m to 5m above ground level). The proposed first floor level is 12.9m AHD and as such would not provide refuge in place for the PMF".	The City has calculated the depth of inundation to be 0.1m in a PMF. (The reviewer has calculated a depth of 0.2m). Given that the ARI of a PMF is approximately 100,000 years, it could serve as a refuge. This would be an 'option of last resort' should, for whatever reason, a person fails to evacuate and becomes trapped.	We agree with the response by Bewsher.
"*.. predictions of the geographic extent of flood risk are subject to inherent inaccuracies as a result of technical limits. Given the flatness of the site, small increases in flood level would result in large expansion of the extent of high flood hazard across the site. There is a high sensitivity to rainfall at this site as evidence by the difference between the 1% AEP level of approx. 7.9m AHD and the PMF level of approx. 13m AHD*".	All hydrological calculations are subject to some uncertainties. The reviewer agrees with the City that that the flood range between the 100 year ARI event and the PMF is large (i.e. approx 5m) and this places additional flood risk considerations on the site. However the proposed floor levels are well above the normal FPLs and there is a rising egress route available for evacuation. There are adequate margins of safety and redundancies to safely cope with any variations in the predicted flood behaviour that could likely occur.	We agree with the response by Bewsher.
"*The proposed use is classified as a 'sensitive use and facility'. Such uses are not considered to be*	Refer to **Section E1** for the reviewer's response on the	We agree with the response by Bewsher.

appropriate even in low hazard flood areas. The DCP sets no distinction between permanent and temporary uses. ".	classification of the land use as a *"sensitive use and facility"*. Whilst the DCP has not specifically referred to "*temporary uses*" the duration of a consent is a very pertinent consideration and clearly influences flood risk assessments. Therefore although not mentioned specifically, because the duration of a consent influences flood risks, it is a relevant consideration in determining compliance with the objectives of the DCP.	This particular proposal does not 'fit the mould' of the DCP – which is not the fault of the applicant. Simply because the DCP sets no distinction between permanent and temporary uses doesn't mean that Council cannot take such matters into consideration, as they are mandated under S74(B)(A) of the EP&A Act.
"*Council's DCP states that new development should not result in any increased risk to human life. While the proposal has gone some way to reduce the risk to human life, the fact that some risk will always remain is considered to be contrary to the principle. As such the proposal is inconsistent with the DCP* ".	Refer comments in **Section E3**.	This clause is identical to a clause in Shellharbour Council DCP, and as stated by SC Roseth in Neate vs Shellharbour City Council for this precise DCP clause – '*it is worded in such a way that no development could meet it'*. The Council position that 'some risk will always remain which is contrary to a principal' is at odds with the widely adopted approach of ALARP (As-Low-As-Reasonably-Practical).. Our view is that Councils position offends S79C(3)(A) of the EP&A Act.
"*The applicant has outlined, and Council officers agree, that it is not appropriate to attempt refuge in place in the event of severe weather* ".	Whilst the reviewer agrees that taking refuge on-site is not the primary means of managing flood risks, the availability of a refuge as an 'option of last resort' is a further mitigating factor in reducing the site's flood risks.	We agree with the response by Bewsher. The risk of exposure to severe flooding in a 12 month period is 1 in 100,000. This is beyond the realm of reasonableness and societal risk we face everyday.
"*Council officers worked with the applicant to optimize the evacuation plan. However, the NSW Government's Floodplain Development Manual is explicit in*	The reviewer does not agree. Refer comments in **Section E2**.	We agree with the response by Bewsher.

denouncing the reliance on evacuation plans ".		
"*Further, given the high number and young age of the students, it is considered that the chance that inappropriate decisions are made and that the flood evacuation management plan is not adequately adhered to are high. Further, while the proposed buildings are raised, the flood evacuation route requires that students descend back to ground level, increasing the risk during evacuation.* ".	Because these children are so young, they will be under the full-time control and supervision of their teachers. This assists in ensuring all children can respond to the FEMP actions when directed to do so by their teachers. With regard to the City's comments about students descending back to ground level, the reviewer agrees. Nevertheless given the good visual clues of advancing flood waters and the early evacuation trigger of 5m, this is not considered to be problematic. In the remote circumstances that the route back to ground level was blocked by flood waters, a higher alternative egress route which does not involve descent, will be available (refer **Section D1**).	We agree with the response by Bewsher.
"*As such the only safeguard that remains is the imperative to cancel school if high rains are predicted.* *Given the inherent uncertainty in meteorology this is not considered to be sufficient basis for fully mitigating the risk to human life* ".	There a range of circumstances that could trigger evacuation or closure of the school, not only a rainfall forecast on the previous day (e.g. triggering of the DipStik gauge, visual notification of rising flood waters, a generalised flood warning, and/or advice from emergency service personnel). In addition, as recommended in this review, the issuance of a Flood Watch by the Bureau of Meteorology should also be used as a trigger to close the school.	The condition required by Council, that the risk to someone's life can be/must be fully mitigated via development, is unrealistic and a criteria that no development could meet.
"*The primary risk to property resulting from the development would be one or more of the demountable units becoming unmoored and travelling down river. The applicant has submitted a statement by qualified structural engineers that the proposed buildings would be able to withstand the estimated flood velocities and associated debris impacts. However, Council's engineer and the external engineer hired to review the proposal have questioned the assumptions used in determining the flow velocities used to make these calculations.*	The reviewer disagrees with the City's assessment. Refer comments in **Section C2.2**.	We agree with the response by Bewsher.

It is unlikely that the proposed structures would withstand significant floods between the 1:100 and the PMF (fast moving water 5m to 6m above ground level). *In such an event the demountable buildings would be destroyed on site and/or washed into the river causing additional risk to human life and property downstream* ".		
"*The demountable buildings have been designed to allow up to 1:100 flood waters to flow through the cavities under the buildings. However, large objects such as trees, vegetation, and vehicles, could back up against the building support legs, diverting the flow of flood waters. However, the entire ground floor of the building would be submerged at the PMF flood and as such would divert floodwaters. From this diversion, flood flow patterns will change and flood levels will be raised in adjoining land.* *Council's Engineering is of the opinion that the buildings would block and disrupt the existing flood flows and flood levels on site, in the river, and on adjoining land, to an unacceptable degree* ".	The reviewer disagrees with the City's assessment.	We agree with the response by Bewsher.

4 RIENCO'S POSITION

4.1 QUANTIFICATION OF FLOOD HAZARD AND RISK

An important consideration for any development proposal of flood prone land is the definition of the hazard, the risk those hazards pose, and how the controls that will be put in place to control those risks. **Table 4.1-1** below summaries the key hazards identified by both Northrop and Bewsher, describes the key risks arising from those hazards, and identifies the controls in place for those risks that are contained within the submission.

Table 4.1-1 – Review of Flood Hazard, Risk and Risk Controls for Proposed Development

Hazard	Risk	Proposed Controls
Rate of Rise of Flood Water	Occupants of the site caught unaware, MFL is drowning. Note: The MFL is the Maximum Foreseeable Loss without any controls in place.	• The proposed school buildings will be located on areas that are only partly inundated in a 100 year event, and none of the buildings will be located in an area classified as 'high hazard' under the NSW Floodplain Development Manual. • The upper storey floors would only be inundated in an event rarer than a 50,000 year flood (Bewsher), and the occurrence of such an extreme event over the 12 month tenure of the site is very remote (Bewsher). • The FEMP provides for several safe evacuation routes to PMF free habitable floor areas.
Velocity of Floodwater	Occupants cannot safely wade through water, drowning. Structures being removed from their foundations and swept downstream.	• The proposed school buildings will be located on areas that are only partly inundated in a 100 year event, and none of the buildings will be located in an area classified as 'high hazard' under the NSW Floodplain Development Manual. • The FEMP provides for several safe evacuation routes to PMF free habitable floor areas. • Structural integrity can be resolved through detailed structural design, mandated through a condition of consent.
Extent of Inundation of Floodwater at the site	Schools and educational establishments are normally regarded as 'sensitive uses and facilities' and the proposed development does not meet this typically applied	• Duration of the land use is approximately 12 months, not potentially 100 years as a normal design life for such development. This reduces the likelihood considerably.

	standard, leading to higher than normal exposure of occupants to flooding.	• The proposed development is not a designated evacuation centre, as might normally be the case with such developments.

It is our view that the proposed controls are sufficient to control the risks posed by the hazards identified at the subject site. Our position on this matter is well aligned with both the Northrop and Bewsher position.

4.2 COMMENTS ON COUNCILS POSITION ON FLOOD HAZARD AND RISK

Rienco's position is markedly different from Council's. Council's inflexible approach to both the interpretation of its DCP and the application of its DCP is illustrated by this example from their assessment report:

> *Council's DCP states that new development should not result in any increased risk to human life. While the proposal has gone some way to reduce the risk to human life, the fact that some risk will always remain is considered to be contrary to the principle.*

Council are in effect seeking a proposal that has zero risk to life. It is our view that a 'zero risk' environment does not exist for human beings, and it is unreasonable for Council to expect any development to be free of risk to life. Our view is reinforced by SC Roseth (NSW L&EC Appeal No 10337 of 2006) with specific regard to this precise flood DCP wording:

> *This <performance criterion> is expressed in such a categorical form that no proposal could meet it. For example, a building that requires scaffolding will increase risk to human life because workers sometimes fall off scaffolding. If the statement is understood to say that there should be no measurable, perceptible, or noticeable increased risk to human life, then the proposal given its numerous safeguards, meets it.*

It is our further view that even if Council's position on zero risk was accepted, and even if it was demonstrated that there was a small increase in risk due to the proposed development (and therefore a non-compliance with a DCP performance criteria), such non-compliance is not determinative. It is a fundamental issue that the governing planning instrument applying to the site is the Local Environmental Plan. As stated by SC Roseth (NSW L&EC Appeal No 10337 of 2006):

> *Council's Flood Risk DCPs must be the focal point in the assessment of flood risk and should be given significant weight, however such weight is not determinative.*

SC Roseth (NSW L&EC Appeal No 10337 of 2006) also held that *Council is obligated to give 'genuine, realistic and specific attention to the disqualifying provision of the DCP in the context of the particular circumstances'*. Council have failed to give any *'genuine, realistic and specific attention to the disqualifying provision of the DCP in the context of the particular circumstances'* and in doing so have sought to have the proposal determined based on a perceived non-compliance with their DCP. Such an approach is also inconsistent with Council's legislated responsibility under S74(B)(A) of the EP&A Act, which requires Council to use the DCP to facilitate development that is permissible under the LEP.

Finally, we consider Council's approach to assessing this proposal as inconsistent with S79C(3A)(a) and (b) of the EP&A Act which states that:

> *if those provisions set standards with respect to an aspect of the development and the development application complies with those standards-is not to require more onerous standards with respect to that aspect of the development.*

In our view, the unwillingness to accept the advice of Northrop and Bewsher is inconsistent with S79C(3A)(b) of the EP&A Act which states:

> *if those provisions set standards with respect to an aspect of the development and the development application does not comply with those standards-is to be flexible in applying those provisions and allow reasonable alternative solutions that achieve the objects of those standards for dealing with that aspect of the development.*

Council have arrived at an interpretation of a document, and have demonstrated no flexibility in considering an alternate interpretation by either Northrop of Bewsher. A further example of the inflexible approach taken by Council is their interpretation that the use of a FEMP *is not in accordance with the Floodplain Development Manual*. Northrop disagreed with this position, as did Bewsher who offered an alternate view and detailed explanation (our emphasis added):

> *Bewsher agrees with the City that the NSW Floodplain Development Manual states that FEMPs should not be used as the basis for development consents. Bewsher agrees with this requirement and considers it a component of good floodplain development practice.*
>
> *However the current Application is not proposing reliance on the FEMP as a basis for the consent. The Application will have access to high ground where occupants can take shelter. The FEMP enhances and facilitates this egress. Without the FEMP this access to high ground would still be available.*
>
> *The Manual and the SES recommend implementation of FEMPs because they reduce flood risks. The development of a FEMP for this Application is fully in accordance with the requirements of the Manual, the SES' guidelines and good floodplain management practice. The development of a FEMP is also consistent with the City's own policies.*

Bewsher's position is consistent with our experience and judgement, and is in our opinion a common way in which the FPDM is interpreted. It is our view that Council have failed to *be flexible in applying those provisions and allow reasonable alternative solutions that achieve the objects of those standards for dealing with that aspect of the development.*

It is our view that the proposed application (inclusive of the FEMP and all the controls nominated within the Northrop report and design plans) offers *reasonable alternative solutions that achieve the objects of those standards for dealing with that aspect of the development.*

4.3 STRUCTURAL STABILITY OF BUILDINGS

Concerns were raised by Council that buildings could be washed away, in particular during extreme (PMF) floods. We agree with Council that consideration of such aspects of any proposal on flood-prone land is an important one.

However, it appears from the documents reviewed that Northrop, OEH and Bewsher are all of the view that ensuring the demountable structures do not wash away, even in extreme flooding, can be readily achieved through sound structural engineering design and can be readily conditioned as part of a consent. In forming their view, Northrop, OEH and Bewsher have all acknowledged the environmental constraints on the site, in that there is to be no excavation of the surface of the oval.

Rienco is also of the view that any such stability issues can be readily overcome by proper structural engineering design. The structural analyses prepared by Northrop (as reviewed by Bewsher) demonstrate that a practical solution ensuring the stability of the buildings can be achieved.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Based on the information contained within this report, it can be concluded that:

- The Department of Education (DOE) needs to decant 1,000 students from Parramatta Public School to temporary demountable accommodation on the Old Kings School oval (the site). To achieve this, the DOE proposed a series of temporary demountable buildings on an adjacent school oval.
- A Development Application (DA) was been lodged with the City of Parramatta (City) and was to be determined by the Sydney West Central Planning Panel (Panel).
- Council took an unsupportive view of the application and although the DOE attempted to address the flood risk concerns that had been raised, on 28th March 2017 the City advised that they did not support the DA and considered *"the proposed sensitive land use should not be supported in a flood area".*
- Subsequent to this decision, Bewsher Consulting was commissioned by the DOE on 7th April 2017, to provide *"an expert and independent review*" of the flood risk issues associated with the DA.
- Notwithstanding the Bewsher report recommending approval of the DA (with some minor modifications to the FEMP), on 12th April 2017 the Sydney West Central Planning Panel determined the DA by way of refusal.
- Given the above, the matter has been further referred to the Minister for Planning for determination.
- As the Department of Planning and Environment (DPE) is assisting the Minister in relation to his consideration of the proposal, the DPE are seeking further independent flood advice on this matter. This report was commissioned (through ELA) and constitutes the additional advice sought by the DPE.
- Our review has reviewed and thoroughly considered the flood risk documents and assessments carried out by:
    - Northrop – the applicant's engineers and authors of the FEMP.
    - Council – who authored the assessment report for the DA.
    - OEH – who are the State agency which provides advice on implementation of the NSW Flood Prone Land Policy and the NSW Floodplain Development Manual, and who provided comments on this specific proposal
    - Bewsher Consulting – regarded as expert in the specialist field of floodplain management.
    - Sydney West Central Planning Panel – who determined the application.
- In our considered professional opinion, and giving due weight to the above referenced documents and our own experience and judgment, we consider:
    - The proposal an appropriate use of the land when taking into account the temporary nature of the development.
    - The application prepared by Northrop, combined with the helpful view of OEH and the recommendation for approval by Bewsher, to be entirely supportable.

5.2 RECOMMENDATIONS

Based on the information contained within this report, it is recommended that:

- It is the opinion of the reviewer that the Application (with the recommendations included within this report) is appropriate having regard to good floodplain management practice. We consider that the flood risks to which users of the site will be exposed are not significant and are acceptable.
- Should the Minister be of the mind to approve the application, we recommend the following considerations to be included in any conditions of consent:
    - Structural performance of buildings
    - Minor additions to the FEMP (as recommend by Bewsher) be included in the final FEMP.

Prepared by:

Anthony Barthelmess
Dip. Eng, MEng. MIEAust CPEng RPEQ NER
Managing Director

Additional References:

Neate v Shellharbour City Council 24 August 2007 NSW Land & Environment Court Appeal No. 10337 0f 2007. S65A Appeal decision of Pain J.

Abbreviations

	Abbreviation Description
AEP	Annual Exceedance Probability; The probability of a rainfall or flood event of given magnitude being equalled or exceeded in any one year.
AHD	Australian Height Datum: National reference datum for level
ALS	Air-borne Laser Scanning; aerial survey technique used for definition of ground height
ARI	Average Recurrence Interval; The expected or average interval of time between exceedances of a rainfall or flood event of given magnitude.
AR&R	Australian Rainfall and Runoff; National Code of Practice for Drainage published by Institution of Engineers, Australia, 1987.
EDS	Embedded Design Storm; synthesised design storm involving embedment of an AR&R design burst within a second design burst of much longer duration
FPDM	Floodplain Development Manual; Guidelines for Development in Floodplains published by N.S.W. State Government, 2005.
FSL	Flood Surface Level;
GIS	Geographic Information Systems; A system of software and procedures designed to support management, manipulation, analysis and display of spatially referenced data.
IFD	Intensity-Frequency-Duration; parameters describing rainfall at a particular location.
ISG	Integrated Survey Grid; ISG: The rectangular co-ordinate system designed for integrated surveys in New South Wales. A Transverse Mercator projection with zones 2 degrees wide (Now largely replaced by the MGA).
LEP	Local Environment Plan; plan produced by Council defining areas where different development controls apply (e.g. residential vs industrial)
LGA	Local Government Area; political boundary area under management by a given local council. Council jurisdiction broadly involves provision of services such as planning, recreational facilities, maintenance of local road infrastructure and services such as waste disposal.
MGA	Mapping Grid of Australia; This is a standard 6° Universal Transverse Mercator (UTM) projection and is now used by all states and territories across Australia.
MHI	Maximum Height Indicator; measuring equipment used to record flood levels
PMF	Probable Maximum Flood; Flood calculated to be the maximum physically possible.
PMP	Probable Maximum Precipitation; Rainfall calculated to be the maximum physically possible.
RCP	Reinforced Concrete Pipe;
km	Kilometre; (Distance = 1,000m)
m	Metre; (Basic unit of length)
m^2	Square Metre; (Basic unit of area)
ha	Hectare; (Area =10,000 m2)
m^3	Cubic Metre; (Basic unit of volume)
m/s	Metres/Second; (Velocity)
m^3/s	Cubic Metre per Second; (Flowrate)
s	Second; (basic unit of time)
WCC	Wollongong City Council; name of the council with jurisdiction over the Wollongong LGA

Technical Terms

Term	Description
Alluvium	Material eroded, transported and deposited by streams.
Antecedent	Pre-existing (conditions e.g. wetness of soils).
Catchment	Area draining into a particular creek system, typically bounded by higher ground around its perimeter.
Critical Flow	Water flowing at a Froude No. of one.
Culvert	An enclosed conduit (typically pipe or box) that conveys stormwater below a road or embankment.
Discharge	The flowrate of water.
Escarpment	A cliff or steep slope, of some extent, generally separating two level or gently sloping areas.
Flood	A relatively high stream flow which overtops the stream banks.
Flood storages	Those parts of the floodplain important for the storage of floodwaters during the passage of a flood.
Floodways	Those areas where a significant volume of water flows during floods. They are often aligned with obvious naturally defined channels and are areas which, if partly blocked, would cause a significant redistribution of flow.
Flood Fringes	Those parts of the floodplain left after floodways and flood storages have been abstracted.
Froude No.	A measure of flow instability. Below a value of one, flow is tranquil and smooth, above one flow tends to be rough and undulating (as in rapids).
Geotechnical	Relating to Engineering and the materials of the earth's crust.
Gradient	Slope or rate of fall of land/pipe/stream.
Headwall	Wall constructed around inlet or outlet of a culvert.
Hydraulic	A term given to the study of water flow, as relates to the evaluation of flow depths, levels and velocities.
Hydrodynamic	The variation in water flow, depth, level and velocity with time
Hydrology	A term given to the study of the rainfall and runoff process.
Hydrograph	A graph of flood flow against time.
Hyetograph	A graph of rainfall intensity against time.
Isohyets	Lines joining points of equal rainfall on a plan.
Manning's n	A measure of channel or pipe roughness.
Orographic	Pertaining to changes in relief, mountains.
Orthophoto	Aerial photograph with contours, boundaries or grids added.
Pluviograph	An instrument which continuously records rain collected
Runoff	Water running off a catchment during a storm.
Scour	Rapid erosion of soil in the banks or bed of a creek, typically occurring in areas of high flow velocities and turbulence.
Siltation	The filling or raising up of the bed of a watercourse or channel by deposited silt.
Stratigraphy	The sequence of deposition of soils/rocks in layers.
Surcharge	Flow unable to enter a culvert or exiting from a pit as a result of inadequate capacity or overload.
Topography	The natural surface features of a region.
Urbanisation	The change in land usage from a natural to developed state.
Watercourse	A small stream or creek.

APPENDIX A – CV OF ANTHONY BARTHELMESS

Anthony John Barthelmess

Managing Director – Rienco Consulting. PO Box 3094, Austinmer NSW 2515.
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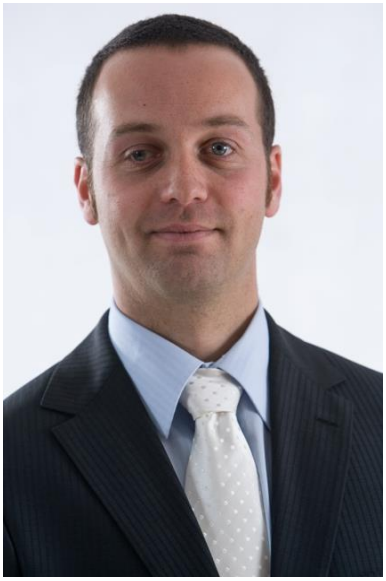
Qualifications



- Diploma of Structural Engineering, 2000 (SIT, Ultimo).
- Masters of Civil Engineering, 2009 (University of Wollongong).
- Statutory Underground Coal Ventilation Officers Certificate of Competency for NSW and QLD (UNSW).
- Chartered Professional Engineer (Civil), Registered Professional Engineer of Queensland, NER.
- *Committees & Memberships:* Member Institute of Engineers Australia, Australian Rainfall & Runoff Project 11 Blockage Committee.
- *Professional Activities:* Guest Lecturer at UOW
- Recipient of several NSW and National industry awards for Excellence in Stormwater Management.

Experience

2015 – Current **Managing Director – Rienco Consulting.**

Managing Director of a regional consulting water and civil engineering firm.

2012 – 2015 **Gas & Ventilation Engineer, BHP Billiton / South32 / Appin Mine**

Responsible for management of underground ventilation and surface gas drainage activities at Appin Mine and managing the ~$6M annual capital works program. Appointed Statutory Ventilation Officer at Appin Mine.

2009 – 2011 **Project Director – Cardno NSW Pty Ltd**

Responsible for leading a large team of employees and sub-consultants to deliver major Part 3A projects across NSW.

2006 – 2009 **Project Manager – Cardno Forbes Rigby Pty Ltd**

Lead flood and water modeller supporting large scale urban development and civil infrastructure projects.

2002 – 2005 **Civil Designer – Forbes Rigby Pty Ltd**

Civil designer on a range of civil engineering projects, involving all facets of project delivery from concept design through to site supervision and contract admin.

2000 – 2001 **Project Engineer – GHD Pty Ltd**

Role involved preparation of civil design plans and specifications for large design and construction contracts and large scale civil infrastructure.

1996 – 2000 **Project / Construction Engineer – MPN Group Pty Ltd**

Prepared civil designs for multiple Westfield Shopping Centre external works. Role also involved extensive site supervision across Australia.

Expert Witness Experience

- Class 1 Land & Environment Court Proceedings 10120 of 2016 (Featherstone vs Wollongong City Council). Acted for the applicant relating on flood and coastal hazard related matters for a development on residentially zoned land in Stanwell Park, NSW. Flood and coastal hazard related matters were successfully resolved for the applicant in a difficult 'joinder' arrangement where an adjoining landowner was also involved alongside WCC.
- Class 1 Land & Environment Court Proceedings 10649 of 2015 (Develop My Land Pty Ltd vs Wollongong City Council). Acted for the applicant relating on flood related matters for a 5-unit development on residentially zoned land in Coledale, NSW. Flood related matters were successfully resolved for the applicant at the Section 34 conference.
- Class 1 Land & Environment Court Proceedings 10337 of 2006 (Neate vs Shellharbour Council). This project involved the creation of 1D and 2D flood models for confirmation of flood behaviour in support of a development application for a Seniors Living complex in 2006. The client then litigated in the L&E Court (for which Expert Witness services were rendered) to obtain a DA, which was successful in 2007.
- Class 1 Land & Environment Court Proceedings 11377 of 2005 (Neate vs Wollongong City Council). This project involved creation of 1D and 2D flood models in support of a development application for a Seniors Living complex. The client litigated in the Court (for which Expert Witness services were rendered) to obtain a DA, which was successful, pending the development of a Flood Warning System (FWS). A FWS was developed, but again litigation was considered the only way of furthering the Development Consent. This further phase involved the additional Expert Witness Statements and participation in Joint Expert Witness Conferences with Council and the SES and attendance in Court.
- Class 1 Land & Environment Court Proceedings (Wakim vs RTA). This project involved compensation of supposed flood affected land up for Compulsory Acquisition by the RTA. The work involved determining the 'highest and best use' of the land with regard to its flood affectation. Acting for Mr. Wakim, the matter was resolved successfully.
- JRPP and PAC Appearances. Various appearances at Joint Regional Planning Panel and Planning & Assessment Commission to provide evidence /submissions for Major Part 3A land development projects (relating to flooding).

Hydrology and Hydraulics Experience

- Hewitts Creek Flood Study and Floodplain Risk Management Study for Wollongong City Council (2002 ongoing).
- Duck Creek Flood Study for Tallawarra Lands/TRUenergy. Catchment wide hydrology (WBNM) and hydraulic (HEC-RAS and TUFLOW) model of Duck Creek with a complicated arrangement of flood storages and diversions.
- Calderwood Flood Study for Delfin Lend Lease. Catchment wide hydrology (WBNM) and hydraulic (TUFLOW) model of Macquarie Rivulet, calibration and validation, and development of a FPRMS.
- Vincentia Flood Study for Stockland Developments. Catchment wide hydrology (WBNM) and hydraulic (HEC-RAS) model of a sensitive Vincentia catchment discharging into St Georges Basin.
- Forde Estate Flood Study, Canberra for Canberra Investment Corporation. Catchment wide hydrology (WBNM) and hydraulic (HEC-RAS) model of for a catchment with ~650 lots proposed.
- Central Hills Rezone for Camden Council. Catchment wide hydrology (WBNM) and hydraulic (HEC-RAS) modelling of an open pasture catchment at Narellan, for proposed 1,000 lots.

- Bulli Dam Investigation for Multiplex. Hydrologic investigation into various over-topping scenarios up to the PMF.
- Flood Study for Proposed Woolworths Supermarket, Princes Highway Bulli. Prepared flood study including detailed site inspections of diversions structures, full hydrologic study including detention basins, blockage scenarios and diversions (WBNM). The area is quite complex due to diversions at each hydraulic structure combined with the Illawarra Railway line acting as a large weir immediately downstream of the site. Study also required detailed hydraulic model and determination of flood risk precincts to Councils DCP54.
- Mt Ousley Bulli Pass Upgrade Study, Wollongong for RTA. Project involved GPS survey using differential GPS and handheld unity on existing culverts for Main Road 95 and 513 (Mt Ousley Road and Bulli Pass) using GIS based field method. Undertake hydrologic (WBNM) and hydraulic (HEC-RAS) calculations based on field captured data and hydrologic/hydraulic analysis.
- Drainage Study of Marrickville Industrial Estate for Marrickville Council. Responsible for modelling and documentation of over 1,500 stormwater pits and pipes, detention basins, open channels and weirs. Assistant Modeller using DRAINS for Marrickville City Council simulating complex flow diversions and flow paths.
- Macquarie Rivulet Flood Studies (various). Several hydraulic models (HEC-RAS and FESWMS) of Macquarie Rivulet lower flood plain to determine previously unknown effects of the PMF event on future development. Preparing flood reports and compliance with the many varying requirements in place in the Illawarra (local DCP's, FDM2005, FMM 2001 etc).
- Review of Lake Illawarra Flood Study and Floodplain Risk Management Study. Review and provide comment to Lake Illawarra Authority on the impacts and technical points of conflict in the Lake Illawarra Flood Study and Risk Management Plan. With respect to appropriate freeboard, the effects of filling around the lakes, entrance conditions etc.

Water Quality and WSUD Experience

- Water Sensitive Urban Design Study, Calderwood Urban Development Project (2010). Lead author of the Water Sensitive Urban Design Study of the Environmental Assessment for the Calderwood Urban Development Project. Involved protracted negotiations with DoP, the PAC and peer review processes to ensure the successful Project Application.

- Water Sensitive Urban Design Study, Bayswood Development, Vincentia (2007). Lead author of the Water Sensitive Urban Design component of the Environmental Assessment for the Bayswood Development (State Significant Major Project). The major project application was successful and additional reporting was required to assess the Director General Requirements and prepare the Project Application. Detailed designs were then prepared and the wetland and environmental protection measures began construction late 2007.

- Water Sensitive Urban Design Study, Sandon Point Development (2007). Lead author of the Water Sensitive Urban Design component of the Environmental Assessment for the Sandon Point development (State Significant Major Project). A detailed Climate Change assessment on increased flood risk and coastal erosion was also undertaken. Involved protracted negotiations with DoP and peer review processes to ensure the successful Project Application.

- Forde Estate Wetland Concept Design, ACT (for Canberra Investment Corporation CIC, 2006). Lead designer of over 4 ha of wetlands and ponds for a new residential estate near Gungahlin in ACT. The wetlands are capable of treating over 400 ha of cleared and developed catchment to below existing nutrient levels. Detailed WBNM, HEC-RAS and

MUSIC modelling was required to afford the development team a certain level of confidence regarding the approach taken by the design.

- Central Hills Rezone – Water Cycle WSUD Study for Camden Council (2005-06). This study was prepared in support of a rezone of agricultural land to urban release. The study contained a detailed water cycle analysis (including preparation of detailed water balance models) and a full assessment of water quality and WQM objectives. Also of note was the heritage water supply canal structures traversing the site, and the ever present salinity problem in western Sydney.

Project Management and Superintendent Experience

- Nan Tien Temple / University (Wollongong). Site Superintendent and Contract Preparation and Administration for the ground consolidation and civil works (Contract value = ~$6M).
- Tullimbar Subdivision (Wollongong). Site Superintendent and Contract Preparation and Administration for a 2km riparian area and first two residential stages ~100 lots (Contract value = $10M).
- Haywards Bay Subdivision (Wollongong). Site Supervision of several 40 lot stages of the subdivision and two RTA bridges.
- Stockyard Creek Subdivision (Wollongong). Site Superintendent and Contract Administration for a riparian area 65 lot residential stage (Contract value = $1.5M).
- Various University of Wollongong Infrastructure. Site supervision and Contract Preparation and Administration for 250 space carpark and extensions to Building 40 ($5M).
- Westfield Warrawong (NSW), Westfield Hornsby (NSW), Westfield Southlands (VIC) and Westfield Tea Tree (SA). Supervision and Contract Administration for all external works such as alterations and additions to existing roads, carparks, external roundabouts, stormwater drainage and pavement reports and rehabilitation.

Urban Development and Civil Engineering Experience

- Lead Designer and Site Superintendent – Stockyard Creek Subdivision, Albion Park. Role involved the design of over 120 lots in three stages, trunk infrastructure, riparian areas and RTA road upgrades.
- Lead Designer and Site Superintendent – Nan Tien Temple. Role involved the design of the remediation of an old landfill to enable the new University to be constructed. This project utilized ~500,000 m^3 of coalwash emplacement.
- Lead Designer and Site Superintendent – Tullimbar Village. Role involved the design of over 1,500 lots, trunk infrastructure, 2km of riparian areas and RTA road upgrades.
- Lead Designer and Site Supervision – Hayward's Bay Subdivision, Albion Park. Role involved the design of over 450 lots in eight stages, trunk infrastructure (including vacuum sewer) and RTA road access including two bridges. This project involved over 800,000 m^3 of coalwash emplacement.
- Energy Australia 132kV Cable Cross-City Tunnel. Responsible for design, documentation and design/construct contract preparation of 1.3km cross city tunnel and portals.
- Somerton Power Station. Responsible for design and documentation of a complex road network and services arrangement at Somerton Power Station.

Mining Experience

- Statutory Appointed Ventilation Officer at Appin Mine. Completion of all statutory responsibilities, monthly ventilation surveys, P/Q surveys with electronic barometers, financial planning and reporting.

- Surface Gas Drainage – Design, construction and operation of gas boreholes, gas drainage plants and monitoring infrastructure.

- Stage 3 Coalwash Emplacement Project, West Cliff Colliery. This project involved the engineering design and construction supervision of $33M of construction works to support the ongoing stages of Illawarra Coal's Stage 3 emplacement. The project involved construction liaison with the Contractor and in excess of 200,000 m^3 of earthworks, two 45ML dams and 7 km of surface water diversion drains.
- Dendrobium Drift (North-West Mains, B Heading 12-20ct) Pavement Design Inbye of Wongawilli Seam fault (500m length).
- Appin Area 7 Longwall 704 2km sub-surface MRD drill and well-head extraction design and Goaf Gas Extraction Plant Detailed Design.
- Appin Area 9 Vent Shaft 6 Drilling Site Layouts, and Appin Area 9 Tailgate 901 STIS 2.2km drill hole and drill pad designs.
- Mine Closure Plans and Cost Estimates for Cordeaux, Dendrobium and Processing/Logistics sites.

Publications

Rigby, E.H, Barthelmess, A.J., Mazengarb, C. and Garcia, R. 2016. *"Experiences Exploring the Feasibility of Constructing a Very Large Scale 2D Flood Model of Tasmania".* Proceedings of 37th Australian Hydrology and Water Resources Symposium, Queenstown, New Zealand.

Barthelmess, A.J. and Nichols, P.S. 2015. "*Suitability of ARR Guidelines as an Alternative Blockage Policy for Wollongong"*. Proceedings of 36th Australian Hydrology and Water Resources Symposium, Hobart, Tasmania.

Weeks, W, Barthelmess, A.J, Rigby, E.H, Witheridge, G and O'Loughlin, G. 2013. "*Blockage of Hydraulic Structures – Stage 2 Report".* ISBN 978-0-85825-956-0, Prepared for Engineers Australia for Australian Rainfall and Runoff revisions.

McIntosh, G.W. and Barthelmess, A.J. 2013. *"Building on an old landfill: design and construction".* Proceedings 18th Int. Conf. on Soil Mechanics and Geotechnical Engineering, Paris.

McIntosh, G.W. and Barthelmess, A.J. 2012. *"Reclamation of an old landfill at Unanderra, NSW".* Proceedings Int. Conf. on Ground Improvement and Ground Control, Wollongong, Australia October 2012. (Invited Paper).

Barthelmess, A.J. and De Jong, O. 2011. *"When are Impacts on Flooding Non-Detrimental? Implications of Development in Flood-Prone Sites".* Proceedings of NSW SIA Conference, Hunter Valley, September 2011.

De Jong, O. and Barthelmess, A.J. 2011. *"Major Flood of March 2011: 1 in 100 year Wipeout for Warilla".* Proceedings of NSW SIA Conference, Hunter Valley, September 2011.

Barthelmess, A.J. and Rigby, E.H. 2011. "*Estimating Culvert Blockages – A simplified Procedure".* 34th World Congress of the International Association for Hydro-Environment Engineering and Research (IAHR) 26 June – 1 July, 2011.

Rigby, E.H. and Barthelmess, A.J. 2011. "*Culvert Blockage Mechanisms and their Impact on Flood Behaviour".* 34th World Congress of the International Association for Hydro-Environment Engineering and Research (IAHR) 26 June – 1 July, 2011.

Barthelmess, A.J. and Nichols, P.S. 2010. *"The Development of a Predictive Flood Warning System to Manage Flood Isolation Risk for Lake Illawarra".* Proceedings of 50th Annual Floodplain Managers Conference, Gosford 2010.

Barthelmess, A.J. and Rigby, E.H. 2009. "*Quantification of Debris Potential and Evolution of a Regional Culvert Blockage Model".* Proceedings of H2009 - 32nd Hydrology and Water Resources Symposium, Newcastle NSW, November.

Weeks, W, Barthelmess, A.J, Rigby, E.H, Witheridge, G and Adamson, R. 2009. "*Blockage in Drainage Structures".* Proceedings of Hydrology and Water Resources Symposium, Engineers Australia, Newcastle.

Nichols, P.S., Barthelmess, A.J. and Webber, K. 2008. *"Merit-based Design in Floodplain Management".* Proceedings of 48th Annual Floodplain Managers Conference, Wollongong 2008.

Weeks, W, Barthelmess, A.J, Rigby, E.H, Witheridge, G and O'Loughlin, G. 2009. "*Blockage of Hydraulic Structures – Stage 1 Report".* ISBN 978-085825-9539, Prepared for Engineers Australia for Australian Rainfall and Runoff revisions.

Barthelmess, A.J. 2007. *"Geomorphology and Urban Stream Rehabilitation: Principles in Practice".* Proceedings of Stormwater Industry Association National Conference, Wollongong 2007.

Barthelmess, A.J. 2007. *"Using GIS to prioritise culvert upgrade".* Proceedings of Stormwater Industry Association National Conference, Wollongong 2007.

Barthelmess, A.J. and Nichols, P.S. 2006. *"A Framework for Culvert Upgrade and Assessment in GIS: An Engineers Approach".* Proceedings of 1st OZRI – National GIS Conference Melbourne 2006.