THE UNIVERSITY OF NEW SOUTH WALES

Water Research Laboratory

School of Civil and Environmental Engineering

28 February 2013

WRL Ref: WRL2012070 JTC LR20130228

Ms Jane Gibbs
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By email: jane.gibbs@environment.nsw.gov.au

Dear Jane,

Peer Review of Revised DA Documents regarding Old Bar Erosion Protection Works

1. Introduction

A peer review of documents forming a Statement of Environmental Effects by International Coastal Management (ICM) for proposed Erosion Protection Works at Old Bar NSW was undertaken by Senior Coastal Engineer James Carley of the Water Research Laboratory (WRL) on 7th August 2012 (WRL Ref: WRL2012070 JTC MJB PLR20120807). In response to WRL's peer review and questions submitted to the applicant by the NSW Coastal Panel and NSW OEH, the applicant submitted revised documents.

This letter report provides a technical peer review of the revised documents relating to this application.

2. Revised Documents Provided

Revised documents were provided to WRL in February 2013. The following documents provided only general background information or were superseded by later versions, and were not the subject of a technical peer review by WRL:

- "OB-EPW amended 2012.11.08.pdf" dated 8 November 2012 - revised drawings which appear to be further superseded by the document below ("Old Bar amended 2013.01.16.pdf"), therefore was not reviewed by WRL.
- "Letter of consent from new owners.pdf" dated 9 November 2012 – does not contain material for review by WRL.
- "Response to NSW Coastal Panel RFI2.pdf" dated 16 January 2013 – is a covering letter introducing the documents reviewed below and therefore was not reviewed by WRL.

The following documents were peer reviewed by WRL's Senior Coastal Engineer James Carley:

- "Response to NSW Coastal Panel RFI.pdf" dated 24 October 2012 – reviewed by WRL.
- "Old Bar Seawall Management Plan.pdf" which is undated within the document text, but the electronic version indicates that this was last modified on 5 December 2012 – reviewed by WRL.

- "Old Bar amended 2013.01.16.pdf" dated 16 January 2013 - revised drawings reviewed by WRL.

While the documents listed above were reviewed, a revised version of ICM's previous design report which considers WRL's comments has not been received by WRL.

3. "Response to NSW Coastal Panel RFI.pdf" dated 24 October 2012

The headings below are abbreviated versions of the questions asked of the applicant by the NSW Coastal Panel. The full version of the heading is contained in the ICM document. Discussion of ICM's answers is provided below the heading.

3.1 Land ownership

No input from WRL.

3.2 Quantification of end effects

The ICM document illustrates the end effects to the south as requested, but not to the north.

The WorleyParsons (2010) study believed that net littoral drift transport was northward under ambient conditions and southward under storm conditions, but there is uncertainty regarding this assumption. WRL concurs with ICM that northward net littoral drift transport may assist with recovery of end effect erosion on the southern side of the proposed wall, but end effects to the north cannot be excluded.

3.3 How end effects are proposed to be managed

Progressive extension of returns as described by ICM is the only practical measure available to prevent flanking. Additional comments are made in Sections 3.5 and 5.4 of this WRL letter.

3.4 If end effects are experienced, how public safety is proposed to be managed

As per Section 3.3 above. WRL would add that the proposed slope of 1V:1.5H complies with stair gradient requirements, but the typical bag height of about 0.6 m exceeds the allowable stair riser height under the Building Code of Australia of 190 mm. That is, if/when the structure is used as a stairway by pedestrians, the gradient would be safe but the step height would exceed the requirements for a conventional stairway. The softness of the structure and the slight curve in the upper face would reduce the impact of the larger than ideal step height.

3.5 Achieving restoration of the beach

The statement that "*seawalls... typically experience heightened accretion subsequent to the storm event*" needs either a reference or further explanation to support it.

WRL agrees with ICM that adding additional beach width over a short length of coastline is not feasible, and could only be implemented over a longer length of coastline as part of a larger scale scheme.

3.6 *Justification of proposed design in terms of its adequacy*

While single layer sandbag structures with a crest of approximately 3 m AHD have been built in NSW, Queensland and elsewhere, many have been substantially damaged in storms.

The ICM revised design has lowered the toe to -1 m AHD and proposes a double layer of bags up to +3 m AHD. The proposed toe level accords with typical "rule of thumb" practice for NSW, but this does not guarantee that it will not be undermined.

With an eroded beach seaward of the structure, runup above +3 m AHD is highly likely in even moderate storms at high tide. The transition from one bag thick to two bags thick at +3 m AHD may be a point of weakness for the structure. The structure may be substantially damaged before the reactive addition of extra bags is undertaken.

3.7 *Justification of proposed rock toe placement*

ICM's revised design with a deeper toe negates any benefit a rock toe would provide. The rock toe proposal has been removed from the revised design.

3.8 *Justification and consideration of alternatives for seawall alignment*

The ICM proposed alignment is wholly within the private property boundaries. Clearly, a more landward alignment could provide more alongshore beach access and amenity seaward of the structure, but this would technically be on private land. This is a complex policy and legal area beyond a coastal engineering peer review.

3.9 *The potential for impacts on dune vegetation*

As stated above, the assumption of southward littoral drift is not certain, and WRL recommends that end effects also be considered to the north.

WRL agrees that the sandspit around the entrance to Racecourse Creek is inherently unstable. It is situated on land subject to the entrance instability hazard within the NSW Coastline Management Manual (1990), though it is somewhat stabilised by a minor gabion training wall.

3.10 *Information on staging*

ICM covers the issue of staging of the revised DA portion of the proposed seawall, but does not address triggers for staging of proposed future extensions which do not form part of this DA.

3.11 *Ongoing management and maintenance of the structure*

A seawall management plan has been provided and is reviewed separately in Section 4 of this letter.

3.12 *Long term plans for decommissioning*

WRL concurs with ICM's response.

3.13 Any impacts of the excavation on groundwater

WRL concurs with ICM's response and adds that the permeability of a sandbag structure is similar to that of a natural sand dune provided the filling sand complies with ICM's requirements.

3.14 Any stormwater management impacts

WRL concurs with ICM's response.

3.15 Confirmation of the source sand

WRL concurs with ICM's response and adds the following. If the seawall is removed and the sand released into the active beach system, the volume would be small, and provided the sand complies with ICM's required properties, it will seamlessly blend into the littoral system.

4. Old Bar Seawall Management Plan

The work presented is generally of professional engineering standard.

The document acknowledges that seawall impacts are likely to occur off site, but notes that other property owners potentially affected may not gain approval to extend the works to protect their land.

The document should acknowledge that within the context of the NSW Coastline Management Manual (1990), the coastal hazards occurring at Old Bar are *erosion* and *recession.*

WRL suggests that the structural condition of the wall be assessed by a qualified coastal engineer and geotechnical engineer. A suggested template for establishing a *condition index* is provided in Oliver et al (1998).

The plan should contain information on where/how records of the inspections are to be held and stored.

It is noted that monitoring of beach change is not proposed in the plan.

5. Drawing Set: Old Bar Erosion Protection Works (Old Bar amended 2013.01.16.pdf)

This drawing set comprises six drawings plus a title sheet. Comments are provided on each drawing below. Some justification and commentary on features shown in the drawings is presented in the document "Response to NSW Coastal Panel RFI.pdf" dated 24 October 2012 – reviewed in Section 3 of this letter.

5.1 ICM Drawing OB-EPW-001 Rev A – General Plan and RP Info

The seawall is shown to be wholly on private land.

As described in Section 3.2, end effects will extend beyond the extent of the seawall shown.

It is likely that the public will use the structure as part of the "public" beach, but it is on private land.

5.2 *ICM Drawing OB-EPW-002 Rev A – Layout Initial Works*

The crest of the seawall is shown to be approximately 30 m seaward of 2008 immediate hazard line.

5.3 *ICM Drawing OB-EPW-003 Rev A – Cross Sections A, B*

As described in Section 3, the cross section shown complies with best current practice for sandbag walls, except that the top five courses in the outer layer are annotated as "*... to be placed if/as required.*" Such reactive maintenance is plausible, however, due to the remoteness of Old Bar and the pattern placed nature of sandbags, substantial damage and/or failure may occur prior to these bags being placed.

If these bags were placed initially (a double layer of full wall height), the proposed design follows best current practice for sandbag seawalls, however, this does not mean that they are guaranteed to not be damaged or fail.

No revised calculations are provided regarding sandbag stability, and the impacts of recession and erosion on nearshore wave heights.

The cross sections show design slopes of 1V:1.5H. This complies with traditional sandbag and rock wall practice, however, recent work on global (geotechnical) stability (e.g. Nielsen and Mostyn, 2011) indicates that flatter slopes may be needed. Such geotechnical review is beyond WRL's expertise. No geotechnical input appears in ICM's design documentation.

5.4 *ICM Drawing OB-EPW-004 Rev A –Temporary Return Detail*

The proposed temporary return does not extend to the immediate hazard line, but as discussed by ICM (Section 3.3 of this WRL letter), this may not be feasible due to excavation needed on existing developed sites. The returns are proposed to be extended on a reactive basis.

The location of Section C is not shown on this drawing.

5.5 *ICM Drawing OB-EPW-005 Rev A – Layout Future Extension*

The location of Section C is shown on this drawing, but should (also) be shown on drawing 004.

This drawing shows the extent of the proposed future seawall extensions for which approval is not being sought in the current application. The construction of the current proposal may accelerate the necessity for a seawall for neighbouring properties due to end effects. These end effects are likely to extend beyond the limits of the future extension shown.

5.6 *ICM Drawing OB-EPW-006 Rev A – Cross Section C*

Cross Section C is for armouring the returns at the end of the wall to prevent flanking erosion. It is a single layer of sandbags. This may be acceptable since it is a temporary return prior to proposed extension and more sheltered from waves, due to not facing the ocean directly.

The SW corner where the return intersects with the main wall may be vulnerable to increased damage from 3D effects – only physical modelling or close monitoring of a trial structure could reliably assess the stability of this and other parts of the structure.

6. Summary

The work presented in the documents for a revised DA by ICM is generally of a professional engineering standard. They address many (but not all) of the issues raised in the original DA documents.

The major issues within the revised DA documents peer reviewed by WRL are:

- The use of only a single armour layer structure above +3 m AHD may be a weak point in the structure, and while additional bags are proposed to be added if required, the wall may be damaged before such a reactive addition could be undertaken.

- If the double layer sandbag seawall is extended to the full height of the wall, the ICM design complies with best current practice for such walls in NSW, but unless more detailed studies are presented, the magnitude of storm event the structure would be expected to withstand is unknown.

- No calculations have been provided regarding the likely stability of the sandbags under wave attack. No geotechnical assessment of the global stability of the proposed seawall has been provided.

- No seawall end effects are considered by ICM to the north of the proposed structure.

7. Conclusion

A summary of this peer review is provided in Section 6. Thank you for the opportunity for providing expert coastal engineering advice to the Office of Environment and Heritage. Please contact James Carley on 8071 9863 or myself on 8071 9800 to further discuss the review if required.

Yours sincerely,

G P Smith
Manager

8. References and Bibliography

Coghlan, I., Carley, J., Cox, R., Blacka, M., Mariani, A., Restall, S., Hornsey, W., and Sheldrick, S., (2009), *Two-Dimensional Physical Modelling of Sand Filled Geocontainers for Coastal Protection*, Proceedings Australasian Coasts and Ports Conference, The Institution of Engineers, Australia.

NSW Government (1990), *Coastline Management Manual.*

NSW Treasury (2007), *NSW Government Guidelines for Economic Appraisal,* pp 07-5, NSW Government.

Nielsen, A. F. and Mostyn, G (2011), "Considerations in Applying Geotextiles to Coastal Revetments", *Australian Geomechanics Society and NSW Maritime Panel - Coastal and Marine Geotechnics Symposium: Foundations for Trade (Sydney).*

Oliver, John, John Lesnik, Don Plotkin and Doug Pirie (1998), "Condition and Performance Rating Procedures for Coastal Structures", *Technical Report REMR-OM-24*, US Army Corps of Engineers.

WorleyParsons (2010), *Black Head to Crowdy Head: Coastline Hazard Definition Study*, Report Prepared for Greater Taree Shire Council.

THE UNIVERSITY OF NEW SOUTH WALES

Water Research Laboratory

School of Civil and Environmental Engineering

7th August 2012

WRL Ref: WRL2012070 JTC PLR20120807

Ms Jane Gibbs
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Dear Jane,

Peer Review of ICM Statement of Environmental Effects: Old Bar – Erosion Protection Works

1. Introduction

This letter report presents a peer review of the report entitled "*Statement of Environmental Effects: Old Bar – Erosion Protection Works*" completed by International Coastal Management. The ICM report, hereafter referred to as ICM SEE, was prepared for Meridian Resort. No version number or date is provided in the ICM SEE report, but it is assumed by WRL to have been prepared in 2012. This review has been undertaken by Senior Coastal Engineer James Carley of the Water Research Laboratory (WRL), who is an acknowledged expert in coastal processes. James' CV can be made available on request.

Key findings of WRL's review of ICM SEE are provided in Section 2, with the detailed section-by-section review provided in Section 3.

2. Summary

The work presented in ICM SEE is generally of professional engineering standard, with the scope generally adequate from a coastal engineering perspective.

The major issues within the ICM SEE are:

- The use of a single armour layer structure founded at 0.0 m AHD is likely to be damaged during a moderate to extreme storm and require more maintenance than a deeper double armour layer structure. Minimal information justifying the sizing of the structure is provided.
- The ICM design may not have properly considered the ongoing long term recession of 0.6 m/year found by WorleyParsons (2010).
- The storm erosion volume adopted in the ICM SEE is insufficient compared with the values derived by WorleyParsons' Hazard Definition Study (2010) and accepted for the NSW open coast. This is primarily due to the use by ICM of a short duration storm (12 hours) to drive a numerical erosion model (SBEACH). The low erosion volumes adopted by ICM are subsequently used in the impact assessment.

3. Detailed Section-By-Section Review

3.1 General

While the terms "*erosion*" and "*recession*" are often used interchangeably, a separate specific definition of recession is provided in the NSW Coastline Management Manual (1990), and should be used in the ICM SEE. Recession is defined in the manual as:

"*Shoreline recession is the progressive landward shift of the average long term position of the coastline. Recession is a different phenomena* [sic] *to beach erosion, although they both may be caused by the same processes.*"

While the manual devotes Appendix C2 to coastal erosion, no concise definition of *erosion* is provided. A suggested definition by the reviewer is: *The removal of sand from the beach face or dune due to a storm or series of storms.*

3.2 ICM SEE Executive Summary

The correct spelling of the coastal management consultants is WorleyParsons.

As stated above, the foreshore at Old Bar is experiencing both *erosion* and *recession*.

It is suggested that "*recommendations*" be replaced with "*studies*".

3.3 ICM SEE Section 1.0

The following sentence should be added to the text above ICM SEE Table 2: "*It is noted that due to erosion and recession, portions of these properties are located in the intertidal zone.*"

3.4 ICM SEE Section 2.0

Table 3: The use of a sea level rise value of 0.9 m is consistent with NSW policy for 2100, but not for the suggested design life of 25 years suggested by ICM in Section 4.3 Table 6.

Figure 3: Axes and legend on graph are not clearly labelled.

Section 2.2:
It is not clear whether the profile adopted for design properly considered storm erosion and the long term recession rates found by WorleyParsons (2010) of 0.6 m/year. If larger storm erosion is adopted (as defined in Section 3.11 of this review) and the recession trend was to continue over the proposed structure's life, the profile in the vicinity of the proposed structure may be deeper than assumed in the ICM SEE, and the depth limited wave height at the structure would be larger than that indicated in Table 4.

Section 2.4:
ICM relies on the work of the WorleyParsons Hazard Definition Study (2010) to describe the coastal processes. This is acceptable, with the caution that the coastal processes in the area are still not well understood, particularly as to why high historical recession rates, and possible acceleration of recession rates have occurred around Old Bar.

Figure 8: A legend showing the meaning of the lines is needed.

Section 2.5: See comments regarding erosion and recession in Section 3.1 of this review.

3.5 ICM SEE Section 3.0

Table 5:
Generally the economic viability of a project is expressed as a *Benefit to Cost Ratio* (BCR) (NSW Treasury, 2007). A BCR greater than 1 indicates economic viability and a BCR less than 1 indicates economic non-viability. Conventional BCRs less than zero are not possible.

Figure 13:
The geotextile container option from WorleyParsons (2010) shown in ICM SEE Figure 13 has the following design features:

- 2 layers of geocontainers on the main revetment slope
- 3 layers of geocontainers at the toe
- Toe at -1 m AHD
- Crest at +6 m AHD
- 0.75 m^3 containers

Without considering site specific container stability, the WorleyParsons (2010) design is close to current best practice for a generic open coast geotextile structure, except that larger 2.5 m^3 containers would provide increased armour stability. Detailed calculations and/or physical modelling may still find that such a structure would be damaged during extreme conditions.

3.6 ICM SEE Section 4.0

The geotextile container proposed by ICM in Figure 15 has the following design features:

- 1 layer of geocontainers on the main revetment slope
- 1 layer of geocontainers at the toe
- Toe at 0.0 m AHD
- Crest at +6.2 m AHD
- 2.5 m^3 containers

ICM compares their design to that of WorleyParsons (2010) in Section 4.3 (see below).

3.7 ICM SEE Section 4.1

WRL concurs with the benefits of geotextile structures as listed. Short of a formal boardwalk on the crest, geotextile structures on suitable slopes provide better alongshore access than rock rubble structures (see Figure 1 of this review as an example). However, it should be noted that while softer than rock, 2.5 m^3 containers weigh approximately 5 tonnes when wet, so any unstable container has the potential to kill or injure.

WRL also concurs that similar structures have been used successfully, but notes that no calculations have been presented in ICM SEE regarding geocontainer stability for the proposed design.

3.8 ICM SEE Section 4.2

The ICM SEE proposed alignment (ICM SEE Figure 17) appears to be within private property boundaries. It is noted that (without the possible future extensions) the proposed alignment could

suffer flanking damage at its ends (Figure 2 of this review) due to ongoing recession and extreme storm erosion. This is likely to occur for any short seawall without substantial returns on the ends.

3.9 ICM SEE Section 4.3

ICM Table 6 provides a comparison of the original WorleyParsons (2010) design and the ICM SEE design. The following comments on each line are provided by the reviewer.

Crest Level:
The additional 0.2 m crest elevation (to +6.2 m AHD) of ICM SEE is within the construction tolerance. While detailed calculations have not been undertaken, it is likely that some overtopping of this level would occur during extreme storm conditions, however, the elevation is acceptable.

Toe Level:
The ICM SEE toe located at 0 m AHD is highly likely to be undermined at some point in the structure's life. Conventional 'rule of thumb' practice is to design for a scour level of -1 m AHD (or deeper) in NSW, as was adopted by WorleyParsons (2010). However, this 'rule of thumb' may not apply for structures on rapidly receding coasts. Scour levels deeper than a structure's toe can be managed through flexible and wide toes (see *Container Size* below) which settle into the scour hole, and/or topping up of the crest of a rubble structure.

It is noted that the boulder wall armouring along the Gold Coast has a design toe of 0.0 m AHD, however, its rock design allows for easier top ups from the crest, and it is accompanied by a designated service easement for this purpose.

Slope:
The ICM SEE proposed slope of 1V:1.5H is acceptable from coastal engineering perspective. Geotechnical calculations on the global stability of the structure as a retaining wall should also be undertaken.

Container Size:
The ICM SEE proposed container size of 2.5 m^3 would offer improved stability over the WorleyParsons (2010) 0.75 m^3 containers, however, this is somewhat negated by the use of a single layer. The use of a single layer is likely to result in reduced stability and lower reserve capacity of the wall. A single layer structure is likely to require increased maintenance and repairs over its life, but would offer a lower initial capital cost. Undermining of the ICM SEE proposed single layer toe could damage the entire wall, whereas the WorleyParsons (2010) toe consisting of three layers could more effectively deal with undermining without the entire wall being damaged.

Geotextile Type:
An additional line in ICM SEE Table 6 is suggested for a design life – listed as 25 years. The fabric proposed is of good quality and from a reputable Australian manufacturer.

General Comments:
Numerous structures of this type have been built, however, knowledge of their performance is still relatively immature compared with rock structures. Little information is provided in the ICM SEE regarding the sizing of the geocontainers or stability of the structure – the design appears to be based on ICM's general experience. Published guidance on bag sizing is provided in Coghlan et al (2009). While detailed design calculations have not been undertaken by the reviewer, experience with similar structures indicates that:

- The bags would likely be unstable under 100 year ARI conditions.
- The use of a single layer design offers cost advantages, but would result in lower stability and robustness of the structure.

3.10 ICM SEE Section 6.0

ICM SEE acknowledges that erosion could occur below the design toe of 0.0 m AHD of their proposed structure. Their proposal for a rock toe has several limitations, namely:

- Unless the rock toe was installed pre-emptively, the entire geotextile structure could collapse due to undermining of its single layer toe at 0.0 m AHD.
- Rock placed in the region of 0 to -1 m AHD would be exposed at low tide and just submerged at mid tide. This could be a hazard for swimmers or surfers returning to shore, which would override a key advantage of geotextile structures.
- Without careful design, the rock toe may sink into the sand, and therefore provide a false sense of security against undermining.

3.11 ICM SEE Section 7.1.2

The storm erosion volume adopted by ICM SEE (45 m^3/m above AHD) is insufficient compared with the values derived by WorleyParsons Hazard Definition Study (2010) and accepted for the NSW open coast (220 m^3/m above AHD). This is primarily due to the use by ICM SEE of a short duration storm (12 hours) to drive a numerical erosion model (SBEACH). The low erosion volumes adopted by ICM SEE have subsequently been used within the impact assessment.

The gross and net littoral drift at Old Bar is not well understood. Modelling by WorleyParsons indicated that under ambient conditions, net littoral drift is northward at Old Bar, while under storm conditions it is southward, due to the influence of wave breaking on the Urana Bombora. It appears that this finding (southward storm littoral drift) led ICM to only consider downdrift effects of the seawall to the south. While the WorleyParsons (2010) findings on littoral drift are credible and plausible, there is not sufficient certainty in this to ignore potential wall impacts to the north. The potential for impacts to the north due to ambient conditions following a storm should also be considered in ICM SEE Sections 7.1.3, 7.1.4, 7.1.5, 7.1.6, 7.1.7, 7.1.11 and 7.1.12.

The area of potential impact of the wall shown in ICM SEE Figure 24 is derived from insufficient erosion volumes and should not dismiss potential impacts to the north.

3.12 ICM SEE Section 7.1.3

WRL concurs with ICM SEE that the complexity of the coastal processes around Old Bar would preclude the application of shoreline evolution models such as GENESIS.

4. Conclusion

A summary of this peer review is provided in Section 2. Thank you for the opportunity for providing expert coastal engineering advice to the Office of Environment and Heritage. Please contact James Carley on 0414 385 053 or myself on 8071 9800 to further discuss the review if required.

Yours sincerely,

G P Smith
Manager

5. Figures

Figure 1: Traversing geotextile container walls, Belongil January 2002 (photo: James Carley, WRL)

Figure 2: End effects and potential flanking of seawalls, Gold Coast 1967 (Source: Delft, 1970)

6. References

Coghlan, I., Carley, J., Cox, R., Blacka, M., Mariani, A., Restall, S., Hornsey, W., and Sheldrick, S., (2009), *Two-Dimensional Physical Modelling of Sand Filled Geocontainers for Coastal Protection*, Proceedings Australasian Coasts and Ports Conference, The Institution of Engineers, Australia.

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WorleyParsons (2010), *Black Head to Crowdy Head: Coastline Hazard Definition Study*, Report Prepared for Greater Taree Shire Council.