Royal HaskoningDHV
Enhancing Society Together

Note / Memo

Haskoning Australia PTY Ltd.
Maritime & Aviation

To: Mark Daley, Senior Coast and Estuaries Officer, OEH
From: Gary Blumberg
Date: 21 September 2016
Copy: Phil Watson, Principal Coastal Specialist OEH
Our reference: PA1431_N001.F02
Classification: Open

Subject: Arrawarra Creek Revetment – Assessment for NSW Coastal Panel

---

Marc

We understand that Astoria Group Pty Ltd is seeking approval to subdivide Arrawarra Beach Caravan Park at 46 Arrawarra Beach Road, Arrawarra, into 24 lots, 15 of which front either Arrawarra Creek or a proposed 20m wide foreshore reserve which borders Arrawarra Creek. As part of this project, Arrawarra Beach Pty Ltd is seeking approval to construct coastal protection works within DP1209371 registered 19/6/05, including a rock revetment wall (seawall).

RHDHV has been retained to undertake an independent engineering assessment of the proposed seawall. In particular, comment is sought on the engineering design of the proposed seawall, its overall suitability and whether it meets contemporary engineering design standards considered appropriate for this location. The purpose of this assessment is to assist the NSW Coastal Panel in making the DA determination for the seawall. We note that the Coastal Panel has already asked for additional information from the applicant on two occasions and met with them on site to discuss requirements. Accordingly, the Panel is at a stage where it needs to assess the information before it. If information gaps remain, the Panel has requested that these be identified in RHDHV's engineering assessment.

Finally, a definitive statement is sought on the implication of s55M of the Coastal Protection Act 1979 as this is a specific head of consideration for the Panel in determining the development application.

1. Background Briefing Information

The following background information provided by OEH has been perused and where appropriate considered in more detail:

Doc Ref	Date	Document Title	Type	Author
1	Feb 2016	Statement of Environmental Effects, Coastal Protection Works, 46 Arrawarra Beach Road, Arrawarra	Report including number of subconsultant reports	Keiley Hunter Town Planning
2	10/3/16	Request for Further Information	Letter	NSW Coastal Panel
3	March 2016	Arrawarra Beach Caravan Park: Rock - Armoured Revetment, Response to request for information from NSW Coastal	Report	Water Technology

Doc Ref	Date	Document Title	Type	Author
		Panel		
4	19/4/16	Request for Further Information DA CP16-001 – Arrawarra Seawall	Letter	NSW Coastal Panel
5	1/5/16	Proposed Subdivision, Arrawarra Beach Caravan Park	Report	de Groot & Benson, Consulting Engineers and Town Planners
6	June 2016	Addendum to Statutory Ecological Assessment – Arrawarra Caravan Park	Report	Ecosure
7	21/6/16	Additional Information Request – Arrawarra Beach Road, Arrawarra	Report	Everick Heritage Consultants Pty Ltd
8	June 2016	Arrawarra Beach Caravan Park: Rock - Armoured Revetment, Final report	Report	Water Technology
9	June 2016	Arrawarra Caravan Park Subdivision, Flooding and Stormwater Assessment	Report	Umwelt
10	1/7/16	Request for Further Information – DA CP16-001 – Arrawarra Seawall	Letter	Keiley Hunter Town Planning

It should be noted that RHDHV has not been engaged to made a site inspection for the purposes of this assessment.

2. Request by Coastal Panel for Further Information

It is noted that the Coastal Panel has sought further information from the Proponent on two occasions, Refs 2 and 4. In relation to the assistance being sought here from RHDHV, the requested information has related primarily to the following:

- Wall design generally, including armour design
- Scour level
- Toe design
- Crest level and crest design
- Management of overtopping
- Impact of wall on geometry of the creek and its entrance
- Maintenance of the wall so it remains “fit for purpose”
- How wall will be adapted or maintained to accommodate sea level rise (SLR)

3. Comments by RHDHV on technical proposal for rock revetment

We set out below our comments on the background briefing information in regard to the engineering design of the proposed seawall for the site. Item numbers are provided to assist with the discussion going forward.

Item	Comment	Outcome
1	The base survey by Newnham Karl Weir has not been provided, except that reproduced in the Coastal Engineering Solutions (CES) drawings. The contours are difficult to track. The survey date is uncertain, possibly April 2015	A base survey showing spot levels and contours is not provided.
2	Is there any history of flooding and wave impacts at the caravan park. Umwelt 2003 flood study may have information? It would be helpful for the Proponent if flooding impacts on the site have not been unduly problematic in the past.	Umwelt (2003) may provide useful information on flood history which does not appear to be included in the current application
3	The gabion wall runs along more than 50% of the shoreline to be protected. When was this installed, and how has it performed? Photos included in the application show damaged gabion cages. It would be very helpful to understand existing toe levels for the gabion wall. Our preference would be for the existing gabion wall including its underside/ toe level to be shown on the CES Annotated cross Section drawings.	Insufficient information is provided on the gabion wall.
4	The crest levels for the proposed seawall appear quite low compared to the storm tide levels identified in Ref 8. The 50 and 100 year ARI storm tide levels in the estuary entrance are reported at 2.91 and 3.04 m AHD respectively, compared to proposed seawall crest levels of 2.0 to 3.0 m AHD.	Comment: If waves penetrate to the structure in design storms the structure will be significantly overtopped.
5	No information provided on the availability of suitable rock. Rock dry density of 2.65 T/m3 noted in Ref 8, 4.2.1, but no consideration of rock quantities and potential sources.	Insufficient information is provided on the availability of suitable rock.
6	Is the timber walkway bridge to be retained? If so, is it to be rebuilt? It is assumed that the proposed seawall could not be constructed without at least the part removal of the walkway bridge.	Insufficient information is provided on the retention or otherwise of the timber walkway bridge and how this is to be accommodated in the design.
7	The Statement of Environmental Effects (SEE) Ref 1, 3.1.2, last para, states that the proposed seawall design takes account of natural processes impacting the site now and severe storms that may eventuate following climate change and sea level rise (SLR) predictions. However, Ref 8, 3.5, 3rd bullet point, states that the rock size has been selected to cater for the present day climate, with the design tailored so that upgrading work can be readily undertaken should future climate change and SLR require modifications. It would appear that the statement in the SEE is not correct, or the proposal has been modified subsequent to the SEE.	Comment.
8	SEE Ref 1, 3.14, p 42, Environmental Impacts, para 1, states"	Insufficient information is

	the proposed revetment wall will be constructed entirely within the subject site and as such, will not adversely affect neighbouring properties". In relation to direct property impacts at construction this may be correct, however the potential for wave reflections and "locking up" of foreshore sand to affect neighbouring properties would not appear to be considered.	provided on the quantum of referred erosion impacts to neighbouring properties and how these are to be managed. Comment: Ref 1, 3.3, discusses funding arrangements for ongoing maintenance of the seawall. Information is lacking on how these arrangements would be extended to manage potential offsite impacts to neighbouring properties.
9	SEE Ref 1, 3.16, para 1, refers to Council's "stormwater outlet". It is not clear where this is. It does not appear to be referred to elsewhere in the background briefing information.	Information is lacking on the details of Council's "stormwater outlet".
10	The MHWM boundary is not clearly defined on the CES design layout for the seawall. This should clearly mark start and end point of each line segment that defines this boundary, with numbering of the line segments cross-referenced to a table on the CES drawings. This table should indicate each line segment, line bearing and distance as shown on DP 1209371 registered 19/6/15	The definition of the MHWM property boundary is not adequate on the CES drawings.
11	Ref 8, 2.4, para 5, gives overtopping rates for varied damage behaviour behind a seawall, but no overtopping rates are reported for the developed site.	Design overtopping rates so overtopping impacts cannot be suitably assessed or a management strategy developed as there is insufficient information.
12	Not used – draft comment in relation to AS 4997 Guidelines for Design of Maritime Structures is not valid since rock armoured walls are expressly excluded from the Standard (refer Clause 1.1 – Scope)	Not used
13	Not used – draft comment in relation to AS 4997 Guidelines for Design of Maritime Structures is not valid since rock armoured walls are expressly excluded from the Standard (refer Clause 1.1 – Scope)	. Not used
14		Comment.

	Seawalls in NSW are often designed to be stable over their working lives against 50 to 100 year ARI storm events. RHDHV considers the 2 scenario approach by CES to consider combinations of 100 year and 50 year ARI waves and storm tides (and vice-versa), with mean wave periods between 7 and 14 s, as reasonable.	
15	In Ref 2, 2c, the Coastal Panel has sought confirmation from the Proponent that the design of the seawall is "fit for purpose". Please be aware that this requirement may not be covered by the professional indemnity insurance policies of the Proponent's professional engineer advisors. In our experience offering such a warranty goes beyond the industry standard and is not insurable. The standard practice is that the guarantee in respect of engineering services should be to comply with a professional standard of care. The common law obligation for the performance of services is that of reasonable skill, care, diligence and that sound professional principles are applied.	Comment.
16	Ref 8, 3.4.2, has selected a 130m wide scoured entrance channel with bed level +0.2 m AHD for assessment of design wave penetration to the site. We are concerned that +0.2 m AHD based on a single survey in April 2003 and understood to represent "average natural conditions for the purposes of the (1 in 100 year) flood study" (Umwelt, 2016) may not capture a suitable case for design wave penetration. To come to this view we have examined available water level data in coastal creek systems of comparable catchment size to Arrawarra Creek. Unfortunately water level data is not collected at Arrawarra Creek and examining the behaviour of similar systems is a reasonable approach. The Estuaries Inventory of NSW (PWD, 1992) lists 91 NSW estuaries and characterises these according to parameters including catchment area. Arrawarra Creek is reported to have a catchment area of 20 km^2 which places it number 86 in order of reducing catchment size. Other systems of comparable size and which we understand are not trained include Saltwater Creek (30 km^2), Werri Lagoon (24 km^2), Back Lagoon, Merimbula (23 km^2), Belongil Creek (18 km^2), Lake Cakora (11 km^2) and Lake Arragan (10 km^2). Of these six estuaries, MHL records water level data at Saltwater Ckeek, Werri Lagoon and Back Lagoon. The full water level records for these three lagoons are shown in **Appendix A**. Of particular interest, and the selected record for this is also shown, is the minimum water level at which tidal penetration occurs as this would represent the maximum bed level across the entrance saddle for the case of ocean water penetration, ie the saddle level could have been no higher, but was probably lower. Also included is a record of the water levels	Insufficient justification is given regarding the selection of +0.2 m AHD as an appropriate entrance saddle level for design wave penetration. With water level data not collected for Arrawarra Creek, inspection of water level records for comparable NSW estuary systems indicates that a saddle level at least 0.6 m lower should reasonably apply.

	through the recent June 2016 storm event. We can see that for these three systems of comparable size to Arrawarra Creek, this limiting saddle level was approximately -0.4 m AHD for Werri Lagoon, -0.1 m AHD for Back Lagoon and 0.45 m AHD for Saltwater Lagoon. Having regard therefore to the information before us, RHDHV would be suggesting that a saddle level of -0.4 m AHD should therefore represent **a maximum entrance saddle level** for the calculation of design storm wave penetration. This is 0.6 m below the +0.2 m AHD saddle level adopted by the proponent which could be expected to lead to significantly higher wave penetration.	
17	Ref 8, 3.4.2, states that "wave climate at the revetment during severe storms is depth-limited". This would seem to be reasonable.	Comment.
18	Ref 8, 3.4.2, lists in Table 6 design significant breaking wave heights at the estuary entrance for 1 and 6 hour duration 100 year ARI storms, for mean wave periods between 7 and 14 s, and for 100 and 50 year ARI storm tide levels (32 wave heights listed). The design wave heights range from 1.9 to 2.4 m, with average 2.2 m. While this approach would seem to be reasonable, the wave heights are likely to be low given the reduction in the entrance saddle bed level (see Item 16).	Comment.
19	Ref 8 uses van der Meer (1988) to calculate armour rock sizes for a 100 year ARI storm event, finding that a 1 tonne (T) primary armour with minimum rock density 2.65 T/m3 placed to a slope of 1:1.5 meets the requirements of van de Meer for 5% damage. RHDHV is comfortable with the assumptions and general calculation approach, however we find that the rock masses reported in Table 7 **range between approximately one half to one third** that specified using van de Meer (1988). We have applied Table VI-5-23 in Coastal Engineering Manual to complete our calculation checks, making reasonable assumptions of porosity (P=0.45), relative eroded area or damage (S=2.5) and applying the wave height modification for depth-limited waves ($H=H_{2\%}/1.4$). We have also applied Hudson (SPM, 1984) to cross-check our assessment. Provisional calculations by RHDHV indicate that providing for primary armour comprising at least 2 layers of 2T median rock (all other parameters unchanged) should provide for suitable seawall slope protection against a 100 year ARI storm event occurring today.	While RHDHV is comfortable with van der Meer (1988) to calculate armour rock sizes, we are concerned that the specified 1.0 T primary armour is one half to one third the mass required by that assessment method, although this makes no allowance for the additional rock size required to accommodate larger wave penetration due to increased saddle water depths. Rock armour calculations to demonstrate compliance with van der Meer (1988) are not provided.
20	Ref 8, 3.56.2, last para, states that for 2100 with 0.8 m SLR, the breaking significant wave height at the revetment would be 20-	RHDHV notes that the Coastal Panel is receptive to

	25% higher than the breaking wave heights in Table 6. Ref 8, 4.2.2, 2nd para, states that when 0.8 m depth added to the design storm tide and wave heights are increased accordingly, then one additional layer of primary armour rocks would accommodate the additional wave loads. Provisional calculations by RHDHV indicate that providing for an additional 2 layers of 2T median rock (all other parameters unchanged) should provide for suitable seawall slope protection to the end of a structure life at 2100. The above assessment is based on the wave climate assessment assuming the +0.2 m AHD entrance saddle level. The additional water depth across the entrance saddle (Item 16) would lead to larger wave penetration and further increase the rock size in the revetment.	an adaptive approach to increase the capacity of the seawall over its life (Ref 4, last bullet point). However, RHDHV is concerned that the adaptive modification proposed in Ref 8 may not suffice to provide suitable protection to the end of structure life. Suitably detailed calculations are not provided which demonstrate the acceptability of the proposed adaptive approach. Increasing the size of the additional (adaptive) rock layers, considered to be necessary by RHDHV, would require the seawall to be initially located further landward from the existing MHWM property boundary than is currently proposed.
21	Ref 8, Figure 9 seems to show the NE end of the seawall terminating some 80 m short of the end termination point shown in the design drawings.	Certification required.
22	The seawall proposal assumes design scour levels at the toe of the wall ranging between -1.0 and -0.5 m AHD, based on this meeting a level equal to one median rock diameter below the local channel thalweg. The actual location of the thalweg was not reported. RHDHV is concerned that this approach may miss deeper localised scour that could occur during high creek flows, particularly during periods of low tail water levels. We have recently modelled, using MIKE21, creek outflows at another North Coast creek system where a design scour level of -1.5 m AHD was identified along a straight section of the protected creek bank, and locally deepened to -2m AHD and deeper at downstream spur walls. Seven Google Earth photos at Arrawarra Creek between 2004 and 2013 show the channel hard up against the gabion wall in the vicinity of SOP 22 and 23 for 4 of the 7 photo dates. It would be of interest to know what the minimum channel bed level may have been against the gabion wall during this period. Furthermore, if there is evidence of the gabion wall having settled in this area, it would be important to know the design toe level for	To adequately define potential scour: (i) Information is required on the minimum channel bed level against the gabion wall in the vicinity of SOP 18 through SOP 29, including a review of the gabion toe level (design and settled) (ii) Consideration should be given to extending the existing flooding assessment to model channel velocities and scour along the toe of the rock revetment.

	the gabion wall and the existing settled toe level. Note that it is possible for a gabion wall to bridge a localised scour hole although this should be evident by loss of backfill.	
23	It appears from the information provided that a geotechnical assessment has not been undertaken to investigate the ground conditions in the vicinity of the proposed seawall. Valuable information could be obtained from a geotechnical site investigation to characterise the subsurface conditions. The work could be expected to include a site walk over by an experienced geotechnical engineer, an assessment of the regional geotechnical context from geological mapping, and intrusive investigations. Techniques might include test pits along the footprint of the proposed seawall including along the toe of the gabion wall, boreholes, CPTs, and DCPs. A suitably designed geotechnical investigation will provide important baseline information to assist develop an appropriate toe detail for the seawall and provide design certainty.	No geotechnical investigation would appear to be included in the background briefing information. To properly inform the seawall toe design it would be highly desirable to conduct a suitably scoped geotechnical investigation.
24	Item 11 refers. Ref 8, 4.4.1, overtopping assessment. Ref 8 refers to overtopping calculation that show discharges will scour any unprotected erodible materials in the area immediately behind the revetment, but no overtopping rates are reported.	Overtopping quantities are not provided to enable a suitably thorough assessment of overtopping impacts and management.
25	Seawall crest levels of 3.0 and 2.0 m AHD seem low for a site that can experience storm tide levels of 2.9 to 3.0 m AHD in a design storm plus breaking wave heights of 2 m or more. If wave heights can increase by around 20 - 25% in a 100 year storm at 2100, this could have a significant impact on wave overtopping.	Detailed information is lacking on the adaptive response to deal with what appear to be low seawall crest levels, particularly given the predicted 20-25% increase in design wave heights by year 2100.
26	Design drawing 15-849NSW-02 B lists design parameters. Wave height H is given as 2.0 m with T = 7-12 s. Notwithstanding the issue of inadequate saddle depth and consequent larger wave penetration, it would be more accurate for H = 1.9 to 2.3 m to be added to the drawing to better reflect Table 6 in Ref 8	Design drawing 15-849NSW-02 B does not fully describe the design wave height.

We estimate the seawall as currently designed to involve the placement of some 8,000 T of rock which is likely to cost in excess of $1M. It is prudent that around 5% of the cost of construction be allocated to design development and detailed design.

4. Opinion in relation to s55M of Coastal Protection Act 1979

The wording in this section of the act is reproduced below with our comments and opinion developed in italics.

s55M of the Coastal Protection Act 1979 states that:

(1) Consent must not be granted under the Environment Planning and Assessment Act 1979 to development for the purpose of coastal protection works unless the consent authority is satisfied that:

(a) the works will not over the life of the works:

(i) unreasonably limit or be likely to unreasonably limit public access to or use of a beach or headland, or

(ii) pose or be likely to pose a threat to public safety, and

The 360 m revetment is to be located on private land, above the MHWM. Along approximately one half of the length of this boundary is a gabion wall in a variable state of disrepair. Parts of this wall would currently pose or likely pose in the near future a hazard to persons who access the bed areas of the creek over the gabion wall. [The bed areas of the creek are considered to be included in the definition of "beach" in the Coastal Protection Act 1979]. Removal of this gabion wall would remove a structure which is potentially hazardous, thereby providing a safety benefit. It is understood that the remainder of the shoreline is not readily accessible due to a steep bank, thick vegetation and other retaining structures.

The open coast beach at the mouth of Arrawarra Creek is currently accessible from the lightweight timber footbridge which is licenced to the caravan park. According to the SEE this is not a public footway (Section 2.5, SEE). The structure of the footbridge would not comply with acceptable standards for public access, and the development submission would appear to be silent on the future of the footbridge.

An existing footpath runs along parts of the eastern boundary leading to the footbridge. This footpath would need to be demolished to construct the rock revetment. The proposal does not appear to provide for the reconstruction of this footpath, although it is unlikely that this footpath, being located within the caravan park, would have been accessible to the general public in any case.

There is a public footpath that leads to Arrawarra Creek located along the western boundary of the site off Arrawarra Beach Road. From this path, the public must cross the creek to get to the beach. This access should not be affected by the proposed revetment.

The intent of the revetment proposal is for the structure to be fully contained on provide land (or approximately above the existing Mean High Water Mark), over its life. RHDHV is of the opinion that the currently proposed layout would not achieve this (see Items 19 and 20 above). Also, it is understood that the entrance to the creek is mostly open to the ocean which would lead to large areas of the bed of the

creek, in the vicinity of the site, drying at mid to low tides and desirable to access. While there are no access steps proposed over the rock revetment to the bed of the creek, pedestrian access to these areas is presently impeded by the gabion wall, a timber crib wall, steep bank and thick vegetation. Possible increased water depths in the lower creek as a consequence of sea level rise may lead to these areas becoming less accessible by pedestrians over time, however this change is unlikely to be exacerbated as a consequence of the proposed revetment.

Access to a "headland" in relation to this clause is not relevant.

Having regard to the above, RHDHV is of the opinion that the revetment, as currently proposed, but with some modification to fully locate the structure within the private property boundary over its life, should not unreasonably limit or be likely to unreasonably limit public access to or use of the beach, nor should it pose or be likely to pose a threat to public safety. We accept that this opinion may be moot, and that the proposal would benefit from site specific public access improvements. Such improvements might include the provision of dedicated public access though what currently appears to be a proposed stormwater easement between new Lots 2 and 15, connecting to a new public footpath constructed behind the crest of the revetment within the Community Lot, and including a set of steps over the revetment and onto the bed of the creek.

(b) satisfactory arrangements have been made (by conditions imposed on the consent) for the following for the life of the works:

(i) the restoration of a beach, or land adjacent to the beach, if any increased erosion of the beach or adjacent land is caused by the presence of the works,

(ii) the maintenance of the works.

(2) That arrangements referred to in subsection (1) (b) are to secure adequate funding for the carrying out of any such restoration and maintenance, including by either of the following:

(a) by legally binding obligations (including by way of financial assurance or bond) of all or any of the following:

(i) the owner or owners from time to time of the land protected by the works,

(ii) the coastal protection works are constructed by or on behalf of landowners or by landowners jointly with a council or public authority,

(b) by payment to the relevant council of any annual charge for coastal protection services (within the meaning of the Local Government Act 1993).

(3) Funding obligations referred to in subsection (2) (a) are to include the percentage share of the total funding to each landowner, council or public authority concerned.

It is likely that the revetment would lead to some increased erosion of adjacent land since it introduces a hard structure in areas potentially exposed to waves and currents which previously were unprotected. Insufficient information is provided in

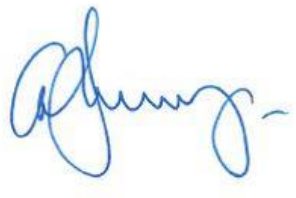
the submission on the quantum of referred erosion impacts to neighbouring properties and how these are to be managed. Ref 1, 3.3, discusses funding arrangements for ongoing maintenance of the seawall. Information is lacking on how these arrangements would be extended to manage potential offsite impacts to neighbouring properties.

5. Conclusion

RHDHV has been requested to provide an independent engineering assessment of the proposed rock revetment at 46 Arrawarra Beach Road, Arrawarra. In particular, comment was sought on the engineering design of the proposed wall, its overall suitability and whether it meets contemporary engineering design standards considered appropriate for this location. The purpose of this assessment is to assist the NSW Coastal Panel in making the DA determination for this structure.

Having regard to the above it is RHDHV's opinion that, based on the key engineering elements as presented by the proponent: saddle bed level affecting wave penetration into the creek (Item 16), toe scour (Item 22), armour size (Item 19) and wave overtopping (Items 4, 24 and 25), and given that no assessment has been made to quantify off-site erosion impacts (Item 8 and Section 4), inadequate information is currently before the NSW Coastal Panel in order for it to consider approval of the proposed revetment.

Please do not hesitate to contact me should you require any further information or clarification.

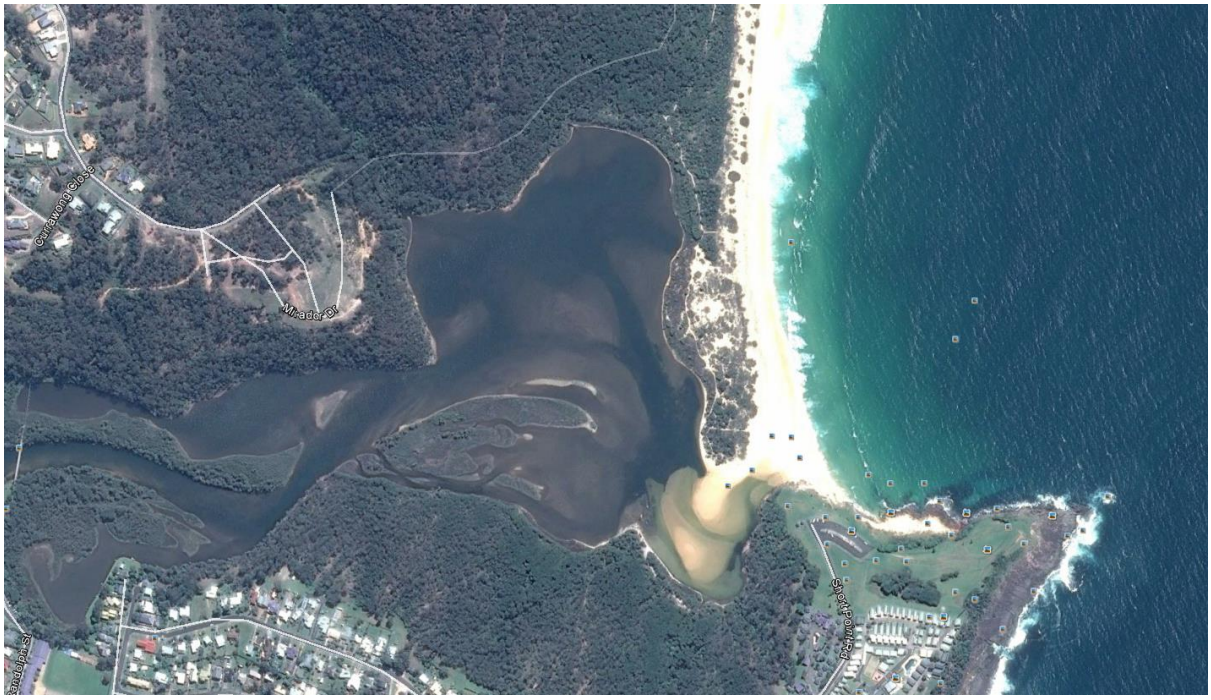


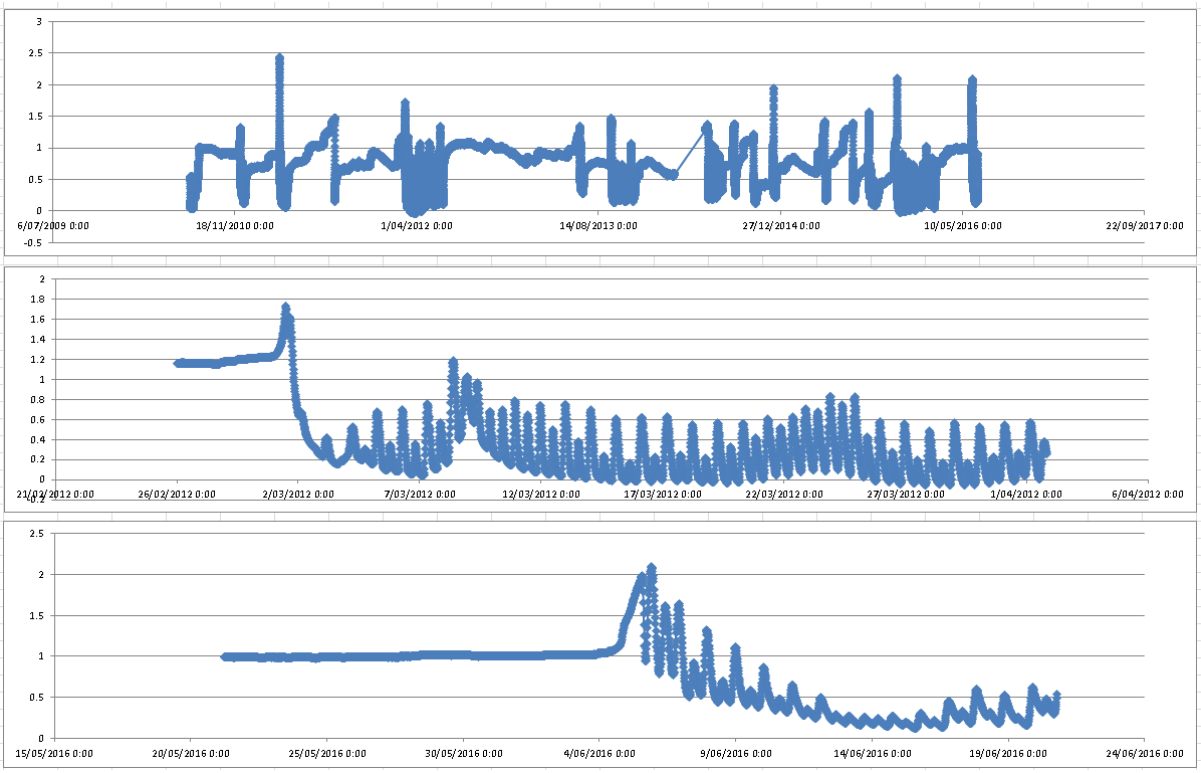
Gary Blumberg
RHDHV, Manager Coastal, Maritime and Waterways Australia

APPENDIX A

WATER LEVEL RECORDS FOR SMALL NSW ESTUARIES OF COMPRABLE CATCHMENT SIZE TO ARRAWARRA CREEK

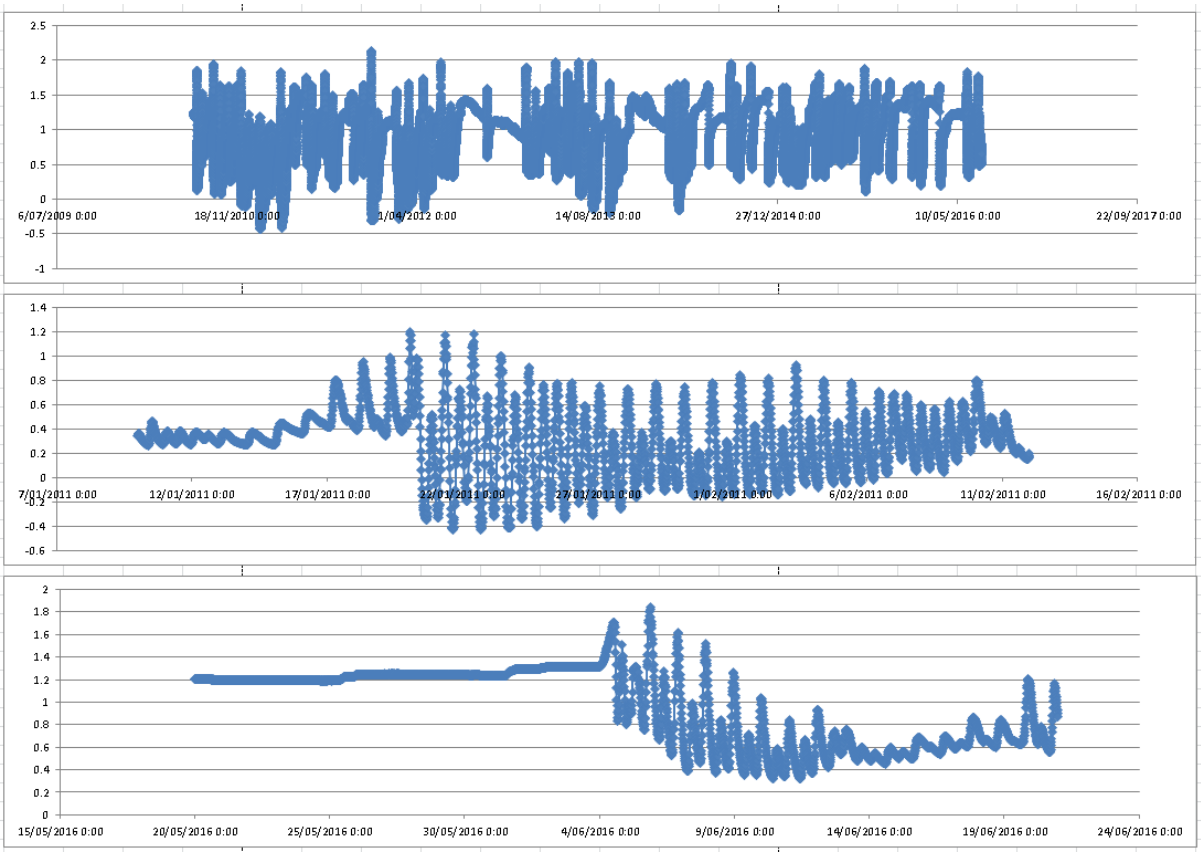
Est No	Name	Length of Main Arm (km)	**Catchment Area (km^2)**	Waterway Area (km^2)	Mean Annual Rainfall (mm)
88	Curalo Lake		31	0.9	970
75	Lake Mummuga		30	1.8	940
26	Saltwtr/Korogoro/Kilick		29.9	0.9	1280
18	Coffs Habour Creek	13	25	0.5	1650
54	Werri Lagoon		24	0.1	1320
85	Back Lagoon		23	0.8	960
16	Arrawarra Creek	5	20	0.2	1400
6	Belongil Creek	3	18	0.3	1850
12	Lake Cakora		11	0.3	1420
11	Lake Arragan		10	1.1	1400
76	Kianga Lake		8.2	0.2	940
25	SW Rocks Creek	2	4.1	0.1	





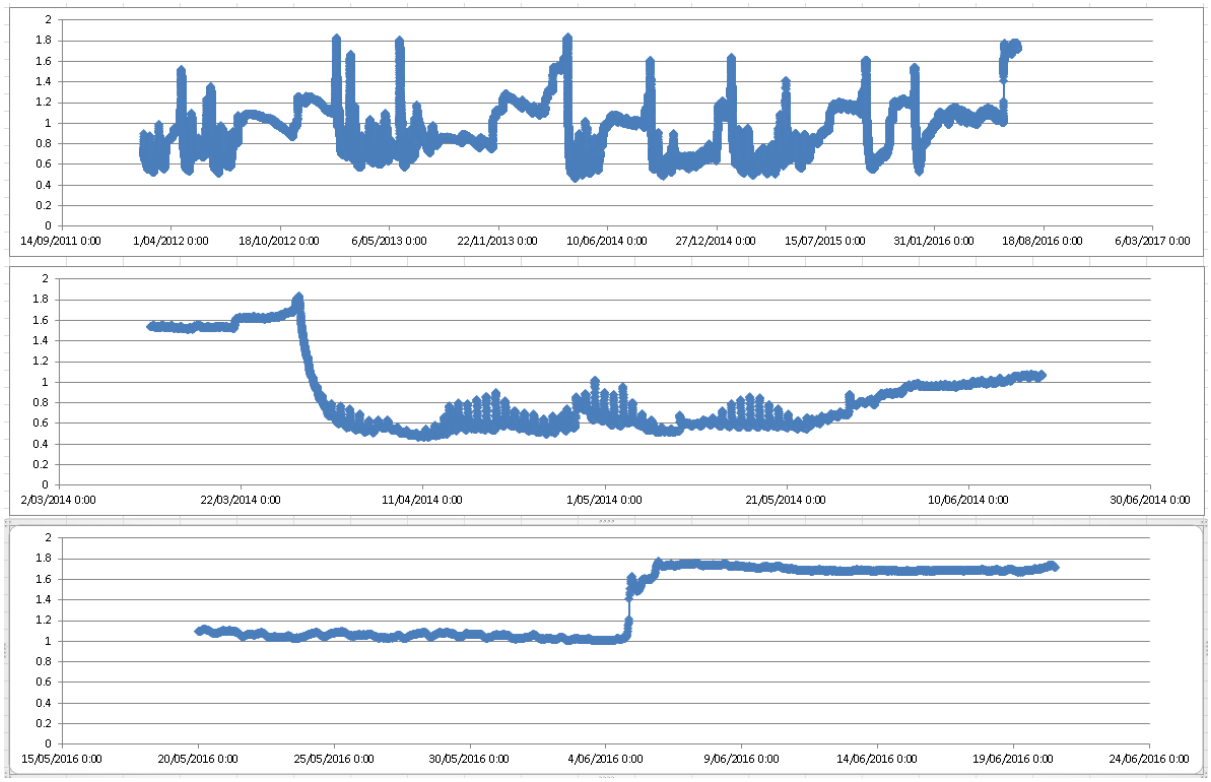
Back Lagoon, Merimbula

Name	Length of Main Arm (km)	**Catchment Area (km^2)**	Waterway Area (km^2)	Mean Annual Rainfall (mm)
Back Lagoon		23	0.8	960



Werri Lagoon

Name	Length of Main Arm (km)	**Catchment Area (km^2)**	Waterway Area (km^2)	Mean Annual Rainfall (mm)
Werri Lagoon		24	0.1	1320



Saltwater creek, SW Rocks

Name	Length of Main Arm (km)	**Catchment Area (km^2)**	Waterway Area (km^2)	Mean Annual Rainfall (mm)
Saltwtr/Korogoro/Kilick		29.9	0.9	1280