Appendix M: Durras Lake Tailwater Conditions

M.1 Preamble

WRL has completed a tailwater condition assessment for the entrance to Durras Lake, to be used as an ocean boundary condition for a future flood study of this estuary for the 63%, 5% and 1% AEP (1, 20 and 100 year ARI) storm events. This appendix outlines the methodology used to establish the site specific water level conditions for this site.

Durras Lake is as an ICOLL (Intermittently Closed and Open Lake or Lagoon) which is classified as a Type C Waterway Entrance in OEH's *Floodplain Risk Management Guide* (OEH, 2015). Since the entrance is likely to be exposed to open ocean waves, the maximum set-up equivalent to the set-up on an open ocean beach is relevant. WRL has undertaken site-specific, detailed analysis of wave setup for the Durras Lake entrance. However, as discussed in Section 8.3.2, the quality of nearshore bathymetry used in the analysis is unknown. WRL recommends that this analysis be repeated when a bathymetry survey is undertaken offshore of Durras Beach (south).

Example photos of the entrance shortly after being mechanically opened after heavy rainfall on 26 August 2014 are reproduced in Figure M-1.

M.2 Astronomical Tides

Using harmonic analysis, a synthetic tide was generated for Batemans Bay, (based on tidal constituents for Princess Jetty. Two tides were chosen for modelling of the Durras Lake tailwater conditions:

- 5% and 1% AEP modelling: 14/06/2011 – 20/06/2011, maximum water level 0.82 m AHD; and
- 63% AEP modelling: 19/09/2014 – 24/09/2014, maximum water level 0.502 m AHD.

The 63% AEP tidal series has been chosen to best represent a MHW tidal condition, while the rarer events have been chosen to coincide with a higher tidal condition.

M.3 Tidal Anomalies

As discussed in Section 3.3.2, adopted offshore extreme water levels for the study area are reproduced in Table M-1. These levels do not include wave setup or wave runup.

Table M-1: Adopted Extreme Water Levels (excluding wave setup and wave runup)

AEP %	ARI (years)	Water Level (m AHD)
63	1	1.22
5	50	1.37
1	100	1.43
Mean High Water		0.508

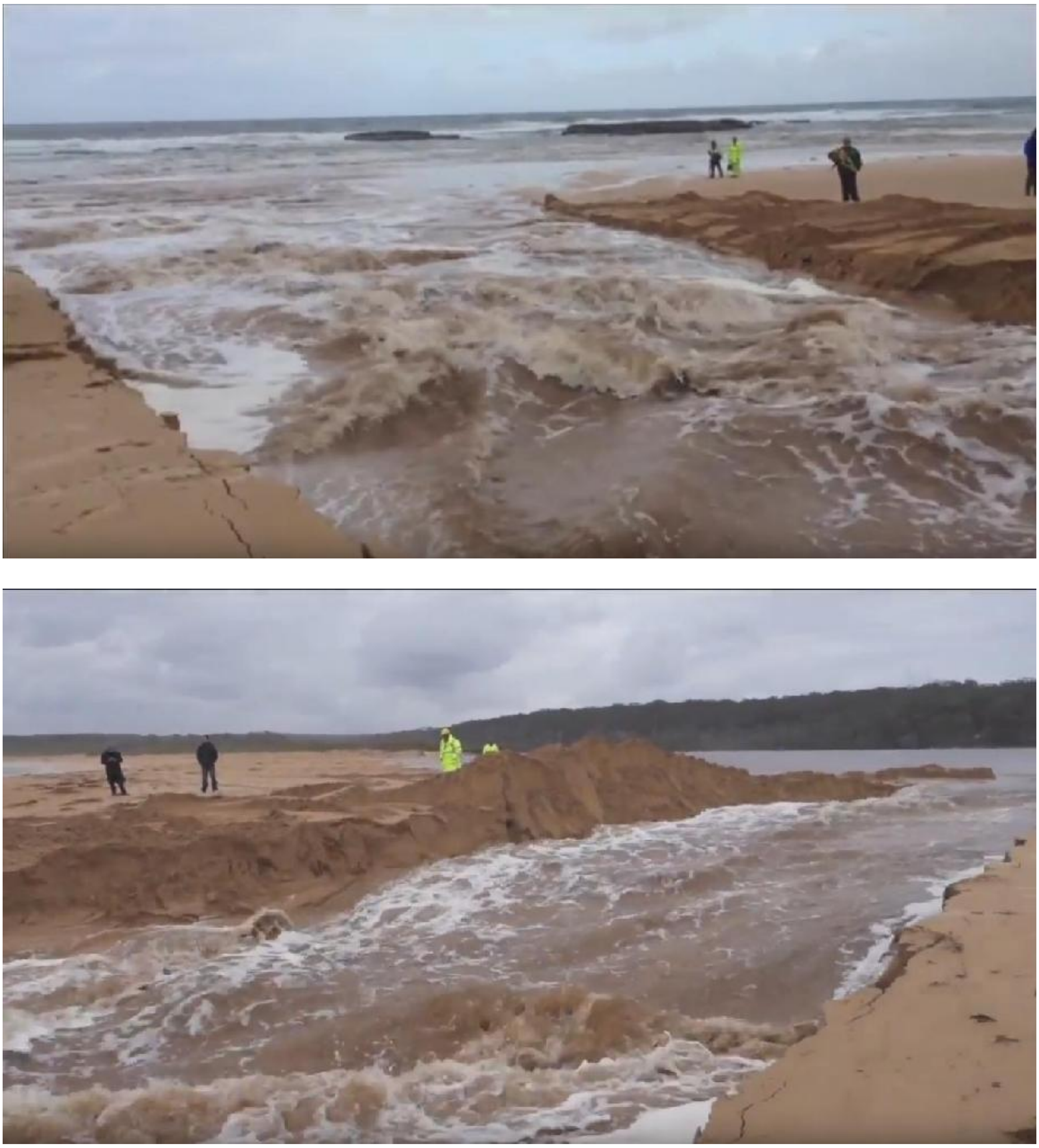

Figure M-1: Durras Lake Entrance Shortly After Mechanical Opening 26 August 2014 (Source: Durras Lake North Holiday Park, 2014)

M.4 Design Wave Conditions

Significant wave heights were extracted from the SWAN wave modelling (as discussed in Appendix D) at the point where approximately 1% of waves were breaking for storm durations between 1 hour and 144 hour for each appropriate recurrence interval. The wave periods and duration of the design storm event is based on the extreme wave analysis in Shand et al. (2011) for the Eden NSW wave buoy, the closest site available to Durras Lake. However the wave statistics from Batemans Bay wave buoy have been used (generally 5 – 15% smaller than the wave climate at Eden). The synthetic 1%, 5% and 63% AEP storm (H_{RMS} and T_p) timeseries is shown in Figure M-2. To investigate the wave setup expect to occur at Durras Beach, the root mean square wave height H_{RMS} (m) corresponding to the significant wave heights extracted from the SWAN model was first calculated according to CIRIA (2007) in Equation M.1.

$$H_{RMS} = 0.706 \times H_S \quad \text{(M.1)}$$

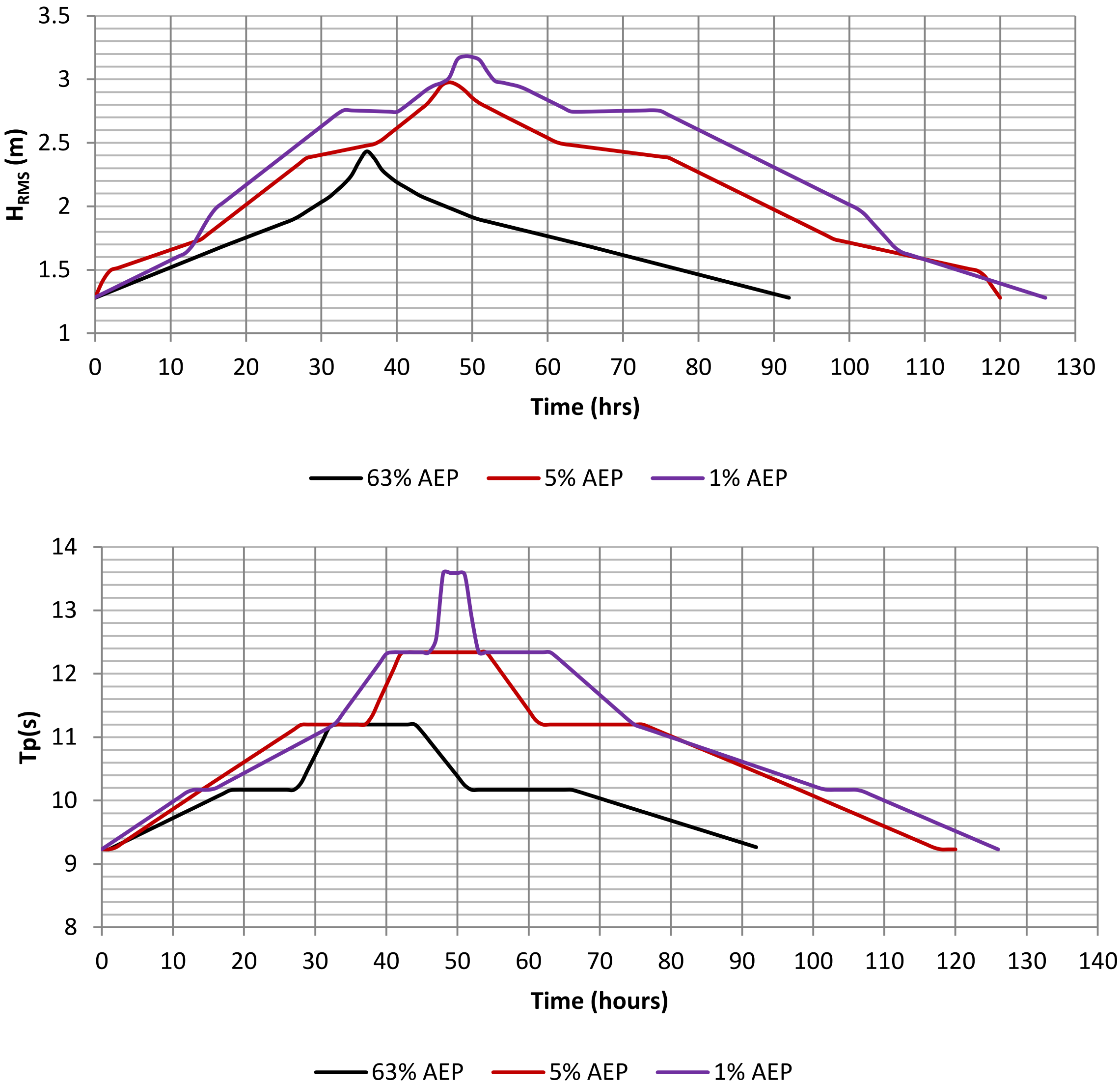

Figure M-2: Synthetic Design Storms (H_{RMS} and T_P) used for Durras Lake Tailwater levels

The Durras Lake tailwater modelling has been based on a profile immediately south of the lake entrance (shown in Figure M-3). Topographic information was extracted of the subaerial portion of the profile from the 2011 LIDAR. As no recent near shore bathymetric data was available for Durras Beach, an Dean Equilibrium Profile (Dean, 1977) was assumed based on a grain size of 0.37 mm, as per the methodology in Section 8.3.2.

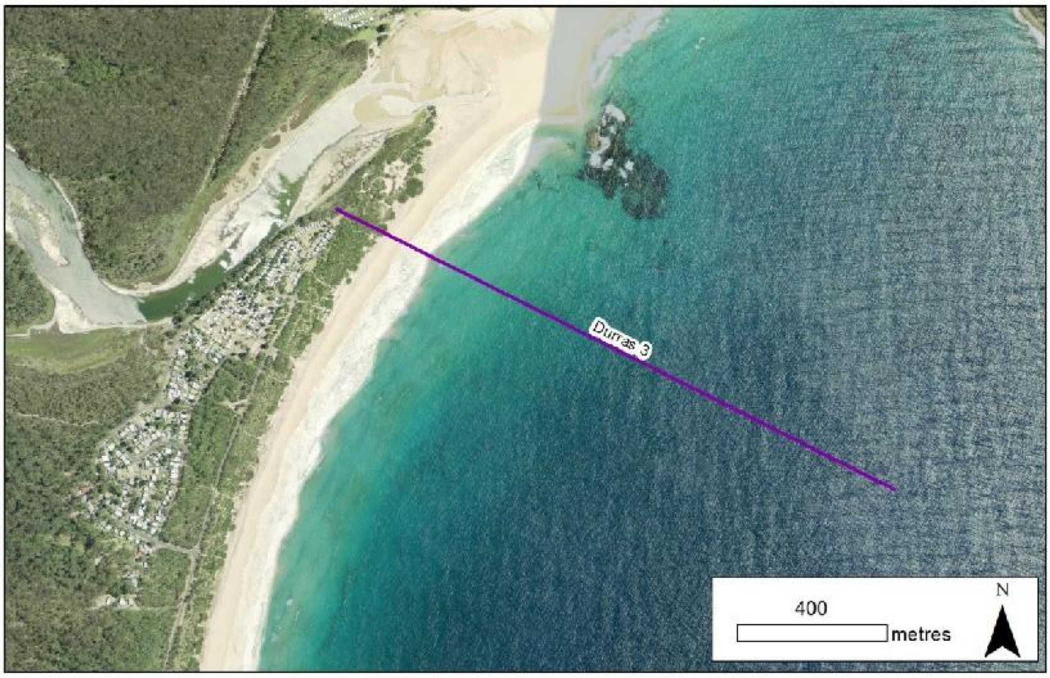

Figure M-3: Location of tailwater conditions analysis for Durras Lake

M.4.1 Phasing of Extreme Ocean Water Levels and Design Wave Conditions

While the 20 and 100 year ARI events wave conditions have been combined with the 20 and 100 year ARI events for water level conditions (tide plus anomaly), respectively, 1 year ARI wave conditions have been combined with the Mean High Water (MHW) level (0.51 m AHD) as previously agreed with OEH. This wave and water level combination is considered more representative of that which would result in 1 year ARI coastal inundation rather than assuming complete dependence of the variables (i.e. 1 year ARI waves and 1 year ARI water level).

M.4.2 Wave Induced Water Level Components

Breaking waves cause an elevated water level in the surf zone due to the radiation stress of the breaking waves being balanced by a gradient in the water surface. The storm waves shown in Figure M-2 were applied as a boundary condition to the Dally, Dean and Dalrymple (1984) two-dimensional surf zone model (implemented using the numerical modelling software SBEACH). From this model, total water levels, including wave setup, were extracted at 15 minute time intervals to define the design tailwater conditions discussed in the following sub-section.

M.5 Summary of Design Water Level Conditions and Constructed Tidal Signals

Elevated design peak water level conditions (excluding wave runup) are summarised in Table M-2. Constructed synthetic water level time series are provided in Figure M-6, Figure M-5 and Figure M-4 for the 63%, 5% and 1% AEP (1, 20 and 100 year ARI) storm events respectively. The length of the provided timeseries corresponds directly with the length of the appropriate coastal storm event, as per Figure M-2.

Table M-2: Summary of Design Water Level Conditions

AEP %	**ARI** (years)	**Peak Tide Level** (m AHD)	**Peak Anomaly** (m)	**Wave Setup at Tide/Anomaly Peak** (m)	**Peak Water Level (including setup)** (m AHD)
63	1	0.50	0	0.80	1.30
5	50	0.82	0.55	1.09	2.46
1	100	0.82	0.61	1.15	2.57

Note that the site specific 5% and 1% AEP values compare well to the default values on OEH (2015) for sites south of Crowdy Head (2.35 m AHD and 2.55 m AHD respectively).

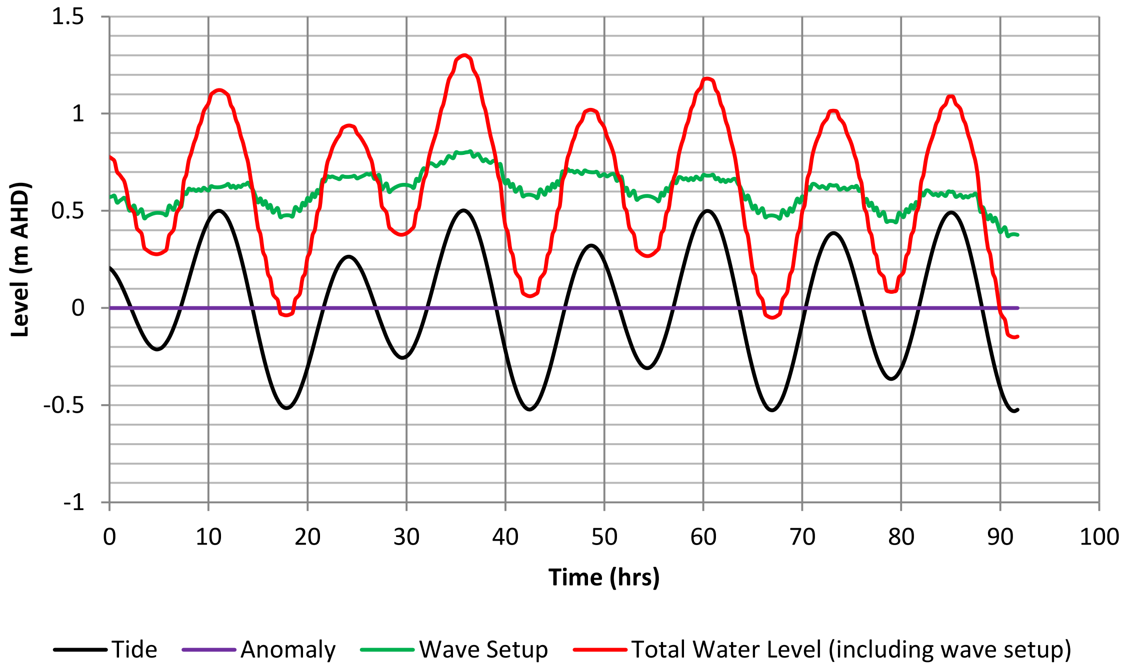

Figure M-4: Durras Lake tailwater conditions: 63% AEP

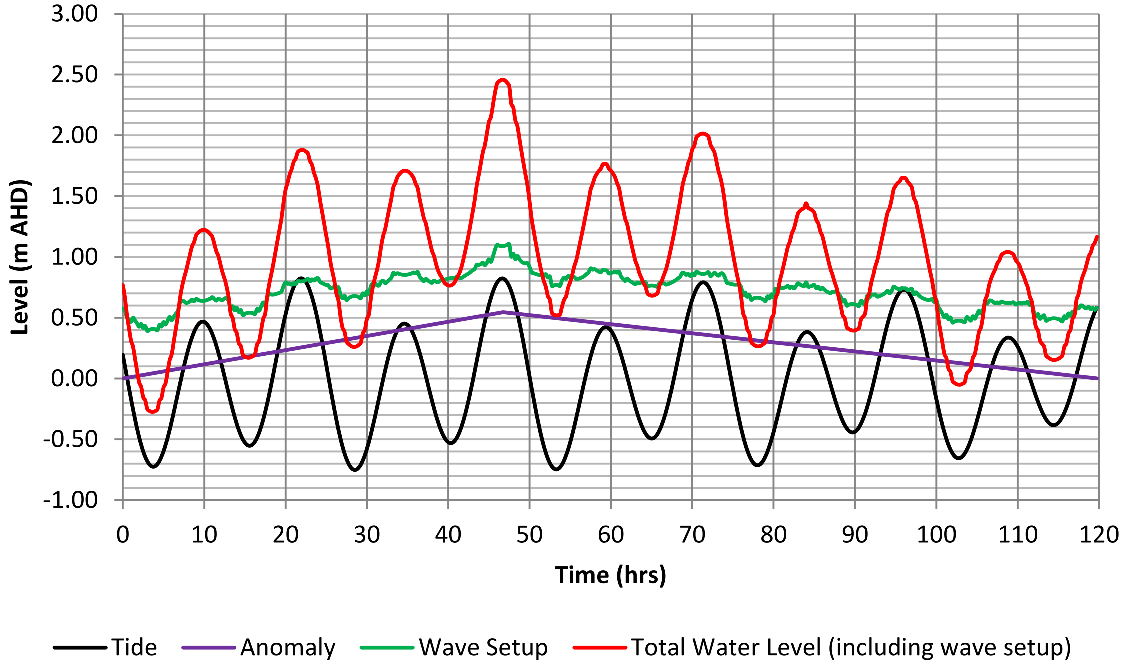

Figure M-5: Durras Lake tailwater conditions: 5% AEP

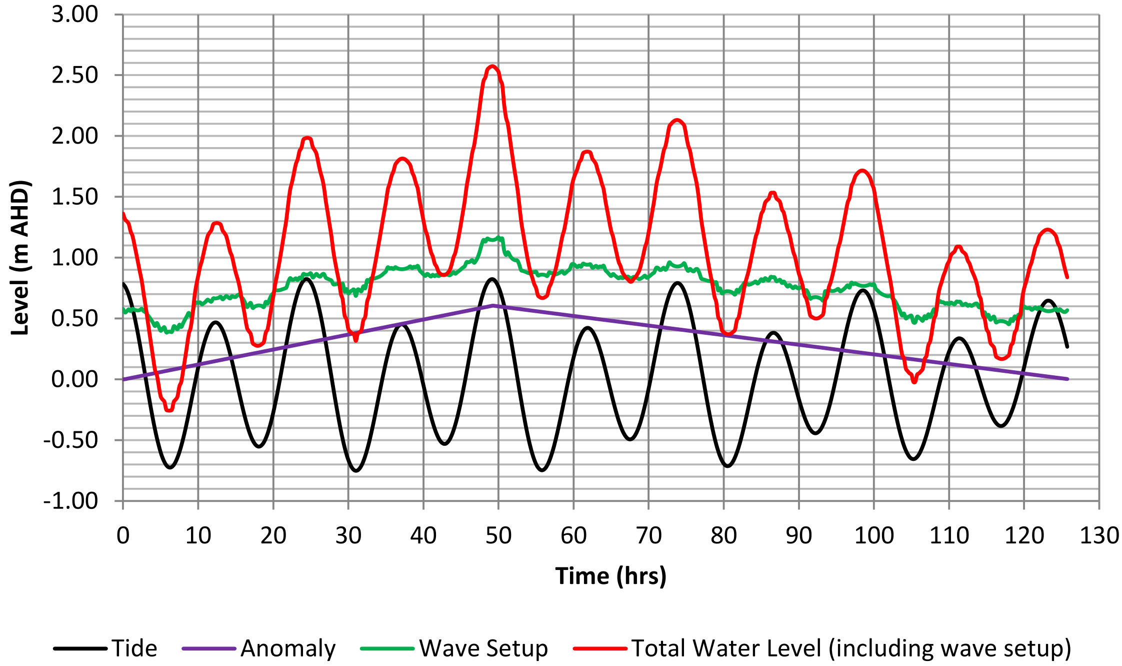

Figure M-6: Durras Lake tailwater conditions: 1% AEP