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Our Reference: AFP240047-PR-MILKWOOD-R00

**More Family Collection**

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**ATTENTION: MR ANDY PATERSON****E-mail address: Andy@more.co.za**

Dear Andy

**MILKWOOD MANOR REVETMENT: COASTAL ENGINEERING ASSESSMENT****1. INTRODUCTION**

PRDW was appointed to undertake an expert appraisal of the current state of the Milkwood Manor rock revetment which was installed as an emergency repair after the November 2007 flooding of the Bitou and Keurboom estuaries.



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The brief includes providing an opinion on how the current revetment will react to future storm events and the influence of climate change. Our findings in respect of the specific issues may be summarized as follows:

- a. What will the impact of a storm event be on the current revetment and proposed infrastructure of the hotel?

The rock revetment construction from November 2007 to May 2008 is in good condition. Subject to occasional periodic maintenance, the revetment is expected to provide adequate protection to the existing buildings when the mouth of the estuary returns to the Lookout beach location. The projected impact of climate change will increase the severity of the storm events which will affect the revetment in terms of increased wave overtopping from the ocean and higher flooding levels from the river. The new infrastructure, as currently proposed, is expected to be protected to an acceptable level of risk, subject to the implementation of mitigatory measures.

- b. What mitigatory measures are needed to ensure an acceptable level of risk?

Periodic maintenance of the rock revetment should be carried out to ensure that any settlement, displacement or weathering of the material is addressed.

To address the future impact of climate change, additional measures have been taken to increase the floor levels for any new developments and setback buildings from the southern boundary to accommodate increased overtopping such that any direct wave loading is avoided. All open areas are to be designed to drain away from the buildings and parking areas back into the estuary.

## **2. SCOPE OF REPORT**

This report is divided into six sections based on the scope of work defined in the brief. Section 1 deals with the site visit and the review of the available as built information. Section 2 provides a brief review of the evolution of the relevant coastal morphology based on historical records whilst section 3 addresses the latest projections for climate change with a view to its potential to impact the Keurbooms/Bitou estuary. This assessment is used to evaluate the impact of a major storm event on the revetment and its implications for the proposed new infrastructure for the hotel. Finally in section 4 measures to mitigate the impact of future severe storm events are addressed and recommendations are made.

### 3. ASSESSMENT OF THE ROCK REVETMENT

#### 3.1 Site visit

A site visit was undertaken on the 11<sup>th</sup> and 12<sup>th</sup> of July 2024. Meetings were held with Dave Visser, the consulting engineer who was involved in the assisting the owner in the construction of the emergency revetment from November 2007 to May 2008, and Michael Bennet of Sharples Environmental Services CC (SES). The meeting dealt with the history of the construction and the performance of the revetment, the current state, sources of material, historical records and photographs and the proposal for the new developments on the site. The documents handed over at the meeting included correspondence submitted by the engineer to the environmental consultants for DEA&DP approval, geotechnical data (jet probes) adjacent to the revetment and NGL survey levels from February 2008. The meeting was concluded with an inspection of the revetment.

#### 3.2 Coastal morphology and the current state of the revetment

The Keurbooms/Bitou estuary has been the subject of numerous scientific studies over the years. Schumann (2021) describes it as a typical bar-built estuary, with a back-barrier lagoon and barrier dune almost 4 kilometres long. Notable is that the barrier dune is not anchored to any substrate (hard rock) and as a result the location of the mouth (tidal inlet) varies over the whole length of the barrier dune. The figure below summarizes the position of the mouth over the last 80 years.

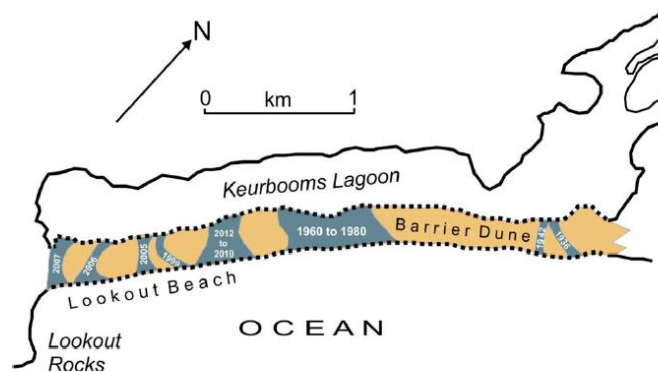
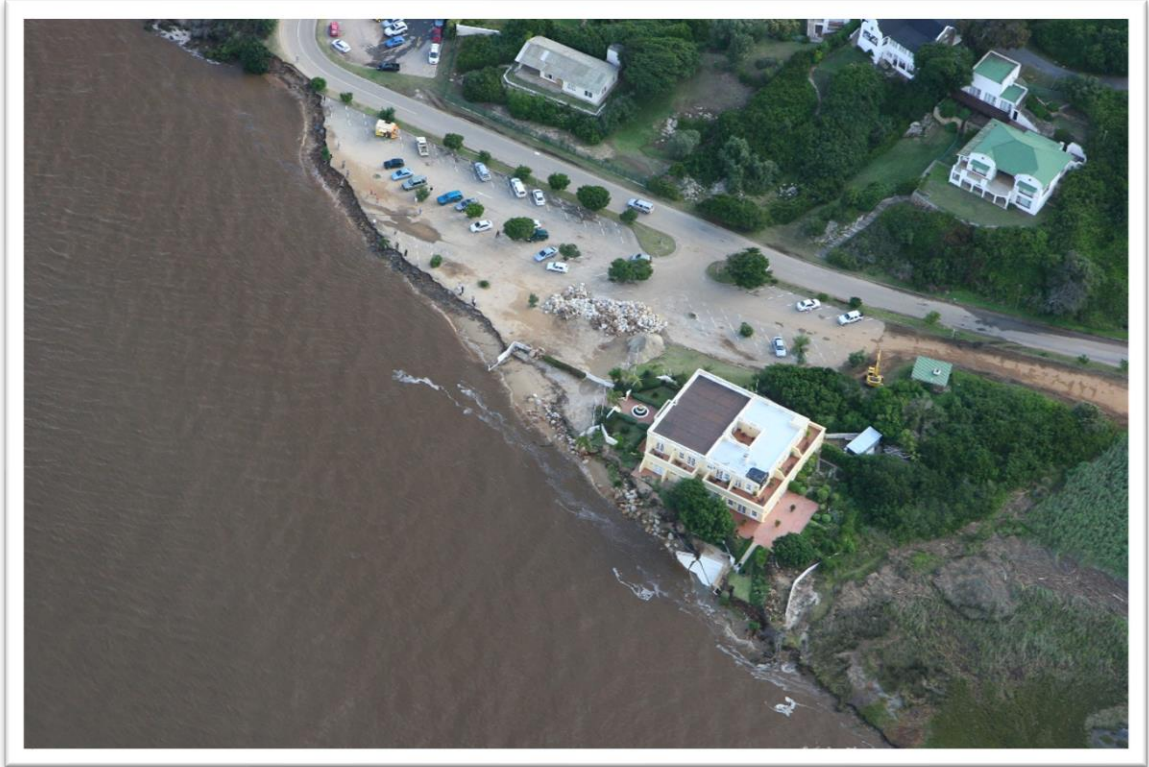


Fig. 2 The Keurbooms Lagoon and associated Barrier Dune. The approximate positions of the mouth over the given years are shown by the dark blue areas on the barrier dune (Duvenhage and Morant 1984; Illenberger 2003; Schumann 2015)

The location of the mouth may be considered as being in a dynamic equilibrium as a function of fluvial flooding, prevailing sea level and ocean storm events. The implication is that the conditions which led to the need to construct the revetment during 2007/2008 should be expected to recur in future. A number of

photographs are presented below to illustrate different states of the estuary which could be expected to recur in future.

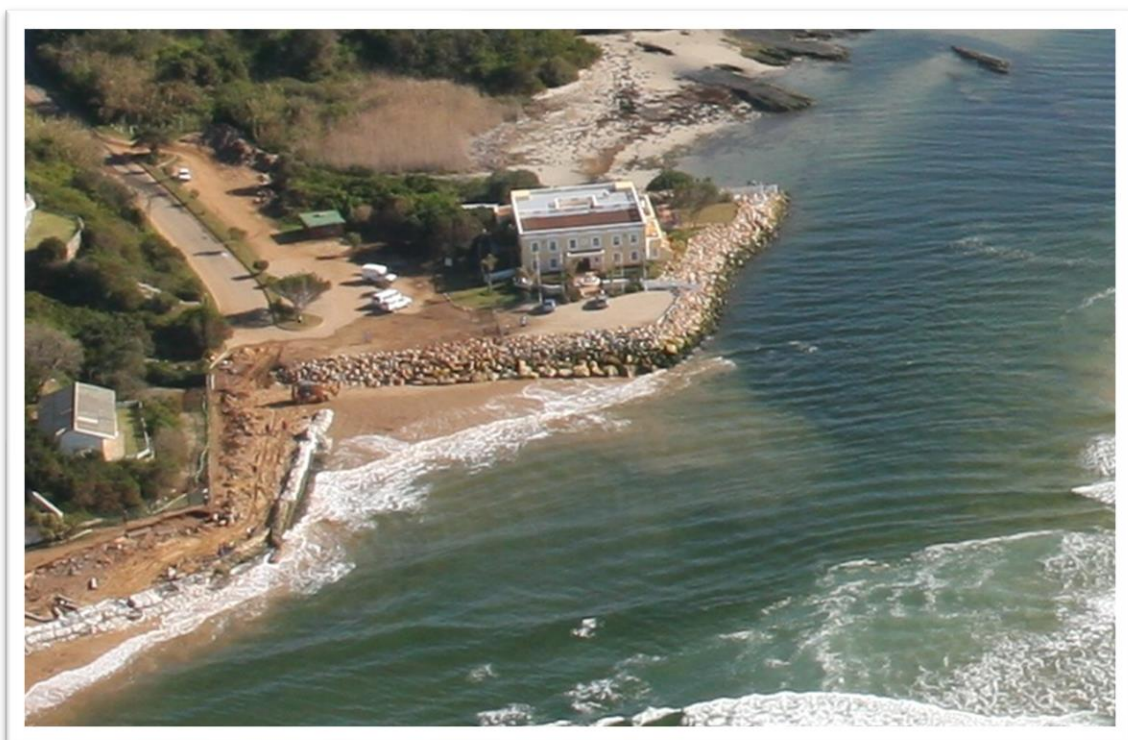


***Figure 3.2.1: November 2007 during flood***

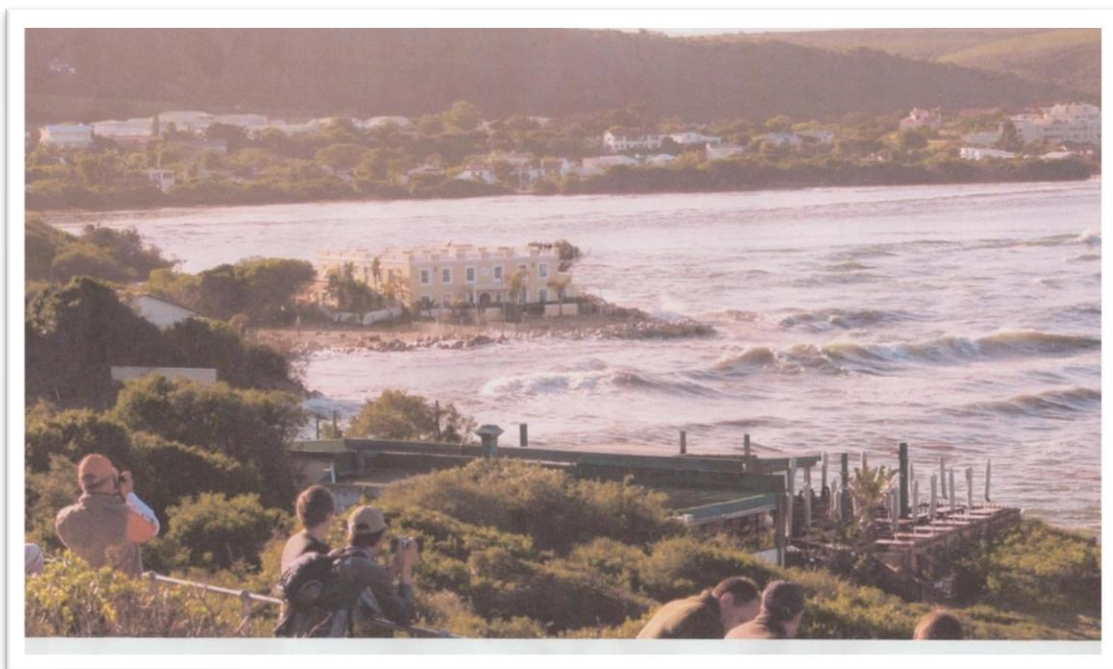




*Figure 3.2.2 after construction of revetment (circa 2008)*



*Figure 3.2.3 Revetment post construction (circa 2008)*



***Figure 3.2.4 Typical high water and wave action***



***Figure 3.2.5 Flooding of the car park (post 2008 construction)***

The conditions illustrated in these photographs are considered extreme events but are nevertheless likely to recur again in future and should therefore be considered in any new development or ongoing maintenance plans.





**Figure 3.2.6 Revetment taken July 2024**

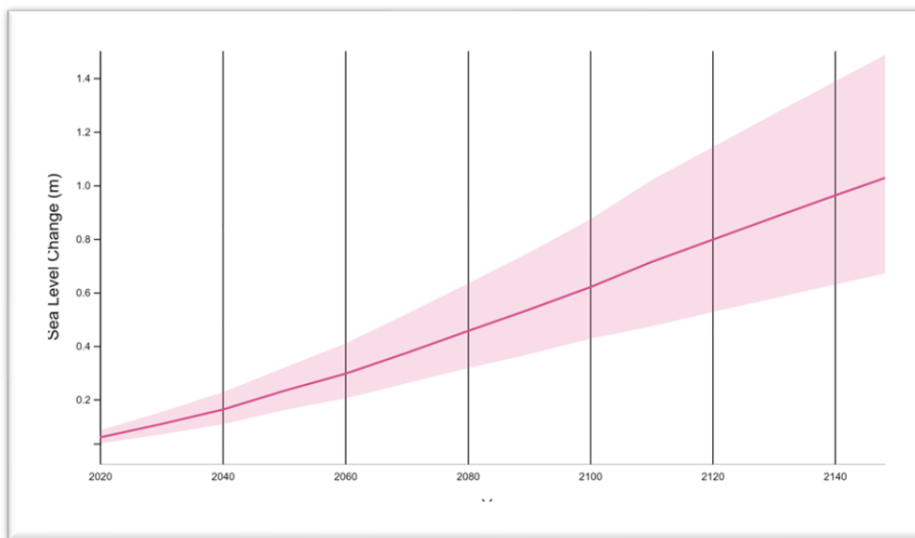
The state of the revetment inspected during the site visit in July 2024 is good. The Table Mountain Sandstone (TMS) rock shows little sign of weathering with only minor settlement over its length. Most of the structure is currently below the accreted beach sand level. The long-term stability of the revetment is dependent on the toe of the structure not being undermined, the units on the slope remaining in position and the crest not being damaged. Jet probe information received at the site meeting indicates that bedrock levels vary between 4 and 9 m below NGL over the length of the revetment. The construction of the revetment could not build the toe of the structure on bedrock and relies on additional rock in front of the main slope to form a falling apron in the event of future erosion. The stability of the structure is therefore a function of the amount of rock placed. Records (bills of quantities delivered) obtained from the owner indicate that a total of 5300 tonnes of rock was placed in the revetment over a period of approximately 7 months. If it is assumed that this was distributed over the 160 m of the revetment this equates to around 18 m<sup>3</sup> of rock per metre. This would appear to be adequate for the maintenance of the integrity most of the structure.

No units appear to have been displaced on the slope of the revetment. The apparent minor settlement of parts of the structure is not of concern but indicates that additional rock should be added to the structure in future to ensure that the crest level is maintained.

### 3.3 The impact of global climate change

It is expected that global climate will affect the conditions prevailing at the site over the next 100 years. This is likely to affect the revetment in the following manner:

- Rainfall patterns in the area are not expected to change and therefore no major changes in the river discharge volumes are expected.
- By 2100 extreme wave conditions are expected to increase by some 5% with a southward rotation of the south westerly swell of approximately 5%.
- The extent of sea level rise is dependent on the future emission reductions achieved globally. If a mid-level scenario (upper confidence level) is selected for 2060 an increase in sea level of 0.4 m is forecast whilst for 2100 an increase of 0.8 m is forecast. (see figure 3.3.1 below). Increased sea levels in future will result in higher flooding levels in the estuary.



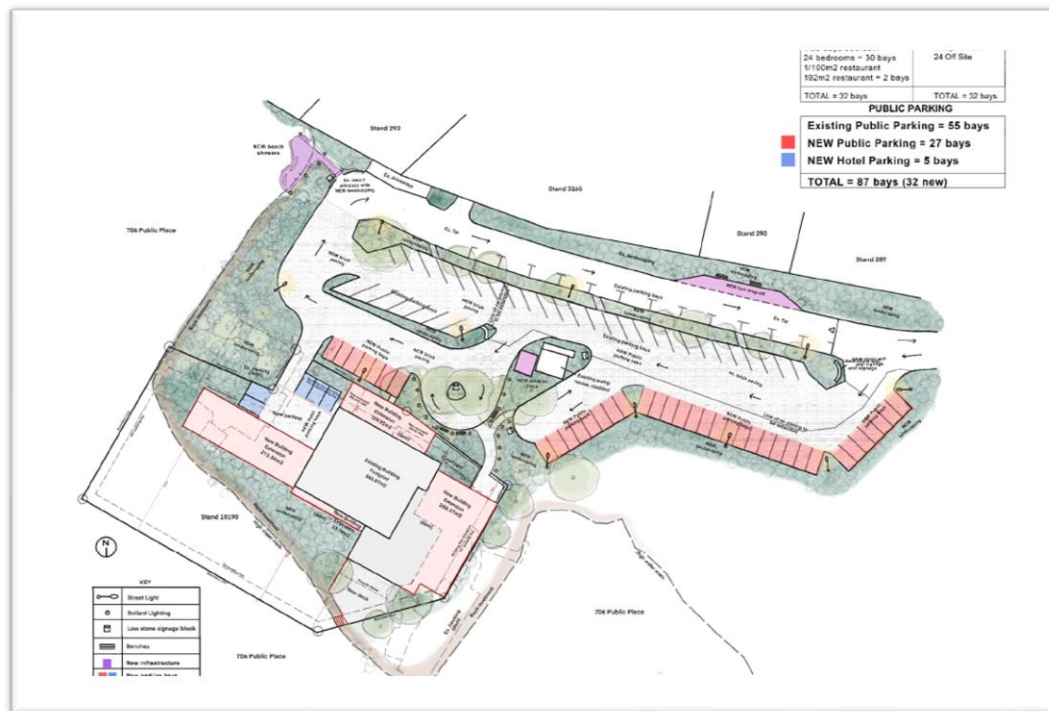
**Figure 3.3.1 Projected Sea Level Rise for SSP2-4.5 scenario**

The impact of climate change will therefore lead to more severe conditions at the site. This will be experienced as higher flooding levels and increased wave heights on the seaward portion of the revetment with resultant higher levels of overtopping and flooding behind the revetment.

### 3.4 Proposed mitigatory measures

The revetment is considered fit for purpose in terms of what has been experienced at the site to date. The new owners of the property propose making changes to the existing buildings on the site. (see Figure 3.4.1)





**Figure 3.4.1 Proposed site development plan**

With the expectation of climate change effects coming into play in future and the resultant increased severity of the site conditions the following mitigatory measures have been considered.

- Additional rock armour to be added to the structure as part the existing management plan. This will ensure that the structure is resilient into the future.
- Consideration to be given to increasing the floor levels in the buildings where possible.
- Setback lines from the sea facing section of the revetment have been considered such that wave loading and overtopping on the buildings is avoided.
- Allowance has been made for adequate drainage away from the buildings toward the estuary to prevent the build-up of flood waters should overtopping of the revetment take place.

#### **4. CONCLUSIONS**

This report provides a high-level assessment of the rock revetment protecting the existing Milkwood Manor buildings. The structure was inspected visually and found to be in good condition. The conditions which led to the need to build the structure at the end of 2007 can be expected to recur in future. Whilst the existing structure is considered adequate for conditions experienced to date, the effects of global climate change are expected to lead to increased flooding and overtopping. Various mitigatory measures have been recommended regarding the development of the site to reduce this risk.

## 5. REFERENCES

1. Schumann, EH (2021); Floods, sedimentation and tidal exchanges in the Keurbooms Estuary, South Africa, Geo-Marine Letters (2021) 41:34
2. <https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool>