Coastal Assessment for Featherbed Restaurant

Coastal Stability Assessment at Featherbed Nature Reserve

By Inanda Port and Coastal Engineers (Pty) Ltd
For Phambi Properties (Pty) (Ltd)
17 October 2025
Draft

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Coastal Stability Assessment at Featherbed Nature Reserve

This report documents a qualitative study of shoreline behavior in the vicinity of Featherbed nature reserve in Knysna. The study is based on publicly available desktop information and engineering judgement. No numerical simulations or extensive data gathering have been undertaken.

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1 SITE DESCRIPTION

The Featherbed Restaurant and Nature Reserve is located on the western headland of the Knysna Estuary on the southern coast of South Africa, within the Western Cape Province. The site occupies the western promontory of the Knysna Heads, which delineate the tidal inlet that connects the Knysna Lagoon to the Indian Ocean. The surrounding terrain comprises coastal slopes that extend from elevated ground to the estuarine margin.

The Knysna Lagoon forms a semi-enclosed estuarine system influenced by tidal exchange and freshwater inflow from the Knysna River. The estuarine areas include intertidal flats, marsh areas, and reed-covered zones that form part of the lower catchment. The terrestrial area within the Featherbed Nature Reserve supports fynbos, coastal thicket, and milkwood forest vegetation types associated with the southern Cape bioregion.

The position of the Featherbed Nature Reserve in relation to the Knysna Lagoon and surrounding terrain is shown in **Figure 1**.

Figure 1 Locality of study area (red erf boundary)

The client wishes to develop the site further. The proposed development consists of several buildings, including a conference facility and a manager's cottage. The overall site development plan (by others) is presented in Figure 2.

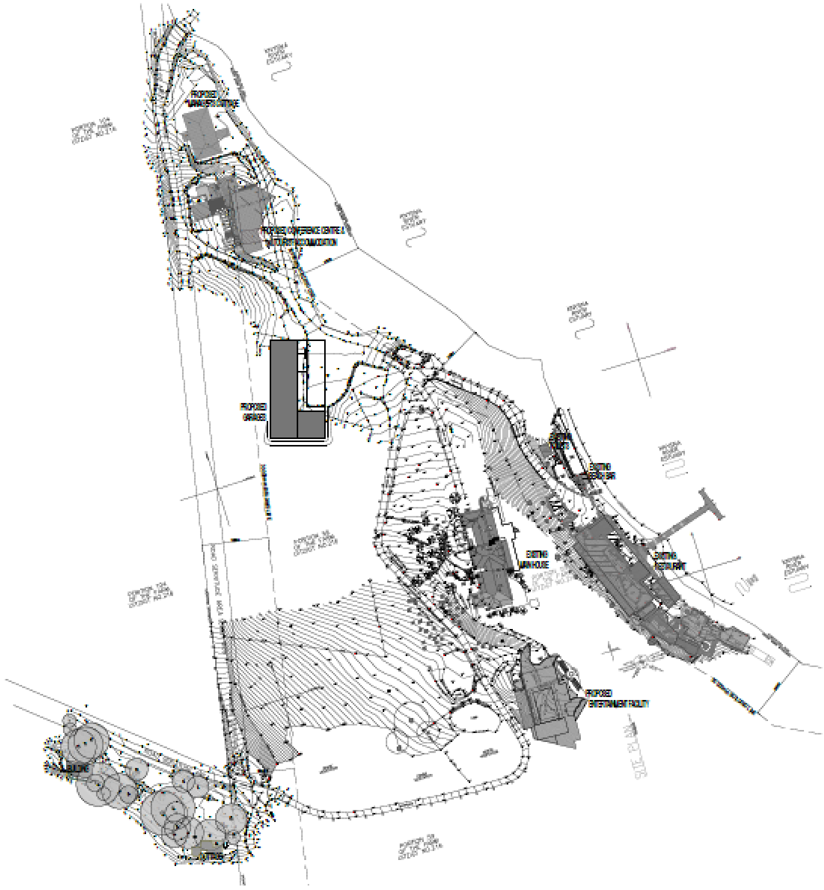

Figure 2: Site Development Plan for the site

This study has been commissioned by Phambi Properties (Pty) Ltd. and is intended to provide an assessment of the coastline at the site, with the following objectives:

- Provide an assessment of the current condition of the estuarine shoreline around the general Featherbed site.
- Provide an assessment of the impact, if any, that the proposed development may have on the estuarine shoreline.
- Provide an assessment of the exceptional impact of shoreline erosion (if any), on the development.

2 SITE VISIT AND OBSERVATIONS

This chapter documents key observations from the site visit using photographs and aerial imagery. The section begins with an appreciation of the vegetative cover across the site, which is then followed by a series of photographs detailing specific observations. Each photograph is paired with a descriptive note highlighting features such as bank condition, vegetation, evidence of scour, protection works (e.g., rip-rap, walls), and any signs of accretion or erosion. An assessment of the impact of the 2017 Knysna fires is provided, which is followed up with an assessment of the expected impacts of climate change on the general site.

2.1 GENERAL APPRECIATION OF VEGETATION ACROSS THE SITE

The current dominant vegetation represents a mix of Goukamma Dune Thicket species and some invasive elements. Low groundcovers such as *Helichrysum* spp. and grasses (notably *Restio* spp. and *Aristida* spp.) were more prevalent than typical foredune pioneers such as *Tetragonia* spp. and *Carpobrotus* spp.

Young shrubs, approximately 4–7 years old, are well established. Pioneer species such as *Chrysanthemoides monilifera* and *Acacia cyclops* dominate the northern end of the ERF, while more mature, late-successional thicket species — *Carissa* spp., *Brachylaena* spp., and *Sideroxylon inerme* — are becoming increasingly dominant toward the southern section and around the jetty.

The main concern is the presence of invasive species (*Acacia* spp. and *Pinus* spp.), which are competing with indigenous flora. If left unmanaged, these invasives may disrupt natural succession and increase the potential of erosion along the dune toe.

2.2 GENERAL EROSION OBSERVATIONS

General erosion and accretion patterns have been identified during the site visit. Each set of observations is discussed in the context of a specific photograph.

Observation:

- Vegetation appears in good condition, which is an indicator of stability.
- Evidence of toe scour or undercutting near the waterline.
- Presence/condition of protection (e.g., timber piles)
- Signs of recent wrack lines indicating high-water marks, attributed to recent spring high tides.
- Presence of sandy beach from water level up to toe of dune embankment

Observation:

- Vegetation appears in good condition, which is an indicator of stability.
- Evidence of toe scour or undercutting near the high spring tide waterline, with some rock outcrops evident on the right side of the photograph (which provide some form of limited erosion protection.)
- Presence/condition of protection (wooden piles) on far left.
- Signs of recent wrack lines indicating high-water marks, attributed to recent spring high tides.
- Presence of sandy beach from water level up to toe of dune embankment.

Observation:

- Vegetation: fynbos with some milkwood trees.
- Evidence of toe scour or undercutting behind the protective man-made rock structure.
- Presence of sandy beach from water level up to toe of dune embankment, with reasonable amounts of lightly cemented sand / weak rock fragments on the lower reaches of the beach.

Observation:

- Evidence of toe scour or undercutting near the high spring water mark covered with vegetation, with erosion area significantly beneath and behind the vegetation line.
- Presence/condition of old/damaged protection without any functionality (expired design life).
- Signs of recent deposition or wrack lines indicating high-water marks, with vegetation growth concealing (and lightly protecting) the eroded dune toe.

Observation:

- Evidence of toe scour or undercutting near the high spring water mark covered with vegetation, with erosion area significantly beneath and behind the vegetation line.
- No erosion protection structures – apparently totally degraded / removed.

Observation:

- Vegetation health and continuity is an indicator of stability, in particular along the edge of the dune toe, inside and/or close to spring high water mark.
- Evidence of toe scour or undercutting near the waterline.
- Presence/condition of protection, e.g. the wooden piles, but again with limited functionality (past design life).
- Signs of recent deposition or wrack lines indicating high-water marks, especially visible at the concrete boat ramp, with similar extents along the beach.

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Observation:

- Rocky cliff face visible in isolated locations, while sandy dunes not visible / apparent.
- Good vegetative cover across the area.
- Rocky pebble beach exists (in lieu of (suggests lack of sediment supply to his location)

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Observation:

- Free and open stormwater discharge flow, largely uncontrolled down to lagoon.

Observation:

- Stormwater discharge from upper areas of the site, along concrete road on to open grassed area

Observation:

- Patchiness of vegetation vs exposed soil.
- Certain areas exhibit localized slope failure inclusive of soil/vegetation mass, or a steep slope more than 45°. This suggests recent local erosion at the base, or recent slope failure, or soil mass with increased internal strength.

Aerial Imagery

Aerial imagery was obtained from the Knysna municipality EgiS Viewer database. Three aerial photographs were available, from 2009, 2015 and 2019 (Figure 3). The aerial photos are considerably clearer than google earth imagery and considered to be more accurate. Google earth imagery was thus not used.

2009 2015 2019

Figure 3: Aerial Imagery utilised in the study (ESRI)

An assessment of the three historical images was undertaken. The findings of the assessment are presented graphically in Figure 4.

Figure 4: Observations from Aerial Imagery

Observation:

- A recession of the vegetation line (interface between vegetation and sandy beach) is evident between 2009 and 2019 of up to 5m (shown as yellow line figure).
- Recession of the top vegetation line by some 5 m between 2009 and 2019 (orange line).
- Lack of vegetation exposing dune face (pink circle).

2.3 IMPACT OF KNYSNA FIRES (2017) ON VEGETATION

In June 2017, a catastrophic wildfire swept through the Knysna region, driven by a prolonged drought, low humidity, and gale-force winds exceeding 120 km/h. The fire spread across the landscape, destroying homes, plantations, and vast areas of natural vegetation.

The fire destroyed an estimated 95% of its vegetation cover. Following the fire, the reserve experienced extensive regrowth, dominated initially by invasive species such as Rooikrans (Acacia cyclops).

Through aerial imagery, it was clear that the fires did cause damage to the vegetation growing on the embankment. The extent of this damage is, however, not completely ascertainable from the available imagery, but it is considered likely that there was a minor influence on vegetative cover loss (for the loss extending to this day), which is likely to have contributed to erosion and or slippage of the dune.

2.4 CLIMATE CHANGE IMPACTS

The impacts of climate change have been assessed. The latest reports of the Intergovernmental Panel on Climate Change (IPCC) have been reviewed and summarised into the most pertinent aspects related to the site. The expected changes in sea level rise, wind, rainfall and wave activity have been assessed (as per IPCC findings), and the impact of each at the site is considered.

2.4.1 SEA LEVEL RISE

Global and regional assessments by the Intergovernmental Panel on Climate Change (IPCC) confirm that global mean sea level (GMSL) is projected to continue rising through the 21st century. Under all emissions scenarios, GMSL is expected to rise by 0.1 m to 0.4 m by 2050, while by 2100 the projections diverge more widely—from 0.2 m to 1.0 m under RCP2.6, to 0.2 m to 1.6 m under RCP4.5, and as high as 2.4 m under RCP8.5.

For the southern African coastline, regional sea level rise is anticipated to be 7 – 14 % higher than the global mean, resulting in projected increases of approximately 0.3 – 0.9 m under low-emission pathways and 0.6 – 1.4 m under high-emission pathways by 2100. A rise of one meter or more would significantly affect coastal infrastructure through increased inundation, storm surge intensity, and wave energy within estuarine and near-shore zones.

For this study, due to the long term nature of the proposed development, it is recommended that infrastructure planning allow for a 0.9 m increase in still water level by 2100 under a high-emissions scenario. This allowance provides a potentially conservative basis for the assessment. The increase in water levels at the site is considered significant and would result in increased shoreline erosion when compared to that experienced to date at the site.

2.4.2 WIND AND CYCLONIC ACTIVITY

IPCC Projections indicate that although the frequency of tropical and subtropical cyclones may decline slightly in coming decades, their average intensity and destructive potential are expected to increase. A 1 – 10 % rise in maximum sustained wind speeds is projected under a 2 °C global temperature increase, with a 10 % increase in wind speed potentially resulting in 30 – 40 % higher structural damages.

Southern Africa remains vulnerable to strong extra-tropical systems, coastal depressions, and cut-off lows that can generate damaging winds and storm surges. While these events are infrequent compared with tropical cyclone basins, they can impose significant short-term loading on coastal structures.

Within the environment of the Knysna lagoon, increasing wind speeds would increase wind generated waves at the site, currently estimated at between 5 and 10% (including an influence of sheltering offered by the Knysna heads) and would result in increased erosion compared to the historical trend.

2.4.3 WAVE CLIMATE

Waves generated by regional wind systems are key drivers of coastal processes, including erosion, sediment transport, and harbour hydrodynamics. Global projections indicate that mean significant wave height may vary by ± 5 – 10 % by 2100, depending on location and emissions pathway. Along southern African waters, trends suggest a gradual increase in wave energy and storm surge frequency, with extreme offshore wave heights occasionally reaching 8 – 9 m under severe conditions.

Given ongoing uncertainty in wave-climate projections—particularly regarding directionality and period—it is prudent to apply a 2 % increase in significant wave height by 2100 for conservative design. This adjustment serves as a precautionary provision, rather than a mitigation measure, to ensure structural robustness against potential increases in wave loading.

Within the Knysna Lagoon environment, any increase in wave height (from ocean swells propagating through the estuary mouth) is expected to increase shoreline erosion at the site. However, the magnitude of this effect is anticipated to be limited, owing to the site's sheltered position and the substantial protection afforded by the Knysna Heads.

2.4.4 RAINFALL AND PRECIPITATION

Although quantitative rainfall projections remain uncertain at local scales, climate models consistently indicate an increase in rainfall variability and extreme precipitation events across southern Africa's coastal zones. In southern and eastern Africa, some models project that mean annual rainfall may increase by 10–25% under higher global warming scenarios, alongside intensified heavy precipitation events. This trend is expected to intensify the frequency of flash flooding, elevated runoff, and sediment transport into estuarine and harbour systems.

Infrastructure design should therefore include enhanced stormwater drainage capacity, ensuring that runoff is captured, treated, and managed without direct discharge to sensitive marine environments. Drainage systems should also account for rising sea levels and potential backflow during concurrent storm surge events.

The potential impact of increased rainfall on further shoreline erosion at the study area is considered likely but minor, if undertaken appropriately. Stormwater management measures will need to be designed with climate change considerations in mind; however, these adaptations are not expected to incur significant additional costs compared to normal good stormwater management practice.

3 SUMMARY OF FINDINGS

The observations and notes made in Section 3 are developed further. Possible causes are attributed, and levels of risk and likelihood are attributed based on professional judgment only. No numerical risk simulation type study work has been undertaken to support the determinations made in the following section.

The findings have been separated into three areas, the top of the dune embankment, across the slope of the dune embankment, and along the toe of the dune embankment. Each is discussed in turn.

Across the top of the embankments:

- Recession landwards of the vegetation is noted by some 5m in one location. The cause of this is unknown but could be due to changes in gardening landscaping practices in the recent past, or due to slope failure. In general, the top of the slope does not show other signs of recession.
- The impact of the Knysna fires on stability on this area is considered likely but minor (in terms of the longer-term erosion trend)
- The impacts of climate change is considered a potential issue with respect to stormwater through potentially increased rainfall but can be managed.

Across the embankments on the site:

- Historical slope failure occurring in isolated locations, resulting in several areas of stepped dune face which have since been vegetated. These locations are considered relatively stable. The cause for the original slope failure is currently unknown and attributed to either excessive ground water resulting in shear failure (most likely), or wave induced erosion at the toe resulting in long term regressive erosion of the entire dune (less likely).
- There are areas where the soil is exposed, and vegetation has not yet grown back. This is due to either insufficient time to reach full regrowth, or poor soil condition inhibiting the growth of the pioneer vegetation following the Knysna fires.
- Overall, the vegetation appeared healthy, with only minor concerns noted. Most of the dune toe has regained good vegetative cover since the 2017 fires. Bare sand exposure was minimal, limited to the erosional scarp along the estuary water line (spring high), where three areas of recent subsidence were observed (likely within the past five years).
- Stormwater management: There are gulleys / ravines that have been eroded from what appears to be stormwater. In addition, the large flat area in the vicinity of the carport, provides a localized area where stormwater from the top of the site is permitted to slow down and settle, permeating through the dune mass. This would result in further slope instabilities, the extent of which is estimated as likely, but a minor influence.
- The impact of the Knysna fires (2017) on the embankment is considered likely and minor.
- The future impact of climate change is considered likely and minor, this driven by potential increases in stormwater runoff. This, however, is manageable if proper measures are implemented.

Along the toe of the embankment:

- Erosion of the first 0.5m to 1.0m (in height from the existing beach level in immediate vicinity of the toe of the dune) is prevalent across the entire site. This has been attributed to either boat wake induced erosion (most likely) and further only at the spring high tides, or increased sea level rise over the last ten to twenty years (less likely) . The impact of wind generated waves within the

Knysna lagoon is considered minimal and is likely to only be problematic under instances of further sea level rise. These erosive events may over the longer term, result in successive erosion and subsequent shear failures of the above slope portions.

- Distance of the remaining wooden piling is some 1-5m from the existing embankment toe, averaging some 1.5m to 2.0m. Assuming these piles were placed between 10 and 20 years ago (judging from their condition), the rate of recession due to erosion is estimated to be one metre over a period of between 5 and 15 years. The extent of this erosion extension up the slope is not ascertainable from the current dataset but does appear to be variable and most certainly extends up to some 5m vertically from the toe of the embankment.
- The imagery shows that there are certain areas where the dune is vertical and consists of either rock (or soil mass of significantly higher stiffness). In these locations, a sandy beach does not exist, which implies that the sediment from the dunes feeds the sandy beaches (likely). This further supports the notion of an erosive trend along the shoreline / embankment toe.
- In time, the toe erosion will begin to result in successive shear failure and eventually show at the top of the slope. For a slope width of 10m (ultimately variable across the site), the current estimate at the erosion rates above imply this could occur between 50 and 150 years from now. This erosion event forming the erosion scarp at the toe, could trigger larger scale slope instabilities across the full slope width at earlier dates than this. However, the likelihood of this needs to be assessed from a geotechnical perspective by a geotechnical engineer.
- The impact of the Knysna fires (2017) on the embankment is considered likely and minor.
- The future impact of climate change is considered likely and moderate, this primarily from the perspective of sea level rise, and the resulting influence on acceleration of the erosion trend as sea levels rise.

4 CONCLUSIONS

4.1 CURRENT CONDITION OF THE FEATHERBED SHORELINE

The shoreline at Featherbed restaurant, and across the proposed site area in general shows signs of well vegetated dunes. There are areas of concern where vegetation is not present, and the dune sand is exposed. The exact cause of this is attributed to isolated instances of slope slippage (most likely) with a possible alternate cause being the Knynsa fires (less likely).

The toe of the dune does exhibit signs of erosion, over a height of up to 1m close to vertical scarp from the beach level, which is observed across virtually the whole site. The height of the scarp is in the order of 0.5m (as an average). The existence of the scarp has been attributed to a long-term erosion trend at the site based on the geometry of the beach, the location of the site relative to boat generated wake waves, and the make-up of the dune soil. Erosion would only occur over the highest spring tides but can increase under climate change.

4.2 EXPECTED IMPACT OF THE DEVELOPMENT ON THE SHORELINE

The development in its current form is not expected to result in increased shoreline accretion or erosion at the study area. However, if stormwater is not properly managed, flow from the existing driveways and stormwater management systems may result (and has already) in the development of erosion gulleys on the dune faces, which is problematic as it may reduce vegetation cover and further open up pathways for wave induced erosion, which is likely to worsen over time. However, if properly managed its impact is likely to be minimal, if not non-existent.

4.3 EXPECTED IMPACT OF EROSION ON THE DEVELOPMENT.

Shoreline erosion, across almost the entire length of the site from the feather bed jetty to the northernmost erf boundary, is evident. The extent of erosion is estimated at a rate of approximately 1m of erosion of the embankment toe every 5-15 years and is attributed to a combination of wave induced erosion from boat generated waves, stormwater runoff and lack of naturally occurring rock outcrops to resist the erosive forces. This erosion would progress further into the dune mass, unless prevented from doing so by one (or more) of the means below:

- Removal of the boat wake waves from the local environment. This is not considered a practical solution due to the potentially negative tourism impact on Knysna.
- Improved stormwater management across the site (at top of dune embankment). This is considered practical and cost effective if done correctly.
- Existence of a highly stable mass of material (naturally occurring rock). Further investigation could be done on understanding the natural rock levels at the site but this is not considered cost effective due to the costly nature of deep geotechnical investigations.
- Existence of a highly stable mass of material / structure, ie. man-made type of structure to effectively halt further erosion. This is practical, effective, but costly when compared to the other means. Further investigation would be needed to understand the most suitable solution. In addition, it is likely to reduce the width of the adjacent beaches.
- Reinstatement of vegetation in selected areas across the slope through a landscaping exercise. This would be practical, low cost and would assist in reducing the overall risk to the development.

- Offsetting the proposed development by some distance from its proposed location. This would buy time but not provide a long-term solution to the coastal erosion problem. In conjunction with other solutions, it can reduce risk significantly.

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