Specialist Coastal Environmental Engineering Report

Portion 19 of 257, Fransmanshoek, Vleesbaai, Municipality of Mossel Bay

Specialist input to the site analysis and design parameters of the proposed residential building and services

report by

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NOVEMBER 2021

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Portion 19 of 257
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Photo: The plateau on Portion 19 of 257, Fransmanshoek

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Limitations of the study

The aerial image and photographic analysis that forms the basis of the site stability assessment, conclusions and recommendations are based on the availability of historical and recent data and information. Due to poor resolution of such historic material it is required to make use of much interpretation of landscapes and features as well as the technical skill to undertake comparative image analysis that is shaped via experiential learning. As such only a broad idea of the relevant dynamics can be reached. However, this approach has proven to be useful in identifying long-term trends that are important when attempting to understand natural processes and their potential impact on and potential response to developmental and / or management actions.

Author

The author (Mr Laurie Barwell) has a B.Eng Civil and an MSc.Eng degree in Coastal Engineering, specializing in coastal environmental assessment and engineering with specific reference to dune and beach dynamics, and climate change risk and vulnerability assessment and response strategies. Having retired from the CSIR in 2014, the author has 39 years of experience related to water and coastal environmental engineering and coastal zone management practices.

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Declaration of Independence

I, **Lauriston Barwell**, declare that I am contracted as specialist consultant by Aquifer Resource Management (Pty) Ltd for a specialist coastal engineering report as input to the professional team on the siting and design of the proposed residential house, outbuildings and access roads and specifically the associated interface with the dune dynamics at the abovementioned property The access road alignment and design as well as the structural design of the building structures and associated water and sanitation services are done by Consulting Engineer, Cobus Louw Pr. Eng.

I declare that:

- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
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- I have expertise in conducting the specialist report relevant to this project, including knowledge of Act No. 36 of 2014: National Environmental Management: Integrated Coastal Management Amendment Act, 2014 regulations and any guidelines that have relevance to the proposed activity;
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- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
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  - any decision to be taken with respect to the application by the competent authority; and
  - the objectivity of any report, plan or document to be prepared by me for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 48 of the EIA Regulations, 2014 (as amended).

Lauriston Barwell

EXECUTIVE SUMMARY

The owners, Aquifer Resource Management (Pty) Ltd, wish to establish a residential house, outbuildings and associated access roads on Portion 19 of 257, Fransmanshoek, Vleesbaai. The Author was appointed to provide a specialist coastal environmental engineering report as input to the professional team on the siting and design parameters of the proposed development.

The specialist report includes a qualitative assessment of the impact of the various identified options on the abiotic environment, and vice versa. This report is to be included in the Basic Assessment Report (BAR) prepared by Cape EAPrac. It complements the botanical specialist report prepared by Dr David McDonald and the civil engineering report by Cobus Louw, Pr.Eng.

The physical environmental context was considered to determine the stability of the coastline and Fransmanshoek Dune Field. Aerial photographs and images are available for a 77-year period (1942 to 2019) and were used as the basis for the analysis.

Reference to the WC: DEA&DP Coastal Management Lines[1] allowed an assessment of the implication of climate change on the coastline and dune field to be undertaken. The conclusions of the assessment were used to recommend an appropriate positioning of the proposed development beyond the coastal processes active zone.

The results of the above analyses are integrated with sound coastal environmental management practices to identify viable options for placing the development and recommending design specifications for the location, alignment, levels and related management actions.

A qualitative impact assessment of the identified options on the abiotic environment was carried out and a comparative assessment done. The results assist to identify and motivate the preferred option as the one that has the best overall net impact.

Key findings are that the Visbaai coastline is in a dynamic state of equilibrium as deduced for the 77 years assessment period. In contrast, the exposed sand area within the Fransmanshoek Dune Field is shrinking as areas become stabilised by vegetation. The analysis shows that revegetation at an estimated average rate of 0.5 ha per year has occurred over the period 1969 to 2019. Large areas of the remainder of the dune field are well covered by pioneer grasses and coastal fynbos. The dune field is functioning as a relic sand sink and that little 'new' sand is feeding into the dune field from the beach.

The analysis results lead to a recommended development coastal processes buffer line located along the + 65 m MSL contour line. This line also translates to the recommended position of the landward edge of the coastal processes active zone for the property and allows for uninhibited mobile dune sand movement along the SW to NE wind-blown sand pathway for as long as there are exposed sandy areas within the dune

[1] DEA, 2018. Coastal Management Guidelines
https://www.environment.gov.za/sites/default/files/reports/coastalmanagementguidelines.pdf
https://www.gov.za/sites/default/files/gcis_document/201409/nationalcoastalmanagementprogrammea.pdf

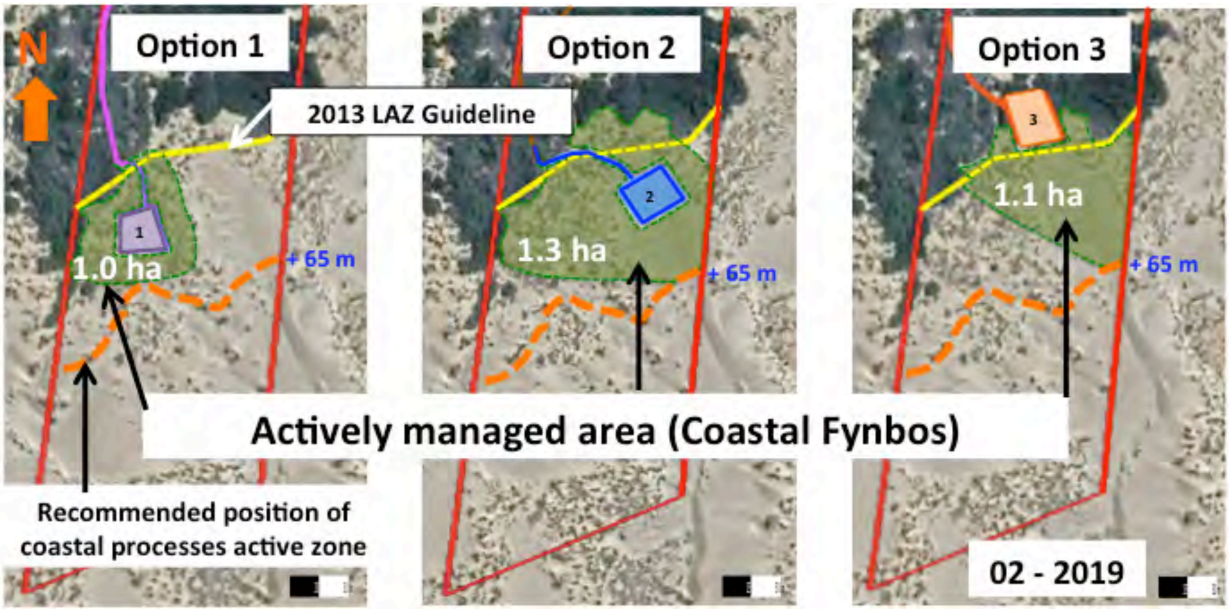
field. Storm erosion and climate change related guidelines depicted as Coastal Management Lines fall within this buffer area.

The topographic information shows that there is a natural plateau located north of the +70 m MSL contour on the property. The western side of this area (Plateau 1) is stabilised by dune vegetation with no wind-blown sand moving into or off this area. The eastern- and northern side of this area (Plateau 2) consists of an exposed sand blow-out.

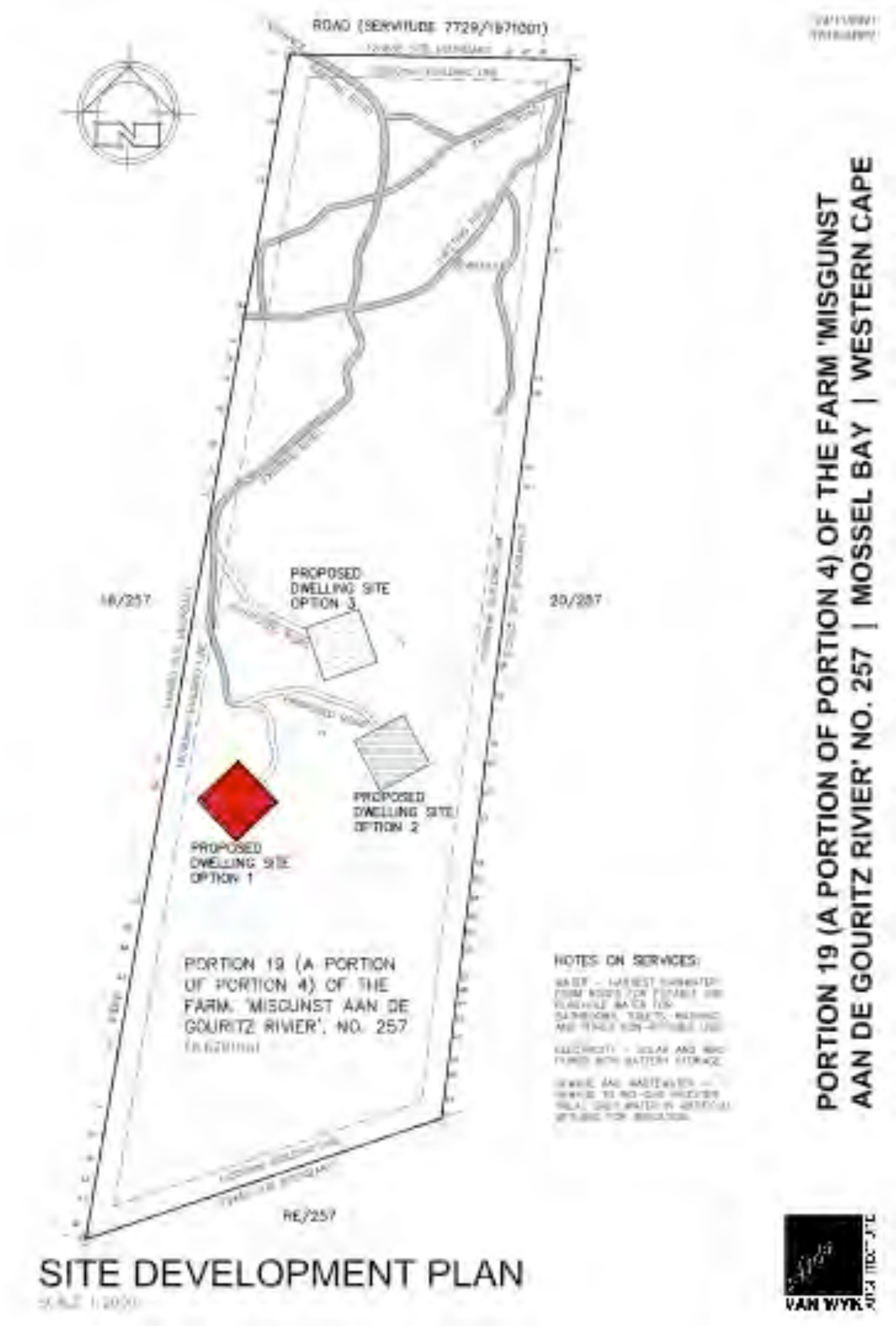
Three different options for placing the proposed residential building and outbuildings have been identified (Options 1, 2 and 3) as depicted in the SDP and on the diagramme below.

The comparative impact assessment shows that building on the natural plateau area, Plateau 1 depicted as Option 1, will have the lowest environmental impact with an added positive benefit of adding coastal fynbos through active coastal vegetation management on 1 ha around the building footprint to ensure an appropriate vegetated buffer interface with the surrounding dune field.

Option 1 is recommended.



Comparitive summary of the three options showing the 2013 LAZ guideline and the recommended positioning of the development landward of the coastal processes active zone landward of the + 65 m contour


PROPOSED
DWELLING SITE
OPTION 3
20/257
PROPOSED
DWELLING SITE
OPTION 2
PROPOSED
DWELLING SITE
OPTION 1
PORTION 19 (A PORTION
OF PORTION 4) OF THE
FARM 'MISGUNST AAN DE
GOURITZ RIVIER', NO. 257
NOTES ON SERVICES:
RE/257
SITE DEVELOPMENT PLAN
PORTION 19 (A PORTION OF PORTION 4) OF THE FARM 'MISGUNST
AAN DE GOURITZ RIVIER' NO. 257 | MOSSEL BAY | WESTERN CAPE
VAN WYK

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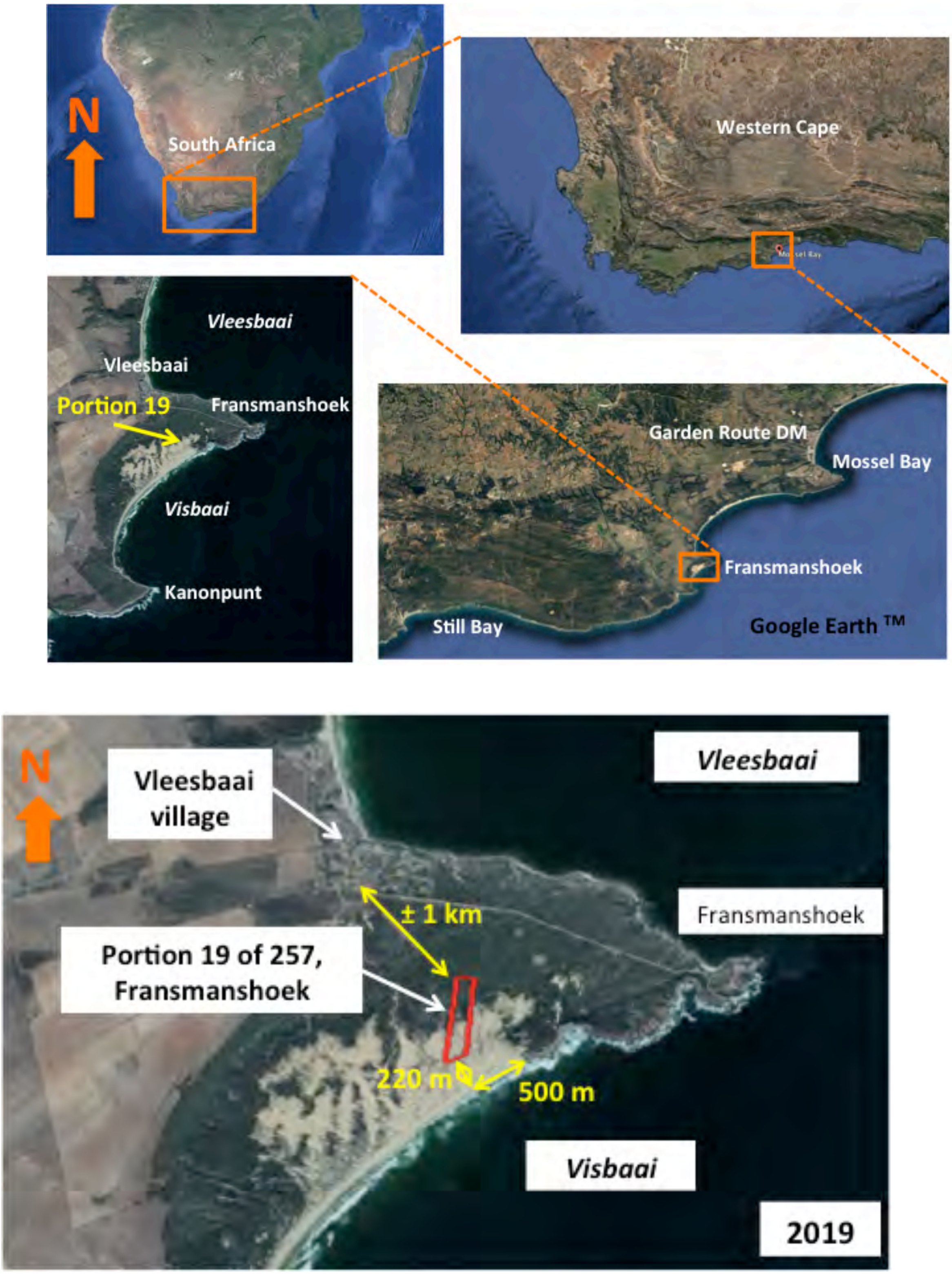

Figure 1: Portion 19 of 257, Fransmanshoek is located about 1 km SE of the small coastal village of Vleesbaai within the Mossel Bay Municipality in the Garden Route District in the Western Province in South Africa

1. INTRODUCTION

The owners of Portion 19 of 257, Fransmanshoek, Vleesbaai, wish to establish a residential house, outbuildings and associated access roads on their property.

Coastal environmental engineering specialist, Laurie Barwell, was appointed by Aquifer Resource Management (Pty) Ltd, the owners and Applicant, to provide a specialist coastal environmental engineering report as input to the professional team. The report will serve as specialist input on the siting and design of the development along with a qualitative assessment of the impact on the abiotic environment.

This report is to be included in the Basic Assessment Report (BAR) prepared by Cape EAPrac. It complements the botanical specialist report prepared by Dr David McDonald and the civil engineering report by Cobus Louw, Pr.Eng.

This report addresses the following:

i. The physical environmental context.
ii. The coastline and dune field stability over the 77-year period from 1942 to 2019 using available aerial images and topographical surveys.
iii. An assessment of the implication of climate change on the coastline and dune field with reference to the WC: DEA&DP Coastal Management Lines[1].
iv. The recommended sizing of a buffer area and associated positioning of the development beyond the coastalprocesses active zone using the relevant historic and current information.
v. The results of the above analyses are integrated with sound coastal environmental management practices to recommend design specifications for the location, alignment and levels related to the proposed development components.
vi. A qualitative impact assessment of the identified options on the abiotic environment.

Recommended design parameters for the positioning of the various components of the proposed development are provided in Sections 8 and 9.

1.1 Study area

Portion 19 of 257, Fransmanshoek is located 1 km ESE of the small coastal village of Vleesbaai within the Mossel Bay Municipality in the Garden Route District in the Western Province in South Africa (Figure 1). The property is situated on the Fransmanshoek promontory that forms the boundary between the two bays of Visbaai on the south and Vleesbaai to the north.

The village of Vleesbaai lies approximately 18 km SW alongshore from the coastal village of Dana Bay, Mossel Bay within the crenulated Vleesbaai bay.

The seaward boundary of Portion 19 of 257 is located 220 m directly NW of the highwater mark on the beach within Visbaai. The property lies approximately 500 m from the rocks at the north-eastern end of the logarithmic spiral-shaped embayment that stretches along a 4 km long sandy shore south-westwards to the area called Kanon (Figure 2).

Also shown on Figure 2 are the Coastal Management Lines as promulgated by the DEA&DP of the Western Cape Province. The property lies well inland of all the erosion lines.

The position of the current Littoral Active Zone (LAZ) guideline, as deduced from the 2013 aerial image, is also indicated on Figure 2.

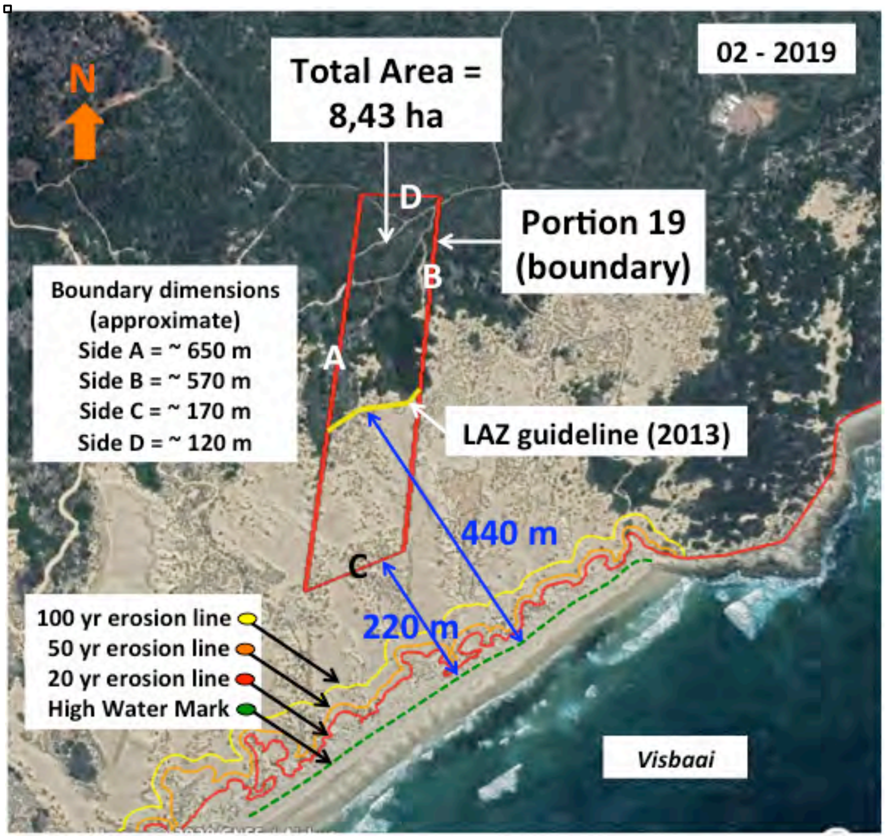

Figure 2: Locality map for Portion 19 of 257, Fransmanshoek. Also shown are the DEA&DP Coastal Management Lines

1.2 Approach and process

In order to understand the biophysical processes and in particular the historic stability of the coastline and dune field, the available information, including historical aerial photographs[2], Google Earth™ images and 2019 topographical surveys were used to determine the dune and beach changes over a period of 77 years (1942 to 2019). Copies of a range of these historical images are included as Appendix 1.

A site visit was undertaken, and discussions were held with the Applicant to understand the needs for utilising the property.

A separately appointed consulting civil engineering company, Cobus Louw, Pr.Eng, is responsible for the design of the structural components and associated services. This report will inform (and be informed by) the dune vegetation specialist on the interface between the proposed development and the adjacent dune vegetation as input to the dune management and maintenance management plans (separate report).

[2] Obtained from South Africa's Surveyor-general, Mowbray.

2. PHYSICAL CONTEXT

2.1 Introduction

In order to ensure that the correct developmental and management decisions are taken and implemented, it is important to have a basic understanding of the physical environment at the study site.

In particular, this involves having knowledge of the established biophysical processes and being able to reasonably predict the environmental consequences of the continuation of current management activities and advise on appropriate future maintenance management actions associated with the proposed development.

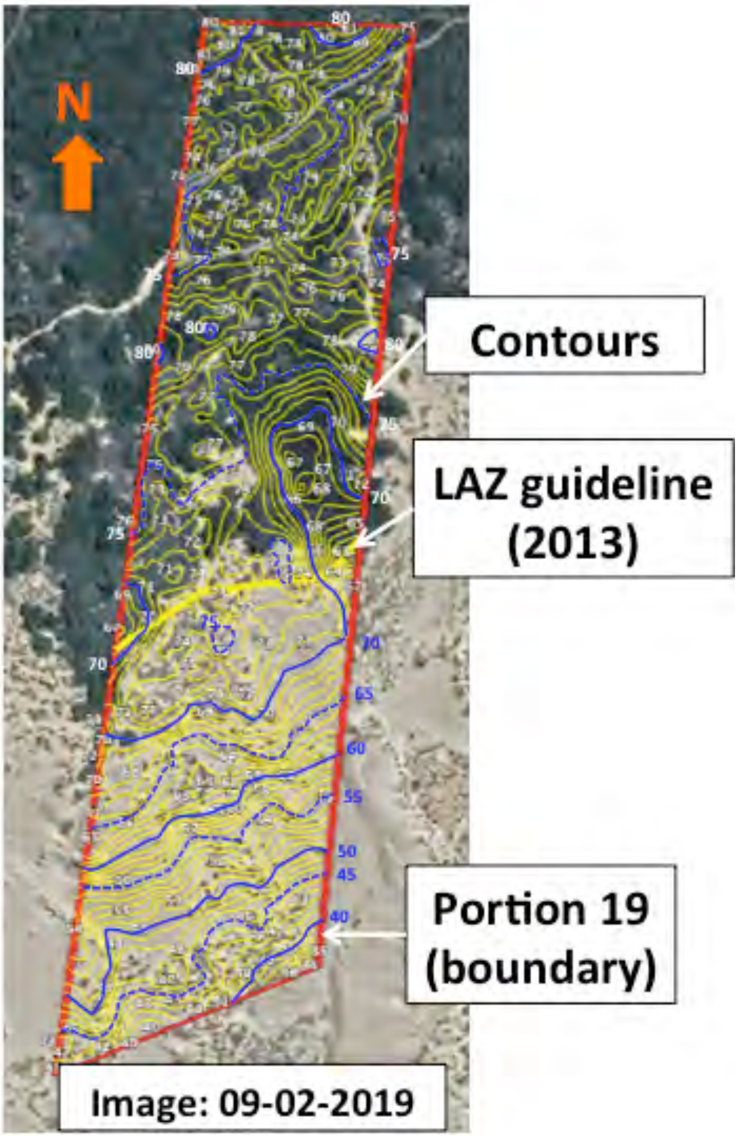

Figure 3: Drone-based topographical survey done in 2019.

2.2 Coastal processes and the sediment budget

The extent and characteristics of the dune field at the site are influenced by a complex interaction between several physical and biotic components. However, it is the prevailing wind regime and associated aeolian sand budget, and the role of current and future dune vegetation management in modifying the rate of wind-blown sand movement that are most relevant to (1) the functioning of the dune field as part of the Fransmanshoek Conservancy, and (2) the location of infrastructure associated with the proposed development on Portion 19. These aspects are discussed below.

Site Topography

As seen in Figure 3 above, the seaward boundary of the property lies at an elevation of + 40 m relative to Mean Sea Level (MSL), the midpoint of the property lies at an elevation of + 72m MSL, which forms a natural plateau. The northern boundary is at a level of +78 m MSL (Figure 3).

This means that the property is located well away from the beach and thus beyond the reach of storm erosion and the influence of any sea level rise due to climate change.

As discussed below, the Fransmanshoek dune field is a relic sand sink and one of the ancient perched dune fields that occur along the southern and eastern coasts of southern Africa.

The physical processes that have caused the log-spiral equilibrium shape of the bay are governed by the dominant SSW sea swells reaching the coastline and the resultant longshore and cross-shore currents that transport the sand within the surfzone[3].

The availability of sediment (sand) in the nearshore and onshore areas plays a significant role in the beach and dune field dynamics and it is this quantified interaction of the movement of the available sediment by nearshore currents and the wind that is termed the local sediment budget.

In other words, the sediment budget is determined by answering the folowing questions: how much sand is available on the beach?; how much sand is moved inland by wind off the beach?; what are the most likely natural sediment pathways that existed before human intervention?; what human interventions have occurred in time?; how have these pathways changed as a result?; how does the current abiotic system operate?; and what is the likely future system to look like? These questions are discussed in the following sections.

<u>Likely source of the beach sand</u>

The Gouritz River is one of the main sources of riverine sediment to the coastal zone along the south coast of South Africa (Birch, 1980). This river has one of the largest catchment areas in southern Africa, much of which is located in the vast areas of the Karoo. Martin (1985)[4] reported that the Gouritz River is responsible for contributing over 13Mm^3 of sediment per year to the coast[5].

Visbaai is located 3 km to the NE of the mouth of the Gouritz River. Sand originating in the catchment and deposited at the river mouth and furher offshore has found its way into Visbaai in two main ways: (1)

[3] A video illustrating these processes can be viewed on You Tube (https://www.youtube.com/watch?v=FqT1g2riQ30)
[4] Martin, A K (1985). The geology of the seafloor between the Mossel Bay / Stilbaai coast and the EM and FA drill sites. Stellenbosch. CSIR Report C/SEA 8510. 11 pp + Figures
[5] CSIR, 1989. Estuaries of the Cape: Part II. Report no 38– Gouritz (CSW 25). CSIR Research Report 437, Stellenbosch.

blown north-eastwards from the (closed) Gouritz mouth beach and across the Kanon Point promontory; and (2) alongshore passed Kanon Point in times when the sea level was lower than at present. Both these processes took place many years ago, and what is seen today is the remnant of the upper part of the relic Fransmanshoek dune system.

Longshore sediment movement within Visbaai

No accurate estimate of the longshore sediment transport potential has been made for Visbaai. However, studies[6,7] on the formation and dynamics of typical half-heart bays along the southern Cape coast have shown that the longshore sediment transport typically moves north-eastwards for 65% of the time at the point within a bay where the site is located. This implies that a portion of the longshore potential transport occurs via a counter current towards the southwest of the bay. The sand deposited on the beach in this way is then available to be blown up into the dune system as discussed in the next section.

3. DUNEFIELD DYNAMICS

3.1 Wind climate and aeolian sediment movement

The seasonal wind-roses, derived from Voluntary Ship data (VOS), for the offshore region are shown in Figure 4. Indicated are sustained onshore winds from the southwestern and eastern sectors all year round.

From a sand movement point of view, it is the prevailing onshore winds relative to the SW-NE orientation of the Visbaai coastline that are of importance as they bring sand into the dune area.

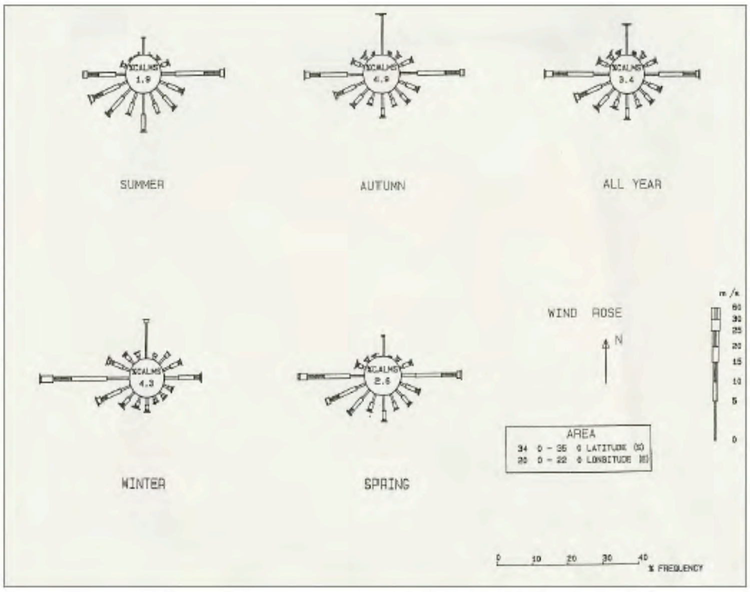

Figure 4: Wind roses for the area as published for Still Bay (in CSIR, 1986[8]).

[6] Barwell, L. 2011. Integrity Assessment Procedure for Buffer Dune Systems on the Cape South Coast, South Africa. MSc Thesis. Faculty of Engineering, Stellenbosch University. December 2011.

[7] Schoonees, J S, 1986. Breaker wave characteristics and longshore sediment transport along a bay. CSIR Research Report 570. Stellenbosch

[8] CSIR, 1986. Waaisand problem by Lappiesbaai, Stilbaai-Oos. By Mr L. Barwell. Submitted to Dept of Environmental Affairs, CSIR Report OX/C/CSW/ 24/6, Stellenbosch.

The wind data were analysed and a set of aeolian creep diagrams (Figure 5) was deduced for the beach and foredune at the study site (after Swart, 1986[9]). The aeolian creep diagrams indicate how wind-blown sand would encroach from different directions towards the centre of an imaginary circle on the ground.

The natural system as prevailed in 1942 reflects these uninhibited processes (Figure 5). The long-term net wind-blown sand pathways can be derived from the orientation of the longitudinal sand dune ridges in the dune system[10]. These confirm the information depicted in the creep diagrams.

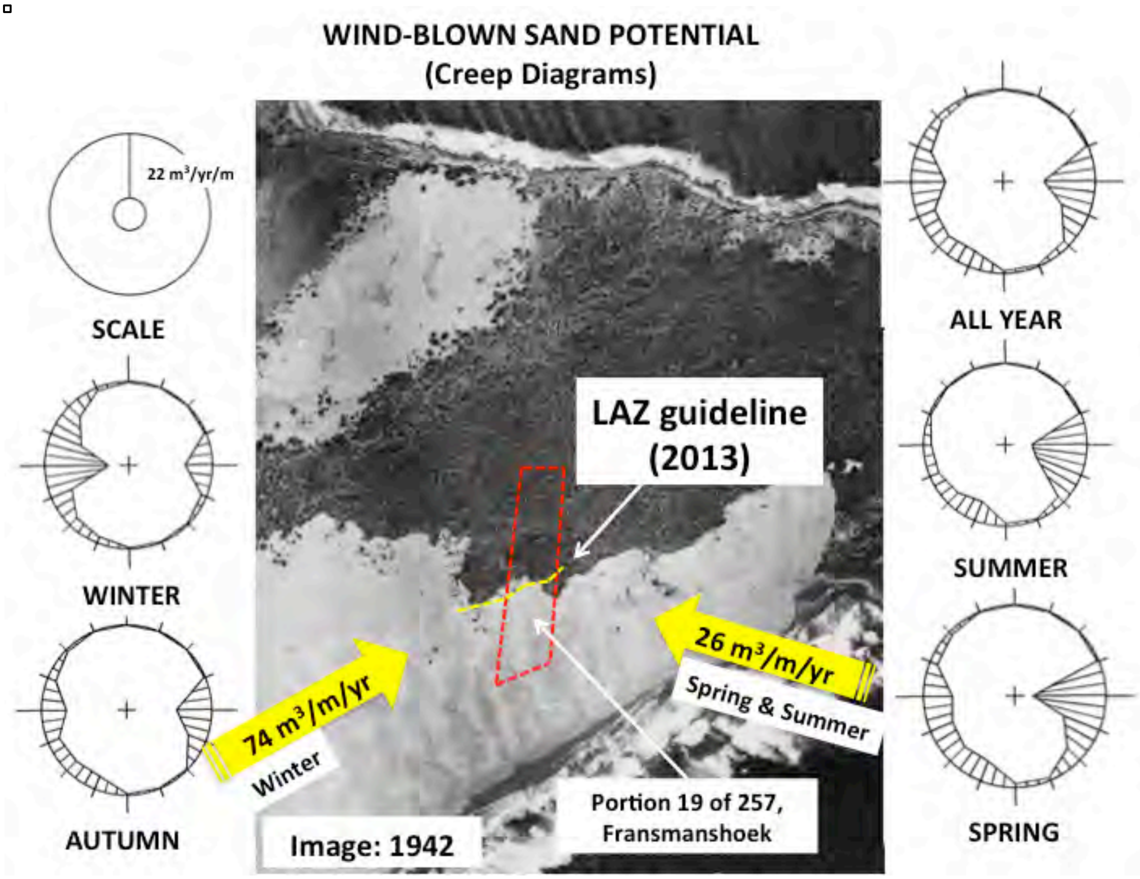

Figure 5: 1942 aerial photo and aeolian creep diagrams

The equivalent volumes of sand blown seasonally in the specified directions by the prevailing winds are calculated using the method devised by Swart (1986). The grain size of the sand is based on an analysis of sand samples taken in the area. The predictive aeolian transport calculations are based on formulae derived for dry, cohesionless sand of unlimited quantity blowing across a flat, unvegetated surface under constant wind conditions. Since these criteria are seldom met in practice, only the potential transport rates are calculated. The predicted transport rates for the different seasons and wind directions are shown in Table 2.1

[9] Swart, D. H. (1986). Prediction of wind-blown sediment transport rates. Proc. 20th International Conference on Coastal Engineering, Taiwan

[10] Heydorn, A E F and Tinley, K L, 1981. Synopsis of the Cape Coast. Part 1, Natural features, dynamics and utilization. Estuaries of the Cape series, CSIR Research Report No. 380. Stellenbosch

Table 2.1: Potential Aeolian transport rates ($m^3/m/yr$) for the study area

DIRECTION	Rate ($m^3/yr/m$)					Net rate ($m^3/yr/m$)				
	SUM	AUT	WIN	SPR	ALL YEAR	SUM	AUT	WIN	SPR	ALL YEAR
N – BOUND:	14	11	15	15	14	12	6	7	12	10
S – BOUND:	2	5	8	3	4					
NE – BOUND:	17	27	57	40	39	14	12	49	22	25
SW – BOUND:	31	15	9	17	14					
E – BOUND:	33	32	74	48	47	7	11	62	22	26
W – BOUND:	26	21	12	26	21					
SE – BOUND:	18	22	51	29	30		4	40	7	12
NW – BOUND:	22	18	11	22	18	4				

It is seen in Table 2.1 and Figure 5 that the net movement of sand at the study site is parallel to the shoreline (NE-bound) with the net potential rate[11] calculated as 25 $m^3/m/yr$ (All Year). As seen in Table 2.1, the net potential rate for summer is 14 $m^3/m/yr$ towards the northeast. The net potential rate for winter is 62 $m^3/m/yr$ towards the east. However, the important direction is NE-bound (parallel to the coastline and normal to the longitudinal dune ridges) where the net potential rate for winter is 49 $m^3/m/yr$.

Taking the worst case as being the maximum potential rate in the dune field (without any returning transport by opposing wind transport), the figures show rates of 74 $m^3/m/yr$ during winter and 48 $m^3/m/yr$ during spring towards the eastern sector. Looking at all seasons the maximum 'All Year' rate of 47 $m^3/m/yr$ is towards the eastern sector.

Furthermore, the maximum west- and northwest bound wind-blown sand rate is 26 $m^3/m/yr$ during spring and summer. The all seasons rate is 21 $m^3/m/yr$ is towards the west-north-western sector, thus obliquely onshore.

The following conclusions can be drawn from these results:

(1) The orientation of the coastline along Visbaai is SW to NE.
(2) Sand is therefore blown north-eastwards (parallel) along the dry beach coastline within Visbaai due to the dominant south-westerlies throughout the year.
(3) During the hot and dry spring and summer months, the dry beach is at its widest and the frontal dune vegetation is sparse. This allows the prevailing south-easterly winds to move sand at a potential rate of 26 $m^3/m/yr$ obliquely onshore towards the NW. Once the sand is blown beyond the natural foredune, the exposed sand is available to be blown to the eastern sector (i.e. NE and E) at the maximum potential rate of 74 $m^3/m/yr$ during both winter and summer months.
(4) The dune ridge orientation seen on all the images (Appendix 1) confirm this net directional trend. It also explains the ENE extension of the dune field towards Fransmanshoek.
(5) During the site visit in the summer of 2019-20, the foredune along Visbaai was well developed and partially vegetated, effectively inhibiting the onshore movement of wind-blown sand.
(6) As will be seen in the next section, this ENE dune movement has effectively been halted due to the rate of revegetation of the dune field between 1969 and the present.

[11] The net potential rate is calculated as the difference between the two wind directions, eg for the 'All Year' case, the NE-bound (onshore) of 39 $m^3/m/yr$ minus the apposing (SW-bound) wind transport (14 $m^3/m/yr$). This equals a net onshore (NE-bound) potential of 25 $m^3/m/yr$. Of course if the dune vegetation is so dense that very little sand can blow back onto the beach, the net onshore (NE-bound) rate will be close to the full amount of 39 $m^3/m/yr$.

(7) The long-term wind-blown sand movement is parallel to the beach and obliquely onshore into the dune field during the dry summer SE winds. The sand blown into the dune field is lost to the overall coastal sediment budget with no sand moving around Fransmanshoek Point into Vleesbaai. This means the dune field is classified as a sand sink as it no longer functions as a headland bypass dune system.

3.2 Aerial image analysis: Coastline and dune field

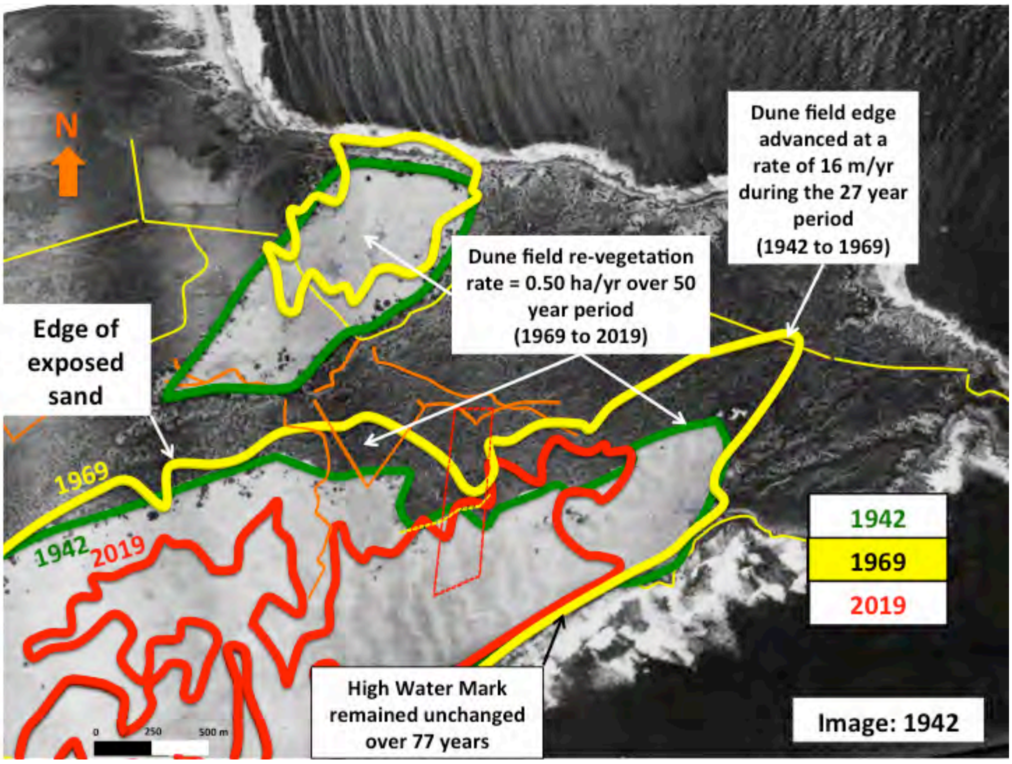

Figure 6: Positional change of the open sand extent within the dune field over the 77 year period (1942 to 2019)

Aerial photographs (sourced from the Surveyor General, Mowbray, Cape Town) and Google Earth™ images are available of the study area for the period 1942 to 2019 as shown in Appendix 1.

As illustrated in Figure 6, reference points, such as tracks, fence lines demarcating agricultural lands and the rocky coastline (and large identifiable features) common to the historic images are used to ensure that the images are at a common scale to allow a comparison of features (such as the edge-of-veg line).[12]

The historical changes that have occurred within the study area were assessed and the following general observations are made:

- **1942**: The main open sand dune field (Fransmanshoek dune field – FMH-DF) extends from the SW towards the NE and reaches a point about 1.5 km from the seashore in Vleesbaai bay. A wider sand dune area is seen in the SW side of the dune field close to farmland. This may be as a result of the

[12] This analysis method is a 'best-fit' approach and only provides a basis for determining change trends. Accuracy is limited to the quality of the images.

gradually sloping topography from the beach and the orientation of the log-spiral bay relative to the dominant SSW winds. The smaller exposed sand dune that is located closer to the current Vleesbaai village appears to have been linked to the larger dune field at some stage in the past, thereby forming a headland bypass dune system that fed sand onto the beaches at Vleesbaai. The FMH-DF narrowed towards the NE.

- **1964:** The NE tip of the FMH-DF has migrated to the NE over a distance of 370 m and is 100 m from the track to Fransmanshoek Point. The remnant dune at Vleesbaai has also migrated to the NE and appears to be feeding sand into the sea at Vleesbaai. Vegetation has started stabilising the SW edge of the remnant dune field.

- **1969:** The NE tip of the FHK-DF has moved to a point that crosses the track to Fransmanshoek Point, an estimated distance of 450 m relative to the 1942 position. This is a rate of 16 m / year over the 27-year period.

- **1991**: The NE tip of the FMH-DF has retreated by about 80 m and appears to be due to active stabilisation activities. It is likely to prevent the (now upgraded) road from being covered by the wind-blown sand. The Vleesbaai remnant dune field has been totally stabilised and a formal road to Fransmanshoek can be seen. Many houses and formal roads exist within the Vleesbaai village.

- **2004**: The exposed sand areas within the FMH-DF have become smaller as the vegetated areas increase. The active stabilisation of the NE end of the dune field continued.

- **2019:** The northern edge of the FMH-DF has migrated about 200 m southwards as vegetation is established.

A comparative analysis of the changes that occurred in the FMH-DF is shown in Figure 6. An average revegetation rate of 0.5 ha/year occurred over the 50-year period 1969 to 2019.

As summarised on Figure 6, the results also show that the seaward edge of the buffer dune vegetation (a good proxy for the long-term High Water Mark) along the sandy coastline within Visbaai has remained dynamically stable within a band of about 30 m over the analysis period.

4. POSTITIONING THE DEVELOPMENT

Background and definitions

The areas located 100 m landwards of the high-water mark in urban areas and 1 000 m landwards of the high-water mark in rural areas have been defined as ‘coastal buffer zones’, where specific activities are restricted. Although the concept of a ‘development setback line’ forms the basis of international practice of development planning and assessment, the term ‘coastal setback line’ has been deleted from Act 36 of 2014 (as amended).

In this report the concept of a 'coastal setback line' is replaced by the definition of a buffer area to locate the development landwards of the assessed landward extent of the coastal processes active zone. Figure 7 below provides a simplified illustration of the concepts[13].

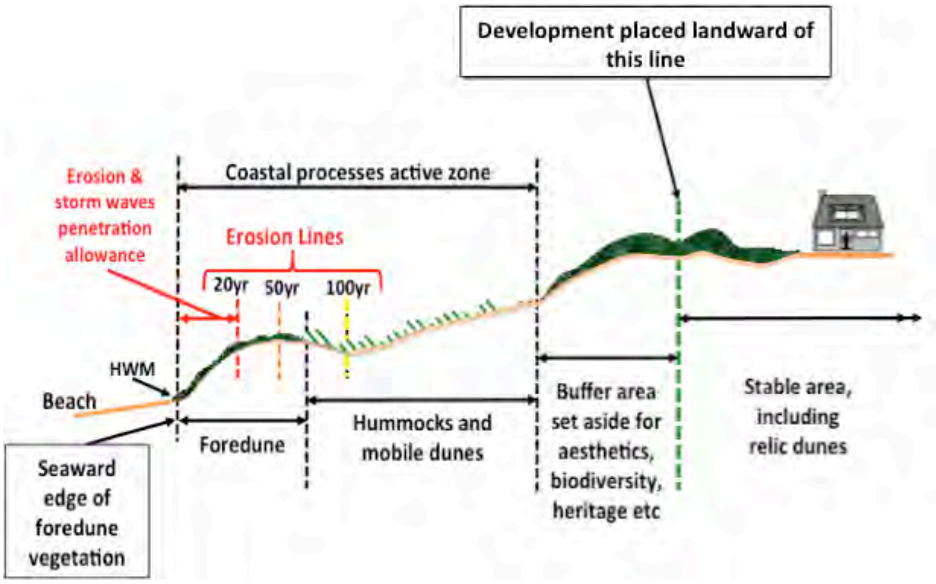

Figure 7: Definition of a buffer area and associated positioning of development landward of the coastal processes active zone (adapted from Barwell, 2011)

As discussed in Section 3 above, the 300 m coastal band parallel to the coastline remains unconsolidated, and active with wind-blown sand moving on the dunes and a limited amount in the partially vegetated dune slacks thereby forming an important bio-physical ecosystem with a variety of habitats.

It is therefore concluded that the FMH-DF is by no means pristine and has undergone a significant amount of human-induced change. As illustrated in Figure 6 and discussed in Section 3, the average rate of increase in vegetated areas within the greater FMH-DF has been 0.5 ha per year using the 1969 baseline.

Figure 8 below shows the landward extent, and the positional changes of the unconsolidated dune field over the 71-year period (1942 to 2013).

[13] Barwell, L. 2011. Integrity Assessment Procedure for Buffer Dune Systems on the Cape South Coast, South Africa. MSc Eng. Thesis. Faculty of Engineering, Stellenbosch University. December 2011.

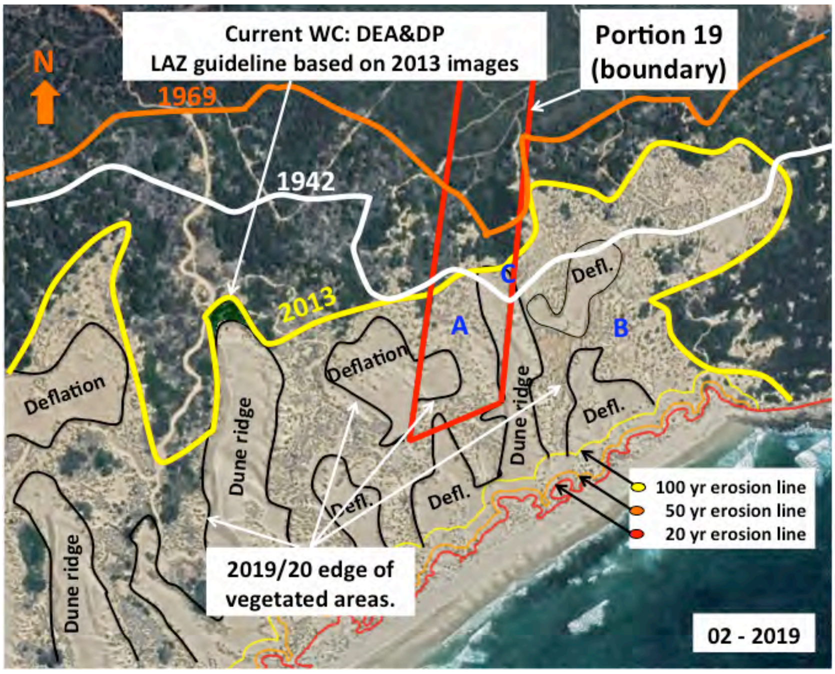

Figure 8: Positional changes of the landward edge of the unconsolidated dune field over the 71-year period (1942 to 2013).

Also shown in Figure 8 is the current extent of vegetated areas within the dune field as at present (2019/20).

Points A, B and C are marked on Figure 9 and the associated photographs show that large areas are colonised by stabilising grass and indigenous coastal fynbos.

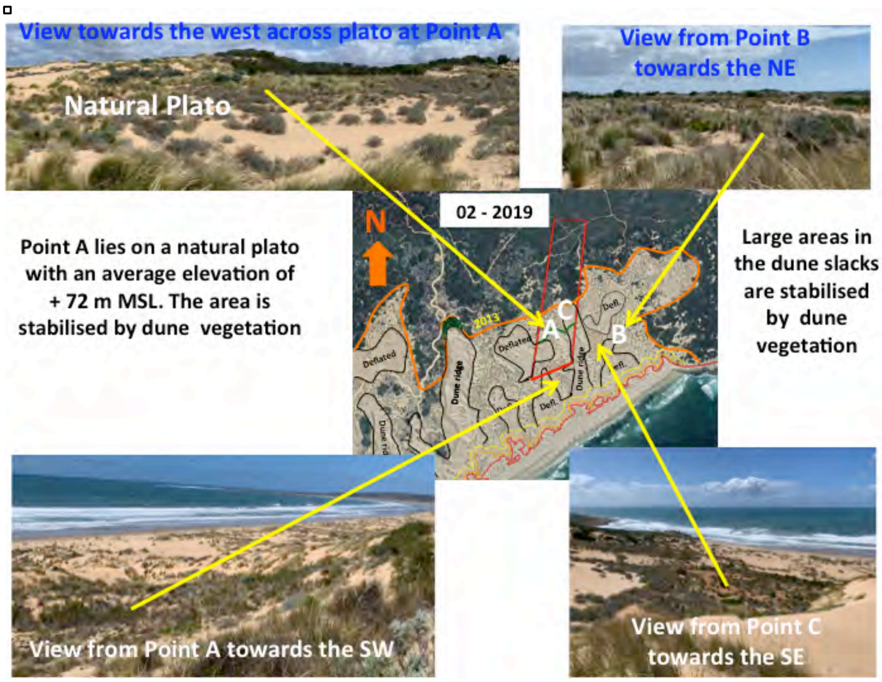

Figure 9: Large areas are colonised by stabilising grass and indigenous coastal fynbos

It is this author's opinion that these 'newly' vegetated areas (illustrated in Figure 10) will be consolidated into a significant coastal fynbos area in time. This will happen, whether or not there is development and or management intervention on the various Fransmanshoek properties, including Portion 19 of 257.

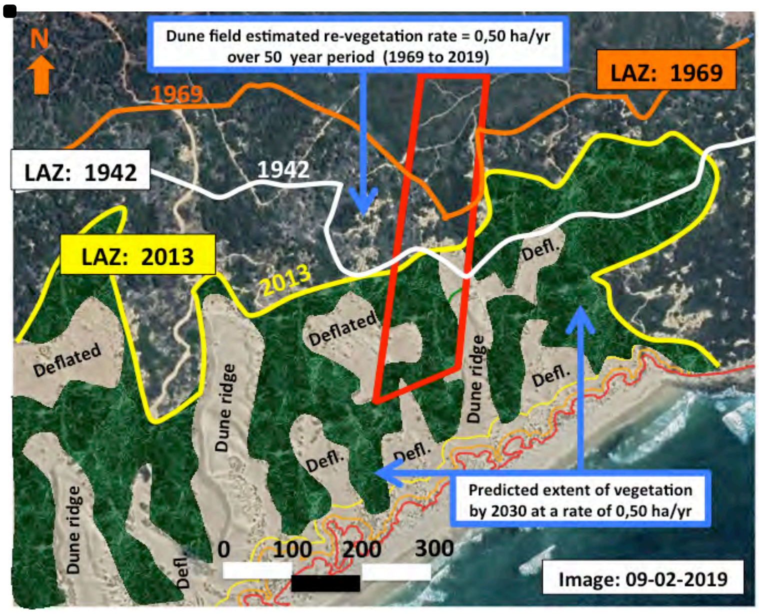

Figure 10: The shaded areas indicate the predicted future extent of vegetated area within the dune field

Figure 11 The foredune and back-dune areas within the coastal processes active zone are well vegetated (Photo: January 2020)

Figure 12 The area east of Portion 19 and seaward of the 2013 LAZ line is well vegetated (and rapidly being stabilised (Photo: January 2020)

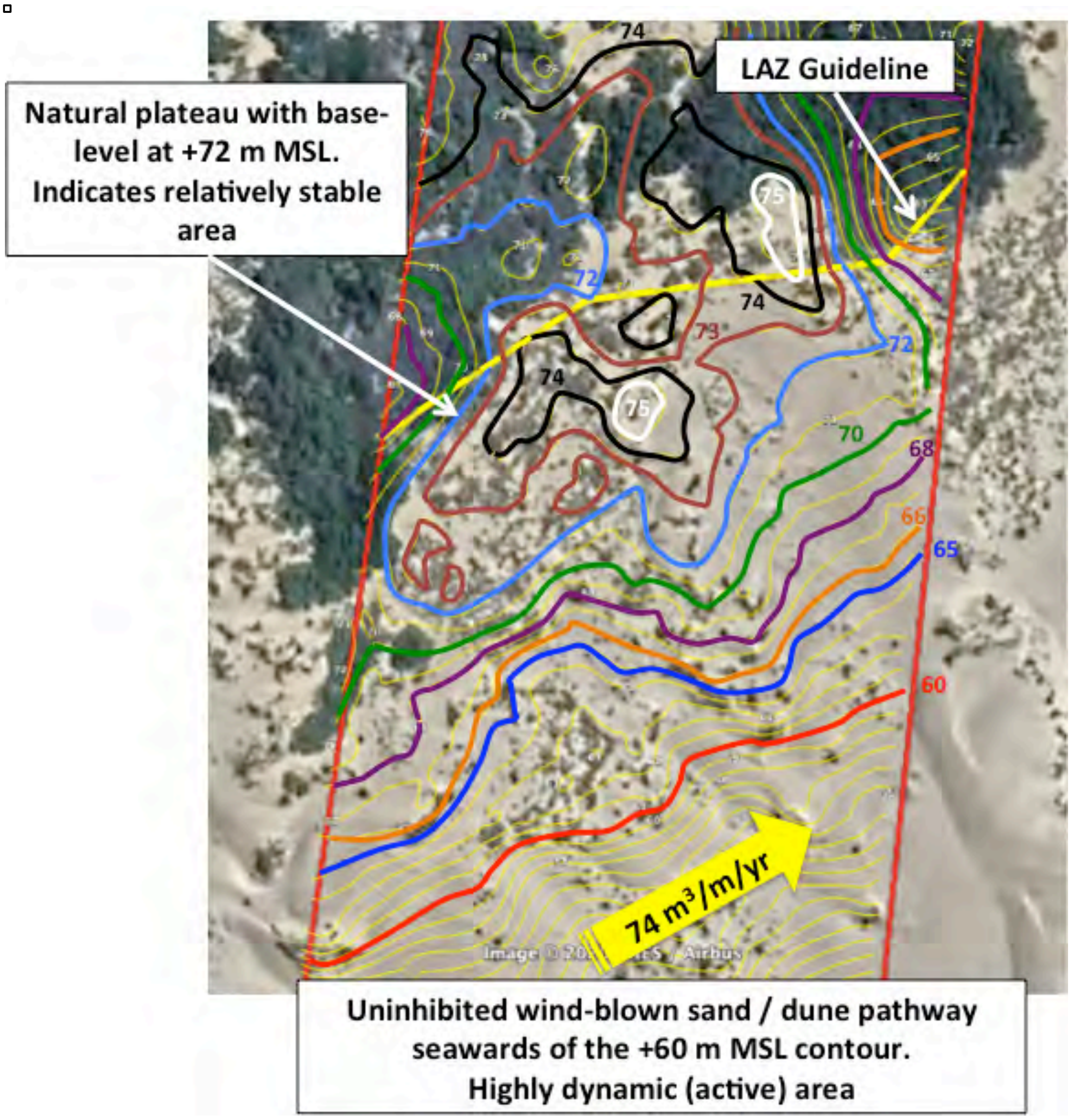

Figure 13 Topographical features on Portion 19 of 257

Applying the definition of the various components of the coastal buffer zone (as depicted in Figure 7) to Portion 19, the following observations assist in determining a realistic buffer between the active coastal processes and the development:

- **Coastline stability**: The analysis of the aerial photographs available for the area for the period 1942 to 2019 (Figure 6), it can be safely concluded that the high-water mark along Visbaai remained fairly stable within a dynamic band of about 30 m. No long-term erosional or accretional trends are observed, leading to the coastline being classified as being 'dynamically stable'.
- **Foredune**: In the January 2020 photograph (Figure 11) there is a well formed foredune backed by a 100 m to 300 m wide hummock dune system that exists along the whole of the Visbaai coastline. Dune vegetation has become well established and a large volume of the wind-blown sand off the beach is trapped within the foredune system. Figures 9 to 12 show large tracks of backdune vegetation effectively prevent sand from moving into the dune field. This is different to the period 1942 to 1969 before active dune stabilisation was started (see Appendix 1).

- **Storm erosion lines**: The guideline positions for the 20 yr, 50 yr and 100 yr erosion lines as published by WC: DEA&DP are shown in Figures 2, 8 and 9 and It is clear that the 100 yr erosion guideline is well seaward of the boundary of Portion 19.
- **Large mobile dunes**: A few large longitudinal sand dunes exist within the FMH-DF (Figures 8 and 10). Of interest to the site analysis of Portion 19, is the large dune located to the SW (about 300 m away) and another smaller dune located immediately to the SE of the property boundary. As can be seen in Figure 10, the basic north-south orientation of the axis of both these dunes indicate that the exposed tops of the dunes 'flip-flop' in response to the dominant south-westerly and south-easterly winds. There are a few exposed stretches of sand that are mainly seen as deflation zones where large blow-outs have formed amongst the rapidly expanding areas of dune vegetation, indicated in Figures 9, 11 and 12. In some areas the sand has been blown away completely, exposing the underlying geology (Figure 9).
- **The wind-blown sand pathways**: From Section 3 and Figure 5 it is seen that sand predominantly moves towards the eastern sector, with a small portion moving towards the NW, mainly in summer. In the period up to 1969 the unvegetated dune field expanded at a net rate of 16 m per year towards the NE. As early as 2013 and in subsequent years up to the present, sand transport within the wind-blown sediment pathways has dropped significantly due to the establishment of vegetation in the areas between the dunes (the dune slacks) (Figures 9 and 11). This means that very little, if any, new sand is moving into the existing dunes at present. As seen in Figure 13 the main wind-blown sand pathway is located seawards of + 60 m MSL contour at Portion 19.

  As seen in Figure 14 above, the landward edge of the uninhibited wind-blown sand pathway within Portion 19 is located at the foot of a steep incline / cliff between the +60 m and +65 m MSL contours. Sand blows in a ENE direction at a potential rate of 74 m3/m/yr and feeds the large dune.

  Also seen in Figures 13 and 14 is the large vegetated plateau area that exists at a level of +72 m MSL. A band of hummock dunes is in the area between the +60 m contour and the +65 m contour. Sand blown off the sediment pathway by the south-easterlies is effectively trapped within the hummock dune band, creating a blown sand-free area where coastal fynbos is rapidly establishing. The existing vegetated area, and high topography located to the west of the plateau prevents sand from reaching Plateau 1 (Figure 14).

  The area marked as Plateau 2 (Figure 14) on Portion 19 consists of the landward edge of an exposed sand blow-out located at the NNW end of the large dune located along the eastern boundary of Portion 19. The blowout is formed by the south-easterlies blowing sand off the dune.

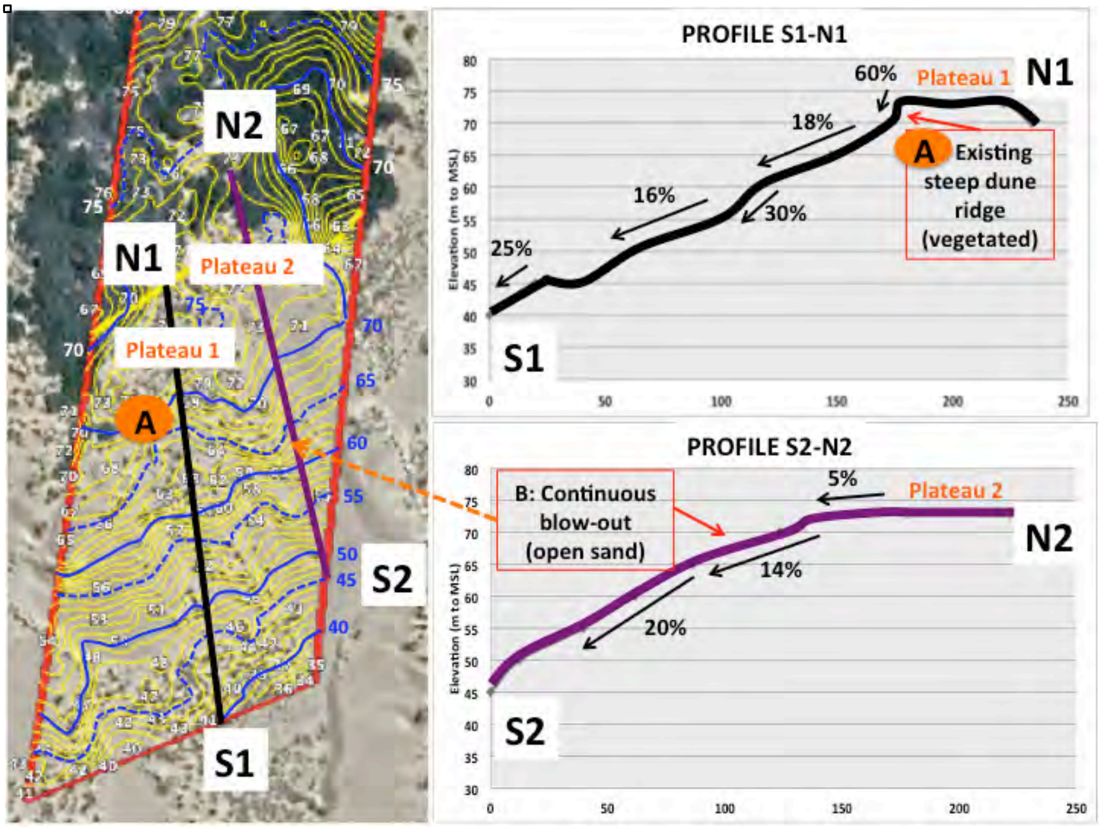

Figure 14 Cross-sectional profiles on Portion 19 of 257

The cross-sections shown across Plateaus 1 and 2 in Figure 14 indicate the various topographical features discussed above.

- **Coastal processes active zone**: Figure 6 shows that active management through stabilisation activities commenced soon after 1969. The measured average stabilisation rate is 0.5 ha per year over the period 1969 to 2019. The extent of the Fransmanshoek dune field has therefore shrunk at a similar rate with the landward edge of the active zone moving seawards. In Figure 10 the potential increase in stable vegetated areas in the FMH-DF by 2030 is shown. This implies that the seaward edge of the coastal processes active zone will be located a lot closer to the coastline than at present.

- **Positioning the development beyond the coastal processes active zone**: Following a precautionary approach, it is considered appropriate to recommend the development to be located landward of the landwards extent of the coastal processes active zone, determined as the + 65 m MSL contour on Portion 19. This is along the foot of a steep cliff as indicated in Figures 13 and 14. The belt of coastal fynbos that is naturally forming landwards of the + 65 m contour and forms a logical interface and buffer area between the stable area and the coastal processes active zone as indicated in Figure 7.

5. CLIMATE CHANGE

As was noted in IPCC (2007)[14] climate change is expected to have a number of consequences that will detrimentally affect coastal resources. These are, amongst others: higher sea levels; higher sea temperatures; changes in precipitation patterns and sediment fluxes from rivers; changed oceanic conditions; as well as changes in storm tracks, frequencies and intensities.

The apparent increase in storm activity and severity will be the most visible impact and the first to be noticed, since higher sea levels will require smaller storm events to overtop existing storm protection measures.

The best estimate ('mid scenario') climate change induced sea level rise (SLR) by 2100 is around 1m, with a plausible worst case scenario of 2 m, and a best case scenario of 0.5 m[15]. The corresponding best estimate ('mid scenario') projection for 2050 is 0.3 m to 0.5 m. These scenarios are considered in the demarcation of the 50 yr and 100 yr erosion lines as part of the Coastal Management Line guidelines published by the Department of Environmental Affairs and Development Planning of the Western Cape Province (WC: DEA&DP).

As shown in Figure 2, the site (Portion 19) is located well above the elevation of the coastal erosion lines.

Climate change projections include theories related to potential changes in wind velocity and direction, and rainfall patterns. No conclusive guidelines are available at present and the precautionary approach to use the present available information and include an appropriate buffer to allow for future changes.

6. OPTIONS FOR THE PROPOSED DEVELOPMENT

In the previous section it is concluded that the Fransmanshoek dune field is a sand sink. It was also shown that large portions of the dune field have been stabilised by vegetation, both alien-invasive and coastal fynbos on the seaward sections within 300 m of the high-water mark.

It was shown that the landward extent of the coastal processes active zone was located significantly northwards in 1969. Since then human enhanced natural dune stabilization has resulted in the northern edge of the partially vegetated dune field moving southwards.

From the aerial photo analysis, the topographic surveys and observations on site, it is concluded that a 300 m wide area running parallel to the high-water mark within Visbaai is still highly dynamic where mobile dunes advance east-north-eastwards. Within this 300 m band sparse vegetation

[14] IPCC (2007). Climate Change 2007: The Physical Science Basis, Summary for Policymakers. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 21 pp, Geneva. Downloaded from http://www.ipcc.ch on February 21, 2007.

[15] DEA, 2018. Coastal Management Guidelines
https://www.environment.gov.za/sites/default/files/reports/coastalmanagementguidelines.pdf
https://www.gov.za/sites/default/files/gcis_document/201409/nationalcoastalmanagementprogrammea.pdf

exists on the foredune, in the backdune area and in the dune slacks. This area thus functions as an active littoral zone and should be managed as such.

For Portion 19 it is thus recommended that the area seaward of the + 65 m MSL contour be seen as being part of the coastal processes active zone and be left to function as an unmanaged system. The mobile dunes will continue moving eastwards as depicted in Figures 13 and 14.

Identified options for placing the proposed development

The topographic information shows that there is a natural plateau located north of the +70 m MSL contour on the property. The western side of this area (Plateau 1) is stabilised by dune vegetation with no wind-blown sand moving into or off this area. The eastern- and northern side of this area (Plateau 2) consists of an exposed sand blow-out.

Three different options for placing the proposed residential building and outbuildings have been identified (Options 1, 2 and 3) as discussed below. The options are indicated in the Site Development Plan (T576-SDP1, 20-07-2020) drawn up by Charles Van Wyk Architecture.

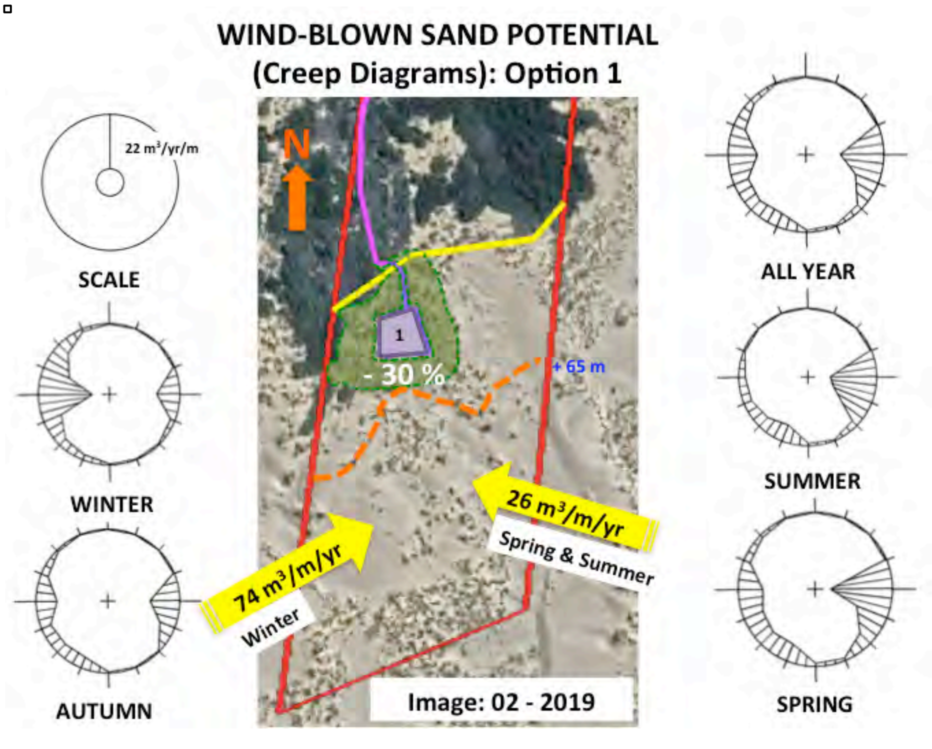

Figure 15a: Option 1 is located on Plateau 1, and is the preferred option

Option 1 is placed on a prepared building platform at a level of +73 m MSL (Figures 14, 15a and 15b) within the natural Plateau 1 area. It is foreseen that the existing vegetated area is protected, and actively managed to maintain a coastal fynbos area of 1 ha surrounding the uilding footprint as indicated. The access road is engineered to link up with the already disturbed track route immediately north of the Option 1 (Figure 15b and Figure 19).

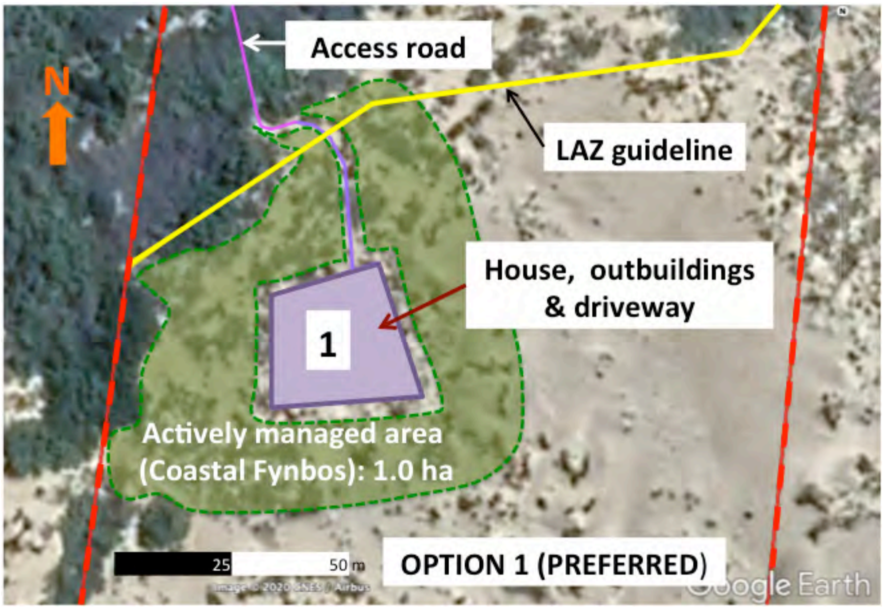

Figure 15b: For Option 1 an area of 1 ha surrounding the dwelling is managed to form a coastal fynbos interface area

Option 2 is placed on a prepared building platform at a level of +72 m MSL (Figures 14, 16a and 16b) within the natural Plateau 2 area. The building platform will require much mechanical reworking of the existing sand to establish the suitable building platform at the required level.

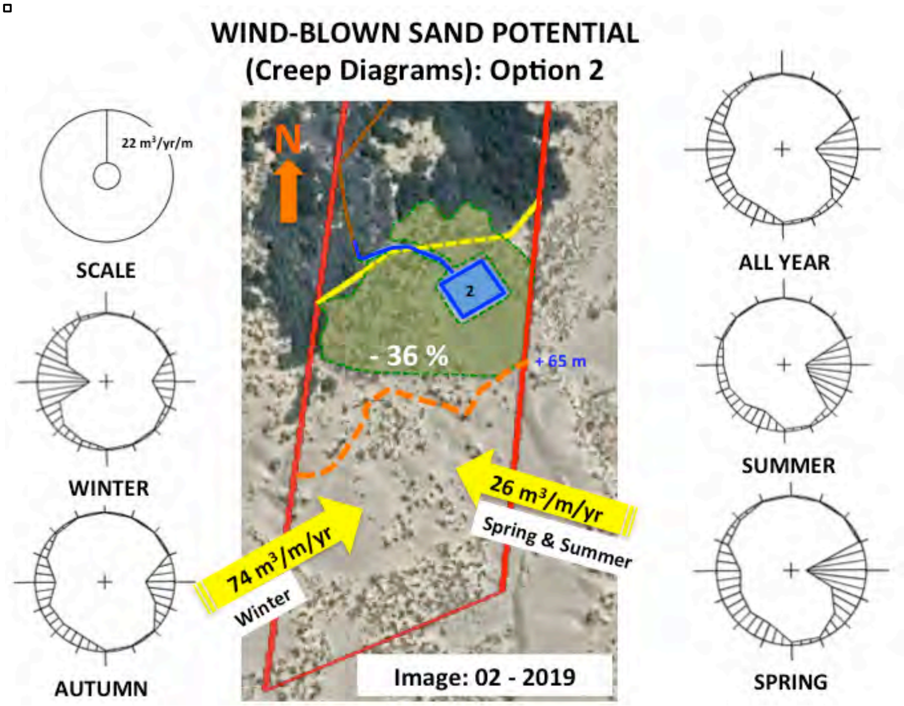

Figure 16a: Option 2 is located on Plateau 2, and is the least preferred option

A vegetated buffer area 40 m wide area between the building footprint and the landward edge of the coastal processes active zone needs to be established through active planting, irrigation and maintenance. This will require that an area of 0.2 ha to be newly planted. The vegetated area on Plateau 1 (Option 1) needs to be included in the managed area to establish a total managed coastal fynbos habitat of 1.3 ha as indicated. The access road is engineered to link up with the already disturbed track route west of the Option 2 footprint (Figure 16b and Figure 19).

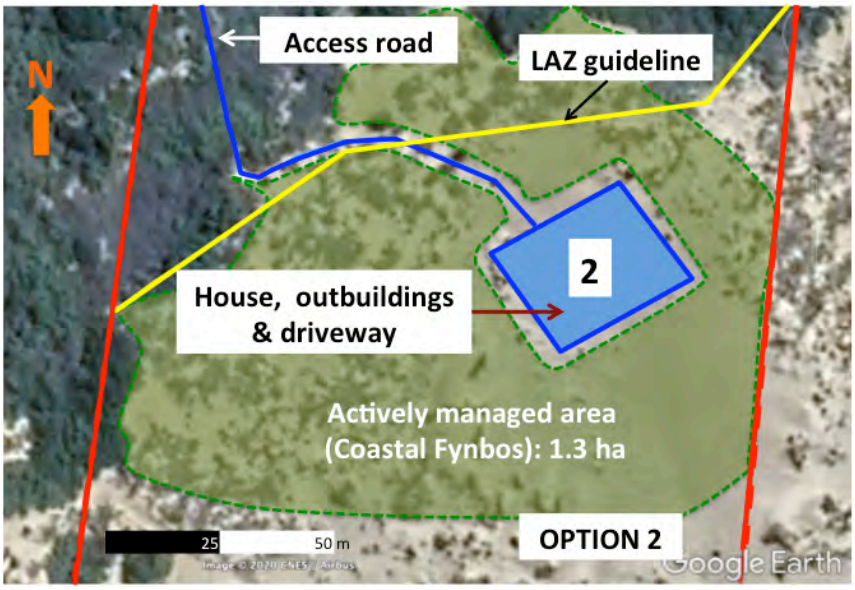

Figure 16b: For Option 2 an area of 1.3 ha surrounding the dwelling is actively gardened to form a coastal fynbos interface to prevent wind-blown sand inundation off the blow-out on the dune top.

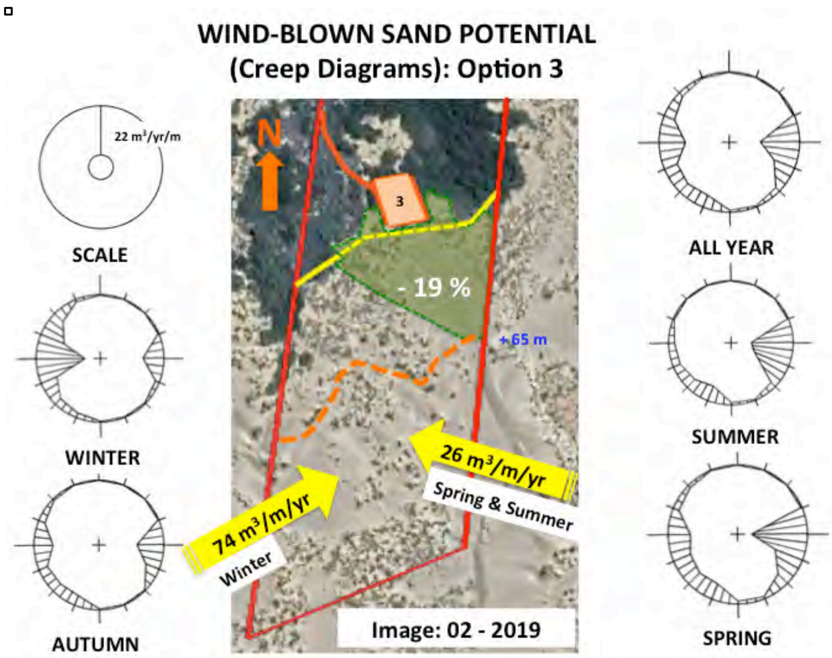

Figure 17a: Option 3 is located north of Plateau 2

Option 3 is placed on a prepared building platform at a level of +74 m MSL (Figures 14, 17a and 17b) within the natural Plateau 2 area. The building platform will require mechanical reworking of the existing sand to establish the suitable building platform at the required level.

A vegetated buffer area between 40 m and 80 m wide needs to be established through active planting, irrigation and maintenance. This will require that an area of 1.1 ha to be newly planted as shown. The access road is engineered along a new alignment (Figure 17b and Figure 19).

Figure 17b: For Option 3 an area of 1.1 ha seawards of the dwelling is actively gardened to form a coastal fynbos interface to prevent wind-blown sand inundation off the blow-out on the dune top.

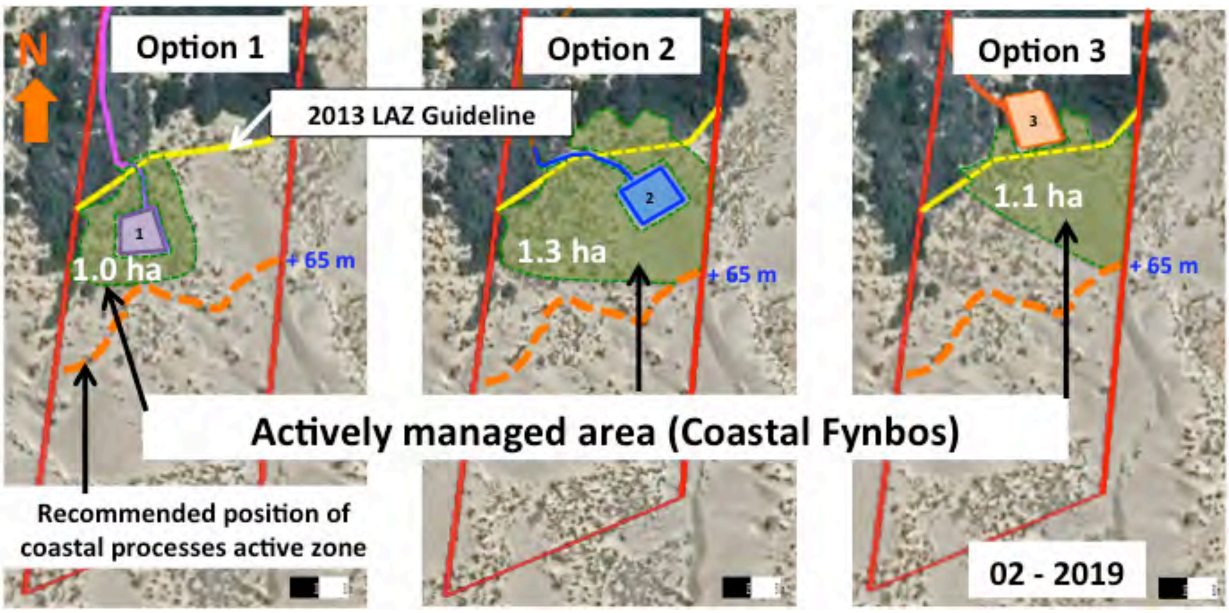

Figure 18: Comparitive summary of the three options showing the 2013 LAZ guideline and the recommended positioning of the **development** landward of the coastal processes active zone landward of **the + 65 m contour**

Road access

Figure 19 shows the proposed routes for the access roads to the proposed main residential buildings. The access roads are to be structurally designed and the road verges stabilised. This will prevent further deterioration through slumping and uncontrolled stormwater management and wind erosion. Maintenance will be limited to pro-active management to prevent deterioration.

The unused tracks within the relic dune field will be rehabilitated using indigenous vegetation.

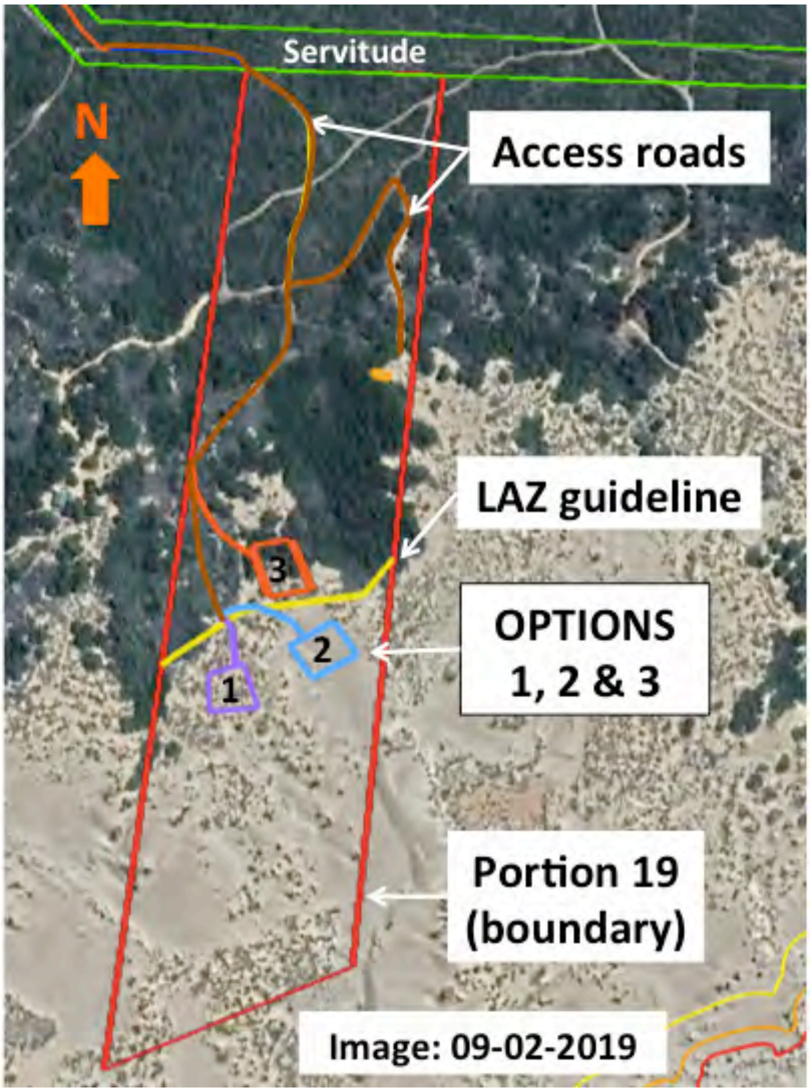

Figure 19: The location of options 1, 2 and 3 and the access roads.

7. IMPACT ASSESSMENT (ABIOTIC FACTORS)

The various options were discussed in the previous section. It was seen that all three options fall landward of the + 65 m MSL contour, being the landward edge of the coastal processes active zone plus a managed buffer area as determined in this report.

Table 7.1 provides a comparative assessment of the proposed development components on the physical (abiotic) coastal processes, and of the coastal processes on the identified options. The relative costs for establishing the proposed development elements for each of the identified options as well as the maintenance costs of each option are assessed in a qualitative manner.

Table 7.1: Comparative impact assessment

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	Impact of development on the prevailing coastal processes	Impact of the coastal processes on the development	Impact of the development on the Fransmanshoek managed conservancy	Establishment cost (Including veg. management)	Maintenance cost (Including veg. management)
Residential development on an approximate 1225 m^2 footprint					
Option 1	**LOW[1]**	**LOW[2]**	**LOW[1]**	**LOW[3]**	**N/A[5]**
Option 2	**LOW[1]**	**LOW[2]**	**LOW[1]**	**MEDIUM[4]**	**N/A[5]**
Option 3	**LOW[1]**	**LOW[2]**	**LOW[1]**	**MEDIUM[4]**	**N/A[5]**
Management to establish coastal dune vegetation as a buffer area					
Option 1 (1.0 ha)	**POSITIVE[6]**	**LOW[2]**	**POSITIVE[6]**	**LOW[8]**	**LOW[8]**
Option 2 (1.3 ha)	**POSITIVE[6]**	**MEDIUM[7]**	**POSITIVE[6]**	**MEDIUM[7]**	**MEDIUM[7]**
Option 3 (1.1 ha)	**POSITIVE[6]**	**MEDIUM[7]**	**POSITIVE[6]**	**MEDIUM[7]**	**MEDIUM[7]**
Access roads					
Option 1	**LOW[2]**	**LOW[2]**	**POSITIVE[9]**	**MEDIUM[10]**	**LOW[9]**
Option 2	**LOW[2]**	**LOW[2]**	**POSITIVE[9]**	**MEDIUM[10]**	**LOW[9]**
Option 3	**LOW[2]**	**LOW[2]**	**POSITIVE[9]**	**MEDIUM[10]**	**LOW[9]**

Notes to Table 7.1:

1. The building footprint area consists of existing well-established dune vegetation which contributes to the vegetated ecosystem within the coastal dune system. An approximate area of 1 225 m^2 of dune habitat will be removed for the footprint.
2. The development area is located outside the main components of the prevailing natural sediment budget and pathway. Little direct impact is foreseen.

3. The proposed developable area is reasonably flat and relatively little earthworks will be needed to prepare the building platform.
4. The proposed developable area for Options 2 and 3 will need more earthworks (than for Option 1) to build up the building platform to a suitable level. Cut-and-fill action will be required with little if any extra material necessary.
5. Maintenance costs of the buildings and services will depend on the design and material used and common to all options.
6. The buffer area consists of existing well-established dune vegetation which contributes to the existing vegetated ecosystem within the coastal dune system. This area will be enhanced through ongoing and focussed management through a maintenance management plan, thereby adding a large area of coastal fynbos habitat to the conservancy.
7. Both options 2 and 3 are located within or downwind of an existing sparsely vegetated dune blow-out area. This will require active management of the wind-blown sand to establish an effective buffer dune over the medium term. This vegetated dune will prevent wind-blown sand from impacting on the development by preventing further blow-out of the local sand and trapping that small portion that blows northwards (see Figure 5 and Table 2.1).
8. The proposed buffer area already consists of a vegetated dune area and the required managed vegetated area needs little intervention barring removal of alien plants and planting of indigenous coastal fynbos.
9. The access roads are to be structurally designed and the road verges stabilised. This will prevent further deterioration through slumping and uncontrolled stormwater management and wind erosion. Maintenance will be limited to pro-active management to prevent deterioration.
10. The current roads are located within a relic dune field hence the sandy road surface and steep slopes over the dune ridges will require specialist design and road construction specialists.
11. Active management of alien vegetation along the route and immediately adjacent to the development along with the re-establishment of indigenous coastal fynbos will stabilise the sandy environment and pro-actively reduce the risk to the development from run-away fires.

8. CONSIDERED OPINION WITH REASONING

It is this author's considered opinion that positioning the proposed residence and outbuildings on Option 1 is the best option. As summarized in Table 7.1, the facts show that Plateau 1, on which the footprint for Option 1 is situated, is the most stable of all the identified options and will require the least intervention to safeguard the development from wind-blown sand and/or blow-out due to the prevailing winds.

Taking a 'no regret[16]' approach means that Option 1 is also preferred above Options 2 and 3. This is because it will be more costly to establish both the required structures and the required vegetated buffer system to prevent further blow-out of the open expanse of sand on Plateau 2. Furthermore ongoing and active buffer dune management will be required on the interface between the edge of the coastal processes active zone (Contour +65 m) and the development footprints of both Options 2 and 3 due to the flat slope upwind of Plateau 2 (Profile S2 – N2, Figure 14).

9. POINTS TO BE INCLUDED IN AN EMPR & EA

9.1 Introduction

As summarised in Section 3.3, the coastline stability analysis shows that the coastline at the sites is 'dynamically stable' with no long-term erosion or accretion (build-up) trends detectable.

In contrast, the exposed sand area within the Fransmanshoek Dune Field shrunk as areas became stabilised by vegetation. Large areas of the remainder of the dune field are already well covered by pioneer grasses and coastal fynbos.

Positioning the proposed development in the identified area requiring the least management intervention (on Option 1) poses an opportunity to add coastal fynbos habitat to the greater Fransmanshoek Conservancy.

9.2 Mitigation actions

The mitigation action is to actively implement the relevant management actions as contained in the existing Fransmanshoek Conservancy plan[17]. This includes controlled removal of invasive vegetation and replacing it with appropriate coastal fynbos. This can only be achieved through active management according to a specialist designed maintenance management plan.

[16] The 'NO REGRET' approach means that a YES decision made today should not be regretted in future, and likewise a NO decision made today should not be regretted in future (ie for example, foreclose on future options or meet future needs)
[17] FMH Conservancy Management Plan

The following should be included in the EMPr:

- The preparation of the building platform on the approved site should be done with a minimal impact on the surrounding dune vegetation. To achieve this the 'no go' areas should be carefully demarcated by a relevant expert and effective temporary fencing erected and the area effectively protected from people and other activities associated with the construction process.
- The indigenous dune vegetation located within the building footprint needs to be harvested and transplanted to identified areas within the managed vegetated area. This should be carried out under expert supervision.
- No formal pathways, road tracks or vegetation activities should be allowed seawards of the + 65 m contour within the private property.
- A sound vegetation maintenance management plan, as specified in the separate specialist report by the botanist, should be implemented to complement the Conservancy management plan.

9.3 Conditions to be included in the Environmental Authorisation

A mitigation point for the EMPr and a condition to be included in the EA is:

- The implementation of a sound coastal vegetation maintenance management plan in the area landwards of the + 65 m MSL aimed at managing the coastal fynbos habitat at a high level of integrity.

9.4 Monitoring requirements to be included in the EMPr and Environmental Authorisation (EA)

A seasonal assessment of the integrity of the coastal fynbos area within Portion 19, and especially around the development footprint, access roads and other associated elements. Appropriate responses should be according to the maintenance management plan.

APPENDIX 1: Aerial images 1942 to 2019