GEOMORPHOLOGICAL ASSESSMENT OF THE PROPOSED WIND ENERGY FACILITY AND ASSOCIATED INFRASTRUCTURE ON THE WEST COAST

Scoping Report Study prepared for SAVANNAH ENVIRONMENTAL (PTY) LTD

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Front cover: A view north along the coastline from a point south of the study area.

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ACRONYMS, ABBREVIATIONS AND DEFINITIONS
Article 3.1 (*sensu* Ramsar Convention on Wetlands)
"Contracting Parties "*shall formulate and implement their planning so as to promote the conservation of the wetlands included in the List, and as far as possible the wise use of wetlands in their territory*"".(Ramsar Convention Secretariat. 2004. Ramsar handbooks for the wise use of wetlands. 2nd Edition. Handbook 1. Ramsar Convention Secretariat, Gland, Switzerland.) (see http://www.ramsar.org/).
DWAF
Department of Water Affairs and Forestry
Indigenous
"Indigenous" for the purposes of this report refers to all biological organisms that occurred naturally within the study area prior to 1800.
Natural properties of an ecosystem (*sensu* Convention on Wetlands)
Defined in Handbook 1 as the "*…physical, biological or chemical components, such as soil, water, plants, animals and nutrients, and the interactions between them*". (Ramsar Convention Secretariat. 2004. Ramsar handbooks for the wise use of wetlands. 2nd Edition. Handbook 1. Ramsar Convention Secretariat, Gland, Switzerland.) (see http://www.ramsar.org/)
NEMA
National Environmental Management Act (Act 107 of 1998) and associated regulations.
NWA
National Water Act (Act 36 of 1998) and associated regulations.
Ramsar Convention on Wetlands
"The Convention on Wetlands (Ramsar, Iran, 1971) is an intergovernmental treaty whose mission is "the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world". As of March 2004, 138 nations have joined the Convention as Contracting Parties, and more than 1300 wetlands around the world, covering almost 120 million hectares, have been designated for inclusion in the Ramsar List of Wetlands of International Importance." (Ramsar Convention Secretariat. 2004. Ramsar handbooks for the wise use of wetlands. 2nd Edition. Handbook 1. Ramsar Convention Secretariat, Gland, Switzerland.) (see http://www.ramsar.org/). South Africa is a Contracting Party to the Convention.
Sustainable Utilization (*sensu* Convention on Wetlands)
Defined in Handbook 1 as the "*human use of a wetland so that it may yield the greatest continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations*". (Ramsar Convention Secretariat. 2004. Ramsar handbooks for the wise use of wetlands. 2nd Edition. Handbook 1. Ramsar Convention Secretariat, Gland, Switzerland.) (see http://www.ramsar.org/).
Wise Use (*sensu* Convention on Wetlands)
Defined in Handbook 1 (citing the third meeting of the Conference of Contracting Parties (Regina, Canada, 27 May to 5 June 1987) as "*the wise use of wetlands is their sustainable utilization for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem*".(Ramsar Convention Secretariat. 2004. Ramsar handbooks for the wise use of wetlands. 2nd Edition. Handbook 1. Ramsar Convention Secretariat, Gland, Switzerland.) (see http://www.ramsar.org/)

1. INTRODUCTION

Savannah Environmental (Pty) Ltd have been appointed by Eskom to co-ordinate an environmental assessment of a proposed wind energy facility and associated infrastructure, to be located north of the Olifants River mouth. As part of the assessment process, Savannah Environmental (Pty) Ltd subcontracted the author to provide a geomorphological assessment of the areas potentially impacted by the proposed development. As a Scoping-level assessment, this report should be followed by a more detailed study once more project planning information becomes available. As a component of an early phase in the Integrated Enviromental Assessment Process the most important outcomes of this report are assumed to be the identification of potential project related issues and impacts and the presentation of the potential Terms of Reference for the specialist study. The key components of this report are listed below.

- A description of the Regional Geomorphological Setting (Section 5).
- Identification of gaps in knowledge (Section 5).
- Identification of potential project related issues and associated impacts (Section 6).
- An assessment of the potential significance of project related impacts (Section 6).
- Identification of areas potentially sensitive to development (Section 7).
- A description of the methods to be used to assess the potential significance of possible project related impacts in the specialist study (Section 8).
- The presentation of the potential Terms of Reference for the specialist study (Section 9).

1.1. Experience of the Author

The author has majors in Botany (UPE), Entmology (Rhodes), Geography (UPE) and Geology (UPE) and honours degrees in Geology (UPE) and Geography (Rhodes). He subsequently obtained an MSc (Geography) (with distinction) and PhD (Entomology) from Rhodes University. Prior to working as a consultant, the author was a member of the Wetlands Group in the Institute for Water Research at Rhodes University. He has participated in earth and/or biological science related field work within Botswana, Malawi, Mozambique, Namibia (lower Orange

River), South Africa, Zimbabwe and the southern oceans. A selection of his geomorphological experience is listed below.

- MSc thesis entitled "*The Morphology and Sedimentology of Two Unconsolidated Quaternary Debris Slope Deposits in the Alexandria District, Cape Province*".
- Paper: Lewis, C.A. and Illgner, P.M. 2001. Late Quaternary glaciation in southern Africa: moraine ridges and glacial deposits at Mount Enterprise in the Drakensberg of the Eastern Cape Province, South Africa. Journal of Quaternary Science, 16, 4, 365-374.
- Paper: Rosen, D.Z., Lewis, C.A., Illgner, P.M.. 1999. Palaeoclimatic and archaeological implications of organic-rich sediments at Tiffindell Ski Resort, near Rhodes, Eastern Cape Province, South Africa. Transactions of the Royal Society of South Africa, 54, 2, 311-321.
- Paper: Lewis, C.A. and Illgner, P.M. 1998. Fluvial conditions during the Holocene as evidenced by alluvial sediments from above Howison's Poort, near Grahamstown, South Africa. Transactions of the Royal Society of South Africa, 53, 1, 53-67.
- Book Chapter: Illgner, P.M. 1996. Ch.4. Coastal features. In C.A. Lewis [Ed], The Geomorphology of the Eastern Cape: South Africa, Grocott & Sherry Publishers, Grahamstown, South Africa, p.52-70.
- Conference: Haigh, E.H. and Illgner, P.M. 2002. Rehabilitation of a small upper catchment seep/wetland of the Kowie River in the Eastern Cape Province, South Africa. Poster presentation, SASAQS Conference, Bloemfontein, July 2002.
- Consulting Report: Illgner, P.M. and Anderson, C.R. 2007. Desktop geomorphological assessment of a site selected for the location of a stormwater outfall - Coega Industrial Development Zone (for Mzizi Msutu and Associates).
- Consulting Report: Dollar, E.S.J. and Illgner, P.M. 2006. Geomorphological Assessment of proposed weirs on the Orange and Vaal rivers (for Bohlweki Environmental (Pty) Ltd).
- Consulting Report: Illgner, P.M., Rynhoud, M.S., Rynhoud, M. and Holland, H. 2006. A Geological and Geomorphological Assessment of the proposed Mercury-Ferrum-Garona Transmission line (for Bohlweki Environmental (Pty) Ltd).
- Consulting Report: Illgner, P.M. 2005. Geological and Geomorphological Overview of the Mbotyi Area (for Coastal and Environmental Services).

1.2. Disclaimer

This report considers landforms, their associated geomorphological processes and the potential impacts of the project on these features and processes. The report does not consider the potential impact of the landscape on the project, unless it relates to the siting of infrastructure or to sediment transport. The report does not consider geotechnical aspects of the environment, the impact of climatic conditions on the weathering of infrastructure, the agricultural potential of soils or substrate associations between biota and landforms and/or the former and geomorphological processes. A review of relevant literature, more detailed analysis of data and an assessment of potential project related impacts will be included in the specialist studies report.

2. ASSUMPTIONS AND LIMITATIONS

2.1. Assumptions

This study assumes that any potential impacts on the environment associated with the proposed development will be avoided, mitigated or offset in order for the proposed project to conform with the definition of wise use provided in the section on "Acronyms, Abbreviations and Definitions" above. Although this definition relates specifically to wetlands it is also more broadly applicable to all aspects of the natural environment and hence has been adopted for use in this report.

2.2. Limitations

This report has been predominantly based on a desktop assessment of the environment, a single site visit (over two days, viz. 7-8 March 2007) of limited duration carried out during daylight hours and conversations with K. Jodas and J.-A. Thomas of Savannah Environmental (Pty) Ltd. The site visit included walkabouts at various sites within the landscape in the vicinity of the study area, accompanied by inter alia Ian Smit (representing Eskom) and the aforementioned individuals. Dedicated field work in the study area has not been carried out, as the current area identified for the siting of the turbines and associated infrastructure was selected after the site visit. No sediment sampling was carried out for later analysis. A site visit planned as part of the specialist study is expected to present the author with the opportunity to make a more detailed assessment of the areas potentially affected by the proposed project.

3. LOCATION OF THE STUDY AREA

LOCATION OF THE STUDY AREA	NOTES
1:50 000 Topographical Map	3118AC and 3118CA
Geographic Location of the Northern Extremity of the Study Area	31.4764°S 18.1520°E
Spatial Extent of the Study Area (excluding route of the distribution line to the Koekenaap Substation)	3760 ha
Geomorphic Province	Namib
Quaternary Catchment	F60E, with the exception of a small area of c. 1.3 ha at the southermost extremity of the study area, which lies within E33H.
Vegetation Type (sensu Mucina & Rutherford 2006)	Namaqualand Sand Fynbos (Least Threatened) (Fynbos Biome) and Namaqualand Strandveld (Least Threatened) (Succulent Karoo Biome). Erosion within the Namaqualand Sand Fynbos and Namaqualand Strandveld is reputed to be very low on both accounts.
Administrative Area	Vredendal Magisterial District, Matzikama Local Municipality; and the WCMA01
Affected Properties (listed in alphabetical order**)**	Gravewaterkop 158 Portion 5, Olifants River Settlement Portion 617, Olifants River Settlement Portion 620
SITE VISIT	**NOTES**
Directions to the Site	Proceed north from Lutzville on the R363 towards Koekenaap. At 31.5210°S 18.2885°E turn off the R363 onto an unpaved road and proceed westwards towards the coast via Kommandokraal (entrance = 31.5084°S 18.2133°E). This unpaved road enters the study area at 31.5045°S 18.1441°E and exits it immediately east of Skaapvlei, at 31.4914°S 18.0819°E.

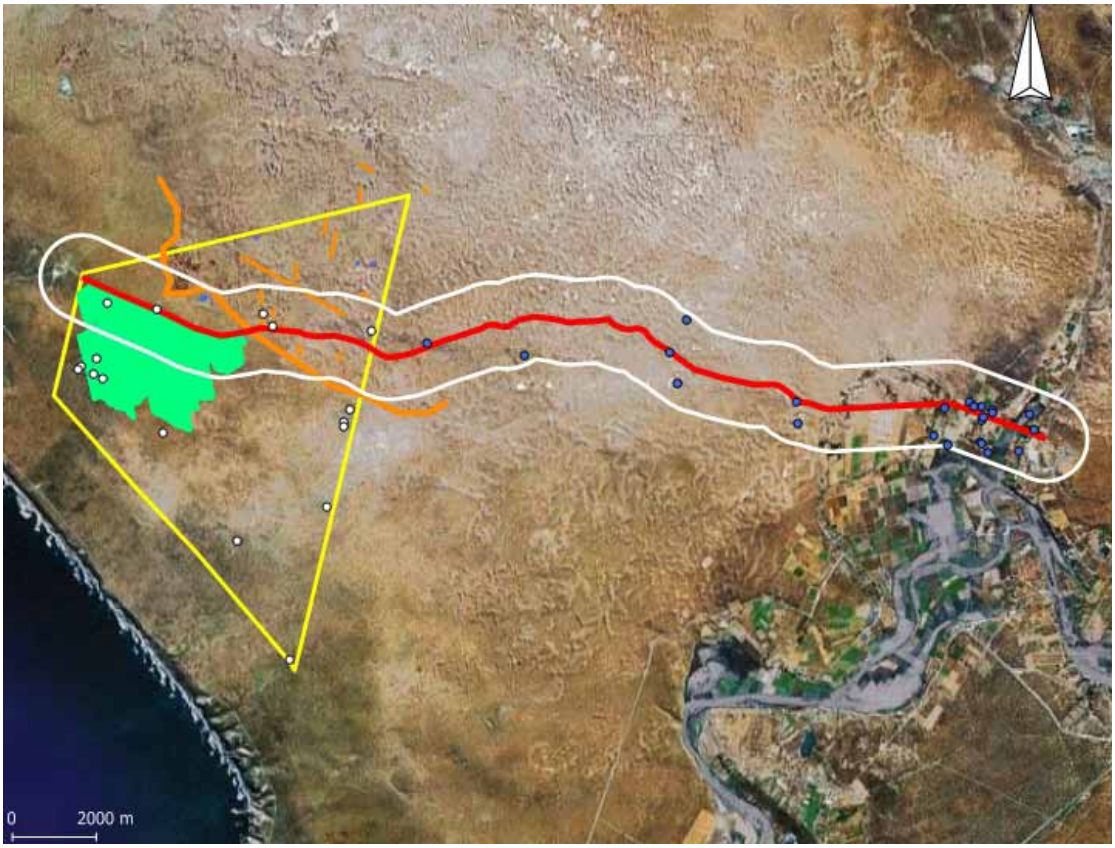

Figure 1. A view of the study area and power line corridor (Source of Image = Google Earth).

Key: *Yellow border* = study area, *Red line* = main unpaved access road to the study area, *White 1 km buffer* = power line corridor, *Solid green shaded area* = land reputedly transformed for cultivation, *Thick orange line* = approximate boundary between the area with relatively clearly discernible dunes and the area where they are less frequent/apparent, *White dots* = unknown features within the study area that should be identified for planning purposes, *Blue dots* = points of interest (that require idenitifcation in the field) within the power line corridor and *Small blue polygons* = pans, *Straight orange lines* = linear dune elements (e.g. dune crests).

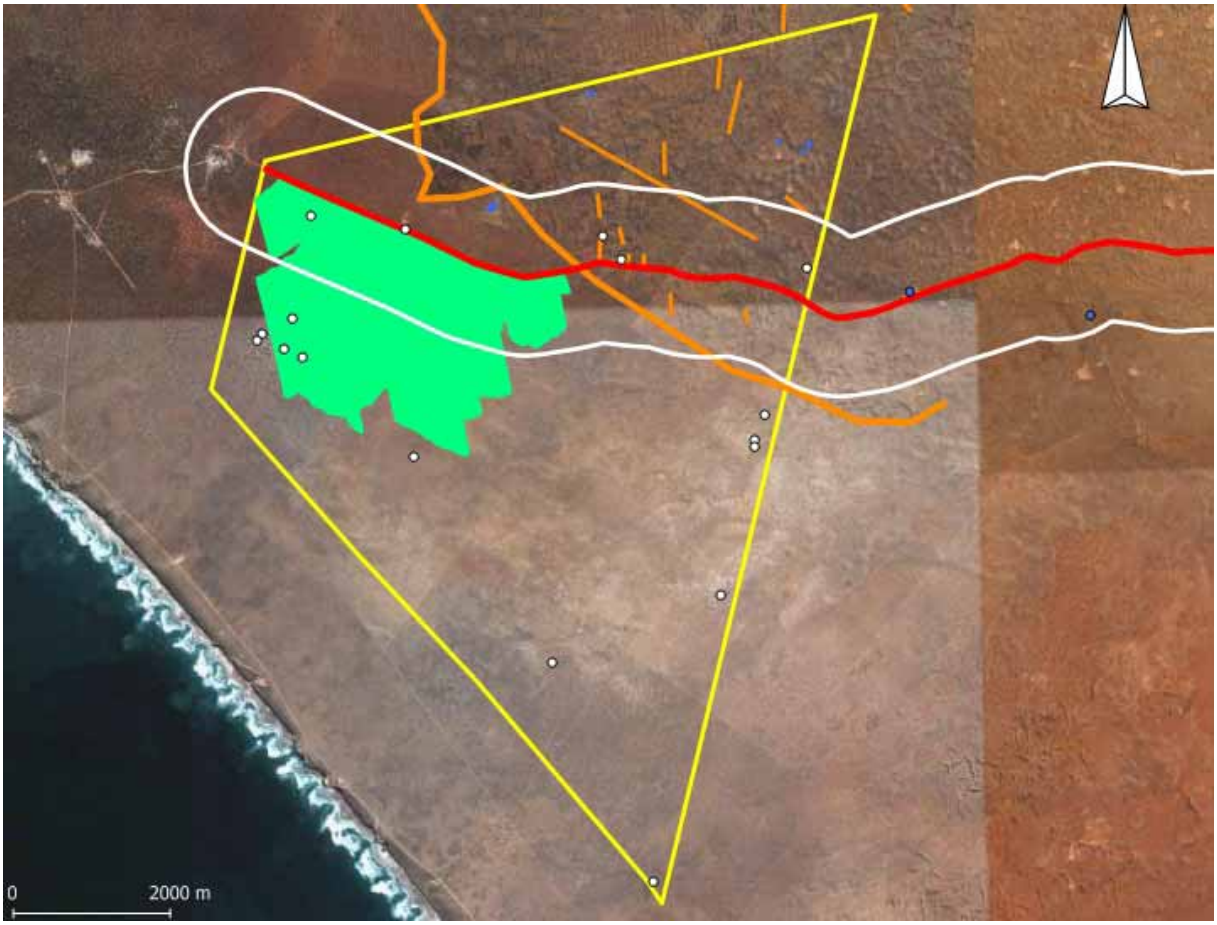

Figure 2. A larger-scale view of the study area than that shown in Figure 1 (Source of Image = Google Earth).

4. PROJECT DESCRIPTION

INFRASTRUCTURE	NOTES
Buildings	
Location(s)	An office and visitors centre may be constructed at the entrance to the wind energy facility.
Dimensions	c. 150 m^2
Issues/Impacts that may affect planning	1. Rainfall runoff from a sealed surface (e.g. roof). 2. Undercutting of the building by wind erosion and subsequent subsidence. 3. Sandblasting of mortar and plaster by wind transported sand. 4. Weathering (corrosion) of metallic building materials. 5. Salt-weathering of cement associated with saline soils.
Turbines	
Location(s)	Exact footprints of 100 turbines to be determined.
Dimensions	Concrete Base ≈ 15 m X 15 m/turbine, Hub Height ≈ 80 m, Rotor Blades ≈ 3 X 45 m (diameter = 90 m).
Other	A maximum of 100 turbines will be located within the study area. The turbines may be located approximately 2 km (i.e. first row) inland, within a double row (500 m - 800 m apart), with the rows orientated in a west - east direction.
Issues/Impacts that may affect planning	1. Possible preferential removal of sediment adjacent to foundation slabs by overland flow. 2. Undercutting of the concrete plinth by wind erosion and subsequent subsidence. 3. Sandblasting of concrete and steel tower by wind transported sand. 4. Weathering (corrosion) of metallic building materials (e.g. tower). 5. Salt-weathering of cement associated with saline soils.

INFRASTRUCTURE	NOTES
Substation	
Location(s)	To be determined. Possibly to be located in a central position to the turbines, with underground cables connecting each turbine to the substation.
Dimensions	Number of substations and size/footprint to be deteremind
Issues / Impacts that may affect planning	1. Possible preferential removal of sediment adjacent to foundation slabs by overland flow. 2. Undercutting of the concrete plinths by wind erosion and subsequent subsidence. 3. Sandblasting of concrete and steel substation components by wind transported sand. 4. Weathering (corrosion) of metallic building materials (e.g. transformers). 5. Salt-weathering of cement associated with saline soils. 6. Deposition of wind transported sand within the substation.
Distribution Lines	
Location(s)	To be determined. The distribution line will have to link the substation on site to the national grid (e.g. Koekenaap or Juno Substation).
Dimensions	Approximate width of servitude = 32 m.
Other	Voltage = 132 kV.
Issues / Impacts that may affect planning	1. Removal of sediment adjacent to the towers by fluvial processes. 2. Winnowing of sediment adjacent to the towers by wind erosion and subsequent subsidence. 3. Sandblasting of concrete and steel by wind transported sand. 4. Weathering (corrosion) of metallic building materials (e.g. towers)(not applicable if concrete or wooden structures selected). 5. Salt-hazard related phenomena associated with saline soils.
Roads	
Location(s)	The existing access road to site will be used, but the location of internal roads to turbines and other structure are still to be determined.
Dimensions	Internal Access Road(s): Width = 5-6 m, Longitudinal Slope < 8^{o}, Lateral Slope < 2^{o}, Axle Weight/m^2 = 15 t, Turning Radius = 25 m.

INFRASTRUCTURE	NOTES
Other	An access road to each turbine will have to be constructed. As far as is possible existing roads will be utilised.
Issues/Impacts that may affect planning	1. Accelerated fluvial erosion within drainage ditches adjacent to the roads. 2. Removal of fine sediment from the road surface by wind. 3. Compaction of surficial sediments due to loading associated with vehicle traffic. 3. Salt-hazard related phenomena associated with saline soils.
DISTURBANCES	**NOTES**
Excavations	Foundation related excavations will be required during the construction phase.
Issues/Impacts that may affect planning	1. Modification of a landform/feature of Special Scientific Interest. 2. Exposure of a stratgraphic profile within a landform that is of Special Scientific Interest.
Stockpiles and Temporary Storage	It is assumed that during the construction phase areas will be required for the stockpile of sediment (e.g. removed from excavations and potentially brought in for construction purposes) and the temporary storage of building materials (e.g. laydown areas for turbine components).
Issues/Impacts that may affect planning	1. Increase in the availability of sediment easily remobilised by wind (e.g. dust blown from stockpiled sediment or from areas denuded of vegetation). 2. Modification of a landform/feature of Special Scientific Interest. 3. Modification of the surface for the construction of roads and the positioning of a crane at each turbine site.

5. REGIONAL GEOMORPHOLOGICAL SETTING

STRATIGRAPHY					
ASPECT	**NOTES**				
Stratigraphy	**Stratigraphic Unit**	**Lithology**	**Age**	**Location**	**Extent**
	Unspecified	"Calcareous and gypsiferous soil"	Quaternary	The far western reaches of the study area and an insignificant area in the extreme south.	Western Area = c. 210 ha. Southern Area = c. 2 ha.
	Unspecified	"Silcrete"	Cenozoic	Five patches in the south and east of the study area.	Total Area of the Five Patches = c. 91 ha.
	Unspecified	"Red Aeolian Sand"	Cenozoic	Throughout the area of interest, with the exception of the far western reaches of the study area.	Most of the study area (c. 3457 ha).
Gaps in Knowledge and Monitoring Requirements					
Gaps in Knowledge	The composition (e.g. salinity) of the soils/sediments present within the study area. It is assumed for the purposes of this report that the potential occurrence of hazardous soils will be addressed in a specialist study during the EIA phase of the assessment process. Hazardous soils within this context would include inter alia acid sulphate soils, saline soils, soils with excess gypsum and soils with a high clay content.				
Monitoring Requirements	None.				

STRUCTURE	
ASPECT	**NOTES**
Faults	None of the faults indicated on the 1:250 000 (3118 Calvinia, Council for Geoscience) geological map traverse the study area.
Seismicity	An approximation of the seismicity of the study area was obtained by using a USGS website (viz. http://neic.usgs.gov/neis/epic/epic_circ.html). In terms of the data available on this website, no earthquake epicentres were located within a 100 km radius of the northernmost extremity of the study area between 1973 and the present.
Gaps in Knowledge and Monitoring Requirements	
Gaps in Knowledge	Detailed record of the seismicity of the study area. A seismic record of the area may be obtained from the Council for Geoscience. It is assumed that a future geotechnical assessment of the study area will include an evaluation of the seismic risk to structures. For example, the top of tall structures are likely to experience greater horizontal movement than that likely to be recorded at the base.
Monitoring Requirements	None.

CLIMATE	
ASPECT	**NOTES**
Climate	
Rainfall	Mean Annual Precipitation = 115.63 mm (based on data for the quaternary catchment F60E). Mean Annual Precipitation[1] at Brand se Baai (1994-2004) = 147 mm (Couto et al. 2006). Maximum Annual Rainfall = Unknown. Variability in Annual Rainfall = Unknown.
Stream Flow	Unknown. Peak Discharge Recurrence Interval = Unknown.
Temperature	Mean Annual Daily Temperature = Unknown. Maximum Mean Annual Daily Temperature = Unknown. Minimum Mean Annual Daily Temperature = Unknown. Variability in Mean Annual Daily Temperature = Unknown. Temperature Range[2] (period unknown) at Brand se Baai = -8.3°C to 46.3°C (Couto et al. 2006).
Potential Evaporation	Unknown. Estimated Mean Annual Evaporation[3] at Brand se Baai = 1750 mm (Couto *et al*. 2006).
Wind	Unknown.
Gaps in Knowledge and Monitoring Requirements	
Gaps in Knowledge	Daily rainfall, temperature, wind and potential evaporation data for the study area need to be obtained to characterise these aspects of the climate in the study area. It is assumed here that Eskom are currently recording these variables in the study area or in close proximity to it for planning purposes. This data will be assessed and described in the specialist study which forms a part of the EIA phase of the integrated environmental assessment process.
Monitoring Requirements	Recording of the climatic variables listed above. It is assumed that this is already being carried out by Eskom.

[1] Assumed to refer to mean annual value.
[2] Assumed to refer to extreme values for the entire record.
[3] Assumed to refer to mean annual value.

GEOMORPHOLOGY	
ASPECT	**NOTES**
Relief	Elevations within the study area appear to lie between 50 m and 150 m above mean sea level (sensu 1:250 000 electronic topographical map for the study area, namely 3118).
Landforms	
Aeolian	Vegetated relict dunes appear to cover most of the area north of the main unpaved access road traversing the study area. A much smaller area is evident south of this road. Many of the more obvious linear elements within this relict dunefield are orientated in a north - south direction. A large linear element that extends for > 2.5 km in a west - east direction may be associated with a change in elevation in the subtopography below the aeolian dune cover. The orientation of this feature approximates that of the coastline. The area seward of this dunefield also appears to be mantled by an aeolian sand cover, although bedforms are less distinctive than in the aforementioned area. The boundary between these two areas is difficult to discern in imagery and hence is conservatively regarded as gradational for the purposes of this report. This will require confirmation during the site visit required for the specialist study in the EIA phase of the integrated environmental assessment process. The mantle of aeolian sand is expected to cover marine terrace gravels, at least in lower lying areas, within the study area.
Biological	Numerous, round, enigmatic structures, approximately 20 m in diameter, are assumed to represent mounds created by Meerkats (*Suricata suricatta*) or Harvester Termites (*Microhodotermes viator*). No other significant landforms of biological origin are known to be present within the study area. Calcretized root casts can be expected to occur within the unconsolidated cover of aeolian sediments, although no landform is known to be the result of these features in the study area.

ASPECT	NOTES
Fluvial	No significant drainage lines are known to be located within the study area. As surface erosion is expected to occur in association with the larger rainfall events, features consistent with this process are also likely to be present within the study area. These features could include stone pedestals, raised mounds associated with plants, rills and shallow erosion gullies. In some instances there may be interaction between the effects of the fluvial activity and aeolian processes, such as the sediment trapping affect of vegetation in relation to aeolian activity.
Marine	A number of marine terrace deposits are located at different elevations along the Namaqualand coast. Marine deposits are known to occur at elevations up to 90 m above mean sea level (Pether 1986). The likelihood of occurrence of the different marine terraces within the study area will need to be assessed in the geomorphological specialist study, as elevations range from 50 m - 150 m above mean sea level within this area.
Mass Movement	No significant landslides, rockfalls or other large mass movements with a significant spatial extent are known to occur in the study area.
Wetlands	A limited number (n = 5) of small (< 1 ha) pans were evident in satellite imagery. Some of the enigmatic features noted in the imagery may also represent small pans, although none are likely to represent wetlands with a notable spatial extent.
Weathering Features	No notable, distinctive, weathering features are known to be present within the study area.
Other	

ASPECT	NOTES
Sites of Special Scientific Interest	
Aeolian	None known to be present.
Biological	None known to be present.
Fluvial	None known to be present.
Marine	None known to be present.
Mass Movement	None known to be present.
Weathering Features	None known to be present.
Other	None known to be present.
Gaps in Knowledge and Monitoring Requirements	
Gaps in Knowledge	1. High resolution (< 20 m contour interval) elevation data during the compilation of this report. 2. The occurrence and spatial extent of the small pans within the study area requires further investigation for the siting of wind turbines and associated infrastructure. The presence of these will need to be confirmed in the EIA phase of the study. 3. Small drainage lines and shallow gullies not evident in imagery may be present within the study area. 4. The nature and extent of the potentially different types of aeolian cover are poorly known. 5. The chemical composition of soils/sediment within the study area is poorly known. The composition of these sediments has important implications for the type of cement that would need to be used for foundations should the project be approved by the relevant authorities. 6. The origin of the low mounds within the study area and adjoining landscape requires further investigation in the EIA phase.
Monitoring Requirements	A photographic record of the spatial extent of surface ponding in the small pans after significant rainfall events.

DISTURBANCE ASPECT	NOTES	POTENTIAL ISSUE(S)
National Review of Land Degradation of South Africa	The metrics listed below provide an indication of the regional (i.e. magisterial district) state of the environment with regard to land degradation. This data provides an indication of which *current* impacts on the potentially affected environment could be of greatest concern. In this context, it would appear that the landscape has been the most susceptible to "loss of veld by rill, gully and donga erosion". This implies that the potential impact of the proposed project on this aspect of the environment should be addressed in the EIA phase of the assessment process. Other impacts that should be addressed include the "loss of veld topsoil by wind" and "loss of veld by sheet erosion".	
Veld degradation: Loss of cover[1]	Degree (0 = None, 4 = Extreme) = 0	
Veld degradation: Alien plants (species)[1]	Degree (0 = None, 4 = Extreme) = 2 (Moderate)	
Loss of veld by sheet erosion[1]	Degree (0 = None, 4 = Extreme) = 1 (Light)	
Loss of veld by rill, gully and donga erosion[1]	Degree (0 = None, 4 = Extreme) = 3 (Strong)	
Loss of veld topsoil by wind[1]	Degree (0 = None, 4 = Extreme) = 2 (Moderate)	
Loss of veld by deflation hollows and dunes[1]	Degree (0 = None, 4 = Extreme) = 0	
Loss of veld by overblowing[1]	Degree (0 = None, 4 = Extreme) = 0	

DISTURBANCE		
ASPECT	**NOTES**	**POTENTIAL ISSUE(S)**
Loss veld by salinisation[1]	Degree (0 = None, 4 = Extreme) = 0	
Loss of veld by soil mining[1]	Degree (0 = None, 4 = Extreme) = 0	
Loss of veld by acidification[1]	Degree (0 = None, 4 = Extreme) = 0	
Loss of veld by pollution[1]	Degree (0 = None, 4 = Extreme) = 0	
Notes	1=As listed in an electronic document that accompanies the "National Review of Land Degradation of South Africa".	
Past		
Alien Vegetation	Unknown. Please refer to the botanical report for further information. In his draft report (Helme 2007), the botanist (Nick Helme) noted that no alien species were recorded in Namaqualand Strandveld.	Aeolian Sediment Trap, Channel Incision, Wind Throw
Vegetation Clearing	A large area (c. 565 ha, c.15 % of the study area) east of Skaapvlei, within the study area, has been cleared in strips for cultivation. These strips were reputedly used for the cultivation of wheat, but have been fallow for at least 12 years (K. Jodas, pers.comm. citing farmer). The spatial extent of this affected area included the strips of vegetation that appear to have been left in tact. This area therefore represents an over estimate of the actual area transformed by the clearing activity. The affect of these impacted areas on sediment erosion and deposition is unknown. As these strips appear to have a much poorer vegetation cover than the untransformed areas, it is assumed that they represent an elevated erosion risk in relation to the latter strips of vegetation.	Sediment Transport

ASPECT	NOTES	POTENTIAL ISSUE(S)
Cultivated Areas & Pasture	Please refer to the entry above, which refers to the past use of an area for wheat farming purposes. The area selected for the siting of the turbines is currently used for grazing sheep and cattle (K.Jodas, pers.comm.), although this is not expected to be on cultivated pastures.	Sediment Transport, Surface Modification (e.g. compaction)
Excavation(s)	The entrance to a possible borrow pit along the main unpaved access road is located at -31.4973°S 18.0981°E.	Fluvial Sediment Trap, Surface Modification
Impoundments	No impoundments (e.g. earthen farm dam) are known to be located within the study area. As no drainage lines are known to traverse the study area, no impoundment (if present) above or below the study area is likely to represent a significant planning element from a sediment management perspective.	Fluvial Sediment Trap, Surface Modification
Livestock	At least a part of the site selected for the location of the turbines is reputedly used for grazing sheep on a rotational basis (K.Jodas, *pers.comm*.).	Channel Bank Modification, Sediment Transport, Surface Modification (e.g. compaction)
Roads and Tracks	One reasonably wide unpaved road traverses the study area. A number of other tracks also appear to be present with the study area. These tracks appear to be located inter alia down fencelines and on the fringes of the area believed to have been transformed for cultivation purposes.	Sediment Transport, Surface Modification (e.g. compaction)

ASPECT	NOTES	POTENTIAL ISSUE(S)
Sealed Surfaces	No sealed surfaces of significant spatial extent are known to be located within the study area. A possible structure (location = 31.5610°S 18.1266°E) visible in satellite imagery, at the southern extremity of the focus area, represents one possible example of a sealed surface, possibly a roof (spatial extent = c. 25 m X c. 7.5 m).	Increased Runoff, Sediment Availability
Stockpiles	No significant stockpiles are known to be present within the study area.	Surface Modification, Sediment Availability
Other	The extent of footpaths within the study area is unknown.	
Gaps in Knowledge and Monitoring Requirements		
Gaps in Knowledge	1. The extent to which road drainage ditches, tracks and other impacted areas have been affected by fluvial erosion and deposition in the study area. 2. The nature of the features recorded as "unknown" in Figure 1.	
Monitoring Requirements	A baseline photographic record of roadside drainage ditches and other impacted areas on steep slopes prior to site development, should this be approved by the government authorities. Determine the nature of the features recorded as "unknown" in Figure 1.	

6. ISSUES AND IMPACTS

ISSUE	**IMPACT (**Effect**)**	**Direct / Indirect / Cumulative** (Additive, Synergistic, Neutralizing)	**Nature**				**Extent** (Local, Regional, National, International)	**Potential Significance**
			Cause (Action**)**	**Affected Aspect(s)**	**Status** (i.e. Negative, Positive, Neutral)	**Frequency** (Singular event, Continuous, Sporadic)		
Flow Modification	Impoundment of channelised flows by roads.	Direct	Roads constructed across drainage lines can impound flows. The smaller the design discharge for the culvert(s), the greater the likely impact on flows in the channel.	Flow in drainage lines.	Negative	Sporadic	Local	None[4]
Flow Modification	Impoundment of overland flows by roads.	Direct	Roads constructed across slopes are likely to impound	Overland flow on slopes.	Negative	Sporadic	Local	Low to Moderate.

[4] As no drainage lines are known to traverse the area selected for the siting of the turbines, with the existing road to this area to be used as an access road.

ISSUE	**IMPACT (**Effect**)**	**Direct / Indirect / Cumulative** (Additive, Synergistic, Neutralizing)	**Nature**				**Extent** (Local, Regional, National, International)	**Potential Significance**
			Cause (Action**)**	**Affected Aspect(s)**	**Status** (i.e. Negative, Positive, Neutral)	**Frequency** (Singular event, Continuous, Sporadic)		
			and/or divert overland flow. The nature of this impact will be dependant on inter alia the length of the slope above the road, its gradient, the composition of the substrate and the nature of the rainfall event.					

ISSUE	**IMPACT (**Effect**)**	**Direct / Indirect / Cumulative** (Additive, Synergistic, Neutralizing)	**Nature**				**Extent** (Local, Regional, National, International)	**Potential Significance**
			Cause (Action**)**	**Affected Aspect(s)**	**Status** (i.e. Negative, Positive, Neutral)	**Frequency** (Singular event, Continuous, Sporadic)		
Geoheritage	Damage to a Site of Special Scientific Interest.[5]	Direct	Landforms of special interest could be used to site infrastructure or be lost as a result of engineering considerations.	Sites of Special Scientifc Interest.	Negative	Singular	N/A	None
Geoheritage	Restriction in the access to a Site of Special Scientific Interest due to a developers public access policies.	Cumulative (neutralizing)	If the project proponent does not allow free public access to their properties it may restrict the appreciation of a	Sites of Special Scientifc Interest.	Negative	Continuous	N/A	None[6]

[5] Sites of Geomorphic Interest (SGI) may include the presence of unique or unusual landforms, the presence of a particularly good example of a common landform and exposures likely to provide good palaeoenvironmental information (e.g. exposure with fossil material present).
[6] No significant geosites are known to be in any area potentially affected by the proposed project.

ISSUE	**IMPACT (**Effect**)**	**Direct / Indirect / Cumulative** (Additive, Synergistic, Neutralizing)	**Nature**				**Extent** (Local, Regional, National, International)	**Potential Significance**
			Cause (Action**)**	**Affected Aspect(s)**	**Status** (i.e. Negative, Positive, Neutral)	**Frequency** (Singular event, Continuous, Sporadic)		
			geosite for aesthetic and/or scientific purposes. This potential impact could be offset by the conservation value restricted access may respresent.					
Increased Runoff	Increased surface runoff from sealed surfaces (e.g. tarred/concrete roads[7], roofs) relative to the	Direct	Increased runoff from a sealed surface in relation to the reference state may be associated with a relative increase in	Areas downslope of sealed surfaces.	Negative	Sporadic	Local	Low

[7] Sealed roads have been included here as they may be recommended for some road segments in a specialist study to be completed during the EIA phase of the assessment process.

ISSUE	**IMPACT (**Effect**)**	**Direct / Indirect / Cumulative** (Additive, Synergistic, Neutralizing)	**Nature**				**Extent** (Local, Regional, National, International)	**Potential Significance**
			Cause (Action**)**	**Affected Aspect(s)**	**Status** (i.e. Negative, Positive, Neutral)	**Frequency** (Singular event, Continuous, Sporadic)		
	undisturbed reference state.		sediment transport and hence erosion on a slope or within a channel.					
Sediment Deposition	Deposition of sediment by aeolian processes adjacent to or within infrastructure (e.g. substation or visitor's centre building).	Direct	A localised descrease in wind velocity caused by an obstacle may be associated with the deposition of sediment.	Substation.	Negative	Sporadic	Local	Moderate

ISSUE	**IMPACT (**Effect**)**	**Direct / Indirect / Cumulative** (Additive, Synergistic, Neutralizing)	**Nature**				**Extent** (Local, Regional, National, International)	**Potential Significance**
			Cause (Action**)**	**Affected Aspect(s)**	**Status** (i.e. Negative, Positive, Neutral)	**Frequency** (Singular event, Continuous, Sporadic)		
Sediment Transport	Accelerated aeolian sediment transport possibly leading to the development of deflation hollows.	Indirect	A loss of vegetation (or other) cover will increase the susceptibility of sediments to wind erosion.	Areas cleared of vegetation (e.g. for construction purposes) or where vegetation has been extensively damaged (e.g. laydown areas).	Negative	Singular	Local	Low
Sediment Transport	Accelerated fluvial sediment transport and hence erosion	Indirect	Erosion may be accentuated in flow concentration zones (e.g. culverts,	Bridges, Culverts, Drainage Ditches.	Negative	Sporadic	Local	Moderate

ISSUE	**IMPACT (**Effect**)**	**Direct / Indirect / Cumulative** (Additive, Synergistic, Neutralizing)	**Nature**				**Extent** (Local, Regional, National, International)	**Potential Significance**
			Cause (Action**)**	**Affected Aspect(s)**	**Status** (i.e. Negative, Positive, Neutral)	**Frequency** (Singular event, Continuous, Sporadic)		
	associated with channelised/concentrated flow.		roadside drainage ditches).					
Sediment Transport	Accelerated fluvial sediment transport and hence erosion associated with overland flow.	Indirect	A loss of vegetation cover may increase the susceptibility of a sediment surface to overland flow related erosion proceses.	Slope sediments.	Negative	Singular	Local	Low[8].
Sediment Transport	Preferential aeolian erosion of sediment adjacent to structures and subsequent	Indirect	The winnowing affect associated with local flow modication caused by structures may lead to	Unconsolidated sediment adjacent to structures.	Negative	Sporadic	Local	Low

[8] Assumed to be low as rainfall is low.

ISSUE	**IMPACT (**Effect**)**	**Direct / Indirect / Cumulative** (Additive, Synergistic, Neutralizing)	**Nature**				**Extent** (Local, Regional, National, International)	**Potential Significance**
			Cause (Action**)**	**Affected Aspect(s)**	**Status** (i.e. Negative, Positive, Neutral)	**Frequency** (Singular event, Continuous, Sporadic)		
	subsidence.		subsidence if these structures are undercut.					
Sediment Transport	Preferential fluvial erosion of sediment adjacent to structures and subsequent subsidence.	Indirect	The winnowing affect associated with local flow modication caused by structures may lead to subsidence if these structures are undercut.	Unconsolidated sediment adjacent to structures.	Negative	Sporadic	Local	Low
Surface Modification	Excavation of foundations for wind turbines and	Direct	Excavation of foundations for infrastructure will be	Sites selected for the construction of	Negative	Singular	Local	Low[9]

[9] Surface modification will occur during the establishment of the project infrastructure (e.g. power line towers, substation, turbines), but is not expected to have a notable impact on the topography of the affected environment.

ISSUE	**IMPACT (**Effect**)**	**Direct / Indirect / Cumulative** (Additive, Synergistic, Neutralizing)	**Nature**				**Extent** (Local, Regional, National, International)	**Potential Significance**
			Cause (Action**)**	**Affected Aspect(s)**	**Status** (i.e. Negative, Positive, Neutral)	**Frequency** (Singular event, Continuous, Sporadic)		
	other project related infrastructure (e.g. access roads, substation and powerline towers).		associated with localised surface modification.	infrastructure.				
Weathering	Sandblasting of structures leading to increased maintenance requirements.	Cumulative (additive)	Sandblasting may lead to the erosion of plaster/mortar and potentially damage painted surfaces.	Structures, particularly those located on unconsolidated sediment with a poor cover.	Negative	Sporadic	Local	Low

ISSUE	**IMPACT (**Effect**)**	**Direct / Indirect / Cumulative** (Additive, Synergistic, Neutralizing)	**Nature**				**Extent** (Local, Regional, National, International)	**Potential Significance**
			Cause (Action**)**	**Affected Aspect(s)**	**Status** (i.e. Negative, Positive, Neutral)	**Frequency** (Singular event, Continuous, Sporadic)		
Weathering	Loss of cement integrity due to the presence of hazardous soils.	Direct	Hazardous soils react chemically with cement, requiring the use of special methods to mitigate the potential impact.	Cement structures sited on hazardous soils.	Negative	Continuous	Local	High[10]
Weathering	Rapid corrosion of metal infrastructure and hence increased maintenance costs.	Direct	Saline soils can lead to accelerated corrosion of metallic objects.	Metal structures sited on saline soils.	Negative	Continuous	Local	High

[10] Hazardous soils in this context refers to acid sulphate soils, gypsiferous soils and saline soils. It is assumed that these aspects will be investigated in a geotechnical study that may or may not be included within the EIA phase of the assessment process.

ISSUE	**IMPACT (**Effect**)**	**Direct / Indirect / Cumulative** (Additive, Synergistic, Neutralizing)	**Nature**				**Extent** (Local, Regional, National, International)	**Potential Significance**
			Cause (Action**)**	**Affected Aspect(s)**	**Status** (i.e. Negative, Positive, Neutral)	**Frequency** (Singular event, Continuous, Sporadic)		
Wetland Loss	A reduction in the surface area of wetlands e.g. (pans) in the study area.	Direct	Construction of roads, tracks or other infrastructure in wetlands will lead to a loss of this habitat in the study area.	Wetlands.	Negative	Singular	International	High[11]

[11] Regarded as high as South Africa is a signatory to the Ramsar Convention, implying wise use of wetland resources should be encouraged. Loss of wetland areas or a degradation in the habitat would not appear to be consistent with the concept of wise use in most circumstances. For a definition of wise use please refer to the section entitled "Abbreviations, Acronyms and Definitions".

7. AREAS SENSITIVE TO DEVELOPMENT

- All wetlands, drainage lines and associated buffer zones should be excluded from the development footprint. Suitable buffer widths adjacent to these features will need to be determined as part of the specialist study in the EIA phase. As a precautionary measure, a buffer width of 100 m should be adopted during the project planning phase. Where impacts on these features are regarded as unavoidable suitable mitigation measures and offsets will need to be considered.
- Unvegetated and largely unvegetated aeolian dunes represent a high erosion risk and should be avoided for the siting of infrastructure wherever possible. Areas that may meet the aforementioned description appear to be present in the area selected for the siting of the turbines and within the powerline corridor. These areas will need to be assessed during the site visit for the specialist study, in the EIA phase of the assessment process.
- Steep slopes susceptible to slope failure, rock fall or that represent a very high erosion risk do not appear to be present with the area selected for the siting of the turbines. The absence of such areas within the all areas potentially affected by project related infrastructure will require confirmation during the site visit for the specialist study, in the EIA phase of the assessment process.

8. METHODS FOR THE ASSESMENT OF POTENTIAL IMPACTS IN THE SPECIALIST STUDIES REPORT

Status

Positive, *Negative* or *Neutral*.

Extent

Local: The impact is restricted to the study area.

Regional: The impact will extend beyond the study area, but not nationally.

National: The impact will be experienced nationally or is controlled by legislation.

International: The impact will be experienced internationally or is affected by international agreements.

Unknown

Duration

Permanent: Does not qualify for any other category.

Long: > 15 years, but requires the presence of an aspect associated with the operational activities of the proposed project.

Moderate: < 15 years

Short: < 5 years

Unknown

Intensity / Magnitude

High: Affects of the impact are permanent, only offset possible.

Moderate: Affects of the impact are moderate to long, with mitigation possible, but not avoidance.

Low: The affects of the impact are expected to be of short duration, with avoidance or mitigation possible.

Unknown

Probability

High: > 75 %

Moderate: 25 - 75 %

Low: < 25 %

Unknown

Significance

High (+): The impact is likely to be of national significance.

High (-): The impact is of critical importance to the viability of the project. The impact could be a fatal flaw for the project unless successfully avoided, mitigated or offset.
Moderate (+): The impact is likely to be of regional importance (e.g. municipality).
Moderate (-): The impact is likely to be of regional importance (e.g. municipality).
Low (+): The impact is likely to of limited importance and largely restricted to the site/study area.
Low (-): The impact is likely to of limited importance and largely restricted to the site/study area.
Unknown

Frequency
A *single* instance, *sporadic*, or *continuous*.

Confidence
Low (1): Based on assumptions, but no data, reports/records in the literature or experience.
Moderate (2): Based on limited data and/or reports/records in the literature and/or some experience.
High (3): Based on supporting data, reports/records in the literature or past experience.

9. TERMS OF REFERENCE FOR THE EIA SPECIALIST STUDY

- Provide a description of the Regional Geomorphic Setting (e.g. climate, geology, topography) of the potentially affected environment (viz. the power line corridor and area selected for the siting of the turbines).
- Provide a map to indicate the area covered by landforms sensitive to development (e.g. pans (wetlands) and drainage lines).
- Describe and indicate on a map any geosites of significance that require management.
- Assess the current state of the landscape in relation to geomorphological indicators of rangeland condition.
- Assess potential projected related impacts listed in this report with a significance rating of low or greater. If applicable, identify other impacts that may not have been identified and assess them in the same way.
- Propose means to avoid, mitigate or offset potential project related impacts.
- Provide a description of assumptions, limitations and gaps in knowledge where applicable.
- The report must include an Environmental Impact Statement.
- The study need not consider the impact of geotechnical aspects of the environment on the proposed development or the potential impact of geomorphic processes on the health of humans or other biological organisms.

10. CONCLUSIONS

- The study area is located close to the Namaqualand coast and is underlain by aeolian sediments.
- The most sensitive landscape elements for planning purposes in the study area and within the power line corridor will be the presence of wetlands (e.g. pans)/drainage lines. These features should be excluded from any development footprint wherever possible. Mapping and assessment of these features must be undertaken in the EIA Phase.
- Other potential impacts of high significance that require careful planning consideration are the potential affects of saline soils (if present) on cement and metal structures.
- The potential deposition of wind transported sediment within infrastructure (e.g. substation) and accelerated erosion within flow concentration zones (e.g. culverts, roadside drainage ditches) were regarded as potential impacts of moderate significance.

- The significance of all other listed impacts was assessed as low or no significance.
- No Sites of Special Scientific Interest are known to occur within the study area.

11. REFERENCES

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