B5.2 IMPACT ASSESSMENT

Impact 1. *Direct faunal impacts during mining*

Impact Description: Direct faunal impacts would occur due to mining-related habitat loss, noise and physical disturbance. .

	Extent	Duration	Severity	Probability	Status	Significance
Without Mitigation	Medium	Long-term	Medium	Highly Probable	-'tve	Medium
With Mitigation	Low	Long-term	Medium-Low	Probable	-'tve	Medium-Low
	Mitigation: 6) New and existing mining voids should be backfilled in a more coordinated manner. 7) New soil dumps should not be within intact areas adjacent to mining pits, but should be used to backfill or rehabilitate existing disturbed areas. 8) The amount of access roads at the site should be reduced and these should be constructed in a more regular manner. 9) If the new processing plant or other infrastructure needs to be lit at night, this should be with low-UV emitting lights that do not attract insects, such as most LED-type lights. 10) There should be a long-term monitoring program developed for the site which monitors both fauna at the site as well as key ecological processes such as sand movement.					
	Impact to be addressed/ further investigated and assessed in Impact Assessment Phase?	Yes, the fauna present at the site will be characterized in the field and sensitive habitats identified and delineated.				

Impact 2. *Impact on CBAs and Broad-Scale Ecological Processes*

Impact Description: Cumulative impact on ESA's and broad scale ecological processes. Cumulative impacts on the ESA along the coast is a significant concern at the site due to the large amount of mining activity that has taken place. Habitat loss due to ongoing mining activity may impact the ecological functioning of the ESA and result in increased habitat fragmentation and reduced landscape connectivity.

	Extent	Duration	Severity	Probability	Status	Significance
Without Mitigation	Local	Long-term	Medium	Probable	-'tve	Medium
With Mitigation	Loca	Long-term	Medium	Probable	-'tve	Medium-Low

Mitigation:

4) Minimise the development footprint, especially with regards to roads which should be planned in a more systematic manner.
5) Ensure that waste-rock and soil dumps are not in currently intact areas, but are rather used to fill existing mining voids or used to aid rehabilitation of previously disturbed areas.
6) An integrated monitoring plan should be developed for the site which includes key faunal and ecological indicators.

B6. CONCLUSIONS & RECOMMENDATIONS

Although large parts of the current mining activities are within previously disturbed areas, significant impact on fauna and ecological processes is still likely to occur if the appropriate mitigation and avoidance measures are not implemented. Historic mining activities at the site took place in a very haphazard manner and the footprint of mining activities can be significantly reduced through better planning and coordination. There are many soil dumps at the site which should have been used to fill existing mining voids rather than impact on additional intact areas. There are a variety of listed and local endemic fauna species present in the area and the extensive mining-related disturbance in the area threatens habitat availability and connectivity for such species. A monitoring plan including key faunal and ecosystem indicators should be developed for the site, especially to monitor the potential impacts of the beach mining and related activities at Mitchell's Bay which may affect sand movement in the area and change input levels from the marine into the terrestrial environment.

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APPENDIX B1. LIST OF TERRESTRIAL MAMMALS

List of mammals which are likely to occur in the vicinity of the study site. Habitat notes and distribution records are based on Skinner & Chimimba (2005), while conservation status is from the IUCN Red Lists 2015 and South African Red Data Book for Mammals (Friedmann & Daly 2004).

Scientific Name	Common Name	Status	Habitat Notes	Likelihood
Afrosoricida (Golden Moles):				
Chrysochloris asiatica	Cape Golden Mole	LC	Coastal parts of the Northern and Western Cape	High
Eremitalpa granti	Grant's Golden Mole	Vulnerable	West coast of South Africa and Namibia in sand dunes	High
Cryptochloris wintoni	De Winton's Golden Mole	Vulnerable	Sandy areas of the Namaqualand coastal plain	Low
Macroscledidea (Elephant Shrews):				
Macroscelides proboscideus	Round-eared Elephant Shrew	LC	Species of open country, with preference for shrub bush and sparse grass cover, also occur on hard gravel plains with sparse boulders for shelter, and on loose sandy soil provided there is some bush cover	High
Elephantulus ruprestris	Western Rock Elephant Shrew	LC	Rocky koppies, rocky outcrops or piles of boulders where these offer sufficient holes and crannies for refuge.	High
Elephantulus edwardii	Cape Rock Elephant Shrew	LC	From rocky slopes, with or without vegetation, from hard sandy ground bearing little vegetation, quite small rocky outcrops	High
Tubulentata:				
Orycteropus afer	Aardvark	LC	Wide habitat tolerance, being found in open woodland, scrub and grassland, especially associated with sandy soil	Definite
Hyracoidea (Hyraxes)				
Procavia capensis	Rock Hyrax	LC	Outcrops of rocks, especially granite formations and dolomite intrusions in the Karoo. Also erosion gullies	Definite
Lagomorpha (Hares and Rabbits):				
Lepus capensis	Cape Hare	LR/LC	Dry, open regions, with palatable bush and grass	Definite
Rodentia				

(Rodents):				
Bathyergus janetta	Namaqua Dune Mole Rat	LC	Sandy sunstrates along the coast or alluvium	High
Hystrix africaeaustralis	Cape Porcupine	LC	Catholic in habitat requirements.	Definite
Petromus typicus	Dassie Rat	LC	Mountainous regions and inselbergs, where they are confined to rocky outcrops and live in crevices or piles of boulders	Low
Graphiurus platyops	Rock Dormouse	LC	Rocky terrain, under the exfoliation on granite bosses, and in piles of boulders	Low
Micaelamys namaquensis	Namaqua Rock Mouse	LC	Catholic in their habitat requirements, but where there are rocky koppies, outcrops or boulder-strewn hillsides they use these preferentially	Definite
Parotomys brantsii	Brants's Whistling Rat	LC	Associated with a dry sandy substrate in more arid parts of the Nama-karoo and Succulent Karoo. Species selects areas of low percentage of plant cover and areas with deep sands.	Definite
Parotomys littledalei	Littledale's Whistling Rat	LC	Riverine associations or associated with Lycium bushes or Psilocaulon absimile	High
Otomys unisulcatus	Bush Vlei Rat	LC	Shrub and fynbos associations in areas with rocky outcrops Tend to avoid damp situations but exploit the semi-arid Karoo through behavioural adaptation.	Definite
Desmodillus auricularis	Cape Short-tailed Gerbil	LC	Tend to occur on hard ground, unlike other gerbil species, with some cover of grass or karroid bush	High
Gerbillurus paeba	Hairy-footed Gerbil	LC	Gerbils associated with Nama and Succulent Karoo preferring sandy soil or sandy alluvium with a grass, scrub or light woodland cover	High
Malacothrix typica	Gerbil Mouse	LC	Found predominantly in Nama and Succulent Karoo biomes, in areas with a mean annual rainfall of 150-500 mm.	High
Petromyscus babouri	Barbour's Rock Mouse	LC	Associated with rocky areas.	Low
Primates:				
Papio hamadryas	Chacma Baboon	LR/LC	Can exploit fynbos, montane grasslands, riverine courses in deserts, and simply need water and access to refuges.	Low
Eulipotyphla				

(Shrews):				
Myosorex varius	Forest Shrew	LC	Prefers moist, densely vegetated habitat	Low
Suncus varilla	Lesser Dwarf Shrew	LC	Often associated with termitaria, little else known	Medium
Crocidura cyanea	Reddish-Grey Musk Shrew	LC	Occurs in relatively dry terrain, with a mean annual rainfall of less than 500 mm. Occur in karroid scrub and in fynbos often in association with rocks.	High
Crocidura flavescens	Greater Red Musk Shrew	LC	Wide habitat tolerance	High
Carnivora:				
Proteles cristatus	Aardwolf	LR/LC	Common in the 100-600mm rainfall range of country, Nama-Karoo, Succulent Karoo Grassland and Savanna biomes	High
Parahyaena brunnea	Brown Hyaena	NT	Nama and Succulent Karoo and the drier parts of the Grassland and Savanna Biomes	Low
Caracal caracal	Caracal	LC	Caracals tolerate arid regions, occur in semi-desert and karroid conditions	High
Felis silvestris	African Wild Cat	LC	Wide habitat tolerance.	High
Felis nigripes	Black-footed cat	VU	Associated with arid country with MAR 100-500 mm, particularly areas with open habitat that provides some cover in the form of tall stands of grass or scrub.	Low
Genetta genetta	Small-spotted genet	LR/LC	Occur in open arid associations	High
Suricata suricatta	Meerkat	LR/LC	Open arid country where substrate is hard and stony. Occur in Nama and Succulent Karoo but also fynbos	Definite
Galerella pulverulenta	Cape Grey Mongoose	LR/LC	Wide habitat tolerance	Definite
Vulpes chama	Cape Fox	LC	Associated with open country, open grassland, grassland with scattered thickets and coastal or semi-desert scrub	High
Canis mesomelas	Black-backed Jackal	LC	Wide habitat tolerance, more common in drier areas.	High
Otocyon megalotis	Bat-eared Fox	LC	Open country with mean annual rainfall of 100-600 mm	Definite
Ictonyx striatus	Striped Polecat	LR/LC	Widely distributed throughout the sub-	High

			region	
Rumanantia (Antelope):				
Sylvicapra grimmia	Common Duiker	LR/LC	Presence of bushes is essential	High
Antidorcas marsupialis	Springbok	LC	Arid regions and open grassland.	Low
Raphicerus campestris	Steenbok	LR/LC	Inhabits open country,	Definite
Oreotragus oreotragus	Klipspringer	LR/cd	Closely confined to rocky habitat.	Low

APPENDIX B2. LIST OF REPTILES

List of reptiles which are likely to occur at the site, based on the SARCA database. Conservation status is from Bates *et al.* (2014).

Family	Genus	Species	Subspecies	Common name	Red list category	No. records
Agamidae	Agama	atra		Southern Rock Agama	Least Concern	13
Agamidae	Agama	hispida		Spiny Ground Agama	Least Concern	7
Agamidae	Agama	knobeli		Knobel's Rock Agama	Not listed	1
Chamaeleonidae	Bradypodion	occidentale		Western Dwarf Chameleon	Least Concern	10
Chamaeleonidae	Chamaeleo	namaquensis		Namaqua Chameleon	Least Concern	1
Colubridae	Dipsina	multimaculata		Dwarf Beaked Snake	Least Concern	1
Colubridae	Philothamnus	semivariegatus		Spotted Bush Snake	Least Concern	2
Colubridae	Telescopus	beetzii		Beetz's Tiger Snake	Least Concern	2
Cordylidae	Cordylus	macropholis		Large-scaled Girdled Lizard	Near Threatened	3
Cordylidae	Karusasaurus	polyzonus		Karoo Girdled Lizard	Least Concern	27
Cordylidae	Namazonurus	peersi		Peers' Girdled Lizard	Least Concern	15
Cordylidae	Platysaurus	capensis		Namaqua Flat Lizard	Least Concern	3
Elapidae	Aspidelaps	lubricus	lubricus	Coral Shield Cobra	Not listed	2
Elapidae	Naja	nivea		Cape Cobra	Least Concern	1

Gekkonidae	Chondrodactylus	angulifer	angulifer	Common Giant Ground Gecko	Least Concern	2
Gekkonidae	Chondrodactylus	bibronii		Bibron's Gecko	Least Concern	18
Gekkonidae	Goggia	lineata		Striped Pygmy Gecko	Least Concern	2
Gekkonidae	Pachydactylus	austeni		Austen's Gecko	Least Concern	8
Gekkonidae	Pachydactylus	barnardi		Barnard's Rough Gecko	Least Concern	3
Gekkonidae	Pachydactylus	labialis		Western Cape Gecko	Least Concern	28
Gekkonidae	Pachydactylus	latirostris		Quartz Gecko	Least Concern	1
Gekkonidae	Pachydactylus	namaquensis		Namaqua Gecko	Least Concern	3
Gekkonidae	Pachydactylus	weberi		Weber's Gecko	Least Concern	2
Gekkonidae	Phelsuma	ocellata		Namaqua Day Gecko	Least Concern	3
Gerrhosauridae	Cordylosaurus	subtessellatus		Dwarf Plated Lizard	Least Concern	3
Gerrhosauridae	Gerrhosaurus	typicus		Karoo Plated Lizard	Least Concern	1
Lacertidae	Meroles	ctenodactylus		Giant Desert Lizard	Least Concern	7
Lacertidae	Meroles	knoxii		Knox's Desert Lizard	Least Concern	22
Lacertidae	Meroles	suborbitalis		Spotted Desert Lizard	Least Concern	2
Lacertidae	Nucras	tessellata		Western Sandveld Lizard	Least Concern	6
Lacertidae	Pedioplanis	lineoocellata	lineoocellata	Spotted Sand Lizard	Least Concern	1
Lacertidae	Pedioplanis	lineoocellata	pulchella	Common	Least	1

				Sand Lizard	Concern	
Lacertidae	Pedioplanis	namaquensis		Namaqua Sand Lizard	Least Concern	3
Lamprophiidae	Boaedon	capensis		Brown House Snake	Least Concern	5
Lamprophiidae	Lamprophis	guttatus		Spotted House Snake	Least Concern	1
Lamprophiidae	Prosymna	frontalis		Southwestern Shovel-snout	Least Concern	3
Lamprophiidae	Prosymna	sundevallii		Sundevall's Shovel-snout	Least Concern	1
Lamprophiidae	Psammophis	crucifer		Cross-marked Grass Snake	Least Concern	10
Lamprophiidae	Psammophis	namibensis		Namib Sand Snake	Least Concern	3
Lamprophiidae	Psammophis	notostictus		Karoo Sand Snake	Least Concern	4
Lamprophiidae	Psammophylax	rhombeatus	rhombeatus	Spotted Grass Snake	Least Concern	9
Lamprophiidae	Pseudaspis	cana		Mole Snake	Least Concern	2
Scincidae	Acontias	lineatus		Striped Dwarf Legless Skink	Least Concern	1
Scincidae	Acontias	litoralis		Coastal Dwarf Legless Skink	Least Concern	45
Scincidae	Acontias	namaquensis		Namaqua Legless Skink	Least Concern	2
Scincidae	Acontias	tristis		Namaqua Dwarf Legless Skink	Least Concern	7
Scincidae	Scelotes	caffer		Cape Dwarf Burrowing Skink	Least Concern	1
Scincidae	Scelotes	capensis		Western Dwarf	Least	1

				Burrowing Skink	Concern	
Scincidae	Scelotes	sexlineatus		Striped Dwarf Burrowing Skink	Least Concern	7
Scincidae	Trachylepis	capensis		Cape Skink	Least Concern	3
Scincidae	Trachylepis	sulcata	sulcata	Western Rock Skink	Least Concern	7
Scincidae	Trachylepis	variegata		Variegated Skink	Least Concern	31
Scincidae	Typhlosaurus	lomiae		Lomi's Blind Legless Skink	Near Threatened	20
Scincidae	Typhlosaurus	vermis		Pink Blind Legless Skink	Least Concern	41
Testudinidae	Chersina	angulata		Angulate Tortoise	Least Concern	15
Testudinidae	Homopus	signatus		Speckled Padloper	Vulnerable	8
Testudinidae	Psammobates	tentorius	trimeni	Namaqua Tent Tortoise	Not listed	2
Typhlopidae	Rhinotyphlops	lalandei		Delalande's Beaked Blind Snake	Least Concern	1
Viperidae	Bitis	arietans	arietans	Puff Adder	Least Concern	1

APPENDIX B3. LIST OF AMPHIBIANS

List of amphibians which are likely to occur in the vicinity of the site. Based on the Frogmap database of the ADU, while conservation status is from the IUCN Red Lists 2014 and Minter et al. (2004).

Scientific Name	Common Name	Status	Habitat	Distribution	Likelihood
Breviceps macrops	Desert Rain Frog	Vulnerable	Up to 10km inland from the Namaqualand coast in Strandveld vegetation	Endemic	High
Breviceps namaquensis	Namaqua Rain Frog	Not Threatened	Arid sandy habitats from the coast to inland mountains	Endemic	High
Vandijkophrynus gariepensis	Karoo Toad	Not Threatened	Karoo Scrub	Widespread	High
Vandijkophrynus robinsoni	Paradise Toad	Not Threatened	Natural springs and waterholes in the arid areas of the Richtersveld	Endemic	Medium
Xenopus laevis	Common Platanna	Not Threatened	Any more or less permanent water	Widespread	Not likely
Cacosternum namaquense	Namaqua Caco	Not Threatened	Upland Succulent Karoo. Breeds in temporary or permanent natural or man-made pools	Endemic	Medium
Strongylopus springbokensis	Namaqua Stream Frog	Vulnerable	Mountainous areas of Namaqualand associated with seeps and springs	Endemic	Not likely

GENERAL CONCLUSIONS

The biodiversity assessment presented here is a collaborative effort between Bergwind Botanical Surveys & Tours CC and Simon Todd Consulting. Four authors were involved. For the most part, the botanical assessment (Section A) was conducted independently of the faunal assessment (Section B). It was only after field-work was completed and draft versions of the respective botanical and faunal reports were in preparation that David McDonald and Simon Todd 'compared notes'. Since the fauna rely on a healthy habitat it stands to reason that negative impacts on habitat (vegetation) directly influence the faunal component of the ecosystem and ecological processes. It was gratifying, therefore, that the conclusions reached by both parties were much the same in terms of overall impacts on the environment in the WCR study area and that recommended mitigation for the potential impacts of future mining are much the same.

Report submitted 6 September 2016

4. Dust plume study

FINAL

WCR DUST STUDY

Site Plan Consulting

SPC # 2744/DP/R2 Final

15 August 2016

Contents

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Diagrams

Photos

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Annexures

Acronyms:

THG:	Transhex Group
WCR:	West Coast Resources
DBNM:	De Beers Namaqualand Mines
SPC:	Site Plan Consulting
SBK:	Samsonsbak
KN:	Koingnaas
MB:	Mitchell's Bay
BMR:	Buffels Marine Right
BIR:	Buffels Inland Right
VB:	Visbeen
LK:	Langklip
EMP:	Environmental Management Programme

References:

Tinley Figure 206; Coastal Dunes of South Africa; South African National Scientific Programmes Report No. 109; 1985; CSIR; ISBN: 7988 3565 6.

Desmet Figure 2.3; The Vegetation and Restoration Potential of the Arid Coastal Belt between Port Nolloth and Alexander Bay, Namaqualand, SA; MSc Thesis; UCT; Philip George Desmet.

Talkenberg Figure 2.2 (page 23); An Investigation of Environmental Impact of Surface Diamond Mining along the Arid West Coast of South Africa; MSc Thesis; UCT; September 1982; Wolfgang FM Talkenberg.

Rogers T; Sedimentation on the Continental Margin of the Orange River and the Namib Desert; PhD Thesis; UCT; Geol. Dept; 1977.

1. DETAILS OF THE SPECIALIST AUTHOR AND DECLARATION OF INDEPENDENCE

1.1. The specialist author

This report has been prepared by Stephen van der Westhuizen (BSc Geology 1976 and MT&RP cum Laude 1979), Geologist and Environmental Planner, with 35 years' experience as a consultant in assessment of mining and other land uses within coastal systems throughout Southern Africa, and serves Site Plan Consulting as an environmental geologist, as member of the Geological Society of South Africa and as an EAP in terms of the NEMA. For CV refer Annexure A.

1.2. Specific expertise in dust assessment

The author's expertise lies in his understanding of, and experience in dealing with environmental dust related to high wind regimes on the coast-line where primary dune blowouts and headland by-pass dunes have been a major element of many of his commissions in the past, while the assessment and monitoring of mine generated dust has been a component of almost every mining EMP and site assessments for non-mining coastal developments he has undertaken in some 300 commissions over the past 35 years.

Of specific note is his development of the understanding of coastal alluvial diamond mining dust in his compilation of the Alexkor EMPr of 2008 and specifically the dust report of 2014.

1.3. Declaration of Independence of the author

See Annexure B for standard declaration.

2. INTRODUCTION TO THE SPECIALIST REPORT

2.1. General Perspective

In this study, while termed a Dust Assessment, it in fact, given the nature of the dust environment of the West Coast, deals primarily with windblown sand drift under high wind speeds, which is carried just above the land surface posing a threat to the ecological systems of the site and being a nuisance factor to the built environment. This is opposed to both the medium fraction "fall-out" dust normally monitored at mines and measured by systems such as DustWatch™ and the very fine fraction airborne inhalation (gravimetric) dust which when it comes to health considerations, is dealt with in terms of the Mine Health and Safety Act and is fully monitored in terms thereof and not dealt with within this study.

It is furthermore fundamental for the study to emphasize the distinction between:

- natural sand plumes; and
- mining sand plumes

as they have their own origins and sometimes own characteristics but at the same time, they both present as plumes with similar impacts, both on vegetation and the built environment and very often overlap to yield cumulative extents and impacts.Furthermore, it is emphasized that the understanding of the windblown sand plumes and broader dust phenomena at WCR derives not only from the satellite imagery interpretation and mapping and the field assessment of 6-7 July 2016 but also from earlier visits to the greater WCR area when under DBNM ownership and additionally from Site Plan Consulting's (SPC) experience in the assessment of dust (sand plumes) at Alexkor where it was studied in-depth, in developing an understanding and categorisation of plumes and sand plume attenuation mechanisms and furthermore from coastal dust assessments of primary dune blowouts at Port Alfred, along the Eastern Cape coast and headland by-pass dunes of Hout Bay/ Llandudno, Port Elizabeth and Cape St. Francis in terms of understanding the phenomenon, their sources and success and failure of control measures of the windblown sand plumes.

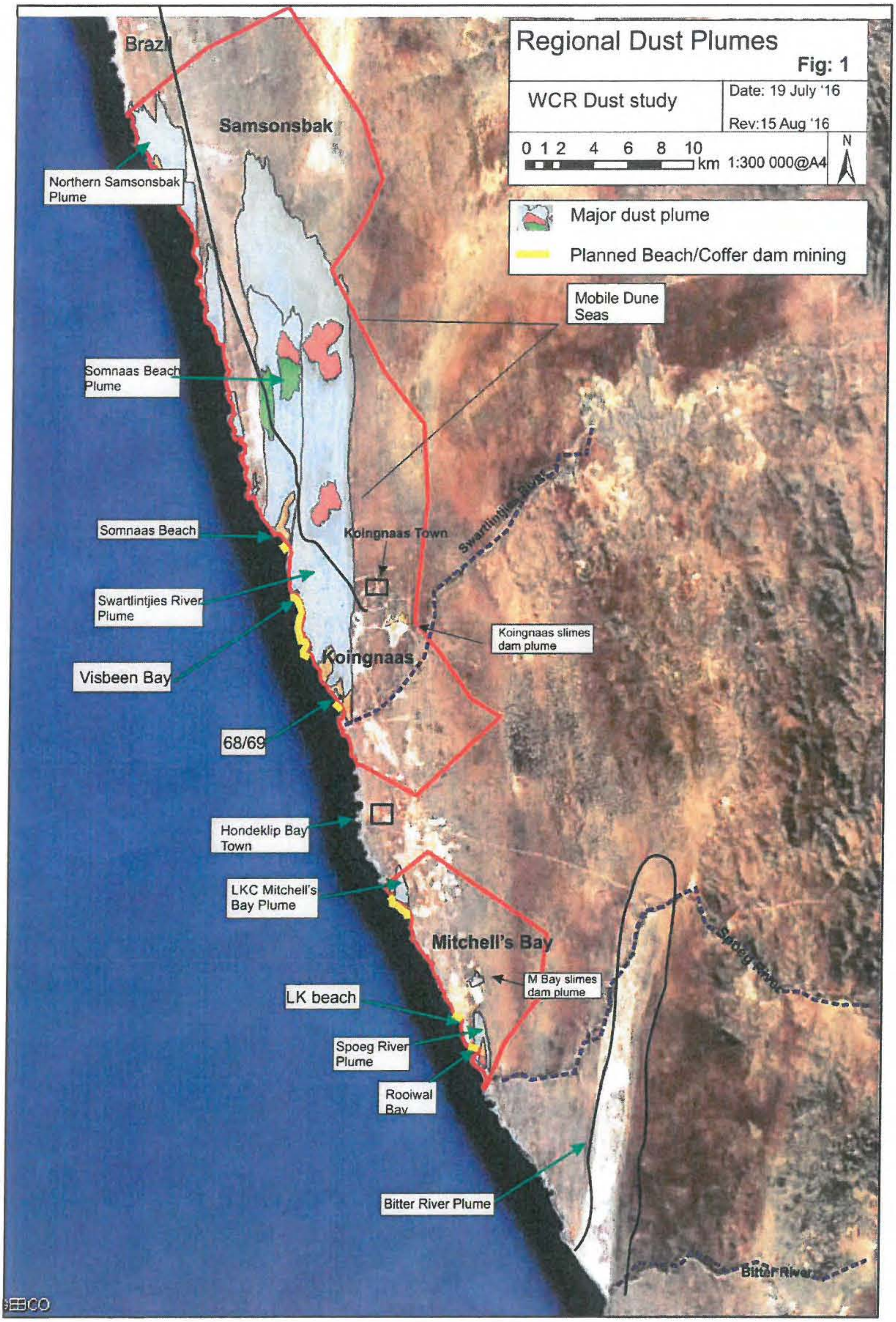


Figure 1: Regional Dust Plumes of the Samsonsbak, Koingnaas and Mitchell's Bay Mining Right Areas and surrounds (refer Figures 2a, 2b and 2c for detail)

As such, this study is not merely an assessment of the impact posed by sand plumes and other dust, but provides a baseline for:

(i) Appreciation of the distinction between natural and mining plumes as a primary underlying consideration for intervention; (as intervention in the forces of natural systems would be futile)
(ii) Intervention on a pro-forma basis to deal with existing and future ad-hoc occurrences; and
(iii) Monitoring through periodic re-measurement of the GIS captured and numbered plumes.

Furthermore, the consideration of the dust assessment must be seen within the context of the extensive mining which has occurred within the study area over the past +-60 years by DBNM both as inland terrace mining and beach and back-of-beach mining, all of which present as disturbed areas. Additionally, the purpose of this input to the EMP update is to develop the attenuation measures to apply to the future mining contemplated by WCR as further inland terrace mining as well as further beach, back-of-beach and coffer dam mining (seaward of the low water mark). Hence this dust study will give specific attention to considering the expected future additional dust generation within the context of the current levels of dust plume impact.

2.2. Purpose and scope of the report

This specialist dust report will serve, together with other specialist reports in providing the base-line information, impact assessment and proposed attenuation measures and monitoring to the current 2016 EIR/ EMP update for the WCR alluvial diamond mining activities.

The study area includes the three Mining Right Areas of:

- Samsonsbak;
- Koingnaas; and
- Mitchell's Bay

as shown in Figure 1.

As discussed in paragraph 2.1. above, this dust assessment focuses on the windblown dust (sand) phenomenon which is characteristic of West Coast diamond mining. Given that such sand movement (drift) occurs at very low above-ground level, it does not allow standard methods of dust monitoring/ quantification (by for example DustWatch™ equipment), nor the application of standard dust levels for Atmospheric dust management, which will be dealt with as a specific item in paragraph 4.4. The further element of inhalation (suspended) dust, which is of a health consideration, is not dealt with by this study as it deals specifically with working environment under the Mine Health and Safety Act in terms of which it has specific prescriptions for its monitoring and reporting.

2.3. Assumptions, uncertainties, knowledge gaps and seasonality

As the schedule for the study was set for the month of July and unusually heavy rains fell during June and early July, no evidence of dust coatings of plants nor visibility impact (such as shown in Photo 2) were evident during the site visit of 6-7 July 2016 but the levels that would occur in dry summer months under the prevailing southerly winds are known to the author and photographs of this element will be used from other West Coast assessments which are directly comparable.

Given the fact that the latest Google Earth™ image for February 2016 is patchy, thereby not allowing consistent assessment of the sand plume intensity levels, the consistent images of 2014 were rather used after determining that the date difference did not hold significant implications for the definition of the extent of the plumes as captured as .shp files in the base-line data. This is largely to be expected as the DBMN discontinued active mining over much of the study area in excess of 6 years ago.

2.4. Methodology

The study began with a perusal of similar assessments conducted by SPC and publications on coastline dynamics and coastal dunes as well as the wind regime of the West Coast. In order to place the WCR study in the correct perspective, an initial satellite image assessment of the West Coast natural regional dust plumes was conducted, the relevant portion of which is shown in Figure 1. Fieldwork base-plans with rough outlining of plumes on the photographic base were then prepared also showing access roads for the site visit verification of the plume imagery. Then, in the week of 6 July 2016, a site visit was held during which targeted sites were visited to document the various plume types, intensities and origins. Such documentation then served the description of "type-localities" in brief field notes with GPS positions and illustrative photographs.

On return to the office:

- The .kml file recording the GPS positions together with photographs of type localities depicting either vegetation impact of plumes or revegetation of earlier disturbed areas and plumes were emailed to specialist botanist Dr Dave McDonald in order that during his pending vegetation survey, he could visit the sites as the basis for our joint discussion on the matter of stabilising dust plumes through either assisted, or natural revegetation with hand broadcasting of seed and the impact level categorization as a factor of vegetation status.
- The extents of each plume were captured in .shp file format and transferred to tabled notes reflecting the classification and all other attributes of each plume including; origin (natural, mining or both), categorized level, extent in hectares, impact on vegetation, risk of further impact etc. Against this basis of mapping and tabled recordal, consideration was then given to the choice of appropriate attenuation options. As the attenuation measures are applicable to both existing plumes and possible future plumes associated with similar future disturbances, the attenuation measures are generically designed but illustrated on chosen existing occurrences. Finally, the levels of impact, attenuation measures and latent risks are documented.

3. SENSITIVITY OF THE RECEIVING ENVIRONMENT

In this regard, a distinction is drawn between Samsonsbak Mining Right Area in the north and the Koingnaas and Mitchell's Bay areas in the central and southern area, given that very little mining disturbance has occurred to-date in the Samsonsbak area as opposed to the extensive mining disturbances in the other two Mining Right Areas.

The receiving environment is that of the ex-DBNM alluvial diamond mine which has operated since the 1950's both as inland terrace mining and beach and back-of-beach mining with wide-spread intensive disturbances by excavations, overburden dumps, roads, mining plant and slimes dams (fine tailings ponds). The matter of sensitivity of the receiving environment is therefore closely related to the extent of existing mining disturbances and the distribution of natural plumes, both having a direct bearing on the degree to which impact is further considered. Figures 2a, b and c accordingly show the 2016 mapped plumes with the existing mining disturbance recordal of 2011 in the background image.

Of greatest significance is the matter of impact of intended beach and coffer dam mining which relate to beach sand plume origins, especially where such disturbed coastlines present as on-shore orientated coastlines and half-heart bays.

3.1. Natural system sensitivities

(i) Natural Vegetation

The veld type is largely uniform over the entire study area Namaqualand Coastal Duneveld as per Mucina and Rutherford (2012) with only the following variations:

- Lower density and smaller plant specimen from south to north.
- Lower density and smaller plant specimen within the seaward slopes affected by on-shore/ long-store salt spray as seen in the northern extremity of Samsonsbak where the lower slopes are additionally impacted by the low-level Samsonsbak natural plume.
- The 2014/ 2015 assessments of natural vegetation at Alexkor showed that the vegetation type is extremely resilient and capable of recovery with limited intervention under the appropriate circumstances. In fact, such recovery was found to be better where it is allowed to occur naturally within the natural West Coast characteristic of combined high levels of windblown sand and seed movement while netting installed to curtail sand movement, totally curtailed seed movement. Resultantly, areas of high levels of sand transfer without netting revegetated very well by comparison to netted areas which had the purpose of promoting revegetation by curtailing sand movement but precluded in-blown seed movement.

(ii) Areas of high natural sand movement

Given that high levels of windblown sand movement is a characteristic of the West Coast, and accordingly as seen in aerial photography showing repeated periods of sand migration followed by revegetation stabilisation, the extent of natural sand plumes is in itself a system of extensive reduced sensitivity and in this regard the following regional sand plumes as shown in Figure 1 are relevant:

- The northern Samsonsbak plume (related to beach orientation)
- The Swartlintjies River-Somnaas Beach plume (natural on-shore beach and half-heart bay plume aggravated by extensive beach mining)
- Mitchell's Bay plume (natural on-shore half-heart bay beach aggravated by intensive mining)
- Spoeg River plume in southern Mitchell's Bay MRA (natural as not yet impacted by mining south of Rooiwal Bay)
- The Bitter River plume (natural south of the study area)

As shown in Figure 1 within these large plumes, migrating natural dune seas occur within the Swartlintjies-Somnaas plume and a smaller sea in the Spoeg River plume just south of Rooiwal Bay (refer Photo 1).

Photo 1: Spoeg River plume seen south of Rooiwal Bay

3.2. Built environments and specific land uses

As no farmsteads occur on the properties, the only receiving built environments on this coast are:

- Hondeklip Bay town; and
- Koingnaas town,

Dust intervention at Koingnaas to-date has included propagating the bush line south of Koingnaas town and the netting and seeding of the Koingnaas slimes dam plume has undoubtedly provided it with protection from the higher dust levels which occurred during the peak operating intensity of earlier DBNM mining operations in Koingnaas Mining Right (KMR). The Koingnaas town is directly downwind of the Koingnaas slimes dam, which has dried since decommissioning of the Koingnaas plant and increased the windblown plume north of the slimes dam having increased the dust impact on the town, at least to a nuisance level.

3.3. Sensitive areas and buffers

The most sensitive natural areas by virtue of the intensity of plume development are the inland areas immediately north and north-east of half-heart bays such as Somnaas where these areas are subject to focused plume invasion and which beaches will be fed with increased sediment as a result of littoral drift from nearby beach and coffer dam mining. This phenomenon is intensified where there are river mouths south of either such half-heart bays or other on-shore (wind) orientated beaches.

Koingnaas town which is directly downwind from the Koingnaas slimes dam plume with insufficient buffer distance.

The privately owned farm of Brazil which is already becoming subjected to the natural Northern Samsonsbak half-heart bay plume generation already naturally affecting the adjacent private land of Brazil and emphasizing the need for attenuation when any mining of this northern coastline is contemplated.

4. FINDINGS: CLASSIFICATION AND MEASUREMENT

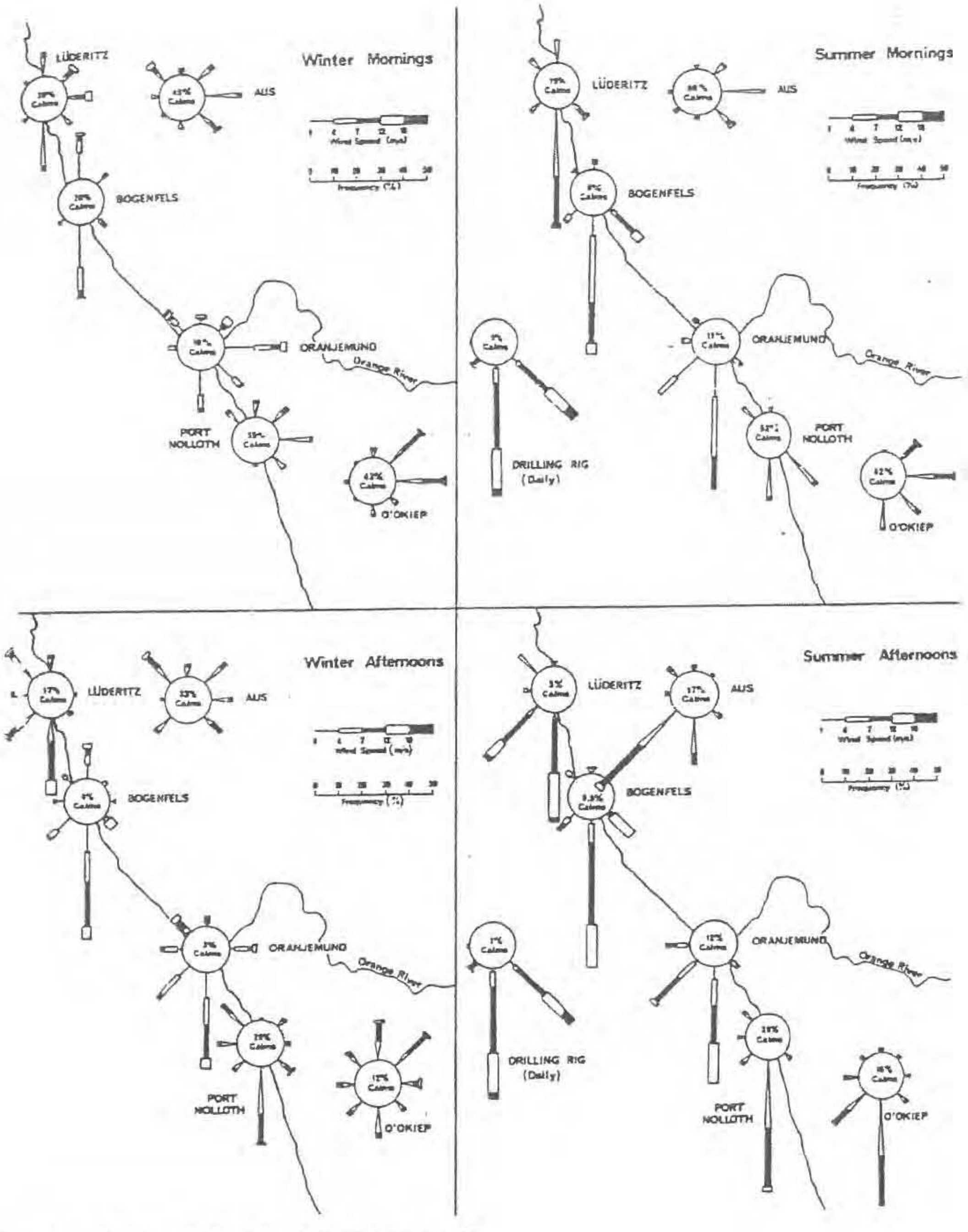
4.1. Origin of dust plumes

The origin of dust plumes on this coastline as part of the West Coast stems from;

- the prevailing winds,
- the sand sources,
- coastline form and orientation; and
- mining disturbance.

4.1.1. Prevailing West Coast winds (applicable to natural and mining dust plume generation)

Prevailing winds are particularly effective in generating dust plumes in this area given their constant direction and strength through most seasons, as seen in the wind roses below. However, it is noted that the literature sources cited hereafter dealt specifically with the areas of extremely high wind speed and frequency of the Alexander Bay/ Southern Namibian coast and it is acknowledged from personal observations that the wind of the study area is of lower speed and frequency than that further north but nonetheless remains best reflected by the technical assessments of Talkenberg and others.



Seasonal wind roses (Talkenberg) FIGURE 2.2 PAGE 23

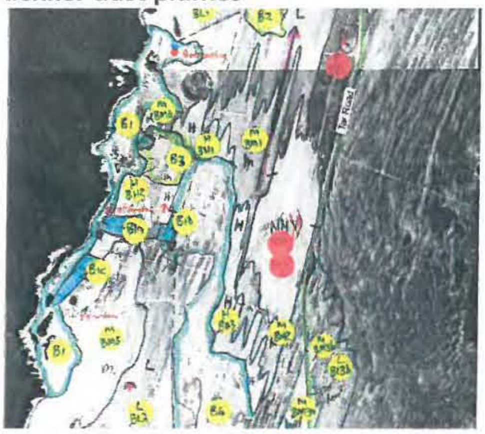
Diagram 1: Wind rose extracts from the Talkenberg report

This consistency in wind direction results in a very high RDD value (resultant drift direction), representing the net sand distribution after reduction of transport in opposite vectors.

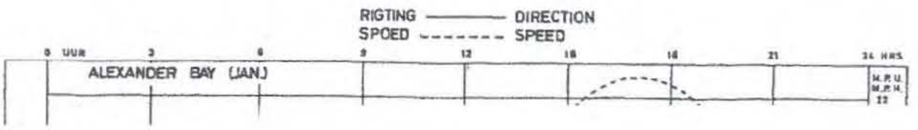
The following photo and extract of plume mapping from the original Alexkor plume quantification of April 2005 indicate that by comparison the WCR enjoys a lower incidence of windblown sand than that at Alexkor.

Photo 2: Typical windblown sand levels of the non-mining urban area of Port Nolloth

Extract from the original 2005 Alexkor dust assessment showing the high intensity of Alexkor dust plumes



The strength and consistency is further supported by the constant Diurnal Variation as shown in the graph bellow to reflect the regular afternoon occurrence of high wind speeds at the time of day which coincides with lowest moisture content in the soil and hottest temperatures thereby increasing the effectivity of these high winds in terms of sand transfer (drift).

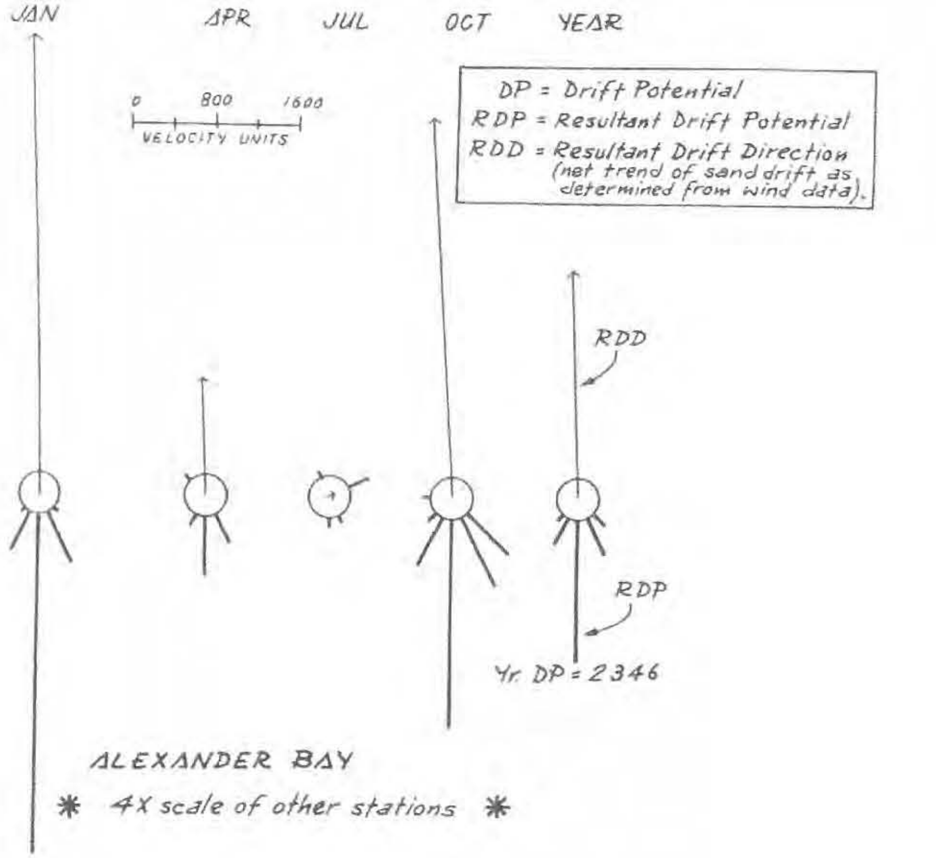


Diurnal variation of Speed and Direction of wind resultants at Alexander Bay (Schultz 1965). Figure 2.3 in DESMET pg 2-72

Diagram 2: Diurnal variation of wind speed and direction from Schultz in Desmet

Given the high wind speed and generally dry conditions with highest wind speeds occurring in the driest part of the day, the threshold wind speed for sand movement is 16km/hour while the average afternoon speeds at Port Nolloth of 26km/hour and Alexander Bay at 22km/hour.

The sand carrying capacity of the mining area winds expressed as a resultant drift potential (RDP) calculations done by David Berger (UCT) and published in Tinley (page 206) shows the sand roses for the four seasons of Alexander Bay as the origin of the wind-blown plumes.



SEASONAL & ANNUAL SAND ROSES FOR SOUTH AFRICAN COAST STATIONS – ILLUSTRATING POTENTIAL SAND DRIFT FROM ALL 16 COMPASS DIRECTIONS.
[computed by David Berger, University of Cape Town, using Fryberger's Equation in McKee 1979]

Seasonal and Annual sand roses for Alexander Bay (from Tinley figure 206)

Diagram 3: Seasonal and annual sand roses from Tinley

The magnitude of the sand movement at Alexander Bay is further reflected by the above graph which shows the annual resultant drift potential at Alexander Bay which is almost equal to that of the Bogenfels located in the heart of the Namib Desert Coast characterised by extreme sand excretion.

4.1.2. Sand sources

a. Natural

The primary source of sand plumes on the West Coast is the combination of river mouth sediment discharge via adjacent beaches to the north of such river mouths and the on-beach sediment which is part of the littoral drift. This relationship of sand plume generation to rivers is clearly illustrated in Figures 1 and 2a, b, and c from which the following image of the Bitter River natural plume is taken.

Diagram 4: The natural Bitter River plume south of the study area (Google Earth™ image)

Additionally other sandy beaches serve as sand sources, especially related to coastline form, discussed in para 4.4.

As primary dunes are generally absent on this portion of the West Coast, the phenomenon of dune blowouts associated with plumes is not a general characteristic of this coast and largely limited to the primary and hummock dune systems to the immediate north of half-heart bays.

By further comparison to Alexkor, it is noted that while the beach origin sands (white sands) compare directly between the two areas in terms of their ability to generate plumes and the rapid establishment by the pioneer reed-grass *Cladoraphis cyperoides* which takes place in such white calcareous sands, the surface soils of the inland areas differ completely between Alexkor and the WCR in that:

- Within Alexkor, surface sands present as light yellow/ grey loose sands with no clay content and are very susceptible to wind erosion in vegetation disturbed areas and in the formation of deflation pans.
- Within the WCR, as particularly experienced in the revegetation of the earlier Hondeklip Bay mining areas by THG, the surface sands of the WCR, which present as orange coloured sands, have a significant clay fraction content. This forms a surface crust and does not permit ready surface dust generation, especially not off undisturbed areas and also not off re-topsoiled areas where the crust forms readily after placement. Consequently in WCR, by comparison to Alexkor, unshaped and shaped overburden dumps show very limited plume development, if at all. Unfortunately, this crust, unless broken, does not permit ready germination of in-blown seed. Consequently raking to break the surface during seeding is vital.

b. Mining

By comparison to Alexkor, the mining dust generation of this WCR study area is relatively low and does not present the same extremely high level of threat to natural eco-systems nor the built environment.

Nonetheless the sand plumes and finer dust impacts derive from the following mining activities in the WCR:

(i) Lines of overburden dumped adjacent to prospecting trenches. At WCR such dust generation occurs on a very limited scale, (while at Alexkor, significant dust plumes result from such overburden dump lines)
(ii) Overburden dumps rounded or unrounded again generate dust on a very limited scale.
(iii) Fine tailings ponds (slimes dams). In the case of the WCR, the clay content of the soils of the slimes dam walls, largely inhibits dust generation from the walls of such slimes dams and consequently the dust source is primarily the silt content of the dam once dried and liberated from the dam surface.
(iv) Heavily trafficked roads if not wetted during mine hauling, again to a lower degree than at Alexkor and with future mining in WCR at a lower level than under DBNM, the significant road-parallel plumes of the past are not expected to occur in future, especially under the current policies for road dust attenuation by water cart wetting in the interest of road safety.
(v) Beach and back-of-beach disturbances by mining (the main mining dust generator in WCR).
(vi) In-field screening plants, if run dry. However as currently witnessed at WCR given the clay content, much of the in-field screening is conducted wet with low dust generation in the plant sites.

c. Sand particle size of high energy beaches and surf zones within which coffer dams will be built and beaches mined.

These West Coast beaches and surf zones (water depth within which coffer dams will be built) are characteristically high energy surf zones with associated coarse particle size sand.
Such coarse sands are much less easily transferred by wind than the finer sands of lower energy beaches. Consequently, where dust plume generation by mining disturbances of on-shore orientated beaches and half-heart bays will lead to increased plume generation, the plume extensions will be more readily controlled by cut-off netting traps.
As littoral drift however will remain a significant transfer mechanism for surf zone sand, the intended disturbance of beaches and littoral zones will result in high levels of littoral transfer, even of the coarse sands within the littoral zones and the resultant accumulation of such sand above low water mark will increase the sand source for plume development in especially the northern end of half-heart bays and will cause increased plume generation despite the coarser nature of the littoral zone sands.

4.1.3. Coastline form and orientation: in the generation of natural dust plumes

From on-site and satellite imagery interpretation of coastline form and orientation in relation to dust plumes on the West Coast, the following coastline characteristics are fundamental to coastal dust plume generation:

- The northern curve of half-heart bays where the predominant south wind blows onshore; and
- On-shore wind orientated beaches. The occasional changes in coastline indentation from south-north to south-east-north-west directly affects on-shore movement primarily from sandy beaches with such orientation.

4.2. Mapping and classification of WCR plumes

The final study mapped the sand plumes from Google Earth™ imagery of 2014 (most consistent image by comparison to 2016) captured at between 1:2000 and 1:5000 scale and the site visit of 6 - 7 July 2016 verified the sand plume levels (intensity) within the respective categories of high, medium and low (as generally shown in Figure 1 but depicted in detail in Figures 2a, b and c, in which these polygons are .shp files):

Note: only a three-way categorization of intensity is used and is based on a subjective classification as quantification of the level in terms of coverage depth or mass per square meter is not attempted as the most significant element of the classification is the degree to which the sand plume affects vegetation and this affect differs between vegetation intensities and plant sizes.

Accordingly, the classification herein in based on the following site observations as illustrated in typical photos below:

High (LKC Plume) Photo 3

Readily visible, exposed wind-blown sand patches are evident between plant specimens but the area does not classify as a mobile dune-sea but small hammock dunes are evident in the lee, of especially pioneer species (particularly pioneer restioid grass: *Cladoraphis cyperoides*), populating the area.

Medium (Medium portions of the Somnaas plume) in the longitudinal dune ridge Photo 4

Significant sand accumulation between plant specimens but with only a limited impact on specimen spacing.

Low (Northern Samson's Bak natural plume) Photo 5

Clear visual evidence of in-blown sand/ dust seen in the veld and defined by Google Earth™ image but with level of sand/ dust not impacting significantly on plant specimen spacing and allowing infill growth of vygie species.

Mobile dune-seas (Typical mobile Barchanoid dunes of a dune-sea within a plume; Bitter River) Photo 6 Google Earth™ image

Such sand seas are evident as natural features along the entire West Coast and occur within the full range of vegetation stability and density with aerial photo interpretation showing them to have existed and moved through many successions of revegetation over their long history.

Table 1 below is the .shp files which capture the plume polygons in GIS with their respective attributes

Fid	Shape*	Class	Type	Origin	Plume_Numb	Name	Area
0	Polygon	Total Plume	N/A	N/A	SR ta	Spoeg River total area	288.4
1	Polygon	High	River mouth	Natural	SR h	Spoeg River	39.1
2	Polygon	Dune sea	River mouth	Natural	SR ds	Spoeg River	21.9
3	Polygon	Medium	River mouth	Natural;	SR m	Spoeg River	227.4
4	Polygon	Medium	Half heart bay	Mine/natural	LK 02	LK02	0.6
5	Polygon	Dune sea	Onshore coast	Mine/natural	MB LKC ds	MBAY LKC	1.6
6	Polygon	High	Onshore coast	Mine/natural	MB LKC h	MBAY LKC	7.8
7	Polygon	Medium	Onshore coast	Mine/natural	MB LKC m	MBAY LKC	146.1
8	Polygon	Dune sea	N/A	Mine/natural	SL S ds	Swartlintjies South	300.0
9	Polygon	Dune sea	N/A	Mine/natural	SL E ds	Swartlintjies East	571.0
10	Polygon	High	Half heart bay	Mine/natural	SN B h	Somnaas Beach	176.9
11	Polygon	Dune sea	Half heart bay	Mine/natural	SN W ds	Somnaas West	169.0
12	Polygon	Low	Half heart bay	Mine/natural	SN W l	Somnaas West l	284.7
13	Polygon	Medium	Half heart bay	Mine/natural	SN m	Somnaas medium	2767.7
14	Polygon	Low	Half heart bay	Mine/natural	SN E l	Somnaas East l	324.0
15	Polygon	High	Half heart bay	Mine/natural	VB h	Visbeen Bay h	4.6
16	Polygon	High	Onshore coast and river mouth	Mine/natural	SL 68/69 h	Swartlintjies 68/69 h	141.1
17	Polygon	High	Onshore coast and river mouth	Mine/natural	SL KN h	Swartlintjies KN h	147.5
18	Polygon		N/A	N/A	SR ta	Swartlintjies total area	11972.1
19	Polygon	Medium	Onshore coast and river mouth	Mine/natural	SL m	Swartlintjies m	10809.4
20	Polygon	Medium	Half heart bay	Mine/natural	NN m	Noup North m	102.2
21	Polygon	Medium	Half heart bay and onshore coast	Natural	Gate 6 m	Gate 6 m	476.5
22	Polygon	Medium	Half heart bay	Mine/natural	NSB m	Noup South bay m	29.3
23	Polygon	High	Half heart bay	Natural	SBK N h	SBK N swart duine h	39.2
24	Polygon	Medium	Onshore coast	Natural	SBK N m	SBK N swart duine m	1409.1
25	Polygon	High	Slimes dam	Mine	KN sd h	Koingnaas slimes dam h	46.2
26	Polygon	Medium	Slimes dam	Mine	MB sd m	Mitchell's Bay slimes dam m	47.2

Table 1: 2016 Plume mapping and categorisation as per Figures 2a, b, c

The following two Tables below are the .shp files for the tar road and the numbers/names of gates in Samsonsbak and northern Koingnaas to assist future fieldwork

Fid	Gate Name	Access_to
0	Gate 4 Samsonsbak	SBK N swart duine plume
1	Gate 5	Swart duine
2	Gate 6	Gate 6 plume south end
3	Wired Gate	Noup North plume
4	Noup Gate	Noup south bay and noup north plume and C Van park
5	Somnaas gate	Somnaas beach

Fid	Length (km)	Name
0	46.1	Tar Road

4.3. Quantification of current plumes

The table below captures the analysis of the Plumes in Excel: extent (in ha) per intensity (level) to yield a mapped total plume extent of 18 290 ha

Final 2016 plumes										
					Intensity levels and area (ha)					
Fid	Origin	Plume_Numb	Name	Class	Dune Sea	High	Medium	Low	Area (ha)	Type
0	N/A	SR ta	Spoeg River total area (288. ha)	Total Plume						N/A
1	Natural	SR h	Spoeg River	High		39.1			39.1	River mouth
2	Natural	SR ds	Spoeg River	Dune sea	21.9				21.9	River mouth
3	Natural;	SR m	Spoeg River	Medium			227.4		227.4	River mouth
4	Mine/natural	LK 02	LK02	Medium			0.6		0.6	Half heart bay
5	Mine/natural	MB LKC ds	MBAY LKC	Dune sea	1.6				1.6	Onshore coast
6	Mine/natural	MB LKC h	MBAY LKC	High		7.8			7.8	Onshore coast
7	Mine/natural	MB LKC m	MBAY LKC	Medium			146.1		146.1	Onshore coast
8	Mine/natural	SL S ds	Swartlintjies South	Dune sea	300.0				300.0	N/A
9	Mine/natural	SL E ds	Swartlintjies East	Dune sea	571.0				571.0	N/A
10	Mine/natural	SN B h	Somnaas Beach	High		176.9			176.9	Half heart bay
11	Mine/natural	SN W ds	Somnaas West	Dune sea	169.0				169.0	Half heart bay
12	Mine/natural	SN W l	Somnaas West l	Low				284.7	284.7	Half heart bay
13	Mine/natural	SN m	Somnaas medium	Medium			2767.7		2767.7	Half heart bay
14	Mine/natural	SN E l	Somnaas East l	Low				324.0	324.0	Half heart bay
15	Mine/natural	VB h	Visbeen Bay h	High		4.6			4.6	Half heart bay
16	Mine/natural	SL 68/69 h	Swartlintjies 68/69 h	High		141.1			141.1	Onshore coast and river mouth
17	Mine/natural	SL KN h	Swartlintjies KN h	High		147.5			147.5	Onshore coast and river mouth
18	N/A	SR ta	Swartlintjies total area (11972.1 ha)							N/A
19	Mine/natural	SL m	Swartlintjies m	Medium			10809.4		10809.4	Onshore coast and river mouth
20	Mine/natural	NN m	Noup North m	Medium			102.2		102.2	Half heart bay
21	Natural	Gate 6 m	Gate 6 m	Medium			476.5		476.5	Half heart bay and onshore coast
22	Mine/natural	NSB m	Noup South bay m	Medium			29.3		29.3	Half heart bay
23	Natural	SBK N h	SBK N swart duine h	High		39.2			39.2	Half heart bay
24	Natural	SBK N m	SBK N swart duine m	Medium			1409.1		1409.1	Onshore coast
25	Mine	KN sd h	Koingnaas slimes dam h	High		46.2			46.2	Slimes dam
26	Mine	MB sd m	Mitchell's Bay slimes dam m	Medium			47.2		47.2	Slimes dam
				Subtotal per intensity	1064	602	16016	609	18290.1	

Table 2: 2016 Quantification of current plumes (refer figures 2a, 2b, and 2c)

4.4. Non-plume fall-out dust

This paragraph deals with dust associated with normal mining conditions excluding the West Coast wind-blown sand phenomenon. This dust fraction is therefore held in semi suspension generally for up to 600m in the coarser fraction and the high fall-out levels and as it is not at ground level, can be monitored by normal fall-out dust monitoring systems such as DustWatch™ and measured against the current NEMA standards, which have derived from the "Dust Fall Standards SANS 1929 of 2004" which have been applied in the mining industry for many years and within which we have developed a good understanding of the attenuation required to be applied at the various sources in order to achieve the set standards.

4.4.1. Industry standards

Accordingly, this report will make reference to the extracts from the SANS report and deal with well-established control measures.

Given the nature of mining dust the Dust Fall Standards recognise that certain enterprises including mining need to operate within "Band 3" by virtue of "the practical operation of the enterprise....provided that the best available control technology is applied for the duration".

"DUST FALL STANDARDS SANS 1929:2004

4.8 Dust Deposition

4.8.1 General

The four-band scale to be used in the evaluation of dust deposition is given in 4.8.2 and target, alert and action levels indicated in 4.8.3. Permissible margins of tolerance are outlines in 4.8.4 and exceptions noted in 4.8.5

4.8.2 Evaluation Criteria for Dust Deposition

Dust deposition rates shall be expressed in units of mg m² day-1 over a 30-day averaging period. Dust deposition shall be evaluated against a four-band scale as presented in Table 9.

Table 9 – Four-band scale evaluation criteria for dust deposition

Band number	*Band description label*	*DUSTFALL RATE (D) (mg /m² /day ¹ 30-day average)*	*Comment*
1	*Residential*	*D < 600*	*Permissible for residential and light commercial.*
2	*Industrial*	*600< D < 1 200*	*Permissible for heavy commercial and industrial.*
3	*Action*	*1 200 < D < 2 400*	*Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.*
4	*Alert*	*2 400 < D*	*Immediate action and remediation required following the first exceedance. Incident report to be submitted to relevant authority.*

4.8.3 Target, Action and Alert Thresholds are given in Table 10

Table 10 – Target, action and alert thresholds for dust deposition