More recent studies by Schlumberger Water Services (SWS 2015) have provided a more detailed characterisation of the estuary and its relationship to other surface and groundwater resources in the area. The studies showed that the spring identified by CSIR (Heydorn & Grindley, 1981a), which is located at the lower limit of a natural wetland in the river channel, approximately 1 km upstream (shown as 2.5km upstream by the CSIR study) of the head of the estuarine lagoon (see Plate 4.2), can reasonably be supposed to be the only source of perennial discharge into the lagoon. In February 2014 the flow rate from the spring was estimated to be 1 litre per second.

The possibility that groundwater beneath the proposed mine site could contribute to the discharge from the spring was investigated by the use of hydrochemical 'fingerprinting', which is a comparison of high-resolution hydrochemical data for three boreholes in the mining area and equivalent data for the spring discharge. Data for all waters was compared statistically, and using conventional hydrochemical 'typing' plots. The results of the comparisons were:

- The TDS level of the estuarine spring water (approximately 8 000 mg/l) is markedly higher than all the groundwaters of the mining area (a range of between 3 300 and 7 300 mg/l)
- While all waters are NaCl dominated, a clear distinction exists with regard to the remaining major ion balance of the groundwater suite and spring water. This is particularly pronounced with respect to the contributions of Ca, Mg and SO_4 to the ion balance. In all instances, levels of Ca and Mg in the Kamiesberg groundwaters range up to approximately 150 and 200 mg/l respectively, while in the spring water the concentrations of these cations are 594 and 423 mg/l respectively. In the case of SO_4, enrichment by a factor of 2 to 3 is evident in the spring water relative to the groundwater suite.
- Relative enrichment of Sr is evident in the spring at a magnitude analogous to that described above for SO_4.
- Groundwater samples of the Kamiesberg district are routinely high in Flouride (F). Despite the conservative nature of F in solution, there is no evidence of fluoride enrichment in the spring water. This provides strong evidence of a lack of direct hydraulic inter-connection.

Key distinctions in the hydrochemical properties between the groundwater data and that of the spring strongly support the conclusion that a direct hydrogeological connection between them is highly unlikely.

In addition to this the possibility of subsurface flow into the estuary was investigated by SWS. A survey of the Groen River bed was conducted to identify any springs, seeps, sumps or any other features which may indicate that sub-surface flow occurs along the channel. Seven locations - referred to as 'sumps' – were identified over a distance of about 17km along the channel in which standing water was identifiable, or where some evidence of the recent presence of water was inferred. Electrical conductivity levels in these sumps were higher by up to a factor of two than those recorded in water sampled from boreholes in the immediate vicinity of the river, indicating significant evapo-concentration in the sumps. It was concluded from these observations that subsurface flow along the channel bed is negligible, and also that there is negligible discharge from base flow or interflow of groundwater to into the river bed. If this was the case, electrical conductivity would have been lower and more similar to groundwater levels.

Based on the above information, it is clear that there is no hydrological connectivity between the mine site and the estuary downstream. Thus it is highly unlikely that the estuary will be impacted upon by mining activities.

Bitterrivier estuary

The estuary of the Bitterrivier, when it exists due to surface water inflow or seawater penetration, is much smaller than that of the Groen, being about 5 ha, and extending only about 400 m upriver from the beach. There is no published flow-related information for the river, and the periods during which the estuary is wet are likely to be short and widely separated in time.

Heydorn & Grindley (1981b) concluded:
"*The* [estuary of the] Bitter [River] *is probably of limited value as an estuary in the true sense, due to the episodic nature of its flow. However, being as yet relatively undisturbed by man's activities (at the time of the CSIR survey the area was part of the De Beers Consolidated Mines prospecting area, and public access was restricted), this scenic section of the coast has high aesthetic value and is part of the last remaining stretch of the Namaqualand coastline as yet unaffected by mining operations."*

Wetlands

The Working for Wetlands Kamiesberg Wetland Project has prepared rehabilitation plans for nine individual wetland systems - Kleingaas, Groenrivier, Kleikop, Schaaprivier, Langvlei, Natpad, Windpoort, Xharas and Kraaifonteinin – in the Northern Cape Province in the general area of the Kamiesberg mining project (Working for Wetlands 2014).

All but one of the wetland systems identified for attention in the project - the Groenrivier wetland - are situated in four quaternary catchments - F30A, F30C, F50A and F50E - near the towns of Kamieskroon and Leliefontein, inland from the mine site. Of these four catchments the nearest catchment boundary - that of F50E - is 27 km inland from the mining area. None of the wetlands in these four quaternaries will be affected in any way by mining or related activities.

Groenrivier wetland

The Groenrivier wetland, however, is situated in quaternary catchment F50G, at the mouth of the Groenrivier some 10.5 km south-west of the south-western corner of the Roode Heuvel block (see Figure 4.5 above). The wetland is situated in the Namaqua National Park, and its extent approximates to that of the Groenrivier estuary, discussed previously.

The rationale for the rehabilitation work proposed for the wetland system is "*The* (proposed bird) *hide site is at a very scenic location visited by a diversity of wetland-dependent birds. It is located within the Namaqualand National Park and there is good public access. In addition, through the use of appropriate signage, there are good opportunities for raising public awareness of the importance of wetlands in the overall catchment."* (Working for Wetlands 2014). The rehabilitation work is rated 4th in order of priority out of a total of nine wetlands in the project as a whole.

The mouth of the Groenrivier is relatively easy to access for camping, bird watching, hiking and 4x4 tracks. As a result the wetland has been subjected to a number of impacts associated with the formation of a number of informal access routes for watching birds, as well as short hiking trails, all of which have increased the impact of erosion and sedimentation by providing preferential flow routes for surface water draining. The primary objective of the rehabilitation is to provide formalised enhanced public access for watching birds and appreciate the scenic beauty of the Groenrivier estuary without impacting negatively on the estuary. This can be achieved by means of a bird hide and boardwalk access to the hide, and the construction of an additional boardwalk at the seaward end of the wetland to enhance access whilst avoiding trampling of saltmarsh.

Although the wetland / estuary is some distance from the mine site, it will be important to ensure that the mining project does not result in direct or indirect impacts on the wetland, nor prejudice the success of the rehabilitation project.

ii. Groundwater

A hydrocensus covering the project area was conducted by SWS during September 2012. The hydrocensus was subsequently extended in 2013 to include the area between the project site and the Atlantic Ocean to the west. A total of 23 sites were investigated, 19 boreholes, two pits (sumps) excavated in the bed of the Groenrivier, and two sites in the ocean. Data from the hydrocensus is shown in Table 4.2, and the locations of the sites on Figure 4.6.

Table 4.4: Hydrocensus summary table

Location & Sample ID	Coordinates		Site type	Use	Collar height (m)	Water level (mbc)	Water level (mbgl)	Water level (mamsl)
	Latitude (south)	Longitude (east)						
Hydrocensus 2012								
ZIR01	-30.7452	17.64536	Borehole	Unused	0.35	Unable to measure		
ZIR02	-30.742	17.62974	Borehole	Livestock	0.16	80.63	80.47	107.7
ZIR03	-30.7053	17.62532	Borehole	Unused	0	58.06	58.06	123.12
ZIR04	-30.7357	17.66761	Borehole	Livestock	0.38	Unable to measure		
ZIR05	-30.6133	17.59311	Borehole	Livestock	0.61	3.37	2.76	88.23
ZIR06	-30.5993	17.6607	Borehole	Livestock	0.16	16.4	16.24	136.26
ZIR07	-30.6766	17.71211	Borehole	Livestock	0.37	34.39	34.39	174.43
ZIR08	-30.718	17.65561	Borehole	Livestock; Domestic	0.41	Unable to measure		
ZIR09	-30.78	17.69353	Borehole	Unused	0.43	7.87	7.44	45.92
ZIR010	-30.7582	17.63989	Borehole	Livestock	0.48	2.12	1.64	31.11
ZIR011	-30.7587	17.63707	Dug Sump	N / A	N / A	N / A	N / A	22.46
ZIR012	-30.8478	17.57605	Seawater	N / A	N / A	N / A	N / A	N / A
Extended Hydrocensus 2013								
GAT1	-30.7301	17.6849	Borehole	Livestock	0.35	Unable to measure		
GAT2	-30.7305	17.6855	Borehole	Unused	0.31	Unable to measure		
ZIR13	-30.7838	17.6028	Dug sump	N / A	N / A	N / A	N / A	16.7
ZIR14	-30.7814	17.6003	Borehole	Livestock	0.21	9.44	9.23	4.79
ZIR15	30.7463	17.5722	Borehole	Livestock	0.62	Unable to measure		
ZIR16	30.7528	17.5789	Borehole	Livestock	0.90	42.89	41.99	41.25
ZIR17	-30.8100	17.5986	Borehole	Livestock	0.79	2.11	1.32	10.68
ZIR18	-30.8054	17.6024	Borehole	Livestock	Unable to measure			
ZIR19	-30.8133	17.5901	Borehole	Livestock	0.78	2.71	1.93	7.34
ZIR020	-30.7670	17.6626	Borehole	Livestock	0.55	2.62	2.07	33.70
ZIR021	-30.8589	17.5751	Seawater	N / A	N / A	N / A	N / A	N / A

Source: Hydrocensus 2012 - SWS 2012, adapted from Table 3.1; Hydrocensus 2013 - SWS 2013, adapted from Table 4.1

According to local landowners, groundwater use is almost exclusively for livestock watering, with minor use for domestic purposes such as washing and cleaning. The high salinity of the groundwater makes it unsuitable for human consumption, and all drinking water is obtained from rainwater harvesting from the roofs of the farmsteads. All existing boreholes in the area were equipped with wind pumps, which pump water to storage dams. From the dams, water is generally distributed to livestock watering points by gravity flow.

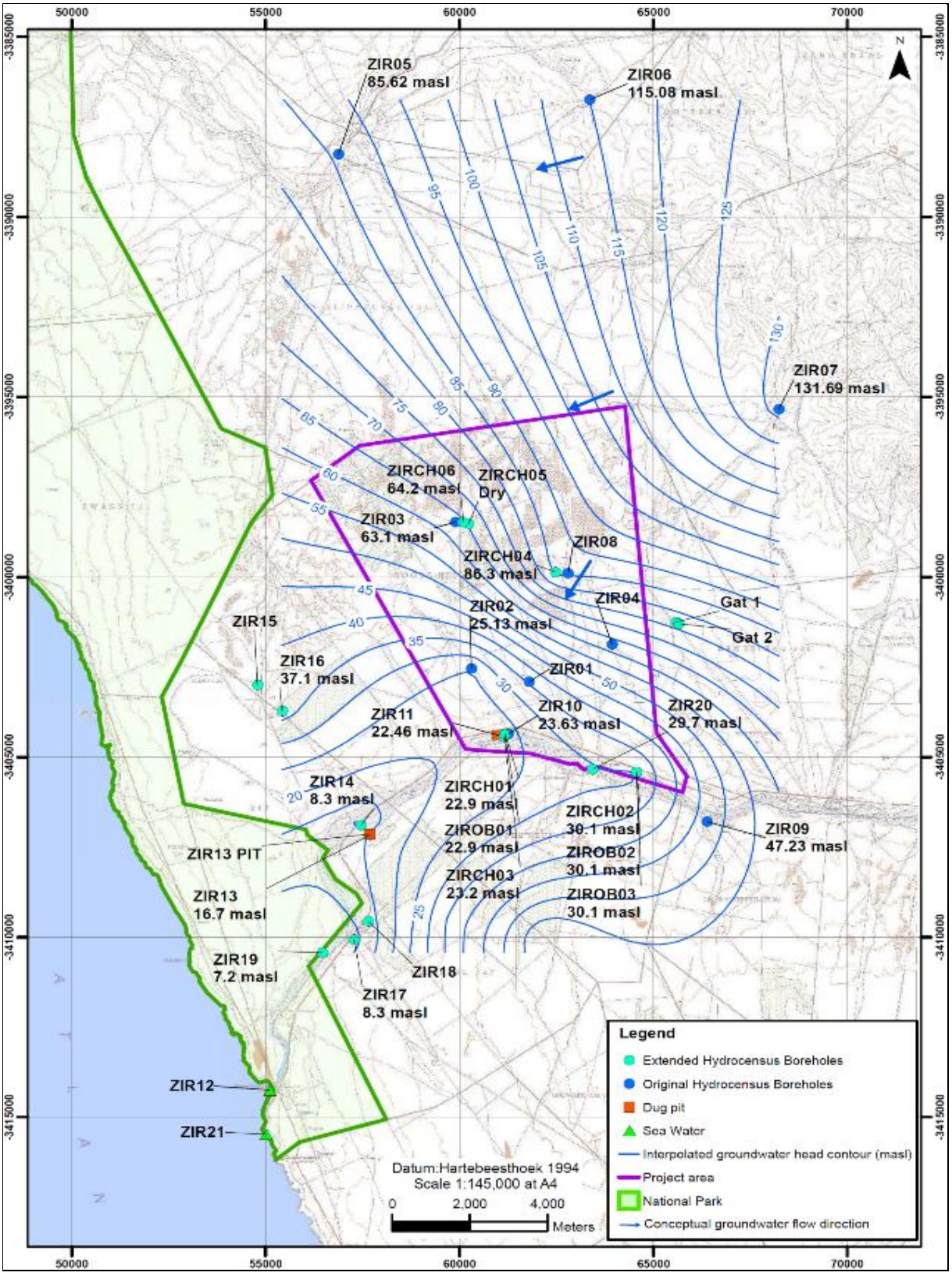


Figure 4.6: Extended hydrocensus points, borehole positions, groundwater contours
Source: SWS 2013, Figure 4.8

4.2.7 Estuarine Habitat

The estuarine study assessed the present ecological state of the Groen Estuary based on macrophytes, invertebrates and birds. In February 2015 the estuary could be divided into a lower hypersaline lagoonal area with abiotic characteristics very different to the narrow and shallow (<50 cm deep) channel in the middle and upper reaches. A salinity of 223 ppt was recorded in the lower reaches, which dropped to 70 ppt at approximately 0.7 km upstream from the mouth of the estuary. Reeds were abundant in the upper reaches - indicating brackish conditions - as they grow best at salinity less than 20 ppt. Freshwater springs at the head of the estuary are an important source of water to the estuary and at the time of the visit in February 2015, spring water recorded a salinity of around 10 ppt.

The dominant habitat at the Groen Estuary was supratidal salt marsh with the dominant species *Sarcocornia pillansii* that covered 8 ha. Intertidal salt marsh represented by *Sarcocornia natalensis* and *Salicornia meyeriana* occurred along the banks of the estuary mostly along the lower reaches of the northern bank. Terrestrial species including *Lampranthus* sp., *Lycium strandveldense* and *Mesembryanthemum guerichianum* were present in the ecotone between the suptratidal zone and terrestrial habitat. The reed and sedge habitat, represented by common reed (*Phragmites australis*), fringed the steeper channel in the upper reaches of the estuary. Filamentous macroalgae with the dominant species *Rhizoclonium riparium* (Cladophoraceae, Chlorophyta) are an important feature of the estuary. The filamentous cyanobacteria *Lyngbya* sp. was abundant in the estuary forming dense floating mats. Windblown algal mats were observed on the surrounding vegetation. This can increase salt load causing die-back but it is also a source of organic material to the surrounding supratidal salt marsh area. Salt pans were present in the middle and upper reaches of the estuary. These waterlogged areas were devoid of vegetation. Much of the vegetation surrounding the estuary was dead at the time of sampling in February 2015.

The only zooplankton found were insect larvae collected in the upper reaches at a salinity of 26 ppt. These larvae were associated with the floating algal mats. Extremely high salinity and anoxic sediment in the lower estuary excluded macroinvertebrates and mesozooplankton, while anoxic sediment in the channel area of the estuary (where salinity was lower) became the main limiting factor impacting the biota. Overall conditions were too stressful for invertebrates to thrive.

Most birds feeding in the estuary were either on the expansive sandflat in the lagoonal area of the lower reaches or present on or around the algal carpets floating on the water surface in the upper estuary. There were 15 different bird species and the total number of individuals was 109. Approximately one-third of the bird numbers were utilizing the estuary as a roosting area and not for feeding purposes. Long-billed benthic feeders and piscivores were not recorded on the estuary.

The absence of benthic macroinvertebrates, mesozooplankton, fish and low bird counts (mainly short-billed waders) support the conclusion that the Groen Estuary was a stressed ecosystem in February 2015. Main stressors were extreme hypersalinity, relatively low water volume, anoxic sediments and a mouth that had remained closed for a relatively long period of time (years).

4.2.8 Marine Environment

i. Oceanography

Regional Oceanography

The physical oceanography of an area, particularly water temperature, nutrient and oxygen levels, and wave exposure are the principal driving forces that shape marine communities. The broader oceanography of the Groenriviersmond region is influenced by the cold Benguela upwelling system of the west coast (Figure 4.7). The Benguela Current originates from the South Atlantic Circulation, which circles just north of the Arctic Circumpolar Current.

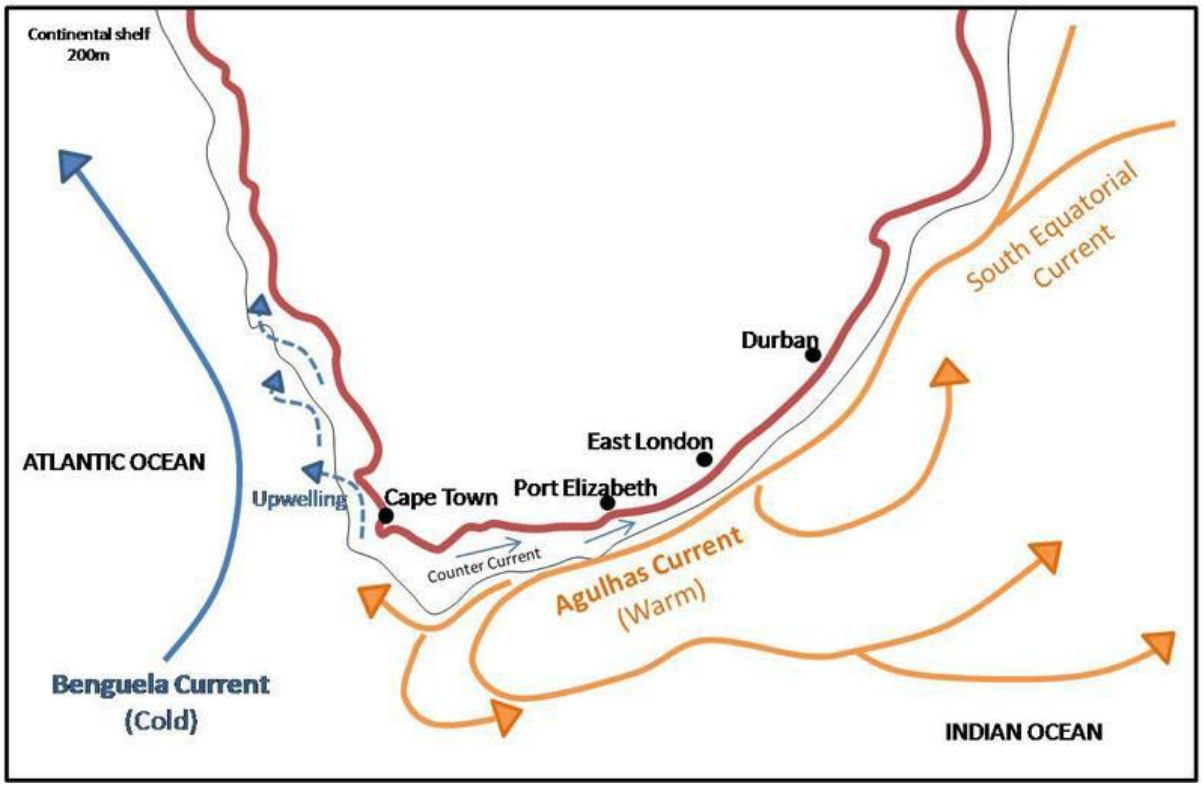


Figure 4.7: Southern Africa showing Agulhas and Benguela currents
(Source Anchor Environmental)

The naturally cool temperature of the Benguela current (average temperature 10-14°C) is enhanced by the upwelling of colder nutrient-rich deep water (Branch 1981). The area experiences strong southerly and south-easterly winds which are deflected by the Coriolis force (rotational force of the earth which causes objects in the southern hemisphere to spin anticlockwise). These prevailing conditions deflect the surface waters offshore and draws cold, nutrient rich water upwards to replace it (Figure 4.8). Phytoplankton bloom when the nutrients reach the surface waters where plenty of light is available for photosynthesis. The phytoplankton is then preyed upon by zooplankton, which is in turn eaten by filter feeding fish such as anchovy or sardine. This makes the west coast one of the richest fishing grounds in the world and also attracts large colonies of birds and seals (Branch 1981). The areas that experience the most intense upwelling activity in the southern Benguela are situated off Cape Columbine, approximately 80 km South of Lamberts Bay, and the Cape Peninsula. The water temperature and nutrient levels are strongly influenced by wind with minimum temperatures and maximum nutrient levels occurring in conjunction with upwelling events (Branch and Griffiths 1988).

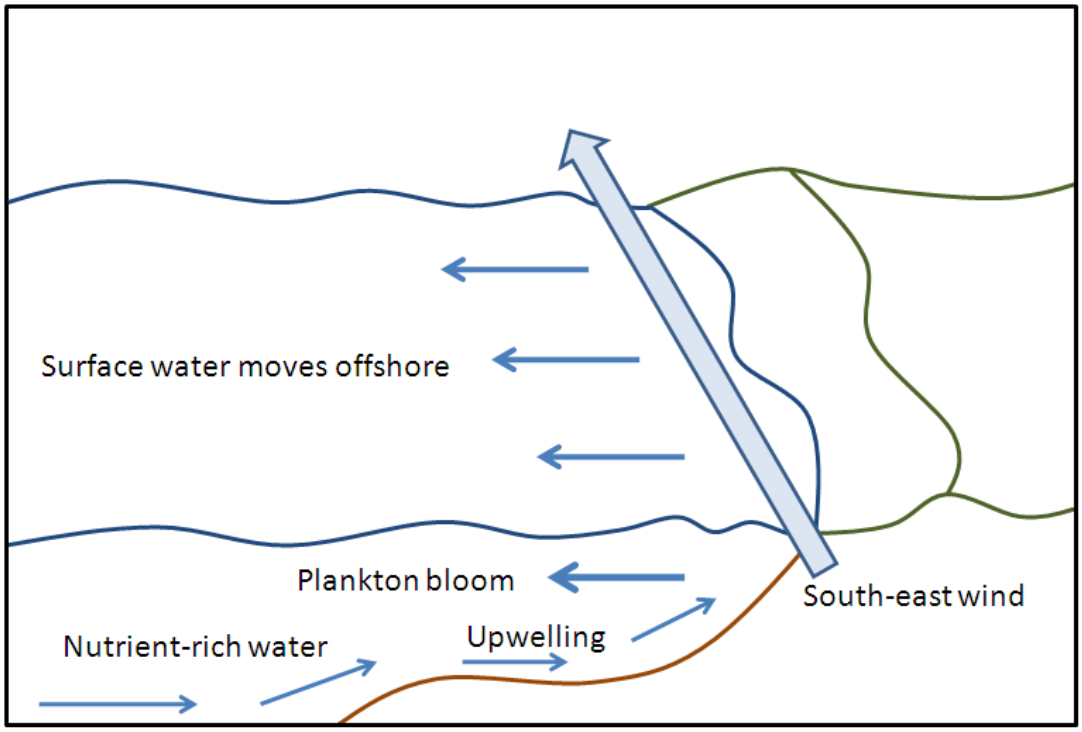


Figure 4.8: Wind-driven upwelling that occurs on the west and south west coasts of South Africa
(Source Anchor Environmental)

Local Oceanography

The study site is subject to semi-diurnal tides, with each successive high (and low) tide separated by 12 hours. Each high tide occurs approximately 25 minutes later every day, which is due to the 28-day rotational cycle of the moon around the earth. Spring tides occur once a fortnight during full and new moons. Tidal activity greatly influences the biological cycles (feeding, breeding and movement) of intertidal marine organisms, and has an influence on when people visit the coastline to partake in various activities (e.g. relax, bathe, harvest marine resources). The tidal variation in the vicinity of Groenriviersmond usually ranges between 0.28 m (relative to the chart datum) at mean low water springs to 1.91m at mean high water springs with the highest and lowest astronomical tide being 2.25m and 0.056m respectively.

Another factor which greatly influences marine ecology and human activities along the coastline is wave energy. Wave size is determined by wind strength and fetch (distance over which it blows) and determines the degree to which breaking waves at the shore will shift sand and erode rock. The west coast of South Africa typically experiences high wave energy and is dominated by south-westerly swells with a long fetch and a period of 10-15+ seconds (Branch and Griffiths 1988).

Regional Biogeography

Numerous attempts have been made to understand and map marine biogeographic patterns around the coast of South Africa (e.g. Stephenson and Stephenson 1972; Brown and Jarman 1978; Emanuel *et al.* 1992; Engledow *et al*. 1992; Stegenga and Bolton 1992; Bustamante and Branch 1996; Bolton and Anderson 1997; Turpie *et al*. 2000; Sink 2001; Bolton *et al*. 2004; Lombard *et al.* 2004). Most of these studies recognised three coastal regions – a cool temperate west coast, a warm temperate south coast and a subtropical east coast region, with the main points of argument relating to the position of the boundaries. Marine biogeographic patterns around the South African coast were recently reviewed and several new ecoregions were described (Sink *et al.* 2011). According to these divisions, Groenriviersmond and the study sites described in this report, fall in the Namaqua inshore ecozone, which is nested within the Southern Benguela Ecoregion.

ii. Ecology

Sandy Beaches

Intertidal sandy beaches are very dynamic environments. The faunal community composition is largely dependent on the interaction of wave energy, beach slope and sand particle size (beach morphodynamics). Three morphodynamic beach types are described: dissipative, reflective and intermediate beaches (McLachlan *et al.* 1993). Dissipative beaches are wide and flat with fine sands and high wave energy. Waves start to break far from the shore in a series of spilling breakers that 'dissipate' their energy along a broad surf zone. This generates slow swashes with long periods, resulting in less turbulent conditions on the gently sloping beach face. These beaches usually harbour the richest intertidal faunal communities. Reflective beaches have low wave energy, and are coarse grained (>500 µm sand) with narrow and steep intertidal beach faces. The relative absence of a surf-zone causes the waves to break directly on the shore causing a high turnover of sand. The result is depauperate faunal communities. Intermediate beach conditions exist between these extremes and have a very variable species composition (McLachlan *et al.* 1993). This variability is mainly attributable to the amount and quality of food available. Beaches with a high input of e.g. kelp wrack have a rich and diverse drift-line fauna, which is sparse or absent on beaches lacking a drift-line (Branch and Griffiths 1988; Field and Griffiths 1991).

The sandy beaches of the Southern Benguela Ecoregion are exposed to high energy waves with the exception of a few small sheltered bays (Bally 1987). The main inputs of food to the sandy beaches in this system are upwelling-related coastal phytoplankton and kelp detritus (Bally 1987). The biomass values reported for beaches along the southern Benguela coast are some of the highest in the world (Bally 1987).

Sandy beaches have no hard substratum onto which animals and plants can attach. Organisms living here rely on a nutrient source in the form of seaweed detritus which is constantly deposited on the beach together with organic rich froth, or spume (Branch 1981). Sandy beaches are highly dynamic; strong waves scour and erode beaches while gentle waves deposit sand. Sand is typically deposited with offshore winds, and eroded with onshore winds. Relatively few species occur on sandy beaches due to their unstable and harsh nature, but those that do occur are hardy, and well adapted to life in these environments (Branch 1981). Animals living here are, however, offered some degree of protection by being able to burrow into the layers of sand to escape desiccation, overheating and strong waves (Branch 1981). Five groups of organisms are typically found on sandy beaches: aquatic scavengers, aquatic particle feeders, air breathing scavengers, meiofauna (smaller than 1 mm in size), and higher predators (Branch 1981).

Aquatic scavengers feed on dead or dying animals that wash up on the beach and their activity is largely regulated by tides. This group includes species such as *Bullia* (the plough snail), that emerge from the sand as the tide rises and are deposited in the same area in which the waves drop debris and decaying matter. Later they follow the tide down the shore as it recedes to avoid being eaten by terrestrial predators. Aquatic particle feeders, such as the sand hopper, occur mostly on the low-shore and feed on small organic particles. The majority of these species migrate up and down the beach with each tidal cycle, such that they remain in the surf zone and can escape avian and terrestrial predators. Sand hoppers are important for the breakdown of washed up seaweed, and are also a major food source for sanderlings and other birds. Air breathing scavengers live high on the shore and feed on kelp and other seaweeds that have been washed up, as well as dead and decaying animal matter. These species complete their life cycles out of water, emerge from the sand during low tide when there is less risk of being washed away, and are almost strictly nocturnal to avoid desiccation and predation. Meiofauna (organisms < 1mm in size) are by far the most abundant of the animals found on sandy beaches, as their small size enables them to live between sand grains. The two most common groups are nematode worms and harpacticoid copepods. Meiofauna play an important role in breaking down organic matter which is then colonised by bacteria. Higher predators which feed on sandy beach organisms include birds,

such as African black oystercatchers, White fronted plovers and sanderlings, and fish such as galjoen and white Steenbras (Branch 1981).

Beaches typically comprise three functional zones, namely the surf zone, the beach (intertidal and backshore zones) and the dunes. The diversity and abundance of species has been shown to increase with depth in the surf zone of beaches along the Benguela system. A rich outer turbulent zone (10-33m from the shore) supports delicate cnidarians (anemones), tube building polychaetes and amphipods, while the less diverse offshore turbulent zone (3m-5m from the shore) is typified by deep burrowing polychaetes and crustaceans. The poor species diversity and abundance, as well as the presence of the cumacean *Cumopsis robusta* (small crustacean), characterise the inner turbulent zone (0-1m from the shore) of the surf zone. Fish such as galjoen and white steenbras frequent turbulent surf zone waters off the west coast where they swim over submerged beaches at high tide and feed on small crustaceans (Branch 1981). Surf zone habitats, particularly medium to low energy beaches, are in fact widely recognised as important nursery areas for fish, and is even thought to rival that of estuaries in some areas (Clark *et al*. 1996, Lenanton *et al*. 1982, Bennett 1989). The intertidal zone of sandy beaches along the coast of the Benguela system can be divided into three zones; the zone of saturation (or the sublittoral fringe), the midshore and the upper drift line (or supralittoral zone). The sublittoral fringe is typified by mysids (*Gastrosaccus* spp.) and scavenging gastropods (*Bullia* spp.), while the midshore region is characterised by isopods (*Eurydice longicornis* and *Pontogeloides latipes*) and a polychaete (*Scolelepis squamata*). The upper drift line is typified by air-breathing amphipods (*Talorchestia*) and giant isopods (*Tylos* spp.), as well as a rich diversity of insects (mostly Coleoptera and Diptera) where large quantities of kelp have been deposited on the drift line.

Sandy beaches are important for the filtering and decomposition of organic matter in sea water. As water percolates down through the sand the organic particles are trapped and decomposed by bacteria, which in turn release nitrates and phosphates that are returned to the sea. Continual flow of water through the sand maintains oxygen levels and aids bacterial decomposition, and thus sandy beaches act as water purifiers (Branch 1981).

Sandy Benthic Habitat

The primary food source in near-shore sediments is plankton and detritus, brought in by currents from rocky shores and reefs, and other more productive coastal communities. Faeces, dead individuals and debris from plankton and nekton in the water column as well as detritus, generated by the bottom dwellers themselves as they die, is also present. Bacteria play a major role in decomposition and are an important source of protein on soft-bottom habitats.

Fauna and flora that inhabit the surfaces of subtidal sand are called benthic epifauna, while those that burrow or dig into the soft sediments are called benthic infauna. Soft-bottom subtidal communities are dominated by benthic infauna, with some epifauna present, however sessile or attached forms are virtually absent as there is nothing to attach to (Castro and Huber 1997). The distribution of infauna and the depth atCe which organisms can live in the substrate is largely dependent on sediment particle size. More porous, larger grained substrates allow greater water circulation through the sediment thereby replenishing the oxygen which is used up during decomposition processes.

Much of the benthic infauna are deposit feeders which either ingest sediments and extract organic matter trapped between the grains or actively collect organic matter and detritus (Castro and Huber 1997). Many species of polychaetes and worms are deposit feeders. Peanut worms (Sipunculida) gather detritus using tentacles at the mouth of an elongate, tubular anterior process that can be squeezed out by muscular contraction and then retracted (Branch *et. al*. 1994).

Suspension feeders eat drifting detritus and plankton from the water column (Castro and Huber 1997). Some suspension feeders are filter feeders which actively pump and filter water to obtain suspended particles. These include clams as well as species of amphipods and polychaetes. Other

suspension feeders lift arms, tubes, branches or polyps vertically into the water column to catch suspended particles.

Predators in soft bottom habitats may burrow through sediments to get to their prey or catch it on the surface (Castro and Huber 1997). Predators such as crabs, hermit crabs, lobsters and octopuses, which inhabit rocky areas, may move to sandy benthos to feed (Castro and Huber 1997). Most bottom-dwelling fish in soft bottom habitats are predators. Rays and skates scoop up clams, crabs and other infauna and epifauna, while flat fishes, such as flounders and soles, lie camouflaged or covered on the bottom and forage for a wide variety of prey.

Rocky Reefs and Kelp Forests

Temperate rocky reefs are found below the low water mark (i.e. are always completely submerged) and are known to support diverse assemblages of life. Disturbance from wave action and sedimentation result in a high turnover of competitors in these habitats. Many large predators such as fish and sharks are attracted to rocky reefs, and thus form an important component of these ecosystems (Barros *et al*. 2001). Rocky reef communities also influence the abundance and distribution of benthic macrofauna in adjacent soft bottom habitats, and it has been found that more benthic species occur close to rocky reefs (Barros *et al.* 2001). Thus many reef-associated fish and crustaceans not only forage directly on the reef but also on the adjacent sandy bottom areas.

The following generic description of subtidal, west coast rocky reef is largely based on information provided by Branch *et al*. (2010) and Meyer and Clark (1999). Rocky reefs provide substratum to which kelp (*Ecklonia*) can attach, and these large kelp forests provide food and shelter for many organisms. Light is the limiting factor for plant growth, and thus kelp beds only extend down to approximately 10 m depth. Many other algal species live underneath the floating canopy of kelp, especially inshore where the light is abundant and the water shallow. A sub-canopy of *Lamanaria* grows beneath the *Ecklonia* in deeper waters (Plate 4.2), and dense communities of mussels, sea urchins, and rock lobster live between the *Lamanaria*. Growing epiphytically on these kelps are the algae *Carradoria virgata*, *Suhria vittata* and *Carpoblepharis flaccida*. Representative under-storey algae include *Botyrocarpa prolifera*, *Neuroglossum binderianum*, *Botryoglossum platycarpum*, *Hymena venosa* and *Epymenia obtusa*, various coralline algae. The dominant grazer is the sea urchin *Parechinus angulosus*, with lesser grazing pressure from limpets, the isopod *Paridotea reticulata* and the amphipod *Ampithoe humeralis*. Herbivores occurring in the kelp forests include the kelp limpet *Patella compressa* which lives on the stipes of the kelp (Branch 1981). West coast rock lobster, *Jasus lalandii*, and *Octopus vulgaris* are two of the most important carnivores that occur within kelp forests in the Groenriviersmond area. Other kelp forest predators include the starfish *Henricia ornata*, various feather and brittle stars (Crinoidea & Ophiuroidea, Echinodermata), *Nucella* spp. and *Burnupena* spp. gastropods. Fish species likely to be found in the kelp beds off Lamberts Bay include hottentot *Pachymetopon blochii* (Plate 4.2), two-tone fingerfin *Chirodactylus brachydactylus*, red fingers *Cheilodactylus fasciatus*, galjoen *Dichistius capensis,* milk fish *Parascorpis typus*, rock suckers *Chorisochismus dentex* and the catshark *Haploblepharus pictus* (Branch *et al*. 2010).

Kelp washed ashore forms an important food source for scavengers and provides shelter for numerous isopods (sea lice), which are in turn preyed upon by birds. Filter feeders such as mussels, red bait and sea cucumbers comprise 70-90% of the faunal community on rocky shores and their principal food source is kelp (Branch et al. 2010). Kelp thus forms an integral part of the rocky shore and sandy beach ecosystems. Kelp also produces large quantities of mucus, which encourages bacterial growth upon which protozoa feed.

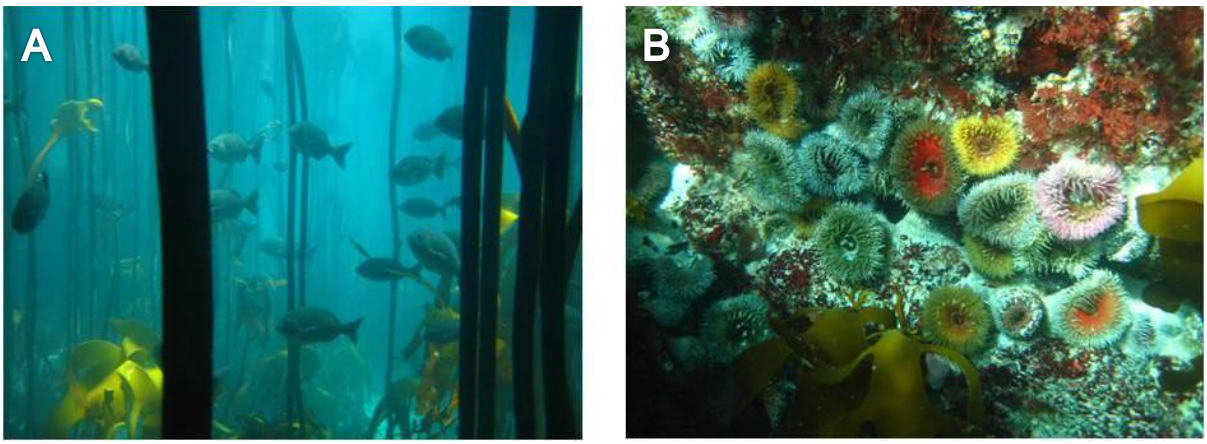


Plate 4.2: (A) E. maxima kelp forest with L. pallida sub-canopy and Hottentot (Pachymetopon blochii) (B) Sandy anemones (Bunodactis reynaudi), a typical west coast shallow reef species

Rocky Shore

Rocky shores can be divided into distinct bands according to the amount of time each is exposed to the air, which in turn influences the organisms that inhabit each section of the shore. Species that are more tolerant to desiccation (drying out) are found near the high-water mark, while those that cannot tolerate long periods of water recession are found near the low-water mark. There are five distinct zones that are typically found on rocky shores. These zones (moving in a landward direction) are named the Infratidal zone, the Cochlear zone, the Lower Balanoid zone, the Upper Balanoid zone and the Littorina zone. A further influencing factor on the distribution of organisms on the rocky shore is the degree of exposure to wave action, with significant differences noted between sheltered and exposed areas (Bustamante et al. 1997).

The Infratidal zone is inhabited by species which cannot withstand long periods of exposure and includes thick algal beds of kelp, *Gigartina, Champia lumbricalis* and articulated corallines interspersed with sea urchins (*Parechinus*) and the invasive black mussel, *Mytilis galloprovincialis*. The large limpets, *Scutellastra argenvillei* and *Cymbula granatina*, form dense stands which extend up into the cochlear zone effectively replacing *S. cochlear* which are somewhat rare in the region. *Octopus vulgaris*, and various species of fish, known as “klipvis” in South Africa, are found in subtidal rock pools where they prey upon bivalves and other invertebrates.

Above the Cochlear zone is the Lower Balanoid, where the limpet *S. granularis*, winkles (*Oxystele tigrina* and *O. variegata*) and whelks (*Burnupena spp.*) are found. The black mussel, *M. galloprovincialis*, also extends into this zone and competes for space with *Gunnarea gaimardi*, the Cape reef worm. Little seaweed occurs within this zone, however some sea lettuce (*Ulva*) is present and there are scattered patches of the encrusting brown alga, *Ralfsia verrucosa*. The upper Balanoid zone is dominated by animals, in particular limpets and barnacles. The harshest of all is the Littorina zone, which is dominated by the snail *Afrolittorina knysnaensis* and the flat-bladed alga *Porphyra capensis* (Branch 1981).

The diversity of intertidal macroalgal species is relatively low in the region (Bustamante et al. 1997). Filter feeders such as mussels and the Cape reef worm comprise ~70% of the faunal community on rocky shores and their principal food source is kelp particulates together with various microorganisms, kelp spores, phytoplankton and other fragments of organic matter (du Toit & Attwood 2008). An ecological assessment of the rocky shore at each of the proposed gully intake sites was conducted in order to assess the importance of the area for rocky intertidal biodiversity conservation, this assessment is available in Chapter 9 of this report.

4.3 BIOLOGICAL ENVIRONMENT

4.3.1 Flora

The project site is located within the Succulent Karoo biome which stretches from the Luderitz district of Namibia along the western extremes of the Northern Cape down towards Cape Town, and thence eastwards into the Little Karoo as far east as Steytlerville. It is the fourth largest biome in South Africa, and much of it consists of flat to undulating terrain, with hilly and more rugged terrain occurring in parts of Namaqualand, and notably so in the Kamiesberg and Richtersveld (Mucina and Rutherford, 2006).

The Succulent Karoo is part of what is now recognised as the Extra Cape Subregion (ECR) of the Greater Cape Floristic Region (GCFR; Snijman 2013). The GCFR is essentially defined by its predominantly winter rainfall, and a distinct flora. The GCFR is one of only six Floristic Regions in the world, and it is also by far the smallest floristic region. The Extra Cape Subregion occupies only 0.1% of the world's land surface, and supports about 3720 plant species, almost 20% of all the plant species in southern Africa, and some 8% of the plant species in sub-Saharan Africa. About 40% of all the plant species in the Extra Cape Subregion do not occur outside this region (Snijman 2013), and many have very small home ranges (these are known as narrow endemics). Although land use pressures are relatively low in the region (apart perhaps from overgrazing and mining), and there are consequently far fewer threatened plants in the region than in the Core Cape Region (commonly referred to as the Fynbos), many of the range restricted species are vulnerable to intense local development due to their very small ranges and specific habitat requirements.

The semi-arid Succulent Karoo is a winter-rainfall region, and is characterized by low to dwarf, open, succulent shrubland, typically including the families *Mesembryanthemaceae* and *Crassulaceae*. This shrubland is dominated by stem and leaf succulents, many of which are deciduous, and a few fine-leaved evergreen shrubs. Grasses are infrequent (partly due to heavy selective grazing) and are mainly annuals. The mass spring flowering displays of annuals (mainly Asteraceae) and geophytes, particularly in disturbed areas, are highly characteristic of the Succulent Karoo. Low trees are common only along river courses, where they may form woodland corridors (Barnes *et al.* 2001).

i. Regional Vegetation

Namaqualand, which forms the largest portion of the Succulent Karoo biome, is best known for its spring floral displays. This winter rainfall desert is home to a unique arid-land flora that is unparalleled globally in terms of its diverse mixture of both species and growth forms. The region is recognized as the only desert biodiversity hotspot on earth (Mittermeier et al. 2000) and hosts the world's greatest variety of succulent plants.

Mucina and Rutherford (2006), which is the most comprehensive data for vegetation types in South Africa, define the following vegetation types (Figure 4.9) from which source these descriptions are derived:

Namaqualand Strandveld (SKs7)

Namaqualand Strandveld (which is part of the Namaqualand Sandveld bioregion) occurs in the Northern and Western Cape Provinces and is characterised by a flat to slightly undulating landscape of coastal peneplain. It is found on Quaternary stabilised deep aeolian red or yellow sands and on stable dunes and deep sand overlying marine sediments and gneisses. These sands are alkaline or neutral, as opposed to the Sand Fynbos sands which are usually slightly acidic. Sometimes weakly defined scattered heuweltjies (circular, abandoned termite mounds) are found further away from the sea. Although predominantly coastal, this vegetation may penetrate as far as 40 km inland from the sea, especially where coastal dune plumes extend inland and where there is a high incidence of coastal fog. Strandveld vegetation structure is highly variable, ranging in height from an average 30 cm to an average 1.2 m, but it is typically low, species-rich shrubland

dominated by a variety of erect and creeping succulent and often deciduous shrubs. This widespread vegetation type could perhaps be divided into at least 6 or 8 distinct forms based on morphology and species composition, but this has not yet been done on a formal basis.

Namaqualand Strandveld is classified as a **Least Threatened** vegetation type on a national basis (DEA 2011), with a conservation target of 26% of its total original extent, and about 10% of its total extent has been transformed (Rouget *et al.* 2004). Relatively little was formally conserved until recently, although the nearby Namaqua National Park does now include significant areas of this vegetation type (>60 000ha, or >15% of the total original extent, being over half of the conservation target of 26%). This vegetation type covers about 46% of the total prospecting area, and about 40% of the proposed mining area.

Namaqualand Heuweltjieveld (SKn4)

This vegetation type occurs in the Northern Cape along the western foothills of the Namaqualand Escarpment. It characterised by undulating plains that lead up the escarpment, and soils are typically relatively rich and derived from underlying granite or gneiss. The vegetation cover comprises a mosaic of low shrubland communities dominated by leaf-succulent shrubs that occur on slightly raised, rounded termite mounds or "heuweltjies"; ascribed to former activity of harvester termites (*Microhodotermes viator*). It is classified as **"Least Threatened"** on a national basis (DEA 2011), with a conservation target of 28% of its original extent. Approximately 11% has been statutorily conserved (mostly in the Namaqua National Park) and 3-4% has been transformed by cultivation (Rouget *et al* 2004). This vegetation type occupies about 18% of the prospecting area, but is not present in the proposed mining area.

Namaqualand Klipkoppe Shrubland (SKn1)

This vegetation type occurs in the Western and Northern Cape in the central and north-central regions of Namaqualand. It is typified by dramatic landscapes of large granite and gneiss domes and disintegrating boulder koppies that support open shrubland dominated by dwarf shrubs with ericoid or succulent leaves, many of which are deciduous. It is classified as **Least Threatened** on a national basis (DEA 2011), with a conservation target of 28%. Approximately 6% has been statutorily conserved and about 5% has been transformed (Rouget *et al* 2004). This vegetation type occupies only about 1% of the prospecting area, and is not present in the proposed mining area.

Namaqualand Sand Fynbos (FFd1)

Namaqualand Sand Fynbos occurs on the coastal plain (usually 5-20 km inland), on Quarternary and Tertiary sands of marine and aeolian origin, and is the only Sand Fynbos type found within the Succulent Karoo biome, all the others being part of the Fynbos biome further south. The topography, soil pH and moisture availability determine the dominance of Sand Fynbos or Strandveld communities. Strandveld communities prefer alkaline soils, while Sand Fynbos is found on leached (acidic) soils. In the case of Namaqualand Sand Fynbos, fire does not play a role in regeneration of the Fynbos elements, in contrast to other Sand Fynbos types. There is often a predictable presence of various shrubs of Fynbos affinity on the dune ridges, and Restionaceae are often dominant in dune slacks, and sometimes also on dune ridges.

The boundary (ecotone) between Sand Fynbos and Strandveld is usually dynamic and rather broad, and is driven primarily by soil pH. This boundary may be very diffuse, or it may be complex, and results in a difficult to map mosaic of vegetation types. The width of the ecotone from pure Strandveld to pure Fynbos may vary from quite abrupt to 2-5 km in certain areas (Mucina & Rutherford 2006). Scarps adjacent to riverine and wetland vegetation often support Strandveld, due to higher salinity in these areas.

Namaqualand Sand Fynbos occurs in the Western and Northern Cape along the coastal plain. The vegetation occurs on slightly undulating plains and is dominated by Cape reeds (Restionaceae) that occur between scattered shrubs. It is classified as **Least Threatened** on a national basis (DEA 2011), with a national conservation target of 29% (Rouget *et al* 2004). The Namaqua National Park has recently incorporated an unknown proportion of this vegetation type (perhaps some 11 000 ha), but the total area statutorily conserved is probably still under 12% of its original extent. It is estimated that about 7% has been transformed by cultivation and by ongoing mineral sand mining near Brand se Baai, which has resulted in the loss of over 3000 ha of this unit. This vegetation type occupies about 29% of the prospecting area, and about 60% of the Roode Heuvel property.

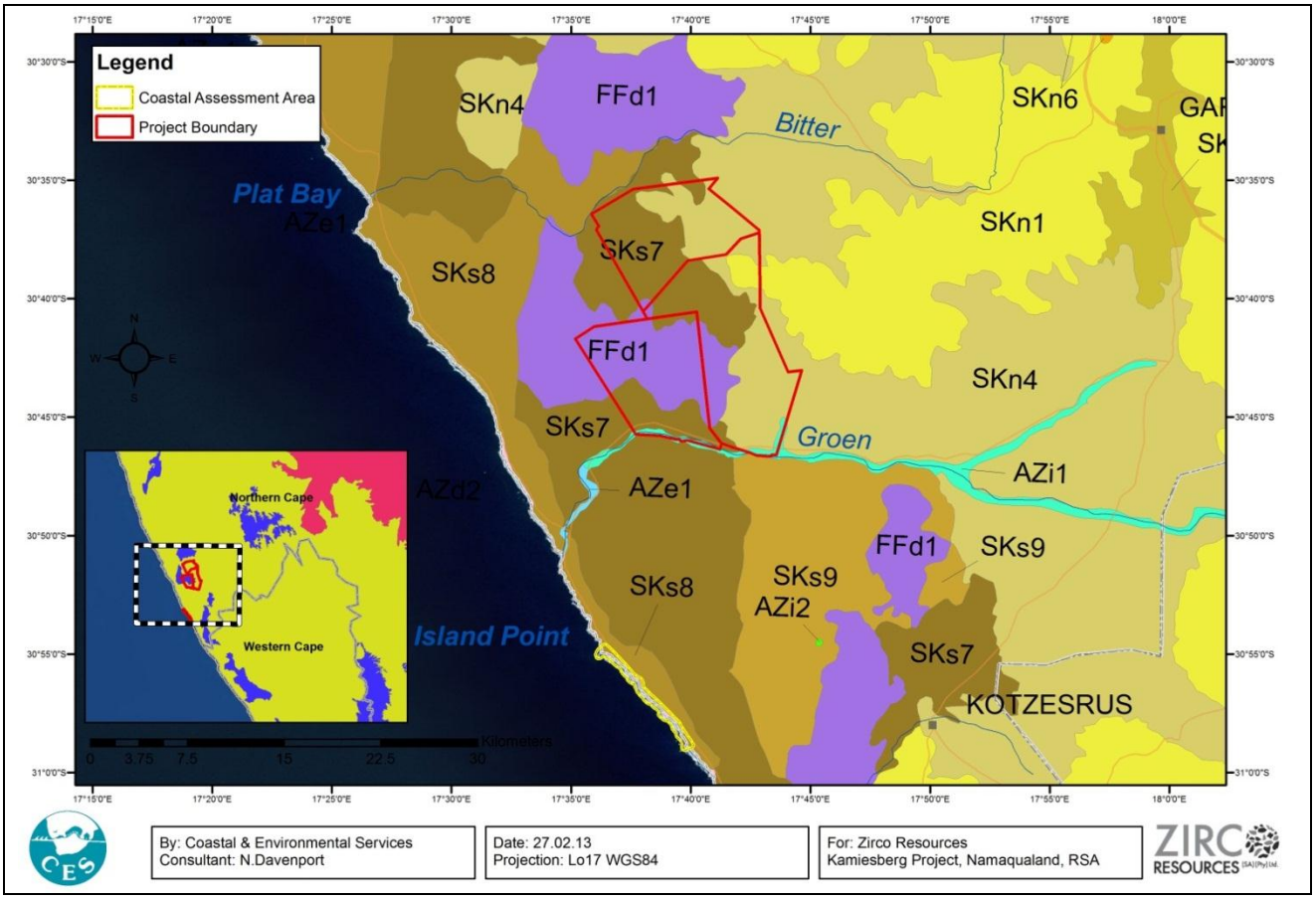


Figure 4.9: Regional vegetation of the study area as per Mucina and Rutherford (2006)
SKs7 - Namaqualand Strandveld; SKn4 – Namaqualand Heuweltjieveld; SKn1 – Namaqualand Klipkpppe Shrubland; FFd1 - Namaqualand Sand Fynbos; AZi1 - Namaqualand Riviere; SKs8 - Namaqualand Coastal Duneveld; AZd2 - Namaqualand Seashore Vegetation.

Namaqualand Riviere (AZi1)

Namaqualand Riviere occurs in the Western and Northern Cape along dry riverbeds throughout Namaqualand. It is characterised by a complex of alluvial shrubland interspersed with patches of tussock graminoids (grasses). Soils are a mix of heavy silts and coarse granitic sands, and are often strongly saline, as reflected by the presence of salt tolerant species such as *Sarcocornia* and *Salicornia*. In places low thickets of *Acacia karroo* and *Tamarix usneoides* are found, and *Phragmites* reeds are common in areas with more regular surface water. The vegetation type is classified as **Least Threatened** (DEA 2011), with a conservation target of 24% (Rouget et al. 2004). Only a small percentage has been statutorily conserved while almost 20% has been transformed through cultivation (Mucina & Rutherford 2006). This vegetation type occupies only about 3% of the prospecting area, and is not present in the proposed mining area.

Namaqualand Coastal Duneveld (SKs8)

This vegetation type occurs in the Western and Northern Cape along the coastal plains. The vegetation is typically dwarf shrubland dominated by erect succulent shrubs and non-succulent shrubs. Spiny grasses are common on the windblown semi-stable dunes. The Namaqualand Coastal Duneveld is classified as **Least Threatened** with a conservation target of 26%. As of 2004 none was statutorily conserved, but the Namaqua National Park has recently incorporated a significant but unknown area of this vegetation type (estimated at about 20% of its total original extent). Some 8% of its original extent has been transformed through diamond mining, mainly in the Hondeklipbaai area (Mucina & Rutherford 2006). This vegetation type occurs in the study area along the coast between Island Point and Knyp Point, but not in the prospecting or mining area.

Namaqualand Seashore Vegetation (AZd2)

Namaqualand Seashore Vegetation is distributed along the Northern Cape coastline, in a very narrow strip above the high water mark, from Holgat River to Olifants River. It is typically found on alkaline coastal dunes, and is typically a sparse vegetation community of partly succulent hummock-forming and spreading dwarf shrubs, grasses and herbs. Namaqualand Seashore Vegetation is classified as **Least Threatened** with a conservation target of 26%. As of 2004 none was statutorily conserved, but the Namaqua National Park has recently incorporated a significant but unknown area of this vegetation type. About 5% has been transformed through diamond mining (Mucina & Rutherford 2006). This widespread vegetation type occurs between the high water mark and the Namaqualand Coastal Duneveld, along the coast between Island Point and Khnyp Point.

ii. Vegetation and floristics of the project area

Prospecting areas

Five (5) key vegetation types occur on the Zirco prospecting areas (Figure 4.2), namely:

1. Strandveld (Namaqualand Strandveld)
2. Sand Fynbos (Namaqualand Sand Fynbos)
3. Heuweltjieveld (Namaqualand Heuweltjieveld)
4. Riparian vegetation (Namaqualand Riviere)
5. Klipkop Shrubland (Namaqualand Klipkoppe Shrubland)

Strandveld (9544 ha) is the dominant vegetation unit in the study area and occurs all along the Groen River basin in the southern sections of Roode Heuvel and Sabies areas (Plate 4.3A). It is also found scattered throughout Sabies, and extends into Leeuvlei (Figure 4.10). Strandveld merges with Sand Fynbos all along the boundary between the two vegetation types, and in places it can be difficult to distinguish a clear boundary. Degraded Strandveld (181 ha) occurs along the southern section of Roode Heuvel (Plate 4.3B). The cause of degradation is overgrazing, resulting from water points and livestock pens (kraals) which occur along the road, and incidentally along the Groen River.

A. Strandveld

B. Previously cultivated and degraded Strandveld which is now dominated by grass species

C. Sand Fynbos, dune slack in foreground, dune ridge behind. The restio *Thamnochortus bachmanii* is dominant in the foreground.

D. Fallow fields in Sand Fynbos

E. Heuweltjieveld, with a high density of dwarf succulents in the foreground

F. Degraded Heuweltjieveld dominated by 'kraalbos' (*Galenia africana*)

G. Riparian bush along the Groen River, with *Acacia karroo*

H. The Groen River riparian vegetation includes salt tolerant succulent shrubs

I. Klipkop shrubland

J. Rocky outcrop with Klipkop Shrubland

Plate 4.3: Examples of the various vegetation types which occur in the prospecting area

Typical species in Strandveld include *Zygophyllum morgsana* (skilpadbos; slaaibos), *Othonna cylindrica* (ossierapuisbos), *Othonna coronopifolia, Tetragonia fruticosa* (klimopkinkelbossie), *Cladoraphis cyperoides*, *Berkheya fruticosa, Tripteris oppositifolia, Osteospermum incanum, Leucoptera nodosa*, *Lycium strandveldense* (muisbos), *Salvia africana-lutea* (bruinstrandsalie), *Limonium peregrinum* (strandroos), *Limonium* sp. nov. (*L. dagmarea* MS), *Calobota angustifolia* (fluitjiesbos), *Ruschia floribunda, R. subpaniculata, R. fugitans, Lampranthus watermeyeri, L. stipulaceus, Heliophila lactea, Euphorbia mauritanica* (melkbos), *Pelargonium gibbosum* (dikbeen malva), *Hermannia trifurca* (poprosie), *H. scordifolia*, *Thesium spinosum, Exomis microphylla, Microloma sagittatum, Pteronia divaricata, Manulea altissima, Stoeberia utilis* (asbos), *Manochlamys albicans* (spanspekbos; seepbos; soutbos), *Cissampelos capensis, Conicosia pugioniformis* ssp. *alborosea* (vetkousie), *Vanzijlia annulata, Phyllopodium pumilum, Gorteria personata, Tylecodon wallichii* (krimpsiektebos), *Eriocephalus racemosa* (kapokbossie; wilderoosmaryn), *Asparagus africana*, *Adenogramma mollugo, Pharnaceum lanatum*, and *Helichrysum tricostatum.* Scattered larger woody shrubs are a feature in some areas, especially in transitions to Sand Fynbos, and may include *Searsia longispina* (taaibos) and *Gymnosporia buxifolia* (pendoring). Grasses may be prominent after rains, mainly *Ehrharta calycina* (rooisaadgras), *Schismus barbatus* and *Stipagrostis zeyheri*. Bulbs include *Babiana brachystachys*, *B. grandiflora*, *Lachenalia unifolia*, *Oxalis flava*, *O. luteola*, *Trachyandra divaricata* (duinekool), *Trachyandra falcata* and *T. muricata* (veldkool), *Drimia capensis* (maerman), and *Boophone haemanthoides* (gifbol).

Relatively few **Species of Conservation Concern (SCC)** are known to occur in true Strandveld, but nevertheless six SCC were recorded in this unit (24% of those in the total study area).

1. *Leucoptera nodosa* (Plate 4.4) is Red Listed as Vulnerable (Helme & Raimondo 2006). This is a succulent shrub in the daisy family, previously known from only five definite localities in the Strandveld between Hondeklipbaai and Lamberts Bay. The species was recorded at three new localities within the study area (see Figure 4.10), and at various other new localities within the Namaqua National Park during the August 2014 survey. The species seems to usually occur as scattered individual plants, although one of the localities (Leeuvlei area) supported what is to date the largest known population of the species (about 150 plants).
2. *Arctotis sp nov.1* is an undescribed perennial daisy known only from this unit, and although widespread (Brand se Baai to Hondeklipbaai) it may be threatened by mining (pers. obs.). As it is yet to be described the species has not been assessed for the Red List.
3. *Calobota lotononoides* (Near Threatened; Helme et al. 2008) is common in this habitat, often on the ecotone with Sand Fynbos.
4. *Helichrysum tricostatum* (Near Threatened) is also fairly common in this habitat, but is a very widespread species (Saldanha to Orange River).
5. *Hermannia* sp nov. is common in this unit, but has not yet been assessed. The species is common in the region from Brand se Baai to Hondeklipbaai.
6. *Wahlenbergia asparagoides* (Vulnerable) is most common in Sand Fynbos, but may also occur in this unit.

Plate 4.4: Leucoptera nodosa is a perennial daisy Red Listed as Vulnerable, photographed here west of Leeuvlei. This is the largest known population of this rare species.

Sand Fynbos (6072 ha) is the second largest vegetation unit in the area. It is the dominant vegetation on Roode Heuvel, but also extends into Sabies and Leeuvlei (Figure 4.10). Sand Fynbos occurs on slightly undulating plains and is often dominated by restios (typically *Thamnochortus bachmanii* and *Restio macer*) in the dune slacks (troughs), and asteraceous fynbos or restios (*Willdenowia incurvata*) on the dune ridges (Plate 4.3C). The vegetation on the dune ridges often includes Strandveld elements.

Species typical of this unit include *Nenax arenicola, Arctotis canaliculata, Willdenowia incurvata* (sonkwasriet), *Thamnochortus bachmanii, Restio macer, Kedrostis psammophila, Ficinia argyropa, Ficinia indica, Grielum humifusum* (pietsnot), *Chrysocoma longifolia., Eriospermum arenosum*, *Salvia lanceolata, Wahlenbergia asparagoides, Lebeckia ambigua, Aspalathus cuspidata, A. quinquefolia, A. spinescens ssp. lepida, Chlorophytum viscosum, Coelanthum*

grandiflorum, Albuca sp., *Nemesia affinis, Justicia cuneata, Elegia sp nov., Diosma ramosissima, Osteospermum incanum, Trichogyne pilulifera, Elytropappus rhinocerotis* (renosterbos), *Stoebe nervigera, Aspalathus cuspidata, Leucospermum rodolentum* (luisbos), *Leucadendron brunioides ssp. brunioides, Metalasia densa, M. adunca, Macrostylis* sp*., Wiborgia obcordata, Ornithoglossum viride* (slangblom), *Moraea ciliata, Calobota lotononoides*, *Muraltia obovata*, *Gethyllis* sp. (kukumakranka), *Asparagus juniperoides, Pteronia onobromoides* and *Limeum africanum*.

This habitat unit is known to support at least **15 SCC**, and is the richest vegetation type in the study area in terms of number of threatened plant species. This is a highly significant number of SCC for a single vegetation unit, being 60% of all SCC recorded in the total study area. See Appendix 2 of the vegetation assessment for a full list of the SCC in this unit, and a list of the significance of the populations of all SCC. Only the most significant are outlined below.

The unit includes a number of undescribed or only recently described species, which is indicative of how poorly known the unit is, or at least was until recently.

- *Elegia* sp nov is a striking, undescribed restio that is only known from the northern Sandveld. Originally (in 2009) recorded close to Kotzesrus, it was found to be fairly common on site (the second known locality) only on the northern edge of Roode Heuvel (Figure 4.11). The August 2014 fieldwork showed that it also occurs in about a 20 ha patch of the adjacent Namaqua National Park, and again in a small area north of the Bitter River, where new cultivation had already resulted in loss of about half this population.
- *Lachenalia* sp nov (Plate 4.5) is a bulb that was first discovered in September 2012 close to Koekenaap, and was then found to be fairly common in the study area, where the Type collection was made, and the species will be described in 2014 (as *L. arenicola* MS). The August 2014 fieldwork revealed this species to be present but never common as far north as Riethuis (giving it a total known range of about 170 km), and is fairly well represented within the Namaqua National Park.
- *Lampranthus procumbens* (Plate 4.6) is a creeping vygie that was described in 2009, and is known from Kommagas south to Kotzesrus, and the species is common on site only in the northern areas of Roode Heuvel. It was found to be common in the adjacent parts of the Namaqua National Park, but was rare elsewhere in the Park.
- *Agathosma elata* is a buchu that was previously only known from near Vanrhynsdorp and Klawer, some 150 km to the southeast, and its discovery here was thus a major surprise. The species is Red Listed as Endangered, and the population in the study area is small. In August 2014 the species was found at various other localities as far north as Riethuis (40km NW of the site), including 3 within the Namaqua National Park, but it is never common, and the total population is small (estimated at <500 plants).
- *Caesia sabulosa* is a common geophyte in Sandveld, but was also only recently described, and is here at or close to its northernmost distribution.

Fallow cereal (oats, rye and wheat) fields (308 ha) occur scattered throughout large sections of the Sand Fynbos communities, especially in the north western sections of Roode Heuvel (Figure 4.10; Plate 4.3D). The Pilot mine (5 ha) is located on Roode Heuvel on the ecotone between Sand Fynbos and Strandveld. These disturbed areas support a limited number of widespread, pioneer species, and generally do not support any SCC. However, a population of *Wahlenbergia asparagoides* (Vulnerable) was observed in the rehabilitated portion of the pilot mine, suggesting that this shrubby species is tolerant of disturbance, and is perhaps a pioneer species. Similar observations from Namakwa Sands support this idea, but it does seem to be the only SCC readily able to colonise the mined areas. Alien invasive species are rare, even in these disturbed areas.

Rehabilitation potential of these disturbed areas is fairly good, as they are generally narrow strips surrounded by extensive areas of natural vegetation which could act as a seed source. Rehabilitation success would be significantly better in the absence of livestock grazing, as heavy grazing of recovering veld promotes the abundance and dominance of unpalatable species such as *Galenia africana* (kraalbos).

Plate 4.5: **This bulbous plant is an undescribed species of *Lachenalia* found in the Sand Fynbos on site (see Figure 4.3), and will be formally described in 2014 as *L. arenicola*.**

Plate 4.6: ***Lampranthus procumbens* is a rare and recently described creeping vygie known only from the northern Sandveld, between Komaggas and Kotzesrus, and is uncommon in the study area. These flowers have yet to open.**

Heuweltjieveld (3798 ha) may be found all along the eastern extent of Leeuvlei, and a large part of north eastern Sabies (Figure 4.10). It generally occurs on undulating topography of the Kamiesberg escarpment foothills, and comprises largely succulent dwarf shrubland communities amongst a mosaic of heuweltjie communities. Degraded Heuweltjieveld (252 ha) occurs in the

south eastern sections of Sabies adjacent to alluvial corridors, and is dominated by the unpalatable shrub *Galenia africana* (kraalbos). This vegetation type may be spectacular after good winter rains, when extensive displays of annuals, herbs and bulbs colour the landscape, and at that stage is capable of supporting a high diversity of insects, birds and other animals.

Common species in this unit include *Drosanthemum hispidum, Othonna sedifolia, Osteospermum pinnatum, Oncosiphon suffruticosum* (stinkkruid), *Zalusianskya villosa, Ursinia cakilefolia, Leysera tenella, Felicia tenella, Zygophyllum retrofractum*, *Aridaria noctiflora, Lycium cinereum, Manochlamys albicans, Ruschia leucosperma,Stoeberia frutescens, Didelta carnosa, Salsola aphylla* (gannabos), *Tetragonia fruticosa, T. spicata, Berkheya fruticosa, Limeum africanum, Lampranthus otzenianum, Psilocaulon foliosum, P. junceum* (asbos), *Ehrharta calycina, Rhynchopsidium pumilum, Oxalis annae* and *Pharnaceum croceum*.

This unit is relatively poorly researched, but at least six **SCC were recorded here, two of which are undescribed species discovered for the first time.** The conservation value of the poorly known quartz patches within this unit (the habitat of 4 of the 6 SCC) is thus Very High (Figure 4.11).

Both the new species were discovered on an isolated quartz patch in the Leeuvlei area, near the Outeep River (Figure 4.11), and both are vygies. The two new species are a species of *Jacobsenia* (Plate 4.7) and a species of *Cheiridopsis* (Plate 4.8). Both species are being sequenced and described by Dr C. Klak of the Bolus Herbarium. Both seem to be restricted to this isolated quartz patch, which is less than 5 ha in extent, and other suitable looking quartz patches in the region (not all within the study area) were surveyed for these species, with no success. This pattern of extreme endemism is not uncommon amongst quartz patch specialists in the region.

Othonna lepidocaulis (Plate 4.9) is a rare, perennial, tuberous daisy known previously only from the Knersvlakte, some 150 km to the south, and its occurrence here, on the same quartz patch (Figure 4.11), is both very interesting and highly significant. *Aloe krapohliana* is a dwarf aloe that was also observed primarily in the vicinity of this quartz patch, and the species is Red Listed as Data Deficient and, according to the available data, should be listed as Threatened (von Staden 2008).

Plate 4.7: A new species of what is likely to be a *Jacobsenia* vygie, discovered near the Outeep River on Leeuvlei. The species will be described by Dr C Klak.

Plate 4.8: A new species of *Cheiridopsis* discovered near the Outeep River, in a different part of the same quartz patch

Plate 4.9: *Othonna lepidocaulis* – a rare species previously only known from 150km to the south, and also found on the quartz patch on Leeuvlei

Riparian (564 ha) areas consist largely of alluvial corridors of the Groen River in the south and Bitter River in the north, but also includes tributary alluvial drainage lines scattered largely in the eastern sections of Leeuvlei and Sabies, commencing in the Kamiesberg escarpment foothills and draining down to the larger river basins (Figure 4.10). The vegetation varies from *Acacia* thicket to alluvial halophytic shrublands. These areas serve as important corridors for bird species.

Acacia karoo is characteristic of this unit, and may form dense thickets in places. The only other notable tree is *Tamarix usneoides*. Shrubs include *Galenia africana* (kraalbos), *Zygophyllum retrofractum, Hoplophyllum spinosum*, *Lycium* spp., *Cephallophyllum* sp., *Malephora lutea, Suaeda fruticosa, Atriplexa cinerea, Salsola tuberculata and Ballota africana*, and the perennial grass *Stipagrostis namaquensis* may be prominent. The succulent *Mesembryanthemum guerichianum* may be prominent in silty areas. Where surface or near surface water accumulates there are also some large patches of reedbed (*Phragmites australis)*, which provide critical roosting sites for many bird species. The reedbeds may be interspersed with *Odyssea paucinervis, Scirpoides dioecus, Juncus* sp. and *Sporobolus virginicus* (brakgras).

Saline areas may be dominated by *Salicornia* sp. (an undescribed species, according to L. Mucina, in Snijman 2013) and *Sarcocornia pillansii* (brakkoraal), with *Salsola* sp. (gannabos), *Odyssea paucinervis* and *Spergularia bocconii*.

No SCC were recorded in this unit, and no such species are likely to occur here in significant numbers.

Klipkop Shrubland (251 ha) vegetation occurs as scattered communities surrounding rocky outcrops of the Kamiesberg escarpment foothills. These can be found in central Leeuvlei and northern Sabies (Figure 4.10). These serve as important sites for local reptile populations.

Typical plant species include *Montinia caryophyllacea* (klappers), *Berkheya fruticosa, Didelta spinosa* (perdebos), *Euphorbia mauritanica* (melkbos), *Leipoldtia schultzei, Manochlamys albicans, Pelargonium crithmifolium, Phyllobolus roseus, Othonna cylindrica, O. furcata, O. macrophylla, Ehrharta calycina, E. barbinodis, Chaetobromus dregei, Stoebera utilis* (asbos*), Senecio junceus, Tylecodon paniculatus* (botterboom), *T. reticulatus, Hermannia disermifolia, Eriocephalus microphyllus* (kapokbos), *Whiteheadia bifolia*, *Calobota sericea, Solanum burchelli, Selago glutinosa, Crassula muscosa, Crassula tomentosa, Conophytum bilobum and C.* spp*., Ornithogalum multifolium, O. rupestre* and *Sarcostemma viminale.*

No SCC are likely to occur within the limited extent of this unit in the study area, but the unit was not surveyed extensively, and it is known to support many SCC in nearby areas.

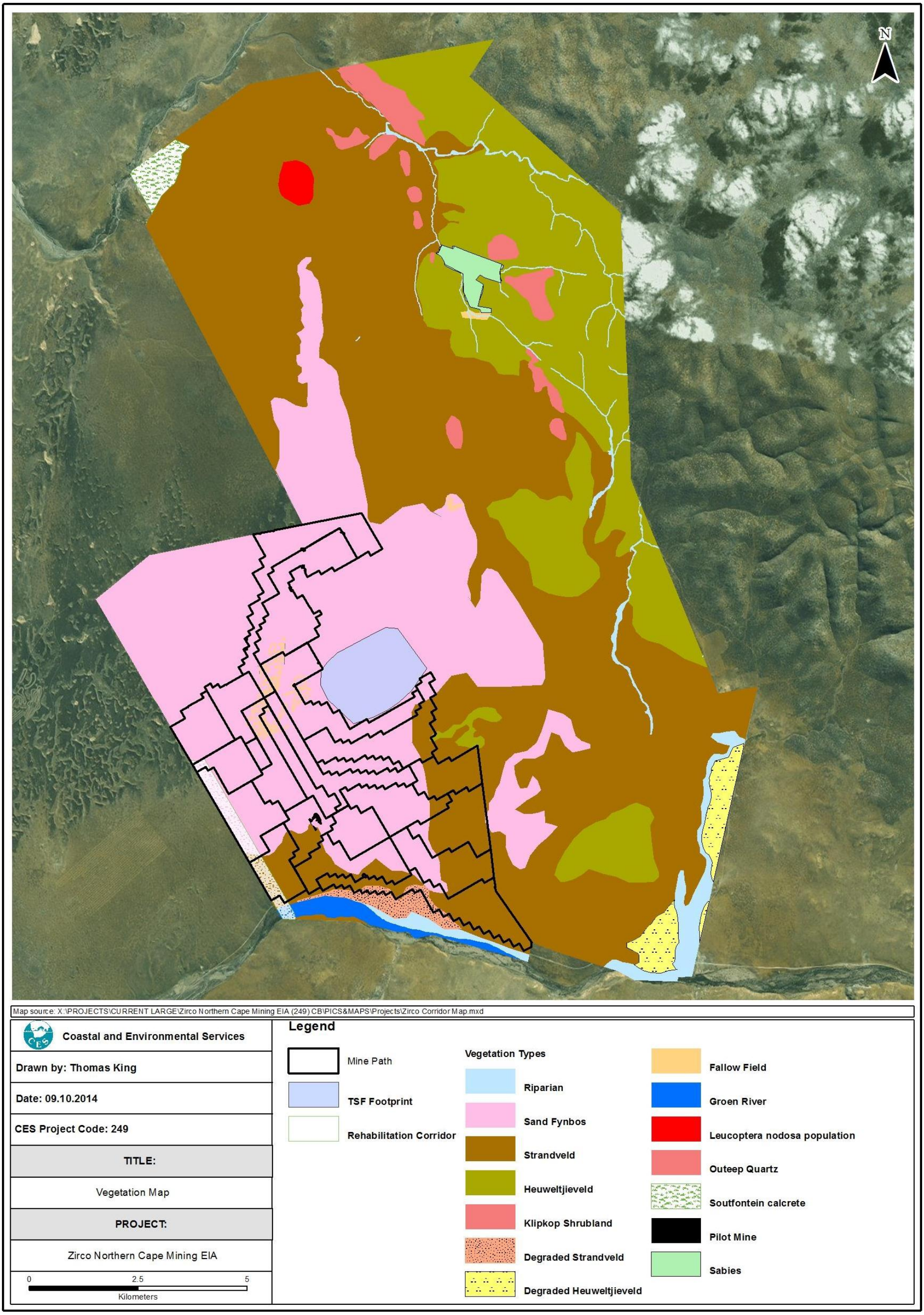


Figure 4.10: Vegetation Map of the Kamiesberg Project area

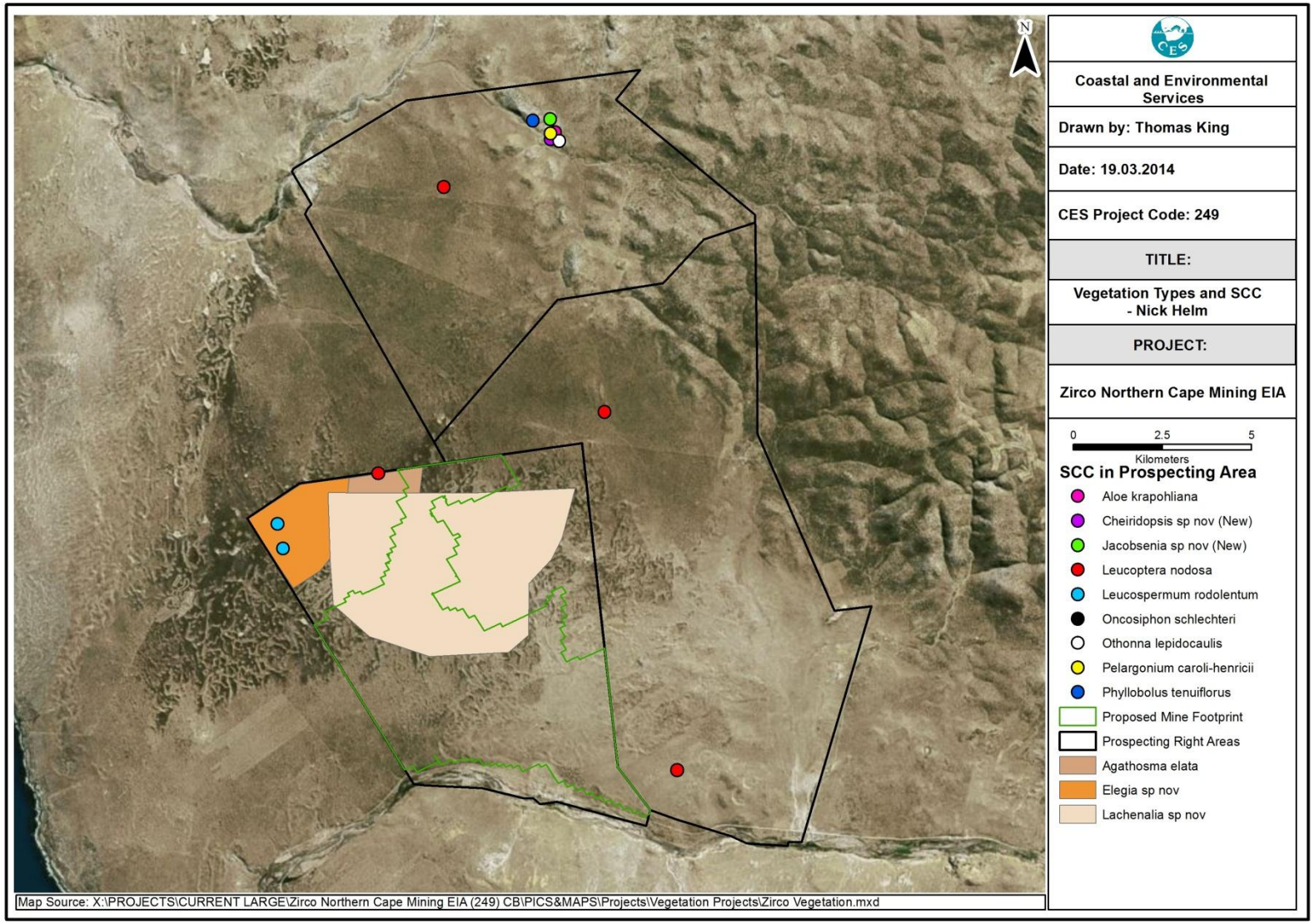


Figure 4.11: Map of 11 of the 23 plant Species of Conservation Concern (SCC) in the project area (black outline). The other 12 SCC are too common and widespread within the RoodeHeuvel property to map at this scale. The green outline is the proposed mine footprint

iii. Coastal Area

Two key vegetation types occur within the coastal assessment area (Figures 4.12-4.15):

1. Seashore Dunes
2. Coastal Duneveld

Seashore Dunes occur as a belt along the coastline, above the high tide water mark, and on the seaward side of the Coastal Duneveld. Essentially it consists of Namaqualand Seashore Vegetation, but also includes transition zones of seashore vegetation occurring on white dune sands, which have taller shrubs, but are not considered part of the Coastal Duneveld (Plate 4.10).

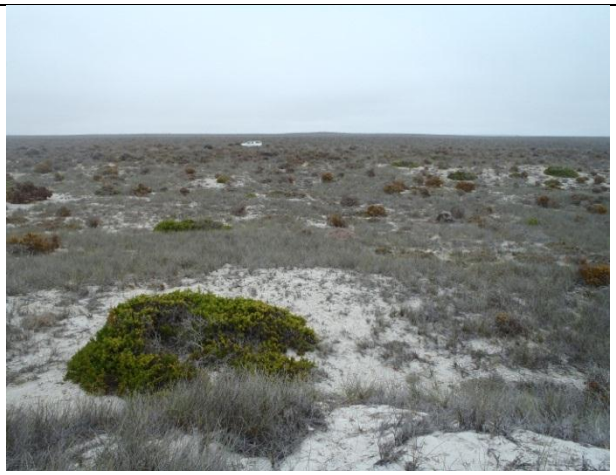
Typical species include *Cladoraphis cyperoides, Eriocephalus racemosus, Lycium strandveldense, Babiana hirsuta, Didelta carnosa, Senecio arenarius, Amphibolia hutchinsonii, Zygophyllum morgsana, Thinopyrum distichum, Arctotheca populifolia, Thesium elatior, Othonna cylindrica, Lessertia* cf. *globosa, Hypertelis angrae-pequenae, Helichrysum tricostatum, Othonna coronopifolia, Arctotis decurrens, Conicosia pugioniformis* ssp. *alborosea, Trachyandra divaricata* and *Tripteris oppositifolia.*

This environment is not known to host many **SCC**, although at Brand se Baai there are at least three SCC in this unit, two of which are local endemics not yet known from the current study area (Desmet & Helme 2003). *Oncosiphon schlechteri* is Red Listed as Endangered, and was recorded only in the vicinity of proposed Gulley Intake 3 (Figure 4.12). What may be *Limonium decumbens* (Data Deficient) was also recorded here. *Helichrysum dunense* (Vulnerable; Helme & Raimondo 2006) is restricted to coastal dunes north of Elands Bay, and was recorded in the study area only in the vicinity of Gulley Intakes 4 and 1 (Figure 4.12). *Manulea cinerea* is restricted to this dune habitat on the Namaqualand coast, and may also occur within the study area (although not recorded), and is Red Listed as Vulnerable (Helme & Raimondo 2005).

Coastal Duneveld is situated on the inland side of the Seashore Dunes, and gradually merges with Strandveld further inland (Plate 4.10 A and D). Common species *Jordaaniella spongiosa, Odyssea paucinervis, Asparagus capensis, Phyllobolus trichotomus, Zygophyllum cordifolium, Z. cuneifolium, Z. morgsana, Mesembryanthemum guerichianum, Dicrocaulon crassum, Ruschia* spp., *Cephallophyllum luteum, Hypertelis salsoloides, Galenia sarcophylla, Didelta carnosa, Drosanthemum* spp*., Leipoldtia schultzei, Osteospermum incanum, Othonna cylindrica, O. sedifolia, Lycium strandveldense* and *Gazania* sp. *aff. krebsiana*.

No SCC were recorded in this unit.

The littoral zone (the area from the high water mark to shoreline areas that are permanently submerged) along the west coast consist of alternating zones of rocky and sandy shores (i.e. sandy beaches), which is true for the coastal assessment area (Figures 4.12-4.15).



A. Seashore Dune vegetation merging inland into Coastal Duneveld, within which the vehicle is parked

B. Seashore Dune vegetation above the high water mark, below which is a sandy beach

C. Seashore Dune vegetation above the high water mark, below which is a rocky shoreline

D. Coastal Duneveld, which in this case comes very close to the littoral zone

Plate 4.10: Examples of the various vegetation types which occur in the coastal assessment area

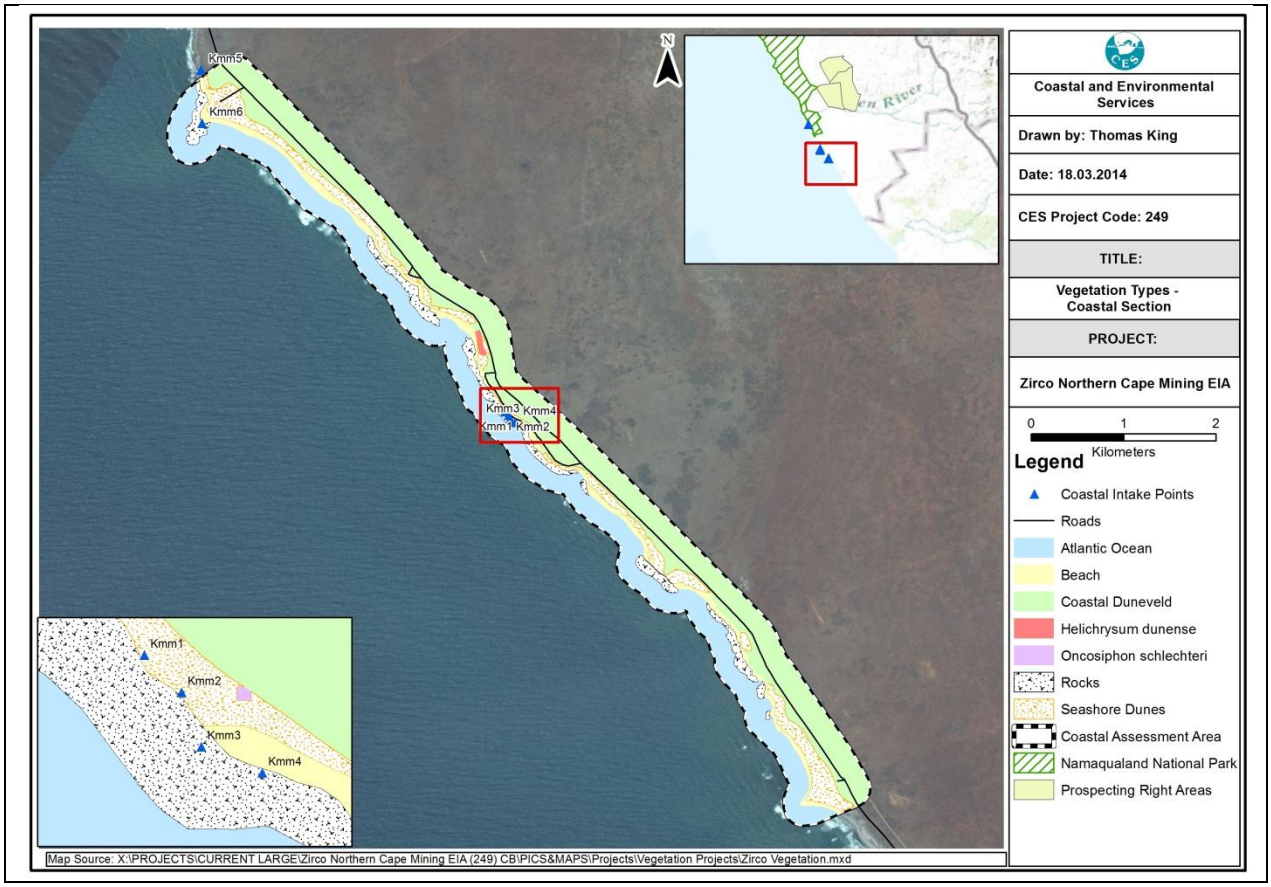


Figure 4.12: Vegetation Map of the coastal assessment area.

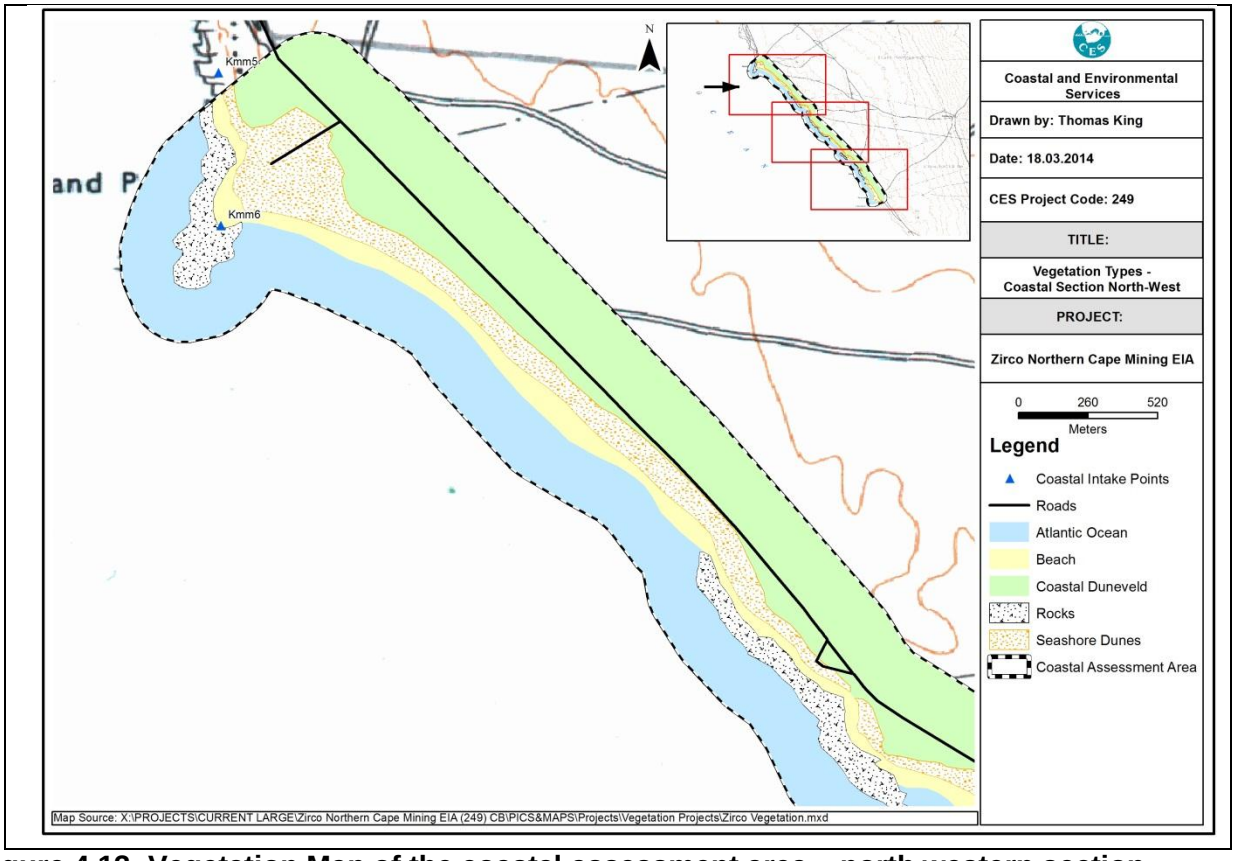


Figure 4.13: Vegetation Map of the coastal assessment area – north western section.

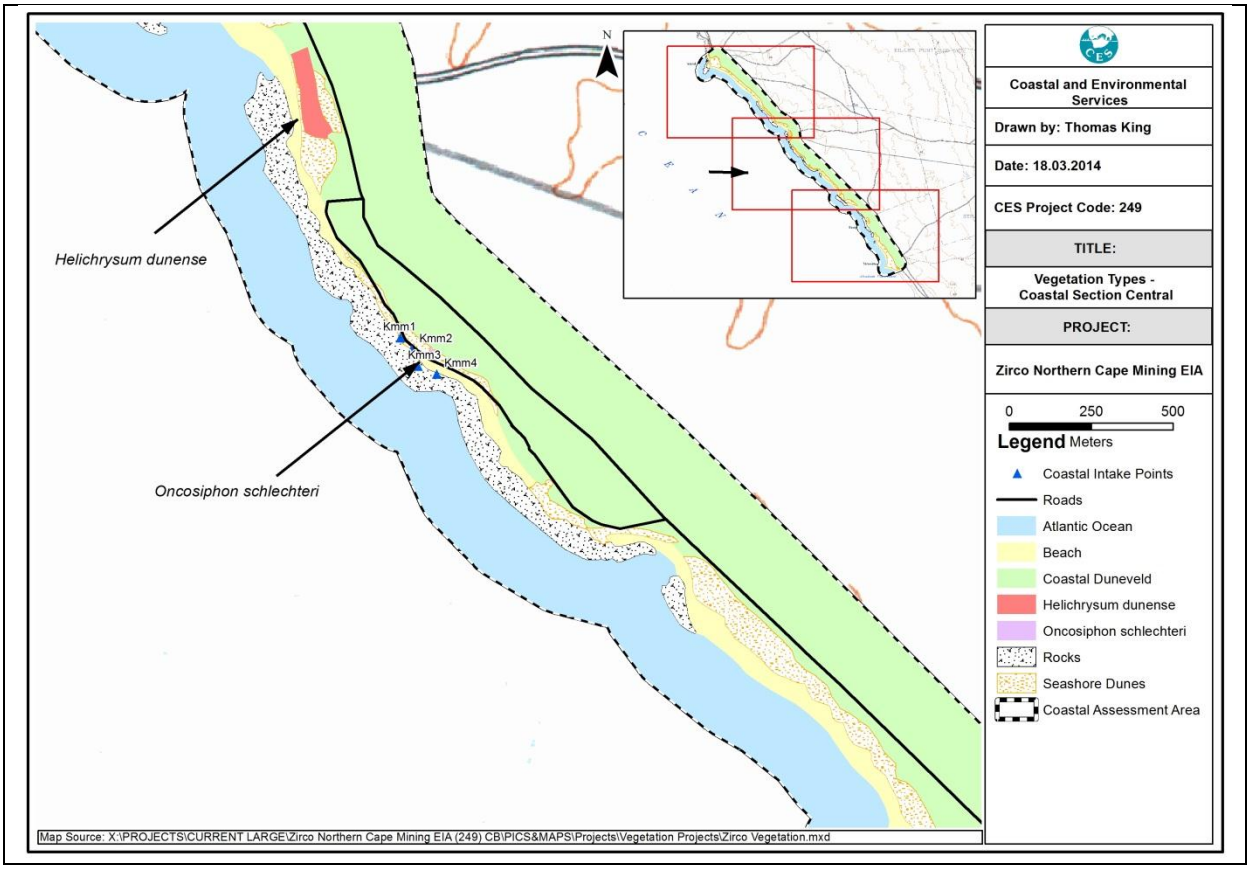


Figure 4.14: Vegetation Map of the coastal assessment area – central section. This map shows the portion of the coastal study area where the two recorded plant Species of Conservation Concern were found

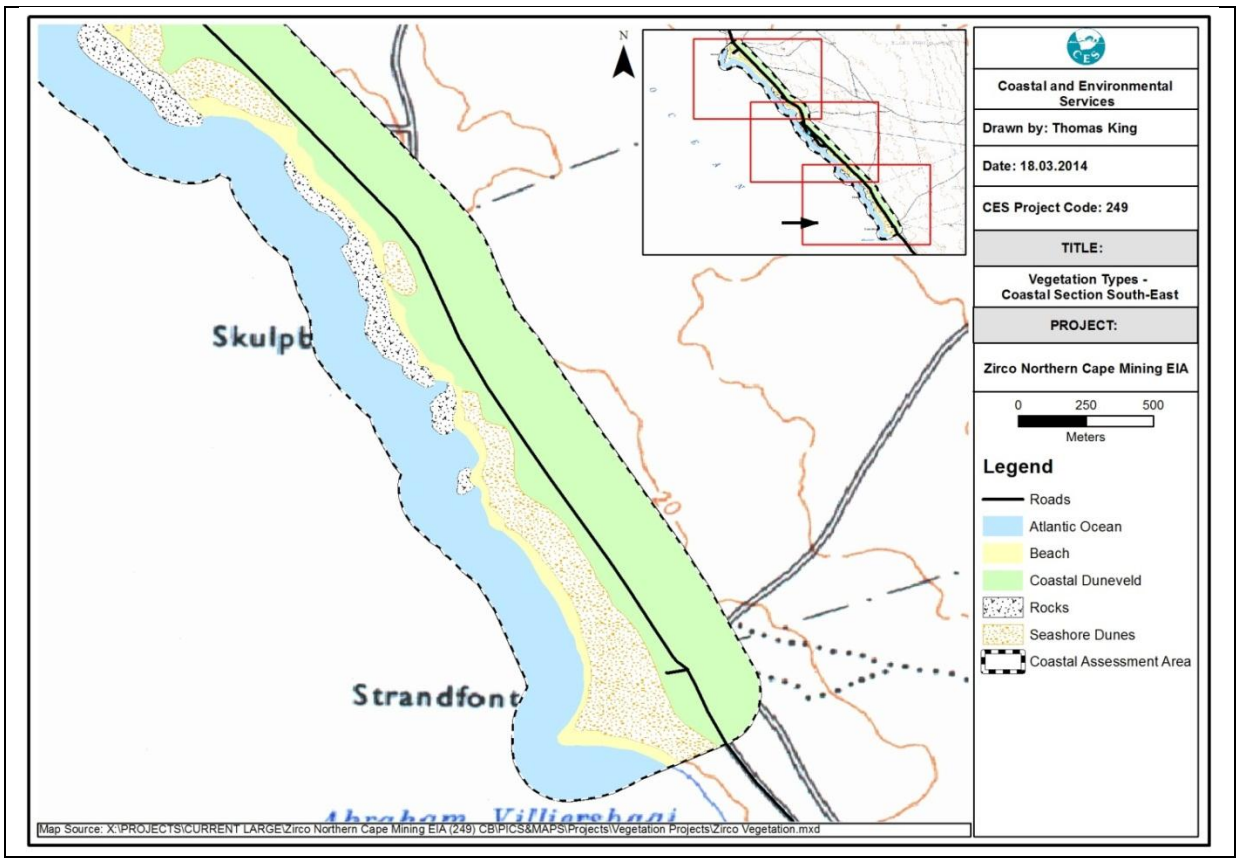


Figure 4.15: Vegetation Map of the coastal assessment area – south eastern section.

iv. Alien Plant Species

Alien invasive plant species are not a major feature of this area, but there are a limited number of invasive species present, most of which occur only in disturbed environments, notably in old lands, around kraals, and along roads. All the invasives currently in the area are likely to become more prominent in an area disturbed by mining, particularly if these areas are grazed after rehabilitation.

Galenia africana (kraalbos) is indigenous, but is also considered as invasive in disturbed and overgrazed areas, as it is unpalatable, and benefits from the lack of competition from more palatable species. The only way to eradicate it is to rest an area from grazing for long periods (>12 years). *Atriplex lindleyi* ssp. *inflata* (klappiesbrak, blasiebrak) is the most common alien invasive in the area, and is likely to be a prominent feature of any areas disturbed by mining. This is a low, grey perennial shrub with wind and water dispersed seeds, and is best removed by mechanical means. *Salsola kali* (Russian tumbleweed; tolbos) is a spiny shrub that also invades disturbed areas, particularly those with higher nutrient loads, such as around kraals, and is common in places. It also has wind dispersed seeds, and can become a problem. The species was noted in the pilot mine rehabilitation areas. *Brassica tournefortii* (wild mustard) is a winter growing annual that can be surprisingly common in sandy soils, even in relatively undisturbed Strandveld. *Erodium moschatum* (cranesbill) is very common annual herb in some areas, but seldom becomes a problem. *Nicotiana glauca* (wildetabak) is most common along watercourses, but is not a problem in the study area. Two species of invasive tree were recorded. *Prosopis glandulosa* (mesquite) also prefers water courses, but will also invade silty soils. It has been planted for shade, firewood and fodder, but can be very difficult to remove once it starts spreading. *Acacia cyclops* (rooikrans) is present in low numbers in the Sand Fynbos areas, mainly in the vicinity of water troughs, and conditions are too arid for it to become a major problem. Various species of alien, annual grasses are likely to be present, including *Vulpia myuros* (ratstail fescue), *Bromus* spp. (brome), *Lolium* spp. (ryegrass), and *Avena* spp. (wild oats), but they are not likely to be a major problem, due mainly to the arid conditions.

v. Floristics and Species of Conservation Concern in the region

Due to the large number of Species of Conservation Concern (SCC) found within the prospecting area, an additional survey was undertaken. This focused on the plant SCC that had been identified within the propecting area and whose populations outside of this footprint area were poorly or not known. The survey was undertaken in August 2014, when most Namakwaland plants are flowering. Two botanist with a good knowledge of the West Coast flora spent over a week in the field specifically to find out if these species occurred elsewhere, and in relatively close proximity to the study area, and if so, where and in what numbers. The secondary aim was to assess possible biodiversity offset areas in terms of the presence of suitable habitat and presence of the focus SCC.

The primary focus was on the following species:

- *Lachenalia* sp. nov. (to be described as *L. arenicola* G. Duncan & N. A. Helme)
- *Elegia* sp. nov.
- *Agathosma elata*
- *Lampranthus procumbens* and
- *Leucoptera nodosa*.

Lachenalia sp. nov.

This species (to be *Lachenalia arenicola* - currently in press) was found to be present as far north as the dunes north of Riethuis, some 63 km north of the project area. It typically occurs as widely scattered plants, in relatively low numbers. Estimated population density in suitable habitat is about 15 plants/ha. The species is thus now known to occur from Riethuis to near Koekenaap, a distance of some 150 km, and the total population, although very difficult to estimate, may be between 35 000 and 100 000 plants, of which as many as 30% may occur within the current boundaries of the Namaqua National Park. The species was found to be widely but sparsely distributed within Focus Areas 10 and 13 (outside the Park, but no data points were taken for this species, and hence it is not mapped in those areas – Figure 4.16)

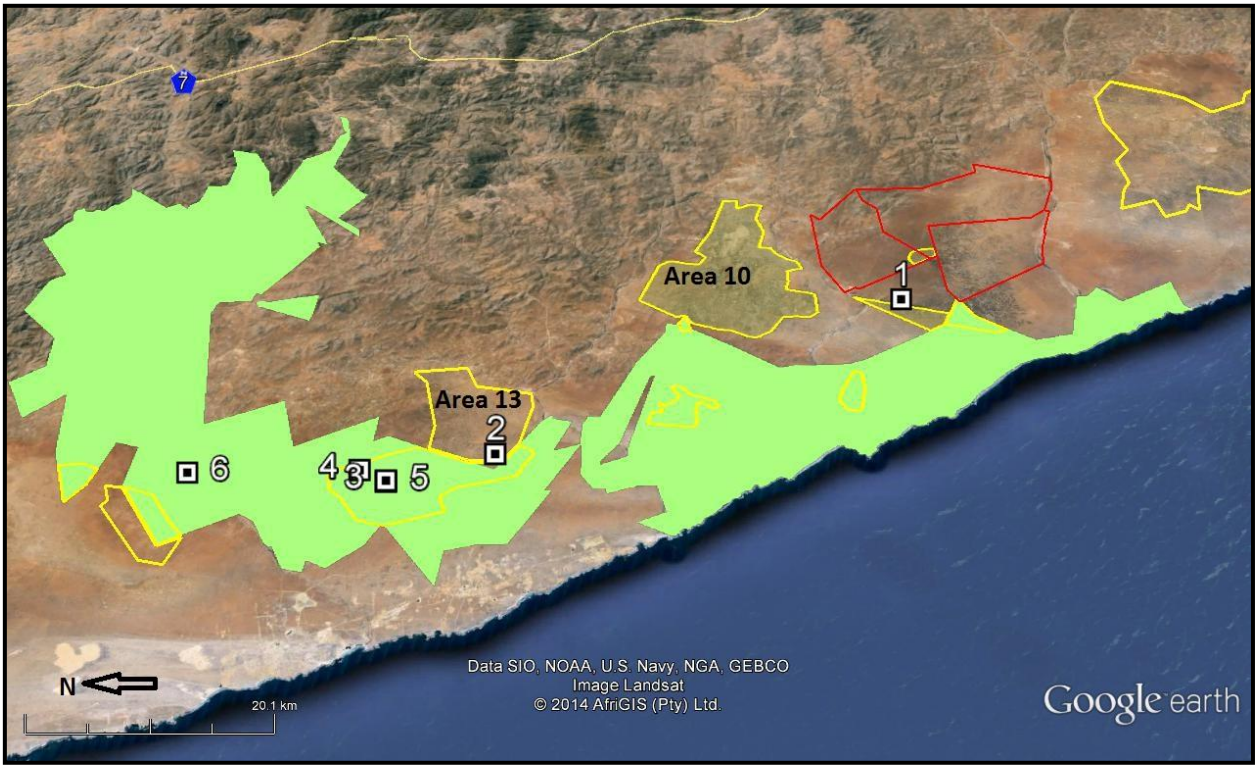


Figure 4.16: The recorded distribution of *Lachenalia* sp nov (numbered squares) in the Namaqua National Park (green shaded area). The Zirco project area is shown as red outlines.

Elegia sp nov.

This species has the most restricted distribution of the focus species, as can be seen in Figure 4.17. In addition to this area it also occurs further south, west of Kotzesrus, where it is also very localised. Its total known range in the study area is 21 km, in which it occupies less than 250 ha. If one includes the Kotzesrus population this expands to a 70 km range, and an occupied area of less than 320 ha. Total population in the current study area is estimated to be about 3000 plants, of which no more than 25% are within the Namaqua National Park. With the inclusion of the Kotzesrus population the total population may be about 4000 plants. The Roode Heuvel project area population occurs in an area of just over 200 ha, which is about two thirds of the total known area for this species, and the property is thus very important in the context of this species.

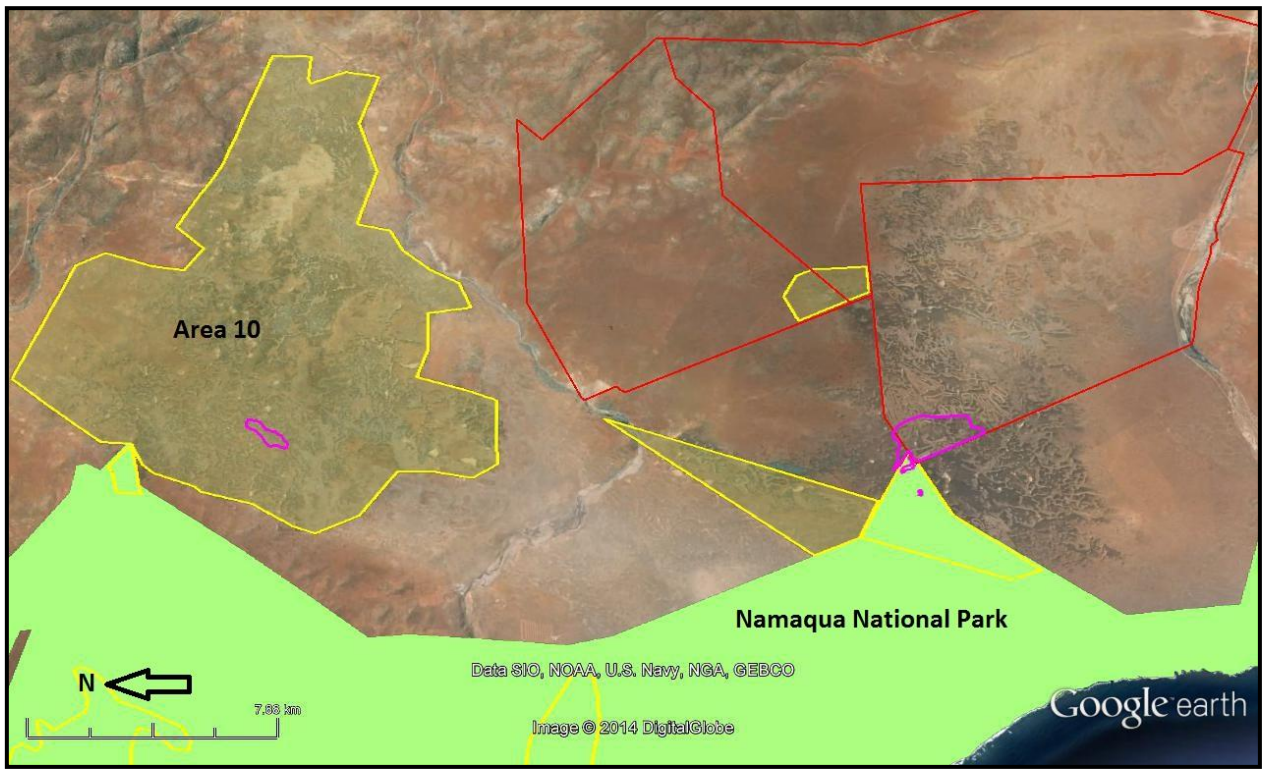


Figure 4.17: The recorded distribution of *Elegia* sp nov (purple polygons) in the total study area. The species is common in the very restricted area where it occurs. The Zirco project area is shown as red outlines.

Agathosma elata

This species, although a perennial shrub, is very cryptic when not in flower. Even allowing for this it appears to be sparsely distributed, and is never very common, although it was found as far north as the Hondeklipbaai area. Given that it occurs as far south as the Vanrhynsdorp area, it has a total range of nearly 200 km, and a possible area of occupation of up to 10 000 ha. The species was not found in Focus Area 13, but was found in a large part of Area 10 (<100 plants) (Figure 4.18). The species was found at two locations within the Namaqua National Park (totalling about 50 plants), but there are almost certainly more, undetected populations in the Park. The Roode Heuvel project area is estimated to support about 10% (50 plants) of the total estimated population (500 plants) of this rather rare, yet widespread species.

Lampranthus procumbens

This creeping succulent may be locally fairly common, and tends to occur in the transition between Sand Fynbos and Strandveld. It has previously been recorded as far north as the Kommagas dunes, and as far south as Kotzesrus – a total range of about 120 km. The population found within the Namaqua National Park was relatively small (estimated to be 10% of the total population of an estimated 3000 plants), whereas the population on the Roode Heuvel project area may constitute as much as 20% of the total population (up to 600 plants). The main populations were actually found in Areas 10 and 13, together estimated to make up about 40% of the total population (Figure 4.19).

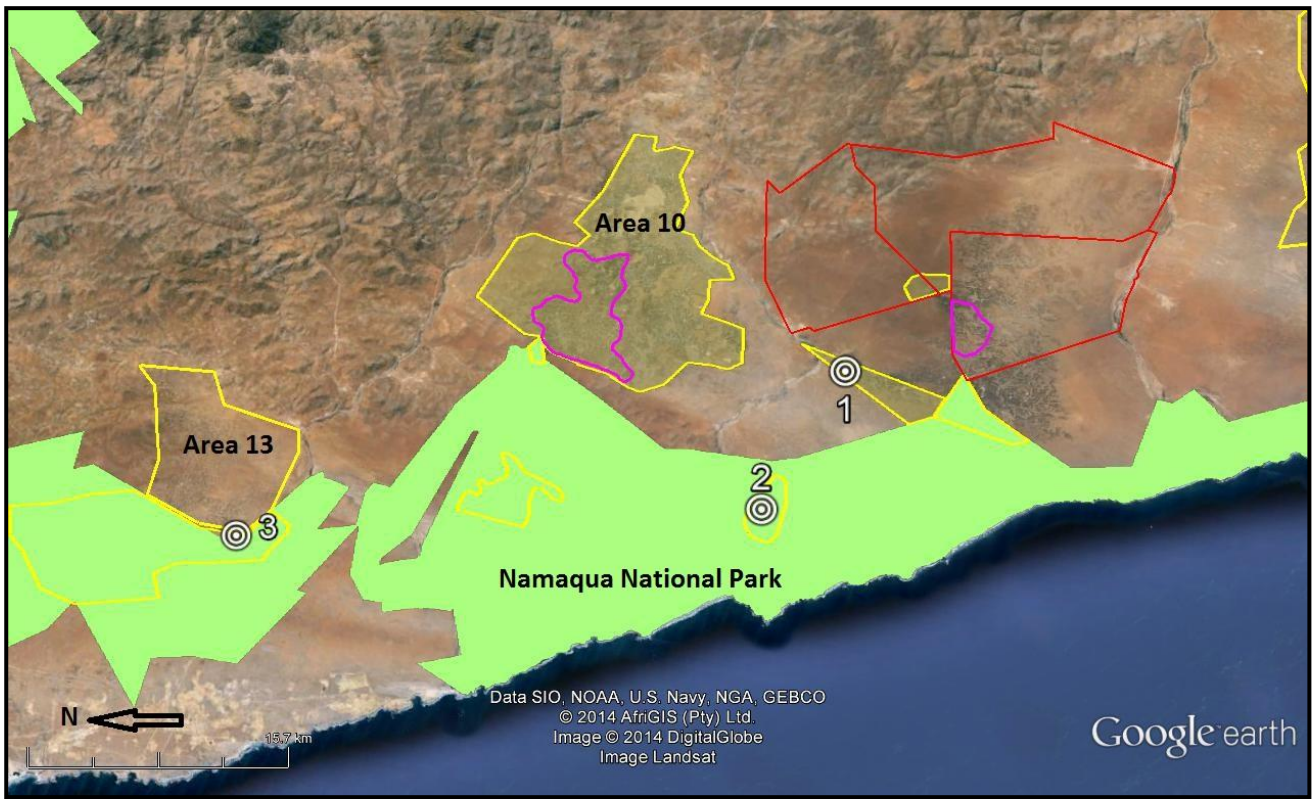


Figure 4.18: The recorded distribution of *Agathosma elata* (purple polygons and numbered circles) in the total study area. The Zirco project area is shown as red outlines.

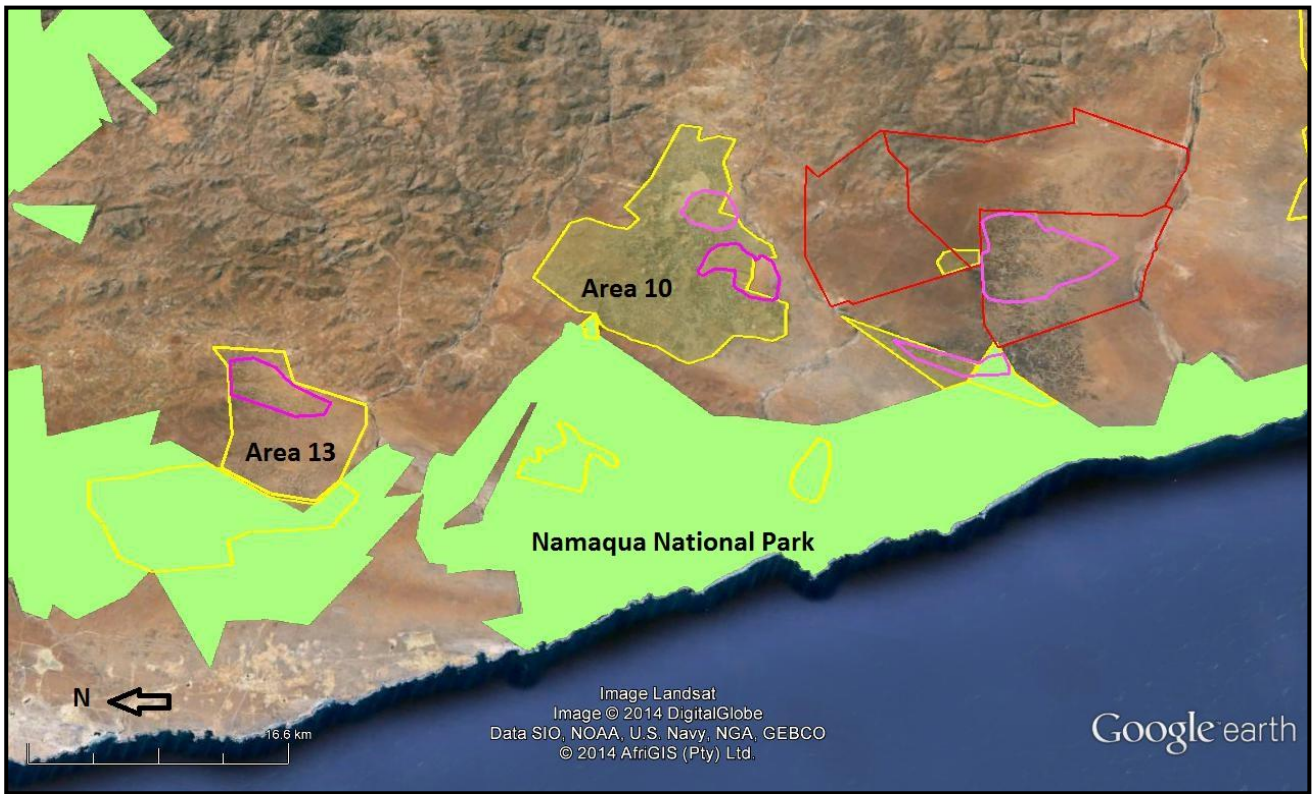


Figure 4.19: The recorded distribution of *Lampranthus procumbens* (purple polygons) in the total study and project area. The Zirco project area is shown as red outlines.

Leucoptera nodosa

This species was found to be fairly common in the Strandveld portions of the Namaqua National Park east of Skuinsbaai (estimated 400 plants), and Simon Todd recorded it as common in Areas 10 and 13 (no estimate of population numbers). The population within the Roode Heuvel project area (<30 plants) is likely to constitute <1% of the total known population, although the population on Leeuvlei (about 400 plants) is still very significant.

Both areas 10 and 13 were found to support significant populations of SCC (including others not discussed in this report), and contain good examples of the key botanical habitats, and are thus identified as potentially suitable biodiversity offset areas, along with the portion of land (De Klipheuvel) shown in Figure 4.18 which includes data point 1.

4.3.2 Fauna

i. Amphibians

Regional Overview of Amphibians

Amphibians are an important and often neglected component of terrestrial vertebrate faunas. They are well represented in sub-Saharan Africa, from which approximately 600 species have been recorded (Frost 2012). Currently amphibians are of increasing scientific concern as global reports of declining amphibian populations continue to appear (Phillips 1994; Blaustein and Wake 1990). Although there is no consensus on a single cause for this phenomenon, there is general agreement that the declines in many areas, even in pristine protected parks, are significant and do not represent simple cyclic events. Frogs have been aptly called bio-indicator species, whose abundance and diversity is a poignant reflection of the general health and well-being of aquatic ecosystems. They are important components of wetland systems, particularly ephemeral systems from which fish are either excluded or are of minor importance. In these habitats, they are dominant predators of invertebrates.

Southern Africa has one of the richest amphibian diversities, comprising 157 species (Du Preez and Carruthers 2009). The arid western region of the Northern Cape Province holds the lowest amphibian diversity (25 species). Only one threatened amphibian species (Desert Rain Frog - *Breviceps macrops:* VU) occurs on the white coastal dunes from Luderitz (Namibia) to Klienzee (South Africa) and is highly threatened by mining and housing developments (Channing and Wahlberg 2011). It is unlikely that this species will occur in the project and associated coastal areas. Amphibians are the least specious group of terrestrial vertebrates in the project area, where only seven species may occur in the study area.

Recorded Amphibians

Only three amphibian species were recorded during the dry and wet season site visits, namely the Namaqua Rain Frog (*Breviceps namaquensis*), Common Platanna (*Xenopus laevis*), and the Cape River Frog (*Amietia fuscigula*). Two are illustrated in Plate 4.11. Two of the three species recorded were not recorded in the immediate region by Minter *et al*. (2004) during their last summary of frog distributions, although their range was likely to include the project area. Both are highly aquatic species, and localized to permanent water sites.

A. Cape River Frog **B. Namaqua Rain Frog**

Plate 4.11: Two amphibian species encountered during the site visit

Amphibians differ in their water requirements for breeding. Rain frogs (*Breviceps* sp.) have direct development, without a free-swimming tadpole stage. The Namaqua rain frog is thus able to breed in sandy habitats throughout the region. Their calls were heard on misty mornings in the Groen River valley, and were likely to also occur on both project sites (inland and coastal). The other frogs in the region have free-swimming tadpoles and their breeding is thus dependent upon standing water. Frogs differ in the length of the tadpole stage and also require non-brackish water for breeding. Species such as the Cape River Frog and Common Platanna have tadpoles that take at least 6-12 months to complete metamorphosis. Their distribution is thus dependent on the presence of permanent water, and the only suitable sites in the region are permanent pools in the Groen River valley (e.g. (30°46'43.3"S, 017°45'54.9"E; 112m asl). No permanent or long-lasting (i.e. 3-4 month) pools occur on either of the two project sites.

Amphibian SCC

No threatened amphibian species or SCC occurs in the project area.

ii. Reptiles

Regional Overview of Reptiles

Reptiles are one of the most diverse and adaptive terrestrial vertebrate groups in the world. However, nineteen percent of all reptile species are currently threatened with extinction (Böhm et al. 2013), with the main threats being habitat destruction, invasive alien species and illegal pet trade. The same trend exists for South African reptiles, with 22% threatened (Bates *et al*. in press).

South Africa has one of the highest reptile diversities in the world, and the highest in Africa, with the highest diversity occurring in the more arid parts of the country (Branch, 1998). Of the 488 reptile species recorded from South Africa (Bates et al. 2013), at least one third (139 species) occur in the Northern Cape (Branch, 1998, plus subsequent studies). Reptile diversity in the study region is high, with 54 species known or likely to occur (Branch 1998); this includes 17 snakes, 32 lizards, and 4 chelonians.

Recorded Reptiles

Of the possible 54 reptile species likely to occur in the project area, 10 were recorded during the dry season survey and an additional four species were recorded during the subsequent wet season survey (Plate 4.12). An additional two, easily recognized species, the Puffadder (*Bitis arietans*) and Cape Cobra (*Naja nivea*) were also known to local farmers. 45 species have been

recorded from the general region (SARCA maps; Bates et al. 2013), and an additional 20+ species may be present on the project site.

Reptile SCC

The Leatherback Turtle (*Dermochelys coriacea*) is the only threatened reptile species or SCC that has been recorded from adjacent areas and thus is likely to occur in the project site (See Table 4.5). It has been recorded once along the shores around Groen River mouth, and the rocky coastline and cold water is unsuitable for turtle nesting beaches. This species is rare along the west coast of the subcontinent, although the species is tolerant of cold water.

Four other 'threatened reptiles, i.e. the Armadillo Girdled Lizard (*Ouroborus cataphractus*), the Namaqua Plated Lizard (*Gerrhosaurus typicus*), the Namaqua Dwarf Adder (*Bitis schneideri*) and the Namaqua Day Gecko (*Phelsuma ocellata*), are all currently listed as threatened on the IUCN data base of Red Listed species. However, the status of all four species has been downgraded to Least Concern in the latest South African Red List (Bates *et al*. 2013), and these assessments have been approved by the IUCN and will be incorporated into the global data base. All the species are endemic to South Africa, and are currently threatened by existing impacts such as coastal diamond mining and habitat loss/degradation from agriculture. Two charismatic species, i.e. the Armadillo Girdled Lizard and the Namaqua Dwarf Adder, are also threatened by illegal collection for the pet trade. The status of all species, although currently none are considered of conservation concern, has been recommended for monitoring.

A. Southern Rock Agama

B. Southern Spiny Agama

C. Bibron's Thick-toed Gecko

D. Weber's Thick-toed Gecko

E. Karoo Girdled Lizard

F. Knox's Desert Lizard

Plate 4.12: Six of the common lizards recorded during the site visit

G. Angulate tortoise

H. Speckled padloper

I. Karoo Tent Tortoise

J. Trimen's Tent Tortoise

K. Wedge-snouted Sand Lizard

L. Barnard's thick-toed Gecko

Plate 4.13: Other reptiles were recorded during the site visit

Ten reptile species are also listed in CITES Appendix II, including three girdled lizards, three tortoises, one marine turtle, two chameleon and one gecko species. All are common throughout much of the region, and/or further afield, and all are well protected in existing conserved areas with no evidence of illegal or unsustainable exploitation in the region. Their inclusion on CITES Appendix II is a precautionary measure covering all members of groups that are regularly involved in the international skin (monitor lizards) or pet trade (tortoises, chameleons and girdled lizards).

Table 4.5: Threatened reptile species likely to be encountered in the project area and surrounds

Full Name	*Scientific Name*	IUCN	SARCA	CITES	Possible*	Recorded
Leatherback Turtle	*Dermochelys coriacea*	CR (G)	EN (R)	1	1	
Armadillo Girdled Lizard	*Ouroborus cataphractus*	VU	LC	1	1	
Namaqua Plated Lizard	*Gerrhosaurus typicus*	VU	LC		1	
Namaqua Dwarf Adder	*Bitis schneideri*	VU	LC		1	
Namaqua Day Gecko	*Phelsuma ocellata*	NT	LC	1	1	
Angulate Tortoise	*Chersina angulata*			1	1	1
Speckled Padloper	*Homopus signatus signatus*			1	1	1
Tent Tortoise	*Psammobates tentorius trimeni*			1	1	1
Namaqua Dwarf Chameleon	*Bradypodion occidentale*			1	1	
Desert Ground Chameleon	*Chameleo namaquensis*			1	1	
Karoo Girdled Lizard	*Karusasaurus polyzonus*			1	1	1
Peer's Girdled Lizard	*Namazonurus peersi*			1	1	
Totals	**5**	**5**	**1**	**10**	**12**	**4**

CR = Critically Endangered , EN = Endangered; VU = Vulnerable; NT = Near Threatened, G = Global Assessment, R = Regional Assessment.
* All have been previously recorded from the adjacent areas, except Desert Ground Chameleon.

iii. Birds

Regional Overview of birds

Despite the floral uniqueness of Namaqualand, it shares most of its bird species with the wider Karoo regions of Bushmanland and the Tanqua Karoo. The Karoo supports a particularly high diversity of bird species endemic to southern Africa. Its avifauna characteristically comprises ground-dwelling species of open habitats. Rainfall in the Nama-Karoo falls mainly during the austral summer, while the succulent Karoo lies within the winter-rainfall region. This provides opportunities for birds to migrate between the Succulent Karoo and the Nama-Karoo, to exploit the enhanced conditions associated with rainfall. A high frequency of endemics and near-endemics with their ranges centred in the Karoo are in the lark family (Alaudidae), including Barlow's Lark (*Certhilauda barlowi*), Karoo Lark (*C. albescens*), Karoo Long-billed Lark (*C. subcoronata*), Cape Long-billed Lark (*C. curvirostris*), Red Lark (*C. burra*), Sclater's Lark (*Spizocorys sclateri*) and Large-billed Lark (*Galerida magnirostris*), as well as Black-eared Sparrowlark (*Eremopterix australis*) (Barnes *et al*. 2001).

Many typical karroid species are nomads, able to use resources that are patchy in time and space (Barnes *et al*. 2001). Although a few birds are commensal, rapidly and successfully adapting to modified environments, the majority of birds are sensitive to disturbance and either migrate away from, or suffer greater mortality within, degraded habitats. However, because of their high mobility, birds are capable of rapidly re-colonising rehabilitated habitats.

The study area is not situated in or near an Important Bird Area (IBA - Birdlife International, 2013). However, the Namaqua National Park lies adjacent to the study area. Species in the park include Cinnamon-breasted Warbler, Cape Long-billed Lark, Karoo Lark, Black-headed Canary, Cape Bulbul, and Black Harriers scan the ground in search of rodents.

According to the Cape Birding Route[3], the gravel road that links Garies with the mouth of the Groen River is one of the best areas to find the Ludwig's Bustard, an endangered bustard species. Other birds include Southern Black Korhaan, Karoo Lark, Southern Grey Tit, Mountain Chat, Chat Flycatcher and Bokmakierie. Acacia Pied Barbet and Pririt Batis occur in the scattered patches of trees along the Groen River. The Groen River Estuary and a section of the Groen River itself is listed as a very important aquatic biodiversity area according to SKEP and the Namakawa Biodiversity Sector Plan and offers good waterbird habitat, suitable for Greater Flamingo, South African Shelduck and Cape Teal. African Black Oystercatcher occurs along the coast and Cape Long-billed Lark is common in the coastal scrublands.

Recorded Birds

Of the possible 431 bird species which occur in the Northern Cape province of South Africa, 246 species may occur in or near the project area, including seabirds. Of these 246 species, 83 were observed during the dry season survey and 92 were observed during the wet season survey, together accounting for 112 of the 246 possible species.

Of the recorded species in the project area, 2 species (House Sparrow and Common Starling) have been introduced by humans, while 7 species (Booted Eagle, Common Quail, Grey Plover, Common Tern, Common Swift, Barn Swallow and Willow Warbler) are non-breeding migrants, 3 species (African Black Oystercatcher, Alpine Swift and African Reed Warbler) are breeding migrants, and 19 species (Jackal Buzzard, Black Harrier, Cape Clapper Lark, Karoo Lark, Large Billed Lark, Grey Tit, Karoo Thrush, Karoo Prinia, Namaqua Warbler, Fiscal Flycatcher, Fairy Flycatcher, Layard's Tit-Babbler, Pied Starling, Southern Double-collared Sunbird, Black-headed Canary and Cape Weaver) are near endemics.

It is worth noting that one third of the potential species (79 of the potential 246 species) are oceanic and/or coastal bird species, which are highly unlikely to occur within the terrestrial section of the project area.

Plate 4.14: Secretary Bird (*Sagittarius serpentarius*), northern border of the project area

[3] http://www.capebirdingroute.org/Namaqualand_Garies.htm

Birds SCC

Out of the possible 246 bird species which may occur in the greater project area, 33 may be considered species of conservation concern (SCC) (Table 4.6); 14 of which were recorded on site. Twenty one (21) of these SCC are globally threatened according to IUCN: five Endangered species; seven Vulnerable species; and nine Near Threatened species (Table 4.6).

At a finer scale, the Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland identify 28 threatened species made up of one Endangered species; nine Vulnerable species; and 18 Near Threatened species (Table 4.6).

Three bird species (Southern Black Korhaan, Cape Long-billed Lark and Cape Bulbul) are endemic South African species, all of which were recorded during the site visit (Table 4.6).

The most significant avian SCC recorded on site included the Ludwig's Bustard (En), Secretary Bird (Vu) and Black Harrier (Vu). These are all wide-ranging species whose population declines result from numerous and wide-spread anthropogenic threats.

Table 4.6: Bird SCC likely to be encountered in the greater project area

Full Name	*Scientific Name*	IUCN	RD	E	Possible	Recorded
Black-browed Albatross	*Thalassarche melanophrys*	EN	NT		1	
Atlantic Yellow-nosed Albatross	*Thalassarche chlororhynchos*	EN	NT		1	
African Penguin	*Spheniscus demersus*	EN	VU		1	
Bank Cormorant	*Phalacrocorax neglectus*	EN	VU		1	
Ludwig's Bustard	*Neotis ludwigii*	EN	VU			1
Spectacled Petrel	*Procellaria conspicillata*	VU	EN		1	
White-chinned Petrel	*Procellaria aequinoctialis*	VU	NT		1	
Secretarybird	*Sagittarius serpentarius*	VU	NT			1
Black Harrier	*Circus maurus*	VU	NT	(*)		1
Wandering Albatross	*Diomedea exulans*	VU	VU		1	
Grey-headed Albatross	*Thalassarche chrysostoma*	VU	VU		1	
Cape Gannet	*Morus capensis*	VU	VU		1	
Cape Cormorant	*Phalacrocorax capensis*	NT	NT			1
Crowned Cormorant	*Phalacrocorax coronatus*	NT	NT		1	
Lesser Flamingo	*Phoeniconaias minor*	NT	NT			1
African Black Oystercatcher	*Haematopus moquini*	NT	NT			1
Chestnut-banded Plover	*Charadrius pallidus*	NT	NT		1	
Shy Albatross	*Thalassarche cauta*	NT	VU		1	
Martial Eagle	*Polemaetus bellicosus*	NT	VU			1
Sooty Shearwater	*Puffinus griseus*	NT			1	
Maccoa Duck	*Oxyura maccoa*	NT				1
Southern Giant Petrel	*Macronectes giganteus*		NT		1	
Northern Giant Petrel	*Macronectes halli*		NT		1	
Great White Pelican	*Pelecanus onocrotalus*		NT		1	
Black Stork	*Ciconia nigra*		NT		1	
Greater Flamingo	*Phoenicopterus roseus*		NT			1
Peregrine Falcon	*Falco peregrinus*		NT		1	
Lanner Falcon	*Falco biarmicus*		NT			1
Caspian Tern	*Sterna caspia*		NT		1	
Kori Bustard	*Ardeotis kori*		VU			1

Full Name	*Scientific Name*	IUCN	RD	E	Possible	Recorded
Southern Black Korhaan	*Afrotis afra*			*		1
Cape Long-billed Lark	*Certhilauda curvirostris*			*		1
Cape Bulbul	*Pycnonotus capensis*			*		1
Totals	**33**				**19**	**14**

* = Endemic to South Africa; (*) = near endemic; EN = Endangered; VU = Vulnerable; NT = Near Threatened.

iv. Mammals

Regional Overview of Mammals

Among the vertebrates of South Africa, most lineages display very high incidences of endemism. Some 20% of South Africa's mammals are endemic, as were the famous and now extinct Quaqqa (*Equus quagga quaqqa*) and Blue Antelope (*Hippotragus leucophaeus*). Although most of the endemic mammals are small, primarily among the rodents (*Rodentia*) and golden moles (*Chrysochloridae*), South Africa also has an impressive collection of endemic large ungulates, including Cape Mountain Zebra (*Equus zebra zebra*), Black Wildebeest (*Connochaetes gnou*), Bontebok (*Damaliscus dorcas dorcas*), Blesbuck (*Damaliscus dorcas phillipsi*), Cape Grysbok (*Raphicerus melanotis*) and Grey Rhebuck (*Pelea capreolus*) (Barnes et al. 2001).

Large game makes up less than 15% of the mammal species in South Africa and a much smaller percentage in numbers and biomass. In the Succulent Karoo, large mammals are not generally a feature with the majority of mammals present being small to medium-sized (Driver *et. al.* 2003). Mammal species that have adapted to these harsh conditions include klipspringer, aardvark, baboon, steenbok, duiker, porcupine, black-backed jackal and leopard. In a study done on small mammal community structure in Namaqua National Park, rodents trapped were predominantly *Gerbillurus paeba* and *Aethomys namaquensis*, with fewer *Mus minutoides* and *Petromyscus* sp. The only non-rodent was the elephant shrew *Elephantulus edwardii* (van deventer & Nel 2006).

Seventy-three mammal species occur within the Succulent Karoo with three being endemic. Of these, De Winton's golden mole (*Cryptochloris wintoni*) and Van Zyl's golden mole (*Cryptochloris zyli*) are insectivorous and the Namaqua dune molerat (*Bathyergus janetta*) is herbivorous. Fifty seven of these species are likely to occur in and around the study site, with a further 11 species which occurred in the area historically (e.g. Cape lion, Black rhino, Elephant, Eland etc.). In addition, 25 marine mammals (e.g. Seals, Dolphins and Whales) may occur in the Atlantic Ocean adjacent to the greater project area.

Recorded Mammals

Of the 57 terrestrial mammal species which may occur in the study region, 16 were observed during the dry season survey, and 16 were observed during the wet season, accounting for 21 species. These were all small mammals such as rodents and small carnivores, with the exception of a Cape Fur Seal which was observed along the coast. Four of the observed mammals can be considered large, namely, Steenbok (Plate 4.15), Springbok (Plate 4.16), Grey Duiker and Bat-eared Fox.

Plate 4.15: Steenbok (*Raphicerus campestris*) and Springbok (*Antidorcas marsupialis*)

Mammal SCC

Of the 57 terrestrial mammal species which may occur on site, 10 are considered to be SCC. The most relevant SCC includes the Endangered van Zyl's Golden Mole, the Vulnerable Small Spotted Cat, and the Near Threatened Schreiber's Long-fingered Bat (see Table 4.7).

The project area is also highly relevant in terms of the golden moles, which inhabit sandy areas such as that of the dunes and sand fynbos areas of the project area. The Grant's Golden Mole is listed by the South African Red Data Book of the Mammals of South Africa (RDBMSA) as Vulnerable, and the Cape Golden Mole as Data Deficient. Both species are likely to occur on site (refer to Plate 4.16).

It is possible that the van Zyl's Golden Mole could occur in the project area, as the species is known to inhabit the coastal dune belt and adjacent sandy areas in Strandveld Succulent Karoo. Until recently, this species was recorded from only the type locality near Lambert's Bay, South Africa (Helgen and Wilson 2001). Another specimen was collected at Groenriviermond, some 150 km further north (north of Lambert's Bay) along the Namaqualand coast in November 2003, suggesting that the range of this species is more extensive than previously recognized, and this may have consequences for its current conservation assessment (IUCN 2012).

In addition, the Namaqua Dune Molerat (Near Threatened according to RDBMSA) also inhabits areas of coastal sand dunes, and consolidated alluvial soils with mean annual rainfall less than 400 mm. It is a subterranean and largely solitary species. There are three isolated populations, one from Alexander Bay, Orange River, the second from Port Nolloth to Groen Rivier, and the third from Steinkopf to Kamieskroon and the Kamiesberg (South Africa). The species rarely occurs above 300 masl. Evidence of a mole-rat was recorded at an altitude below 300 masl (Plate 4.16).

The Small Spotted Cat (also referred to as the Black-footed Cat) is rare compared to the other small cats of southern Africa (Sliwa 2008). The species is endemic to southern Africa and is found primarily in Namibia and South Africa, but also Botswana, and marginally in Zimbabwe and likely marginally in extreme southern Angola. This species is a cat specialist of open, short grass areas with an abundance of small rodents and ground-roosting birds. It inhabits dry, open savanna, grasslands and Karoo semi-desert with sparse shrub and tree cover and a mean annual rainfall of between 100 and 500 mm at altitudes of 0-2,000 m (IUCN 2012). While this species is rated as Vulnerable by the IUCN, the RDBMSA classify it as Least Concern. This species may occur on site.

Plate 4.16: Left: Evidence of Golden Moles, in the form of a tunnel trail, most likely that of the Grants Golden Mole (*Eremitalpa granti*). Right: Evidence of a Molerat, most likely the Namaqua Dune Molerat (*Bathyergus janetta*)

Schreiber's Long-fingered Bat may pass through the site, but no appropriate roosting sites were recorded. This species forages in a variety of open and semi-open natural and artificial habitats, including suburban areas. It feeds mainly on moths, and occasionally on flies. It is a colonial species that roosts mostly in caves and mines, often in large mixed colonies with other cave-dwelling bat species. Large warm caves are preferred during the nursing season. In winter it hibernates in underground sites. Schreiber's bat is a migrant species which changes its roosts several times during the year; long-distance movements occur occasionally (IUCN 2012).

Table 4.7 lists the SSC likely to occur on site; 2 of these species were recorded on site. Many species which occurred in the area historically are threatened species which are also listed in Table 4.7.

The large majority of marine mammals which occur along the South African west coast (Table 4.7) are Data Deficient, and thus cannot be assessed, whilst three are endangered and one other is Vulnerable (IUCN, 2012).

Table 4.7: Mammals SCC which are likely to occur or have occurred (indicated as historical) within the project area

English Name	Scientific Name	IUCN	RDB	Historical	Possible	Present
TERRESTRIAL MAMMALS						
Van Zyl's Golden Mole	*Cryptochloris zyli*	EN	CR		1	
Wild Dog	*Lycaon pictus*	EN	EN	1		
Small Spotted Cat	*Felis nigripes*	VU			1	
Cheetah	*Acinonyx jubatus*	VU	VU	1		
Lion	*Panthera leo*	VU	VU	1		
African Elephant	*Loxodonta Africana*	VU		1		
Hook-lipped Rhinoceros	*Diceros bicornis bicornis*	VU	CR	1		
Straw-coloured Fruit Bat	*Eidolon helvum*	NT			1	
Schreiber's Long-fingered Bat	*Miniopterus schreibersii*	NT	NT		1	
Brown Hyaena	*Hyaena brunnea*	NT	NT		1	
Leopard	*Panthera pardus*	NT		1		
Cape Golden Mole	*Chrysochloris asiatica*		DD		1	
Grant's Golden Mole	*Eremitalpa granti*		VU			1
Cape Horseshoe Bat	*Rhinolophus capensis*		NT		1	

English Name	Scientific Name	IUCN	RDB	Historical	Possible	Present
Geoffroy's Horseshoe Bat	*Rhinolophus clivosus*		NT		1	
Dassie Rat	*Petromus typicus*		NT		1	
Namaqua Dune Molerat	*Bathyergus janetta*		NT			1
Honey Badger	*Mellivora capensis*		NT			
Spotted Hyaena	*Crocuta crocuta*		NT	1		
Sub Total	**18**			**7**	**9**	**2**
MARINE MAMMALS						
Sei Whale	*Balaenoptera borealis*	EN			1	
Fin Whale	*Balaenoptera physalus*	EN			1	
Blue Whale	*Balaenoptera musculus*	EN	EN		1	
Sperm Whale	*Physeter catodon*	VU	VU		1	
Bryde's Whale	*Balaenoptera edeni*	DD	VU		1	
Gray's Beaked Whale	*Mesoplodon grayi*	DD			1	
Strap-toothed Beaked Whale	*Mesoplodon layardii*	DD			1	
Pygmy Sperm Whale	*Kogia breviceps*	DD			1	
Southern Right Whale Dolphin	*Lissodelphis peronii*	DD			1	
Killer Whale	*Orcinus orca*	DD			1	
False Killer Whale	*Pseudorca crassidens*	DD			1	
Pygmy Killer Whale	*Feresa attenuate*	DD			1	
Long-finned Pilot Whale	*Globicephala melas*	DD			1	
Heaviside's Dolphin	*Cephalorhynchus heavisidii*	DD			1	
Dusky Dolphin	*Lagenorhynchus obscurus*	DD			1	
Humpback Whale	*Megaptera novaeangliae*		NT		1	
Sub Total	**12**			**0**	**12**	**0**
Overall Total	**30**			**7**	**23**	**0**

4.3.3 The Namaqua National Park Managament plan and its Buffer zones

The Namaqua National Park Mnagement Plan identifies three buffer zones, namely Priority natural areas, Catchment protection areas and Viewshed protection areas (Figure 4.20).

Priority natural areas (pale green, Figure 4.20) are key areas for both pattern and process that are required for the long term persistence of biodiversity in and around the park. The zone also includes areas identified for future park expansion. Developments and activities should be restricted to sites that are already transformed. Inappropriate developments and negative land use changes (such as additional ploughing of natural veld, development beyond existing transformation footprints, urban expansion, intensification of landuse through golf estates) should be opposed within this area.

Catchment protection areas (light blue, Figure 4.20) are areas important for maintaining key hydrological processes within the park.

Viewshed protection areas (yellow hatching, Figure 4.20) are areas where development is likely to impact on the aesthetic quality of the visitor's experience in a park. Within these areas any development proposals should be screened to ensure that they do not impact excessively on the aesthetics of the park. The areas identified are only broadly indicative of sensitive areas, as at a fine scale many areas within this zone would be perfectly suited for development. In addition, major projects with large scale regional impacts may have to be considered even if

they are outside the Viewshed Protection Zone.

The proposed site for mining falls within both the Priority natural area and Viewshed protection area.

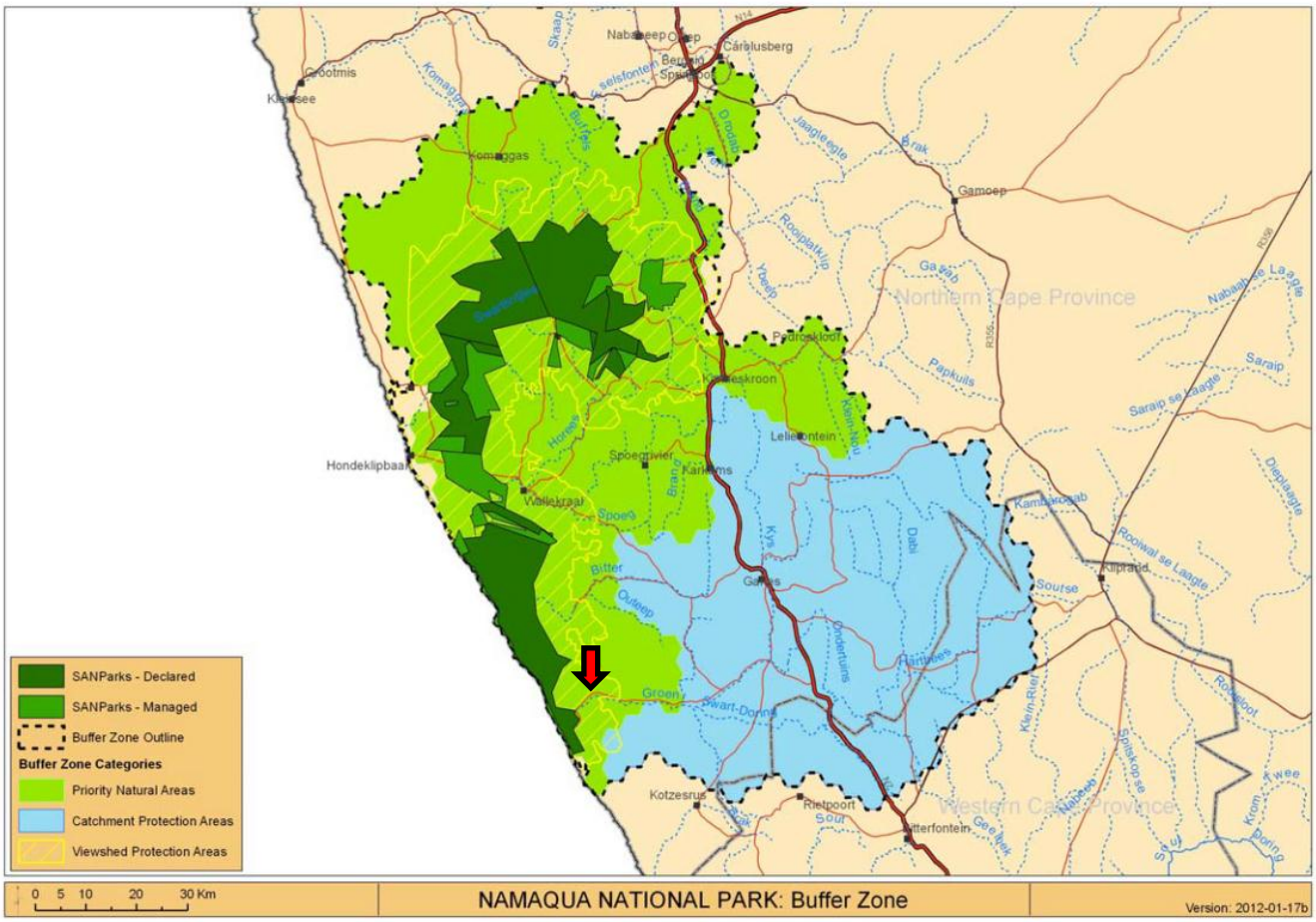


Figure 4.20: The three categories of buffer zone defined around the NNP.

4.4 SOCIO-ECONOMIC ENVIRONMENT

As the proposed project is situated in Ward 2 of the KLM, the next section focuses largely on the socio-economic context of the KLM. The greatest part of the data was obtained from StatsSA (2011), as well as the IDP's of the KLM (2013-2014) and NDM (2012-2016). The chapter has also been informed by primary data obtained through discussions with the municipality, farmer interviews, as well as focus groups held with representatives from the PACs during field work undertaken for the SIA.

The section below is divided into two main sections. The first section considers the socio-economic baseline conditions of the KLM with a specific reference to the PACs from which the labour might be drawn. This section includes migrancy patterns and population trends, followed by the municipality's households' socio-economic living conditions. General livelihood strategies are also elaborated upon, such as occupations and income trends. The data from this section was primarily obtained through an analysis of the KLM's IDP, data from StatsSA (2011), as well as community focus group discussions and municipality engagements. The second section provides a closer look at the area where the mine will be developed with a specific reference to the direct and indirect PAFs. The data for this section was obtained from face-to-face farmer interviews, as well as from key informant interviews.

4.4.1 The Kamiesberg Local Municipality

i. Demographic Overview

The NDM embodies six municipalities. These are:

- The Richtersveld;
- Nama-Khoi;
- Khai-Ma;
- Hantam;
- Hoogland; and
- Kamiesberg.

With an area of 126,747km^2, the NDM represents approximately 35% of the province. It is the largest municipality in South Africa, as well as the most sparsely populated (NDM, 2012-2016).

The population of the NDM is estimated at around 115,842 people, representing around 10% of the provinces' population (StatsSA, 2011). The largest section of the district's population is coloured (83.2%), followed by White (8.7%), Black (6.8%) and Indian/Asian people (1.3%). In terms of gender, the male and female populations are near similar with the male-to-female ratio at 1:0.9. Most of the district's settlements are very poor, whilst the population continues to shrink as young people migrate to larger South African cities in search of job opportunities. For example, according to the KLM's IDP, the district has seen a negative growth rate of around 0.54% per annum (KLM, 2013-2014). One reason for this is the lack in employment opportunities, which force many skilled labourers to migrate to larger cities. Table 4.8 below provides the population breakdown for the NDM, as well as the KLM.

Table 4.8 Population Dynamics

Municipalities	Total Population	Black		Coloured		White		Other	
		Nr	*% (N)*	*Nr*	*% (N)*	*Nr*	*% (N)*	*Nr*	*% (N)*
NDM	115,848	7,905	6.8	96,363	83.2	10,125	8.7	1,455	1.3
KLM	10,188	543	5.3	8,724	85.6	822	8.1	99	1.0

With the KLM's population estimated at 10,188, this local municipality represents an even smaller segment of the province at 0.9% of its entire population. The population seems to have decreased marginally from around 11,064 in 1996 (StatsSA, 2011). As illustrated by Table 4.8 above, the largest section of both the NDM and KLM's population is coloured (83.2% and 85.6% respectively). In terms of gender, the male and female populations are near similar for the entire area; the male-to-female ratio for the NDM as well as KLM is 1:0.9.

During the community meetings, most residents claimed that their towns do not experience an influx of residents apart from occasional government services workers (nurses or school teachers). In Garies some residents mentioned that the town does have its sporadic influx of contract workers (especially road upgrade workers) who are housed in the informal settlements. In terms of age distributions, Table 4.9 below depicts the age categories for the NDM and KLM; the latter at a ward-level.

As illustrated in the Table 4.9, the working-age population (within the age brackets of 15 and 64 years) is the largest for the entire area. For example, 66.1% of the entire NDM's population are within this age bracket, followed by very similar percentages for each ward under the KLM (64.2%, 66.1%, 62.0% and 60.0% for wards 1-4 respectively). A sizeable section of the population can also be considered as youthful members between the ages of 15 and 29 (as defined by the National Youth Policy of South Africa). Using this age category, approximately 24.1% of the entire district's population can be considered youthful. This percentage remains similarly for all the wards under the KLM, with wards 2 and 3 having the highest number of youthful members. Figure 4.20 below provides the age categories for the KML in isolation, revealing that the largest population group is between 30 and 64 years of age (41.26%). Around 64.9% can be considered as the working-age

population (15-65 years).

Table 4.9: Age Distribution*

Categories	NDM		KLM							
	N	*%*	Ward 1		Ward 2		Ward 3		Ward 4	
			N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
0 – 4	9,746	8.4	189	9.3	250	7.7	221	8.4	205	9.1
5-14	20,135	17.4	351	17.3	493	15.1	520	19.8	470	20.8
15-29	27,916	24.1	429	21.1	762	23.3	624	23.7	433	19.1
30-64	48,682	42.0	875	43.1	1,398	42.8	1,008	38.3	926	40.9
65-79	7,590	6.6	151	7.4	292	8.9	206	7.8	190	8.4
80>	1,773	1.5	34	1.7	69	2.1	51	1.9	41	1.8
Unspecified	6	0.0	0	0.0	0	0.0	0	0.0	0	0.0
TOTAL	**115,842**	**100.0**	**2,029**	**100.0**	**3,264**	**100.0**	**2,630**	**100.0**	**2,265**	**100.0**

** Source: KLM (2013-2014)*

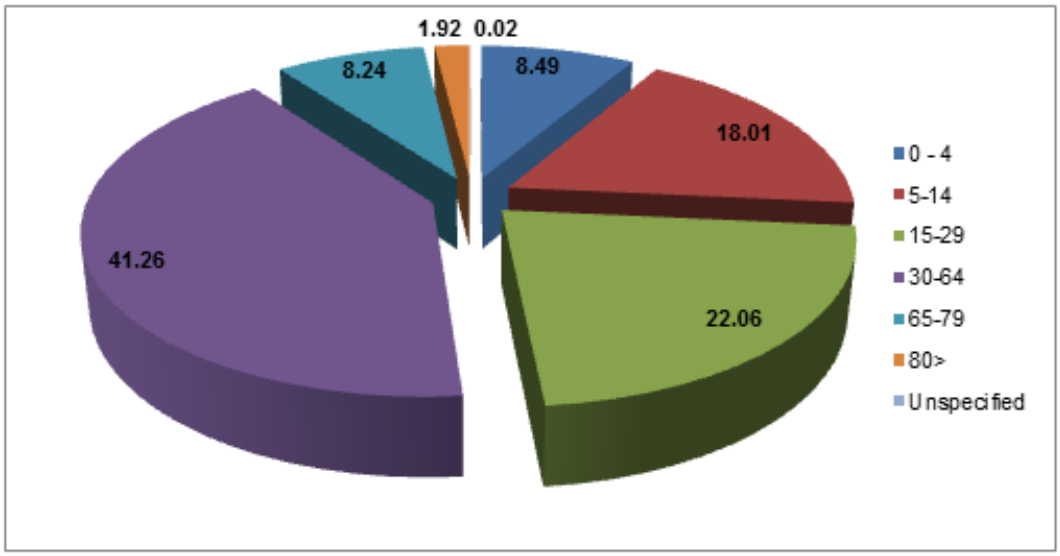


Figure 4.20: Kamiesberg Local Municipality's Age Categories (%)

The NDM's IDP (2012-2016) points out that a quarter of the area's population are under the age of 15 years, whilst the economically active population account for just more than two thirds of the total population of the area. Lastly, there seems to be an out-migration of economically active women in the age group of 20-34 years. This highlights the need for economic investment in order to retain an active workforce and a healthy male-to-female ratio in the area. Apart from this specific group, many young people in the province also tend to migrate to the Western Cape and Gauteng in search of employment opportunities. The reasons for such migration are summarised by the NDM's IDP as follows:

- The absence of tertiary educational institutions;
- Promises of better living and working conditions;
- Poorly developed rural areas; and
- The poverty context and high unemployment levels.

ii. Employment and Household Income and Expenditure Trends

Table 4.10 below depicts the unemployment status of the NDM and KML; the latter at the ward-level.

Table 4.10: Employment Status*

Categories	NDM		KLM							
	N	*%*	Ward 1		Ward 2		Ward 3		Ward 4	
			N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Employed	33,687	29.1	438	21.6	963	29.5	450	17.1	381	16.8
Unemployed	8,475	7.3	258	12.7	330	10.1	123	4.7	273	12.1
Not economic active/discouraged work-seekers	73,680	63.6	1,333	65.7	1,971	60.4	2,057	78.2	1,611	71.1
TOTAL	**115,842**	**100.0**	**2,029**	**100.0**	**3,264**	**100.0**	**2,630**	**100.0**	**2,265**	**100.0**

** Source: StatsSA (2011)*

The largest section of the NDM's population is not economically active (63.6%). This percentage is very similar for all the wards of the KML, with a significantly higher percentage for wards 3 and 4 (78.1% and 71.1% respectively). The labour force (the population within the working-age group) for the NDM is estimated at 42,162 (or 36.4% of the population). For the KLM, this is 3,216 people, or 31.6% of the municipality's population. Using Table 4.10 above, the formal unemployment rate (calculated as a percentage of the labour force)[4] can be calculated (people who are informally employed are also counted as being part of the labour force). This rate is approximately 20.1% for the NDM and 30.6% for the KLM. Considering the various wards under the KLM, the official unemployment rates for wards 1 and 4 are the highest at around 37.1% and 41.7% respectively. These high unemployment rates might be explained by the fact that many community members in this area used to be employed on mines which have closed in recent years. This resulted in many retrenchments. For this reason, there is a strong possibility that the area might harness mining skills that can be utilised and drawn on by the project proponent. Table 4.11 below depicts the employment sectors of the NDM (2012-2016).

Table 4.11: Namakwa District Municipality Employment Sectors (2010)*

Categories	*N*	% (of total nr listed)
Community services	6,789	27.5
Trade	5,093	20.6
Agriculture	4,948	20.0
Mining	3,989	16.1
Finance	1,205	4.9
Construction	1,155	4.7
Transport	749	3.0
Manufacturing	693	2.8
Electricity	98	0.4
TOTAL	**24,719**	**100.0**

** Source: NDM IDP, 2012.*

As can be concluded from Table 4.11, of all the employment sectors listed, community services, trade and agriculture are the largest employment sectors (68.1% combined). This is followed by the mining industry (16.1%). During the community meetings, many residents confirmed that, of those few people who are employed, few are currently working on the roads which are being maintained and constructed as part of the government's Expanded Public Works Programme (EPWP). A limited number of people are employed at the Namakwa NP.

Concerning tourism, although the area's flowers attract numerous tourists during the spring period (August to October), many residents claim that their communities do not reap any benefits from this industry. Some reasons for this might be the communities' lack of capital to invest in tourist infrastructure or training in operating and managing guesthouses. Some residents called upon the need to establish 4x4 tourist routes, which might be an ideal community driven local business

[4]The labour force comprises working-age members between the ages of 15 and 65, however excludes those who are disabled, home-seekers or who are not looking for work.

opportunity.

Few people are also employed as farm labourers, although this work is said to be mostly irregular, seasonal and offered to men. Most seasonal farm work opportunities seem to be offered centred around the Vredendal Wine District and Swartland areas on wine and deciduous fruit farms.

Although the mining sector has been one of the most prominent sectors in the area (contributing 52.0% to the NDM's GPD), the significance of this industry and the employment provided have been declining in recent years as several mining companies (such as De Beers and Trans Hex diamond mines) have closed in the past few years. In light of this, many older residents still have mine-related skills which many say are not being passed on to the younger generation. Some of these skills also include building and carpentry, as well as electrical work. At present, the only mine that seems to be providing contractual employment around the studied areas is the Namakwa Sands operation at Brandsebaai, approximately 65 km south of Groenriviermond.

Today, the largest employment sectors in the KLM are wholesale, retail, catering and accommodation. The latter (catering and accommodation) accounts for around 21.1% of the total employment in the formal sector. However, these sectors are known to be susceptible to economic changes and global recessions. As a result, the KLM stresses the need for the area to diversify its economy to create real and sustainable employment opportunities. The largest majority of households in the area are highly reliant on social grants. Most of these grants include Child Support Grants, Social Disability Grants and Old-Age Pensions.

Table 4.12 below depicts income categories for households living in the KLM.

Table 4.12: Kamiesberg Local Municipality Household Annual Income*

Income Categories	N	% (of households)
No income	339	10.8
R1-4800	120	3.8
R4801-9600	186	5.9
R9601-19600	705	22.5
R19601-38200	750	23.9
R38201-76400	462	14.7
R76401-153800	291	9.3
R153801-307600	189	6.0
R307601-614400	60	1.9
R614001-1228800	18	0.6
R1228801-2457600	9	0.3
R2457601 >	12	0.4
TOTAL	**3,414**	**100.0**

** Source (StatsSa, 2011)*

Table 4.12 illustrates that the bulk of the households (52.3%) receive between R4,801- R38,200 per year. Very few households (only 6.97%) receive more than R307,601per year (or R25,633 per month). In terms of expenditures, during the community meetings, residents were solicited to elaborate upon their households' largest monthly expenses. To this question most mentioned items such as food, electricity, healthcare and school-related expenses (uniforms and books, for example).

Although poverty is defined across a range of socio-economic indicators, generally in terms of an income definition, the World Bank has produced an international poverty line rate. This was calculated in 2013 at around US$2.8/day (World Bank, 2014). This translates to around R26.6 per day (using a 9.5% rate), or around R611.8/month (23 working days a month). Using this poverty line, households that earn under the R7,341.6/year bracket in the table above (around R800/month) can be considered as poor in terms of the World Bank's poverty line, measures

against Purchasing Power Parity (PPP). For this income-bracket, around 20.5% of households in the KLM can be defined as being poor.

iii. Socio-Economic Living Conditions

Land-Use, Residency and Households

Apart from around 700 to 750 farms in the local municipality (StatsSA, 2011), the area is largely comprised of residential-based households. Some of these households have been established in areas (such as Molsvlei, Stofkraal and Holdeklipbaai) which are currently under a land claim in accordance with the South Africa Restitution of Land Rights Act No. 22 of 1994. According to StatsSA (2011), there are approximately 33,852 households in the NDM, whereas this number is significantly less for the KLM (3,141). According to the KLM's IDP (2013-2014), the average household size is around 3.2 members. Within the KLM, about 95.6% of all households live in a formal dwelling. Yet, fewer households seem to have formal ownership of their houses (only 63.9%). Table 4.13 below depicts the household residential status of the NDM and KLM, in addition to the types of household dwellings.

Female-headed households account for around 40% of all households. According to some residents, this high percentage can be accrued to single female-headed households as, increasingly, women have a desire to be independent and chose not marry after a pregnancy. A meeting with Mr Cloete, Municipal Manager of the KLM, clarified this tendency. As he explains, many young women prefer to remain single with child dependants in order to obtain state social grants. Moreover, single female-headed households with dependants also seem to quality for state housing, as some claim.

Table 4.13: Dwelling and Housing Types *

Type of dwelling	NDM	KLM			
		Ward 1	*Ward 2*	*Ward 3*	*Ward 4*
House or brick/concrete block structure on a separate stand or yard or on a farm	29,312	592	913	703	667
Traditional dwelling/hut/structure made of traditional materials	662	0	8	2	15
Flat or apartment in a block of flats	682	26	49	24	2
Cluster house in complex	33	1	0	1	0
Townhouse (semi-detached house in a complex)	31	2	2	0	0
Semi-detached house	852	0	0	0	0
House/flat/room in backyard	337	2	2	8	2
Informal dwelling (shack; in backyard)	430	4	6	2	10
Informal dwelling (shack; not in backyard; e.g. in an informal/squatter settlement or on a farm)	416	7	2	2	9
Room/flatlet on a property or larger dwelling/servants quarters/granny flat	519	8	5	0	0
Caravan/tent	133	5	20	0	0
Other	445	14	13	6	7
TOTAL	**33,852**	**661**	**1,020**	**748**	**712**

** Source: Adjusted from KLM IDP (2013-2014)*

It is clear from Table 4.13 above that the largest majority of all the households in the NDM and KLM live in brick and/or concrete block structures on a separate stand, yard or farm. Approximately 2,875 of all households in the KLM live in such structures (i.e. 84.2% of all households in the KLM). Some of these built houses are self-constructed, whereas many are government-provided houses.

Figure 4.21 below portrays the household residential status of the KLM's in percentages of all the households in the municipal area.

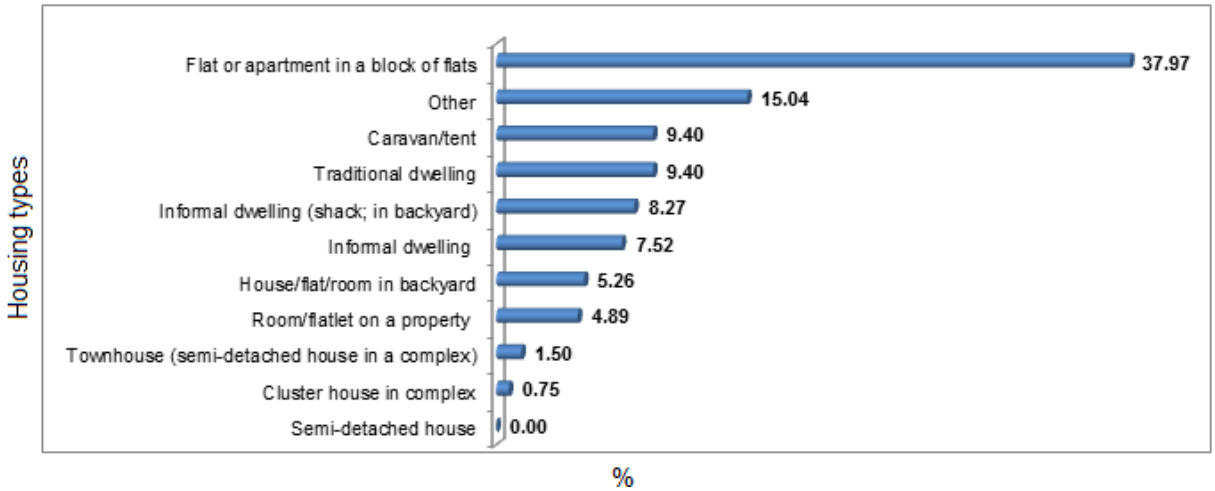


Figure 4.21: Kamiesberg Local Municipality's Dwelling and Housing Types (% of households).
(Source: Adjusted from KLM IDP (2013-2014))*

Figure 4.21 above illustrates that, of those households in the KLM that do not live in a brick and/or concrete block structure, the bulk of the remaining households (37.97%) reside in a flat or apartment block. Only 9.4% of the remaining households live in traditional structures, whereas a higher number (15.79%) live in informal settlements (either a shack in a backyard, or a separate informal dwelling). As indicated in the Table 4.13, only around 42 households seem to live in informal dwellings. Presently, the municipality does not have a Human Settlement Plan (HSP), although such a plan is in the pipeline to address housing in the future.

Lastly, the KLM is comprised of nearly 3,138 households (KLM, 2013-2014). StatsSA data (2011) indicates that this number increased since 1996 (from 2,592), although the population decreased. Although this data could be interpreted and analysed in many ways, it could possibly indicate that, despite a population decrease, households have become smaller as youth tend to out-migrate. This is indeed reflected by the data, as the average household size in 1996 was estimated at around four members. Today, households are comprised of around three people. Furthermore, nearly 41% of households seem to be female-headed. This is noteworthy, as it might point to a cultural change where women are being empowered with responsibilities. This should not be surprising, as the GoSA strongly advocates the rights of women and, in particular, their contribution to the economy. Many Expanded Public Works Programmes (EPWPs) are being implemented in the area (especially road upgrades), which empowers women not only with employment, but also with skills to strengthen their traditional roles in their households. Still, in light of the area's limited economic opportunities, many of these female-headed households are reliant on social grants to make ends-meet. Women in particular might therefore benefit significantly from employment and skills opportunities.

Education

In terms of education, each of the possible labour-sending wards has one primary school (Gr1-7), whereas a high school is located in Garies and Kharkams. The latter mentioned high schools attract pupils from as far as the central areas of the Northern Cape and even the northern parts of the Western Cape, who are housed in hostels. Table 4.14 below depicts the educational levels of those above 18 years of age for the NDM and KML (per ward).

Table 4.14: Educational Status in Numbers (2010 – those above 18 years of age)

Category	NDM	KLM	Ward 1	Ward 2	Ward 3	Ward 4
No schooling	4,794	329	77	94	53	105
Some primary	12,928	1,363	275	321	317	450
Completed primary	7,332	776	207	233	159	176
Some secondary	28,743	2,579	567	845	626	541
Grade 12/Std 10	13,737	1,044	191	420	295	137
Higher	5,396	277	61	141	49	26
Unspecified	184	10	1	2	2	4
Not applicable	2,657	177	0	122	55	0
TOTAL	**75,771**	**6,554**	**1,379**	**2,178**	**1,557**	**1,439**

According to most of the community members interviewed, the general educational status of the residents is low. This is confirmed by Table 4.14 above, showing that a small but significant percentage of the population do not have any schooling (6.33% for the NDM and 5.02% specifically for the KLM), whereas the largest section of the population have some secondary schooling (37.93% for the NDM). There seems to be no significant difference between the schooling status data for the NDM and the KLM, as both data sources indicate that few members in the region have Grade 12 (18.13% for the NDM, and 15.93% for the KLM). Significantly more people within wards 2 and 4 of the KLM do not have any schooling, whereas Ward 4 of the KLM also accommodates a section of the population with the most number of Grade 12 and higher educational graduates. This data makes sense, as the town of Garies is situated in Ward 2 where there is a combined primary and secondary school. The school has a current enrolment of 326 learners, with 10 staff members.

When considering school attendance, it appears that only around 68% of children (roughly in the 5 to 24 age-bracket) actually attend school (Stats, 2011). This is more than the average for the district (65%). Although this percentage increased since 1996 (from approximately 60%), it still illustrates that many parents do not send their children to school.

During the community meetings, many residents explained that, although children are often sent to the nearest high school (either in Kharkams or Garies), the high school drop-out rate remains very high. A reason for this might be the fact that these high schools are far from the majority of the local communities, forcing parents to send their children to the high school hostels in Kharkams and Garies. The government is subsiding hostel accommodation, which is around R550 per child per year. One of the most serious challenges that might contribute to such a high drop-out rate is said to be poor transportation between these hostels and the local communities, as well as rising school-related expenses, such as school uniforms, books and general school supplies.

However, other social ailment factors are also contributing to high drop-out rates. According to Garies High School Principal, Ms Vottering (pers. comm., 2014), few children are sent to Further Educational Training (FET) facilities, such as colleges or universities. In illustration, of around 52 matric graduates in 2013 from Garies' High School, less than 20 have left Garies for FET's in areas such as Cape Town or Wellington in the Western Cape.

As confirmed by Ms Vottering, some of the most serious challenges that contribute to high school drop-out rates include teenage pregnancies and drug and alcohol-abuse. Drug-usage is said to have been on the increase as it follows in suit of the Rastafarian Culture, which are apparently becoming widespread amongst the youth. According to Ms Vottering, this culture (or religion) tends to attract youth members into a culture of drug-use; rationalising drug usage on the grounds of their religion and spiritual growth path.