Figure 15 A&B). Hartlaub's gull and kelp gull were resting on the banks, while the Antarctic tern and pied crow flew overhead. Cape wagtails, white-fronted plovers and the common-ringed plover were feeding in the mud and shallow water near the edges of the water body. A number of passerines were also seen on the estuary banks and during a 30 minute transect walk through the dry flood plain. These included, Cape long-billed larks, grey-backed cisticola, bokmakierie and flocks of yellow canaries. Rufous-eared warbler and Karoo prinia were also frequently heard on the flood plain. The common ostrich roams the EFZ, which is evident by footprints in muddy parts of the upper estuary and the floodplain (

Figure 15).

The seasonal effect on bird species composition (types of species and abundance) of the Swartlintjies Estuary is well pronounced. In comparison to the species found during this survey, summer migratory waders, including sanderling and curlew sandpiper, were present in large numbers at the estuary in October 1980 (Table 4). Furthermore, the estuary was dry at that time and water was only available in the excavated trenches north of the estuary mouth (Heinecken, 1980) and would have been too deep to provide feeding grounds for flamingos, avocets and black-winged stilts. It is apparent that when the estuary contains water, the hypersaline conditions produce a thriving population of brine shrimp, which in turn support a number of bird species.

Table 4 Birds recorded in the Swartlintjies Estuary (Source: Heinecken 1980; Field visit by Anchor Environmental Consultants (Pty) Ltd. on 22 June 2016).

Common name	*Scientific name*	*ECRU survey 16 October 2016*	*Anchor Environmental 22 June 2016*
Cape Teal	*Anas capensis*		11
South African Shelduck	*Tadorna carna*	6	
Red-knobbed Coot	*Fulica cristata*	10	
Greater flamingo	*Phoenicopterus ruber*		17 (including 5 juveniles)
White-fronted plover	*Charadrius marginatus*	19	7
Black-winged stilt	*Himantopus himantopus*	2	30
Pied avocet	*Recurvirostra avosetta*	1	6
Three-banded plover	*Charadrius tricollaris*	2	
Sanderling	*Calidris alba*	12	
Curlew sandpiper	*Calidris ferruginea*	23	
Blacksmith lapwing	*Vanellus armatus*	4	
Common-ringed plover	*Charadrius hiaticula*		1
Kelp gull	*Larus dominicanus*		1
Hartlaub's gull	*Larus hartlaubii*		2
Antarctic tern	*Sterna vittara*		1
Cape wagtail	*Motacilla capensis*	6	3
Grey-backed cisticola	*Cisticola subruficapilla*		11
African stonechat	*Saxicola torquatus*	2	6
Yellow canary	*Crithagra flaviventris*		10
Bokmakierie	*Telophorus zeylonus*		3
Cape long-billed lark	*Certhilauda curvirostris*		7
Rufous-eared Warbler	*Malcorus pectoralis*		2
Southern double-collared sunbird	*Cinnyris chalybeus*		1
Karoo prinia	*Prinia maculosa*		2
Pied crow	*Corvus albus*	3	2
Sand martin	*Riparia riparia*	2	11
Common ostrich	*Struthio camelus*		? (Footprints)

Table 5 Taxonomic composition of waterbirds in the Swartlintjies Estuary (Source: Heinecken 1980; Field visit by Anchor Environmental Consultants (Pty) Ltd. on 22 June 2016).

Common groupings	*Order*	*No. SA resident species*	*No. of migrant species*
Waterfowl	Anseriformes (Ducks, geese)	2	
	Gruiformes (Rails, crakes, gallinules, coots)	1	
Wading birds	Phoenicopteriformes (Flamingos)	1	
Waders	Charadriiformes (Sandpipers, stints, 'shanks', stilts, plovers etc)	5	3
Gulls, terns	Charadriiformes	2	1
Wagtails	Passeriforms	1	

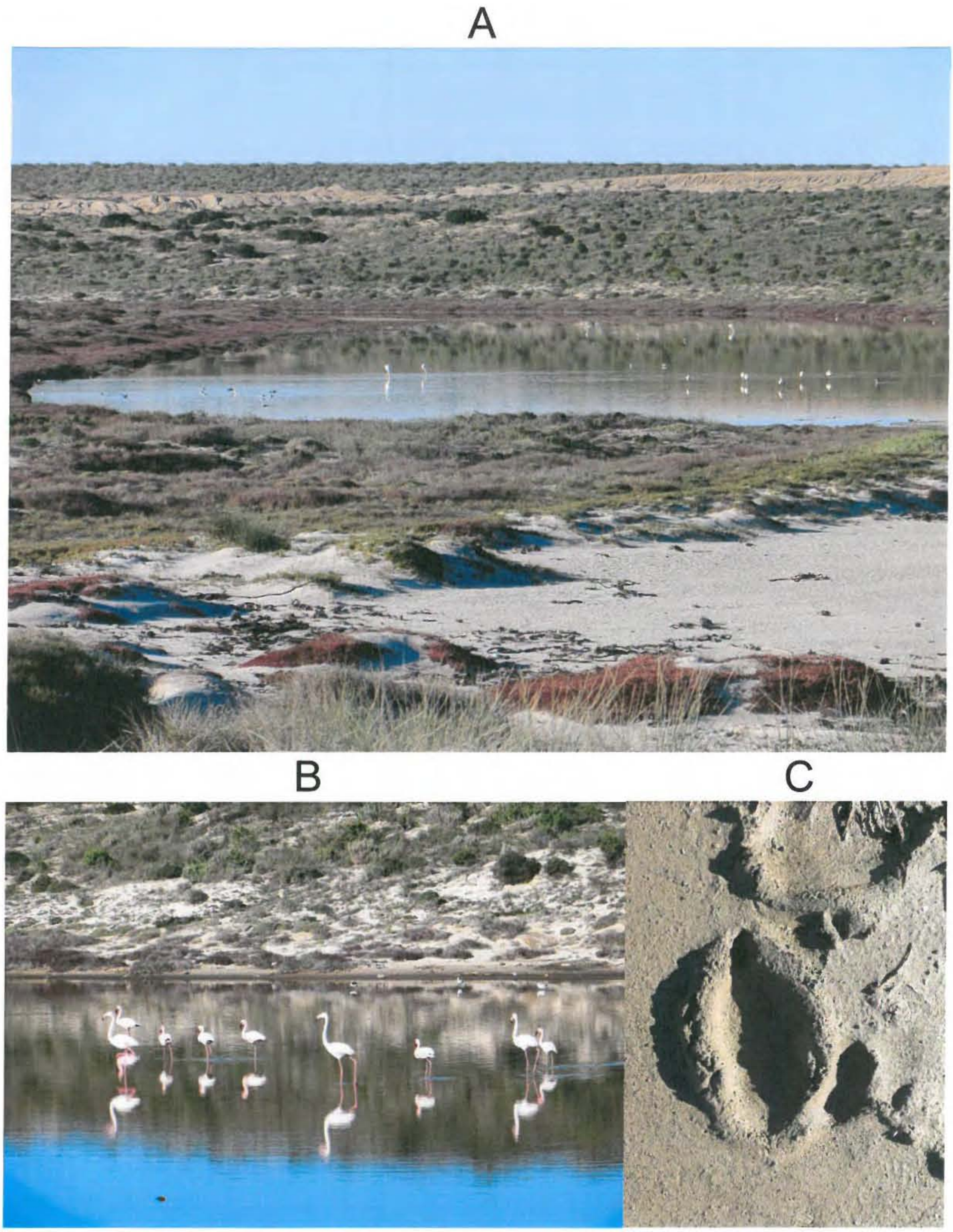

Figure 15 **Birds feeding on brine shrimp at the Swartlintjies Estuary mouth (A&B). Photo C: Common ostrich footprint approximately 1 km from the mouth (Liebenberg 2008). Photos were taken on 22 June 2016.**

10.3.3.4 Mammals

No live mammals were seen during the field survey on 22 June 2016. However, the spur and faeces of several animals were found and identified where possible. The tracks and faeces of a small antelope (Liebenberg, 2008) were found approximately 800 m from the mouth and in the dry floodplain (Figure 16). These could belong to the steenbok (*Raphicerus campestris*) (seen during EPRU survey in 1980) or the common duiker (*Sylvicapra grimmia)* (skull found during EPRU survey in 1980) as they commonly occur in the area. The tracks of medium sized antelope were found in 1980 and it was confirmed that springbok (*Antidorcas marsupialis*) were present in the area.

The tracks of water mongoose (*Atilax paludinosus*) was found during both surveys (Figure 16), while porcupine tracks (*Hystrix sp.*) and a dassie (*Procavia* capensis) skull were only found in 1980. The tracks in Figure 16C best match those of the African civet, although the spur lacks visible claw marks (Liebenberg, 2008). The size (5.5 cm) and the shape (round front foot, oval hind foot) of the spur match the description in Liebenberg (2008).

Domestic horse tracks (unless plain zebra has been introduced into the area) were also found during the site visit. To date, 13 mammal species have been recorded within the Swartlintjies EFZ surroundings (including Hondeklip Bay). Species and sources are listed in Table 6.

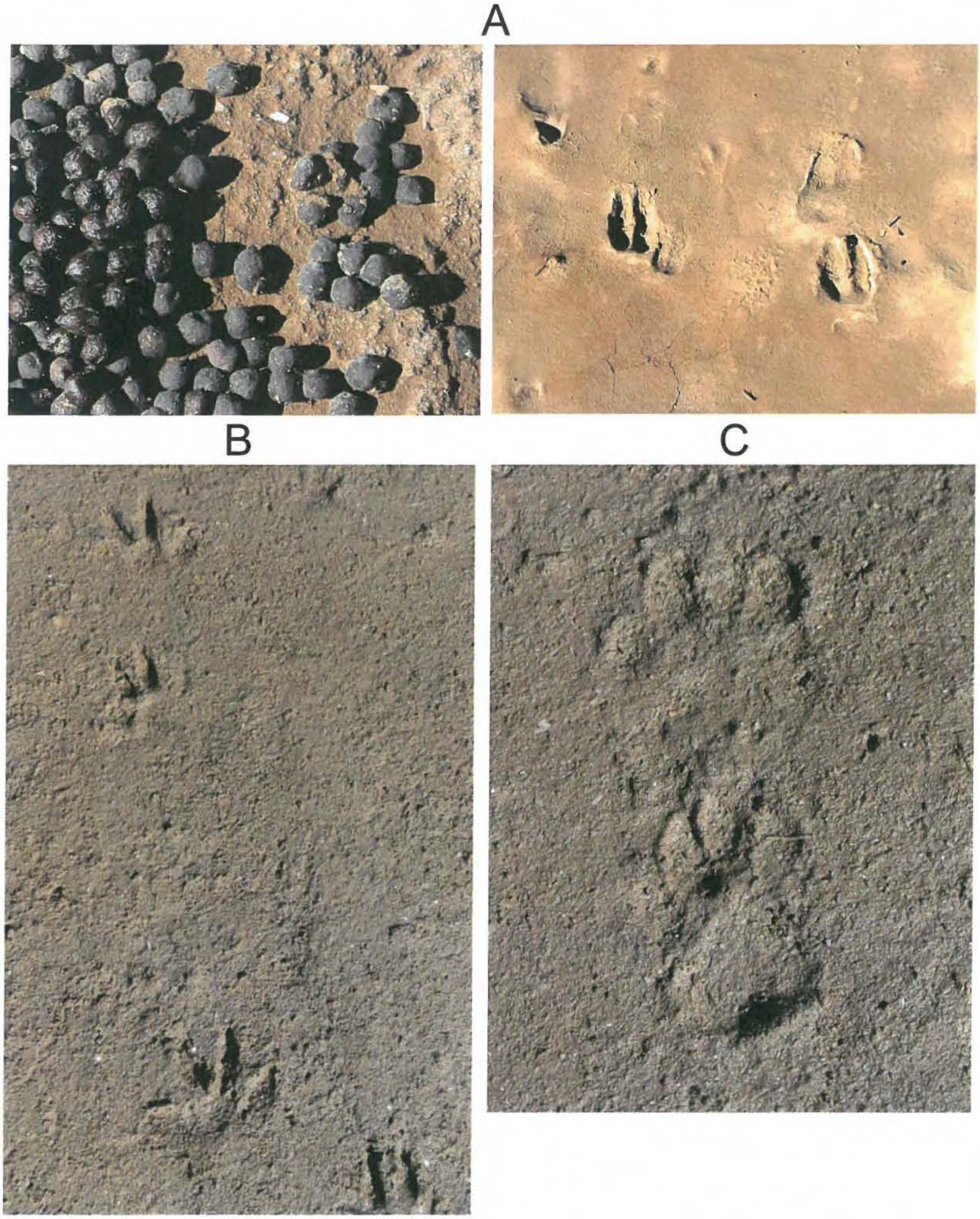

Figure 16 Photos of mammal tracks and faeces in the Swartlintjies Estuarine Functional Zone. The top pictures show the dung and tracks of a small unidentified antelope, which is likely to be a steenbok or a common duiker. Photo B shows the tracks of a water mongoose (track length is approximately 5 cm). Photo C shows the possible tracks of an African civet (track length is approximately 5.5 cm). Photos were taken on 22 June 2016.

Table 6 List of mammals identified in the Swartlintjies EFZ and greater Hondeklip area.

Common name	Scientific name	Swartlintjies EFZ	Greater area	Source A=Heinecken, 1980 B= Current survey 2016
Steenbok	*Raphicerus campestris*	X	X	A, B
Dassie	*Procavia capensis*	X		A
Common duiker	*Sylvicapra grimmia*	X		A
Springbok	*Antidorcas marsupialis*	X		B
Porcupine	*Hystrix africaeaustralis*	X		A
Water mongoose	*Atilax paludinosus*	X		A, B
African civet	*Civetictis civetta*	X?		B
Brant's Karroo rat	*Parotomys brantsi*		X	A
South African Pygmy gerbil	*Gerbillurus paeba*		X	A
Bush Karoo Rat	*Otomys unisulcatus*		X	A
Bat	*Eidolon helvum*		X	A
Suricate	*Suricata suricatta*		X	B
Horse	*Equus caballus*	X		B

10.3.4 Management history

The Swartlintjies Estuary has been situated within a strictly access controlled Koignaas mining concession area for quite some time and management of the estuary has been minimal. De Beers Consolidated Diamond Mines (DBCDM) attempted to artificially open the mouth with bulldozers in 1978 and 1980 for unknown reasons. While the mouth closed immediately after the two attempts in 1978, it stayed open/contained seawater for six months after it had been opened in early 1980. The altered flow regime (Section 10.3.1) in combination with the artificial opening of the estuary mouth is likely to have permanently and artificially increased salinity in the soil. Abandoned roads leading through the riverbed and slimes dams impacting on estuary health have not been removed at this point in time.

10.3.5 Current ecosystem health

The Swartlintjies Estuary ecosystem health is largely dependent on episodic flood events that maintain biodiversity by shaping the topography of the floodplain. The estuary has not experienced a flood since several roads associated with mining activities filled the riverbed at various points in the lower catchment of the Swartlintjies River. Fragmentation of the ecosystem is moderate and focused near the slimes dam in the northern EFZ and in the vicinity of roads cutting through the EFZ.

10.3.6 Conservation importance

Although the Swartlintjies EFZ is not part of a formally protected area, the upper reaches of the river and its tributaries occur within the Namaqua National Park (Figure 4). The Swartlintjies Estuary has not been earmarked for conservation at the time of writing. However, rehabilitation of this estuary by restoring flow to the lower catchment could have major benefits to conserving biodiversity in the EFZ. Rehabilitation could also contribute towards ensuring that endemic plant species such as *Limonium equisetinum, Chaetobromus involucratus subsp. Dregeanus* and *Eragrostis sabulosa* remain species of 'least concern'.

10.4 Impact Assessment

None of the proposed land based, surf zone, beach- and offshore channel mining activities are planned to be carried out within the Swartlintjies EFZ. However, mining activities occurring outside the boundaries of the EFZ could have an impact on the estuary itself and are assessed in the sections below.

10.4.1 Surf zone, beach- and offshore channel mining

The southern boundary of the proposed surf zone, beach- and offshore channel mining area is located 600 m north of the Swartlintjies Estuary (Figure 3). A seawall will be built from gabions, protruding into the bay to an unknown distance. The Swartlintjies bay is very small and open, and is influenced by the northward flowing Benguela current. Due to the small size and shape of the bay, as well as the direction of the current, the Swartlintjies Estuary is unlikely to be impacted by these mining operations. It is, however, recommended that the seawall does not extend more than 300 m seaward from the high water mark. The potential impact on sedimentation processes of the Swartlintjies Estuary is assessed in terms of a seawall that does not extend beyond the area as indicated in (Figure 3 and Table 7). No mitigation measures are required.

Table 7 The potential impact of surf zone, beach- and offshore channel mining on sedimentation processes in the Swartlintjies Estuary.

	Without mitigation	*Assuming mitigation*
Severity	Low	N/A
Duration	Permanent: The wall will only be removed once mining activities have been completed.	N/A
Extent	Local: The estuary is situated within the mining concession area.	N/A
Consequence	Medium	N/A
Probability	Unlikely	N/A
Significance	Low	N/A
Status	Negative	N/A
Confidence	Medium	N/A
Reversibility	Fully reversible	N/A
Nature of cumulative impact	N/A	N/A
Degree of which impact may cause irreplaceable loss of resources	Low	N/A
Degree to which impact can be mitigated	None: Shortening the wall will not influence sedimentation dynamics of the estuary	N/A

10.4.2 Slime dams

While the preferred sites for future slimes dams (Sites C and G) are not going to impact on the Swartlintjies Estuary, the alternative (Site 2) to sites A, C and G is situated 9 km upstream of the Swartlintjies Estuary and may be problematic. This alternative site is an existing slimes dam and is located within the Swartlintjies River catchment (Figure 2). Although the prevailing wind carries most of the dried saline sediment to the northeast, it is likely that the surface runoff during episodic rainfall events washes salt from the dam into the Swartlintjies River.

It is evident that the rainfall has carried salty sediment from the small abandoned slimes dam situated in the northern part of the EFZ down towards the river channel and has had an impact on the vegetation (Section 10.3.3.1). A salt pan is situated directly below the dam, which could be an indication of increased rates of salt accumulation in the soil. The proposed alternative site for the slimes dam could have a similar effect on the river and therefore may impact on the upper reaches of the estuary. This impact would be further exacerbated by the current inability of the system to flush accumulated salts out to sea. Very few plant species can survive in saline soils, which results in the increasing extent of saltmarsh vegetation outcompeting Namaqualand Duneveld and Strandveld vegetation patches.

It is not feasible to cover slimes dams while they are in use and salt water runoff into the riverbed can therefore not be mitigated. The impacts on the estuary can only be prevented by utilising the preferred sites north of the estuary, which are situated outside of the Swartlintjies River catchment and are anticipated to drain into the sea via existing abandoned mining channels. The potential impact on biodiversity as a result of accelerated salinisation of the Swartlintjies Estuarine Functional Zone is assessed in Table 8.

Table 8 The potential impact of saltwater runoff from the proposed alternative slimes dam site on the biodiversity of the Swartlintjies Estuarine Functional Zone.

	Without mitigation	*Assuming mitigation*
Severity	High	N/A
Duration	High	N/A
Extent	Medium: The river is situated outside the concession area and would be impacted too.	N/A
Consequence	High	N/A
Probability	Medium	N/A
Significance	High	N/A
Status	Negative	N/A
Confidence	Medium	N/A
Reversibility	Partially reversible	N/A
Nature of cumulative impact	High	N/A
Degree of which impact may cause irreplaceable loss of resources	Medium	N/A
Degree to which impact can be mitigated	None: No mitigation measures available	N/A

10.4.3 Obstructions to freshwater inflow

The 10-15 m high haul road situated 3 km upstream of the mouth leads through the Swartlintjies EFZ and prevents the river from entering the estuary. Pipes in the haul road connect either side of the river, but the inlet is elevated at least 1 m above the river bed, making it impossible for water to pass through during episodic rainfall events. Prior to mining activities in the area, the Swartlintjies River came down in flood unhindered during episodic rainfalls, creating a braided flood plain with channels of varying depths (Section 10.3.1). These channels were then colonised by plants during dry periods, creating a biodiverse habitat that reflects the topographic mosaic of the floodplain (Section 10.3.3.1). This shows that the episodic flooding of the Swartlintjies River is an important ecological process for maintaining biodiversity of the Swartlintjies EFZ.

Restoring freshwater flows to the estuary should not be left until mine closure. The pipes in the haul road should be replaced with larger culverts (at least 1 m wide) that allow the Swartlintjies River to flow into the lower EFZ.

Table 9 The impact of the haul road on the hydrological functioning and biodiversity of the Swartlintjies Estuary.

	Without mitigation	*Assuming mitigation*
Severity	High	Medium
Duration	High	Medium
Extent	Low: The direct impact is restricted to the Estuarine Functional Zone	Low
Consequence	High	Medium
Probability	High	Medium
Significance	High	Medium
Status	Negative	Negative
Confidence	High	Medium
Reversibility	Partially reversible: It is not known whether the restoration of flow will ensure that excess salt is flushed into the sea.	
Nature of cumulative impact	Impacts on the extent and plant diversity within the Namaqualand Stranveld and Namaqualand Coastal Dunveld vegetation types are amplified due to the widespread mining activities and destruction of habitat in the area.	
Degree of which impact may cause irreplaceable loss of resources	High	Medium
Degree to which impact can be mitigated	Low	Low

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11 Any mitigation measures for inclusion in the EMPr;

No mitigation measures are required for future mining activities. The pipes in the haul road should be replaced with larger culverts that allow the Swartlintjies River to flow into the lower EFZ.

12 Any conditions for inclusion in the environmental authorisation;

Environmental Authorisation should include the need to rehabilitate the estuary by implementing the Swartintjies Estuary Management Plan (to be finalised).

13 Any monitoring requirements for inclusion in the EMPr or environmental authorisation;

None

14 A reasoned opinionas to whether the proposed activity or portions thereof should be authorised; and if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;

There are no direct impacts on the Swartlintjies Estuary by the proposed mining activities. Future slimes dams at Sites C and G are favoured over the alternative Site 2, which is situated 9 km upstream of the Swartlintjies Estuary and may be problematic. The alternative site (Site 2) should be avoided to prevent accelerated salinisation of the Swartlintjies Estuarine Functional Zone and associated negative long-term impacts on biodiversity. The freshwater flow to the estuary should be restored as best as possible prior to closure focusing on replacing the ineffectual pipes in the haul road with proper culverts.

15 A description of any consultation process that was undertaken during the course of preparing the specialist report;

Not applicable

16 A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and

Not applicable

17 Any other information requested by the competent authority

The competent authority requested WCR to submit an Estuarine Management Plan. This plan is currently being drafted by Anchor Environmental Consultants (Pty) Ltd. and will be available for comment by 5th August 2016.

6. Ground water study

WEST COAST RESOURCES-KOINGNAAS AND SAMSONS BAK COMPLEXES

ENVIRONMENTAL IMPACT ASSESSMENT

REPORT ON GEOHYDROLOGICAL IMPACT ASSESSMENT FOR WEST COAST RESOURCES DIAMOND MINING OPERATIONS ALONG THE WEST COAST AROUND KOINGNAAS, NORTHERN CAPE PROVINCE

Report Ref: 2016/ENV008

July 2016

Prepared for

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Principal Hydrogeologist
Pr.Sci.Nat, MSc Hydrogeology UCL-UK

EXECUTIVE SUMMARY

1 INTRODUCTION

1.1 BACKGROUND

West Coast Resources (Pty) Ltd (hereafter called WCR) intends to re-visit and mine certain areas on the Namaqualand Coast. WCR is re-establishing diamond-mining operations in the existing mining rights areas on the Namaqualand coast, previously mined by De Beers, and under the existing mining rights of July 2012, i.e. Koingnaas Mining Right (522MRC) and Samsons Bak Mining Right (525MRC. As part of their operations, WCR intend to mine deposits that are located on the beach and extend seaward, potentially for several hundred metres. WCR wants to continue with mining on the areas covered by these rights i.e. areas within the existing mining rights authorization, with immediate target being the Langklip and Koingnaas mining areas. The target areas are those that will not trigger new listed activities in terms of the National Environmental Management Act, Act No. 107 of 1998 (NEMA). The life of mine is anticipated to be about 11 years.

Waters Without Frontiers cc was appointed to conduct a geohydrological impact assessment for the proposed mining activities, as part of a broader Environmental Impact Assessment (EIA) for the mine. The EIA process is coordinated by Myezo Environmental Services (Pty) Ltd.

1.2 PREVIOUS STUDIES

A groundwater study was previously conducted at the site by M L Francis for De Beers Consolidated Mines Limited - Namaqualand Mines in 2003. The study however, focused on the chemistry of water encountered in the mining excavations which were generally shallow. No boreholes were drilled.

1.3 ASSUMPTIONS AND LIMITATIONS

There were no assumptions made in the study.

The main limitation was that the study was based entirely on existing data, no primary data were generated in the study by way of drilling new boreholes. Heavy reliance was placed on data from the National Groundwater Archive, NGA.

2 OBJECTIVES

The main objective of the study was to assess the potential impact of diamond mining activities on groundwater; and to recommend management options to mitigate or remedy the impacts.

3 METHODOLOGY

The study comprised a desktop study complemented by a hydrocensus.

4 CONCLUSION

The conclusion is based entirely on the evaluation of existing data coupled with a hydrocensus. No new boreholes were drilled in this investigation.

The main conclusion derived from the assessment is that the proposed diamond mining activities will have very small negative impact on groundwater resources for reasons listed below:

- Mining excavations will be limited to shallow depths of less than 20 metres below surface, by most probability above the water-table.
- The natural or ambient groundwater quality in the proposed mining area is of very poor quality; hence further degradation through contamination by sea-quality water will not make a big difference.
- Diamond processing relies on the physical properties of the mineral, no chemically active substances with potential to introduce toxins are added. This means that the process water emerging from the processing plant will have been little altered in chemical composition from its original state. The impact of contaminated groundwater discharging into the sea on the marine ecology is currently a subject of debate, but logically, should be negligible.

The study was not exhaustive and definitive as it was based entirely on existing data. No primary data were generated in this study. The presence or absence of potable groundwater in the proposed mining area needs further investigation by way of siting and drilling exploratory boreholes in the 500 metre wide coastal strip of the mining area.

5 RECOMMENDATIONS

The investigation provided a preliminary understanding of the groundwater situation at the site. The recommendations seek to ensure the mine complies with the relevant government legislation, particularly the National Water Act of 1998. To this end, the following recommendations are made:

- Site and drill at least five exploratory boreholes in the strip of land along the coast, extending 500 metres inland; and at least 100 metres from the sea edge. Siting of the boreholes should employ geophysical survey techniques to increase the chances of locating geological structures that influence groundwater flow such as faults, fracture zones and dykes. Electromagnetic (EM), magnetic, and electro-seismic techniques are recommended in this regards. The approximate positions of the geophysical survey lines are shown in Figure 11.1, and their coordinates are given in Table 11.1. A single borehole will be drilled on the strongest geophysical anomaly on each survey line. In other words, the borehole may be located anywhere along the survey line. The survey positions will be refined in the field based on local conditions encountered during the survey.

- Place some of the boreholes down-stream of the slimes dams so that they can also function as monitoring boreholes, should potable groundwater be found.
- Electrical conductivity of all water strikes should closely be monitored to identify possible pockets of fresh water.
- Water quality parameters to be analysed for should include but not limited to the following: pH, EC, TDS, Ca, Mg, Na, K, Fe, Mn, Cu, Pb, Zn, Cd, Cr, CL, SO_4, F, NO_3, PO_4, CO_3, and HCO_3. Sampling should be carried out quarterly.
- All waste containment facilities must be lined with impermeable or low permeability material. Common lining materials include clay, concrete and HDPE liners; the latter two being expensive.

Should however, no fresh groundwater be found on the properties, then the Department of Water and Sanitation should be engaged to discuss the logic of protecting naturally degraded water quality that does not support both basic human and ecological needs.

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APPENDICES

Appendix (I) CV for Andrew Mavurayi

Acronyms

BHN	Basic Human Needs
DWS	Department of Water and Sanitation
EC	Electrical conductivity
EIA	Environmental Impact Assessment
EM	Electro-magnetic
ES	Electro-seismic
HDPE	High density Polyethylene
Mamsl	Metres above mean sea level
WCR	West Coast Resources
WRC	Water Research Commission
WWF	Waters Without Frontiers

GLOSSARY OF TECHNICAL TERMS

Alkalinity: is a measure of the acid-neutralising capacity of water. Ions which commonly contribute to the alkalinity of water are bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}), and at high pH values, hydroxide (OH^-. The total alkalinity is the sum of these three ions. Anion: negatively charged ion.

Aquifer: Rock or sediment in a formation or group of formations or part of a formation which is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Baseflow: Groundwater contribution to stream-flow during the dry season.

Basic Human Needs (BHN): Minimum quantity and quality of water required to sustain humans.

Bedrock: solid rock underlying loose deposits such as soil or alluvium.

Ecological Requirements (ER): Minimum quantity and quality of water required to sustain an ecological system.

Electrical conductivity (EC): measure of the capacity of water to conduct an electrical current. This capacity is a result of the presence of ions in water, all of which carry an electrical charge. In most waters nearly all the EC is due to the major cations (calcium, magnesium, sodium, potassium and nitrate) and anions (carbonate, bicarbonate, chloride and sulphate). In acidic or basic waters the proton (H_+) or hydroxyl ion (OH_-) contributes extensively to the EC. Most organic compounds dissolved in water do not dissociate into ions, consequently they do not affect the EC. Approximately equivalent to the total dissolved solids.

Overburden: loose earth or rock material overlying solid rock.

Total dissolved solids (TDS): measure of the quantity of various inorganic salts dissolved in water. The TDS concentration is proportional to the electrical conductivity (EC) of water. Since EC is much easier to measure, it is routinely used as an estimate of the TDS concentration.

Water type: Chemical facies are calculated by first converting the milli-equivalents per litre of the major cations (Na_+, Ca^{2+}, Mg^{2+}) and anions (Cl^-, SO_4^{2-}, HCO_3^-) to percentages. The water type expression is formed by listing the ions with concentrations greater than 10% in decreasing order.

1 INTRODUCTION

1.1 BACKGROUND

West Coast Resources (Pty) Ltd (hereafter called WCR) intends to re-visit and mine certain areas on the Namaqualand Coast. WCR is re-establishing diamond-mining operations in the existing mining rights areas on the Namaqualand coast, previously mined by De Beers, and under the existing mining rights of July 2012, i.e. Koingnaas Mining Right (522MRC) and Samsons Bak Mining Right (525MRC. As part of their operations, WCR intend to mine deposits that are located on the beach and extend seaward, potentially for several hundred metres. WCR wants to continue with mining on the areas covered by these rights i.e. areas within the existing mining rights authorization, with immediate target being the Langklip and Koingnaas mining areas. The target areas are those that will not trigger new listed activities in terms of the National Environmental Management Act, Act No. 107 of 1998 (NEMA). The life of mine is anticipated to be about 11 years.

Waters Without Frontiers cc (WWF) was appointed to conduct a geohydrolocal impact assessment for the proposed mining activities, as part of a broader Environmental Impact Assessment (EIA) for the mine. The EIA process is coordinated by Myezo Environmental Services (Pty) Ltd.

1.2 PREVIOUS STUDIES

A groundwater study was previously conducted at the site by M L Francis for De Beers Consolidated Mines Limited - Namaqualand Mines in 2003. The study however, focused on the chemistry of water encountered in the mining excavations which were generally shallow. No boreholes were drilled.

1.3 ASSUMPTIONS AND LIMITATIONS

There were no assumptions made in the study.

The main limitation was that the study was based entirely on existing data, no primary data were generated in the study by way of drilling boreholes. Have reliance was placed on data from the National Groundwater Archive, NGA.

2 OBJECTIVES

The main objective of the study was to assess the potential impact of diamond mining activities on groundwater; and to recommend management options to mitigate or remedy the impacts.

3 LEGAL CONSIDERATIONS

The National Water Act of 1998 recognises the Department of Water Affairs (DWA) as the custodian of all water resources in South Africa; and gives it overall responsibility for and authority over water resource management, including the equitable allocation and beneficial use of water in the public interest. A person can only be entitled to use water if the use is permissible under the Act. The Act recognises the following types of water uses:

21(a):- taking water from a water resource;
21(b):- storing water;
21(c):- impeding or diverting the flow of water in a watercourse;
21(d):- engaging in a stream flow reduction activity contemplated in section 36;
31(e):- engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);
21(f):- discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
21(g):- disposing of waste in a manner which may detrimentally impact on a water resource;
21(h):- disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;
21(i):- altering the bed, banks, course or characteristics of a watercourse;
21(j):- removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
21(k):- using water for recreational purposes.

The water uses that have relevance to WCR operation include Sections 21 (a), (b), (g) and (j)

4. SITE DESCRIPTION

4.1 LOCATION

WRC mining area is located along the Namaqualand coastal foreland extending for about 70 km from roughly halfway between Kleinsee and Koingnaas in the north, to Mitchell's Bay in the South. The mining operations extend over portions of seven farms in the Namakwa District, Northern Cape Province. WCR administrative offices are located at Koingnaas. Access to Koingnaas is possible by several routes that include from Springbok via Kleinsee (170 km) or directly from Springbok through Namanqua National Park (105 km), both have sections of gravel. The location of the study area is shown in figure 4.1.

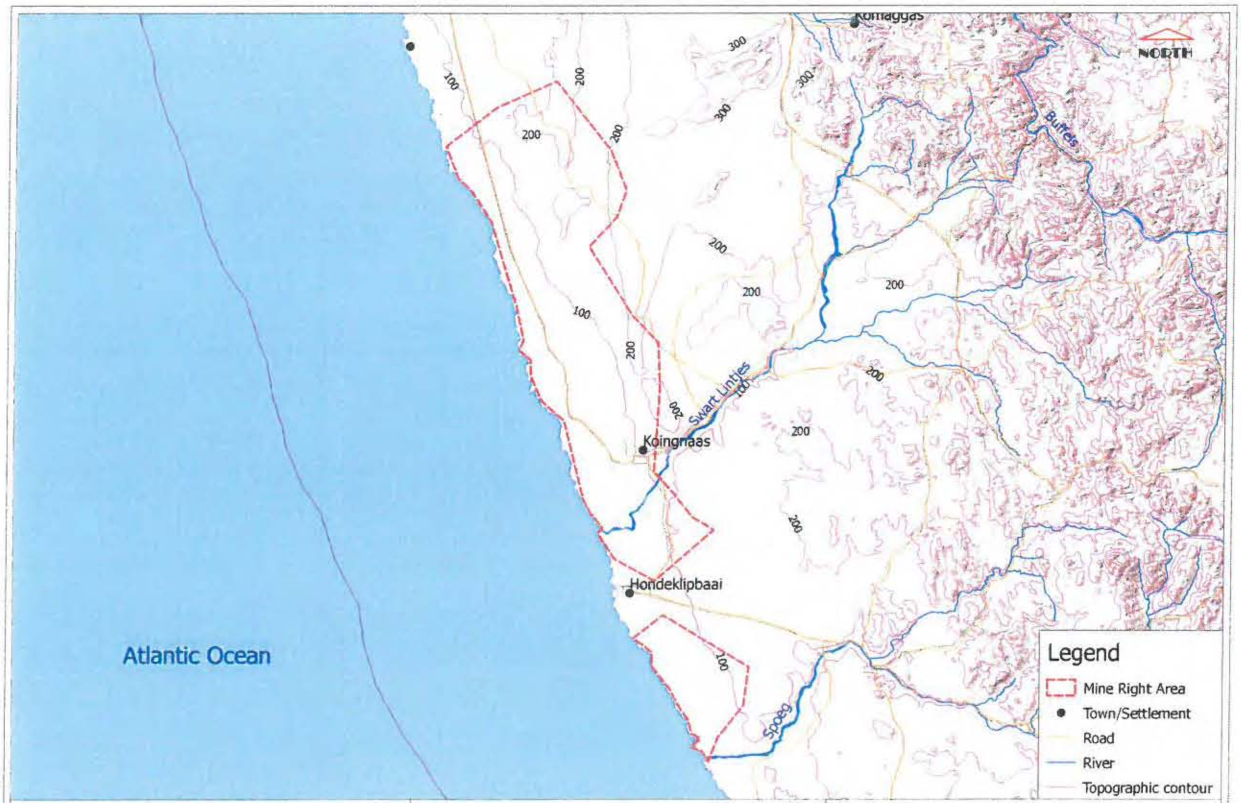
4.2 TOPOGRAPHY AND DRAINAGE

WRC mining area straddles three quaternary catchments which are, from the north to the south; F40A, F40D and F40F; all of which fall within the Lower Orange Water Management Area. The study area is located on a coastal plain, west of the Kamiesburg Mountains. The topography is fairly flat and homogeneous; and for the most part reflects the gently undulating nature of the predominantly sand covered land surface. The topography of the study area is shown in Figure 4.2. Various dune systems provide some topographic variation to the comparatively featureless landscape. Ground elevation in the mine operational areas ranges from 0 to 200 metres above mean sea level (mamsl). The topography becomes very from the sea going inland. Figure 4.3 shows a topographical cross-section from (Point A) in the sea, through Koingnaas to Point B located inland. Several pans occur in the area. The project area is drained by several rivers that rise in the mountains and flow westwards to the Atlantic Ocean. The main rivers include Zwart Lintjes and Spoeg.

4.3 CLIMATE

Koingnaas is located within an arid region with a climate characterised by relatively cool and dry desert conditions. The low temperatures and low incidence of low rainfall are controlled by the South Atlantic subtropical anticyclone, which maintains an almost isothermal atmosphere over the Namaqualand coast (Nieman, 1981). The predominant southerly winds cause the upwelling of the Benguela system which cools and stabilises the near surface air mass and reduces the potential for rainfall occurrence. Coastal fogs occur year round but are more frequent during the winter period.

Geohydrological Impact Assessment	50 0 50 km	West Coast Resources
Figure 4.1 Location of the project area		Koingnaas and Samsons Complex



Geohydrological Impact Assessment

Figure 4.2 Topography of the project area

West Coast Resources
Koingnaas and Samsons Complex

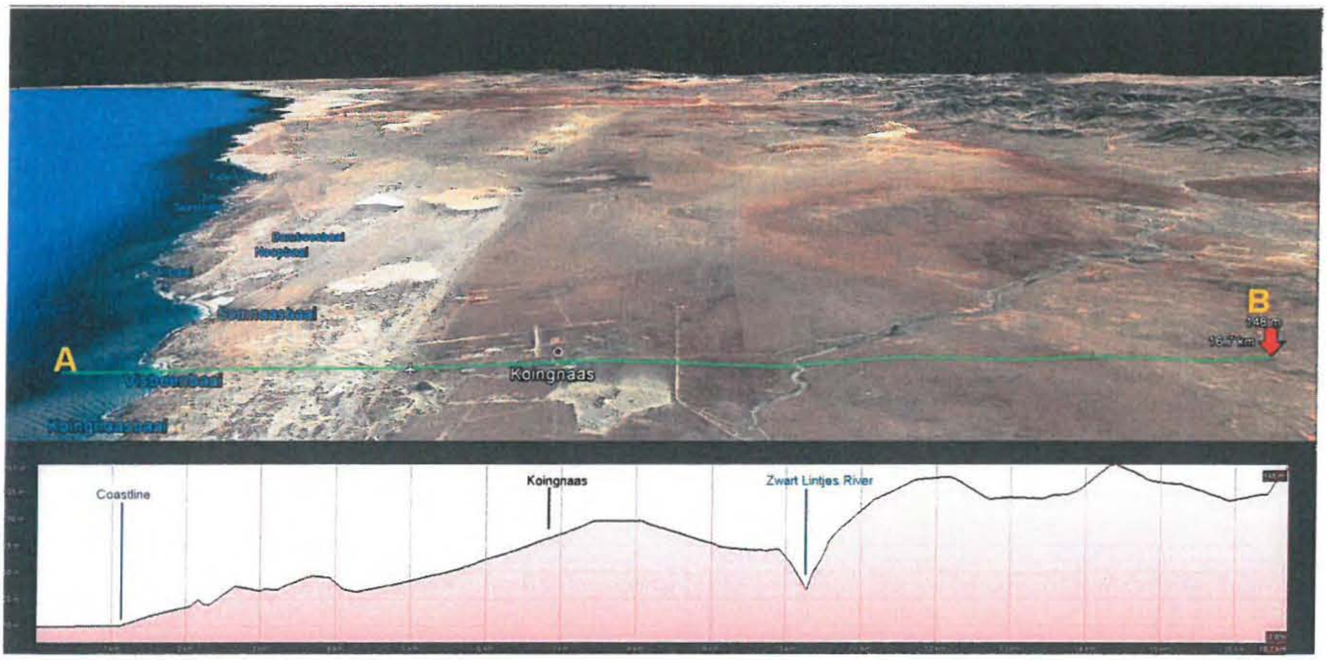


Figure 4.3 West-East topographical cross-section through Koingnaas

Koingnaas coastline receives about 100mm of rain per year during winter. Rainfall events are distributed between April and August and peak during May, June and July. It receives the lowest rainfall (0 mm) in January and the highest (6 mm) in June. Fog develops frequently as a result of oceanic surface evaporation which saturates the cool coastal air mass. Fog covers the area 40% of the year. Summer and autumn experience the greatest number of days with fog.

The average midday temperatures range from 20.6°C in July to 27.5°C in January. The region is the coldest during July when the mercury drops to 8.3°C on average during the night. The Atlantic Ocean has a significant moderating effect on the coastal temperature regime. Minimum temperatures are particularly stable and are not subject to large fluctuations. Rainfall and temperature trends are shown in Figures 4.3 and 4.4 respectively.

4.4 LAND USE

The diamond mining and fishing industries are the economic mainstay and largest employment source on the West Coast. Small-scale recreation and tourism are additional growth industries generating an increasing source of revenue for West Coast towns.

4.5 WATER SUPPLY

Groundwater represents the main source of water for domestic supply in the region. The settlements of Koingnaas, Hondeklip Bay and Samson Bak derive water from the Somnaas Noup aquifer located about 20 km north of Koingnaas. Two boreholes, BH 12 and BH 14, are currently in use. A third borehole, BH15 adjacent to BH 12, is equipped and used as a standby borehole.

4.6 SANITATION

Koingnaas is serviced by a water borne sewage system. Temporary ablution facilities are used at the mining and processing sites.

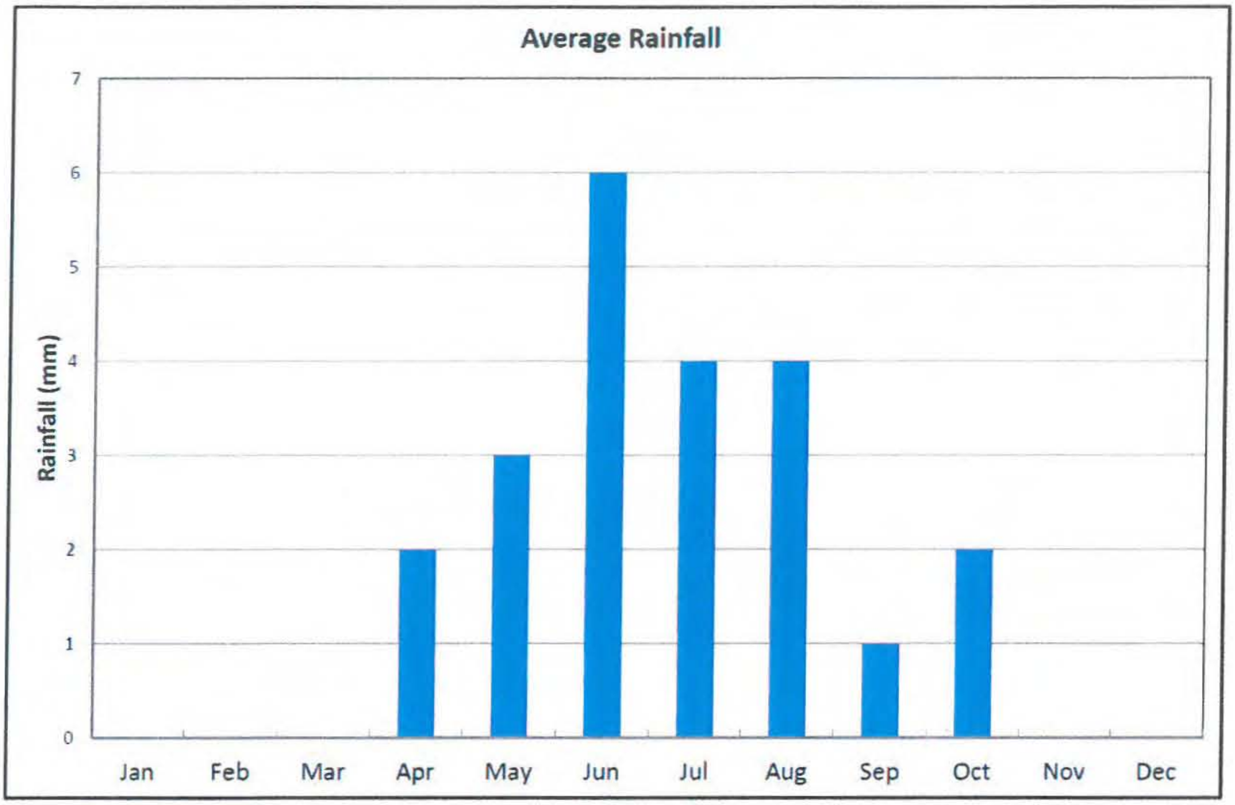


Figure 4.4 Rainfall pattern at Port Nolloth/Alexander Bay

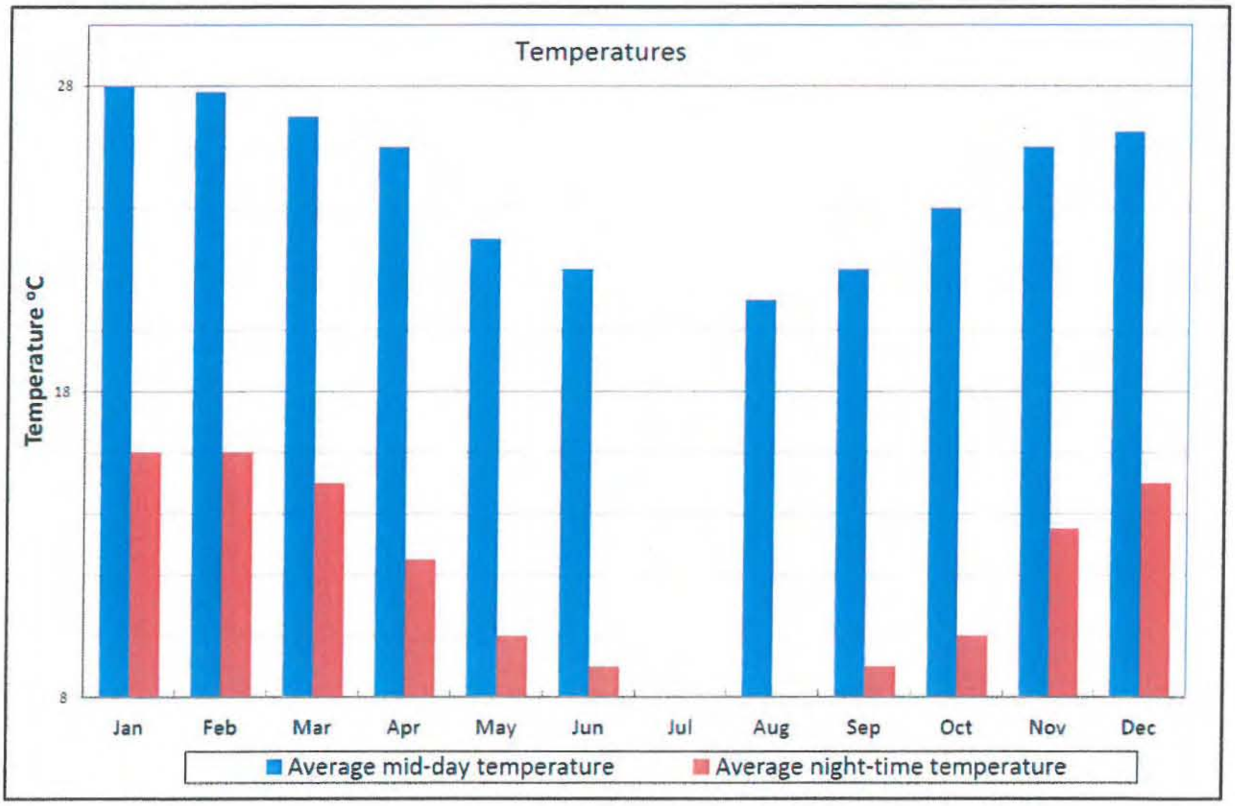


Figure 4.5 Temperature patterns at Port Nolloth/Alexander Bay

5 GEOLOGICAL SETTING

5.1 REGIONAL GEOLOGY

The study area is located in the Namaqua Metamorphic province, characterised by metamorphosed Precambrian basement rocks overlain by Cenozoic to Recent sediments. Figure 5.1 shows the simplified geology of the study area.

The basement consists predominantly of the Little Namaqualand Suite and; to a lesser extent, the Garries biotite gneiss and the Spektakel granite. The Little Namaqualand Suite occurs in an area bounded by the Orange River in the north and the Buffels River in the east, the Sandveld Coastal Plain in the west and the Bushmanland Peneplain in the east. It consists of a series of quartz-feldspar-biotite orthogneisses which have intrusive relations with one another and with the country rocks. Eight varieties of the gneisses are recognised. Rocks of the Namaqua Metamorphic Province were formed contemporaneously with the Natal metamorphic rocks in KwaZulu Natal. Remnants of the original Precambrian granites include the Spektakel granite.

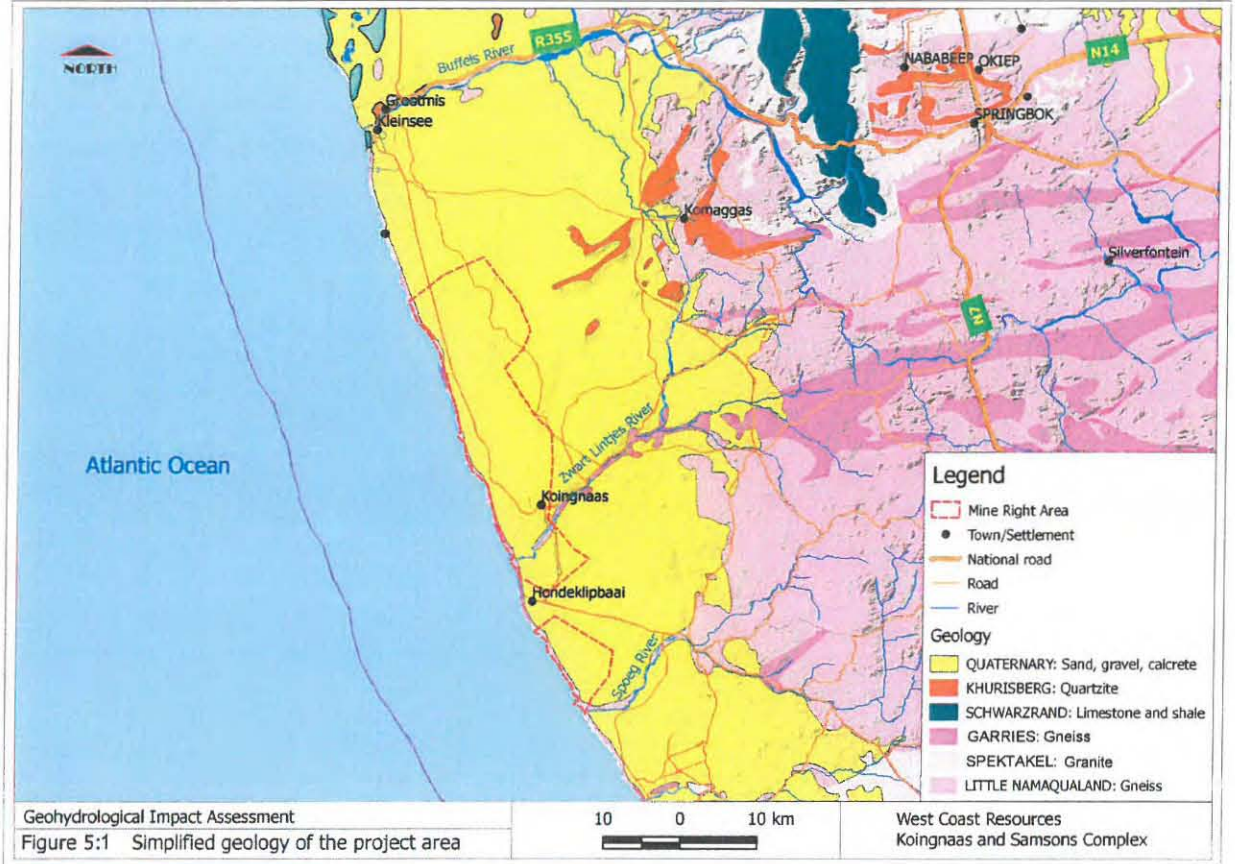
The metamorphic origin of the basement rocks implies that the rock masses were subjected to tectonic activities. East- west trending weaknesses are inferred to be related to transform faults generated by tectonism associated with the creation of the African plate. These weaknesses were exploited by the rivers to cut out the palaeo-channels targeted for diamond extraction. The diamonds were originally derived from intrusive kimberlites inland and were transported to the sea by erosion and fluvial processes.

5.2 LOCAL GEOLOGY

The study area is covered by a thin veneer of Cenozoic sediments comprising coastal dunes, which overlie fluviatile, beach and near-shore sediments. Sandy gravels occur on marine terraces most of the way along the western coastline from the Olifants River to to Hondeklip Bay, and overlie older channel deposits.

In general, the coastal sediments are sands of Pleistocene origin, grading upwards into silty sands. These are overlain by a calcrete layer varying in depth and consistency from hard rock to unconsolidated lime-rich sands. The surface sands are of eolian origin, and increase in depth from the north to the south.

The palaeo-channel at Koingnaas measures approximately 150 metres wide and in excess of 6 km long, trending north-east to south-west. The basal deposits consist of angular to sub-rounded quartz rubble lying on basements rocks. Late sediments consist of well sorted medium-grained sands and clays with peat layers.



Geohydrological Impact Assessment

Figure 5:1 Simplified geology of the project area

West Coast Resources
Koingnaas and Samsons Complex

6 GEOHYDROLOGICAL SETTING

6.1 REGIONAL SETTING

Groundwater utilisation is of major importance across wide areas in the study area and often constitutes the only source of water. It is mainly used for rural domestic supplies, stock watering and water supplies to towns. As a result of the low rainfall, recharge of groundwater is limited and only small quantities can be abstracted on a sustainable basis. Artificial recharge of groundwater is practiced in some areas where water from small dams is transferred through pipes into boreholes. Aquifer characteristics (borehole yields and storage of groundwater) are also typically unfavorable because of the hard geological formation underlying most of the area. Groundwater availability in the coastal region is extremely limited as a result of the lack of rainfall. Close to the sea there is a strong risk of seawater intrusion into coastal aquifers

6.2 LOCAL SETTING

The study area is characterised by both primary and secondary aquifers.

6.2.1 Primary Aquifer

Primary aquifers are associated with the unconsolidated deposits comprising sand and gravel in paleao drainage channels and associated valleys. They vary in thickness from 0 m (bedrock outcrops) to about 30 metres below surface.

6.2.2 Secondary Aquifer

The secondary aquifers are associated with fractures and fissures in the bedrock of Little Namaqualand gneiss and the Garries Complex. These rocks typically possess extremely small primary porosity and hydraulic conductivity when formed, and consequently have little to offer in terms of groundwater resources. Secondary process, however, improve their groundwater potential through fracturing and weathering.

Several different modes of groundwater occurrence have been recognised as follows:

- Jointing and fracturing associated with faulting,
- Weathering in lavas and gneisses,
- Fracturing at contacts between lithologies,
- Partings between bedding planes.
- Solution cavities in limestone and dolomite.

The groundwater yield potential in the study area is low with borehole yield generally less than 0.1 L/s.

The region receives very little groundwater recharge. Vegter's groundwater recharge map estimates recharge at 2 mm per annum, whilst the groundwater water harvest map indicates that 2

500 m^3 of groundwater can be sustainably abstracted per square kilometre per annum in the region.

6.2.3 Groundwater Quality

Groundwater quality is typical of arid regions, which is generally poor and characterised by high salinity. Electrical conductivity generally exceeds 500 mS/m. Groundwater is predominantly of the Na-Cl affinity. The poor water quality is attributed to several factors that include:

- Very low groundwater recharge (estimated at 0 to 2mm per annum), hence limited flushing out of old water.
- Marine origin of gravels described earlier in Geology Section forming terraces extending about 2 km inland and rising to about 90 m above mean sea level.
- Leaching and dissolution of terrestrial salts emanating from salt outfall from the sea.
- Ancient (old) water in paleao-drainage channels, recharged during periods of less arid regional climate in the past.
- Excessive surface water evaporation relative to rainfall, resulting in the concentration of salts in the water infiltrating the ground.

Figure 6.1 shows the groundwater electrical conductivity distribution in South Africa.