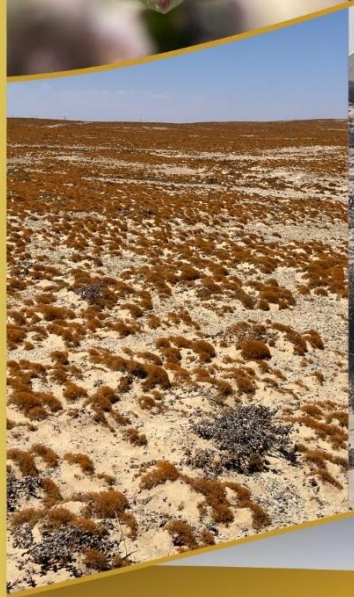
Work Package 1:

Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone

December 2025





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Edited by Greg Schreiner, Babalwa Mqokeli, Luanita Snyman-Van der Walt, Paul Lochner and Rinae Tsedu

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Published by:
CSIR
Meiring Naudé Road
Brummeria
Pretoria, 0184
www.csir.co.za

Project website: Boegoebaai Port | CSIR

Funded by: South African National Energy Development Institute (SANEDI)

Date of publication: December 2025

ISBN 978-0-7988-5675-1

CSIR Publication number: CSIR/SPLS/Ems/EXP/2025/1107/A

Recommended book citation: Schreiner, G., Mqokeli, B., Snyman-van der Walt, L., Lochner, P and Tsedu, R. (eds.). (2025). Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1.

Recommended chapter citation: Recommended citation provided on the front page of the specific chapter

Entire publication © 2025 by CSIR

Chapters © 2025 by authors

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Front cover photograph credits: Paul Lochner and Luanita Snyman-van der Walt

Report layout by Magdel van der Merwe (DTP Solutions)

Work Package 1:

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The Editors would like to acknowledge and sincerely thank all those who contributed to the development of Work Package 1. This Work Package comprises seven chapters drafted by thirty-five authors, peer reviewed by eight independent expert reviewers, and enriched by the contributions of a diverse range of stakeholders who engaged through the formally constituted project Working Group.

The process to generate the scientific material for this publication included a collaborative endeavour consisting of authors, peer reviewers, as well as contributions from a diversity of stakeholders involved in the SEA process via a formally constituted Working Group. The Editors would like to acknowledge and sincerely thank all those who contributed to the development of Work Package 1. The peer reviewers played a critical role in providing valuable input and strengthening the quality and rigour of the chapters. Their names and affiliated institutions are also listed below:

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Werkpakket 1:

Strategiese Omgewings Assessering vir die voorgestelde Boegoebaai hawe en Spesiale Ekonomiese Sone

Desember 2025

OPSOMMING VIR BELEIDMAKERS



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Publiseer deur:	Wetenskap en Nywerheids Navorsingsraad (WNNR) Meiring Naudé Road Brummeria Pretoria, 0184 www.csir.co.za *Projek webtuiste:* https://www.csir.co.za/boegoebaai-port
Befondsing:	South African National Energy Development Institute (SANEDI), in vennnootskap met Transnet National Ports Authority (TNPA) and the Northern Cape Economic Development, Trade and Investment Promotion Agency (NCEDA)
Datum:	Desember 2025
ISBN:	978-0-7988-5675-1
WNNR document nommer:	CSIR/SPLS/Ems/EXP/2025/1107/A
Verwysing:	Schreiner, G., Mqokeli, B., Snyman-Van der Walt, L., Tsedu, R., Pulfrich, A., Clark, B., Ho, Y.-T., Gammon, E., Biccard, A., Rees, A., Wright, A., Taljaard, S., Weerts, S., Gammage, L., Zeeman-du Toit, Z., Mpala, A., Norton, M., Ortega-Cisnero, K., Ward, C., van Rooyen, G., van Rooyen, N., van Wyk, P., Day, L., Niemandt, C., Froneman, A., Colyn, R., Oosthuizen, M., Loftie-Eaton, M., Marais, W., Botha, M., Orton, J., Maitland, V., Webley, L., & Pether, J. **Summary for Policymakers Work Package 1 of the Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone.** CSIR/SPLS/Ems/EXP/2025/1107/A. ISBN: 978-0-7988-5675-1
Weergawe:	Konsep Werkpakket 1 verslag vir publieke hersiening.
Voorblad foto's:	Paul Lochner en Luanita Snyman-van der Walt

Hierdie dokument is 'n vertaling van die oorspronklike Engelse weergawe. Sekere figure en kaarte mag steeds in Engels verskyn.

Publikasie bestuur deur Magdel van der Merwe (DTP Solutions)

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Lys van akronieme en afkortings

"CBA"	"Critical Biodiversity Area"
"CR"	"Critically Endangered"
"ESA"	"Ecological Support Area"
"IFC"	"International Finance Corporation"
"KBA"	"Key Biodiversity Area"
"NCEDA"	"Northern Cape Economic Development, Trade and Investment Promotion Agency" (Noordkaapse Agentskap vir Ekonomiese Ontwikkeling, Handel en Beleggingsbevordering)
"NPAES"	"National Protected Area Expansion Strategy"
"SANEDI"	"South African National Energy Development Institute" (Suid-Afrikaanse Nasionale Energieontwikkelingsinstituut)
"SCC"	"Species of Conservation Concern"
"TNPA"	"Transnet National Ports Authority" (Transnet Nasionale Hawe-owerheid)
FPIC	Free, Prior and Informed Consent
GH_2	Groen waterstof
Ha	Hektaar
NBA	National Biodiversity Assessment
OBM	Opsomming vir Beleidsmakers
OIS	Omgweingsimpakstudie
RGEV	Richtersveld Gemeenskaplike Eiendomsvereniging
RKBLW	Richtersveld Kulturele en Botaniese Landskap Wêrelderfenisgebied
SANBI	South African Nasionale Biodiversieitsinstituut
SES	Spesiale Ekonomiese Sone
SOA	Strategiese Omgweings Assessering
WNNR	Wetenskaplike en Nywerheidsnavorsingsraad

1. DIE OORSPRONG, BESTEK, DOEL EN METODES VAN DIE ASSESSERING

Groen waterstof (GH_2), en sy afgeleide Krag-na-X produkte, soos groen ammoniak en groen metanol, kan die Suid-Afrikaanse energie-ekonomie minder koolstofintensief maak, nuwe inkomste genereer, werksgeleenthede en vaardighede skep, en 'n regverdige energie-oorgang fasiliteer.

As deel van Suid-Afrika se strewe om sy afhanklikheid van fossielbrandstowwe te verminder en 'n rolspeler in die opkomende GH_2-mark te word, is 'n omvangryke program van nuwe infrastruktuur en ontwikkeling in die Noordkaap voorgestel, bestaande uit drie hoofkomponente:

1. 'n Nuwe breekwater hawe[1] en hawegebied, ongeveer 1 km noordwes van die kenmerkende Buchu- of Boegoe-berg Tweeling, in 'n area genaamd "Boegoebergbaai", en hierna, vir die doel van die SOA, na verwys as "Boegoebaai".

2. 'n Spesiale Ekonomiese Sone[2] (SES) vir gemengde gebruik langs die voorgestelde hawe.

3. 'n Netwerk meegaande hernubare krag opwekkingsfasiliteite (son- en windkrag), kraglye, paaie, pypelyne en ander infrastruktuur benodig om GH_2 produksie en vervoer te ondersteun.

Blok OBM 1: Wat is Groen Watersof (GH_2) en Krag-na-X produkte?

Groen waterstof (GH_2) is 'n vorm van waterstofbrandstof wat geproduseer word deur 'n watermolekule te split in waterstof en suurstof met behulp van hernubare energiebronne soos son- of windkrag. Anders as grys of blou waterstof, genereer dit geen kweekhuisgasvrystellings tydens produksie nie. PtX is 'n breër konsep wat verskeie tegnologieë en prosesse insluit om elektriese energie, afkomstig van hernubare bronne, om te skakel in verskillende vorme van energie-draers, chemikalieë of materiale. Hierdie omskakeling maak die berging, vervoer en gebruik van waterstof (Krag-to-Waterstof), sintetiese brandstowwe (Krag-na-Vloeistof), en selfs chemikalieë (Krag-na-Chemikalieë) moontlik, wat die toepassingsgebied van hernubare energie verbreed. Dit is veral belangrik vir nywerhede en sektore waar groen elektrifisering uitdagend is, soos swaar vervoer, maritieme skeepsvaart en lugvaart.

Daar is baie verskillende filosofiese standpunte oor wat dit beteken wanneer iets "groen" is. "Groen", soos dit in die konteks van waterstofproduksie gebruik word, word meestal in 'n nou, reduksionistiese sin aangewend, waar die enigste maatstaf kweekhuisgasvrystellings is. Dit beteken dat 'n produk as "groen" beskou word wanneer die produksie-insette uitsluitlik deur hernubare energie voorsien is, met minimale of geen koolstofvrystellings nie. Die konsep van "groen" waterstof sluit dus breër ekologiese en sosiale aspekte uit, soos byvoorbeeld biodiversiteitsbewaring en billike sosiale voordele, wat dit 'n relatief swak konsep maak vanuit 'n volhoubaarheidsperspektief. Met ander woorde, "groen" waterstof is nie noodwendig "volhoubare" waterstof nie. Iets wat "groen" is, maak dit nie intrinsiek goed. volhoubaar of sosiaal wenslik nie – alhoewel dit uiteraard beide goed, volhoubaar en sosiaal wenslik kan wees, afhangend van die konteks en hoe goed projekte ontwerp, gebou en bedryf word.

[1] 'n Breekwater hawe n tipe hawe wat beskerm word deur 'n kunsmatige aflandige struktuur wat gebou is om die hawe te beskerm teen die krag van golwe, stroomvloei en stormgolwe.
[2] 'n Spesiale Ekonomic Sones (SES) is 'n geografies aangewese gebied van 'n land wat opsy gesit is vir spesifiek geteikende ekonomiese aktiwiteite, ondersteun deur spesiale reëlings (wat wetgewing kan insluit) en stelsels wat dikwels verskil van dié wat in die res van die land geld (DTIC, 2017).

'n Nuwe hawe-ontwikkeling en SES, tesame met die ondersteunende GH_2-infrastruktuur wat oor wye areas kan strek, soos beoog op die voorgestelde skaal, sal verskeie direkte en indirekte impakte hê op die sosiale en ekologiese ontvangende omgewings – beide positief en negatief. Daarom is 'n Strategiese Omgewings Assessering (SOA) geïnisieer deur 'n samewerking tussen die Suid-Afrikaanse Nasionale Energieontwikkelingsinstituut ("South African National Energy Development Institute" ("SANEDI")), die Noordkaapse Agentskap vir Ekonomiese Ontwikkeling, Handel en Beleggingsbevordering (""Northern Cape Economic Development, Trade and Investment Promotion Agency" ("NCEDA")), en Transnet Nasionale Hawe-owerheid ("Transnet National Ports Authority" ("TNPA")). Gegewe hul ervaring in SOA, hernubare energie, hawe- en GH_2-beplanning, is die Wetenskaplike en Nywerheidsnavorsingsraad (WNNR) deur SANEDI versoek om 'n koördinerende rol te speel.

Blok OBM 2: What is a Opsomming vir Beleidsmakers (OBM)?

'n Opsomming vir Beleidsmakers (OBM) is 'n bondige samevatting van die sleutelbevindinge wat voortspruit uit grootskaalse, gesofistikeerde wetenskap-beleidprosesse – met Strategiese Omgewings Assessering (SOA) as een voorbeeld. SPM's word gebruik om die huidige stand van kennis te kommunikeer en te versprei, gebaseer op die beste beskikbare bewyse, in 'n toeganklike styl en taal. Alhoewel die primêre teikengehoor van 'n OBM beleidsmakers is – met die oog op die rigting van bewyse-geïnformeerde besluitneming – word die inhoud van SPM's wyd beskikbaar gestel aan alle belanghebbende rolspelers, van die privaatsektor tot die burgerlike samelewing. Op hierdie manier bied 'n OBM 'n platform vir geloofwaardige, publiek toeganklike bewysamevatting, wat help om besluitneming te rig terwyl dit meer deursigtig en publiek aanspreeklik gemaak word.

Die doel van die SOA is om strategiese beplanning vir voorgestelde infrastruktuurontwikkeling in en rondom Boegoebaai, sowel as die breër Namakwa-streek van die Noordkaap, te lei. Lesers moet daaraan herinner word dat SOA nie 'n besluitnemingsproses is op dieselfde manier as byvoorbeeld 'n Omgewingsimpakstudie (OIS) is nie. Die doel van die SOA is om op 'n deursigtige wyse afwaartse beplanning en besluitnemingsprosesse (wat oor baie jare – indien nie dekades – mag plaasvind, of dalk glad nie) te lei. Deur 'n verskeidenheid van beste praktyk wetenskap-beleidprosesse te integreer, behoort die SOA 'n bewysgebaseerde, interdissiplinêre perspektief te bied op die belangrikste geleenthede en risiko's wat verband hou met die voorgestelde hawe en SES, binne die breër konteks van grootskaalse GH_2 ontwikkeling in die wyer streek.

Gegewe die veelvoudige skale wat die SOA in ag moet neem, is die prosesse en uitsette verdeel tussen twee Werkpakkette (Schreiner et al., 2025). Neem kennis dat slegs die bevindinge van Werkpakket 1 in hierdie OBM (Blok OBM 2) gerapporteer word. 'n Verdere SOA-verslag en OBM vir Werkpakket 2 word ontwikkel en vroeg in 2026 publiek beskikbaar gestel.

Blok OBM 3: Die inhoud van Werkpakket 1

Werkpakket 1 bestaan uit sewe hoofstukke wat deur vyf-en-dertig outeurs opgestel is, en deur agt onafhanklike portuurbeoordelaars nagegaan is. Dit sluit ook bydraes in van verskeie belanghebbendes wat by die proses betrokke was via 'n formeel saamgestelde Werkgroep.

Die hoofstukke van Werkpakket 1 is as volg (beskikbaar in Engels):

1. Inleiding en konteksbepaling (Schreiner et al., 2025)
2. Mariene ekologie (Clark et al., 2025)
3. Terrestriële en binnelandse akwatiese ekologie (van Rooyen et al., 2025)
4. Biodiversiteitskompenseringsraamwerk (Botha, 2025)
5. Erfenis (Orton et al., 2025)
6. Visserye en kusleefwyses (Gammage et al., 2025)
7. Volhoubare hawebeplanning (Taljaard & Weerts, 2025)

1.1 Werkpakket 1

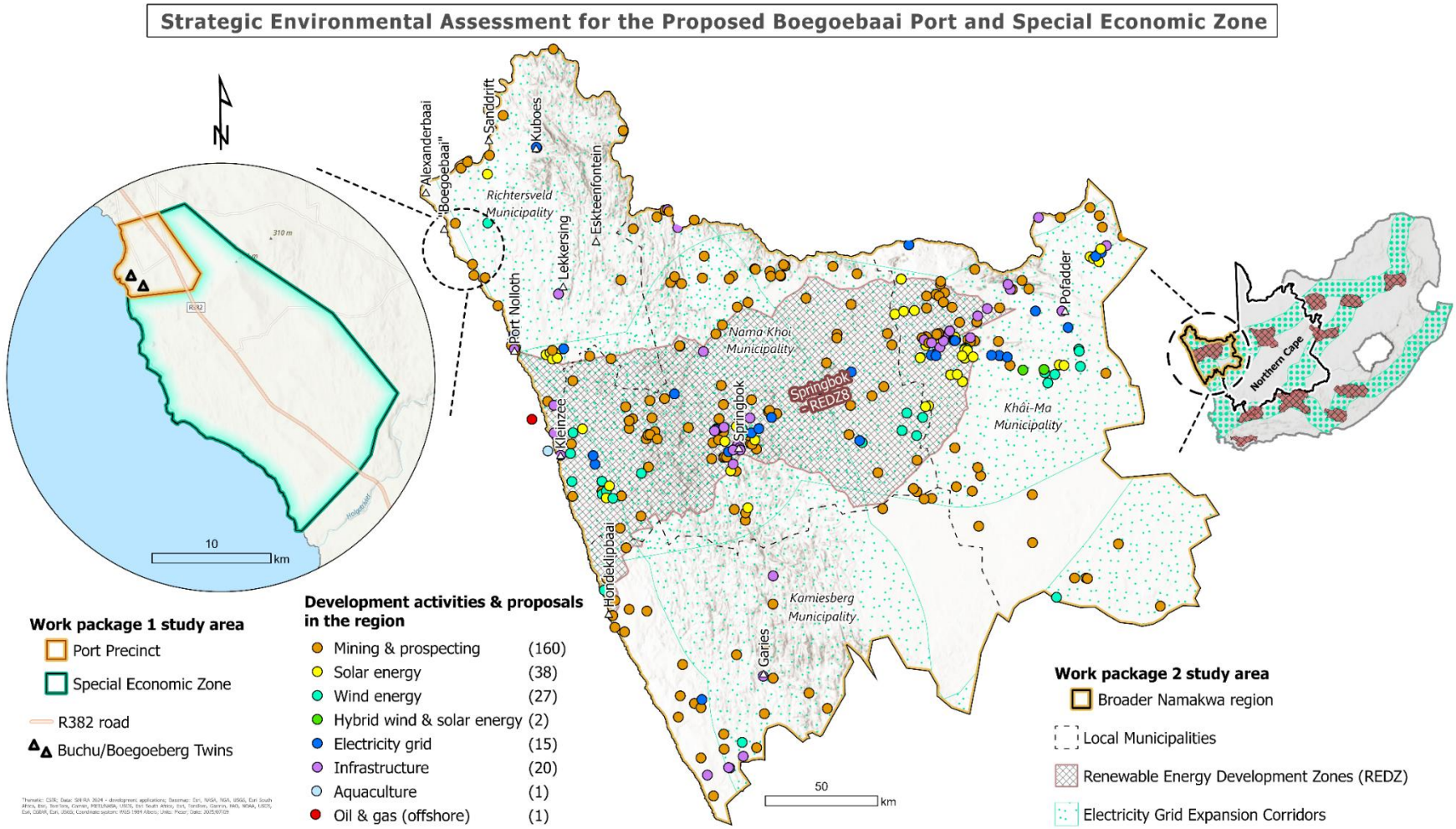
Werkpakket 1 fokus op die ontwikkeling van 'n SOA-verslag op plaaslike skaal, wat gemik is op die beoordeling van die sosiale en ekologiese sensitiwiteit van die omgewing (Tabel OBM 1), teen 'n relatief hoë resolusie (dikwels basseer op veldwerk), rondom die voorgestelde hawe- en SES-ontwikkeling, wat 'n ruimtelike skaal van ongeveer 33 500 hektaar (ha) dek. Hierdie proses is onderneem met die doel om plaaslik-geskikte vatbaarheidsstudies te ondersteun (veral vir die voorgestelde hawe) asook om toekomstige besluitnemingsprosesse, soos OIS prosesse en ander beplanningsaktiwiteite, te ondersteun. Die ruimtelike fokus van Werkpakket 1, binne die breër streeksverband en insluitend mededingende grondgebruike, word in Figuur OBM 1 aangedui.

Tabel OBM 1: Sensitiwiteitskategorieë vir die omgewing van die Werkpakket 1-studiegebied

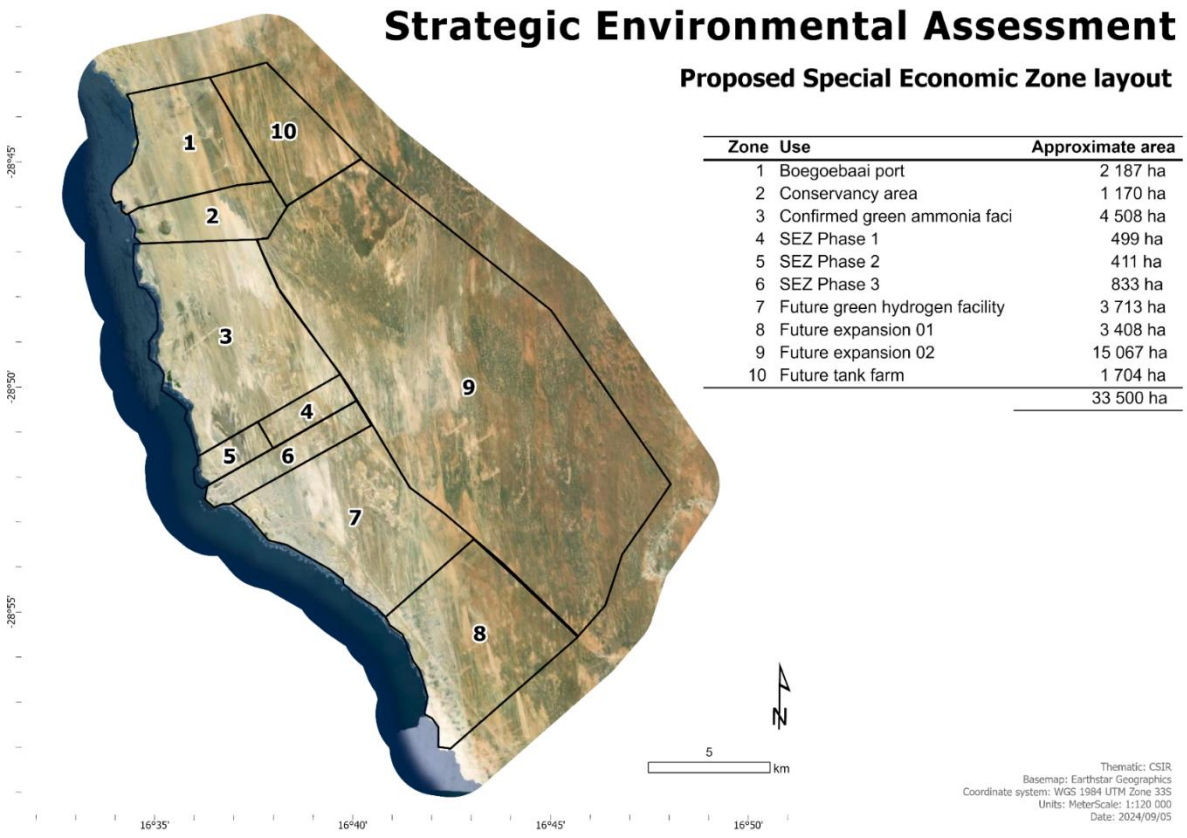
Kategorie	Beskrywing
BAIE HOOG	Hoogs kwesbaar vir versteuring met min/geen kapasiteit vir herstel nie. Sluit bedreigde spesies, kritieke habitatte, erfenis-/sosiale hulpbronne of ekosisteme met baie noue toleransies vir verandering in.
HOOG	Sensitief vir ekologiese en sosiale verandering, maar met beter herstelpotensiaal. Laer konsentrasies van bedreigde spesies, kritieke habitatte, erfenishulpbronne of ekosisteme met 'n mate van toleransie vir verandering.
MEDIUM	Matig veerkragtigheid teen stres of verandering. Stelsels kan matige impakte absorbeer sonder langtermyn skade of onomkeerbare verlies. Sluit aanpasbare spesies, minder waardevolle sosiale/kulturele hulpbronne en matig sensitiewe habitatte in..
LAAG	Waarskynlik reeds erg gedegradeer deur vorige versteurings, of hoër aanpasbare veerkragtigheid en lae kwesbaarheid. Sluit wydverspreide sosiale hulpbronne, ekosisteme of spesies met breë ekologiese nisse en hoë regeneratiewe kapasiteit in.
GETRANSFORMEERDE PLANTGEMEENSKAPPE	Plantgemeenskappe wat nadelig verander is van hul verwagte oorspronklike toestand deur vorige menslike aktiwiteite en omgewingsveranderinge.
BESTAANDE MENSLIKE VERTEURING	Gebiede waar mensgemaakte aktiwiteit (bv. geboue, infrastruktuur, en paaie) en fisiese versteurings (bv. gemynte gebiede, sterthope, veeposte) tans bestaan of sigbaar is in die landskap.

Binne die 33 500 ha hawe- en SES-gebied (insluitend 'n voorgestelde bewaringsgebied aangrensend aan die hawegebied), is tien konsep-ontwikkelingsones deur beleidmakers voorgestel, soos aangedui in Figuur OBM 2):

- **Sone 1:** Hawegebied – 2 187 ha
- **Sone 2:** Bewaringsgebied – 1 170 ha
- **Sone 3:** Bevestigde groen ammoniakfasiliteit – 4 508 ha
- **Sone 4:** SES Fase 1 – 499 ha
- **Sone 5:** SES Fase 2 – 411 ha
- **Sone 6:** SES Fase 3 – 833 ha
- **Sone 7:** Toekomstige GH_2-fasiliteit – 3 713 ha
- **Sone 8:** Toekomstige uitbreiding 01 – 3 408 ha
- **Sone 9:** Toekomstige uitbreiding 02 – 15 067 ha
- **Sone 10:** Toekomstige bergingsfasiliteit – 1 704 ha



Figuur OBM 1: Die voorgestelde Boegoebaai hawe en SES (Werkpakket 1-studiegebied) is geleë in die Plaaslike Munisipaliteit Richtersveld, Namakwa-distrik, in die Noordkaap Provinsie. Ekonomiese aktiwiteite sluit uitgebreide mynbou en prospektering in. Die gebied tussen Port Nolloth en Alexanderbaai, insluitend die grond wes van die R382 waar die hawe en SES voorgestel word, is al meer as ’n eeu lank vir diamante ontgin. ’n Hernubare-energie sektor is ook besig om te ontwikkel, met gevestigde Hernubare Energie Ontwikkelingsones (“REDZ”) en Elektrisiteitsnetinfrastruktuur (“EGI”) Korridors.



Figuur OBM 2: Die voetspoor van die voorgestelde Boegoebaai hawe en fases van die voorgestelde SES (Sones 1 – 10)

Sone 1, die Hawegebied, is ontwerp as 'n nuwe breaakwaterhawer, met Fase 1A wat voorsiening maak vir 'n twee-aanlegsteiger vir vloeibare massagoedere (ammoniak, dieselolie), droë massagoedere (ystererts, mangaan), en verskeie breekmassagoedere (lood, sink), tesame met noodsaaklike infrastruktuur soos stoortenks, vervoerbande, veeldoelige en droë massaterminale, en administratiewe geboue. Langtermynplanne vir Fase 1B behels uitgebreide breekwaters, bykomende veeldoelige en vloeibare massaanlegte, 'n houerterminaal en 'n skeepsherstelwerf, asook spoorverbindings. Sone 2 is 'n Bewaringsgebied van ongeveer 1 170 ha, spesifiek aangewys vir die beskerming van bewaringsprioriteite, insluitend die Boegoeberg Tweeling, 'n Kaapse pelsrobkolonie, en 'n argeologiese terrein. Sone 3, die Bevestigde Groen Ammoniakfasiliteit, sal 'n grootskaalse groen waterstof- en ammoniakproduksiefasiliteit huisves met 'n aanvanklike elektroliseerderkapasiteit van 5 GW teen 2030, ondersteun deur 'n 188 ML/dag ontsoutingsaanleg, waterbehandelingseenhede, en stoortenks vir waterstof, suurstof en ammoniak. Sones 4, 5 en 6 vorm die SES Nywerheidspark, bedoel vir gemengde gebruik, vervaardiging, logistiek, berging en kantore, en sal 'n 2.7 ML/dag ontsoutingsaanleg insluit vir eie gebruik en verspreiding na Port Nolloth. Sones 7, 8 en 9 is aangewys as Toekomstige Groen Waterstof-fasiliteite en Toekomstige Uitbreidingsgebiede, beplan vir die herhaling van groen waterstof- en ammoniakproduksiefasiliteite, soortgelyk aan die aanvanklike opstelling in Sone 3. Sone 10 is geïdentifiseer as 'n Toekomstige bergingsarea, 'n voorgestelde gebied van ongeveer 1 704 ha oos van die R382-pad vir bykomende berging.

Multi-outeur spanne (Blok OBM 4) was saamgestel vir Werkpakket 1 en versoek om verslae te ontwikkel wat die sleutel-sensitiwiteite en impakte identifiseer wat met ontwikkeling op die voorgestelde skale geassosieer mag word. Die opsommings van hierdie bevindinge word in Afdeling 2 van hierdie SPM gekommunikeer. Benewens die multi-outeur spanne (wat deels dien as 'n metode om deelname te verbreed), is wyer deelname gefasiliteer deur 'n formeel gemandateerde SOA Werkgroep (Blok OBM 5).

Blok OBM 4: Die multi-outeur spanmodel

'n Multi-outeur span, in die konteks van 'n SOA, verwys na 'n gestruktureerde, pluralistiese outeurskapmodel wat ontwerp is om uiteenlopende perspektiewe en kundigheid oor 'n beoordelingsproses heen te integreer. Vir die Boegoebaai SOA is multi-outeur spanne saamgestel deur 'n konsultatiewe proses met die Werkgroep (wat verteenwoordigers van die regering, akademie, NRO's en ander belanghebbendes ingesluit het) om navorsers te nomineer wat oor die nodige niskennis van hierdie afgeleë streek beskik, tesame met 'n begrip van strategiese infrastruktuurimpakte, akademiese geloofwaardigheid, en kundigheid in hoëvlak strategiese beoordelings.

Betrekking van belanghebbendes was ook setnraal tot to SOA vir beide Werkspakkette. In die konteks van Werkspakket 1 het dit tot dusver die toeganklike inligting versprei d.m.v. die SEA website, plaaslike kennisgewings/plakkate, koerantadvertensies, radio-onderhoude en formele Werkgroepvergaderings. Verdere Werkgroep-sessies en openbare inligtingsessies[3] is beplan oor sewe liggings, waar voorlopige SOA-bevindinge aangebied sal word en direkte gemeenskapsinsette aangemoedig sal word deur middel van hierdie konsultasiesessies.

Blok OBM 5: Die SOA Werkgroup

Die Werkgroep is 'n multisektorale span kundiges wat saamgestel is uit nasionale, provinsiale en plaaslike regeringsdepartemente, staatsinstellings, akademiese en navorsingsinstellings, nie-regerings- en gemeenskapsgebaseerde organisasies, asook die nywerheid- en privaatsektore. Die doel daarvan is tweeledig: om kundige insette regdeur die SOA-proses te lewer; en om as 'n inligtingskanaal te dien, met lede wat as skakels tussen dié wie hulle verteenwoordig en die SOA optree, en sodoende tweerigtingkommunikasie, deursigtigheid en inklusiewe deelname regdeur die SOA te fasiliteer.

1.2 Werkpakket 2

Hierdie SOA-verslag op streekskaal is tans naby aan voltooiing (einde 2025) en sal die belangrikste volhoubaarheidskwessies dek wat verband hou met 'n uitgebreide GH_2-ekonomie in die Noordkaap. Dit word meer strategies beoordeel vanuit die perspektief van kumulatiewe risiko en geleenthede, maar teen 'n laer resolusie as Werkspakket 1. Werkspakket 2 sluit geen veldwerk in nie.

Die ruimtelike skaal van Werkspakket 2 dek dele van die Namakwa-distrik, afgebaken deur die plaaslike munisipaliteite van Richtersveld, Nama Khoi, Kamiesberg en Khâi Ma. Werkspakket 2 sal, binne 'n hoogs gestruktureerde risiko-/geleentheidsraamwerk, die omvang van impakte op streekskaal beoordeel oor verskeie toekomstige scenario's. Werkspakket 2 poog om plaaslike en streeksbeplanning te rig deur prosesse soos ruimtelike ontwikkelingsraamwerke, geïntegreerde ontwikkelingsplanne en

[3] Obenbare inligtingsessies om die konsepbevindinge van Werkpakket 1 aan te bied, het plaasgevind in Port Nolloth, Alexanderbaai, Sanddrift, Kuboes, Lekkersing, Eksteenfontein, Springbok en Steinkopf in die week van 12-15 Augustus 2025.

omgewingsbestuursraamwerke, en sluit uiteraard enige OIS-prosesse in wat moontlik in die streek onderneem mag word.

Die strategiese kwessies wat in Werkspakket 2 gedek word, sluit in ekologie, biodiversiteit en bewaringsbeplanning (insluitend biodiversiteitsverrekening), waterbronne en akwatiese ekologie, erfenis, infrastruktuur en beplanning, en sosio-ekonomiese impakte.

Tabel OBM 2: Opsomming van die SOA-werkspakkette oor verskillende ruimtelike skale, metodes en datainsamelingspraktyke.

	Werkpakket 1	Werkpakket 2
Ruimtelike skaal	Plaaslik (33 500 ha) – dek die omvang van die voorgestelde hawe en SES.	Streekskaal (>5 miljoen ha) – oor vier Plaaslike Munisipaliteite, insluitend die 33 500 ha wat deur Werkspakket 1 gedek word.
Metode	Hoë resolusie bepaling van die sensitiwiteit van die ontvangende omgewing met die oog op die toepassing van vermyding (bo-aan die mitigasiehiërargie).	Bepaling van die kumulatiewe sosiale en ekologiese impakte van 'n streeksgewys uitgebreide GH_2-ekonomie oor ontwikkelingscenario's.
Resolusie	Veldwerk, gekoppel aan lessenaarstudies (geëvalueerde akademiese en populêre literatuur) en ander bronne waar nodig (bv. onderhoude).	Lessenaarstudies (geëvalueerde akademiese en populêre literatuur, onderhoude ens.) en ander publiek beskikbare data en bronne.

2. KERN BEVINDINGE VAN WERKPAKKET 1

Die sleutelbevindinge uit die onafhanklike, geakkrediteerde spesialishoofstukke word uiteengesit in die volgende OBM-afdelings.

2.1 Die sensitiwiteit van die omgweing

2.1.1 Mariene ekologie (basseer op Clark et al., 2025)

Rotsagtige kuslyn by Boegoebaai punt binne Sone 1 wissel van HOOG tot BAIE HOOG sensitiwiteit rondom die voorgestelde hawegebied. Hierdie areas dien as 'n belangrike broeiplek vir Kaapse pelsrobbe (Figuur OBM 3) en bedreigde seevoëls. Ontwikkeling rondom Boegoebaai-punt (wat gekenmerk word deur kranse en 'n rotsagtige kop), insluitend binne 300 meter noord en suid van die kolonie hou 'n hoë risiko van versteuring en verplasing vir hierdie spesies in, met moontlik onomkeerbare ekologiese gevolge (veral rekende die konstruksie van 'n breekwater en hawe). Dit lei tot 'n sterk aanbeveling om alternatiewe posisie vir die breekwater te oorweeg (sien Figuur 2-6.1 van Hoofstuk 2).

Blok OBM 6: Wat is "Critical Biodiversity (CBA)" en "Ecological Support Areas (ESA)"?

"CBAs" is terrestriële of akwatiese gebiede wat geïdentifiseer is as belangrik vir die bewaring van biodiversiteit en die instandhouding van ekosisteemfunksionering. Sulke areas is noodsaaklik vir die bereiking van nasionale biodiversiteitsteikens. "ESAs" is gebiede wat die ekologiese funksionering van "CBAs" en ander natuurlike stelsels ondersteun, en 'n rol speel in die volhoubaarheid van biodiversiteit en ekosisteemdienste. Terwyl "CBAs" in 'n natuurlike of byna-natuurlike toestand behou moet word, mag "ESAs" meer buigsame grondgebruik toelaat, mits ekologiese prosesse volgehou word.



Figuur OBM 3: Kaapse pelsrob broeikolonie by die rotsagtige kust by Boegoebaai punt (Bron: L. Snyman-vd Walt, 2024).

Sagte-bodem seehabitatte rondom Boegoebaai word as "bedreig" ("Endangered") gelys in die Nasionale Biodiversiteitassessering (NBA, 2018)[4] weens beperkte beskerming en bedreigings soos die vermindering van die Oranjerivier se vloei en diamantmynbou. 'n Groot deel van hierdie habitat is aangewys as "CBA"-Herstel of "ESA". Eweneens word rotsagtige seebodem habitatte, insluitend vlak kelpwoude, as "kwesbaar"("Vulnerable") geklassifiseer en val grotendeels binne CBA"-Herstel of "ESA", wat noukeurige bestuur vereis. Hierdie habitatte is met 'n **MEDIUM** sensitiwiteit geklassifiseer.

Gemengde rotsagtige kuslyne en subtidale riwwe het 'n MEDIUM tot HOOG sensitiwiteit weens hul biodiversiteitswaarde, habitatkompleksiteit en beperkte formele beskerming. Terwyl sandstrande (Blok OBM 9) oor die algemeen laer sensitiwiteit toon, vertoon intermediêre sandstrande hoër sensitiwiteit weens die teenwoordigheid van die bedreigde reuse-isopood, *Tylos granulatus*, 'n spesie wat uiters sensitief is vir versteuring en ligbesoedeling. Brander sones se habitatte word egter as **LAE** sensitiwiteit beskou weens lae spesiesrykheid. Volgens Clark et al., 2025 ondersteun die mariene omgewing om Boegoebaai belangrike nasionale visserye, maar is nie noodwendg belangrik (**MEDIUM** tot **LAAG**) vir grootskaalse kommersiële visserye nie. Verder word daar nie verwag dat ander aktiwiteite soos demersale sleepnetvissery of 'n perlemoenboerdery-konsessies waarskynlik nie beduidend beïnvloed sal word nie,. Let wel, Gammage et al., 2025, bied 'n teenstrydige siening: alhoewel grootskaalse kommersiële visserye nie noodwending aktief is in die direkte Boegoebaai omgweing nie, kan die area steeds as 'n belangrike kweek-area vir kommersieël-belangrike visspesies beskou word. Dus kan die ontwikkkeling die werwing van sulke spesies, en toekomstige vangs, vir twee van Suid Afrika se belangrikste kommersiële visserye, naamlik klein pelagiese en kommersiële stokvis visserye, indirek beïnvloed.

Blok OBM 7: Die robkolonie by Boegoebaai

Die Kaapse pelsrobkolonie by Boegoebaai, Suid-Afrika se mees noordelike kolonie, het omstreeks 2010 begin broei en bly klein, maar toon groei (107 kleintjies is in 2007 getel). Geleë langs 'n unieke 1 km-strook van rotsagtige kuslyn, maak die gebied se steil kranse dit waarskynlik geskik vir broei. Die kolonie word beskerm ingevolge die Wet op die Beskerming van Seevoëls en Robbe van 1973, wat sê dat robbe nie sonder toestemming versteur of benadeel mag word nie. Die voorgestelde konstruksie van 'n breekwater en hawe by Boegoebaai hou egter 'n ernstige bedreiging in vir hierdie robkolonie en nabygeleë broeiende seevoëls.

Blok OBM 9: Herstelling en beskerming van sanderige strand habitatte

Na die beëindiging van mynbou, en met behoorlike rehabilitasie, kan fauna-gemeenskappe van sanderig strande in die Boegoebaai-gebied herstel tot 'n byna-natuurlike toestand, soos bewys deur soortgelyke terreine noord van die Oranjerivier. Daar word aanbeveel dat 'n verteenwoordigende reeks sanderige strande binne die Boegoebaai-gebied (weg van die voetspoor van die voorgestelde ontwikkeling) ten syde gestel word vir rehabilitasie en beskerming - strande wat die spesierykste fauna-gemeenskappe ondersteun moet geprioritiseer word.

Blok OBM 8: Wat bedoel Krities Bedreig ("CR")?

Krities Bedreig ("Critcally Engangered" ("CR")) is 'n formele bewaringstatus wat gebruik word om spesies en ekosisteme wat 'n uiters hoë risiko van uitwissing of ineenstorting in die gesig staar, te beskryf. 'n Spesie word as "CR" geklassifiseer wanneer die beste beskikbare bewyse aandui dat die spesie 'n uiters hoë risiko vir uitwissing het. Vir ekosisteme beteken die "CR"-status dat ekosisteemfunksionering naby aan ineenstorting is. Dit beklemtoon dringende nasionale bewaringsprioriteite en vereis onmiddellike optrede om onomkeerbare verlies aan biodiversiteit te voorkom en herstelpogings te ondersteun.

[4] Die Nasionale Biodiversiteitsassessering is Suid-Afrika se primêre wetenskaplike assessering van die stand van die land se biodiversiteit, gelei deur die Suid-Afrikaanse Nasionale Biodiversiteitsinstituut (SANBI) in samewerking met talle vennote.

2.1.2 Terrestriële en akwatiese ekologie (basseer op van Rooyen et al., 2025)

Binnelandse akwatiese ekosisteme, alhoewel nie nie volop in die studie-area nie, is van groot belang vir terrestriële diere. Daar word vermoed dat kortstondige panne en rotspoele, veral die groter panne (Visagiespan, Rietfontein, Rietfonteinpan), skaars akwatiese ongewerwelde gemeenskappe met hoë vlakke van streeksendemiese spesies ondersteun en word geklassifiseer as "CR" in die Namakwaland Sandveld Biostreek. Hierdie natuurlike insinkings word spesifiek geïdentifiseer as **BAIE HOOG** sensitiwiteit, met kunsmatige vleilande met **HOOG** sensitiwiteit, en buffersones rondom insinkings met **MEDIUM** sensitiwiteit. Die Oranjeriviermonding, alhoewel nie in die studie-area nie, is 'n nasionaal en internasionaal belangrike Ramsar-vleiland in die nabyheid, en enige direkte of indirekte bedreigings van die ontwikkeling sal die reeds onseker toestand negatief beïnvloed. Ontwikkelingsuitlegte moet hierdie kritieke binnelandse akwatiese stelsels vermy.

Rakende voëls vertoon die Boegoebaai hawe en SES-ontwikkelingsterrein (wat oor verskeie sones strek) oorwegend MEDIUM en HOOG sensitiwiteit. Die area huisves, of huisves moontlik, 'n verskeidenheid prioriteitspesies, insluitend Suid-Afrikaanse Rooilys-spesies, endemiese, amper-endemiese spesies en spesies met beperkte verspreidingsgebiede soos die Damara-sterretjie, Swarvlerkpaddavreter en Ludwigse pou.

Vir vlermuise word belangrike voedings- en slaapplekke as BAIE HOOG sensitiwiteit beskou. Tydelike waterbronne van **HOOG** sensitiwiteit, en kleinvee weidingsareas (was van die R382) is **MEDIUM** sensitiwiteit, met ligbesoedeling en waterkoelingstorings wat as beduidende impakrisiko's geïdentifiseer is.

Blok OBM 10: Wat is Spesies van Bewaringsbelang ("SCCs")?

Spesies van bewaringsbebelang ("Species of Conservation Cocern" ("SCC")) is spesies wat belangrik is vir die bewaring van Suid-Afrika se biodiversiteit. Dit sluit nie net spesies in wat as bedreig gelys word nie, maar ook dié wat geklassifiseer is as Uitgesterf in die natuur, Uitgesterf of streeksvlak, Byna Bedreig, Skaars, Krities of Uiters Skaars, Afnemend, en Data-gebrekkig as gevolg van onvoldoende inligting. Hierdie spesies word erken as gevolg van hul bewaringsstatus, seldsaamheid of gebrek aan inligting, wat dui op 'n behoefte aan monitering en moontlike bewaringsaksie.

Die assessering van soogdiere, reptiele en amfibieë het BAIE HOOG sensitiwiteit vir ekosisteme soos die Richtersveld Kusduineveld ("CR") en Namib Seekusplantegroei ("CR") aan die lig gebring, sowel as gebiede wat geskikte habitat bied vir 10 Spesies van Bewaringsbelang ("SCC")[5], insluitend die De Winton se goue mol en die Woestynreënpadda. Ander gebiede soos soutlaagtes, die Westelike Gariepvlakte-woestyn, en ekologiese korridors wat kus- en binnelandse habitats verbind, word besou as **MEDIUM** tot **HOOG** sensitiwiteit. Habitatverlies en -verandering, veral vir spesies wat afhanklik is van gespesialiseerde duin-ekosisteme, en steurnisse van verhoogde menslike aktiwiteite soos geraas, ligbesoedeling en stof, is kritieke bekommernisse.

Die plantegroei- en flora-assessering dui daarop dat die terrein talle prioriteitshabitatte vir biodiversiteitsbewaring huisves, wat lei tot BAIE HOOG sensitiwiteitskattings vir beide plante en relatiewe terrestriële biodiversiteit. Dit sluit in twee ekosisteme (Richtersveld Kusduineveld ("CR") (Figuur OBM 4a) en Namib Seekusplantegroei ("CR"), habitat vir ongeveer agt[6] krities bedreigde plantspesies (CR), groot gebiede van onvervangbare "CBA's", gedeeltes wat ingesluit is in die Nasionale Beskermde Gebiedsuitbreidingstrategie ("National Protected Area Expansion Strategy" ("NPAES", 2018)) [7], en insluiting in 'n internasionaal erkende "Key Biodiversity Area" ("KBA"), met die krities bedreigde Namib-korsmosvelde in die nabyheid (CR) (Figuur OBM 4b). **Die verlies habitat in hierdie BAIE HOOG**

[5] Die fauna-gemeenskap in die studiegebied sluit 10 SCC's in. Bevestigde soogdier-SCC's sluit die Bruin hiëna in, met De Winton se goue mol en Grant se goue mol wat waarskynlik voorkom. Onder die reptiele is beide die Namaqua-dwergadder en die Namib-webvoetgeitjie op die terrein bevestig.

[6] Let wel dat bewaringsbelangstatusse van spesies en ekosisteme sistematies opdateer word, dus mag spesies se status toekomstig verhoog of verlaag word.

[7] Die Nasionale Beskermde Gebiedsuitbreidingstrategie ("National Protected Area Expansion Strategy" ("NPAES")) is Suid-Afrika se langtermynplan om beskermde gebiede (soos Nasionale Parke en Natuurreservate) op 'n koste-effektiewe manier uit te brei en te versterk, met die doel om biodiversiteit te bewaar, ekosisteemveerkragtigheid teen klimaatsverandering te verbeter en ekologiese volhoubaarheid te bevorder. Dit stel duidelike teikens, identifiseer prioriteitsgebiede en skets meganismes vir implementering.

sensitiwiteitsareas word as onaanvaarbaar beskou, aangesien dit bewaringsdoelwitte in gevaar stel en nie verreken kan word nie.

a)



b)



Figuur OBM 4: a) Krities bedreigde Richtersveld Kusduinveld-plantegroeitipe (CR) in die voorgestelde hawegebied met 'n uitsig van die Boegoeberg Tweeling; en b) Namib-korsmosvelde ongeveer 13 km noord van die voorgestelde Boegoebaa hawe en SES studie-area. (Bron: L. Snyman-vd Walt, 2024).

2.1.3 Erfenis (basseer op Orton et al., 2025)

Verskeie sensitiewe erfenishulpbronne is duidelik in die studie-area. Paleontologiese sensitiwiteit is oor die algemeen **LAAG** vir die SES, maar **MEDIUM** sensitiwiteit word in Sone 1 (Hawegebied) opgemerk waar laat Plioseen[8] Hondeklipbaai-formasie kan teëkom.

Geïsoleerde Vroeë Steentydperk[9]-materiaal is in laer gebiede (Sones 3, 4, 6 & 7) gevind, en 'n Middel-Steentydperk-voorkoms is in Sone 1 (hawegebied) by Namakwakop geïdentifiseer, met die moontlikheid van hoogs betekenisvolle terreine wat premoderne menslike oorskot in begrawe skuilings bevat. Beduidende voorkomste van Laat-Steentydperk-skulphope en ander bewoningsrommel is teenwoordig langs die kus (Sones 1, 3, 7 & 8), by panne (Sones 3, 4, 6 & 7), en binnelands naby waterbronne (Sone 9). Kusgebiede (binne 0.5 km) met hierdie terreine word as **BAIE HOOG** argeologiese sensitiwiteit beskou, terwyl dié 0.5-4.5 km van die kus van **HOOG** sensitiwiteit is.

[8] Die Laat Plioseen verwys na 'n tydperk in die Aarde se geologiese tydskaal wat ongeveer 3,6 tot 2,58 miljoen jaar gelede plaasgevind het, gekenmerk deur globale afkoeling en die evolusie van vroeë hominiene, met fossielterreine uit hierdie tyd wat as erfenishulpbronne onder die Wet op Nasionale Erfenishulpbronne beskerm word.

[9] Die Vroeë Steentydperk verwys na die vroegste fase van menslike tegnologiese ontwikkeling, wat dateer uit ongeveer 2,6 miljoen tot 250 000 jaar gelede, gekenmerk deur die gebruik van eenvoudige klipgereedskap deur oermense.

Blok OBM 11: Wat is Erfenis?

In die konteks van die Wet op Nasionale Erfenishulpbronne sluit erfenis Suid-Afrika se tasbare en ontasbare kulturele en natuurlike bates in, soos historiese terreine, tradisies en inheemse kennis, wat historiese, sosiale en wetenskaplike waarde het. Kenmerkende kulturele apsekte sluit, onder andere, in: omgewingsbeelskoonheid, argitektuur, spirituele- en taal-erfenis. Die Wet beskerm sulke en vereis Erfenisimpakstudies om volhoubare ontwikkeling te lei, en te verseker dat ekonomiese groei die land se diverse en waardevolle erfenis vir huidige en toekomstige geslagte respekteer en bewaar.

Die bestaand van drie grafte is bekend in Sone 2 aan die westelike voet van Boegoeberg-Suid, en mondelinge geskiedenis beklemtoon die belangrikheid van die Boegoeberg-gebied (Sones 1 en 2) vir die Nama-mense, met bekende grafte wat BAIE HOOG sensitiwiteit toegeken is. Vir maritieme erfenis is een skeepswrak van voor 1965 hoogs waarskynlik binne die see langs die SES-studiegebied, met vier ander ook hoogs waarskynlik, wat lei tot **MEDIUM** sensitiwiteit vir gebiede wat in die literatuur genoem word.

Lewende erfenisgebiede, veral dié wat deur plaaslike herdersgemeenskappe vir seisoenale weiding gebruik word (Swartbank en Witbank in Sones 2, 9 en 10), word as HOOG sensitief geag, aangesien ontwikkeling hul tradisionele lewensbestaan-siklus[10] kan ontwrig. Die kulturele landskap, veral die R382, kuslyn, Boegoeberg-tweeling (Sone 1, 2) en panne, word vanuit 'n visuele / beeldskoonheidsperspektief as **HOOG** sensitiewe gebiede geïdentifiseer, aangesien die voorgestelde industriële ontwikkeling moontlik sigbaar sal wees en sterk kontrasteer met die bestaande landskap, wat indirek die nabygeleë Richtersveld Kulturele en Botaniese Landskap Wêrelderfenisgebied (RKBLW)[11] sal beïnvloed.

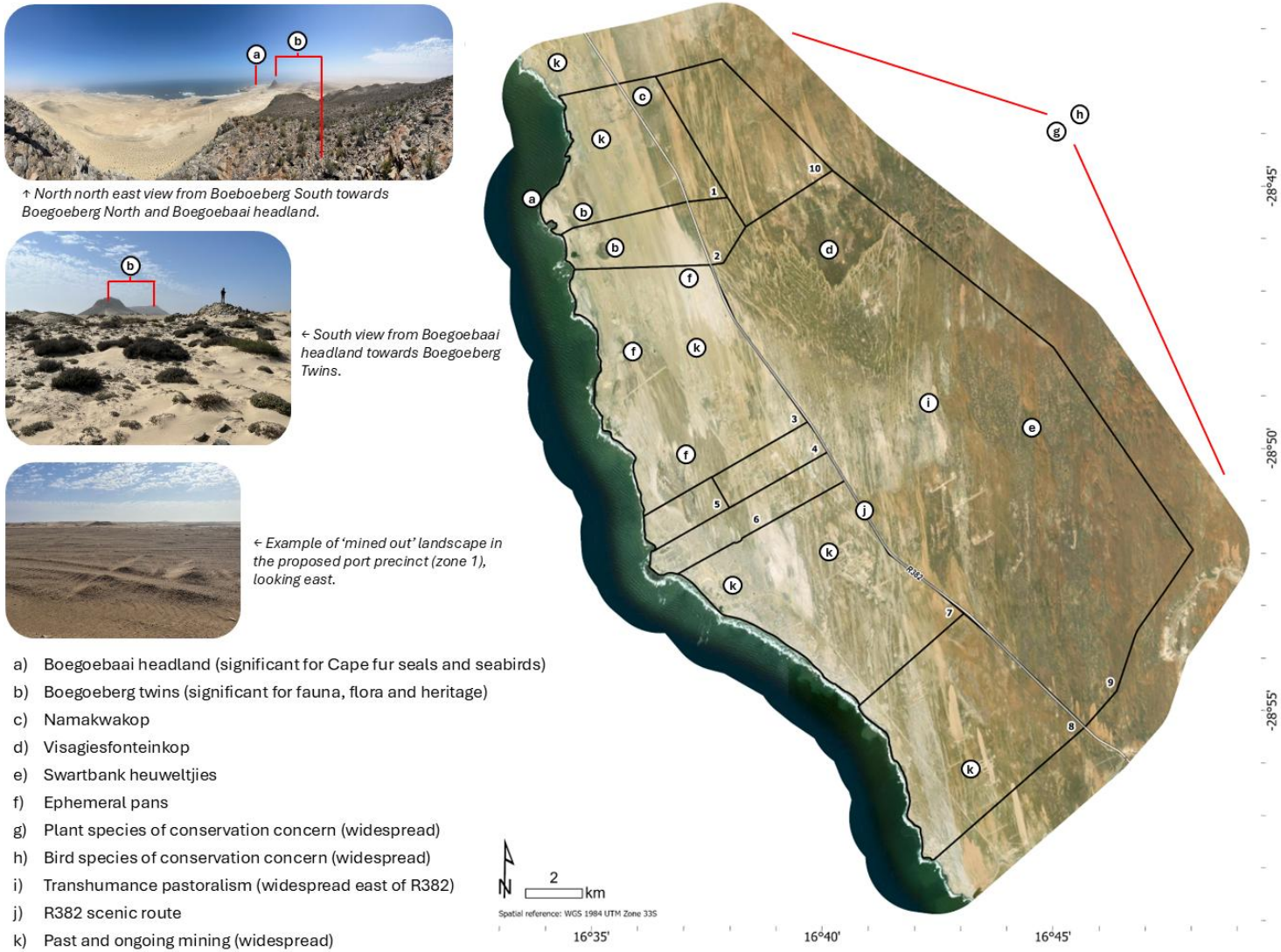
2.1.4 Kuslewensbestane (basseer op Gammage et al., 2025)

Die sosiale omgewing rondom die voorgestelde Boegoebaai hawe en SES is HOOGS sensitief, hoofsaaklik as gevolg van die diepgaande historiese en kulturele verbintenisse van plaaslike gemeenskappe met die land en see, vererger deur die aanhoudende impak van vorige ongeregtighede deur industriële ontwikkelings, veral diamantmynbou. Verskeie kusdorpe is die primêre gemeenskappe aangrensend aan die Boegoebaai-ontwikkeling, insluitend Alexanderbaai, Port Nolloth, Kleinzee en Hondeklipbaai. Elke gemeenskap se lewensbestaan en sosiale struktuur is diep gevorm deur hulpbronontginning. Alexanderbaai, 'n voorheen welvarende myndorp, het ekonomiese agteruitgang, verswakte infrastruktuur en hoë werkloosheid ervaar namate diamantontginning afgeskaal het. Terwyl landbou en toerisme na vore kom, bly geleenthede skaars. Ontspanningsvisvang by die Oranjeriviermond is gewild.

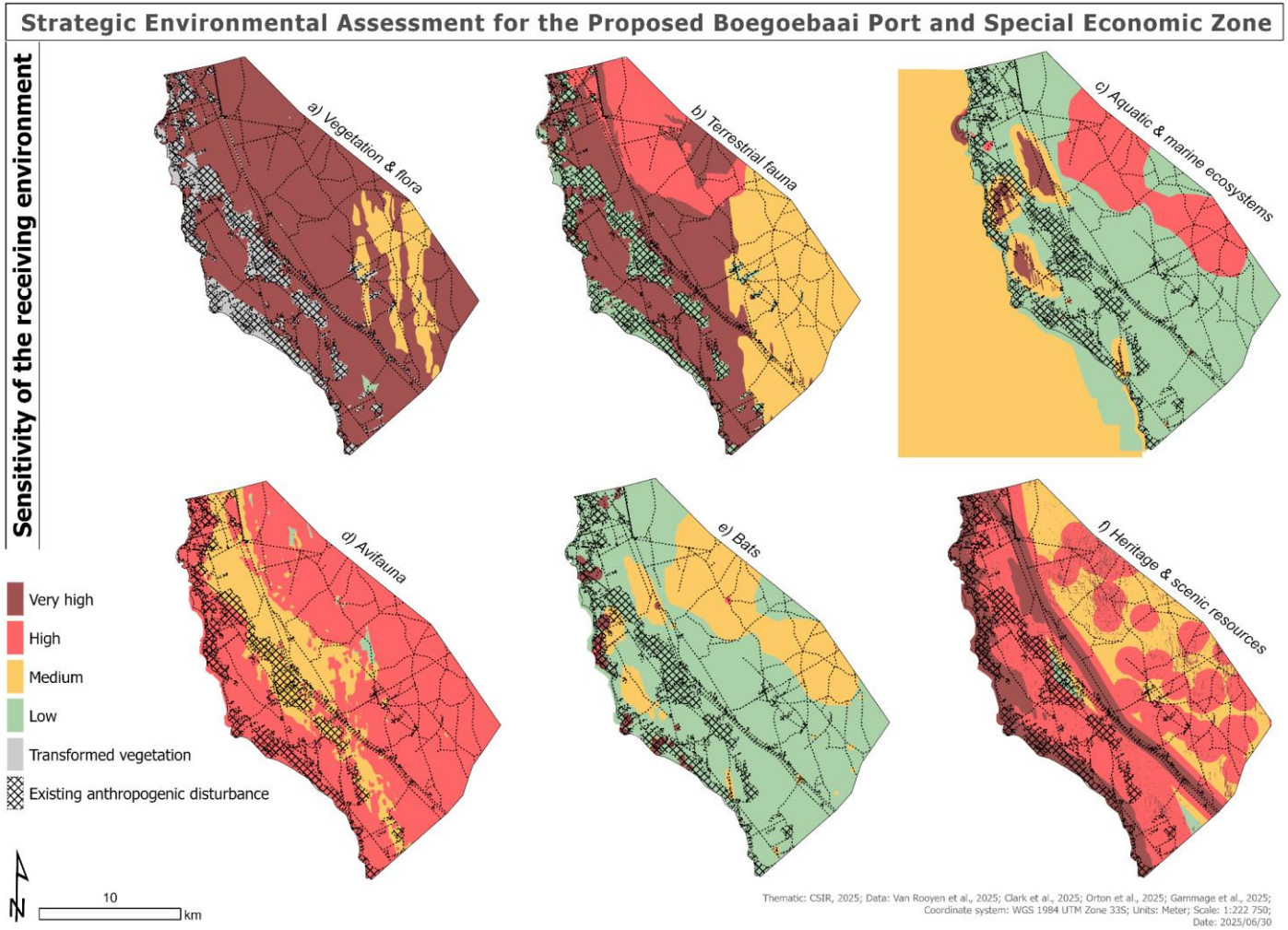
Port Nolloth is 'n tradisionele vissersgemeenskap met sterk intergenerasionele bande met die see. Dit ondersteun verskeie visvangregtehouers, insluitend kleinskaalse koöperasies wat snoek en Kaapse brasem teiken, en kommersiële regte vir Weskus kreef. Toegang tot tradisionele visvanggronde het egter toenemend beperk geword as gevolg van mariene mynbouaktiwiteite, hoë brandstofkoste, uitputting van voorraad en beperkte infrastruktuur. Kleinzee, nog 'n voormalige De Beers-myndorp, het probeer om te diversifiseer na akwakultuur (perlemoen, seewierboerdery) en seisoenale toerisme, wat 'n mate van formele werk bied. Ontspanningsvisvang hier is erg beïnvloed deur verslikking deur vorige mynboubedrywighede. Hondeklipbaai, 'n klein, tradisionele vissersdorpie, maak staat op kleinskaalse visvang en groeiende toerisme, maar staar uitdagings in die gesig soos dalende Weskus kreefvoorrade, beperkte visvangregte en swak infrastruktuur.

[10] Tradisionele seisoenalelewensbestaan, dikwels siklies, wat deur inheemse pastorale gemeenskappe beoefen word, soos diegene wat met hul vee tussen kusweidingsgebiede in die winter en binnelandse gebiede in die somer trek.

[11] Die Richtersveld Kulturele en Botaniese Landskap is 'n 1 600 km² bergagtige woestyn in Suid-Afrika se Noordkaap, wat gemeenskaplik besit en bestuur word deur die Nama-mense. Dit vertoon 'n unieke kulturele landskap waar die Nama tradisionele seisoenale herderspraktyke beoefen en in draagbare haru oms-huise woon. Die gebied is ryk aan endemiese vetplante en weerspieël byna 2 000 jaar se volhoubare grondgebruik en kulturele erfenis, wat dit 'n wêreldwyd belangrike Wêrelderfenisgebied maak vir beide natuurlike en kulturele bewaring.



Figuur OBM 5: Oorsig van die belangrikste ekologiese, erfenis- en grondgebruikskenmerke in die voorgestelde hawe en SES studie-area.



Figuur OBM 6: Sensitiwiteit van die omgewing waar die Boegoebaai hawe en SES voorgestel word. Sensitiwiteit is aangedui vir elk van die onderskeie tema's in Werkpakket 1 – (a) plantegroei en flora, (b) terrestriële fauna, (c) akwatiese en mariene ekosisteme, (d) voëls, (e) vlermuise, en (f) erfenis- en natuurskoonbronne.

Alhoewel die Boegoebaai-gebied self tans geen permanente inwoners of formele wonings het nie (as deel van 'n beperkende mynboukonsessie), het dit diep kulturele, spirituele en historiese betekenis vir die omliggende Nama-gemeenskappe. Plaaslike mondelinge geskiedenisse dui op langdurige tradisionele gebruik van die gebied, insluitend weidingsroetes en visvanggronde. As gevolg van plaaslike belanghebbendes is die terrein bekend om ten minste 17 bekende Nama-grafte in te sluit, insluitend dié van Kaptein Swartbooi, sowel as kultureel belangrike Buchu-plante. Dit het ook histories deel gevorm van tradisionele visvanggronde vir kleinskaalse vissers van Port Nolloth, waarvan toegang verlore gegaan het weens mynboubeperkings.

'n Kernaspek van die sosiale sensitiwiteit spruit uit die Nama-gemeenskappe se tradisionele grondgebruik. Mondelinge geskiedenis bevestig dat Nama-herders van die Richtersveld histories 'n siklus gevolg het wat die hele studiegebied omvat, insluitend dele wat nou binne die SES is. Hul toegang is verhoed deur veiligheidsheinings wat opgerig is na die ontdekking van diamante in 1925, met verdere heinings in die middel-1950's. Van kritieke belang is dat gedeeltes van Plaas 2 (die Korridor Wes-plase), insluitend Swartbank en Witbank (geleë in Sones 2, 9 en 10), in 2007 aan die gemeenskap terugbesorg is, wat vee-eienaars toegelaat het om seisoenale weiding te herstel. Die voorgestelde ontwikkeling, deur toegang tot hierdie gebiede te voorkom, kan hierdie hervestigde tradisionele siklus direk ontwrig, wat die lewensbestaan van plaaslike herders verder beïnvloed. Dus sal intensiewe konsultasie rondom instemming, sonering en meganismes vir samebestaan tussen gemeenskappe en industriële ontwikkeling belangrik wees.

Blok OBM 12: Die nalatenskap van mynbou in hierdie streek

Mynbou het die sosio-ekonomiese en omgewingslandskap van die streek diepgaande gevorm. Histories is dorpe soos Alexanderbaai en Kleinzee rondom diamantontginning gevestig, met bedrywighede gelei deur maatskappye soos Alexkor en De Beers. Terwyl mynbou eens voorspoed en werk verskaf het, vir sommiges, het die agteruitgang daarvan bedoel dat gemeenskappe ekonomiese probleme, verswakkende infrastruktuur en stygende werkloosheid in die gesig gestaar. Die nalatenskap sluit beperkte toegang tot die kus in, veral vir kleinskaalse vissers wat tradisionele visvanggronde verloor het as gevolg van mynbouverwante veiligheidsones. Omgewingsagteruitgang, insluitend see verslikking en habitatversteuring, het mariene ekosisteme beïnvloed en visvoorrade verminder, wat die lewensbestaan van die kus verder bedreig. Kulturele erfenis het ook gely, met voorvaderlike grafte en heilige plekke in die Boegoebaai-gebied wat in gevaar is as gevolg van industriële aktiwiteite. Ten spyte van hierdie uitdagings het sommige dorpe begin oorskakel na alternatiewe lewensbestaan soos akwakultuur en toerisme. Die mynbou-nalatenskap beïnvloed egter steeds grondgebruik, toegangsregte en gemeenskapskwesbaarheid. Toekomstige ontwikkeling moet hierdie historiese impakte aanspreek deur inklusiewe beplanning, herstel van toegang en beskerming van kulturele en ekologiese bates om volhoubare en billike groei te verseker.

2.2 Register van ontwikkelingsaspekte en -impakte

2.2.1 Aanduiding van moontlike impakte op ekologiese- en erfenishulpbronne

Tabel OBM 3 bied 'n gekonsolideerde opsomming van die moontlike positiewe en negatiewe impakte wat geïdentifiseer is in spesialisstudies (mariene ekologie, terrestriële en binnelandse akwatiese ekologie, en erfenis) vir die beplande Boegoebaai hawe en SES-infrastruktuurkomponente. Elke infrastruktuuraspek, aktiwiteit of SES-subsone is gekoppel aan moontlike impakte en die ooreenstemmende ontvangende omgewing van belang. Die tabel bied 'n geïntegreerde oorsig van waarskynlike impakte en mik om 'n fondasie te skep vir toekomstige OIS, die identifisering van gebiede wat deur ontwikkeling vermy moet word, geteikende versagtingsstrategieë, of kennisgapings wat toekomstige, fyn-skaalse, spesialisaandag benodig.

Tabel OBM 3: Ontwikkelingsaspekte en moontlike gepaardgaande impakte op ekologiese- en erfenishulpbronne

	Verwante ontwikkelingsaspek, aktiwiteit of SES sone	Moontlike impak	Omgewing van belang
	Mariene ekosisteme		
MARINE ECOLOGY	Jetties, breekwater en kaaie (Sone 1)	**Versteuring en skade aan mariene fauna,** insluitend fisiologiese en gedragseffekte, werwingsontwrigting, en spesieverplasing of -mortaliteit.	Mariene fauna, insluitend die robkolonie.
		Agteruitgang van seebodem- en demersale-gemeenskappe, insluitend habitatverlies, versmoring en verandering in biologiese gemeenskapstruktuur	Seebodem- en demersale-gemeenskappe in CBA1- herstel en ESA gebiede.
		Hidrodinamiese veranderinge, soos veranderinge in kusstrome en littorale drywing, wat moontlik kussedimentvervoer en ekosisteemstabiliteit beïnvloed**.**	Litorale dryfsones en kus-sedimentstelsels.
	Baggerwerk, seewater inlaat-/uitlaatpyplyne (vir bv. ontsoutingsfasiliteit) en algemene aktiwiteite (Sone 1, Sone 3 en Sones 4-6)	**Verlies en agteruitgang van mariene habitat**, insluitend permanente verlies van ongekonsolideerde seebodem en geassosieerde gemeenskappe as gevolg van infrastruktuurplasing.	Seebodem-makrofauna en demersale gemeenskappe
		Versteuring en versmoring van seebodem fauna as gevolg van baggerwerk en storting van gebaggerde materiaal.	Waar baggerwerk en storting van gebaggerde materiaal plaasving
		Agteruitgang van watergehalte as gevolg van storting, rommel en afvoer.	Mariene fauna en kus-ekosisteme.
	Hawe- en industriële aktiwiteite, skeepsaktiwiteit, mariene infrastruktuur en instandhouding (Sone 1, Sone 3 en Sones 4-6))	**Versteuring van mariene fauna,** veroorsaak deur skeepsafvoer, toevallige chemiese storting, verhoogde onderwatergeraasvlakke, liguitstraling, skeepbotsings en vasvanging in seewaterinlaatpype.	Mariene fauna (bv. seevoëls, seesoogdiere, see skilpaaie, walvisse en dolfyne).
		Agteruitgang van watergehalte, as gevolg van skeepafvoer, toevallige operasionele stortings, soutwater terugvoer, verhoogde troebelheid en losmaak van sedimentgebonde kontaminante.	Mariene fauna; kus-ekosisteme.
		Verlies en verandering van mariene habitats, insluitend permanente verlies van	Seebodem-gemeenskappe in baggersones en

	Verwante ontwikkelingsaspek, aktiwiteit of SES sone	Moontlike impak	Omgewing van belang
		ongekonsolideerde seebodem en ontwrigting van geassosieerde seebodem-gemeenskappe.	rondom mariene strukture.
	Skepe, brandsof berging en -hervulling, en pyplyne (Sone 1, Sone 3 & Sones 4-6)	**Verswakking van watergehalte** as gevolg van toevallige koolwaterstofstortings / vrystellings (bv. skeepsongelukke, brandstof hervulling en pypbreuke)	Mariene fauna, bodem-gemeenskappe en kushabitatte (bv. rotsagtige en sanderige strande).
INTEGRATED TERRESTRIAL AND AQUATIC ECOLOGY	**Akwatiese ekosisteme**		
	Boegoebaai hawegebied (Sone 1)	**Versteuring van breër moontlike herlaaigebiede van nabygeleë vleilande** of panne, wat moontlik hul volhoubaarheid bedreig as gevolg van onsekere hidrologiese drywers.	Moontlike herlaaigebied vir BB1-pan (Visagiespan) (soos getoon in Day, 2025[12]) en fonteine; Boegoeberg-Noord ondersteun tydelike akwatiese biota.
	Bewaringsarea (Sone 2)	**Positief: Moontlike beskerming van herlaaigebiede vir die pan, megaande vleilande en gepaardgaande fonteine** indien dit as bewaringsgebied vermy word[13].	BB1 (inkluisend BB1A)
	Groen waterstof- en ammoniakfasiliteit (sone 3)	**Vernietiging en agteruitgang van vleilande en panne,** d.m.v. stormwater en voertuigversteurings.	CR panne, grootste en mees belangrike panne en fonteine in die studie-area
	SES idustriele park, Fases 1-3 (Sones 4-6)	**Vernietiging van CR-pan en vleilandhabitat**, d.m.v. voedingstofverryking, hidrotydperksveranderinge, fisiese versteuring.	BB3 pan/fonteine
	Toekomstige groen waterstoffasiliteit (Sone 7)	**Vernietiging van panne en vleilandhabitat,** d.m.v. voedingstofverryking, hidrotydperksveranderinge, fisiese versteuring.	BB4, BB5 (kunsmatig), BB6 (vermoed natuurlik) en herlaai-gebied
	Toekomstige uitbreiding 01 (Sone 8)	**Vernietiging van vermoedelike natuurlike pan- en vleilandhabitat**, hidrotydperksveranderinge, agteruitgang a.g.v. veranderde vloei.	Suidelike deel van CR BB6, kunsmatige BB7 & BB8 panne/vleilande (waarskynlik ekologies belangrik)
	Toekomstige uitbreiding 02 (Sone 9)	**Vernietiging van panhabitat, eutrofikasie, ekosisteemdegradasie, biodiversiteitsverlies.**	Visagiesfonteinkop: efemere panne en rotsagtige koppies wat HOOG sensitiwiteit is.
	Terrestriële ekosisteme (insluitend voëlsl vlrmuise; soogdiere, reptiele en amfibieë; plantegroei en flora)		
	Sone 1 infrastruktuur (hawe)	**Plantegroeiverlies, habitatfragmentasie, verlies van individue van "SCC's" en beskermde en/of endemiese plant- of dierspesies**, afname in ekosisteemdienste, erosie, sandbeweging wat aangrensende plantegroei versmoor, versteuring van dieregedrag, moontlike diersterftes.	BAIE HOOG sensitiwiteit areas aaingedui in Figuur OBM 4a, b, d, e.
	Sone 1 - Droë Grootmaathantering (Mangaan, Sink, Lood)	**Stofbesoedeling, grond-/waterbesoedeling**, toksisiteit, vermindering van luggehalte.	Vestig ingfrastruktuur in gewysigde habitatgebiede; vermy alle sensitiewe natuurlike

[12] Verwys na Hoofstuk 3a (Terrestrial & Aquatic Ecology Supplementary Material)" van die hoof SOA verslag vir besonderhede oor en fotografiese illustrasies van die hoof binnelandse akwatiese ekosisteem habitatte in die studie-area.
[13] Let wel dat die vestiging van 'n bewaringsarea nie noodwending voldoende verrekening vir moontlike impakte in Sone 1 (hawegebied) of in die SES bied nie.

	Verwante ontwikkelingsaspek, aktiwiteit of SES sone	Moontlike impak	Omgewing van belang
			gebiede.
	Sone 1 - Vervoerbande	**Besoedeling (grond/water)**, vervoerbande kan **dierebeweging hinder.**	Lug, grond en water naby vervoerbandlyne
	Sone 1 - Stofbeheer	Ongespesifiseerde afvalhantering, moontlike **omgewingsbesoedeling**.	Stofversamelingspunte; areas met BAIE HOOG sensitiwiteit.
	Sone 1 – Ontsoutingsfasiliteit	**Skade aan mariene fauna (**seewater inlaatpype), gekonsentreerde soutwater (uilaatpype) wat mariene ekosisteme beïnvloed, chemiese **besoedeling**, verandering in **watertemperatuur**	Mariene omgewing; inname-/afvoergebiede.
	Sone 1 - Rioolinfrastruktuur	Kunsmis uit voedingstofherwinning, **besoedeling, grondwaterbesoedeling, oorblywende chemikalieë, slykbestuur.**	Afvalwaterbehandelingsones, grondwatertafel; Sone 1 sensitiewe gebiede.
	Sone 1 - Stormwaterstelsels	**Besoedeling, verspreiding van indringerspesies, grondwaterimpakte**.	Stormwaterdamme; Sone 1 sensitiewe ekosisteme
	Sone 1 - Elektriese infrastruktuur	**Plantegroei verlies**, uitlatings wat met konstruksie geassosieer word, risiko van elektrokusie, habitatfragmentasie	Substasiegebiede, kraglyne; Sone 1 sensitiewe habitatte (insluitend voëls)
	Sone 1 – Brandstofberging Sone 10 – Toekomstige tenkberging	**Brandstofstortings** wat grond, water en grondwater besoedel, plante en akwatiese stelsels beskadig, "Volatile Organic Compound (VOS)"-uitlatings wat luggehalte verminder, brand- en ontploffingsrisiko.	Sone 1 en Sone 10 sensitiewe habitatte, Namib-korsmosvelde, Boegoeberg-tweeling
	Sone 1 - Interne Paaie en Brûe	**Fragmentasie, beperking van dierebeweging, padsterftes, erosie, besoedeling, stof, indringerspesies.**	Sone 1 sensitiewe habitatte, habitatkorridors; aangrensende plantegroei; Namib korsmosterreine
	Sone 1 - Eksterne Paaie (R382)	**Verlies van plantegroei** as gevolg van verbreding van R382, verkeersbesoedeling.	Gebiede aangrensend aan R382, sensitiewe habitatte
	Sone 2 - Bewaringsarea	**Positief: Beskerming van intakte plantegroei** en CR-ekosisteme (en toevlugsoorde vir diere), wat die rehabilitasie van gemynte gebiede moontlik maak. **Negatief: risiko van lugbesoedeling op ligene** in Sone 2, gedeeltelike verteenwoordiging of beskerming van sensitiewe gebiede (insluitend CBA1's en CR-ekosisteme), verhoogde mortaliteit van SCC.	Boegoeberg Twins (include both Boegoeberg North and South), Cape fur seal colony (should also be included in Zone 2), BB1, CBA1s, CR ecosystems
	Sones 3–10 - SES infrastruktuur	**Uitgebreide verwydering van plantegroei**, hulpbronvraag, habitattransformasie.	Areas met BAIE HOOG sensitiwiteit.
	Sone 3 - Ontsoutingsfasiliteit	**Afvoer van soute** in die mariene omgewing. Verwydering van plante.	Areas met BAIE HOOG sensitiwiteit.
	Sone 3 - Elektroliseerder	**Water- en energievraag, chemiese besoedeling, veiligheidsrisiko's** (H2-lek/ontploffing).	Areas met BAIE HOOG sensitiwiteit.
	Sone 3 - Ammoniak Faciliteit Sones 7–9 - Toekomstige Uitbreidings	**Positief (Indirek): Verminderde fossielbrandstofgebruik**, emissievrye groen ammoniak as kunsmis, energiedraer wat hernubare energieberging en -vervoer moontlik maak, skoner ammoniakproduksie. **Negatief (insluitend indirek): Hoë hulpbronvraag** (energie uit hernubare bronne), grond- en waterintensief, veiligheidsrisiko's, ammoniakgesondheidsrisiko's, lug-/grondbesoedeling, vlermuissterftes/beseringsrisiko as gevolg van warm	Areas met BAIE HOOG sensitiwiteit.; Namib-korsmosvelde, Boegoeberg-tweeling.

	Verwante ontwikkelingsaspek, aktiwiteit of SES sone	Moontlike impak	Omgewing van belang
		stoomafvoer.	
	Sone 3 - Brandwaterstelsel	Soutgehalte neem toe (wanneer seewater gebruik word), skuimbesoedeling, mariene besoedeling.	Seewaterinlaat-/ontladingsgebiede.
	Sones 4–6 – Industriële park	**Verwydering van plantegroei,** ontsoutingsfasiliteit impakte.	Areas met BAIE HOOG sensitiwiteit.
	Alle Sones: Verhoogde kraai populasie	Ontwikkeling kan die habitat van kraaie vergroot, wat lei tot hoër predasie en afname in die skilpadbevolking.	Alle Sones.
	Alle Sones: Klank, stof, beligting	Konstruksiegeraas, beligting en aktiwiteit kan dieregedrag versteur; verhoogde beserings- of sterfterisiko; slote grawe verhoog die sterfterisiko's verder.	Alle Sones.
	Alle Sones: Grondwerke	Verwoesting van neste (voëls en vlermuise).	Alle Sones.
HERITAGE	**Paleontologie**		
	Alle Sones	Konstruksie kan fossiele blootstel en/of vernietig.	Mariene afsettings van die laat Plioseen Hondeklipbaai Fm rotsformasie. Seekranse in die voorgestelde hawegebied (Sone 1). Alle ongemynte gebiede, maar meer waarskynlik op laerliggende kusgebiede.
	Alle Sones	Terugvulling van grond vanaf stortingsterreine kan fossiele blootstel.	Mynhope wat gebruik word om mynputte op te vul.
	Sones 1, 2, 3, 5, 6, 7 & 8	Konstruksie kan verhoogde strandafsettings blootstel en/of vernietig.	Gebiede waar verhoogde strande van die Curlew Strand Fm rotsformasie bewaar word.
	Terrestriële Argeologie		
	Sones 1, 2, 3, 4, 5, 6, 7 & 8	Konstruksie kan MSA-terreine in ou seekranse wat deur windverwaaide sand begrawe is, blootstel en/of vernietig.	Alle gebiede langs die kus met rotsagtige areas, hetsy sigbaar of begrawe
	Sones 1, 2, 3,4, 5, 6, 7 & 8	Konstruksie kan verspreide en hope LSA skulpe blootstel en/of vernietig.	Alle gebiede waar argeologiese skulphope langs die ongestoorde kuslyn voorkom.
	Sone 1	Konstruksie kan verspreaide MSA-artefakblootstel en/of vernietig.	Die rotsagtige areas van Namakwakop in die noordooste van Sone 1.
	Sones 3, 4, 6 & 7	Konstruksie kan verspreide en hope LSA skulpe blootstel en/of vernietig.	Rondom en binne Visagiepan en Rietfonteinpan.
	Sone 9	Konstruksie kan verspreide en hope LSA skulpe en/of kontakperiode-/historiese verstrooiings blootstel en/of vernietig.	HOOG sensitiewe gebiede rondom blote graniet in die oostelike deel van die SES.
	Grafte		
	Sone 2	Konstruksie kan bekende grafte beïnvloed.	Geïdentifiseerde grafte aan die westelike voet van Boegoeberg-Suid.
	Alle Sones	Konstruksie kan onbekende grafte blootstel en/of vernietig.	Ongemerkte grafte kan enige plek voorkom wat nog nie deur mynbou onbloot is nie.

	Verwante ontwikkelingsaspek, aktiwiteit of SES sone	Moontlike impak	Omgewing van belang
	Mariene Erfenis		
	Sones 1, 2, 3, 5, 6, 7, & 8	Konstruksiewerk in die see vir die breekwater en ander hawe-infrastruktuur kan ondergedompelde skeepswrakke blootstel en/of vernietig.	Enige gebiede waar impakte op die seebodem deur konstruksie of baggerwerk sal voorkom (Sone 1).
	Lewende Erfenis		
	Sones 2, 9 & 10	Ontwikkeling kan seisoenale nedersettingspatrone ontwrig en toegang tot die gebied verbied.	Alle gebiede wat deur kleinskaalse veeboere gebruik word, veral gebiede bekend as Witbank/Visagiesfonteinkop, Swartbank en Grondputs/Zwartwater.
	Alle Sones	Ontwikkeling van die hawe en SES kan die landskapkonteks waarin kleinskaalse herders hulle lewensbestane uitleef, massief verander deur die byvoeging van industriële fasiliteite.	Hele hawe- en SES-studiegebied
	Alle Sones	Ontwikkeling van die hawe en SES kan die konneksie tussen die plaaslike gemeenskap en die kus verander.	Hele hawe- en SES-studiegebied
	Kulturele Landskap		
	Alle Sones	Ten spyte van die bestaande mynbou, kan ontwikkeling die “gevoel van plek” / die “mooie niksheid”van die streek onherroeplik verander deur die byvoeging van industriële fasiliteite.	Hele hawe- en SES-studiegebied

2.2.2 Sosio-ekonomiese en kuslewensbestaan impakte

2.2.2.1 Moontlike voordele

Die voorgestelde Boegoebaai hawe en SES ontwikkeling bied 'n belangrike geleentheid om inklusiewe ekonomiese groei te stimuleer en strategiese belegging in die Noordkaap te bevorder. Indien dit ontwerp en geïmplementeer word met volhoubaarheid, billikheid en plaaslike deelname as kern, kan die projek 'n reeks omgewings-, ekonomiese en sosiale voordele bied.

Blok OBM 13: Voorbeeld van mariene ekonomiese diversifikasie

Kleinzee, 'n voormalige myndorp, het oorgeskakel na akwakultuur en seisoenale toerisme, met perlemoen- en seewierboerdery nou die primêre werkgewers. Die bestaande infrastruktuur en dienslewering maak dit 'n proeflokaal vir mariene ekonomiese diversifikasie. Toerisme gedryf deur veldblomme en voëlkyk dra ook by tot lewensbestaan. Dit ondersteun breër vissery-gekoppelde ekonomiese veerkragtigheid, hoewel kommer steeds bestaan oor kusbesoedeling deur vaartuigverkeer. Terugvoer van belanghebbendes weerspieël versigtige optimisme oor die voorgestelde Boegoebaai hawe-ontwikkeling se potensiaal om plaaslike inkomste te verhoog.

Die ontwikkelingsprogram kan aansienlike werks- en lewensbestaansgeleenthede ontsluit wat direk en indirek gekoppel is aan die visserysektor en verder (bv. toerisme). Akwakultuurbedrywighede kan ook baat vind by uitgebreide watertoegang, energievoorsiening en stroomaf-ondersteuningsdienste. Die diversifikasie van inkomstestrome kan kwesbaarheid verminder in gemeenskappe wat tans afhanklik is van dalende of seisoenale visserye en kan sommige van die negatiewe impakte wat met oseaandruk geassosieer word, versag.

Opgraderings aan mariene- en land-baseerde infrastruktuur sal operasionele doeltreffendheid en veiligheid vir vissers in dorpe soos Port Nolloth verbeter. Verbeterde dienslewering kan nuwe of onderbenutte waardekettings soos gedroogde visprodukte, kelpverwerking en mariene toerisme ondersteun. Uitgebreide watervoorsiening en elektrifisering kan ook kusgebaseerde akwakultuuraktiwiteite moontlik maak en geleenthede bied vir koöperatief-geleide ondernemings om produksie op te skaal. Verbeterde hawe-infrastruktuur kan na-oesverliese verminder en die kwaliteit en rakleeftyd van aangelande vangs verbeter.

Blok OBM 14: 'n Tekort aan infrastruktuur en kapasiteit vir kleinskaalse vissers

N Port Nolloth staar kleinskaalse vissers dalende visvoorrade, hoë brandstofkoste en beperkte toegang tot tradisionele visvanggronde as gevolg van mynbou in die gesig. Infrastruktuur is beperk, met slegs een operasionele pier en volgehoue watertekorte wat toerisme en ontwikkeling beïnvloed. Terwyl akwakultuur en visserye sentraal staan tot lewensonderhoud, ontbreek plaaslike kapasiteit vir buitelandse bedrywighede. Vaardigheidsontwikkeling is minimaal, en koöperasies sukkel met hulpbronbeperkings. Hierdie uitdagings beklemtoon die behoefte aan verbeterde infrastruktuur en geteikende kapasiteitsbou in mariene sektore.

Tegniese opleidings- en mentorskapprogramme bied die moontlikheid om kapasiteit binne vissers- en kusgemeenskappe te bou. Dit sluit in die opgradering van vaardighede in mariene veiligheid, vaartuigonderhoud, na-oes hantering, seekosverwerking, akwakultuurbedrywighede, omgewingsmonitering en mariene rentmeesterskap. Gerigte opleiding vir die jeug en vroue kan toegang tot voorheen manlik gedomineerde of kapitaalintensiewe sektore verbreed, wat inklusiewe plaaslike ontwikkeling ondersteun. Vaardigheidsontwikkeling gekoppel aan hawe- en SES-bedrywighede kan ook intergenerasionele oordrag van kennis moontlik maak en paaie na formele mariene werksektore bied.

Indien dit inklusief geïmplementeer word, kan die ontwikkeling verbeterde plaaslike bestuursreëlings kataliseer en 'n platform bied om visserskoöperasies en -verenigings te versterk deur verbeterde toegang tot finansiering, sakeondersteuningsdienste en beleidsbetrokkenheidsruimtes. Toegang tot beter gehalte

water-, energie- en vervoerstelsels kan die lewensvatbaarheid van kus-akwakultuurinisiatiewe aansienlik versterk, veral in dorpe soos Kleinzee. Geformaliseerde ondersteuning kan loodsprojekte in geïntegreerde multitrofiese akwakultuur, seewierboerdery of kleinskaalse marikultuur in staat stel om tot volhoubare lewensbestaansgeleenthede te ontwikkel. Infrastruktuur kan ook groter waardetoevoeging deur plaaslike verwerking, verpakking en koue berging moontlik maak, wat inkomstebehoud binne gemeenskappe verhoog.

Die hawe kan die logistieke uitvoerbaarheid van die ontplooiing van patrollievaartuie en moniteringspanne verbeter om onwettige, ongerapporteerde en ongereguleerde visvang in die noordweste van Suid-Afrika se eksklusiewe ekonomiese sone te bestry. Versterkte toesig- en nakomingskapasiteit kan beide bewaringsdoelwitte en plaaslike vissers bevoordeel deur hul hulpbronbasis teen oorbenutting te beskerm en meer billike toegang tot gedeelde voorrade te verseker.

Blok OBM 15: Wat is om onwettige, ongerapporteerde en ongereguleerde visvang en die rol wat hawes speel?

Onwettige, ongerapporteerde en ongereguleerde visvang verwys na die onwettige oes van mariene hulpbronne, waar buitelandse vaartuie sonder magtiging in 'n land se eksklusiewe ekonomiese sone opereer of skadelike visvangmetodes gebruik. Hawens en die lande wat hulle bestuur, is noodsaaklik in die toesig oor visserye en maritieme aktiwiteite. Internasionale reg vereis inspeksie van vaartuie en vis wat hawens binnekom, wat help om onwettige visvang, onveilige vaartuie en swak arbeidsomstandighede te identifiseer, en te verseker dat sulke oortredings opgespoor en aangespreek word.

Deur vervoer, nutsdienste en marktoegang te verbeter, kan nis-toerisme-aanbiedinge wat plaaslike visserykultuur insluit (bv. seekosfeeste, visser-vir-'n-dag-ervarings, of erfenisboottoere) gevestig word. Infrastruktuuropgraderings kan gemeenskappe ook in staat stel om ontasbare erfenis- en kulturele bates (bv. tradisionele kennis, kuslandskappe, handwerk) te monetiseer, veral gedurende die blomseisoen.

Gediversifiseerde inkomstegeleenthede en verbeterde infrastruktuur kan kusgemeenskappe help om aan te pas by omgewings- en ekonomiese wisselvalligheid. Met visserye wat toenemend beïnvloed word deur klimaatsverandering (bv. verskuiwende voorrade, mariene hittegolwe) en markdruk (bv. stygende brandstofkoste), kan ondersteuning vir verbeterde akwakultuur-, toerisme- en seekoswaardekettings, tesame met geleenthede om vaardighede buite visserye te diversifiseer, huishoudelike veerkragtigheid verbeter deur die afhanklikheid van enige enkele hulpbron of seisoen te verminder.

2.2.2.2 Moontlike negatiewe impakte

Ruimtelike mededinging in 'n reeds oorbelaste mariene sone sal verskerp word. Dit kan 'n negatiewe impak hê op reeds gemarginaliseerde kus- en kleinskaalse vissers wat reeds toenemende verplasing in die gesig staar as gevolg van oorvleuelende eise van mynbou, olie en gas op see, bewaring en industriële verskepingsaktiwiteite.

Blok OBM 16: Die "Oseaandruk"-verskynsel

Oseaandruk is 'n verskynsel waar die seekant van die kus toenemend mededingend word, wat vissers se reeds beperkte bedryfsruimte verder verminder. Daar word berig dat oseaandruk veroorsaak het dat tradisionele vissersgemeenskappe in Port Nolloth beide land- en seetoegang tot hul visvanggronde verloor het. Byvoorbeeld, vissers het voorheen klein bote (bakkies) oor land per sleepwa vervoer om noord van Port Nolloth te visvang, maar mynboubeperkings het nou hierdie toegang afgesluit.

Toegang tot tradisionele visvanggebiede is reeds verminder deur mynsekuriteitsbeperkings (bv. vissers kan nie meer vaartuie na Boegoebaai sleep nie), en verdere beperkings bedreig die volhoubaarheid van kleinskaalse lewensbestaan. Klimaatsverandering se impak, soos seevlakstyging en veranderde spesieverspreidings, vererger hierdie druk.

Namate infrastruktuurverbeterings en nuwe werksgeleenthede eksterne beleggers en hoërinkomstegroepe lok, sal gentrifikasiedruk op die bestaande gemeenskappe toeneem. Dit kan die risiko inhou om eiendomswaardes en lewenskoste te verhoog, langdurige inwoners uit te prys en tradisionele

lewensbestaan te erodeer. In dorpe soos Port Nolloth en Alexanderbaai, waar werkloosheid hoog is en dienste beperk is, kan sulke verskuiwings sosio-ekonomiese ongelykhede verdiep en kwesbare bevolkingsgroepe verplaas. Maatskaplike samehorigheid kan ontwrig word, veral as gemeenskappe ervaar dat ontwikkelingsvoordele ekstern vasgelê word.

Die indruk van plaaslike belanghebbendes is dat huidige bestuursreëlings en belanghebberbetrokkenheidsprosesse oorheers word deur regerings- en privaatsektorbelange, met beperkte insluiting van kleinskaalse vissers, Nama-gemeenskappe, vroue en informele hulpbrongebruikers. Dit herhaal 'n nalatenskap van onvoldoende konsultasie gekoppel aan vorige ontwikkelingspogings in die streek, wat bydra tot gemeenskapsfrustrasie en wantroue. Boonop erken huidige raamwerke nie indirekte en verborge belanghebbendes of die kompleksiteit van die mariene en kus-sosiaal-ekologiese stelsels nie, wat lei tot swak aangepaste intervensies en verminderde legitimiteit.

Blok OBM 17: Gentrifikasie in die konteks van ontwikkeling?

Gentrifikasie verwys na die transformasie van histories ondervoorsiene of werkersklasgebiede deur die bekendstelling van hoër-klas behuising, infrastruktuur en kommersiële projekte. Terwyl nuwe ontwikkelings dienslewering kan verbeter en beleggings kan lok, lei dit dikwels tot stygende eiendomswaardes en lewenskoste. Dit kan langdurige, laer-inkomste inwoners verplaas en plaaslike kulture en lewensonderhoud erodeer, namate welgestelde nuwelinge intrek en die sosiale, ekonomiese en fisiese landskap van die gebied hervorm.

3. AANBEVELINGS VIR STRATEGIESE BEPLANNING EN BESTUUR

Gebaseer op die bevindinge van die multidissiplinêre spesialis-inset en gegrond op die beginsel van voorsorg (Blok OBM 18), skets hierdie afdeling belangrike strategiese aanbevelings om beleidmakers te lei in die beplanning en bestuur van die voorgestelde ontwikkelingsprogram by Boeboebaai op 'n verantwoordelike wyse.

Blok OBM 18: 'n Stapsgewyse- en voorsorg-benadering

Die voorsorgbeginsel veronderstel dat indien 'n ontwikkeling vermoedelik skade aan die publiek of die biofisiese omgewing sal veroorsaak, in die afwesigheid van 'n wetenskaplike konsensus dat skade nie sal ontstaan nie, die bewyslas op diegene wat vir die projek voorspraak maak, rus (DEA&DP, 2013). Met ander woorde, dit is die projekvoorstanders wat moet bewys dat die voorgestelde aktiwiteit nie tot beduidende of onaanvaarbare skade sal lei nie, eerder as dat die publiek of omgewingsgroepe moet bewys dat dit wel sal. Suid-Afrika voer die voorsorgbeginsel in die Nasionale Omgewingswet uit. Grootskaalse infrastruktuurontwikkeling wat verband hou met die voorgestelde Boegoebaai hawe en SES moet 'n risiko-afkeerige en versigtige benadering toepas wat die perke van huidige kennis oor die ontvangende omgewings en tegnologieë en infrastruktuur wat ontwikkel word, in ag neem.

'n Sleuteldoelwit van Werkpakket 1 is om die uitleg van die hawe en SES te beïnvloed sodaande ontwikkeling te vermy in areas wat hoogs beperk is, lae waarskynlikheid om Omgewingsgoedkeuring te ontvang, en/of baie duur en komplekse versagtingsmeganismes sal benodig (Blok OBM 19). Gegewe die omvang en impakpotensiaal van die werkprogram, is dit noodsaaklik dat enige toekomstige besluite ingelig word deur hoëgehalte-bewyse, ondersteun deur sosiale billikheidsoorwegings, en in lyn is met breër Suid-Afrikaanse volhoubaarheidsambisies. Die aanbevelings wat hier aangebied word, fokus op die versagting van sleutelrisiko's, die moontlikheid vir die ontwikkeling van kruissektorale, kruiskiesafdeling-koördinering en -bestuur, en die verbetering en diversifikasie van enige langtermynvoordele wat moontlik uit hierdie ontwikkelingsprogram mag voortspruit.

3.1 Die posisie van die breekwater en hawegebied

'n Sleutelkwessie is die plasing van die breekwater en hawegebied relatief tot gebiede met BAIE HOË omgewingsensitiwiteit. Die konstruksie van 'n breekwater en gepaardgaande hawe-infrastruktuur op hierdie plek sal byna sekerlik lei tot onaanvaarbare ekologiese versteuring. Beleidsmakers moet oorweeg om die hawebreekwater te verskuif om hierdie gebied te vermy. Figuur OBM 7 bied 'n paar alternatiewe posisies vir die breekwater en hawe meer ekologies gepas kan wees. Terwyl die seediepte noord van (tans voorgestelde) Boegoebaaipunt tegnies minder gunstig kan wees, blyk gebiede na die suide minder omgewingsbeperkings te hê en gunstiger seediepte toestande vir die konstruksie van breekwaters te bied.

Blok OBM 19: Alternatiewe hawegebied

'n Strategiese geleentheid bestaan om die ligging van die voorgestelde hawe te heroorweeg om ekologiese risiko's te verminder. Voorlopige analise dui daarop dat 'n terrein net noord van Port Nolloth (buite die SOA Werkpakket 1-studie area) 'n meer geskikte alternatief kan bied. Hierdie gebied word reeds deur historiese mynbou versteur, lê binne 10 km van die bestaande hawe, en het nie biodiversiteitskenmerke wat uitsluitingsdrempels sou veroorsaak nie.

Alhoewel dit aanduidend is, bied hierdie riglyne 'n verwysingspunt vir die stuur van ontwikkeling weg van ekologies onvervangbare gebiede en behoort dit vroeë stadiums van beplanning te beïnvloed om die ontwikkeling te verminder en 'n meer volhoubare projekuitkoms te ondersteun.

3.2 Teiken van gedegradeerde gebiede en bestuur windverwaaide sand

Ongeveer 5 000 ha (15% van die 33 500 ha studiegebied) is getransformeerde habitat wat reeds onderworpe aan ekologiese versteuring is – hoofsaaklik as gevolg van historiese en voortdurende mynbou-aktiwiteite. Dit sluit in gebiede van intense historiese mynbou en sones waar natuurlike ekologiese prosesse ontwrig is tot die mate dat herstel beperk of onwaarskynlik is sonder ingryping. Hierdie aktiwiteite het 'n sigbare nalatenskap van gedegradeerde landskappe gelaat, insluitend gebiede gestroop van natuurlike plantegroei, blootgestelde grond en uitgebreide windverwaaide sandpluime, veral wes van die R382. Hierdie gebiede word gegradeer as óf **GETRANSFORMEER** óf van **LAAG** ekologiese sensitiwiteit oor verskeie temas, insluitend soogdiere, reptiele en amfibieë, plantegroei en flora. Net so het die binnelandse akwatiese en vlermuissensitiwiteitstemas hierdie gebiede grootliks as **LAAG** sensitiwiteit gegradeer. Slegs die voëlfauna-tema het **MEDIUM** tot **HOOG** sensitiwiteit aan sommige van hierdie versteurde gebiede toegeken, vanweë hul moontlike gebruik deur sekere voëlspesies.

Blok OBM 20: Die grondvereistes om GH_2- en Krag-na-X-produkte te produseer

Krag-na-X beteken dat hernubare energie (bv. elektrone wat bv. uit wind- en sonkragbronne geproduseer word) vasgevang en omgeskakel word in 'n alternatiewe energiedraer, naamlik molekules (bv. waterstof, ammoniak). Die oorgrote meerderheid van die infrastruktuurvereistes lê by die hernubare energie-ontwikkelingskomponent. In die geval van die voorgestelde Boegoebaai GH_2-ontwikkelingsprogram:

- Die hawe- en industriële infrastruktuur in die SES word beraam om in die reeks van ~ 1 700 - 4 600 ha grond (direkte voetspoor van infrastruktuur) te benodig;
- Aanvullende infrastruktuur soos nuwe pad-, spoor-, pyplyn- en kraglyne kan in die reeks van ~ 4 750 - 12 183 ha grond benodig word; terwyl
- Hernubare energie (wind- en sonkragontwikkeling) tussen 16 000 en 128 000 ha grond kan benodig.

Hernubare energie is dus verantwoordelik vir meer as 70% van die infrastruktuurgrondvereistes om Krag-na-X-produkte te produseer. Hernubare energie sal waarskynlik verkry word van wind- en sonkragaanlegte in die breër Namakwa-streek, en verder, vandaar die behoefte dat die SOA 'n streekskomponent (Werkpakket 2) in ag neem.

Boegoebaai GH_2-ontwikkelingscenario's (wat die basis vorm vir Werkpakket 2) skat dat die hawe- en industriële infrastruktuur in die SES in die reeks van ~ 1 700 - 4 600 ha grondbesetting / fisiese voetspoor sal benodig (Blok OBM 20)**.** Gebiede wat as moontlik 'meer geskik' vir ontwikkeling geïdentifiseer is (~8 500 ha) (sien Afdeling 3.4) teiken gedegradeerde grond en behoort beplande hawe- en SES-verwante infrastruktuur gemaklik te ondersteun.

Daar word aanbeveel dat die voorgestelde hawe- en SES-voetspoor op hierdie bestaande menslik-getransformeerde/versteurde gebiede vir ontwikkeling teiken. Die plasing van landbaseerde infrastruktuur vir die hawe en SES binne hierdie getransformeerde gebiede sal die risiko van 'n impak van nuwe biodiversiteitsverlies aansienlik verminder, mits prioriteitshabitatte nie negatief beïnvloed word deur die ontwikkelingsaktiwiteite nie. Om langtermyn ekologiese volhoubaarheid te verseker, moet infrastruktuurbeplanning egter ook ekologiese korridors in ag neem wat konnektiwiteit tussen belangrike terrestriële, kus- en binnelandse akwatiese habitats ondersteun. Dit sluit in die vermyding van gekarteerde gebiede met **BAIE HOOG** sensitiwiteit en die integrasie van die impakbestuurbeginsels wat in Afdeling 4 hieronder uiteengesit word.

Blok OBM 21: Stabilisering van beweegbare sandpluime

Dit word aanbeveel dat gedetailleerde modellering van sand- en stofvervoer vanaf die voorgestelde ontwikkeling uitgevoer word om moontlike impakte teen die wind af te verstaan. Prioriteit moet gegee word aan die implementering van versagtingsmaatreëls wat sandbeweging stabiliseer voordat dit sensitiewe ekosisteme bereik, soos die Namib-korsmosvelde en die Oranjeriviermonding. Verder moet geteikende intervensies, tesame met noukeurige infrastruktuurbeplanning, geïmplementeer word om mobiele sandpluime te stabiliseer wat dreig om seldsame plantegroei-oorblyfsels op die binneberge en langs die kus te versmoor. Dit sal help om unieke, onvervangbare ekosisteme te bewaar wat kwesbaar is vir windgedrewe sandbeweging wat deur ontwikkelingsaktiwiteite versterk word.

Proaktiewe maatreëls moet getref word om windverwaaide sand te bestuur, wat beide omgewings- en ingenieursrisiko's inhou. Stabiliseringsintervensies, aangepas vir die kuslyndinamika en die hoogs winderige omgewing van hierdie streek, moet in vroeë ontwikkelingsfases ingebed word.

3.3 Gebiede waar grootskaalse ontwikkeling vermy moet word

Geen groot ontwikkeling moet oos van die R382 toegelaat word nie. Dit sluit oostelike gedeeltes van Sones 1 en 2 (Hawe- en Bewaringsarea) (Blok OBM 22) en Sones 9 en 10 (Toekomstige Uitbreiding 02 en Toekomstige bergingsfasiliteit) in. Hierdie gebiede bevat 'n samevloeiing van **BAIE HOOG** ekologiese sensitiwiteit en **HOOG** erfenissensitiwiteit, insluitend Krities Bedreigde (CR) Ekosisteme, Kritieke Biodiversiteitsgebiede (CBAs), vlermuis-neste en voedselsoeksones, argeologiese terreine, lewende erfenis-veeposte en aangrensende landskappe van kulturele en skilderagtige belang. Daarbenewens is die volgende areas waar ontwikkeling nie moet plaasfind nie geïdentifiseer:

- Alle **HOOG**-sensitiwiteitsgebiede oor geïntegreerde fauna-, flora- en akwatiese assesserings;
- Natuurlike panne en depressies, veral in en om Sones 3 en 9), wat CR-vleilandstelsels is;
- Die Oranjeriviermonding (alhoewel nie op die terrein nie);
- • Kaapse pelsrobkolonie en kuskranse habitats, wat andersins ernstig deur hawe-infrastruktuur beïnvloed sou word;
- **BAIE HOOG** vlermuis-sensitiwiteitsgebiede, insluitend rotsagtige dagsome en klowe (bv. Holgatrivier [alhoewel nie op die terrein nie], Boegoeberg-tweeling);
- Grafte naby Boegoeberg-Suid (Sone 2), insluitend die beweerde begraafplaas van Kaptein Paul Links, wat as heilig vir die Nama-mense beskou word;
- Lewende erfenisposte in Sones 9 en 10 (Witbank en Swartbank), die sleutel tot die Nama-manse se sikluse- en pastorale lewenswyse;
- Visuele en kulturele korridors, wat wêrelderfeniswaarde het, gekoppel is aan die Richtersveld Kulturele en Botanises Landskap-buffersone. insluitend die R382-skilderagtige roete en uitsigte na die Boegoeberg-tweeling,

Blok OBM 22: Ontwerp 'n optimale Boegoebaai SES bewaringsarea.

Die huidige uitleg van die SES en sy aangewese "Bewaringsarea" weerspieël 'n poging om kulturele prioriteite en ekologiese sensitiwiteite te akkommodeer. Die doeltreffendheid van die Bewaringsarea kan egter aansienlik verbeter word deur geteikende herontwerp. Spesifiek moet die Bewaringsgebied uitgebrei en herkonfigureer word om die volgende in te sluit:

- Fynskaalse sensitiewe biodiversiteitsterreine wat deur spesialiste geïdentifiseer is (bv. Hoofstuk 3_5B en Hoofstuk 3 van die SOA).
- Intakte plantegroei in **BAIE HOOG** sensitiwiteitsones, veral gebiede oos van die R382, insluitend die Toekomstige Tenkplaas en Toekomstige Uitbreiding 01 sones en wes van R328.
- Intakte kusplantegroei aangrensend aan die nabye kus, eerder as gedegradeerde sones wat tans in die bewaringsgebied ingesluit is.
- Volledige insluiting van beide Boegoeberg-tweeling (d.w.s. insluitend Boegoeberg-Noord wat tans nie heeltemal in die aangewese Bewaringsgebied ingesluit is nie). Hierdie berge huisves uitsonderlike biodiversiteit, insluitend baie bedreigde plantspesies en hoogs sensitiewe korsmos- en mikrobiese gemeenskappe.

Grootskaalse hernubare energie infrastruktuur is doelbewus uitgesluit van die SES in die oorspronklike ontwikkelingsvoorstelle, gegewe die SES se beperkte ruimtelike voetspoor (vir herrnubare energie), nabyheid aan die kus en sensitiewe omgewings. Hierdie standpunt moet vorentoe gehandhaaf word. Hernubare energie infrastruktuur op die skaal wat vereis word vir 'n streeks GH_2/PtX-ekonomie (wat moontlik meer as 100 000 ha grondoppervlak kan benodig), moet eerder in laer-sensitiwiteit ontvangende omgewings, buite die SES, geleë wees en versprei oor die uitgestrektheid van die Noord-Kaap, soos geïdentifiseer deur die streeks-SOA (Werkpakket 2). Dit beteken nie dat geen hernubare energie ontwikkeling binne die SES toegelaat kan word nie[14] (dit sal van geval tot geval oorweeg moet word deur

[14] Let wel: 'n nuwe windplaas "Richtersveld Wind Energy Facility" is gedeeltelik in die Boegoebaai SES area oos van die R382 pad voorgestel, en het reeds Omgewingsgoedkeuring ontvang.

verskeie instrumente soos OIS prosesse), maar dat grootskaalse hernubare energieontwikkeling, spesifiek vir die doel om die elektrisiteitsbehoeftes vir GH2/PtX-produksie te produseer, buite die SES geplaas moet word.

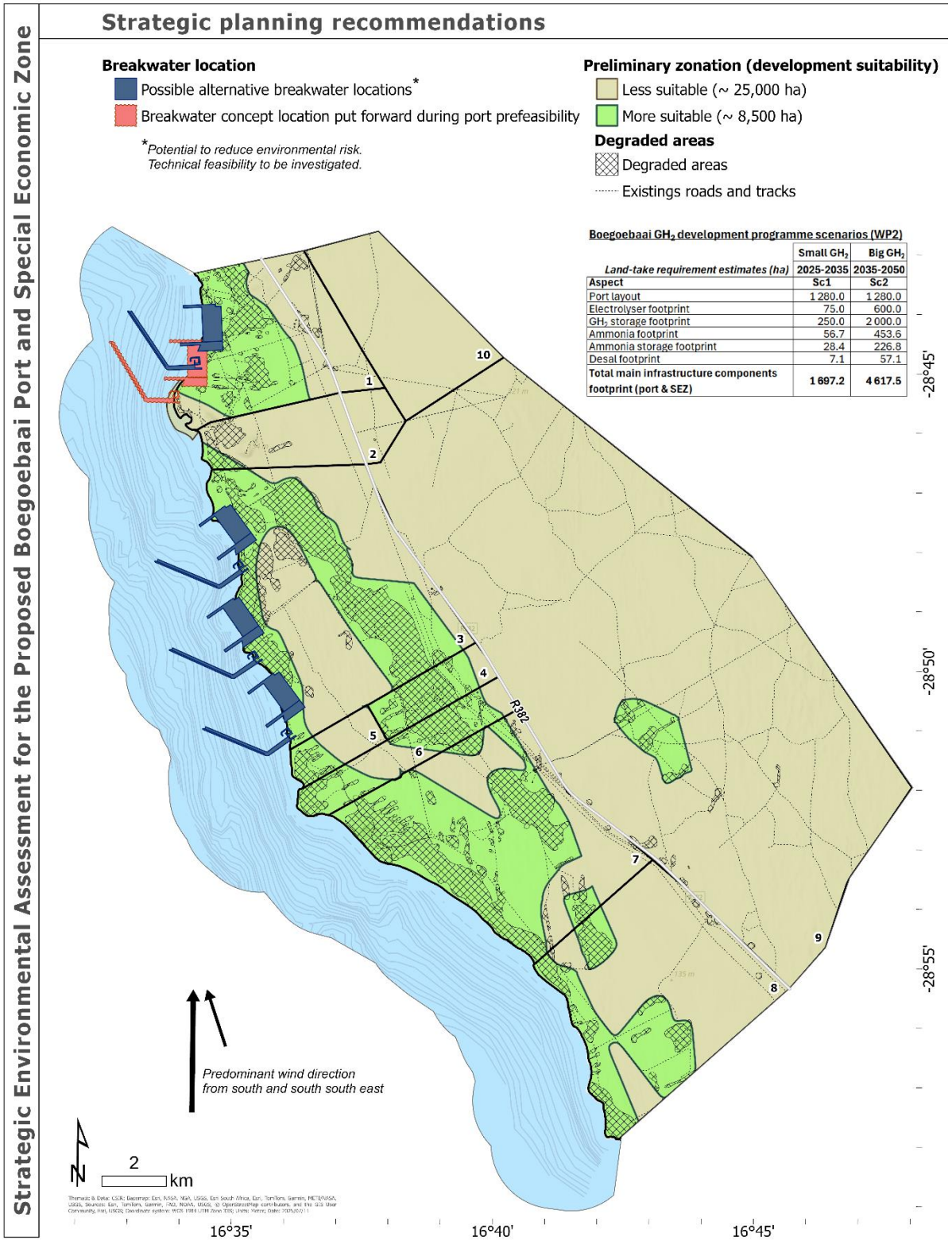
3.4 'n Voorlopige soneringskema vir ontwikkelingsbeplanning

'n Voorlopige soneringskema (ontwikkelingsgeskiktheid) is breedweg afgelei van die ruimtelike sensitiwiteitsanalises (sien Afdeling 2.1), gebiede wat moontlik deur bestaande menslike versteuring (hoofsaaklik mynbou) gedegradeer word (sien Afdeling 3.2), en aanbevole gebiede waar ontwikkeling eerder vermy moet word (sien Afdeling 3.3). Die gevolglike skema bevat twee relatiewe ontwikkelingsgeskiktheidsklasse (Tabel OBM 4).

Tabel OBM 4: Twee ontwikkelingsgeskiktheidsklasse is afgelei van die oorvleueling van sosiale en ekologiese sensitiwiteitsareas en gebiede wat reeds deur mynbouaktiwiteite gedegradeer is.

Ontwikkelingsgeskiktheid	Implikasies vir projekbeplanning
MEER GESKIK	• Kan moontlik grootskaalse ontwikkelbare voetspore vind tydens projekkeuring en OIS-fases, veral in gebiede wat reeds deur historiese mynbouaktiwiteite getransformeer is. • Nietemin, hoë waarskynlikheid om mosaïeke van **HOOG** tot **BAIE HOOG** sensitiwiteitshulpbronne steeds teë te kom, wat, afhangende van die konteks, uitgebreide veldwerk, komplekse OIS en versagtings-/bestuursaksies en/of verrekening mag vereis.
MINDER GESKIK	• Baie onwaarskynlik om ontwikkelbare area tydens projeksifting en OIS-fases te vind. Hierdie gebiede is nie deur mynbou beïnvloed nie en is grootliks ongeskonde, of het redelike herstelpotensiaal, indien daar beperkte versteuring was, bv. gebiede met windverwaaide sand. • Hoë waarskynlikheid om groot gebiede met **BAIE HOOG** sensitiewe ekologiese en erfenishulpbronne teë te kom. • Lae waarskynlikheid om Omgewingsgoedkeuring te verkry, uitsluitlik (moontlik) kleinskaalse infrastruktuur-/ontwikkelingsaktiwiteite, soos oorteer van bestaande grondpaaie of lae-impak elektrisiteitsverspreidingslyne.

Gebiede wat geïdentifiseer is as potensieel **MEER GESKIK** vir ontwikkeling (~8 500 ha), Figuur OBM 7) teiken gedegradeerde grond en behoort voorgestelde infrastruktuur gemaklik te ondersteun, wat na raming in die reeks van ~ 1 700-4 600 ha grond sal benodig, wat ongeveer 5 - 15% van die volle ~33 500 ha omvang verteenwoordig wat voorlopig vir die Boegoebaai SES geïdentifiseer is. Om dit in konteks te plaas: die gevestigde Saldanhabaai Industriële Ontwikkelingsone ("Industrial Development Zone" ("IDZ")) en Coega "IDZ" het onderskeidelik 'n omvang van ongeveer 356 ha (DTIC, 2017a) en 9 000 ha (DITC, 2017b).



Figuur OBM 7: Voorgestelde soneringskema vir die voorgestelde Boegoebaai hawe en SES wat fokus op moontlike alternatiewe breekwaterliggings wat die sensitiefste gebiede van die Boegoebaai-kop vermy. Gebiede wat as moontlik 'meer geskik' vir ontwikkeling geïdentifiseer is (~8 500 ha) teiken reeds gedegradeerde grond en ondersteun gemaklik die beoogde ruimtelike voetspoor-vereiste van die beplande hawe- en SES-verwante infrastruktuur, wat na raming in die reeks van ~1 700 tot 4 600 ha grond is.

3.5 Verryk data in ‘n omgewing waar data beperk is

Dit word aanbeveel dat 'n langtermyn-omgewingsmoniteringsprogram vroeg in die projeklewensiklus ingestel word om data-gapings wat veroorsaak word deur die afgeleë ligging van die studie area aan te spreek. Hierdie program moet die konsekwente insameling van interseisoenale velddata oor klimaat, oseaniese prosesse, omgewingsgehalte en biodiversiteit prioritiseer. Dit sal die wetenskaplike grondslag bied wat nodig is vir ingeligte besluitneming, effektiewe omgewingsbestuur, geskikte verrekeningsgebiede en intervensies, en klimaatsveerkragtigheidbeplanning dwarsdeur die voorgestelde ontwikkelings- en operasionele fases.

3.6 Dink strategies oor Biodiversiteitsverrekeninge

3.6.1 Terrestriële omgewing (basseer op Botha 2025)

Verrekeninge sal veroorsaak word as gevolg van die teenwoordigheid van beperkende statutêre beplanningskenmerke soos “CBA’s“, gelyste bedreigde ekosisteme, internasionaal erkende aanwysings (bv. KBA’s), sowel as habitat vir baie “SCCs”, wat groot dele van die SES en die onmiddellike omgewing daarvan dek. Terwyl die omvang van die impak aansienlik wissel, van meer as 21 000 ha vir 'n Klein GH_2-scenario tot meer as 144 000 ha vir 'n groter een (verwys na Werkpakket 2 van die SOA), kan ongeveer 40 000 ha verrekeninge slegs vir 'n Klein GH_2-scenario benodig word (indien die vroeë uitlegplanne wat voorgelê is, nagestreef word.

Indien die moontlike beduidende impakte wat die tans voorgestelde hawe- en SES-ontwikkeling op verskeie bedreigde, seldsame of bewaringswaardige biodiversiteitskenmerke (waarvan die meeste as streng "nie-verrekenbaar" beskou word) inhou, nie vermy kan word nie, moet mitigasie herformuleer word as Ekologiese Kompensasie. (Blok OBM 24) eerder as “verreken *sensu strictu*”. Hierdie onderskeid is belangrik vir duidelike kommunikasie met belanghebbendes, en beklemtoon dat sommige biodiversiteitsverliese onomkeerbaar is en bewaringsdoelwitte beïnvloed.

Blok OBM 23: Wat is Biodiversiteitsverrekeninge (“Biodiversity Offsets”)?

Biodiversiteitsverrekeninge is die meetbare uitkomste van voldoening aan 'n formele vereiste vervat in 'n omgewingsmagtiging om 'n intervensie te implementeer wat die doel het om die oorblywende negatiewe impakte van 'n aktiwiteit, of aktiwiteite, op biodiversiteit te balanseer deur verhoogde beskerming en toepaslike bestuur, nadat alle pogings aangewend is om impakte te vermy en te minimaliseer, en geaffekteerde gebiede te rehabiliteer.

Blok OBM 24: Wat is Ekologiese Kompensasie?

Die uitkoms van meetbare aksies om prioriteitsbiodiversiteit te beskerm, te herstel en te bestuur, wat daarop gemik is om te kompenseer vir oorblywende negatiewe impakte op onvervangbare biodiversiteit en ekologiese infrastruktuur waar hierdie impakte nie geneutraliseer kan word nie en wat eerder en in die eerste plek vermy moet word.

Om die behoefte aan verrekenings te minimaliseer of aan te spreek, moet alle ontwikkelings op versteurde mynbougebiede geleë wees, aangesien dit ooreenstem met die versagtingshiërargie en nie verrekenings sal veroorsaak nie. Vir gebiede wat geraak word deur windverwaaide sand en sandpluime, hoewel dit nie as soortgelyk getransformeer beskou word nie, word lae verrekeningsvermenigvuldigers voorgestel, aangesien herstel in hierdie gebiede steeds moontlik en wenslik mag wees om risiko's vir GH_2-fasiliteit- en infrastruktuurbestuur te verminder. Van kritieke belang is dat habitatverlies in gebiede van **BAIE HOOG** sensitiwiteit, veral dié met onvervangbare biodiversiteitswaarde, as onaanvaarbaar beskou word, aangesien dit die vermoë om bewaringsteikens te bereik, in gevaar kan stel, en die oorblywende impak op sulke onvervangbare biodiversiteit kan nie verreken word nie.

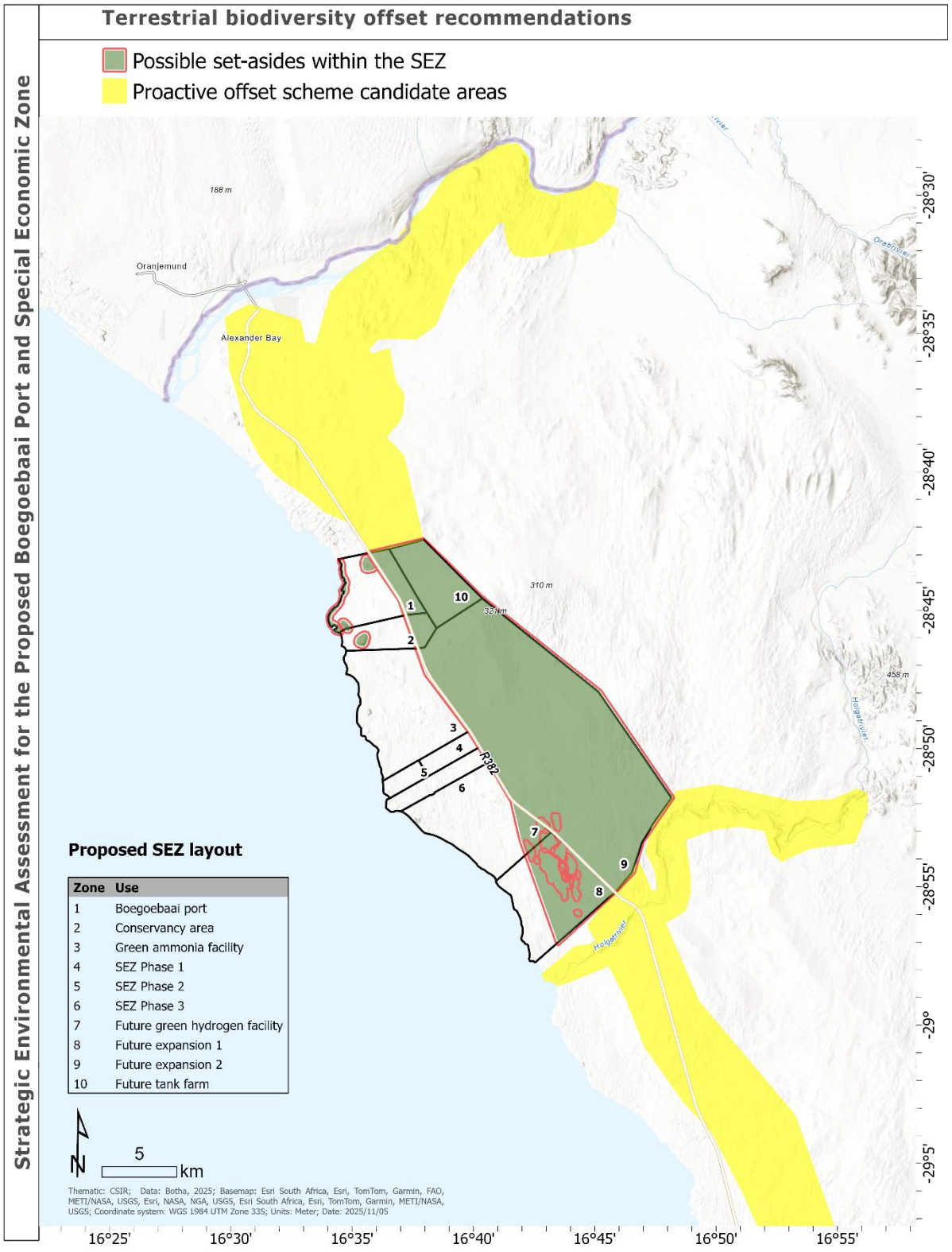
Daar is gevare verbonde aan projekvlak-kompensasie-assessering en ad hoc-implementering van kompensasies, aangesien geskikte terreine mettertyd onbeskikbaar kan raak of kostes onaanvaarbaar hoog kan word. Daarom is die primêre taak vir projekvlak-OIS's nie bloot die tegniese berekening van verlies:wins-maatstawwe nie, maar om geskikte kompensasieterreine en die mees gepaste en duursame implementerings- of bestuursreëlings te identifiseer, te onderhandel en toegang daartoe te verseker. Proaktiewe kompensasieskemas word verkies omdat hulle beter is om kumulatiewe impakte aan te spreek, bedreigings te bestuur en suksesvolle implementering en uitkomste te verseker. (Blok OBM 25). Drie grootskaalse verrekeningsontvangsomgewings vir die verrekening van die impakte wat verband hou met die hawe en SES word voorgestel, wat daarop dui dat die meeste SES-impakte waarskynlik binne hierdie gebiede vergoed kan word. (Figuur OBM 8). Daarbenewens bestaan daar voldoende area binne geïdentifiseerde en goedgekeurde prioriteitsfokusareas vir die uitbreiding van formele Bewaringsareas/Natuurreservate om die impakte van Hernubare kragopwekking in die groter streek te verreken (sien Werkpakket 2). Hernubare kragopwekking in die groter streek sal ook verrekening in geaffekteerde ekosisteme vereis. 'n Bestaande proaktiewe verrekeningskema-loodsprojek rondom die Namaqua Nasionale Park kan uitgebrei word na ontvangende omgewings naby die SES vir plaaslike impakte, en na ander parke of reservate vir streeksimpakte.

Blok OBM 25: Gekoördineerde Verrekeningsbeplanning en -implementering

Om die risiko's van gefragmenteerde, opeenvolgende verrekening, soos die verlies van geskikte terreine, wetlike vertragings, grondgebruikskonflikte en swak bewaringsuitkomste, te vermy, moet verrekeningsgebiede vir die Boegoebaai hawe en SES proaktief geïdentifiseer, verseker, effektief beskerm en gerehabiliteer word. Befondsing moet gewaarborg word vir langtermynbestuur deur 'n begiftigingstipe instrument. Hierdie benadering sal groter sekerheid bied aan reguleerders, owerhede, gemeenskappe en belanghebbendes.

Die Richtersveld Gemeenskaplike Eiendomsvereniging (RGEV), as die wettige grondeienaar-entiteit, tesame met ander gemeenskapstrukture, moet proaktief betrokke wees by die ontwerp en implementering van enige biodiversiteitsverrekening om vertroue te bou, plaaslike voordeel te verseker en langtermyn sukses te verseker. Verrekenings moet statutêre beskerming van prioriteitsgebiede wat deur die gemeenskap geïdentifiseer is, prioritiseer.

Verder moet 'n toegewyde koördineringsliggaam ingestel word om toesig te hou oor implementering, met bestuur (reguleerders en grondeienaars) duidelik geskei van implementering (staats- of private entiteite), om betwisting te verminder en lewering te stroomlyn.



Figuur OBM 8: Voornemende verrekeningsontvangsgebiede rondom die SES. Let wel dat die moontlike verrekeningsontvangsgebiede binne die SES oos en wes van die R382 ook in hierdie figuur ingesluit is, in lyn met die aanbevole gebiede waar ontwikkeling eerder vermy moet word, soos uiteengesit in Afdeling 3.3 hierbo. Geen poging word aangewend om die konsep "bewaringsarea"-sone as 'n verrekeningsontvangsgebied te herontwerp nie (verwys na Afdeling 3.3).

3.6.2 Kustelik / mariene (baseer op Clark et al., 2025)

Volgens die Konsep Mariene Biodiversiteitssektorplan (DFFE, 2023), word die vestiging van 'n nuwe hawe as onversoenbaar beskou met gebiede wat as "CBA"-Natuurlik of "CBA"-Herstel geklassifiseer is. Die omgewingsvriendelike opsie is om sulke gebiede heeltemal te vermy. Volledige vermyding is egter nie altyd haalbaar nie, aangesien talle klein "CBA" Natuurlike gebiede wyd verspreid langs die kus is, en 'n beduidende gedeelte van die mariene omgewing op see in die studiegebied as "CBA" Herstel geklassifiseer word. In omstandighede waar vermyding bewysbaar nie moontlik is nie, beveel beste praktykriglyne die toepassing van biodiversiteitsverrekeninge of die identifisering van alternatiewe "CBA"-gebiede aan om bewaringsteikens te bereik. Dit word egter sterk aanbeveel dat sulke bepalings nie van toepassing is op Boegoebaaipunt nie, wat as onvervangbaar beskou word as gevolg van sy baie hoë ekologiese sensitiwiteit.

Suid-Afrika se Nasionale Biodiversiteitsverrekeningsriglyne (2023) is van toepassing op terrestriële en varswaterstelsels en is nie van toepassing op mariene en riviermondingomgewings nie. Alhoewel die riglyne hierdie uitsluiting nie eksplisiet verduidelik nie, verduidelik hulle wel dat dit mariene en riviermondingstelsels nie van verrekeningsverantwoordelikheid vrystel nie. In die lig van hierdie regulatoriese gaping word dit in hierdie konteks as gepas beskou om uit te wyk na die Internasionale Finansieringskorporasie (IFC) se biodiversiteitsverrekeningsvereistes. IFC-prestasiestandaard 1 vereis dat biodiversiteitsverrekenings slegs toegepas word nadat alle haalbare vermydings-, minimaliserings- en herstelmaatreëls geïmplementeer is, om die oorblywende impak op natuurlike habitat aan te spreek. Volgens IFC-prestasiestandaard 6 moet verrekenings meetbare, meetbare bewaringsuitkomste op die grond lewer om soortgelyke of beter ekologiese waarde en skaal te bereik. Die besluit om 'n biodiversiteitsverrekening te onderneem, kan nie dien as 'n plaasvervanger vir versagtings- en bestuursmaatreëls om beduidende impak te vermy nie.

Die volgende sleutelstappe word aanbeveel vir die ontwerp van biodiversiteitsverrekeninge om die impak op "CBA"-Natuurlike en "CBA"-Herstelgebiede te verminder:

- Omvangbepaling, in oorleg met relevante belanghebbendes, van moontlike bewaringsaktiwiteite of verrekeningsterreine binne die landskap wat die biodiversiteitswaardes wat moontlik deur die projek beïnvloed word, kan bevoordeel (d.w.s. "soortgelyk of beter").
- Beoordeling of die verlies aan biodiversiteit op die projekterrein vergoed kan word deur winste op die verrekeningsterrein.
- Identifisering van maniere om verrekeningsaktiwiteite oor die lang termyn te verseker, insluitend byvoorbeeld wetlike beskerming.
- Vestiging van 'n effektiewe proses vir gemeenskappe wat deur die verrekening geraak word om deel te neem aan die ontwerp en implementering van die biodiversiteitsverrekening.
- Definisie van die spesifieke verrekeningsaktiwiteite en hoe dit in 'n biodiversiteitsverrekeningsbestuursplan geïmplementeer sal word, insluitend die rolle, verantwoordelikhede en begrotingsprojeksies vir die betrokke partye.
- Vestiging van 'n befondsingsmeganisme om die verrekening te ondersteun solank die projekimpakte voortduur.
- Ontwerp van 'n stelsel vir monitering, evaluering en aanpasbare bestuur.
- Verseker dat die projek voldoen aan alle toepaslike wette, regulasies en beleide met betrekking tot biodiversiteitsverrekeninge.

3.7 Beginsels vir volhoubare hawebeplanning (basseer op Taljaard & Weerts, 2025)

Om 'n volhoubare hawe te beplan, is dit noodsaaklik om 'n gebalanseerde benadering te implementeer wat ekonomiese groei, omgewingsbeskerming en sosiale vooruitgang vanaf die vroegste beplanningsfases integreer om langtermyn lewensvatbaarheid te verseker en die 'lisensie om te bedryf' daarvan te verseker. 'n Sterk Raamwerk vir Volhoubare Hawebeplanning en -Ontwikkeling, in lyn met beste praktyke, is van kardinale belang en dek bestuur, omgewings-, sosiale en ekonomiese domeine. Wat bestuur betref, sluit sleutelkriteria in die vestiging van 'n wetgewende raamwerk, die bevordering van 'n organisatoriese kultuur wat op volhoubaarheid gerig is, die toewysing van toegewyde begrotings, die implementering van openbare kommunikasiemeganismes en die oprigting van formele instellings vir die betrek van beide haweklante en eksterne belanghebbendes, tesame met die bevordering van samewerkingsreëlings met aangrensende plaaslike owerhede. Dit noodsaak ook omvattende omgewingsassessering en -bestuur dwarsdeur die projeklewensiklus, wat SOA's, OIS's met gepaardgaande Omgewingsbestuursprogramme en gebeurlikheidsbeplanning insluit.

Blok OBM 26: Wat is 'n volhoubare hawe?

Volhoubare hawens kan gedefinieer word as:
"Hawens wat die konsep van hulpbronbesparing en omgewingsvriendelike ontwikkeling nakom, aktief hul sosiale verantwoordelikhede nakom, en omvattende tegnologieë en bestuursmaatreëls aanneem wat bevorderlik is vir die besparing van hulpbronne en energie, die beskerming van die omgewing en ekologie, en die hantering van klimaatsverandering" Guo and Liu (2018).

Omgewingsoorwegings is van uiterse belang en sluit in eko-doeltreffendheidsmaatreëls soos water- en energieverbruiksdoeltreffendheid, die keuse van omgewingsvriendelike materiale, robuuste afvalbestuur (insluitend herwinning en die minimalisering van bouafval), en doeltreffende, verantwoordelike grond-/seegebruik deur ruimtelike beplanning, tesame met die aanspreek van klimaatsversagting. Daar moet deursigtige verslagdoening wees oor moontlike impakbronne soos atmosferiese uitlatings, geraas, afvalwaterstortings en vaste/gevaarlike afval, wat voldoening aan omgewingsstandaarde verseker en gereelde oudits uitvoer. Omgewingsgehalte moet effektief gemonitor word vir lug-, geraas-, seewater-, mariene sediment-, grond- en grondwatergehalte, tesame met die beheer van mariene indringerspesies en die assessering van die status van terrestriële en mariene habitats en biodiversiteit.

Blok OBM 27: Kern volhoubaarheidskriteria ontwikkel vir die voorgestelde Boegoebaai hawe

Om hawevolhoubaarheidsbeplanning met prestasiebeoordeling en -verslagdoening in lyn te bring, is konsekwente raamwerke en aanwysers noodsaaklik. Die hawevolhoubaarheidsprestasie-indeks, wat saam met TNPA ontwikkel is, het die volhoubaarheidskriteria vir die voorgestelde hawe van Boegoebaai gelei. Hierdie kriteria is gestruktureer onder vier volhoubaarheidspilare en in lyn met relevante Volhoubare Ontwikkelingsdoelwitte ("SDGs"). Dit sluit wetgewende ondersteuning, institusionele reëlings en gesonde bestuurspraktyke in, wat verseker dat beplanning meetbare, wêreldwyd vergelykbare en plaaslik relevante volhoubaarheidsuitkomste integreer vir effektiewe volhoubaarheidsprestasiebeoordeling en -verslagdoening.

Van kritieke belang is dat beplanning sensitiwiteitsassesserings moet insluit om habitatverlies in gebiede met BAIE HOOG sensitiwiteit te vermy, veral dié met onvervangbare biodiversiteitswaarde, aangesien oorblywende impakte op sulke onvervangbare biodiversiteit nie verreken kan word nie en vergoeding nie haalbaar sou wees nie. Waar impakte onvermydelik is, dien biodiversiteitsverrekeninge as beduidende effektiewe ekologiese kompensasie, met 'n voorkeur vir proaktiewe verrekeningskemas om kumulatiewe impakte beter aan te spreek en suksesvolle uitkomste te verseker.

Ontwikkelaars moet ook prioritiseer dat fasiliteite op versteurde mynbougebiede geplaas word waar moontlik, aangesien dit ooreenstem met die versagtingshiërargie en nie verrekeninge sal veroorsaak nie.

Maatskaplike volhoubaarheid vereis aandag **aan gemeenskapswelstand deur korporatiewe sosiale inisiatiewe, wat toegangsregte vir gemeenskappe verseker, waar toepaslik**, gemeenskapsgebaseerde omgewingsopvoeding, die ondersteuning van volhoubaarheidsverwante gemeenskapsondernemings, en belegging in navorsing, ontwikkeling en innovasie. Ondersteuning vir plaaslike en klein besighede is noodsaaklik, asook gesonde hawe-munisipale verhoudings en, belangrik, die beskerming van kulturele erfenisbates. Werknemertevredenheid en -welstand, insluitend opleiding, betrokkenheidsforums en die hantering van griewe, is ook 'n integrale komponent. Verder, as die projek/te goedgekeur word en voortgaan, moet opleiding en kapasiteitsbou oor volhoubaarheidsbeplanning en die toepassing van belangrike kriteria vir alle betrokke rolspelers geprioritiseer word. Dit sal verbintenisse oor werknemerstevredenheid en welstand versterk.

Vanuit 'n ekonomiese perspektief moet beplanning rekening hou met klimaatsveerkragtigheid, insluitend voorbereiding, vroeë waarskuwingstelsels en voorvalassessering. Dit behels die versekering van hoë diensgehalte en doeltreffendheid deur tegniese kapasiteit, drinkwatervoorsiening, kliëntetevredenheid, sekuriteit, digitalisering en die handhawing van infrastruktuurgehalte. Die hawe moet bydra tot ekonomiese groei en ontwikkeling deur inkomstegenerering, werksgeleenthede en die bevordering van nuwe sakeproduksie. Doeltreffende interkonnektiwiteit, beide in die agterland en internasionaal, is ook 'n belangrike ekonomiese kriterium. Laastens is die vooruitsig van waarskynlike toekomstige ontwikkelingsplanne (industrieel, stedelik, voorstedelik) noodsaaklik vir ruimtelike beplanning om toekomstige hawe-stad en hawe-gemeenskap-konflikte te vermy. Gegewe die afgeleë ligging van sommige gebiede, is die versekering van toegang tot langtermyn-, interseisoenale velddata oor klimaat, oseaniese prosesse, omgewingsgehalte en biodiversiteit 'n kritieke uitdaging wat vroeg in die beplanningsproses opgelos moet word.

3.8 Billike konsultasie en onderhandelinge (basseer op Atkinson et al., 2025 & Gammage et al., 2025)

Die Boegoebaai-streek, geleë in die Richtersveld van die Noordkaap, het diep kulturele en ekologiese betekenis. Histories is die gebied gevorm deur mynbou, veral deur bedrywighede deur Alexkor, wat gelei het tot beperkte toegang en verplasing van tradisionele gebruike. Die Richtersveld-gemeenskap het, deur die RGEV, grondregte teruggeëis in 'n landmerk-restitusiesaak. Hierdie grond vorm nou die basis vir groot ontwikkelings, insluitend die voorgestelde Boegoebaai hawe en SES. As sodanig moet die RGEV 'n sentrale akteur wees in enige ontwikkelings- en grondverwante onderhandelinge. Die RGEV sou van kritieke belang wees om gemeenskapsvlakbetrokkenheid te fasiliteer deur as tussengangers tussen eksterne ontwikkelaars en plaaslike gemeenskappe op te tree.

Die voorgestelde ontwikkeling belowe transformerende ekonomiese moontlikhede, maar dit het ook kommer uitgespreek. Die gebied rondom Boegoebaai bevat voorvaderlike grafte, heilige natuurlike kenmerke en tradisionele visvanggronde wat sentraal staan tot die identiteit en erfenis van plaaslike gemeenskappe. Verlede ervarings van uitsluiting van besluitneming, beperkte voordele van mynbou en omgewingsagteruitgang het 'n nalatenskap van wantroue geskep. Sonder betekenisvolle betrokkenheid is daar 'n risiko van herhaalde patrone van marginalisering en kulturele erosie. 'n Konstruktiewe en inklusiewe dialoog moet verder strek as konvensionele belanghebberkonsultasie. Dit moet vroeg in die projekontwerpfase plaasvind, i**nklusief, kultureel gepas, deurlopend en samewerkend,** en gemeenskappe moet toegerus wees om **betekenisvol** deel te neem.

Blok OBM 28: "FPIC" Beginsels

- **Vry**: Toestemming moet vrywillig en sonder dwang wees.
- **Vroegtyding**: Betrokkenheid moet plaasvind voordat enige projekbesluite of -aktiwiteite begin.
- **Ingelig**: Gemeenskappe moet volledige, toeganklike en kultureel gepaste inligting ontvang.

- **Toestemming**: Gemeenskappe het die reg om toestemming goed te keur of te verwerp, en om toestemming terug te trek.

Die beginsel van "Free, Prior and Informed Consent" ("FPIC") is 'n wêreldwyd erkende standaard vir die betrek van inheemse en plaaslike gemeenskappe by besluite wat hul grond, hulpbronne en kulturele erfenis raak. Die Sosio-ekonomiese Verslag vir Werkpakket 2 (Atkinson et al., 2025) van die SOA steun op die "Initiative for Responsible Mining Assurance" deur uiteen te sit dat FPIC nie net 'n eenmalige betrokkenheidsinstrument is nie, maar 'n omvattende beginsel gegrond op inheemse mense se regte op selfbeskikking, grond, kultuur, ontwikkeling en 'n gesonde omgewing. as 'n reg gegrond op selfbeskikking. Die raamwerk skets praktiese stappe om konstruktiewe en inklusiewe betrokkenheid met inheemse mense tydens konsultasieprosesse te verseker:

- **Pas betrokkenheidsmetodes aan** op elke Inheemse groep se voorkeure en konteks.
- **Identifiseer gesamentlik geaffekteerde regte en belange**, en verseker dat gemeenskapsbekommernisse besprekings lei.
- **Werk saam aan verdere assesserings om moontlike impakte ten volle te verstaan**, insluitend die opdrag gee van onafhanklike navorsing indien nodig.
- **Ondersteun ingeligte deelname deur kapasiteitsbeperkings aan te spreek** deur middel van befondsing, opleiding en gesamentlike leeraktiwiteite (bv. werkswinkels of terreinbesoeke).
- **Bevorder breë gemeenskapsbetrokkenheid** om oormatige afhanklikheid van verteenwoordigers te vermy en kollektiewe insette te verseker.
- **"FPIC" is nie eenmalige nie, maar is 'n deurlopende proses**. Dit moet in bestuursstrukture ingebed wees en deur alle belanghebbendes, insluitend ontwikkelaars, die regering en finansiers, gerespekteer word.

Om billike konsultasie te verseker en "FPIC" beginsels te handhaaf, word die volgende aanbeveel (insluitend, maar nie beperk tot):

- **Integreer en implementeer die "FPIC"-raamwerk binne projekbestuurstrukture** en besluitnemingsprosesse, en verseker dat dit 'n deurlopende proses is.
- **Onderneem inklusiewe onderhandelinge met die grondeienaars** in alle stadiums van die ontwikkelingsproses.
- **Voer onafhanklike vooronderhandelingsomvangbepaling uit om gemeenskapsgereedheid en -verwagtinge te bepaal.**
- **Verseker dat grondtoegangsooreenkomste deursigtig** onderhandel word om volle steun van die RGEV en geaffekteerde gemeenskappe te verkry.
- **Respekteer die grondrestitusiegeskiedenis en gemeenskaplike bestuurstrukture**, en vermy bo-na-onder-afdwinging.
- **Neem 'n samewerkende, gemeenskapsgesentreerde benadering** aan vanaf die projekomvangbepaling en ontwerpfase, en verseker dat diverse plaaslike behoeftes, kennisstelsels en prioriteite betekenisvol in beplanning en besluitneming geïntegreer word om meer inklusiewe, buigsame en volhoubare uitkomste te behaal.
- **Verskaf finansiële en tegniese ondersteuning aan gemeenskappe om effektief betrokke te raak**.
- **Betrokkenheid moet kultureel gepas, veeltalig en toeganklik wees**.
- **Skep onafhanklike klagteherstelstelsels** wat wetlik ondersteun en kultureel sensitief is.
- **Vestig burgerwetenskap en gemeenskapsgeleide monitering** om omgewings- en sosiale impakte dop te hou.
- **Ontwikkel voordeeldelingsmodelle wat histories gemarginaliseerde groepe prioritiseer**.
- **Verseker dat oorgange na die projek grondherstel, kulturele bewaring en ekonomiese diversifikasie insluit.**

4. BEGINSELS EN PRAKTYKE VIR IMPAKBESTUUR

Hierdie afdeling bied 'n opsomming van die moontlike impakte en sintetiseer voorstelle vir bestuursbeginsels en -aksies wat negatiewe impakte kan verminder en positiewe impakte kan versterk.

Tabel OBM 5: Opsomming van moontlike impakte en gepaardgaande aanbevole impakbestuur beginsels en praktyke vir die voorgestelde Boegoebaai hawe en SES ontwikkeling.

	Impak	Beginsels/aksies vir bestuur (verbetering en versagting)
MARIENE EKOLOGIE	**See- en kusekosisteme**	
	Versteuring en skade aan mariene fauna, insluitend fisiologiese en gedragseffekte, werwingsontwrigting, en spesieverplasing of -sterftes.	Oorweeg die verskuiwing van die hawe om gebiede met hoë ekologiese sensitiwiteit (veral rob- en seevoëlkolonies) te vermy; vermy konstruksie gedurende sensitiewe lewensfases van fauna.
	Afbraak van bentiese en demersale gemeenskappe, insluitend habitatverlies, versmoring en veranderde gemeenskapsstruktuur.	Vermy ontwikkeling in gebiede wat as “CBA”-Herstel en “ESA” aangewys is; oorweeg biodiversiteitsverrekeninge (in lyn met toepaslike riglyne) waar impakte nie vermy kan word nie.
	Hidrodinamiese veranderinge, soos veranderinge in kusstrome en littorale drywing, wat moontlik kussedimentvervoer en ekosisteemstabiliteit kan beïnvloed.	Oorweeg alternatiewe areas met minder ekologiese sensitiwiteit en soortgelyke batimetriese geskiktheid; vermy plekke waar golf- en stroompatrone krities is vir habitatstabiliteit.
	Verlies en agteruitgang van mariene habitatte, insluitend permanente verlies van ongekonsolideerde seebodem en geassosieerde gemeenskappe as gevolg van infrastruktuurplasing.	Vermy die plasing van infrastruktuur in kritieke of onvervangbare habitatte soos rotsriwwe en CBA-Herstelsones; gebruik die versagtingshiërargie: vermy → versag → verrekening.
	Versteuring van mariene fauna, veroorsaak deur verhoogde onderwatergeraasvlakke, liguitstraling, skipbotsings en seewaterinnames.	Vermy gebiede waar robbe en walvisse broei of saamtrek; oorweeg die verskuiwing om risikosones te vermy; beperk aktiwiteit naby kolonies
	Afbraak van watergehalte, as gevolg van roetine-vaartuiglozings, operasionele stortings, pekelwaterlozings, verhoogde troebelheid en hermobilisering van sedimentgebonde besoedelingstowwe.	Positioneer ontsoutingsfasiliteite weg van ekologies sensitiewe sones af; beheer besoedeling van skepe en verseker monitering van uitvloeiselimpakte.
	Verlies en verandering van mariene habitatte, insluitend permanente verlies van ongekonsolideerde seebodem en ontwrigting van geassosieerde bentiese gemeenskappe.	Vermy ekologies sensitiewe ongekonsolideerde habitatte; indien onvermydelik, oorweeg habitatrehabilitasie en verrekeningstrategieë
	Toevallige koolwaterstofstortings/vrystellings (bv. vaartuigongeluk, bunkering en pypbreuk).	Ontwikkel stortingsnoodplanne en verseker vinnige reaksiekapasiteit; vermy haweplasing in hoogs sensitiewe kusomgewings.
GEÏNTEGREERDE TERRESTRIËLE EN AKWATIESE EKOLOGIE	**Akwatiese Ekosisteme**	
	Die beplande Boegoebaai hawe-ontwikkeling in Sone 1 kan uitbrei na herlaaigebiede van nabygeleë vleilande of panne, wat hul volhoubaarheid bedreig as gevolg van onsekere hidrologiese drywers.	Vermy ontwikkeling in herlaai-sensitiewe gebiede; sluit hidrologiese buffers in en behou natuurlike vloeipaaie.
	Insluiting van die noordelike gedeelte van BB1 in die Sone 2-bewaringsgebied, wat lei tot die moontlike beskerming van herlaaigebiede vir die pan, sy vleiland en gepaardgaande fontein.	Sluit die boonste gedeelte van die BB1-pan in of wys dit aan in bewaringsgebied; beskerm volle herlaaisones.

	Impak	Beginsels/aksies vir bestuur (verbetering en versagting)
	Konstruksie van die bevestigde Groen Waterstof- en Ammoniakfasiliteit in Sone 3 kan lei tot vleiland- en pan-degradasie, stormwater- en voertuigversteurings.	Vermy hoë sensitiwiteitsgebiede (CR-vleilande); buffer vleilandrande; bestuur stormwaterimpakte.
	Ontwikkeling van Fases 1-3 van die SES-nywerheidspark in Sones 4-6 kan lei tot die vernietiging van CR-pan- en vleilandhabitat (BB3), nutriëntverryking en hidroperiode-ontwrigting.	Vermy waterloop BB3 (kortstondige pan met vleilandelemente); handhaaf hidroperiodes; beheer voedingstof- en afloopladings.
	Die voorgestelde toekomstige Groen Waterstoffasiliteit in Sone 7 kan vermoedelike natuurlike (BB6) en kunsmatige pan- (BB4 en BB5) en vleilandhabitats vernietig en hidroperiodes verander deur fisiese versteuring.	Vermy suidwes van Sone 7 (vermoede natuurlike pan BB6); handhaaf vloeipaaie; beperk ontwikkeling in sensitiewe sones.
	Ontwikkeling in Sone 8 kan lei tot die vernietiging van vermoedelike natuurlike pan- en vleilandhabitat en kunsmatige panne BB7 en BB8, hidroperiode-ontwrigting en vloeiverwante degradasie.	Vermy die noordelike deel van Sone 8; beskerm oppervlakvloei en grondwaterhabitatte.
	Uitbreidingsaktiwiteite in Sone 9 kan lei tot die vernietiging van panhabitatte, eutrofikasie, breër ekosisteemdegradasie en biodiversiteitsverlies.	Vermy sensitiewe waterkenmerke, rotsskietery, platmaak van hellings en/of verlies van rotsagtige dagsooms wat kortstondige rotspoele en panhabitat kan insluit; vestig afloopbeheer en ekologiese korridors.
	Terrestriële ekosisteme (insluitend voëlfauna; vlermuise; soogdiere, reptiele en amfibieë; plantegroei en flora)	
	Die konstruksie van hawe-infrastruktuur in Sone 1 en SES-infrastruktuur oor Sones 3 tot 10 kan plantegroeiverlies veroorsaak (deel van 'n CR-ekosisteem, onvervangbare CBA1 of optimale CBA2, 'n Prioriteitsfokusarea van die NPAES en 'n KBA), habitatfragmentasie, verlies van SCC- en endemiese spesies, afname in ekosisteemdienste, erosie en fauna-versteuring.	Vermy gebiede met baie hoë sensitiwiteit; prioritiseer versteurde terreine wes van R382 (mits prioriteitshabitat nie negatief beïnvloed word nie). Vermy ook die “Namib Seashore”plantegroeitipe, selfs dele wat getransformeer is, aangesien dit baie klein en kritiek bedreig (CR) is.
	Die hantering van mangaan, sink en lood in Sone 1 kan lei tot stofvrystellings, lugbesoedeling en toksisiteit wat grond- en watergehalte beïnvloed.	Gebruik ingeslote hantering; monitor en bestuur emissies; vermy sensitiewe habitats.
	Vervoerstelsels wat vir Sone 1 beplan word, kan grond/water besoedel en as hindernisse vir dierebeweging dien.	Sluit volledig af; monitor emissies; ontwerp om fauna-deurgang toe te laat.
	Stofonderdrukkingsaktiwiteite in Sone 1 kan lei tot omgewingsbesoedeling indien dit nie behoorlik bestuur word nie.	Ontwikkel duidelike afvalprotokolle en bestuur stofbeheermaatreëls verantwoordelik.
	Die bedryf van die ontsoutingsaanleg in Sone 1 en Sone 3 kan mariene fauna benadeel via inlaatstelsels en pekelwaterafvoer, en termiese/chemiese besoedeling veroorsaak.	Spesialis-insette (mariene ekoloog) oor inname-/afvoerterreine; monitor afvoer en verminder termiese impakte.
	Die rioolinfrastruktuur in Sone 1 kan lei tot grondwaterbesoedeling, voedingstofbesoedeling en uitdagings met slykbestuur.	Vermy sensitiewe gebiede; gebruik robuuste behandelingstelsels en veilige slykbestuur. Positiewe impakte kan ontstaan as voedingstowwe herwin en as kunsmis gebruik word.
	Stormwaterinfrastruktuur in Sone 1 kan besoedeling versprei, indringerspesies inbring en grondwater beïnvloed.	Skei skoon/vuil water; installeer filters; monitor en bestuur afloop.
	Die installering van elektriese infrastruktuur in Sone 1 sal bydra tot die opruiming van plantegroei, konstruksie-uitlatings, die risiko van elektrokusie en habitatfragmentasie.	Vermy hoogsensitiewe gebiede; beplan roetes om impak te minimaliseer; voëlveilige infrastruktuur.
	Brandstofbergingsinfrastruktuur in Sone 1 en Sone 10 kan lei tot grond- en grondwaterbesoedeling, VOS-uitlatings en brand-/ontploffingsrisiko's.	Vermy sensitiewe ekosisteem, inperkingsinfrastruktuur; lugbewegingsmodellering (met inagneming van “Namib Lichen Fields”); brandrisikoprotokolle.
	Die konstruksie van paaie, brûe, pypleidings en kraglyne in Sone 1 kan habitatte	Vermy sensitiewe gebiede; fauna-onderpadde; erosiebeheer; bestuur van uitheemse

	Impak	Beginsels/aksies vir bestuur (verbetering en versagting)
	fragmenteer, die beweging van fauna beperk, die risiko van paddood verhoog en erosie en indringerspesies bevorder.	spesies.
	Verbreding van die R382 in Sone 1 kan addisionele plantegroeiverlies veroorsaak en besoedeling deur verkeer verhoog.	Beperk die ontwikkelingsvoetspoor; implementeer besoedelings- en erosiebeheer.
	Die vestiging van 'n bewaringsgebied in Sone 2 kan lei tot gedeeltelike beskerming van CR-ekosisteme en oorblywende intakte plantegroei, maar lugbesoedeling van die aangrensende ontwikkeling kan ligene in hierdie sone negatief beïnvloed. Die uitbreiding van die gebied oor die R382 sonder geskikte fauna-oorgang sal waarskynlik lei tot 'n toename in SCC-mortaliteit.	Verfyn grens om die hele Boegoeberg-Noord in te sluit; alle ontwikkeling om Sone 2 te vermy; monitor korsmosgesondheid; verbeter ekologiese verteenwoordiging (rehabilitasie).
	Die elektroliseerderfasiliteit in Sone 3 kan hoë water- en energievraag, chemiese besoedeling en ontploffingsrisiko's skep.	Vermy gebiede met baie hoë sensitiwiteit; optimaliseer hulpbrondoeltreffendheid; verseker chemiese veiligheid en lekopsporing.
	Die ammoniakfasiliteit in Sone 3 en oor Sones 7 tot 9 kan lei tot ammoniak-toksisiteit, lug-/grondbesoedeling en vlermuismortaliteit as gevolg van warm stoomontlading.	Monitor emissies; sluit vlermuisbeskerming in; vermy sensitiewe slaapplekke.
	Die gebruik van 'n brandwaterstelsel in Sone 3 kan soutgehalte verhoog wanneer seewater gebruik word en mariene besoedeling veroorsaak wanneer brandbestrydingsskuim gebruik word.	Gebruik omgewingsvriendelike stelsels; spesialisleiding oor gebruik en inperking.
	Die voorgestelde ontwikkeling (oor alle sones) kan habitat skep vir korvide wat swaar op klein, stadig bewegende skilpaaie vreet. Predasie kan lei tot bevolkingsafname in skilpaaie.	Ontmoedig nesstrukture; bestuur korwiedbevolkings aanpasbaar.
	Konstruksieaktiwiteite in alle sones kan fauna versteur, beserings-/sterfterisiko verhoog en loopgraafverwante sterftes veroorsaak.	Beperk raserige/verligte werk tot dagtyd; herstel loopgrawe onmiddellik.
	Grondwerke in alle sones kan slaapplekke vir voëls en vlermuise vernietig.	Vermy aktiewe slaapplekke; rehabiliteer gebiede na versteuring.
HERITAGE	**Palaeontologie**	
	Fossielmateriaal kan tydens grootskaalse grondwerke of uitgrawings ontdek word, of tydens die opvul van grond van mynhope oor alle sones.	Sluit 'n paleontoloog in die OIS-fase in om die behoefte aan 'n paleontologiese spesialisstudie te bepaal; pas standaard paleontologiese toevallige vondsprotokol toe.
	Konstruksie kan verhoogde strandafsettings blootstel en/of vernietig.	
	Terrestriële argeologie	
	Konstruksie kan MSA-verspreiding by Namakwakop in Sone 1 en MSA-terreine in ou seekranse wat deur windverwaaide sand langs die kus begrawe is (Sones 1, 2, 3, 5, 6, 7 en 8) blootstel en/of vernietig.	Onderneem gedetailleerde argeologiese veldopnames vir elke ontwikkeling of projek - argeoloë sal vereis word om terreine te identifiseer en te prioritiseer wat die mees verteenwoordigend is van elke ontwikkelingsvoetspoor vir monsterneming (dit kan die keuse van terreine van laer individuele betekenis insluit waar hulle betekenisvol bydra tot die begrip van die breër argeologiese konteks van die gebied); Voer deurlopende argeologiese monitering uit tydens grondwerke, veral in kusgebiede waar begrawe afvalhope teenwoordig kan wees.
	Vernietiging van LSA-afvalhope en ander besettingsrommel langs die kus (Sones 1, 3, 7, 8 en waarskynlik ander kussones), by die panne in Sones 3, 4, 6 en 7 en op binnelandse plekke by waterbronne (Sone 9).	
	Grafte	
	Bekende grafte by Boegoeberg-Suid kan deur die ontwikkeling beïnvloed word.	Vermy grafte en / of betrek plaaslike gemeenskappe en erfenisowerhede voor ontwikkeling om die moontlikheid vir herbegrawing van menslike oorskot te bepaal. Implementeer protokol vir toevallige vondste; staak werk onmiddellik en stel
	Toevallige ontdekking van ongemerkte of ongedokumenteerde grafte in alle	

	Impak	Beginsels/aksies vir bestuur (verbetering en versagting)
	sones tydens konstruksie.	erfenisowerhede in kennis indien grafte gevind word.
	Mariene erfenis	
	Konstruksie van hawe-infrastruktuur op see kan onderwaterskeepswrakke versteur.	'n Spesialisstudie oor maritieme erfenis sal ingesluit moet word in die erfenisaansoek vir die hawe-ontwikkeling, sowel as enige ander ontwikkelings wat byvoorbeeld onderwater pypleidings mag vereis.
	Moontlike versteuring van skeepswrakke tydens die installering van onderwaterinfrastruktuur (pyplyne/kabels) in sones langs die kus (Sone 3, 5, 6, 7 en 8).	
	Lewende erfenis	
	Ontwikkeling sal seisoenale weiding en veewagterbewegingspatrone ontwrig en toegang tot die gebied verbied, veral in Sones 2, 9 en 10.	Raak betrokke by die plaaslike veewagtergemeenskap om die impak van die verlies van winterweidingsgebiede, spesifiek Swartbank en Witbank, te verstaan. Konsultasies moet die redes vir die keuse van hierdie gebiede, hul seisoenale waarde, moontlike alternatiewe en die kulturele betekenis van die weidingslandskap ondersoek.
	Ontwikkeling van die Hawe en SES sal die landskapkonteks waarin kleinskaalse veeboerdery plaasvind, massief verander deur die byvoeging van industriële fasiliteite.	
	Die ontwikkeling van die hawe en SES kan die verband tussen die plaaslike gemeenskap en die kus verander.	Raadpleeg plaaslike gemeenskappe om maniere te vind wat hul band met die kus sal versterk, veral met betrekking tot tradisionele visvang-inkomste.
	Kulturele landskap	
	Die ontwikkeling van die hawe en SES sal die gevoel van plek van die streek onherroeplik verander deur die byvoeging van industriële fasiliteite; dit sal die landskapintegriteit beïnvloed en die kulturele landskapkontinuïteit verander.	Visuele Impakassesserings word vereis. Betrokkenheid met plaaslike gemeenskappe, SANParke, UNESCO, SAHRA (SA Erfenis Agentskap) en toerisme-operateurs is noodsaaklik. Besprekings moet ook met die Suid-Afrikaanse regering en UNESCO begin word oor moontlike gevolge vir die RKBLW se Wêrelderfenisstatus.
VISSERYE EN KUS LEWENSBESTANE	**Visserye en kus lewensbestane**	
	laaslike gemeenskappe, veral kleinskaalse vissers en Nama-groepe, voel uitgesluit van huidige bestuursprosesse, wat lei tot wantroue.	Vestig 'n kruissektorale, inklusiewe mariene bestuursplatform wat histories gemarginaliseerde en verborge belanghebbendes insluit.
	Vorige betrokkenheid van belanghebbendes het 'n gebrek aan deursigtigheid, inklusiwiteit en kulturele sensitiwiteit getoon, wat vertroue en deelname beperk.	Ontwikkel deursigtige, kultureel gepaste, deurlopende belanghebberbetrokkenheidsprosesse gebaseer op mede-skepping, gedeelde monitering en regsmeganismes vir klagtes.
	Gefragmenteerde omgewings- en sosiale impakstudies loop die risiko om kumulatiewe en langtermyn-impakte te onderskat.	Integreer kumulatiewe impakstudies en harmoniseer regulatoriese raamwerke deur interdepartementele koördinering en gedeelde datastelsels.
	Visvang- en kusgemeenskappe het nie toegang tot opleiding en tegniese vaardighede vir geleenthede in die mariene sektor nie.	Belê in gelokaliseerde vaardigheidsontwikkeling en regverdige oorgangsondersteuning, veral gemik op die jeug, vroue en informele werkers.
	Infrastruktuurontwikkeling hou die risiko van gentrifikasie en verplasing van kwesbare plaaslike inwoners in.	Beplan vir bekostigbare, klimaatsbestande behuising en verseker dat basiese dienste beskikbaar is om gemeenskapsverplasing te voorkom.
	Die afwesigheid van basislyndata en langtermynmonitering belemmer aanpasbare bestuur en leer.	Ontwikkel deelnemende moniterings-, evaluerings- en leerraamwerke vir ekologiese en sosio-ekonomiese aanwysers.
	Kleinskaalse vissers staar bedreigings vir hul lewensbestaan en kulturele erfenis in die gesig as gevolg van industriële indringing en sistemiese uitsluiting.	Prioritiseer billike voordeeldeling vir benadeelde groepe deur middel van inklusiewe verkrygings-, aanstellings- en opleidingsbeleide.
	Ruimtelike mededinging van mynbou, olie/gas en skeepvaart verplaas kleinskaalse vissers en bedreig ekosisteemvolhoubaarheid.	Gebruik ekosisteemgebaseerde Mariene Ruimtelike Beplanning om visserygebiede te beskerm en toegang vir kleinskaalse vissers te verseker.

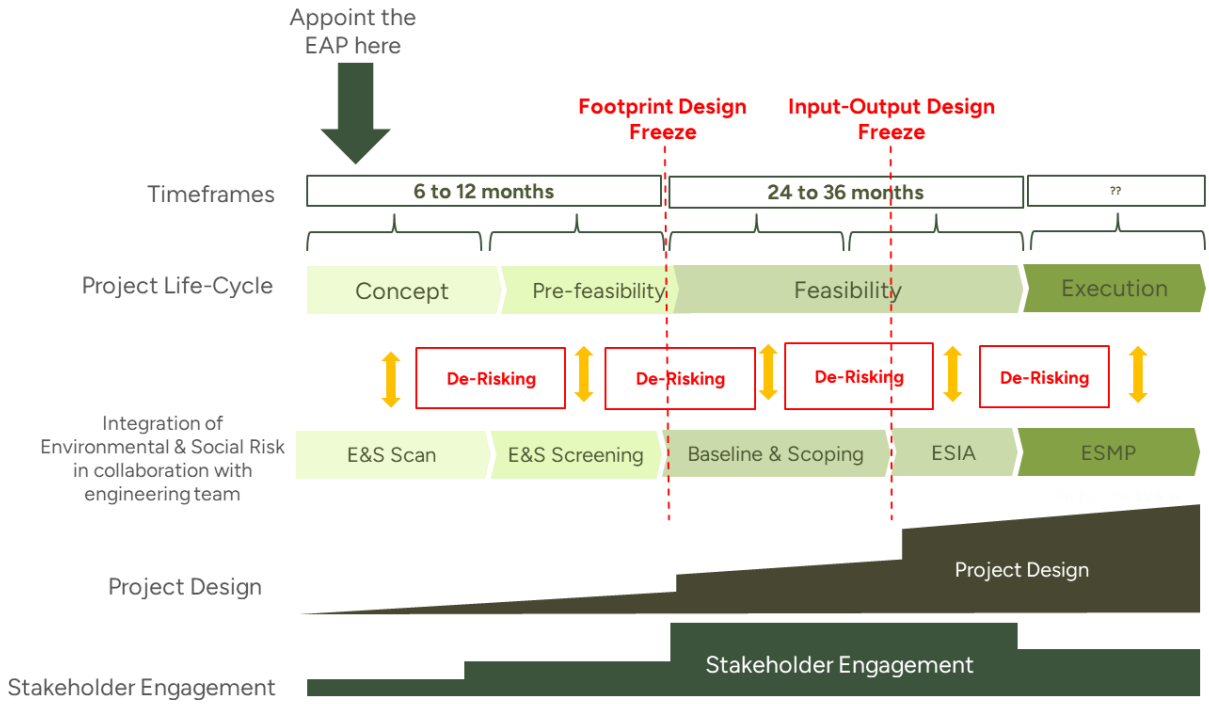
	Impak	Beginsels/aksies vir bestuur (verbetering en versagting)
	Die Boegoebaai-projek is 'n strategiese toetsgeval vir inklusiewe, volhoubare mariene ontwikkeling in Suid-Afrika.	Rig ontwikkeling in lyn met nasionale volhoubaarheidsdoelwitte deur Inheemse kennis, mede-bestuur en billike bestuur te integreer.

5. IMPLEMENTEER GOEIE OIS-PROSESSE EN VERLAAG PROJEKRISIKO

Ywerige, proaktiewe en beste-praktyk beplanning en implementering van robuuste OIS-prosesse is sleutelinstrumente vir die vermindering van risiko's in projekte.. "Managing the Impacts of a Green Hydrogen/Power-to-X Economy: An Environmental Assessment Guideline for South Africa" (Schreiner et al., 2024) bied uitgebreide leiding hieroor. Hierdie afdeling som hierdie aanbevelings op.

5.1 Aanstelling van die Omgewingsassesseringspraktisyn

Wanneer 'n voorsteller projekkonseptualisering in detail inisieer, in oorleg met ingenieurs, en 'n aanvanklike besluit neem om voort te gaan, is een van die eerste stappe om 'n toepaslik gekwalifiseerde, ervare en professioneel geregistreerde Omgewingsassesseringspraktisyn ("Environmental Assessment Practitioner" ("EAP"))[15] aan te stel. Ontwikkelaars moet 'n omgewings- en finansiële projekbestuurder (EAP) betrek om in die vroegste stadiums van projekbeplanning saam met die tegniese en finansiële spanne te werk. Dit sal die EAP in staat stel om 'n volle waardering vir die kompleksiteit en omvang van die projek te ontwikkel en om die risiko van die projek vanuit 'n omgewings- en sosiale perspektief te verminder**.** (Figuur OBM 9).



Figuur OBM 9: Die vroeë aanstelling van 'n Omgewingsassesseringspraktisyn en die integrasie van omgewings- en sosiale risiko's in die grootskaalse hawe- en GH_2-projekontwikkelingslewensiklus is van kritieke belang om projekte te derisiko. (Bron: SLR in Schreiner et al., 2024)

[15] "EAPs" moet proffesioneel gerigstreer wees by die Environmental Assessment Practitioner Association of South Africa (EAPASA), soos mandaat in terme van Hoofstuk Section 24H van die Nationale Omgewiongsbestuurswet ("NEMA").

5.2 Intergreer lener-oorwegings

Grootskaalse ontwikkelingsprojekte maak dikwels, geheel of gedeeltelik, staat op finansiering van derdepartybanke, leners en beleggers wat moontlik die "Equator"-beginsels en die Internasionale Finansieringskorporasie ("IFC") se Prestasiestandaarde onderskryf. (Tabel OBM 6). Om toegang tot sulke befondsing te kry, moet projekvoorstelle en OIS's in lyn gebring word met beide die plaaslike OIS-regulasies sowel as internasionale lenerstandaarde. Verskillende finansiële instellings het verskillende volhoubaarheidsvereistes, maar tipies sal die meeste banke of leners die Equator-beginsels en IFC-Prestasiestandaarde gebruik om omgewings- en sosiale risiko's vir hul belegging te identifiseer en te bestuur.

Tabel OBM 6: Opsomming van die Equator-beginsels en IFC-prestasiestandaarde wat nagekom moet word om befondsing van groot derdeparty-banke, leners en beleggers te ontsluit

Standaard	Doelwit
"Equator" Beginsels (2020)	Die "Equator" Beginsels estaan uit 'n stel beginsels en prosedures wat deur finansiële instellings aangeneem word om te verseker dat die omgewings- en sosiale kwessies wat verband hou met 'n projek wat deur daardie instellings gefinansier word, gerespekteer word. Die Ewenaarbeginsels word hieronder opgesom: • *Beginsel 1 – Hersiening en Kategorisering:* Die projekte word in drie kategorieë geklassifiseer volgens die moontlike omgewings- en sosiale risiko's wat hulle verteenwoordig. • *Beginsel 2 – Omgewings- en Sosiale Assessering*: Dit is nodig om 'n omgewingsevaluering van die projek uit te voer wat die risiko's aanspreek wat tydens die analise en kategorisering geïdentifiseer is. • *Beginsel 3 – Toepaslike Omgewings- en Maatskaplike Standaarde*: Die projekte wat in ontluikende lande geïmplementeer word, moet, benewens die nakoming van plaaslike wette, ook die IFC Prestasiestandaarde en die Wêreldbank se Omgewings-en Sosiale Beskermingsriglyne te volg. • *Beginsel 4 – Omgewings- en Maatskaplike Bestuurstelsel en Equator beginsels-aksieplan*: Die projekte moet 'n aksieplan hê om die risiko's wat tydens die omgewingsevaluering geïdentifiseer is, aan te spreek. • *Beginsel 5 – Betrokkenheid van Belanghebbendes*: Dit is nodig om konsultasies met die belanghebbendes op 'n kultureel gepaste en gestruktureerde wyse te bevorder en uit te voer. • *Beginsel 6 – Klagtemeganismes*: Dit is nodig om meganismes te vestig vir die voortgesette betrokkenheid van belanghebbende en geaffekteerde partye, om die indiening van klagtes of kwessies tydens alle fases van projekontwikkeling moontlik te maak. • *Beginsel 7 – Onafhanklike Hersiening*: Die omgewingsprestasie moet geouditeer word deur onafhanklike kundiges, met ervaring in die gebied wat deur die projek gedek word. • *Beginsel 8 – Ooreenkomste*: Die wette en regulasies, lisensiëring en aksieplanne moet in alle aspekte uitgevoer word. • *Beginsel 9: Onafhanklike Monitering en Verslagvoering*: Die projekte moet 'n onafhanklike omgewings- en sosiale kenner aanstel om die monitering uit te voer en bykomende verslae op te stel. • *Beginsel 10 – Verslagvoeting en Deursigtigheid:* Die finansiële instellings moet inligting oor die toegestaan lenings publiseer, ten minste jaarliks, in ooreenstemming met die reëls van die "Equator"-beginsels.

Standaard	Doelwit
IFC Prestasiestandaarde (2012)	Die IFC Prestasiestandaarde word op 'n projek toegepas om omgewings- en sosiale risiko's en -impakte dwarsdeur die lewensduur van 'n belegging te bestuur. Daar is agt prestasiestandaarde wat die volgende bepaal: • Die belangrikheid van 'n geïntegreerde benadering tot die identifisering van die omgewings- en sosiale impakte, risiko's en geleenthede van projekte; effektiewe gemeenskapsbetrokkenheid deur die openbaarmaking van projekverwante inligting en konsultasie met plaaslike gemeenskappe oor sake wat hulle direk raak; en effektiewe bestuur van omgewings- en sosiale prestasie dwarsdeur die lewensduur van die projek; en • Doelwitte en vereistes om risiko's en impakte vir werkers, geaffekteerde gemeenskappe en die omgewing te vermy, te minimaliseer, en waar oorblywende impakte voortduur, te vergoed/te verreken. • Prestasiestandaard 6 spesifiek vereis duidelike identifisering van biodiversiteitsrisiko's en toepaslike versagting, insluitend verrekening. • Prestasiestandaard 7 beklemtoon die beskerming van Inheemse Volke se regte wanneer projekte hul grond, hulpbronne of kulturele erfenis raak. Dit vereis dat maatskappye betekenisvolle, kultuursensitiewe gesprekke en onderhandelinge voer deurlopend 'n hele projek, sodat daar ingeligte deelname is, en nie net simboliese betrokkenheid nie. Waar die impak groot is, soos hervestiging of verlies van inkomste, word "Free, Prior, and Informed Consent (FPIC)" vereis, in lyn met grondwetlike beskerming en gebruiksregte onder Suid-Afrikaanse wetgewing. Hierdie benadering bou vertroue, verminder konflik en bevorder regverdige ontwikkeling deur respek vir identiteit, waardigheid en tradisionele bestuurstrukture in projekbeplanning en besluitneming in te sluit.

5.3 Voldoende oorweging van alternatiewe

Alternatiewe word gedefinieer as verskillende maniere om aan die algemene doel en vereistes van die aktiwiteit te voldoen (Tabel OBM 7). Alternatiewe wat hulpbrongebruiksdoeltreffendheid maksimeer (bv. grond-, energie- en watergebruiksdoeltreffendheid) en afvalproduksie tot die minimum beperk, moet deur die "EAP" gesoek word. Alhoewel alternatiewe so vroeg as moontlik in die proses oorweeg moet word, kan die noodsaaklikheid om wysigings en veranderinge te oorweeg om impakte wat tydens die assesseringsproses geïdentifiseer word, te voorkom en/of te verminder, ook ontstaan.

Tabel OBM 7: Tipes alternatiewe wat oorweeg moet word tydens grootskaalse hawe- en GH_2-ontwikkelingsprojekte, gebasseer op DEA&DP (2013)

Tipe alternatiewe	Verduideliking
Ligging	Verwys na beide alternatiewe eiendomme op streeks- of nasionale skaal, sowel as alternatiewe terreine op dieselfde eiendom.
Aktiwiteit	Waar dit moontlik is om 'n aktiwiteit te onderneem wat dieselfde projekuitkoms het, maar met minder ekologiese en sosiale koste gepaardgaan
Ontwerp of Uitleg	Verskillende argitektoniese style, ingenieursontwerpe en tegnologieë, of oorweging van verskillende ruimtelike konfigurasies op 'n spesifieke terrein (bv. die plasing van sonkrag-PV weg van vleilande).
Invoer	Insetalternatiewe is van toepassing op toepassings wat energiebronne in hul proses kan gebruik (bv. PtX-projekte wat wind- teenoor sonkrag-PV-insette oorweeg).
Roetering	Oorweging van alternatiewe roetes is oor die algemeen van toepassing op lineêre ontwikkelings soos kraglyn-serwitute, vervoer en pyplynroetes.
Skeduling en tydsberekening	Waar verskeie maatreëls 'n rol in 'n algehele program kan speel, maar die volgorde waarin hulle geskeduleer is, kan bydra tot die algehele doeltreffendheid van die eindresultaat.
Skaal en omvang	Aktiwiteite wat in kleiner eenhede afgebreek kan word en op verskillende skale onderneem kan word (bv. die groottebepaling van sonkrag-PV-fasiliteite).
Die "geen	OIS's moet die "geen ontwikkeling "-opsie as 'n basislyn insluit waarteen alle ander alternatiewe

ontwikkeling" opsie	gemeet moet word. Die opsie om die aktiwiteit nie te implementeer nie, moet altyd beoordeel word en tot dieselfde vlak van detail as die ander haalbare en redelike alternatiewe.

5.4 Identifisering van gereguleerde aktiwiteite en spesialisstudies vir toekomstige OIS-prosesse

Die Suid-Afrikaanse OIS-regulasies (soos gewysig in 2014) is uitgevaardig ingevolge Hoofstuk 5 van die Nasionale Omgweingsbestuur Wet ("National Environmental Management Act" ("NEMA")). Hul doel is om die voorbereiding, evaluering, indiening, verwerking, oorweging van en besluitneming oor aansoeke vir Omgewingsgoedkeuring ("Environmental Authorisation" ("EA")) vir die aanvang van aktiwiteite, onderworpe aan omgewingsassessering, te reguleer, om nadelige impakte op die omgewing te vermy en impakte tot 'n aanvaarbare vlak te verminder wanneer vermyding nie moontlik is nie, en om positiewe omgewingsimpakte te versterk.

Blok OBM 29: Ander permitte en goedkeurings benodig.

Benewens EA sal verskeie ander permitte en goedkeurings vereis word vir infrastruktuurontwikkeling, afhangende van die projekbeskrywing en ontvangsomgewing, insluitend, maar nie beperk tot:

- Erfenisgoedkeuring
- Atmosferiese Emissielisensie
- Kusafvoerpermit
- Gebruik van voertuie in 'n kusgebied
- Afvallisensie
- Watergebruiklisensie
- Goedkeuring om grondoppervlak te gebruik op 'n manier wat die Wet op die Ontwikkeling van Minerale en Petroleumhulpbronne kan weerspreek

Die belangrikste gereguleerde aktiwiteite ("Listed Activities") wat die behoefte aan omgewingsontwikkeling ("Environmental Authorisation" ("EA")) veroorsaak, wat waarskynlik van toepassing is op hawe- en PtX-projekte, word uiteengesit in Tabel OBM 8. Ander geïdentifiseerde aktiwiteite kan relevant wees, afhangende van die projekontwerp en -spesifikasies.

Verskeie spesialisstudies sal as insetstudies vereis word om besluite oor sekere magtigings, permitte en goedkeuringsaansoeke in te lig. Elke spesialisstudie moet 'n opgedateerde oorsig van die nuutste literatuur en wetgewing insluit wat verband hou met die spesifieke tema wat dit assesseer. Impakte moet beoordeel word volgens die projekfases, d.w.s. konstruksie, bedryf en ontmanteling, en in terme van hul aard, omvang, duur, gevolg, waarskynlikheid van voorkoms, onvervangbaarheid, omkeerbaarheid, potensiaal vir versagting, kumulatiewe effekte en algehele betekenis. Duidelike Opdragte vir konsep spesialisstudies moet ingesluit word, veral waar dit dui op geskiktheid vir deelname aan enige gevestigde proaktiewe verrekeningskema, en die vereiste toestemmings en intervensies om verrekeningsuitkomste te verseker – bo 'n vae verklaring van biodiversiteitsverliese en -winste.

Die "EAP", in konsultasie met belanghebbendes en met behulp van die "National Environmental Web-based Screening Tool sal die mees geskikte spesialisstudies vir die projek bepaal, afhangende van die beskrywing en omvang van die voorgestelde projek, en die toestand van die ontvangende omgewings. Die volgende spesialisstudies mag nodig wees vir grootskaalse hawe- en GH_2-ontwikkelingsprojekte:

1. Mariene Ekologie-assessering
2. Visserye-assessering
3. Terrestriële Biodiversiteitsassessering
4. Terrestriële Plantspesiesassessering
5. Terrestriële Dierspesiesassessering
6. Akwatiese Biodiversiteitsassessering
7. Dispersiemodelleringstudie
8. Sedimentbewegingstudie
9. Voëlassessering (+voorkonstruksiemonitering)
10. Vlermuisessering
12. Landbou- en Grondassessering
13. Argeologiese en Kulturele Erfenis
14. Paleontologie-assessering
15. Sosio-ekonomiese assessering
16. Geraasassessering
17. Visuele en Landskapassessering
18. Hidrologie-assessering
19. Burgerlike Lugvaartassessering
20. Verdedigingsassessering
21. Verkeersstudie
22. Groot Gevaarlike Installasie

(+voorkonstruksiemonitering)
11. Ongewerwelde Diere-assessering

Risikoassessering
23. Radiofrekwensie-interferensieassessering

Tabel OBM 8: Moontlike gereguleerde aktiwiteit "Listed Activities" (nie-volledig) wat moontlik van toepassing is vir hawe- en GH_2-verwante projekte in die voorgestelde Boegoebaai SES, per tegnologietipe, oor "Listing Notices" 1, 2 en 3[16].

Tegnologie / ontwikkeling tipe	Listing Notice 1	Listing Notice 2	Listing Notice 3[17]
Hawe ontwikkeling	Activity 14; Activity 16; Activity 18; Activity 19A; Activity 23[18]	Activity 4; Activity 12; Activity 14; Activity 15[19]; Activity 23[20]; Activity 26	Activity 2 (g); Activity 3(g); Activity 12(g); Activity 14(g)
Seewater onstouting	Activity 9; Activity 12; Activity 16; Activity 17 (i) (e); Activity 19A; Activity 25	Activity 6; Activity 15; Activity 26	Activity 12(g); Activity 14(g)
Waterstof via elektrolise	Activity 16; Activity 24(ii); Activity 25; Activity 27; Activity 28(ii)	Activity 4; Activity 7 (ii); Activity 15	Activity 12(g)
Ammoniak via Haber-Bosch	Activity 16; Activity 24(ii); Activity 25; Activity 27; Activity 28(ii)	Activity 4; Activity 6; Activity 7 (ii); Activity 15	Activity 12(g)
Lineêre infrastruktuur (paaie, pyplyne, kraglyne)	Activity 9(i); Activity 10(i); Activity 11(i); Activity 24(ii); Activity 27; Activity 56(i)(ii)	Activity 9	Activity 4(g); Activity 18(g)
Windplase (op land) (waarskynlik in die breër streek ontwikkel, nie beperk tot die SES nie)	Activity 12; Activity 14; Activity 19; Activity 24; Activity 56	Activity 1; Activity 15	Activity 12(g)
Sonkrag (waarskynlik in die breër streek ontwikkel, nie beperk tot die SES nie)	Activity 12; Activity 14; Activity 19; Activity 24; Activity 56	Activity 1; Activity 15	Activity 12(g)

6. GEVOLGTREKKING EN SLOTOPMERKINGS

Die studiegebied in Werkpakket 1 bevat ongeveer 5 000 ha grond wat deur menslike aktiwiteite erg beskadig of verander is — die oorblywende letsels van 'n eeu se diamantmynbou. In plaas daarvan om verder in sensitiewe ekologiese en sosiale gebiede in te dring, moet die idee van 'herwinning' ("regeneration") gebruik word om alle voorgestelde of toekomstige ontwikkeling in die streek te lei.

[16] Die uiteengesitte gelyste aktiwiteite weerspieël nie die volledige lys van aktiwiteite wat van toepassing sou wees op 'n spesifieke GH2/PtX-projek nie. Die volledige lys van toepaslike aktiwiteite moet van geval tot geval deur die "EAP" geïdentifiseer word.

[17] Die toepaslike Lyskennisgewing 3-aktiwiteite sal van geval tot geval geïdentifiseer word, afhangende van potensiële snellers met betrekking tot die drempels of geografiese beperkings wat verband hou met die Noordkaap Provinsie wat in die lyskennisgewing uiteengesit word.

[18] Ingeval 'n afvalwaterbehandelingsaanleg gebou word en sodanige werke 'n daaglikse deursetkapasiteit van meer as 2 000 m^3 maar minder as 15 000 m^3 het.

[19] Ingeval die Voorgestelde Ontwikkeling op 'n grondgebied van 20 ha of meer sal plaasvind waar sodanige grond nie deur mynbou of enige ander aktiwiteit versteur is nie.

[20] Hierdie Gelyste Aktiwiteit kan van toepassing wees, onderhewig aan die gekose heimeganisme, d.w.s. 'n heistruktuur oor 'n swaartekragstruktuur vir die konstruksie van 'n kaai.

Herwinning, in hierdie konteks, beteken dat reeds beskadigde gebiede geprioritiseer word vir enige nuwe hawe- of SES-infrastruktuur. Deur versteurde grond te teiken, kan nuwe infrastruktuur onomkeerbare verlies van biodiversiteit voorkom, druk op kritiek bedreigde plantegroei verminder en ontwikkeling weg van belangrike kulturele erfenisgebiede verskuif.

'n Herwinningstrategie vereis sterk ingryping om die krisis van beweeglike sand te stop en reg te stel, wat die OBM as 'n ekologiese bedreiging en 'n praktiese ingenieursrisiko identifiseer. Dekades van mynbou het duine langs die R382 en kus onstabiel gelaat en los sand blootgestel wat nou onvoorspelbaar beweeg, plantegroei versmoor, skaars duinhabitat vernietig en ekologiese korridors begrawe. Sonder doelgerigte stabilisering sal sandpluime aanhou uitbrei en beide die natuur en toekomstige infrastruktuur bedreig. Herstel vereis dat sandbeheer, duinherstel, herbeplanting met inheemse plante en beskermende buffers deel van die ontwerp en fases van die hawe, SES en vervoerroetes moet wees. In plaas daarvan om sand as 'n probleem te sien, beskou herwinningsbeplanning duinherstel as 'n belangrike langtermyn belegging om landskapweerstand te herstel.

Die idee van herwinning sien ontwikkeling by Boegoebaai as 'n kans om ekologiese en sosiale stelsels tesame te herstel. Deur ongerepte of onvervangbare habitatte te vermy, beskadigde mynbougebiede te prioritiseer en sandstabilisering en ekologiese herstel vroeg in beplanning in te sluit, kan die voorgestelde infrastruktuur help om jarelange skade om te keer. Saam met regverdige bestuur en besluitneming — insluitend "FPIC"-gesprekke met plaaslike gemeenskappe, insluitend Nama-veeboere en kusgemeenskappe — plaas 'n herwinningsraamwerk die hawe en SES as katalis om ekologiese funksie te herstel, kulturele erfenis te beskerm en langtermyn stabiliteit in 'n landskap, tans onder groot druk, te vestig.

Box SPM 30: Die beginsels wat herwinning lei

Herwinning is 'n volhoubaarheidsbenadering wat nie net skade wil verminder nie, maar aktief ekologiese en sosiale stelsels wil herstel, vernuut en verbeter. Dit sien landskappe en gemeenskappe as lewende stelsels wat met ondersteuning kan herstel. Die hoofbeginsels sluit in: regstelling van vorige skade, veral in beskadigde of uitgeputte gebiede; werk saam met natuurlike prosesse soos duindinamika en herstel van inheemse plantegroei; beskerming van onvervangbare ekologiese en kulturele hulpbronne deur sensitiviewe sisteme streng te vermy; versterking van gemeenskapswelstand en deelname; en ontwerp van infrastruktuur wat meer herbou as wat dit verbruik, om langtermyn veerkragtigheid vir mense en ekosisteme te verseker.

Aan die ander kant is dit belangrik om te beklemtoon dat swak geplaasde of swak ontwerpte infrastruktuur nie net herwinningsdoelwitte sal misluk nie — dit sal bestaande probleme vererger, moontlik op groot skaal. Foute in ligging van infrastruktuur, sowel as swak bou en bestuur, kan die ineenstorting van sensitiewe stelsels versnel, die sandkrisis vererger en lei tot groot en onomkeerbare verlies van sosiale en ekologiese hulpbronne in die streek.

7. BRONNELYS

Atkinson, D., Gerber, H., Saayman, A., Borchardt, S. and Kirsten, S. (2025) Macro-economic, social and institutional impacts of the Boegoebaai Port and Green Hydrogen complex. Report to CSIR.

Botha, M. (2025) *Chapter 4: Biodiversity offset framework* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Clark, B.M., Ho, Y., Gammon, E., Biccard, A., Rees, A, Ulrich, A. & Wright, A.G. (2025) *Chapter 2: Marine Ecology* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

DEA&DP (2013) EIA Guideline and Information Document Series. Cape Town. Available at: https://www.westerncape.gov.za/eadp/sites/eadp.westerncape.gov.za/files/atoms/files/DEA%26DP_EIA_Guidelines_March2013.pdf.

Department of Trade, Industry and Competition (the DTIC) (n.d.) Special Economic Zones. Available at: https://www.thedtic.gov.za/sectors-and-services-2/industrial-development/special-economic-zones/

DFFE (2023) Draft Marine Biodiversity Sector Plan. South Africa.

DFFE (2023) The National Biodiversity Offset Guideline. G. 48841. GoN. Available at: https://www.dffe.gov.za/sites/default/files/legislation/2023-09/nema_nationalbiodiversityoffsetguideline_g48841gon3569.pdf

DTIC (2017a) Special Economic Zones Act: Saldanha Bay Industrial Development Zone: Amendment. G. 40883. GoN 504. Available at : https://www.gov.za/documents/special-economic-zones-act-saldanha-bay-industrial-development-zone-amendment-2-jun-2017

DTIC (2017b) Special Economic Zones Act: Coega Industrial Development Zone: Amendment. G. 40883. GoN 505. Available at: https://www.gov.za/documents/special-economic-zones-act-coega-industrial-development-zone-amendment-2-jun-2017-0000

FAO (Food and Agriculture Organization of the United Nations) (2009) Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing: https://faolex.fao.org/treaty/docs/tre000003E.pdf

Gammage, L. C., Zeeman Z., Mpala, A., Norton M. & Ortega-Cisnero, K. (2025) *Chapter 6: Fisheries and coastal livelihoods* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Guo X & Liu L. (2018) Approach to the Construction of Green Port in Tianjin Port. MATEC Web Conf. 175 04012. https://doi.org/10.1051/matecconf/2018175

Orton, J., Webley, L., Pether., J. & Maitland, V. (2025). *Chapter 5: Heritage resources* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Presidential Climate Commission (2022) Just Transition Framework. Republic of South Africa: https://pccommissionflo.imgix.net/uploads/images/22_PAPER_Framework-for-a-Just-Transition_revised_242.pdf

Schreiner, G., Mqokeli, B., Snyman-van der Walt, L., Lochner, P., Louw, H., Modise, S., Ruthenavelu, M., Zukulu, T. & Maluleke, J. (2025) Strategic Environmental Assessment for the proposed Boegoebaai Port, SES and Namakwa Region: Briefing note for research partners. CSIR: Pretoria.

Schreiner, G., Snyman-van der Walt, L., Heather-Clark, S., Van den Berg, S., Strong, A., Claasen, L., Russo, V., Mqokeli, B., & De Wet, B. (2024) Managing the Impacts of a Green Hydrogen/Power-to-X Economy: An Environmental Assessment Guideline for South Africa. CSIR: Stellenbosch. CSIR/SPLA/SECO/IR/2024/0005/B. Available at: https://greenhydrogensummit.org.za/resources/

Taljaard, S. & Weerts, S. (2025) *Chapter 7: Sustainable port planning* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Van Rooyen, G., Van Rooyen, N., Van Wyk, P., Day., L., Froneman, A., Colyn, R., Oosthuizen, M., Loftie-Eaton, M., Marais., W. & Niemandt, C. (2025). *Chapter 3: Terrestrial and aquatic ecology* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Werkpakket 1:

Strategiese Omgewings Assessering vir die voorgestelde Boegoebaai hawe en Spesiale Ekonomiese Sone

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December 2025

SUMMARY FOR POLICYMAKERS



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Published by:	CSIR Meiring Naudé Road Brummeria Pretoria, 0184 www.csir.co.za *Project website:* Boegoebaai Port | CSIR
Funded by:	South African National Energy Development Institute (SANEDI), in partnership with Transnet National Ports Authority (TNPA) and the Northern Cape Economic Development, Trade and Investment Promotion Agency (NCEDA)
Date of publication:	December 2025
ISBN:	978-0-7988-5675-1
CSIR publication number:	CSIR/SPLS/Ems/EXP/2025/1107/A
Recommended citation:	Schreiner, G., Mqokeli, B., Snyman-Van der Walt, L., Tsedu, R., Pulfrich, A., Clark, B., Ho, Y.-T., Gammon, E., Biccard, A., Rees, A., Wright, A., Taljaard, S., Weerts, S., Gammage, L., Zeeman-du Toit, Z., Mpala, A., Norton, M., Ortega-Cisnero, K., Ward, C., van Rooyen, G., van Rooyen, N., van Wyk, P., Day, L., Niemandt, C., Froneman, A., Colyn, R., Oosthuizen, M., Loftie-Eaton, M., Marais, W., Botha, M., Orton, J., Maitland, V., Webley, L., & Pether, J. (2025). ***Summary for Policymakers*** in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L., Lochner, P & Tsedu, R. (eds.). (2025). ***Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone***. CSIR/SPLS/Ems/EXP/2025/1107/A. ISBN:978-0-7988-5675-1
Front cover photographs:	Paul Lochner and Luanita Snyman-van der Walt

Publishing managed by Magdel van der Merwe (DTP Solutions)

Summary for Policymakers (SPM) © 2025 by CSIR

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List of acronyms and abbreviations

CBA	Critical Biodiversity Area
CR	Critically Endangered
CSIR	Council for Scientific and Industrial Research
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMF	Environmental Management Framework
EMPr	Environmental Management Programme
ESA	Ecological Support Area
FPIC	Free, Prior and Informed Consent
GH_2	Green Hydrogen
Ha	Hectares
IFC	International Finance Corporation
KBA	Key Biodiversity Area
NBA	National Biodiversity Assessment
NCEDA	Northern Cape Economic Development, Trade and Investment Promotion Agency
NHRA	National Heritage Resources Act
NPAES	National Protected Area Expansion Strategy
PA	Protected Area
RCPA	Richtersveld Communal Property Association
SANBI	South African National Biodiversity Institute
SANEDI	South African National Energy Development Institute
SCC	Species of Conservation Concern
SDF	Spatial Development Framework
SEA	Strategic Environmental Assessment
SEZ	Special Economic Zone
SPM	Summary for Policymakers
TNPA	Transnet National Ports Authority
PtX	Power-to-X

1. THE ORIGIN, SCOPE, PURPOSE AND METHODS OF THIS ASSESSMENT

Green hydrogen (GH_2), and its derivative Power-to-X (PtX) products, such as green ammonia and green methanol, could decarbonise the South African energy economy, generate new revenues, create jobs and skills, and facilitate a Just Energy Transition[1].

As part of South Africa's ambition to reduce its reliance on fossil fuels and become a player in the emerging GH_2 market, a substantial programme of greenfield infrastructure and development has been proposed in the Northern Cape consisting of three main components:

1. A new breakwater port[2] and port precinct 1 km north-west of the landmark called the Buchu or Boegoeberg Twins (hereinafter referred to as "Boegoebaai").
2. A mixed-use Special Economic Zone[3] (SEZ) located adjacent to the proposed Boegoebaai port.
3. A network of regional renewable energy generation facilities (wind and solar PV), electrical grid infrastructure, roads, pipelines and other GH_2 support infrastructure.

Box SPM 1: What is Green Hydrogen (GH_2) and Power-to-X (PtX) products?

GH_2 is a form of hydrogen fuel produced by splitting water into hydrogen and oxygen using renewable energy sources like solar or wind power. Unlike grey or blue hydrogen, it generates no greenhouse gas emissions during production. PtX is a broader concept that encompasses various technologies and processes (including GH_2) to convert electrical power, from renewable sources, into different forms of energy carriers, chemicals, or materials. This conversion enables the storage, transportation and use of hydrogen (Power-to-Hydrogen), synthetic fuels (Power-to-Liquid), and even chemicals (Power-to- Chemicals), broadening the scope of renewable energy applications, particularly crucial for industries and sectors where green electrification is challenging, such as heavy- duty transport, maritime shipping, and aviation ('hard-to- abate' sectors).

There are many different philosophical positions on what it means for something to be "green". "Green", as it is applied in the context of hydrogen production, is predominantly used in the narrow, reductionist sense, where the sole metric of greenhouse gas emissions is considered, meaning that a product is "green" when its upstream production inputs have been supplied exclusively by renewable energy with minimal, or no carbon emissions. The concept of "green" hydrogen thus excludes broader ecological and social aspects such as, for example, biodiversity conservation and equitable social beneficiation, making it a relatively weak concept from a sustainability perspective. In other words, "green" hydrogen is not necessarily "sustainable" hydrogen. For something to be "green", does not make it intrinsically good, sustainable or socially desirable, although obviously is can be good, sustainable and socially desirable, depending on the context, and how well projects are designed, constructed and operated.

[1] The Just Energy Transition is a South African policy framework for managing the shift from a high-carbon to a low-carbon, economy in a manner that advances socially equality and inclusivity (Presidential Climate Commission Report, 2022).
[2] A breakwater port is a type of harbor protected by an artificial offshore structure built to shield the port from the force of waves, currents, and storm surges
[3] Special Economic Zones (SEZs) are "geographically designated areas of a country set aside for specifically targeted economic activities, supported through special arrangements (that may include laws) and systems that are often different from those that apply in the rest of the country" (the DTIC, 2017).

A new greenfield port development and SEZ, plus the regional supporting GH_2 infrastructure, at the scales envisaged, will have many direct and indirect impacts on social and ecological receiving environments, both positive and negative. For this reason, a Strategic Environmental Assessment[4] (SEA) was initiated through a collaboration between the South African National Energy Development Institute (SANEDI), the Northern Cape Economic Development, Trade and Investment Promotion Agency (NCEDA), and Transnet National Ports Authority (TNPA). Given their experience in SEA[5], renewable energy, port and GH_2 planning, the Council for Scientific and Industrial Research (CSIR) were asked to play a coordinating role.

Box SPM 2: What is a Summary for Policymakers (SPM)?

A Summary for Policymakers (SPM) is a concise synthesis of the key findings which emerge from large, sophisticated science-policy processes – Strategic Environmental Assessment (SEA) being one example. SPMs are used to communicate and disseminate the current state of knowledge, based on the best available evidence, in an accessible style and language. While the primary target audience of an SPM is policymakers – in view of guiding evidence-informed decision-making – SPM contents are made widely available to all interested stakeholders, from the private sector to civil society. In this way, SPMs provide a platform for credible, publicly available evidence synthesis, helping to guide decision-making while making it more transparent and publicly accountable.

The purpose of the SEA is to guide strategic planning for proposed infrastructure development in and around Boegoebaai, as well as the broader Namakwa region of the Northern Cape. Readers must be reminded that SEA is not a decision-making process, in the same way that, for example, an Environmental Impact Assessment (EIA) is. The purpose of the SEA is to, in a transparent way, guide downstream planning and decision-making processes that may, or may not, occur over many years, if not several decades into the future. Integrating a variety of best practice science-policy processes, SEA should provide an evidence-based, cross-disciplinary perspective on the main opportunities and constraints associated with the proposed port and SEZ, within the broader context of large-scale, regional GH_2 development. Given the multiscale scope of the SEA, its processes and outputs were split between two Work Packages (Schreiner et al., 2025). Please note that only the findings from Work Package 1 are reported in this SPM (Box SPM 2) publication. Another SEA report and SPM will be developed for Work Package 2, and made publicly available to all stakeholders, in early 2026.

[4] A Strategic Environmental Assessment (SEA) is a systematic process used to evaluate the social and ecological consequences of proposed policies, plans, or programmes before they are adopted and implemented. It is a broader and more high-level science-policy process than an Environmental Impact Assessment (EIA), which is done for individual projects on a case-by-case basis. SEA is often used to inform and guide local scale planning and decision-making processes.

[5] CSIR is South Africa's leading national science and technology research organisation. It conducts cutting-edge research, development, and innovation to support the country's industrial development, environmental sustainability, and socio-economic progress. CSIR has played a foundational role in bringing SEA to South Africa since the mid-1990s and since then has been globally recognised for its leading contributions to SEA theory and practice.

1.1 Work Package 1

Work Package 1 focused on developing a local-scale SEA report concerned with assessing the social and ecological sensitivities of the receiving environment (Table SPM 1), at relatively high resolution (often including fieldwork), around the proposed port and SEZ development, covering a spatial scale of approximately 33 500 hectares (ha). This was undertaken with the intention of guiding local-scale feasibility studies (especially for the proposed port) and future decision-making processes, like EIAs and other planning exercises. The spatial focus of Work Package 1, within the broader regional context, including competing land use trends, is provided in Figure SPM 1.

Box SPM 3: The contents of Work Package 1

Work Package 1 consists of seven chapters drafted by thirty-five authors, peer reviewed by eight independent peer reviewers, and includes contributions from various stakeholders involved in the process via a formally constituted Working Group.

The Work Package 1 chapters are as follows:

1. Introduction and context setting (Schreiner et al., 2025)
2. Marine ecology (Clark et al., 2025)
3. Terrestrial and inland aquatic ecology (van Rooyen et al., 2025)
4. Biodiversity offset framework (Botha, 2025)
5. Heritage (Orton et al., 2025)
6. Fisheries and coastal livelihoods (Gammage et al., 2025)
7. Sustainable port planning (Taljaard & Weerts, 2025)

Table SPM 1: Calibration of sensitivity categories for ecological receiving environments across the Work Package 1 study area

Category	Description
VERY HIGH	Highly vulnerable to disturbance with little/no capacity for recovery. Includes endangered species, critical habitats, heritage/social resources, or ecosystems with very narrow tolerances for change.
HIGH	Sensitive to ecological and social change but with better recovery potential. Lower concentrations of endangered species, critical habitats, heritage resources, or ecosystems with some tolerance for change.
MODERATE	Some resilience to stress or change. Systems can absorb moderate impacts without long-term harm, or irreversible loss. Includes adaptable species, less valuable social/cultural resources and moderately sensitive habitats.
LOW	Likely already severely degraded by past disturbance, or higher adaptive resilience and low vulnerability. Includes widespread social resources, ecosystems or species with broad ecological niches and high regenerative capacity.
TRANSFORMED VEGETATION	Plant communities that have been adversely altered from its expected original state by past human activities and environmental change.
EXISTING ANTROPOGENIC DISTURBANCE	Areas where human-built features (e.g. buildings, infrastructure, tracks and roads) and physical disturbance (e.g. mined areas, tailing heaps, stock posts) currently exists or are visible in the landscape.

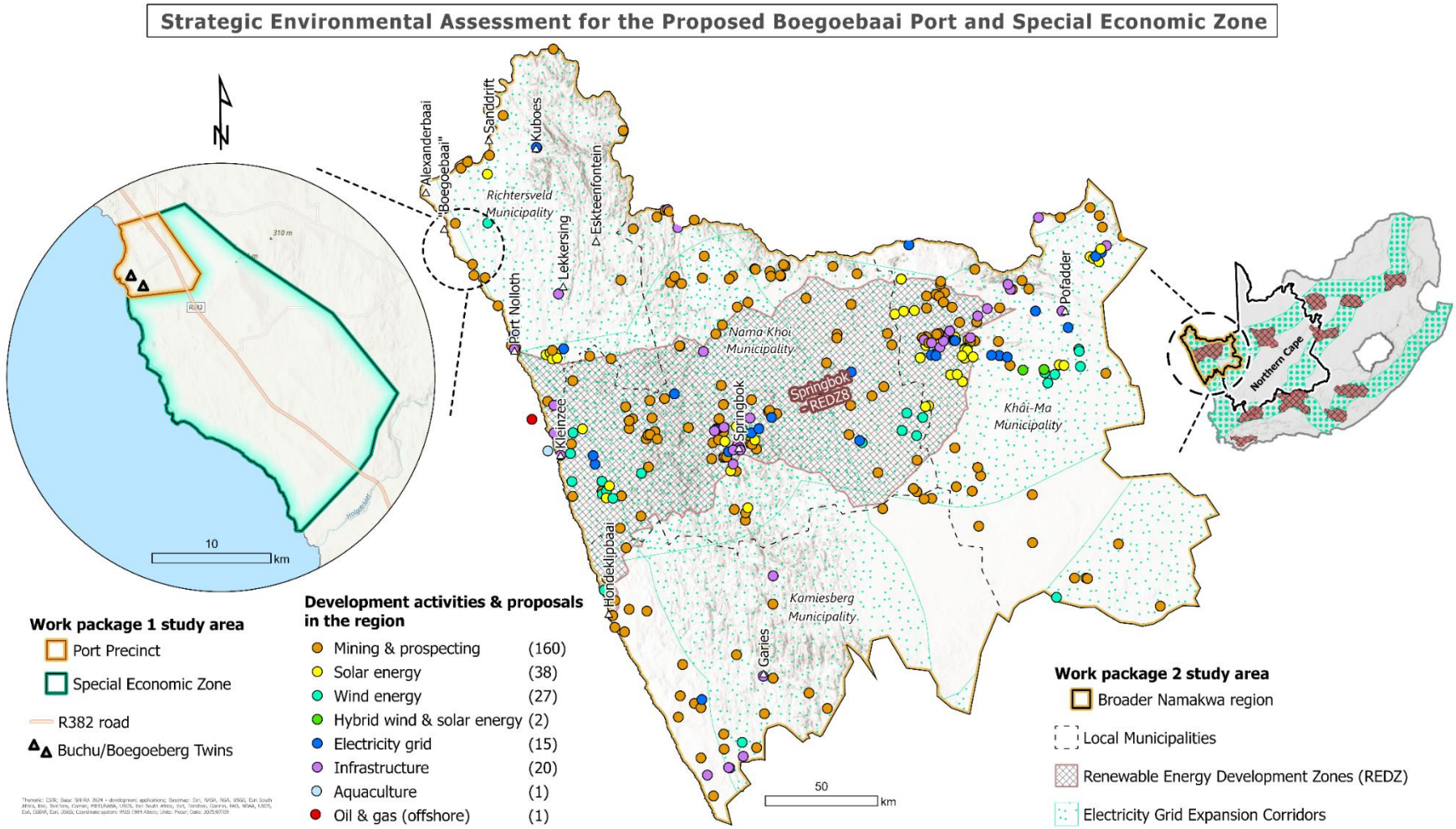


Figure SPM 1: The proposed Boegoebaai port and SEZ (Work Package 1 study area) are located in the Richtersveld Local Municipality, Namakwa District, of the Northern Cape Province. Economic activities include widespread mining and prospecting. Between Port Nolloth and Alexander Bay, including the land to the west of the R382 where to port and SEZ are proposed, has been mined for diamonds for over a century. A renewable energy sector is also emerging with established Renewable Energy Development Zones (REDZ) and Electricity Grid Infrastructure (EGI) Corridors.

Within the 33 500 ha port and SEZ area (inclusive of a proposed conservancy area adjacent to the port precinct), ten development zones have been proposed by policymakers, allocated as follows Figure SPM 2):

- **Zone 1:** Port Precinct - 2 187 ha
- **Zone 2:** Conservancy area – 1 170 ha
- **Zone 3:** Confirmed green ammonia facility – 4 508 ha
- **Zone 4:** SEZ Phase 1 – 499 ha
- **Zone 5:** SEZ Phase 2 – 411 ha
- **Zone 6:** SEZ Phase 3 – 833 ha
- **Zone 7:** Future green hydrogen facility – 3 713 ha
- **Zone 8:** Future expansion 01 – 3 408 ha
- **Zone 9:** Future expansion 02 – 15 067 ha
- **Zone 10:** Future tank farm – 1 704 ha

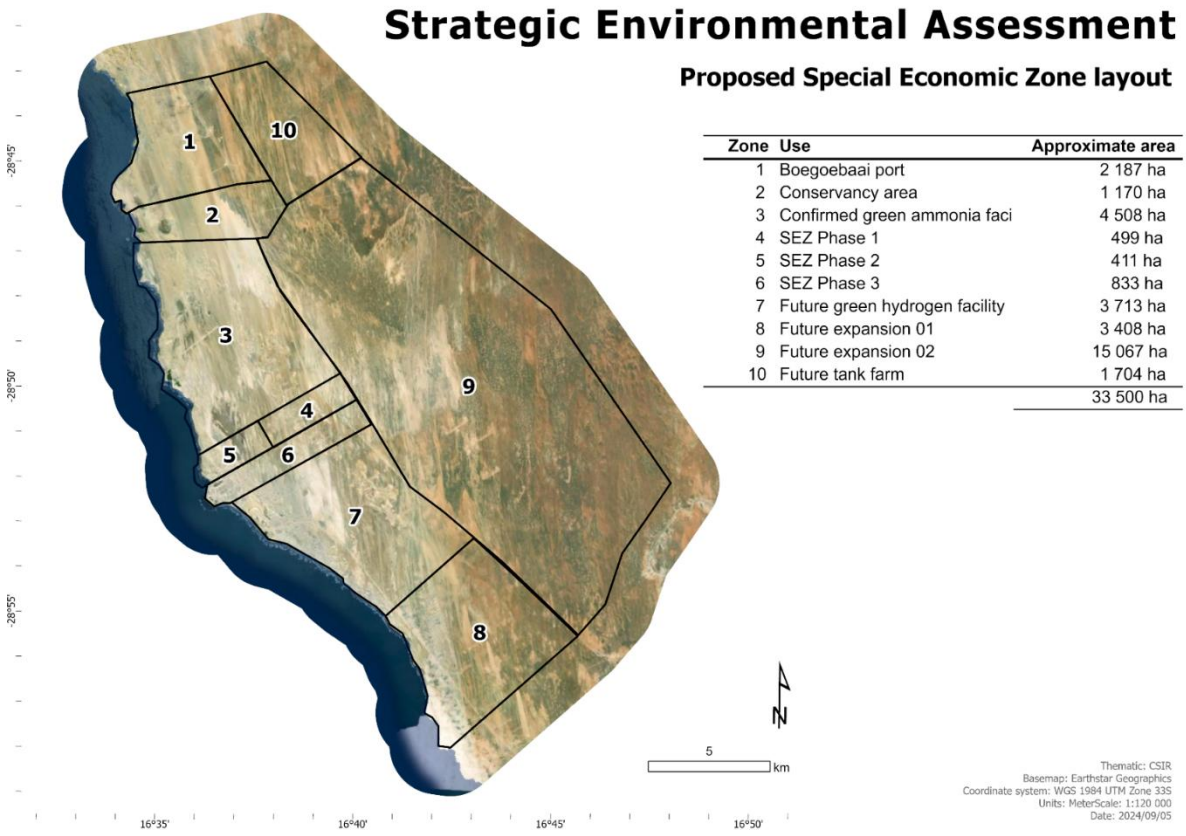


Figure SPM 2: The port footprint of the proposed Boegoebaai Port and phases of the proposed SEZ (Zones 1 – 10)

Zone 1, the Port Precinct, is designed as a new breakwater port, with Phase 1A accommodating a two-berth jetty for bulk liquid (ammonia, diesel oil), dry bulk (iron ore, manganese), and assorted break bulk cargo (lead, zinc), alongside essential infrastructure like storage tanks, conveyor systems, multi-purpose and dry bulk terminals, and administration buildings. Long-term plans for Phase 1B envision extended breakwaters, additional multi-purpose and liquid bulk berths, a container terminal, and a ship repair yard, along with rail connections. **Zone 2** is a Conservancy area, approximately 1 170 ha, specifically designated for the protection of conservation priorities, including the Boegoeberg koppies, a Cape fur seal colony, and an archaeological site. **Zone 3**, the Confirmed Green Ammonia Facility, will house a large-scale green hydrogen and ammonia production facility with an initial 5 GW electrolyser capacity by 2030, supported by a 188

ML/day desalination plant, water treatment units, and storage tanks for hydrogen, oxygen, and ammonia. **Zones 4**, **5**, and **6** form the SEZ Industrial Park, intended for mixed-use purposes, manufacturing, logistics, warehousing, and offices, and will include a 2.7 ML/day desalination plant for its own use and for distribution to Port Nolloth. **Zones 7**, **8**, and **9** are designated as Future Green Hydrogen Facilities and Future Expansion Areas, planned for the replication of green hydrogen and ammonia production facilities, mirroring the initial setup in **Zone 3**. Zone **10** is identified as a Future Tank Farm, a proposed area of approximately 1 704 ha inland of the R382 road for additional storage.

Box SPM 4: The multi-author team model

A multi-author team, in the context of SEA refers to a structured, pluralistic authorship model designed to integrate diverse perspectives and expertise across an assessment process. For the Boegoebaai SEA, multi-author teams were constituted through a consultative process with the Working Group (which included representatives from government, academia, NGOs, and other stakeholders) to nominate researchers who possess the required niche knowledge of this remote region, along with an understanding of strategic infrastructure impacts, academic credibility, and expertise in high-level strategic assessments.

Multi-author teams were assembled for Work Package 1 and asked to develop peer reviewed reports identifying the key sensitivities and impacts associated development at the scales proposed. The summaries of these findings are communicated in Section 2 of this SPM. In addition to the multi-author teams (which, in part, function as a method of diversifying participation), wider participation was facilitated through a formally mandated project Working Group (Box SPM 5).

Box SPM 5: The SEA Working Group

The Working Group is a multi-sectoral team of experts drawn from national, provincial, and local government departments, state agencies, academic and research institutions, non-governmental and community-based organisations, as well as industry and the private sector. Its purpose is twofold: to provide expert input throughout the SEA process; and to act as an information conduit, with members acting as links between their constituencies and the SEA, facilitating two-way communication, transparency, and inclusive engagement throughout the assessment.

Stakeholder engagement was also a key part of the SEA, for both Work Packages. In the context of Work Package 1, to date, this has included the dissemination of accessible information via the SEA website, local notices/posters, newspaper adverts, radio interviews and formal Working Group meetings. Additional Working Group sessions and in-person public briefings are planned across seven locations, where draft SEA findings will be presented and direct community input will be encouraged through these consultation sessions.

1.2 Work Package 2

This regional-scale SEA report is currently nearing completion (end-2025) and will cover the main sustainability issues associated with an expansive Northern Cape GH_2 economy, assessed more strategically from the perspective of cumulative risk and opportunity, but at a lower resolution than Work Package 1. Work Package 2 does not include any fieldwork.

The spatial scale of Work Package 2 covers parts of the Namakwa District, delineated by the Richtersveld, Nama Khoi, Kamiesberg and Khâi Ma Local Municipalities. Work Package 2 will, in a highly structed risk/opportunity framework, assess the magnitude of impacts at regional scale across various future scenarios. Work Package 2 will seek to guide local and regional planning, through processes like Spatial Development Frameworks (SDFs), Integrated Development Plans (IDPs) and Environmental Management

Frameworks (EMFs), obviously including any EIA processes that may be undertaken in the region. The strategic issues covered in Work Package 2 include ecology, biodiversity and conservation planning (including biodiversity offsets), water resources and aquatic ecology, heritage, infrastructure and planning, and socio-economic impacts.

Table SPM 2: Summary of the SEA Work Packages across different spatial scales, methods, and data collection practices.

	Work Package 1	Work Package 2
Spatial scale	Local (33 500 ha) covering the extent of the proposed port and SEZ.	Regional (>5 million ha) across four Local Municipalities, including the 33 500 ha extent covered by Work Package 1.
Methods	High resolution determination of receiving environment sensitivity with a view to practicing avoidance (top of the mitigation hierarchy).	Determination of the cumulative social and ecological impacts of a regional expansive GH_2 economy across development scenarios.
Resolution	Fieldwork, coupled with desktop reviews (peer reviewed and grey literature) and other sources where necessary (e.g., interviews).	Desktop reviews (peer reviewed and grey literature, interviews etc.) and other publicly available data and sources.

2. KEY FINDINGS FROM WORK PACKAGE 1

The key findings from the independent, peer reviewed specialist chapters are outlined in the SPM sections which follow.

2.1 The sensitivity of the receiving environment

2.1.1 Marine ecology (after Clark et al., 2025)

Rocky headlands within Zone 1 range from HIGH to VERY HIGH sensitivity around proposed Port Precinct, which serves as an important breeding site for Cape fur seals (Figure SPM 3) and threatened seabirds. Development around Boegoebaai Point (characterised by cliffs and a rocky headland), including within 300 meters north and south of the colony, particularly the construction of a breakwater and port, poses a high risk of disturbance and displacement to these species, with potentially irreversible ecological consequences, leading to a strong recommendation for considering alternative breakwater locations (See Figure 2-6.1 of SEA Chapter 2).

Box SPM 6: What are Critical Biodiversity (CBA) and Ecological Support Areas (ESA)?

CBAs are terrestrial or aquatic areas identified as being important for conserving biodiversity and maintaining ecosystem functioning. These areas are essential for achieving national biodiversity targets. ESAs are areas that support the ecological functioning of CBAs and other natural systems, and play a role in sustaining biodiversity and ecosystem services. While CBAs should be maintained in a natural or near-natural state, ESAs may allow for more flexible land uses, provided ecological processes are sustained.



Figure SPM 3: Cape Fur Seal colony at breeding location (rocky headland at Boegoebaai Point). (Source: L. Snyman-vd Walt, 2024).

Soft bottom subtidal habitats around Boegoebaai are listed as "endangered" by the National Biodiversity Assessment (NBA, 2018)[6] due to limited protection and threats from Orange River flow reduction and diamond mining, with much of this habitat being designated as Critically Biodiversity Area (CBA)-Restore or Ecological Support Area (ESA). Similarly, rocky subtidal habitats, including shallow kelp forests, are classified as "vulnerable" and largely fall within CBA-Restore or ESA, necessitating careful management. These habitats were assigned **MEDIUM** sensitivity.

Box SPM 7: The seal colony at Boegoebaai

The Cape fur seal colony at Boegoebaai, South Africa's northernmost, began breeding around 2010 and remains small but is growing (107 pups counted in 2007). Located along a unique 1 km stretch of rocky coastline, the site's steep cliffs likely make it suitable for breeding. Protected under the Sea Birds and Seals Protection Act of 1973, seals may not be disturbed or harmed without authorisation. However, proposed breakwater and port construction at Boegoebaai poses a serious threat to this seal colony and nearby breeding seabirds.

Mixed rocky shores and subtidal reefs hold MEDIUM to HIGH sensitivity due to their biodiversity value, habitat complexity, and limited formal protection. While sandy beaches (Box SPM 8) generally exhibit lower sensitivity, reflective and intermediate sandy shores show higher sensitivity due to the presence of the endangered giant isopod, *Tylos granulatus*, a species highly sensitive to disturbance and light pollution. Surf zone habitats, however, are considered **LOW** sensitivity due to low species richness. The offshore region around Boegoebaai supports important national fisheries, but are not particularly important (**MEDIUM** to **LOW**) for major commercial fisheries, and other activities like demersal trawling and abalone ranching concessions are not expected to be significantly affected, according to Clark et al., 2025. In contrast, according to Gammage et al., 2025, although commercial fisheries do not operate in the immediate area, they could act as important nursery grounds for commercially important fish species, and development of the area may affect recruitment of these species and future catches in the two most important commercial fisheries in South Africa - the small pelagic and commercial hake industries.

Box SPM 8: Recovery and protection of sandy beach habitats

Following cessation of mining and with proper rehabilitation, sandy beach faunal communities in the Boegoebaai area can recover to near-natural conditions, as shown in comparable sites north of the Orange River. It is recommended that a representative range of sandy beach habitats within the Boegoebaai area (away from the footprint of the proposed development) are earmarked for rehabilitation and are afforded some form of protection going forward. Priority should be given to the dissipative beaches which support the richest faunal communities.

2.1.2 Terrestrial and aquatic ecology (after van Rooyen et al., 2025)

Inland aquatic ecosystems, though not rich in number, are of high importance for terrestrial fauna. Ephemeral pans and rock pools, particularly the larger pans (Visagiespan, Rietfontein, Rietfonteinpan), are presumed to support rare aquatic invertebrate communities with high levels of regional endemism and are classified as Critically Endangered (CR) depressions in the Namaqualand Sandveld Bioregion. These natural depressions are specifically identified as having **VERY HIGH** sensitivity, with artificial wetlands at **HIGH** sensitivity, and buffer zones around

Box SPM 9: What does Critically Endangered (CR) mean?

Critically Endangered is a formal conservation status used to describe species and ecosystems that face an extremely high risk of extinction or collapse. A species is Critically Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Critically Endangered, indicating that the species is facing an extremely high risk of extinction. For ecosystems, CR status means ecosystem function is nearing collapse. It highlights urgent national conservation priorities, requiring immediate action to prevent irreversible biodiversity loss and support recovery efforts.

[6] The National Biodiversity Assessment is South Africa's primary scientific assessment of the state of the country's biodiversity, led by the South African National Biodiversity Institute (SANBI) in collaboration with numerous partners.

depressions at **MEDIUM** sensitivity. The Orange River Estuary, although not on-site, is a nationally and internationally important Ramsar Wetland in close proximity, and any direct or indirect threats from the development would negatively impact its already precarious condition. Development layouts must avoid these critical inland aquatic systems.

From an avifaunal perspective, the Boegoebaai Port and SEZ development site (spanning across various zones) exhibits predominantly MEDIUM and HIGH sensitivity. It hosts, or potentially hosts, a variety of priority species, including South African Red List species, endemics, near-endemics, and range-restricted species such as the Damara tern, black harrier, and Ludwig's bustard.

For bats, important foraging and roosting sites are deemed to be of VERY HIGH sensitivity. Temporal water sources of **HIGH** sensitivity, and livestock aggregation areas of **MEDIUM** sensitivity, with light pollution and water-cooling tower designs identified as significant impact risks.

Box SPM 10: What are Species of Conservation Concern (SCCs)?

Species of conservation concern are species that are important for conserving South Africa's biodiversity. This includes not only species listed as threatened but also those classified as Extinct in the Wild, Regionally Extinct, Near Threatened, Rare, Critically or Extremely Rare, Declining, and Data Deficient due to insufficient information. These species are recognised because of their conservation status, rarity, or lack of information, indicating a need for monitoring and potential conservation action.

The mammal, reptile, and amphibian assessment revealed VERY HIGH sensitivity for ecosystems like the Richtersveld Coastal Duneveld (CR) and Namib Seashore Vegetation (CR), as well as areas providing suitable habitat for 10 Species of Conservation Concern (SCC)[7], including the De Winton's golden mole[8] and the desert rain frog, both confirmed on-site. Other areas like saline depressions, Western Gariep Plains Desert, and ecological corridors linking coastal and inland habitats are rated **MEDIUM** to **HIGH** sensitivity. Habitat loss and alteration, especially for species reliant on specialised dune ecosystems, and disturbances from increased human activities like noise, light pollution, and dust, are critical concerns.

The vegetation and flora assessment indicates that the site hosts numerous priority habitats for biodiversity conservation, resulting in VERY HIGH sensitivity ratings for both the Plant Theme and the Relative Terrestrial Biodiversity Theme. These include two ecosystems (Richtersveld Coastal Duneveld (CR) (Figure SPM 4a) and Namib Seashore Vegetation (CR), habitat for approximately eight critically endangered[9] plant species (CR), large areas of irreplaceable CBAs, portions included in the National Protected Area Expansion Strategy (NPAES, 2018)[10], and inclusion in an internationally recognised Key Biodiversity Area (KBA)[11], with the critically endangered Namib Lichen Fields in close proximity (CR) (Figure SPM 4b). **The loss of habitat in these VERY HIGH sensitivity areas is considered unacceptable as it compromises conservation targets and cannot be offset.**

[7] The faunal community on site includes 10 SCCs. Confirmed mammal SCC include the brown hyaena, with De Winton's golden mole and Grant's golden mole likely to occur. Among the reptiles, both the Namaqua dwarf adder and the Namib web-footed gecko have been confirmed on site.
[8] Although not confirmed on site, the De Winton's golden mole and Grant's golden mole have a high likelihood of occurrence. The species was recorded with eDNA samples along the West Coast from Lamberts Bay to Visagiesfontein.
[9] SANBI is currently updating ecosystem threat assessments for this region. The number of critically endangered species is likely to change as new data becomes available.
[10] The National Protected Area Expansion Strategy (NPAES) is South Africa's long-term plan to expand and strengthen protected areas in a cost-effective way, aiming to conserve biodiversity, enhance ecosystem resilience to climate change, and promote ecological sustainability. It sets clear targets, identifies priority areas, and outlines mechanisms for implementation
[11] Key Biodiversity Areas (KBAs) are sites that are internationally recognised for their exceptional importance to global biodiversity. They are identified using globally standardised criteria, based on the presence of threatened species, endemic species, or unique ecosystems.

a)



b)



Figure SPM 4: a) CR Richtersveld Coastal Duneveld vegetation type in the proposed port precinct zone with a view of the Boegoeberg Twins; and b) Namib Lichen Fields approximately 13 km north of the proposed Boegoebaai Port and SEZ study area. (Source: L. Snyman-vd Walt, 2024).

2.1.3 Heritage (after Orton et al., 2025)

Several sensitive heritage resources are evident across the zones. Palaeontological[12] sensitivity is generally **LOW** for the SEZ, but **MEDIUM** sensitivity is noted in Zone 1 (Port Precinct) where excavations might encounter the buried late Pliocene[13] Hondeklipbaai Formation.

Box SPM 11: What is Heritage?

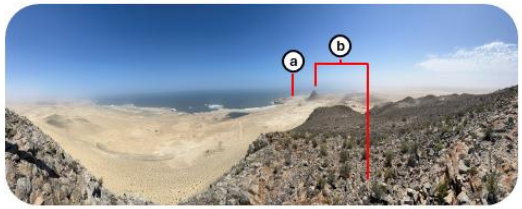
In the context of the National Heritage Resources Act (NHRA), heritage includes South Africa's tangible and intangible cultural and natural assets, such as historic sites, traditions, and indigenous knowledge, that hold historical, social, spiritual and scientific value, among others. The NHRA protects such resources and requires Heritage Impact Assessments to guide sustainable development, ensuring that economic growth respects and preserves the country's diverse and valuable heritage for current and future generations.

Isolated Early Stone Age[14] material has been found in deflated areas (Zones 3, 4, 6 & 7), and a Middle Stone Age occurrence is identified in Zone 1 (Port Precinct) at Namakwakop, with the possibility of highly significant sites containing pre-modern human remains in buried shelters. Significant occurrences of Later Stone Age shell middens and other occupation debris are present along the coast (Zones 1, 3, 7 & 8), at pans (Zones 3, 4, 6 & 7), and inland near water sources (Zone 9). Coastal areas (within 0.5 km) with these sites are considered of **VERY HIGH** archaeological sensitivity, while those 0.5-4.5 km from the coast are of **HIGH** sensitivity.

Three known graves exist in Zone 2 at the western foot of Boegoeberg South, and oral history highlights the significance of the Boegoeberg area (Zones 1 & 2) for the Nama people, with known graves allocated VERY HIGH sensitivity. For maritime heritage, one pre-1965 shipwreck is highly likely to be within the sea adjacent to the SEZ study area, with four others also highly likely, leading to **MEDIUM** sensitivity for areas mentioned in literature.

Living heritage areas, particularly those used by local herder communities for seasonal grazing (Swartbank and Witbank in Zones 2, 9 & 10), are rated as HIGH sensitivity, as development would disrupt their traditional transhumance cycle[15]. The cultural landscape, particularly the R382, coastline, Boegoeberg Twins (Zone 1, 2), and pans, are identified as highly sensitive areas from a visual perspective, as the proposed industrial development would be highly visible and contrast strongly with the existing landscape, indirectly impacting the nearby Richtersveld Cultural and Botanical Landscape World Heritage Site [16]

[12] Palaeontological refers to fossilised remains of ancient plants, animals and other organisms preserved in the geological record. These remains are considered heritage resources under the NHRA due to their scientific, cultural, and historical significance.
[13] The Late Pliocene refers to a period in Earth's geological timescale that occurred approximately 3.6 to 2.58 million years ago, marked by global cooling and the evolution of early hominins, with fossil sites from this time protected as heritage resources under the NHRA.
[14] The Early Stone Age refers to the earliest phase of human technological development, dating from about 2.6 million to 250 000 years ago, characterised by the use of simple stone tools by early hominins.
[15] The traditional transhumance cycle is a seasonal, often cyclical movement practiced by indigenous pastoralist communities, such as those who move with their livestock between coastal grazing areas in winter and inland areas in summer.
[16] The Richtersveld Cultural and Botanical Landscape is a 1,600 km^2 mountainous desert in South Africa's Northern Cape, communally owned and managed by the Nama people. It showcases a unique cultural landscape where the Nama practice traditional seasonal herding and live in portable *haru oms* homes. The area is rich in endemic succulent plants and reflects nearly 2,000 years of sustainable land use and cultural heritage, making it a globally significant World Heritage Site for both natural and cultural conservation.



↑ North north east view from Boeboeberg South towards Boegoeberg North and Boegoebaai headland.



← South view from Boegoebaai headland towards Boegoeberg Twins.



← Example of 'mined out' landscape in the proposed port precinct (zone 1), looking east.

a) Boegoebaai headland (significant for Cape fur seals and seabirds)
b) Boegoeberg twins (significant for fauna, flora and heritage)
c) Namakwakop
d) Visagiesfonteinkop
e) Swartbank heuweltjies
f) Ephemeral pans
g) Plant species of conservation concern (widespread)
h) Bird species of conservation concern (widespread)
i) Transhumance pastoralism (widespread east of R382)
j) R382 scenic route
k) Past and ongoing mining (widespread)

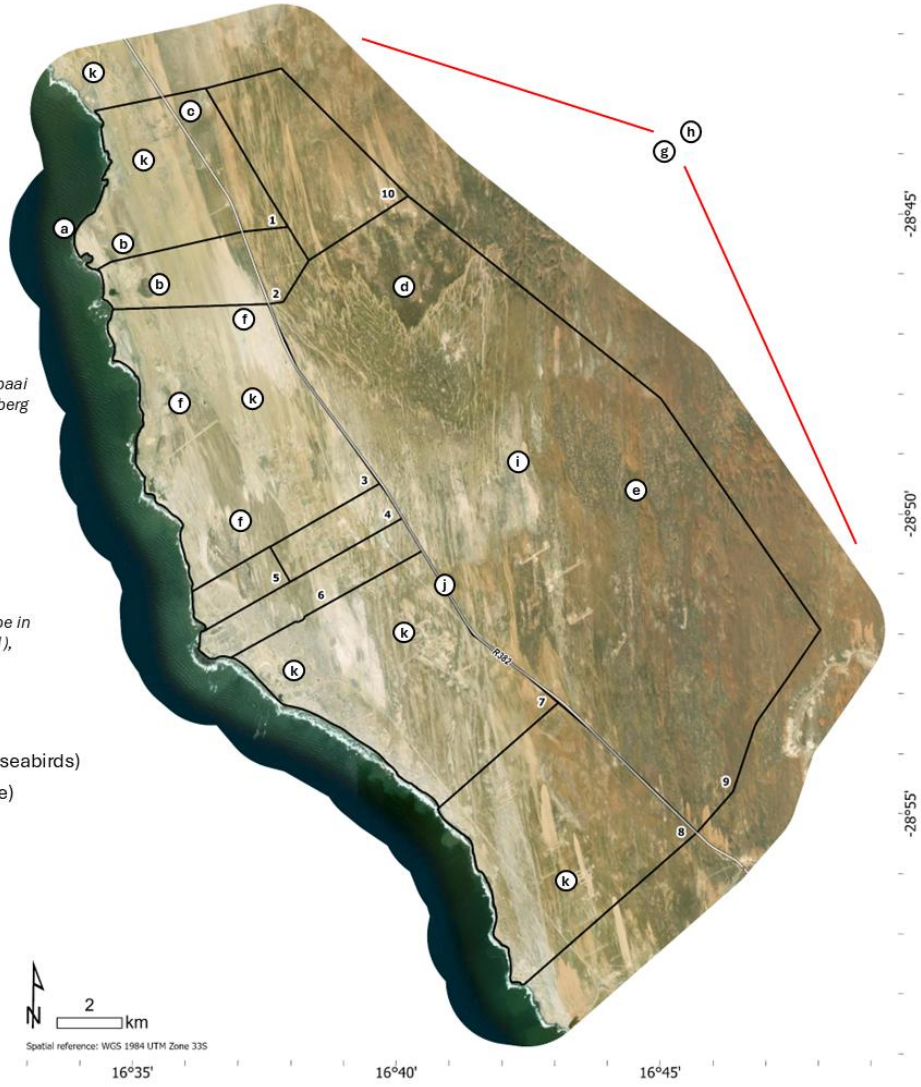


Figure SPM 5: A snapshot of the key ecological, heritage and land-use features in the proposed port precinct and SEZ study area.

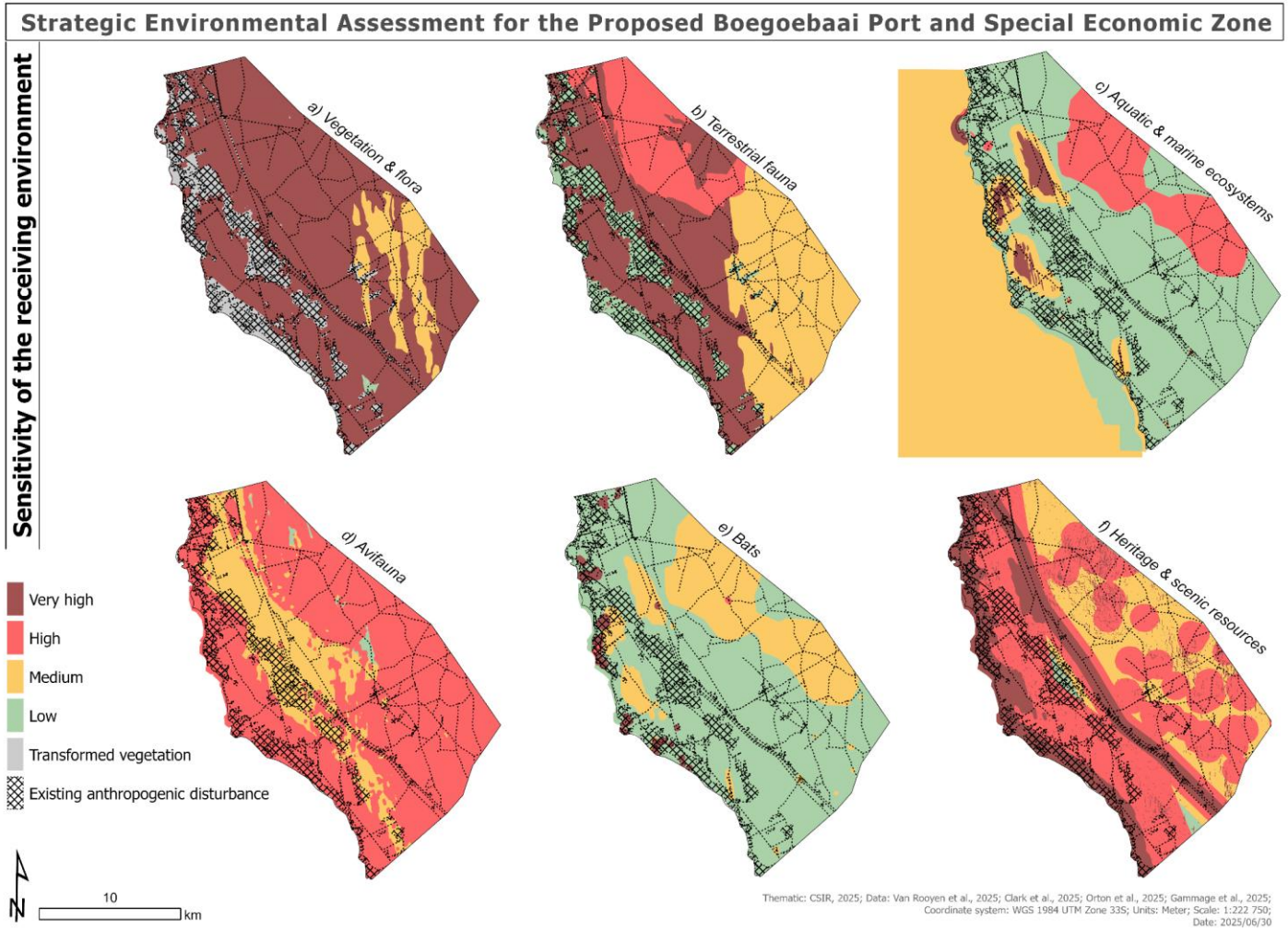


Figure SPM 6: Sensitivity of the receiving environment for the proposed Boegoebaai Port and SEZ for the respective themes of Work Package 1 – (a) vegetation and flora, (b) terrestrial fauna, (c) aquatic and marine ecosystems, (d) avifauna, (e) bats, and (f) heritage and scenic resources.

2.1.4 Coastal livelihoods (after Gammage et al., 2025)

Box SPM 12: The legacy of mining in this region

Mining has profoundly shaped the socio-economic and environmental landscape of the region. Historically, towns like Alexander Bay and Kleinzee were established around diamond extraction, with operations led by companies such as Alexkor and De Beers. While mining once provided prosperity and employment, **for some**, its decline has left communities facing economic hardship, deteriorating infrastructure, and rising unemployment. The legacy includes restricted coastal access, particularly for small-scale fishers who have lost traditional fishing grounds due to mining-related security zones. Environmental degradation, including siltation and habitat disturbance, has impacted marine ecosystems and reduced fish stocks, further threatening coastal livelihoods. Cultural heritage has also suffered, with ancestral graves and sacred sites in the Boegoebaai area at risk from industrial activity. Despite these challenges, some towns have begun transitioning toward alternative livelihoods such as aquaculture and tourism. However, the mining legacy continues to influence land use, access rights, and community vulnerability. Future development must address these historical impacts through inclusive planning, restoration of access, and protection of cultural and ecological assets to ensure sustainable and equitable growth.

The social environment surrounding the proposed Boegoebaai Port and SEZ is HIGHLY sensitive, largely due to the profound historical and cultural connections of local communities to the land and sea, compounded by the lingering impacts of past injustices from previous industrial developments, particularly diamond mining. Several coastal towns are the primary communities adjacent to the Boegoebaai development, including Alexander Bay, Port Nolloth, Kleinzee, and Hondeklipbaai. Each community's livelihoods and social fabric have been deeply shaped by resource extraction. Alexander Bay, a formerly prosperous mining town, has experienced economic decline, deteriorated infrastructure, and high unemployment as diamond extraction scaled down. While agriculture and tourism are emerging, opportunities remain scarce. Recreational fishing at the Orange River mouth is popular.

Port Nolloth is a traditional fishing community with strong intergenerational ties to the sea. It supports various fishing rights holders, including small-scale cooperatives targeting snoek and Cape bream, and commercial rights for West Coast Rock Lobster (WCRL). However, access to traditional fishing grounds has become increasingly restricted due to marine mining activity, high fuel costs, stock depletion, and limited infrastructure. Kleinzee, another former De Beers mining town, has attempted to diversify into aquaculture (abalone, seaweed farming) and seasonal tourism, providing some formal employment. Recreational fishing here has been severely impacted by siltation from past mining operations. Hondeklipbaai, a small, traditional fishing village, relies on small-scale fishing and growing tourism, but faces challenges such as declining WCRL stocks, limited fishing rights, and poor infrastructure.

Although the Boegoebaai area itself currently has no permanent residents or formal dwellings (being part of a restricted mining concession) it holds deep cultural, spiritual, and historical significance for surrounding Nama communities. Local oral histories point to long-standing traditional use of the area, including transhumance grazing routes and fishing grounds. On account of local stakeholders, the site is known to include at least 17 known Nama graves, including that of Kaptein Swartbooi, as well as culturally significant Buchu plants. It also historically formed part of traditional fishing grounds for small-scale fishers from Port Nolloth, access to which has been lost due to mining restrictions.

A core aspect of the social sensitivity stems from the Nama communities' traditional land use. Oral history confirms Nama herders from the Richtersveld historically followed a transhumance cycle encompassing the entire study area, including parts now within the SEZ. Their access was prevented by security fences erected after the discovery of diamonds in 1925, with further fencing in the mid-1950s. Crucially, portions of Farm 2 (the Korridor Wes farms), including Swartbank and Witbank (located in Zones 2, 9 & 10), were returned to the community in 2007, allowing stock owners to re-establish seasonal grazing. The proposed development, by preventing access to these areas, would directly disrupt this re-established traditional transhumance cycle, further impacting the livelihoods of these local herders. It would also necessitate complex consultation processes around consent, zonation and implementation of any required mitigation measures.

2.2 Aspects and impacts register

2.2.1 Spatially delimited ecological and heritage impacts

Table SPM 3 presents a consolidated summary of the potential positive and negative impacts identified across specialist studies (marine ecology, terrestrial and inland aquatic ecology, and heritage) for the planned Boegoebaai Port and SEZ infrastructure components. Each infrastructure aspect, activity or SEZ subzone is linked to potential impacts and the corresponding receiving environment of concern. The table offers an integrated overview of likely impacts that could inform future EIAs, the identification of areas requiring avoidance, targeted mitigation strategies, or knowledge gaps requiring future, fine-scale, specialist attention.

Table SPM 3: Spatially delimited aspects and impacts register across ecological and heritage themes

	Infrastructure aspect, activity or SEZ zone	Potential impacts	Receiving environments of concern
MARINE ECOLOGY	Jetties, breakwaters and quays (Zone 1)	**Disturbance and harm to marine fauna**, including physiological and behavioural effects, recruitment disruption, and species displacement or mortality.	Marine fauna, including seal colony.
		Degradation of benthic and demersal communities, including habitat loss, smothering and altered community structure.	Benthic and demersal communities in CBA1 restore and ESA.
		Hydrodynamic alterations, such as changes in longshore currents and littoral drift, potentially affecting coastal sediment transport and ecosystem stability.	Littoral drift zones and Coastal sediment systems.
	Dredging, intake/outfall pipelines and general housekeeping (Zone 1, Zone 3 & Zones 4-6)	**Loss and degradation of marine habitats**, including permanent loss of unconsolidated seafloor and associated communities due to infrastructure placement.	Benthic macrofauna and demersal communities.
		Disturbance and smothering of benthic fauna from dredging and spoil disposal.	Spoils dump site and dredge footprint.
		Degradation of water quality due to spills, litter, and runoff.	Marine fauna and coastal ecosystems.
	Port and industrial operations, vessel activity, marine infrastructure and maintenance (Zone 1, Zone 3 and Zones 4-6))	**Disturbance to marine fauna**, caused by elevated underwater noise levels, light emissions, ship strikes, and seawater intakes.	Marine fauna (e.g. seabirds, marine mammals, turtles, cetaceans).
		Degradation of water quality, resulting from routine vessel discharges, operational spills, brine discharges, increased turbidity, and remobilisation of sediment-bound contaminants.	Marine fauna; nearshore and coastal ecosystems.
		Loss and alteration of marine habitats, including permanent loss of unconsolidated seabed and disruption of associated benthic communities.	Benthic communities in dredge zones and around marine structures.
	Vessels, bunkering and pipelines (Zone 1, Zone 3 & Zones 4-6)	**Degradation of water quality** due to accidental hydrocarbon spills / releases (e.g. vessel accident, bunkering and pipe rupture)	Marine fauna, benthic communities, and coastal habitats (e.g. rocky shores, beaches).

	Infrastructure aspect, activity or SEZ zone	Potential impacts	Receiving environments of concern
INTEGRATED TERRESTRIAL AND AQUATIC ECOLOGY	**Aquatic Ecosystems**		
	Boegoebaai Port Development Footprint (Zone 1)	**Disturbance to broader possible recharge areas** of nearby wetlands or pans, potentially threatening their sustainability due to uncertain hydrological drivers.	Potential recharge area for BB1 pan (Visagiespan) (as shown in Day, 2025[17]) and springs; Boegoeberg North supporting ephemeral aquatic biota
	Conservancy Area (Zone 2)	**Positive: Potential protection of recharge areas** for the pan, its wetland, and associated spring if avoided as conservancy[18].	BB1 (including BB1A)
	Confirmed Green Hydrogen & Ammonia Facility (Zone 3)	Destruction and degradation of wetlands and pans, stormwater and vehicle disturbances	CR wetlands, largest and most important pans and springs in study area
	SEZ Industrial Park Phases 1-3 (Zones 4-6)	CR pan and wetland habitat destruction, nutrient enrichment, hydroperiod changes, physical disturbance	BB3 pan/wetland/spring system
	Future Green Hydrogen Facility (Zone 7)	Destruction of pans and wetland habitats, hydroperiod changes, physical disturbance	BB4, BB5 (artificial), BB6 (presumed natural) and recharge area
	Future Expansion 01 (Zone 8)	Destruction of presumed natural pan and wetland habitat, hydroperiod changes, degradation from altered flows	Southern extent of CR rated BB6, artificial BB7 & BB8 pans/wetlands (likely ecologically important)
	Future Expansion 02 (Zone 9)	Destruction of pan habitat, eutrophication, ecosystem degradation, biodiversity loss	Visagiesfonteinkop: ephemeral pans and rocky outcrops of **HIGH** sensitivity
	Terrestrial Ecosystems (including avifauna; bats; mammals, reptiles and amphibians; vegetation and flora)		
	Zone 1 Infrastructure (Port)	Vegetation loss, habitat fragmentation, loss of individuals of SCCs and protected and/or endemic plant or animal species, ecosystem service decline, erosion, sand movement smothering adjacent vegetation, disturbance to animal behaviour, potential animal mortality	**VERY HIGH** sensitivity mapped areas for terrestrial ecology subthemes (**Figure SPM 6** a, b, d, e)
	Zone 1 - Dry Bulk Handling (Manganese, Zinc, Lead)	Dust contamination, soil/water pollution, toxicity, air quality reduction	Locate in modified habitat areas only; avoid all sensitive natural areas
	Zone 1 - Conveyor Belts	Pollution (soil/water), conveyors will be barriers to animal movement	Air, soil and water near conveyor lines
	Zone 1 - Dust Control	Unspecified waste handling, possible **environmental contamination**	Dust collection points; Very High sensitivity mapped areas
	Zone 1 - Desalination Plant	**Marine fauna harm** (intake of seawater), concentrated brine discharge impacting marine ecosystems, **chemical pollution, thermal impacts**	Marine environment; intake/discharge areas
	Zone 1 - Sewage Infrastructure	Fertiliser from nutrient recovery, pollution, groundwater contamination, residual chemicals, sludge management	Wastewater treatment zones, groundwater table; Zone 1 sensitive areas

[17] See Chapter 3a (Terrestrial & Aquatic Ecology Supplementary Material) of the main SEA Report for a map and photographic illustrations of key inland aquatic ecosystem habitats in the study area.
[18] Designation of a conservancy zone alone does not necessarily constitute sufficient offset mitigation for the impacts anticipated from Zone 1 or the broader SEZ.

	Infrastructure aspect, activity or SEZ zone	Potential impacts	Receiving environments of concern
	Zone 1 - Stormwater Systems	Pollution, invasive species spread, groundwater impacts	Stormwater ponds; Zone 1 sensitive ecosystems
	Zone 1 - Electrical Infrastructure	Vegetation clearance, emissions associated with construction, electrocution risk, habitat fragmentation	Substation areas, powerlines; Zone 1 sensitive habitats (including birds)
	Zone 1 - Fuel Storage Zone 10 – Future Tank Storage	Fuel spills contaminating soil, water, and groundwater, harming plants and aquatic systems, VOCs emitted reducing air quality, fire and explosion risk	Zone 1 and Zone 10 sensitive habitats, Namib Lichen Fields, Boegoeberg Twins
	Zone 1 - Internal Roads & Bridges	Fragmentation, restricting animal movement, roadkills, erosion, pollution, dust, invasive species	Zone 1 sensitive habitats, habitat corridors; adjacent vegetation; lichens sites
	Zone 1 - External Roads (R382)	Expanded **vegetation loss** due to widening of R382, traffic pollution	Areas adjacent to R382, sensitive habitats
	Zone 2 - Conservancy Area	Positive: Intact vegetation and CR ecosystems (and refugia for animals) protection, enabling rehabilitation of mined areas Negative: **air pollution** risk on lichens in Zone 2, partial representation or protection of sensitive areas (including CBA1s and CR ecosystems), **increased mortality of SCC**	Boegoeberg Twins (include both Boegoeberg North and South), Cape fur seal colony (should also be included in Zone 2), BB1, CBA1s, CR ecosystems
	Zones 3–10 - SEZ Infrastructure	Extensive vegetation clearance, resource demands, habitat transformation	**VERY HIGH** sensitivity mapped areas
	Zone 3 - Desalination Plant	Marine discharge risks, vegetation clearance	**VERY HIGH** sensitivity mapped areas
	Zone 3 - Electrolyser	Water & energy demand, chemical pollution, safety risks (H_2 leak/explosion)	**VERY HIGH** sensitivity mapped areas
	Zone 3 - Ammonia Facility Zones 7–9 - Future Expansions	**Positive (Indirect): Reduced fossil fuel use**, emission-free green ammonia as fertiliser, energy carrier allowing renewable energy storage and transportation, cleaner ammonia production **Negative (including indirect): High resource demands** (energy from renewable sources), land and water intensive, safety risks, ammonia health risks, air/soil contamination, bat mortalities/injuries risk due to hot steam discharge	**VERY HIGH** sensitivity mapped areas; Namib Lichen Fields, Boegoeberg Twins
	Zone 3 - Firewater System	Salinity increases (when using seawater), foam pollutants, marine pollution	Seawater intake/discharge areas
	Zones 4–6 - Industrial Park	**Vegetation clearance**, desalination impacts	**VERY HIGH** sensitivity mapped areas
	Common to all Zones: Increased Corvids Predation	Development may increase corvid habitat, leading to higher predation and tortoise population declines.	All zones
	Common to all Zones: Noise, Dust, Lighting	Construction noise, lighting, and activity may disturb animal behaviour; increased injury or mortality risk; trenching further increases mortality risks.	All zones
	Common to all Zones: Earthworks	Roosting habitat destruction (birds/bats)	All zones
HERITAGE	Palaeontology		
	All zones	Construction could expose and/or destroy fossils	Marine deposits of late Pliocene Hondeklipbaai Fm. Behind cliffs in proposed port area (Zone 1). All unmined areas, but higher likelihood on coastal lowlands
	All zones	Backfilling of soils from dumps could **expose fossils**	Mine dumps used to backfill mine pits

	Infrastructure aspect, activity or SEZ zone	Potential impacts	Receiving environments of concern
	Zones 1, 2, 3, 5, 6, 7 & 8	Construction could expose and/or destroy raised beach deposits	Areas where raised beaches of the Curlew Strand Fm are preserved
	Terrestrial Archaeology		
	Zones 1, 2, 3, 4, 5, 6, 7 & 8	Construction could **expose and/or destroy MSA sites** in old sea cliffs buried by wind blown sand	All areas along the coast which have rocky outcrops, whether visible or buried
	Zones 1, 2, 3,4, 5, 6, 7 & 8	Construction could expose and/or destroy LSA shell scatters and middens	All areas where archaeological shell middens occur along undisturbed coastline
	Zone 1	Construction could expose and/or destroy MSA artefact scatters	The rocky outcrops of Namakwakop in the NE of Zone 1
	Zones 3, 4, 6 & 7	Construction could expose and/or destroy LSA shell scatters and middens	Around and within Visagiepan and Rietfontein Pan
	Zone 9	Construction could expose and/or destroy LSA shell scatters and contact period/historical scatters	**HIGH** sensitivity areas around granite outcrops in the eastern part of the SEZ
	Graves		
	Zone 2	Construction could **impact known graves**	Identified graves at western foot of Boegoeberg South
	All zones	Construction could expose and/or destroy unknown graves	Unmarked graves could occur anywhere that has not been mined
	Maritime Heritage		
	Zones 1, 2, 3, 5, 6, 7, & 8	Offshore construction work for the breakwater and other port facilities may **expose and/or destroy submerged shipwrecks**	Any areas where seabed impacts would occur through construction or dredging (Zone 1).
	Living Heritage		
	Zones 2, 9 & 10	Development would disrupt transhumant settlement patterns and prohibit access to the area	All areas used by small-scale pastoralists, especially areas known as Witbank/ Visagiesfonteinkop, Swartbank and Grondputs/Zwartwater
	All zones	Development of the Port and SEZ would massively alter the landscape context in which small-scale herding occurs through the addition of industrial facilities	Entire Port and SEZ study area
	All zones	Development of the Port and SEZ could alter the connection between the local community and the coastline.	Entire Port and SEZ study area
	Cultural Landscape		

	Infrastructure aspect, activity or SEZ zone	Potential impacts	Receiving environments of concern
	All zones	Despite the existing mining, development will irrevocably **alter the sense of place** of the region through the addition of industrial facilities	Entire Port and SEZ study area

2.2.2 Socio-economic and coastal livelihood impacts

2.2.2.1 Potential benefits

The Boegoebaai Port and SEZ development presents an important opportunity to stimulate inclusive economic growth and promote strategic investment in the Northern Cape. If designed and implemented with sustainability, equity and local participation at its core, the project could offer a range of environmental, economic and social benefits.

The work programme could unlock substantial employment and livelihood opportunities directly and indirectly linked to the fisheries sector and beyond (e.g. tourism). Aquaculture operations may also benefit from expanded water access, energy supply, and downstream support services. The diversification of income streams may reduce vulnerability in communities currently reliant on declining or seasonal fisheries and could mitigate some of the negative impacts associated to ocean squeeze.

Box SPM 13: Example of marine-based economic diversification

Kleinzee, a former mining town, has transitioned toward aquaculture and seasonal tourism, with abalone and seaweed farming now the primary employers. Its existing infrastructure and service delivery make it a pilot site for marine-based economic diversification. Tourism driven by wildflowers and birdwatching also contributes to livelihoods. This supports broader fisheries-linked economic resilience, though concerns remain about coastal pollution from vessel traffic. Stakeholder feedback reflects cautious optimism about the proposed Boegoebaai Port development's potential to boost local revenue.

Upgrades to marine and land-based infrastructure will improve operational efficiency and safety for fishers in towns like Port Nolloth. Improved service delivery could support new or underutilised value chains such as dried fish products, kelp processing and marine tourism. Expanded water supply and electrification may also enable shore-based aquaculture activities and provide opportunities for co-operative-led enterprises to scale up production. Improved harbour infrastructure may reduce post-harvest losses and improve the quality and shelf life of landed catch.

Box SPM 14: Infrastructure and capacity gaps in small-scale fishers

In Port Nolloth, small-scale fishers face declining fish stocks, high fuel costs, and restricted access to traditional fishing grounds due to mining. Infrastructure is limited, with only one operational jetty and persistent water shortages affecting tourism and development. While aquaculture and fisheries are central to livelihoods, local capacity for offshore operations is lacking. Skills development is minimal, and cooperatives struggle with resource constraints. These challenges underscore the need for improved infrastructure and targeted capacity-building in marine sectors.

Technical training and mentorship programmes offer the potential to build capacity within fishing and coastal communities. This includes upskilling in marine safety, vessel maintenance, post-harvest handling, seafood processing, aquaculture operations, environmental monitoring, and marine stewardship. Targeted training for youth and women may broaden access to previously male-dominated or capital-intensive sectors, supporting inclusive local development. Skills development linked to port and SEZ operations may also enable intergenerational transfer of knowledge and provide pathways into formal marine employment sectors.

If implemented inclusively, the development could catalyse improved local governance arrangements, offering a platform to strengthen fisher cooperatives and associations through improved access to finance, business support services, and policy engagement spaces. Access to better-quality water, energy, and transport systems could significantly strengthen the viability of coastal aquaculture initiatives, particularly in towns like Kleinzee. Formalised support may enable pilot projects in integrated multi-trophic aquaculture (IMTA), seaweed farming, or small-scale mariculture to grow into sustained livelihood opportunities.

Infrastructure could also enable greater value addition through local processing, packaging, and cold storage, increasing income retention within communities.

The port may improve the logistical feasibility of deploying patrol vessels and monitoring crews to combat illegal, unreported, and unregulated (IUU) fishing in the northwest of the EEZ. Strengthened surveillance and compliance capacity may benefit both conservation objectives and local fishers, by protecting their resource base from overexploitation and ensuring more equitable access to shared stocks.

Box SPM 15: What is IUU fishing and the role of ports?

Illegal, unreported, and unregulated (IUU) fishing refers to the unlawful harvesting of marine resources, where foreign vessels operate in a country's exclusive economic zone (EEZ) without authorisation or use harmful fishing methods. Ports and the countries that manage them are vital in overseeing fisheries and maritime activities. International law requires inspection of vessels and fish entering ports, helping identify illegal fishing, unsafe vessels and poor labour conditions, and ensuring such violations are detected and addressed.

By improving transport, utilities and market access, niche tourism offerings that include local fisheries culture (e.g. seafood festivals, fisher-for-a-day experiences, or heritage boat tours) could be established. Infrastructure upgrades may also allow communities to monetise intangible heritage and cultural assets (e.g. traditional knowledge, coastal landscapes, artisanal crafts), particularly during the flower season.

Diversified income opportunities and improved infrastructure may help coastal communities adapt to environmental and economic volatility. With fisheries increasingly impacted by climate change (e.g. shifting stocks, marine heatwaves) and market pressures (e.g. rising fuel costs), support for improved aquaculture, tourism and seafood value chains together with opportunities to diversity skills beyond fisheries, could enhance household resilience by reducing reliance on any single resource or season.

2.2.2.2 Potential negative impacts

Spatial competition in an already congested marine zone will be intensified. This will negatively impacts already marginalised coastal and small-scale fishers who already face increasing displacement due to overlapping claims from mining, offshore oil and gas, conservation, and industrial shipping activities.

Box SPM 16: The "Ocean squeeze" phenomenon

Ocean squeeze is a phenomenon where the seaward-facing side of the coast becomes increasingly competitive, further reducing fishers' already limited operating space. It is reported that ocean squeeze has caused traditional fishing communities in Port Nolloth to lose both land and sea access to their fishing grounds. For example, fishers previously moved small boats (bakkies) over land via trailer to fish north of Port Nolloth, but mining restrictions have now closed off this access.

Access to traditional fishing areas has already been reduced by mining security restrictions (e.g., fishers are no longer able to trailer vessels to Boegoebaai), and further limitations threaten the sustainability of small-scale livelihoods. Climate change impacts, such as sea-level rise and altered species distributions, exacerbate these pressures.

As infrastructure improvements and new employment opportunities attract outside investors and higher-income groups, gentrification pressures on the existing communities will increase. This could risk raising property values and living costs, pricing out long-standing residents, and eroding traditional livelihoods. In towns like Port Nolloth and Alexander Bay, where unemployment is high and services are limited, such shifts could deepen socio-economic inequalities and displace vulnerable populations. Social cohesion may be disrupted, particularly if communities perceive that development benefits are externally captured.

Perceptions from local stakeholders are that current governance arrangements and stakeholder engagement processes are dominated by government and private sector interests, with limited inclusion of small-scale fishers, Nama communities, women, and informal resource users. This reproduces a legacy of inadequate consultation linked to previous development efforts in the region, contributing to community frustration and mistrust. Moreover, current frameworks fail to recognise indirect and hidden stakeholders or the complexity of the marine and coastal social-ecological systems, leading to poorly tailored interventions and reduced legitimacy.

Box SPM 17: Gentrification in the context of development?

Gentrification refers to the transformation of historically under-resourced or working-class areas through the introduction of higher-end housing, infrastructure, and commercial projects. While new developments can improve service delivery and attract investment, they often lead to rising property values and living costs. This can displace long-standing, lower-income residents and erode local cultures and livelihoods, as wealthier newcomers move in and reshape the social, economic, and physical landscape of the area.

3. STRATEGIC PLANNING AND GOVERNANCE RECOMMENDATIONS

Drawing from the findings of the multidisciplinary specialist inputs and grounded in the principle of precaution (Box SPM 18), this section outlines key strategic recommendations to guide policymakers in planning for, and governing, the proposed programme of development at Boegoebaai in a responsible way.

A key objective of Work Package 1 is to inform the layout of the port and SEZ to avoid planning development footprints in areas that are highly constrained and with a very low likelihood of receiving Environmental Authorisation and/or expensive and complex mitigation (Box SPM 19). Given the scale and impact potential of the programme of work, it is essential that any future decisions are informed by high quality evidence, underpinned by social equity considerations, and are in alignment with broader South African sustainability ambitions. The recommendations presented here focus on the mitigation of key risks, the potential for developing cross-sectoral, cross-constituency coordination and governance, and enhancing and diversifying any long-term benefits that may accrue from this programme of work.

Box SPM 18: Embracing a stepwise and precautionary approach

The precautionary principle presupposes that if a development is suspected of causing harm to the public or to the biophysical environment, in the absence of a scientific consensus that harm would not ensue, the burden of proof falls on those advocating for the project (DEA&DP, 2013). In other words, it's the project proponents who must prove that the proposed activity will not lead to significant harm, rather than the public or environmental groups having to prove that it will. South Africa has given effect to the precautionary principle in the NEMA. Large-scale infrastructure development associated with the proposed Boegoebaai port and SEZ must apply a risk-averse and cautious approach that considers the limits of current knowledge about the receiving environments and technologies and infrastructure being developed.

3.1 The position of the breakwater and port precinct

A key issue is the positioning of the breakwater and port precinct relative to areas of VERY HIGH environmental sensitivity. The construction of a breakwater and associated port infrastructure in this location would almost certainly result in unacceptable ecological disturbance. Policymakers should consider relocating the port breakwater to avoid this area. **Figure SPM 7** offers some alternatives for where the breakwater and port may be more ecologically appropriate. While the bathymetry to the north of (currently proposed) Boegoebaai Point could be technically less favourable, areas to the south appear to carry fewer environmental constraints and offer more favourable offshore bathymetric conditions for breakwater construction.

Box SPM 19: Alternative port location

A strategic opportunity exists to reconsider the location of the proposed port to reduce ecological risks. Preliminary analysis suggests that a site just north of Port Nolloth (outside of the SEA Work Package 1 study area) may offer a more suitable alternative. This area is already disturbed by historical mining, lies within 10 km of existing harbour, and lacks biodiversity features that would trigger exclusionary thresholds.

Although indicative, this guidance provides a reference point for steering development away from ecologically irreplaceable areas and should inform early-stage planning to derisk the development and support a more sustainable project outcome.

3.2 Targeting degraded areas and managing windblown sand

Approximately 5 000 ha (15 % of the 33 500 ha study area) is transformed habitat and has already been subject to ecological disturbance, primarily because of historic and ongoing mining activities. This includes areas of intense historic mining and zones where natural ecological processes have been disrupted to the extent that recovery is limited or unlikely without intervention. These activities have left a visible legacy of degraded landscapes, including areas stripped of natural vegetation, exposed soils, and extensive windblown sand plumes, particularly west of the R382. These areas are rated as either **TRANSFORMED** or of **LOW** ecological sensitivity across multiple themes, including mammals, reptiles and amphibians, vegetation and flora. Similarly, the inland aquatic and bat sensitivity themes largely rated these areas as **LOW** sensitivity. Only the avifaunal theme assigned **MEDIUM** to **HIGH** sensitivity to some of these disturbed areas, on account of their potential use by certain bird species.

Boegoebaai GH_2 development scenarios (which form the basis for Work Package 2) estimate that the port and industrial infrastructure in the SEZ would require in the range of ~ 1,700 - 4,600 ha of land land-take / physical footprint (Box SPM 20)**.** Areas identified as potentially 'more suitable' for development (~8,500 ha) (see Section 3.4) target degraded land and should comfortably support planned port and SEZ-related infrastructure.

Box SPM 20: The land requirements to produce GH_2 and PtX products

Power-to-X means that renewable energy (e.g. electrons produced from e.g. wind and solar resources) are captured and converted into an alternative energy carrier, namely molecules (e.g. hydrogen, ammonia). The vast majority of infrastructure requirements lie with the renewable energy development component. In the case of the proposed Boegoebaai GH_2 development programme:

- The port and industrial infrastructure in the SEZ is estimated to require in the range of ~ 1,700 - 4,600 ha of land (direct footprint of infrastructure);
- Ancillary infrastructure such as new road, rail, pipeline and powerline could require in the range of ~ 4,750 – 12,183 ha of land; whilst
- Renewable energy (wind and solar development) could require between16,000 and 128,000 ha of land.

Renewable energy thus accounts for upwards of 70% of the infrastructure land requirements to produce PtX products. Renewable energy is likely to be sourced from wind and solar facilities located in the broader Namakwa region, and beyond, thus the need for the SEA to consider a regional component (WP2).

It is recommended that the proposed port and SEZ footprint targets these existing anthropogenically transformed/disturbed areas for development. Siting land-based infrastructure for the port and SEZ within these transformed areas would significantly reduce the risk of an impact from biodiversity loss, provided that priority habitats are not negatively impacted by the development activities. However, to ensure long-term ecological sustainability, infrastructure planning must also factor in ecological corridors that support connectivity between key terrestrial, coastal and inland aquatic habitats. This includes avoiding **VERY HIGH** sensitivity mapped areas and integrating the impact management principles outlined in Section 4 below.

Box SPM 21: Stabilising mobile sand plumes

It is recommended that detailed modelling of sand and dust transport from the proposed development is conducted to understand potential downwind impacts. Priority must be given to implementing mitigation measures that stabilise sand movement before it reaches sensitive ecosystems, such as the Namib Lichen Fields and the Orange River Estuary. Furthermore, targeted interventions, alongside careful infrastructure planning, must be implemented to stabilise mobile sand plumes that threaten to smother rare vegetation remnants on the inselbergs and along the coast. This will help preserve unique, irreplaceable ecosystems vulnerable to wind-driven sand movement intensified by development activities.

Proactive measures must be taken to manage windblown sand, which poses both environmental and engineering risks. Stabilisation interventions, tailored to the shoreline dynamics and highly windy environment of this region, should be embedded into early development phases.

3.3 Areas that should be considered off limits for major development

No major development should be permitted east of the R382. This includes eastern portions of Zones 1 and 2 (Port and Conservancy area (Box SPM 22) and Zones 9 and 10 (Future Expansion 02 and Future Tank Farm). These areas contain a convergence of **VERY HIGH** ecological and **HIGH** heritage sensitivity, including Critically Endangered ecosystems, Critical Biodiversity Areas, bat roosting and foraging zones, archaeological sites, living heritage stockposts, and neighbouring landscapes of cultural and scenic importance. In addition, the following no-go areas have been identified:

- **VERY HIGH** sensitivity areas across integrated fauna, flora, and aquatic assessments;
- Natural pans and depressions, particularly in and around Zones 3 and 9), which are CR wetland systems;
- The Orange River Estuary (although not on site);
- Cape fur seal colony and coastal cliff habitats, which would otherwise be severely impacted by port infrastructure;
- **VERY HIGH** bat sensitivity areas, including rocky outcrops and ravines (e.g. Holgat River [although not on site], Boegoeberg Twins);
- Graves near Boegoeberg South (Zone 2), including the reputed burial site of Kaptein Paul Links, considered sacred to the Nama;.
- Living heritage stockposts in Zones 9 and 10 (Witbank and Swartbank), key to the Nama transhumance cycle and pastoralist way of life;
- Visual and cultural corridors, including the R382 scenic route and views towards the Boegoeberg Twins, which hold World Heritage value linked to the RCBL buffer zone.

Box SPM 22: Designing an optimal Boegoebaai SEZ conservancy zone.

The current layout of the SEZ and its designated "Conservancy area" reflects an effort to accommodate cultural priorities and ecological sensitivities. However, the Conservancy's effectiveness can be significantly improved through targeted redesign. Specifically, the Conservancy should be expanded and reconfigured to include:

- Fine-scale sensitive biodiversity sites identified by specialists (e.g. Chapter 3_5B & Chapter 3 of the SEA).
- Intact vegetation in **VERY HIGH** sensitivity zones, particularly areas east of the R382, including the Future Tank Farm and Future Expansion 01 zones and west of R328.
- Intact coastal vegetation adjacent to the nearshore, rather than degraded zones currently included in the conservancy.
- Full inclusion of both Boegoeberg Twins (i.e., including Boegoeberg North currently not entirely included in the designated Conservancy area). These mountains host exceptional biodiversity, including many threatened plant species and highly sensitive lichen and microbial communities.

Utility-scale renewable energy (RE) infrastructure was intentionally excluded from the SEZ in original development proposals, given the SEZ's limited spatial footprint (for RE), proximity to the coast and sensitive receiving environments. This position should be maintained going forward. RE infrastructure at the scale required for a regional GH_2/PtX economy (which may require in excess of 100 000 ha of land surface), should instead be located within lower sensitivity receiving environments outside the SEZ and distributed across the expanse of the Northern Cape, as identified through the regional SEA (Work Package 2). That is not to say that no RE development can be permitted within the SEZ[19] (this will have to be considered on a case by case basis through various instruments like EIAs), but that large scale RE development, specifically for the purpose of meeting the electricity demands for GH_2/PtX production, must be placed outside of the SEZ.

3.4 A preliminary zonation scheme for development planning

A preliminary zonation scheme (development suitability) was broadly derived from the spatial sensitivity analyses (see Section 2.1), areas which are potentially degraded by existing anthropogenic disturbance

[19] It is noted that the proposed Richtersveld Wind Energy Facility has received Environmental Authorisation in a part of the proposed Boegoebaai SEZ, east of the R382 road.

(mainly mining) (see Section 3.2), and recommended areas where development is best avoided (see Section 3.3). The resulting scheme contains two relative development suitability classes (Table SPM 4)

Table SPM 4: The two development suitability classes derived from overlaying social and ecological sensitivity polygons and areas already degraded by mining activities.

Development suitability	Implications for project planning
MORE SUITABLE	• May find potentially large-scale developable footprints during project screening and EIA phases, especially in areas already **TRANSFORMED** by historical mining activities. • Nonetheless, high likelihood of encountering mosaics of **HIGH** to **VERY HIGH** sensitivity resources, which may require, depending on the context, extensive fieldwork, complex EIAs and mitigation/management actions and/or offsetting.
LESS SUITABLE	• Very unlikely to find developable footprints during project screening and EIA phases. These areas have not been affected by mining and are largely intact, or have reasonable restoration potential, if there has been limited disturbance e.g., areas of windblown sand. • High likelihood of encountering vast areas of **VERY HIGH** sensitivity ecological and heritage resources. • Very low likelihood of obtaining Environmental Authorisation, apart (potentially) from small-scale infrastructure/development activities, such as tarring existing dirt tracks or low impact electricity distribution lines.

Areas identified as potentially **MORE SUITABLE** for development (~8,500 ha) (Figure SPM 7) target degraded land and should comfortably support the proposed infrastructure, which is estimated to require in the range of ~ 1,700-4,600 ha of land, representing around 5 - 15 % of the full ~33,500 ha extent preliminarily identified for the Boegoebaai SEZ. To put this into context, the established Saldanha Bay Industrial Development Zone (IDZ) and Coega IDZ have respective extents of approximately 356 ha (DTIC, 2017a) and 9,000 ha (DTIC, 2017b).

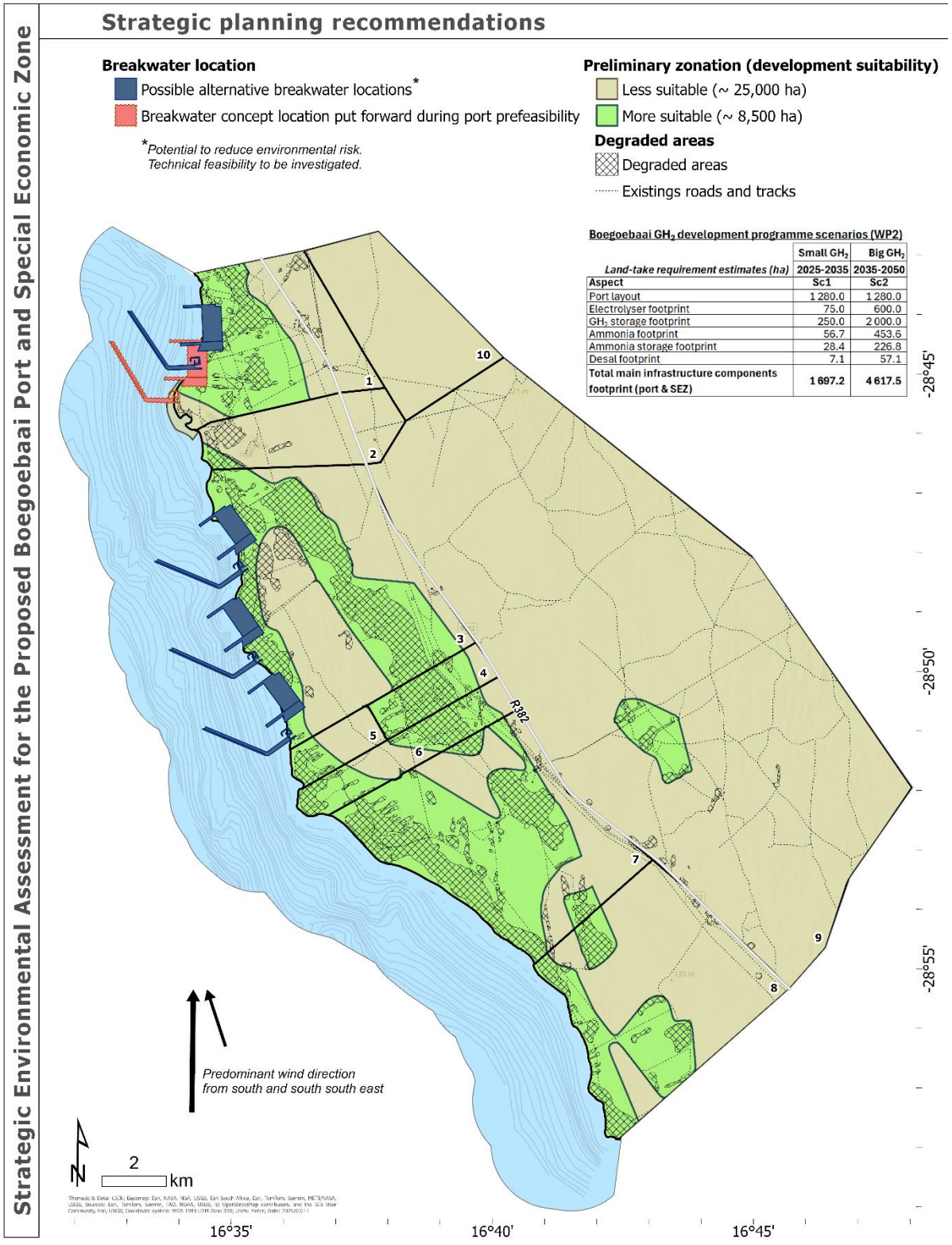


Figure SPM 7: Proposed zonation scheme for the proposed Boegoebaai port and SEZ focussing on potential alternative breakwater locations which avoid the most sensitive areas of the Boegoebaai head. Areas identified as potentially 'more suitable' for development (~8,500 ha) target already degraded land and comfortably support the envisaged spatial footprints of planned port and SEZ-related infrastructure, which is estimated to be in the range of ~ 1,700 to 4,600 ha of land.

3.5 Filling gaps in a data-poor environment

It is recommended that a long-term environmental monitoring programme be established early in the project lifecycle to address data gaps caused by the remoteness of the Boegoebaai site. This programme should prioritise the consistent collection of inter-seasonal field data on climate, oceanic processes, environmental quality, and biodiversity. This will provide the scientific foundation necessary for informed decision-making, effective environmental management, suitable offset areas and interventions, and climate resilience planning throughout proposed development and operational phases.

3.6 Thinking strategically about biodiversity offsets

3.6.1 Terrestrial environment (after Botha 2025)

Offsets will be triggered due to the presence of restrictive statutory planning features such as CBAs and listed threatened ecosystems, internationally listed designations (e.g., KBAs) as well as habitat for many SCC, which cover large parts of the SEZ and its immediate vicinity. While the scale of impact varies significantly, from over 21,000 hectares for a Small GH_2 scenario to more than 144,000 hectares for a larger one (see Work Package 2), approximately 40,000 hectares of offsets might be required for a Small GH_2 scenario alone (if the early layout plans put forward are pursued).

Box SPM 23: What are Biodiversity Offsets?

Biodiversity Offsets are the measurable outcomes of compliance with a formal requirement contained in an environmental authorisation to implement an intervention that has the purpose of counterbalancing the residual negative impacts of an activity, or activities, on biodiversity, through increased protection and appropriate management, after every effort has been made to avoid and minimise impacts, and rehabilitate affected areas.

If the potentially significant impacts posed by the currently proposed port and SEZ development on several threatened, rare or conservation-worthy biodiversity features (most of which are considered strictly "non-offsetable"), cannot be avoided, mitigation should be reframed as Ecological Compensation (Box SPM 24) rather than "offsets *sensu strictu*". This distinction is important for clear communication with stakeholders, highlighting that some biodiversity losses are irreversible and impact conservation goals.

Box SPM 24: What is Ecological Compensation?

The outcome of measurable actions to protect, restore and manage priority biodiversity, aimed at compensating for residual negative impacts on irreplaceable biodiversity and ecological infrastructure where these impacts cannot be offset and which should, instead and in the first instance, be avoided.

To minimise or address the need for offsets, all developments should be located on disturbed mining areas, as this aligns with the mitigation hierarchy and would not trigger offsets. For areas affected by windblown sand and sand plumes, while not considered similarly transformed, low offset multipliers are proposed, as restoration in these areas might still be possible and desirable to reduce risks to GH_2 facility and infrastructure management. Crucially, habitat loss in areas of **VERY HIGH** sensitivity, particularly those with irreplaceable biodiversity value, is deemed unacceptable as it may compromise the ability to meet conservation targets, and residual impacts on such irreplaceable biodiversity cannot be offset.

There are dangers associated with project-level offset assessment and ad hoc implementation of offsets, as suitable sites may become unavailable over time or costs could become unacceptably high. Therefore, the primary task for project-level EIAs is not merely the technical calculation of loss:gain metrics, but to identify, negotiate, and secure access to suitable offset sites and the most appropriate and durable implementation or management arrangements. Proactive offset schemes are preferred because they are better at addressing cumulative impacts, managing threats, and ensuring successful implementation and outcomes (Box SPM 25). Three large-scale offset receiving environments for offsetting the impacts related to the port and SEZ are proposed, suggesting that most SEZ impacts can plausibly be compensated within these areas (Figure SPM 8). Additionally, sufficient area exists within identified and approved protected area (PA) expansion priority focus areas to offset impacts from regional RE developments– dealt with in Work Package 2. Regional RE generation will also require offsetting in affected ecosystems. An existing proactive offset scheme pilot around Namaqua National Park could be expanded to receiving environments near the SEZ for local impacts, and to other parks or reserves for regional impacts.

Box SPM 25: Coordinated offset planning and implementation

To avoid the risks of fragmented, sequential offsetting, such as loss of suitable sites, legal delays, land use conflicts, and poor conservation outcomes, offset areas for the Boegoebaai Port and SEZ should be proactively identified, secured, effectively protected and rehabilitated. Funding should be guaranteed for long-term management through an endowment-type instrument. This approach would offer greater certainty to regulators, authorities, communities, and stakeholder.

The Richtersveld CPA, as the legal landowner entity, together with other community structures and land users, should be proactively involved in the design and implementation of any biodiversity offset to build trust, ensure local benefit, and secure long-term success.
Offsets should prioritise statutory protection of community identified priority areas.

Furthermore, a dedicated coordination body should be established to oversee implementation, with governance (regulators and landowners) clearly separated from implementation (state or private entities), to reduce contestation and streamline delivery.

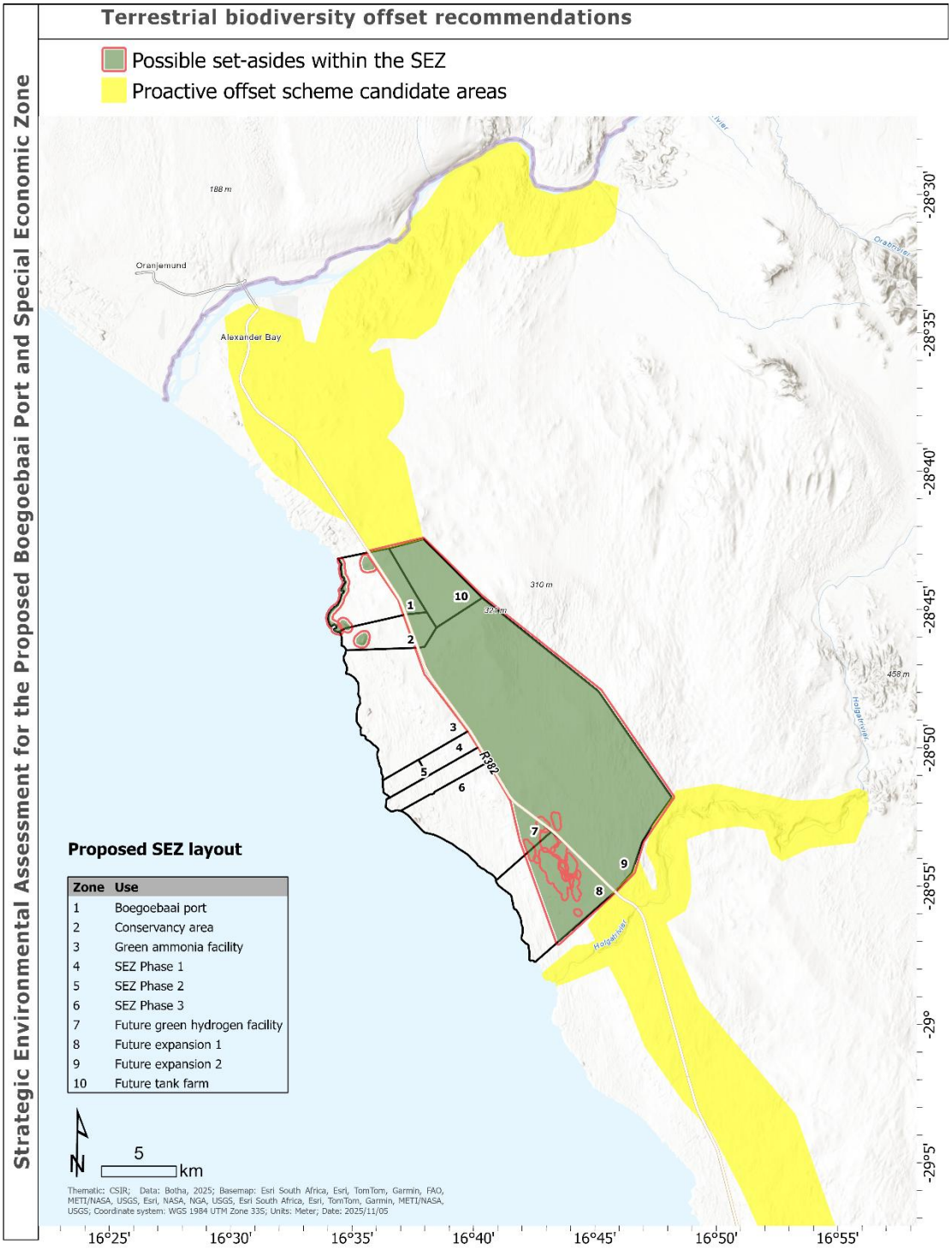


Figure SPM 8: Prospective Offset receiving areas around the SEZ. Note the *Possible set-asides within the SEZ,* East and West of the R382, are also included in this figure, in line with the recommended areas where development is best avoided, as outlined in Section 3.3 above. No attempt to redesign the "conservancy" zone as an Offset receiving area is made (see Box SPM 22:, Section 3.3).

3.6.2 Coastal/marine (after Clark et al., 2025)

According to the Draft Marine Biodiversity Sector Plan (DFFE, 2023), the establishment of a new port is considered incompatible with areas classified as CBA Natural or CBA Restore. The environmentally preferrable option is to avoid such areas altogether. However, complete avoidance may not always be feasible, as numerous small CBA Natural areas are widely scattered along the coast, and a significant portion of the offshore marine environment in the study area is classified as CBA Restore. In circumstances where avoidance is demonstrably not possible, best practice guidance recommends the application of biodiversity offsets or the identification of alternative CBA areas to meet conservation targets. However, it is strongly advised that such provisions do not apply to Boegoebaai Point, which is considered irreplaceable due to its very high ecological sensitivity.

South Africa's National Biodiversity Offset Guidelines (2023) apply to terrestrial and freshwater systems and are not applicable to marine and estuarine environments. While the guidelines do not explicitly explain this exclusion, they do clarify that this does not exempt marine and estuarine systems from offset responsibility. Considering this regulatory gap, deferring to the International Finance Corporation (IFC) biodiversity offset requirements is considered appropriate in this context. IFC Performance Standard 1 requires that biodiversity offsets be applied only after all feasible avoidance, minimisation and restoration measures have been implemented, to address residual impacts on natural habitat. According to IFC Performance Standard 6, offsets must deliver measurable, on-the-ground measurable conservation outcomes to achieve like-for-like or better ecological value and scale. The decision to undertake a biodiversity offset cannot act as a replacement for mitigation and management measures to avoid significant impact.

The following key steps are recommended for designing biodiversity offsets to mitigate impacts on CBA Natural and CBA Restore areas:

- Scoping, in consultation with relevant stakeholders, of potential conservation activities or offset sites within the landscape that could benefit the biodiversity values potentially impacted by the project (i.e., "like-for-like or better").
- Assessing if the loss of biodiversity at the project site can be compensated by gains at the offset site.
- Identifying means for securing offset activities over the long term, including, for example, legal protections.
- Establishing an effective process for communities affected by the offset to participate in the design and implementation of the biodiversity offset.
- Defining the specific offset activities and how they will be implemented in a biodiversity offset management plan, including the roles, responsibilities, and budget projections for the involved parties.
- Establishing a funding mechanism to support the offset for as long as project impacts persist.
- Designing a system for monitoring, evaluation, and adaptive management.
- Ensuring that the project meets all applicable laws, regulations, and policies pertaining to biodiversity offsets.

3.7 Principles guiding sustainable port planning (after Taljaard & Weerts, 2025)

To plan a sustainable port, it is essential to implement a balanced approach that integrates economic growth, environmental protection, and social progress from the earliest planning stages to ensure long-term viability and secure its 'license to operate'. A robust Framework for Sustainable Port Planning and Development (SPP&D), aligned with best practices, is crucial, covering governance, environmental, social, and economic domains. In terms of governance, key criteria include establishing a legislative framework, fostering an organizational culture geared towards sustainability, allocating dedicated budgets, implementing public communication mechanisms, and setting up formal institutions for engaging both port customers and external stakeholders, alongside fostering collaborative arrangements with adjacent local authorities. This also necessitates comprehensive environmental assessment and management throughout the project lifecycle, encompassing SEAs, EIAs with associated Environmental Management Programmes (EMPrs), and contingency planning.

Box SPM 26: What are Sustainable Ports?

Sustainable ports can be defined as:
"Ports which adhere to the concept of resource saving and environment-friendly development, actively fulfilling its social responsibilities, and comprehensively adopting technologies and management measures that are conducive to saving resources and energy, protecting environment and ecology, and coping with climate change" Guo and Liu (2018)

Environmental considerations are paramount and include eco-efficiency measures such as water and energy use efficiency, selecting eco-friendly materials, robust waste management (including recycling and minimising construction waste), and efficient, responsible land/sea use through spatial planning, along with addressing climate mitigation. There must be transparent reporting on potential impact sources like atmospheric emissions, noise, wastewater discharges, and solid/hazardous waste, ensuring compliance with environmental standards and conducting regular audits. Environmental quality must be effectively monitored for air, noise, marine water, marine sediment, soil, and groundwater quality, along with controlling marine invasive species and assessing the status of terrestrial and marine habitats and biodiversity.

Box SPM 27: Key Sustainability Criteria developed for the proposed Boegoebaai Port

To align port sustainability planning with performance assessment and reporting, consistent frameworks and indicators are essential. The port sustainability performance (PSP) Index, developed with TNPA, guided the sustainability criteria for the proposed Port of Boegoebaai. These criteria are structured under four sustainability pillars and aligned with relevant SDGs. They include legislative support, institutional arrangements, and sound management practices, ensuring planning integrates measurable, globally comparable, and locally relevant sustainability outcomes for effective sustainability performance assessment and reporting.

Crucially, planning must incorporate sensitivity assessments to avoid habitat loss in areas of VERY HIGH sensitivity, particularly those with irreplaceable biodiversity value, as residual impacts on such irreplaceable biodiversity cannot be offset and compensation would not be feasible. Where impacts are unavoidable, biodiversity offsets serve as significant effective ecological compensation, with a preference for proactive offset schemes to better address cumulative impacts and ensure successful outcomes. **Developers should also prioritize locating facilities on disturbed mining areas where possible, as this aligns with the mitigation hierarchy and would not trigger offsets.**

Social sustainability requires attention to **community wellbeing through corporate social initiatives, ensuring access rights for communities where appropriate**, community-based environmental education, supporting sustainability-related community enterprises, and investing in research, development, and innovation. Support for local and small businesses is vital, as are sound port-municipal relations and, importantly, **the protection of cultural heritage assets**. Employee satisfaction and wellbeing, including training, engagement forums, and addressing grievances, are also integral. Additionally, capacity building and training on sustainability planning and the implementation of key criteria for all involved stakeholders should be prioritised if the project is approved and goes ahead, reinforcing commitments under employee satisfaction and wellbeing.

From an economic perspective, **planning must account for climate resilience**, including preparedness, early warning systems, and incident assessment. It involves ensuring high service quality and efficiency through technical capacity, potable water supply, customer satisfaction, security, digitalization, and maintaining infrastructure quality. The port should contribute to economic growth and development through revenue generation, employment opportunities, and fostering new business production. **Effective inter-connectivity, both hinterland and international, is also a key economic criterion**. Finally, foresight of likely future development plans (industrial, urban, suburban) is essential for spatial planning to avoid future port-city and port-community conflicts. Given the remoteness of some areas, securing access to long-term, inter-seasonal field data on climate, oceanic processes, environmental quality, and biodiversity is a critical challenge that must be resolved early in the planning process.

3.8 Equitable consultation and negotiations (after Atkinson et al., 2025 & Gammage et al., 2025)

The Boegoebaai region, located in the Richtersveld of the Northen Cape holds deep cultural and ecological significance. Historically, the area was shaped by mining, particularly through operations by Alexkor, which led to restricted access and displacement of traditional uses. The Richtersveld community, through the Richtersveld Communal Property Association (RCPA), reclaimed land rights in a landmark restitution case. This land now forms the basis for major developments, including the proposed Boegoebaai Port and SEZ. As such, the RCPA must be a central actor in any development and land-related negotiations. The RCPA would be crucial in facilitating community-level engagement by acting as intermediaries between external developers and local communities.

The proposed development promises transformative economic potential, but it has also raised concerns. The area surrounding Boegoebaai contains ancestral graves, sacred natural features, and traditional fishing grounds that are central to the identity and heritage of local communities. Past experiences of exclusion from decision-making, limited benefits from mining, and environmental degradation have created a legacy of mistrust. Without meaningful engagement, there is a risk of repeating patterns of marginalisation and cultural erosion. A constructive and inclusive dialogue must go beyond conventional stakeholder consultation. It should be **early** in the project design stage, **inclusive, culturally appropriate, continuous, collaborative,** and communities be resourced to participate meaningfully.

The principle of Free, Prior and Informed Consent (FPIC) is a globally recognised standard for engaging Indigenous and local communities in decisions that affect their land, resources, and cultural heritage. The Socio-economic Report for Work Package 2 (Atkinson et al., 2025) of the SEA draws on the Initiative for Responsible Mining Assurance (IRMA) in outlining that FPIC is not just a one-time engagement tool but a comprehensive principle grounded in Indigenous people's rights to self-determination, land, culture, development, and a healthy environment. as a right grounded in self-determination. The framework outlines practical steps to ensure constructive and inclusive engagement with Indigenous people during consultation processes:

Box SPM 28: FPIC Principles

- **Free:** Consent must be voluntary and without coercion.
- **Prior:** Engagement must occur before any project decisions or activities begin.
- **Informed:** Communities must receive full, accessible, and culturally appropriate information.
- **Consent:** Communities have the right to approve or reject, and to withdraw consent.

- **Tailor engagement methods** to each Indigenous group's preferences and context.
- **Jointly identify affected rights and interests,** ensuring that community concerns guide discussions.
- **Collaborate on further assessments** to fully understand potential impacts, including commissioning independent research if needed.
- **Support informed participation** by addressing capacity constraints through funding, training, and joint learning activities (e.g. workshops or site visits).

- **Promote broad community involvement** to avoid over-reliance on representatives and ensure collective input.

It is highlighted that FPIC is not a once off but a continuous process. It must be embedded in governance structures and respected by all stakeholders, including developers, government and financiers.

To ensure equitable consultation and uphold FPIC, the following are recommended (but not limited to):

- Integrate and implement the FPIC framework within project governance structures and decision-making processes, and ensure it is a continuous process.
- Undertake inclusive negotiations with the landowners in all stages of the development process.
- Conduct independent pre-negotiation scoping to assess community readiness and expectations.
- Ensure that land access agreements are negotiated transparently to obtain full support of the CPA and affected communities.
- Respect the land restitution history and communal governance structures, avoiding top-down impositions.
- Adopt a collaborative, community-centred approach from the project scoping and design stage, ensuring that diverse local needs, knowledge systems, and priorities are meaningfully integrated into planning and decision-making to achieve more inclusive, flexible, and sustainable outcomes.
- Provide financial and technical support to communities to engage effectively.
- Engagement should be culturally appropriate, multilingual, and accessible.
- Create independent grievance redress systems that are legally supported and culturally sensitive.
- Establish citizen science and community-led monitoring to track environmental and social impacts.
- Develop benefit-sharing models that prioritise historically marginalised groups.
- Ensure post-project transitions include land restoration, cultural preservation, and economic diversification.

4. IMPACT MANAGEMENT PRINCIPLES AND PRACTICES

This section presents a summary of the potential impacts and synthesises suggestions for management principles and actions which might mitigate negative impacts and enhance positive ones.

Table SPM 5: Summary of potential impacts and associated recommended management principles and actions for the proposed Boegoebaai Port and SEZ

	Impact	Principles/actions for management (enhancement and mitigation)
MARINE ECOLOGY	Disturbance and harm to marine fauna, including physiological and behavioural effects, recruitment disruption, and species displacement or mortality.	Consider relocating the port to avoid areas of high ecological sensitivity (especially seal and seabird colonies); avoid construction during sensitive life stages of fauna.
	Degradation of benthic and demersal communities, including habitat loss, smothering and altered community structure.	Avoid development in areas designated as CBA-Restore and ESA; consider biodiversity offsets (in line with applicable guidelines) where impacts cannot be avoided.
	Hydrodynamic alterations, such as changes in longshore currents and littoral drift, potentially affecting coastal sediment transport and ecosystem stability.	Consider alternative sites with less ecological sensitivity and similar bathymetric suitability; avoid locations where wave and current patterns are critical to habitat stability.
	Loss and degradation of marine habitats, including permanent loss of unconsolidated seafloor and associated communities due to infrastructure placement.	Avoid infrastructure placement in critical or irreplaceable habitats like rocky reefs and CBA-Restore zones; use the mitigation hierarchy: avoid → minimise → offset.
	Disturbance to marine fauna, caused by elevated underwater noise levels, light emissions, ship strikes, and seawater intakes.	Avoid areas where seals and cetaceans breed or aggregate; consider relocating to avoid risk zones; restrict activity near colonies.
	Degradation of water quality, resulting from routine vessel discharges, operational spills, brine discharges, increased turbidity, and remobilisation of sediment-bound contaminants.	Site desalination plant discharges away from ecologically sensitive zones; control pollution from ships and ensure monitoring of effluent impacts.
	Loss and alteration of marine habitats, including permanent loss of unconsolidated seabed and disruption of associated benthic communities.	Avoid ecologically sensitive unconsolidated habitats; if unavoidable, consider habitat rehabilitation and offsetting strategies.
	Accidental hydrocarbon spills / releases (e.g. vessel accident, bunkering and pipe rupture)	Develop spill contingency plans and ensure rapid response capacity; avoid port placement in highly sensitive coastal environments.
INTEGRATED TERRESTRIAL AND AQUATIC ECOLOGY	**Aquatic Ecosystems**	
	The planned Boegoebaai Port development in Zone 1 may extend into recharge areas of nearby wetlands or pans, threatening their sustainability due to uncertain hydrological drivers.	Avoid development in recharge-sensitive areas; include hydrological buffers and retain natural flow paths.
	Inclusion of northern section of BB1 in the Zone 2 conservancy area resulting in potential protection of recharge areas for the pan, its wetland, and associated spring.	Include or designate upper section of BB1 pan in conservancy; protect full recharge zones.
	Construction of the confirmed Green Hydrogen and Ammonia Facility in Zone 3 may lead to wetland and pan degradation, stormwater and vehicle disturbances	Avoid high sensitivity areas (CR wetlands); buffer wetland edges; manage stormwater impacts.

	Impact	Principles/actions for management (enhancement and mitigation)
	Development of Phases 1–3 of the SEZ Industrial Park in Zones 4–6 may result in destruction of CR pan and wetland habitat (BB3), nutrient enrichment, and hydroperiod disruption.	Avoid watercourse BB3 (ephemeral pan with wetland elements); maintain hydroperiods; control nutrient and runoff loads.
	The proposed future Green Hydrogen Facility in Zone 7 may destroy presumed natural (BB6) and artificial pan (BB4 and BB5) and wetland habitats and alter hydroperiods through physical disturbance.	Avoid southwest of Zone 7 (presumed natural pan BB6); maintain flow paths; restrict development in sensitive zones.
	Development in Zone 8 may lead to the destruction of presumed natural pan and wetland habitat and artificial pans BB7 and BB8, hydroperiod disruption, and flow-related degradation.	Avoid northern part of Zone 8; protect surface flows and ground-truth habitats.
	Expansion activities in Zone 9 may result in destruction of pan habitats, eutrophication, broader ecosystem degradation, and biodiversity loss.	Avoid sensitive aquatic features, rock blasting, flattening of slopes and/or loss of rocky outcrops that could include ephemeral rock pool and pan habitat; establish runoff controls and ecological corridors.
	Terrestrial Ecosystems (including avifauna; bats; mammals, reptiles and amphibians; vegetation and flora)	
	Construction of port infrastructure in Zone 1 and SEZ infrastructure across Zones 3 to 10 may cause vegetation loss (part of a CR ecosystem, irreplaceable CBA1 or optimal CBA2, a Priority Focus Area of the NPAES and a KBA), habitat fragmentation, loss of SCC and endemic species, ecosystem service decline, erosion, and faunal disturbance.	Avoid Very High sensitivity areas; prioritise disturbed sites west of R382 (provided priority habitat are not negatively impacted). Also avoid transformed areas within the Namib Seashore vegetation type, as it is very small and classified as Critically Endangered.
	Handling manganese, zinc, and lead in Zone 1 may lead to dust emissions, air pollution, and toxicity affecting soil and water quality.	Use enclosed handling; monitor and manage emissions; avoid sensitive habitats.
	Conveyor systems planned for Zone 1 may pollute soil/water and act as barriers to animal movement.	Fully enclose; monitor emissions; design to allow fauna passage.
	Dust suppression activities in Zone 1 may result in environmental contamination if not properly managed.	Develop clear waste protocols and manage dust control measures responsibly.
	Operation of the desalination plant in Zone 1 and Zone 3 may harm marine fauna via intake systems and brine discharge, and introduce thermal/chemical pollution.	Specialist input (marine ecologist) on intake/discharge sites; monitor discharge and mitigate thermal impacts.
	The sewage infrastructure in Zone 1 may lead to groundwater contamination, nutrient pollution, and challenges with sludge management.	Avoid sensitive areas; use robust treatment systems and secure sludge management. Positive impacts could arise if nutrients are recovered and used as fertilizers.
	Stormwater infrastructure in Zone 1 could spread pollution, introduce invasive species, and impact groundwater.	Separate clean/dirty water; install filters; monitor and manage runoff.
	Installation of electrical infrastructure in Zone 1 will add to vegetation clearance, construction emissions, electrocution risk, and habitat fragmentation.	Avoid high sensitivity areas; plan routes to minimise impact; bird-safe infrastructure.
	Fuel storage infrastructure in Zone 1 and Zone 10 may lead to soil and groundwater contamination, VOC emissions, and fire/explosion risks.	Avoid sensitive ecosystem, containment infrastructure; air movement modelling (in consideration of Namib Lichen Fields); fire risk protocols.
	Construction of roads, bridges, pipelines and powerlines in Zone 1 may fragment habitats, restrict fauna movement, increase roadkill risk, and promote erosion and invasive species.	Avoid sensitive areas; fauna underpasses; erosion control; alien species management.
	Widening of the R382 in Zone 1 may cause additional vegetation loss and increase pollution from traffic.	Minimise footprint; implement pollution and erosion controls.

	Impact	Principles/actions for management (enhancement and mitigation)
	Establishing a conservancy in Zone 2 may lead to partial protection of CR ecosystems and remnant intact vegetation, however air pollution from the neighbouring development could negatively affect lichens in this zone pollution. Extending the area across the R382 without suitable fauna crossing will likely result in SCC mortality increase.	Refine boundary to include the entire Boegoeberg North; all development to avoid Zone 2; monitor lichen health; enhance ecological representation (rehabilitation).
	The electrolyser facility in Zone 3 may create high water and energy demand, chemical pollution, and explosion risks.	Avoid Very High sensitivity areas; optimise resource efficiency; ensure chemical safety and leak detection
	The ammonia facility in Zone 3 and across Zones 7 to 9 may result in ammonia toxicity, air/soil contamination, and bat mortality from hot steam discharge.	Monitor emissions; include bat protection; avoid sensitive roost zones
	Use of a firewater system in Zone 3 could increase salinity when using seawater and introduce marine pollution when using firefighting foams.	Use environmentally compatible systems; specialist guidance on use and containment.
	The proposed development (across all zones) may create habitat for corvids that predate heavily on small, slow-moving tortoises. Predation can lead to population declines in tortoises.	Discourage nesting structures; manage corvid populations adaptively.
	Construction activities across all zones may disturb fauna, increase injury/mortality risk, and cause trench-related deaths.	Limit noisy/lighted work to daytime; restore trenches immediately.
	Earthworks across all zones may destroy roosting habitats for birds and bats.	Avoid active roost zones; rehabilitate areas post-disturbance.
HERITAGE	**Palaeontology**	
	Fossil material may be uncovered during bulk earthworks or excavation, or during backfilling of soils from mine dumps across all zones.	Include palaeontologist in EIA stage to determine the need for a palaeontological specialist study; apply standard palaeontological chance find protocol.
	Construction could expose and/or destroy raised beach deposits.	
	Terrestrial Archaeology	
	Construction could expose and/or destroy MSA scatter at Namakwakop in Zone 1 and MSA sites in old sea cliffs buried by wind-blown sand along the coast (Zones 1, 2, 3, 5, 6, 7 & 8).	Undertake detailed archaeological field surveys for each development or project - archaeologists will be required to identify and prioritise sites that are most representative of each development footprint for sampling (this may include the selection of sites of lower individual significance where they contribute meaningfully to understanding the broader archaeological context of the area); Conduct continuous archaeological monitoring during earthworks, particularly in coastal zones where buried middens may be present.
	Destruction of LSA middens and other occupation debris along the coast (Zones 1, 3, 7, 8 and likely other coastal zones), at the pans in Zones 3, 4, 6 & 7 and at inland locations at water sources (Zone 9).	
	Graves	
	Known graves at Boegoeberg South may be impacted by the development.	Engage with local communities and heritage authorities prior to development to assess potential for reburial of human remains. Implement chance finds protocol; halt work immediately and notify heritage authorities if graves are found
	Chance uncovering of unmarked or undocumented graves across all zones during construction.	
	Maritime Heritage	
	Construction of offshore port infrastructure could disturb submerged shipwrecks.	A Maritime Heritage specialist study will need to be included in the heritage application for the Port development, as well as any other developments that might require, for example, undersea pipelines.
	Potential disturbance to shipwrecks during installation of undersea infrastructure (pipelines/cables) in Zones along the coast (Zone 3, 5, 6, 7 & 8).	

	Impact	Principles/actions for management (enhancement and mitigation)
	Living Heritage	
	Development would disrupt transhumant grazing and herder movement patterns and prohibit access to the area, particularly in Zones 2, 9 and 10.	Engage with the local herder community to understand the impact of losing winter grazing areas, specifically Swartbank and Witbank. Consultations should explore the reasons for selecting these areas, their seasonal value, possible alternatives, and the cultural significance of the grazing landscape.
	Development of the Port and SEZ would massively alter the landscape context in which small-scale herding occurs through the addition of industrial facilities.	
	Development of the Port and SEZ could alter the connection between the local community and the coastline.	Consult the local community to identify ways to strengthen their coastal connection, particularly regarding traditional fishing livelihoods.
	Cultural Landscape	
	Development of the Port and SEZ will irrevocably alter the sense of place of the region through the addition of industrial facilities; affecting scenic integrity and altering cultural landscape continuity.	Visual Impact Assessments required. Engagement with local communities, SANParks, UNESCO, SAHRA, and tourism operators is essential. Discussions should also be initiated with the South African Government and UNESCO about possible effects on the RCBL's World Heritage status.
FISHERIES & COASTAL LIVELIHOODS	Local communities, especially small-scale fishers and Nama groups, feel excluded from current governance processes, leading to mistrust.	Establish a cross-sectoral, inclusive marine governance platform that includes historically marginalised and hidden stakeholders.
	Past stakeholder engagement has lacked transparency, inclusivity, and cultural sensitivity, limiting trust and participation.	Develop transparent, culturally appropriate, ongoing stakeholder engagement processes based on co-creation, shared monitoring, and legal grievance mechanisms.
	Fragmented environmental and social impact assessments risk underestimating cumulative and long-term impacts.	Integrate cumulative impact assessments and harmonise regulatory frameworks through interdepartmental coordination and shared data systems.
	Fishing and coastal communities lack access to training and technical skills for marine sector opportunities.	Invest in localised skills development and just transition support, especially targeting youth, women, and informal workers.
	Infrastructure development risks gentrification and displacement of vulnerable local residents.	Plan for affordable, climate-resilient housing and ensure basic services are available to prevent community displacement.
	Absence of baseline data and long-term monitoring impairs adaptive management and learning.	Develop participatory monitoring, evaluation, and learning frameworks for ecological and socio-economic indicators.
	Small-scale fishers face threats to their livelihoods and cultural heritage from industrial encroachment and systemic exclusion.	Prioritise equitable benefit-sharing for disadvantaged groups through inclusive procurement, hiring, and training policies.
	Spatial competition from mining, oil/gas, and shipping displaces small-scale fishers and threatens ecosystem sustainability.	Use ecosystem-based Marine Spatial Planning to protect fishery areas and ensure access for small-scale fishers.
	The Boegoebaai project is a strategic test case for inclusive, sustainable marine development in South Africa.	Align development with national sustainability goals by embedding Indigenous knowledge, co-management, and equitable governance.

5. IMPLEMENTING GOOD EIA PROCESSES AND DE-RISKING PROJECTS

Diligent, proactive and best-practice planning and implementation of robust EIA processes are a key tools for de-risking projects. "Managing the Impacts of a Green Hydrogen/Power-to-X Economy: An Environmental Assessment Guideline for South Africa" (Schreiner et al., 2024) provides extensive guidance on this. This section summarises these recommendations.

5.1 Appointing the Environmental Assessment Practitioner

When a proponent initiates project conceptualisation in some detail, in consultation with engineers, and made an initial decision to proceed, one of the first steps is to appoint a suitably qualified, experienced, and professionally registered Environmental Assessment Practitioner (EAP)[20]. Developers should engage an EAP to work collaboratively with the technical and financial teams at the earliest stages of project planning. This will allow the EAP to develop a full appreciation of the complexity and scale of the project and to de-risking the project from an environmental and social perspective (Figure SPM 9).

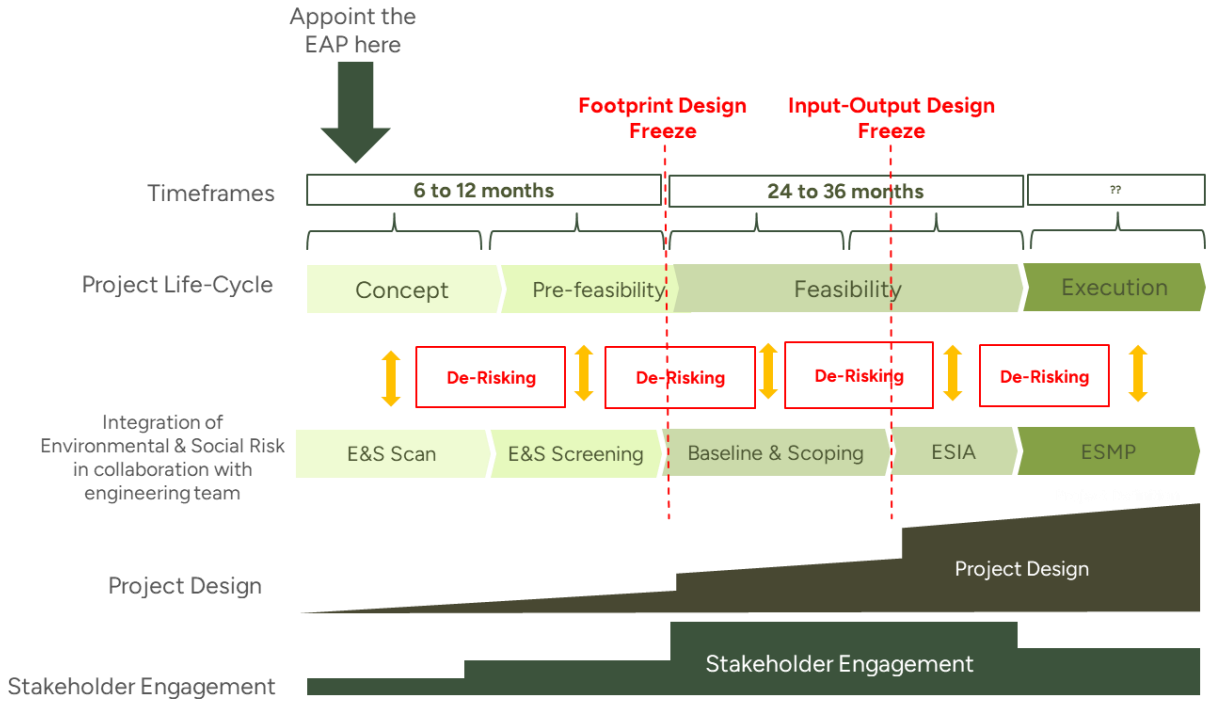


Figure SPM 9: Early appointment of an Environmental Assessment Practitioner and integration of environmental and social risks into the large-scale port and GH_2 project development lifecycle is critical to de-risking projects. (Source: SLR in Schreiner et al., 2024)

5.2 Integrating lender considerations

Large-scale development projects often rely, fully or partially, on financing from third party banks, lenders and investors who may subscribe to the Equator Principles and International Finance Corporation (IFC) Performance Standards (PS) (Table SPM 6). To unlock such funding, project proposals and EIAs will need to

[20] EAPs must be registered with the Environmental Assessment Practitioner Association of South Africa (EAPASA), mandated in terms of Section 24H of the NEMA.

be aligned with both the local EIA Regulations as well as international lender standards. Different financial institutions have different sustainability requirements, but typically most banks or lenders will use the Equator Principles and IFC Performance Standards to identify and manage environmental and social risks for their investment.

Table SPM 6: Summary of the Equator Principles and IFC Performance Standards that need to be met to unlock funding from major third party banks, lenders and investors.

Standard	Objective
Equator Principles (2020)	The Equator Principles consist of a set of principles and procedures adopted by financial institutions to ensure that the environmental and social issues associated with a project financed by those institutions are respected. The Equator Principles are summarised below: • *Principle 1 – Review and Categorisation*: The projects are classified into three categories according to the potential environmental and social risks they represent. • *Principle 2 – Environmental and Social Assessment*: It is necessary to carry out an environmental evaluation of the project that addresses the risks identified during the analysis and categorisation. • *Principle 3 – Applicable Environmental and Social Standards*: The projects implemented in emerging countries, apart from complying with local laws, must also follow the IFC Performance Standards and the WBG EHS Guidelines. • *Principle 4 – Environmental and Social Management System (ESMS) and Equator Principles Action Plan*: The projects must have an action plan to address the risks identified during the environmental evaluation. • *Principle 5 – Stakeholder Engagement:* It is necessary to promote and carry out consultations with the stakeholders in a culturally appropriate and structured manner. • *Principle 6 – Grievance Mechanisms:* It is necessary to establish mechanisms for ongoing involvement of interested and affected parties, to allow for the submission of grievances or issues, during all phases of project development. • *Principle 7 – Independent Review:* The environmental performance must be audited by independent experts, with experience in the area covered by the project. • *Principle 8 – Covenants:* The laws and regulations, licensing, and action plans, must be carried out in all aspects. • *Principle 9: Independent Monitoring and Reporting:* The projects should appoint an independent environmental and social expert to carry out the monitoring and produce additional reports. • *Principle 10 – Reporting and Transparency:* The financial institutions must publish information on the loans granted, at least annually, in accordance with the rules of the Equator Principles.
IFC Performance Standards (2012)	The IFC Performance Standards are applied to a project to manage E&S risks and impacts throughout the life of an investment. There are eight performance standards which establishes: • The importance of undertaking an integrated approach to identifying the E&S impacts, risks, and opportunities of projects; effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and effective management of E&S performance throughout the life of the project; and • Objectives and requirements to avoid, minimise, and where residual impacts remain, to compensate / offset for risks and impacts to workers, affected communities, and the environment. • PS 6 requires clear identification of biodiversity risks and appropriate mitigation, including offsetting. • PS7 emphasises safeguarding Indigenous Peoples' rights when projects affect their lands, resources, or cultural heritage. It requires companies to engage in meaningful, culturally appropriate dialogue and negotiation throughout the project lifecycle, ensuring informed consultation and participation rather than

Standard	Objective
	token engagement. Where impacts are significant—such as relocation or loss of livelihoods—PS7 mandates Free, Prior, and Informed Consent (FPIC), aligning with constitutional protections and customary rights recognized under South African law. This approach aims to foster trust, mitigate conflict, and promote equitable development outcomes by embedding respect for identity, dignity, and traditional governance structures into project planning and decision-making

5.3 Adequate consideration of alternatives

Alternatives are defined as different means of meeting the general purpose and requirements of the activity (Table SPM 7). Alternatives that maximise resource use efficiency (e.g., land, energy and water-use efficiency) and minimise waste production must be sought by the EAP. Although alternatives are to be considered as early as possible in the process, the necessity to consider modifications and changes, to prevent and/or mitigate impacts identified during the assessment process, may also arise.

Table SPM 7: Types of alternatives that should be considered during for large-scale port and GH_2 development projects, adapted after DEA&DP (2013)

Type of alternative	Explanation
Location	Refers to both alternative properties at regional or national scale, as well as alternative sites on the same property.
Activity	Where it is possible to undertake an activity which has the same project outcome but comes with less ecological and social costs.
Design or Layout	Different architectural styles, engineering designs, and technologies, or consideration of different spatial configurations on a particular site (e.g., siting solar PV away from wetlands).
Input	Input alternatives are applicable to applications that may use energy sources in their process (e.g., PtX projects considering wind versus solar PV inputs).
Routing	Consideration of alternative routes generally applies to linear developments such as power line servitudes, transportation, and pipeline routes.
Scheduling and timing	Where several measures might play a part in an overall programme, but the order in which they are scheduled might contribute to the overall effectiveness of the end result.
Scale and magnitude	Activities that can be broken down into smaller units and can be undertaken on different scales (e.g., sizing of solar PV facilities).
'No-Go' option	EIAs must include the "no-go" option as a baseline against which all other alternatives must be measured. The option of not implementing the activity must always be assessed and to the same level of detail as the other feasible and reasonable alternatives.

5.4 Identification of Listed Activities and specialist studies for future EIAs

The South African EIA Regulations (as amended in 2014), have been promulgated in terms of Chapter 5 of the NEMA. Their purpose is to regulate the preparation, evaluation, submission, processing, consideration of, and decision on, applications for Environmental Authorisation (EA) for the commencement of activities, subjected to environmental assessment, to avoid detrimental impacts on the environment and to mitigate impacts to an acceptable level when avoidance is not possible, and to enhance positive environmental impacts.

The key identified activities, that trigger the need for EA, that are likely applicable to port and PtX projects are outlined in Table SPM 8. Other identified activities may be relevant, depending on project design and specifications.

Box SPM 29: Other permits and approvals required.

In addition to EA various other permits and approvals will be required for infrastructure development, depending on the Project Description and receiving environment, including, but not limited to:

- Heritage Approval
- Atmospheric Emissions Licence
- Coastal Discharge Permit
- Use of vehicles in a coastal area
- Waste Licence
- Water Use Licence
- Approval to use land surface in a way which may contradict the Mineral and Petroleum Resources Development Act

Various specialist assessments will be required as input studies to inform, decisions on certain authorisations, permits and approval applications. Each specialist assessment should include an up-to-date review of the latest literature and legislation related to the specific theme it is assessing. Impacts must be assessed according to the project phases, i.e., construction, operation and decommissioning and in terms of their nature, extent, duration, consequence, probability of occurrence, irreplaceability, reversibility, potential for mitigation, cumulative effects, and overall significance. Clear ToRs for Offset specialist studies should be included, especially where these point to eligibility for participation in any established proactive offset scheme, and the required consents and interventions to secure offset outcomes – over a bland statement of biodiversity losses and gains.

The EAP, in consultation with stakeholders and with the use of the National Environmental Web-based Screening Tool will determine the most appropriate specialist studies for the project on a case-by-case basis, depending on the description and extent of the proposed project, and the state of the receiving environments. The following specialist studies might be required for large scale port and GH_2 development projects:

1. Marine Ecology Assessment
2. Fisheries Assessment
3. Terrestrial Biodiversity Assessment
4. Terrestrial Plant Species Assessment
5. Terrestrial Animal Species Assessment
6. Aquatic Biodiversity Assessment
7. Dispersion Modelling Study
8. Sediment Movement Study
9. Bird Assessment (+pre-construction monitoring)
10. Bat Assessment (+pre-construction monitoring)
11. Invertebrate Assessment
12. Agricultural and Soils Assessment
13. Archaeological and Cultural Heritage
14. Palaeontology Assessment
15. Socioeconomic Assessment
16. Noise Assessment
17. Visual and Landscape Assessment
18. Hydrology Assessment
19. Civil Aviation Assessment
20. Defence Assessment
21. Traffic Study
22. Major Hazardous Installation Risk Assessment
23. Radio Frequency Interference Assessment

Table SPM 8: Likely Listed Activities (non-exhaustive) which may be triggered for port and GH_2-related projects in the proposed Boegoebaai SEZ, per technology type, across Listing Notices 1, 2 and 3.[21]

Technology type	Listing Notice 1	Listing Notice 2	Listing Notice 3[22]
Port development	Activity 14; Activity 16; Activity 18; Activity 19A; Activity 23[23]	Activity 4; Activity 12; Activity 14; Activity 15[24]; Activity 23[25]; Activity 26	Activity 2 (g); Activity 3(g); Activity 12(g); Activity 14(g)
Seawater RO	Activity 9; Activity 12; Activity 16; Activity 17 (i) (e); Activity 19A; Activity 25	Activity 6; Activity 15; Activity 26	Activity 12(g); Activity 14(g)
Hydrogen via electrolysis	Activity 16; Activity 24(ii); Activity 25; Activity 27; Activity 28(ii)	Activity 4; Activity 7 (ii); Activity 15	Activity 12(g)
Ammonia via Haber-Bosch	Activity 16; Activity 24(ii); Activity 25; Activity 27; Activity 28(ii)	Activity 4; Activity 6; Activity 7 (ii); Activity 15	Activity 12(g)
Linear infrastructure (Roads, Pipelines, Powerlines)	Activity 9(i); Activity 10(i); Activity 11(i); Activity 24(ii); Activity 27; Activity 56(i)(ii)	Activity 9	Activity 4(g); Activity 18(g)
Onshore wind (likely to be developed in the broader region, not confined to the SEZ)	Activity 12; Activity 14; Activity 19; Activity 24; Activity 56	Activity 1; Activity 15	Activity 12(g)
Solar PV (likely to be developed in the broader region, not confined to the SEZ)	Activity 12; Activity 14; Activity 19; Activity 24; Activity 56	Activity 1; Activity 15	Activity 12(g)

6. CONCLUSION AND FINAL REMARKS

The study area assessed in Work Package 1 contains approximately 5,000 ha of heavily degraded or anthropogenically transformed land — the remnant scars of a century of diamond mining. Rather than further encroaching into high sensitivity ecological and social environments, the concept of 'regeneration' should be used to guide all proposed or future development in the region. Regeneration would dictate a repurposing of already-damaged landscapes as priority footprints for any new port or SEZ infrastructure. By targeting historically disturbed ground, any new infrastructure can avoid irreversible biodiversity loss, reduce pressure on Critically Endangered vegetation types, and redirect development away from cultural heritage landscapes of deep significance.

A regenerative strategy demands decisive intervention to halt and repair the region's escalating windblown sand crisis, which the SPM identifies as both an ecological threat and a practical engineering risk. Decades

[21] Listed Activities outlined do not reflect the full list of activities that would be applicable to a specific GH_2/PtX project. The full list of applicable Activities must be identified on a case-by-case basis by the EAP.
[22] The applicable Listing Notice 3 Activities would be identified on a case-by-case basis depending on potential triggers with regard to the thresholds or geographical restrictions related to the Northern Cape Province outlined in the listing notice.
[23] In the event that a wastewater treatment works is constructed and such works has a daily throughput capacity of more than 2 000 m^3 but less than 15 000 m^3.
[24] In the event that the Proposed Development will occur on an area of land of 20 hectares or more where such land has not been disturbed by mining or any other activity.
[25] This Listed Activity may be applicable subject to the piling mechanism selected, i.e., a piled structure over a gravity structure for the construction of a quay.

of mining have destabilised dune systems along the R382 and westward towards the coast, exposing loose sediments that now migrate unpredictably, smothering vegetation, degrading rare duneveld habitats, and burying ecological corridors. Without deliberate stabilisation measures, sand plumes will continue to expand, undermining both conservation objectives and any future infrastructure potential. Regeneration requires integrating sand-movement management, dune rehabilitation, revegetation using indigenous species, and engineered buffers directly into the design and phasing of the proposed port, SEZ, and associated haul routes. Instead of treating sand as an obstacle, regenerative planning sees dune restoration as one of the central long-term investments needed to restore any type of landscape resilience.

The concept of regeneration reframes development at Boegoebaai as a potential opportunity to heal ecological and social systems simultaneously. By avoiding pristine or irreplaceable habitats, prioritising degraded mining areas, and embedding sand-stabilisation and ecological restoration into early-stage planning, the infrastructure proposed in the region could help reverse patterns of degradation that have accumulated for generations. When paired with equitable governance and decision-making processes — including FPIC-driven engagement, with local communities, including Nama pastoralists and coastal communities — a regenerative framework positions the port and SEZ not as a new layer of extraction but as catalysts for restoring ecological function, safeguarding cultural heritage, and re-establishing long-term stability in a landscape currently under tremendous stress.

Box SPM 30: The principles guiding regeneration

Regeneration is a sustainability approach focused not merely on minimising harm, but on actively restoring, renewing and enhancing the ecological and social systems that development depends on. It recognises landscapes and communities as living systems capable of healing when supported. Its guiding principles include: repairing past damage, especially in degraded or previously exploited areas; working with natural processes such as dune dynamics and indigenous vegetation recovery; protecting irreplaceable ecological and cultural assets through strict avoidance; strengthening community wellbeing and agency; and designing infrastructure that restores more than it extracts, ensuring long-term resilience for people and ecosystems alike.

On the other hand, it is important to emphasise that poorly located or poorly designed infrastructure will not simply fall short of regeneration goals — it will actively make existing problems worse, possibly in an exponential way. Missteps in siting, as well as badly constructed and mismanaged infrastructure could accelerate the collapse of sensitive systems, intensify the windblown sand crisis, and trigger cascading and irreversible loss of social and ecological assets in the region.

7. REFERENCES

Atkinson, D., Gerber, H., Saayman, A., Borchardt, S. and Kirsten, S. (2025) Macro-economic, social and institutional impacts of the Boegoebaai Port and Green Hydrogen complex. Report to CSIR.

Botha, M. (2025) *Chapter 4: Biodiversity offset framework* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Clark, B.M., Ho, Y., Gammon, E., Biccard, A., Rees, A, Ulrich, A. & Wright, A.G. (2025). *Chapter 2: Marine Ecology* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

DEA&DP (2013) EIA Guideline and Information Document Series. Cape Town. Available at: https://www.westerncape.gov.za/eadp/sites/eadp.westerncape.gov.za/files/atoms/files/DEA%26DP_EIA_Guidelines_March2013.pdf.

Department of Trade, Industry and Competition (the DTIC) (n.d.) Special Economic Zones. Available at: https://www.thedtic.gov.za/sectors-and-services-2/industrial-development/special-economic-zones/

DFFE (2023) Draft Marine Biodiversity Sector Plan. South Africa.

DFFE (2023) The National Biodiversity Offset Guideline. G. 48841. GoN. Available at: https://www.dffe.gov.za/sites/default/files/legislation/2023-09/nema_nationalbiodiversityoffsetguideline_g48841gon3569.pdf

DTIC (2017a) Special Economic Zones Act: Saldanha Bay Industrial Development Zone: Amendment. G. 40883. GoN 504. Available at : https://www.gov.za/documents/special-economic-zones-act-saldanha-bay-industrial-development-zone-amendment-2-jun-2017

DTIC (2017b) Special Economic Zones Act: Coega Industrial Development Zone: Amendment. G. 40883. GoN 505. Available at: https://www.gov.za/documents/special-economic-zones-act-coega-industrial-development-zone-amendment-2-jun-2017-0000

FAO (Food and Agriculture Organization of the United Nations) (2009) Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing: https://faolex.fao.org/treaty/docs/tre000003E.pdf

Gammage, L. C., Zeeman Z., Mpala, A., Norton M., Ortega-Cisnero, K. & Ward, C. (2025) *Chapter 6: Fisheries and coastal livelihoods* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Guo X & Liu L. (2018) Approach to the Construction of Green Port in Tianjin Port. MATEC Web Conf. 175 04012. https://doi.org/10.1051/matecconf/2018175

Orton, J., Webley, L., Pether., J. & Maitland, V. (2025). *Chapter 5: Heritage resources* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Presidential Climate Commission (2022) Just Transition Framework. Republic of South Africa: https://pccommissionflo.imgix.net/uploads/images/22_PAPER_Framework-for-a-Just-Transition_revised_242.pdf

Schreiner, G., Mqokeli, B., Snyman-van der Walt, L., Lochner, P., Louw, H., Modise, S., Ruthenavelu, M., Zukulu, T. & Maluleke, J. (2024) Strategic Environmental Assessment for the proposed Boegoebaai Port, SEZ and Namakwa Region: Briefing note for research partners. CSIR, Pretoria.

Schreiner, G., Snyman-van der Walt, L., Heather-Clark, S., Van den Berg, S., Strong, A., Claasen, L., Russo, V., Mqokeli, B., & De Wet, B. (2024) Managing the Impacts of a Green Hydrogen/Power-to-X Economy: An Environmental Assessment Guideline for South Africa. CSIR: Stellenbosch. CSIR/SPLA/SECO/IR/2024/0005/B. Available at: https://greenhydrogensummit.org.za/resources/

Taljaard, S. & Weerts, S. (2025) *Chapter 7: Sustainable port planning* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Van Rooyen, G., Van Rooyen, N., Van Wyk, P., Day., L., Froneman, A., Colyn, R., Oosthuizen, M., Loftie-Eaton, M., Marais., W. & Niemandt, C. (2025). *Chapter 3: Terrestrial and aquatic ecology* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Work Package 1:

Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone

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CHAPTER 1

Introduction and context

CHAPTER 1: Introduction and context

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Recommended citation: Mqokeli, B., Schreiner, G., Snyman-van der Walt, L., Louw, H., Modise, S., Ruthenavelu, M., Zukulu, T. & Maluleke, J. (2025). *Chapter 1: Introduction and context* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR

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CHAPTER 1. INTRODUCTION AND CONTEXT

1.1 PURPOSE OF THIS CHAPTER

This chapter provides the background and context to, and the strategic rationale for, the proposed programme of development in the Northern Cape. The chapter outlines the main development components comprising the proposed Boegoebaai port and Special Economic Zone (SEZ), as well as outlining the approach and methods adopted by the Strategic Environmental Assessment (SEA).

1.2 BACKGROUND TO THE PROPOSED DEVELOPMENT PROGRAMME

Green hydrogen[1] (GH_2), and its derivative Power-to-X (PtX) products, such as green ammonia and green methanol, could decarbonise the South African energy economy, generate new revenues, create jobs and skills, and facilitate a Just Energy Transition[2]. As part of South Africa's ambition to reduce its reliance on fossil fuels and become a player in the globally emerging GH_2 market, the Northern Cape has proposed the development of large-scale GH_2 production in the region. The Northern Cape Green Hydrogen Masterplan (NCGHM) (2023) posits that GH_2 potential could be realised through the development of the proposed Boegoebaai port and rail project, an adjacent SEZ, and supporting regional energy generation and transmission networks and pipelines (Figure 1-1).

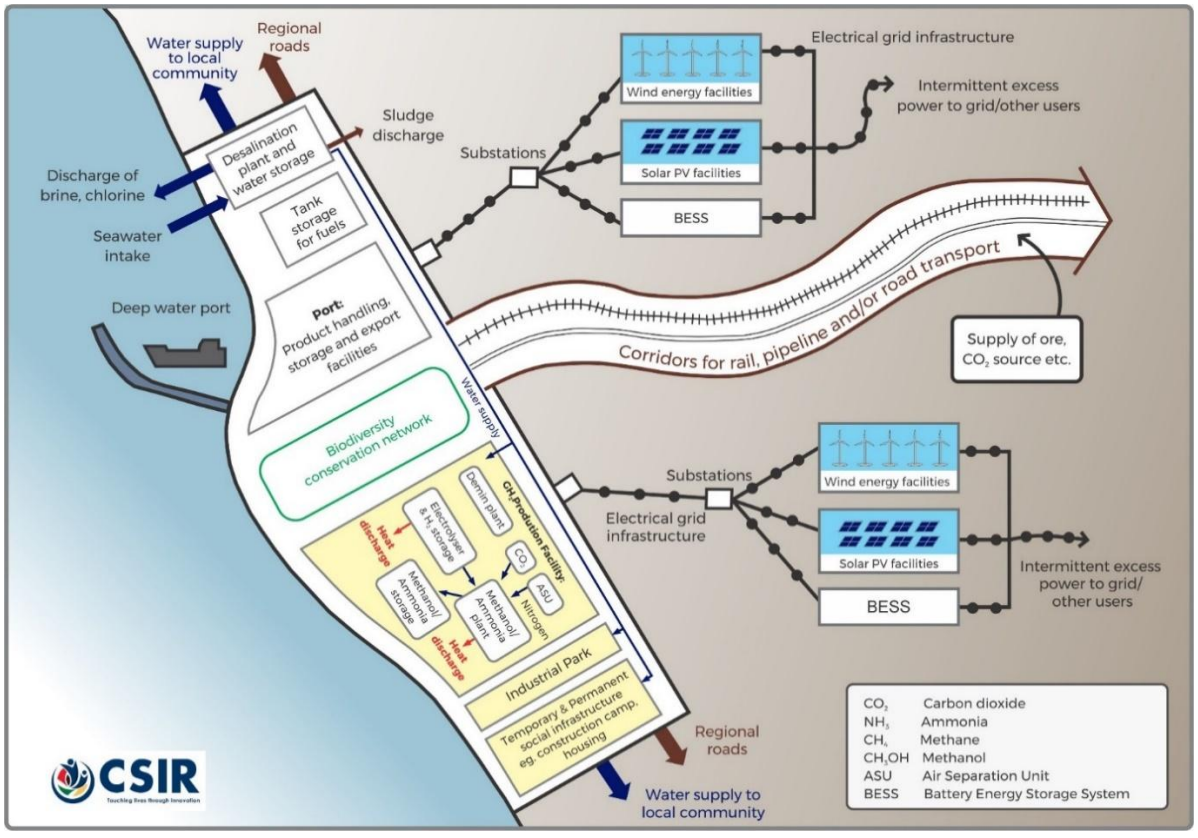


Figure 1-1: Schematic of the main infrastructure components for the Northern Cape regional GH_2 programme (notional drawing, not to scale).

[1] There are many different definitions and perspectives on the concept of "green". Here, we use the term in the narrow sense, meaning a product developed where upstream production facilities are supplied by renewable energy.
[2] The Just Energy Transition is a South African policy framework for managing the shift from a high-carbon to a low-carbon, economy in a manner that is socially equitable and inclusive.

As a signatory to the Paris Agreement, South Africa has committed to transitioning to a net-zero carbon economy by 2050. GH_2 may play a key role in realising this ambition (DSI, 2021). This transition aligns with South Africa's National Development Plan 2030 and Just Energy Transition agenda, which include the development of GH_2 as a keystone opportunity for the nation. With its very high solar and wind resource potential, South Africa is well-positioned to become a global player in the GH_2 economy, contributing to decarbonisation while creating jobs and enhancing energy security (The Presidency, 2025).

The Northern Cape, South Africa's largest province, is well positioned to become a leading GH_2 production hub, at the same time, contributing to the broader development of a national green hydrogen ecosystem across the South African energy and manufacturing sector (NCGHM, 2023). The *Boegoebaai Port and Rail Infrastructure Project: Northern Cape*, has been designated a Strategic Integrated Project (SIP) under SIP 21(o) (DPWI, 2020), as well as an industrial development initiative under the South African National Development Plan 2030. The *Boegoebaai Green Hydrogen Development Programme* has also received SIP status and will be overseen by the Presidential Infrastructure Coordinating Committee (DPWI, 2022).

While the primary export from the port would be green ammonia supplied to both international and local customers, the economic rationale for the port is also supported by the region's mineral endowments including iron ore, manganese, zinc, lead, and copper, and is home to approximately 24% of global manganese reserves. However, despite access to 338 km of Atlantic coastline, the province is currently economically 'landlocked'. All mineral exports are transported by road or rail to ports in other provinces, leading to high logistic costs and limited direct economic benefit from export activities. Limited access to port infrastructure has hampered the ability of both existing and emerging exporters to meet market demand. In some instances, such as manganese exports, neighbouring countries like Namibia have benefited economically from Northern Cape resources due to more accessible port infrastructure. The development of a deep-water port in Boegoebaai could reduce transport distances and costs, increase export competitiveness, and unlock substantial value for the provincial economy. This could further encourage industrial development within the SEZ, attract green manufacturing (e.g., solar PV and wind turbine production), and support the industrialisation of the regional economy.

The Northern Cape intends to establish 5 gigawatts (GW) of electrolyser capacity by 2030, supported by 10 GW of solar and wind power generation infrastructure. The long-term vision is to scale this to 40 GW by 2050. GH_2 production, at the scale envisaged, will be a diverse and multifaceted process with many direct and indirect impacts on social and ecological receiving environments, both positive and negative. All programme components, including their interconnected transport corridors, will require substantial areas of land surface, as well as other resource intensive inputs, all proposed in a sparsely populated but ecologically sensitive arid region. Existing, and potentially competing, land uses in the region include conservation, agriculture, fishing, tourism, mining, and other subsistence livelihoods (Figure 1-2).

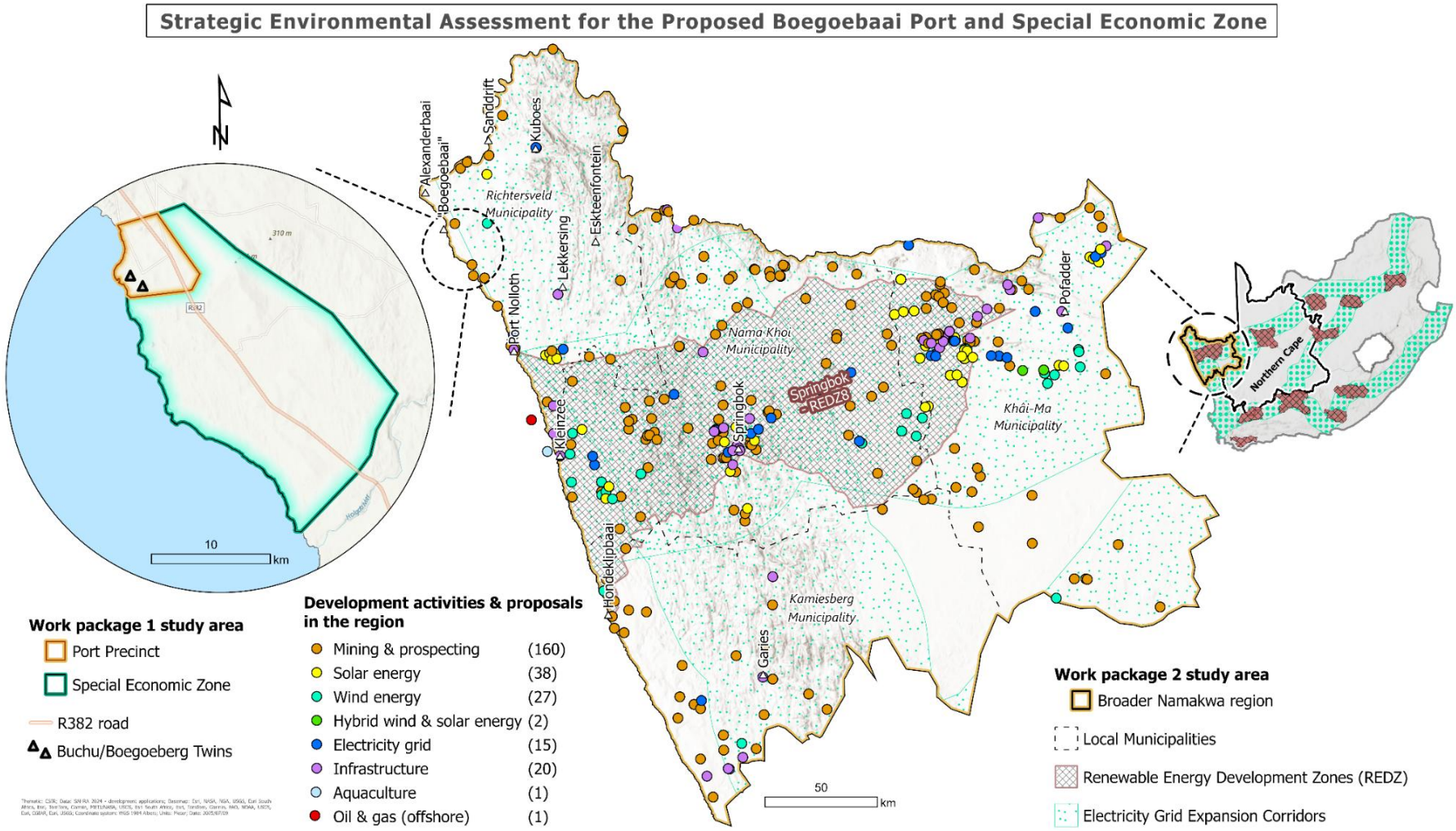


Figure 1-2: The proposed Boegoebaai port and SEZ (Work Package 1 study area) are located in the Richtersveld Local Municipality, Namakwa District, of the Northern Cape Province. Economic activities include widespread mining and prospecting. The area between Port Nolloth and Alexander Bay, including the land to the west of the R382 where the port and SEZ are proposed, has been mined for diamonds for over a century. A renewable energy sector is also emerging with established Renewable Energy Development Zones (REDZ) and Electricity Grid Infrastructure (EGI) Corridors.

If GH_2 products were to be produced at scale in the Northern Cape, the macro socioeconomic benefits could be substantial. Likewise, the local benefits across the entire value chain of GH_2 production, storage, transportation could help to create new opportunities, jobs and skills. But the social and ecological risks of development at these scales are not insubstantial and need to be guided by transparent, evidence-informed planning processes with a view to long-term sustainability. For this reason, a SEA was initiated through a collaboration between the South African National Energy Development Institute (SANEDI), the Northern Cape Economic Development, Trade and Investment Promotion Agency (NCEDA), and Transnet National Ports Authority (TNPA). Given their experience in SEA, renewable energy, port and GH_2 planning, the Council for Scientific and Industrial Research (CSIR) was appointed to play a coordinating role and undertake an independent SEA process

1.3 PROJECT ASPECTS

Given the multiscale scope of the SEA, its processes and outputs were split between two Work Packages (see Section 1.4). This section describes the types and scale of infrastructure and development activities considered within the scope of Work Package 1 of the SEA.

1.3.1 The Proposed Boegoebaai Port

The proposed short-term port layout (Figure 1-3), is intended to accommodate bulk liquid items such as ammonia and diesel oil, dry bulk materials such as iron ore and manganese, and assorted break bulk cargo, which arrives in bulk and is then separated into individual components, such as lead and zinc. Consequently, TNPA needs to make provision for the infrastructure necessary to facilitate the import and export operations for all these commodities. According to the current project schedule, an estimated 5 million tonnes per annum (Mtpa) of dry bulk (manganese) and 1.0 Mtpa of break bulk (lead and zinc) are expected to be exported by 2033. There are also plans to export 1.4 Mtpa of GH_2 derivatives and various agricultural products (0.2 Mtpa). Diesel imports are expected to reach around 1.3 Mtpa by 2033. All exports and imports will be transported mainly through the road network in the first phase of the new port.

The port will include a two-berth jetty connected to the land via an access trestle; a sea-side berth dedicated to dry bulk and liquid cargo and a conventional multi-purpose berth (landside). The berths are sheltered from wave energy by a concrete armoured breakwater. The bulk berth will be fitted with a ship loader and a conveyor system connected to landside closed stockpiles. The bulk berth will be capable of liquid bulk import and export, and fitted with pipelines that are connected to diesel and ammonia storage tanks. The multi-purpose berth will handle containerised cargo and break bulk using two mobile cranes. Multi-purpose cargo will be stored in a dedicated multi-purpose terminal. An Admin Craft Basin will initially store equipment for breakwater construction and will be used to berth the marine fleet once the port is operational. The Admin Craft Basin will be designed as a dig-out basin within the main breakwater, protected by a secondary breakwater. The short-term port layout also involves constructing the required dry bulk terminal, multi-purpose terminal, and port administration and control buildings. Security fencing, port entrance facilities, fire station and clinic will be required. Internal port roads and rail, and truck staging facility will also be required to respond to the needs of the first phase of development.



Figure 1-3: Artist's impression of the Boegoebaai port layout. indicating the initial elements of Phase 1A development required to meet initial import and export demands (TNPA, 2024).

Detailed descriptions of the infrastructure aspects associated with the proposed short-term Boegoebaai port layout (Phase 1A) are provided in Table 1-1 below. The longer-term vision for the Boegoebaai port (Phase 1B) is designed for flexibility to accommodate future changes in commodities and operations. This assumes that the port will continue to primarily export commodities from Phase 1A, with the potential for other GH_2 derivatives such as methanol, naphtha and e-kerosene to be added to the export mix. The projected export volumes of green ammonia, combined with methanol, naphtha and e-kerosene is expected to increase to 2.15 Mtpa from 2035 to 2050. By 2050, plans include extending the breakwater, adding multi-purpose and liquid bulk berths, a container terminal, a ship repair yard, and expanding stockpiling and enclosed warehouses for dust control. Supporting infrastructure will include rail connections, road-over-rail bridges, and tippler facilities.

Table 1-1: Detailed description of infrastructure aspects in the vicinity of the proposed Boegoebaai port (Phase 1A).

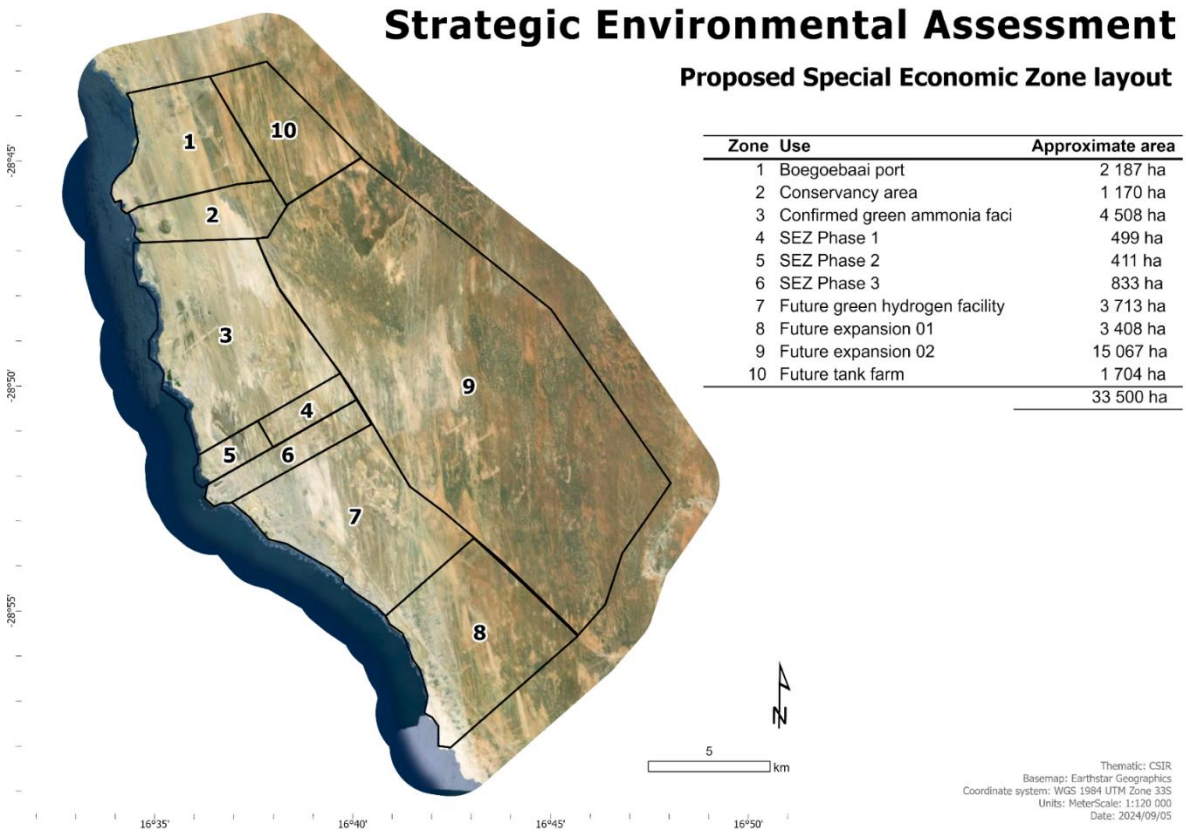
Infrastructure aspect	Description
Jetty	The jetty structure will act as a multi-use berth facility, designed to handle dry bulk, liquid bulk and multi-purpose cargo. The main jetty will consist of two berths: a 295 m long multi-purpose berth designed to accommodate Panamax vessels and a 350m long bulk berth that can accommodate Capesize vessels. The main jetty is connected to the shoreline via a 160m long access trestle. The main jetty and access trestle are founded on circular reinforced concrete piles with a sacrificial steel tubular casing. The superstructure includes reinforced concrete precast beams and slabs with in-situ concrete casts and topping to stitch the structure together. The main jetty supports ship loaders, conveyor and mobile cranes which service the bulk and multi-purpose terminal berths respectively., Vehicular access is provided via a single carriageway located beneath the ship loaders with turning circles provided at the ends of both the dry bulk and multi-purpose terminal jetty. The access trestle comprises of a single carriageway for vehicular access with the conveyor and ancillary services running adjacent.
Breakwaters	The rubble mound main and secondary breakwaters protect against wave energy at the berths and in vessel turning areas. The primary armour will be an appropriately designed, requiring an estimated 2,785 million m^3 of rock, 63,150 m^3 of reinforced concrete, and approximately 13,150 armour units.
Admin Craft Basin (Harbour)	A dig-out admin craft basin provides additional wave protection inside the main breakwater for marine fleet. The structure comprises a concrete deck supported on vertical concrete piles cast into steel casings, with a transverse beam supported by an anchored concrete abutment on the land side.
Materials Handling Equipment	The equipment will be defined by the terminal operator based on operational requirements and contracted volumes. For the bulk berth, this includes a travelling shiploader, conveyors, and stacker/reclaimers for dry bulk cargos like manganese, lead, and similar break bulk. The multi-purpose terminal berth will use mobile cranes, trucks, and front-end loaders for break bulk and containers.
Dry Bulk Material Handling	Manganese will be stored in closed stockpiles, similarly to lead and zinc which require enclosed warehouses. Dust suppression systems, which involve water spraying the stockpile and conveyor cargo, are specified for manganese storage. A mobile stacker and bucket wheel will handle stacking and reclaiming operations.
Quayside Material Handling Equipment	Travelling ship loaders are selected for efficiency in handling large volumes of dry bulk cargo, with spatial dimensions allowing truck passage underneath during operations.
Conveyor Belts	Systems handling zinc and lead must be fully enclosed, while those handling manganese require arched coverage. Elevated belt conveyors are designed with handrailed walkways for safe access and maintenance.
Dust Control	Dust suppression and collection systems are incorporated, with all material handling equipment designed to prevent material accumulation outside the dust collection system.
Buildings	Proposed port buildings include a Port Access Gateway and Induction Centre, Port Authority Building (with a Wellness Centre and Emergency Services Building), and Terminal Operator's Building (with workshops and satellite ablution buildings).
Bulk Services: Water	Average daily water demand is estimated at 660 kL/day. Two options were considered: a pipeline from Alexander Bay with a water treatment plant, or an onsite desalination plant. The desalination plant (1ML/day capacity) is considered more feasible. Elevated reservoirs will provide pressure for fire suppression discharge.
Bulk Services: Sewer	The site will be divided into separate drainage areas with isolated reticulation systems, on-site treatment, and disposal. Drainage areas will use a

Infrastructure aspect	Description
	combination of wastewater treatment plant, septic tank and soak-away systems.
Stormwater	The drainage system will separate clean and dirty water, with clean water runoff diverted around the site. High-risk dirty runoff water will flow into concrete-lined channels, and low-risk dirty runoff water will flow into block and vegetated channels. Pollution control ponds will be lined with HDPE, attenuated to the 1:50 year pre-development condition and discharged to the receiving natural environment, such as the ocean.
Electrical	The internal electrical network will include an intake substation (22kV), primary and secondary substations, distribution substations, street and area lighting, and small power and lighting for buildings.
Electronics	Security systems include fencing, CCTV coverage, access control, and coastal/railway protection systems, and will comply with the International Ship and Port Facility Security requirements. General electronic systems include fire detection, public address, evacuation systems, building management system, and security control room. Information and Communication Technology services include fibre connections, server rooms, network equipment, microwave links, and manhole and sleeve infrastructure.
Fuel storage	A liquid bulk storage facility with two 35,000 m^3 tanks and tanker loading facilities is included. Tanker vessels will discharge into storage tanks via pipeline at the multi-purpose terminal berth. This represents the first phase of the liquid bulk terminal development.
Internal Port Roads and Bridges	Port Access Interchange: Located 60 km north of Port Nolloth off the R382, designed to accommodate large volumes of heavy vehicle traffic for continuous flow. Port Access Control: Separate entrances with an access gateway and a combined weighbridge and access gateway, allowing multiple trucks to queue without causing congestion. Truck Offloading Area: Designed with three offloading terminals operating independently to prevent congestion and ensure continuous offloading.
External Roads	Development of the port in the short-term will attract mining ore transported by trucks along the R382, serving as the primary route for transporting mining commodities until rail transport viability is considered for future port expansion phases.

1.3.2 The proposed Boegoebaai Special Economic Zone

The Boegoebaai SEZ is envisioned as a multifaceted hub, primarily focusing on the export of GH_2/PtX products and commodities through the port. The SEZ will prioritise opportunities in manufacturing, logistics, and agro-processing to deliver a broad range of products and services (NCGHM, 2023). The Northern Cape targets include an initial 1.2 GW of electrolyser capacity to be completed by 2028, scaling up to 5 GW by 2030, and reaching 40 GW by 2050. The Boegoebaai SEZ area, encompassing approximately 33 500 ha (inclusive of the proposed conservancy area adjacent to the Boegoebaai port), will be developed in phases (as described in Table 1-2 and depicted in Figure 1-4) consisting of 10 proposed zones:

- **Zone 1**: Port Precinct (described in Section 1.3.1) – 2 187 ha
- **Zone 2**: Conservancy area – 1 170 ha
- **Zone 3:** Confirmed green ammonia facility – 4 508 ha
- **Zone 4:** SEZ Phase 1 – 499 ha
- **Zone 5:** SEZ Phase 2 – 411 ha
- **Zone 6:** SEZ Phase 3 – 833 ha
- **Zone 7:** Future green hydrogen facility – 3 713 ha
- **Zone 8:** Future expansion 01 – 3 408 ha
- **Zone 9:** Future expansion 02 – 15 067 ha
- **Zone 10:** Future tank farm – 1 704 ha



Zone	Use	Approximate area
1	Boegoebaai port	2 187 ha
2	Conservancy area	1 170 ha
3	Confirmed green ammonia faci	4 508 ha
4	SEZ Phase 1	499 ha
5	SEZ Phase 2	411 ha
6	SEZ Phase 3	833 ha
7	Future green hydrogen facility	3 713 ha
8	Future expansion 01	3 408 ha
9	Future expansion 02	15 067 ha
10	Future tank farm	1 704 ha
		33 500 ha

Figure 1-4: The footprint of the proposed Boegoebaai Port (Zone 1) and phases of the proposed SEZ which include a diversity of landuses across Zones 2 to 10.

The initial development of the SEZ will accommodate the green ammonia facility and the envisaged 5 GW of electrolyser capacity by 2030. This will include a sea water intake line, discharge lines to the ocean, a desalination plant, 5 GW electrolyser GH_2 production facility and green ammonia production facility, and hydrogen and ammonia storage tanks. Future SEZ activities are outlined in Table 1-2. Two entrances to the SEZ Phase 1 are proposed: a northern entrance for commercial, socio-service, and private traffic, and a southern entrance for industrial traffic. The truck staging area and the SEZ desalination plant are planned to be located near the southern entrance, facilitating road freight to and from the N14 and N7 highways.

Table 1-2: Proposed infrastructure and development activities per SEZ zone

SEZ zone	Description of infrastructure
1) TNPA port precinct	See Section 1.3.1 and Table 1.1 above.
2) Conservancy area	Conservancy area of approximately 1 170 ha that has been roughly demarcated based on initial inputs on conservation priorities such as the Boegoeberg koppies and seal colony on the Boegoebaai point. According to Botha & Desmet (2022), a habitat unit known as Swartvygie Heuweltjie Strandveld, located just inland of Boegoebaai, has suffered extensive damage from mining over the past century. The only intact areas are protected by the Buchuberg twins and hardened roads, which prevent sand scour. It is crucial for any port and GH_2 projects to avoid these intact portions, as they cannot be offset. There is also an interesting archaeological site at the proposed development – the Boegoebaai cave/lair.
3) Green ammonia facility	The green ammonia facility will be located near the TNPA port precinct to minimise pipeline length and enhance efficiency. The site is adjacent to the coast to facilitate desalination processes and house the 188 ML/day desalination plant. Infrastructure will include desalination plant and associated infrastructure (including seawater intake infrastructure and discharge pipeline); Water treatment unit and water reservoir; Containerised units for the electrolysers; Air separation unit; Liquid air energy system for nitrogen storage; Hydrogen and oxygen storage; Ammonia processing unit and liquid ammonia storage tank; Pipelines required for hydrogen, its' derivatives and by-products, and a control room. Seawater will be desalinated through a Reverse Osmosis (RO) process and then further processed to Demineralized water, which is needed for the production of GH_2 via water electrolysis. Cooling tower blowdown will be disposed of back to sea with the Reverse Osmosis brine and other treated wastewater streams. It is expected that the blended total dissolved solids of the cooling tower blowdown stream and the Reverse Osmosis brine and waste streams will be acceptable for seawater discharge. Firewater will be provided through firewater tanks on site. There is an opportunity to combine firewater and desalinated water storage on site. Seawater will be the backup source of firewater in case of an emergency and the stored firewater is not adequate. Lye solution purge from the GH_2 Plant will be discharged with the other return streams to the sea. Other effluent is oxygen and small quantities of off-gas which are expected to be safe to vent to atmosphere.
4-6) SEZ Industrial Park	The Industrial Park will be designated for mixed-use purposes, a manufacturing cluster, logistics and warehousing, offices. The SEZ will also include a 2.7 ML/day desalination plant, including pump station, supply pipelines, feeder pipelines etc. Seawater will be extracted and filtered, with a portion of the filtered water supplied to the SEZ Industrial Park for its use and for distribution to Port Nolloth. The SEZ Industrial Park will then desalinate this water at its own facility. The remaining filtered water will be processed through a separate desalination plant for operational use.
7) Future GH_2 facility	This will be a replication of the work that is anticipated at the initial Green Ammonia Facilities: Water treatment unit and water reservoir; Containerised units for the electrolysers; Air separation unit; Liquid air energy system for nitrogen storage; Hydrogen and oxygen storage; Ammonia processing unit and liquid ammonia storage tank; Pipelines required for hydrogen, its' derivatives and by-products, and a control room.
8) Future expansion area 01	This will be a replication of the work that is anticipated at the initial Green Ammonia Facilities: Water treatment unit and water reservoir; Containerised units for the electrolysers; Air separation unit; Liquid air energy system for nitrogen storage; Hydrogen and oxygen storage; Ammonia processing unit and liquid ammonia storage tank; Pipelines required for hydrogen, its' derivatives and by-products, and a control room.
9) Future expansion area 02	This will be a replication of the work that is anticipated at the initial Green Ammonia Facilities: Water treatment unit and water reservoir; Containerised units for the electrolysers; Air separation unit; Liquid air energy system for nitrogen storage; Hydrogen and oxygen storage; Ammonia processing unit and liquid ammonia storage tank; Pipelines required for hydrogen, its' derivatives and by-products, and a control room.
10) Future tank storage	Proposed area of approximately 1 704 ha inland of the R382 road.

1.4 APPROACH TO THE SEA

The SEA is being undertaken to guide strategic planning for proposed infrastructure development in and around Boegoebaai, as well as the broader Namakwa region of the Northern Cape, South Africa. Readers are reminded that the SEA is not a decision-making process, in the same way that, for example, an Environmental Impact Assessment (EIA) is. The purpose of the SEA is to, in a transparent way, guide downstream planning and decision-making processes that may, or may not, occur over many years, if not several decades into the future. Integrating a variety of best practice science-policy processes, SEA should provide an evidence-based, cross-disciplinary perspective on the main opportunities and constraints associated with the proposed port and SEZ, within the broader context of large-scale, regional GH_2 development.

Given the multiscale scope of the SEA, its processes and outputs were split between two Work Packages: **Work Package 1** and **Work Package 2**. The scope, spatial scales and methodological approach across the two Work Packages are outlined in the sections which follow and summarised in Table 1-3. The geographical scope of the two Work Packages is depicted in Figure 1-2.

Table 1-3: Summary of the SEA Work Packages across different spatial scales, methods, and data collection practices.

	Work Package 1	Work Package 2
Spatial scale	Local (33 500 ha) covering the extent of the proposed port and SEZ.	Regional (>5 million ha) across four Local Municipalities, including the 33 500 ha extent covered by Work Package 1.
Methods	High resolution determination of receiving environment sensitivity with a view to practicing avoidance (top of the mitigation hierarchy).	Determination of the cumulative social and ecological impacts of a regional expansive GH_2 economy across development scenarios.
Resolution	Fieldwork, coupled with desktop reviews (peer reviewed and grey literature) and other sources where necessary (e.g., interviews).	Desktop reviews (peer reviewed and grey literature, interviews etc.) and other publicly available data and sources.

1.4.1 Work Package 1 (Boegoebaai Port & SEZ SEA)

Work Package 1 (the contents of this report) assessed the social and ecological sensitivities of the local-scale receiving environment within a systematic sensitivity framework (Table 1-4). Work Package 1 assessed sensitivities at relatively high resolution (often including fieldwork), around the proposed port and SEZ development, covering a spatial scale of approximately 33 500 hectares (ha). This was undertaken with the intention of guiding local-scale feasibility and planning studies (especially for the new proposed port) and future decision-making processes, like EIAs and other local-scale planning exercises which may occur in the future.

Table 1-4: Calibration of sensitivity categories for receiving environments across the Work Package 1 study area

Category	Description
VERY HIGH	Highly vulnerable to disturbance with little/no capacity for recovery. Includes endangered species, critical habitats, heritage/social resources, or ecosystems with very narrow tolerances for change.
HIGH	Sensitive to ecological and social change but with better recovery potential. Lower concentrations of endangered species, critical habitats, heritage resources, or ecosystems with some tolerance for change.
MODERATE	Some resilience to stress or change. Systems can absorb moderate impacts without long-term harm, or irreversible loss. Includes adaptable species, less valuable social/cultural resources and moderately sensitive habitats.
LOW	Likely already severely degraded by past disturbance, or higher adaptive resilience and low vulnerability. Includes widespread social resources, ecosystems or species with broad ecological niches and high regenerative capacity.
TRANSFORMED VEGETATION	Plant communities that have been adversely altered from its expected original state by past human activities and environmental change.
EXISTING ANTROPOGENIC DISTURBANCE	Areas where human-built features (e.g. buildings, infrastructure, tracks and roads) and physical disturbance (e.g. mined areas, tailing heaps, stock posts) currently exists or are visible in the landscape.

Work Package 1 consists of seven chapters drafted by thirty-five authors, peer reviewed by eight independent peer reviewers, and includes contributions from a diversity of stakeholders involved in the process via a formally constituted project Working Group[3]. In addition to the Summary for Policymakers (SPM) (Schreiner et al., 2025), Work Package 1 includes the following chapters (Table 1-5):

Table 1-5: Chapter numbers, titles and recommended citations for Work Package 1

Chapter	Title	Citation
Chapter 1	Introduction and context (***this Chapter***)	Mqokeli et al., 2025
Chapter 2	Marine ecology	Clark et al., 2025
Chapter 3	Terrestrial and aquatic ecology	van Rooyen et al., 2025
Chapter 4	Biodiversity offset framework	Botha, 2025
Chapter 5	Heritage resources	Orton et al., 2025
Chapter 6	Fisheries and coastal livelihoods	Gammage et al., 2025
Chapter 7	Sustainable port planning	Taljaard & Weerts, 2025

Each Chapter was tasked with developing the following content in their respective contributions:

1. An Executive Summary of 2 pages with headline findings/recommendations;
2. A description of the receiving environment and land use dynamics;
3. Detailed sensitivity mapping classifying different receiving environments across the study area (Table 1-4);

[3] The Working Group is a multi-sectoral team of experts drawn from national, provincial, and local government departments, state agencies, academic and research institutions, non-governmental and community-based organisations, as well as industry and the private sector. Its purpose is twofold: to provide expert input throughout the SEA process; and to act as an information conduit, with members acting as links between their constituencies and the SEA, facilitating two-way communication, transparency, and inclusive engagement throughout the assessment.

4. An aspects and impacts register describing the impacts that may occur because of new infrastructure aspects and within sensitive receiving environments; and

5. Recommended strategic management actions for enhancing positive impacts and reducing negative ones, with a view to guiding future Port/SEZ planning and layouts, as well as guiding future project-specific EIAs.

A multi-author team, in the context of SEA refers to a structured, pluralistic authorship model designed to integrate diverse perspectives and expertise across an assessment process (see Schreiner et al., 2025). For the Boegoebaai SEA, multi-author teams were constituted through a consultative process with the Working Group (which included representatives from government, academia, NGOs, and other stakeholders) to nominate researchers who possess the required niche knowledge of this remote region, along with an understanding of strategic infrastructure impacts, academic credibility, and expertise in high-level strategic assessments. Multi-author teams were assembled for both Work Package 1 and Work Package 2 (Figure 1-5). The teams developed peer reviewed reports, with the Work Package 1 teams focusing on identifying the key sensitivities and impacts associated with the port and SEZ development, and the Work Package 2 teams undertaking a more strategic assessment of the cumulative risks and opportunities at a broader scale. Writing teams worked closely across both Work Packages for the duration of the SEA process, ensuring that all the salient issues were covered in at least one of the Work Package Chapters.

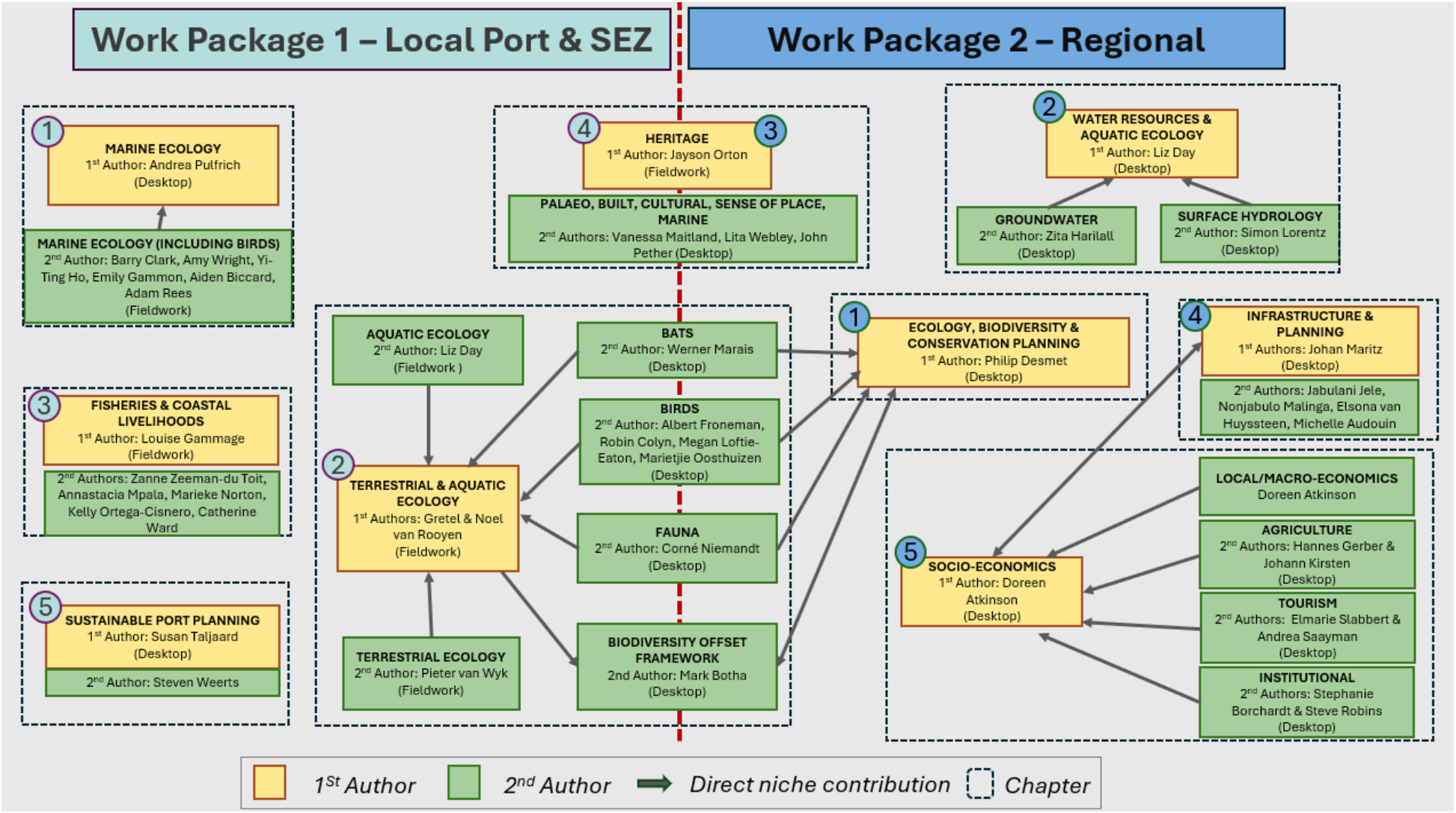


Figure 1-5: Multi-author teams and specialist chapters across the two Work Packages with points of collaboration and overlap indicated

1.4.2 Work Package 2 (Namakwa Region SEA)

A regional-scale assessment is currently underway and will cover, at a broader, cumulative scale, the main sustainability issues associated with an expansive Northern Cape GH_2 economy, assessed within the methodological paradigm of risk and opportunity. Work Package 2 content will be developed at a lower resolution than Work Package 1 and does not include any fieldwork. The spatial scale of Work Package 2 covers parts of the Namakwa District, delineated by the Richtersveld, Nama Khoi, Kamiesberg and Khâi Ma Local Municipalities. Work Package 2 will, in a highly structed risk/opportunity framework, assess the magnitude of impacts at regional scale across various future scenarios (see Schreiner et al., 2024). Work Package 2 will seek to guide local and regional planning, through processes like Spatial Development Frameworks (SDFs), Integrated Development Plans (IDPs) and Environmental Management Frameworks (EMFs), and any EIA processes that may be undertaken in the region. The strategic issues covered in Work Package 2 include ecology, biodiversity and conservation planning (including biodiversity offsets), water resources and aquatic ecology, heritage, infrastructure and planning, and socio-economic impacts.

1.5 REFERENCES

Botha, M. (2025) *Chapter 4: Biodiversity offset framework* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Botha M & Desmet P (2022). Namakwa Satellite SEZ Boegoebaai Port Biodiversity Offset Strategic Perspective. Report prepared for NCEDA. January 2022

Clark, B.M., Ho, Y., Gammon, E., Biccard, A., Rees, A, Ulrich, A. & Wright, A.G. (2025). Chapter 2: Marine Ecology in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR

Department of Forestry, Fisheries and the Environment (DFFE) (2020). South Africa's Low Emission Development Strategy. Available at: https://www.dffe.gov.za/sites/default/files/docs/2020lowemission_developmentstrategy.pdf

Department of Public Works and Infrastructure (DPWI) (2020). Strategic Integrated Projects. Government Notice 812, Government Gazette 43547. Available at: https://infrastructuresa.org/wp-content/uploads/2022/01/Strategic-Integrated-Projects-July-2020.pdf

Department of Science and Innovation (DSI). 2021. Hydrogen Society Roadmap for South Africa.

DPWI) (2022). Strategic Integrated Projects. Government Notice 2835, Government Gazette 47658. Available at: https://www.gov.za/sites/default/files/gcis_document/202212/47658gon2835.pdf

Gammage, L. C., Zeeman, Z., Mpala, A., Norton M., Ortega-Cisnero, K. & Ward, C. (2025). *Chapter 6: Fisheries and coastal livelihoods* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Mqokeli, B., Schreiner, G., Snyman-van der Walt, L., Louw, H., Modise, S., Ruthenavelu, M., Zukulu, T. & Maluleke, J. (2025). Chapter 1: Introduction and context in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR

Northern Cape Green Hydrogen (NCGH2) (2023). Northern Cape Green Hydrogen Masterplan. Available at: https://www.ncgh2.co.za

Orton, J., Webley, L., Pether., J. & Maitland, V. (2025). *Chapter 5: Heritage resources* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

The Presidency (2025) Just transition to a low-carbon economy. State of the Nation Address 2025. Available at: https://www.stateofthenation.gov.za/priorities/growing-the-economy-and-jobs/just-transition-to-a-low-carbon-economy

Republic of South Africa (2014) Special Economic Zones Act No. 16 of 2014. Government Gazette No. 37664. Available at: https://www.gov.za/documents/special-economic-zones-act

Schreiner, G., Mqokeli, B., Snyman-van der Walt, L., Lochner, P., Louw, H., Modise, S., Ruthenavelu, M., Zukulu, T. & Maluleke, J. (2024) Strategic Environmental Assessment for the proposed Boegoebaai Port, SEZ and Namakwa Region: Briefing note for research partners. Note produced by CSIR, NCEDA and TNPA.

Schreiner, G., Mqokeli, B., Snyman-Van der Walt, L., Tsedu, R., Pulfrich, A., Clark, B., Ho, Y.-T., Gammon, E., Biccard, A., Rees, A., Wright, A., Taljaard, S., Weerts, S., Gammage, L., Zeeman-du Toit, Z., Mpala, A., Norton, M., Ortega-Cisnero, K., Ward, C., van Rooyen, G., van Rooyen, N., van Wyk, P., Day, L., Niemandt, C., Froneman, A., Colyn, R., Oosthuizen, M., Loftie-Eaton, M., Marais, W., Botha, M., Orton, J., Maitland, V., Webley, L., & Pether, J. (2025). *Summary for Policymakers* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L., Lochner, P & Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai*

Port and Special Economic Zone. CSIR/SPLS/Ems/EXP/2025/1107/ACSIR/SPLS/SE/ER/2025/0023/B 978-0-7988-5675-1.

Taljaard, S. & Weerts, S. (2025) *Chapter 7: Sustainable port planning* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

United Nations Framework Convention on Climate Change (UNFCCC), *The Paris Agreement*. Available at: https://unfccc.int/process-and-meetings/the-paris-agreement

Van Rooyen, G., Van Rooyen, N., Van Wyk, P., Day., L., Froneman, A., Colyn, R., Oosthuizen, M., Loftie-Eaton, M., Marais., W. & Niemandt, C. (2025). *Chapter 3: Terrestrial and aquatic ecology* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

CHAPTER 2

Marine ecology

CHAPTER 2:
Marine ecology

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Recommended citation: Clark, B.M., Ho, Y., Gammon, E., Biccard, A., Rees, A., Ulrich, A. & Wright, A.G. (2025). *Chapter 2: Marine Ecology* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR

Executive Summary

Introduction

South Africa has ambitions to become a player in the globally emerging green hydrogen market, and a substantial programme of greenfield infrastructure has been proposed in the Northern Cape consisting of three components:

- A new breakwater port at Boegoebaai, dry and liquid bulk berths, and multi-purpose terminals.
- A mixed-use Special Economic Zone (SEZ) located in the region adjacent to the proposed Boegoebaai port.
- An expansive regional renewable energy (wind and solar photovoltaic) generation and transmission infrastructure.

The CSIR was appointed to undertake a Strategic Environmental Assessment (SEA) to address potential concerns around this proposed development by a consortium comprising of the South African National Energy Development Institute (SANEDI), Northern Cape Economic Development Trade and Investment Promotion Agency (NCEDA), and Transnet National Ports Authority (TNPA). The CSIR, in turn, appointed Pisces Environmental Services (Pty) Ltd and Anchor Environmental Consultants (Pty) Ltd to undertake necessary marine ecology specialist studies as part of the SEA.

The purpose of the SEA is "*to develop an integrated decision-making framework to guide the planning of the proposed Boegoebaai port, Special Economic Zone, and wider Namakwa region in a sustainable manner".*

The SEA has been divided into two components, a local-scale SEA concerned with assessing the sensitivities of the receiving environment around the proposed port and Special Economic Zone (Work Package 1) and a regional-scale SEA report covering the main sustainability issues associated with an expansive Northern Cape Green Hydrogen economy covering parts of the Namakwa District, delineated by the Richtersveld, Nama Khoi, Kamiesberg and Khâi Ma Local Municipalities (Work Package 2).

This document represents the marine ecological specialist report compiled as part of Work Package 1. Findings from this study (briefly summarised below) have been designed to inform the planning of the Port and SEZ, as well as provide reference and recommendations for future project-specific Environmental Impact Assessments.

Physical environment

Aspects of the physical environment that are likely to influence the design, layout and implementation of this project are largely dealt with in the prefeasibility study report for the Boegoebaai Port prepared by PRDW (2015) and do not need to be reiterated here. Suffice is to say that the bathymetry of the coastline, or at least proximity of deep water close to the shore, is the primary factor from a physical environment perspective that will likely influence selection of a suitable location for the port. Boegoebaai Point is immensely suitable in this respect (which it why it has been selected for this purpose) but there are a number of important marine ecological considerations that militate against the selection of this site as being suitable for port development (highlighted below). There are many other locations on the shoreline between the Orange River Mouth and Port Nolloth where the bathymetry profile of the shoreline is also likely to be suitable for port

development that are not as sensitive from a biophysical perspective, which should be considered for this purpose.

Marine fauna and flora

According to the National Biodiversity Assessment (NBA), the Boegoebaai study area is positioned in the "Namaqua inshore" portion of the Southern Benguela Ecoregion (Harris et al. 2019a). The latter extends all along the western coast of southern Africa between Cape Agulhas and Angola, while the former makes up the inner most portion of this area, extending from the Orange River to Cape Point. Rocky intertidal habitat in this region comprises mainly one habitat type (termed Namaqua Exposed Rocky Shore). A review of available literature on the area and field surveys conducted as part of this study suggests that there is a high overall similarity between communities of this habitat type in the Boegoebaai area and those that have been studied elsewhere in the Southern Benguela Ecoregion. None of the species present on the shore are listed as endangered, threatened or rare (ETP) species, although it must be said that few of these species have been subject to any formal assessment. It is important to note that the proposed development would significantly increase the amount of sheltered rocky shore habitat within the region to several times that of what currently exists within the inlets of Homewood Harbour and Peacock Bay. Such habitats are rare within the region and have been shown to host a completely different community of intertidal fauna and flora (Blamey & Branch 2009).

Three broad morphodynamic sandy-beach types are recognised worldwide: dissipative, intermediate and reflective, distinguished on the basis of interaction of wave energy, beach slope and sand particle size. All three major beach types exist in the Boegoebaai area, along with two intermediate types (e.g. dissipative-intermediate and reflective-intermediate). Macrofaunal communities associated with beaches normally vary strongly in accordance with morphodynamic state but tend to be similar across beaches of similar types within the same ecoregion. Dissipative beaches usually support higher diversity, abundance and biomass of macrofauna than do intermediate beaches, while reflective beaches are normally most depauperate. Beaches in the study area all follow this general pattern but faunal communities were all depauperate relative to other beaches of similar morphodynamic state elsewhere in the Southern Benguela Ecoregion. This is likely a result of disturbance by diamond mining operations in the region, evidence of which can been seen throughout the area, but especially in the north. Little has been done in terms of identifying ETP beach macrofauna species but one species, the giant isopod *Tylos granulatus,* has been singled out as being important. The range of *T. granulatus* once extended across the whole southern African west coast from Swakopmund to Cape Point but has now been reduced to probably less than half that. More than two decades ago it was suggested that *T. granulatus* should be assigned red data status of perhaps 'Vulnerable' or 'Low Risk. Recent genetic research has uncovered high levels of population structure in southern African *T. granulatus* populations with two distinct lineages present on the west coast, to the north and south of a Hondeklip/Kleinzee break (Mbongwa et al. 2019), which are sufficiently different that they may constitute separate species. A recent, preliminary IUCN red list assessment supports the classification of *T. granulatus* as an endangered species under Criterion B due to its small natural habitat (sandy beaches, supratidal to low water mark only), declines in habitat quality, and fragmented populations as shown by the population genetics results (Linda Harris, Nelson Mandela Metropolitan University, pers. comm.). This species is very sensitive to disturbance, appears strongly photophobic and rapidly disappears as development encroaches possibly due to light pollution.

Mixed shore ecosystems, which include any area of the shore that is not pure rock or pure sand, makes up a significant portion (almost one third) of the intertidal shoreline habitats in the Boegoebaai area. These habitats have been poorly studied in general and were not specifically surveyed in this study. Species present in these habitats are mostly also present in the pure sections of each component habitat type, but species richness on mixed shore can be higher due to increased habitat complexity and heterogeneity.

Surf zone habitats are located offshore of sandy beaches, extending from the low water mark out to the back of the breaker zone where they grade into more extensive unconsolidated soft bottom subtidal habitats. Despite their turbulent nature, surf zone habitats are an important nursery and feeding area for a range of marine fish and invertebrate species. Pilot seine net sampling undertaken in surf zone habitats in the Boegoebaai region revealed low species richness (only three species) none of which are listed as ETP species. These habitats are therefore not considered particularly sensitive in the Boegoebaai area.

Fauna that inhabits unconsolidated (soft bottom) subtidal areas include both epifaunal and infaunal organisms. On the west coast of South Africa, benthic infauna assemblages are typically made up of (a) deposit feeders, such as worms (polychaetes), which either ingest sediments to extract organic matter trapped between the grains or actively gather organic detritus, (b) suspension feeders, such as sea pens and some crab species, which consume drifting detritus and plankton from the water column, and (c) filter feeders, including bivalves and certain amphipods and polychaetes, that actively pump and filter water to capture suspended particles. Predators in these soft-bottom habitats either burrow through sediments to hunt prey or ambush prey on the surface. According to the NBA (Sink et al. 2019a), unconsolidated (soft bottom) subtidal habitats around Boegoebaai are listed as "endangered" due to the limited protection afforded to these areas through the formal protected area network, and threats from flow reduction in the Orange River and disturbance from diamond mining. Much of this habitat type in the study area is listed as Critically Biodiversity Area (CBA)-Restore or Ecological Support Area (ESA) and thus should be subject to as little disturbance as possible.

Consolidated (or rocky) subtidal habitat is widespread in the study area. Rocky reefs in shallow waters (less than 20 m depth) support dense kelp forests comprising mostly of *Ecklonia maxima* and *Laminaria pallida.* Other important species that inhabit rocky reefs in the study area include whelks, limpets, sea anemones, black mussel, red algae (*Rhodymenia* sp., *Gigartina* sp., and *Champia* sp.), encrusting coralline algae, crabs, chitons, reticulated starfish, barnacles, and sea cucumbers. Rocky reef habitats near Boegoebaai are classified as "vulnerable" due to limited protection afforded to these areas through the formal protected area network. Much of this habitat is listed as CBA-Restore or Ecological Support Area and thus should be subject to as little disturbance as possible.

A total of 72 water birds has been recorded in the Boegoebaai study area. Many of these birds are classified as threatened by the IUCN, including five species of coastal seabirds (20%) and 15 pelagic seabird species (25%). Many anthropogenic activities and uses of the marine environment (including those likely to be associated with the development of a new port and SEZ at Boegoebaai) pose a serious risk to these already threatened seabirds. At least two species of seabirds (including the Endangered Bank Cormorant *Phalacrocorax neglectus*) are known to breed on the rocky cliffs at Boegoebaai Point, which is the identified site for the port breakwater. Other costal seabird species are known to breed on the rocky and mixed shore (e.g. African Black Oystercatcher *Haematopus moquini)* and sandy beach (White fronted plover *Charadrius marginatus*) habitats in the study area. Care needs to be taken to ensure that these threatened marine and coastal birds are not unduly disturbed by project activities.

At least thirty-six marine mammals are likely to occur in the study area, including numerous cetacean species (whales and dolphins). This also includes a breeding population of Cape fur seal *Arctocephalus pusillus* at the proposed site for the port breakwater. The most sensitive area is around the headland within the proposed port precinct area of the SEZ. The high-profile rocky shore and cliffs not only offer some degree of protection from land-based predators but also provide shaded refugia and pools for seals to thermoregulate. The latter has been shown to be the most important environmental factor for breeding seal haul-outs in the lower latitudes where there is a high risk of overheating (Stevens & Boness 2003).

Seals started breeding at this site in 1991 and the colony remains small (n = 107 pups counted in 2007) but is growing. Despite their IUCN red list status of "Least Concern" and the prevalence of seal colonies

along the west coast of southern Africa, seals are protected in South Africa under the Sea Birds and Seals Protection Act 1973. Further to this, any activities that disturb seals without a permit are deemed to be illegal according to the NEMBA (National Environmental Management: Biodiversity Act).

Construction of a breakwater and or port at Boegoebaai is likely to seriously disturb and/or displace both the seals and breeding seabirds present at this site and it is strongly recommended that consideration be given to identifying an alternate site for port development for this reason alone. If displaced, it is unlikely that the Cape fur seal colony would re-establish on adjacent low-profile rocky shore areas as these offer no shaded refugia, pools or protection from land-based predators. Female seals are likely to be disturbed by human activities associated with port construction, and may elect to avoid contact with humans to reduce the risk of conflict and are therefore unlikely to return to the breeding colony and their pups. This is supported by research showing that breeding and pupping harbour seals on the west coast of North America have been displaced by shellfish aquaculture activities (Becker et al. 2011). Potential mitigation in the form of an artificial haul-out area that could be constructed as part of the port development may offer a solution, however, there is a risk that such initiatives may fail.

Seals started breeding at this site in 1991, and the colony remains small (n = 107 pups counted in 2007) but is growing. In South Africa, seals are protected under the Sea Birds and Seals Protection Act 1973 which states that it is an offence to pursue, shoot, wilfully disturb, kill or capture any sea bird or seal unless duly authorised by the relevant authority. Construction of a breakwater and or port at Boegoebaai is likely to seriously disturb both the seal colony and breeding seabirds present at this site. It is strongly recommended that consideration be given to identifying an alternate site for port development for this reason alone.

The South African west coast is generally a highly productive area that supports a high biomass of marine biota and several important fisheries. Surprisingly though, few of these fisheries extend into the Boegoebaai area. The Northern Cape is also sparsely populated, which means it is also not heavily utilised by small scale commercial, subsistence or recreational fishers. Demersal trawling, demersal longlining and pelagic longlining, are practiced in the offshore water greater than 200 m depth, but the area is not considered particularly important for any of these fisheries. There is an abalone ranching concession area that extends from just south of Alexander Bay to Port Nolloth, but the owner of this fishing right is not practicing any ranching at present. Neither activity is likely to be negatively affected by the proposed development at Boegoebaai.

Sensitivity Assessment

An environmental sensitivity assessment is a critical component when informing future development as it provides a spatially explicit understanding of ecological vulnerability of a defined area to anthropogenic disturbance(s). The assessment of environmental sensitivity is particularly relevant in dynamic and biodiverse coastal and marine ecosystems, where environmental changes and human activities can have significant and lasting impacts. Sensitivity assessments integrate multiple environmental and ecological factors to evaluate both vulnerability and resilience of various habitat types to development pressures. Determining environmental sensitivity was an important component of the WP1 Boegoebaai SEA as this can be used to inform where, from a marine ecology perspective, development might be constrained, and where development might be permissible (subject to future authorisation) as part of future development and conservation planning, as well as informing mitigation strategies to minimize environmental impacts. The sensitivity assessment aims to be intuitive for policy makers, developers and non-technical audiences.

The environmental sensitivity assessment for the Boegoebaai SEZ provides a GIS-based analysis, incorporating conservation, environmental and threatened status, validated by in situ field sampling. The assessment categorized habitats into four sensitivity levels (Low, Medium, High and Very High) (see Figure S-1 below). A key finding is that mixed rocky shores and subtidal reefs hold medium to high sensitivity due

to their biodiversity value, habitat complexity, and limited formal protection. These habitats support diverse marine communities and are classified as Vulnerable, emphasizing the need for conservation measures. In contrast, sandy beaches generally exhibited lower sensitivity, except for reflective and intermediate sandy shores, where relatively high numbers of *Tylos granulatus* were recorded. The assessment also found that surf zone fish communities in the area had low species richness and no recorded Endangered, Threatened, or Protected species, further confirming lower sensitivity in sandy beach areas.

The most sensitive area identified in the assessment is the rocky headland within the proposed port precinct, which serves as a breeding site for Cape fur seals and threatened seabirds, including Bank Cormorants. Development in this area, particularly the construction of a port and breakwater, poses a high risk of disturbance to these species and could have irreversible ecological consequences. The assessment strongly recommends considering alternative port locations to avoid significant impacts on these critical habitats. Additionally, much of the intertidal and nearshore environments within the SEZ are listed as Critical Biodiversity Areas (CBA-Restore), reinforcing the need for careful management and mitigation measures. Field surveys also revealed inaccuracies in existing national ecosystem type classifications of reflective and intermediate sandy shore in the SEZ region, which were corrected to ensure a more accurate sensitivity assessment. The findings underscore the importance of integrating ecological sensitivity into spatial planning, ensuring that development aligns with conservation priorities, and minimizing impacts on vulnerable marine and coastal ecosystems.

The options of relocating the breakwater to the north of the current site seem limited given the bathymetry of the area but there appear to be some options to the south of Boegoebaai Point. Potential areas to the south of the current proposed site have been identified as areas to be considered as viable alternative areas based on their ecological sensitivity and their bathymetry profile immediately offshore.

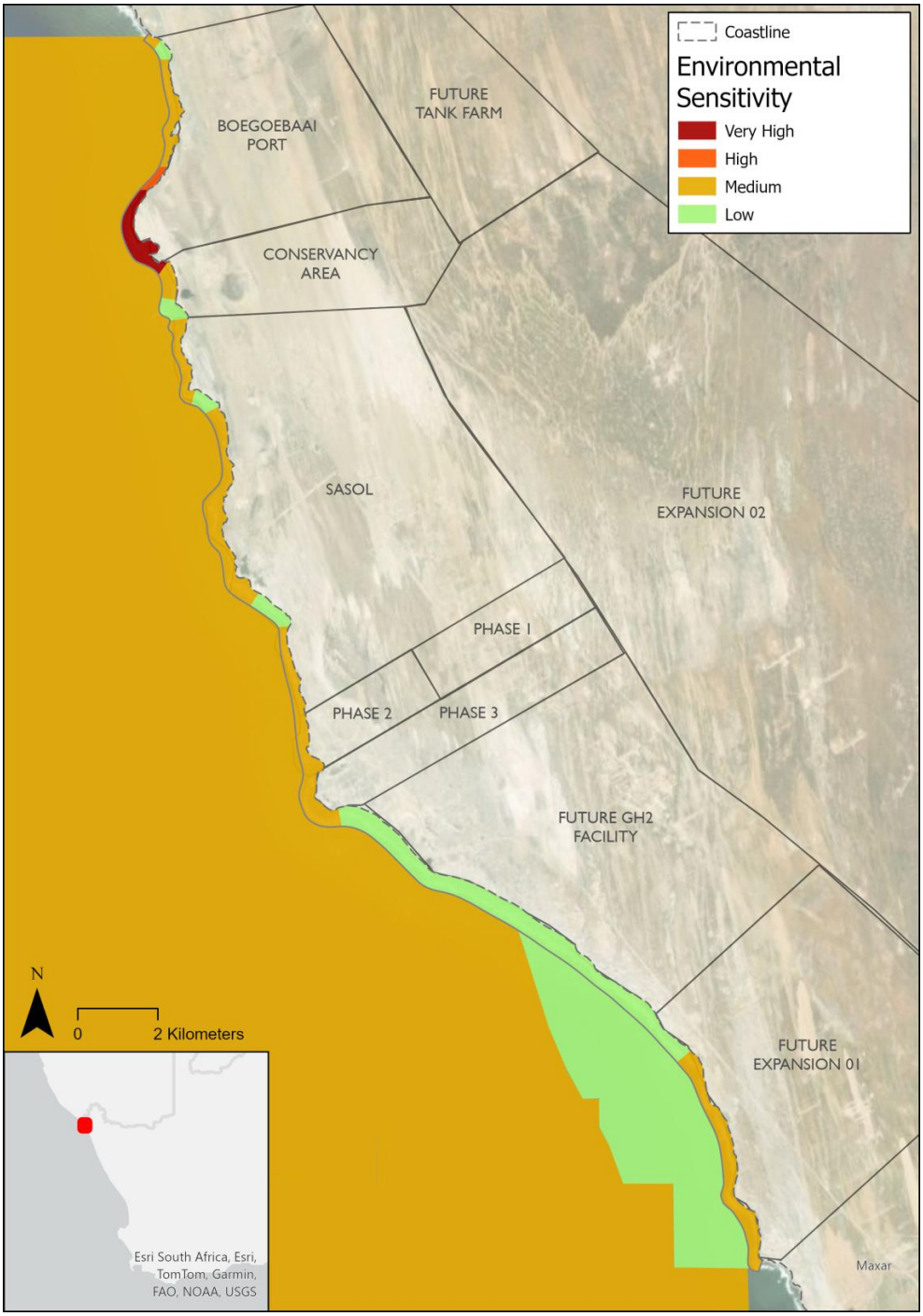


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Glossary

Alien species: Species that occur outside their natural range and dispersal potential. Alien species are spread by human activity, intended or unintended, to new areas. May or may not become 'invasive species'.

Anthropogenic: Relating to or resulting from the influence of human beings on nature.

Avifauna: The birdlife of a particular region or habitat.

Benthic: The benthic zone is the ecological region at the lowest level of a body of water such as an ocean or a lake, including the sediment surface and some sub-surface layers. Organisms living in this zone are collectively referred to as the "benthos", e.g., the benthic invertebrate community, including crustaceans and polychaetes.

Biogeography: the patterns and processes that have influenced the distribution of species and ecosystems over space and time.

Bioregion: A region defined by characteristics of the natural environment rather than by man-made divisions.

Critical Biodiversity Area: An area in a natural condition that is required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure. The management objectives for these areas require that they are to remain in a natural or near-natural state, with no further loss of natural habitat. Defined as "Strict Biodiversity Conservation Zones" in the 2024 Marine Spatial Planning (MSP): Biodiversity Sector Plan.

CBA Natural Area: Sites that have natural/near-natural ecological condition, with the management objective of maintaining the sites in that natural/near-natural state. Defined as "Biodiversity Conservation Areas (Natural)" in the 2024 Marine Spatial Planning (MSP): Biodiversity Sector Plan.

CBA Restore Area: Sites have moderately modified or poorer ecological condition, with the management objective to improve ecological condition and, in the long term, restore these sites to a natural/near-natural state, or as close to that state as possible. As a minimum in CBA Restore sites, further deterioration in ecological condition must be avoided, and options for future restoration must be maintained. Defined as "Biodiversity Restoration Areas (Modified)" in the 2024 Marine Spatial Planning (MSP): Biodiversity Sector Plan.

Diversity: The number of different species that are represented in a given community.

Detritivore: An organism that feeds on dead and decomposing organic matter (detritus).

Ecological Support Area: An area that is not essential for meeting biodiversity targets but does play an important role in supporting the functioning of Protected Areas or CBAs and are often vital for delivering ecosystem services. Within ESAs, negative impacts of human activities on key biodiversity features are managed and minimised to maintain the features in at least a functional, semi-natural state and/or to allow the area to improve in ecological condition. The 2024 Marine Spatial Planning (MSP): Biodiversity Sector Plan defines these areas as "Biodiversity Impact Management Zones".

Ecologically or Biologically Significant Marine Areas: Defined by the Convention on Biological Diversity (CBD) as "geographically or oceanographically discrete areas that provide important services to one or more

species/populations of an ecosystem or to the ecosystem as a whole, compared to other surrounding areas or areas of similar ecological characteristics, or otherwise meet the [EBSA] criteria". EBSAs are

Ecosystem Threat Status: Developed by SANBI (2018) is an indicator of how threatened ecosystems are, specifically the degree to which ecosystems are still intact or alternatively losing vital aspects of their structure, function, or composition (Harris et al. 2018).

Ecosystem: a biological community of interacting organisms and their physical environment – a complex network or interconnected system.

Ecozone/Ecoregion: The 2011 National Biodiversity Assessment used the terms 'ecoregions' and 'ecozones' to replace the similar, but revised 'bioregions' and 'biozones' used previously and to avoid confusion between the different map layers from previous assessments

Environment: The external circumstances, conditions and objects that affect the existence of an individual, organism, or group. These circumstances include biophysical, social, economic, historical, and cultural aspects.

Environmental Authorisation: Permission granted by the competent authority for the applicant to undertake listed activities in terms of the NEMA EIA Regulations, 2014.

Environmental Impact Assessment: A process of evaluating the environmental and socio-economic consequences of a proposed course of action or project.

Epifauna: Organisms residing in the benthos, specifically on surfaces of the seafloor and/or attached to surfaces such as rocks, shells and pilings.

Fauna: General term for all the animals found in a particular location.

Filter feeder: A sub-group of suspension feeding animals that feed by straining suspended matter and food particles from water, typically by passing the water over a specialized filtering structure.

Grazer: Any animal that relies on herbivory (feeds on plants) as its primary food source. Examples of ocean grazers include herbivorous fish, sea urchins and certain sea snails.

Impact: A change to the existing environment, either adverse or beneficial, that is directly or indirectly due to the development of the project and its associated activities.

Infauna: The assemblage of organisms inhabiting the seafloor.

Intertidal zone: The section of the marine environment that lies exposed at low tide and submerged at high tide.

Invasive species: Alien species capable of spreading beyond the initial introduction area and have the potential to cause significant harm to the environment, economy or society.

Invertebrate: Animals that do not have a backbone. Invertebrates either have an exoskeleton (e.g. crabs) or no skeleton at all (worms).

IUCN listed species: Species included and rated by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species, a comprehensive inventory of the global conservation status of biological species. It uses a set of precise criteria to evaluate the extinction risk of thousands of species and subspecies.

Macrobenthos/macrofauna: Those animals retained by a 1.0-mm-mesh sieve. Macrobenthic invertebrates are defined as organisms that live on or inside the deposit at the bottom of a water body.

Marine Spatial Planning: The public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that have been specified through a political process.

Nursery habitat: A subset of all habitats where juveniles of a species occur, having a greater level of productivity per unit area than other juvenile habitats.

Offshore: The area seaward of the nearshore environment boundary.

Polychaete: Segmented worms with many bristles (i.e., bristle worms).

Predator: (Marine) Animals that hunt and kill other animals for food. They play a vital role in marine ecosystems, helping to regulate populations and maintain balance.

Sediment: Mud, sand, silt, clay, shell debris, and other particles that settle on the bottom of rivers, lakes, estuaries, and oceans.

Species richness: the number of species within a defined region.

Species: A category of biological classification ranking immediately below the genus, grouping related organisms. A species is identified by a two-part name; the name of the genus followed by a Latin or Latinised un-capitalised noun.

Suspension feeder: An animal that feeds on particles of organic matter that are suspended in water.

Taxon (plural – taxa): Refers to any unit used in the science of biological classification, or taxonomy.

Upwelling: An oceanographic phenomenon that involves wind-driven motion of dense, cooler, and usually nutrient-rich water from deep water towards the ocean surface, replacing the warmer, usually nutrient-depleted surface water.

Vulnerable Marine Ecosystem: Groups of species, communities or habitats characterized by their structural functionality and their vulnerability to physical disturbance. The identification of VMEs includes (i) uniqueness or rarity; (ii) functional significance of the habitat; (iii) fragility; (iv) live-history traits of component species that make recovery difficult; and (iv) structural complexity. Includes seamounts, hydrothermal vents, cold water corals and sponge fields.

Abbreviations and Acronyms

Anchor	Anchor Environmental Consultants
BCC	Benguela Current Commission
CBD	Convention on Biological Diversity
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DFFE	Department of Forestry, Fisheries and the Environment
DHI	Danish Hydraulic Institute
EBSA	Ecologically or Biologically Significant Marine Area
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ESA	Ecological Support Area
ETP	endangered, threatened or rare
FAO	Food and Agricultural Organisation
GH2	Green Hydrogen
ha	hectares
Hm0	Significant wave height calculated from the zeroth moment (M0) of a wavespectrum
ICCAT	the International Commission for the Conservation of Atlantic Tunas
IOTC	Indian Ocean Tuna Commission
IMD-SA	International Mining and Dredging – South Africa
IUCN	International Union for the Conservation of Nature
km	kilometre
KZN	KwaZulu Natal
MARISMA	Marine Spatial Management and Governance Programme
MIBA	Marine Important Bird Areas
MPA	Marine Protected Area
MSL	mean sea level
MSP	Marine Spatial Planning
NASA	National Aeronautics and Space Administration
NBA	National Biodiversity Assessment
NCEDA	Northern Cape Economic Development Trade and Investment Promotion Agency
NCEP	National Centres for Environmental Prediction

NTU	Nephelometric Turbidity unit
PSD	Particle Size Distribution (sediment)
QDGC	Quarter-Degree Grid Cell
RFMOs	Regional Fisheries Management Organisations
RO Plant	Reverse Osmosis (desalination) Plant
SABAP	South African Bird Atlas Project
SANBI	South African National Biodiversity Institute
SANEDI	South African National Energy Development Institute
SAWS	South African Weather Service
s	seconds
Sc0	dynamic baseline scenario
SEA	Strategic Environmental Assessment
SEZ	Special Economic Zone
SW	southwest
TAC	Total Allowable Catch
TAE	Total Allowable Effort
TNPA	Transnet National Ports Authority
TOC	Total Organic Carbon
Tp	Peak wave period
TSS	Total Suspended Solid
WASA	Weather Atlas of South Africa
WCRL	West Coast Rock Lobster
WP1	Work Package 1
WP2	Work Package 2
°C	degrees centigrade
g/m^2	grams per square metre
mg/L	milligrams per litre
%	percent (parts per hundred)

CHAPTER 2. MARINE ECOLOGY

2.1 INTRODUCTION

As part of South Africa's ambition to become a player in the globally emerging green hydrogen market, a substantial programme of greenfield infrastructure has been proposed in the Northern Cape consisting of three components:

- A new breakwater port at Boegoebaai, dry and liquid bulk berths, and multi-purpose terminals (Figure 2-1.1).
- A mixed-use Special Economic Zone (SEZ) located in the region adjacent to the proposed Boegoebaai port (Figure 2-1.2).
- An expansive regional renewable energy (wind and solar photovoltaic) generation and transmission infrastructure.



Figure 2-1.1. Artist's impression of the Port of Boegoebaai. Source: TNPA (2024)

Green hydrogen production, at the scale envisaged for this project, will be a diverse and multifaceted process with many direct and indirect impacts, both positive and negative. All programme components, including their interconnected transport corridors, will require substantial areas of land surface, as well as other resource intensive inputs, all proposed in a sparsely populated but ecologically sensitive region. Existing, and potentially competing, land uses in the region include conservation, agriculture, fishing, tourism, mining, and some subsistence livelihoods.

A Strategic Environmental Assessment (SEA) was therefore initiated through a collaboration between the South African National Energy Development Institute (SANEDI), Northern Cape Economic Development Trade and Investment Promotion Agency (NCEDA), and Transnet National Ports Authority (TNPA).

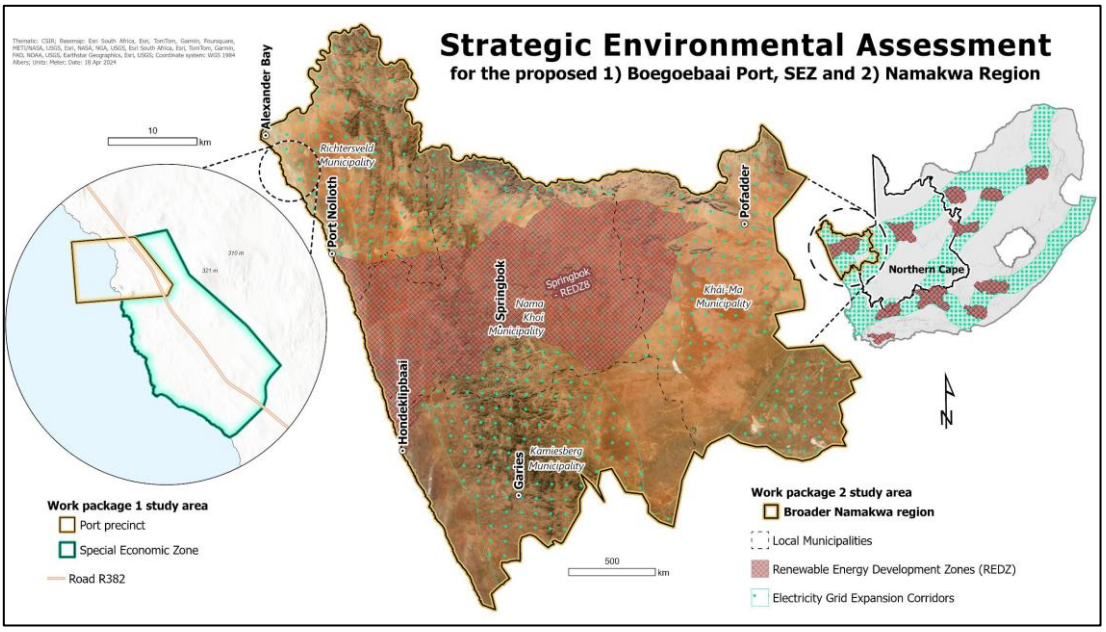


Figure 2-1.2. Boegoebaai Special Economic Zone.

The Council for Scientific and Industrial Research (CSIR) was appointed to undertake the SEA. The CSIR, in turn, appointed Pisces Environmental Services (Pty) Ltd and Anchor Environmental Consultants (Pty) Ltd to undertake necessary marine ecology specialist studies as part of the SEA.

The purpose of the SEA is "*to develop an integrated decision-making framework to guide the planning of the proposed Boegoebaai port, Special Economic Zone, and wider Namakwa region in a sustainable manner".*

The objectives of the SEA are to:

- Assess the social and ecological sensitivity of local and regional receiving environments;
- Classify spatial regions, based on multiple criteria, as being more, or less, suitable for future development;
- Identify strategic-level constraints, opportunities, cumulative impacts, and strategic management actions; and
- Provide an integrated decision-making framework and suite of tools, to guide project developers, practitioners, and policymakers.

The SEA has been divided into two components:

1. **Boegoebaai Port and Special Economic Zone (Work Package 1):** Local-scale SEA report concerned with assessing the sensitivities of the receiving environment around the proposed port and SEZ.
2. **Namakwa Region (Work Package 2):** Regional-scale SEA report covering the main sustainability issues associated with an expansive Northern Cape Green Hydrogen economy covering parts of the Namakwa District, delineated by the Richtersveld, Nama Khoi, Kamiesberg and Khâi Ma Local Municipalities.

This document represents the marine ecological specialist report compiled as part of Work Package 1. It is a local-scale, spatially focused SEA report identifying sensitivities around the proposed port and SEZ development covering ~33 500 ha ("Boegoebaai Port and SEZ SEA"). It includes expert on-site, ground-truthing to produce high resolution spatial data. Findings from this study have been designed to inform the

planning of the Port and SEZ, as well as provide reference and recommendations for future project-specific Environmental Impact Assessments.

The Terms of Reference for this study required that the following key tasks be undertaken for this study:

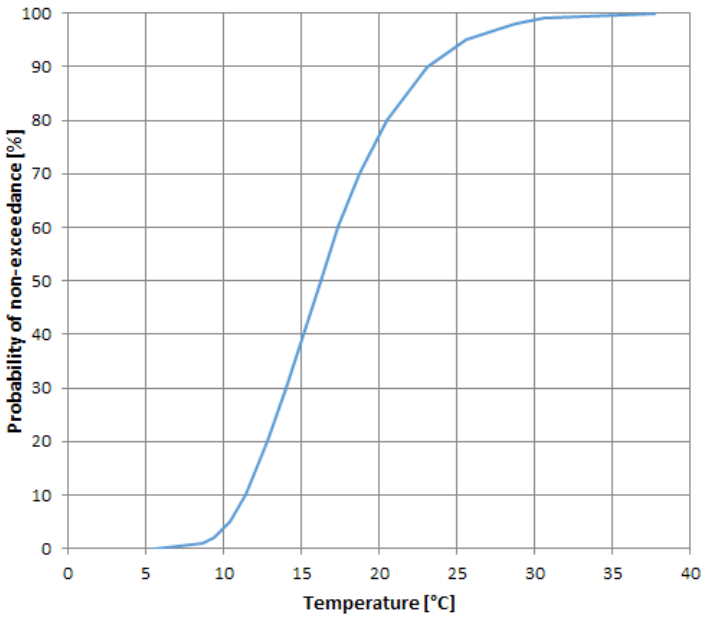
1. Prepare a Plan of Study:
    - Outline the approach, data requirements, assumptions, limitations and timeframe of tasks.
    - Provide report / chapter framework.
2. Description of the receiving environment:
    - Describe the land use dynamics and likely changes in the receiving environment and broader region as it relates to your topic. This will feed into the dynamic baseline scenario (Sc0) used in WP2 "Regional SEA" as needed – "how is the social-ecological system changing even if a GH_2 economy does not realise?".
    - Describe the key characteristics of the receiving environment as it pertains to your area of expertise - *"What, where, why is it important?"*
    - Should be spatially explicit as far as possible.
3. Site visit / ground-truthing:
    - Site visit to augment the receiving environment description, and to map and verify environmental sensitivity, including limited offshore sampling (within the limits of the budget and time available), to validate habitat sensitivity maps.
4. Sensitivity analysis:
    - Spatial layers distinguishing relative sensitivity of the receiving environment (Low, Medium, High, Very High).
    - Verified and refined based on site visit / ground-truthing.
5. Aspects and impacts register:
    - Potential impacts (negative and positive) that may arise from the planned activities and infrastructure (based on a project description provided by CSIR).
6. Recommendations for planning and future Environmental Impact Assessments (EIAs):
    - Practical recommendations to inform the planning and layout of the Port and SEZ.
    - Practical recommendations for future EIA studies.
    - Practical recommendations to enhance positive impacts and reduce negative impacts.

2.2 DESCRIPTION OF THE AFFECTED MARINE ENVIRONMENT

2.2.1 Climate

2.2.1.1 Temperature

No detailed data on air temperature at Boegoebaai are available. However, PRDW (2015) present data from air temperature measurements at 60 m above ground level (taken around 20 km away from the Boegoebaai site) available from the "Weather Atlas of South Africa (WASA) project" (Mabille et al. 2014). These data indicate a moderate climate with air temperatures between 10.4 °C and 25.5°C for 90% of the time. The highest and lowest temperatures recorded in the three-year dataset were 37.7 °C and 5.4 °C, respectively (Figure 2-2.1).



Probability of non-exceedance [%]	Temperature at 60m above ground level [°C]
0	5.4
1	8.6
2	9.4
5	10.4
10	11.4
20	12.8
30	14.0
40	15.1
50	16.2
60	17.4
70	18.7
80	20.5
90	23.1
95	25.5
98	28.7
99	30.6
100	37.7

Figure 2-2.1. Air temperature measurements taken at 60 m above ground level available from the "Weather Atlas of South Africa (WASA) project". Taken from PRDW (2015).

2.2.1.2 Wind

Four datasets of wind data are available for the study area, as presented in PRDW (2015). The NOAA/NCEP WAVEWATCH III CFSR Reanalysis Hindcast dataset and the data collected through the "Weather Atlas of South Africa (WASA) project" (Mabille et al. 2014) is considered to be the most reliable of these (PRDW 2015). Wind measurements from WASA station (WM01, located at 28.602°S 16.664°E, approximately 20 km NW of Boegoebaai) are available at 10-minute intervals over a range of heights above ground level for the period of October 2010 to March 2014 (Figure 2-2.2). Wind rose and wind speed exceedance plots derived from these measurements averaged over 10-minute intervals at 10 m above the ground and wind directions at the 20-m level are presented in Figure 2-2.3 and Figure 2-2.4.

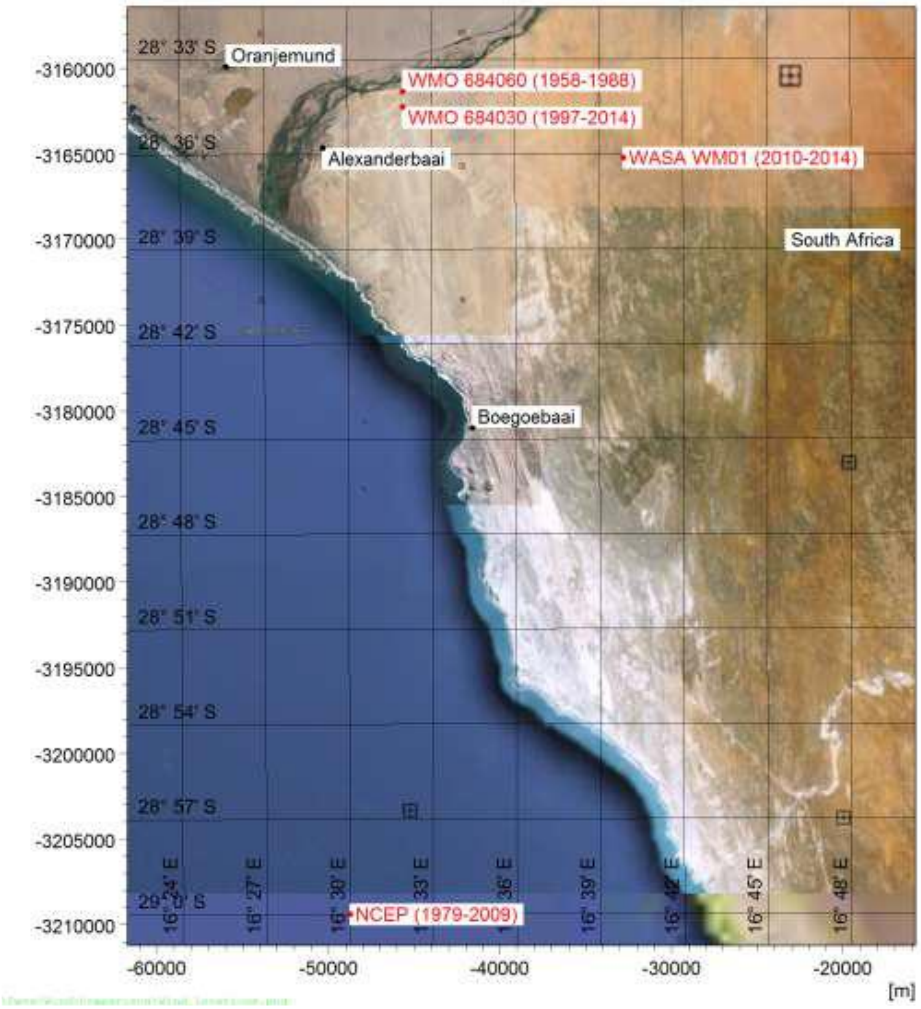


Figure 2-2.2. Locations of available wind datasets for Boegoebaai. Source: PRDW (2015).

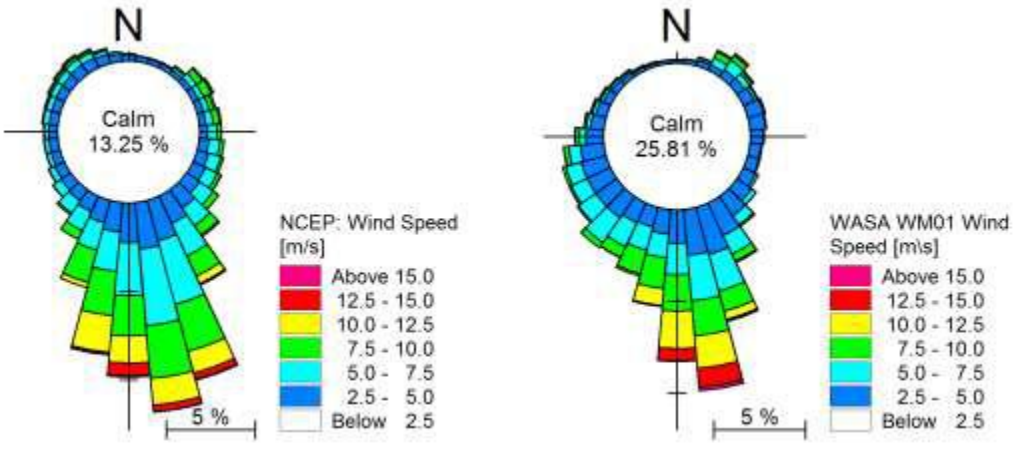
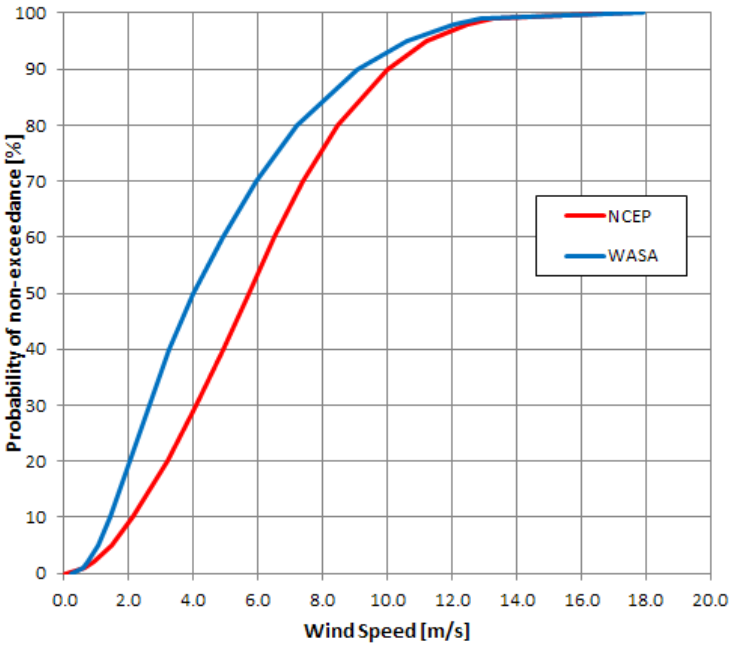


Figure 2-2.3. Wind rose data for Boegoebaai from the NCEP and WASA. Source: PRDW (2015).



Probability of non-exceedance [%]	Wind Speed [m/s]	
	NCEP	WASA
0	0.04	0.22
1	0.64	0.58
2	0.91	0.74
5	1.45	1.05
10	2.14	1.43
20	3.19	2.04
30	4.09	2.63
40	4.90	3.26
50	5.70	4.00
60	6.51	4.90
70	7.39	5.96
80	8.48	7.18
90	10.00	9.06
95	11.22	10.58
98	12.45	12.06
99	13.27	12.90
100	17.53	17.93

Note: The NCEP dataset represents 1-hour averaged wind speeds. The WASA data has been converted to 1-hour average wind speeds from the measured 10-minute averages.

Figure 2-2.4. Wind speed exceedance comparison of the NCEP and WASA datasets. Source: PRDW (2015).

2.2.1.3 Rain and fog

Detailed data on rainfall at Boegoebaai are not available at this stage, however, data from a weather station located in Alexander Bay managed by the South African Weather Service (SAWS) as reported by PRDW (2015) indicate that Alexander Bay is the driest station in South Africa with a mean annual rainfall of 46 mm per year (SAWS 2015).

PRDW (2015) presents data on hourly fog occurrence recorded at Port Nolloth, sourced mostly from weather logs provided by De Beers Marine. Months for which no data were available (Apr, Nov, Fe and Mar, filled in green) were filled with data from months with an average similar number of fog days per month sourced from the South African Sailing Directions (1975). Fog is most prevalent during summer and autumn (Jan-May), both in terms of frequency of occurrence and duration (Figure 2-2.5).

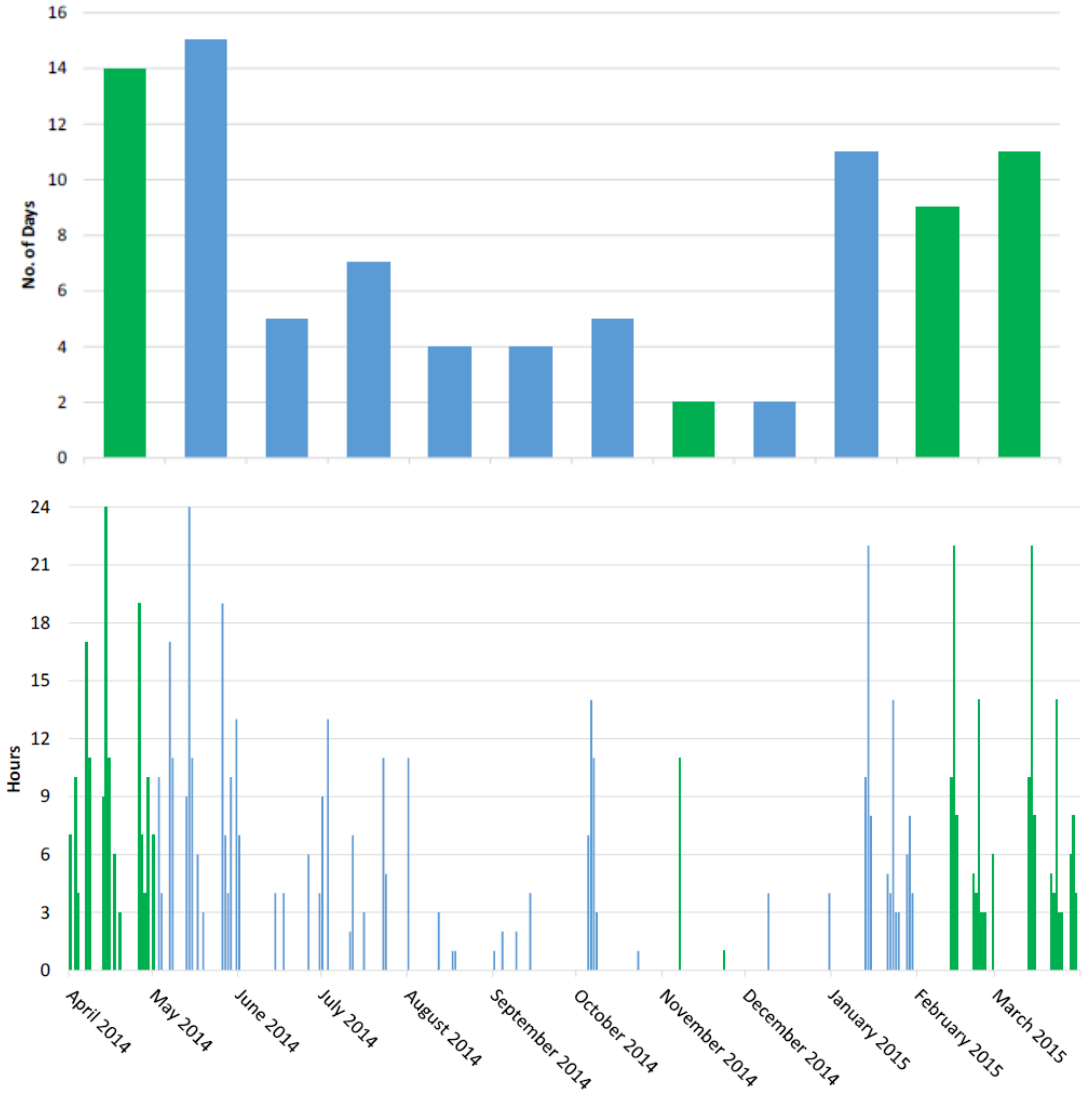


Figure 2-2.5. (Top) Number of fog days per month and (bottom) duration of fog (hours per day) at Port Nolloth. Values in green are interpolated (see text). Source: PRDW (2015).

2.2.2 Oceanography

2.2.2.1 Overview

The Benguela system is influenced predominantly by the wind-driven upwelling of deep nutrient rich water close to the coast. Wind is the primary driver of life in the system, strongly influencing both water temperature and inorganic nutrient levels, and in turn, primary production. The prevailing south-easterly winds displace surface water offshore during the summer, and cause cold, nutrient rich water to rise from deeper water masses to replace this surface water. These upwelling events are the trigger for minimum temperatures and maximum nutrient levels (Branch & Griffiths 1988). The oceanic primary producers, phytoplankton, bloom when upwelled inorganic nutrients become available for photosynthesis in the presence of sunlight. These are consumed by zooplankton, which are in turn consumed by small pelagic fish species such as anchovy and sardine. The Benguela is one of the world's most productive systems, supporting rich fishing grounds and attracting large colonies of sea birds and seals (Branch & Branch 2018b).

2.2.2.2 Tides and waves

The West Coast is subject to semi-diurnal tides, with each successive high (and low) tide separated by about 12.25 hours. 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 such as bathing and the harvesting of marine resources. The tidal variation on the West Coast usually ranges between 0.28 m (relative to the chart datum) at mean low water springs and 1.91 m at mean high water springs, with the highest and lowest astronomical tide being 2.25 m and 0.056 m, respectively.

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 to 15 seconds (Branch et al. 1988). Southerly and south-westerly waves frequently exceed 2 m (Figure 2-2.6). The predominant SW swell direction in this area results in a northward-flowing littoral current that runs parallel to the coast (MacDonald & Rozendaal 1995). PRDW (2015) undertook a wave refraction modelling study with a view to characterise the operational and extreme wave climates at the proposed Boegoebaai port. Results of this modelling study indicate that peak wave periods fall primarily between 7 s to 18 s with some occurrences of periods exceeding 20 s (Figure 2-2.6). Short period wave energy originating from locally generated seas was also observed from the southerly and westerly to north-westerly sectors.

2.2.2.3 Currents

Currents measured inshore at 10 m depth during late summer are mostly shore parallel (north westerly or south easterly) and 90% of the measured current velocities are low (<10 cm/second). The average water temperature during the summer months is cool due to upwelling (approximately 11 °C) and slightly warmer during downwelling events, which are caused by westerly winds or occasional Benguela Niños when unseasonal westerly winds result in a breakdown of the upwelling front with movement of warm oceanic water towards the coast (Laird & Clark 2018). Average background Total Suspended Solid (TSS) concentration in seawater along the west coast is highly variable and dependent on prevailing weather and sea conditions. For example, TSS was measured off Tormin Mine to the north of Doringbaai as 73.73 mg/L on 14 March 2017, while average turbidity over the period 10 February to 14 March 2017 was calculated at 5.24 NTU (~1.75 mg/L) (Laird & Clark 2018). Turbidity peaks in the vicinity of Doringbaai are expected during large wave events where fine material is resuspended, intense upwelling events when phytoplankton blooms, and during floods from the Olifants Estuary when a considerable input of fine terrestrial sediments can be expected.

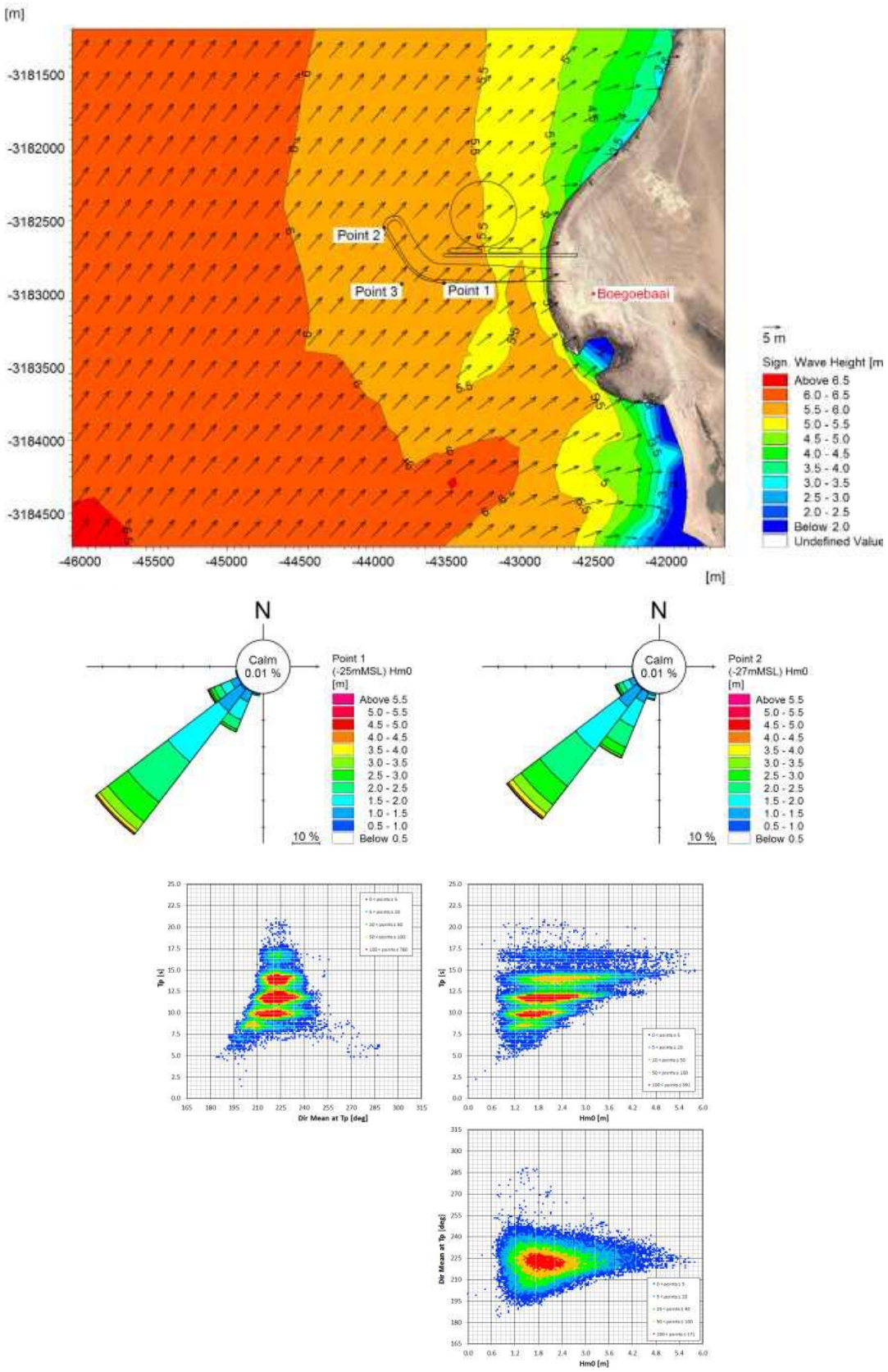


Figure 2-2.6. (Top) Typical wave refraction during a storm event (Offshore condition: Hm0 = 8.5 m, Tp = 15 s, Mean direction at Tp = 215 degrees). (Middle) Wave rose plots for Point 1 and Point 2 along the proposed breakwater. The roses are constructed from 31 years of modelled data. (Bottom) Source: Scatter plot of wave parameters at Point 3. Source: PRDW (2015).

2.2.3 Bathymetry

PRDW (2015) presents data on regional and nearshore bathymetry that were sourced from the 'MIKE by DHI' CMAP Electronic Charts (DHI 2017) and nearshore bathymetry surveys of the Boegoebaai area obtained from IMD-SA (Pty) Ltd. The available data extend from the shore (at -7 m mean sea level) to approximately 7 km west of the Boegoebaai headland (Figure 2-2.7). Of greatest significance here is the way in the bathymetric contours are compressed in the region of Boegoebaai point, indicating the proximity of deep water (>15 m) close to the shoreline, which is the primary reason for the selection of this site for construction of the port breakwater. According to PRDW (2015) this presents an opportunity to reduce initial capital cost by limiting the length of the primary marine structures, i.e. breakwater and access trestle.

A more recent bathymetric survey of the northern portion of the Boegoebaai area presents similar results, confirming the proximity of deep water close to the shoreline at Boegoebaai point (Tritan Survey 2018). These survey results also show scattered subtidal reefs close to the shore along most of the mapped section of coastline and also an extensive reef area offshore of the coast in the range of 3-6 km from the shore in the north that approaches right up to the coast south of Boegoebaai point. These reefs may be important for biodiversity and/or from a fisheries perspective.

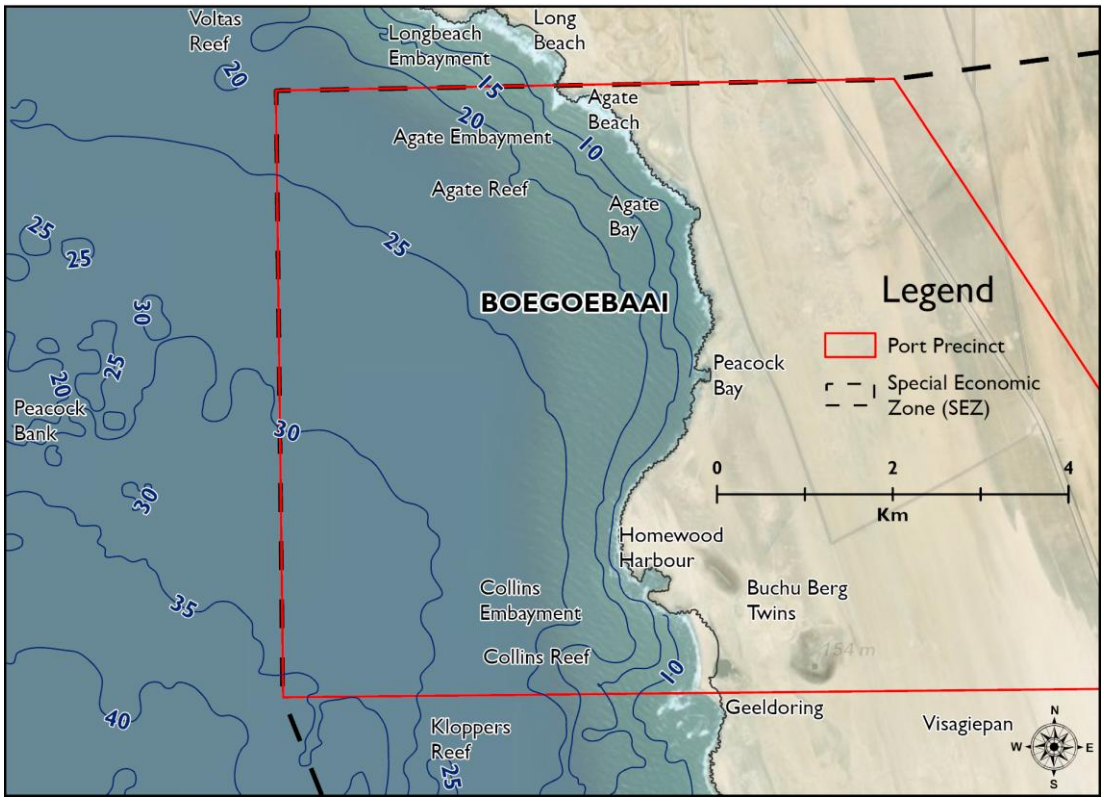


Figure 2-2.7. Nearshore bathymetry at Boegoebaai. Vertical datum is nominally Mean Sea Level, although the presented bathymetric data have not been corrected for tidal variation and the accuracy is thus at best ±1 m. Source: Anchor Environmental Consultants.

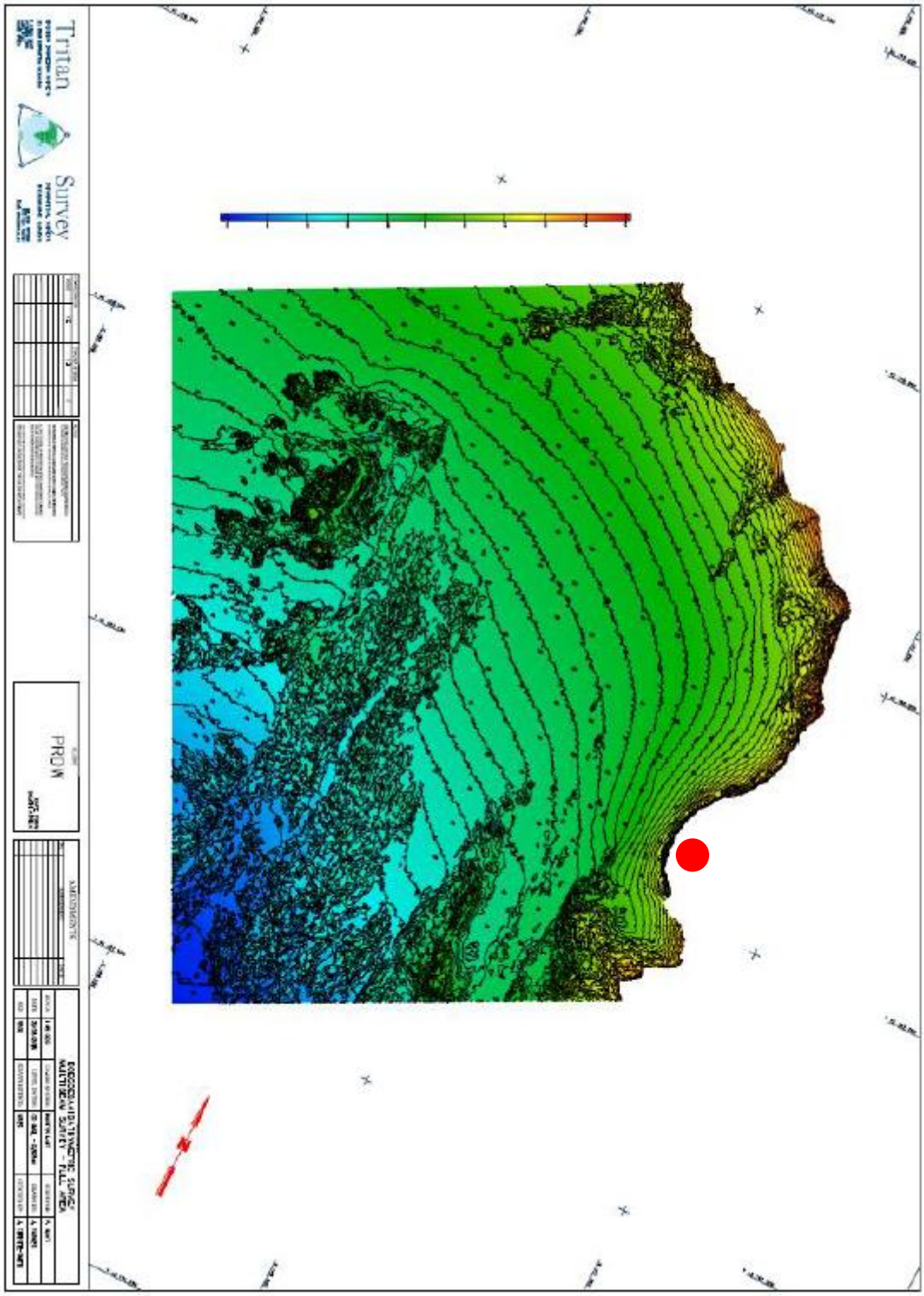


Figure 2-2.8. Bathymetry map of the northern portion of Boegoebaai area. Boegoebaai Point is marked with a red dot. Source: Tritan Survey (2018).

2.2.4 Climate change

Climate change is widely recognised as posing a significant threat to South African ecosystems, economies, and livelihoods. South Africa has reportedly warmed by approximately 0.2°C per decade, which is roughly twice as fast as the global average (Johnston et al. 2024). Increasing temperature is contributing to climate impacts ranging from extreme heat and drought to sea level rise and flooding. Although less well publicised,

significant changes in marine and coastal ecosystems in South Africa have also been reported. Parts of the Agulhas Current have warmed more rapidly than 90% of the world's oceans (Grantham et al. 2011, Hobday and Pecl 2014, Popova et al. 2019), while upwelling on the west and south coasts has increased due to intensified winds, leading to inshore cooling (Rouault et al. 2010). These shifts are accompanied by increases in sea level, changes in ocean currents, wave height, ocean acidification, low oxygen events, increasingly frequent storms and harmful algal blooms (Davis-Reddy and Vincent 2017, Augustyn *et al.* 2018, Young and Ribal 2019).

Increases in sea level and increased storm surges are likely the greatest threats to the Boegoebaai development. Global sea level has reportedly risen 3.3 ± 0.4 mm/year over the last decade (Rahmstorf et al. 2007) and it is virtually certain that these increases will continue into the future, rising by up to 90 cm under a very high emissions scenario (SSP5-8.5, comparing 2081–2100 levels with 1995–2014 levels) or by up to 50 cm in a very low emissions scenario (SSP1-2.6, over the same period) (Ranasinghe et al. 2021). Coupled with an increase in the intensity of sea storms and wave heights (the extent to which remains uncertain at this stage), this poses a significant threat to coastal ecosystems and infrastructure. Fortunately, projected increases in sea level and wave height seem to have been taken into account in the Boegoebaai port prefeasibility assessment at least (PRDW 2015).

2.2.5 Biogeography

The classification and mapping of ecosystem types is foundational to their assessment and management. South Africa's first National Spatial Biodiversity Assessment (Lombard et al. 2004) used a hierarchical habitat classification to map and describe different marine bioregions. This has been further developed through several iterations and the latest National Biodiversity Assessment recognises 150 different marine ecosystem types in the South Africa Exclusive Economic Zone embedded within a hierarchical classification system (Figure 2-2.9) (Sink et al. 2019a).

- At the largest spatial scale of Level 1 (Ecoregion), four shelf ecoregions and two deep ocean ecoregions have been defined. These are the Southern Benguela, the Agulhas, the Natal and the Delagoa, and the Southeast Atlantic Deep Ocean and the Southwest Indian Deep Ocean respectively (Figure 2-2.9).

- At the next level, Level 2 (Bathyregions), ecoregions are subdivided into bathyregions on the basis of depth, with five major bathyregions identified: shore, shelf, slope, plateau and abyss. On this basis, the Southern Benguela ecoregion is split into "shore" and "shelf" regions, while the Southeast Atlantic Deep Ocean ecoregion is split into "slope", "plateau" and "abyss" regions (Figure 2-2.9).

- At Level 3 (Substratum types), ecoregions and bathyregions are further subdivided based on substratum types (sandy, rocky, mixed or mosaic) and geomorphological units (submarine canyons and seamounts). These have been further sub-classified at Level 4 (Ecosystem types) in accordance with local-scale drivers that are known to influence biodiversity pattern. Examples of these sub-classifiers include wave exposure on rocky shores, beach morphodynamic state, fluvial fans, major reef complexes or banks (e.g. Childs, Alphard and Browns Bank), slope features (e.g. Port Elizabeth Ridge), finer scale regional and depth patterns (inner versus mid shelf), and oceanographic features (presence of gyres, eddies and the cold ridge). In some cases, biotopes or distinct biological assemblages have also been used to further sub-classify ecosystem types (Figure 2-2.9).

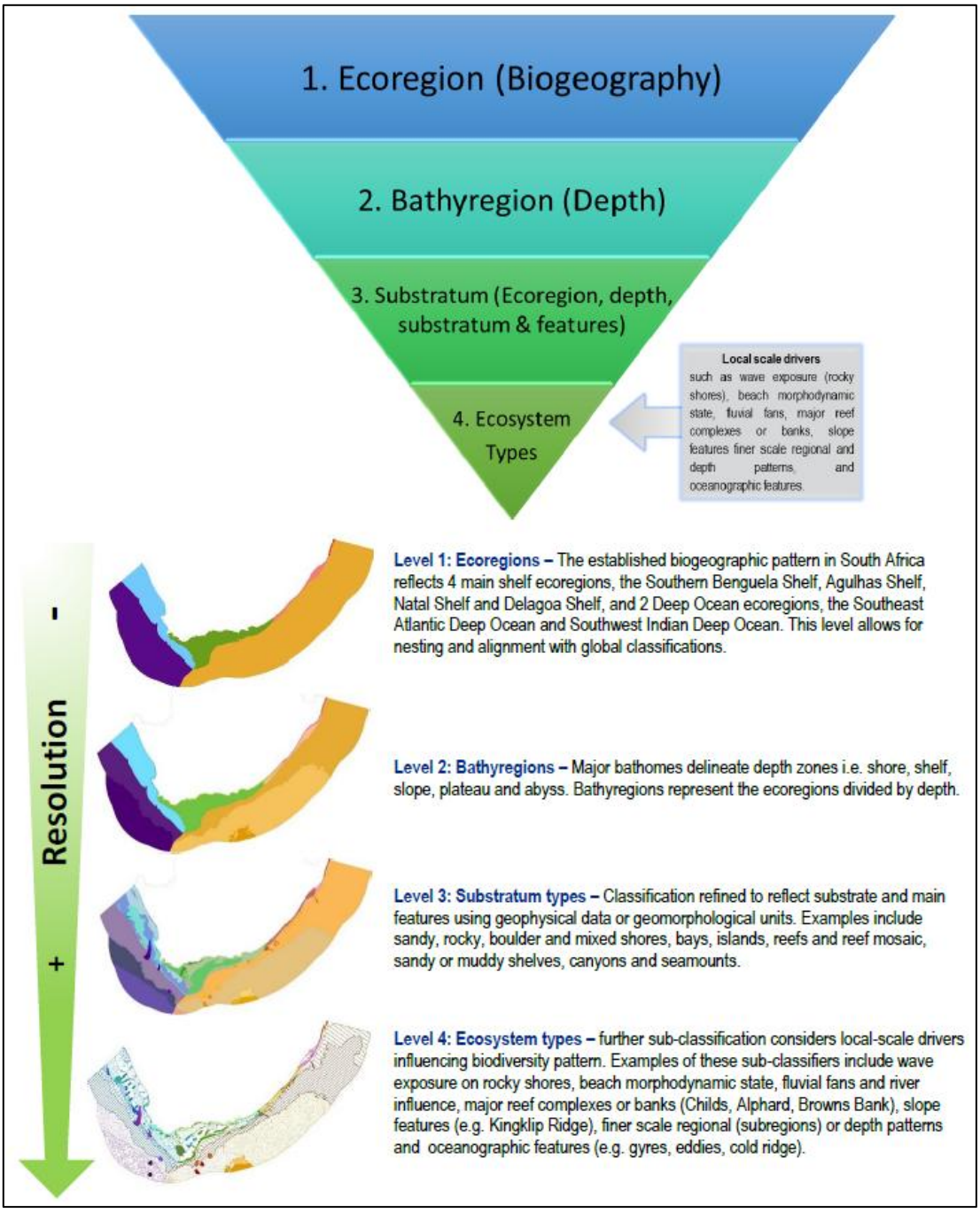


Figure 2-2.9. Hierarchical classification approach used to classify marine ecosystem types around South Africa (Sink et al. 2019a).

Boegoebaai is located in the Southern Benguela ecoregion, with the Southeast Atlantic Deep Ocean ecoregion located offshore the site (Figure 2-2.9 and Figure 2-2.10). The study area is positioned in the "Namaqua inshore" portion of the "Southern Benguela Ecoregion" (Figure 2-2.10). The latter extends all along the western coast of southern Africa between Cape Agulhas and Angola, while the former makes up the inner most portion of this area, extending from the Orange River to Cape Point.

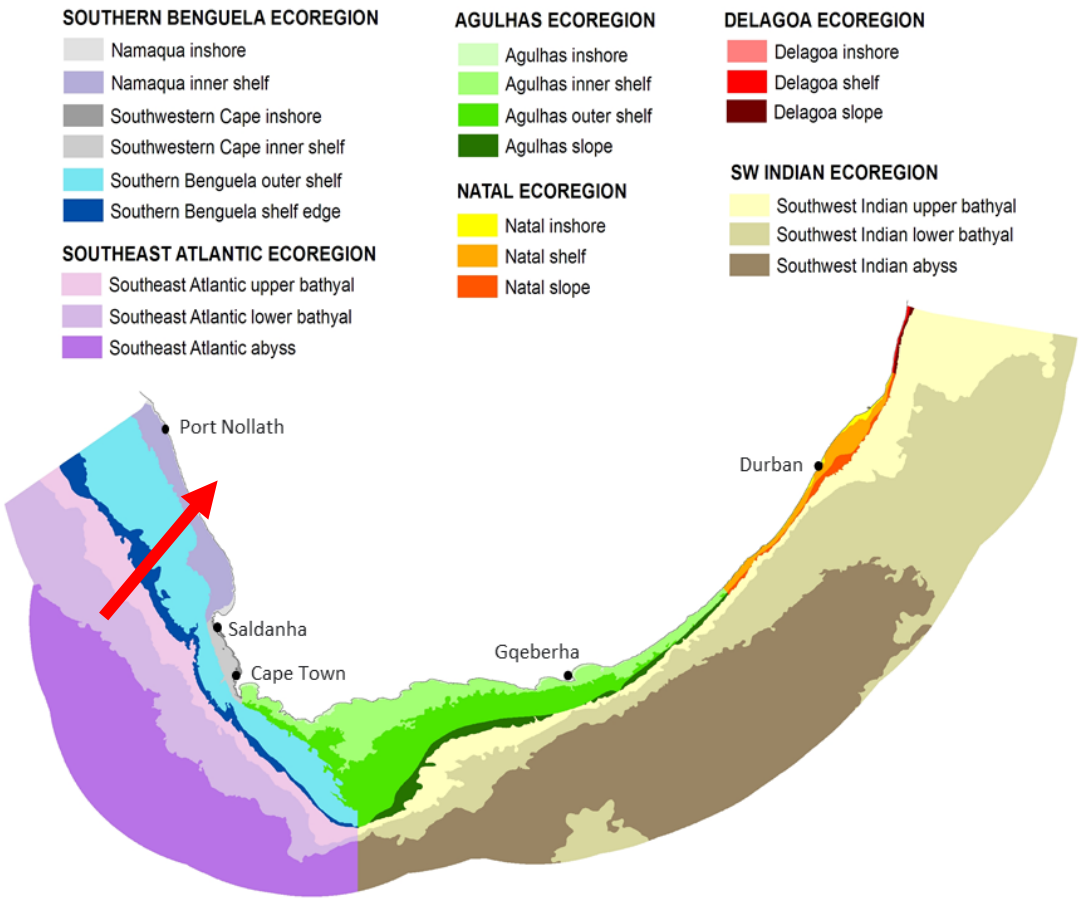


Figure 2-2.10. Six marine ecoregions with 22 ecozones incorporating biogeographic and depth divisions in the South African marine environment as defined by Sink et al. (2019b). The red arrow indicates the location of the project.

The following shoreline (or intertidal) marine habitats exist in the study area (Sink et al. 2019a, Figure 2-2.11):

- Namaqua Exposed Rocky Shore
- Namaqua Mixed Shore
- Southern Benguela Reflective Sandy Shore
- Southern Benguela Intermediate Sandy Shore
- Southern Benguela Intermediate-Dissipative Sandy Shore
- Southern Benguela Dissipative Sandy Shore

In addition, the Namaqua Kelp Forest and Namaqua Cone Inner Shelf are shelf (or subtidal) ecosystem types are present in the study area: (note these are located immediately offshore of the coast and extend out to the edge of the continental shelf at around 100 m depth).

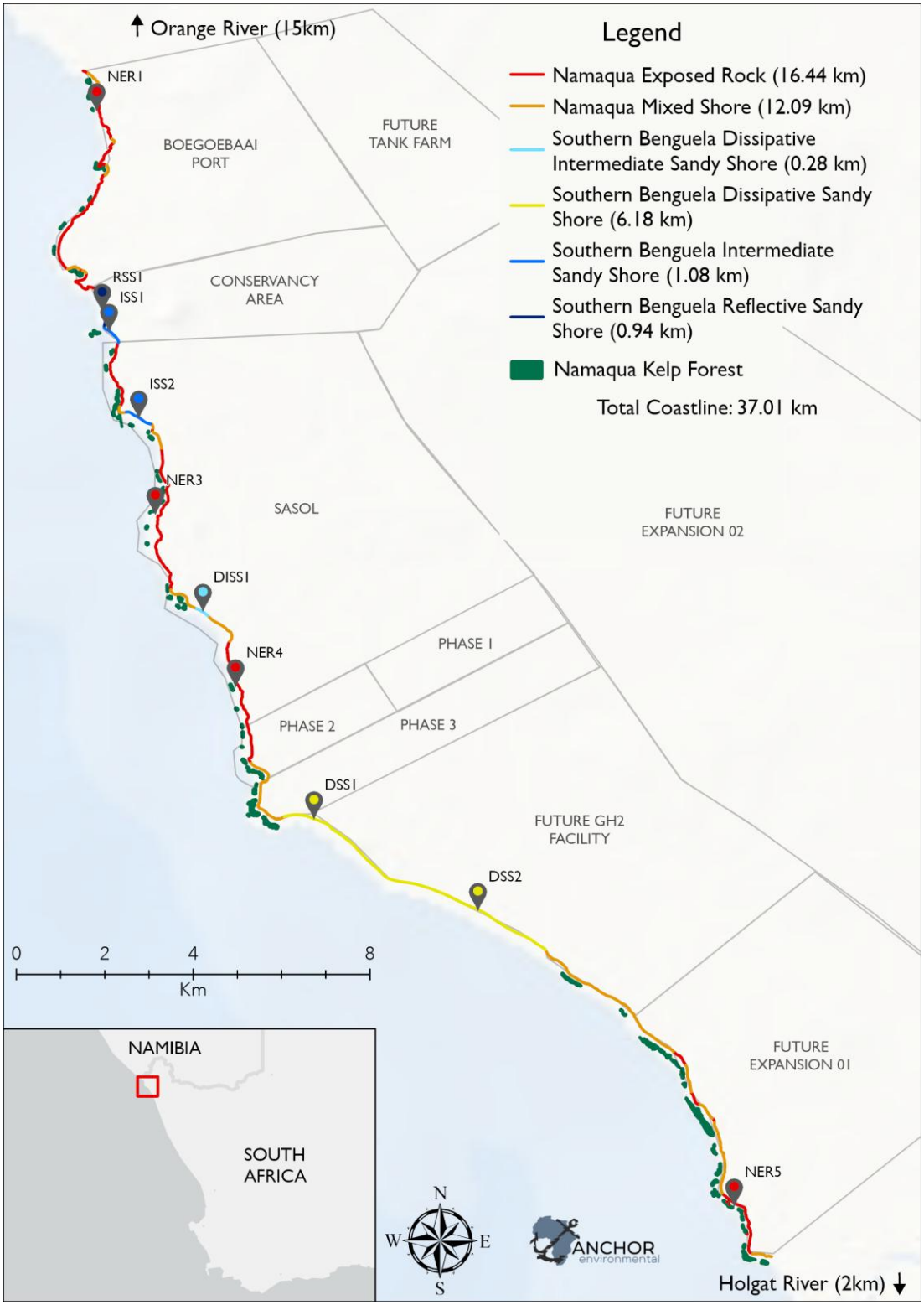


Figure 2-2.11. Intertidal and subtidal habitat types present in the study area as mapped through the National Biodiversity Assessment (Sink et al. 2019a). Red pins indicate rocky-shore sampling sites. Blue and yellow pins indicate sandy beach sampling sites with various degrees of wave-exposure (see Table 2-2.3).

Note that these habitat types are named in accordance with the ecoregion or portion thereof in which they are found (i.e., “Southern Benguela” or “Namaqua”) and are further subdivided into substratum-type and wave exposure categories (in the case of the shoreline habitats) and substratum-type only in the case of the subtidal or shelf habitat types. Wave exposure strongly influences the ecology of all intertidal habitats and

is a key determinant of alongshore patterns of biodiversity observed in rocky intertidal (Stephenson & Stephenson 1972, Menge & Branch 2001, Branch & Branch 2018b) and sandy beach habitats (McIntyre 1971, McLachlan 1980, McLachlan et al. 1981). The net result of this is that rocky and sandy shores that are in close proximity to each other but experience different wave exposures, are generally occupied by entirely different organisms, while others that are further apart but have the same wave exposure feature similar biotic communities. The 2018 NBA (Sink et al. 2019a) distinguishes among very exposed, exposed and sheltered rocky intertidal types, which were determined by a group of experts, who assigned wave exposure levels to each rocky shore according to its shoreline orientation and - where known - its community attributes. All rocky intertidal habitats in Boegoebaai area have been classified as "Exposed".

Table 2-2.1. Various habitat types present in the study area.

Habitat type	Habitats in study area	Shoreline length/ habitat area
Rocky Intertidal	Namaqua Exposed Rocky Shore	16.44 km
Sandy Beach	Southern Benguela Reflective Sandy Shore	0.94 km
	Southern Benguela Intermediate Sandy Shore	1.08 km
	Southern Benguela Dissipative-Intermediate Sandy Shore	0.28 km
	Southern Benguela Dissipative Sandy Shore	6.18 km
Mixed shore	Namaqua Mixed Shore	12.09 km

In the case of sandy beach habitats, the NBA (Sink et al. 2019a) relied on an approach developed by Harris et al. (2011) for distinguishing different beach types within each ecoregion. In terms of this approach, beach types are distinguished based on beach morphodynamic state (a function of breaking wave conditions, grain size and tidal range) (Jackson & Short 2020) which is widely recognised as a strong predictor of macrofauna diversity. Harris et al. (2011) looked at correlations between a range of physical characteristics acquired from Google Earth at sites where measures of beach morphodynamic state have historically been conducted and identified beach width as being the only factor that significantly predicted beach-morphodynamic type, giving four categories (in order of increasing wave exposure): dissipative, dissipative-intermediate, intermediate and reflective. Note that dissipative and reflective beaches mark the two extremes of this morphodynamic continuum (Wright & Short 1984, Short 2006). Dissipative beaches have a flat and wide fine-sand littoral component, with multiple lines of breakers that dissipate the majority of their wave energy in the very wide surf zone. Reflective beaches, in contrast, are narrow and steeply sloping, comprising usually coarser sand. They have a limited surf zone with waves surging directly onto the shore. Intermediate forms are defined by the presence (or absence), nature and form of sand bars and rip currents in the surf (Short 2006). As beach conditions tend towards the dissipative end of the morphodynamic spectrum, species richness and abundance of macrofauna increases (McLachlan & Dorvlo 2005).

Mixed shore communities comprise species from both rocky and sandy shores that are tolerant of sand inundation and rock presence, respectively (Smith et al. 1999, Garner 2013), and can be more, less or equally diverse compared to their adjacent rocky or sandy counterparts. There is limited information on mixed shores in South Africa. Harris et al. (2011) reports that there is no ecologically based classification scheme for mixed shores that is based on national sampling, even though they comprise a third of the coast. In the 2018 NBA (Sink et al. 2019a), no distinction is drawn between mixed shores in the different ecoregions.

Namaqua Exposed Rocky Shore (16.44 km and 44.4% of the total), Namaqua Mixed Shore (9.99 km or 30% of the total) and Southern Benguela Dissipative Sandy Shore (6.18 km, 16.7%) are the dominant shoreline habitats in the study area, while the other habitat types make much smaller contributions (1–3%, Table 2-2.1).

Mapping of subtidal (or shelf) habitats in the Southern Benguela was guided by the presence of kelp floating on the surface (which can be discerned on satellite imagery) owing to limited data available on substratum characteristics in the area. Thus, areas mapped as "Namaqua Kelp Forest" offshore of Boegoebaai include only those areas shallow enough to be colonized by kelp with fronds that extend all the way to the sea surface (specifically *Ecklonia maxima*). All of the remaining subtidal (or shelf) habitat in the study area has been classified as "Namaqua Cone Inner Shelf" habitat and includes both unconsolidated (soft bottom) and consolidated (rocky reef) habitat.

2.2.6 Marine fauna and flora associated with marine habitats in the study area

2.2.6.1 Rocky intertidal

Rocky shores are a common habitat type along the southern African west coast (Jackson & Lipschitz 1984). The abundance and distribution of organisms in this habitat varies across different sites and are influenced primarily by exposure to wave action and to a lesser extent, shoreline topography (Branch & Branch 2018b). Common species found along these rocky shores include various species of algae (seaweeds and kelp), gastropods (limpets and sea snails), bivalves (mussels), echinoderms (sea stars, sea cucumbers and sea urchins), tunicates (ascidians and sea squirts), cnidarians (sea anemones), sea sponges and crustaceans (amphipods, shrimps, prawns, barnacles, and crabs). More tolerant species capable of withstanding desiccation (drying out) are found near the high water mark while those unable to sustain prolonged exposure are found near the low water mark or subtidally. Five distinct zones, linked to tide levels, can be distinguished within this habitat (moving landward), the infratidal zone, the cochlear zone, the lower balanoid zone, the upper balanoid zone, and the Littorina zone.

The infratidal zone, only exposed during spring low tide, is inhabited by species that cannot withstand long periods of exposure (desiccation). These include several species of algae (*Gigartina* sp., *Champia lumbricalis* and corallines), sea urchins *Parechinus angulosus* and the invasive black mussel *Mytilus galloprovincialis*. The cochlear zone, often low shore/shallow subtidal, is on exposed shores home to dense stands of limpets *Scutellastra argenvillei* and *S. cochlear* while more sheltered shores are defined by high densities of *Cymbula granatina*. *Octopus vulgaris*, and various species of fish, particularly those known as 'klipvis', are found in rock pools where they prey upon bivalves and other invertebrates. Above the cochlear zone is the lower balanoid, where the limpet *Cymbula oculus*, the gastropods *Oxystele antoni* and *O. impervia*, the Mediterranean invasive mussel *Mytilus galloprovincialis*, and the ribbed mussel *Aulacomya atra* occur (Stephenson et al. 1937, Robinson et al. 2007, Branch & Branch 2018b). Seaweed is sparse in the lower balanoid zone; however, the sea lettuce *Ulva* spp. and encrusting brown algae *Pseudoralfsia verrucosa* are often present in patches. The barnacles *Tetraclita serrata*, *Balanus glandula* and *Octomeris angulosa* densely populate the upper reaches of the balanoid zone along with various other species. The southern periwinkle *Affrolittorina knysnaensis* and the algae *Porphyra* spp. colonise the Littorina zone.

Four rocky intertidal sites were surveyed in the Boegoebaai area (NER1, NER3, NER4, NER5), starting at the high-water mark and extending seaward to the spring low-tide low water mark, to characterise the rocky intertidal community in this area (Figure 2-2.11, red pins labelled as NER1–5, Figure 2-2.16). Sites were all located in the "Namaqua Exposed Rock" habitat type identified by (Sink et al. 2019a) which is considered the dominant rocky intertidal habitat types present in the study area. Sites were selected to span the full geographic range of this habitat type present in the study area.

Each transect was divided into three distinct shore height zones: high, mid and low shore. Within each zone, three standard 0.5 m x 1 m replicate quadrats were randomly placed, and the percentage cover of all sessile species was recorded as either primary (occurring directly on the rock) and/or secondary (occurring on other benthic fauna or flora) cover. Additionally, individual mobile organisms were counted within the quadrat area to calculate densities of 1 m^2. The primary and secondary cover data for both mobile and sessile organisms were subsequently combined and standardised to a total of 100%. Percentage cover represents the area occupied by organisms on the rock surface, while abundance refers to the number of individual organisms present (Table 2-2.2). This survey protocol aligns with those used in similar studies conducted along the South African south and west coasts.

Table 2-2.2. Percentage cover per 1 m^2 of rocky shore sites: NER1, NER3, NER4 and NER5. Assigned taxonomic and functional groupings are included for reference. Where applicable, (p) represents primary attachment and (s) secondary attachment.

Taxon	Taxonomic Group	Functional Group	NER1	NER3	NER4	NER5
Actinia equina	Anemone	Predator	0	0	0	0.01
Afrolittorina knysnaensis	Gastropod	Grazers	0	0.13	0.46	0.05
Ahnfeltiopsis complicata	Red algae	Articulated algae	0	0.04	0	0.02
Ahnfeltiopsis glomerata	Red algae	Articulated algae	0	0	0.07	0
Anthopleura michaelseni	Anemone	Predator	0	0.13	0	0
Aulacomya atra	Bivalve	Filter feeder	0.77	0.17	0.94	2.75
Botryocladia paucivesicaria	Red algae	Articulated algae	0	0	0	0.01
Brown turf	Brown algae	Corticated algae	0	0.03	0	0
Bunodactis reynaudi	Anemone	Predator	0	0	0	0.09
Burnupena spp.	Gastropod	Predator	0	0.2	0.36	0.56
Callithamnion collabens	Red algae	Articulated algae	0	0.05	0	0.04
Caulacanthus ustulatus	Red algae	Articulated algae	0.29	0.15	0	0.19
Centroceras clavulatum	Red algae	Ephemeral algae	0.08	0	0	0
Ceramium spp.	Red algae	Ephemeral algae	0.03	0.01	1.93	0.08
Chaetomorpha robusta	Green algae	Articulated algae	0	0	0.04	0
Champia lumbricalis	Red algae	Articulated algae	1.9	0.21	0.27	4.8
Chiton	Chiton	Grazers	0	0.01	0	0
Chordariopsis capensis	Brown algae	Articulated algae	0.36	0.12	0	0.04
Chthamalus dentatus	Barnacle	Filter feeder	0.12	0	0.04	0.01
Cladophora spp.	Green algae	Ephemeral algae	0.04	0.05	0.24	0.06
Colonial ascidian	Sea squirt	Filter feeder	0	0	0.02	0
Coralline (crustose)	Coral	Corticated algae	7.35	0.07	8.07	1.98
Coralline (upright)	Coral	Corticated algae	0.1	0.11	1.09	0.15
Cymbula granatina	Gastropod	Grazers	0.66	1.53	0.25	0.26
Cymbula oculus	Gastropod	Grazers	0	0	0	0.01
Diatoms	Diatom	Corticated algae	0	0	0	22.5
Dodecaceria pulchra (s)	Marine worm	Detritivore/Scavenger	0	0	0.03	0
Ecklonia maxima	Brown algae	Corticated algae	0	0.16	0	0.47
Fanworm	Marine worm	Filter feeder	3.59	0.96	0.07	0.55
Fissurella mutabilis	Gastropod	Grazers	0	0.04	0	0.02
Gigartina bracteata	Red algae	Articulated algae	1.76	2.02	0.29	0.17
Gigartina polycarpa	Red algae	Articulated algae	0.07	0.06	0.18	0
Green turf	Green algae	Ephemeral algae	0.03	0.01	0	0.01
Gunnarea gaimardi	Marine worm	Filter feeder	3.59	0.96	0.07	0.55
Gymnogongrus dilatatus	Red algae	Articulated algae	0	0.05	0	0

Taxon	Taxonomic Group	Functional Group	NER1	NER3	NER4	NER5
Helcion dunkeri	Gastropod	Grazers	0	0	0.04	0
Helcion pectunculus	Gastropod	Grazers	0.13	0.01	0.07	0.34
Helcion pruinosus	Gastropod	Grazers	0	0.03	0	0
Helcion spp	Gastropod	Grazers	0.02	0	0	0
Hildenbrandia spp.	Red algae	Corticated algae	2.15	0	8.59	0
Isopod	Isopod	Detritivore/Scavenger	0	0	0	0.01
Kelp limpet	Limpet	Grazers	2.04	0	0	0
Laminaria pallida	Brown algae	Corticated algae	2.1	0	0.1	0
Leathesia difformis	Brown algae	Articulated algae	0	0.17	0	0.01
Leathesia marina	Brown algae	Corticated algae	0	0.04	0	0
Mazzaella capensis	Red algae	Articulated algae	0	0.1	0.11	0.03
Mytilus galloprovincialis	Bivalve	Filter feeder	5.63	7.48	6.75	2.43
Neuroglossum binderianum	Red algae	Articulated algae	0	0	0.07	0.04
Nucella dubia	Gastropod	Predator	0.08	0	0.07	0
Nucella squamosa	Gastropod	Predator	0	0.01	0	0.01
Octomeris angulosa	Barnacle	Filter feeder	0.03	0	0.15	0.29
Ophiuroidea	Sea star	Predator	0	0.01	0	0
Oxystele antoni	Gastropod	Grazers	0.17	0.01	0.35	0.23
Oxystele tigrina	Gastropod	Grazers	0.03	0.01	0	0
Pachymenia cornea	Red algae	Ephemeral algae	0	0.23	0	0
Pachymenia orbitosa	Red algae	Ephemeral algae	0.62	0	0.11	0.1
Parechinus angulosus	Sea urchin	Grazers	0	0.03	0	0.18
Parvulastra exigua	Sea star	Grazers	0	0.01	0.46	0.03
Pentacta doliolum	Sea cucumber	Filter feeder	0	0.01	0	0
Plocamium spp.	Red algae	Articulated algae	0	0.05	0.17	0.03
Porphyra capensis	Red algae	Ephemeral algae	0.24	4	0	0.14
Pseudoralfsia verrucosa	Brown algae	Corticated algae	0.53	0.01	0.46	0
Pycnogonida	Sea spider	Predator	0	0.01	0	0
Red turf	Red algae	Articulated algae	0	0	0	0.12
Sarcothalia radula	Red algae	Articulated algae	0.05	0	0	0
Sarcothalia stiriata	Red algae	Articulated algae	0.85	0	0	0
Scutellastra argenvillei	Gastropod	Grazers	0	0.13	0.7	0.19
Scutellastra barbara	Gastropod	Grazers	0.12	0	0	0
Scutellastra granularis	Gastropod	Grazers	3.88	0.65	2.29	0.72
Siphonaria capensis	Gastropod	Grazers	0	0.05	0	0.03
Splachnidium rugosum	Brown algae	Articulated algae	0.05	0.14	0	0
Sponge	Sea sponge	Filter feeder	0	0	0.06	0
Tetraclita serrata	Barnacle	Filter feeder	0	0	0	0.07

Taxon	Taxonomic Group	Functional Group	NER1	NER3	NER4	NER5
Tricolia neritina	Gastropod	Grazers	0	0.01	0	0
Trochia cingulata	Gastropod	Predator	0	0	0	0.1
Ulva spp.	Green algae	Ephemeral algae	0.12	0.83	0.58	0.24

As no biota were removed during sampling, smaller infaunal species (e.g., polychaetes, amphipods, isopods) inhabiting the complex matrix of mussel beds or dense algae stands were not recorded. Algae and invertebrates that could not be easily identified to generic or specific levels in the field were recorded under a higher classification (e.g. crustose and articulate corallines, red turfs, sponge, colonial ascidian) (Table 2-2.2).

Analysis tools used included univariate (i.e., total number of species per site and average species richness per shore height) and multivariate statistics. Multivariate analyses exploring similarities or dissimilarities among communities across rocky shore sites were employed to assess species and/or groups driving community dissimilarities. For some of these analyses, intertidal species were grouped into seven functional groups: articulated algae (*Ahnfeltiopsis complicate, A. glomerata* and *Gigartina bracteata*), corticated algae (encrusting coralline, diatoms, *Ecklonia maxima* and *Pseudoralfsia verrucosa*), ephemeral foliose algae (mainly *Ulva* and *Poryphora* spp.), grazers (mostly limpets and winkles), filter-feeders (including sessile suspension feeders such as mussels and barnacles), predators and detritivore/scavengers (e.g., carnivorous whelks, crabs and anemones).

Average species richness (number of species) was calculated for each shore height zone and was visualised as bar graphs for comparison. Multivariate analyses exploring similarities or dissimilarities among communities across transects were conducted in R (Oksanen et al. 2024, R Core Team 2025). Data were fourth root (square root by square root) transformed to facilitate non-metric multidimensional scaling (nMDS), PERMDISP and PERMANOVA using the Bray-Curtis dissimilarity index (Oksanen et al. 2024). SIMPER (similarity percentages) analyses were subsequently performed to compare specific sites and identify species driving community dissimilarities.

A total of 77 species, all characteristic of rocky shore habitats along the west coast of South Africa (Day 1974, Branch et al. 2022), was recorded across the four sites surveyed in October 2024 (Figure 2-2.11). Marine invertebrate comprised 43 species (56% of the total community composition), while algae accounted for 34 species (44%). These species spanned 19 taxonomic groups, including green algae (Chlorophyta), red algae (Rhodophyta), brown algae (Ochrophyta), gastropods (sea snails and limpets), bivalves (mussels), echinoderms (sea stars), cnidarians (sea anemones) and crustaceans (barnacles and crabs) (Figure 2-2.12 and Figure 2-2.13). To visualize differences in community composition across these sites, a heatmap of taxonomic groups was generated (Figure 2-2.12 and Figure 2-2.13).

Diatoms exhibited a high total percentage cover at site NER5 but were absent at the other three sites (Figure 2-2.13). Of the marine invertebrate animals, bivalves and gastropods were dominant and most consistently present at all sites (Figure 2-2.13). All algal groups were also found at every site, with red algae displaying the highest total percentage cover (Figure 2-2.13). Certain taxonomic groups (e.g., chiton, isopod, limpet, sea cucumber, sea spider, sea sponge and sea squirt) were only recorded at one site (Figure 2-2.13).

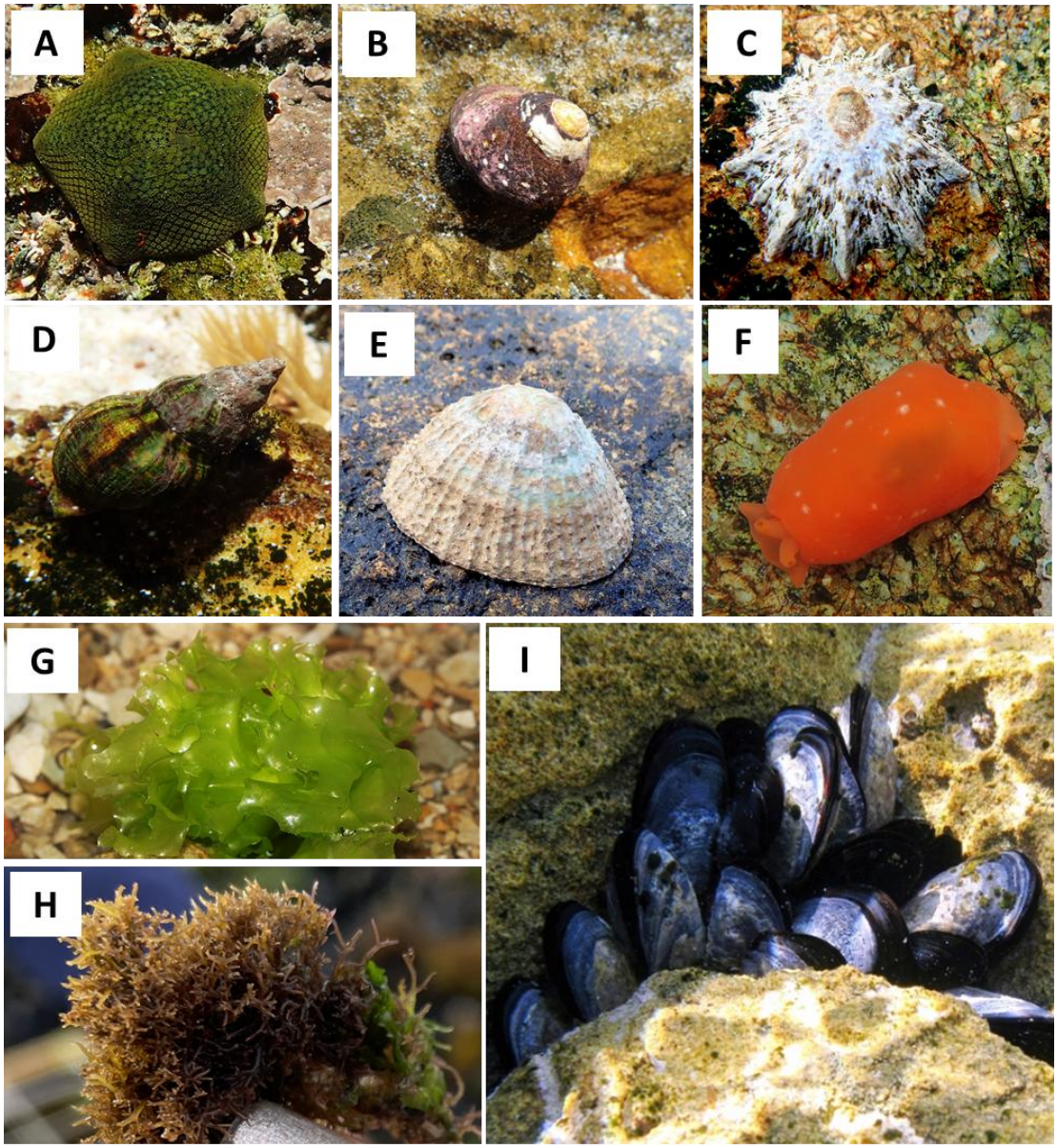


Figure 2-2.12. Examples of species commonly found at the mid shore sites included (A) the dwarf cushion-star *Parvulastra exigua*, (B) the variegated topshell *Oxystele tigrina*, (C) the granite limpet *Cymbula granatina*, (D) burnupena whelks *Burnupena catarrhacta*, (E) the granular limpet *Cymbula granularis*, (F) a nudibranch, (G) the sea lettuce *Ulva* sp., (H) spiky turf weed *Caulacanthus ustulatus* and (I) the invasive Mediterranean mussel *Mytilus galloprovincialis*.

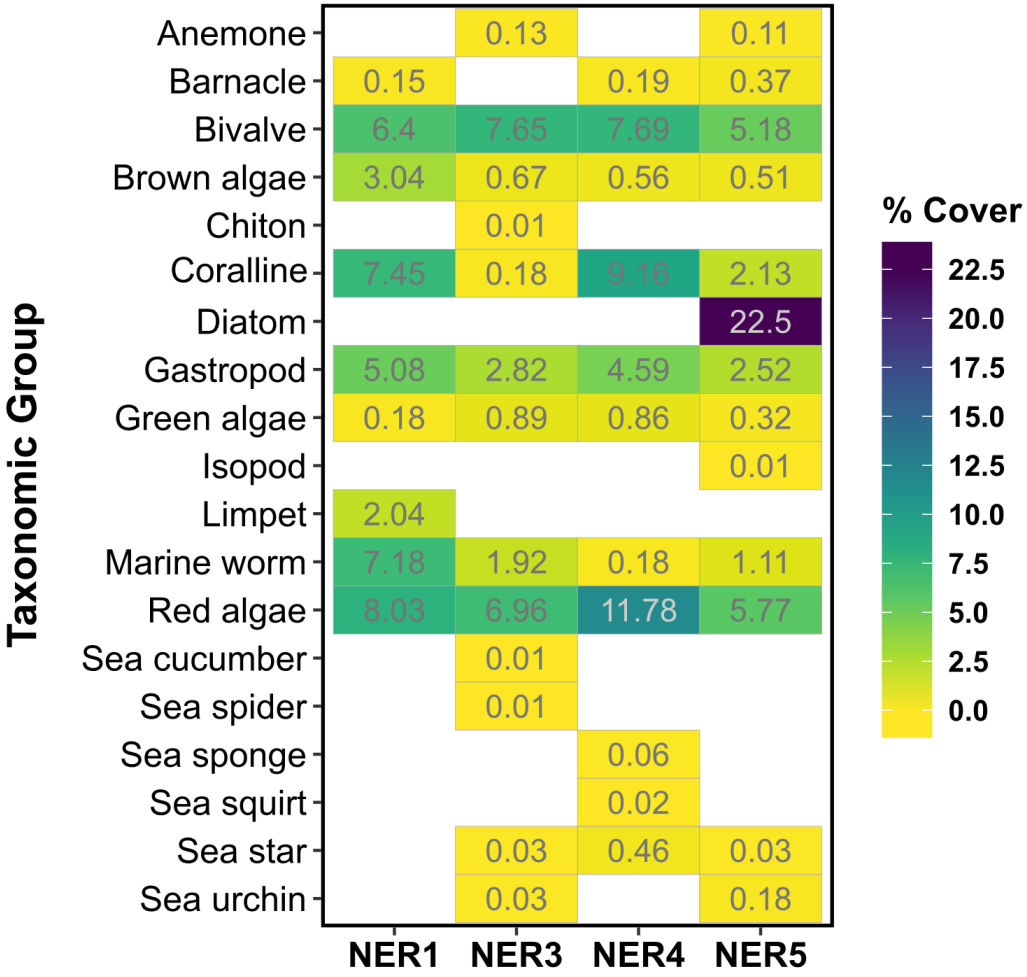


Figure 2-2.13. Total percentage cover of each taxonomic group at each rocky shore site. Percentage cover (rounded to two decimal places) annotate each cell when presence was recorded.

The overall faunal composition included ten species of filter feeders (13%), 19 grazers (25%), ten predators (13%) and two detritivore/scavengers (3%). The algal component consisted of 18 articulated algae (23%), nine corticated algae (12%) and nine ephemeral algae (12%). Similar trends were observed for functional groupings as for taxonomic groups– algae were present at all sites, along with filter feeders, grazers and predators (Figure 2-2.14). Corticated algae were dominant at most sites, particularly at NER5, where they accounted for 25.1% of the cover (Figure 2-2.14). Detritivores/scavengers, such as crabs, were only found at NER4 and NER5, comprising 0.03% and 0.01% of the cover, respectively (Figure 2-2.14).

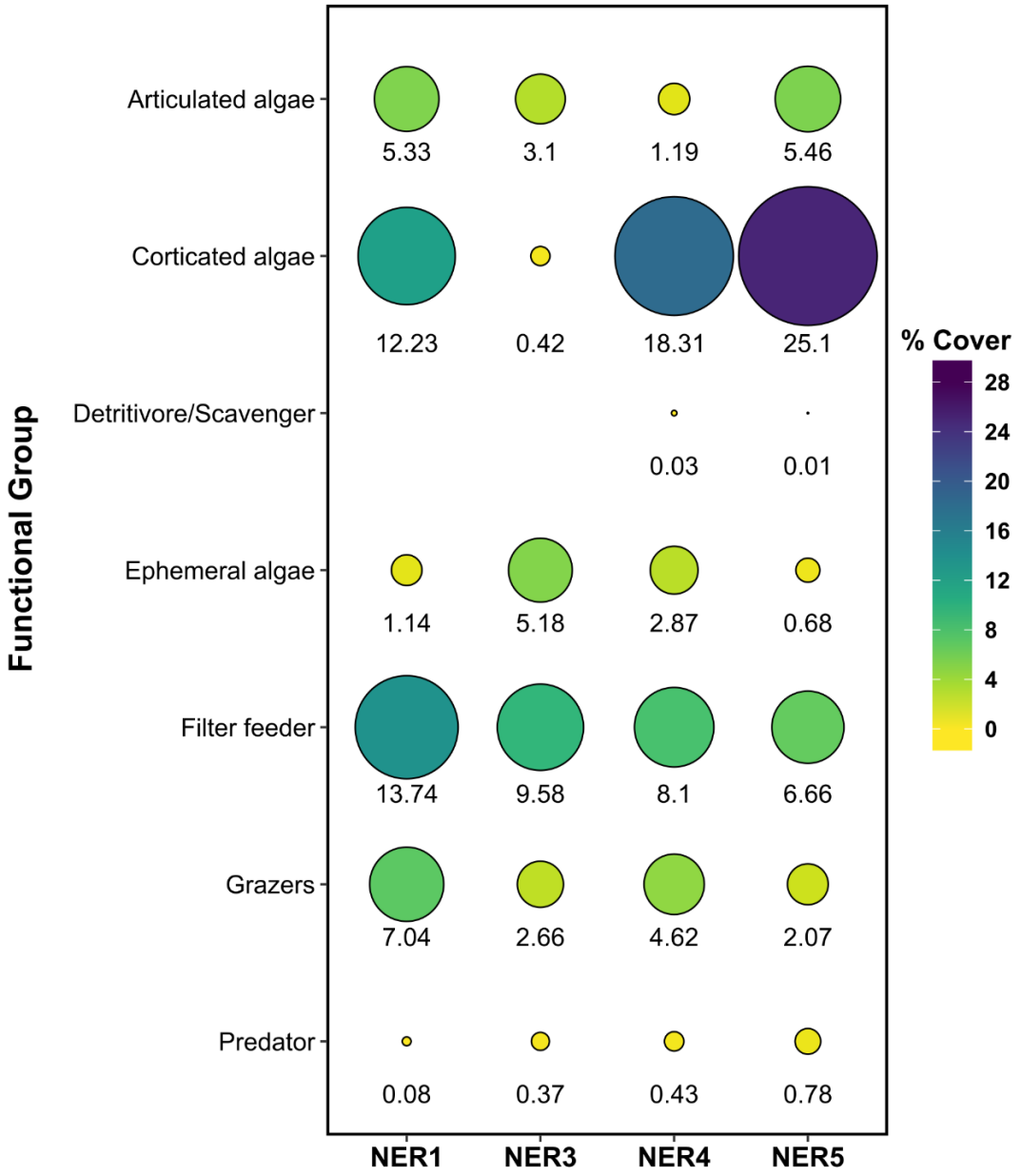


Figure 2-2.14. Total percentage cover of each functional group at each rocky shore site. Percentage cover (rounded to two decimal places) is included beneath each bubble (size corresponds to percentage cover).

The average numbers of species per shore height and site were calculated from four replicates (Figure 2-2.15). Rocky shore habitats are typically characterised by an increase in species richness moving seaward (see Section 2.2.5 and Section 2.2.6.1) (Bustamante et al. 1997). This trend was observed at all surveyed sites with NER3 and NER5 possessing higher numbers of species in the low shore (Figure 2-2.15). NER1 and NER4 showed similar trends, although the high shore of NER1 supported eight species compared to only three species at NER4. Mid-shore species richness was consistent across all sites (Figure 2-2.15).

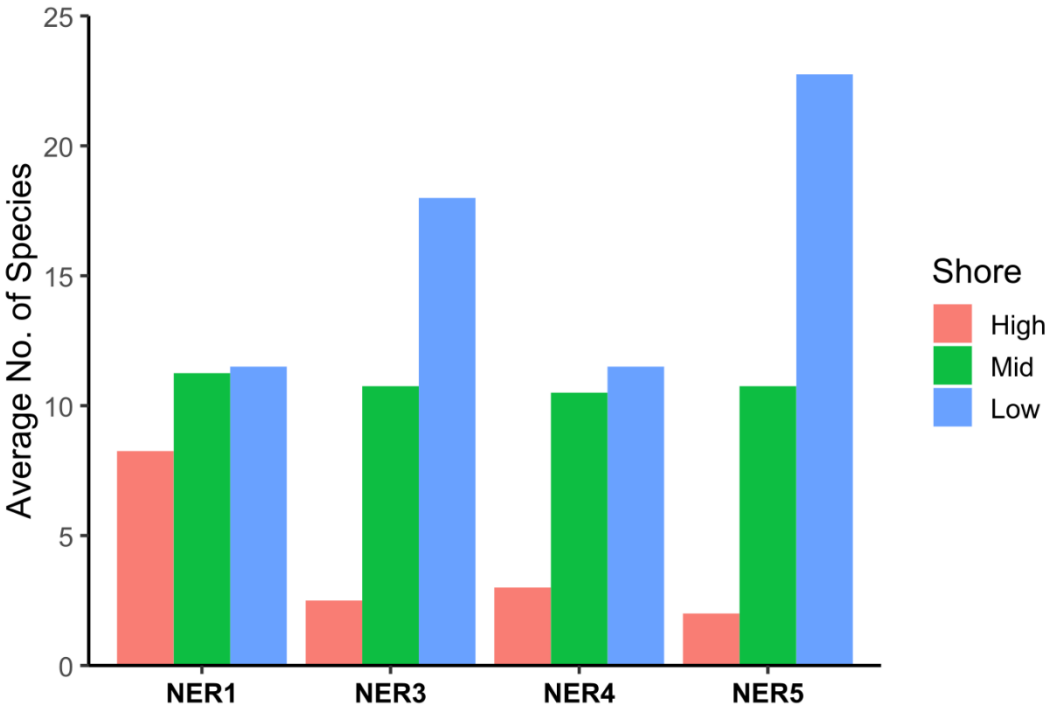


Figure 2-2.15. Average number of species (species richness) for the three shore heights at each rocky shore site. Colours are indicative of shore heights.

The topography of NER1 and NER4 likely explains the lower species richness observed at these locations, particularly at NER1 (Figure 2-2.16). Zonation at these sites was less pronounced, as high shore regions featured rock structures typical of mid and low shores (Figure 2-2.16). Additionally, these sites were highly exposed, leading to strong wave action and decreased desiccation during low tides. The reduced zonation and overlap of mid/low shore habitats in the high shore regions contribute to the minimal differences observed between shore heights.



Figure 2-2.16. Rocky shore habitats found at NER1 (left) and NER4 (right).

Analysis of the spatial distribution using non-metric multidimensional scaling (nMDS) (Figure 2-2.17) revealed that low-shore communities differed from mid- and high-shore communities, though mid- and high-shore communities were more similar to each other (Branch & Branch 2018b). High-shore communities across all sites were relatively consistent, while mid- and low-shore communities displayed more variability. Site NER5 exhibited the greatest dissimilarity among shorelines. These findings reflect the differences in average species richness between shore heights, with low-shore communities showing the greatest spatial dispersion (Figure 2-2.15 and Figure 2-2.17).

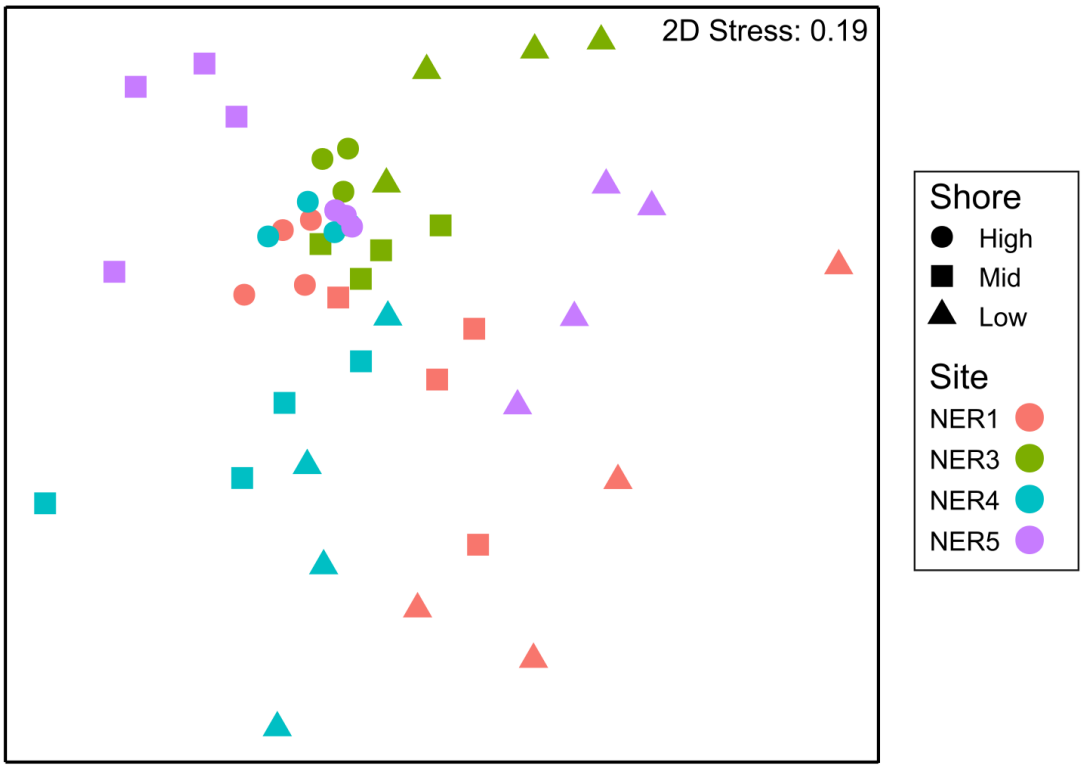


Figure 2-2.17. Spatial distribution of rocky intertidal species composition across varying shore heights (high, mid, and low) at four sites, represented by different colours, based on a non-metric multidimensional scaling (nMDS) ordination plot using Bray-Curtis dissimilarity.

A PERMDISP analysis evaluating group dispersions showed significant differences among shore heights ($F_{(3, 2)} = 37.8$, $p < 0.001$), indicative of distinct communities at high, mid and low shores. However, differences among site location along the proposed port development region was not significant. Within-group clustering was further analysed using a PERMANOVA, which found significant effects of both site ($F_{(3, 2)} = 4.49$, $p = 0.001$) and shore height ($F_{(3, 2)} = 6.95$, $p = 0.001$). These results suggest that community composition is strongly influenced by shore height, wave action and exposure, consistent with descriptions of such environments by Branch & Branch (2018) and in Section 2.2.5.

SIMPER analysis indicated that the average dissimilarity in community composition between sites was 1.1–1.2% and between shore heights ranged from 0.9–1.4%. Despite differences in species richness across sites and shore heights, the Namaqua exposed rock ecosystem along the Boegoebaai Port to Future Expansion 01 region shows high overall similarity.

Other rocky shore surveys undertaken on the west coast were included to provide context for the findings at Boegoebaai (Biccard & Clark 2014b a, Laird et al. 2014, Pulfrich 2018). These communities reflect the characteristic west-coast zonation and species composition described by (Branch & Branch 2018b). Life on highly exposed, wave-beaten shores tends to be more diverse compared to sheltered shores. Our findings across different sites along the west coast align with this trend, although with considerable variation (Figure 2-2.18). Saldanha Bay and Boegoebaai sites exhibited the highest species richness, with 79 and 77 species, respectively while other sites had varying species counts (Figure 2-2.18). Brand-se-Baai 2 displayed the lowest count, with only 24 species despite its 'exposed' classification (Figure 2-2.18).

The diversity figure was, however, compromised as sampling effort varied across surveys and, consequently, sites; Saldanha Bay had the most comprehensive sampling (six replicates per shore height), followed by Boegoebaai (four replicates per shore height). Other sites were sampled with three replicates per shore height, except for Brand-se-Baai 1 and 2, and Groenrivier, where only one transect was sampled. It is also important to note that Hondeklip South 1 was incomplete due to weather constraints (low-shore quadrats were not sampled) as described by Pulfrich (2018). These differences in sampling effort likely contributed to the variation in species counts, as fewer replicates result in less habitat coverage (Pulfrich 2018).

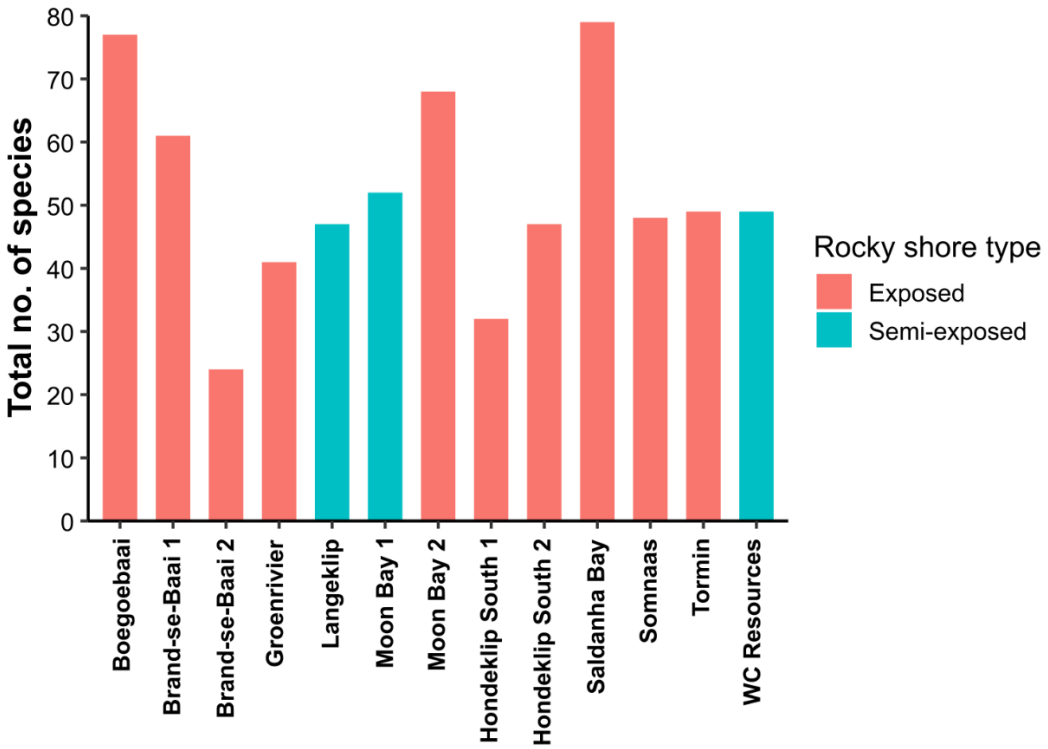


Figure 2-2.18. Total number of species recorded per site along the upper west coast of South Africa.

The presence and absence of taxonomic groups were analysed to better understand the community composition of these rocky shore habitats and assess the representativeness of the diversity (Figure 2-2.19) described at higher taxonomic levels. Community composition across surveyed rocky shore sites was broadly similar, with algae, gastropods, and bivalves consistently represented. Rare or small species, including sea cucumbers, isopods, sea spiders, bryozoans, sea squirts, sea stars, and chitons, were observed at select sites only (Figure 2-2.19). This accounts for differences in species counts across sites (Figure 2-2.18, Figure 2-2.19).

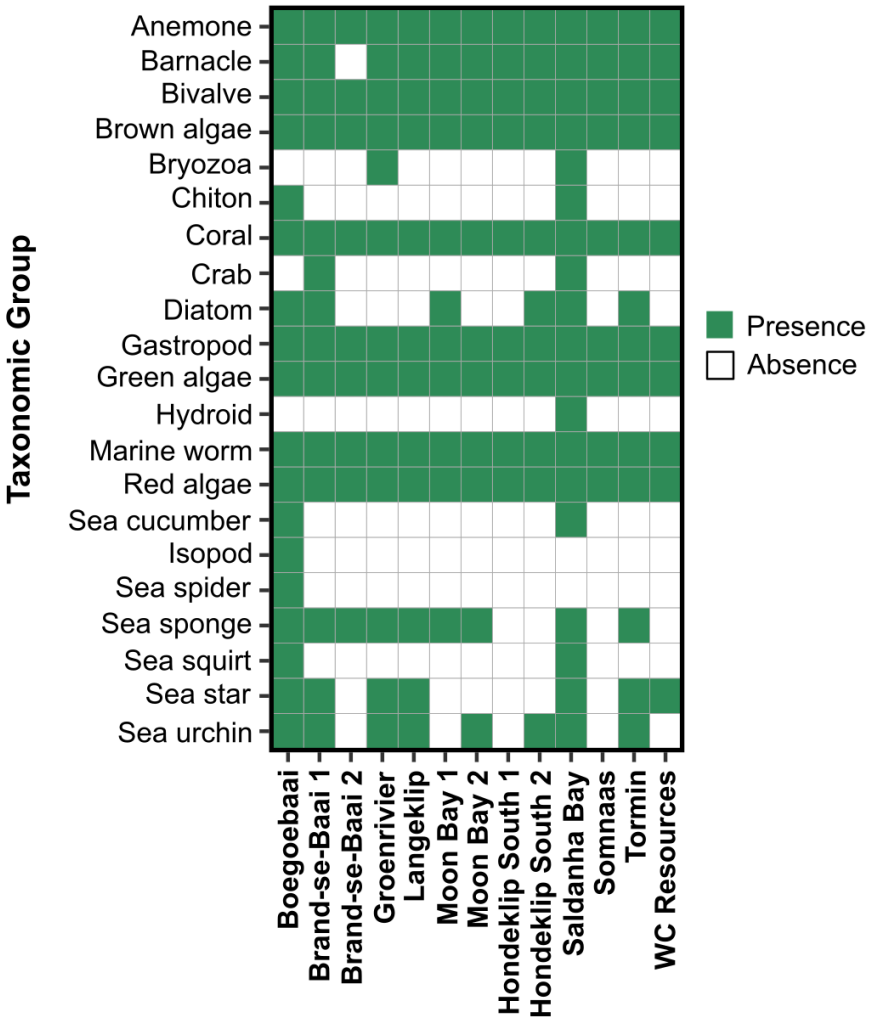


Figure 2-2.19. Presence and/or absence heatmap of taxonomic groups found on rocky shore habitats along the west coast of South Africa.

Greater sampling effort at certain locations, such as Saldanha Bay (~570 km south of Boegoebaai), allowed for broader habitat coverage, providing a more comprehensive representation of these exposed rocky intertidal ecosystems. Nevertheless, the rocky intertidal community observed at Boegoebaai closely aligns with that characteristic of west-coast rocky shores in general, as described by Branch & Branch (2018) and observed in Saldanha Bay as well as other parts of the west coast (Figure 2-2.18, Figure 2-2.19). Sheltered rocky shores are considered a rare occurrence on this exposed coastline

It has been shown that sheltered rocky shore habitat on the west coast of South Africa host a completely different community of intertidal fauna and flora (Blamey & Branch 2009). Such habitat types within this region are rare and exist only within the protected inlets of Homewood Harbour and Peacock Bay (Figure 2-2.7). It is important to note that the proposed development would significantly increase the amount of sheltered rocky shore habitat within the region to several times that of what exists at present.

2.2.6.2 Sandy beaches

2.2.6.2.1 Overview

The coastline from the Orange River mouth to Kleinzee is dominated by rocky shores, interspersed by isolated short stretches of sandy shores. Sandy beaches are one of the most dynamic coastal environments. With the exception of a few beaches in large bay systems (such as St Helena Bay, Saldanha Bay, Table Bay), the beaches along the South African west coast are typically highly exposed. Exposed sandy shores consist of coupled surf zone, beach and dune systems, which together form the active littoral sand transport zone

(Short & Hesp 1982). The composition of their faunal communities is largely dependent on the interaction of wave energy, beach slope and sand particle size, which is termed beach morphodynamics. Three morphodynamic beach types are described: dissipative, reflective and intermediate beaches (McLachlan et al. 1993). Generally, dissipative beaches are relatively wide and flat with fine sands and low 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 in contrast, have high 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 variable species composition (McLachlan et al. 1993, Soares 2003). 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 & Griffiths 1988). As a result of the combination of typical beach characteristics, and the special adaptations of beach fauna to these, beaches act as filters and energy recyclers in the nearshore environment (Brown & McLachlan 2002).

Numerous methods of classifying beach zonation have been proposed, based either on physical or biological criteria. The general scheme proposed by Branch and Griffiths (1988) is used below (Figure 2-2.20), supplemented by data from various publications on West Coast sandy beach biota (Bally 1987, Brown et al. 1989, Soares et al. 1996, 1997, Nel 2000, Nel et al. 2003, Branch et al. 2010, Harris 2012). The macrofaunal communities of sandy beaches are generally ubiquitous throughout the southern African West Coast region, being particular only to substratum type and/or wave exposure. Due to the exposed nature of the coastline in the study area, most beaches are of the intermediate-dissipative to reflective type. The upper beach dry zone (supralittoral) is situated above the high-water spring (HWS) tide level and receives water input only from large waves at spring high tides or through sea spray. This zone is characterised by a mixture of air breathing terrestrial and semi-terrestrial fauna, often associated with and feeding on kelp deposited near or on the driftline. Terrestrial species include a diverse array of beetles and arachnids and some oligochaetes, while semi-terrestrial fauna include the oniscid isopod, *Tylos granulatus*, and amphipods of the *genus Africorchestia.* The mid-beach retention zone and low-beach saturation zone (intertidal zone or mid-littoral zone) have a vertical range of about 2 m.

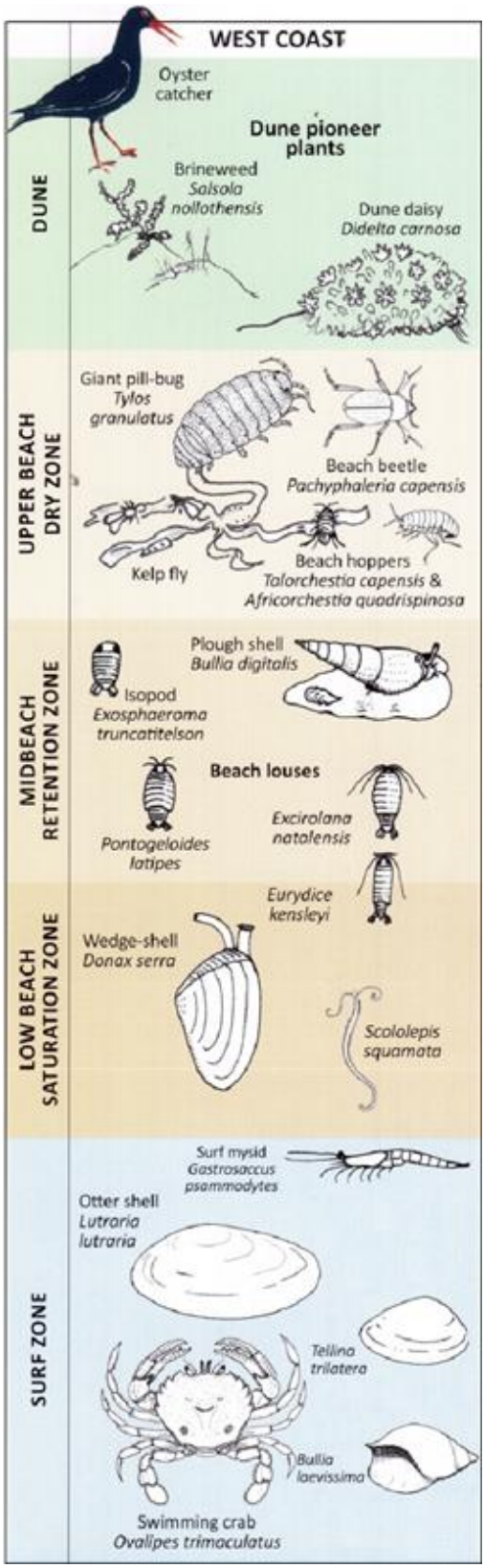


Figure 2-2.20. Schematic representation of the West Coast intertidal beach zonation (adapted from Branch & Branch 2018).

This mid-shore region is characterised by the cirolanid isopods *Excirolana latipes*, *Eurydice kensleyi*, *and Excirolana natalensis*, the polychaetes *Scolelepis capensis* (previously named *S. squamata*), *Orbinia angrapequensis*, *Nepthys hombergii* and *Lumbrineris tetraura*, and amphipods of the families Haustoridae and Phoxocephalidae. In some areas, juvenile and adult sand mussels *Donax serra* may also be present.

The surf zone (inner turbulent and transition zones) extends from the Low Water Spring mark to about 2 m depth. The mysid *Gastrosaccus nambiensis* (Mysidacea, Crustacea), the ribbon worm *Cerebratulus fuscus* (Nemertea), the cumacean *Cumopsis robusta* (Cumacea) and a variety of polychaetes including *Scolelepis squamata* and *Lumbrineris tetraura*, are typical of this zone, although they generally extend partially into the midlittoral above. In areas where a suitable swash climate exists, the gastropod *Bullia digitalis* (Gastropoda, Mollusca) may also be present in considerable numbers, surfing up and down the beach in search of carrion.

A transition zone spans approximately 2-5 m depth beyond the inner turbulent surf zone. Extreme turbulence is experienced in this zone, and as a consequence this zone typically harbours the lowest diversity on sandy beaches. Typical fauna include amphipods such as *Cunicus profundus* and burrowing polychaetes such as *Cirriformia tentaculata* and *Lumbrineris tetraura*.

The outer turbulent zone extends below 5 m depth, where turbulence is significantly decreased, and species diversity is again much higher. In addition to the polychaetes found in the transition zone, other polychaetes in this zone include *Pectinaria capensis*, and *Ampharete ludertizii*. The sea pen *Virgularia schultzei* (Pennatulacea, Cnidaria) is also common as is a host of amphipod species and the three spot swimming crab *Ovalipes trimaculatus* (Brachyura, Crustacea).

There are numerous indices, based on benthic invertebrate fauna information, which can be used to explore conditions and trends in the state of sandy beach ecosystems. These include abundance, biomass, diversity and community composition each of which can be used to evaluate ecosystem conditions and trends over time. Given the complexity inherent in environmental assessment it is recommended that several indices be used (Salas et al. 2006). The community composition, diversity, abundance and biomass of intertidal beach and soft bottom benthic macrofauna samples, collected in Boegoebaai, are considered in this report.

Of particular importance is the presence and abundance of the giant isopod *Tylos granulatus*, found predominantly on the upper portion of sandy beaches, as one of two semi-terrestrial isopod species that occur on sandy beaches in southern Africa (Figure 2-2.21). It is commonly referred to as the 'Pill bug' due to its propensity to curl up into a ball when disturbed (Figure 2-2.21). Historically, *T. granulatus* is known to have a natural distribution range extending from Swakopmund in Namibia to Cape Point in South Africa (Kensley 1974), being restricted to the west coast of southern Africa.

Tylos granulatus is strictly nocturnal and exhibits lunar and semi-lunar behavioural rhythmicity (Kensley 1974). *T. granulatus* remains buried up to 40 cm under the sand above the Spring High Water Mark during the day. During periods of burial, its metabolic rate drops dramatically, conserving energy (Marsh & Branch 1979). It emerges *en masse*, at least one hour after sunset, to scavenge on kelp wrack and other organic flotsam on sandy beaches (Figure 2-2.21). *T. granulatus* will infrequently emerge on high (but ebbing) tides during neaps, but most foraging activity takes place in a couple of hours during low tides each night (Kensley 1974). *T. granulatus* appears strongly photophobic — Kensley (1974) noted that *T. granulatus* seldom emerges during full moons, and Odendaal et al. (1999) state that the species is inactive during full moon. The latter authors studied *T. granulatus* populations in Namaqualand and found evidence that *T. granulatus* is preyed on by yellow mongoose *Cynictis pencillata*. Odendaal et al. (1999) postulated that predation may be an important factor regulating activity (resulting in inactivity during daytime and full moon nights).



Figure 2-2.21. Left: *T. granulatus* – one individual rolling into a ball for protection (right of image), after being disturbed (Scale: 20 mm body width). Right: *T. granulatus* burrowing (foreground) and feeding on kelp (upper individual).

The population status of *T. granulatus* remains mostly unknown, but there is evidence suggesting that certain populations may be severely threatened, and others have completely disappeared (Brown 2000). The range of *T. granulatus* once extended across the whole southern African west coast, stretching far north into Namibia, but has now been reduced to probably less than half that. Human-induced disturbance (in the form of pollution, kelp harvesting, vehicles, construction and development) in the coastal zone was hypothesised to be responsible for the reduction in *T. granulatus* abundance and distribution (Brown & Odendaal 1994). Recent genetic research has uncovered high levels of population structure in southern African *T. granulatus* populations with two distinct lineages present on the west coast, to the north and south of a Hondeklip/Kleinzee break (Mbongwa et al. 2019). More than two decades ago it was suggested that *T. granulatus* should be assigned a Red Data Book[1] status of perhaps 'Vulnerable' or 'Low Risk' (Brown & Odendaal 1994, Brown 2000). A preliminary IUCN red list assessment supported the classification of *T. granulatus* as an endangered species under Criterion B due to its small natural habitat (sandy beaches, supratidal to low water mark only), declines in habitat quality, and fragmented populations as shown by the population genetics results (Linda Harris, Nelson Mandela Metropolitan University, pers. comm.).

Diamond mining, the primary coastal activity affecting sandy beaches in the Boegoebaai study area, inevitably alters the morphology of impacted shorelines, a situation that often persists, depending on the rehabilitation undertaken, for some time post-mining. Understanding the effects of beach diamond-mining on *T. granulatus* populations on Namibian sandy beaches (20-100 km north of Boegoebaai) is improving due to the long-term monitoring that is being undertaken. Nearly the entire northern *T. granulatus* lineage exists in areas impacted by coastal diamond mining and given the wide-scale decrease in abundance and distribution of this species (Brown & Odendaal 1994, Brown 2000), the proposed Boegoebaai development may be of concern.

Beach macrofaunal sampling (such as that described in the following section) usually detects some degree of *T. granulatus* abundance, but during the day (when beach macrofauna is generally sampled), the species tends to occupy the upper regions of the beach zone and is buried too deep in the sand for detection though conventional beach sampling methods. To provide a more representative reflection of *T. granulatus* abundance and population status, dedicated sampling using pitfall traps is conducted (see below).

Sediment quality is also important for understanding ecosystem health as it reflects alterations in benthic sediments from its natural state, by measuring factors like Particle Size Distribution (PSD), organic content, and contaminant levels. The proportion of various sediment grain sizes, including gravel, sand, and mud, play a pivotal role in shaping biological communities and determining the potential for organic and contaminant accumulation (Clabaut & Davoult 1989, Martinez-Garcia et al. 2015, Kim et al. 2020). For example, fine sediment particles, like mud and silt, tend to accumulate trace metals and can elevate organic inputs, including Total Organic Carbon (TOC), which can lead to eutrophication, affecting benthic macrofauna through various responses such as increased growth rates, species loss due to oxygen depletion, and shifts in community composition (Warwick 1993, Hyland et al. 2005, Dewenter et al. 2023). Disturbances such as dredging activities can resuspend mud, releasing pollutants into the water column (Eggleton & Thomas

[1] Species whose continued existence is threatened are classified into different categories of perceived risk and listed in an appropriate Red Data Book.

2004). Although buried metals are typically inert (non-threatening), they can become hazardous once transformed into soluble forms like metal sulphides. Additionally, coastal desalination plants and associated discharges have been found to increase heavy metal concentrations in outfall areas (Alshahri 2017), which can affect the health of the marine species, especially filter feeders like mussels. Understanding sediment PSD is thus necessary for assessing the impact of the proposed development on the Boegoebaai coastal ecosystem.

2.2.6.2.2 Methods

Sampling was conducted at six sites as part of this study, one station at each of the smaller, more wave exposed beaches, and two on the more extensive dissipative beaches in the south (Figure 2-2.11 and Table 2-2.3).

Physical variables were measured at each sampling site within half an hour of low tide. These included grain size, and wave height and frequency, which are used to define beach morphodynamic states. The beach gradient, effluent-line crossings and surf-zone width were also measured to determine exposure rating. These factors were measured and calculated as follows:

- Grain size (in µm): Surface sediment samples (250 ml) were collected from Stations 1, 3, and 5 (i.e. high, mid and low shore) at each site, and dry sieved and weighed to determine sedimentary composition. GRADISTAT Version 8 (Blott & Pye 2001) was used to calculate mean particle diameter, settling velocity, sorting and skewness;

- Wave height (m): A visual estimate of the maximum height difference between the wave trough and the highest point before breaking;

- Wave frequency (no.min^{-1}): Counted as the number of waves passing a fixed point in the surf zone, per minute. Wave period (in seconds) is calculated as 1/Frequency x 60;

- Dean's Parameter/Beach morphodynamic state (Ω): $\Omega = H_b / (T_b \times W_s)$ (where H_b is the wave height in cm, T_b the wave period in seconds, and W_s the sand fall velocity in cm.s^{-1});

- Beach gradient: Measured as the ratio of the height difference between the first and last sampled stations and the beach width between the drift line and water line;

- Effluent line crossings (no. min^{-1}): The number of waves that reaches the beach and swash past the edge of the glassy layer per five minutes;

- Surf-zone Width (m): A visual estimate of the width from the swash line to the seaward edge of the breaker zone; and

- Exposure Index: Calculated according to McLachlan (1980).

Table 2-2.3. Boegoebaai sandy beach sampling sites and (in brackets) Tylos sampling effort.

Habitat type	Site name	Lat	Long	Tylos sampling effort
Intermediate-Dissipative Sandy Shore	DISS1	28.834595° S	16.591579° E	4 transects (5 traps/ transect)
Dissipative Sandy Shore	DSS1	28.875858° S	16.610804° E	7 transects (3 traps/transect, 1 transect with 2 traps – no supratidal habitat present at dune foot)
	DSS2	28.898079° S	16.652923° E	5 transects (5 traps/transect, 1 transect with 4 traps, 1 transect with 2 traps)
Intermediate Sandy Shore	ISS1	28.777684° S	16.572499° E	4 transects (5 traps/transect)
	ISS2	28.795334° S	16.578549° E	4 transects (5 traps/transect)
Reflective Sandy Shore	RSS1	28.773609° S	16.571109° E	4 transects (5 traps/transect)

All visual estimates were made by the same individual during each survey, to keep estimates consistent and comparable.

At each beach site, three transect lines, 5 m apart, were surveyed perpendicular to the shore. Each transect consisted of five equidistant stations across the width of the beach. The three samples at corresponding heights at each station were treated as replicates and were used to measure the level of variability at each site (a total of 15 samples were collected at each beach site). At each sampling station on the three transects, 0.1 m^2 core samples were excavated to a depth of 30 cm and washed through a 1-mm mesh sieve bag to remove fine material. All fauna retained in the sieve bag were then preserved in 96% ethanol (Figure 2-2.22). On beaches where a large fraction of coarser sediment was retained in the sieve bags, sediments were elutriated until three consecutive decants yielded no further macrofauna. Large, heavy organisms (such as large molluscs) were recovered from samples by hand.



Figure 2-2.22. Field survey team surveying beach sites, measuring beach profiles, and elutriating sediment samples to extract macrofauna.

This is less intensive sampling than that outlined by McLachlan (1980), typically involving 30 samples at each beach site. This reduction in sampling intensity was due to the relatively narrow width and reflective nature of the beaches in the study area. The survey team were satisfied that the reduced sampling effort was sufficient to capture the sandy beach macrofaunal community structure and aligned sampling effort with that for the subtidal macrofaunal sites.

In the laboratory, beach macrofauna were identified to species level where possible. The biomass (blotted wet mass in grams to four decimal places) and abundance of each species was recorded for each sample. Molluscs were weighed in their shells. Numbers and biomass of each species were expressed per m^2 at each station, to compare samples. In addition, the species richness (total number of species) per transect was calculated, as well as the total abundance (no./m) and biomass (g/m) of all species combined per running metre[2] of beach down the transect line.

Monitoring ecosystem health of an area also involves identifying stress effects and evaluating recovery post-environmental disturbances. On the west coast of South Africa, monitoring populations of the intertidal isopod, *T. granulatus* populations can offer insights into the overall health of the marine environment, with changes to these populations acting as early-warning signs of environmental impacts like pollution or habitat degradation.

Sampling for *T. granulatus* was conducted at each of the beach sampling sites (Table 2-2.3) during the new moon phase from 30 September to 3 October 2024. Pitfall traps consisted of clear 1 litre plastic jars with an 8 cm diameter opening and a depth of 19 cm. The jars were baited with a teaspoon of peanut butter and dug into the sand so that the opening of the jar lay flush with the surface of the ground. Any *T. granulatus* attracted by the bait fell directly into the trap. Pitfall traps were evenly distributed throughout the available *T. granulatus* habitat (from the dune vegetation to the driftline). For the purposes of this baseline study, traps were distributed evenly along parallel transect lines set perpendicular to the coastline at each beach site (see Table 2-2.3 for the number of transect lines and traps per transect that were set at each site). Traps were set an hour after sunset for a total time of two hours either side of the evening spring low tide.

After the allocated two-hour sampling period, all traps were collected and the captured *T. granulatus* were counted and measured to the nearest 0.5 mm across their maximum body width and then returned to the beach. As *T. granulatus* curls into a ball when disturbed, it was necessary to measure body width rather than length. Body width is proportional to length (Mclachlan & Sieben 1991).

2.2.6.2.3 Sandy beach macrofauna results

The beach widths were all relatively wide (48-72 m), with a gently sloping upper *drift* line, becoming steeper closer to the low-water mark except for intermediate sandy shore site, ISS1 which had a beach width of 31 m and a relatively steep slope (1:7.5) (Figure 2-2.23 and Figure 2-2.24). This is an odd result for an intermediate sandy beach which should be wider and not as steep. Further inspection of the physical beach data revealed that the beach width at the reflective sandy shore site, RSS1, was 48 m and the beach slope was 1:19. It is obvious that the NBA classification of these two beach habitats have been erroneously swapped around. Beach ISS1, which is located on a south-west facing shore (directly opposite the prevailing swell direction), should be classified as a reflective beach and beach RSS1, which faces directly west, should be classified as an intermediate sandy shore. For consistency, we have maintained the original erroneous classification, as it appears in the NBA, in this report. In general, the Boegoebaai beaches that were surveyed in this study can be described as relatively high energy beaches.

Data on key physical and biological (infauna) parameters measured at each site are presented in Table 2-2.4. Overall, sediments were coarsest at beach sites RSS1, DSS1 and ISS1 and were dominated by medium sand. All the sediments were well sorted. The skewness values were mostly symmetrical or fine skewed at DISS1. Apparent wave height across the 6 beaches sampling sites ranged from 1.7-3 m during the survey. Dean's values (Ω, morphodynamic state - a dimensionless number used to classify beach states based on wave energy and sediment characteristics) ranged between 1.78 and 4.45 (Table 2-2.4). When rated on the McLachlan (1980) exposure scale, nearly all of the sites were classified as exposed (12-14), with little difference in exposure rating between sites (Table 2-2.4).

[2] The term 'running meter' of beach is used to designate a 1 m wide strip down the beach, from the spring high tide to spring low tide mark. The area of this will be the length of the transect x 1 m, and estimates from the sampled quadrats were scaled up to this area to provide an estimate of total abundance or numbers along the entire transect, notwithstanding variations in beach width among transects.

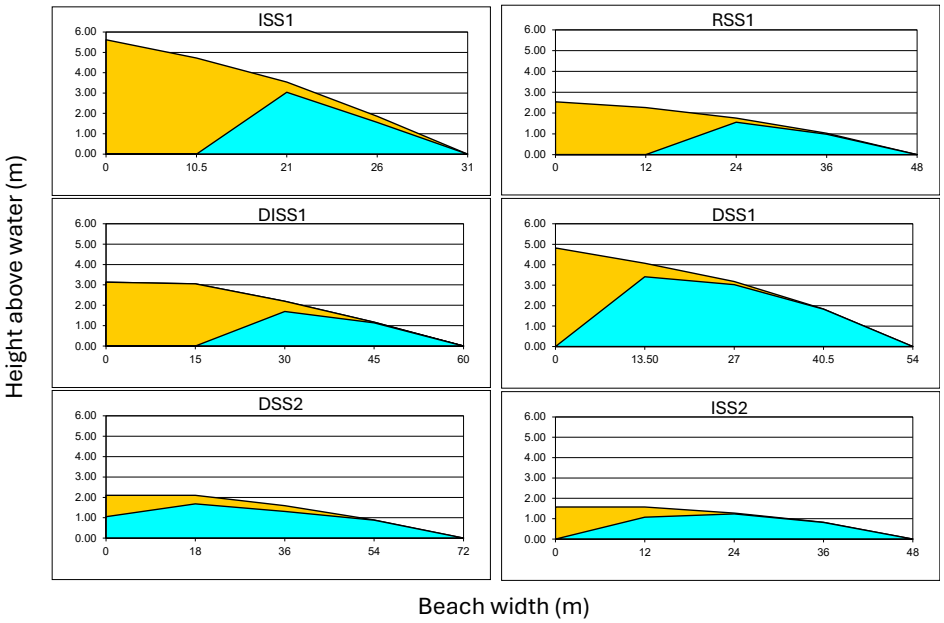


Figure 2-2.23. Measured beach profiles at Boegoebaai sandy beach sampling sites. In each graph the yellow shaded area represents the beach profile (sand) and the blue area represents the water table.

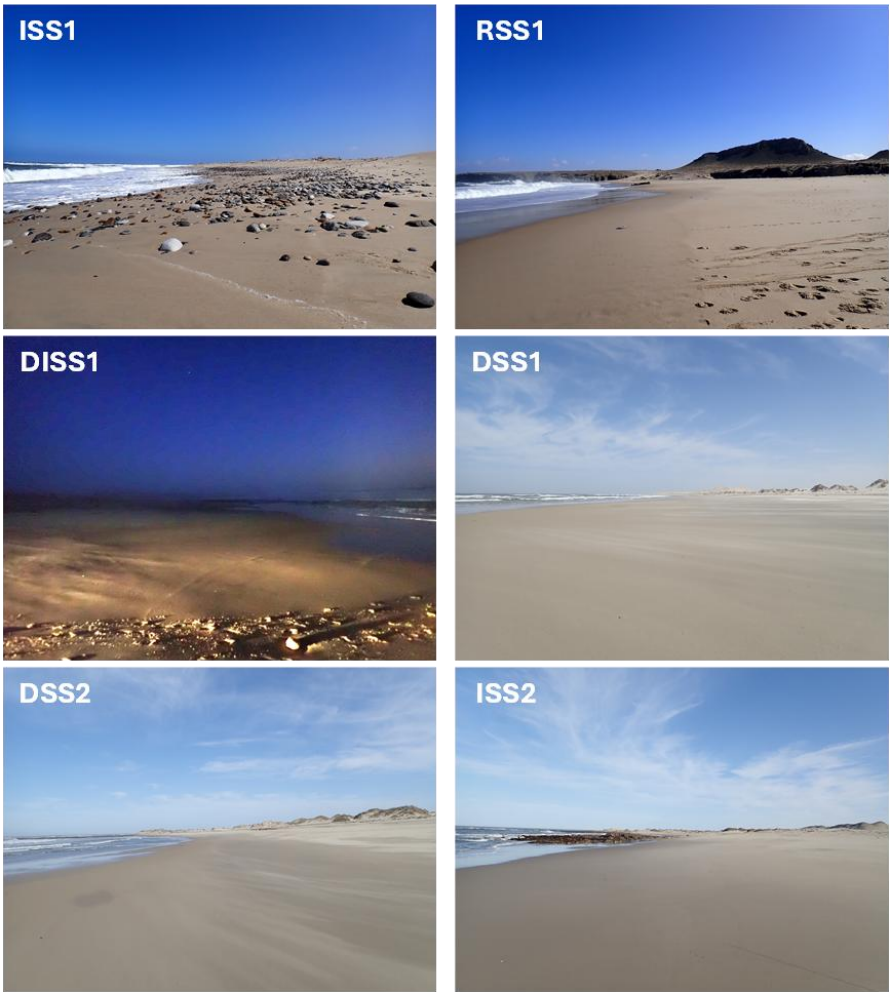


Figure 2-2.24. Boegoebaai sandy beach sampling sites.

Table 2-2.4. Key physical and biological variables recorded at the Boegoebaai beach sites. For species number, abundance and biomass, only supra- and intertidal 'marine' species are included, i.e. insects and arachnids are omitted. Sediment data are presented for station 5 (low shore).

	ISS1	RSS1	DISS1	DSS1	DSS2	ISS2
	Station 3	Station 3	Station 3	Station 3	Station 3	Station 3
Mean particle size (μm)	382.8	384.6	242.2	384.2	293.2	404
Mean particle size (ϕ)	1.471	1.464	2.113	1.46	1.849	1.372
Mean	Medium sand	Medium sand	Fine sand	Medium sand	Medium sand	Medium sand
Sorting	Well sorted	Well sorted	Very well sorted	Very well sorted	Well sorted	Very well sorted
Skewness	Symmetrical	Symmetrical	Fine skewed	Symmetrical	Symmetrical	Symmetrical
Beach width (m)	31	48	60	54	72	48
Wave Height (m)	3	3	3	1.7	2	2
Wave Freq. (no./min)	6	6	10	9	7	8
Wave period (secs)	10	10	6	7	9	8
Effluent Crossings / min.	4	2	1	1	1	2
Slope (1:H)	1:7.5	1:19	1:19	1:11	1:34	1:30.5
Dean's parameter	1.78	2.31	4.45	3.2	2.65	3.02
Beach state	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
Exposure	14	14	13	12	14	13
Total no. of Species	7	8	7	10	13	7
Total no. of Species (marine)	4	5	4	8	9	5
Total abundance per m^2	317.33	22.67	52.00	471.33	231.33	38.67
Total abundance per m^2 (marine)	171.33	17.33	42.67	461.33	221.33	32.00
Total abundance per running m	9837	1088	3120	25452	16656	1856
Total abundance per running m (marine)	5311	832	2560	24912	15936	1536
Total biomass per m^2	1.39	0.27	0.17	1.38	0.74	0.44
Total biomass per m^2 (marine)	1.18	0.27	0.09	1.37	0.74	0.35
Total biomass per running metre	43.16	13.04	10.48	74.42	53.60	20.95
Total biomass per running m (marine)	36.65	12.80	5.46	74.04	53.07	16.63

In total, 17 macrofauna taxa (11 of which are marine) were collected across the habitats (see examples in Figure 2-2.25), comprising five broad taxonomic groups, including crustaceans (Amphipoda, Isopoda and Mysida), molluscs (Bivalvia), Nemertea, worms (Polychaeta) and Insecta (Table 2-2.5 and Table 2-2.6). The fauna was dominated by crustaceans (eight taxa), and insects (five taxa), with lesser contributions from worms (two taxa), molluscs (one taxon), and bivalves. The amphipod, *Africorchestia* sp., and isopods, *Excirolana latipes* and *T. granulatus* dominated the intertidal habitats of Boegoebaai. *Africorchestia* sp., *Excirolana natalensis* and *T. granulatus* were present across all habitat types (Table 2-2.5 and Table 2-2.6).

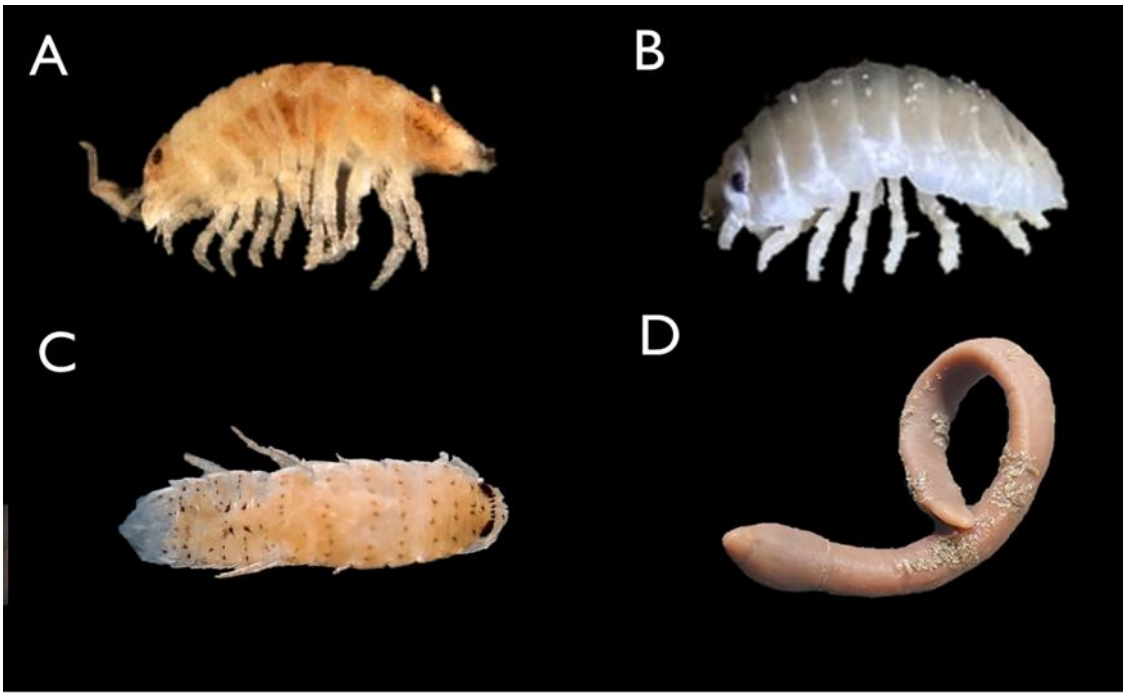


Figure 2-2.25. Selection of intertidal macrofauna species collected during the Boegoebaai baseline survey in 2024. A) Isopoda sp. 1 B) *Tylos granulatus*, C) *Eurydice kensleyi* and D) Nemertea sp.

Dissipative beaches, DSS1 and DSS2, had the highest recorded mean abundance, averaging 461 and 221 ind./m^2, respectively, primarily due to high counts of the amphipod, *Africorchestia* sp., and the isopod, *Excirolana latipes* (Figure 2-2.26 and Table 2-2.5). As expected, and according to Table 2-2.5, the lowest abundances were recorded at sites ISS1 (reflective beach) and RSS1 (intermediate beach), averaging 15 and 17 ind./m^2, respectively. In contrast, site DISS1 and ISS2 had moderately high abundances, averaging 43 and 32 ind./m^2, respectively.

Biomass results generally agree with the abundance results except for site ISS1 (reflective beach) where low abundance was recorded: mean recorded biomass was highest at site DSS1 (1.37 g/m^2) due the high abundance of the isopod, *Excirolana latipes*, at this site followed by ISS1 (1.18 g/m^2) due to the presence of the isopod *T. granulatus* (Figure 2-2.27 and Table 2-2.6). Relatively high biomass was also observed at DSS2 (0.74 g/m^2), and ISS2 (0.35 g/m^2). Lowest indices of mean biomass were recorded at sites DISS1 (0.09 g/m^2) and RSS1 (0.09 g/m^2).

Table 2-2.5. Abundance (total number of individuals per running meter) of beach macrofauna sampled at Boegoebaai. Abundance per running meter can be converted to unit area (m^2) by dividing by shore width (Refer to Table 2-2.4 with beach parameters information).

	DISS1	DSS1	DSS2	ISS1	ISS2	RSS1
CRUSTACEA						
Amphipoda						
Africorchestia sp.	1080	8676	12960	280	576	128
Griffithsius latipes	40	1656	288	0	0	64
Isopoda						
Excirolana latipes	0	10980	144	28	256	96
Excirolana natalensis	760	144	912	224	352	416
Isopoda sp. 1	0	36	0	0	288	0
Tylos granulatus	680	864	240	6664	64	128
Eurydice kensleyi	0	2448	816	0	0	0
Mysida						
Gastrosaccus namibiensis	0	0	288	0	0	0
MOLLUSCA						
Bivalvia						
Semimytilus patagonicus	0	0	48	0	0	0
NEMERTEA	0	108	0	0	0	0
POLYCHAETA						
Scolelepis capensis	0	0	240	0	0	0
INSECTA						
Diptera (adult)	0	252	96	0	96	64
Diptera larva sp. 1	280	0	480	4844	0	160
Diptera larva sp. 2	40	0	48	1232	0	32
Insect Beetle sp. 1	240	0	96	56	224	0
Insect Beetle sp. 2	0	288	0	0	0	0
Grand Total	**3120**	**25452**	**16656**	**13328**	**1856**	**1088**

Table 2-2.6. Biomass (total per running metre) of beach macrofauna sampled at the Boegoebaai. Biomass per running metre can be converted to unit area (m^2) by dividing by the shore width (Refer to Table 2-2.4 with beach parameters information).

	DISS1	DSS1	DSS2	ISS1	ISS2	RSS1
CRUSTACEA						
Amphipoda						
Africorchestia sp.	3.32	18.91	34.91	1.33	1.29	0.12
Griffithsius latipes	0.05	1.23	0.13	0.00	0.00	0.04
Isopoda						
Excirolana latipes	0.00	47.21	0.84	0.00	7.05	2.06
Excirolana natalensis	1.80	0.68	13.00	2.00	8.02	9.30
Isopod 1	0.00	0.00	0.00	0.00	0.24	0.00
Tylos granulatus	0.28	0.91	1.92	33.31	0.02	1.29
Eurydice kensleyi	0.00	3.52	1.23	0.00	0.00	0.00
Mysida						
Gastrosaccus namibiensis	0.00	0.00	0.64	0.00	0.00	0.00
MOLLUSCA						
Bivalvia						
Semimytilus patagonicus	0.00	0.00	0.04	0.00	0.00	0.00
NEMERTEA	0.00	1.57	0.00	0.00	0.00	0.00
POLYCHAETA						
Scolelepis capensis	0.00	0.00	0.37	0.00	0.00	0.00
INSECTA						
Diptera (adult)	0.00	0.05	0.01	0.00	0.02	0.05
Diptera larva sp. 1	0.31	0.00	0.46	4.73	0.00	0.18
Diptera larva sp. 2	0.17	0.00	0.02	0.98	0.00	0.00
Insect Beetle sp. 1	4.54	0.00	0.04	0.80	4.31	0.00
Insect Beetle sp. 2	0.00	0.33	0.00	0.00	0.00	0.00
Grand Total	**10.48**	**74.42**	**53.60**	**43.16**	**20.95**	**13.04**

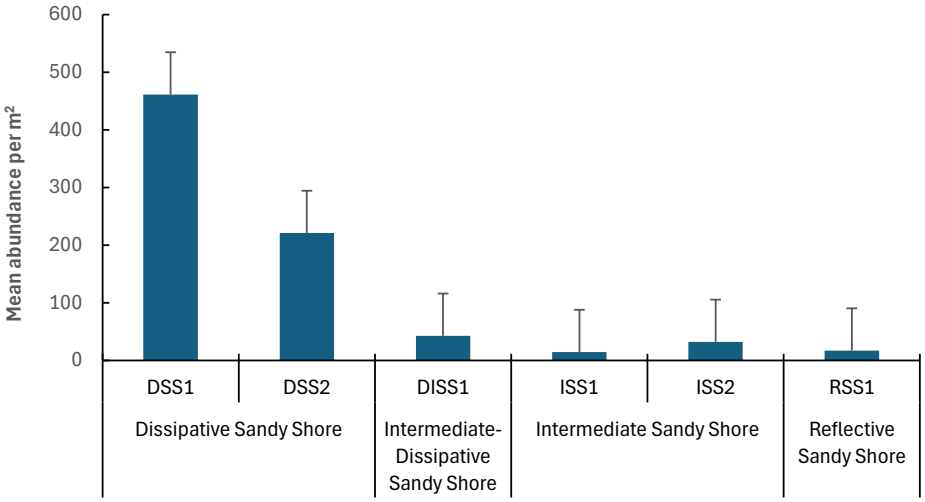


Figure 2-2.26. Mean abundance per m² (+ one standard error) of intertidal macrofauna (marine species only) sampled at four habitat types in Boegoebaai. Error bars are one standard error.

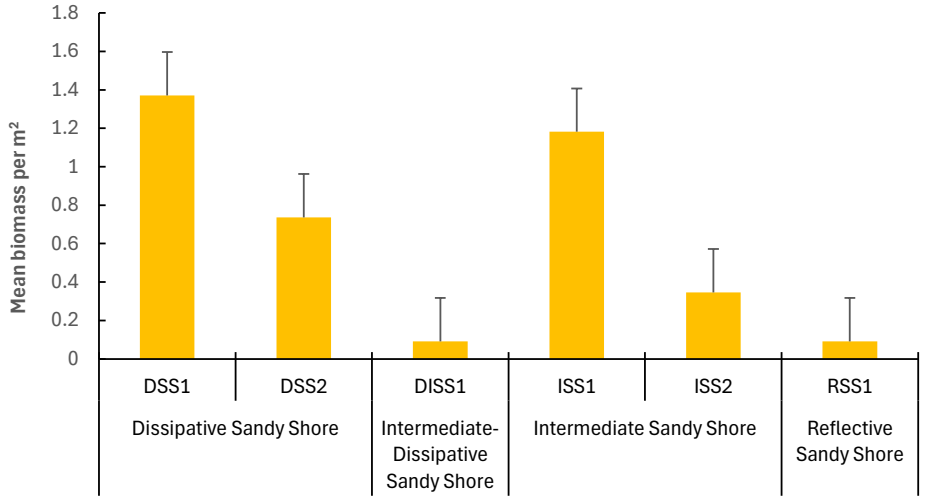


Figure 2-2.27. Mean biomass (grams per m² + one standard error) of intertidal macrofauna (marine species only) sampled at four habitat types in Boegoebaai. Error bars are one standard error.

By comparison, mean abundance of intertidal macrofauna for six intermediate dissipative beaches (of similar widths) sampled at Doringbaai, 380 km south of Boegoebaai (also within the Namaqua inshore ecoregion), ranged between 79-163 ind./m² while mean biomass ranged between 0.95-15.5 g/m² and total diversity of beach macrofauna recorded was 16 taxa (12 of which were marine) (Biccard et al. 2024). Overall, mean biomass across all Boegoebaai beaches sampled during the present study (0.64 g/m²) is an order of magnitude lower than that recorded at Doringbaai (4.91 g/m²). The Doringbaai beaches that were surveyed are relatively undisturbed in comparison to the Boegoebaai beaches which are considered highly disturbed as a result of diamond mining activity. Baseline data (prior to mining activities) for the Boegoebaai beaches are not available, however, our survey results, when compared to those from Doringbaai, suggest that coastal diamond mining activities have had a detrimental impact on intertidal sandy beach macrofauna communities in Boegoebaai and that univariate indices of abundance, biomass and diversity observed in this study are not necessarily representative of the habitat types that were surveyed.

Some taxa were restricted to the DSS habitat, including the isopod, *E. kensleyi*, the mysid, *G. namibensis*, the polychaete, *Scolelepis capensis*, an unidentified nemertean and the bivalve, *Semimytilus patagonicus* – the latter likely to have been washed ashore from nearby rocky shore habitats. This restricted distribution could point to the sensitivity of these taxa to high wave action and their preference for more dissipative beaches.

The multidimensional scaling (MDS) ordination plot (a technique for grouping samples with similar macrofaunal communities and separating dissimilar samples – see Section 2.2.6.1) depicts infaunal community structures among Boegoebaai habitat types (Figure 2-2.28). Based on the results, it appears that the samples from the dissipative beaches (DSS1 and DSS2) are grouped together and share greater similarity than samples from the other beach habitat types (Figure 2-2.28). As expected, samples also appear to be clustered according to their height on the shore (Figure 2-2.28) with those from stations one and two (higher on the shore) clustering separately from those collected at stations three four and five (lower on the shore). This result indicates that the environmental conditions present at varying heights across the width of the shore (presence/absence of seawater) appears to be the most important predictor of intertidal macrofaunal community structure, in this case more so than beach habitat type.

2.2.6.2.4 Tylos results

Average *T. granulatus* abundance per trap for the six sites sampled in Boegoebaai are shown in Figure 2-2.29. Surprisingly, of all the beaches sampled, site ISS1 (with a narrow beach width, steep profile and reflective sandy shore), had the highest catches of *T. granulatus* (11.7 individuals per trap). This was followed by the adjacent beach, RSS1 (intermediate sandy shore) with an average abundance of 4.7 individuals per trap. Beaches ISS2, DSS1 and DSS2 had poor average catches ranging from 0.5-1.9 individuals per trap with a zero-catch recorded for DISS1 (Figure 2-2.29). In comparison to the catches made at Doringbaai (27.8 and 23.6 individuals per trap at the two beaches sampled), the abundance of Tylos at the Boegoebaai is extremely low. Size frequency data from each of the beaches paint a similar picture with only the juvenile cohorts present at each of the beaches sampled (Figure 2-2.30) – the complete absence of adult Tylos from the population on Boegoebaai beaches will compromise reproductive success and is likely to result in complete collapse or local extinction of the species (already observed at site DISS1).

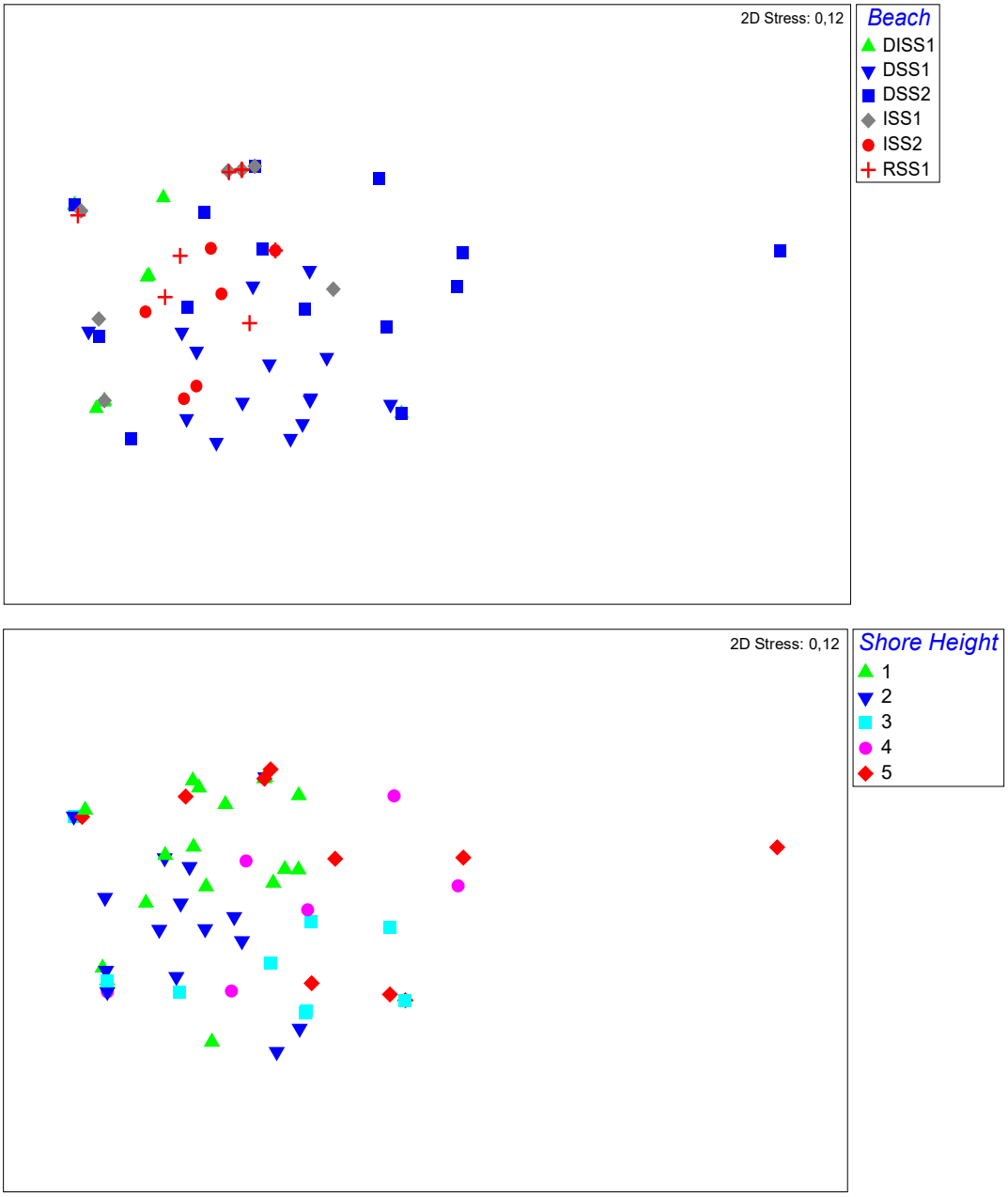


Figure 2-2.28. Non-metric multi-dimensional scaling (nMDS) ordination plot depicting relative similarity between the macrofaunal communities sampled from four beach habitat types (intermediate dissipative sandy shore, dissipative sandy shore, intermediate sandy shore and reflective sandy shore) at Boegoebaai. Samples were plotted according to the habitat types (top graph) and shore height (bottom graph: station 1 at the high-water mark and station 5 at the low-water mark).

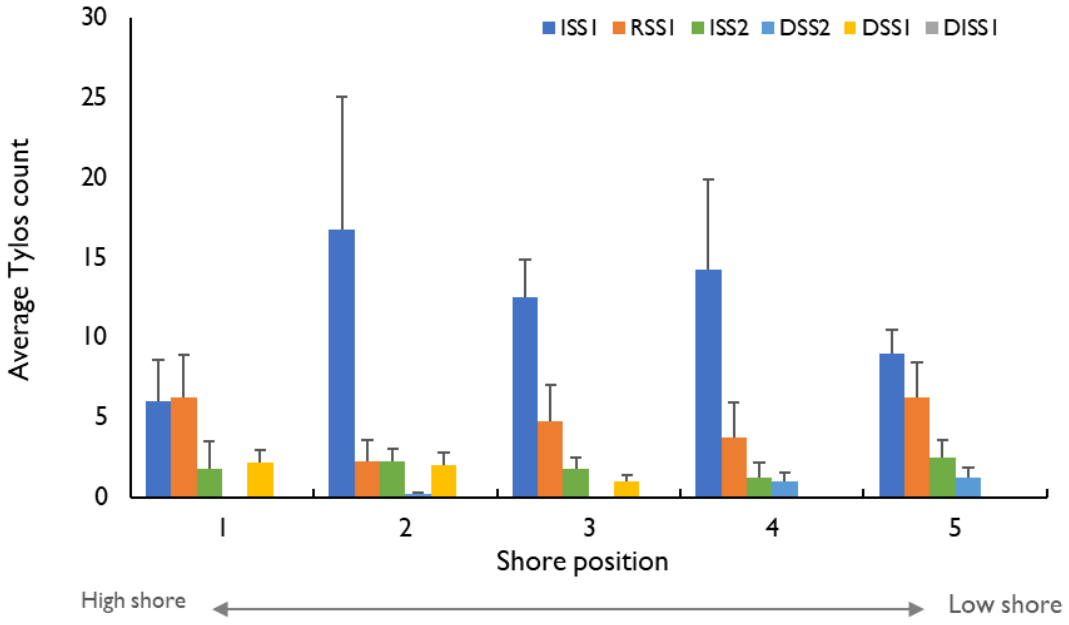


Figure 2-2.29. Average Tylos counts (per trap, moving from high shore to low shore) at Boegoebaai. The error bars denote one standard error.

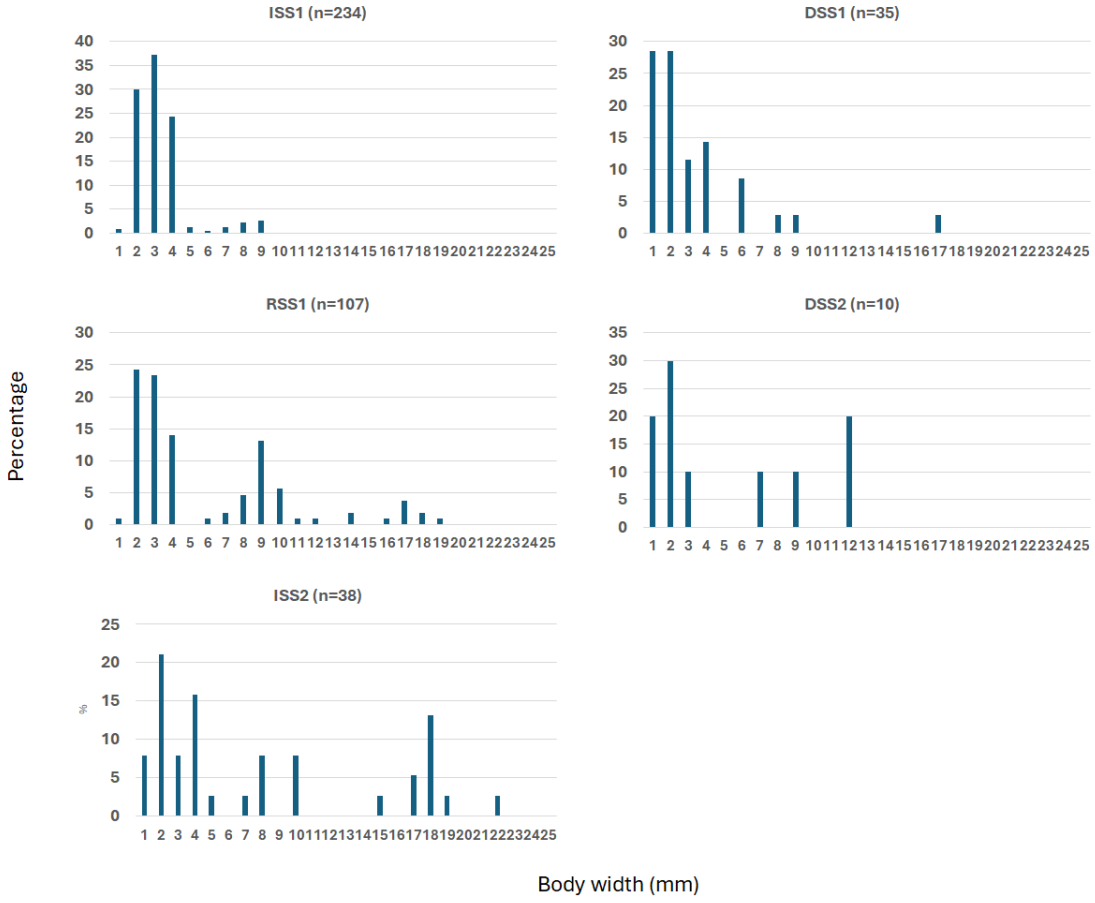


Figure 2-2.30. *T. granulatus* body width frequency distributions at Boegoebaai beach sites sampled during the 2024 field survey. Note that a zero-catch rate was recorded for DISS1.

It is well established that intertidal diamond mining by means of seawall and/or cofferdam construction tends to destroy or remove nearly all of the available inter- and supra-tidal habitat needed by *T. granulatus* and, as a consequence, this species usually disappears from beaches in the immediate vicinity of such activities. This has been observed on beaches just to the north of the Orange River where monitoring of the impacts associated with intertidal diamond mining on sandy beaches has been taking place for more than two decades (Pulfrich & Hutchings 2023) and is almost certainly the case here in Boegoebaai. Other anthropogenic effects such as the presence of vehicles, lights, prospecting (drilling), accretion activities associated with the 'Sand to Sea' project in Southern Coastal Mines just north of the Orange River and natural disturbance events (Orange River discharges of freshwater and sediment and beach erosion from storm events) have also been identified as potential drivers of declines and temporal variation observed in *T. granulatus* populations in southern Namibia (Pulfrich & Hutchings 2023) and are also likely to play a role explaining the low abundance of *T. granulatus* observed on the Boegoebaai beaches in this study. Again, it needs to be acknowledged that there are no baseline data against which current results can be compared, but when compared to results from Doringbaai (Biccard et al. 2024) and control sites just north of the Orange River (Pulfrich & Hutchings 2023) it is clear that the abundances of *T. granulatus* populations on all beaches that were sampled in Boegoebaai are very low and most likely have been heavily impacted and are approaching collapse (with total collapse observed at DISS1).

Based on these findings, and those presented in the previous section (intertidal macrofauna) it is difficult to identify particular sandy beach habitat that are sensitive and should be avoided/conserved during the proposed Boegoebaai Port development. Our results are indicative of depauperate sandy beach infaunal communities across all beach habitat types that were sampled – we suspect this is a direct result of the high amount of anthropogenic disturbance associated with intertidal diamond mining observed throughout the entire study area. In general, more dissipative beaches are known to harbour the richest intertidal faunal communities (in comparison to reflective beaches) and these are habitats that should be avoided. If there is cessation of mining activities, and with adequate rehabilitation, sandy beach faunal communities within the Boegoebaai study area are likely to recover. Such recovery, to a condition comparable to 'natural' populations, has indeed been demonstrated on mined beaches that have been rehabilitated to the north of the Orange River (Pulfrich & Hutchings 2023). It is recommended that a range of sandy beach habitat types within the Boegoebaai area (away from the footprint of the proposed development) are earmarked for rehabilitation and are afforded some form of protection going forward. Priority should be given to rehabilitation and conservation of dissipative beaches as these have the richest faunal communities.

2.2.6.3 Mixed shore

Any area of the shore that is not pure rock or pure sand is classed as "mixed shore", where sections of each kind are small enough to be influenced throughout by the adjacent shore type (Bally et al. 1984). Classifying mixed shores presents a challenge, as they cover the full range between pure sand and pure rock, covering types such as 'sand with isolated rocks', 'sand with many rocks', 'sand in the low shore and rock in the high shore' (and vice versa), 'rock with extensive sand', and 'rock with patches of sand'. They also have the added complexity of shifts among these broad categories temporally, giving them a potential seasonality not found on the pure shore types. All of this gives mixed shores a unique habitat structure that needs consideration. Mixed shores make up between 22 and 52 percent of the southern African shoreline, with 24 percent of the stretch of coast between the Orange River and Cape Point falling into this habitat classification (Bally et al. 1984). Note that in the 2018 NBA mixed shores in the Namaqualand region are all grouped as a single type.

Species richness on mixed shores has been shown to be greater than that on either pure sand or pure rock shores due to increased habitat complexity and heterogeneity (McQuaid & Dower 1990). The species composition found on the rocky and sandy components of the mixed shore are significantly different from their respective pure habitats. The rocky components are differentiated by species with higher tolerance to sand distribution in the forms of inundation, clogging, and abrasion. Mean grain size does not drive the differences in species composition in mixed sand and pure sand habitats; rather, the rocks interfere with migrating sandy beach macrofauna through the swash climate (Brown et al. 1991). Mixed shore communities have a high diversity of detritivores, primary producers and herbivores. Secondary consumers, like small carnivores, are highly opportunistic. Molluscs are the most diverse taxonomic group, followed by algae, then crustaceans, polychaetes and then other groups. Biomass of mixed shore habitats in southern Africa are dominated by filter feeders, mainly mussels (Smith et al. 1999).

Mixed shores in the Boegoebaai area were not sampled directly as part of this study but are expected to support species found on both the sandy beaches and the rocky shores. They are expected to follow the same pattern of dominant groups as that found by Smith et al. (1999) in False Bay.

2.2.6.4 Nearshore surf zone habitats

Surf zone habitats are located offshore of sandy beaches, extending from the low wark mark out to the back of the breaker zone where they grade into more extensive unconsolidated soft bottom subtidal habitats. Despite its turbulent nature, surf zone habitat is an important nursery and feeding area for a range of marine fish and invertebrate species. Pilot seine netting on four of the intertidal beach sites (three hauls per site) was conducted using a beach-seine net, 30 m long, 2 m deep, with a stretched mesh size of 12 mm (Figure 2-2.31). The seine net catch was used to quantify and characterize the fish population in the surf zone at sites RSS1, ISS2, DSS1, and DSS2 (and Figure 2-2.32).

Three species were caught across the combined sampling sites, namely the southern mullet, *Chelon richardsonii*, elongated sand klipfish, *Cancelloxus longior,* and a horned blenny, *Parablennius cornutus* (Table 2-2.7). The variability in the number of mullet caught among sites and their size differences (Figure 2-2.32) is not an unexpected result, given the life history and behaviour of the species. Sites RSS1 and ISS2 had lower catch rates and higher wave action than sites DSS1 and DSS2. This follows the expected trend in a decline in catch abundance and diversity with increasing wave disturbance (Romer 1990, Clark 1997). Seine net sampling could not be conducted at ISS1 as the intertidal profile and wave energy at this site made it too rough to sample. As previously mentioned, it is likely that the NBA classification of sites RSS1 and ISS1 have been erroneously swapped around - beach ISS1 should be classified as a reflective beach and beach RSS1should be classified as an intermediate sandy shore. This trend of lower density of fish in areas with higher wave action is seen clearly in Saldanha Bay and Langebaan Lagoon, 570 km south of Boegoebaai, where mean density of catches in Big Bay are half of what they are in Small Bay, which are in turn lower than those from Langebaan Lagoon (Clark et al. 2024a).



Figure 2-2.31. Trek net sampling in Boegoebaai.

Table 2-2.7. Abundance (number of fish) of each fish species sampled at Boegoebaai fish sampling sites.

Species	Common name	Site			
		DSS1	DSS2	ISS2	RSS1
Chelon richardsonii	Southern mullet	24	313	0	1
Cancelloxus longior	Elongated sand klipvis	0	1	0	0
Parablennius cornutus	Horned blenny	0	0	0	1

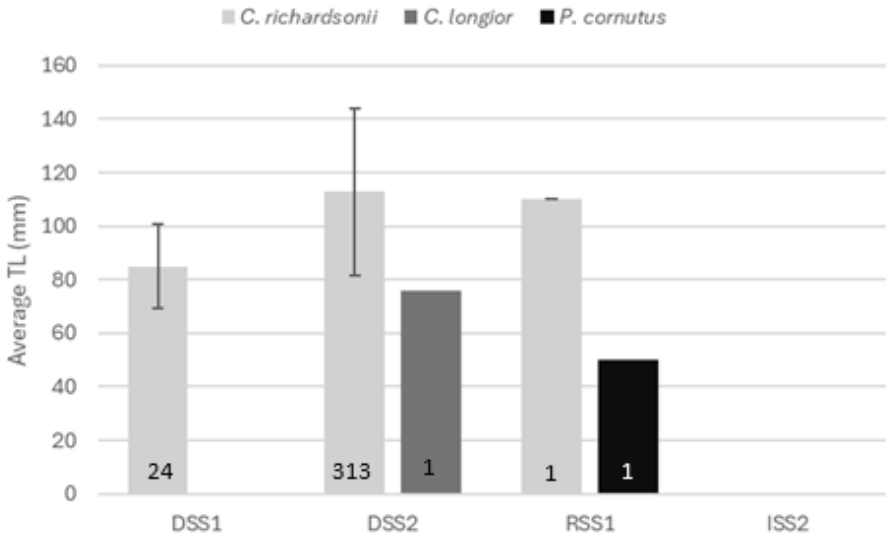


Figure 2-2.32. Average size of fish caught during the October 2024 survey at each of the four surf zone sites (TL = Total Length). Number indicates how many individuals measured at each site. Error bars denote standard deviation.

2.2.6.5 Subtidal unconsolidated substrata

Biological indicators provide an integrated measure of the state/health of the ecosystem across both space and time. Intertidal and subtidal biota are most frequently monitored to detect changes in the health of the marine environment. This is largely because these taxa are relatively short-lived and, as a consequence, their community composition responds rapidly to environmental changes (Warwick 1993). Given that they are also relatively non-mobile (as compared with fish and birds) they tend to be directly affected by development/pollution and they are easy to sample quantitatively (Warwick 1993). Furthermore, they are well-studied compared with other sediment-dwelling components (e.g., meiofauna and microfauna), with taxonomic keys are available for most groups. In addition, intertidal faunal community responses to a number of anthropogenic influences are well documented.

The benthic biota of unconsolidated marine sediments constitutes invertebrates that live on (epifauna) or burrow within (infauna) the sediments and are generally divided into macrofauna (animals >1 mm) and meiofauna (<1 mm).

Results of a hydrographic survey undertaken by Tritan Survey (Tritan Survey 2018) using an Applied acoustic low frequency “Boomer” suggests that much of the marine subtidal habitat directly offshore of Boegoebaai Point comprises unconsolidated sediments lying on top of bedrock, with a peak thickness of ~6.0 m, an average of 2.5 m and a median of 2.13 m (Figure 2-2.33). This grades into rocky reef around 1 000 m offshore, which is also evident on the bathymetry maps of the same area (Figure 2-2.7).

Fauna that inhabits unconsolidated subtidal areas includes both epifaunal and infaunal organisms. Benthic epifauna refers to fauna that inhabit the surfaces of subtidal sediment, while benthic infauna is those that burrow or dig into the soft sediments (Castro & Huber 1997). The distribution of infauna and the depth at

which organisms can live in the substrate is largely dependent on sediment particle size. Coarser, more porous substrates allow for greater water circulation through the sediment, which replenishes oxygen depleted during the decomposition processes.

On the west coast of South Africa, much of the benthic infauna comprises deposit feeders, such as worms, which either ingest sediments to extract organic matter trapped between the grains or actively gather organic detritus (Castro & Huber 1997). Suspension feeders, such as sea pens and some crab species, consume drifting detritus and plankton from the water column, while filter feeders, including bivalves and certain amphipods and polychaetes, actively pump and filter water to capture suspended particles (Castro & Huber 1997). Predators in these soft-bottom habitats either burrow through sediments to hunt prey or ambush prey on the surface (Castro & Huber 1997).

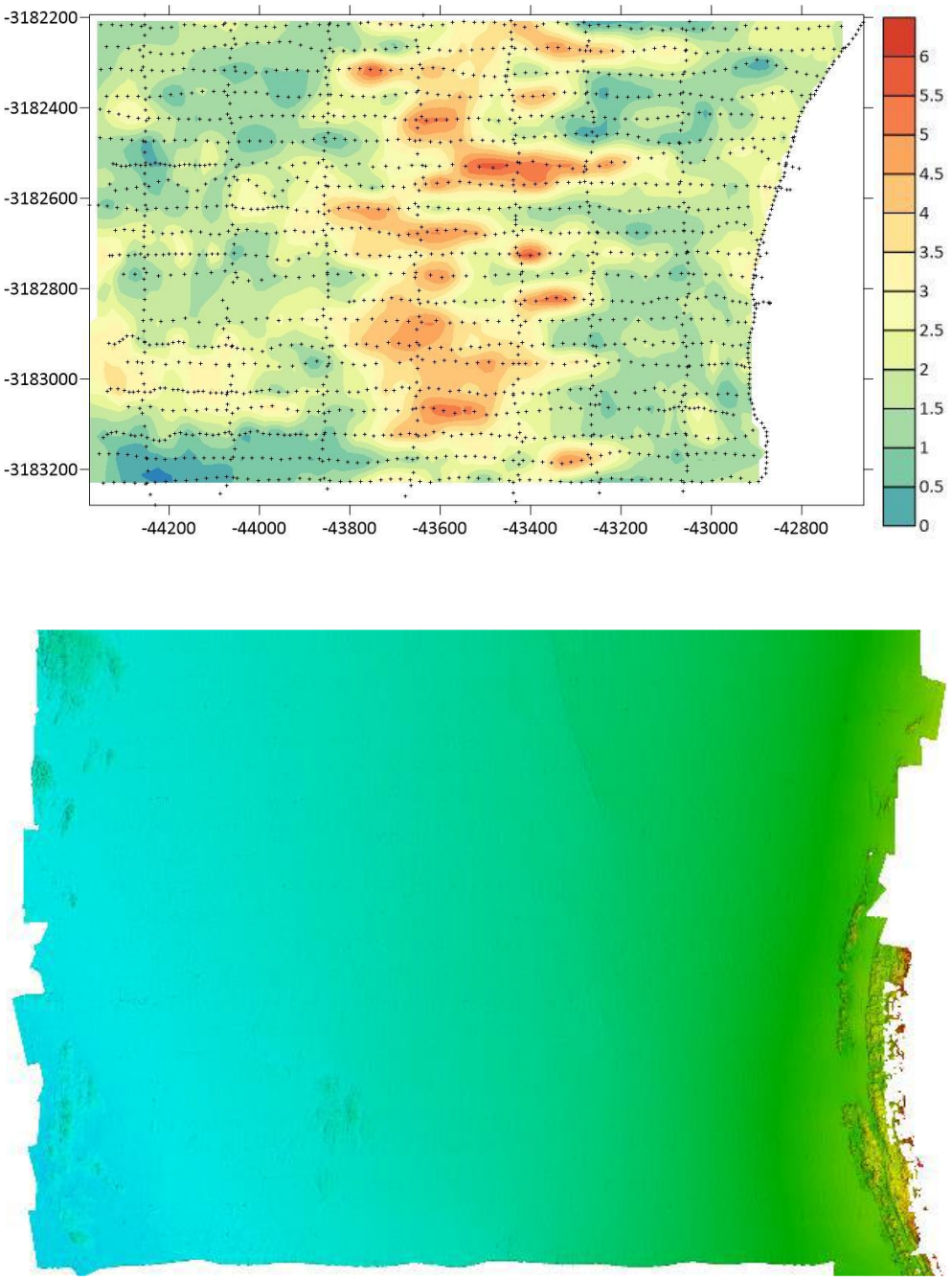


Figure 2-2.33. Sediment thickness (top) and bathymetry (bottom) of the environment offshore of Boegoebaai point. Source: Tritan Survey (2018).

Benthic soft bottom habitats in Boegoebaai, and their associated infauna, remain largely understudied. To provide a comparative context, findings from other offshore benthic studies in the region are considered here (Figure 2-2.34). For example, the benthic macrofaunal communities of St Helena Bay and Saldanha Bay have been intensively studied, with over 150 species recorded (Clark et al. 2023, 2024b). Anchor Environmental Consultants have also collected Van Veen grab samples at greater depths further north and offshore of Boegoebaai, on the continental shelf within the same ecoregion (Duna et al. 2016, Mostert et al. 2016, Tunley 2016) (Figure 2-2.34).

Data from these offshore studies were utilised to infer aspects of subtidal benthic community structure, as no subtidal sampling was undertaken as part of this study. Duna et al. (2016), Mostert et al. (2016), and Tunley (2016) documented a total of 63 benthic macrofauna taxa, with polychaetes dominating the assemblages at 44.4% followed by crustaceans (Class: Malacostraca) at 30.2% (Figure 2-2.35). Numerous species recorded in these offshore studies correspond to those observed in St Helena Bay and Saldanha Bay (Clark et al. 2023, 2024b). Examples of species identified are shown in Figure 2-2.35.

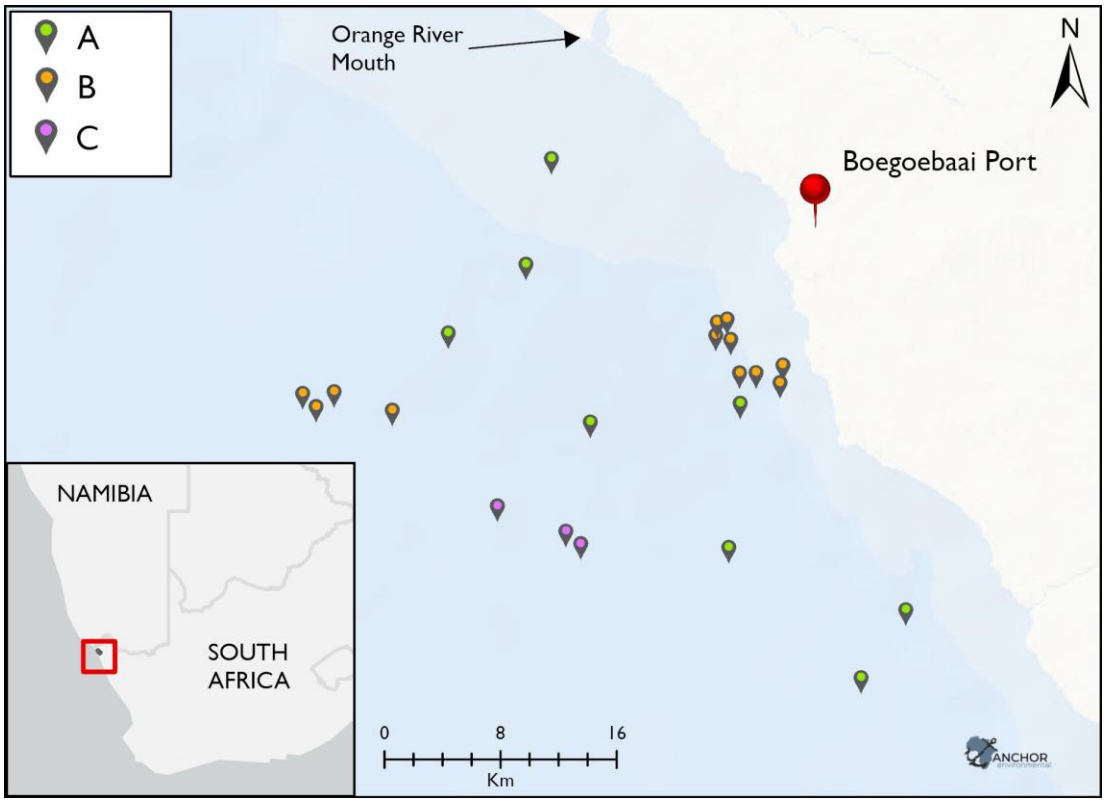


Figure 2-2.34. Sampling locations of subtidal macrofauna surveys offshore along the continental shelf near Boegoebaai. (A) Tunley (2016); (B) Mostert et al. (2016) and C) Duna et al. (2016).

Table 2-2.8. Subtidal macrofauna taxa collected from the Atlantic continental shelf off southern Africa (Duna et al. 2016, Mostert et al. 2016, Tunley 2016).

Class	Order	Family	Taxon	Range
Phylum: Annelida				
Polychaeta	Sipuncula		*Sipunculid* sp.	
	Eunicida	Lumbrineridae	*Lumbrineris heteropoda difficilis*	Southern Africa
			Lumbrineris meteorana	Indo-Atlantic (?)
		Onuphidae	*Diopatra monroi*	Indo-Atlantic (?)
			Diopatra neapolitana	Indo-Atlantic (?)
	Phyllodocida	Glyceridae	*Glycera benguellana*	Indo-Atlantic (?)
			Glycera tridactyla	Cosmopolitan
		Nephtyidae	*Micronephthys sphaerocirrata*	Cosmopolitan
			Nephtys hombergii	Cosmopolitan
		Nereididae	*Nereis*	-
		Pilargidae	*Cabira capensis*	Cosmopolitan (?)
			Sigambra parva	Cosmopolitan (?)
		Polynoidae	*Harmothoe*	-
	Spionida	Spionidae	*Paraprionospio pinnata*	Cosmopolitan
			Prionospio saldanha	Cosmopolitan (?)
			Scolelepis (Parascolelepis) gilchristi	Cosmopolitan
	Terebellida	Ampharetidae	*Ampharete luederitzi*	Indo-Atlantic (?)
			Amphicteis gunneri	Cosmopolitan
		Cirratulidae	*Chaetozone setosa*	Cosmopolitan
			Kirkegaardia dorsobranchialis	Cosmopolitan
		Flabelligeridae	*Brada villosa capensis*	Southern Africa
			Stylarioides swakopianus	Indo-Atlantic (?)
		Pectinariidae	*Amphictene capensis*	Indo-Atlantic (?)
		Trichobranchidae	*Terebellides stroemii*	Cosmopolitan
		Arenicolidae	*Abarenicola affinis africana*	Southern Africa
		Capitellidae	*Mediomastus capensis*	Cosmopolitan
		Cossuridae	*Cossura coasta*	Cosmopolitan
		Magelonidae	*Magelona*	-
		Sabellariidae	Sabellariidae	-
Phylum: Anthozoa				
Octocorallia	Scleralcyonacea	Virgulariidae	*Virgularia schultzei*	Cosmopolitan (?)
Phylum: Arthropoda				
Malacostraca	Amphipoda	Ampeliscidae	*Ampelisca anomala*	Cosmopolitan
Malacostraca	Amphipoda	Ampeliscidae	*Ampelisca spinimana*	Cosmopolitan
		Atylidae	*Nototropis guttatus*	Cosmopolitan
		Liljeborgiidae	*Idunella lindae*	Atlantic (?)
		Oedicerotidae	*Perioculodes pallidus*	Southern Africa
			Westwoodilla manta	Southern Africa
		Photidae	*Latigammaropsis afra*	Cosmopolitan
			Photis longidactyla	Southern Africa

Class	Order	Family	Taxon	Range
		Phoxocephalidae	Phoxocephalidae	-
		Pontogeneiidae	*Paramoera capensis*	Southern Africa
	Cumacea		Cumacea	-
	Decapoda	Axiidae	*Calocaris barnardi*	Atlantic (?)
		Callianassidae	*Callianassa australis*	Atlantic (?)
		Nautilocorystidae	*Nautilocorystes ocellatus*	Atlantic (?)
	Isopoda	Anthuridae	*Amakusanthura africana*	Southern Africa
			Haliophasma	-
		Cirolanidae	*Natatolana hirtipes*	Cosmopolitan
		Idoteidae	*Synidotea hirtipes*	Cosmopolitan
	Stomatopoda	Squillidae	*Pterygosquilla capensis*	Southern Africa (?)
Phylum: Chordata				
Ascidiacea			Ascidian	-
Phylum: Cnidaria				
Hexacorallia	Actiniaria		Actiniaria	-
Phylum: Echinodermata				
Holothuroidea			Holothuroidea	-
Phylum: Mollusca				
Bivalvia	Adapedonta	Pharidae	*Afrophaxas decipiens*	Indo-Atlantic
	Cardiida	Tellinidae	*Macomopsis crawfordi*	Southern Africa
			Moerella tulipa	Indo-Atlantic
	Carditida	Condylocardiidae	*Carditopsis rugosa*	Southern Africa
	Lucinida	Lucinidae	Lucinidae	-
Gastropoda	Cephalaspidea	Philinidae	Philine	-
	Neogastropoda	Volutidae	*Capensisvoluta lutosa*	Atlantic (?)
			Gastropoda	-
Hexacorallia	Actiniaria		Actiniaria	-
Phylum: Nermetea				
			Nemertea	-

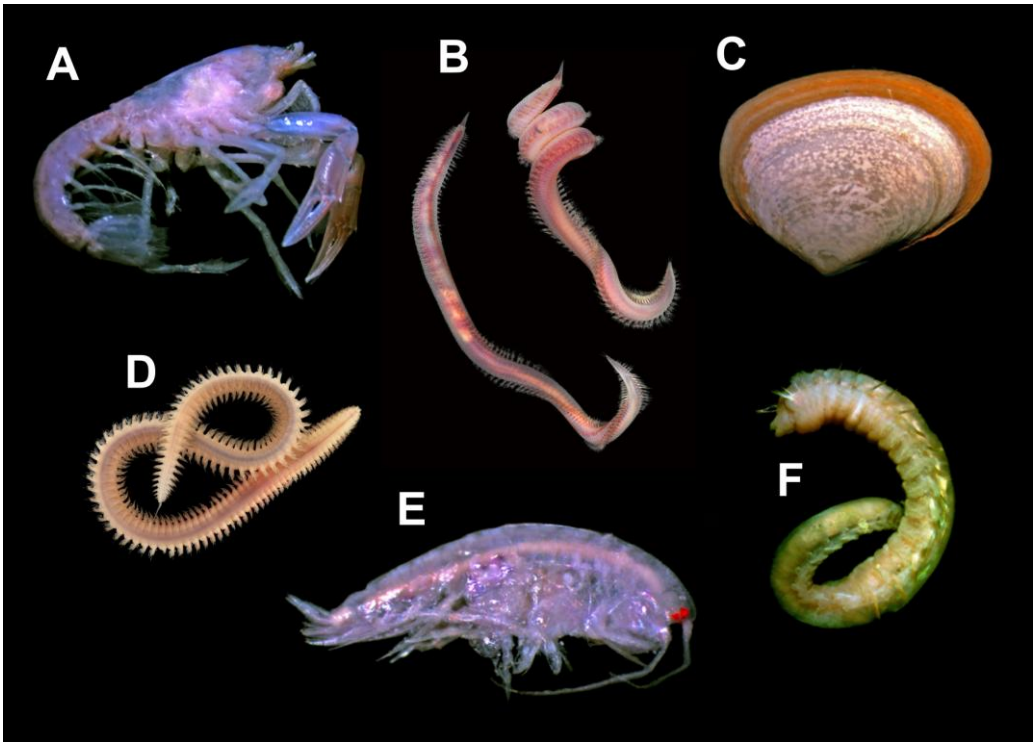


Figure 2-2.35. Examples of subtidal (benthic) infauna found in grab samples from the inner continental shelf off the west coast of South Africa: A – prawn *Calocaris barnardi*; B – glycerine worm *Glycera tridactyla* (Paul Sterry, Nature Photographers); C – bivalve *Macoma* sp.; D – polychaete *Nephtys hombergii* (Fredrik Pleijel); E – amphipod *Ampelisca anomala*; F – cosmopolitan polychaete *Amphicteis gunneri*.

2.2.6.6 Subtidal consolidated substrata

Temperate rocky reefs are found below the low water mark, where they experience disturbances such as wave action and sedimentation from surrounding unconsolidated sediments. Many large predators such as fish and sharks are attracted to rocky reefs and as such represent an important component of these ecosystems (Barros et al. 2001). Reefs also provide a stable substratum for kelp species such as *Ecklonia maxima* and *Laminaria pallida*, which form extensive kelp forests. These forests offer food and shelter to a diverse array of marine organisms. *E. maxima* thrives at depths of up to approximately 12 m, while *L. pallida* extends to depths of about 30 m (Branch et al. 2010). Beneath the kelp canopy, encrusting coralline algae dominate, accompanied by understorey algae species and epiphytic algae growing on the kelp itself (Meyer & Clark, 1999). Filter feeders such as mussels, red bait and sea cucumbers comprise a large part of the faunal community on subtidal rocky reefs (Branch et al. 2010). Grazers include the dominant sea urchin *Parechinus angulosus*, limpets, isopods like. *Paridotea reticulata* and amphipods such as *Ampithoe humeralis* (Branch & Branch 2018b).

Rocky shore and shallow subtidal reef habitats near Boegoebaai are classified as vulnerable by the 2018 NBA (Sink et al. 2019a). While photographic reef surveys using underwater video cameras were not conducted in Boegoebaai, other ecological reef surveys conducted by Anchor Environmental Consultants at study sites further south, within the same ecoregion, (Hutchings et al. 2023, 2024, Biccard et al. 2024, Hutchings & Schmidt 2024) were used to characterise these habitats.

Reef surveys south of Boegoebaai were conducted in the subtidal areas of Kleinsee (~120 km away), Hondeklip Bay (~185 km away), Doringbaai (380 km away) and Saldanha Bay (~570 km away). These habitats primarily consisted of kelp forests interspersed with large boulders and rocky outcrops resting on substrates of fine to gravelly sand (Figure 2-2.36 and Figure 2-2.37). Dominant species observed included whelks, limpets, sea anemones, and the black mussel species *Choromytilus meridionalis*. (Figure 2-2.37). Red algae (*Rhodymenia* sp., *Gigartina* sp., and *Champia* sp.) and encrusting coralline algae (*Mesophyllum engelhartii*) were commonly found among these reefs (Figure 2-2.36 and Figure 2-2.37). Other species recorded included Cape rock crabs, chitons, reticulated starfish, barnacles, and sea cucumbers.

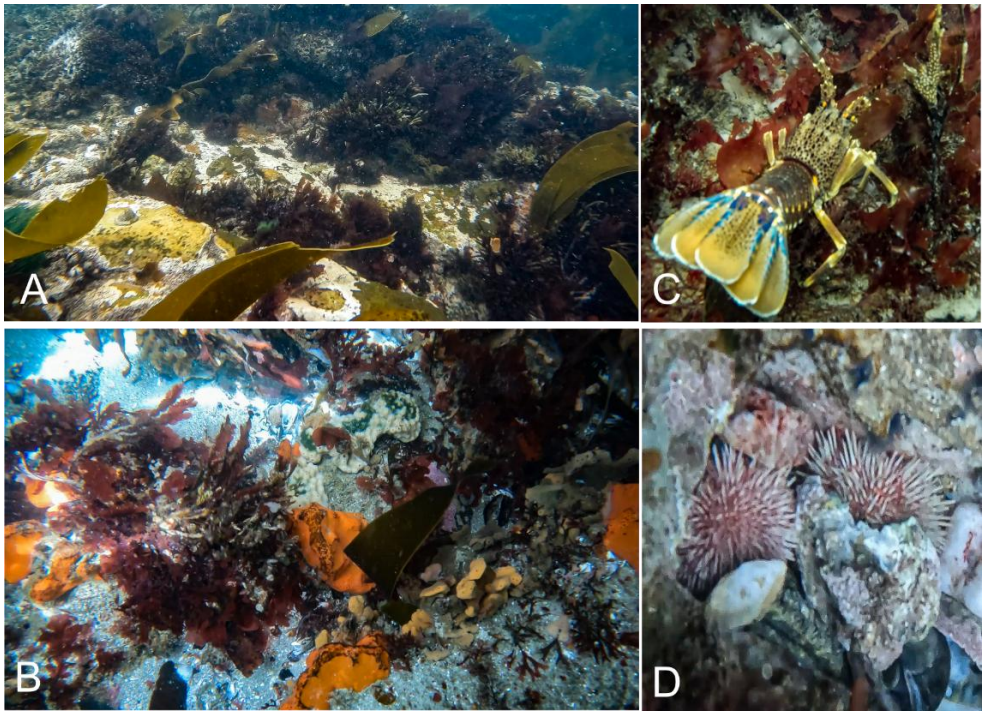


Figure 2-2.36. An overview of: (A) the shallow subtidal reef habitat in Kleinsee, (B) subtidal sediment composition of fine to gravelly sand among large boulders, (C) West Coast rock lobster, *Jasus lalandii*, observed among red algae, and (D) common sea urchin, *Parechinus angulosus*.

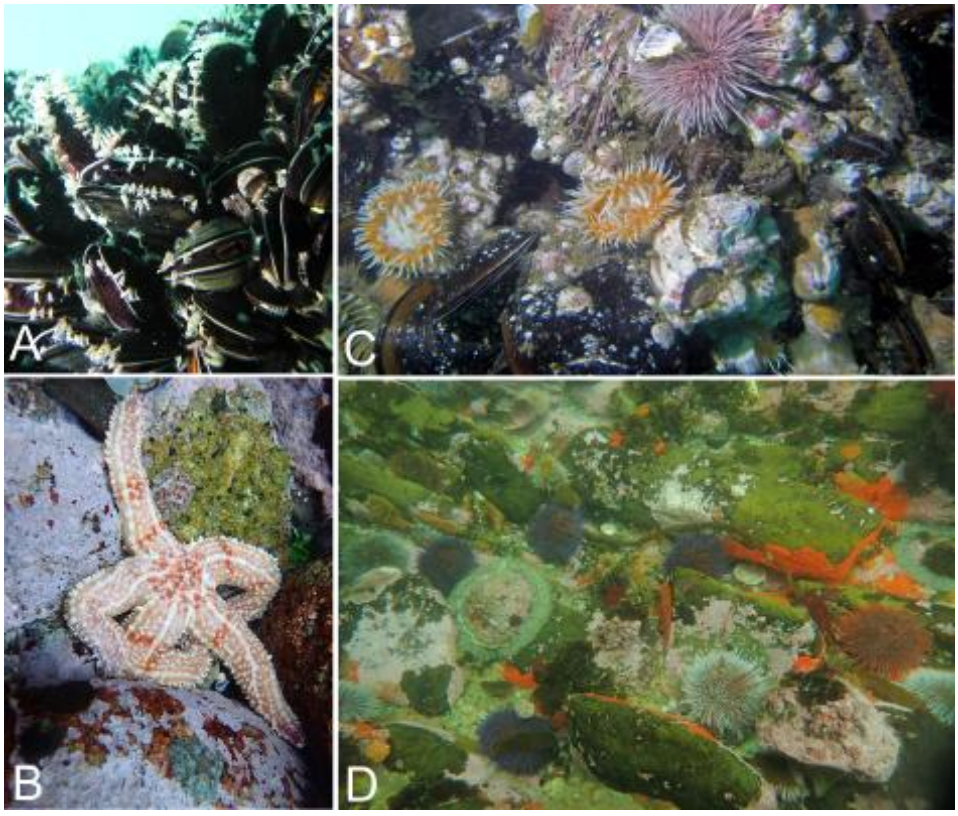


Figure 2-2.37. An example of (A) the invasive Mediterranean mussel *Mytilus galloprovincialis*, (B) a spiny starfish *Marthasterias africanus*; an overview of (C) and (D) the shallow reef habitat hosting the common sea urchin, sea anemones, barnacles and the black mussel *Choromytilus meridionalis* from Robben Island.

2.2.6.7 Sea birds

A total of 72 water birds has been recorded in the Boegoebaai study area according to the South African Bird Atlas Project (SABAP2) database, which is a citizen science project based at the University of Cape Town funded by the FitzPatrick Institute of African Ornithology and the South African National Biodiversity Institute and supported by BirdLife South Africa and BirdLasser. Data are collected by volunteers on a monthly basis across southern Africa (South Africa, eSwatini, Lesotho, Namibia, Zimbabwe, Zambia, Botswana, Mozambique, Malawi).

SABAP2 uses a grid system to divide the region into smaller survey areas. The region is divided into a grid of 5-minute by 5-minute cells of latitude and longitude, known as pentads. Each pentad covers an area of approximately 8 x 7.6 km. Each quarter-degree grid cell (QDGC) is a larger unit that measures 15 minutes by 15 minutes of latitude and longitude. There are nine pentads within each QDGC1. The numbering of pentads is based on their position within the QDGC. The coordinates of the top-left corner of the pentad are used to identify it. For example, if the top-left corner of a pentad is at 25°00'S, 30°00'E, this coordinate is used to name the pentad. When entering data, the latitude and longitude of the pentad's top-left corner are entered into the SABAP2 system, which then calculates the correct pentad and its corresponding QDGC. This system ensures that bird observations are systematically recorded and can be accurately mapped and analyzed.

Counts have been undertaken in a total of four pentads in the study area (Figure 2-2.38), with the most counts (89) undertaken in the northmost pentad (2835_1625) and lower numbers (11-23) in the other three, (Table 2-2.9).

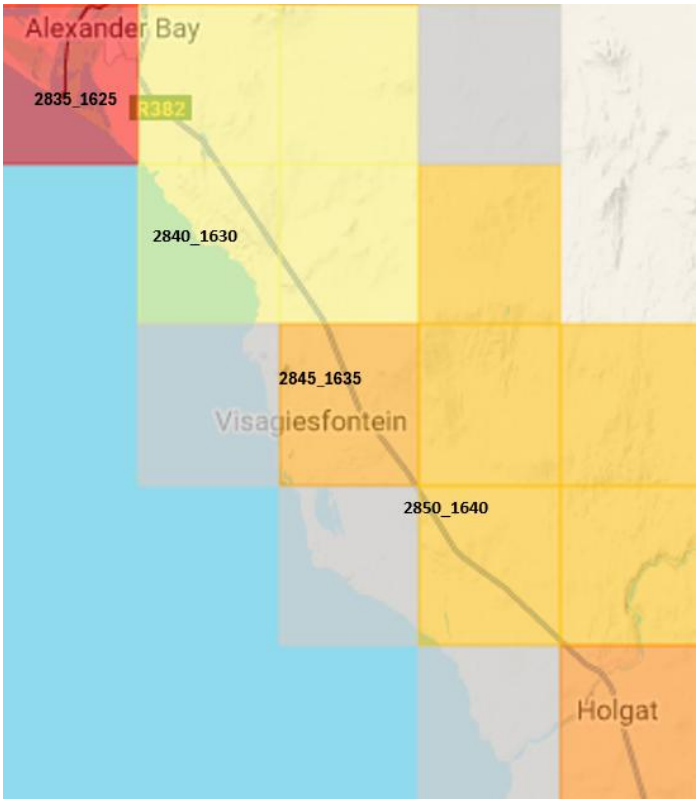


Figure 2-2.38. SABAP pentads in the Boegoebaai study area. Pentads for which count data exist are numbered.

The northmost pentad includes the Orange River estuary which is outside the study area and explains the disproportionately high numbers of birds recorded here (1696) relative to the other pentads (10-115). Pentads with the smallest section of coast (2845-1635 and 2850-1640) support few waterbirds (10 and 29, respectively). Only 20 truly "marine" or "coastal" species have been recorded in the area (species names underlined in Table 2-2.9). The presence of the remaining species can be attributed to the presence of the Orange River estuary and artificial water bodies (such as mining ponds) in and adjacent to the study area. Maritz (2020) lists birds associated with mining ponds in southern Namibia. Seventeen waterbird species

were recorded during the site visit that was conducted as part of this study (highlighted in bold in Table 2-2.9). No truly pelagic seabird species were recorded in the SABAP2 counts or those done for this study; but this is not surprising given these birds seldom venture very close in shore and the counts were all done on land.

A significant proportion of South African seabird species are currently classified as threatened by the International Union for the Conservation of Nature (IUCN). This includes five species of coastal seabirds (20%) and 15 pelagic seabird species (25%) (BirdLife South Africa 2024). Many anthropogenic activities and uses of the marine environment (including those likely to be associated with the development of a new port and SEZ at Boegoebaai) pose a serious threat to these already threatened seabirds. This includes resource competition between seabirds and fishing fleets for the same prey resources (Sydeman et al. 2017), bycatch of seabirds in fishing gear (Dias et al. 2019), noise and oil pollution (Crawford et al. 2000, Wolfaardt et al. 2009, Pichegru et al. 2017) etc. Brief notes on these species are included below, specifically referencing the importance of the Boegoebaai study area for these species.

Table 2-2.9. Waterbirds species recorded in four SABAP pentads (2835-1625, 2840-1630, 2845-1635 and 2850-1640) in the Boegoebaai area. Species names for the truly "coastal" and "marine" species are underlined while those that were recorded during field surveys undertaken as part of this study are highlighted in bold.

Common name	Species	2835-1625	2840-1630	2845-1635	2850-1640	Total
Black-necked Grebe	***Podiceps nigricollis***	8		1	2	11
Little Grebe	*Tachybaptus ruficollis*	27				27
Great White Pelican	*Pelecanus onocrotalus*	48				48
Cape Gannet	*Morus capensis*	1				1
White-breasted Cormorant	*Phalacrocorax lucidus*	59	2			61
Cape Cormorant	*Phalacrocorax capensis*	40	102			142
Bank Cormorant	*Phalacrocorax neglectus*	2				2
Reed Cormorant	*Microcarbo africanus*	30				30
Crowned Cormorant	*Microcarbo coronatus*	9				9
African Darter	*Anhinga rufa*	18				18
Grey Heron	*Ardea cinerea*	52	1	1		54
Goliath Heron	*Ardea goliath*	2				2
Purple Heron	*Ardea purpurea*	16				16
Great Egret	*Ardea alba*	9			25	34
Little Egret	*Egretta garzetta*	59				59
Intermediate Egret	*Ardea intermedia*	3				3
Western Cattle Egret	*Bubulcus ibis*	27				27
Black Heron	*Egretta ardesiaca*	2				2
Little Bittern	*Ixobrychus minutus*	1				1
Black-crowned Night Heron	*Nycticorax nycticorax*	7				7
Hamerkop	*Scopus umbretta*	2				2
White Stork	*Ciconia ciconia*	2				2
African Sacred Ibis	***Threskiornis aethiopicus***	18				18

Common name	Species	2835-1625	2840-1630	2845-1635	2850-1640	Total
African Spoonbill	*Platalea alba*	45				45
Greater Flamingo	*Phoenicopterus roseus*	65		1		66
Lesser Flamingo	***Phoeniconaias minor***	57				57
Spur-winged Goose	*Plectropterus gambensis*	15				15
Egyptian Goose	***Alopochen aegyptiaca***	40				40
South African Shelduck	*Tadorna cana*	53			1	54
Cape Shoveler	*Anas smithii*	31				31
African Black Duck	*Anas sparsa*	1				1
Yellow-billed Duck	*Anas undulata*	29				29
Red-billed Teal	***Anas erythrorhyncha***	14				14
Cape Teal	*Anas capensis*	65		3		68
African Fish Eagle	*Haliaeetus vocifer*	24				24
Western Osprey	*Pandion haliaetus*	5				5
African Crake	*Crex egregia*	1				1
African Swamphen	*Porphyrio madagascariensis*	8				8
Common Moorhen	*Gallinula chloropus*	23				23
African Jacana	*Actophilornis africanus*	2				2
African Oystercatcher	*Haematopus moquini*	23	3			26
Ruddy Turnstone	*Arenaria interpres*	7				7
Common Ringed Plover	*Charadrius hiaticula*	24				24
White-fronted Plover	***Charadrius marginatus***	44				44
Chestnut-banded Plover	*Charadrius pallidus*	13				13
Kittlitz's Plover	*Charadrius pecuarius*	22				22
Three-banded Plover	*Charadrius tricollaris*	27				27
Grey Plover	*Pluvialis squatarola*	18				18
Blacksmith Lapwing	*Vanellus armatus*	35				35
Curlew Sandpiper	*Calidris ferruginea*	21				21
Little Stint	*Calidris minuta*	29				29
Sanderling	*Calidris alba*	7				7
Ruff	*Calidris pugnax*	22				22
Common Sandpiper	***Actitis hypoleucos***	8				8
Marsh Sandpiper	*Tringa stagnatilis*	4				4
Common Greenshank	*Tringa nebularia*	37				37
Wood Sandpiper	*Tringa glareola*	6				6
Bar-tailed Godwit	*Limosa lapponica*	6				6
Eurasian Curlew	*Numenius arquata*	2				2
Eurasian Whimbrel	*Numenius phaeopus*	10	1			11

Common name	Species	2835-1625	2840-1630	2845-1635	2850-1640	Total
Pied Avocet	*Recurvirostra avosetta*	58		1		59
Black-winged Stilt	***Himantopus himantopus***	31		1		32
Kelp Gull	***Larus dominicanus***	78	3			81
Grey-headed Gull	*Chroicocephalus cirrocephalus*	9				9
Hartlaub's Gull	***Chroicocephalus hartlaubii***	69	2			71
Caspian Tern	*Hydroprogne caspia*	50				50
Common Tern	*Sterna hirundo*	23				23
Sandwich Tern	*Thalasseus sandvicensis*	33		1		34
Greater Crested Tern	***Thalasseus bergii***	37	1	1		39
Little Tern	*Sternula albifrons*	2				2
Damara Tern	*Sternula balaenarum*	20			1	21
White-winged Tern	*Chlidonias leucopterus*	1				1
Total		**1696**	**115**	**10**	**29**	**1850**
No. counts (2007-2024)		**89**	**11**	**21**	**23**	

Cape Gannets, *Morus capensis*, are endemic to southern Africa and breed on only six islands off South Africa and Namibia. This species is included as "Vulnerable" on the IUCN red list. There were an estimated 78 800 breeding pairs present in the late 1970s (Crawford et al. 1983), but this increased to around 106 500 by 2014 (Crawford et al. 2015). According to the South African Bird Atlas Project (SABAP) data this species Is not commonly found in the study area (Figure 2-2.39).

The Cape Cormorant *Phalacrocorax capensis* is endemic to southern Africa, breeding at 69 localities between Namibia and the Eastern Cape Province (Cooper et al. 1982). This species is listed as "Endangered" on the IUCN red list (IUCN 2025). All of the main breeding colonies lie in the western and eastern Cape Provinces and therefore do not overlap with the study area (Cook 2015b). There were approximately 106 500 breeding pairs in 1982, but this decreased to an estimated 65 800 by 2014 (Crawford et al. 2015). The Cape Cormorant is generally strictly a marine species, breeding on offshore island and rocks and cliffs and on artificial structures on the coastline. The main breeding season for birds off the west coast is September to February. According to the SABAP data, this species is moderately abundant in the study area (Figure 2-2.39).

The Bank Cormorant *Phalacrocorax neglectus* is a marine species endemic to southern Africa. Its range extends from Walvis Bay to Cape Agulhas, broadly following the beds of *Ecklonia maxima* kelp. This species is considered "Endangered" (IUCN 2025). While these were an estimated 1 500 breeding pairs of birds at 44 breeding localities in the 1980's this has declined to around 800 pairs (Cooper 1981, Crawford et al. 1999, 2015). This species is moderately common in the study area (Figure 2-2.39 and Figure 2-2.40).

The White Breasted Cormorant, *Phalacrocorax lucidus*, is found in Europe, eastern North America, northwest Africa, and most of sub-Saharan Africa. The species frequents dams, impoundments, rivers and inshore coastal areas, and breeds colonially at predator free localities such as offshore islands, cliff ledges, rock stacks, and man-made structures (Berruti 1980, Brooke et al. 1982). The portion of the population breeding along the coast is estimated at around 1700 pairs (up from 1100 in the 1980s) (Brooke et al. 1982, Crawford et al. 2015). This species is present in moderate to high numbers in the study area, and is known to breed on the coast in this area (Figure 2-2.39 and Figure 2-2.40). The species is listed as "Least Concern" (IUCN 2025).

The Crowned Cormorant *Phalacrocorax coronatus* is endemic to southern Africa and breeds at 48 localities between Walvis Bay and Cape Agulhas in a variety of habitats, including rocky cliffs, ledges, stacks, caves,

boulders, and trees (Crawford et al. 1982). .It is a coastal species and is seldom found more than 10 km offshore (Siegfried et al. 1975). The size of the breeding population was estimated at 1 700 pairs in the late 1970s and in 2014 had risen to around 1 900 pairs (Crawford et al. 2015). This species is moderately abundant in the study area and is listed as "Least Concern" globally (IUCN 2025) and "Near Threatened" regionally (Figure 2-2.39) (Cook et al. 2015).

Swift Terns (also named Greater Crested Tern) *Thalasseus bergii* are widely distributed across the southern hemisphere in the south-east Atlantic, the Indian and Pacific Oceans. The nominate subspecies S*. b. bergii* is endemic to southern Africa. The southern African population is actually increasing in abundance up from around 4 700 pairs in 1984 to 10 1000 in 2013 (Cooper et al. 1990, Crawford et al. 2014). Swift terns occur in moderate to low numbers in the study area (Figure 2-2.39). The majority of their population breeds at islands between Saldanha Bay and Cape Town and is listed as "Least Concern" (IUCN 2025) (Crawford & Dyer 1995, IUCN 2025).

Kelp Gulls *Larus dominicanus* are widely distributed in the southern hemisphere from South America to New Zealand and is listed as "Least Concern" (Croxall 1984, IUCN 2025). The subspecies *L. d. vetula* is endemic to southern Africa and has been recorded breeding at 79 localities between Angola and the eastern Cape (Brooke & Cooper 1979, Bridgeford 1982, Crawford et al. 1982). The southern African population numbers around 17 400 individuals (Whittington et al. 2016). Kelp gulls nest colonially in a wide variety of marine habitats including cliffs, rock stacks, small islets and sand banks in estuaries, salt works and sewage works, and on larger islands in lagoons and offshore (Crawford et al. 1982). There are colonies present on the Orange River estuary and on the islands to the south of Boegoebaai but none in the study area itself (Whittington et al. 2016).

The African Black Oystercatcher *Haematopus moquini* forages exclusively in the intertidal zone and they can be found on both rocky and sandy shores throughout the year along the Benguela coast. The species is listed as 'Least Concern" by the IUCN (IUCN 2025). Its favoured breeding habitats including offshore islands and sandy beaches, and on mainland rocky shores (Biccard & Clark 2014b). The birds build their nests just above the high-water mark (usually within 30 m). It is likely that breeding pairs will occur on this stretch of coastline and will likely be present on site between December and February each year (Biccard & Clark 2014b). This species is present in low numbers in the study area (Figure 2-2.39).

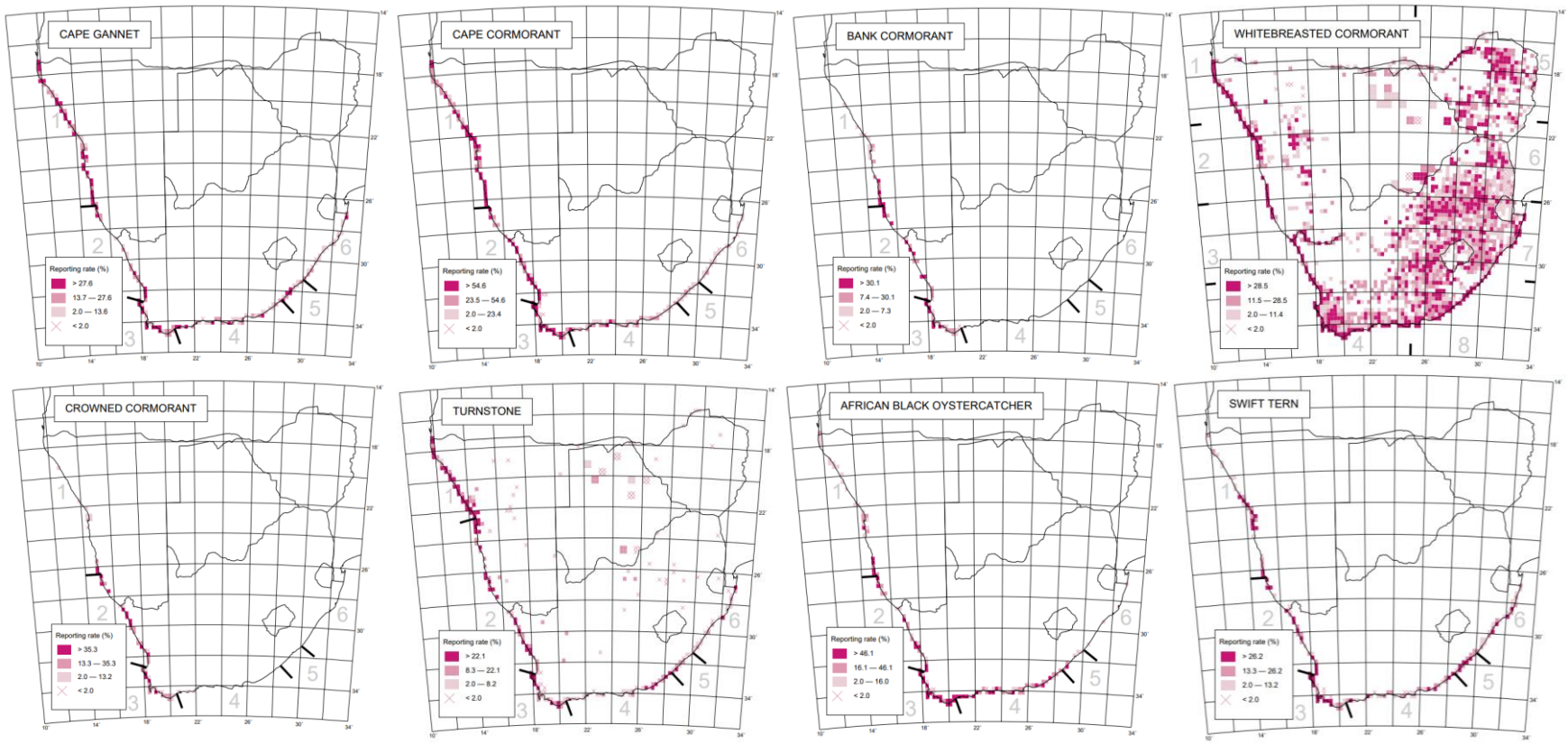


Figure 2-2.39. Distribution maps of Cape gannet, Cape, Bank, White breasted and Crowned cormorants, African black oystercatcher, turnstone and Swift tern. Source: https://sabap2.birdmap.africa/.

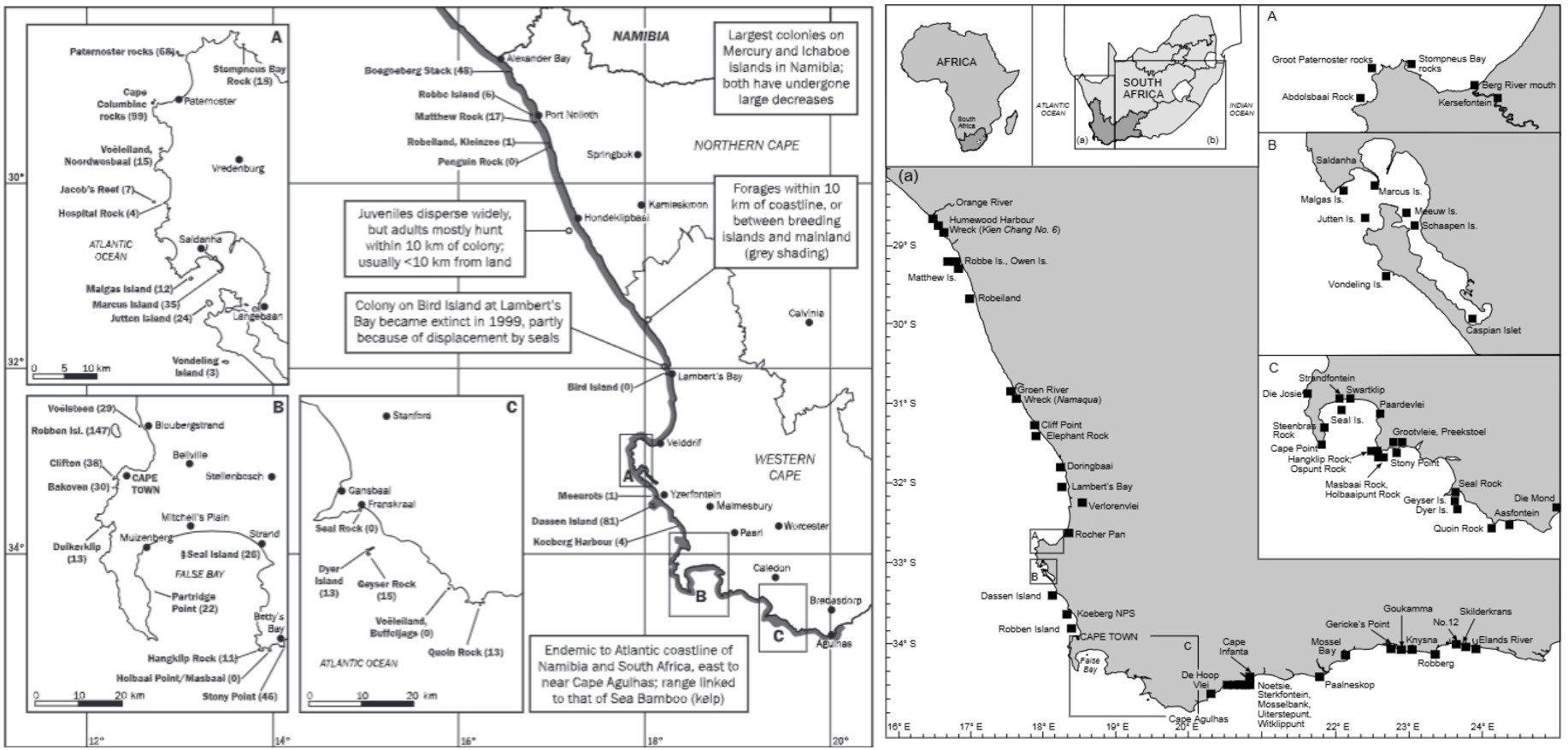


Figure 2-2.40. (Left) Current and historic breeding sites for Bank Cormorant *Phalacrocorax neglectus*. Note that this includes the Boegoeberg Stack at the site of the proposed Boegoebaai port (Cook 2015a). (Right) Locations of known coastal and some adjacent inland breeding localities of white-breasted cormorants in western South Africa (Crawford et al. 2013).

The White fronted plover *Charadrius marginatus* has an extremely large range and global population in excess of 80 000 individuals (Wetlands International 2023). Adults of coastal populations in southern and eastern Africa are sedentary, although they often move from exposed to sheltered shores in the winter, while others are migratory (Urban et al. 1986, del Hoyo et al. 1996, Hockey et al. 2005). This species shows a preference for sandy seashores and coastal dunes but is often found on rocky shores, coastal and inland mudflats, salt-pans, estuaries (Urban et al. 1986, del Hoyo et al. 1996). White fronted plovers nest on the shore on dunes, sandbars, and occasionally in quarries, typically more than 70 m above the high-water mark (Urban et al. 1986, del Hoyo et al. 1996, Watson et al. 1997, Hockey et al. 2005). This "Least Concern" species is present in low numbers in the study area (IUCN 2025).

Ruddy turnstone *Arenaria interpres* is a circumpolar breeder in artic tundra. Several nominate races exist, with the central Siberian population migrating through the Mediterranean and Black Sea to southern Africa. This population comprises of around 34 000 individuals (Summers et al. 1977). While in southern Africa, these birds mostly inhabit sheltered rocky shores and mixed rock and sandy shores (Summers et al. 1977, Underhill & Whitelaw 1977, Underhill et al. 1980). This species is present in moderate to low numbers in the study area (Figure 2-2.40) and is included as "Least Concern" on the IUCN red list.

Birdlife South Africa (2024) have made an attempt to collate available tracking data for threatened seabirds which occur within the South African Exclusive Economic Zone (EEZ) in an effort to identify areas of the marine environment that are important for these species. They have delineated marine Important Bird Areas and utilization distributions from tracking data for three Endangered coastal seabird species (African Penguin, Cape Gannet and Cape Cormorant) that breed in various colonies in South Africa and a further five pelagic seabird species (Indian Yellow-nosed [Endangered], Atlantic Yellow-nosed [Endangered] and Wandering [Vulnerable] albatrosses and Northern Giant Petrel [Least Concern]) breeding in colonies on islands within the Southern Ocean but that regularly occur within the South African EEZ. For species for which there is no available tracking data, or for which tracking data is only available for a limited number of colonies, buffers of the species' known foraging ranges were created.

Based on the results of this study, no overlap was evident between identified Marine Important Bird Areas (MIBAs) and important distribution areas for certain seabird species. This applies to threatened coastal seabird species breeding in South Africa for which good tracking data was available. However, there is some overlap between buffers of 30 and 20 km (for Cape and Bank Cormorants respectively) placed around each species' known breeding colonies (Figure 2-2.41) and also with raw tracks from non-breeding adult Cape Gannets tracked from Malgas Island (Saldanha Bay) and Bird Island (Algoa Bay), and juvenile Cape Gannets tracked from Bird Island (Figure 2-2.42).

Similarly, there is some overlap between foraging areas for incubating Atlantic Yellow-Nosed Albatrosses from Gough Island and Nightingale in the Southern Ocean (Figure 2-2.43).

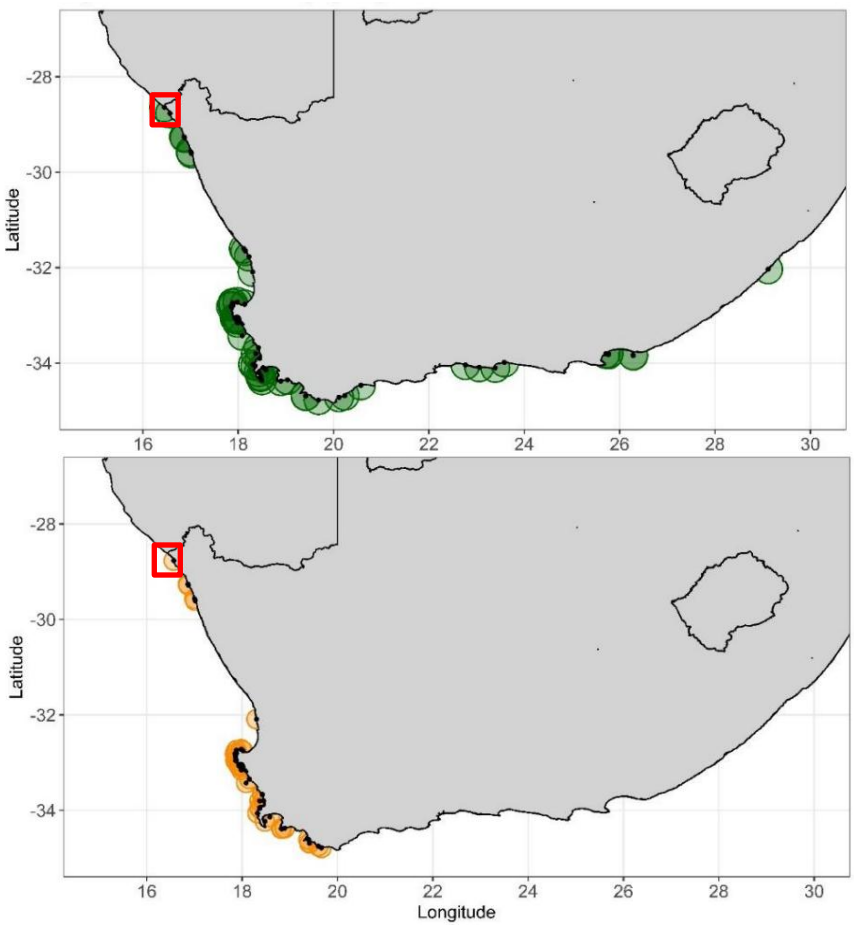


Figure 2-2.41. Buffers of 20 km around known Cape Cormorant (top) and Bank Cormorant (bottom) breeding colonies. The Boegoebaai study area is indicated by a red block. Source: Birdlife South Africa (2024).

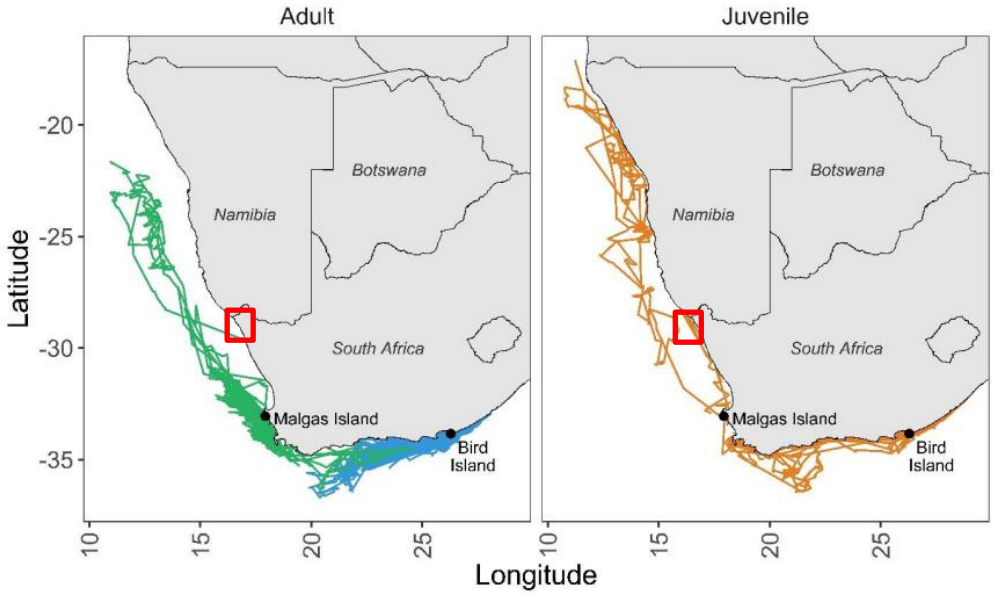


Figure 2-2.42. Raw tracks from non-breeding adult Cape Gannets (left panel) tracked from Malgas Island (Saldanha Bay, green tracks) and Bird Island (Algoa Bay, blue tracks) in South Africa, and juvenile Cape Gannets tracked from Bird Island in Algoa Bay (orange tracks in right panel). The Boegoebaai study area is indicated by a red block. Source: Birdlife South Africa (2024).

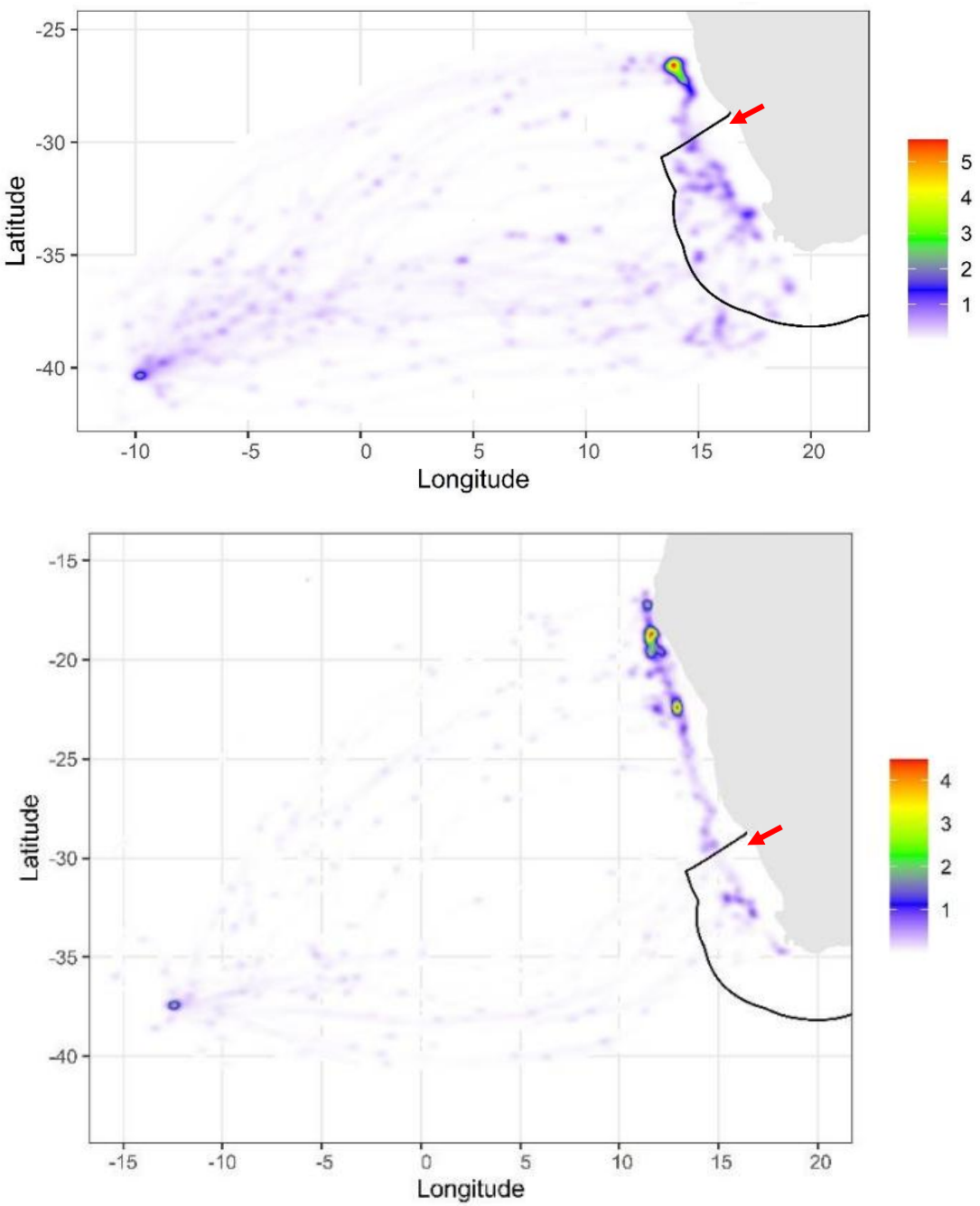


Figure 2-2.43. Utilization distribution of incubating Atlantic Yellow-Nosed Albatrosses from Gough Island (top) and Nightingale Island (bottom), Southern Ocean. The two islands are located in the bottom left corner of each image. The Boegoebaai study area is indicated by a red arrow on the map. Source: Birdlife South Africa (2024).

2.2.6.8 Marine mammals

This remote and relatively undisturbed area is part of the Benguela Current ecosystem supports a rich diversity of marine life, including several species of marine mammals. Thirty-six marine mammals may occur in the study area (Meyer & Clark 1999, Penney et al. 2007, Child et al. 2016, Biccard et al. 2018, Pulfrich 2021, SLR 2021).

The Cape fur seal, *Arctocephalus pusillus* (listed as 'least concern' by the IUCN) is the only pinniped mammal that has established breeding colonies in southern Africa. Its range extends from the centre of Angola to the east coast of South Africa, with breeding colonies extending south from Baia dos Tigres on the southern

border of Angola, through Namibia, down the west coast of South Africa and around to Algoa Bay in the Eastern Cape of South Africa (Figure 2-2.45). Historically (before 1900), it is likely that seals were present on most (if not all) islands off South Africa and Namibia, where they prefer to breed as they are protected from mainland predators. However, populations on many of the islands were significantly depleted or disappeared completely as a result of uncontrolled hunting, and human occupation of the islands for the collection of guano and other seabird related products (Kemper et al. 2003). Subsequent to the ban on seal hunting, the Cape fur seal population recovered, showing an almost 20-fold growth in numbers in the 20th century before stabilizing at about two million animals (Kemper et al. 2003). In addition, the number of breeding colonies have increased since 1970 from 23 to 40 colonies (Kirkman et al. 2013). The overall population count has reportedly remained largely unchanged since 1993 and is estimated at 1.5–2.0 million, however, the distribution of these seals has been shown to vary in relation to prey distribution and shortages (Kemper et al. 2003, Kirkman et al. 2013, 2019).

The northern-most colony in South Africa is at Buchu Twins (28°45.57 S, 16°33.78 E), and was formerly a non-breeding colony but has recently attained breeding status (Kirkman 2010, EIMS 2021) with seals utilising a ~1 km stretch of exposed rocky coastline within the proposed port development area (Figure 2-2.45 and Figure 2-2.46). The coastline at Buchu Twins/Boegoebaai Point is unique in comparison to surrounding areas in that it consists of high-profile rocky outcrops/cliffs that offer pools and shaded refugia (Figure 2-2.46) for seals as well as a certain degree of protection from land-based predators. Habitat associated with thermoregulation (e.g. shade or pools) may be more important to fur seals in southern Africa, which breed at lower latitudes and are at greater risk of overheating on land than other populations (Stevens & Boness 2003). These factors may explain why seals have selected this area to establish a breeding colony. The colony numbers at this site are increasing (mean rate of change (± SE) 1991–2008 0.1412 ± 0.1674, see Kirkman 2010), but in comparison with other Cape Fur seal breeding sites around South Africa, seal numbers are relatively low (n = 107, aerial pup counts, (Kirkman et al. 2007).

In South Africa, seals are protected under the Sea Birds and Seals Protection Act 1973. Specifically, the Cape fur seal, which is one of the most common seal species found along the South African coastline, is protected under this legislation. The seals are protected against hunting, harassment, and disturbance in their natural habitats. Additionally, South Africa is a signatory to international agreements and conventions aimed at protecting marine life, including seals. These include agreements such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention for the Protection of the Marine Environment and Coastal Area of the South-East Atlantic (the Benguela Current Convention), which further support the protection of seals and other marine species in South Africa's waters.

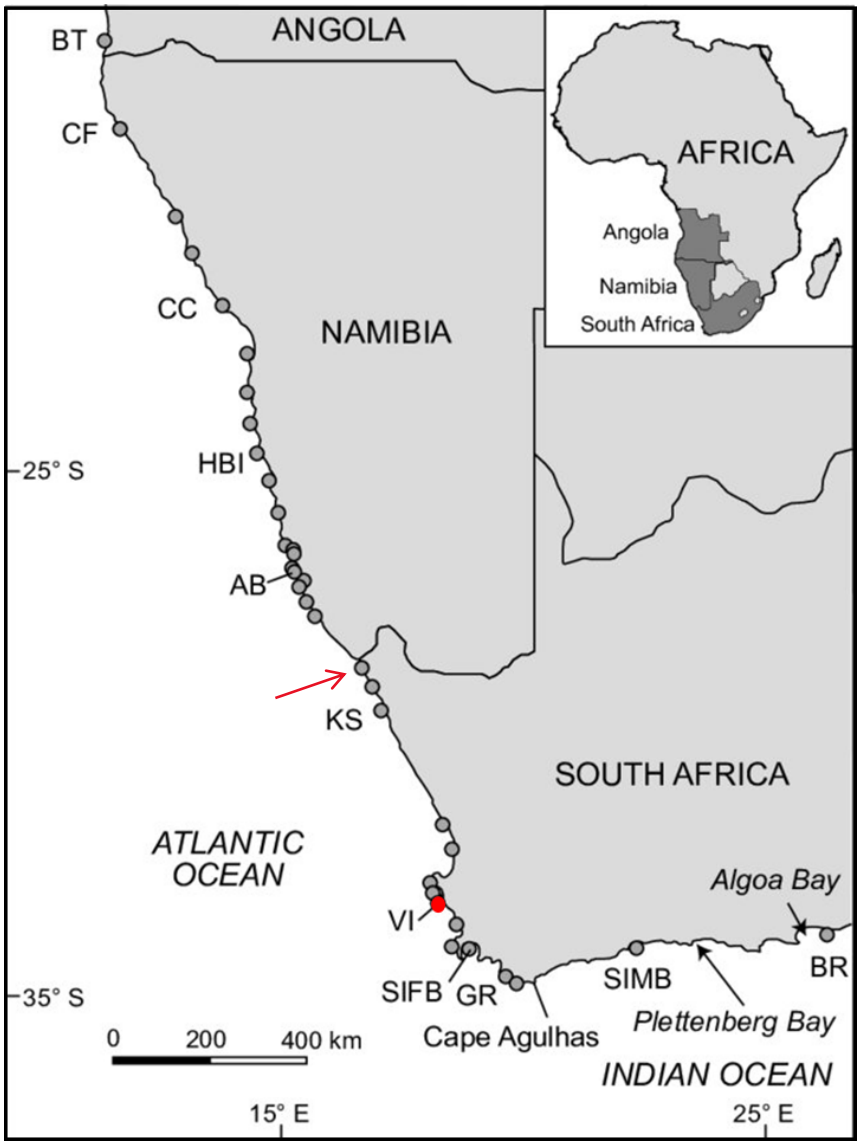


Figure 2-2.44. Distribution of Cape fur seal breeding colonies of Southern Africa from Black Rocks (BR), Algoa Bay to Baia dos Tigres (BT), southern Angola, with selected breeding colonies indicated including Seal Island in Mossel Bay (SIMB), Geyser Rock (GR), Seal Island in False Bay (SIFB), Vondeling Island (VI), Kleinsee (KS), Atlas Bay (AB), Hollam's Bird Island (HBI), Cape Cross (CC) and Cape Frio (CF). The red arrow indicates the location of the Buchu Twins colony within the proposed port development area - adapted from Huisamen et al. (2011).

The marine mammal cetacean fauna occurring off this part of southern African coast includes several species of baleen whales, toothed whales, beaked whales, dolphins. The most abundant baleen whales in the Benguela are humpback whales (*Megaptera novaeangliae*) and southern right whales (*Eubalaena australis*). During the last decade, the prevalence of both species on the West Coast of South Africa outside of the usual June-November whale season has increased with feeding behaviour observed in upwelling zones off Kommetjie, Saldanha and St Helena Bay (Mate et al. 2011, Barendse et al. 2011, Findlay et al. 2017) . Increasing numbers of summer records of both species from the southern half of Namibia suggest that animals may also be feeding in the Lüderitz upwelling cell (NDP unpublished data) and could therefore pass through the area of interest (Pulfrich 2021). Southern Right whales come annually from sub-Antarctic regions to calve off the western coast of Africa during the months of June to November, often very close to shore. Humpback whales may be sighted during the months of October and November as they migrate south from their breeding grounds in tropical West Africa to their feeding grounds in the Antarctic. Over the last decade, large supergroups (20-200 individuals) of feeding humpback whales have frequented the West Coast during spring and summer (Findlay et al. 2017). Schools of over 1 000 common dolphins *Delphinus delphis* and dusky dolphins *Lagenorhynchus obscurus* have been known to occur in the area surrounding the site, as have the endemic Heaviside's dolphins *Cephalorhynchus heavisidii.* Impacts of the proposed

development on cetaceans that utilise this area are likely to arise from increased vessel traffic i.e., noise and the associated increase in risk of ship-strikes.

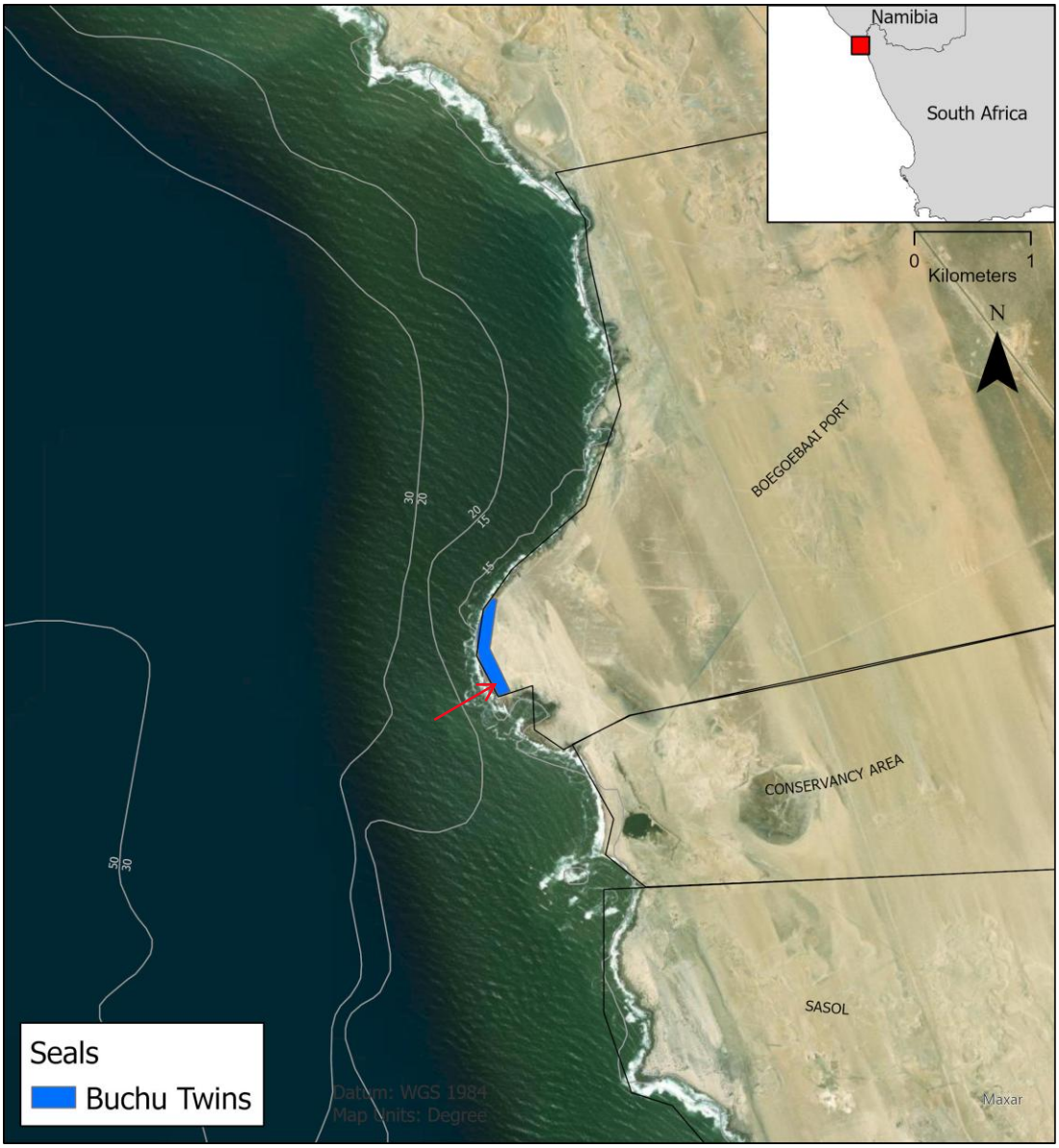


Figure 2-2.45. Known Cape fur seal, *Arctocephalus pusillus*, breeding colony location (Buchu Twins – indicated by red arrow) within the proposed project area (Kirkman et al. 2016).



Figure 2-2.46. This figure demonstrates the ~ 1 km extent of the Cape Fur Seal colony at Buchu Twins and the unique high-profile rocky structure at this site offering shaded refugia for the seals – a rarity on this coast. The figure inset is a zoomed-in view with black arrows indicating groups of seals that have hauled-out. Source: Google Earth.

2.2.7 *Fisheries*

The Namaqua upwelling cell is characterised by nutrient rich water, as is much of the West Coast of South Africa (Monteiro & Roychoudhury 2005). Due to this enrichment, the western coast is generally a productive system that supports a high biomass of marine biota and several important fisheries. However, the more exposed coast of the Northern Cape is less protected from weather conditions and is more uniform in respect to its coastline, with few protected bays. As a result, this coast is less retentive and generally considered less productive, compared to St Helena Bay, for example. The Northern Cape is also sparsely populated which contributes to large commercial fisheries not being as prevalent in this area.

Brief descriptions of the different types of fishing activity that are practiced in the vicinity of Boegoebaai are provide below, largely drawn from descriptions provided by the 2018 NBA (Sink et al. 2019a).

2.2.7.1 Demersal trawling

Demersal trawling means the trawl is dragged on the seafloor, with the 'ground' gear, consisting of the trawl doors, bridles and net (especially the groundrope) making contact with the sediments and fauna living there. South Africa has both an inshore and an offshore demersal trawl sector targeting hake and other fish species. The inshore trawl fishery operates on the south coast only, not on the west coast. The offshore trawl sector operates predominantly between 230 m and 630 m. Drag durations tend to range from 1 to 6 hours (median=3 hours) and towing speeds from 3 to 4 knots. The effort distribution for these inshore and offshore demersal trawling sectors is shown on Figure 2-2.47 below. Trawling intensity offshore of Boegoebaai is relatively low and mostly practiced more than 50 km offshore and, hence, very unlikely to be affected by the development.

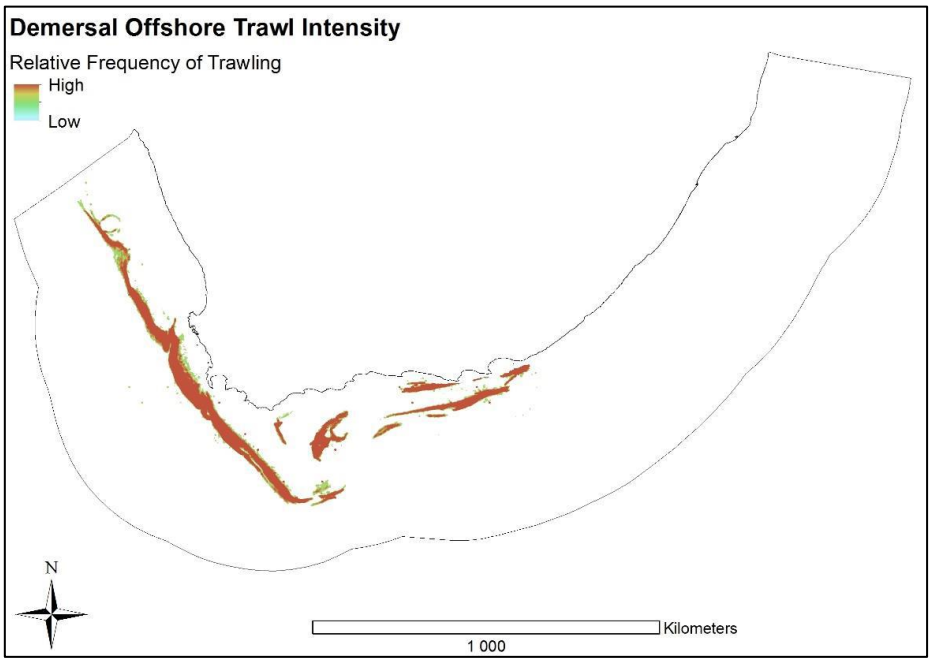


Figure 2-2.47. Demersal trawl fishing intensity off the coast of South Africa (Sink et al. 2019a).

2.2.7.2 Demersal longline

In South Africa, demersal longlines are typically set on rocky substrate, adjacent to demersal trawling grounds (Badenhorst 1988). The demersal longline gear is composed of a mainline or groundline which forms the branching point of shorter lines called gangions or snoods, to which baited hooks are attached (Stevenson et al. 2004, Dietrich & Fitzgerald 2010). Surface floats are attached to the ends of vertical droplines or anchor lines which connect to the mainline (Dietrich & Fitzgerald 2010). The mainline lies on the seafloor or may be weighed down with anchors at regular intervals in the presence of strong currents,

which is the method employed in the South African fishery (Badenhorst 1988). The mainline is generally long, ranging anywhere from 1 to 40 km (Stevenson et al. 2004). The South African demersal longline fishery targets deep sea hake and employs the Spanish double-longline system whereby a top and bottom line is set between the anchor lines, and the number of hooks deployed can vary between 6 000-7 000 for smaller vessels and 9 000-14 000 hooks for longer vessels (Japp 1989). Lines are generally 30 km in length and are deployed around depths of 200-400 m (Fairweather et al. 2006, Petersen 2008). Deployment of longlines takes place at night and they are recovered by hauling during the day (Petersen 2008). Demersal longline fishing effort is concentrated off the southwestern Cape and southern Cape coastlines (Figure 2-2.48). Effort in the region of Boegoebaai is relatively low and is almost entirely located more than 50 km offshore and, hence, very unlikely to be affected by the development.

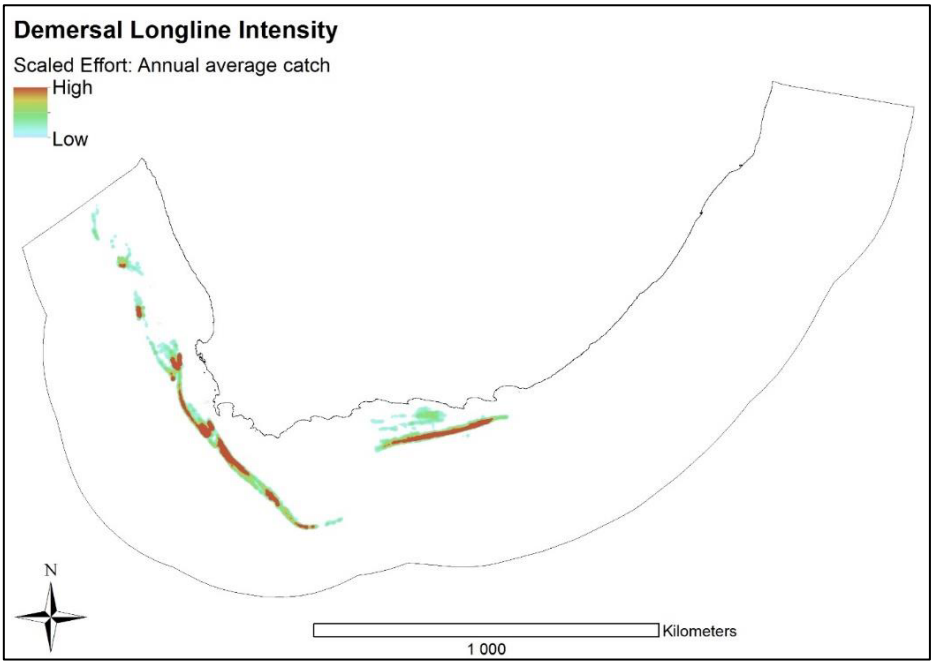


Figure 2-2.48. Demersal longline fishing intensity off the coast of South Africa (Sink et al. 2019a).

2.2.7.3 Pelagic longline

The pelagic longline fishery in South Africa uses gear similar to that of the demersal sector; the main differences being that in the pelagic sector, longlines consist of a double-line system suspended at different depths covered in baited hooks that do not touch the seafloor, as they have small buoys and float lines to suspend the gear below the surface (Watson & Kerstetter 2006). The pelagic longline fishery targets large, highly mobile species including Bigeye Tuna *Thunnus obesus*, Yellowfin Tuna *Thunnus albacares*, Bluefin Tuna *Thunnus thynnus* and Swordfish *Xiphias gladius*. Albacore Tuna *Thunnus alalunga*, Blue Shark *Prionace glauca* and Shortfin Mako Shark *Isurus oxyrinchus* (DAFF 2016). Management of these highly migratory species is the responsibility of Regional Fisheries Management Organisations (RFMOs). South Africa is a member of three tuna directed RFMOs namely the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Indian Ocean Tuna Commission (IOTC) and the Commission for the Conservation of Southern Bluefin Tuna (CCSBT). Pelagic longline fishing activity is distributed right around the South African coast with peaks off the Orange River (Boegoebaai), the southwestern Cape and southern Cape coastlines and KwaZulu Natal (Figure 2-2.49). Fishing activity off Boegoebaai is restricted to areas more than 100 km from the coast and will not be affected by the development.

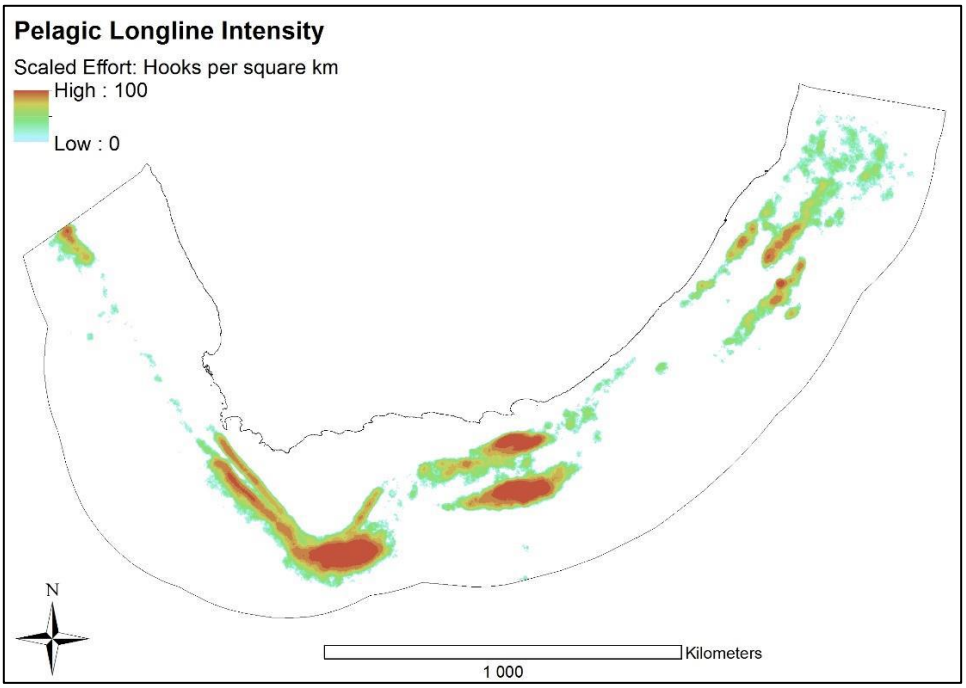


Figure 2-2.49. Pelagic longline fishing intensity off the coast of South Africa (Sink et al. 2019a).

2.2.7.4 Tuna pole

The South African Tuna Pole-Linefishery uses pole fishing gear or rod-and-reel (DAFF 2016); the latter being similar to the fishing gear used by the commercial linefishery. Rod and reel gear is typically used to target yellowfin tuna and pole gear used to target Albacore (Atkinson & Sink 2008, DAFF 2016). Pole fishing gear consists of a hooked line (usually a barbless hook with a feathered jig) attached to a rigid pole of 2-3 m. Boats use bait and/or water-spraying to aggregate fish (spray gives the illusion of activity from a shoal of small fish). Once the target species has aggregated, pole fishing is conducted by casting feathered jigs into the water and hauling them back a few seconds later. Once a tuna lands on the vessel's deck, it releases itself from the barbless hook and the line can be thrown again, leading to several tonnes of tuna being fished in a few hours. Smaller vessels make short trips of 5-7 days and have a specialised crew of 8-10 fishermen equipped with long poles and gaffs (long poles with hooks), while larger vessels with crew of 20 or more are capable of fishing further from port and operate along the entire west coast (Norman et al. 2018). The Tuna Pole-Line fishery operates out of Cape Town and Saldanha Bay and is strongly focussed around the southwestern Cape with boats seldom fishing as far north as Boegoebaai (Figure 2-2.50) and never sufficiently nearshore for the development to influence the fishery.

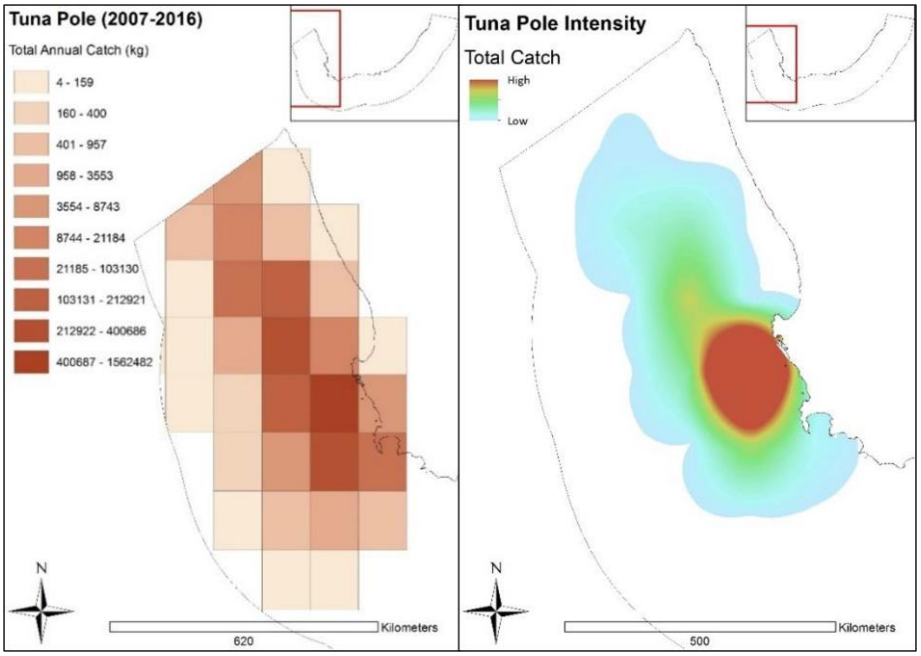


Figure 2-2.50. Tuna pole fishing intensity using annual average catch on a one-degree grid (left), and the scaled tuna pole intensity (right) (Sink et al. 2019a).

2.2.7.5 Small pelagics

South Africa's small pelagic fishery catches the largest catch volume of all of the fishery sectors and constitutes the second largest catch value, second only to the hake trawl fishery (DAFF 2016). This fishery targets adult sardine *Sardinops sagax*, juvenile Anchovy *Engraulis encrasicolus* and adult redeye round herring *Etrumeus whiteheadi* using purse-seine nets. Purse-seine fishing consists of rapidly sinking a wall of netting around a group of fish, then closing the bottom edge with purse strings and finally hauling the catch aboard the vessel (He & Wardle 1986). Purse seine nets are deployed once a shoal of fish has been detected, and a smaller vessel is launched to deploy the net and encircle the shoal. The current fleet operating in this fishery consists of 101 vessels with landings ranging between approximately 200 000 and 600 000 tonnes from 2000 to 2016 (Norman et al. 2018). The small pelagic purse-seine fishery focusses mostly between Lamberts Bay and Gansbaai, with smaller pockets of effort off Mossel Bay and Port Elizabeth (Figure 2-2.52) and East London, mostly in nearshore waters (within 10 km of the coast). There is very little fishing effort offshore of Boegoebaai.

Several west coast nursery grounds that are utilised by small pelagic fish species including sardine, *Sardinops sagax*, horse mackerel, *Trachurus capensis* and anchovy, *Engraulis capensis,* including one near Boegoebaai (centred around Port Nolloth, Northern Cape) (Hutchings et al. 2002) (Figure 2-2.52). The western coast nursery areas extend along much of the West Coast shelf and are bookended by the Cape Columbine upwelling cell in the south and the Lüderitz upwelling cell in the north (Hutchings et al. 2002). Spawning of anchovy and sardines mostly takes place during the spring and summer months with recruits reaching the west coast via general north-westerly drift of Agulhas Bank surface waters and a coastal jet current off Cape Point and Cape Columbine. Models of egg and larval dispersal estimate that most recruits would reach the western coast within 1-3 weeks of spawning i.e., December to May would see the greatest abundance of juvenile small pelagic fish within nursery grounds (Hutchings et al. 2002, Rasehlomi et al. 2024).

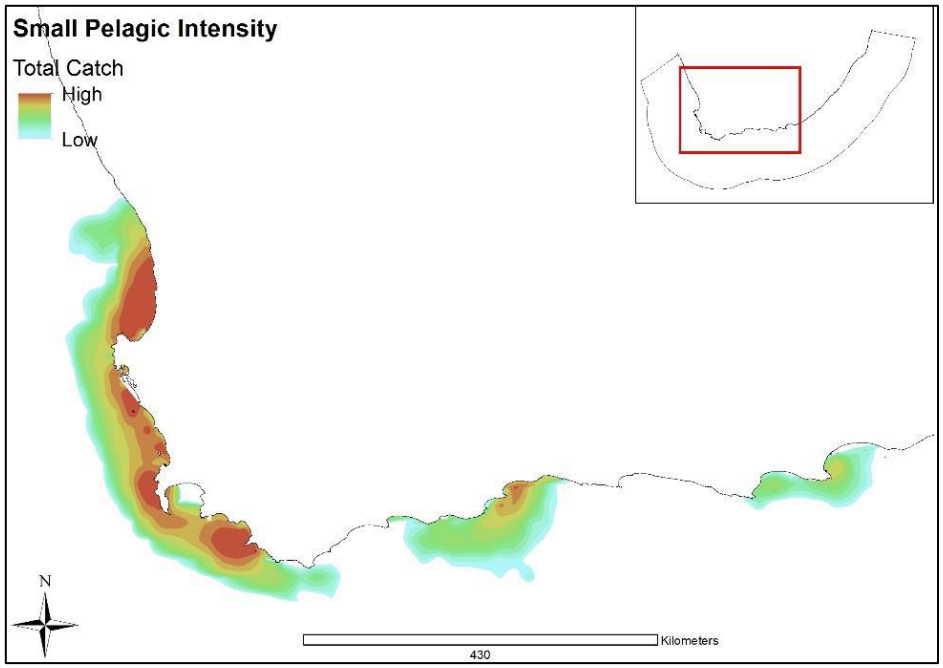


Figure 2-2.51. Small pelagic fishing intensity off the coast of South Africa (Sink et al. 2019a).

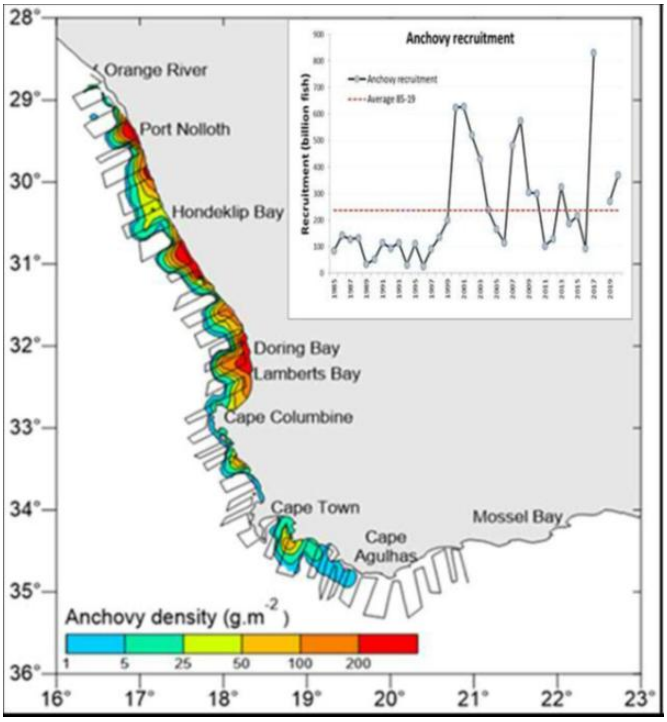


Figure 2-2.52. Recruitment survey results (May 2020) for anchovy and recruitment trend (inset). The red dotted line is the running average level of recruitment since 1985 (information and figure provided by J. Coetzee and D. Merkel of DFFE).

2.2.7.6 West coast rock lobster

The West Coast Rock Lobster (WCRL) fishery targets the temperate or cold-water rock lobster *Jasus lalandii.* It South Africa's most valuable crustacean fishery. This is due to the high market value of the resource (more than R 260 million per year) and provides jobs for more than 4 200 people (DAFF 2016). Two major fishing sectors harvest this resource; the offshore trap vessels operating in waters up to 100 m depth, and the

inshore sector that utilises hoop nets to harvest WCRL in shallow water up to 1 nautical mile from the shore (Sink et al. 2019a). Hoop nets (also known as fyke, barrel or fiddler nets) are tubular shaped nets with a series of tapered hoops spaced along the length of the net to keep it open. The net is laid out and the bait is placed in the closed or tail end of the net, relying on lobsters to enter voluntarily and becoming trapped inside. Traps can be shaped as tubes or boxes that are set out and left to soak for a period of time and also rely on lobsters being lured by bait and becoming trapped inside. The near-shore resource is also harvested by recreational fishers and the informal small-scale subsistence fishers (Cockcroft & Mackenzie 1997) (DAFF 2016). The majority of the catch is apportioned to the offshore sector (80%) with a smaller portion (20%) being landed by the inshore sector (DAFF 2016). The fishing grounds extend from Quoin Point in the east up to Hondeklipbaai in the west but do not extend up into the Boegoebaai area, so there is no overlap with the proposed development.

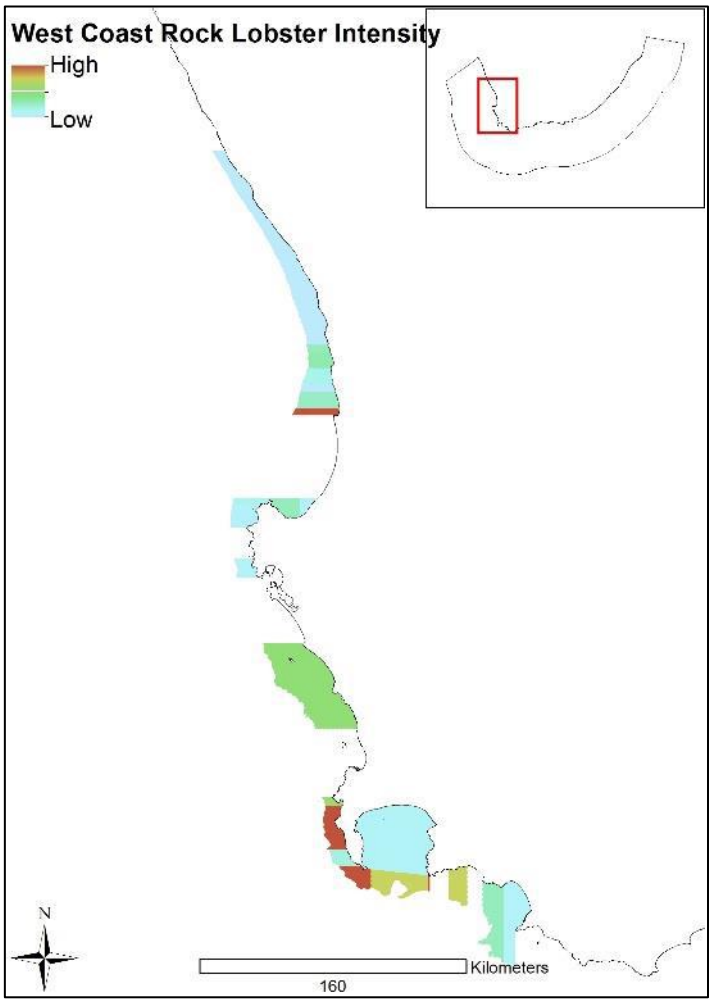


Figure 2-2.53. Fishing intensity for west coast rock lobster (Sink et al. 2019a).

2.2.7.7 Linefish

Linefishing is defined as the capture of fish with hook and line, and has a long history in South Africa dating as far back as the 1500s (DAFF 2016). Approximately 250 species have been reported in catches for this sector, although only 35 species make up the majority of catches. Vessels involved in the linefishery in South Africa range from 6-8 m ski-boats capable of surf-launching, to harbour-based freezer vessels (generally longer than 20 m) that can remain at sea for more than 2 weeks at a time (Mann 2013). The commercial linefishery has the largest fleet but its catches make up only 6% of the total value of all commercial marine fisheries (DAFF 2016). Linefishing effort in South Africa is concentrated between Lamberts Bay on the west coast through to East London on the South coast and also in KZN (Figure 2-2.54). Very little if any commercial linefishing effort is undertaken offshore of Boegoebaai (Figure 2-2.54).

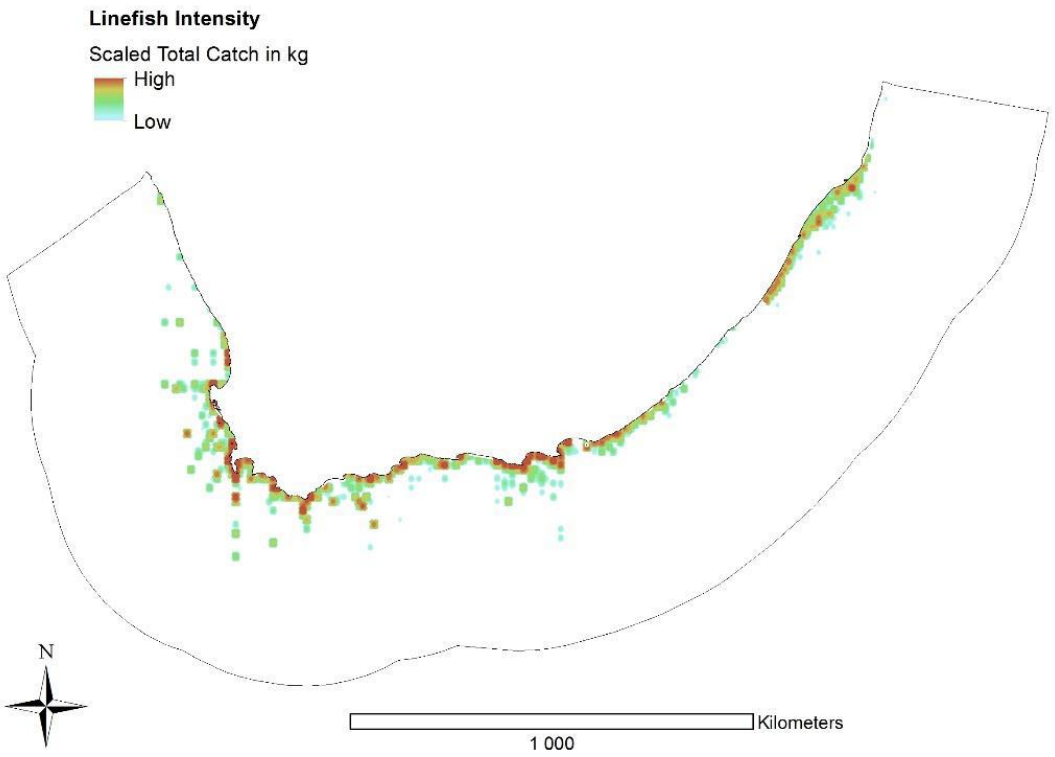


Figure 2-2.54. Commercial linefishing intensity South Africa for period 2000-2016 (Sink et al. 2019a).

2.2.7.8 Abalone

Abalone, *Haliotis midae,* is a slow-growing mollusc and highly prized seafood delicacy both in South Africa and the Far East. Abalone are harvested by divers and pried from rocks using a blade. Abalone harvesting permits strictly forbid the use of scuba gear and no more than 3 bags are permitted on board an abalone boat (DAFF 2016). The commercial (diver) fishery for abalone started in the late 1940s and was dominated by a few large abalone-processing plants. Initially, catches were unregulated, peaked at close to 3 000 tonnes in 1965, but by 1970, catches had declined rapidly, to around 600–700 t. The recreational fishery boomed in the early 1990s, and this, along with a significant increase in illegal fishing activities contributed to further declines in abalone stocks. Subsistence rights were introduced in 1998/1999, and were later replaced by medium-term and long-term rights, which broaden participation in the fishery to some 300 right-holders. The fishery was closed in 2008 after rampant poaching and continued resource declines (DAFF 2016). The commercial fishery was re-opened in 2010, with a Total Allowable Catch (TAC) of 150 t. Commercial fishing effort is concentrated around the southwestern Cape, but illegal fishing is practiced throughout the range of the species, all the way into the Eastern Cape (Figure 2-2.55) and greatly exceed annually allocated legal Total Allowable Catches (Branch & Branch 2018a).

Although the Northern Cape coast lies beyond the northern-most distribution limit of abalone on the West Coast, ranching experiments have been undertaken in the region since 1995 (Sweijd 1998, De Waal & Cook 2001, De Waal 2004). As some sites have shown high survival of seeded juveniles, the Department of Agriculture, Forestry and Fisheries (DAFF) published criteria for allocating rights to engage in abalone ranching or stock enhancement (Government Gazette No. 33470, Schedule 2, 20 August 2010) in four areas along the Namaqualand Coast (Figure 2-2.56). Ranching in these areas is currently being investigated at the pilot phase. The Boegoebaai study area falls within Northern Cape Area 1 held by Turnover Trading. No seeding has as yet commenced in the area and DFFE are still awaiting the baseline assessment for the area as required in terms of permit conditions (Zimasa Jika, DAFF, pers. comm.).

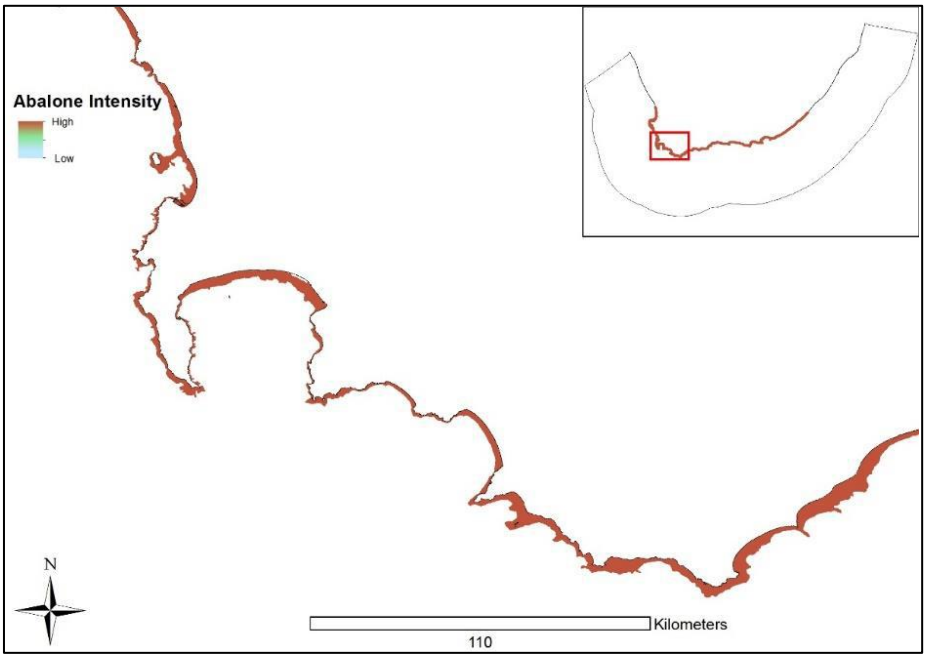


Figure 2-2.55. Fishing effort (legal and illegal) for abalone (Sink et al. 2019a).

2.2.7.9 Seaweed

The South African seaweed harvesting industry is based mainly on the harvesting of the kelp (mainly *Ecklonia maxima* and to a lesser extent *Laminaria pallida*) used by the abalone aquaculture industry as feed and for use in other kelp-based products, while the red seaweeds *Gelidium* and *Gracilaria* are used for agar. There are 23 commercial seaweed harvesting concession areas, arranged along the coast between the Orange River and the Mtamvuna River on the East Coast. The Boegoebaai project area falls within seaweed concession 19 held by Premier Fishing Area, and extends from the border of the proclaimed State Alluvial Diggings just north of Port Nolloth (29°13′56″S, 16°51′15″E) to the southern bank of the Orange River (28°38′18″S, 16°27′42″E). Commercially harvested seaweeds that are present in this concession area include the two kelp species *E. maxima* and *L. pallida, which* are widely distributed between Cape Agulhas and northern Namibia (and hence occur in the study area).

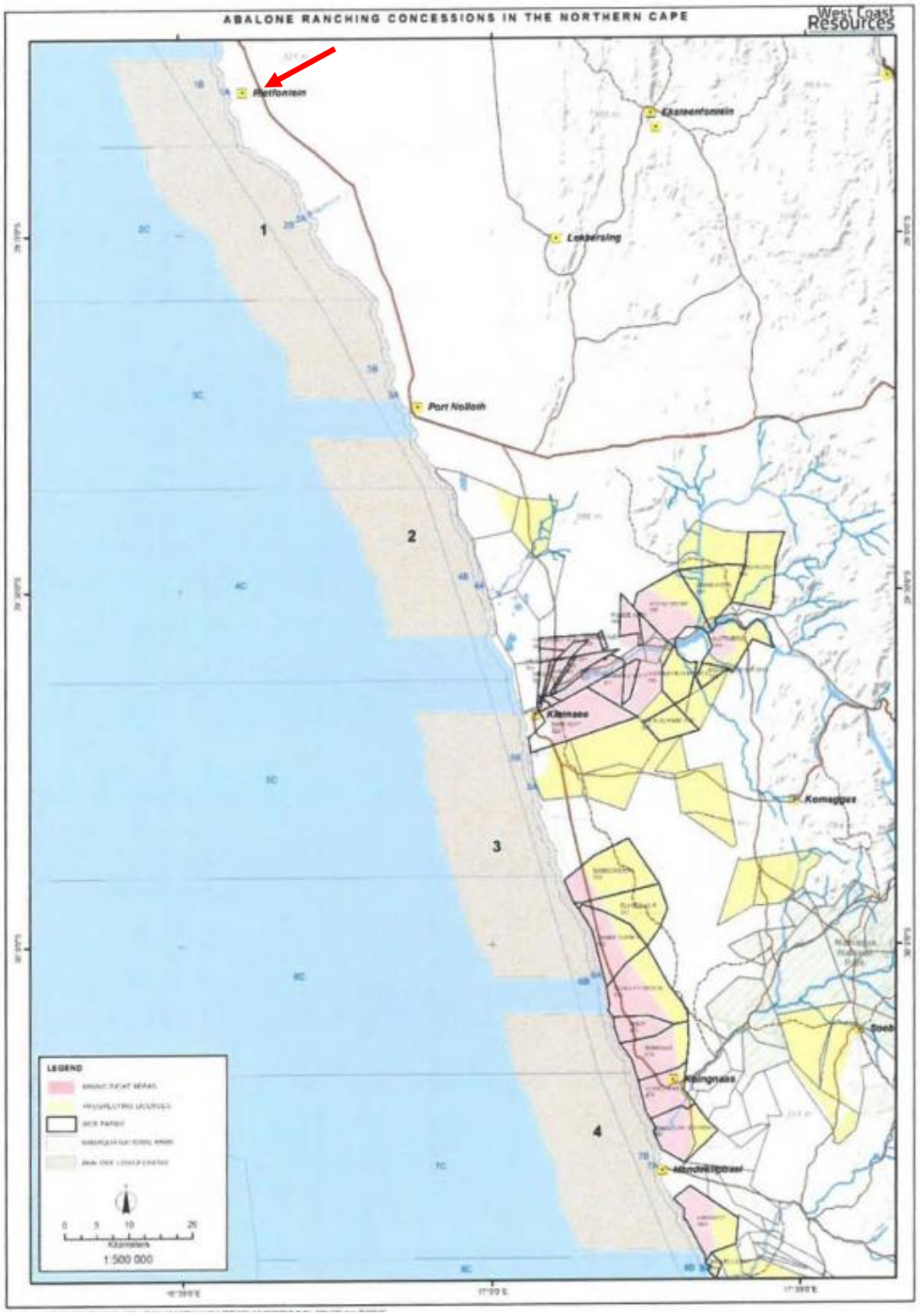


Figure 2-2.56. Abalone ranching concession areas (1-4) in the Northern Cape. Boegoebaai Point is indicated with red arrow.

Kelp harvesting entails harvesting of fresh kelp from live stocks and removal of kelp that has washed up in the surf from beaches, referred to as beach-cast kelp (DAFF 2016). Beach cast kelp is picked up off the beach or rocks by teams of labourers, usually when it is partly or completely dry. Material is removed and spread out in the foreland dune area to dry completely, then milled to various size chips. It is graded, bagged and (mainly) exported for the extraction of alginate, a colloid with many industrial uses. In the areas around abalone hatcheries fresh beach-cast kelp is also collected as food for cultured abalone, although quantities have not been reported. Live kelp harvesting (almost *entirely E. maxima*) is generally done from boats, at low tide, when kelp fronds are accessible from the surface. Workers lean over the side, pull up the kelp head, and either cut the whole head off, or (preferably) cut the fronds off but leave the first 30 cm intact and

attached to the head, which allows the plant to re-grow. Fresh kelp fronds are landed and immediately delivered to abalone farms where they are supplied to the abalone as food.

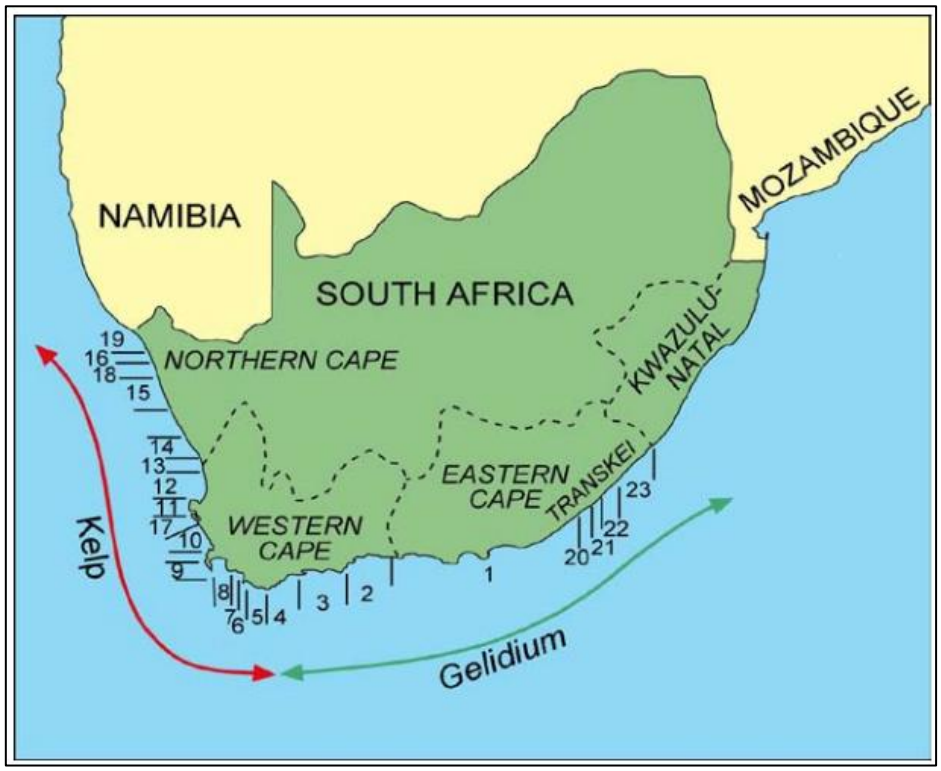


Figure 2-2.57. Seaweed concession areas in South Africa (DFFE 2013).

Access to a seaweed concession is granted by means of a permit from the DFFE to a single party for each concession area for a period of five years. The seaweed industry was initially based on sun dried beach-cast seaweed, with harvesting of fresh seaweed occurring in small quantities only (Anderson *et al.* 1989). Beach-cast kelp harvesting is managed by controlling Total Applied Effort (TAE) while live kelp harvesting is managed by Maximum Sustainable Yields, as set out in annual permits. The level of beach-cast kelp collection varies substantially among years, being dependent on storm action to loosen kelp from subtidal reefs. The harvesting of live kelp has been mapped in South Africa and is focussed around the southwestern Cape, between Cape Agulhas and St Helena Bay (Figure 2-2.58). Information on kelp harvesting in Boegoebaai (Area 19) and the areas south of there is presented in Table 2-2.10.

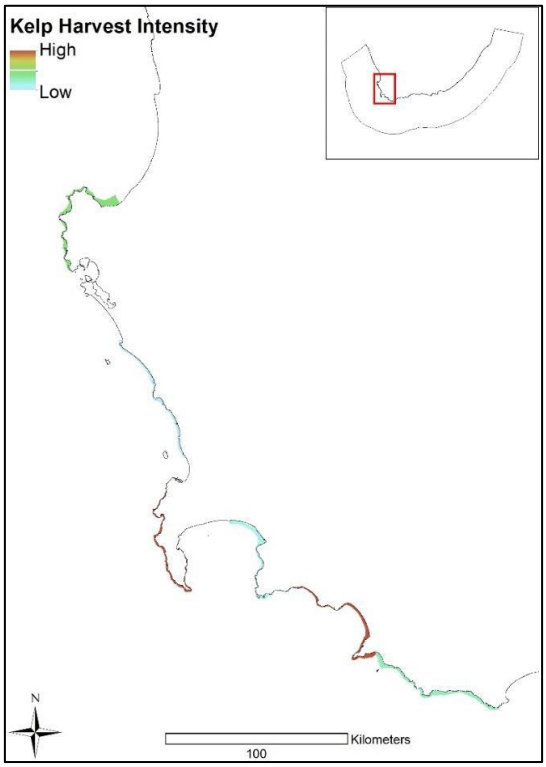


Figure 2-2.58. Kelp harvesting intensity in South Africa (Sink et al. 2019a).

Table 2-2.10. Beach-cast collections (in kg dry weight per annum) for kelp concessions north of Lamberts Bay (Data source: Seaweed Section, DFFE).

Year	Concession Number					
	13	14	15	16	18	19
2005	65 898	165 179	10 300	35 920	0	0
2006	94 914	145 670	19 550	28 600	0	0
2007	122 095	79 771	0	84 445	0	0
2008	61 949	204 365	23 646	16 804	0	0
2009	102 925	117 136	0	0	0	0
2010	53 927	166 106	0	0	0	0
2011	40 511	72 829	0	0	0	0
2012	43 297	151 561	160 500	156 000	0	0
2013	20 485	97 283	36 380	24 000	0	0
2014	19 335	136 266	74 300	75 743	0	0
2015	52 827	158 184	0	0	0	0
2016	69 363	154 010	0	0	0	0
2017	0	168 268	0	0	43 700	0
2018	3 000	148 560	0	0	34 053	216 900
2019	93 514	91 906	0	0	29 510	132 955

Year	Concession Number					
	13	14	15	16	18	19
2020	22 758	29 747	0	0	0	90 885
2021	4 633	109 080	0	0	0	37 600
2022	7 164	0	0	0	0	0
2023	0	0	0	0	0	128 820

2.2.7.10 Recreational/subsistence fishing

Recreational fisheries in South Africa include linefisheries, rock lobster fisheries and harvesting of intertidal resources such as mussels, redbait and oysters (Griffiths et al. 2004, Cooke and Cowx 2006, Winker et al. 2014, Parker et al. 2016, Maggs et al. 2017, Kerwath et al. 2019, Steyn et al. 2019, Lewin et al. 2006). Recreational linefishing is a popular activity in South Africa and takes place across the coast. Between 1994 and 1997, the first nation-wide survey was conducted to evaluate participation in South Africa's recreational shore angling fishery, and its management (Brouwer et al. 1997, Mann et al. 2003).

Recreational fishing in South Africa includes participation from approximately 1.32 million fishers, of which approximately half fish from the ocean, targeting mainly linefish and rock lobster (Saayman et al. 2017). The Marine Living Resources Act (1998) legally recognised subsistence fishers and made provision for the declaration of coastal areas for their exclusive use. Since it is a restricted diamond area, the intensity of recreational fishing around Boegoebaai is extremely low, as is the case with subsistence harvesting harvesters (Figure 2-2.59).

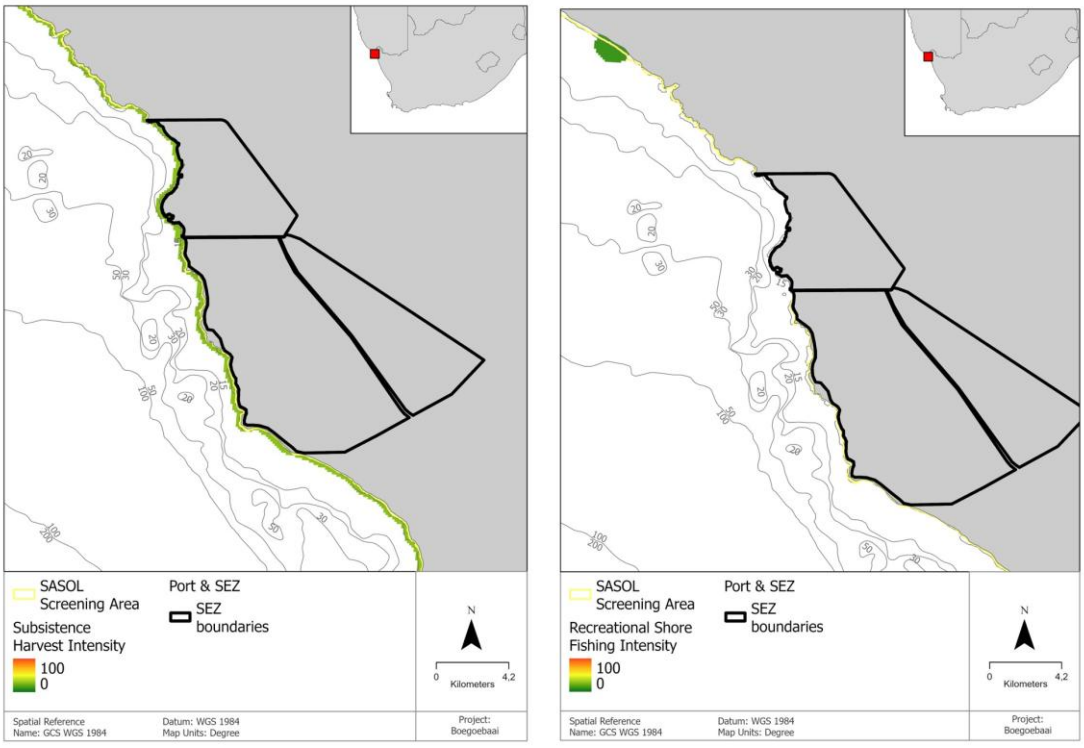


Figure 2-2.59. Map of scaled intensity for subsistence harvesting (left) and the recreational shore fisheries (right) and in the screening area and around the proposed site location for green hydrogen developments (Rees et al. 2022).

2.3 MARINE SPATIAL PLANNING

2.3.1 Overview

Marine Spatial Planning (MSP) is an approach to improving the rational planning, management and governance of ocean space and marine resources. MSP entails a development planning approach for marine areas which organizes the use of space to guide single- and multi-sector decision-making and provides for coherent, comprehensive, integrated and complementary planning and management. It also offers a practical way to address specific challenges and to select appropriate management strategies to maintain good ecosystem health that will, in turn, facilitate sustainable national and regional economic and socio-cultural development. In South Africa, MSP is undertaken under the auspices of the Marine Spatial Planning Act (Act No. 16 of 2018) and the national Marine Spatial Planning Framework (DFFE 2021). A number of draft Marine Sector Plans have been prepared by sector national government departments to support the development of Marine Area Plans as part of the Marine Spatial Planning process. These Marine Sector Plans specify and outline the spatial claims and interests of each sector in the South African marine environment from a national point of view. They specify and outline the spatial claims and interests of each sector in the South African marine environment. The following draft Marine Sector Plans are being released for public comment: 1) Marine Biodiversity Sector Plan; 2) Coastal and Marine Tourism Sector Plan; 3) Marine Transport and Ports Sector Plan; 4) Maritime and Underwater Cultural Heritage Sector Plan; 5) Marine Defence (Navy) Sector Plan; 6) Marine Science and Innovation Sector Plan; 7) Marine Aquaculture Sector Plan; 8) Marine offshore Oil and Gas Sector Plan; 9) Marine Underwater Infrastructure Sector Plan; 10) Wild Fisheries Sector Plan.

The Marine Biodiversity Sector Plan is of greatest relevance to this study. This plan sets out the overall national spatial development objectives and priorities of the sector for the next two decades. It specifies the spatial requirements of the sector for South Africa's mainland EEZ marine area. It includes proposed biodiversity zones and their spatial regulations. As with other Marine Sector Plans, the Biodiversity Sector Plan summarises spatial priority areas and their associated management requirements, for which the sector is making the case to secure in the Marine Area Plans as part of the coming Marine Area Plan development processes. Essential components and spatial layers that have been developed for the Marine Biodiversity Sector Plan are summarised below. Combined, these MSP layers and delineations form a significant component of our marine and coastal sensitivity assessment (see Section 2.4). The location of all MSP features (EBSAs, MPAs, CBAs and ESAs – each of which are expounded upon below) in relation to the proposed SEZ area are shown together on a regional map (Figure 2-3.1).

2.3.2 Ecosystem Threat Status

The Ecosystem Threat Status developed by SANBI (2018) is an indicator of how threatened ecosystems are, specifically the degree to which ecosystems are still intact or alternatively losing vital aspects of their structure, function, or composition (Harris et al. 2019b). All of the coastal (intertidal) ecosystem types identified through the National Biodiversity Assessment have been categorised into one of five categories: "Critically Endangered", "Endangered", "Vulnerable", "Near Threatened" or "Least Concern", based on the proportion of the original extent of each ecosystem type that remains in good ecological condition relative to a series of biodiversity thresholds.

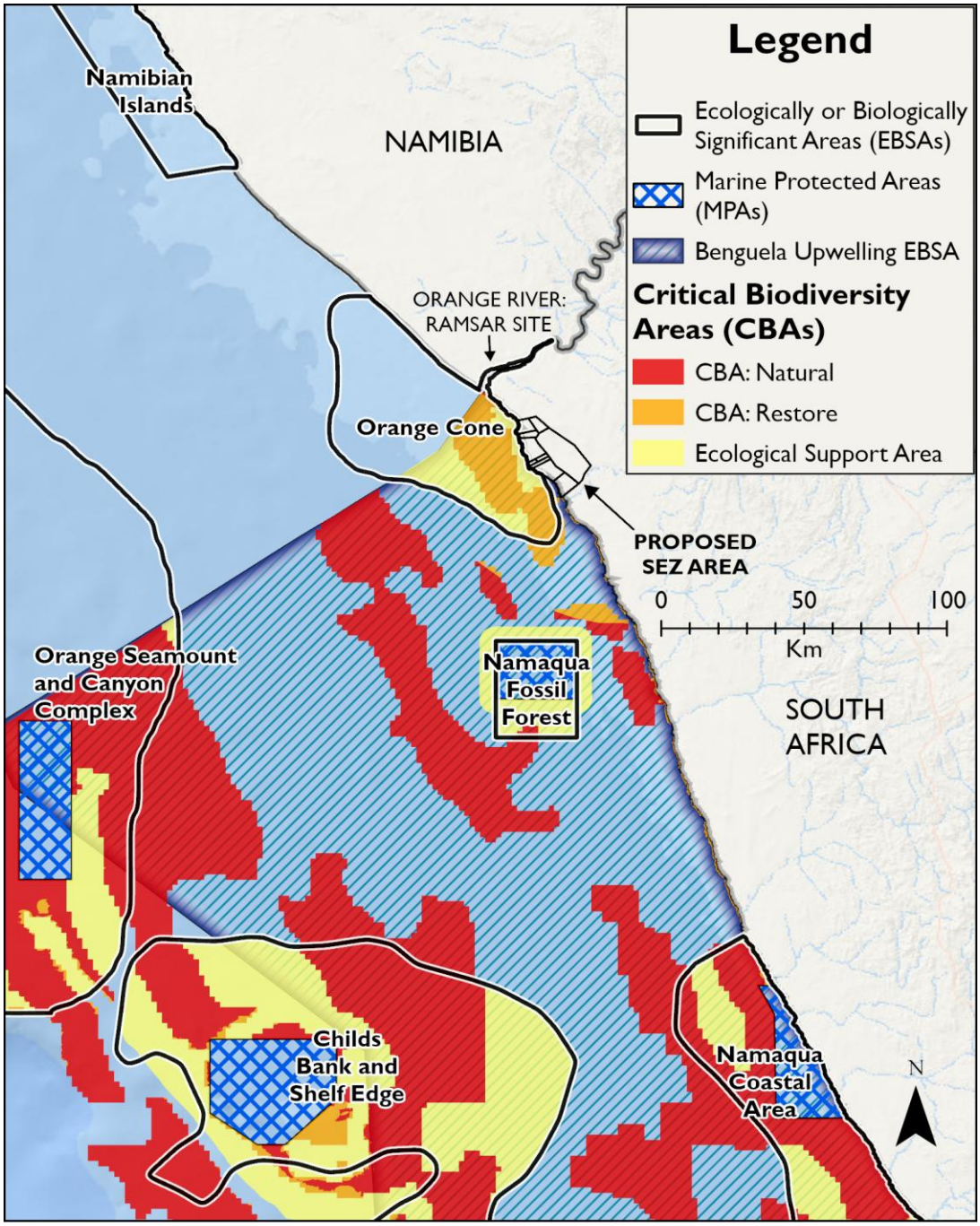


Figure 2-3.1. Regional Marine Spatial Planning map displaying the proximity of the proposed SEZ area to Ecologically or Biologically Significant Areas (EBSAs), Marine Protected Areas (MPAs), and Critical Biodiversity Areas (CBAs).

This threat status is considered to apply to a distance of ~200 m from the coast, with areas further offshore being classified in a similar manner (Figure 2-3.2). The outcome of this is that most of the coastal (intertidal) habitats, in the Boegoebaai study area, including the rock intertidal, mixed shore habitats have been classified as vulnerable, the dissipative and dissipative-intermediate sand shore as least concern, the intermediate sandy shores as near threatened, and the reflective sandy shore and all of the offshore habitats as endangered. The classification of the offshore habitats as endangered is linked to impacts of flow reduction and reduced sediment outputs from the Orange River estuary.

2.3.3 Ecologically or Biologically Significant Marine Areas

Ecologically or Biologically Significant Marine Areas (EBSAs) are defined by the Convention on Biological Diversity (CBD) as "geographically or oceanographically discrete areas that provide important services to one or more species/populations of an ecosystem or to the ecosystem as a whole, compared to other surrounding areas or areas of similar ecological characteristics, or otherwise meet the [EBSA] criteria". In the marine realm, South Africa has a network of EBSAs, based on original focus areas for offshore MPAs, which were adopted by the CBD in 2014 (Sink et al. 2011). The Benguela Current Commission (BCC) and its member states have been working on a regional Marine Spatial Management and Governance Programme (MARISMA EBSA Workstream 2020). The intent is to refine the boundaries of existing EBSAs and identify relevant new ones, assess their status and management requirements, and incorporate these into MSP processes in South Africa to achieve sustainable ocean use in the Benguela Current (Harris et al. 2019b). Through the MARISMA Project (https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/MARISMA), South Africa has refined the boundaries of its EBSAs and identified new EBSAs.

Note, in South Africa, these older EBSAs are integrated with newer Critical Biodiversity Areas (See Section 2.3.4) and are linked through MSP frameworks that aim to integrate biodiversity conservation with sustainable ocean use. While EBSAs inform broad-scale conservation goals and international reporting, Critical Biodiversity Areas are directly used in decision-making tools like EIAs, permitting, and sectoral planning (e.g., mining, fisheries, offshore energy. This ensures that spatial planning remains dynamic, adapting to new ecological data and pressures.

South Africa has 18 recognised EBSAs excluding those that extend into the high seas area. Of these recognised EBSAs, 16 of these 18 areas have some protection. The Orange Cone is one of two EBSAs entirely within national jurisdiction that currently lack any form of protection from anthropogenic activities.

The proposed site location and the northern part of the screening area falls within the Orange Cone EBSA. Orange Cone is a transboundary EBSA between Namibia and South Africa that spans the mouth of the Orange River. The marine environment in this area experiences slow, but variable currents and weaker winds, making it potentially favourable for reproduction of pelagic species. Furthermore, given the proven importance of river outflow for fish recruitment at the Thukela Banks (a comparable shallow, fine-sediment environment on the South African east coast) (Lamberth et al. 2009), a similar ecological dependence for the inshore Orange Cone has been inferred. Evidence supporting this hypothesis has not yet been consolidated.

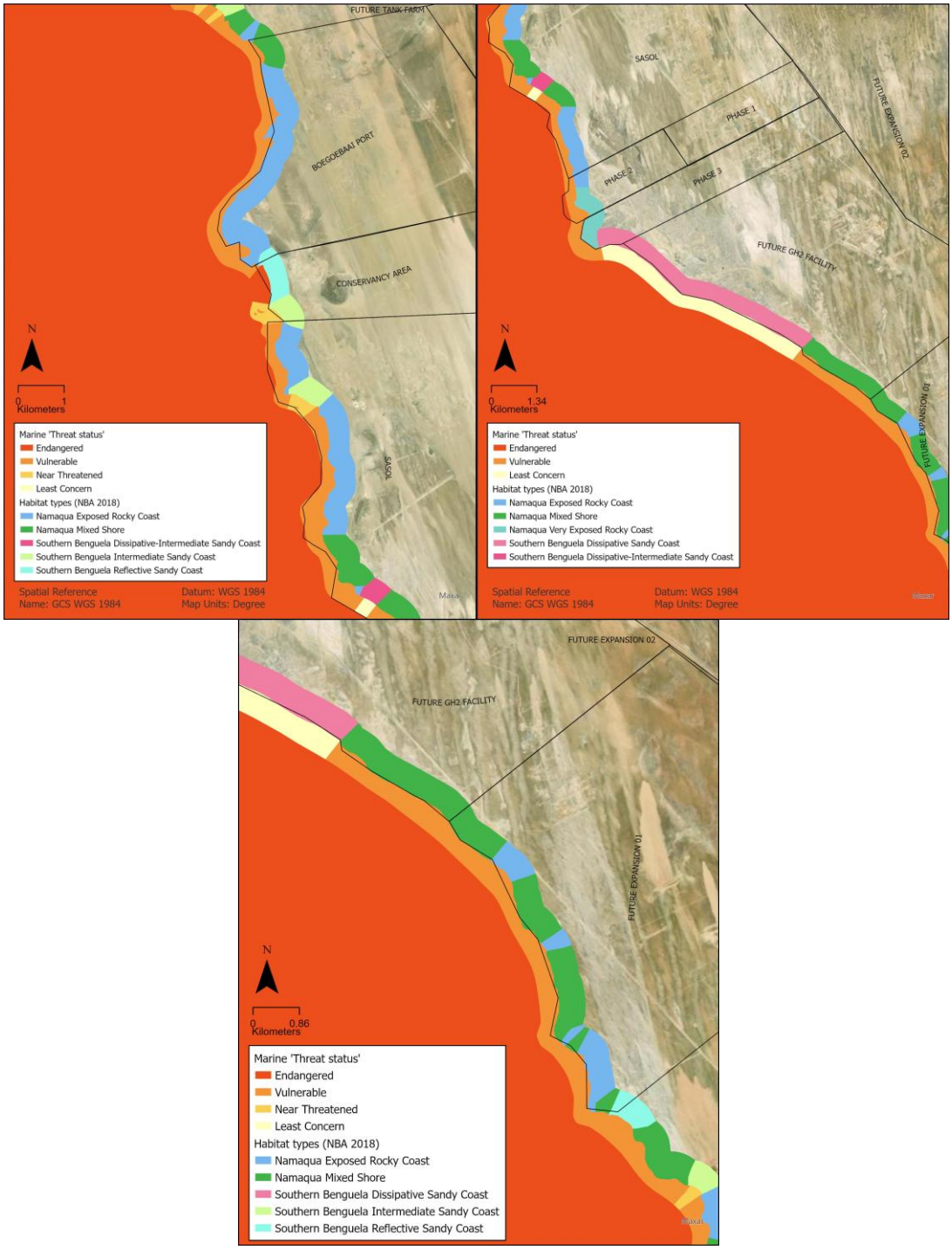


Figure 2-3.2. Ecosystem Threat Status (northern (left), central (left), and southern (bottom left) regions of the SEZ as per the NBA (Sink *et al*. 2019) around Boegoebaai. Coastal Habitat Classification types are also shown (NBA 2018). The three panels overlap but run consecutively southwards.

The proposed site location and the northern part of the screening area falls within the Orange Cone EBSA. Orange Cone is a transboundary EBSA between Namibia and South Africa that spans the mouth of the Orange River. The marine environment in this area experiences slow, but variable currents and weaker winds, making it potentially favourable for reproduction of pelagic species. Furthermore, given the proven importance of river outflow for fish recruitment at the Thukela Banks (a comparable shallow, fine-sediment environment on the South African east coast) (Lamberth et al. 2009), a similar ecological dependence for the inshore Orange Cone has been inferred. Evidence supporting this hypothesis has not yet been consolidated.

The goal of this zoning is to protect biodiversity while also allowing for some human activities. Biodiversity Conservation Zones aim to protect critical biodiversity areas (both natural and those requiring restoration) while Impact Management Zones (equivalent to Ecological Support Areas) aim to manage human impacts to maintain ecological functionality. The division of the Orange Cone EBSA into these Conservation and Impact Management zones, and their relevance to the proposed development, are indicated in Figure 2-3.3. The immediate nearshore around the proposed development site is adjacent to the 'Impact Management' zone of the EBSA.

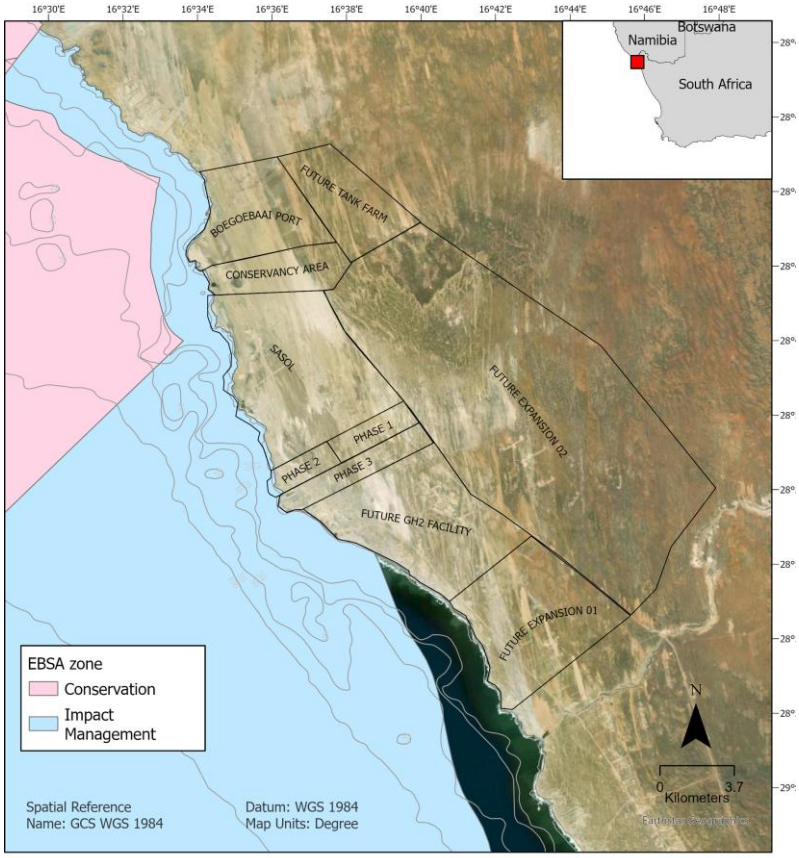


Figure 2-3.3. Ecologically or Biologically Significant Marine Areas (EBSAs) near to the Boegoebaai SEZ. Data from Sink et al. (2019a). The inshore around the proposed development site is adjacent to the Impact Management zone of the Orange Cone EBSA.

2.3.4 Critical Biodiversity Areas

A Critical Biodiversity Area (CBA) assessment presents a newer spatial plan for the natural environment, designed to inform planning and decision-making in support of sustainable development (Van Niekerk et al. 2019). CBA maps are developed using the principles of systematic biodiversity planning. These maps comprise three categories of biodiversity priority areas, namely Protected Areas, CBAs and Ecological Support Areas (ESAs). These are all considered important for the persistence of a viable representative sample of all ecosystem types and species, as well as the long-term ecological functioning and connectivity of the landscape or seascape as a whole.

There are two categories of CBA, namely 'CBA Natural' areas and 'CBA Restore' areas. CBA Natural sites have natural/near-natural ecological condition, with the management objective of maintaining the sites in that natural/near-natural state; and CBA Restore sites have moderately modified or poorer ecological condition, with the management objective to improve ecological condition and, in the long term, restore these sites to a natural/near-natural state, or as close to that state as possible. As a minimum in CBA Restore sites, further deterioration in ecological condition must be avoided, and options for future restoration must be maintained. The ESAs include all portions of EBSAs that are not already within MPAs or CBAs, and a 5 km buffer area around all MPAs (where these areas are not already CBAs or ESAs). Within ESAs, negative

impacts of human activities on key biodiversity features are managed and minimised to maintain the features in at least a functional, semi-natural state and/or to allow the area to improve in ecological condition.

A CBA assessment was completed for the South African marine environment as part of the National Biodiversity Assessment and results are presented on Figure 2-3.4 below. This assessment yielded a very large number of small (many less than 100 m in length) CBA Natural areas scattered along the coast in the Boegoebaai area along with a smaller number of slightly larger (2 km +) sized CBA Restore areas. It is not clear why the analysis yielded this plethora of tiny CBA Natural areas but they are unlikely to offer much in the way of conservation benefits. They do not align with any of the shoreline or offshore habitat types. The slightly larger CBA restore areas presumably align with areas that have been subject to mining in the past. Again, these areas do not align with specific shoreline or offshore (subtidal) habitat types and it is not clear how much value they would add if they were conserved. Much of the remaining coastal and offshore habitat in the study areas has been incorporated into what appears to be a single large ESA. Again, this does not align with any of the shoreline or subtidal habitat types and its value as a conservation area is questionable. It is generally recommended that caution be taken when interpreting the CBA maps. Given the scale of the national assessments, the datasets recording pressures are mapped and analysed at a scale and resolution entirely appropriate for the realm, but not for the very narrow shore and backshore which are barely even visible when viewed on a national map (Harris et al. 2022b). Indeed, the authors of the CBA assessment identify the resolution of the datasets and analyses are probably too coarse for accurate assessment at high resolution such as the current assessment.

This notwithstanding, it must be noted that a set of guidelines, termed “sea-use guidelines” have been developed to inform planning and decision-making around CBAs and ESAs in support of sustainable development (Harris et al. 2022b). These are based on an assessment of activities compatibility with the management objectives of CBAs and ESAs. Because the management objectives relate to the ecological condition of the site, the extent and severity of degradation resulting from an activity is considered in the compatibility assessment to determine whether the management objective could still be maintained if the activity were present.

A compatibility matrix has thus been compiled as part of a conceptual framework for evaluating each activity, indicating which combinations of extent and severity of degradation are compatible, not compatible or have restricted compatibility with the management objectives of the different CBA Map categories. This matrix was informed by the IUCN Red List of Ecosystems and the NBA 2018 Marine assessment of ecological condition (Sink et al. 2019b), which are both based on the same principles. Principals used for assessing compatibility of activities within the CBA Map categories, and recommendations for management of those activities are included in Table 2-3.1 below, while the actual matrix of sea-use guidelines is presented in Table 2-3.2.

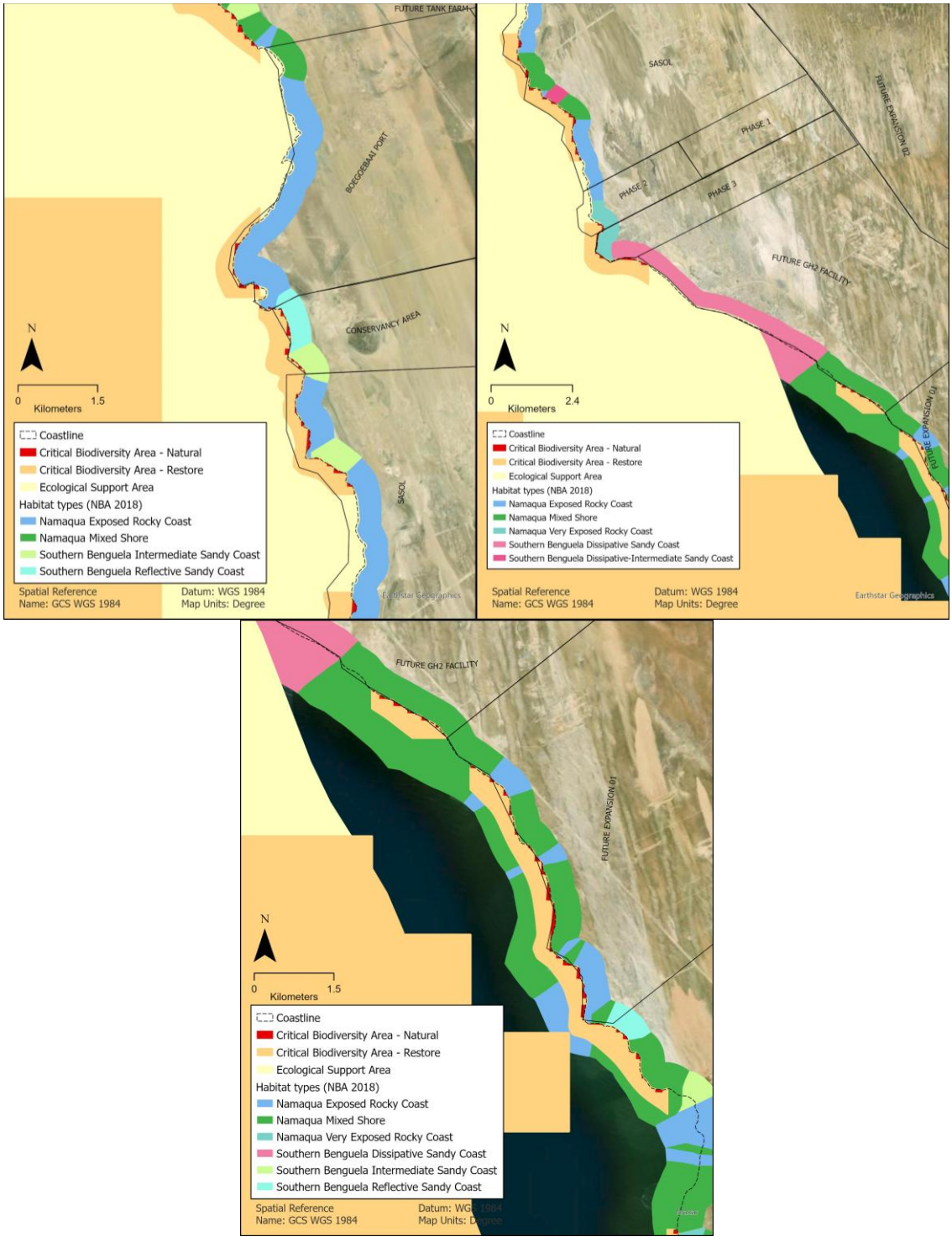


Figure 2-3.4. Critical Biodiversity Areas (CBAs) in area surrounding the northern (top left), central (top right) and southern (bottom left) sections of the study area. Data source: Sink et al. (2019a).

Table 2-3.1. Principals for assessing compatibility of activities within the CBA Map categories, and recommendations for management of those activities. Source: (Harris et al. 2022b).

Type of activity	Critical Biodiversity Area (Natural) *Compatibility with the management objective: to keep the area in a natural / near-natural state*	Critical Biodiversity Area (Restore) *Compatibility with the management objective: to improve ecological condition and, in the long term, restore to a natural / near-natural state, or as near to that state as possible. As a minimum, avoid further deterioration in ecological condition and maintain options for future restoration.*	Ecological Support Areas *Compatibility with the management objective: to avoid further deterioration in ecological condition.*
Activities that could result in **Severe or Very Severe degradation** over **broad areas** (includes activities that have a high disaster risk)	**Not compatible**	**Not compatible**	**Restricted compatibility**
Activities that could result in **Severe or Very Severe degradation** of **localised sites** but do not result in degradation across broad areas	**Not compatible**	**Not compatible**	**Restricted compatibility**
Activities that could result in or contribute to **Moderate degradation** over **broad areas**	**Not compatible**	**Restricted compatibility**	**Compatible**
Activities that could result in or contribute to **Moderate degradation** over **localised sites**	**Restricted compatibility**	**Restricted compatibility**	**Compatible**
Activities that could result in **low to very low degradation** and/or are not managed by biodiversity zones	**Compatible**	**Compatible**	**Compatible**

Management recommendations:

- **Compatible:** Activities should be allowed and regulated by current general rules. Notwithstanding, there should still be duty of care, possibly requiring monitoring and evaluation programmes, to avoid unintended cumulative impacts to the biodiversity features for which this area is recognised.
- **Restricted compatibility:** A robust site-specific, context-specific assessment is required to determine the activity compatibility depending on the biodiversity features for which the site was selected. Particularly careful attention would need to be paid in areas containing irreplaceable to near-irreplaceable features where the activity may be more appropriately evaluated as not permitted. The ecosystem types in which the activities take place may also be a consideration as to whether or not the activity should be permitted, for example. Where it is permitted to take place, strict regulations and controls over and above the current general rules and legislation would be required to be put in place to avoid unacceptable impacts on biodiversity features. Examples of such regulations and controls include: exclusions of activities in portions of the zone; avoiding intensification or expansion of current impact footprints; additional gear restrictions; and temporal closures of activities during sensitive periods for biodiversity features.
- **Not compatible:** The activity should not be permitted to occur in this area because it is not compatible with the management objective. If it is considered to be permitted as part of compromises in MSP negotiations, it would require alternative CBAs and/or offsets to be identified. However, if this is not possible, it is recommended that the activity remains prohibited within the CBA.

Table 2-3.2. List of all sea-use activities, grouped by their broad sea use and Marine Spatial Planning (MSP) Zones, and categorised according to their compatibility with the management objective of Critical Biodiversity Areas (CBA-N = CBA Natural; CBA-R = CBA Restore) and Ecological Support Areas (ESA) described in Table 2-3.1. Activity compatibility is given as Y = yes, compatible, R = restricted compatibility, or N = not compatible. Marine protected areas (MPAs) are managed according to their gazetted regulations. Data sources: (Harris et al. 2022b, DFFE 2023)

Broad sea use	Associated MSP Zones	Associated sea-use activities	MPA	CBA-N	CBA-R	ESA
Conservation	Biodiversity Zones	Expansion of place-based conservation measures (e.g., MPA expansion)	Sea-use activities as per gazetted MPA regulations	Y	Y	Y
Recreation and tourism	Marine Tourism Zone	Beach recreation, non-motorised water sports		Y	Y	Y
		Ecotourism (e.g., shark cage diving, whale watching)		Y	Y	Y
		SCUBA diving		Y	Y	Y
		Motorised water sports (e.g., jet skis)		R	R	Y
		Recreational fishing (e.g., shore-based, boat-based and spearfishing)		N	R	Y
		Shark control: exclusion nets		Y	Y	Y
		Shark control: drumlines and gillnets		N	R	Y
Heritage	Heritage Conservation Zone	Protection of sites of heritage importance, including historical shipwrecks		Y	Y	Y
		Protection of sites of seascape value		Y	Y	Y
Fisheries	Commercial and Small-Scale Fishing Zones	Abalone harvesting		R	R	Y
		Linefishing		N	R	R
		Demersal shark longlining		N	R	Y
		Demersal hake longlining		N	R	R
		Midwater trawling		N	R	Y
		Pelagic longlining		R	R	Y
		Small pelagics fishing		N	R	Y
		South coast rock lobster harvesting		R	R	Y
		Squid harvesting		R	R	Y
		Tuna pole fishing		R	R	Y
		West coast rock lobster harvesting		R	R	Y
		Crustacean trawling		N	N	R
		Demersal hake trawling (inshore and offshore)		N	R	R
		Hake handlining		R	R	Y
		Seaweed harvesting		R	R	Y
		Commercial white mussel harvesting		R	R	Y
		Beach seining		R	R	Y
		Gillnetting		R	R	Y
		Kelp harvesting		R	R	Y
		Oyster harvesting		R	R	Y
		Small-scale fishing		R	R	Y
	Fisheries Resource Protection Zone	Resource protection		Y	Y	Y
Aquaculture	Aquaculture Zone	Sea-based aquaculture		N	R	R
Mining	Mining Zone	Mining: prospecting (non-destructive)		R	R	R
		Mining: prospecting (destructive, e.g., bulk sampling)		N	N	R
		Mining: mining construction and operations[1]		N	N	R
Petroleum	Petroleum Zone	Petroleum: exploration (non-invasive)		R	R	R
		Petroleum: exploration (invasive, e.g., exploration wells)		R	R	R
		Petroleum: production[1,2]		N	N	R
		Petroleum: oil and gas pipelines		N	N	R
Renewable Energy	Renewable Energy Zone	Renewable energy installations		N	R	R
Defence	Military Zone	Military training and practice areas		R	R	Y
		Missile testing grounds		R	R	Y
Transport	Maritime Transport Zone	Designated shipping lanes (including port approach zones)		R	R	Y
		Anchorage areas		R	R	Y
		Bunkering		N	N	R
		Ports and harbours (new)		N	N	R
		Dumping of dredged material		N	N	R
Infrastructure	Underwater Infrastructure Zone	Pipelines (excluding oil and gas)		N	R	Y
		Undersea cables (new installations)		N	R	Y
	Land-based Infrastructure Zone	Coastal development (new installations, including piers, breakwaters, and seawalls)[3]		N	N	R
Abstraction and Disposal	Disposal Zone	Waste-water (new installations)		N	R	Y
	Sea-water abstraction and disposal	Sea-water abstraction and disposal (e.g., desalination)		R	R	Y
		Sea-water abstraction and disposal (e.g., aquaculture disposal)		N	R	Y

[1] The activity should not be permitted to occur in CBAs because it is not compatible with the respective management objectives. However, if significant mineral or petroleum resources are identified during prospecting/exploration, then the selection of the site as a CBA could be re-evaluated as part of compromises negotiations in current or future MSP processes. This would require alternative CBAs and/or biodiversity offsets to be identified. However, if it is not possible to identify alternative CBAs to meet targets for the same biodiversity features that are found at the site, it is recommended that the activity remains prohibited.

[2] The recommended prohibition of the activity in CBAs (because it is not compatible with the management objective) refers to the location of the biodiversity disturbance rather than the location of the petroleum resource. If petroleum production is possible using lateral drilling or other techniques that do not result in any impacts on biodiversity within the CBAs, then production may be treated as an activity with restricted compatibility (i.e., recommended to be a consent activity).

[3] New coastal development should not be permitted in CBA Restore sites unless it is part of rehabilitation and restoration activities to improve ecological condition.

2.3.5 *Marine Protected Areas*

A Marine Protected Area (MPA) is an area of ocean and/or coastline specifically protected for the benefit of people and the environment, which receives a higher level of protection than the surrounding areas. MPAs may be zoned to permit defined human activities in parts of the MPA while providing complete protection from extractive and harmful activities in other parts. It is stated in the Protected Areas Act (Act No. 57 of 2003) that "no person may conduct commercial prospecting or mining, exploration, production or related activities in a protected environment without the written permission of the Minister and the Cabinet member responsible for minerals and energy affairs". Therefore, these areas provide some refuge from human induced impacts for marine species and ecosystems. Prior to 2019, South Africa had 25 formally declared MPAs which covered a total ocean area of 0.43% of South Africa's mainland ocean territory (not including the Prince Edward Island in the Southern Ocean). In May 2019, the government formally gazetted the addition of 20 new or expanded MPAs (identified through Operation Phakisa), thereby increasing the total number of MPAs to 41 and the protected area of South Africa's EEZ to 5% (Government Gazette 42478, Notice No. 757). These areas provide some protection to 87% of the different marine ecosystem types found in South African waters, ensuring that the MPA network is representative of the country's important diversity. Included in this was the addition of several new offshore MPAs, the purpose of which is to help ensure the sustainability of food and job security provided by fisheries, by securing the spawning grounds of numerous marine species as well as protecting vulnerable and unique habitats. No MPAs have been proclaimed in the study area. The nearest MPA is the Namaqua Fossil Forest MPA located offshore around 60 km south of the development area (Figure 2-3.5).

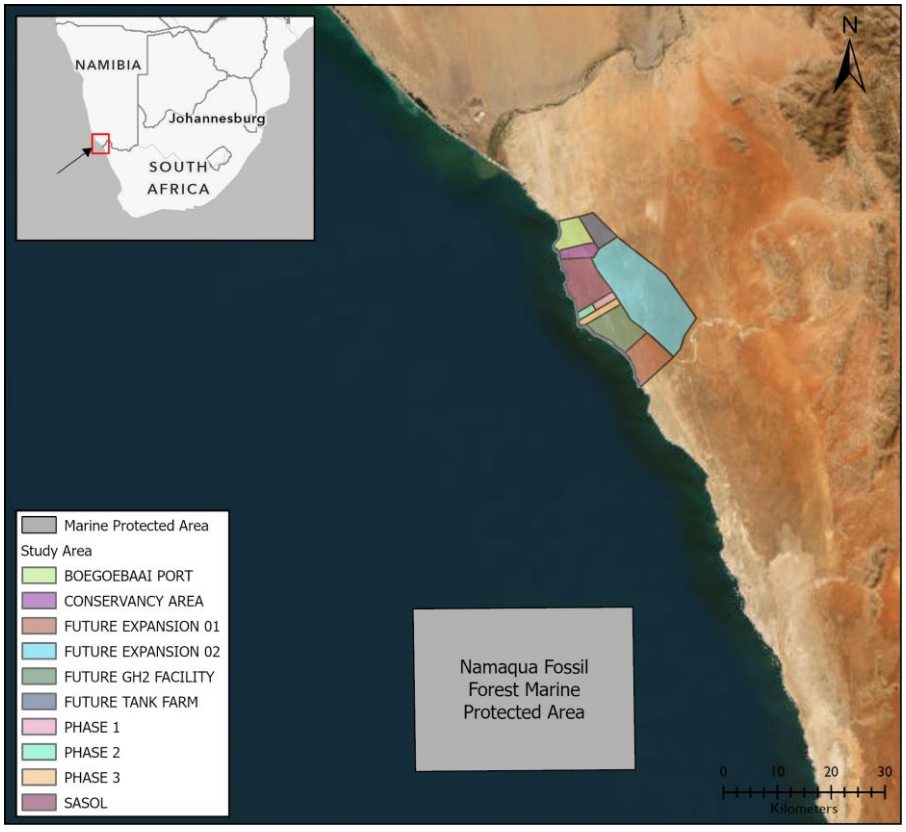


Figure 2-3.5. Location of the proposed project area in relation to the nearest Marine Protected Area.

2.4 SENSITIVITY ASSESSMENT

2.4.1 Introduction

An environmental sensitivity assessment is a critical component of development planning, as it provides a spatially explicit understanding of ecological vulnerability of a defined area to anthropogenic disturbances. The assessment of environmental sensitivity is particularly important in dynamic and biodiverse coastal and marine ecosystems. These systems are known to support a wide range of ecological functions, including biodiversity conservation, fisheries productivity, shoreline protection, and carbon sequestration and as such, environmental changes and human activities can have significant and lasting impacts.

Sensitivity assessments aim to integrate multiple environmental and ecological factors to evaluate both the vulnerability and as well as the resilience of various habitat types to development pressures. In coastal and marine environments, these factors may include species composition, ecological function, exposure to human activities, and regulatory designations (i.e., spatial constraints, such as those defined as part of the MSP process). Determining environmental sensitivity was an important component of the WP1 Boegoebaai SEA to provide intuitive, objective, ground-truthed input on where, from a marine ecology perspective, development might be constrained, permitted, or a clear no-go. This sensitive assessment also serves as the baseline point to inform mitigation planning and performance management to minimize potential environmental impacts.

This sensitivity assessment aims to be intuitive for policy makers, developers and non-technical audiences.

2.4.2 Scoring methods

This assessment was undertaken to identify the key areas of marine coastal and offshore sensitivity associated with the proposed development area of the Boegoebaai SEZ. This GIS-based environmental sensitivity analysis incorporated existing spatial constraints such as habitat vulnerability, marine spatial planning frameworks, and regulatory conservation priorities, and was further refined through targeted field surveys and site verification to ground-truth findings. Objective criteria were applied (detailed below) that incorporated the following inputs to classify areas into four sensitivity categories (Very High, High, Medium, and Low):

- Spatial constraints and marine spatial planning, including Marine Threat Status (Sink et al. 2019c), Critical Biodiversity Areas (Harris et al. 2022a b) and Marine Protected Areas (Sink et al. 2019a).

- Species level information based on a combination of desktop review and in situ validation/field sampling results (see Section 2.2.6). These included the composition (abundance and diversity) of macrofaunal communities; the population structure of *Tylos granulatus* populations; the presence of kelp forest habitat (indicative of subtidal reef systems); the observed presence of seabird and marine mammal populations, especially breeding populations; and surf zone marine fish communities.

The sensitivity assessment was underpinned by the Ecosystem Type layer as described in the NBA 2018 (Sink et al. 2019a), which serves as the foundational framework for evaluating ecological vulnerability. These data delineate distinct habitat types within the study area, providing essential ecological context for assessing sensitivity.

First, these ecosystem types were contextualized at the site (SEZ) level (see Section 2.2.6). To achieve this, the ecosystem types that occur within the study area were compared to those that occur within the Southern Benguela Ecoregion (coarsest scale of habitat biogeography) to determine whether any site-specific habitats were regionally rare. The proportional representation of each ecosystem type (area) within the site was assessed against regional trends to evaluate whether the site's habitat composition was reflective of the broader coastal and marine environment of the region. This proportionality was then weighted as part of the sensitivity assessment i.e. if certain ecosystems were overrepresented within the site compared to their regional distribution, they were assigned higher importance in the sensitivity assessment than those that were relatively underrepresented within the site (see Section 2.4.3). This approach recognizes that even if a

habitat is not inherently rare, its local dominance may indicate a key ecological role within the site, warranting greater consideration in environmental planning and impact mitigation.

Secondly, spatial data layers were assessed, including habitat distribution maps, Marine Protected Area boundaries, biodiversity priority areas (including EBSAs), and other environmental constraints to establish a baseline understanding of habitat vulnerability and any spatial restrictions relevant to development (as per Section 2.3). Areas within these delineated sensitive/protected sites were assigned higher importance in the sensitivity assessment than those that that fell outside of these areas (see Section 2.4.3).

Thirdly, a scoring protocol was designed to systematically evaluate the sensitivity and biodiversity status within of different habitat areas. Each spatial constraint/ biodiversity feature was assigned a score, per delineated ecosystem type, based on its ecological importance and susceptibility to disturbance within each delineation. The cumulative scores were then used as part of the sensitivity matrix to classify habitat areas intone of the four sensitivity categories, with higher scores indicating greater sensitivity (see Section 2.4.3). The assessment encompassed both the intertidal and offshore marine environments to provide a comprehensive sensitivity profile across the study area.

Finally, field survey and site verification results were used for validation (Section 2.2.6). This involved in situ observations, habitat condition assessments, and verification of key ecological features identified in the spatial analysis.

2.4.3 Scoring matrix

The proportionality of habitats within the site, along with the biodiversity status scoring, were integrated into a matrix to determine final sensitivity classifications for each delineated area (Table 2-4.1). This matrix cross-references two key factors: the percentage area of each habitat within the site relative to regional expectations and its biodiversity status score based on ecological vulnerability and resilience:

- Ecosystem Proportionality – Each habitat was categorized as being less than expected, equal to expected, or more than expected compared to regional distributions. Overrepresented habitats were assigned greater importance due to their local ecological dominance.

- Biodiversity Status – Ecosystems were given a score based on their conservation importance, threatened status and their sensitive ecological features present, ranging from < 4 (Low) to 8+ (Very High), reflecting their conservation value and resilience.

These scores were added together to give a final Biodiversity Status score (Table 2-4.1).

Table 2-4.1. Scoring method for each spatial constraint/ecological feature within each delineation as part of the Environmental Sensitivity Assessment.

Feature/constraint	Category	Assigned score
Marine Threat Status	Endangered	4
	Vulnerable	3
	Near Threatened	2
	Least Concern	1
Critical Biodiversity Area	Natural	3
	Restore	2
	Ecological Support Area	1
Species importance e.g., marine mammals	High	1
	Medium	0.5
	Low	0

Final Sensitivity Classification – The intersection of these two factors in the matrix determined the final habitat sensitivity category (Table 2-4.2). For example:

- A habitat with a low status score but overrepresented in the site was elevated to a higher sensitivity category.
- A habitat with a high status score but less than expected in the site retained its high sensitivity classification.
- Equal representation followed a baseline scoring approach.

Table 2-4.2. Environmental Sensitivity scoring matrix

		ECOSYSTEM PROPORTIONALITY		
		Less than expected	*Equal*	*More than expected*
BIODIVERSITY STATUS	*< 4*	LOW	LOW	MEDIUM
	4 - 5.9	MEDIUM	MEDIUM	MEDIUM
	6 - 7.9	MEDIUM	HIGH	HIGH
	8+	HIGH	VERY HIGH	VERY HIGH

The final sensitivity assessment produced a sensitivity map delineating habitat sensitivity across the study area (Section 2.4.4). These maps visually represent the spatial distribution of Very High, High, Medium, Low sensitivity zone. The integration of GIS analysis with field verification ensured that the outputs were both data-driven and ecologically robust.

2.4.4 Sensitivity Assessment – spatial output

The mapped sensitivity distributions for the coastal and offshore marine realms of the Boegoebaai proposed SEZ area, highlighting key areas of concern, and implications for environmental management is presented in Figure 2-4.1, and discussed below.

A large proportion of the coastal habitat of the Boegoebaai SEZ area is rated a **medium environmental sensitivity** (Figure 2-4.1). This is largely on account of the exposed and mixed rocky shore contributing to a large proportion of coastal habitat in this region. Mixed shore ecosystems, which include any area of the shore that is not pure rock or pure sand, makes up a significant (almost one third) of the intertidal shoreline habitats in the Boegoebaai area. Species richness on mixed shore can be higher due to increased habitat complexity and heterogeneity. Furthermore, the bathymetry of the SEZ indicates scattered subtidal reefs close to the shore adjacent to most of the rocky and mixed shores within the SEZ. There is also evidence of significant subtidal reefs from the shore (3-6 km offshore) in the north that approaches right up to the coast south of Boegoebaai point. These reefs may be important for biodiversity and or from a fisheries perspective. The rocky and mixed shore habitats near Boegoebaai are classified as Vulnerable due to biodiversity they support and limited protection afforded to these areas through the formal protected area network. Much of these habitats within the SEZ area listed as CBA-Restore, and should be subject to as little disturbance as possible.

In general, the Boegoebaai beaches that were surveyed in this study can be described as relatively high energy beaches. Beaches sampled in the study area showed the general pattern of depauperate macrofauna populations relative to other beaches of similar morphodynamic state elsewhere in the Southern Benguela Ecoregion and so are less environmentally sensitive, except in the case of the reflective and intermediate beach habitats which had relatively higher and numbers of the indicator species *Tylos granulatus* recorded at them during the survey (Section 2.2.6.2), with evidence of multiple cohorts present. Furthermore, experimental seine net sampling undertaken in surf zone habitats of sandy beaches in the Boegoebaai region revealed low species richness and none of the species caught are listed as ETP species. This further confirms generally these habitats are not considered particularly sensitive in the Boegoebaai area (Figure 2-4.1). The large, dissipative sandy shore to the south of the concession area has the lowest level of environmental sensitivity in our assessment, rated as **low environmental sensitivity** (Figure 2-4.1).

The most sensitive area is around the headland within the proposed port precinct area of the SEZ, in combination with the presence of the seal breeding colony. This area is rated as of **very high environmental sensitivity** (Figure 2-4.1) on account of the breeding population of Cape fur seals, *Arctocephalus pusillus,* that exist here (Section 2.2.6.8). The high-profile rocky shore and cliffs not only offer some degree of protection from land-based predators but also provide shaded refugia and pools for seals to thermoregulate. The latter has been shown to be the most important environmental factor for breeding seal haul-outs in the lower latitudes where there is a high risk of overheating (Stevens & Boness 2003).

Seals started breeding at this site in 1991 and the colony remains small (n = 107 pups counted in 2007) but is growing. Despite their IUCN red list status of "Least Concern" and the prevalence of more than 40 seal colonies along the coast of southern Africa, seals are protected in South Africa under the Sea Birds and Seals Protection Act 1973. Further to this, any activities that disturb seals are deemed to be illegal according to the NEMBA (National Environmental Management: Biodiversity Act).

Construction of a breakwater and or port at Boegoebaai is likely to seriously disturb and/or displace both the seals and breeding seabirds present at this site and it is strongly recommended that consideration be given to identifying an alternate site for port development for this reason alone. If displaced, it is unlikely that the Cape fur seal colony would re-establish on adjacent low-profile rocky shore areas as these offer no shaded refugia, pools or protection from land-based predators. Female seals are likely to be disturbed by human activities associated with port construction, and may elect to avoid contact with humans to reduce the risk of conflict and are therefore unlikely to return to the breeding colony and their pups. This is supported by research showing that breeding and pupping harbour seals on the west coast of North America have been displaced by shellfish aquaculture activities (Becker et al. 2011). Potential mitigation in the form of an artificial haul-out area that could be constructed as part of the port development may offer a solution, however, there is a risk that such an initiative may fail.

Many anthropogenic activities and uses of the marine environment (including those likely to be associated with the development of a new port and SEZ at Boegoebaai) pose a serious risk to these already threatened seabirds. At least two species of seabird (Bank Cormorant *Phalacrocorax neglectus* and White breasted cormorants *Phalacrocorax lucidus*) are known to breed on the rocky cliffs at Boegoebaai Point (the identified site for the port breakwater). Other costal seabird species are known to breed on the rocky and mixed shore (e.g. African Black Oystercatcher *Haematopus moquini)* and sandy beach *(*White fronted plover *Charadrius marginatus*) habitats in the study area. Much care needs to be taken to ensure that these threatened marine and coastal birds are not overly disturbed by project activities.

It is important to note, that the two ecosystem types that border the Conservancy Area of the SEZ (see Figure 2-4.1) have been incorrectly labelled in the National Biodiversity Assessment. From our sampling sites, beach ISS1 (Intermediate Sandy Shore), which is located on a south-west facing shore (directly opposite the prevailing swell direction), should be classified as a reflective beach and beach RSS1 (Reflective Sandy Shore), which faces directly west, should be classified as an intermediate sandy shore. Although throughout the report we have maintained the original erroneous classification, as it appears in the NBA, for our Environmental Sensitivity Assessment, to avoid a misleading final sensitivity classification, we have assessed the ecosystems based on the site survey and *in situ* validation i.e., the reflective beach is actually intermediate and the macrofauna and *Tylos* sampling results in particular support this so their relative importance has been accounted for in our final classification.

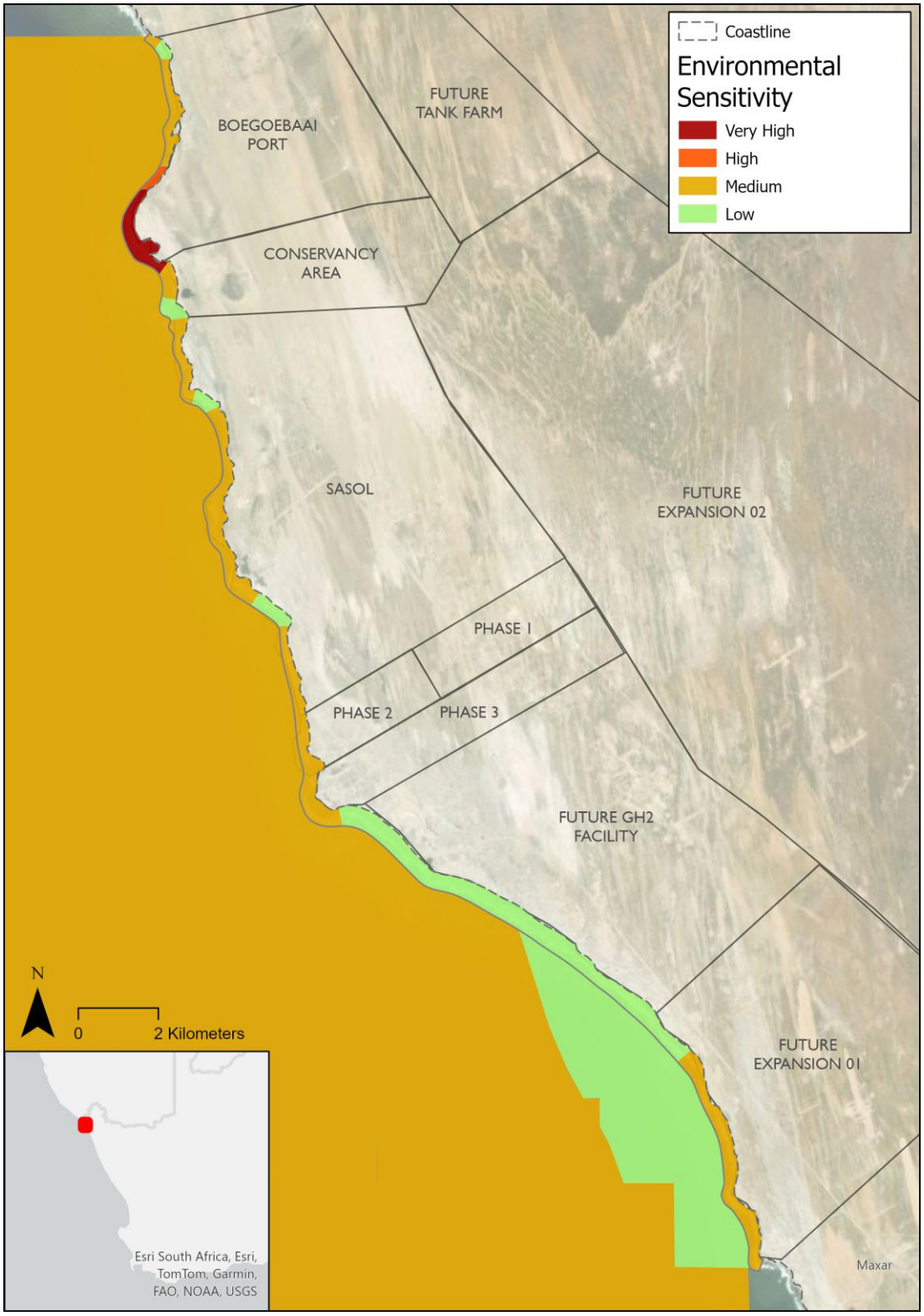


Figure 2-4.1. Marine and coastal Environmental Sensitivity Assessment of the Boegoebaai SEZ region.

2.5 ASPECTS AND IMPACT REGISTER

Consideration has been given to potential impacts the Boegoebaai development may have on the marine environment during the construction and operational phases of the project along with potential impacts from unplanned activities (e.g. increase in shipping traffic). These are summarised in Table 2-5.1 below.

Table 2-5.1. Summary of potential impacts on the marine environment associated with the Boegoebaai Port and SEZ.

Activity Phase	Activity	Aspect	Potential Impact
1. Construction	Building of breakwater, jetties and quays	Increase in underwater noise levels (construction/blasting/pile driving)	Physiological and behavioural effects on marine fauna
		Permanent loss of habitat and associated communities under breakwater and alteration of substrate type and associated communities through introduction of non-native rock	Changes in benthic and associated demersal communities in CBA1restore and ESA areas
			Falls within EBSA Impact Management Zone
			Overlap with coastal habitats assigned a threat status of "vulnerable' and nearshore habitats that are considered 'endangered
		Increased turbidity	Physiological and behavioural effects on marine fauna
		Routine discharges to sea from construction vessels/machinery and local reduction in water quality	Physiological effect on marine fauna
		Hindrance of alongshore movement of juvenile and adult fish in the surf zone	Effects on recruitment
		Changes in wave patterns and/or currents causing sand accumulation or erosion	Changes in longshore currents affecting littoral drift
		Disturbance of seals and destruction of seal colony	Displacement or mortality
	Capital dredging	Increased turbidity	Physiological and behavioural effect on marine fauna
		Remobilisation of contaminants in the sediments	Physiological effect on marine fauna and bioaccumulation risks
		Loss of unconsolidated habitat and associated communities	Disturbance and removal of benthic macrofauna in dredge footprint
			Disturbance and smothering of benthic fauna at spoils dump site
			Cascade effects on higher-order consumers
		Routine discharges to sea from construction vessels/machinery and local reduction in water quality	Physiological effect on marine fauna
	Installation of intake and discharge pipelines for RO Plant	Permanent loss of habitat under submerged intake and discharge pipelines	Loss of endangered Orange Cone Inner Shelf mud reef mosaic and vulnerable Namaqua exposed rocky shores ecosystem types
		Underwater noise levels (blasting)	Physiological and behavioural effects on marine fauna
			Physiological effect on marine fauna

Activity Phase	Activity	Aspect	Potential Impact
	General housekeeping during construction	Accidental spills, litter, sewage, run-off	Degradation of coastal environment
2. Operation Phase	Presence of vessels and operation of port	Increase in underwater noise levels	Physiological and behavioural effects on marine fauna
		Routine discharges to sea (e.g. deck and machinery space drainage, sewage and galley wastes) and local reduction in water quality	Physiological effect on marine fauna
	Lighting from port and vessels	Light emissions in marine environment	Disorientation and mortality of seabirds and marine mammals
			Attraction of plankton and increased risk to fish, turtles and cetaceans
	Increase in vessel traffic	Increase in underwater noise levels	Physiological and behavioural effects on marine fauna
		Increased risk of ship strikes	Injury or mortality of marine mammals/turtles
		Increased risk of vessel accidents and operational spills leading to reduction in water quality	Effects on faunal health (e.g. respiratory damage) or mortality (e.g. suffocation and poisoning)
			Physical damage to and mortality of benthic species / habitats
			Oiling of coastal habitats
	Maintenance dredging	Increased turbidity	Physiological and behavioural effect on marine fauna
		Remobilisation of contaminants in the sediments	Physiological effect on marine fauna and bioaccumulation risks
		Loss of unconsolidated habitat and associated communities	Disturbance and removal of benthic macrofauna in dredge footprint
			Disturbance and smothering of benthic fauna at spoils dump site
	Operation of RO Plant	Seawater intakes	Impingement and Entrainment
		Brine discharges	Physiological effect on marine fauna of RO Plant effluents
			Flow distortion around outlet
3. Unplanned Activities	Increase in vessel traffic	Increased risk of collision with marine fauna	Physiological and behavioural effects on marine fauna
	Accidental hydrocarbon spills / releases (e.g. vessel accident, bunkering and pipe rupture)	Loss of hydrocarbons to sea and reduction in water quality	Effects on faunal health (e.g. respiratory damage) or mortality (e.g. suffocation and poisoning)
			Physical damage to and mortality of benthic species / habitats
			Oiling of coastal habitats

2.6 SUMMARY & RECOMMENDATIONS

2.6.1 Physical environment

Aspects of the physical environment that are likely to influence the design, layout and implementation of this project are largely dealt with in the prefeasibility study report for the Boegoebaai Port prepared by PRDW (2015) and do not need to be reiterated here. Suffice is to say that the bathymetry of the coastline, or at least proximity of deep water close to the shore, is the primary factor from a physical environment perspective that will likely influence selection of a suitable location for the port. Boegoebaai Point is immently suitable in this respect (which it why it has been selected for this purpose) but there are a number of important marine ecological considerations that militate against the selection of this site as being suitable for port development (highlighted below). There are many other locations on the shoreline between the Orange River Mouth and Port Nolloth where the bathymetry profile of the shoreline is also likely to be suitable for port development that are not as sensitive from a biophysical perspective, which should be considered for this purpose.

2.6.2 Marine fauna and flora

According to the National Biodiversity Assessment (NBA), the Boegoebaai study area is positioned in the "Namaqua inshore" portion of the "Southern Benguela Ecoregion" (Sink et al. 2019a). The latter extends all along the western coast of southern Africa between Cape Agulhas and Lüderitz. Rocky intertidal habitat in this region comprises mainly of one habitat type (termed Namaqua Exposed Rocky Shore). A review of available literature on the area and field surveys conducted as part of this study suggests that there is a high overall similarity between communities in the Boegoebaai area and those that have been studied elsewhere on Exposed Rocky Shores in the Southern Benguela Ecoregion. None of the species present on the shore are listed as endangered, threatened or rare (ETP) species, although it must be said that few of these species have been subject to any formal assessment. It is important to note that the proposed development would significantly increase the amount of sheltered rocky shore habitat within the region to several times that of what currently exists within the inlets of Homewood Harbour and Peacock Bay (Figure 2-2.7). Such habitats are rare within the region and have been shown to host a completely different community of intertidal fauna and flora (Blamey & Branch 2009).

Three broad morphodynamic sandy-beach types are recognised worldwide: dissipative, intermediate and reflective, distinguished on the basis of interaction of wave energy, beach slope and sand particle size. All three major beach types exist in the Boegoebaai area, along with two intermediate types (e.g. dissipative-intermediate and reflective intermediate). Macrofaunal communities associated with beaches normally vary strongly in accordance with morphodynamic state but tend to be similar across beaches of similar types within the same ecoregion. Dissipative beaches usually support higher diversity, abundance and biomass of macrofauna than do intermediate beaches, while reflective beaches are generally most depauperate. Beaches in the study area all follow this general pattern but faunal communities were all depauperate relative to other beaches of similar morphodynamic state elsewhere in the Southern Benguela Ecoregion. This is likely a result of disturbance by diamond mining operations in the region, evidence of which can been seen throughout the area, but especially in the north. Little has been done in terms of identifying ETP beach macrofauna species but one species, the giant isopod *Tylos granulatus,* has been singled out as being important. The range of *T. granulatus* once extended across the whole southern African west coast from Swakopmund to Cape Point but has now been reduced to probably less than half that. More than two decades ago it was suggested that *T. granulatus* should be assigned red data status of perhaps 'Vulnerable' or 'Low Risk' (Brown 2000). Recent genetic research has uncovered high levels of population structure in southern African *T. granulatus* populations with two distinct lineages present on the west coast, to the north and south of a Hondeklip/Kleinzee break (Mbongwa et al. 2019). A recent, preliminary IUCN red list assessment supports the classification of *T. granulatus* as an endangered species under Criterion B due to its small natural habitat (sandy beaches, supratidal to low water mark only), declines in habitat quality, and fragmented populations as shown by the population genetics results (Linda Harris, Nelson Mandela Metropolitan University, pers. comm.). This species is very sensitive to disturbance, appears strongly photophobic and rapidly disappears as development encroaches, possibly due to alterations of beach state related to mining or light pollution. It is recommended that a range of sandy beach habitat types within the Boegoebaai area (away from the footprint of the proposed development) are earmarked for rehabilitation

and are afforded some form of protection going forward. Priority should be given to rehabilitation and conservation of dissipative beaches as these have the richest faunal communities.

Mixed shore ecosystems, which include any area of the shore that is not pure rock or pure sand, makes up a significant (almost one third) of the intertidal shoreline habitats in the Boegoebaai area. These habitats have been poorly studied in general and were not specifically surveyed in this study. Species present in these habitats are mostly also present in the pure sections of each component habitat type, but species richness on mixed shore can be higher due to increased habitat complexity and heterogeneity.

Surf zone habitats are located offshore of sandy beaches, extending from the low water mark out to the back of the breaker zone where they grade into more extensive unconsolidated soft bottom subtidal habitats. Despite their turbulent nature, surf zone habitats are an important nursery and feeding area for a range of marine fish and invertebrate species. Pilot seine net sampling undertaken in surf zone habitats in the Boegoebaai region revealed low species richness (only three species), none of which are listed as ETP species. These habitats are not considered particularly sensitive in the Boegoebaai area.

Fauna that inhabits nonconsolidated (soft bottom) subtidal areas include both epifaunal and infaunal organisms. On the west coast of South Africa, benthic infaunal assemblages are typically made up of (a) deposit feeders, such as worms, which either ingest sediments to extract organic matter trapped between the grains or actively gather organic detritus; (b) suspension feeders, such as sea pens and some crab species, which consume drifting detritus and plankton from the water column, and (c) filter feeders, including bivalves and certain amphipods and polychaetes, that actively pump and filter water to capture suspended particles (Castro & Huber 1997). Predators in these soft-bottom habitats either burrow through sediments to hunt prey or ambush prey on the surface. According to the NBA (Sink et al. 2019a), nonconsolidated (soft bottom) subtidal around Boegoebaai are listed as “endangered” due to the limited protection afforded to these areas through the formal protected area network, and threats from flow reduction in the Orange River and disturbance from diamond mining. Much of this habitat type in the study area is listed as CBA-Restore or ESA and thus should be subject to as little disturbance as possible.

Consolidated (or rocky) subtidal habitat is widespread in the study area. Rocky reefs in shallow waters (less than 20 m depth) support dense kelp forests comprising mostly *Ecklonia maxima* and *Laminaria pallida*. Other important species that inhabit rocky reefs in the study area include whelks, limpets, sea anemones, black mussel, red algae (*Rhodymenia* sp., *Gigartina* sp., and *Champia* sp.), encrusting coralline algae, crabs, chitons, spiny starfish, reticulated starfish, barnacles, and sea cucumbers. Rocky reef habitats near Boegoebaai are classified as Vulnerable due to limited protection afforded to these areas through the formal protected area network. Much of this habitat is listed as CBA-Restore or Ecological Support Area (ESA) and thus should be subject to as little disturbance as possible.

A total of 72 water birds has been recorded in the Boegoebaai study area. Many of these birds are classified as threatened by the IUCN, including five species of coastal seabirds (20%) and 15 pelagic seabird species (25%). Many anthropogenic activities and uses of the marine environment (including those likely to be associated with the development of a new port and SEZ at Boegoebaai) pose a serious risk to these already threatened seabirds. At least two species of seabird (Bank Cormorant *Phalacrocorax neglectus* and White breasted cormorants *Phalacrocorax lucidus*) are known to breed on the rocky cliffs at Boegoebaai Point (the identified site for the port breakwater). Other costal seabird species are known to breed on the rocky and mixed shores (e.g. African Black Oystercatcher, *Haematopus moquini*) and on sandy beaches (White Fronted Plover, *Charadrius marginatus*) habitats in the study area. Much care needs to be taken to ensure that these threatened marine and coastal birds are not unduly disturbed by project activities.

At least thirty-six marine mammals are likely to occur in the study area, including numerous cetacean species (whales and dolphins). This also includes a breeding population of Cape fur seal *Arctocephalus pusillus* at Boegoebaai Point (the proposed site for the port breakwater). Seals only recently (1991) started breeding at this site and the colony remains small (n = 107 pups counted in 2007) but is growing. In South Africa, seals are protected under the Sea Birds and Seals Protection Act 1973 which states that it is an offence to pursue, shoot, wilfully disturb, kill or capture any sea bird or seal unless duly authorised by the relevant authority. Construction of a breakwater and or port at Boegoebaai is likely to seriously disturb both the seal colony and breeding seabirds present at this site. It is strongly recommended that consideration be given to identifying an alternate site for port development for this reason alone. Impacts of the proposed development on cetaceans that utilise this area are likely to arise from increased vessel traffic i.e., noise and the associated increase in risk of ship-strikes.

The South African west coast is generally a highly productive area that supports a high biomass of marine biota and several important fisheries. Surprisingly though, few of these fisheries extend into the Boegoebaai area. The Northern Cape is also sparsely populated which means it is also not heavily utilised by small scale commercial, subsistence or recreational fishers. Demersal trawling, demersal longline and pelagic longlining, are practiced in the offshore water greater than 200 m depth, but the area is not considered particularly important for any of these fisheries. There is an abalone ranching concession area that extends from the just south of Alexander Bay to Port Nolloth, but the owner of this fishing right is not practicing any ranching at present. Neither activity is likely to be negatively affected by the proposed development at Boegoebaai.

2.6.3 Sensitivity

A large proportion of the coastal habitat of the Boegoebaai SEZ area is rated a **medium environmental sensitivity**, largely on account of the exposed and mixed rocky shore contributing to a large proportion of coastal habitat in this region. The rocky and mixed shore habitats near Boegoebaai are classified as Vulnerable due to biodiversity they support and limited protection afforded to these areas through the formal protected area network. Much of these habitats within the SEZ area listed as CBA-Restore, and should be subject to as little disturbance as possible.

In general, the Boegoebaai beaches that were surveyed in this study can be described as relatively high energy beaches. The large, dissipative sandy shore to the south of the concession area has the lowest level of environmental sensitivity in our assessment, rated as **low environmental sensitivity**.

The most sensitive area is around the headland within the proposed port precinct area of the SEZ on account of the cliffs and rocky headland, with sheltered coves, suitable for seal haul out. This area is also host to the roosting and nesting sites of a number of IUCN listed seabirds. The area is rated as of **very high environmental sensitivity** (this area includes a 300 m buffer to the north and south of the colony). It is strongly recommended that consideration be given to identifying an alternate site for port development. The options of relocating the breakwater to the north of the current site seem limited given the bathymetry of the area but there appear to be some options to the south of Boegoebaai Point. Potential areas have been identified in Figure 2-6.1 as areas to be considered as viable alternative areas based on their ecological sensitivity and their bathymetry profile immediately offshore which could accommodate the proposed breakwater. The areas identified are only approximate and this map should be used as high level guidance.

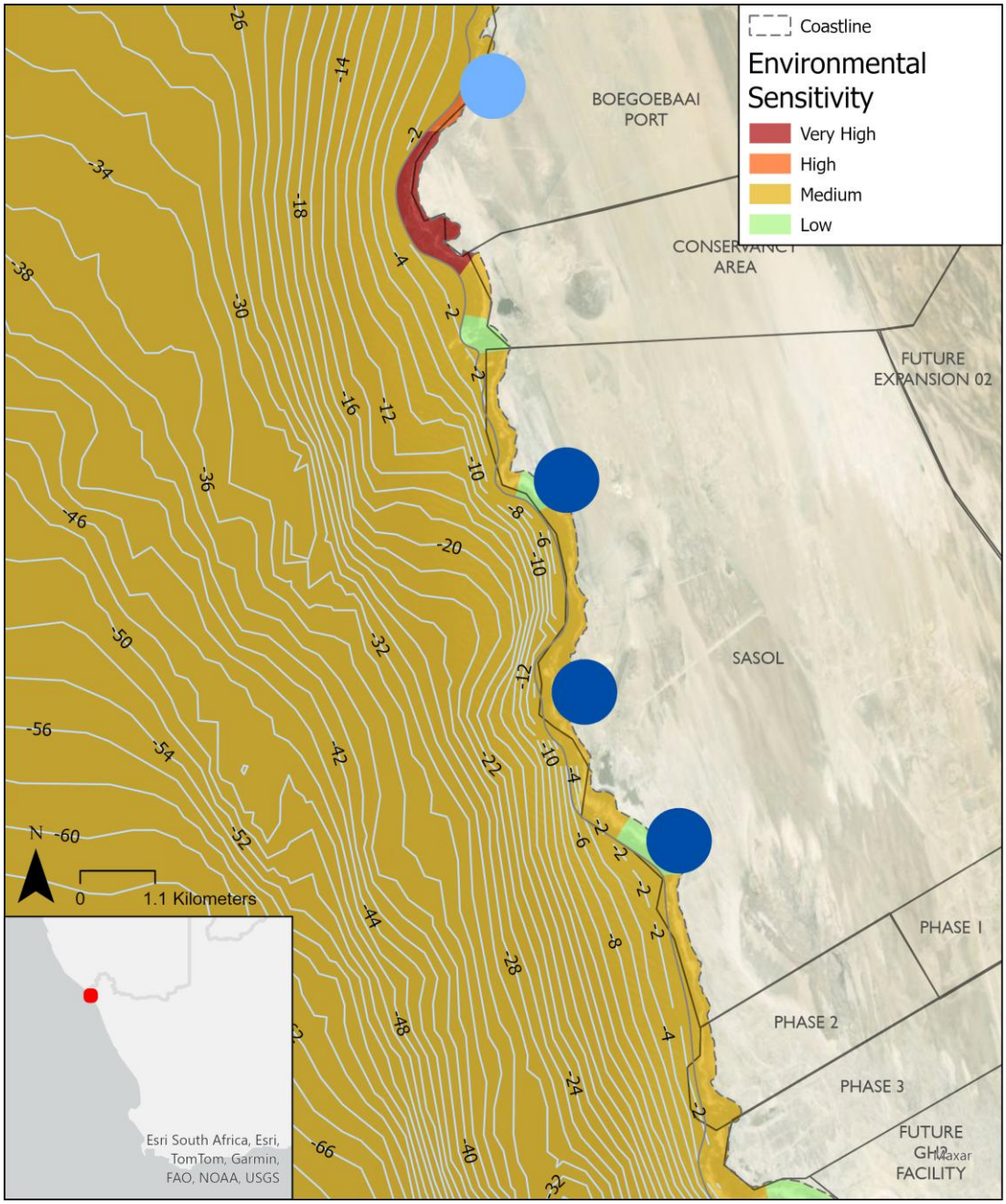


Figure 2-6.1. Potential sites (dark blue dot) and current proposed site (light blue dot) for the Boegoebaai breakwater location. 2 m resolution bathymetry contours and underlying sensitivity assessment is also displayed for guidance.

2.6.4 Offset and/or compensation requirements

As per the Draft Marine Biodiversity Sector Plan (2023), the development of new ports or harbours are considered **non-compatible** with CBA Natural and CBA Restore areas (Table 2-3.2). The environmentally preferable option would be to contrast the Boegoebaai port in an area not classified as CBA Natural or CBA Restore. However, complete avoidance or CBA Natural and/or Restore areas may not be feasible, as there are a plethora of small CBA Natural areas scattered all the way down the coast in the area under consideration in this study, and much of the offshore environment in the study area has been classified as CBA Restore (Figure 2-3.4). There is provision in Harris *et al.* (2022) that, should avoidance of identified CBA areas be deemed impossible, alternative CBAs and/or biodiversity offsets should be identified to meet targets for the same biodiversity features that are found at the site. This provision would be potentially

applicable in this instance, however, we do not feel that this should extend to development on Boegoebaai Point, which is an area that has been identified as being of very high sensitivity and is likely irreplaceable.

As per the National Biodiversity Offset Guidelines (2023), a biodiversity offset is defined as a "measurable outcome of compliance with a formal requirement contained in an environmental authorisation to implement an intervention that has the purpose of counterbalancing the residual negative impacts of an activity, or activities, on biodiversity, through increased protection and appropriate management, after every effort has been made to avoid and minimise impacts, and rehabilitate affected". However, the guideline is noted to only be applicable in the terrestrial and freshwater realms and is not applicable in the offshore marine realm and estuarine ecosystems. (No explanation is provided in the gazette notice as to why this is the case. The gazette notice does, however, state that this does not mean that biodiversity offsetting is not required for residual negative impacts on biodiversity in estuarine ecosystems and the marine realm).

Given the foregoing, we consider that deferring to the IFC biodiversity offset requirements have merit. As per the mitigation hierarchy specified in IFC Performance Standard 1, it is required that an "offset" be designated to compensate for direct impacts on delineated "Natural habitat[3]" as a result of the proposed development activities that cannot be abated or reduced at the source. As per IFC Performance Standard 6, *"biodiversity offsets are a set of actions with on-the-ground 'measurable conservation outcomes' that can balance significant residual biodiversity losses caused by the client's project only after appropriate avoidance, minimization and restoration measures have been applied, with equivalent biodiversity gains in terms of ecological characteristics ("like-for-like or better") and size of expected gains*". In other words, the decision to undertake a biodiversity offset cannot act as a replacement for mitigation and management measures to avoid significant impact.

The IFC Performance Standard 6 GN31 stipulates that two general types of offsets can be used to compensate for significant residual impacts:

- Restoration offsets, which are designed to remediate past damage to biodiversity (due to factors unrelated to the client's project) via rehabilitation or enhancement of biodiversity components (or even re-creation of ecosystems and their associated biodiversity values) at suitable offset sites; and,

- Protection or averted loss offsets protect biodiversity in an area demonstrated to be under threat of imminent or projected loss (due to factors unrelated to the client's project). Projections of the losses of biodiversity that will be averted by an offset require credible analysis of those trends. In some cases, this type of offset may not be appropriate where there is great uncertainty or there is a lack of stakeholder support for the analysis supporting those projections.

The main biodiversity offset design steps include:

1. Scoping, in consultation with relevant stakeholders, of potential conservation activities or offset sites within the landscape that could benefit the biodiversity values potentially impacted by the project (i.e., "like-for-like or better").

2. Assessing if the loss of biodiversity at the project site can be compensated by gains at the offset site.

3. Identifying means for securing offset activities over the long term, including, for example, legal protections.

4. Establishing an effective process for communities affected by the offset to participate in the design and implementation of the biodiversity offset.

[3] According to the IFC standards, "Natural habitats" are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition. This aligns well with the definition of CBA Natural areas which are defined as areas which must be safeguarded in their natural or near-natural state because they are critical for conserving biodiversity and maintaining ecosystem functioning.

5. Defining the specific offset activities and how they will be implemented in a biodiversity offset management plan, including the roles, responsibilities, and budget projections for the involved parties.

6. Establishing a funding mechanism to support the offset for as long as project impacts persist.

7. Designing a system for monitoring, evaluation, and adaptive management.

8. Ensuring that the project meets all applicable laws, regulations, and policies pertaining to biodiversity offsets.

Full consideration of a potential offset is beyond the scope of this study, but we strongly recommend that these steps be followed in identifying any offsets required to mitigate against negative impacts on any habitat identified as being CBA Natural or CBA restore on Figure 2-3.3.

2.7 REFERENCES

Alshahri F (2017) Heavy metal contamination in sand and sediments near to disposal site of reject brine from desalination plant, Arabian Gulf: Assessment of environmental pollution. Environ Sci Pollut Res 24:1821–1831.

Atkinson L, Sink K (2008) SANBI Biodiversity Series 10 User profiles for the South African offshore environment.

Badenhorst A (1988) Aspects of the South African longline fishery for kingklip Genypterus capensis and the Cape hakes Merluccius capensis and M. paradoxus. South African J Mar Sci 6:33–42.

Bally R (1987) The ecology of sandy beaches of the Benguela ecosystem. South African J Mar Sci 5:759–770.

Bally R, McQuaid CD, Brown AC (1984) Shores of mixed sand and rock: an unexplored marine ecosystem. S Afr J Sci 80:500–503.

Barendse J, Best PB, Thornton M, Elwen SH, Rosenbaum HC, Carvalho I, Pomilla C, Collins TJQ, Meÿer MA, Leeney RH (2011) Transit station or destination? Attendance patterns, movements and abundance estimate of humpback whales off west South Africa from photographic and genotypic matching. African J Mar Sci 33:353–373.

Barros F, Underwood AJ, Lindegarth M (2001) The influence of rocky reefs on structure of benthic macrofauna in nearby soft-sediments. Estuar Coast Shelf Sci 52:191–199.

Becker BH, Press DT, Allen SG (2011) Evidence for long-term spatial displacement of breeding and pupping harbour seals by shellfish aquaculture over three decades. Aquat Conserv Mar Freshw Ecosyst 21:247–260.

Berruti A (1980) Status and review of waterbirds breeding at Lake St Lucia. Lammergeyer 28:1–19.

Biccard A, Clark BM (2014a) Marine ecology specialist study and impact assessment for upgrades to seawater intake and transfer infrastructure at the Tronox Namakwa sands mine. Marine Specialist Study and Impact Assessment. Report prepared by Anchor Environmental Consultants (AEC) fo.

Biccard A, Clark BM (2014b) Zirco Roode Heuvel Mine, Northern Cape, South Africa. Marine Specialist Study and Impact Assessment. Report prepared by Anchor Environmental Consultants (AEC) for Coastal & Environmental Services.

Biccard A, Gihwala KN, Clark BM, Mostert BP, Brown E, Hutchings K, Massie V, Melidonis MC (2018) Desktop study of the potential impacts of marine mining on marine ecosystems and marine biota in South Africa – Final report. Report prepared by Anchor Research & Monitoring (Pty) Ltd for Council for Geoscience. Report no. 1795/1.

Biccard A, Hutchings K, Payne R, Malan A, Nashima P, Gammon E, Henry T, Schmidt K, Wright A, Clark BM (2024) Marine Baseline Study for WKN Benguela H2 Project, Doringbaai. Cape Town.

BirdLife South Africa (2024) Threatened seabird habitats in the South African Exclusive Economic Zone.

Blamey LK, Branch GM (2009) Habitat diversity relative to wave action on rocky shores: Implications for the selection of marine protected areas. Aquat Conserv Mar Freshw Ecosyst 19:645–657.

Blott SJ, Pye K (2001) GRADISTAT: a grain size distribution and statistics package for the analysis of unconsolidated sediments. Earth Surf Process Landforms 26:1237–1248.

Branch G, Branch M (2018a) Living Shores: Interacting with South Africa's Marine Ecosystems. Penguin Random House, South Africa, Cape Town.

Branch G, Griffiths CL, Branch M, Beckley L (2010) Two Oceans — a guide to marine life of South Africa. Random House Struik, South Africa.

Branch GM, Branch ML (2018b) Living Shores: Interacting With Southern Africa's Marine Ecosystems. Struik Travel & Heritage, Cape Town.

Branch GM, Griffiths CL (1988) The Benguela Ecosystem. Part V. The Coastal Zone. In: *Oceanography and Marine Biology Annual Review 26*. Barnes M (ed) Aberdeen University Press, p 395–486

Branch GM, Griffiths CL, Branch ML, Beckley LE (2022) Two Oceans – A Guide to the Marine Life of Southern Africa, Fifth Edit. Struik Nature.

Branch GM, Griffiths CL, Field JG (1988) Progress report to SEREF - December 1988: Monitoring the effects of new conservation areas in False Bay. Rondebosch, Cape Town.

Bridgeford PA (1982) New breeding locality data for southern African seabirds. Cormomnr

Brooke RK, Cooper J (1979) The distinctiveness of southern African Larus dominicanus (Aves: Laridae). Durban Museum Novit 12:27–37.

Brooke RK, Cooper J, Shelton PA, Crawford RJM (1982) Taxonomy, distribution, population size, breeding and conservation of the whitebreasted cormorant, Phalacrocorax carbo, on the southern African coast. Gerfaut 72:189-220.

Brouwer SL, Mann BQ, Lamberth SJ, Sauer WHH, Erasmus C (1997) A survey of the South African shore-angling fishery. South African J Mar Sci:165–177.

Brown A (2000) Is the sandy beach isopod Tylos granulatus an endangered species? S Afr J Sci 96:466.

Brown AC, McLachlan A (2002) Sandy shore ecosystems and the threats facing them: some predictions for the year 2025. Environ Conserv 29:62–77.

Brown AC, Odendaal FJ (1994) The Biology of Oniscid Isopoda of the Genus Tylos.Blaxter JHS, Southward AJBT-A in MB (eds) Academic Press, p 89–153

Brown AC, Stenton-Dozey JME, Trueman ER (1989) Sandy-beach bivalves and gastropods: A comparison between Donax serra and Bullia digitalis. Adv Mar Biol 25:179–247.

Brown AC, Wynberg RP, Harris SA (1991) Ecology of shores of mixed rock and sand in False Bay. Trans R Soc South Africa 47:563–573.

Bustamante RH, Branch GM, Eekhout S (1997) The influences of physical factors on the distribution and zonation patterns of South African rocky-shore communities. South African J Mar Sci 18:119–136.

Castro P, Huber M (1997) Life on the Continental Shelf. In: *Marine Biology*, 2nd ed. McGraw-Hill, p 460

Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies-Mostert HT (2016) The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Clabaut P, Davoult D (1989) Interaction between benthic macrofaunas and associated sediments of a high-energy subtidal zone. Example of Baie de Wissant, eastern English Channel. Comptes Rendus - Acad des Sci Ser II 308.

Clark BM (1997) Variation in surf-zone fish community structure across a wave-exposure gradient. Estuar Coast Shelf Sci 44:659–674.

Clark BM, Rees A, Hutchings K, Bovim LA, Dawson J, Malan A, Schmidt KM, Gammon E, Payne RP, Ho Y, Christensen Z, Biccard A, Rajeev H, Parker A, Conrad J, Wright A (2024a) The State of Saldanha Bay and Langebaan Lagoon. Anchor Environmental Consultants Report no. 2183.

Clark BM, Rees A, Hutchings K, Bovim LA, Dawson J, Malan A, Schmidt KM, Gammon E, Payne RP, Ho Y, Christensen Z, Biccard A, Rajeev H, Parker A, Conrad J, Wright A (2024b) The State of Saldanha Bay and Langebaan Lagoon.

Clark BM, Wright A, Rees A, Armitage M, Ho Y, Hutchings K, Bovim LA, Swart C (2023) The State of St Helena Bay 2023.

Cockcroft AC, Mackenzie AJ (1997) The recreational fishery for west coast rock lobster Jasus lalandii in South Africa. African J Mar Sci 18.

Cook TR (2015a) Bank Cormorant Phalacrocorax neglectus. In: *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland.* Taylor M, Peacock F, Wanless R (eds) BirdLife South Africa

Cook TR (2015b) Cape Cormorant Phalacrocorax capensis. In: *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland.* Taylor M, Peacock F, Wanless RM (eds) BirdLife South Africa

Cook TR, Crawford RJ, Hagen CT, Taylor MR (2015) Phalacrocorax coronatus. In: *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*. Taylor M, Peacock F, Wanless R (eds) BirdLife South Africa, Johannesburg, South Africa

Cooke SJ, Cowx IG (2006) Contrasting recreational and commercial fishing: Searching for common issues to promote unified conservation of fisheries resources and aquatic environments. Biol Conserv 128:93–108.

Cooper J (1981) Biology of the Bank Cormorant, Part 1: Distribution, Population Size, Movements and Conservation. Ostrich 52:208–215.

Cooper J, Brooke R, Shelton P, Crawford R (1982) Distribution, population size and conservation of the Cape cormorant Phalacrocorax capensis. Fish Bull South Africa 16:121–143.

Cooper J, Crawford RJM, Suter W, Williams AJ (1990) Distribution, Population Size and Conservation of the Swift Tern Sterna Bergii in Southern Africa. Ostrich 61:56–65.

Crawford RJM, Davis SA, Harding RT, Jackson LF, Leshoro TM, Meÿer MA, Randall RM, Underhill LG, Upfold L, Van Dalsen AP, Van Der Merwe E, Whittington PA, Williams AJ, Wolfaardt AC (2000) Initial impact of the Treasure oil spill on seabirds off western South Africa. South African J Mar Sci 22:157–176.

Crawford RJM, Dyer BM (1995) Responses by four seabird species to a fluctuating availability of Cape Anchovy Engraulis capensis off South Africa. Ibis (Lond 1859) 137:329–339.

Crawford RJM, Dyer BM, Cordes I, Williams AJ (1999) Seasonal pattern of breeding, population trend and conservation status of bank cormorants Phalacrocorax neglectus off south western Africa. Biol Conserv 1:49–58.

Crawford RJM, Makhado AB, Waller LJ, Whittington PA (2014) Winners and losers – responses to recent environmental change by South African seabirds that compete with purse-seine fisheries for food. Ostrich 85:111–117.

Crawford RJM, Makhado AB, Whittington PA, Randall RM, Oosthuizen WH, Waller LJ (2015) A changing distribution of seabirds in South Africa-the possible impact of climate and its consequences. Front Ecol Evol 3:126425.

Crawford RJM, Randall RM, Whittington PA, Waller L, Dyer BM, Allan DG, Fox C, Martin AP, Upfold L, Visagie J, Bachoo S, Bowker M, Downs CT, Fox R, Huisamen J, Makhado AB, Oosthuizen WH, Ryan PG, Taylor RH, Turpie JK (2013) South Africa's coastal-breeding white-breasted cormorants: population trends, breeding season and movements, and diet. African J Mar Sci 35.

Crawford RJM, Shelton PA, Brooke RK, Cooper J (1982) Taxonomy, distribution, population size and conservation of the crowned cormorant Phalacrocorax coronatus. Le Gerfaut 72:3–30.

Crawford RJM, Shelton PA, Cooper J, Brooke RK (1983) Distribution, population size and conservation of the Cape gannet Morus capensis. South African J Mar Sci 1:153–174.

Croxall JP (1984) Seabirds. Academic Press.

DAFF (2016) Status of the South African marine fishery resources 2016. Cape Town.

Davis-Reddy CL, Vincent K (2017) Climate Risk and Vulnerability: A Handbook for Southern Africa (2nd Ed), CSIR, Pretoria, South Africa.

Day JH (1974) A guide to marine life on South African shores. A.A. Balkema: Cape Town.

Dewenter J, Yong J, Schupp PJ, Lõhmus K, Kröncke I, Moorthi S, Pieck D, Kuczynski L, Rohde S (2023) Abundance, biomass and species richness of macrozoobenthos along an intertidal elevation gradient. Ecol Evol 13:1–20.

DFFE (2013) Description of the commercial seaweed sector. Available at: <https:// www.dffe.gov.za/sites/default/files/reports/descriptionofcommercial_ seaweedsector.pdf>.

DFFE (2021) National Framework for Marine Spatial Planning in South Africa. Cape Town, South Africa.

DHI (2017) MIKE C-MAP Extraction of World Wide Bathymetry Data and Tidal Information User Guide.

Dias MP, Martin R, Pearmain EJ, Burfield IJ, Small C, Phillips RA, Yates O, Lascelles B, Borboroglu PG, Croxall JP (2019) Threats to seabirds: A global assessment. Biol Conserv 237:525–537.

Dietrich KS, Fitzgerald SM (2010) Analysis of 2004-2007 vessel-specific seabird bycatch data in Alaska demersal longline fisheries.

Duna O, Clark BM, Biccard A, Hutchings K, Harmer R, Mostert BP, Brown E, Massie V, Makunga M, Dlaku Z, Makhosonke A (2016) Assessment of mining-related impacts on macrofaunal benthic communities in the Northern Inshore Area of Mining Licence Area MPT 25-2011 and subsequent recovery. Technical Report. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants (Pty) Ltd. Report no. 1646/1.

Eggleton J, Thomas K V. (2004) A review of factors affecting the release and bioavailability of contaminants during sediment disturbance events. Environ Int 30:973–980.

Fairweather TP, Booth AJ, Sauer WHH, Leslie RW (2006) Spatial description of hake-directed fishing activity off the west coast of South Africa. African J Mar Sci 28:13–24.

Findlay KP, Seakamela SM, Meÿer MA, Kirkman SP, Barendse J, Cade DE, Hurwitz D, Kennedy AS, Kotze PGH, McCue SA, Thornton M, Vargas-Fonseca OA, Wilke CG (2017) Humpback whale 'super-groups' - A novel low-latitude feeding behaviour of Southern Hemisphere humpback whales (Megaptera novaeangliae) in the Benguela Upwelling System. PLoS One 12:1–18.

Garner CJ (2013) Characterisation and biotic classification of Eastern Cape mixed substrate shores. Nelson Mandela Meteropolitan University

Grantham HS, Game ET, Lombard AT, Hobday AJ, Richardson AJ, Beckley LE, Pressey RL, Huggett JA, Coetzee JC, van der Lingen CD, Petersen SL, Merkle D, Possingham HP (2011) Accommodating dynamic oceanographic processes and pelagic biodiversity in marine conservation planning. PLoS One 6.

Griffiths CL, Van Sittert L, Best PB, Brown AC, Clark BM, Cook PA, Crawford RJM, David JHM, Davies BR, Griffiths MH, Hutchings K, Jerardino A, Kruger N, Lamberth S, Leslie RW, Melville-Smith R, Tarr R, Van Der Lingen CD (2004) Impacts of human activities on marine animal life in the Benguela: A historical overview. Oceanogr Mar Biol An Annu Rev 42:303–389.

Harris L (2012) An ecosystem-based spatial conservation plan for the South African sandy beaches. Nelson Mandela Metropolitan University

Harris L, Bessinger M, Dayaram A, Holness S, Kirkman S, Livingstone T-C, Lombard A, Lück-Vogel M, Pfaff M, Sink KJ, Skowno A, Van Niekerk L (2019a) Chapter 4: Coastal ecosystem types. In: *South African National Biodiversity Assessment 2018: Technical Report. Volume 5: Coast*. Harris LR, Sink KJ, Skowno AL, Van Niekerk L (eds) South African National Biodiversity Institute, Pretoria. http://hdl.handle.net/20.500.12143/6374

Harris L, Nel R, Schoeman D (2011) Mapping beach morphodynamics remotely: A novel application tested on South African sandy shores. Estuar Coast Shelf Sci 92:78–89.

Harris LR, Holness SD, Kirkman SP, Sink KJ, Majiedt P, Driver A (2022a) A robust, systematic approach for developing the biodiversity sector's input for multi-sector Marine Spatial Planning. Ocean Coast Manag 230:106368.

Harris LR, Holness SD, Sink KJ, Majiedt P, Driver A (2022b) National Coastal and Marine Spatial Biodiversity Plan, Version 1.2 (Released 12-04-2022): Technical Report. South Africa.

Harris LR, Sink KJ, Skowno AL, Van Niekerk L (eds) (2019b) South African National Biodiversity Assessment 2018: Technical Report. Volume 5: Coast. South African National Biodiversity Institute, Pretoria.

He P, Wardle CS (1986) Tilting behaviour of the Atlantic mackerel, Scomber scombrus , at low swimming speeds. J Fish Biol 29:223–232.

Hobday AJ, Pecl GT (2014) Identification of global marine hotspots: Sentinels for change and vanguards for adaptation action. Rev Fish Biol Fish 24:415–425.

Hockey PAR, Dean WRJ, Ryan PG (2005) Roberts Birds of Southern Africa. Trustees of the John Voelcker Bird Book Fund, Cape Town, South Africa.

del Hoyo J, Elliott A, Sargatal J (1996) Handbook of the birds of the world.

Huisamen J, Kirkman SP, Watson LH, Cockcroft VG, Pistorius PA (2011) Recolonisation of the Robberg Peninsula (Plettenberg Bay, South Africa) by Cape fur seals. African J Mar Sci 33:453–461.

Hutchings K, Schmidt KM (2024) Abalone Ranching Concession Area NC2 Stock Assessment Report.

Hutchings K, Schmidt KM, Clark BM (2024) Abalone Ranching Concession Area NC4 Stock Assessment Report.

Hutchings K, Schmidt KM, Dominy T (2023) Abalone Ranching Concession Area NC2 Stock Assessment Report.

Hutchings L, Beckley LE, Griffiths MH, Roberts MJ, Sundby S, Van der Lingen C (2002) Spawning on the edge: Spawning grounds and nursery areas around the southern African coastline. In: *Marine and Freshwater Research*. p 307–318

Hyland J, Balthis L, Karakassis I, Magni P, Petrov A, Shine J, Vestergaard O, Warwick R (2005) Organic carbon content of sediments as an indicator of stress in the marine benthos. Mar Ecol Prog Ser 295:91–103.

IUCN (2025) The IUCN Red List of Threatened Species. Version 2025-1. https://www.iucnredlist.org/

Jackson D, Short A (2020) Sandy beach morphodynamics. Jackson D, Short A (eds) Elsevier.

Jackson LF, Lipschitz S (1984) Coastal Sensitivity Atlas of Southern Africa. Dept. of Transport of the Republic of South Africa.

Japp DW (1989) Longlining in South Africa.

Johnston P, Egbebiyi TS, Zvobgo L, Omar SA, Cartwright A, Hewitson B (2024) Climate change impacts in South Africa: What climate change means for a country and its people.

Kemper J, Underhill LG, Crawford RJM, Kirkman SP, Rock B, Is S, Mandela N (2003) Chapter 42 Revision of the conservation status of seabirds and seals breeding in the Benguela Ecosystem. 325–342.

Kensley B (1974) Aspects of the biology and ecology of the genus Tylos Latreille. Ann South African Museum 65:401–471.

Kerwath SE, Parker D, Winker H, Potts W, Mann B, Wilke C, Attwood C (2019) Tracking the decline of the world ' s largest seabream against policy adjustments. Mar Ecol Prog Ser 610:163–173.

Kim S, Yang DS, Kim YS (2020) Distribution of metal contamination and grain size in the sediments of Nakdong River, Korea. Environ Monit Assess 192.

Kirkman S (2010) The Cape fur seal: monitoring and management in the Benguela current ecosystem. University of Cape Town

Kirkman SP, Costa DP, Harrison AL, Kotze PGH, Oosthuizen WH, Weise M, Botha JA, Arnould JPY (2019) Dive behaviour and foraging effort of female Cape fur seals Arctocephalus pusillus pusillus. R Soc Open Sci 6.

Kirkman SP, Hofmeyr G, Seakamela SM, Pistorius PA (2016) A conservation assessment of Arctocephalus pusillus pusillus. In: *The Red List of Mammals of South Africa, Swaziland and Lesotho*. Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies-Mostert HT (eds) South African National Biodiversity Institute and Endangered Wildlife Trust, p 1–9

Kirkman SP, Oosthuizen WH, Meÿer MA, Kotze PGH, Roux JP, Underhill LG (2007) Making sense of censuses and dealing with missing data: Trends in pup counts of Cape fur seal Arctocephalus pusillus pusillus for the period 1972-2004. African J Mar Sci 29:161–176.

Kirkman SP, Yemane D, Oosthuizen WH, Meÿer MA, Kotze PGH, Skrypzeck H, Vaz Velho F, Underhill LG (2013) Spatio-temporal shifts of the dynamic Cape fur seal population in Southern Africa, based on aerial censuses (1972-2009). Mar Mammal Sci 29:497–524.

Laird M, Hutchings K, Liebau V, Clark BM (2014) Marine Ecology Baseline Report for Proposed Abalone Aquaculture Farm at Brand-se-Baai, West Coast, South Africa. Prepared by Anchor Environmental Consultants for SRK Consulting. 37.

Laird MC, Clark BM (2018) Marine Environmental Impact Assessment for the Proposed Extension of Tormin Mine, West Coast, South Africa. Report no. 1743/3 prepared for SRK Consulting South Africa (Pty) Ltd.

Lamberth SJ, Drapeau L, Branch GM (2009) The effects of altered freshwater inflows on catch rates of non-estuarine-

dependent fish in a multispecies nearshore linefishery. Estuar Coast Shelf Sci 84:527–538.

Lewin WC, Arlinghaus R, Mehner T (2006) Documented and Potential Biological Impacts of Recreational Fishing: Insights for Management and Conservation. Rev Fish Sci 14:305–367.

Lombard AT, Strauss T, Harris J, Sink K, Attwood C, Hutchings L (2004) South African National Spatial Biodiversity Assessment 2004: Technical Report. Volume 4: Marine Component. Pretoria.

Mabille E, Prinsloo E, Mortensen NG, Hansen JC (2014) Wind Atlas for South Africa (WASA). Report on Measurements.

MacDonald WG, Rozendaal A (1995) The Geelwal Karoo heavy mineral deposit: a modern day beach placer. J African Earth Sci 21:187–200.

Maggs J, Parker D, Kerwath S, Attwood C, da Silva C, Winker H (2017) The 2017 assessment of Slinger (Chrysloblephus puniceus) for the South African linefishery.

Mann B (2013) Southern African Marine Linefish Species Profiles. Oceanographic Research Institution, Durban, South Africa, South Africa.

Mann BQ, McDonald AM, Sauer WHH, Hecht T (2003) Evaluation of participation in and management of the transkei shore linefishery. African J Mar Sci 25:79–97.

MARISMA EBSA Workstream (2020) Ecologically or Biologically Significant Marine Areas in the Benguela Current Large Marine Ecosystem: South Africa, Technical Report updated 2023. South Africa.

Maritz L (2020) Ecological role of mining pongs in Southern Coastal Mines, Namibia. Msc. Thesis, University of Cape Town

Marsh BA, Branch GM (1979) Circadian and circatidal rhythms of oxygen consumption in the sandy-beach isopod Tylos granulatus Krauss. J Exp Mar Bio Ecol 37:77–89.

Martinez-Garcia E, Carlsson MS, Sanchez-Jerez P, Sánchez-Lizaso JL, Sanz-Lazaro C, Holmer M (2015) Effect of sediment grain size and bioturbation on decomposition of organic matter from aquaculture. Biogeochemistry 125:133–148.

Mate BR, Best PB, Lagerquist BA, Winsor MH (2011) Coastal, offshore, and migratory movements of South African right whales revealed by satellite telemetry. Mar Mammal Sci 27:455–476.

Mbongwa NA, Hui C, Pulfrich A, Von Der Heyden S (2019) Every beach an island — deep population divergence and possible loss of genetic diversity in Tylos granulatus, a sandy shore isopod. Mar Ecol Prog Ser 614:111–123.

McIntyre AD (1971) Control factors on meiofauna populations. Thalass Jugosl 7:209–215.

McLachlan A (1980) The definition of sandy beaches in relation to exposure: a simple rating system. S Afr J Sci 76:137–138.

McLachlan A, Dorvlo A (2005) Global patterns in sandy beach macrobenthic communities. J Coast Res 21:674–687.

McLachlan A, Jaramillo E, Donn TE, Wessels F (1993) Geographical Comparison Communities and their Control by the Physical Environment : A Geographical Comparison. J Coast Res 15:27–38.

Mclachlan A, Sieben PR (1991) Growth and Production of Tylos Capensis Krauss, 1843 (Isopoda). Crustaceana 61:43–48.

McLachlan A, Wooldridge T, Dye AH (1981) The ecology of sandy beaches in southern Africa. South African J Zool 16:219–231.

McQuaid CD, Dower KM (1990) Enhancement of habitat heterogeneity and species richness on rocky shores inundated by sand. Oecologia 84:142–144.

Menge BA, Branch GM (2001) Rocky intertidal communities. In: *Marine Community Ecology*. Bertness M, Gaines S, Hay M (eds) Sinauer, p 221–251

Meyer W, Clark BM (1999) Description of the Environment of the South African West Coast Marine Diamond Mining

Concession ‘a’. Anchor Environmental Consultants report compiled for Sue Lane and Associates and Robin Carter for use in the compilation of Environmental Management Progr.

Monteiro PMS, Roychoudhury AN (2005) Spatial characteristics of sediment trace metals in an eastern boundary upwelling retention area (St. Helena Bay, South Africa): A hydrodynamic- biological pump hypothesis. Estuar Coast Shelf Sci 65:123–134.

Mostert BP, Biccard A, Duna O, Clark BM (2016) Baseline survey of the benthic marine environment in the South African diamond mining Concession areas: 1B and 1C. Report prepared for Alexkor and Placer Resource Management by Anchor Environmental Consultants (Pty) Ltd. Report no. 1696/1.

Nel P (2000) Physical and biological factors structuring sandy beaches macrofauna communities. Phd Thesis, University of Cape Town

Nel R, Pulfrich A, Penney AJ (2003) Impacts of Beach Mining Operations on Sandy Beach Macrofaunal Communities on the Beaches of Geelwal Karoo.

Van Niekerk L, Adams JB, Lamberth SJ, Mackay CF, Taljaard S, Turpie JK, Weerts SP, Raimondo DC (eds) (2019) South African National Biodiversity Assessment 2018: Technical Report. Volume 3: Estuarine Realm, CSIR repor. South African National Biodiversity Institute, Pretoria, Pretoria. Report Number: SANBI/NAT/NBA2018/2019/Vol3/A. http://hdl.handle.net/20.500.12143/6373.

Norman SJ, Wilkinson SJ, Japp DW, Reed J, Sink KJ (2018) A Review of Spatial Management in South Africa’s Offshore Fisheries. Unpublished Report. Cape Town, South Africa: Capricorn Marine Environmental (Pty) Ltd.

Odendaal FJ, Eekhout S, Brown AC, Branch GM (1999) Aggregations of the sandy-beach isopod, Tylos granulatus: adaptation or incidental-effect? South African J Zool 34:180–189.

Oksanen J, Simpson GL, Blanchet FG, Kindt R, Legendre P, Minchin PR, O’Hara RB, Solymos P, Stevens MHH, Szoecs E, Wagner H, Barbour M, Bedward M, Bolker B, Borcard D, Carvalho G, Chirico M, De Caceres M, Durand S, Evangelista HBA, FitzJohn R, Friendly M, Furneaux B, Hannigan G, Hill MO, Lahti L, McGlinn D, Ouellette MH, Cunha ER, Smith T, Stier A, Ter Braak CJF, Weedon J (2024) Package ‘vegan’: Community Ecology Package. CRAN:1–294.

Parker D, Winker H, Attwood CG, Kerwath SE (2016) Dark times for dageraad Chrysoblephus cristiceps: evidence for stock collapse. African J Mar Sci 38:341–349.

Penney AJ, Pulfrich A, Rogers J, Steffani N, Mabille E (2007) Project: BEHP/CEA/03/02: Data Gathering and Gap Analysis for Assessment of Cumulative Effects of Marine Diamond Mining Activities on the BCLME Region. Final Report to the BCLME mining and petroleum activities task group. March 2008.

Petersen SL (2008) Understanding and mitigating vulnerable bycatch in southern African longline and trawl fisheries. University of Cape Town

Pichegru L, Nyengera R, McInnes AM, Pistorius P (2017) Avoidance of seismic survey activities by penguins. Sci Rep 7:16305.

Popova E, Vousden D, Sauer WHH, Mohammed EY, Allain V, Downey-Breedt N, Fletcher R, Gjerde KM, Halpin PN, Kelly S, Obura D, Pecl G, Roberts M, Raitsos DE, Rogers A, Samoilys M, Sumaila UR, Tracey S, Yool A (2019) Ecological connectivity between the areas beyond national jurisdiction and coastal waters: Safeguarding interests of coastal communities in developing countries. Mar Policy 104:90–102.

PRDW (2015) Boegoebaai Port Prefeasibility Study FEL2: Phase1.

Pulfrich A (2018) Intertidal rocky-shore communities of the Namaqualand coastline.

Pulfrich A (2021) Proposed 3D Seismic Exploration in Block 1 off the West Coast of South Africa: Marine Faunal Specialist Assessment. Report prepared by Pisces Environmental Services (Pty) Ltd. for Environmental Impact Management Services on behalf of Tosaco Energy (Pty) L.

Pulfrich A, Hutchings K (2023) Consolidated Beach Monitoring Report: 2023 Sandy-Beach Macrofaunal Communities on the Sperrgebiet Coastline. Cape Town South Africa.

R Core Team (2025) A Language and Environment for Statistical Computing. R Found Stat Comput.

Rahmstorf S, Cazenave A, Church JA, Hansen JE, Keeling RF, Parker DE, Somerville RCJ (2007) Recent climate observations compared to projections. Science (80-) 316:709.

Ranasinghe R, Ruane A, Vautard R, Arnell N, Coppola E, Cruz F, Dessai S (2021) Climate change information for regional impact and for risk assessment. Chapter 12 of the IPCC Working Group 16th Assessment Report.

Rasehlomi T, Krug M, Myksvoll MS (2024) Larval anchovy and sardine dispersal patterns in South Africa's exclusive economic zone. Front Mar Sci 11:1508479.

Rees A, Wright A, Clark B (2022) Marine ecological screening analysis for proposed green hydrogen project, Boegoebaai, Northern Cape. Specialist Report no. 2053/5 prepared by Anchor Environmental Consultants (Pty) Ltd for WSP Group Africa (Pty) Ltd.

Robinson TB, Griffiths CL, Branch GM, Govender A (2007) The invasion and subsequent die-off of Mytilus galloprovincialis in Langebaan Lagoon, South Africa: Effects on natural communities. Mar Biol 152:225–232.

Romer GS (1990) Surf zone fish community and species response to a wave energy gradient. J Fish Biol 36:279–287.

Rouault M, Pohl B, Penven P (2010) Coastal oceanic climate change and variability from 1982 to 2009 around South Africa. African J Mar Sci 32:237–246.

Saayman M, Saayman A, Zeelie E, Potts W, Mann B, Weyl O, Van der Merwe P, Wood A, Raemeakers S, Cowlet P, Pledger J, Bova C, Scholtz M (2017) Economic significance of a recreational angling in South Africa.

Salas F, Marcos C, Neto JM, Patrício J, Pérez-Ruzafa A, Marques JC (2006) User-friendly guide for using benthic ecological indicators in coastal and marine quality assessment. Ocean Coast Manag 49:308–331.

SANBI (2018) National Biodiversity Assessment: The status of South Africa's ecosystems and biodiversity.

SAWS (2015) South African Weather Service; Annual Report 2015/16.

Short AD (2006) Australian beach systems - Nature and distribution. J Coast Res 22:11–27.

Short AD, Hesp PA (1982) Wave, beach and dune interactions in southeastern Australia. Mar Geol 48:259–284.

Siegfried WR, Williams AJ, Frost PGH, Kinahan JB (1975) Plumage and Ecology of Cormorants. Zool Africana 10:183–192.

Sink K, Attwood C, Lombard A, Grantham H, Leslie R, Samaai T, Kerwath S, Majiedt P, Fairweather T, Hutchings L (2011) Systematic planning to identify focus areas for offshore biodiversity protection in South Africa. Final Report for the Offshore Marine Protected Area Project. Cape Town, South Africa: Unpublished Report.

Sink KJ, van der Bank MG, Majiedt PA, Harris LR, Atkinson LJ, Kirkman SP, Karenyi NF (eds) (2019a) South African National Biodiversity Assessment 2018 Technical Report Volume 4: Marine Realm. South African National Biodiversity Institute, Pretoria.

Sink KJ, Harris LR, Skowno AL, Livingstone T, Franken M, Porter S, Atkinson LJ, Bernard A, Cawthra H, Currie J, Dayaram A, de Wet W, Dunga L V., Filander Z, Green A, Herbert D, Karenyi N, Palmer R, Pfaff M, Makwela M, Mackay F, van Niekerk L, van Zyl W, Bessinger M, Holness S, Kirkman SP, Lamberth S, Lück-Vogel M (2019b) Chapter 3: Marine Ecosystem Classification and Mapping. In: *South African National Biodiversity Assessment 2018 Technical Report Volume 4: Marine Realm*. Sink KJ, van der Bank MG, Majiedt PA, Harris LR, Atkinson LJ, Kirkman SP, Karenyi N (eds) South African National Biodiversity Institute, Pretoria

Sink KJ, Holness S, Skowno AL, Franken M, Majiedt PA, Atkinson LJ, Bernard A, Dunga L V., Harris LR, Kirkman SP, Oosthuizen A, Porter S, Smit K, Shannon L (2019c) Chapter 7: Ecosystem Threat Status. In: *South African National Biodiversity Assessment 2018 Technical Report Volume 4: Marine Realm*. Sink K, van der Bank MG, Majiedt PA, Harris LR, Atkinson LJ, Kirkman SP, Karenyi N (eds) South African National Biodiversity Institute, Pretoria

SLR (2021) Basic Assessment for a Prospecting Right Application for South African Sea Areas 4C and 5C, West Coast, South Africa. Prepared by SLR Consulting (South Africa) (Pty) Ltd for De Beers Marine (Pty) Ltd on behalf of De Beers Consolidated Mines (Pty) Ltd. SLR.

Smith CE, Brown AC, Branch GM (1999) A Comparison Between Macrofaunal Communities on Mixed Shores and Rocky

and Sandy Shores in False Bay. MSc Thesis, University of Cape Town

Soares AG (2003) Sandy beach morphodynamics and macrobenthic communities in temperate, subtropical and tropical regions: a macroecological approach. PhD Thesis, University of Port Elizabeth

Soares AG, McLachlan A, Schlacher TA (1996) Disturbance effects of stranded kelp on populations of the sandy beach bivalve Donax serra (Röding). J Exp Mar Bio Ecol 205:165–186.

Soares AG, Schlacher TA, McLachlan A (1997) Carbon and nitrogen exchange between sandy beach clams (Donax serra) and kelp beds in the Benguela coastal upwelling region. Mar Biol 127:657–664.

Stephenson TA, Stephenson A (1972) Life between tidemarks on rocky shores. W. H. Freeman.

Stephenson TA, Stephenson A, Du Toit CA (1937) THE SOUTH AFRICAN INTERTIDAL ZONE AND ITS RELATION TO OCEAN CURRENTS. Trans R Soc South Africa 24:341–382.

Stevens MA, Boness DJ (2003) Influences of habitat features and human disturbance on use of breeding sites by a declining population of southern fur seals (Arctocephalus australis). J Zool 260:145–152.

Stevenson D, Chiarella L, Stephan D, Reid R, Wilhelm K, McCarthy J, Pentony M (2004) Characterization of the fishing practices and marine benthic ecosystems of the northeast U.S. shelf, and an evaluation of the potential effects of fishing on essential fish habitat. NOAA Tech Memo NMFS-NE-181.

Steyn E, Groeneveld JC, Santos J, Kruger A, Mselegu XI, Schleyer MH (2019) Trends in a recreational fishery for mussels in eastern South Africa, based on postal, telephone and online surveys. Ocean Coast Manag 179.

Summers RW, Cooper J, Pringle JS (1977) Distribution and numbers of coastal waders (Charadrii) in the southwestern Cape, South Africa, summer 1975–76. Ostrich 48:85–97.

Sweijd N (1998) The potential of abalone (Haliotis midae) seeding in South Africa. Chapter from PhD Thesis. University of Cape Town, South Africa.

Sydeman WJ, Thompson SA, Anker-Nilssen T, Arimitsu M, Bennison A, Bertrand S, Boersch-Supan P, Boyd C, Bransome NC, Crawford RJM, Daunt F, Furness RW, Gianuca D, Gladics A, Koehn L, Lang JW, Logerwell E, Morris TL, Phillips EM, Provencher J, Punt AE, Saraux C, Shannon L, Sherley RB, Simeone A, Wanless RM, Wanless S, Zador S (2017) Best practices for assessing forage fish fisheries-seabird resource competition. Fish Res 194:209–221.

Tritan Survey (2018) Boegoeberg Hydrographic Survey. Report NO. 9501.1.

Tunley KL (2016) Permission granted to use macrofauna and sediment data from 2014. University of Cape Town

Underhill LG, Cooper J, Waltner M (1980) The status of waders (Charadrii) and other birds in the coastal region of the southern and eastern Cape, summer 1978/79. West Cape Wader Study Gr.

Underhill LG, Whitelaw DA (1977) An ornithological expedition to the Namib Coast: summer 1976/77. Cape T West Cape Wader Gr:106.

Urban EK, Fry CH, Keith S (1986) The Birds of Africa., Volume II. Academic Press, London.

De Waal S, Cook P (2001) Quantifying the physical and biological attributes of successful ocean seeding sites for farm-reared juvenile abalone (Haliotis midae). J Shellfish Res 20:857–861.

De Waal SWP (2004) Stock assessment, Port Nolloth Sea Farms abalone (Haliotis midae) ranching project.

Warwick RM (1993) Environmental impact studies on marine communities: Pragmatical considerations. Aust J Ecol 18:63–80.

Watson JJ, Kerley GIH, McLachlan A (1997) Nesting habitat of birds breeding in a Coastal Dunefield, South Africa and management implications. J Coast Res 13:36–45.

Watson JW, Kerstetter DW (2006) Pelagic longline fishing gear: a brief history and discussion of research efforts to improve selectivity and sustainability. Mar Technol Soc J 40:5–10.

Wetlands International (2023) The Source: 2023 Annual Review Wetlands International.

Whittington PA, Ford RJMC, Martin AP, Randall RM, Brown M, Ryan PG, Dyer BM, Harrison KHB, Huisamen J, Makhado AB, Upfold L, Waller LJ, Witteveen M (2016) Recent Trends of the Kelp Gull (Larus dominicanus) in South Africa. Waterbirds 39:99–113.

Winker H, Kerwath SE, Attwood CG (2014) Report on age-structured stock assessments and the simulation of the impact of various fisheries management options for the South African linefishery. Cape Town, South Africa.

Wolfaardt AC, Williams AJ, Underhill LG, Crawford RJM, Whittington PA (2009) Review of the rescue, rehabilitation and restoration of oiled seabirds in South Africa, especially African penguins Spheniscus demersus and Cape gannets Morus capensis, 1983–2005. African J Mar Sci 31:31–54.

Wright L, Short A (1984) Morphodynamic variability of surf zones and beaches: a synthesis. Mar Geol 56:93–118.

Young IR, Ribal A (2019) Multiplatform evaluation of global trends in wind speed and wave height. Science (80-) 364:548–552.

CHAPTER 3

Terrestrial and Aquatic Ecology

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Terrestrial and Aquatic Ecology

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Recommended citation: Van Rooyen, G., Van Rooyen, N., Van Wyk, P., Day., L., Froneman, A., Colyn, R., Oosthuizen, M., Loftie-Eaton, M., Marais., W. & Niemandt, C. (2025). *Chapter 3: Terrestrial and aquatic ecology* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR

Executive Summary

This chapter on Aquatic and Terrestrial Ecology is an integration of the (i) Aquatic; (ii) Avifaunal; (iii) Bat; (iv) Mammal, Reptile and Amphibian; as well as (v) Vegetation and Flora components assessed and reported on in free-standing reports that are provided as Supplementary Material to this chapter.

Aquatic ecology

The aquatic ecology report, based mainly on a desktop review of available literature and spatial mapping products, with limited time for ground-truthing/calibration of mapped wetland areas, highlights the importance and sensitivity of the inland and estuarine aquatic ecosystems on and in the vicinity of the proposed Boegoebaai Port and Special Economic Zone (SEZ).

- Overall, the assessment showed that the study area is not rich in inland aquatic ecosystems, however, those that do occur are likely to be of **Very High** importance for terrestrial fauna. The ephemeral pans are assumed to support rare aquatic invertebrate communities, including crustacean zooplankton fauna, with potentially high levels of regional endemism. The larger pans (Visagiespan, Rietfontein and Rietfonteinpan) afford substantial wetland and pan habitat, with links to primary and/or secondary aquifers, which form springs (e.g. Visagiespan), creating permanent standing water pools. These are utilised by wildlife, either directly as a brackish to saline water source or indirectly, for grazing of wetland plants. Other inland aquatic ecosystems of assumed **High** biodiversity and conservation importance include ephemeral pans (rock pools) in rocky outcrops, some of which are likely to support invertebrate communities adapted to ephemeral conditions and of high conservation importance.

- The National Wetland Map (V5) classified all mapped inland aquatic ecosystems on site as depressions. Larger pans belong to the Namaqualand Sandveld Bioregion with depressions rated as **Critically Endangered (CR).**

- There are no estuaries on site. However, two estuarine systems lie in close proximity and could potentially be affected by impacts associated with the proposed development.

    - (i) The Orange River Estuary flows into the sea between Alexander Bay and Oranjemund. This estuary comprises an almost permanently open river mouth; a 2–3 m deep tidal basin; a braided channel system; and a severely degraded saltmarsh. It is a rare and unusual wetland type on the arid coastline of southern Africa, deriving its flows from a large catchment that begins in the Lesotho Highlands. The estuary is both nationally and internationally important, having been accorded Ramsar Wetland status. The condition of this estuary falls short of its Recommended Ecological Category, requiring active interventions to improve estuarine condition. New developments e.g. the Boegoebaai Port and SEZ that, directly or indirectly, threaten its condition, would have direct negative implications for meeting the estuary's Resource Quality Objectives.

    - (ii) The Holgat River enters the sea just south of the study area. It is ephemeral and classified as a micro-outlet, with river flows rarely passing into the estuarine area. The outlet has been highly modified by mining operations.

The main report findings indicate that the proposed development would result in the potential loss of all inland aquatic ecosystems identified in the study area. Of these, natural pans and depression are rated as **CR** systems in the 2018 National Biodiversity Assessment. The report thus recommends that the development layout must **avoid** these systems. It furthermore recommends the inclusion of ecological corridors that link important terrestrial, coastal and inland aquatic areas across the site. The site sensitivity map (see section 6.1) indicates the natural depressions as having a **Very High** sensitivity and the artificial

wetlands as having a **High** sensitivity. Buffer zones around the depressions were allocated a Medium sensitivity.

Mitigation measures include addressing potential impacts such as concentrated stormwater flows, which could bypass dependent aquatic ecosystems or result in downstream erosion or blockages of flows in flood conditions. Other mitigation measures address indirect impacts due to expansion of urban areas, such as the need for upgrading solid waste management. The report further recommends that, if the development were approved, it would need to allow for increased human and financial resources at the Orange River Estuary to control and police fishing, grazing, hunting and vehicle access and movement within the estuary, including its saltmarshes. In addition, it would need to match any provision of fresh water from desalination plants to any communities/urban areas with an equal increase in infrastructure and human resource capacity to treat the additional wastewater to a level that would not impact negatively on any receiving watercourse, and the Orange River Estuary in particular.

The report highlighted some **information gaps** that would need to be addressed if the proposed project is considered further. These include (i) detailed studies to unpack surface/groundwater linkages driving the larger pan and associated wetland function and structure in the Visagiespan, Rietfontein and Rietfonteinpan systems; (ii) identification and refined mapping of key temporary pan habitat in rocky outcrops; (iii) wet-season assessment of ephemeral wetland invertebrate faunal communities; (iv) development of detailed stormwater management plans; and (v) details on measures to address impact avoidance, mitigation and management outlined in the report.

The aquatic report concluded that that there are no positive impacts to inland or estuarine aquatic ecosystems that would be associated with the proposed Boegoebaai Port and SEZ development, and substantial negative impacts could accrue, unless stringently addressed in development layout (avoidance), design and management.

Terrestrial ecology

Fauna: Avifauna

To assess the avifaunal sensitivity of the broader area, various data sets were used to compile sensitivity layers for each Species of Conservation Concern (SCC). The layers were ranked according to endemicity, conservation status and fine-scale habitat suitability to develop a four-tier sensitivity map.

The Second Southern African Bird Atlas Project (SABAP2) has recorded 87 bird species in the broader area. Of the 87 bird species, 47 are considered priority species where priority species are defined as South African Red List species (SCC); South African endemics, near-endemics or range-restricted species; waterbirds; raptors; and species vulnerable to disturbance and/or habitat loss. Of the 87 bird species recorded in the broader area, 13 species were selected for further assessment. This selection includes SCC as well as endemics, near-endemics to South Africa or range-restricted species.

Although the region does not host a wide diversity of birds, it is home to the range-restricted regional subspecies of the dune lark (*Calendulauda erythrochlamys patae;* previously classified as the **NT** Barlow's lark *Calendulauda barlowi*). The sheltered bays and dune fields along the coast could provide suitable habitat for the **CR** Damara tern *(Sterna balaenarum),* while freshwater pans and estuarine habitats along the coast could support various species of conservation concern, including the **VU** curlew sandpiper *(Calidris ferruginea);* **VU** great white pelican (*Pelecanus onocrotalus);* **VU** Caspian tern *(Sterna caspia);* **NT** Eurasian curlew (*Numenius arquata);* and **NT** greater flamingo (*Phoenicopterus roseus).* Suitable habitat is also present on site for the **EN** black harrier (*Circus maurus);* **EN** Ludwig's bustard (*Neotis ludwigii);* endemic Cape long-billed lark (*Certhilauda curvirostris);* and near-endemic jackal buzzard (*Buteo rufofuscus).* The site could potentially also support the **EN** martial eagle *(Polemaetus bellicosus)* and **VU** Lanner falcon (*Falco biarmicus*).

Broad mitigation measures to be considered with all new developments include the avoidance of known large raptor nests and sensitive, core breeding habitats to reduce the impact on reproduction, feeding and roosting of avifauna. In addition, powerlines should be fitted with bird flight diverters to reduce the risk of collisions with this infrastructure.

From an avifaunal perspective the Boegoebaai Port and SEZ development site exhibits predominantly **Medium** and **High** sensitivity (see section 6.2). All proposed developments within the Port and SEZ should incorporate an avifaunal specialist study.

Fauna: Bats

The bat report was based mainly on a desktop review of available literature with the sensitivity map based partially on satellite imagery and partially on ground-truthing during a brief site visit. The sensitivity map considers man-made structures, habitat alterations and natural terrain features that are likely to offer roosting and foraging opportunities for bat species. The predominantly desktop assessment on bats concluded that there are no fatal flaws from a bat sensitivity perspective which should prevent the proposed development from proceeding towards the Environmental Impact Assessment process.

Based on literature sources, ten (10) bat species have previously been recorded in the area or may occur in the region. One of these species has a regional **NT** status (2016) and three species had a **NT** status in the 2004 listing. The Angolan wing-gland bat (*Cistugo seabrae*) (regional **NT**) may roost in buildings, the Holgat ravine or the Boegoeberg Twins. The sensitivity map (see section 6.3) showed important foraging and roosting sites for bats as having a **Very High** sensitivity; temporal water sources as a **High** sensitivity; and areas where livestock aggregate as Medium sensitivity.

The most prominent impacts on bats were: (i) light pollution affecting light averse bat species and creating artificial foraging habitats; (ii) possible bat mortalities or injuries due to hot steam/water discharge at the water-cooling tower blowdown; and (iii) foraging and roosting habitat destruction. Of these impacts, light pollution is the most significant. However, if the water-cooling towers are equipped with exposed radiator designs, acute and high bat mortality impacts may occur. A bat specialist should be consulted on the intended design of the water-cooling towers. Mitigation measures proposed include (i) keeping artificial lighting on infrastructure to a minimum, while still adhering to safety and security requirements; (ii) closing up water-cooling radiators with a mesh/grid with a diameter of 10 mm or less, to prevent bats and other wildlife from taking refuge inside radiator spaces; and (iii) adhering to the bat sensitivity map should adequately mitigate against habitat and roosting habitat destruction.

Fauna: Mammals, reptiles and amphibians

The desktop fauna assessment on mammals, reptiles and amphibians is based on secondary data sources, including GIS mapping, literature reviews and biodiversity databases, which inherently present spatial and temporal limitations.

The proposed Boegoebaai Port and SEZ site includes habitats of ecological importance, characterised by critical biodiversity features and a diversity of faunal SCC. The area encompasses **CR** ecosystems such as the Richtersveld Coastal Duneveld and Namib Seashore Vegetation. These habitats host unique fauna, some of which are highly specialised and endemic to the region. Species such as the **CR** De Winton's golden mole (*Cryptochloris wintoni*), **VU** Grant's golden mole (*Eremitalpa granti granti*) and the **VU** desert rain frog (*Breviceps macrops*) rely on specific sandy habitats for survival. Overall, the faunal community includes a diverse array of mammals, reptiles and amphibians, comprising 10 SCC consisting of four mammal, five reptile and one amphibian species. Among the mammal SCC, the brown hyaena (*Parahyaena brunnea*) has been confirmed on site, while De Winton's golden mole and Grant's golden mole (*Eremitalpa granti granti*) have a high likelihood of occurrence. Notable representatives among the reptiles are the Namaqua dwarf adder (*Bitis schneideri*) and Namib web-footed gecko (*Pachydactylus rangei*) that have both been confirmed on site. The only amphibian SCC, the desert rain frog, has also been

confirmed on site. These species underscore the ecological significance of the area and highlight the potential risks posed by habitat loss and disturbance.

The site sensitivity map (see section 6.4) applied a **Very High** sensitivity to the CR ecosystems (Richtersveld Coastal Duneveld and Namib Seashore Vegetation) and other unique features as well as areas providing suitable habitat for some SCC. Remaining habitat of the saline depressions; Western Gariep Plains Desert; corridors connecting coastal and inland habitats and areas included in the NPAES were rated as **Medium to High** sensitivity.

Habitat loss and alteration are noteworthy concerns, particularly for species relying on the specialised dune ecosystems that are vulnerable to disturbance by construction and operational activities. The ecosystems on site provide critical ecological services, including supporting rare and endemic species, stabilising sandy substrates and maintaining biodiversity corridors. Fragmentation of habitats due to infrastructure development, such as roads, pipelines and buildings, can restrict species movement, disrupt breeding patterns and isolate populations. These impacts are especially critical for fossorial species, such as moles and reptiles, that depend on undisturbed sandy habitats. Disturbance from increased human activities such as noise, light pollution and dust could have long-term implications for biodiversity.

During construction, impacts are expected to be most severe due to the direct transformation of natural ecosystems, specifically, activities that disturb nocturnal and crepuscular species. Additionally, roadkill by increased traffic presents a tangible threat to slow-moving species e.g. tortoises and frogs. The operational phase may see reduced activity, but residual impacts from wind erosion and alien plant invasions may persist unless mitigated effectively.

A suite of mitigation measures aimed at minimising ecological harm were identified. **Avoiding** development in areas of **Very High** sensitivity, such as the remnants of **CR** ecosystems which support fauna SCCs, is a primary recommendation. Strategic site selection can help protect key habitats while maintaining biodiversity corridors. During the construction phase, minimising vegetation clearance, implementing species-specific conservation actions and avoiding sensitive periods for breeding and foraging can reduce impacts. To reduce roadkill, speed limits and wildlife crossings should be established on access roads. Noise and light pollution can be mitigated by limiting construction hours and using directional lighting to minimise spillover into natural areas. Rehabilitation plans should focus on re-establishing native vegetation and stabilising disturbed soils to prevent erosion. Mitigation strategies should include training programs for staff to minimise inadvertent impacts on fauna and promoting community involvement in conservation initiatives.

Information gaps of the faunal assessment include the underrepresentation of cryptic or nocturnal species and the limited resolution of habitat maps for site-specific assessments. To address these limitations, targeted field surveys are recommended to validate findings and refine sensitivity maps. These surveys should focus on confirming the presence of SCC and updating ecological data to ensure accuracy and comprehensiveness. No invertebrates were assessed.

Vegetation and Flora

The assessment of the vegetation and flora was based mainly on a desktop review of available literature and spatial mapping products followed by a reconnaissance site visit. The site hosts many features indicating priority habitat for biodiversity conservation, e.g. (i) two **CR** ecosystems, the Richtersveld Coastal Duneveld and the Namib Seashore Vegetation; (ii) habitat to **CR** plant species (*ca*. eight spp. some still being re-assessed); (iii) large areas classified as **irreplaceable CBA 1s** or **optimal CBA 2s**; (iv) portions included in the **National Protected Area Expansion Strategy** (NPAES); (v) inclusion into an internationally recognised **Key Biodiversity Area** (KBA); and (vi) the close proximity of the **CR** Namib Lichen Fields. From a vegetation and flora perspective the major source of impacts from the proposed development will result directly or indirectly from vegetation clearance with the associated habitat loss and transformation which will lead to the loss of the priority features mentioned above.

A large proportion of the site was previously mined and the vegetation in these mined areas has been transformed. Furthermore, mine-induced sand plumes cover large sections of land. These transformed habitats, west of the R382, could be used for the proposed development provided that areas of priority habitat are not negatively impacted by the development. The level of infestation by alien invasive plant species on site is currently low.

The Screening Tool rated the sensitivity of the Plant Theme[1] as Medium based on the presence of model-derived suitable habitat for threatened and/or rare species (see section 6.5). The current assessment recommends an upscaling of the Plant Theme to **Very High** due to the presence of 46 SCC on site and ca. 75% of the site having a **Very High** sensitivity (Figure S.1a). The current assessment supported the Screening Tool's **Very High** sensitivity of the Relative Terrestrial Biodiversity Theme (75%; Figure S.1b). During the planning phase, areas of **Very High** sensitivity should be **avoided**, and as far as possible also areas of **High** sensitivity. Habitat loss in areas of **Very High** sensitivity, i.e. irreplaceable biodiversity value, is unacceptable as this may compromise the ability to meet conservation targets and furthermore, residual impacts on irreplaceable biodiversity cannot be offset and compensation would not be feasible according to EWT (2023).

Information gaps relating to the vegetation and flora include the lack of comprehensive point data for SCC and a detailed baseline vegetation map of the proposed site. As a priority, it is strongly recommended that the current coarse-scale vegetation and sensitivity maps are refined to inform the planning and layout of the Boegoebaai Port and SEZ. Considering the large areas with a **Very High** sensitivity rating, it would be prudent to conduct an in-depth, fine-scale analysis of the vegetation as soon as possible (before the EIA phase) to produce a detailed vegetation map that could be used to plan the layout of the port and SEZ in order to avoid placing footprints in areas that could potentially not receive Environmental Authorization.

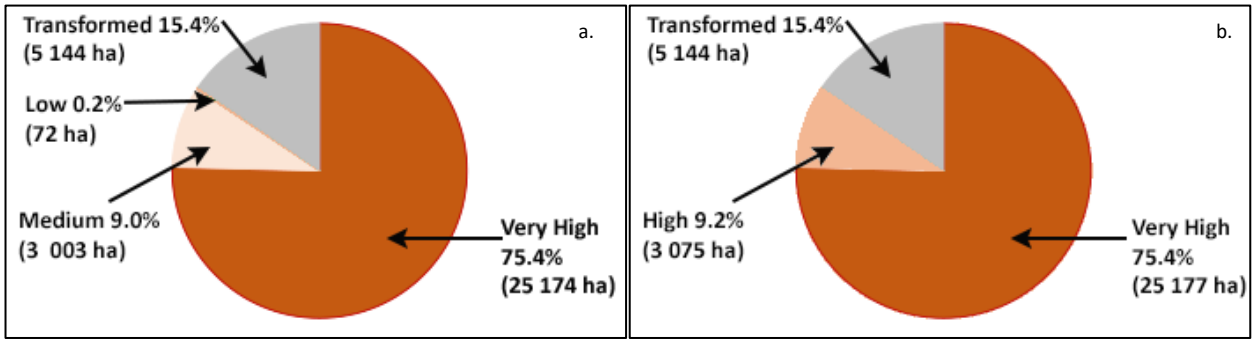


Figure S.1: Areas covered by the various sensitivity classes as assessed during the current evaluation of (a) the Plant Theme (High sensitivity is too small to indicate in the figure and covers 0.01% of the total area = 3 ha) and (b) the Relative Terrestrial Biodiversity Theme.

Overall, the integrated terrestrial and aquatic ecology report concludes that:

- The potential benefits of the Boegoebaai development must be evaluated against the irreversible loss of fauna and flora diversity and ecosystem services.
- The aquatic assessment contended that the proposed development has no positive impacts and substantial negative impacts could accrue, unless addressed in layout (avoidance), design and management.
- The high-level plant and animal theme assessments demonstrated large areas of **High to Very High** sensitivity.

[1] Theme refers to each of the environmental and planning spatial datasets contained in the Screening Tool. The Plant Theme considers the plant Species of Conservation Concern (SCC).

- The current high-level evaluation of the site demonstrated a **Very High** sensitivity for the Relative Terrestrial Biodiversity Theme. The findings of this assessment highlight the importance of adopting a precautionary approach, balancing economic objectives with the preservation of ecological integrity.

- In section 6.6 the site sensitivity maps of all the Aquatic and Terrestrial assessments were integrated using the maximum rule, i.e. the highest sensitivity overrides the lower sensitivities. According to the integrated sensitivity map most of the proposed development site has a **Very High** sensitivity.

- Transformed habitats, west of the R382, could be used for the proposed development provided that areas of priority habitat are not negatively impacted by the development.

- Monitoring will be essential to assess how effective mitigation measures are and to ensure long-term ecological sustainability. A full monitoring programme should be development during the EIA phase.

- While mitigation can reduce some risks, it cannot eliminate irreversible loss of critical habitats and species, where **avoidance** is the only option.

- Sand stabilisation will be crucial to avoid negative impacts on threatened ecosystems further north. The use of geotextiles or chemical approaches should be investigated.

- Hyper-arid areas are very difficult to revegetate/rehabilitate successfully. A rehabilitation specialist, with West Coast expertise, should be consulted for advice on techniques and species that could potentially be used.

- There is a risk that inadequate rehabilitation during decommissioning could leave behind a degraded and vulnerable ecosystem.

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Abbreviations and Acronyms

Acronym	Explanation
AIS	Alien Invasive Species
ADU	Animal Demography Unit
AOO	Area of Occupancy
CBA	Critical Biodiversity Area
CITES	Convention on International Trade in Endangered Species
CR	Critically Endangered
CSIR	Council for Scientific and Industrial Research
DD	Data deficient
DFFE	Department of Forestry, Fisheries and the Environment
DAERL	Department of Agriculture, Environmental Affairs, Rural Development and Land Reform
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EN	Endangered
EOO	Extent of Occurrence
ESA	Ecological Support Area
EWT	Endangered Wildlife Trust
GIS	Geographic Information System
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act (107/1998)
NEM:BA	National Environmental Management: Biodiversity Act (10/2004)
NEM:PAA	National Environmental Management: Protected Areas Act (57/2003)
NFA	National Forest Act (84/1998)
NFEPA	National Freshwater Ecosystem Priority Areas
NHS	National Heritage Site
NPAES	National Protected Area Expansion Strategy
NT	Near Threatened
NWM	National Wetland Map
ONA	Other Natural Area
PA	Protected Area
PAOI	Project Area of Influence
SABAP2	Second Southern African Bird Atlas Project
SACAD	South African Conservation Areas Database
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SAPAD	South African Protected Areas Database
SCC	Species of Conservation Concern
SEA	Strategic Environmental Assessment
SKEP	Succulent Karoo Ecosystem Programme
TNPA	Transnet National Ports Authority
ToPS	Threatened or Protected Species Regulations (2013)
TOR	Terms of Reference
VU	Vulnerable
WHS	World Heritage Site

CHAPTER 3. TERRESTRIAL AND AQUATIC ECOLOGY

3.1 INTRODUCTION

3.1.1 Background

Energy is one of the most carbon-intensive sectors in South Africa and to reduce global warming a radical change in energy production and consumption is needed. Hydrogen produced from renewable sources is termed "green hydrogen (GH_2)" and could potentially provide an opportunity to decarbonise the South African energy economy while also generating revenues, creating jobs and developing skills. As part of South Africa's drive to become a player in the globally emerging GH_2 market, an ambitious programme of greenfield infrastructure has been proposed in the Northern Cape.

The production of GH_2 at the scale envisaged could have multiple direct and indirect impacts, including on local economies, infrastructure, communities and natural ecosystems and resources. In order to consider these potential impacts, the Council for Scientific and Industrial Research (CSIR) has been appointed to undertake an independent Strategic Environmental Assessment (SEA). The overarching purpose of the SEA is to develop an integrated decision-making framework to guide the planning of the proposed Boegoebaai Port, Special Economic Zone (SEZ) and wider Namakwa region in a sustainable manner (Schreiner *et al.,* 2024).

The Boegoebaai Port and SEZ, i.e. the study site, covering 33 500 ha (Figure 3-1), in the Northern Cape has been proposed to advance South Africa's GH_2 strategy. The conceptual layout of the project site, which is to be assessed for Work Package 1 includes the Port precinct (Zones 1 & 2) at 3 357 ha and the SEZ at 30 143 ha (Zones 3 – 10). A phased approach has been proposed for constructing the infrastructure and facilities for the Boegoebaai Port and SEZ.

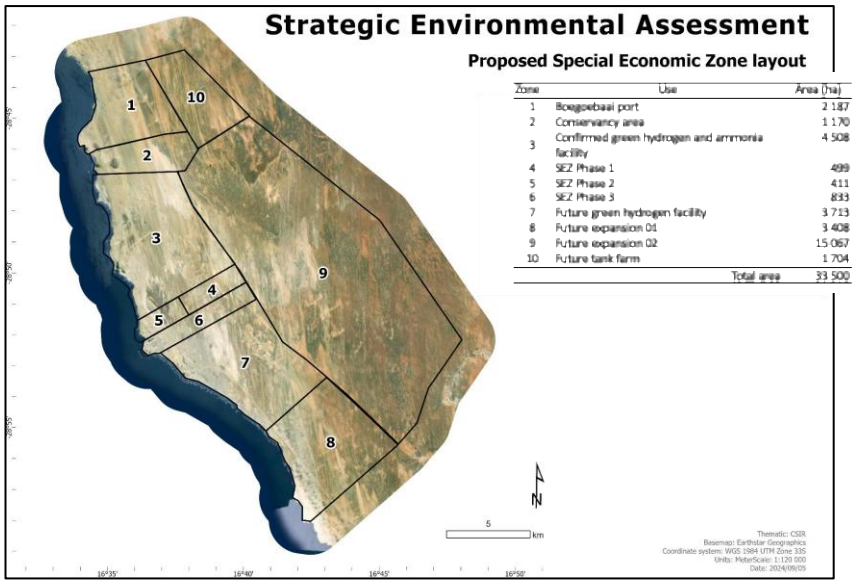


Figure 3-1**:** The layout of the Boegoebaai Port and Special Economic Zone (source: Schreiner *et al.,* 2024).

This chapter on Aquatic and Terrestrial Ecology is an integration of the (i) Aquatic; (ii) Avifaunal; (iii) Bat; (iv) Mammal, Reptile and Amphibian; as well as (v) Vegetation and Flora components assessed and reported on in free-standing reports that are provided as Supplementary Material to this chapter.

3.1.2 Assumptions, limitations and uncertainties

The **aquatic report** is a broad-based, primarily desktop assessment, based on existing mapped data and available reports with no new biophysical data collected, other than once-off water quality data, of limited value.

- The assessment relied on existing watercourse and estuary maps, included in the NFEPA and NWM (V5) datasets. These data are useful to inform broad conservation planning, but have not been ground-truthed sufficiently for high-confidence information for detailed development planning. This is a noteworthy limitation since the mapped extent of watercourses in the above datasets is not necessarily accurate.

- Although the current extent of most watercourses is discernible from aerial imagery, floodplain extent for major storm events is unknown.

- This report was not informed by a project-specific geohydrological report, which would have increased the confidence with which surface/groundwater interactions could be reported. Geohydrological reports for the Alexkor Mining area (Mavurayi, 2014) did not comment in any detail on groundwater interactions with any of the wetlands and/or springs within the current study area.

The **avifaunal study** assumed that the sources of information used in the report are reliable and noted the following:

- The focus of the study is primarily on the potential impacts of the development on priority species which were defined as: South African Red List species (SCC); South African endemics, near-endemics or range-restricted species; waterbirds; raptors; and species vulnerable to disturbance and/or habitat loss.

- The assessment of impacts is based on the baseline environment as it currently exists at the development site and nearby surrounding environment.

- Conclusions are based on experience of these and similar species in different parts of South Africa. Bird behaviour can however, never be entirely reduced to formulas that will be valid under all circumstances.

- The broader area refers to the area covered by 20 SABAP2 pentads within which the proposed site is located.

The **bat report** mentioned that distribution maps of South African bat species still require further refinement, and thus if a species has a known distribution proximal to the site, it was assumed to occur in the area. The sensitivity map is based partially on satellite imagery and one site visit. There is always the possibility that what has been mapped may differ slightly to what is on the ground.

Using secondary data for the **mammals, reptile and amphibian** desktop assessment in a remote region, involves several limitations and assumptions that can impact the reliability and applicability of the findings.

- Available secondary data might not cover all habitats or especially lesser-studied or cryptic species.

- Historical data lack recent trends on population dynamics due to environmental changes.

- Full coverage of the 33 500 ha area is constrained in the databases, particularly in remote areas.

- The scale of secondary data may not align with the finer resolution required for site-specific assessments.

- Habitat or species distribution maps may not accurately reflect microhabitats present in the area.

- Static datasets do not capture migration or seasonal variations in species distribution.
- Secondary data may overrepresent certain areas or species due to researcher interest or accessibility.
- Surveys may exclude nocturnal, fossorial or migratory species, leading to underrepresentation.
- Secondary data often lack behavioural, ecological or physiological context to assess impacts on fauna.
- Inconsistencies of data due to data collection methods, accuracy and sampling effort across studies.
- It is assumed that ecological and environmental conditions have remained fairly stable since data collection.
- A risk-averse and cautious approach is applied to take into account the limits of current knowledge.

The **botanical assessment (vegetation and flora)** is a screening-level, predominantly desktop assessment, aimed at identifying potential, botanically related environmental sensitivities based on existing spatial data. The predominantly desk-top approach used here was regarded as adequate for the purpose of an SEA.

- No detailed fieldwork was done and limited raw data were collected and analysed. Species records were obtained from P. van Wyk and supplemented by existing databases. However the entire site has not been intensively sampled or surveyed in the past because of the limited access to the mining area.
- The site visit was conducted from 31 August - 3 September 2024 which is normally the most favourable time of year for botanically related field work in the Succulent Karoo Biome and winter-rainfall Desert Biome. Most of the Richtersveld as well as the current assessment area suffered from an extreme drought from 2011 to 2022 (peak in 2019) which killed many plants and entire populations. Recovery may take many years and it is likely that the complete species pool was not present in 2024. Furthermore, the low rainfall during the winter of 2024 was not ideal for annual and geophytic plant species.
- Sensitivity ratings were applied per plant community due to a lack of point data covering the entire area.
- Because many of the plant communities are large, the current analysis and mapping of sensitive features is at a broad scale and many small or localised features were not mapped.

Disclaimer 1: The final update on the red list status of all plant species was on 18 December 2024 following data supplied by SANBI. At the time of finalising this report (20 May 2025) no further updates of the red list status of plant species had been received. The final red list status update for the animal species supplied by SANBI was 7 May 2025. We kindly acknowledge SANBI for the use of their data. This work forms part of the Boegoebaai Strategic Environmental Assessment (CSIR project EEMS086). The scientific material for this publication was developed through a collaborative effort involving various stakeholders and datasets contributed by the South African National Biodiversity Institute.

Disclaimer 2: This report is based on the 2016 Northern Cape Critical Biodiversity Areas map available from the Biodiversity GIS website. The 2024 Northern Cape CBA map has undergone several revision, but at the time of finalising this report (20 May 2025) Version 3 was not yet publicly available on SANBI BGIS.

3.2 RESEARCH APPROACH AND METHODOLOGY

This section outlines the methodology used to conduct the Terrestrial and Aquatic Ecology SEA detailing the steps taken to develop an integrated decision-making framework to guide the planning of the proposed development.

3.2.1 Approach

The findings of the **aquatic** assessment were based mainly on a desktop review of available literature and spatial mapping products, with limited ground-truthing. The study area was visited in early summer, when pans and other watercourses would not be expected to be inundated. The purpose of the site visit was to ground-truth the presence, rough extent and type of wetlands indicated in the 2018 NBA data (Van Deventer *et al.,* 2019).

The (i) bird, (ii) bat, (iii) mammal, reptile and amphibian assessments were desktop studies relying on available databases and distribution maps. The bat assessment was supported by an on-site visit.

The **vegetation and flora** assessment commenced as a desktop study, followed by a reconnaissance site visit to undertake a screening level site sensitivity evaluation to ground-truth the Screening Tool's environmental sensitivity as provided by the DFFE. No provision was made for a detailed survey of the vegetation in the scope of work.

3.2.2 Data Sources

A full list of the data sources is provided in the individual specialist reports and is not repeated here:

- **Inland and estuarine aquatic ecology; Supplementary material 1:** Day, L. 2025. Strategic Environmental Assessment for the proposed Boegoebaai Port and Strategic Economic Zone, Northern Cape, South Africa, Work Package 1: Aquatic Ecosystems Assessment – Inland Aquatic Ecosystems and Estuaries.

- **Fauna: Avifauna; Supplementary material 2:** Froneman, A., Colyn, R., Oosthuizen, M. & Loftie-Eaton, M. 2025. Strategic Environmental Assessment for the proposed Boegoebaai Port and Strategic Economic Zone (SEZ): Avifaunal Specialist Assessment.

- **Fauna: Bats; Supplementary material 3:** Marais, W. 2025. Bat Specialist Assessment for the Strategic Environmental Assessment of the Proposed Boegoebaai Port and SEZ (Special Economic Zone), Northern Cape, South Africa.

- **Fauna: Mammals, reptiles and amphibians; Supplementary material 4:** Niemandt, C. 2025. Strategic Environmental Assessment (SEA) for the Proposed Boegoebaai Port and SEZ: Fauna Desktop Assessment.

- **Vegetation and Flora:**

    - **Supplementary material 5a:** Van Rooyen, G., Van Rooyen, N. & Van Wyk, P. 2025. Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone, Northern Cape, South Africa: Vegetation and Flora Component.

    - **Supplementary material 5b:** Van Wyk, P. 2025. Boegoebaai Strategic Environmental Assessment: Exploring the floral richness of the Boegoebaai Port development site and surrounding areas, Richtersveld Municipal Area, Western Gariep Desert, Northern Cape, South Africa.

3.2.3 Methodology

Aquatic: Inland aquatic habitats were mapped using the 2018 NBA data (Van Deventer *et al*., 2019). Ground-truthing eliminated a few of these wetlands while adding some others. In total, 16 inland aquatic habitats were mapped, these included three major pan systems, some smaller wetlands and a few artificial scrapes or depressions. Runoff from steep, rocky areas, where rainfall is likely to run as multiple fast flows or trickles to the sand below, were mapped as the entire rocky structure and the area immediately surrounding it, as far as visible runnels extend.

Fauna - Avifauna: Bird distribution data from the SABAP2 was obtained to ascertain which species occur in the pentads where the proposed Boegoebaai development is located. A target species list was generated by assessing SABAP2, BirdLasser citizen science data and intersecting species distribution models with a 5 km buffer around the proposed site. This assessment of all available data yielded a priority list of 13 threatened and/or endemic avian species that were included in the analysis. A weighted sensitivity model was used for all 13 SCC identified. Data input to the model included: a species distribution model (SDM) for each SCC; nest sites; confirmed species presence (BirdLasser®, tracking data, SABAP2); freshwater body/aquatic ponding GIS layer; and habitat suitability models.

Fauna - Bats: The site was evaluated by considering man-made structures, surface rock (possible roosting space), topography (influencing surface rock in most cases), climate (can influence insect numbers), and presence of surface water and drainage areas (influences insects and acts as a source of drinking water) to identify habitats that may be frequently used by bat species. These considerations principally involved studying the literature, available satellite imagery and vegetation descriptions. One site visit was conducted on 18 February 2025 to obtain an understanding of the environmental setting of the site. Google Earth satellite imagery and verification during the site visit were used to spatially demarcate areas on site with **Very High, High** and **Medium** sensitivities relating to bat species ecology and habitat preferences. The map considers man-made structures and habitat alterations (such as dams), as well as natural terrain features that are likely to offer roosting and foraging opportunities for bat species found in the broader area. With regards to hydrology features, a distinction was made between permanent and seasonal water sources.

Fauna - Mammals, reptiles, amphibians: The study adopted a spatially focused assessment to ensure high-resolution environmental sensitivity mapping. To generate an expected species list, observation data in iNaturalist, the Global Biodiversity Information Facility (GBIF), the Virtual Museum (VM of ADU) of African Mammals, Frog Atlas of southern Africa and Reptile Atlas of Africa were sourced. Existing data layers were incorporated into QGIS to establish how the proposed development would interact with important terrestrial features. Emphasis was placed on the following spatial datasets: Vegetation Map of South Africa, Lesotho and Swaziland (SANBI, 2012–2024); Northern Cape Critical Biodiversity Areas (2016); National Protected Area Expansion Strategy (NPAES, 2018); Red List of Ecosystems (RLE) (NEMBA, 2022; SANBI, 2022); Protected and Conservation areas of South Africa (SAPAD; SACAD). The study design integrated spatial data from existing surveys and secondary sources into GIS; literature review; and collaboration with fauna specialists. No on-site fauna assessments were undertaken but based on habitat and vegetation descriptions, key habitats for fauna could be described. Coupled with secondary data collection, sensitive areas were mapped for SCC.

Vegetation and flora: A provisional checklist for the proposed development site was generated from data collected by P. van Wyk (Van Wyk, 2025; Supplementary Material 5b); the current site visit in August/September 2024; iNaturalist; SANBI NewPOSA database; and data supplied by SANBI (2024). Prior to the site visit a satellite image of the site was stratified into homogeneous terrain/vegetation units or habitats and as many of these units as feasible were visited during the site visit. Fieldwork was limited to recording the most prominent plant species at 37 sites spread across the study area. Floristic data of these sites were classified into groups of associated species representing plant communities on site. To allocate a sensitivity rating to a plant community, the presence of plant species of conservation concern (SCC); CR ecosystems; presence of CBAs; and the occurrence within the NPAES were assessed.

3.3 DESCRIPTION OF THE RECEIVING ENVIRONMENT

The Boegoebaai Port and SEZ site is located in the Namaqualand District, Richtersveld Local Municipality, on the West Coast in the northwestern corner of the Northern Cape province, approximately 18 km south

of the small mining town of Alexander Bay. For a full description of the receiving environment see Day (2025), Froneman *et al*., (2025), Niemandt (2025), Van Rooyen *et al.* (2025) in the supplementary material. A brief summary of the outstanding features is provided below.

3.3.1 Abiotic environment

3.3.1.1 Climate

According to the Köppen-Geiger climate classification both Alexander Bay and Port Nolloth have a BWk climate i.e. a cool, desert climate with a winter rainfall. The mean annual rainfall at Alexander Bay is 80 mm. The aridity of this coastal area can be ascribed to the South Atlantic anticyclone and the cold Benguela current. There is a general decrease in rainfall from south to north along the West Coast, with a concomitant increase in the unreliability of the rainfall.

Most of the Richtersveld, as well as the current Boegoebaai assessment area, suffered an extreme drought from 2011 to 2022. The year 2019 was the peak of this longest and most intense drought recorded in the Richtersveld since 1902.

A distinctive feature of the desert climate on site is the occurrence of fog. The sea fog results from the advection of relatively warm moist air over the cold water of the Benguela-upwelling zone (Olivier, 2002). The extent of this upwelling zone varies seasonally and depends on prevailing climatic conditions. The highest fog day frequency is found at the coast and there is a decrease with distance from the sea. The fog supplements the meagre rainfall in the region and is a more reliable source of moisture than rainfall (Gottlieb *et al.,* 2019). Heavy dew further supplements the rainfall.

The area experiences strong winds that cause dust and sand storms with associated erosion of topsoil material and sandblasting, which has a destructive effect on the vegetation. This destructive wind action is particularly prominent in areas where the vegetation has been degraded and is sparse (Desmet, 1996). Hot, dry eastern berg winds with associated sand storms, cause a rapid increase in temperature and have a desiccating effect on the vegetation.

3.3.1.2 Inland and estuarine aquatic environment

There are no major drainage lines on site. The Orange River is the only perennial river in the region and is located approximately 20 km north of the site. The Holgat River lies approximately 2 km south of the site and is ephemeral, flowing only after high rainfall events mostly occurring in its upper catchment, which is remote from the coast. Other drainage lines and watercourses within the study area peter out and dissipate into the sands, with no surface outlets into the sea. Neither the Orange River estuary nor the Holgat River estuary are on site.

The study area lies wholly in the Department of Water and Sanitation (DWS)'s quaternary catchment F10C, within the Coastal Orange sub-Water Management Area (Sub-WMA), which is nested within the Lower Orange Water Management Area. The Coastal Orange sub-WMA does not drain into the Orange River, but drains west towards the coastline by way of multiple ephemeral watercourses. According to the ecoregional classification of South African rivers (Kleynhans *et al.,* 2005) the study site falls entirely within the Western Coastal Belt Ecoregion.

There are no Freshwater Ecosystem Priority Areas (FEPAs) or Strategic Water Source Areas (SWSAs) within the study area with the closest SWSA (groundwater) south of the study area. FEPAs are strategic priority subcatchments that are needed for conserving freshwater ecosystems and supporting the sustainable use of water resources (Driver *et al*., 2011). River FEPA ratings assign levels of conservation importance to rivers, associated with requirements for protection, rehabilitation and/or management of aquatic resources.

Data from the National Biodiversity Assessment (NBA) of aquatic ecosystems (Figure 3-2; Van Deventer *et al*., 2019) classify all aquatic ecosystems within the study area as part of the Namaqualand Sandveld Bioregion. Furthermore, all the inland aquatic ecosystems mapped were classified as wetland depressions

(Ollis *et al.,* 2013) and are referred to as Namaqualand Sandveld Bioregion Depressions. Within the Namaqualand Sandveld Bioregion, depressions (including pans) have been rated as **Critically Endangered (CR)** with a protection status of Not Protected.

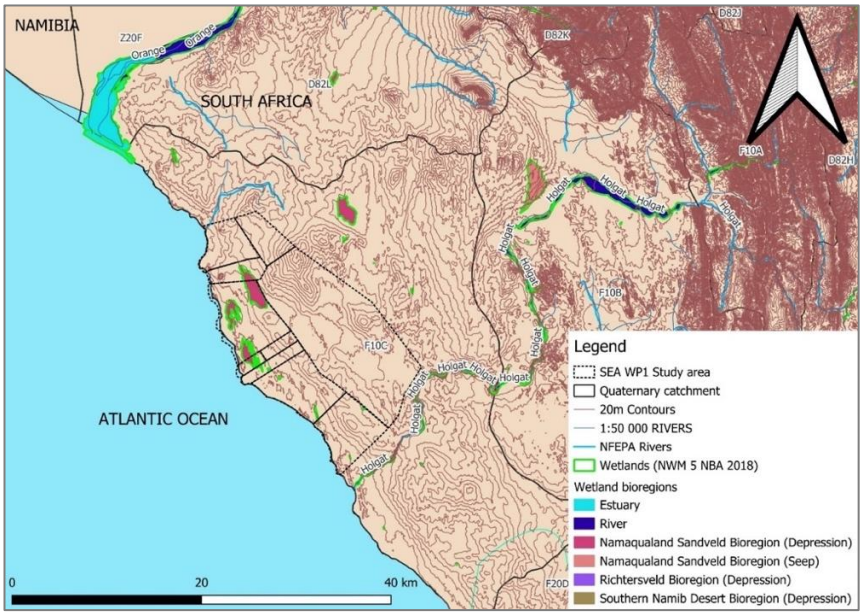


Figure 3-2**:** National Wetland Map (Version 5) (Van Deventer *et al*., 2019) for the Boegoebaai Port and SEZ.

3.3.1.3 Terrain types

A terrain type describes the terrain or relief of an area by means of the percentage level land and local relief. The Port section is covered predominantly by 'level plains with some relief' (Figure 3-3). Most of the SEZ is covered by 'plains with open low hills or ridges', while along the coast 'plains with open high hills or ridges' can be found.

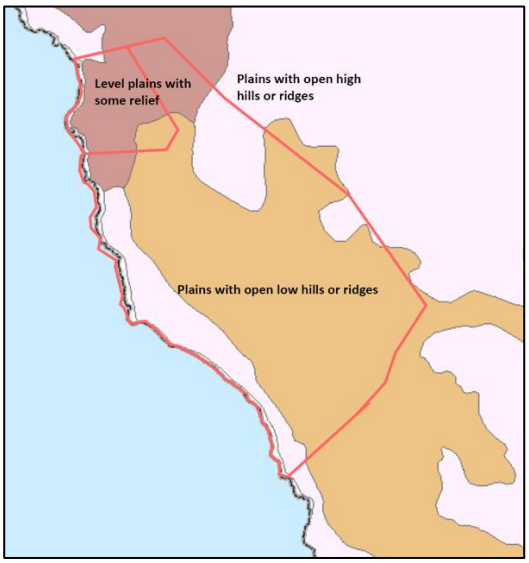


Figure 3-3**:** Terrain types in the Boegoebaai Port and SEZ site (source: https://ndagis.nda.agric.za/).

3.3.1.4 Geology

There is a close relationship between the geology, soils and vegetation. The Boegoebaai Port and SEZ site falls in the Gariep Supergroup, Holgat Formation, which lies to the south of the Schakalsberge Thrust (Figure 3-4; Council for Geoscience, 2011). The Boegoeberg Twins and Namakwakop are prominent outcrops on site and consist of schist, greywacke, quartzite and arkose (Nho) of the Holgat Formation. The bedrock is exposed along the rocky shore in the Port section. To the east of the R382 tar road some coarse-grained porphyritic granite outcrops occur (ϵsw).

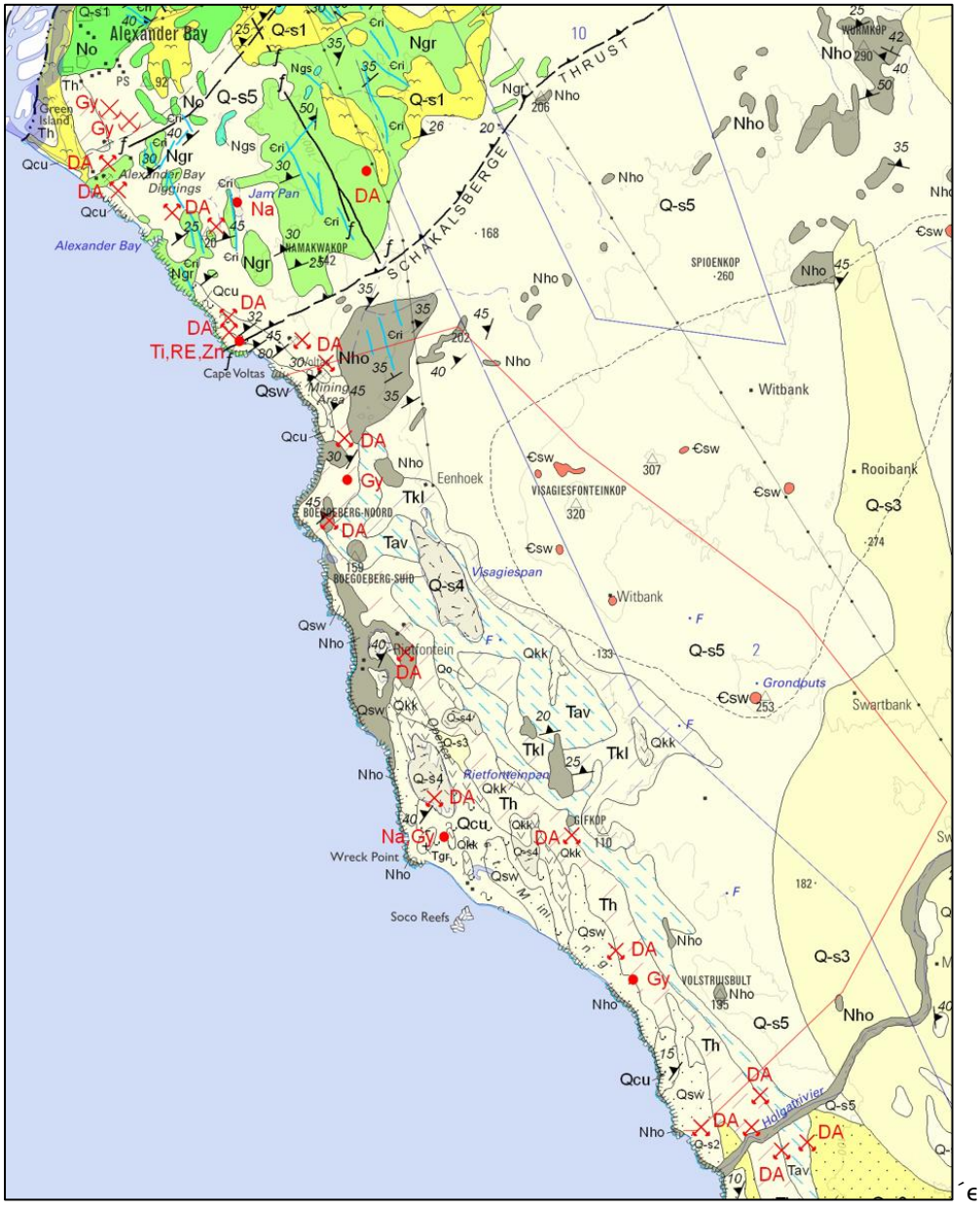


Figure 3-4: Detailed geology in the Boegoebaai Port and SEZ site (Council for Geoscience, 2011).

Most of the site is covered by sediments of Tertiary and Quaternary age (Q-s2 = white aeolian sand; Q-s3 = red aeolian sand; Q-s4 = saline soil; Q-s5 = surficial sandy soil; Qsw = white to grey dune sand; Qkk = young aeolian, reddish, mobile, vegetated sediment; and Qcu = coarse gravels; Van Rooyen *et al*., 2025). Large areas of saline soils (Q-s4) occur at Visagiespan, Rietfontein and Rietfonteinpan which are nearly permanently dry. The Tertiary sediments are represented by three shoreline terraces also referred to as 'packages': Th = 30 m shoreline terrace (or Hondeklip Bay Member); Tav = 50 m terrace (Avontuur Member); and Tkl = 90 m shoreline terrace (Kleinsee Member) (Roberts *et al.,* 2006).

3.3.1.5 Soils

Soils on site are sandy soils with little or no profile development. The sand particles are loosely packed and the soils are well-aerated and well-drained. The sandy soils have a low clay and silt content and consequently a low water holding capacity (Henschel & Jürgens, in press) and a low nutrient content and are not favourable for plant growth. Below a 30 cm depth in dune sand there is little evaporative water loss and this water is available to deep-rooted perennial plants.

Mobile dune soils have little or no vegetation mainly because of the strong winds and associated sandblasting. Once plains become vegetated, soil particles may be trapped by plant canopies, initiating the development of phytogenic mounds (also referred to as nebkhas). The ability of some dune vegetation to stabilise wind-driven dunes is a practical tool for protecting industrial and urban infrastructure placed in dune pathways, however, further research is needed to apply this principle effectively (Henschel & Jürgens, in press). Once the silt and clay content of the top sand layer reaches a certain level, a biological crust can develop.

Replacement commonly occurs in the sandy soils along the West Coast when soluble components are eluviated and later crystallised in the subsoil to form cemented hardpan formations (Desmet, 1996). Calcrete, dorbank and silcrete are the most prominent replacement products along the West Coast of South Africa.

3.3.1.6 Land Types

Land types are areas with a uniform climate, terrain form and soil pattern. The study area falls in the Ah, Ai, Fc, and Ha Land Types (Du Plessis, 1987) (Figure 3-5).



Figure 3-5: Land types in the Boegoebaai Port and SEZ site (https://ndagis.nda.agric.za/).

- The Ah Land Type includes red and yellow apedal, freely drained soils with a high base status and <15% clay, whereas the Ai Land Type comprises yellow apedal, freely drained soils with a high base status and <15% clay.

- Land Types Fa - Fe accommodate pedologically young landscapes that are not predominantly rock and not predominantly alluvial or aeolian. Fc refers to land where lime is generally present in the entire landscape. Land Type Fc129 occurs mainly on greywacke, schist and arkose of the Holgat Suite of the Gariep Complex.

- The Ha Land Type refers to grey, regic sands and accommodates areas where deep, grey sands are dominant. Land Type Ha32 occurs on young aeolian sands.

3.3.1.7 Land Cover

According to the 2022 land cover map of South Africa Figure 3-6; DFFE, 2022), the western portion of the Boegoebaai Port section is covered predominantly by mine tailings and dumps with some patches of 'other bare areas'. Further inland the Port section consists mostly of 'other bare areas' with only a small section of low shrubland of the Succulent Karoo. The Conservancy Area is additionally partly covered by the dry Visagiespan and an artificially flooded mine dam. The SEZ section is dominated by mine tailings and dumps as well as other bare areas to the west of the tar road (R382), while to the east of the R382, the land cover is primarily low succulent shrubland.

Comparing the 2022 land cover map to the 2020 and 2018 land cover maps, the most prominent change is the increase in the area mapped as bare area and this has mostly been to the detriment of low succulent shrubland. This trend could probably largely be attributed to the severe drought conditions that the region had experienced since 2011. In 2000 (see map [Figure 8, Chapter 3e] in the Supplementary Material: Van Rooyen *et al.*, 2025) the areas classified as mines and quarries were even smaller than in 2018.

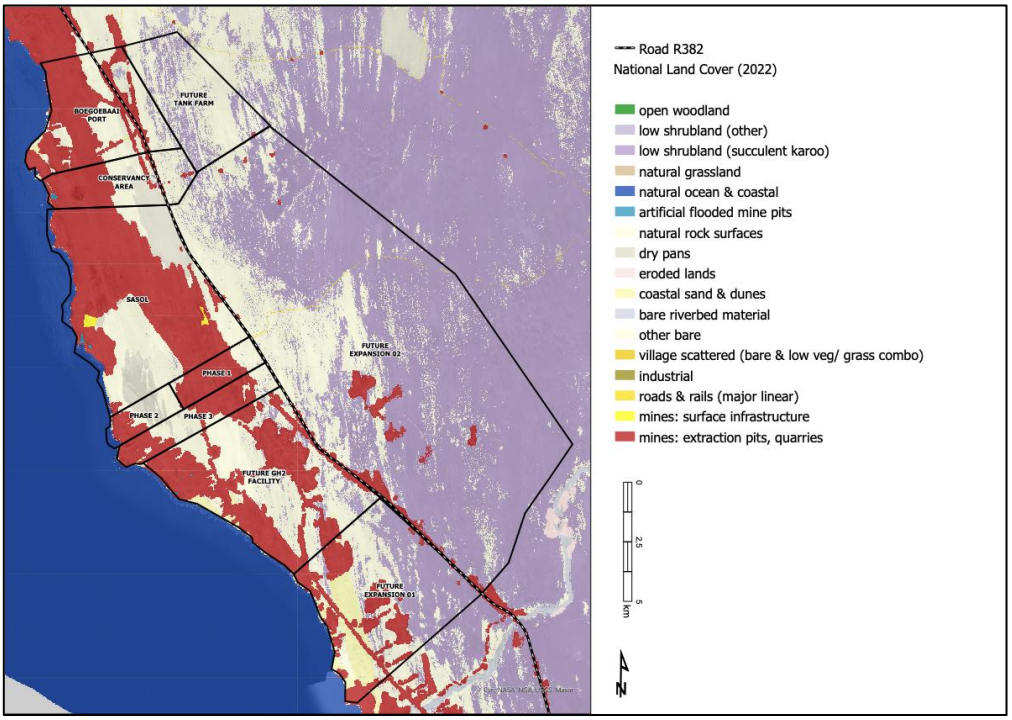


Figure 3-6: The 2022 land cover map of the Boegoebaai Port and SEZ site (DFFE, 2022).

3.3.2 Biodiversity attributes

3.3.2.1 Biomes and National Vegetation Types

The study area includes two biomes, *viz*. Desert and Succulent Karoo Biomes. When compared to other deserts with the same level of aridity globally, the Desert Biome in South Africa is exceptionally rich in plant species and hosts a large number of endemic plant species (Mucina & Rutherford, 2006). The Succulent Karoo is renowned for its unrivalled levels of diversity and endemism for an arid region (Cowling & Hillton-Taylor, 1999; Cowling *et al.*, 1999; Desmet & Cowling, 1999; Desmet, 2007) and is recognised by the International Union for Conservation of Nature (IUCN) as a global hotspot of diversity (CEPF, 2003;

Mittermeier *et al*., 2000; Myers *et al.,* 2000), and one of only two global hotspots that are entirely arid (https://www.cepf.net/our-work/biodiversity-hotspots).

Five National Vegetation Types are represented in the study area, belonging to two different biomes and an Azonal Coastal Vegetation Type (Mucina & Rutherford, 2006; mapping as presented in 2024 by SANBI) (Figure 3-7).

- Succulent Karoo Biome:
  - Richtersveld Coastal Duneveld (SKs 1)
  - Northern Richtersveld Yellow Duneveld (SKs 2)
  - Richtersveld Sandy Coastal Scorpionstailveld (SKs 4)
- Desert Biome:
  - Western Gariep Plains Desert (Dn 3)
- Azonal Coastal Vegetation Type:
  - Namib Seashore Vegetation (AZd 1)

Richtersveld Coastal Duneveld (SKs 1)

This vegetation type occupies a belt of 1–12 km broad along the Atlantic coast from approximately Alexander Bay in the north to halfway between Port Nolloth and Kleinzee in the south. The landscape is generally flat with some large, gently rolling coastal dunes. The dominant succulent shrubs are *Cephalophyllum ebracteatum* (VU), *Euphorbia mauritanica, Crassothonna sedifolia, Salsola nollothensis* and *Roepera morgsana.* Other noteworthy succulents include *Amphibolia rupis-arcuatae, Drosanthemum luederitzii, Jordaaniella cuprea, Lampranthus stipulaceus, Stoeberia utilis* and *Roepera cordifolia*. Non-succulent shrubs include *Asparagus capensis* and *Pteronia glabrata* and herbs are represented by *Grielum grandiflorum, Mesembryanthemum dinteri* and *Fenestraria rhopalophylla*. The most prominent graminoid is *Cladoraphis cyperoides* (Mucina & Rutherford, 2006). The Richtersveld Coastal Duneveld supports an array of fauna uniquely adapted to its challenging environment e.g. Namaqua chameleon (*Chamaeleo namaquensis*); brown hyaena (*Parahyaena brunnea*); Cape fur seal (*Arctocephalus pusillus pusillus;* see marine report); fog-dependent reptiles e.g. the Namib web-footed gecko (*Pachydactylus rangei*); and desert-adapted skinks.

The Richtersveld Coastal Duneveld is **Critically Endangered** with a conservation target of 26%. It is poorly protected and sustained conservation efforts are needed to protect its unique landscapes and species for future generations.

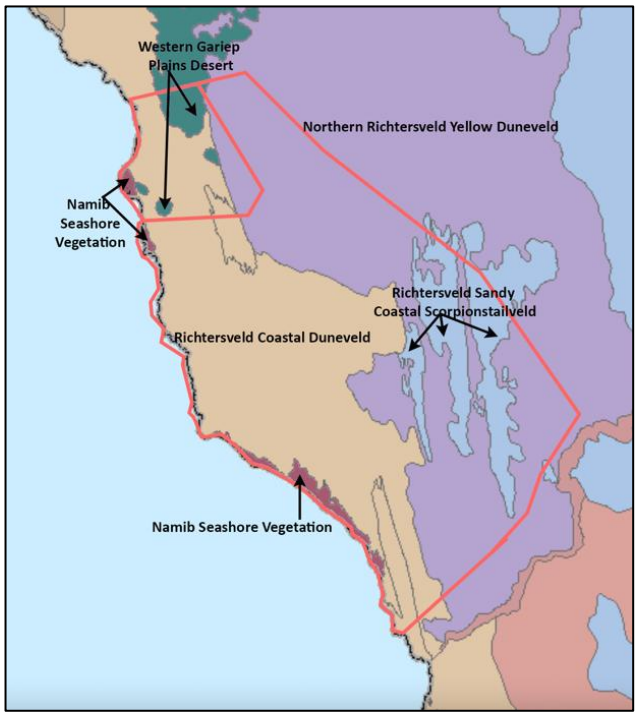


Figure 3-7: National Vegetation Type map of the Boegoebaai Port and SEZ site (Mucina and Rutherford, 2006 as updated in 2024 by the South African National Biodiversity Institute).

Northern Richtersveld Yellow Duneveld (SKs 2)

SKs 2 occupies the land 5–25 km from the coast from southern Namibia to the Holgat River. The dune ridges and accompanying valley systems of the ancient dune fields are still partly visible. This region experiences a high frequency of coastal fog, providing vital moisture to sustain life in this arid environment. The dominant succulent shrubs are *Euphorbia* spp., *Crassothonna cylindrica* with associated species e.g. *Cephalophyllum ebracteatum* (VU), *Cheiridopsis robusta, Didelta carnosa, Jordaaniella cuprea, Lampranthus stipulaceus, Salsola tuberculata* and *Roepera morgsana*. Non-succulent shrubs include *Asparagus capensis, Calobota cinerea* and *Calobota angustifolia* and herbs are represented by *Grielum humifusum, Oncosiphon piluliferum* and *Mesembryanthemum schlichtianum*. The most prominent grass is *Cladoraphis cyperoides* (Mucina & Rutherford, 2006).

The Northern Richtersveld Yellow Duneveld has a **Least Concern** status with a conservation target of 26%. The vegetation type is not statutorily protected.

Richtersveld Sandy Coastal Scorpionstailveld (SKs 4)

In the study site, SKs 4 occurs as three north-south trending bands. The unit is clearly visible on satellite images due to the dark colour caused by the biological soil surface crusts. The dominant succulent shrubs are *Mesembryanthemum pseudoschlichtianum* (locally known as groot skerpioenbos), *Cephalophyllum ebracteatum* (VU), *Crassothonna cylindrica, Mesembryanthemum serotinum, Cheiridopsis robusta,* various *Euphorbia* spp. and *Roepera morgsana*. Non-succulent shrubs are represented by *Calobota angustifolia* and *Asparagus capensis* and herbs include *Oncosiphon piluliferum* and *Trachyandra falcata*. The most prominent graminoid is *Cladoraphis cyperoides* (Mucina & Rutherford, 2006). Overall, prominent species in SKs 4 agree well with those in the Northern Richtersveld Yellow Duneveld (SKs 2).

The Richtersveld Sandy Coastal Scorpionstailveld (SKs 4) has a **Least Concern** status with a conservation target of 26%. The vegetation type is represented in the Richtersveld Cultural and Botanical Heritage Landscape.

Western Gariep Plains Desert (Dn 3)

The landscape is dominated by plains with undulating hills and rocky outcrops, the most notable of which are the Boegoeberg Twins. Dn 3 houses several near-endemic species that occur more frequently in Namibia. Common succulent shrubs are *Crassothonna sedifolia, Cephalophyllum ebracteatum* (VU)*, Mesembryanthemum* spp.*, Othonna lasiocarpa, Stoeberia beetzii, Amphibolia rupis-arcuatae, Cheiridopsis brownii* (EN), *Conophytum saxetanum* (EN)*, Crassula deceptor, Dracophilus dealbatus* (CR)*, Drosanthemum luederitzii, Euphorbia* spp.*, Monsonia patersonii* (VU)*, Psammophora modesta* (VU) and *Tylecodon schaeferianus* (VU). Low shrubs include *Asparagus capensis, Hermannia gariepina* and *Lycium decumbens* with herbs represented by *Pelargonium sibthorpiifolium* (CR) and grasses by *Cladoraphis cyperoides* (Mucina & Rutherford, 2006). The vegetation supports desert-adapted fauna, including the gemsbok (*Oryx gazella*); rodents e.g. *Gerbillurus* spp*;* and a rich variety of geckos, skinks and snakes e.g. Namaqua dwarf adder (*Bitis schneideri)*.

The Boegoeberg Twins deserve a very high protection level. From Angola to Port Nolloth there are only two mountainous structures located right next to the Atlantic Ocean viz. the two Boegoeberg Twins and the Laguneberg, 800 km further north. Only these qualify as fog oases comparable to the Lomas of the Atacama. The unique environmental setting supports a high probability that this environmental filter gave rise to an unique collection of plant and lichen species (Jürgens[2], review comment).

The Western Gariep Plains Desert is not statutorily protected. It has a **Least Concern** status with a conservation target of 28%. However, the threatened status of the Richtersveld Vegetation Types are currently being re-assessed. The current **Least Concern** status for the Western Gariep Plains Desert is inadequate and it is likely that it will be upgraded by the responsible authority.

Namib Seashore Vegetation (AZd 1)

This vegetation type is found along the Richtersveld coast between the Orange River mouth in the north and the Holgat River in the south. The sandy beaches are slightly sloping and bordered by mobile or fixed sand dunes and occasional coastal cliffs. Dominant shrubs are *Lycium tetrandrum*, *Tetragonia fruticosa, Didelta carnosa* and *Roepera clavata*. Low shrubs include *Asparagus capensis* and *Hebenstretia cordata* and the most prominent graminoid is *Cladoraphis cyperoides* (Mucina & Rutherford, 2006). Fauna likely to occur in this vegetation type include Grant's golden mole (*Eremitalpa granti granti*); Cape fur seal (*Arctocephalus pusillus pusillus;* see marine report); and various fog-dependent geckos and lizards. Adaptations to obtain moisture from the coastal fog are key in this environment.

The Namib Seashore Vegetation has a **Critically Endangered** status with a conservation target of 26%. It is not statutorily protected and has almost totally been transformed by mining.

3.3.2.2 Centres of Endemism

The Boegoebaai Port and SEZ site falls in the Gariep Centre of Endemism as defined by Van Wyk & Smith (2001). This centre of endemism is a combination of two quite distinct climatic, biogeographic and evolutionary units (Jürgens, 1991; Jürgens *et al.,* 1997; Mucina & Rutherford, 2006). Jürgens (1991, 1997) studied the distribution ranges of a very large number of species and proposed to split the Gariep Centre into 'East Gariep Centre' for the palaeotropical summer rainfall elements and a 'West Gariep Centre' for the Greater Cape winter rainfall elements, incidence of fog and floristic affinities with the Succulent Karoo Biome. At a lower hierarchical level within the West Gariep Centre, a 'Western Gariep Circle' has been identified as a local centre of endemism stretching from Alexander Bay to Sendelingsdrift/Lorelei. Several SCC on site are endemic to South Africa, although a large proportion of SCC are distributed from southern Namibia into the northwestern Richtersveld.

3.3.2.3 Protected Areas and National Protected Area Expansion Strategy

The study site is not part of a protected area (https://egis.environment.gov.za/data_egis/data SAPAD_IR_2024_Q2_01). The closest protected area to the site is the Richtersveld Cultural & Botanical

[2] Prof. Norbert Jürgens, Professor Emeritus, University of Hamburg, Germany.

Landscape, which has a Natural Heritage Site status declared in terms of the World Heritage Convention Act. To the north of the site lie the Orange River Mouth Nature Reserve and Orange River Mouth Wetland, a Ramsar Site (https://rsis.ramsar.org/ris/526).

Although the Boegoebaai Port section has not been included in the NPAES, a substantial portion of the SEZ section has been included in NPAES (2018) (Figure 3-8).



Figure 3-8: Map of the National Protected Areas Expansion Strategy around the Boegoebaai Port and SEZ site (NPAES, 2018).

3.3.2.4 Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs)

Critical Biodiversity Areas (CBAs) are areas required to meet biodiversity targets for ecosystems, species or ecological processes. They are regarded as areas of high biodiversity and ecological value and need to be kept in a natural or near-natural state, with no further loss of habitat or species to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. The definitions for CBAs are (SANBI, 2018):

- CBA 1: Areas that are irreplaceable for meeting biodiversity targets. There are no other options for conserving the ecosystems, species or ecological processes in these areas.

- CBA 2: Areas that are the best option for meeting biodiversity targets, in the smallest area, while avoiding conflict with other land uses.

Permissible land uses in CBAs are those that are compatible with maintaining the natural vegetation cover in a healthy, ecological state and that do not result in a loss or degradation of natural habitat (Pool-Stanvliet *et al*., 2017). Undesirable land uses cause a loss of natural habitat or ecosystem functionality, e.g.: (i) industrial, commercial or residential developments; (ii) mining or prospecting; and (iii) intensive agriculture. It is thus clear that the Boegoebaai development would constitute an undesirable land use that would not be permissible in a CBA (Oosthuyzen & Geldenhuys, 2024).

An Ecological Support Area (ESA) is not essential for meeting biodiversity targets, but plays an important role in supporting the ecological functioning in a CBA. ESAs need to be maintained in a functional and often natural state, but some limited habitat loss may be acceptable. Other Natural Areas (ONAs) have not been identified as a priority and retain most of their natural character and perform a range of biodiversity and ecological functions.

Almost the entire proposed development site, not affected by mining, has been classified as either CBA 1 or CBA 2 (CBA map, 2016), with a single small ESA and ONA occurring near the southern boundary (Figure 3-9). The mining transformed areas were not classified. The main reasons provided for the mapping were the presence of: (a) threatened ecosystems; (b) NPAES; (c) threatened species; (d) high value climate resilience area; (e) SKEP expert area; and (f) natural wetlands.

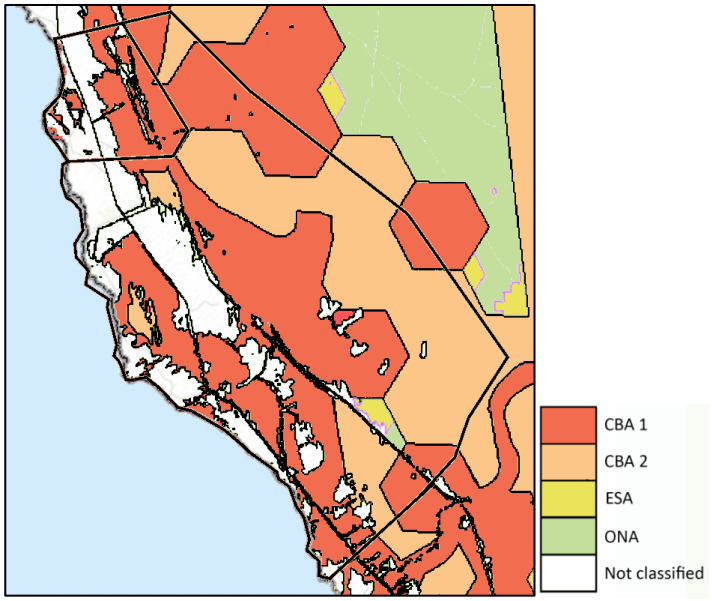


Figure 3-9: 2016 Northern Cape Critical Biodiversity Area map of the Boegoebaai Port and SEZ site.

3.3.2.5 Key Biodiversity Areas

The Key Biodiversity Area (KBA) Partnership (https://www.keybiodiversityareas.org) provides biodiversity information to assist governments and other stakeholders in decision-making on where to avoid development and how best to manage the land. A site qualifies as a global KBA if it meets one or more of 11 internationally agreed scientific criteria. The Boegoebaai Port and SEZ site is located in the Namaqualand Sandveld North KBA (Figure 3-10) that met 10 criteria (A1a[3], A1b, A1d, A2, B1, B2, B3a, B4, D1a and E).

[3] A1a: ≥0.5% of the global population size AND ≥5 reproductive units of a CR or EN species; A1b: ≥1% of the global population size AND ≥10 reproductive units of a VU species; A1d; ≥0.2% of the global population size AND ≥10 reproductive units of a species assessed as VU due only to population size reduction in the past or present; A2; holds a significant proportion of the global extent of an ecosystem type facing a high risk of collapse; B1: Site regularly holds ≥10% of the global population size AND ≥10 reproductive units of a species; B2: Site regularly holds ≥1% of the global population size of each of a number of restricted-range species in a taxonomic group, determined as either ≥2 species OR 0.02% of the global number of species in the taxonomic group, whichever is larger; B3a: ≥0.5% of the global population size of each of a number of ecoregion-restricted species within a taxonomic group, determined as either ≥5 species OR 10% of the species restricted to the ecoregion, whichever is larger; B4: Site holds ≥20% of the global extent of an ecosystem type; D1a: An aggregation representing ≥1% of the global population size of a species, over a season, and during one or more key stages of its life cycle; E: Site has a level of irreplaceability of ≥0.90 (on a 0–1 scale), measured by quantitative spatial analysis, and is characterised by the regular presence of species with ≥10 reproductive units known to occur (or ≥ 5 units for EN or CR species).

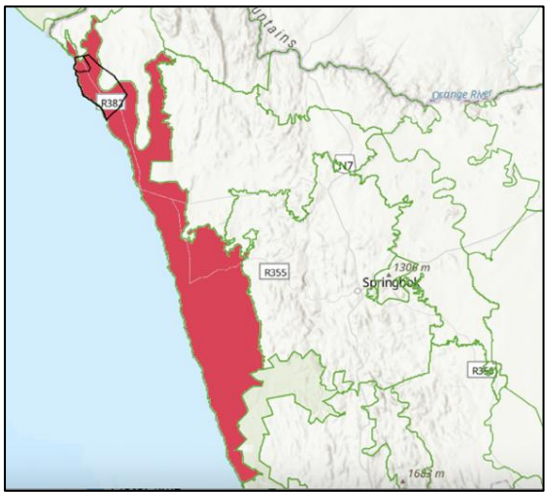


Figure 3-10: Location of the Namaqualand Sandveld North Key Biodiversity Area.

3.3.2.6 Areas with high concentrations of threatened species

The South African National Biodiversity Institute (SANBI) produced a map depicting areas within the Richtersveld with a high concentration of threatened species (Van Wyk, 2025; Figure 3-11). Two of these areas were mapped on site corresponding to the Boegoeberg Twins and Visagiesfonteinkop. Most of the areas with a concentration of threatened species occur further north of the site in the environs of the Orange River at Kortdoorn and Grootderm. Should accommodation be provided to employees in Alexander Bay, this would encroach on the areas with a high concentration of threatened species. The influx of people will increase air pollution levels from road traffic and the region will likely experience increased pressure of illegal plant harvesting.

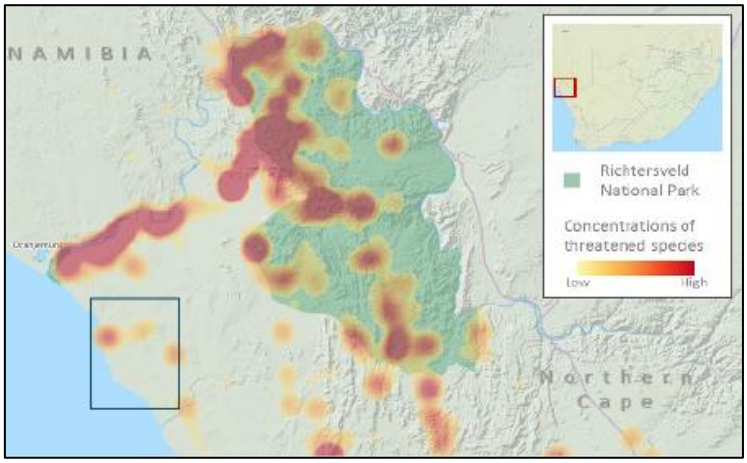


Figure 3-11: Map indicating areas with a concentration of threatened species in the Richtersveld with the Boegoebaai Port and SEZ shown as a rectangle (source: Van Wyk, 2025).

3.3.2.7 Lichen fields

The Namib Lichen Fields vegetation type, which lies approximately 13 km north of the proposed Boegoebaai Port and SEZ, is a **CR** ecosystem. It covers <80 ha, but represents a globally unique habitat and has been proclaimed as a Natural Heritage Site. Compared to the lichen fields in Namibia, these fields, the only in South Africa, have a higher diversity and biomass of lichens than those in Namibia and merit a very high conservation status (Jürgens & Niebel, 1991; Jürgens & Niebel-Lohmann, 1995).

Several environmental elements can be detrimental to lichens e.g. mobile sands (Jürgens & Niebel, 1991; Jürgens & Niebel-Lohmann, 1995); as well as dust and air pollution produced by road traffic. Most species live for decades and because they take up water and nutrients directly from the atmosphere they are exposed to the cumulative effects of pollutants (Nash, 2008). The Boegoebaai development is likely to exacerbate the negative effects of pollution and mobile sand.

3.3.2.8 Sensitive areas as indicated by local knowledge

Several localities (Figure 3-12) were identified as sensitive (Van Wyk, 2025) for the reasons provided below.

- It is critical that the **Boegoeberg Twins** (no 1, Figure 3-12) are fully conserved in the Conservation Area (Figure 3-1). **According to the current delineation, Boegoeberg North is not entirely included in the Conservation Area.** These two mountains host many threatened higher plant taxa and the lichen and microbiome richness is exceptional. Lichens are sensitive to air pollution and with the predominant southerly winds, air pollution coming from the proposed SEZ may negatively impact lichens on the Boegoeberg Twins.

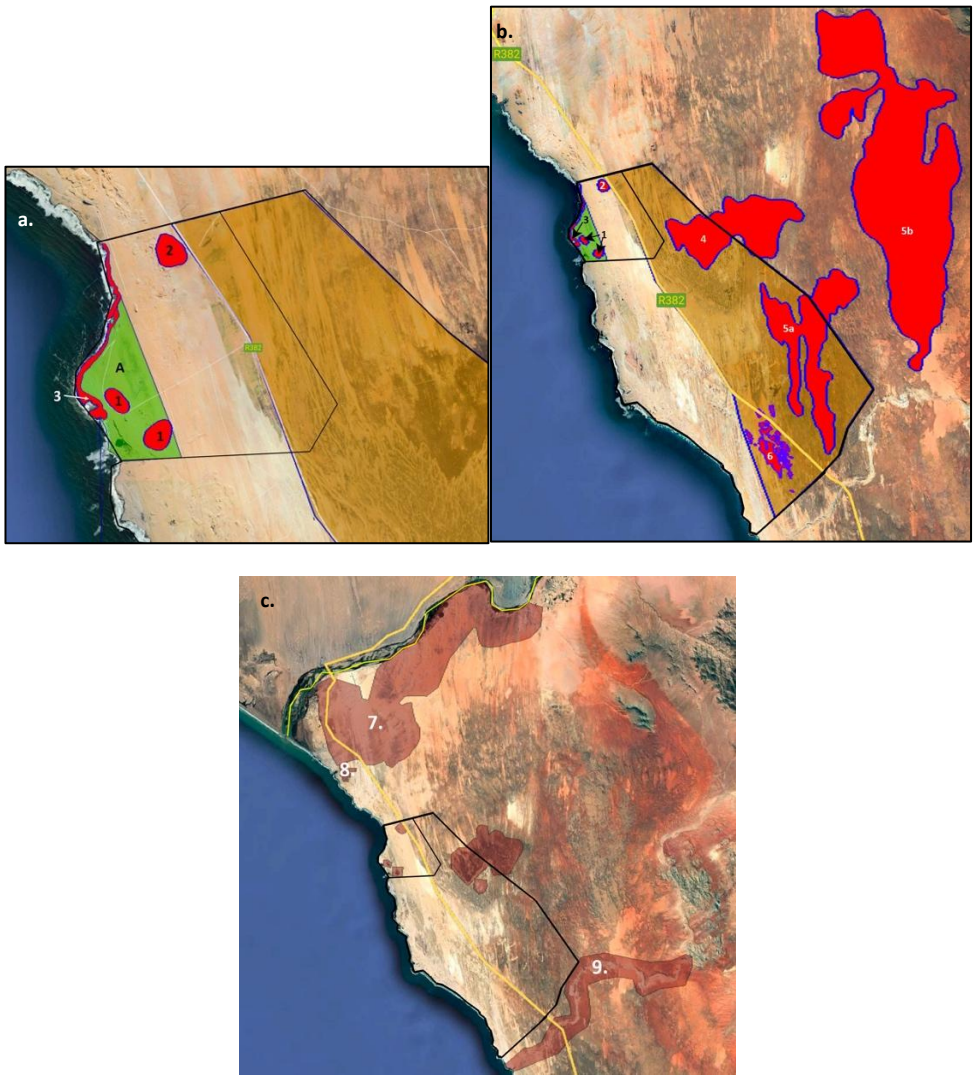


Figure 3-12**:** (a) Detail of Boegoebaai Port showing areas of **High** sensitivity as indicated by local knowledge. (b) Areas of **High** sensitivity in the Boegoebaai Port and SEZ site; and (c) Sensitive areas in the environs of the site. 1 = Boegoeberg Twins; 2 = Namakwakop; 3 = Northern coastline; 4 = Visagiesfonteinkop; 5a = Swartbank heuweltjies; 5b = Rooibank heuweltjies; 6 = Brant's whistling rat colonies 7. Pagvlei, Grootderm and Brandkaros; 8. outcrops near Alexander Bay; and 9. Holgat River (Van Wyk, 2025).

- **Namakwakop** (no 2, Figure 3-12) is a small hill, sharing several SCC with the Boegoeberg Twins.

- **The coastline north of Collins Jetty** (no 3, Figure 3-12), is the most sensitive section of shoreline left after the 98 years of diamond mining, from both a biodiversity and heritage point of view (Van Wyk, 2025; email comm.). It includes rocky sections containing the highest concentration of Sensitive species 305 **(CR)** within the species' distribution range. Moreover, the **EN** Bank cormorant is known to breed on these rocky cliffs. It also includes sections of the **CR** Namib Seashore Vegetation. Furthermore, it is home to a breading population of the Cape fur seal, a protected species.

- **Visagiesfonteinkop** (no 4, Figure 3-12) is an important habitat for the desert rain frog, *Breviceps macrops* **(VU).** It is also habitat to an undescribed *Pelargonium* sp.; a new *Crassula* sp.; populations of *Ruschia pallens;* Sensitive species 720 **(VU)**; *Ceropegia pulvinata (=Stapelia pulvinata);* Sensitive species 734 **(VU)**; and unique lichen flora, with several lichen species not found on the Boegoeberg Twins nor in the Namib lichen fields. Visagiesfonteinkop is also home to insects that have not been recorded elsewhere on the coastal plains.

- The **Rooibank & Swartbank Heuweltjies** (no 5, Figure 3-12) are associated with termites (Southern harvester termite, *Microhodotermes viator*) that are regarded as ecosystem engineers creating nutrient-rich loamy soil. At the Buffels River, Namaqualand, the termite nests were the oldest active termite features ever dated (Francis *et al.,* 2024).

- A large colony of **Brant's Whistling Rats** (*Parotomys brantsii*) (no 6, Figure 3-12) occurs in the SEZ site. The presence of these rats is often associated with an increase in reptile, raptor and small predator species.

3.3.2.9 Development proposals that have been approved for the site

There are currently two approved development proposals within the proposed Boegoeberg Port and SEZ site (Figure 3-13):

- The 225 MW Richtersveld Wind Energy Facility (dark blue line, Figure 3-13); and

- The Namakwa Prospecting proposal to establish the presence of economic deposits of heavy minerals by non-invasive and invasive prospecting over a period of five years (green line, Figure 3-13).

Other development applications/proposals include: the prospecting proposal (light blue line, Figure 3-13), mining right application by Whale Head Minerals (not indicated in Figure 3-13) and construction of a water supply pipeline between Alexanderbaai and Port Nolloth (not indicated in Figure 3-13).

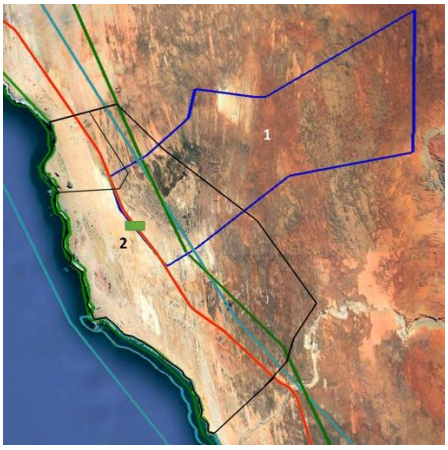


Figure 3-13: Location of the approved Richtersveld Wind Energy Facility (1) and the prospecting proposal (2).

3.3.2.10 Current land use

The main land uses in the region are mining and small stock farming. The Boegoebaai Port and SEZ land is owned by the Richtersveld Sida !Hub Community Property Association (CPA). Alexkor SOC Limited (Alexkor) and the Richtersveld Mining Company (Pty) Ltd (RMC) formed a Pooling and Sharing Joint Venture (PSJV) to oversee mining activities relating to Alexkor's mining rights. The PSJV outsources most of the marine prospecting and mining operations to contractors.

Currently, sand due primarily to soil disturbance by past diamond mining activities probably poses one of the greatest environmental threats to the natural environment, both in the mined areas and on adjacent land. The sand plume development is ascribed to prevailing winds and sand supply as well as coast line form. Early in this century a distinction could still be made between natural coastal sand plumes and mining-induced plumes, however, at present this distinction is lost and natural and mine-induced plumes have merged. Currently, a major cause for concern is the sand dune/plume threatening Boegoeberg South.

Severe overgrazing in many areas of the Richtersveld has led to widespread land degradation and a reduction in overall species diversity Jürgens *et al.* (in press). Some vegetation types are more vulnerable than others, with heuweltjieveld being one of the vulnerable types. Signs of overgrazing are particularly noticeable around stockposts.

In a recent publication by Jürgens *et al.* (in press) the observed vegetation degradation in the Richtersveld (as well as in the current assessment area) was interpreted as a combination of anthropogenic causes and climate change. Jürgens *et al*. (in press) presented a conceptual model of how the vegetation in the coastal region of the Richtersveld is degraded by the anthropogenic impacts of farming (e.g. overgrazing), mining and roads. These human activities all degrade or remove the vegetation and thus trigger either the erosion of silt or the mobilisation of aeolian sand with associated sand abrasion and the formation of sand plumes. In the original vegetation state the silty soils are stable and often covered by a biological surface crust. Further grazing, trampling, drought and sandblasting drives the development of an entirely new vegetation state composed of a different complement of species. Eventually the vegetation becomes buried in the sand. There is thus a retrogression from a species-rich, stable and productive Succulent Karoo vegetation state to a species-poor, unstable and less productive grassy Desert vegetation state.

3.3.2.11 Ecosystem processes

The Boegoebaai Port and SEZ site lies in a hyper-arid region and years with below average annual rainfall are a common occurrence. Terrestrial ecosystems in the study area are subject to high wind speeds that result in severe aeolian erosion, transport and sedimentation. These processes have been exacerbated by the extreme transformation of the land by mining. The destructive action of the wind is particularly prominent in areas where the vegetation has been degraded and is sparse (Desmet, 1996). The sandblasting reduces photosynthetic activity and affects plant reproduction with young plants being particularly vulnerable. Eventually the vegetation becomes buried under the aeolian sand.

It is critical that the trajectories of sand and dust transport from the proposed development is modelled. Mitigation measures to stabilise the sand before it impacts on priority ecosystems (e.g. the Namib Lichen Fields and the Orange River Estuary) further north are crucial.

Ecological processes such as primary production, decomposition, nutrient cycling and fluxes of nutrients and energy will all be altered by the clearing of the vegetation at the footprints of the infrastructure. Disruption of broad-scale ecological processes such as dispersal, migration or the ability of fauna to respond to fluctuations in climate or other conditions will depend on the presence of ecological corridors and the size of the disturbed area in relation to the adjacent landscape where no change to the ecological processes is anticipated. Seed dispersal in many species occupying arid areas is often characterised by adaptations that hinder seed dispersal. In such species, recolonisation of an area after a disturbance is likely to be very slow.

Psammophytes are plants or animals that thrive in sandy environments. Psammophilous plants exhibit many survival strategies such as mechanisms to reduce water loss by having small leaves or the shedding of plant parts. A noteworthy adaptation of some Namib psammophytes is their ability to harvest fog, while other species produce succulent leaves, stems and/or roots. Some psammophilous plants survive wind

erosion due to the possession of thick sheaths around their roots that withstand root exposure and sandblasting, while others produce a thick bark or wax layers. Some psammophilous species exhibit epidermis adaptations that allow them to fix a protective layer of sand grains to the leaf surface. Yet other species disappear seasonally below the sand surface by shrinking their succulent tissue during the dry summer months, and re-emerging during the rainy season. A unique set of psammophilous animals has also evolved in the Namib dunes, with sand moisture being the most important driver of their adaptations (Henschel & Jürgens, in press).

3.3.2.12 Climate change

Depending on the model parameterisation and climate scenarios used, widely divergent projections are produced for the Succulent Karoo Biome. Early projections predicted a substantial contraction of the Succulent Karoo (Midgley *et al*., 2001), while more recent models suggest that the biome will be rather resilient to climate change and will in future not differ substantially from its current distribution (Driver *et al.,* 2012). Repeat photography studies indicate that modelled projections and observed measurements of vegetation change differ significantly (Davis *et al*., 2016, Hoffman *et al*., 2019). For most southern African biomes, there is little evidence yet of the catastrophic shifts in ecosystem structure and function that are envisaged for the future due to climate change.

The 2018 NBA projected a limited switch from Succulent Karoo to Desert in its northern reaches and its expansion in the southern coastal region to replace parts of the Fynbos Biome (Skowno *et al.,* 2019). A study by Broennimann *et al.* (2006) found that geophytes and succulents, were particularly vulnerable to climate change and Midgley & Thuiller (2007) also contended that succulents could be susceptible to the impacts of climate change. The risk to dwarf succulents, in particular *Conophytum* spp., was highlighted by Young *et al*. (2016).

It is widely recognized that vegetation degradation is occurring at an alarming rate in the region due to a combination of anthropogenic factors and climate change. This habitat deterioration will inevitably also impact avifaunal, bat and mammal, reptile and amphibian diversity and abundance. Mapping of land use dynamics and change trends over time relating to aquatic, avifauna, bat and other fauna is not feasible for these primarily desktop studies.

3.4 KEY FINDINGS OF THE ASSESSMENTS

3.4.1 Aquatic Ecology

Overall, the assessment showed that the study area is not rich in inland aquatic ecosystems. However, in such an arid area, these ecosystems are likely of very high importance to terrestrial fauna (Niemandt, 2025), and the ephemeral pans are assumed to support interesting and rare aquatic macroinvertebrates, including crustacean zooplankton fauna. The larger pans, such as Visagiespan, Rietfontein and Rietfonteinpan (BB1, BB2 and BB3 in Figure 3-14) afford wetland and pan habitat, with links to primary and/or secondary aquifers, which form springs (Visagiespan), creating permanent standing water. These are utilised by terrestrial fauna, either directly as a brackish to saline water source or indirectly, for grazing of wetland plants. Other inland aquatic ecosystems of assumed high biodiversity importance are ephemeral pools (rock pools) located in rocky outcrops, some of which are likely to support invertebrate communities with potentially high levels of regional endemism and of a high conservation importance. These rock pools have, however, been mapped in this study with low confidence.

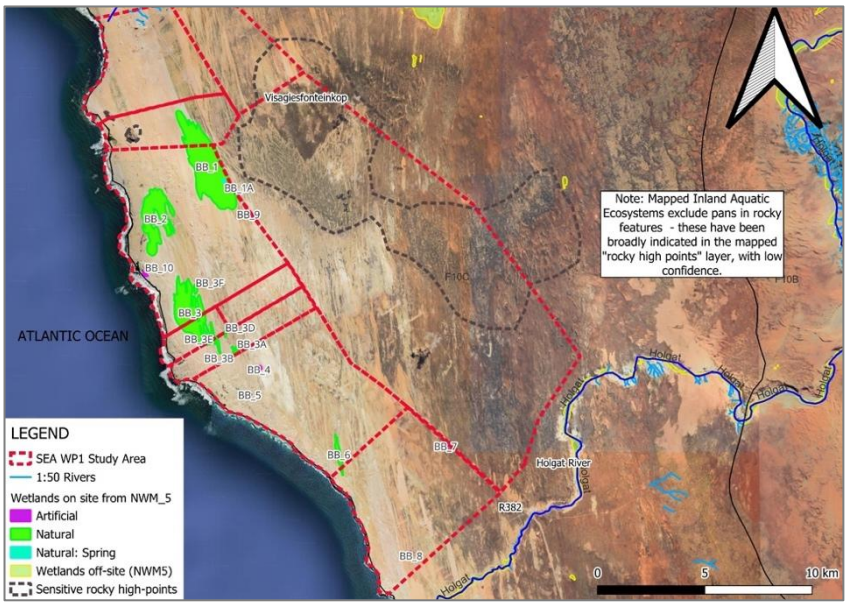


Figure 3-14: Coded, mostly ground-truthed inland watercourses in the study area, with extent based on NWM Ver 5 (Van Deventer *et al*., 2019). Rocky high points have been mapped at desktop level with low confidence.

At least one species of fish is supported in the waters of Visagiespan. The species is currently unconfirmed. The mullet (*Chelon richardsonii*) has supposedly been introduced into excavated channels in the Holgat Estuary, and it is possible that it might also have been introduced into the spring environment. None of the other pans are likely to support fish as they all dry out in summer, with even Rietfontein, which still had some hypersaline, hypertrophic pools in December 2024, being likely to dry out completely over summer.

Ephemeral pans and pools in the study area; various artificial scrapes; and temporary pools in rocky areas could all potentially support communities of invertebrate fauna that are adapted to life in transient aquatic conditions. Such fauna could include branchiopod crustaceans, with taxa from four orders associated with temporary freshwater habitats (Conchostraca (clam shrimps); Cladocera (water fleas – e.g. daphnia); Notostraca (tadpole shrimps of the genus *Trips* (Rayner, 1996); and Anostraca (fairy shrimps)). Species richness in temporary waterbodies relates to the size and habitat diversity of the water body and to habitat duration (Ebert & Balko, 1987; Hamer & Rayner, 1996; Mabidi *et al.,* 2016).

3.4.2 Terrestrial Ecology

3.4.2.1 Avifauna

Eighty-seven (87) bird species were recorded in the broader area of which 47 are priority species. Of the 87 bird species, 13 species are either terrestrial SCC and/or SA endemics/near-endemics or range-restricted. Seabirds are discussed in the marine report.

Black harrier *(Circus maurus):* The black harrier (Globally and Regionally **EN**) is one of southern Africa's rarest near-endemic raptors. The regional population has been quantified at <1 000 mature individuals with an estimated continuing decline of *ca*. 20% within the next two generations (Taylor *et al.,* 2015). Although they are unlikely to breed on site, suitable foraging habitat is present. An isolated population of about 10 mature individuals occurs in northern coastal Namibia, where they may breed.

Cape long-billed lark *(Certhilauda curvirostris):* The Cape long-billed lark is **near-endemic** to South Africa, occurring from the south of Namibia through the western parts of the Northern and Western Cape. It generally prefers coastal scrub with sparse vegetation (Hockey *et al.,* 2005) and could therefore occur on

site within scrubland habitat. Their population is suspected to be in decline as a result of the effects of agriculture and mining (BirdLife International, 2025).

Caspian tern *(Sterna caspia):* The regional population of Caspian tern (Regionally **VU**) is estimated to be <1 000 mature individuals. The species has a restricted number of breeding locations which makes it prone to the effects of human activities and stochastic events (Taylor *et al.,* 2015). Within the region, it is concentrated at estuaries and sheltered bays on the coast and at large, permanent inland waterbodies (Hockey *et al*., 2005). During their breeding period Caspian terns are susceptible to egg collecting and predation by domestic dogs (Crawford *et al.,* 2012) as well as extreme weather events (Du Toit *et al.,* 2003). Lesser threats include the bioaccumulation of heavy metals, pesticides and other chemical pollutants (Crawford *et al.,* 2012).

Curlew sandpiper *(Calidris ferruginea):* The curlew sandpiper (Globally **VU**) occurs on coastal brackish lagoons, tidal mud- and sand-flats, estuaries, saltmarshes, exposed coral, rocky shores and tidewrack on sandy beaches (Hockey *et al.,* 2005). Inland it occurs on the muddy edges of marshes, flooded areas, dams and saltpans (Dodman, 2014). Within the PAOI it is likely to use estuarine habitats.

Damara tern *(Sterna balaenarum):* The Damara tern (Globally **LC**; Regionally **CR**) is locally common along the coast of Namibia and the Northern Cape (Hockey *et al.,* 2005). It prefers arid/desert shores, especially sheltered bays and reefs, while it mainly breeds on gravel plains between dunes and on salt pans. They are known to have bred in dune fields along the coast in the PAOI (Taylor *et al.,* 2015). Off-road vehicles threaten colonies by causing nest abandonment and crushing nests (Braby *et al*., 2009). Increased jackal and gull populations driven by human activity, as well as the growing numbers of seals and seal colonies in South Africa and Namibia, have increased the risk of predation (Braby *et al.,* 2011).

Dune lark (Coastal) *(Calendulauda erythrochlamys patae)* (Globally **LC**)*:* The regional subspecies of the dune lark that occupies the coastal plain in the north-western Northern Cape, was until recently regarded as a unique species, Barlow's lark *Calendulauda barlowi* (Ryan & Kirwan, 2022). This regional range-restricted subspecies was treated as a priority species because of its high local abundance and its distinct habitat requirements. It is estimated that approximately 30% of its South African distribution falls with the PAOI. The regional subspecies is found anywhere within the PAOI with suitable shrubland. It is restricted to natural habitats and generally absent from transformed areas. Habitat loss in this key area could significantly impact the subspecies.

Eurasian curlew *(Numenius arquata):* This **NT** (Global and Regional) species is a non-breeding Palaearctic migrant, present in South Africa from September to March (Taylor *et al.,* 2015). In southern Africa, Eurasian curlews frequent muddy coasts, bays and estuaries with tidal mudflats and sandflats (Snow & Perrins, 1998) and rocky and sandy beaches (Navedo *et al.,* 2013). Curlews are likely to occur in estuarine habitats along the coast within the PAOI. Several key populations of the Eurasian curlew, are suspected to be experiencing moderately rapid declines.

Greater flamingo *(Phoenicopterus roseus):* The greater flamingo (Globally **LC;** Regionally **NT**) generally prefers coastal mudflats, inland dams, sewage treatment works, small temporary pans and river mouths, while it breeds at recently flooded, large eutrophic shallow salt pans (Hockey *et al.,* 2005). Within the PAOI flamingos are likely to use freshwater pans and estuarine habitats. Population declines are largely due to lowering water tables at breeding sites and collisions with powerlines and wind turbines.

Great white pelican *(Pelecanus onocrotalus):* The regional population of the great white pelican (Regionally **VU**) has been quantified at *ca.* 2 500 pairs, restricted to less than five breeding locations. Freshwater pans and estuarine habitats along the coast are habitats that pelicans are likely to use. Threats include human disturbance at breeding colonies (Berry *et al*., 1973), pollution (Crawford *et al*., 1995), collisions with power lines and the effects of drought.

Jackal Buzzard *(Buteo rufofuscus):* The jackal buzzard is classified as **near-endemic** with its range including South Africa, Lesotho, Namibia, extreme southern and southwestern parts of Mozambique and Botswana (Kemp & Kirwan, 2020). They are abundant in the central and north-western Karoo (Tippett, 2024). They are well adapted to diverse environments, from fairly wet habitats to semi-desert coastal regions of Namibia. Threats include habitat loss, and collisions with man-made structures such as wind turbines, powerlines and drowning in steep-sided reservoirs or farm dams (Nkomo *et al*., 2024). Additionally, their scavenging behaviour exposes them to the risk of poisoned carcasses.

Lanner falcon *(Falco biarmicus):* The Lanner falcon (Regionally **VU**) is widely distributed across Africa, the Arabian Peninsula and the Western Palaearctic (Ferguson-Lees & Christie, 2001). It occurs mostly in open grassland, cleared woodlands and agricultural areas. Breeding pairs tend to favour cliffs as nesting and roosting sites; however, they will also use alternative structures such as trees, pylons and buildings (Hockey *et al*., 2005). Within the PAOI they would use the powerline in the west and could potentially hunt over the entire area.

Ludwig's bustard *(Neotis ludwigii):* Ludwig's bustard (Globally and Regionally **EN**) occurs mainly in western Namibia and western South Africa (Taylor *et al.,* 2015). It prefers semi-arid shrublands of the Karoo, Namib Desert and Nama Karoo. It could occur throughout the PAOI within shrubland habitat. The main threat to Ludwig's Bustards originate from collisions with power and telephone lines causing unsustainable mortality rates in the Karoo (Jenkins *et al*., 2011). Poisoning and displacement due to disturbance are also threats to this bird species.

Martial eagle *(Polemaetus bellicosus):* Martial eagles (Globally and Regionally **EN**) occur in much of sub-Saharan Africa. In southern Africa, it is widespread but uncommon, generally preferring flat, open woodland. Within the PAOI, they would utilise the powerline in the west and potentially cover the entire area for hunting. Key threats include direct persecution through shooting and trapping by small-stock farmers, indirect poisoning, drowning in sheer-walled farm reservoirs, loss of natural prey due to habitat degradation, nest site disturbance, electrocution on electricity pylons and rangeland degradation affecting the distribution, abundance and accessibility of prey (Taylor *et al.,* 2015).

Mitigation measures to minimise impacts on avifauna at specific developments within the SEZ should be identified during an avifaunal specialist study. These measures should include strategic planning to avoid nests of large raptors and core breeding habitat areas of smaller passerine species, thereby minimizing disturbances at breeding, feeding, and roosting sites. Additionally, marking powerlines with flight diverters is a widely adopted approach to reduce collision risks, as these devices improve the visibility of powerlines for birds in flight. Incorporating such measures into development plans not only helps safeguard avian populations but also aligns with sustainable environmental principles.

3.4.2.2 Bats

Based on literature sources ten (10) bat species have previously been recorded in the area or may occur in the region. One of these species has a regional **NT** status (2016) and three have a **NT** status in the 2004 listing. The Angolan wing-gland bat (*Cistugo seabrae*) (regional **NT**) may roost in buildings, the Holgat ravine or Boegoeberg Twins.

Four impacts on bats were identified: (i) light pollution affecting light-averse bat species and creating artificial foraging habitats; (ii) possible bat mortalities or injuries due to hot steam/water discharge at the water-cooling tower blowdown; (iii) foraging habitat destruction; and (iv) roosting habitat destruction. Of these impacts light pollution would be the most significant. However, if the water-cooling towers are equipped with exposed radiator designs, acute and high bat mortalities may occur. It is therefore critical that a bat specialist be consulted on the intended design of the water-cooling towers.

Mitigation measures proposed include (i) keeping artificial lighting on infrastructure to a minimum, while still adhering to safety and security requirements; (ii) closing up water-cooling radiators with a mesh/grid with a diameter of 10 mm or less, to prevent bats and other wildlife from taking refuge inside radiator spaces; and (iii) adhering to the bat sensitivity map should adequately mitigate against foraging and roosting habitat destruction.

According to available information consulted during this study, there are no fatal flaws from a bat sensitivity perspective which should prevent the proposed development from proceeding towards the Environmental Impact Assessment process.

3.4.2.3 Mammals

Approximately 40 mammal species occur in the broader region (Virtual Museum ADU http://vmus.adu.org.za/; iNaturalist records), however, habitat for all these species is not available on site. The site is ideal for smaller mammals and a relatively large number of rodents, shrews, moles and mole rats occur in the surrounding area. Common species observed within the vicinity include *Parotomys brantsii*, *Micaelamys namaquensis* and *Otomys unisulcatus* and some medium to larger species such as *Oryx gazella, Parahyaena brunnea* and *Felis lybica.* The Cape fur seal will be discussed in the marine report. Four species of conservation concern (SCC) could potentially occur on site:

Cryptochloris wintoni **(CR) (De Winton's golden mole)** is known only from the type locality at Port Nolloth and was recently rediscovered after 86 years (Mynhardt, 2023; Mynhardt *et al*., 2024; Figure 3-15). It occurs in an area threatened by habitat transformation by diamond mining. The species was recorded with eDNA samples along the West Coast from Lamberts Bay to Visagiesfontein (Mynhardt *et al*., 2024). The presence of the species on site must still be established through appropriate survey techniques. **If recorded, the presence of the species likely represents a fatal flaw to the project, especially the Richtersveld Coastal Duneveld.**

Eremitalpa granti granti **(VU) (Grant's golden mole)** is endemic to southern Africa, with its distribution focused in the arid western parts of the Northern Cape and Namibia (Figure 3-15). Its narrow habitat requirements and sensitivity make it vulnerable to human and environmental changes. The species was recorded with eDNA samples along the West Coast at Visagiesfontein (Mynhardt *et al*., 2024) and south of the site. The presence of the species on site must still be established through appropriate survey techniques. **If recorded, the presence of the species likely represents a fatal flaw to the project, especially the Richtersveld Coastal Duneveld habitat.**

Panthera pardus pardus **(VU; CITES Appendix I) (African leopard)** is widely distributed across southern Africa occurring at low densities in the Northern Cape (Figure 3-15). Primary threats to leopards include habitat loss and fragmentation, prey depletion, human-wildlife conflict, trophy hunting, poaching for skins and body parts and indiscriminate killing. The species has not been recorded on site but it does occur east of the site. Should it occur on site, it does not represent a fatal flaw as the necessary mitigation measures can be implemented to reduce impacts on the species.

Parahyaena brunnea **(NT) (brown hyaena)** occurs throughout southern Africa, but primarily occupies the western Northern Cape (Figure 3-15). Its distribution is fragmented due to habitat degradation and human activity. The species has been recorded on and surrounding the site. Appropriate mitigation measures are required to reduce direct and indirect impacts on the species and its habitat. The presence of the species does not represent a fatal flaw to the project.

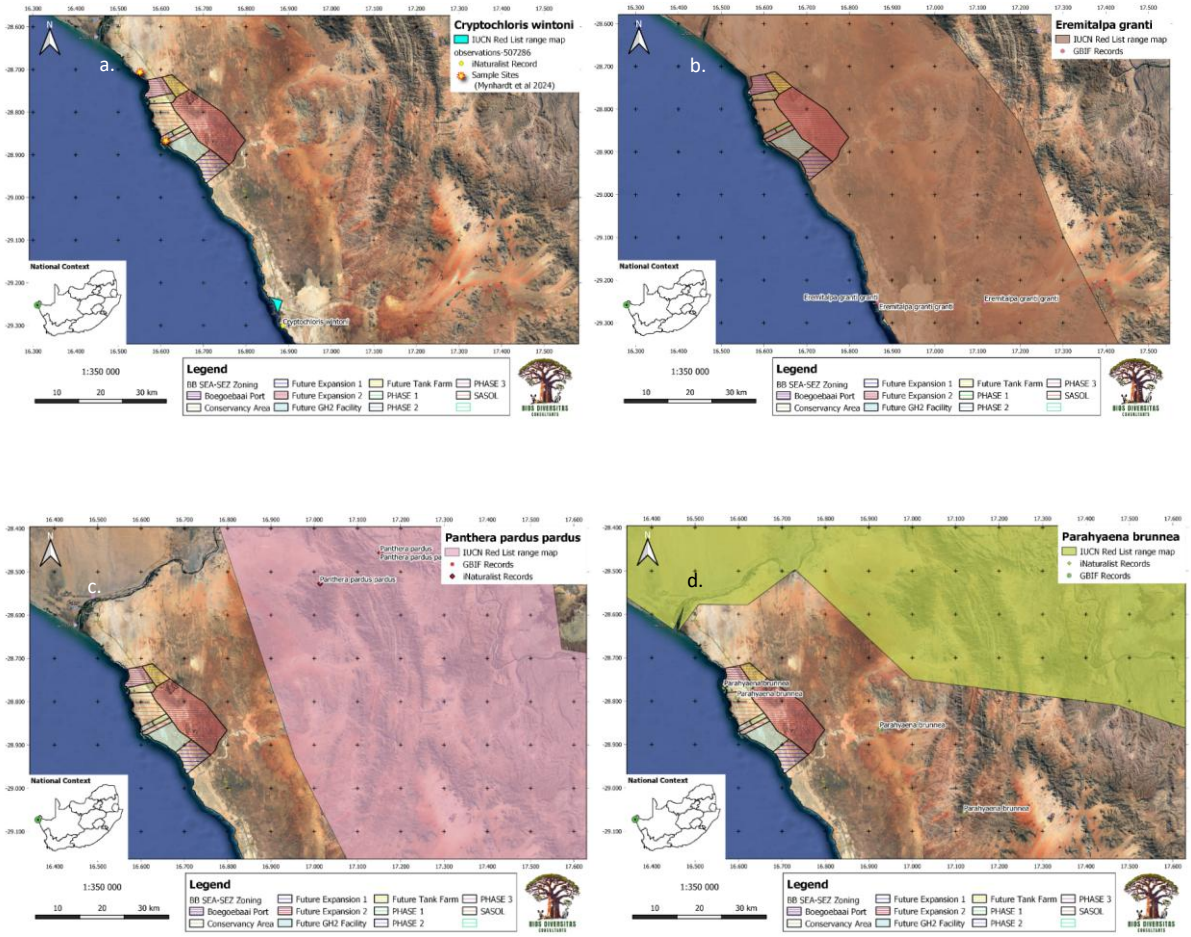


Figure 3-15: IUCN distribution range for (a) *Cryptochloris wintoni*; (b) *Eremitalpa granti*; (c) *Panthera pardus pardus*; and (d) *Parahyaena brunnea* in relation to the study area.

3.4.2.4 Reptiles

As many as 58 reptile species may potentially occupy the site. The area is particularly rich in lizards and snakes. Several chameleons, lizards and tortoises are vulnerable to collection, and the increased accessibility resulting from the development would raise the risk for these species. Five SCC have been recorded in the region:

Psammobates tentorius trimeni **(EN; CITES Appendix II) (western tent tortoise)** is restricted to a few vegetation types in the western Succulent Karoo (Figure 3-16), which are under continued pressure from overgrazing, destructive mining, uncontrolled plant harvesting and climate change. Predation by the pied crow (*Corvus albus*) on this taxon is severe. The species is protected in South Africa by provincial nature conservation ordinances and biodiversity laws at regional level. Based on the IUCN range data for the higher taxon group and observational records, the species can potentially occur on site although it is found mainly east of the site. The site is considered to have a **medium sensitivity** for the species.

Dermochelys coriacea **(CR regionally; VU globally) (leatherback sea turtle)** is distributed circumglobally, with its distribution range overlapping the Boegoebaai Port & SEZ site (Figure 3-16), although the site has not been identified as a nesting beach. The Namib Seashore Vegetation could be utilised by the species. It is unlikely that the species would represent a fatal flaw, but in the absence of sufficient field data the precautionary principle must be followed.

Chersobius signatus **(EN) (speckled Cape tortoise)** is endemic to South Africa, with the most northerly records from the Richtersveld (Bauer & Branch, 2001; iNaturalist; Figure 3-16). Based on IUCN range data and iNaturalist records, it is unlikely to occur on site as it prefers rocky terrain east of the site. The site is considered to have a **low to medium sensitivity** for the species.

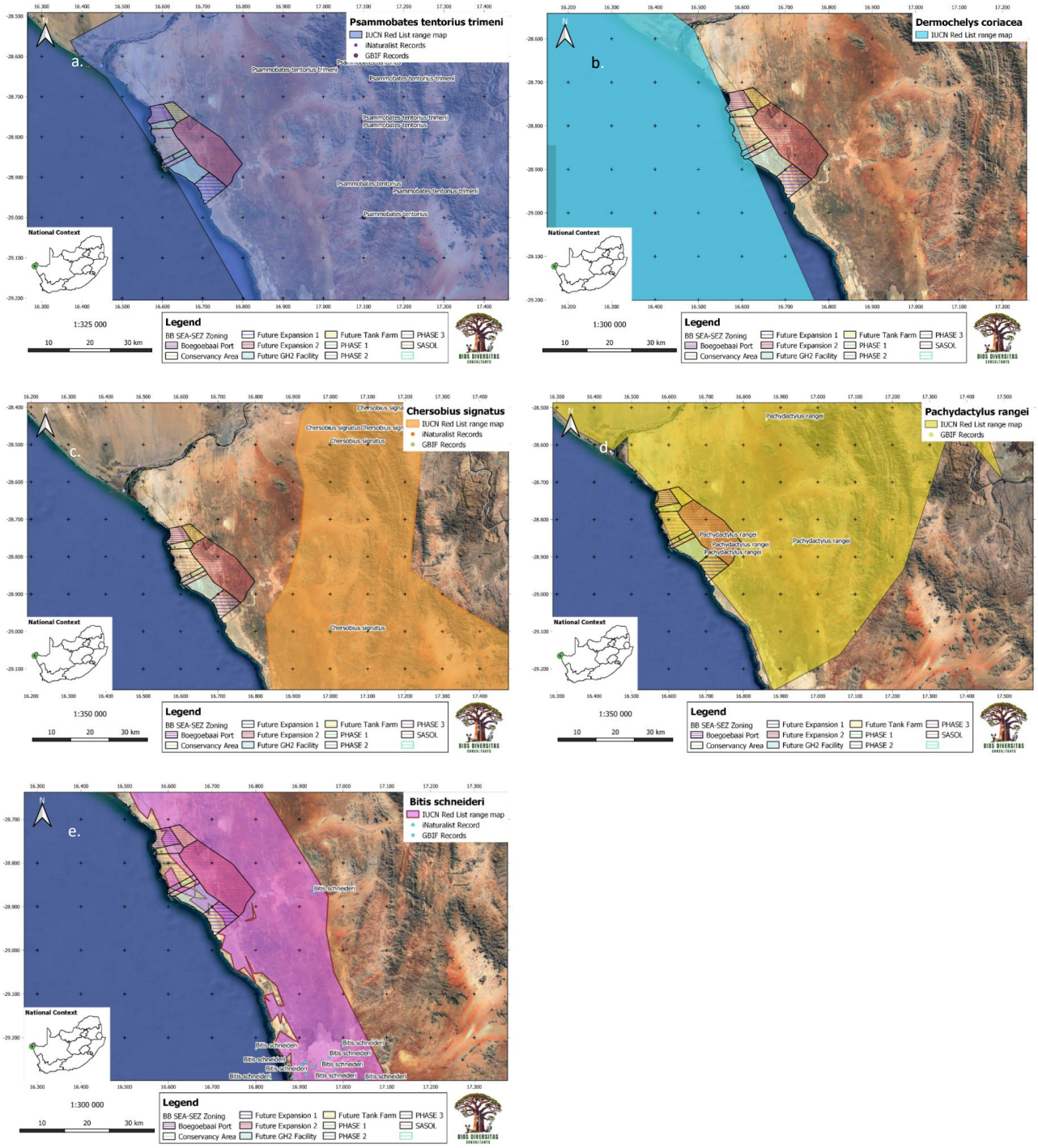


Figure 3-16: IUCN distribution range for (a) *Psammobates tentorius trimeni*; (b) *Dermochelys coriacea*; (c) *Chersobius signatus*; (d) *Pachydactylis rangei*; and (e) *Bitis schneideri* in relation to the study area.

***Pachydactylus rangei* (CR regionally; LC globally) (Namib web-footed gecko)** is a nocturnal, dune-dwelling gecko endemic to southern Africa (Figure 3-16). Its distribution extends marginally into South Africa where it is threatened by diamond mining (Bates *et al*., 2014) but it has an extensive range in Namibia and Angola where it is abundant, with a stable population (Baptista *et al*., 2020). The species has been recorded on site and thus the site is considered to have a **high sensitivity** for the species. Additional mitigation measures will be required in the breeding period during the construction phase.

Bitis schneideri **(NT Regionally, LC globally) (Namaqua dwarf adder)** is endemic to southern Africa (Figure 3-16). It is a habitat specialist and its habitat is impacted by habitat transformation due to mining and urbanisation. The species has been observed on site and the site is considered to have a **moderate sensitivity** for the species.

3.4.2.5 Amphibians

As a result of the scarcity of fresh water in the area, only four amphibian species are likely to occur on site with only one species classified as SCC.

Breviceps macrops **(desert rain frog) (VU)** occupies a narrow coastal strip along the northwestern Namaqualand coast (Figure 3-17). It is active during dense fog conditions. The species has been recorded on site. It is unlikely that it presents a fatal flaw to the project, but recorded habitat must be preserved and the appropriate mitigation measures applied.

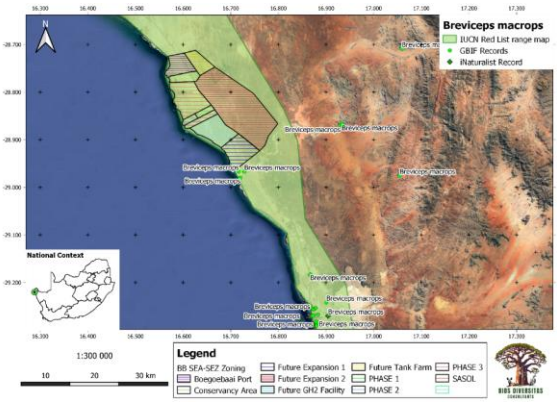


Figure 3-17: IUCN distribution range for *Breviceps macrops* in relation to the study area.

3.4.2.6 Vegetation and Flora

The provisional checklist (Supplementary material: Van Rooyen *et al*., 2025) for the Boegoebaai Port and SEZ site contains 390 plant species that have been confirmed as occurring on site from data collected by P. van Wyk; the current site visit in 2024; iNaturalist; data supplied by SANBI (2024) and extracted from SANBI's Brahms database (NewPOSA). The confirmed on-site checklist includes eight species with a **CR** IUCN status; nine **EN** species; 15 **VU** species; seven **NT** species; six **DD** species; and one **Rare** species. Thus, in total 46 species could be classified as SCC representing 11.8% of all species on site. Twenty one species, currently listed as LC could potentially become SCC should the Boegoebaai development proceed (SANBI, 2024).

Considering the limited access to the mining area to the west of the R382, the on-site checklist is probably not a full inventory of plant species occurring on site. Furthermore, the impacts of a large development such as the Boegoebaai Port and SEZ will generally not be limited to the site but will be more widespread and land adjoining the site will also be affected. Areas indirectly impacted by the development could include parts of Kortdoorn and Grootderm along the Orange River, an area with a particularly high concentration of SCC. These areas could also be targeted by plant poaching as a result of increased human activities due to the development.

Plant families contributing most species to the provisional checklist were the Aizoaceae (vygie family) and Asteraceae (daisy family). Seed dispersal in the Aizoaceae is generally restricted in space and time. These plants possess hygrochastic fruits that open when moistened to allow the seeds to disperse by falling raindrops and close again during dry weather. Primary dispersal is usually over very short distances. However, seed dispersal occurs only when it rains and conditions for germination should theoretically be suitable. In contrast, the fruits of the Asteraceae are often well equipped with mechanisms that aid wind

dispersal (e.g. wings or plumes). Habitat fragmentation will therefore have a greater negative effect on the Aizoaceae than the Asteraceae and recolonisation after a major disturbance will be slower in the Aizoaceae. Many of the SCC occurring on site are members of the Aizoaceae.

Although a detailed field assessment of the vegetation was not necessary at the screening level required for the SEA, a broad-scale, high-level, on-site reconnaissance and evaluation of the vegetation was deemed necessary to verify the Screening Tool's site sensitivity. Floristic data gathered during the site visit were classified following phytosociological procedures and nine plant communities (habitats) were identified (Figure 3-18). A full description of the plant communities is provided in the report on the vegetation (Supplementary material: Van Rooyen *et al.,* 2025).

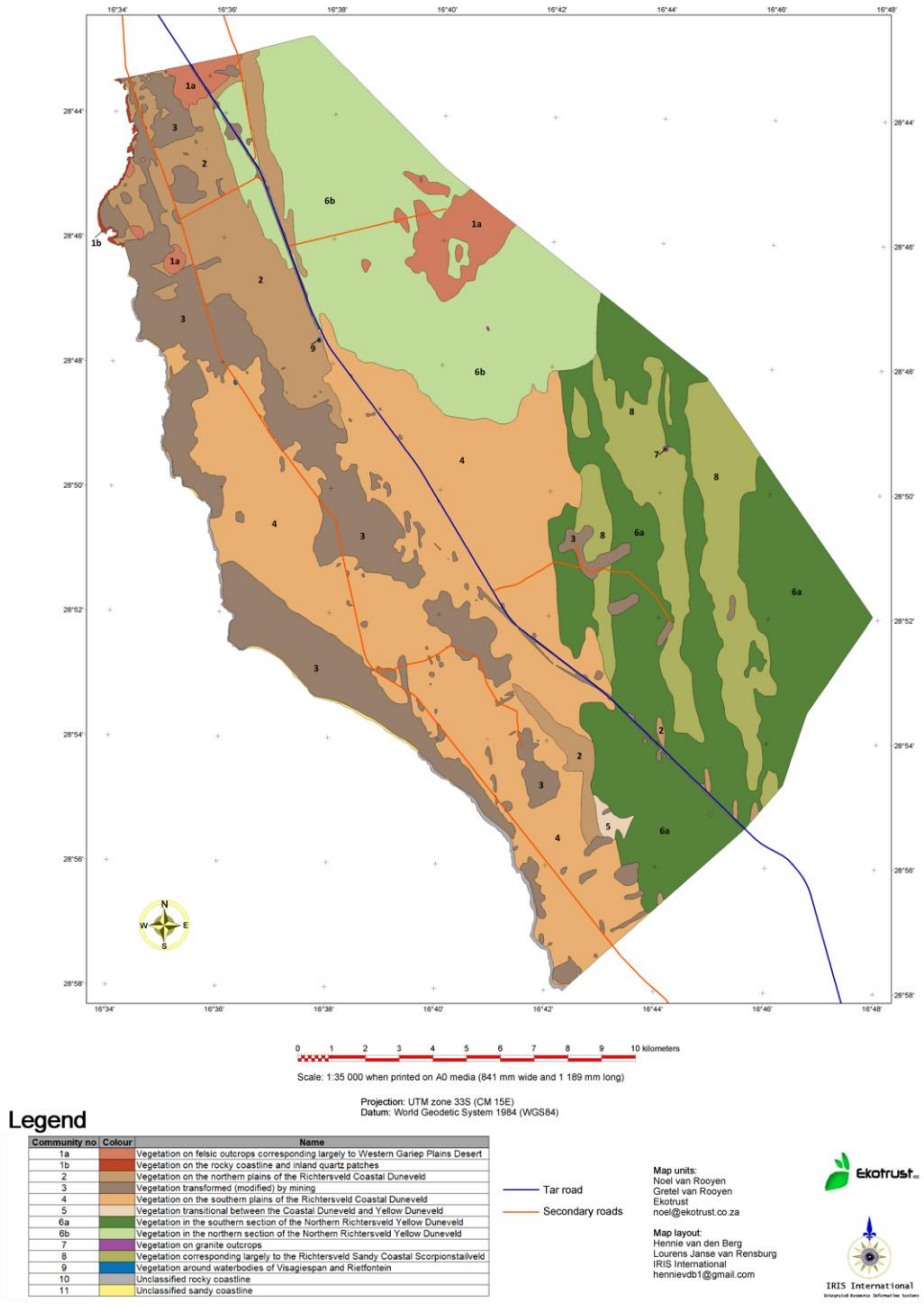


Figure 3-18: Broad-scale vegetation map indicating the location of the plant communities distinguished in this report.

Plant Community/Habitat 1 (C1): This habitat occurs where the basement geology is exposed, most notably on the outcrops such as the Boegoeberg Twins, Namakwakop and around the Telkom tower

(Visagiesfonteinkop). Small outcrops were not all mapped. These rocky outcrops are sensitive environments associated with unique vegetation.

- ***Presence of SCC:*** This plant community contained a wealth of SCC: 6 **CR** plant species; 2 **EN** plant species*;* 6 **VU** plant species*;* 2 **NT** plant species*;* 2 **DDT** plant species*;* and 1 **Rare** plant species.

- ***Occurrence of threatened ecosystems:*** Although Plant Community 1 is typical of the Western Gariep Plains Desert, which has a Least Concern status, sections of this plant community occur in the areas mapped as Namib Seashore Vegetation and in the Richtersveld Coastal Duneveld, both of which have a **CR** status.

- ***Occurrence in a CBA (2016 CBA map):*** Large portions of this community are located in a **CBA 1**.

- ***Located in a Focus Area of the NPAES:*** The area around Visagiesfonteinkop has been included in the **NPAES**.

- ***Degree of disturbance vs intact vegetation:*** In some parts the vegetation is still fairly intact, although some areas are degraded.

- ***Time needed for vegetation to recover:*** Once disturbed, the vegetation in Plant Community 1 will take many decades to recover.

Plant Community/Habitat 2 (C2): These wind-swept plains appear to be a degraded, species-poor variant of C4.

- ***Presence of SCC:*** Plant Community 2 contained the following SCC: 2 **CR** plant species; and 1 **VU** plant species.

- ***Occurrence of threatened ecosystem:*** For the most part it falls in the **CR** Richtersveld Coastal Duneveld.

- ***Occurrence in a CBA (2016 CBA map):*** The unit is largely mapped as a CBA 1.

- ***Located in a Focus Area of the NPAES:*** The area is not included in the NPAES.

- ***Degree of disturbance vs intact vegetation:*** The vegetation is considered to be a degraded variant of the Richtersveld Coastal Duneveld.

- ***Time needed for vegetation to recover:*** Without stabilising the sand and other rehabilitation measures, the vegetation in Plant Community 2 will take very long to recover after a major disturbance.

Plant Community/Habitat 3 (C3): Plant Community 3 has been **transformed** by mining and currently represents modified habitat *sensu* IFC Performance Standard 6 (IFC, 2012, updated 2019). It is floristically strongly related to C2, but differs in the level of transformation. For the most part, the unit is located within the area mapped as Richtersveld Coastal Duneveld (SANBI 2012-2024 as amended), but due to the level of disturbance might never return to its original state.

- ***Presence of SCC:*** No SCC were recorded during the site visit.

- ***Occurrence of threatened ecosystems:*** For the most part the community falls in the Richtersveld Coastal Duneveld. However, due to the transformed nature of the unit, it does not warrant a CR ecosystem status.

- ***Occurrence in a CBA (2016 CBA map):*** The plant community was not classified in the CBA map.

- ***Located in a Focus Area of the NPAES:*** The area is not included in the Expansion Strategy.

- ***Degree of disturbance vs intact vegetation:*** The vegetation is transformed.

- ***Time needed for vegetation to recover:*** Considering the permanent transformation, Plant Community 3 might never return to its original state.

Plant Community/Habitat 4 (C4): The species composition recorded in this plant community during the site visit agrees well with the description of the Richtersveld Coastal Duneveld provided in Mucina & Rutherford (2006).

- ***Presence of SCC:*** Several SCC were recorded during the site visit, with some additional records obtained from iNaturalist: 2 **CR** plant species; 1 **EN** plant species; 2 **VU** plant species*;* and 1 **NT** plant species.

- ***Occurrence of threatened ecosystems:*** This unit falls mainly in the **CR** Richtersveld Coastal Duneveld.

- ***Occurrence in a CBA (2016 CBA map):*** Community 4 has for the most part been classified as **CBA 1**.

- ***Located in a Focus Area of the NPAES:*** Only a small section has been included in the **NPAES**.

- ***Degree of disturbance vs intact vegetation:*** The community is interspersed with mine trenches, diggings and dumps. There are some areas with intact vegetation and other areas that were disturbed a very long time ago that are now in a good condition.

- ***Time needed for vegetation to recover:*** Considering the harsh environment, Plant Community 4 will take a long time to recover fully after a major disturbance.

Plant Community/Habitat 5 (C5): Plant Community 5 represents a transition from the vegetation characteristic of the Richtersveld Coastal Duneveld to the vegetation typically found in the Northern Richtersveld Yellow Duneveld.

- ***Presence of SCC:*** No SCC were recorded during the site visit.

- ***Occurrence of threatened ecosystem:*** This habitat falls in the Northern Richtersveld Yellow Duneveld (**LC**).

- ***Occurrence in a CBA (2016 CBA map):*** Plant Community 5 has been mapped as **CBA 2**.

- ***Located in a Focus Area of the NPAES:*** The area has not been included in the NPAES.

- ***Degree of disturbance vs intact vegetation:*** The community consists largely of intact vegetation.

- ***Time needed for vegetation to recover:*** The vegetation will take very long to recover after a major disturbance.

Plant Community/Habitat 6 (C6): The plant community represents the area mapped as Northern Richtersveld Yellow Duneveld within the Boegoebaai Port and SEZ.

- ***Presence of SCC:*** *Subcommunity* 3 **CR** plant species; 7 **VU** plant species; and 3 **NT** plant species.

- ***Occurrence of threatened ecosystem:*** The community falls into the Northern Richtersveld Yellow Duneveld with a **LC** status.

- ***Occurrence in a CBA (2016 CBA map):*** The unit has been mapped partly as **CBA 1** and partly as **CBA 2**.

- ***Located in a Focus Area of the NPAES:*** The area has largely been included in the **NPAES.**

- ***Degree of disturbance vs intact vegetation:*** Plant Community 6 is largely intact vegetation used for livestock grazing.

- ***Time needed for vegetation to recover:*** The vegetation will take long to recover after a major disturbance.

Plant Community/Habitat 7 (C7): This small plant community represents a unique habitat, occurring on and around granite boulder outcrops. During the rainy season, the hollows in the granite boulders are filled with water providing an important source of water for wildlife.

- ***Presence of SCC:*** The following SCC were recorded during the site visit: 2 **VU** plant species; 1 **NT** plant species.

- ***Occurrence of threatened ecosystems:*** This unit falls into both the Northern Richtersveld Yellow Duneveld and Richtersveld Sandy Coastal Scorpionstailveld, both of which have a **LC** status.

- ***Occurrence in a CBA (2016 CBA map):*** The unit has been mapped as **CBA 2**.

- ***Located in a Focus Area of the NPAES:*** The area has been included in **NPAES.**

- ***Degree of disturbance vs intact vegetation:*** Plant Community 7 represents natural habitat but shows signs of disturbance by humans and livestock.

- ***Time needed for vegetation to recover:*** The vegetation will take very long to recover after a major disturbance.

Plant Community/Habitat 8 (C8): Plant Community 8 agrees with the area mapped as Richtersveld Sandy Coastal Scorpionstailveld and was characterised by the heuweltjies occurring in the unit. The heuweltjies on site lack the typical surface mounding and appear as flat, rather barren patches (McAuliffe *et al*., 2019).

- ***Presence of SCC:*** Only 1 **NT** plant species was encountered during the site visit.

- ***Occurrence of threatened ecosystems:*** This unit falls in the **LC** Richtersveld Sandy Coastal Scorpionstailveld.

- ***Occurrence in a CBA (2016 CBA map):*** The unit has mostly been mapped as **CBA 2**, with parts as **CBA 1**.

- ***Located in a Focus Area of the NPAES:*** Most of Plant Community 8 has been included in the **NPAES.**

- ***Degree of disturbance vs intact vegetation:*** The unit represents natural habitat and is used for livestock grazing.

- ***Time needed for vegetation to recover:*** The vegetation will take a very long time to recover after a major disturbance.

Plant Community/Habitat 9 (C9): Plant Community 9 represents the vegetation around the waterbodies of Visagiespan and Rietfonteinpan.

- ***Presence of SCC:*** No SCC were recorded in Plant Community 9 during the site visit.

- ***Occurrence of threatened ecosystems:*** It is embedded in the Richtersveld Coastal Duneveld with a **CR** status.

- ***Occurrence in a CBA (2016 CBA map):*** Rietfonteinpan's waterbody was mapped as **CBA 1**, the waterbody at Visagiespan was not classified.

- ***Located in a Focus Area of the NPAES:*** The area has not been included in the **NPAES.**

- ***Degree of disturbance vs intact vegetation:*** The waterbody at Visagiespan appears to be highly disturbed, however, Rietfonteinpan is a natural wetland.

- ***Time needed for vegetation to recover:*** The vegetation will take very long to recover after a major disturbance.

3.5 SITE SENSITIVITY

This section considers aquatic and terrestrial ecosystems in the context of their likely sensitivity to the various activities associated with the proposed development.

3.5.1 Aquatic Ecology

Inland aquatic ecosystems are highly sensitive to changes in hydroperiod, water quality and surface runoff patterns; physical disturbance; and fragmentation from other watercourses and supporting terrestrial areas (Supplementary material: Day, 2025).

Estuarine aquatic ecosystems: (i) The *Orange River Estuary* is highly sensitive to activities/impacts that result in: changes in freshwater flows (as a result of increased demand for fresh water, with water demand in Alexander Bay being met in part by flows from the Orange River upstream of the estuary (Hattingh, 2016)); increased road infrastructure across the estuary, affecting flows into the estuarine saltmarshes; increased nutrient input associated with increased treated sewage effluent discharge; increased recreational activities; increase in physical disturbance by vehicle and other traffic into the estuary; and increased dumping of solid waste. (ii) The *Holgat River Estuary* is classified as a micro-outlet. Although its catchment has been rated as near-natural, the estuary itself has been highly altered by mining-associated activities and, coupled with its highly ephemeral character, means that it has little estuarine function.

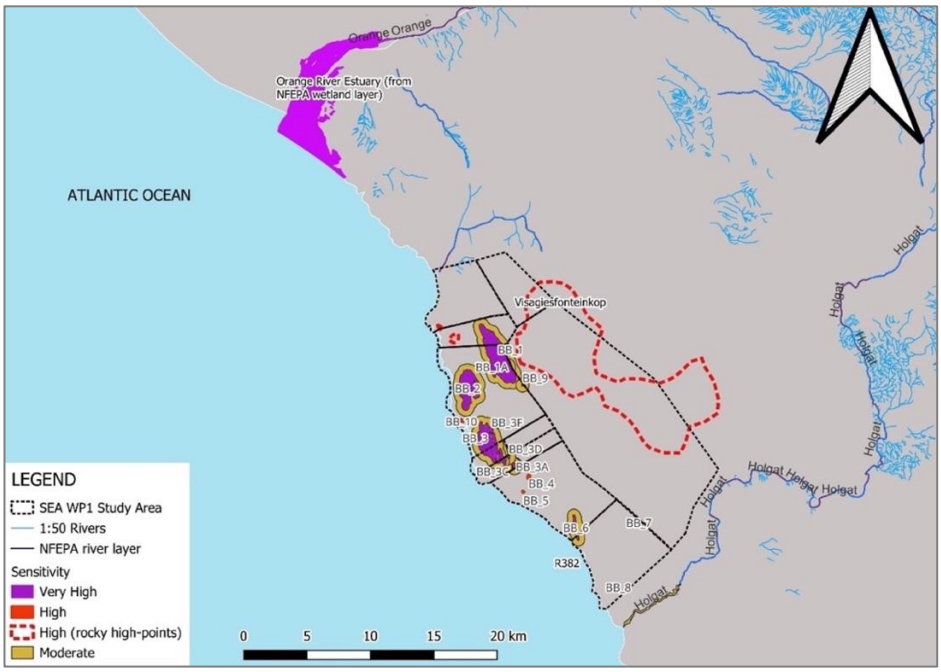


Figure 3-19**:** Inland and estuarine aquatic ecosystems sensitivity (assuming no mitigation measures) of the proposed Boegoebaai Port and SEZ study area. Grey areas are rated as of Low sensitivity to the present proposed project.

The following sensitivity classes were applied for mapping the sensitivity of inland and estuarine aquatic ecosystems in the proposed Boegoebaai Port and SEZ (Figure 3-19):

- **Very High sensitivity:**
  - Natural pans, associated wetlands and springs. Critically Endangered **(CR)** and Endangered **(EN)** wetland types from the NBA (Van Deventer *et al*., 2019) (i.e. depressions/pans);
  - The Orange River Estuary although not on site.
- **High sensitivity:**
  - Artificial pans/excavations;
  - Pan/pool habitat assumed to be included in parts of rocky outcrops such as the Visagiesfonteinkop.
- **Medium sensitivity:**
  - Buffer areas (50 m) outside of all mapped aquatic ecosystems have been included as protective setback to ensure that inland and estuarine aquatic ecosystems are protected from physical developmental impacts;
  - Hydrological buffers (500 m), intended to improve confidence that hydrological linkages required for ensured ecosystem functioning can be maintained. This conservative buffer could be reduced, with an improved, data-driven understanding of surface/groundwater/interflow linages and processes in the area.
  - The Holgat River Estuary lies outside of the proposed development and it is unlikely to be targeted as a water resource.
- **Low sensitivity:**
  - All non-aquatic areas outside of recommended aquatic ecosystem buffer zones.

Note: Not included in the sensitivity mapping are corridors to allow for aquatic-to-aquatic and aquatic-to-terrestrial and coastal ecosystems, to ensure sustained ecological connectivity between different habitat types. This issue would need to be developed further during detailed development design.

3.5.2 Fauna: Avifauna

According to the DFFE Screening Tool the Animal Species Theme (Figure 20) for the Boegoebaai Port and SEZ contains portions with a **High** sensitivity linked to the possible occurrence of the Lanner falcon (*Falco biarmicus*) (**VU**).

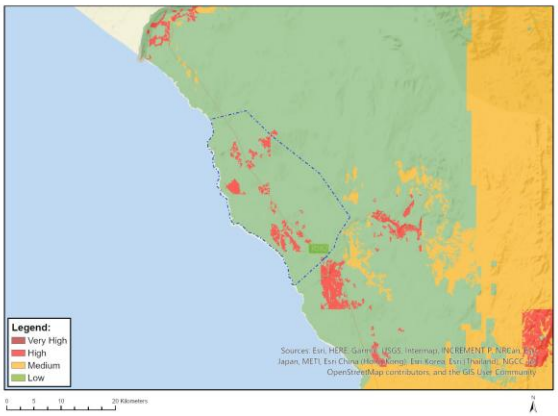


Figure 3-20: Sensitivity map for the Animal Species Theme of the Screening Tool for the Development Site.

To define low, medium, high and very high sensitivity classes for the Boegoebaai Port and SEZ, R-workflow was used to prepare, pre-process and analyse remote sensing, topographical, land-cover and climatic data. A classification modelling framework was used to assess habitat suitability for the target species. The modelling workflow included data partitioning, model training, variable selection, model testing, model optimisation through hyperparameter tuning and final model predictions. Primary models were trained using the Random Forest, ANN and Maxnet algorithms, followed by hyperparameter tuning and model optimisation using the genetic algorithm (Vignali *et al.,* 2020).

A weighted algorithm was scripted and implemented in Python. The weighted algorithm applies greater sensitivity weights to species that are more threatened and are either endemic, near-endemic or highly range-restricted within South Africa. Furthermore, data types that included nests, roosts and/or areas of core occupancy received the highest weights for the respective data/model type criterion. All distribution models, habitat suitability models and other data types are ingested into the weighted algorithm with species and data specific weights applied to generate an overall avian sensitivity map for the Boegoebaai Port and SEZ (Figure 3-21).

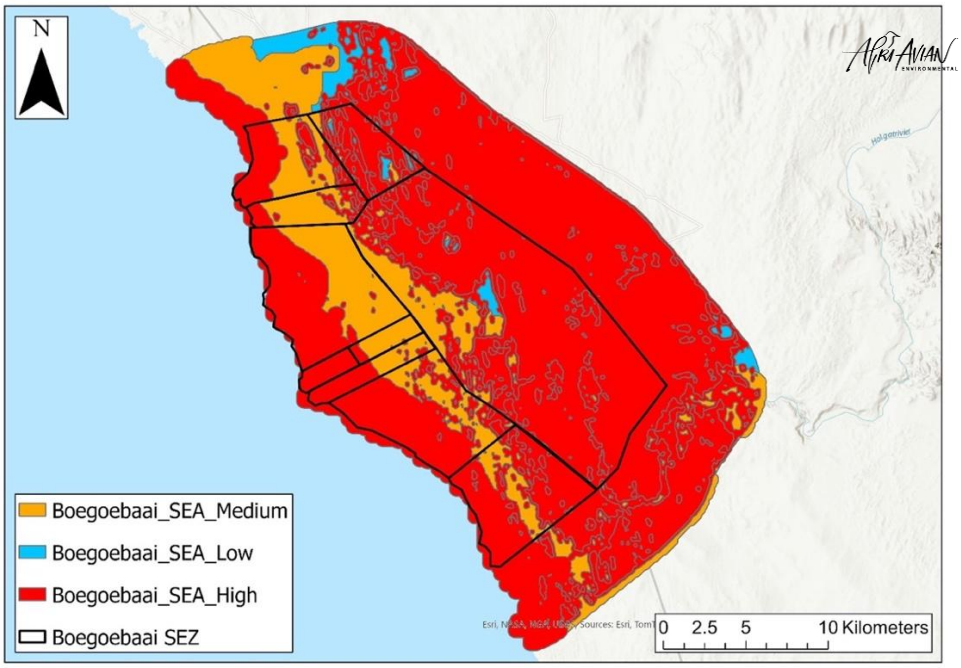


Figure 3-21: The avian sensitivity layer generated from the weighted analysis incorporating 13 avian SCCs. The map does not consider transformed areas.

3.5.3 Fauna: Bats

The sensitivity map (Figure 3-22) is based on features identified to be important for foraging and roosting of bat species that most commonly occur in the area.

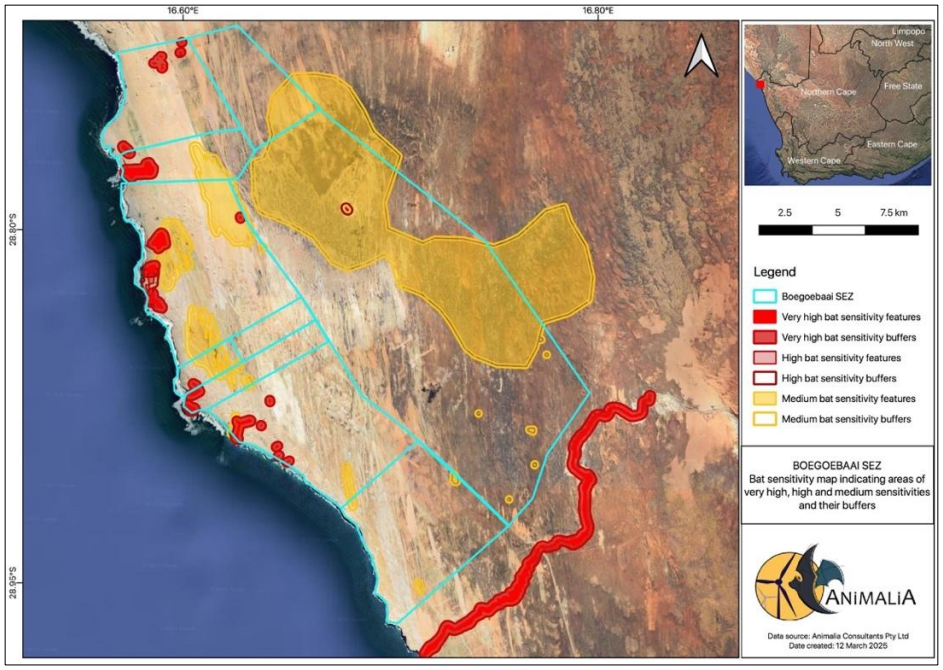


Figure 3-22: Bat sensitivity map of the proposed Boegoebaai Port and SEZ development. The map does not consider transformed areas.

The following sensitivity classes were applied:

- **Very High sensitivity:**
    - Rocky outcrops and the rocky Holgat drainage ravine;
    - Aquatic water sources with exposed surface water;
    - A 200 m no-go zone buffer was applied.

  These areas are 'no-go' zones and infrastructure may not be placed in these areas and their buffers.
- **High sensitivity:**
    - Temporal water sources;
    - A 200 m buffer was assigned.

  Only infrastructure with no artificial lighting may be placed in these areas.
- **Medium sensitivity:**
    - Non-perennial washes, pans and other seasonal water sources;
    - Livestock aggregation areas and kraals;
    - Terrain with regular undulating dunes, interspersed livestock aggregations and occasional high points;
    - A 150 m buffer was assigned.

  Keep development to a minimum in these areas, preferably no outside lighting if practically feasible.

3.5.4 Fauna: Mammals, Reptiles and Amphibians

Based on the precautionary principle and available secondary data a preliminary sensitivity map was produced for the site (Figure 3-23). It must be noted that species-specific baseline assessments are required to verify and update this sensitivity map and delineate buffer zones.

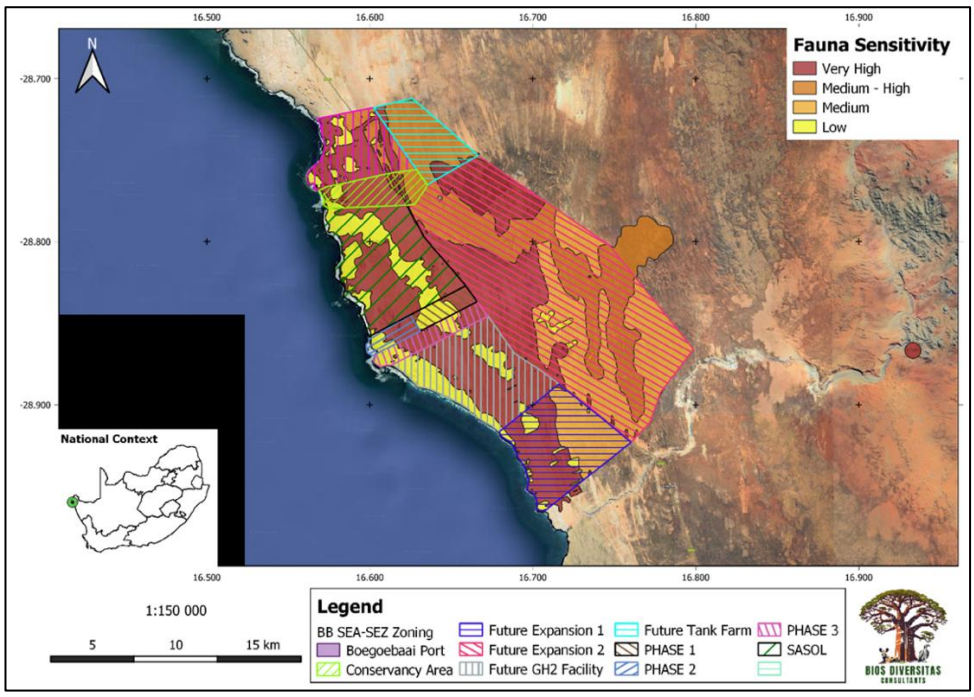


Figure 3-23: Site sensitivity based on the faunal assessment of the mammals, reptiles and amphibians.

The following sensitivity classes were applied:

- **Very High sensitivity:**
  - Remnants of the Richtersveld Coastal Duneveld and Namib Seashore Vegetation which are **CR ecosystems** and potentially harbour several fauna SCC.
  - Suitable habitat for faunal SCC, including *Pachydactylus rangei, Bitis schneideri, Breviceps macrops, Cryptochloris wintoni, Eremitalpa granti granti* and *Parahyaena brunnea.*
  - Unique and important features on site, e.g. Boegoeberg Twins, Visagiesfonteinkop and sandy beaches.

Development within areas of **Very High** sensitivity should be avoided due to the sensitive nature of these areas and potential negative impacts of the development on faunal SCC.

- **Medium to High sensitivity:**
  - Important and unique features of the Northern Richtersveld Yellow Duneveld.
  - Remaining natural habitat of Namaqualand Salt Pans and Western Gariep Plains Desert.
  - The Swartbank Heuweltjies, part of the Richtersveld Sandy Coastal Scorpionstailveld.
  - Corridors connecting coastal to inland habitats, which several SCC could utilise.
  - Include focus areas for protected areas of expansion which intersect sensitive features.

- **Medium sensitivity:**
    - Remaining natural habitat of the Northern Richtersveld Yellow Duneveld and Richtersveld Sandy Coastal Scorpionstailveld, excluding the Swartbank Heuweltjies which are considered more sensitive.
    - Few faunal SCC have suitable habitat in this region, but they could be important ecological corridors and act as high value climate resilience areas (to be confirmed).
- **Low sensitivity:**
    - Transformed or modified habitat due to mining and other human activities. Faunal species use these areas to move between intact habitats, but it is not suitable for breeding and foraging.

3.5.5 Vegetation and Flora

The Screening Tool (DFFE) rated the sensitivity of the Plant Theme as **Medium** and provided a list of 19 plant species with all species rated as of medium sensitivity (Table 3-1, Figure 3-24). The presence of 13 of these species were confirmed on site (data site visit in 2024; P. van Wyk; SANBI, 2024; iNaturalist; NewPOSA database). An additional 33 SCC were confirmed for the site (Appendix A). In total, there are thus **46 confirmed SCC on site**. Moreover, 163 Northern Cape provincially protected/specially protected and 20 CITES-listed species are also present on site.

The criteria used for the current site sensitivity assessment of the Plant Theme per plant community were as follow:

- A plant community was rated as **Very High** if it was habitat for a **CR** species;
- A plant community was rated as **High** if it was habitat for an **EN or VU** species;
- A plant community was rated as **Medium** if it was habitat for a **NT, DD or Rare** species; and
- A plant community was rated as **Low** if it was not habitat for any SCC.

On the basis of these criteria it is recommended that the sensitivity of the Plant Theme should be upscaled to **Very High** (Figure 3-25a). Areas transformed by mining, had no SCC and were rated as modified or transformed habitat.

Table 3-1: Species of Conservation Concern (SCC) listed for the Boegoebaai Port and SEZ site in the Screening Tool and whether their presence could be confirmed on site

Sensitivity	Feature(s)	IUCN Status	Confirmed on site
Medium	*Bassia dinteri*	CR	Yes (SANBI)
Medium	Sensitive species* 305	Was VU; now CR	Yes
Medium	*Mesembryanthemum occidentale (= Aridaria vespertina)*	EN	
Medium	Sensitive species 282	EN	
Medium	Sensitive species 407	Was VU; now EN	Yes
Medium	Sensitive species 293	EN	Yes
Medium	Sensitive species 1110	EN	Yes
Medium	*Calobota acanthoclada*	EN	Yes
Medium	Sensitive species 827	VU	Yes
Medium	Sensitive species 435	VU	
Medium	Sensitive species 734	VU	Yes
Medium	Sensitive species 1187	VU	Yes
Medium	Sensitive species 720	VU	Yes
Medium	*Adromischus montium-klinghardtii*	VU	Yes
Medium	*Nemesia saccata*	VU	Yes

Sensitivity	Feature(s)	IUCN Status	Confirmed on site
Medium	*Helichrysum dunense*	VU	Yes
Medium	Sensitive species 744	VU	
Medium	*Manulea cinerea*	VU	
Medium	Sensitive species 1090	RARE	

(*As per best practise guideline that accompanies the Plant Species Protocol for the screening tool, the **name of the sensitive species may not appear in any specialist reports released into the public domain**. It should be referred to as *sensitive plant species* and its threat status may be included, e.g. *critically endangered sensitive plant species* nr.)

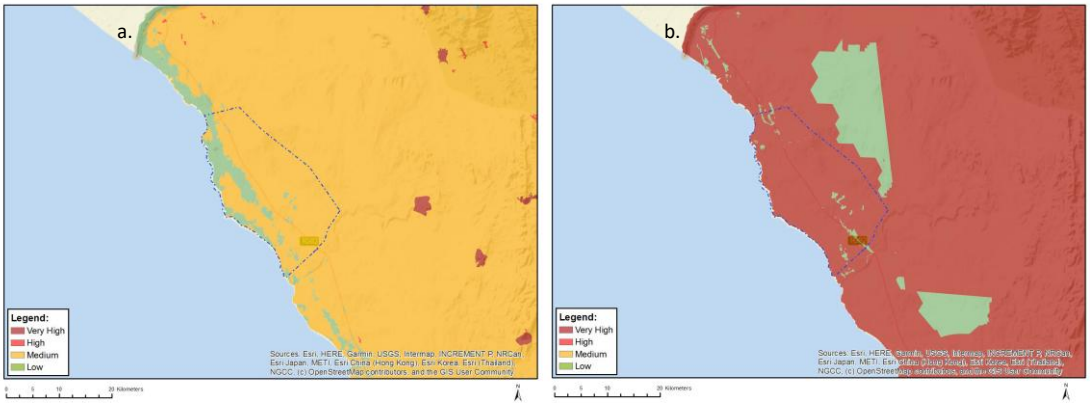


Figure 3-24: Screening Tool's site sensitivity map of (a) the Plant Theme and (b) Relative Terrestrial Biodiversity Theme.

The Screening Tool (DFFE) rated the sensitivity of the Relative Terrestrial Biodiversity Theme as **Very High** based on the features listed in Table 3-2 (Figure 3-24b). Because the 2016 CBA map was used in the Screening Tool the same version was used for the current comparison. The desktop evaluation confirmed the presence of these features and if the same sensitivity ratings were used as in the Screening Tool, the Very High sensitivity for almost the entire site would be supported.

Table 3-2: Features used by the Screening Tool to assess the Relative Terrestrial Biodiversity Theme and the sensitivity rating used by the Screening Tool as well as the adjusted ratings used in the current assessment

Feature(s)	Sensitivity (Screening Tool)	Sensitivity used in the current assessment
Low Sensitivity	Low	
CBA 1	Very High	Very High
CBA 2	Very High	High
ESA	Very High	Medium
National Protected Area Expansion Strategy (NPAES)	Very High	High
CR Namib Seashore Vegetation	Very High	Very High
CR_Richtersveld Coastal Duneveld	Very High	Very High
CR plant species	-	Very High

The sensitivity ratings were slightly modified in the current assessment to correspond more closely with the 'Best Practice Guidelines for Implementing the Mitigation Hierarchy in South Africa' (EWT, 2023) and the National Biodiversity Offset Guideline (DFFE, 2023). These rating slightly modified the sensitivity map for the Relative Terrestrial Biodiversity Theme (Figure 3-24b) although the overall sensitivity would still be **Very High.**

The criteria used for the current site sensitivity assessment of the Relative Terrestrial Biodiversity Theme per plant community were as follow:

- **Very High sensitivity:**
  - a **CR ecosystem**;
  - an irreplaceable Critical Biodiversity Area (**CBA 1**); and
  - confirmed habitat of a **CR plant species**.

According to the mitigation hierarchy (EWT, 2023) a **Very High** impact rating would indicate that the proposed development must be **avoided/prevented**, since these changes cannot be remedied and offsets or compensation would not be feasible because of the high threat status or irreplaceability of the affected biodiversity or ecosystem services (EWT, 2023).

- **High sensitivity:**
  - an optimal Critical Biodiversity Area (**CBA 2**);
  - an **EN ecosystem**;
  - the inclusion in **NPAES**; and
  - confirmed habitat of an **EN** species, or impacts leading to an increase in their threat status.

Where residual negative impacts of **High** significance remain, biodiversity offsets/compensation can be considered.

- **Medium sensitivity:**
  - an Ecological Support Area (**ESA**);
  - irreversible impacts on Priority Focus Areas in **NPAES**;
  - **VU** ecosystems;
  - **VU** species, or endemic (but not range-restricted) or protected species; and
  - impacts on ecosystems or species which would result in them being listed as threatened.

Avoidance or minimisation of impacts is essential and restoration of degraded areas must be undertaken when the impact rating is Medium. Should significant negative impacts of medium significance remain, biodiversity offsets/compensation can be considered.

- **Low sensitivity:**
  - loss of vegetation of least concern (ONA), supporting no threatened ecosystems or species, and not constituting important ecological process areas or corridors, or providing important ecosystem services.

Impacts with a Low sensitivity rating should as far as possible be minimised and rehabilitation/restoration would minimise residual negative impacts and biodiversity offsets or compensation would not be required.

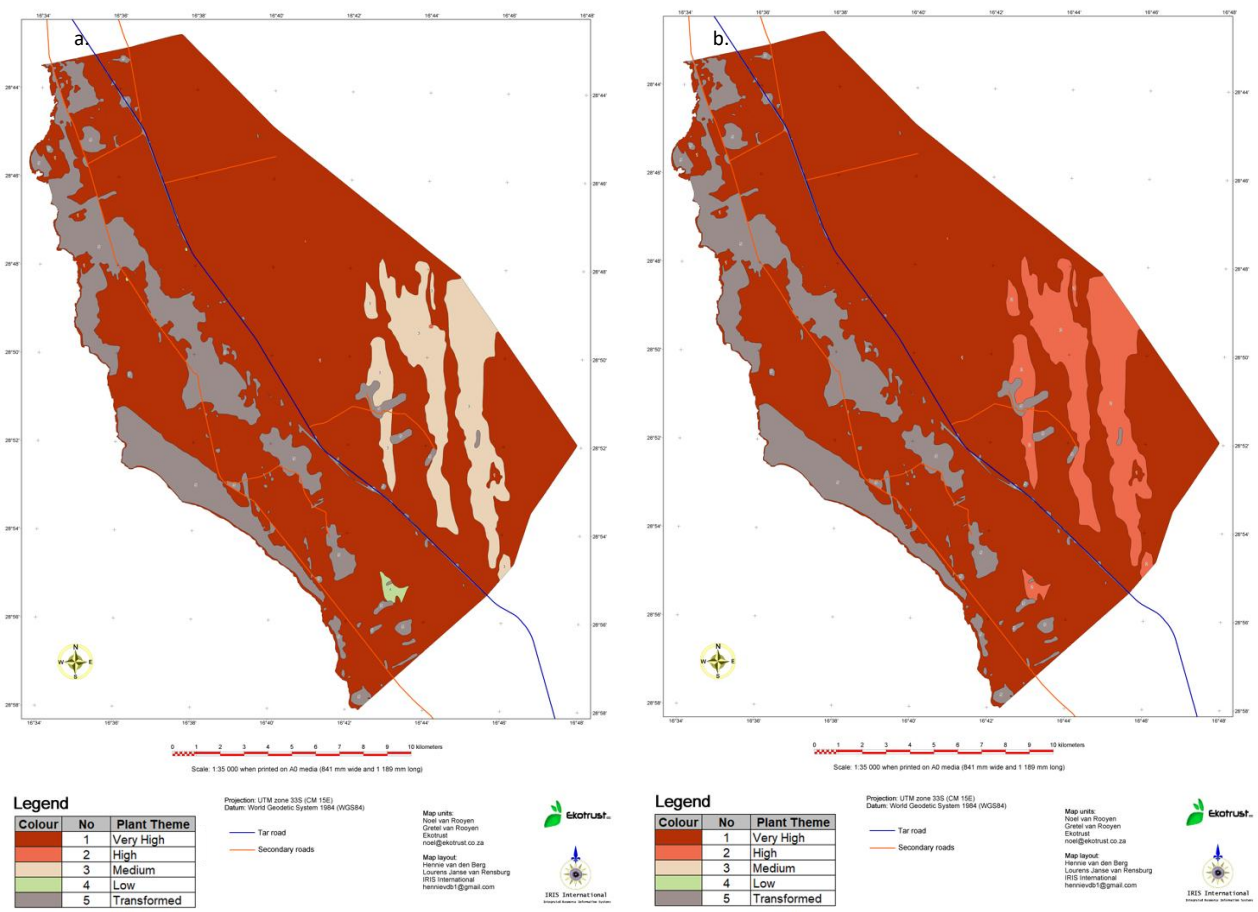


Figure 3-25: Site sensitivity of (a) the Plant Theme and (b) the Relative Terrestrial Biodiversity Theme for the Boegoebaai Port and SEZ site as found in the current study.

The **Very High sensitivity** of the Relative Terrestrial Biodiversity Theme found using the criteria in the current assessment (Figure 3-25b) still agrees well with the sensitivity generated by the Screening Tool. It should be noted that the available information used to produce the sensitivity maps for the current assessment is at a coarse scale and conducting an in-depth, fine-scale analysis of the vegetation and flora is required to verify and refine this sensitivity map.

3.5.6 Integrated site sensitivity

Taking the existing anthropogenically disturbed areas into consideration, the site sensitivity maps for the aquatic and terrestrial ecology assessments are presented in Figure 3-26a. In the case of both the mammal, reptile and amphibian as well as the vegetation and flora themes the anthropogenically disturbed areas were classified as either transformed or of low sensitivity. For the most part, both the inland aquatic and the bat sensitivity assessments also rated as anthropogenically disturbed areas as of low sensitivity. Only in the case of the avifaunal assessment were the disturbed areas classified as either High or Medium sensitivity.

An integrated sensitivity map for terrestrial and aquatic ecology was compiled by die CSIR using the maximum rule, i.e. the highest sensitivity overrides the lower sensitivities (Figure 3-26b). According to this integrated sensitivity map most of the site has a **Very High** sensitivity. The anthropogenically transformed areas could be used for the proposed development.

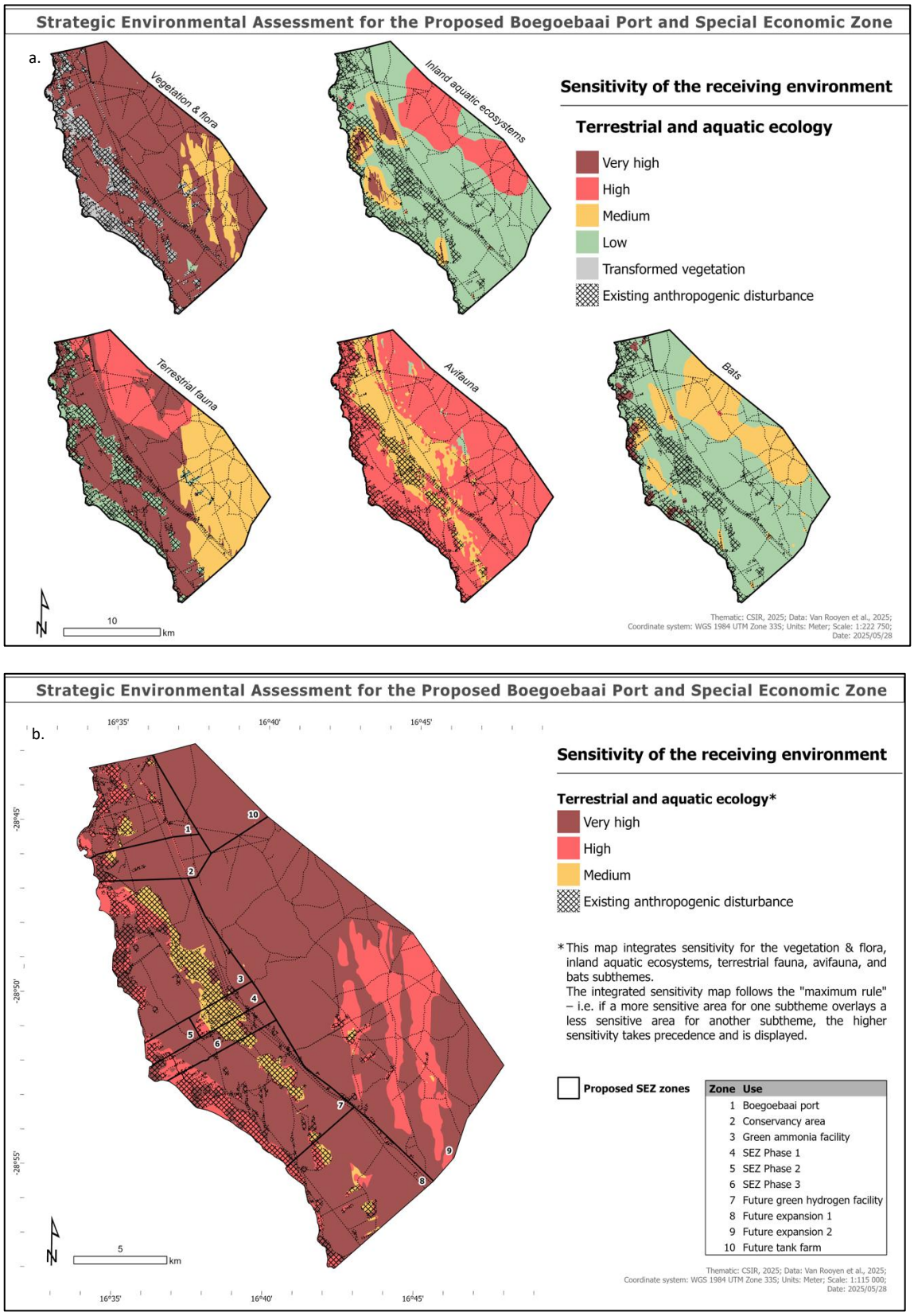


Figure 3-26: (a) & (b) Integrated site sensitivity of the Aquatic and Terrestrial Ecology studies of the Boegoebaai Port and SEZ.

3.6 ASPECTS AND IMPACTS REGISTER

An aspects and impacts register (Table 3-3) was compiled based on the project description provided by the CSIR (Schreiner *et al.,* 2024). The major impacts on terrestrial ecology, associated with the development, will occur during the construction phase, with human activity and disturbance levels appreciable lower during the operational phase. Impacts during the operational phase are likely to be carry-over effects resulting from the construction phase. Impacts during the decommissioning phase will be similar to the construction phase. A major risk would be that the site is not adequately rehabilitated to a functioning system and a degraded, vulnerable and disturbed ecosystem is left behind. Cumulatively, the impacts may lead to shifts in local faunal and floristic communities, favouring generalist species over specialists. This could result in reduced biodiversity and changes in ecosystem functioning. The resilience of fauna to these impacts would depend on the availability of nearby suitable habitat and effective mitigation strategies.

Table 3-3: Aspects/impacts register applicable to the Boegoebaai Port and SEZ site

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
Inland and Estuarine Aquatic Ecosystems (see Section 3.4.1; Figure 3-14 **&** Figure 3-19**)**		
Boegoebaai Port: Development footprint	Given the low certainty about hydrological drivers for wetlands and/or pans, the development footprint of the planned development would extend into the postulated recharge area of these important systems, and could potentially threaten their sustainability.	Extends into potential recharge area for BB1 pan and springs. Also includes Boegoeberg North, which could potentially support inland aquatic biota typical of temporary/ephemeral pools.
Conservancy area: This includes the northern portion of BB1 (Visagiespan)	Inclusion of the upper section of the mapped pan in the conservancy area would potentially protect recharge areas for the pan, its wetlands and associated spring.	BB1 (including BB1A)
Confirmed Green Hydrogen and Ammonia facility: This area extends across the three largest pan/wetland/spring areas in the study area. Aspects of concern include: • development footprint; • stormwater management; and • roads (and associated culverts).	• Destruction of **CR** wetlands: These are rare and key wetland systems, which are likely to play a critical role in supporting terrestrial fauna. • Degradation of wetlands, pans and springs as a result of stormwater management systems that contain and divert stormwater; reduce recharge and increase concentration of flows; and potentially "freshen" flows into receiving pans/wetlands, as a result of bypassing sands and other substrate that would normally contribute dissolved salts to runoff. • Degradation by physical disturbance (vehicles).	This area includes the largest and most important pans, associated springs and wetlands within the study area.
SEZ Industrial Park Phases 1, 2 and 3: This area extends across the Rietfonteinpan (BB3) pan/wetland/spring area, and its hydrological buffer. Aspects of concern include: • development footprint; • stormwater management; • roads; and • treated sewage effluent disposal through septic tanks and use of infiltration systems.	• Destruction of **CR** pan and wetland habitat (BB3) **see Confirmed Green Hydrogen and Ammonia facility.** • Degradation of remaining pan and wetland areas by physical disturbance (e.g. vehicles). • Potential increases in inflows of stormwater and treated sewage effluent into remnant wetlands/ pans, likely to result in nutrient enrichment and possible changes in hydroperiod. These would likely result in changes in vegetation and loss of conditions that support important ephemeral pan biotic assemblages.	Watercourse BB3 (ephemeral pan with wetland elements)
Future Green Hydrogen Facility: Aspects of concern include:	• Destruction of presumed natural (BB6) and artificial pan (BB4 and BB5) and wetland habitats. • Potential increases of stormwater inflows into remnant	This area includes artificial pans/wetlands, as well as an (not ground-truthed) natural pan (BB6) and its potential recharge area).

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
• development footprint; • stormwater management; • roads; and • treated sewage effluent disposal.	wetlands/pans, likely to result in changes in hydroperiod - **see Phases 1, 2 & 3.** • Degradation from physical disturbance (vehicles).	
Future Expansion 01: Aspects of concern include: • stormwater management; • roads; and • treated sewage effluent disposal.	• Some destruction of presumed natural pan and wetland habitat (BB6) and artificial pans BB7 & 8. • Potential increases in inflows of stormwater into remnant wetlands/pans, likely to result in changes in hydroperiod - **see Phases 1,2 & 3.**	Includes artificial pans/wetlands (BB7 & BB8) and southern extent of natural pan (BB6). BB6 is rated as **CR** and the artificial systems probably have high ecological importance.
Future Expansion 02: Aspects of concern would include: • blasting of rocks for construction; • the development footprint; • treatment of stormwater from the site, potentially impacting on downstream systems including those within the confirmed green hydrogen and ammonia facilities site and Phases 1-3 of the propose SEZ Industrial Park	• Destruction of presumed natural temporary pools/pan habitat. • Possible eutrophication of pan habitat by inflows of polluted water. • Degradation of downstream ecosystems due to concentration of flows from upslope areas and/or increased rate of surface flows as a result of stormwater management interventions. • Biodiversity impacts as a result of loss of physical connectivity between high-lying areas and downstream areas.	Includes the high-lying rocky outcrops at Visagiesfonteinkop including areas of ephemeral pans and pool of (undetermined) high biodiversity importance.
Terrestrial Ecosystems		
BOEGOEBAAI PORT		
Zone 1: Infrastructure *Any structure to be built or covering land related to the port facility e.g.:* • buildings; • bulk material stockpiles, warehouses and handling facilities; • ship loaders; • conveyor belt structures;	***Infrastructure:*** ***Vegetation clearance:*** • Vegetation clearance could cause a loss of part of (i) a **CR** ecosystem; (ii) an **irreplaceable CBA 1** or **optimal CBA 2**; (iii) a Priority Focus Area in NPAES; and (iv) a **KBA,** if the structure is located in one of these systems. • Vegetation clearance will likely cause a loss of individuals of SCC, protected and/or endemic plant or animal species since many such species are present in the port precinct. • Vegetation clearance will be associated with increased sand	Except for areas that have been mapped as modified habitat, the rest of the Port area has been assigned a **Very High** sensitivity and vegetation clearance should thus be avoided (Figure 3-25). In support of avoidance as the only option, are the presence of the following: • **CR** Namib Seashore Vegetation as well as Richtersveld Coastal Duneveld which are irreplaceable and cannot be offset (Figure 3-7);

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
• water reservoirs; • sewage systems; • stormwater drainage systems; • electrical substations; • fuel storage facilities; • internal port roads; and • external port roads (only widening of R382 on site is relevant to WP1).	movement and erosion of topsoil material. Transported sand may smother adjacent vegetation, particularly affecting small plant species. • Sand storms may intensify and the effects of sandblasting on the vegetation may increase. • Vegetation clearance is accompanied by a loss of faunal habitat and could eliminate essential habitats for SCC. • Vegetation clearance will decrease ecosystem services and could prevent meeting biodiversity targets. • Vegetation clearance is associated with habitat fragmentation, restricting animal species movement and reducing food availability. ***Construction:*** • Construction is associated with increased human activity, noise and often artificial lighting. These disturbances negatively affect animal behaviour, particularly in areas where they feed, breed, nest and rest. It can also lead to injuries or mortalities. Trenching could increase animal mortality. • Small mammals, are attracted to infrastructure and may create burrows under the infrastructure. Extensive burrowing may alter vegetation patterns, affecting other ground-dwelling species.	• irreplaceable **CBA 1s** or optimal **CBA 2s**; (Figure 3-9); • **CR** plant and animal species; • focus areas of the **NPAES** (Figure 3-8); and • a **KBA** (Figure 3-10). In areas of Medium to High sensitivity impacts need to be minimised through appropriate mitigation measures to ensure sustainable development. ***Construction:*** In the case of birds, negative impacts can reach up to a distance of 500 m – 2 km depending on the species.
Zone 1: Dry bulk material handling ***Manganese:*** Manganese will be stored in closed stockpiles, with dust suppression using water spraying.	***Dry bulk material handling:*** ***Manganese:*** • Manganese is an essential micronutrient for plants but in excess it can be toxic. • Wind can disperse fine particles from stockpiles contaminating the soil and affecting vegetation. **Recommendation:** store manganese in a warehouse or silo and move via piped conveyor. • Water is such a scarce commodity in the area that an alternative method for dust suppression must be sought. Using water for dust suppression is expensive and inefficient and this water will become contaminated. No indication has been given of how the impurities will be extracted or how the water will be disposed of or reused.	Location of the manganese stockpile can impact vegetation and species negatively and all areas listed in **Zone 1: Infrastructure** must be avoided. The stockpiles can only be located in habitat that has been intensively modified by mining. Air quality must be monitored and atmospheric emissions around stockpiles and warehouses must be managed. Ensure that monitoring equipment is adequately maintained.

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
Lead and zinc: Lead and zinc will be stored in enclosed warehouses.	***Zinc and lead:*** • Zinc is an essential micronutrient for plants but in excess it can be toxic. Lead is a toxic heavy metal which negatively affects plant growth. • The bulk storage warehouses must be fully contained to protect against chemical spillage.	
Zone 1: Conveyor belts Systems handling zinc and lead must be fully enclosed. Systems handling manganese generally require arched coverage.	***Conveyor belts:*** ***Manganese:*** In faulty systems dust can contain manganese particles and other pollutants which may affect plant life if they enter the soil in large amounts. ***Lead and zinc:*** Runoff from the conveyor can lead to the leaching of lead/zinc into the groundwater. Conveyors will be barriers to animal movement.	Monitor the air, soil and water quality to manage emissions around the conveyor system and ensure that monitoring equipment is adequately maintained.
Zone 1: Dust control Dust suppression and collection systems are incorporated with all material handling equipment to prevent accumulation of material outside the dust collection system.	***Dust control:*** It has not been specified how and where the material accumulated in the dust collection system will be discarded.	Dust control systems should avoid the areas mentioned in ***Zone 1: Infrastructure.*** All material collected in the dust suppression system should be disposed of at a registered waste facility.

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
Zone 1: Bulk services – Water **Option 1:** Pipeline from Alexander Bay with water treatment plant. The pipeline from Alexander Bay is not assessed since it has not been indicated on site. It has been assumed that the water treatment plant for this option would be at Alexander Bay. Option 2 (preferred): On-site desalination plant with 1 ML capacity. Elevated reservoirs will provide pressure for fire suppression discharge.	***Desalination of water:*** **For vegetation clearance - see Zone 1: Infrastructure** ***Option 2: Desalination by reverse osmosis:*** • The intake of seawater can harm marine life by impingement and entrainment. • The concentrated brine will have a negative impact on marine ecosystems when discharged into the ocean, especially if done without the necessary diffusion. • The possibility to use the brine solution to produce salt can be investigated. The salt must be purified to achieve the desired quality. • New advances in technology may allow a nearly waste-free zero liquid discharge desalination which crystalises salt and chemicals. • Chemicals used in the desalination process such as defouling and cleaning agents can enter the marine environment.	Desalination plants may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** ***Option 2: Desalination:*** • Marine ecologists should assist with the selection of the site of the seawater intake and discharge. • Continuous monitoring of the discharge site is needed to allow for adjustment if unacceptable negative impacts are found. • Observe compliance with local and international regulations to ensure that discharge practices meet environmental standards.
Zone 1: Bulk services – Sewage The site will be divided into separate drainage areas with isolated reticulation systems, on-site treatment and disposal. Drainage areas will use a combination of waste-water treatment plants, septic tanks and soak-away systems.	***Bulk services – Sewage:*** • **For vegetation clearance - *see Zone 1: Infrastructure*** • Positive impacts could arise if nutrients are recovered and used as fertilizers. • Investigate if wastewater could be used for industrial purposes. • Use of chemicals for disinfection can lead to residual pollutants in treated water. • Sludge disposal can contaminate soil and water. • Inadequate treatment of sewage water poses health risks.	Waste water treatment plants, septic tanks and soak-away systems may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** Furthermore, groundwater contamination by these systems must be avoided.

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
Zone 1: Stormwater drainage systems The drainage system will separate clean and dirty water, with clean water runoff diverted around the site. High-risk dirty runoff water will flow into concrete-lined channels to the pollution control pond and low-risk dirty runoff water will flow into block and vegetated channels. Pollution control ponds will be lined with high density polyethylene, and water discharged to the ocean.	***Stormwater drainage systems:*** **For vegetation clearance - see *Zone 1: Infrastructure*** For stormwater drainage **see Aquatic ecosystems**. • Favourable habitat for invasive species could be created. • Pollutants can enter the groundwater.	The storm water treatment structures, may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** Pollutants may not enter the groundwater.
Zone 1: Electrical: The internal network will include an intake substation, primary and secondary substations and distribution substations.	***Electrical:*** • **For vegetation clearance - *see Zone 1: Infrastructure*** • Electrical infrastructure will not be limited to sub-stations. Powerlines need to carry the electricity from the source to the intake substation. Powerlines will add to vegetation clearance. • A lifecycle assessment must include all emissions associated with the construction of renewable energy structures, generation and transport. A life cycle assessment clearly indicates the use of carbon during infrastructure manufacturing, thus the renewable energy is not entirely carbon free. • Electrical infrastructure can act as attractive basking or foraging sites for reptiles. Contact with live components, increases the likelihood of electrocution. Porcupines may dig under transmission towers, compromising foundation stability and increasing maintenance costs. • Powerlines can cause habitat fragmentation, restrict animal movement and reduce food availability.	None of the substations may be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** In the case of birds, the impacts of pipelines and powerline can reach up to a distance of 500 m – 1 km depending on the species.
Zone 1: Fuel storage (Phase 1) A liquid bulk storage facility with two 35 000 m³ tanks and tanker loading facilities is included. Tanker vessels will discharge into storage tanks via pipeline.	***Fuel storage (Phase 1):*** • **For vegetation clearance - *see Zone 1: Infrastructure*** • Fuel spills can contaminate the soil or water bodies and potentially enter the groundwater which will affect plant life and aquatic systems. • Volatile organic compounds, other pollutants and strong odours are emitted, reducing air quality.	The fuel storage structures and loading facilities, may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** Lichens are particularly sensitive to pollution. A study must be conducted on the dominant movement of air from the planned port and SEZ site, to ensure that pollutants from the port and SEZ are not carried onto

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
	• Inadequate compliance, management and monitoring will lead to increased risks of contamination and pollution. • Flammable fuels pose a fire and explosion risk.	the Namib Lichen Fields or the Boegoeberg Twins (also rich in lichens).
Zone 1: Internal port roads and bridges: Port Access Interchange for large volumes of heavy vehicles Port Access Control: access gateways and weighbridge Truck Offloading Area: Three offloading terminals	***Internal port roads and bridges:*** • **For vegetation clearance - *see Zone 1: Infrastructure*** • Roads, pipelines and powerlines, fragment habitats and may restrict animal movement, particularly for range restricted and fossorial species. Such barriers disrupt normal foraging, mating and dispersal. This is especially crucial for slow-moving tortoises that are less adapted to fragmented landscapes. • Increased traffic and expanded road networks, raise the likelihood of roadkills. Reptiles using warm road surfaces for thermoregulation are at risk. Roads are death traps for slow moving animals. • Vehicle emissions reduce air quality and negatively affect lichens and some plant species. • Runoff from roads carry pollutants affecting water quality in adjacent areas. • Roads can lead to soil erosion. • Roads can facilitate the spread of alien invasive species. • Roads can change natural water flow patterns. • Gravel roads lead to the production of dust.	The internal port roads and bridges should avoid the areas mentioned in ***Zone 1: Infrastructure*** wherever possible. In the case of birds, the impacts of roads can reach up to a distance of 500 m – 1 km depending on the species. A study needs to be conducted on the dominant movement of air from the planned Boegoebaai Port and SEZ site, to ensure that the pollutants from the vehicle emissions are not carried onto the Namib Lichen Fields or the Boegoeberg Twins that are also rich in lichens.
Zone 1: External roads: In the short-term mining ore will be transported by trucks along the R382, until rail transport viability is considered and established.	***External roads:*** **For vegetation clearance - see *Zone 1: Infrastructure and Internal port roads.*** Widening of R382 will increase the area where vegetation is cleared. See internal roads for environmental impact.	The external port roads and bridges should avoid the areas mentioned in ***Zone 1: Infrastructure.*** See internal roads for receiving environment at risk.
Zone 2: Conservancy area: A conservancy area (ca. 1 170 ha) has been set aside based on conservation priorities such as the presence of the Boegoeberg Twins and Cape fur seal colony. There is also an archaeological site *viz.* the Boegoebaai	***Conservancy area:*** Positive impacts include: (i) protection of remnant intact vegetation patches; (ii) protection of CR ecosystems and refugia for animal species; and (iii) opportunity for rehabilitation of mining areas.	**The boundary of the conservation area must be revised to include the entire Boegoeberg North. The Cape fur seal colony should also be included in the Conservancy area. The CSIR is to provide a new delineation of the Conservation area.**

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
cave/lair.	Air pollution from the neighbouring SEZ could negatively affect the lichens in the Conservation Area. Negative impacts include: (i) all habitats and sensitive features are not represented in the conservancy area; (ii) it only partially protects CBA1s and the CR ecosystems and will not meet biodiversity targets; (iii) it crosses the R382 and without appropriate crossings for fauna an increased mortality of SCC will result.	All development must avoid the Conservancy area. A study must be conducted on the dominant air movement from the planned port and SEZ site, to ensure that pollutants from the port and SEZ are not carried onto the Boegoeberg Twins that are rich in lichens.
BOEGOEBAAI: SPECIAL ECONOMIC ZONE (SEZ)		
Zones 3 – 10: Infrastructure *Any structure to be built or covering land related to the SEZ e.g.:* • ammonia facilities; desalination plants; electrolyser; • offices and warehouses; • manufacturing infrastructure; • water treatment units & reservoirs; and • N_2, H_2, and O_2 storage facilities	**For vegetation clearance - see above in Terrestrial Ecosystems: Boegoebaai Port - *Zone 1: Infrastructure***	The SEZ infrastructure should avoid the areas mentioned above in Terrestrial Ecosystems: Boegoebaai Port - in ***Zone 1: Infrastructure.***
Zone 3: Desalination plant: Desalination plant and associated infrastructure	***Desalination plant* - see *Zone 1: Desalination plant*:** **Vegetation clearance - see *Zone 1: Infrastructure***	Desalination plants may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***
Zone 3: Electrolyser: Electrolyser will split water into hydrogen and oxygen to produce Green H_2. Hydrogen and oxygen storage Lye solution purge from the GH_2 plant will be discharged with the other return streams to the sea.	**Electrolyser:** • **For vegetation clearance - see *Zone 1: Infrastructure*** • Electrolysers require large amounts of water to produce hydrogen. Desalination of seawater is costly and the discharge of the brine is environmentally harmful. • If chemicals are used, there are risks of pollution. • Large areas of land are needed to generate renewal power by wind and solar for desalination and subsequent electrolysis. Alternatively, small nuclear power reactors could be used as carbon-free source, however these systems are expensive and	The electrolyser may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
	also come with risks. • In many systems the lye solution can be recycled for re-use. If the lye solution is discharged it must undergo treatment to neutralise its alkalinity and remove contaminants before releasing into the environment or wastewater treatment systems. • Hydrogen is a very light, non-toxic, flammable gas. When released in gaseous form, it will typically rise and disperse rapidly. If, however, it is released into the atmosphere and it is not dispersed it may ignite. • Because hydrogen is colourless and odourless, sensors must be appropriately positioned to detect leakages. It burns with a pale blue flame that is nearly invisible in daylight, so detection by human senses is difficult.	
Zone 3: Ammonia facility: The ammonia facility will be located near the TNPA port and adjacent to the coast and desalination plant. ***Associated infrastructure:*** • Air separation unit; • liquid air energy system (LAES) for nitrogen storage; • ammonia processing unit and liquid ammonia storage tank; • pipelines required for hydrogen, its derivatives and by-products, and a control room; • cooling tower blowdown; and • gasses expected to be safe to vent to the atmosphere.	***Ammonia facility:*** • For vegetation clearance - *see Zone 1: Infrastructure* • The facility has some positive impacts such as (i) a reduction in fossil fuel use; (ii) production of green ammonia as fertiliser without greenhouse gas emissions; (iii) ammonia is an energy carrier that allows the storage and transport of renewable energy; (iv) production from GH_2 produces less harmful pollutants than traditional ammonia production. • The negative impacts of the facility include: (i) electrolysis and ammonia production require large amounts of energy from renewable resources; (ii) large areas of land are needed to generate renewable energy by wind and solar; (iii) large amounts of water are needed for electrolysis; (iv) strict safety measure to prevent leaks and accidents are essential. • Ammonia is a hazardous substance and leaks can cause air pollution and pose serious health risks. • Ammonia can contaminate the soil, although it would act as fertiliser to plants. • Cooling tower blowdown may contain accumulated solids (minerals). Treatment of blowdown prior to release is	The ammonia facility and associated infrastructure may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** It is essential to monitor the atmospheric emissions around the ammonia facility. A study needs to be conducted on the dominant movement of air from the planned SEZ, to ensure that the pollutants from the SEZ are not carried onto the Namib Lichen Fields or the Boegoeberg Twins that are also rich in lichens. Potentially, acute localised impacts on bat mortality at water-cooling towers if appropriate mitigation measures are not applied.

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
	essential. • Possible bat mortalities/injuries due to hot steam discharge.	
Zone 3: Firewater: Firewater will be stored in firewater tanks. Seawater will be used as backup source when stored firewater is not adequate.	***Firewater:*** • Firewater runoff can introduce pollutants into the soil and water bodies. • If firefighting foams are used, toxic substances can persist in the environment. • When using seawater, discharge will have a high salinity and increased pollutant load.	Firewater infrastructure may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** The point of seawater intake needs to be selected by marine ecologist.
Zone 4 – 6: Industrial Park Designated for mixed-use purposes; offices; desalination plant; manufacturing cluster; and warehouses.	**Vegetation clearance - see *Zone 1: Infrastructure*** See discussion on desalination in ***Zone 1: Bulk services - water***	The Industrial Park may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***
Zones 7, 8 & 9. Future Green Hydrogen facility; Future Expansion Zone 01 & 02 Replication of Green Ammonia Facilities	***Ammonia facility - See SEZ Zone 3***	Facility may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***
Zone 10. Future tank storage	***See Zone 1: Fuel storage***	No structures may be located in areas mentioned in ***Zone 1: Infrastructure.***
Common to all zones: **Increased Predation by Corvids**	***Common to all zones*** The proposed development will create habitat for corvids that predate heavily on small, slow-moving tortoises. Predation can lead to population declines in tortoises.	***Common to all zones***
Common to all zones: **Disturbance from Noise, Dust, and Lights**	***Common to all zones*** • Construction is associated with increased human activity, noise and often artificial lighting. These disturbances negatively affect animal behaviour, particularly in areas where they feed, breed, nest and rest. It can also lead to injuries or mortalities. • Trenching could increase animal mortality.	***Common to all zones***
Common to all zones: **Earthworks during construction in the Port and SEZ**	***Common to all zones*** Destruction of roosting habitat of bats and birds.	***Common to all zones***

3.7 DISCUSSION AND RECOMMENDATIONS

3.7.1 Aquatic

The study area is not rich in inland aquatic ecosystems, but those that do occur are important for terrestrial wildlife and the ephemeral pans are assumed to support rare aquatic invertebrate communities. The larger pans afford substantial wetland and pan habitat, with Visagiespan providing permanent standing water pools. Ephemeral rock pools in rocky outcrops could support invertebrate communities (possibly endemic) of high biodiversity value and adapted to ephemeral conditions.

The study area abuts two estuaries, namely the ephemeral Holgat River estuary, classified as a micro-outlet, and the Orange River Estuary. The condition of the Orange River Estuary, a Ramsar Wetland site, falls well short of its Recommended Ecological Category, requiring active interventions to improve estuarine condition. This is important, because the proposed Boegoebaai development could directly or indirectly threaten its condition, which would have negative implications for meeting the estuary's Resource Quality Objectives.

The proposed development would result in the potential loss of all inland aquatic ecosystems in the study area including natural pans and depressions that are Critically Endangered systems. The following **recommendations** are made:

- **Avoid** development of Zone 3; western parts of Phases 2 & 3 of the SEZ Industrial Park; the south-western portion of the Future GH_2 Facility; and the northern corner of Future Expansion Area 01 because development in these areas would not be compatible with the required conservation of important inland aquatic ecosystems. **Avoid** rock blasting, flattening of slopes and/or loss of rocky outcrops that could include ephemeral rock pool and pan habitat.

- Furthermore, if approved, development of the Boegoebaai Port and SEZ, would need to allow for **increased resources** at the Orange River Estuary, to control and police fishing, hunting and vehicle access and movement within the estuary and associated saltmarshes. It would also need to match any provision of fresh water from desalination plants to any communities/urban areas with an equal increase in infrastructure and human resources capacity to treat the additional wastewater that would be generated, to a level that would not impact negatively on any receiving watercourse, and the Orange River Estuary in particular.

- **Mitigation** measures include (i) no-development areas being tied to corridors that allow for faunal connectivity within and between terrestrial and aquatic habitats; (ii) addressing potential impacts associated with concentrated stormwater flows through areas of increasingly hardened surfaces, which could result in concentration of flows or bypassing dependent aquatic ecosystems; (iii) waste water treatment would need to ensure that waste streams from these activities do not pass, by way of seepage or flows, into pans, wetlands or their buffer area, unless treated to levels that would have negligible impact on aquatic habitat (as determined by an aquatic ecologist); (iv) provision must be made for the management of solid waste in expanding urban settlements associated directly or indirectly with the proposed development; and (v) designing new and/or upgraded access roads that they do not result in downstream erosion or blockages of flows in flood conditions.

Going forward the following additional information would be needed: (i) investigation of surface/groundwater linkages at major pan/spring/wetland areas, potentially by way of a hydropedological study and/or geohydrological assessment; (ii) wet-season assessment of ephemeral wetland invertebrate faunal communities; (iii) identification and mapping of key temporary rock pool/pan habitat in rocky outcrops; (iv) detailed stormwater management plans; and (v) measures dealing with impact avoidance, mitigation and management issues.

3.7.2 Fauna: Avifauna

The Second Southern African Bird Atlas Project (SABAP2) recorded 87 bird species in the broader area. Of the 87 species, 47 are considered priority species and 13 species were selected for further assessment. This selection includes species of conservation concern as well as those that are endemic, near-endemic or range-restricted in South Africa.

Although the region does not host a wide diversity of birds, it is home to the range-restricted regional subspecies of the dune lark (previously classified as Barlow's lark). The sheltered bays and dunefields along the coast could provide suitable habitat for the **CR** (regional) Damara tern, while freshwater pans and estuarine habitats along the coast could support various species of conservation concern, including the **VU** (global) curlew sandpiper; **VU** (regional) great white pelican; **VU** (regional) Caspian tern; **NT** (global and regional) Eurasian curlew; and **NT** (regional) greater flamingo. Suitable habitat is also present on site for the **EN** (global and regional) black harrier; **EN** (global and regional) Ludwig's bustard; endemic Cape long-billed lark; and near-endemic jackal buzzard. The site could also potentially support the **EN** (global and regional) martial eagle and **VU** (regional) Lanner falcon.

From an avifaunal perspective the Boegoebaai Port and SEZ development site exhibits predominantly **High** and **Medium** sensitivity. All proposed developments within the Port and SEZ should incorporate an avifaunal specialist study.

3.7.3 Fauna: Bats

Overall, the impacts on bat species for the proposed development are expected to be low and limited to four impacts: (i) light pollution affecting light-averse bat species and creating artificial foraging habitats; (ii) possible bat mortalities or injuries due to hot steam/water discharge at the water-cooling tower blowdown; (iii) foraging habitat destruction; and (iv) roosting habitat destruction. Of these impacts light pollution would be the most significant. However, if the water-cooling towers are equipped with exposed radiator designs, acute and high bat mortality impacts may occur. It is therefore critical that a bat specialist be consulted on the intended design of the water-cooling towers.

The outlined mitigation measures must be adhered to, and the sensitivity map observed when considering infrastructure components.

According to the currently available information, there are no fatal flaws from a bat sensitivity perspective which should prevent the proposed development from proceeding towards the Environmental Impact Assessment phase.

3.7.4 Fauna: Mammals, reptiles and amphibians

The proposed Boegoebaai development presents a range of potential environmental impacts on fauna and SCC. The confirmed or potential presence of sensitive species such as *Pachydactylus rangei, Cryptochloris wintoni* and *Eremitalpa granti granti* combined with CBA 1s and CBA 2s, and two threatened ecosystems (both listed as **CR**) underscore the ecological sensitivity of the project area. While comprehensive mitigation measures can reduce the severity of some impacts, **avoidance** of highly sensitive features should be the first and best option.

Some of the proposed **mitigation** measures, e.g., habitat offsets, wildlife corridors, predator deterrence, are effective in theory but challenging to implement in practice. Many SCC, such as De Winton's golden mole and the desert rain frog, have specific microhabitat requirements that are difficult to replicate or restore. Ensuring the success of mitigation measures also requires sustained monitoring and adaptive management, which may not always be feasible or adequately resourced. Despite mitigation, residual impacts on fauna and habitats are likely in highly sensitive areas.

Going forward the following additional information would be needed: (i) fine-resolution spatial data generated through on-site ground-truthing; (ii) comprehensive baseline biodiversity surveys for impacted SCC; (iii) collaboration with taxa-specific specialists and conservation organisations to refine impact assessments and conservation actions; and (iv) install a rainfall, temperature and relative humidity logger

at a relevant trap location to record the prevailing temperature and relative humidity at 30-minute intervals. Herpetofauna are ectothermic and their behaviour is strongly influenced by temperature and rainfall. To interpret survey data more comprehensively, it is necessary to present herpetofauna survey data in the context of the prevailing weather conditions.

At this stage it is recommended to assume the presence of SCC under the precautionary principle and develop appropriate mitigation and management considerations to limit any anticipated impacts, with avoidance being the best possible approach.

3.7.5 Vegetation and flora

The proposed Boegoebaai Port and SEZ development poses major risks to plant diversity. The proposed site hosts many features that emphasise the ecological sensitivity and indicate priority habitat for biodiversity conservation, such as: (i) two Critically Endangered ecosystems; (ii) large areas classified as irreplaceable CBA 1s or optimal CBA 2s (2016 Northern Cape CBA map); (iii) habitat for Critically Endangered plant species; (iv) portions included in the National Protected Area Expansion Strategy (NPAES); (v) inclusion into an internationally recognised KBA; (vi) the presence of 46 SCC; and (vii) the Critically Endangered Namib Lichen Fields, *ca* 13 km north of the site.

From a vegetation and flora perspective the major source of impacts of the Boegoebaai development will result directly or indirectly from vegetation clearance which will lead to habitat loss and transformation and loss of the priority diversity features mentioned above. On the positive side, the Boegoebaai Port and SEZ site is not included in a protected area and the level of infestation by alien invasive plant species is low. A large portion of the site was previously mined and the vegetation in these areas is transformed (modified habitat *sensu* IFC). Furthermore, mine-induced sand plumes cover large sections of land. The transformed habitats, west of the R382, could be used for the Boegoebaai Port and SEZ development **provided adjacent areas of priority habitat are not negatively impacted by the development.**

Although the Screening Tool rated the sensitivity of the Plant Theme as Medium, the current assessment recommends an upscaling of the Plant Theme to **Very High**. The Screening Tool rated the sensitivity of the Relative Terrestrial Biodiversity Theme as Very High and the current assessment largely concurs with a **Very High** rating.

Going forward the screening-level sensitivity maps provided in this report must be improved when major revisions of the underlying data are produced or when detailed studies of the site become available. Considering the large areas with a Very High sensitivity rating, it would be prudent to conduct an in-depth, fine-scale analysis of the vegetation and flora on the entire port and SEZ area as soon as possible to verify and/or update the sensitivity maps. These fine-scale maps could be used to guide planning the layout of the port and SEZ to avoid placing development footprints in areas that could possibly not receive Environmental Authorization.

3.7.6 Practical recommendations for future EIA studies; rehabilitation; sand stabilisation and monitoring

Practical recommendations for future EIA studies:

All EIA studies will have to adhere to national and provincial environmental legislation, standards, protocols, guidelines and norms as relevant at the time of the assessments. The assessments should also consider relevant agreements or conventions e.g. African-Eurasian Waterbird Agreement; CBD; Convention on the Conservation of Migratory Species of Wild Animals; CITES; Ramsar Convention on Wetlands if International Importance; and Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia.

It is recommended that the aquatic, terrestrial fauna (avifauna, bat, other fauna) and terrestrial botanical specialist studies should provide:

- A description of the biodiversity at ecosystem level including (i) CBAs, ESAs (provide reasons for CBA mapping); (ii) threatened ecosystems; (iii) NPAES Focus Areas; and (iv) main vegetation types

and their environmental determinants; (v) NFEPA Priority Catchments, rivers, wetlands and estuaries within the site.

- A fine-scale map of plant communities/habitats, wetlands, rivers and estuaries that occur on site.
- Avifaunal assessments should consult existing avifaunal data resources such as SABAP2 and Birdlasser® to obtain known records of avifauna for the proposed area of influence (PAOI).
- Perform comprehensive avifaunal baseline monitoring within the proposed development footprint to establish the avian species composition with specific reference to SCC. In high and very high sensitivity areas multiple surveys, spanning different seasons, would be required. Surveys are to be designed in line with best practise guidance.
- A fine-scale 4-tier sensitivity map should be compiled with specified criteria for allocating units to the different sensitivity classes.
- A description of species biodiversity including (i) distribution of threatened fauna and flora; (ii) if possible, viability and estimated population size of threatened species and, if possible, a likely reduction in population size and viability due to the development.
- A description of any other significant landscape features such as (i) rocky outcrops; (ii) seasonal wetlands; (iii) quartz patches; (iv) lichen fields; (v) salt marshes; (vi) rare or important vegetation.
- An assessment of the level of alien invasive plant infestation.
- An assessment of site condition based on current or previous land uses.
- A description of biodiversity patterns and processes and the potential impacts of the proposed development and related activities on these patterns and processes.
- Recommendations on preventing, mitigating or restoring disturbed vegetation, aquatic features, or ecological processes.
- Evidence of how the layout of the development incorporated biodiversity considerations.
- A list of all relevant legislation, permits and standards that would apply to the development.
- If applicable, list additional studies that should be conducted to avoid/ameliorate impacts to sensitive features.
- Indicate mitigation/avoidance measures to be implemented to ensure that the development does not generate impacts beyond the footprint area.
- Recommendations on design and implementation of monitoring.

Revegetation/Rehabilitation:

Hyper-arid areas such as the Richtersveld coast are very difficult to rehabilitate successfully where rehabilitation aims to ensure the long-term stability of soils, landforms and hydrology required to establish and sustain a natural ecosystem that supports the approved future land use. Rehabilitation also aims to partially or fully repair the capacity of ecosystems to provide habitats for biota and services for people. A rehabilitation specialist, with expertise in the rehabilitation and ecological restoration along the West Coast of South Africa (e.g. Nurture, Restore, Innovate), should be consulted to advise on the possibilities of rehabilitating and potentially even restoring the vegetation. The rehabilitation specialist should be able to advise on setting rehabilitation targets and objectives and which locally occurring species of different functional types could be used in rehabilitation (Desmet, 1996; De Villiers *et al*., 2004; Carrick *et al.,* 2022) and whether the use of restoration packs or transplanting would be feasible in the area.

Sand stabilisation:

Because the predominant wind direction is from the south the damaging wind effects will impact areas downwind (i.e. north) of the source area. For planning purposes it will be essential to model the trajectories of sand and dust transport. Mitigation measures to effectively stabilise the sand will be crucial to avoid negative impacts on threatened ecosystems further north. Although sand stabilisation can be achieved by revegetation/rehabilitation it will take many decades. Sand stabilisation by chemical means or the use of geotextiles should be investigated.

Monitoring:

A full monitoring programme should be development during the EIA phase. Such a monitoring programme should include:

- Populations of key fauna and plant SCC, that could potentially be impacted by the proposed development, should be monitored throughout construction and operation to ensure that these SCC are not negatively impacted by the development or being poached. Any identified impacts must be mitigated. Monitoring frequency will depend on the phenology and life cycle of the particular species.

- A monitoring program for the early detection of alien invasive plant species should be implemented and a control program to combat declared alien invasive plant species must be employed.

- Rehabilitation progress should be monitored annually.

3.7.7 Concluding integrated recommendations

- The current SEA reports on the terrestrial and aquatic ecology were primarily desktop studies based on available data. However, due to the restricted access to large areas, the site is still relatively under-sampled and available databases of the area are incomplete as demonstrated by ongoing discoveries of new species. We therefore need to emphasise that a desktop report in an under-sampled area cannot be a sufficient foundation to take far-reaching decisions.

- The potential benefits of the Boegoebaai development, (e.g. renewable energy production and economic development) must be evaluated against the irreversible loss of biodiversity and ecosystem services.

- The development should only proceed if it can demonstrate net ecological benefit or neutrality through rigorous mitigation strategies.

- The aquatic assessment contended that there are no positive environmental impacts associated with the proposed Boegoebaai Port and SEZ development.

- The current high-level evaluations of the botanical and faunal components (with the exception of the bat assessment) demonstrated **High** to **Very High** sensitivity for most of the proposed site and consequently the proposed development requires a cautious approach with a strong emphasis on the conservation of biodiversity.

- While mitigation can reduce some of these risks, it cannot eliminate irreversible losses of critical habitats and species, where avoidance is the only option.

- Should the proposed development proceed, it is strongly recommended to establish all planned infrastructure in the already transformed mining landscapes, west of the tar road, **provided adjacent areas of priority habitat are not negatively impacted by the development.**

- The possibility of designating the areas east of the tar road (R382) as set-aside could be considered.

- Due to the **High to Very High** sensitivities associated with the proposed development at the Boegoebaai site, **it is strongly recommended to revisit alternative sites where the impacts on the receiving environment may have lower sensitivities.** Sites with lower ecological sensitivities can achieve development goals with minimal environmental trade-offs.

- The **impacts** of such a large development such as the Boegoebaai Port and SEZ **will generally not be limited to the site but will be more widespread and land adjoining the site will likely also be affected.** Neighbouring areas could thus be targeted by plant poaching as a result of increased human activities due to the development.

- Populations of key fauna and plant SCC, potentially impacted by the proposed development, must be monitored and if impacts are identified, they must be mitigated.

- Sand stabilisation should be addressed by biological, chemical or mechanical means or the use of geotextiles.

- Because hyper-arid areas are very difficult to rehabilitate successfully, a major risk would be that the site is not adequately rehabilitated to a functioning system and a degraded, vulnerable and disturbed ecosystem is left behind. Consult a rehabilitation specialist, with West Coast expertise, to advise on the possibilities of revegetating and potentially restoring the vegetation.

3.8 REFERENCES AND BIBLIOGRAPHY

Alexkor EMP, 2008. *Revised Environmental Management Programme*. Prepared by Site Plan Consulting.

Baptista, N., Bauer, A.M., Becker, F., Conradie, W. & Ceríaco, L.M.P. 2020. *Pachydactylus rangei*. *The IUCN Red List of Threatened Species* 2020: e.T196947A120595584. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T196947 A120595584.en.

Barnes, K.N. 2000. Martial Eagle *Polemaetus bellicosus*. In: Barnes, K.N. (Ed.) *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg, South Africa, pp. 83–85.

Barnes, K.N. & Jenkins, A.R. 2000. Lanner Falcon *Falco biarmicus*, In: Barnes, K.N. (Ed.) *BirdLife South Africa*: 141.

Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & De Villiers, M.S. (Eds) 2014. Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. *Suricata 1.*

Bauer, A.M. & Branch, W.R. 2001. The herpetofauna of the Richtersveld National Park and the adjacent northern Richtersveld, Northern Cape Province, Republic of South Africa. *Herpetological Natural History* 8: 111–160.

Berry, H.H., Stark, H.P. & Vuuren, A.S. 1973. White Pelicans *Pelecanus onocrotalus* breeding on the Etosha Pan, South West Africa, during 1971. *Madoqua* 7: 17–31.

BirdLife International. 2025a. Species factsheet: Cape Long-billed lark *Certhilauda curvirostris*. https://datazone.birdlife.org/species/factsheet/cape-long-billed-lark-certhilauda-curvirostris.

BirdLife International 2025b. Species factsheet: Curlew sandpiper *Calidris ferruginea*. https://datazone.birdlife.org/species/factsheet/curlew-sandpiper-calidris-ferruginea.

Botha, M. 2025. *Chapter 4: Biodiversity offset framework* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Botha, M. & Desmet, P. 2022. *Boegoebaai Port & Namakwa Satellite SEZ Biodiversity Offset Strategic Perspective*. Report to NCEDA by Conservation Strategy Tactics & Insight.

Bourne, A., Donatti, C., Holness, S. & Midgley, G.F. 2012. *Climate change vulnerability assessment for the Namakwa District Municipality*. Cape Town: Conservation South Africa.

Braby, J., Braby, S.J., Braby, R.J. & Altwegg, R. 2011. Immature survival and age at first breeding of Damara terns: conservation from a non-breeding perspective. *Ardea* 99: 185–190.

Braby, J., Braby, R.J., Braby, N. & Simmons, R.E. 2009. Protecting Damara terns *Sterna balaenarum* from recreational disturbance in the Namib Desert increases breeding density and overall success. *Ostrich* 80: 71–75.

Branch, B. 2008. *Tortoises, terrapins & turtles of Africa*, Cape Town: New Holland Publishing.

Branch, W.R. 1998. *Field Guide to Snakes and other Reptiles of Southern Africa.* Third Edition. Cape Town: Struik.

Broennimann, O., Thuiller, W., Hughes, G., Midgley, G.F., Alkemade, J.R. & Guisan, A. 2006. Do geographic distribution, niche property and life form explain plants' vulnerability to global change? *Global Change Biology* 12:1079–1093.

Bronner, G.N. & Asher, R. 2016. A conservation assessment of *Cryptochloris wintoni*. In: Child, M.F.R.L., Do Linh San, E., Raimondo, D. & Davies-Mostert, H.T. (Eds). *The Red List of Mammals of South Africa, Swaziland and Lesotho.* SANBI and EWT.

Buchanan, C.A., Eifler, M.A., Kanyanga, M.K., Utsumi, K.L., Liu, E.F., Luyanda, B., Muradzikwa, T.E. & Eifler, D.A. 2023. The lizard with kaleidoscope eyes: Population characteristics of the Namib web-footed gecko, *Pachydactylus rangei*. *Journal of Arid Environments* 214, 104985.

Carrick, P.J., Botha, M.S. & Krüger, R. 2022. *Ecological restoration in Namaqualand: a practical guide. (Ekologiese restourasie in Namaqualand: 'n praktiese gids.)* Cape Town: Nurture, Restore, Innovate.

Channing, A. & Rödel, M.O. 2019. *Field guide to the frogs and other amphibians of Africa*. Cape Town: Struik Nature.

Channing, A. & Wahlberg, K. 2011. Distribution and conservation status of the desert rain frog *Breviceps macrops*. *African Journal of Herpetology* 60: 101–102.

Child, M.F., Roxburgh, L., Do Linh San, E., Raimondo, D. & Davies-Mostert, H.T. (Eds). 2016. *The Red List of Mammals of South Africa, Swaziland and Lesotho.* SANBI and EWT.

Crawford, R.J.M., Cooper, J. & Dyer, B.M. 1995. Conservation of an increasing population of great white pelicans *Pelecanus onocrotalus* in South Africa's Western Cape. *South African Journal of Marine Science* 15: 33–42.

Crawford, R.J.M., Dyer, B.M., Kotze, P.G.H., McCue, S., Meÿer, M.A., Upfold, L. & Makhado, A.B. 2012. *Status of seabirds breeding in South Africa in 2011*. Oceans and Coasts, Department of Environmental Affairs. Technical report.

Cunningham, S.J., Madden, C.F., Barnard, P. & Amar, A. 2016. Electric crows: powerlines, climate change and the emergence of a native invader. *Diversity and Distributions* 22: 17–29.

Council for Geoscience. 2011. Geological Map 2816 Alexander Bay. Pretoria: Government Printer.

Cowling, R.M., Esler, K.J. & Rundel, P.W. 1999. Namaqualand, South Africa – an overview of an unique winter-rainfall desert ecosystem. *Plant Ecology* 142: 3–21.

Cowling, R.M. & Hilton-Taylor, C. 1999. Plant biogeography, endemism and diversity. Pp 42–56. In: Dean, W.R.J. & Milton, S.J. (Eds). *The Karoo, ecological patterns and processes.* Cambridge: Cambridge University Press.

Cowling, R.M., Richardson, D.M. & Pierce, S.M. (Eds). 1997. *Vegetation of southern Africa.* Cambridge: University Press.

CEPF (Critical Ecosystem Partnership Fund). 2003, *Ecosystem Profile: The Succulent Karoo hotspot*, Namibia and South Africa, Critical Ecosystem Partnership Fund report.

De Villiers, A.J., Van Rooyen, M.W. & Theron, G.K. 2004. The restoration of Strandveld Succulent Karoo degraded by mining: an enumeration of topsoil seed banks. *South African Journal of Botany* 70: 717–725.

Du Plessis, H.M. (Ed.) 1987. Land Types of the maps: 2816 Alexander Bay; 2818 Warmbad; 2916 Springbok; 2918 Pofadder; 3017 Garies; 3018 Loeriesfontein. *Memoirs on the Agricultural Natural Resources of South Africa* 9.

Du Preez, L.H. & Carruthers, V.C. 2017. *Frogs of Southern Africa: A Complete Guide*. 2nd Revised edition, Struik Nature.

Davis, C.L., Hoffman, M.T. & Roberts, W. 2016. Recent trends in the climate of Namaqualand, a megadiverse arid region of South Africa. *South African Journal of Science* 112: Art. 2015–0217, 9 pp.

Day, L. 2025. *Chapter 3a: Aquatic ecology* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

DFFE (Department of Forestry, Fisheries and the Environment) 2022. South Africa Protected Areas Database (SAPAD_OR_2021_Q4). http://egis.environment.gov.za.

DFFE (Department of Forestry, Fisheries and the Environment). 2023. National Environmental Management Act, 1998 (Act No. 107 of 1998) The National Biodiversity Offset Guideline. *Government Gazette No.* 48841, Government Notice No. 3569. 23 June 2023.

Desmet, P.G. & Cowling, R.M. 1999. Biodiversity, habitat and range-size aspects of a flora from a winter-rainfall desert in north-western Namaqualand, South Africa. *Plant Ecology* 142: 23–33.

Desmet, P.G. 1996. *The vegetation and restoration potential of the vegetation of the arid coastal belt between Port Nolloth and Alexander Bay, Namaqualand, South Africa.* MSc dissertation. Cape Town: University of Cape Town.

Desmet, P.G. 2007. Namaqualand—A brief overview of the physical and floristic environment. *Journal of Arid Environments* 70: 570–587.

Dodman, T. 2014. *Status, Estimates and Trends of Waterbird Populations in Africa:* AEWA-listed African populations. Wetlands International.

Driver, A., Nel, J.L., Snaddon, K., Murray, K., Roux, D., Hill, L., Swartz, E.R., Manuel, J. & Funke, N. 2011. *Implementation Manual for Freshwater Ecosystem Priority Areas*. WRC Report No. 1801/1/11. ISBN 978-1-4312-0147-1. Pretoria.

Driver, A., Sink, K.J., Nel, J.L., Holness, S.H., Van Niekerk, L., Daniels, F., Jonas, Z., Majiedt, P.A., Harris, L. & Maze, K. 2012. *National Biodiversity Assessment 2011: An assessment of South Africa's biodiversity and ecosystems*. Synthesis report. Pretoria: South African National Biodiversity Institute & Department of Environmental Affairs.

Department of Water and Sanitation (DWS), South Africa. 2017a. Determination of Ecological Water Requirements for surface water (river, estuaries and wetlands) and Groundwater in the Lower Orange WMA. *Report on consequences of scenarios*. Rivers for Africa eFlows Consulting (Pty) Ltd. DWS Report No: RDM/WMA06/00/CON/COMP/0117.

Department of Water and Sanitation (DWS), South Africa. 2017b. Determination of Ecological Water Requirements for Surface water (river, estuaries and wetlands) and Groundwater in the Lower Orange WMA. *Ecological Specifications and monitoring report*. Rivers for Africa eFlows Consulting (Pty) Ltd. DWS Report No: RDM/WMA06/00/CON/COMP/0217.

Ebert, T. & Balko, M. 1987. Temporary pools as islands in space and in time: the biota of vernal pools in San Diego, Southern California, USA. *Arch. Hydrobiol.* 110:101–123.

Eckert, K.L., Wallace, B.P., Frazier, J.G., Eckert, S.A. & Pritchard, P.C.H. 2012. *Synopsis of the biological data on the leatherback sea turtle* (*Dermochelys coriacea*). Washington, DC: U.S. Department of Interior, Fish and Wildlife Service, Biological Technical Publication BTP-R4015-2012.

EWT (Endangered Wildlife Trust). 2023. *Best Practice Guidelines for Implementing the Mitigation Hierarchy in South Africa*. EWT.

Ferguson-Lees, J. & Christie, D.A. 2001. *Raptors of the World.* Houghton Mifflin Company.

FitzPatrick Institute of African Ornithology. 2024. MammalMAP. https://vmus.adu.org.za/?vm=MammalMAP.

FitzPatrick Institute of African Ornithology. 2024. FrogMAP. https://vmus.adu.org.za/?vm=FrogMAP.

Francis, M.L., Palcsu, L., Molnár, M., Kertész, T., Clarke, C.E., Miller, J.A. & Van Gend, J. 2024. Calcareous termite mounds in South Africa are ancient carbon reservoirs. *Science of the Total Environment* 926: DOI:10.1016/j.scitotenv.2024.171760.

Froneman, A., Colyn, R., Oosthuizen, M. & Loftie-Eaton, M. 2025. *Chapter 3b: Avifauna* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR .

Frost, D.R. 2024. Amphibian Species of the World: An Online Reference. Version 6.1 (February 2023). https://amphibiansoftheworld.amnh.org/index.php. American Museum of Natural History, New York, USA. doi.org/10.5531/db.vz.0001.

GBIF.org (02 December 2024) GBIF Occurrence Download https://doi.org/10.15468/dl.7bax2v.

Goldberg, S.R. 2008. Note on reproduction of the web-footed gecko, *Pachydactylus rangei* (Squamata: Gekkonidae) from Namibia. *Bull. MDHS* (Md. Herpetol. Soc.) 44: 15–17.

Gottlieb, T.R., Eckardt, F.D., Venter, Z.S. & Cramer, M.D. 2019. The contribution of fog to water and nutrient supply to *Arthraerua leubnitziae* in the central Namib Desert, Namibia. *Journal of Arid Environments* 161:35–46.

Haacke, W.D., 1976. The burrowing geckos of southern Africa, 2 (Reptilia: Gekkonidae). Ann. *Transvaal Mus.* 30: 13–29.

Hamer, M. & Rayner, N.A. 1996. A note on the unusual crustacean community of a temporary pool in the northern Cape. *South African Journal of Aquatic Science* 22: 100–104.

Hattingh, J. 2016. *Surface and Groundwater Assessment.* Report to PHS Consulting for VAST Mineral Sands (Pty) Ltd.

Henschel, J.R. & Jürgens, N. In press. Ecology of psammophily in the Namib dunes. In: Eckardt, F.D., Livingstone, I., Thomas, D.S.G. (Eds). *Southern African Dunes*. Springer.

Hockey, P.A.R., Dean, W.R.J. & Ryan, P.G. (Eds). 2005). *Roberts – Birds of Southern Africa, VIIth edition*. Cape Town: The Trustees of the John Voelcker Bird Book Fund.

Hoffman, M.T., Rohde, R. & Gillson, L. 2019. Rethinking catastrophe? Historical trajectories and modelled future vegetation change in southern Africa. *Anthropocene* 25. https://doi.org/10.1016/j.ancene.2018.12.003.

Hofmeyr, M.D., Leuteritz, T. & Baard, E.H.W. 2018. *Psammobates tentorius* ssp. *trimeni*. *IUCN Red List of Threatened Species* e.T121936835A121936853. https://dx.doi.org/10.2305/IUCN.UK.20182.RLTS.T121936835A121936853.en

Hofmeyr, M.D., Loehr, V.J.T. & Baard, E.H.W. 2018[b]. *Chersobius signatus*. The IUCN Red List of Threatened Species 2018: e.T10241A115650943. http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T10241A115650943.en

Holness, S., & Oosthuysen, E. 2016. Critical Biodiversity Areas of the Northern Cape: Technical Report.

IFC PS6. 2019. *International Finance Corporation's Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources*. International Finance Corporation. World Bank Group. ww.ifc.org/ps6.

IUCN SSC. Amphibian Specialist Group & South African Frog Re-Assessment Group (SA-FRoG). 2017. *Breviceps macrops*. *The IUCN Red List of Threatened Species* e.T3070A2794989. https://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T3070A2794989.en.

IUCN. 2021. *IUCN Red List Categories*. Prepared by the IUCN Species Survival Commission. Gland: Switzerland.

Jenkins, A.R., Shaw, J.M., Smallie, J.J., Gibbons, B., Visagie, R. & Ryan, P.G. 2011. Estimating the impacts of power line collisions on Ludwig's Bustards *Neotis ludwigii*. *Bird Conservation International* 21: 303–310.

Jürgens, N. 1991 A new approach to the Namib Region: Phytogeographic subdivision. *Vegetatio* 97: 21–38.

Jürgens, N., Burke, A., Van Wyk, P., Gröngröft, A. & Oldeland, J. Preprint. A perfect storm: Unprecedented expansion of the Namib Desert and cascading desertification processes in the northernmost Succulent Karoo (Richtersveld, South Africa, Namibia). https://ssrn.com/abstract=5189871 or http://dx.doi.org/10.2139/ssrn.5189871

Jürgens, N., Burke, A., Seeley, M.K. & Jacobsen, 1997. Desert. In: Cowling, R.M., Richardson, D.M. & Pierce, S.M. (eds). *Vegetation of southern Africa* pp. 189-214. Cambridge: Cambridge University Press.

Jürgens, N. & Niebel, A. 1991. The unknown lichen hill. *Journal of the Botanical Society of South Africa* 77: 24–26.

Jürgens, N. & Niebel-Lohmann, A. 1995. Geobotanical observations on lichen fields of the Southern Namib Desert. *Mitteilungen aus dem Institut für Allgemeine Botanik in Hamburg* 25, 135–156.

KBA. 2024. Key Biodiversity Areas factsheet: Namaqualand Sandveld North. Extracted from the World Database of Key Biodiversity Areas. Key Biodiversity Areas Partnership. https://keybiodiversityareas.org<.

Kemp, A.C. & Kirwan, G.M. 2020. Jackal Buzzard *(Buteo rufofuscus*), version 1.0. In: Del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. & de Juana, E. (Eds) Birds of the World. Cornell Lab of Ornithology, Ithaca, NY, USA.

Kleynhans, C.J., Louw, M.D., Thirion, C., Rossouw, N.J. & Rowntree, K. 2005. *River EcoClassification: Manual for EcoStatus determination* (Version 1). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. KV 168/05.

Kot, C.Y.,. Fujioka, E., DiMatteo, A.D., Bandimere, A., Wallace, B.P., Hutchinson, B.J., Cleary, J., Halpin P.N. & Mast, R.B. 2023. *The State of the World's Sea Turtles Online Database: Data provided by the SWOT Team and hosted on OBIS-SEAMAP.* Oceanic Society, Conservation International, IUCN Marine Turtle Specialist Group (MTSG) and Marine Geospatial Ecology Lab, Duke University. http://seamap.env.duke.edu/swot.

Land Type Survey Staff, 1986. Land Type Map 2816 Alexander Bay.

Le Maitre, D., O'Farrell, P., Milton, S., Atkinson, D., De Lange, W., Egoh, B., Reyers, B., Colvin, C., Maherry, A. & Blignaut, J. 2009. *Assessment and Evaluation of Ecosystem Services in the Succulent Karoo Biome.* Report 27 prepared by CSIR for the Succulent Karoo Ecosystem Programme (SKEP) Coordination Unit, SANBI.

Le Maitre, D.C., Seyler, H., Holland, M., Smith-Adao, L.B., Nel, J.L., Maherry, A. & Witthüser, K. 2018. *Strategic Water Source Areas for groundwater* (Vector data). WRC Report No TT 754/1/18, Water Research Commission, Pretoria.

Loehr V.J.T. 2002. Population characteristics and activity patterns of the Namaqualand speckled padloper (*Homopus signatus signatus*) in the early spring. *Journal of Herpetology* 36: 378–389.

Loehr M.D. & Henen B.T. 2007. Annual variation in the body condition of a small, arid-zone tortoise, *Homopus signatus signatus*. *Journal of Arid Environment,* 71: 337–349.

Loehr M.D. & Henen B.T. 2009. Small and sensitive to drought: consequences of aridification to the conservation of *Homopus signatus signatus*. *African Herpetology* 58: 116–125.

Loehr B.T. & Hofmeyr M.D. 2011. Reproductive responses to rainfall in the smallest tortoise, *Homopus signatus signatus*. *Copeia* 2011: 278–284.

Mabidi, A., Bird, M.S., Perissinotto, R. & Rogers, D.C. 2016. Ecology and distribution of large branchiopods (Crustacea, Branchiopoda, Anostraca, Notostraca, Laevicaudata, Spinicaudata) of the Eastern Cape Karoo, South Africa. *ZooKeys* 618: 15–38.

Marais, W. 2025. *Chapter 3c: Bats* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Maree, S., Bronner, G.N. 2016. A conservation assessment of *Eremitalpa granti granti*. In: Child, M.F., Roxburgh, L., Raimondo, D., Davies-Mostert, H.T. (eds). *The Red List of Mammals of South Africa, Swaziland and Lesotho.* SANBI & EWT.

Mavurayi, A. 2014. *Geohydrological Impact Assessment for Alexkor Diamond Mine along the west coast between Port Nolloth and Alexander Bay, Northern Cape Province.* Report for Myezo Environmental Services.

McAuliffe, J.R., Hoffman, M.T., McFadden, L.D., Jack, S., Bell, W. & King, M.P. 2019. Whether or not heuweltjies: Context-dependent ecosystem engineering by the southern harvester termite, *Microhodotermes viator*. *Journal of Arid Environments* 163: 26–33.

MDT 2018. *Boegoebaai Environmental Screening Report*. Part of Phase 2 of a pre-feasibility study for the Boegoebaai Port. Report to TNPA.

Midgley, G.F., Rutherford, M.C., Bond, W.J. & Barnard, P. 2001. *The heat is on – impacts of climate change on plant diversity in South Africa.* Pretoria: South African National Botanical Institute.

Midgley, G.F. & Thuiller, W. 2007. Potential vulnerability of Namaqualand plant diversity to anthropogenic climate change. *Journal of Arid Environments* 70: 615–628.

Milton, S.J., Zimmermann, H.G. & Hoffmann, J.H. 1999. Alien plant invaders of the Karoo: attributes, impacts and control. In: Dean, W.R.J. & Milton, S.J. (Eds). *The Karoo: Ecological Patterns and Processes.* Cambridge: Cambridge University Press.

Mittermeier, R.A., Myers, N., Robles, G.P. & Mittermeier, C.G. 2000. *Hotspots: Earth's biologically richest and most endangered terrestrial ecoregions*, CEMEX, Mexico.

Mucina, L. & Rutherford, M.C. (Eds). 2006. Vegetation of South Africa, Swaziland and Lesotho. *Strelitzia* 19.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., De Fonseca, G.A.B. & Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 402: 853–858.

Mynhardt, S., Matthew, E., le Roux, J.P., Little, I., Bloomer, P. & Theron, C. 2024. Environmental DNA from soil reveals the presence of a "lost" Afrotherian species. *Biodiversity and Conservation* 33: 31–50.

Mynhardt, S. 2023. Golden mole that swims through sand is rediscovered in South Africa after 86 years. Published in *The Conversation*, December 5, 2023. https://theconversation.com/golden-mole-that-swims-through-sand-is-rediscovered-in-south-africa-after-86-years-219022.

National Environmental Management: Biodiversity Act (10/2004). 2022: *Revised national list of ecosystems that are threatened and in need of protection* (Government Gazette No. 47526 – Government Notice No. 2747))

Nash, T.H. 2008. *Lichen Biology.* 2nd Edition, Cambridge: Cambridge University Press.

National Environmental Management: Biodiversity Act (10/2004). 2022: Revised national list of ecosystems that are threatened and in need of protection (Government Gazette No. 47526 – Government Notice No. 2747).

Navedo, J.G., Arranz, D., Herrera, A.G., Salmón, P., Juanes, J.A. & Masero, J.A. 2013. Agroecosystems and conservation of migratory waterbirds: importance of coastal pastures and factors influencing their use by wintering shorebirds. *Biodiversity and Conservation* 22: 1895–1907.

NCNCA. 2009. *Northern Cape Nature Conservation Act (Act No. 9 of 2009).* Provincial Gazette Extraordinary, Vol 17, No. 1374, Kimberley: 21 January 2010.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., Van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L. & Nienaber, S. (2011). *Technical Report for the National Freshwater Ecosystem Priority Areas project*. WRC Report No. K5/1801

NFA. 2024. The publication of the annual list of all tree species which are protected under Section 12 of the National Forest Act, 1998 (Act No. 84 of 1998). *Government Gazette No.* 50291, Government Notice No. 4496. 13 March 2024. Pretoria: Government Printer.

Nkomo, M.N., Murgatroyd, M., Ralston-Paton, S. & Amar, A. 2024. Using stakeholder knowledge to co-produce research priorities for a raptor species vulnerable to impacts of wind energy facilities. *Ostrich* 95: 200-212.

Niemandt, C. 2025. *Chapter 3d: Fauna* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Northern Cape Department of Environment and Nature Conservation. (2016). Northern Cape Critical Biodiversity Areas [Vector] 0. Available from the Biodiversity GIS website.

National Protected Areas Expansion Strategy. 2018. NPAES PA Negotiated Focus Areas 2018. https://egis.environment.gov.za/data_egis/data

Olivier, J. 2002. Fog-water harvesting along the West Coast of South Africa: a feasibility study. *Water SA* 28: 349–360.

Ollis, D.J., Snaddon, C.D., Job, N.M. & Mbona, N. 2013. *Classification System for Rivers and other Aquatic Ecosystems in South Africa.* User Manual: Inland Systems.

Oosthuysen, E. & Geldenhuys, L. 2024. *Northern Cape Biodiversity Spatial Plan: Technical Report.* Northern Cape Department of Agriculture, Environmental Affairs, Rural Development and Land Reform, Springbok.

Pool-Stanvliet, R., Duffel-Canham, A., Pence, G. & Swart, R. 2017. *Western Cape Biodiversity Spatial Plan Handbook.* Stellenbosch: CapeNature.

Rayner, N.A. & Bowland, A.E. 1985 Notes on the taxonomy and ecology of *Triops granaries* (Lucas) (Notostraca: Crustacea) in South Africa. *South African Journal of Science* 81: 500–505.

Rayner, N. 1999. Notostraca. Pp. 7-13. In: Day, J.A., Stewart, B.A., de Moor, I.J. & Louw, A.E. (eds.) *Freshwater Invertebrates of Southern Africa. Crustacea I: Notostraca, Anostraca, Conchostraca and Cladocera* Water Research Commission Report TT 121/00, Pretoria.

ReptileMAP. 2024. The Southern African Reptile Conservation Assessment (SARCA, now ReptileMAP. http://vmus.adu.org.za/.

Roberts, D.L., Botha, G.A., Maud, R.R. & Pether, J., 2006, Coastal Cenozoic deposits. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds), *The geology of South Africa.* Johannesburg: Geological Society of South Africa, pp. 605–628.

Rutherford, M.C., Midgley, G.F., Bond, W.J., Powrie, L.W., Roberts, R. & Allsopp, J. 2000. Plant biodiversity: Vulnerability and adaptation assessment. In: Kiker, G. (Ed.). *Climate change impacts in southern Africa*. Report to the National Climate Change Committee. Pretoria: Department of Environment Affairs and Tourism.

Ryan, P.G. & Kirwan, G.M. 2022. Dune Lark (*Calendulauda erythrochlamys*), version 1.0. In Billerman, S.D. (Ed.) Birds of the World. Ithaca: Cornell Lab of Ornithology, NY, USA.

SANBI. 2012-2024. *The Vegetation Map of South Africa, Lesotho and Swaziland*, Mucina, L., Rutherford, M.C. & Powrie, L.W. (Eds), Online, http://bgis.sanbi.org/Projects/Detail/186, Version 2024.

SANBI. 2018. *Using CBA Maps to support land-use planning and decision-making*. SANBI Factsheet Series. Pretoria: South African National Biodiversity Institute.

SANBI. 2022. *Species Environmental Assessment Guideline.* Guideline for the implementation of the Terrestrial Fauna and Terrestrial Flora Species Protocols for Environmental Impact Assessments in South Africa. Version 3.1.Pretoria: SANBI.

SANBI. 2022. *Red List of Ecosystems (RLE) for terrestrial realm for South Africa*.

SANBI. 2024. Red List of South African Plants version 2024.1. Provided by SANBI, accessed on 2024/11/22.

Schreiner, G., Mqokeli, B., Snyman-van der Walt, L., Lochner, P., Louw, H., Modise, S., Ruthenavelu, M., Zukulu, Y. & Maluleke, J. 2024. *Strategic Environmental Assessment for the proposed Boegoebaai Port, SEZ and Namakwa Region: Briefing note for research partners.* Note produced by CSIR, NCEDA and TNPA.

Screening Tool. 2024. *Screening Report for an Environmental Authorization as required by the 2014 EIA Regulations – Proposed Site Environmental Sensitivity*. Department of Forestry, Fisheries and the Environment.

Simmons, R.E., Curtis, O.E. & Jenkins, A.R. 2005. *Black Harrier Circus macrourus*, In: Hockey, P.A.R., Dean, W.R.J. & Ryan, P.G. (Eds). The Trustees of the John Voelcker Bird Book Fund: 502–503.

Skowno, A.L., Poole, C.J., Raimondo, D.C., Sink, K.J., Van Deventer, H., Van Niekerk, L., Harris, L.R., Smith-Adao, L.B., Tolley, K.A., Zengeya, T.A., Foden, W.B., Midgley, G.F. & Driver, A. 2019. *National Biodiversity Assessment 2018: The status of South Africa's ecosystems and biodiversity. Synthesis Report*. Pretoria: South Africa. 214 pp.

Snow, D.W. & Perrins, C.M. 1998. *The Birds of the Western Palearctic, Volume 1: Non-Passerines*. Oxford: Oxford University Press.

Swart, E. & Geldenhuys, L. 2020. *Preliminary Report: Environmental concerns associated with the proposed Boegoebaai Harbour and refinery developments*. Internal departmental report No. 4/2020. Confidential.

Taylor, M., Peacock, F. & Wanless, R.M. (Eds). 2015. *The 2015 Eskom Red Data Book of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg.

Tippett, R.M. 2024. Jackal Buzzard (*Buteo rufofuscus*). Biodiversity and Development Institute. Available online at https://thebdi.org/2024/07/02/jackal-buzzard-buteo-rufofuscus/

Todd, S. 2011. *Ecological and Biodiversity Assessment: Terrestrial vertebrate fauna and botanical Specialist Study*. Report to G7 Renewable Energies for Richtersveld Wind Farm.

Tolley, K.A. & Burger, M. 2007. *Chameleons of Southern Africa*. Cape Town: Struik.

Tolley, K.A., Alexander, G.J., Weeber, J., Maritz, B. & Turner, A.A. 2019. *Bitis schneideri*. *The IUCN Red List of Threatened Species* 2019: e.T2818A147708662. https://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T2818A147708662.en.

Transnet National Ports Authority, 2024. *Boegoebaai Port and Rail Development Site Selection*.

Uetz, P., Freed, P, Aguilar, R., Reyes, F. & Hošek, J. (Eds). 2024. The Reptile Database, http://www.reptile-database.org.

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. 2019. *South African National Biodiversity Assessment 2018: Technical Report.* Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3. Pretoria: CSIR & SANBI.

Van Rooyen, G., Van Rooyen, N. & Van Wyk, P. 2025. *Chapter 3e: Vegetatio and flora (A)* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Van Wilgen, B.W., Reyers, B., Le Maitre, D.C., Richardson, D.M. & Schonegevel, L. 2008. A biome-scale assessment of the impact of invasive alien plants on ecosystem services in South Africa. *Journal of Environmental Management* 89: 336 –349.

Van Wyk, A.E. & Smith, G.F. 2001. *Regions of Floristic Endemism in southern Africa*. Pretoria: Umdaus Press.

Van Wyk, P. 2025. *Chapter 3f: Vegetation and flora (B)* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR.

Vignali, S., Barras, A.G., Arlettaz, R. & Braunisch, V. 2020. SDMtune: An R package to tune and evaluate species distribution models. *Ecology and Evolution* 10: 11488–11506.

Walker, C., Milton, S.J., O'Connor, T.G., Maguire, J.M. & Dean, W.R.J. 2018. Drivers and trajectories of social and ecological change in the Karoo, South Africa. *African Journal of Range and Forage Science* 35:157–177.

Wallace, B.P., Tiwari, M. & Girondot, M. 2013. *Dermochelys coriacea (Southwest Indian Ocean subpopulation)*. *The IUCN Red List of Threatened Species* 2013: e.T46967863A46967866. https://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T46967863A46967866.en.

Young, A.J., Guo, D., Desmet, P.G. & Midgley, G.F. 2016. Biodiversity and climate change: Risks to dwarf succulents in Southern Africa. *Journal of Arid Environments* 129: 16–24.

3.9 SUPPLEMENTARY MATERIAL: SPECIALIST REPORTS

1. Aquatic report

Day, L. 2025. *Strategic Environmental Assessment for the proposed Boegoebaai Port and Strategic Economic Zone, Northern Cape, South Africa, Work Package 1: Aquatic Ecosystems Assessment – Inland Aquatic Ecosystems and Estuaries.* Report to CSIR.

2. Fauna: Avifauna report

Froneman, A., Colyn, R. & Loftie-Eaton, M. 2025. *Strategic Environmental Assessment for the proposed Boegoebaai Port and Strategic Economic Zone: Avifaunal Specialist Assessment*. Report to CSIR.

3. Fauna: Bat report

Marais, W. 2025. *Bat Specialist Assessment for the Strategic Environmental Assessment of the Proposed Boegoebaai Port and SEZ* (Special Economic Zone), Northern Cape, South Africa.

4. Fauna: Mammal, Reptile and Amphibian report

Niemandt, C. 2025. *Strategic Environmental Assessment (SEA) for the Proposed Boegoebaai Port and SEZ Fauna Desktop Assessment*. Report to CSIR.

5. Vegetation and Flora report

(A.) Van Rooyen, N., Van Rooyen, G. & Van Wyk, P. 2025. *Boegoebaai Port and Special Economic Zone Strategic Environmental Assessment. Terrestrial Ecology: Vegetation and Flora component.* Report to CSIR.

(B.) Van Wyk, P. 2025. *Boegoebaai Strategic Environmental Assessment; Report 1; exploring the floral richness of the Boegoebaai Port development site and surrounding areas, Richtersveld Municipal Area, Western Gariep Desert, Northern Cape, South Africa.* Report to CSIR.

CHAPTER 3

Supplementary Material: Specialist Report

Aquatic report

Main Consultant
CSIR

STRATEGIC ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED BOEGOEBAAI PORT AND STRATEGIC ECONOMIC ZONE, NORTHERN CAPE, SOUTH AFRICA

WORK PACKAGE 1:



AQUATIC ECOSYSTEMS ASSESSMENT:

INLAND AQUATIC ECOSYSTEMS AND ESTUARIES

JANUARY 2025

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Executive Summary

E1 Introduction

As part of South Africa's ambition to become a player in the globally emerging green hydrogen (GH_2) market, a substantial programme of greenfield infrastructure has been proposed in the Northern Cape consisting of three main components:

1. A new deepwater port at Boegoebaai, dry and liquid bulk berths, and multi-purpose terminals;
2. A mixed-use Special Economic Zone (SEZ) located in the region adjacent to the proposed Boegoebaai port; and
3. Expansive regional renewable energy (wind and solar PV) generation and transmission infrastructure.

The production of GH_2 at the scale envisaged could have multiple direct and indirect impacts, including on local economies, infrastructure, communities and natural ecosystems and resources. In order to consider these potential impacts, the Council for Scientific and Industrial Research (CSIR) has been appointed to undertake an independent Strategic Environmental Assessment (SEA). The overarching purpose of the SEA is to develop an integrated decision-making framework to guide the planning of the proposed Boegoebaai Port, Special Economic Zone, and wider Namakwa region in a sustainable manner (Schreiner *et al*. 2024).

The present report was commissioned to provide specialist assessment of the potential impacts of the proposed Boegoebaai Port and SEZ (termed Work Package 1) for aquatic ecosystems, namely **inland aquatic ecosystems** and **estuaries**.

E2 Study approach

The findings of this report were based mainly on desktop review of available literature and spatial mapping products, with limited time for ground-truthing / calibration of mapped wetland areas. Information gaps were identified, including the need for high-confidence investigation of surface / groundwater linkages driving the larger pan and associated wetland function and structure in the Visagiespan, Rietfontein and Rietfonteinpan systems; the need for identification and mapping of key temporary pan habitat in rocky outcrops; and the need for wet-season assessment of ephemeral wetland invertebrate faunal communities. These information gaps would need to be filled, in the event that the proposed development was considered in more detail, as part of an Environmental Impact Assessment and/or water use licence application.

E3 Summary of aquatic ecosystems assessed on and associated with the study area

The report provides an overview of inland and estuarine aquatic ecosystems on and in the vicinity of the proposed Boegoebaai Port and SEZ areas, highlighting their importance and sensitivity to various development-related aspects.

E3.1 Inland aquatic ecosystems

Overall, the assessment showed that the study area is not rich in inland aquatic ecosystems. However, given the aridity of the area, those ecosystems that do occur are likely to be of very high importance from a terrestrial faunal perspective (see Niemandt 2025), and the ephemeral pans in this area are assumed to support interesting and rare aquatic invertebrate communities, including crustacean zooplankton fauna, with potentially high levels of regional endemism. The larger pans (Visagiespan, Rietfontein and

Rietfonteinpan (BB1, BB2 and BB3 in Figure E1)) in particular afford substantial wetland and pan habitat, with (unquantified) links to primary and/or secondary aquifers, which form springs in at least Visagiespan, creating permanent standing water pools. These are clearly utilised by terrestrial fauna, either directly (as a brackish to saline water source) or indirectly, for grazing of wetland plants that are supported by perennial water supply in places. Other inland aquatic ecosystems of assumed high biodiversity importance include ephemeral pans located in rocky outcrops across the site, some of which are likely to support communities of invertebrates adapted to ephemeral conditions and with high conservation importance. These systems have however been mapped in this study with low confidence.

All of the inland aquatic ecosystems mapped are classified as **depressions** in the National Wetland Map (Version 5) of the 2018 National Biodiversity Assessment (NBA) (Van Deventer et al. 2018). The larger pans include wetland habitat and belong to the Namaqualand Sandveld Bioregion. Within this bioregion, depressions have been rated as Critically Endangered with a protection status of Not Protected.

E3.2 Estuarine ecosystems

There are no estuaries in the study area. However, two estuarine systems lie in close proximity to the study area, and could potentially be affected by impacts associated with the proposed development. These comprise the Orange River Estuary to the north of the study area and the Holgat River Estuary, immediately to the south.

E3.2.1 The Orange River Estuary

The Orange River Estuary flows into the sea between the coastal towns of Alexander Bay (South Africa) and Oranjemund (Namibia). The estuary covers an area of about 2700 ha, and comprises an (almost) permanently open river mouth; a 2 to 3 m deep tidal basin; a braided channel system (located between sand banks covered with pioneer vegetation); and a severely degraded saltmarsh on the south bank of the river mouth (DWS 2017a). It is a rare and unusual wetland type on the arid and semi-arid coastline of southern Africa, deriving its flows from a large catchment that begins in the Lesotho Highlands in Lesotho, some 2432 km upstream of Alexander Bay.

The estuary is important at both a national and international level, having been accorded Ramsar Wetland status and being one of only two estuaries on the Namibian coast. The condition of the Orange River Estuary does however fall well short of its Recommended Ecological Category, requiring active interventions to improve estuarine condition. This is important, because new developments, such as that proposed, that further threaten its condition, directly or indirectly, would have direct negative implications for meeting the estuary's Resource Quality Objectives.

E3.2.1 The Holgat River Estuary

The Holgat River enters the sea just south of the study area. The outlet has been highly modified by mining operations. The system is ephemeral, with river flows rarely passing into the estuarine area, which is classified as a micro-outlet, signifying its small and highly ephemeral character.

Figure E1 illustrates the inland aquatic ecosystems identified within the study area, while **Figure E2** presents the results of sensitivity mapping of inland and estuarine aquatic ecosystems associated with the study area, with specific regard to sensitivity to the kinds of impacts likely to be associated with the proposed development.

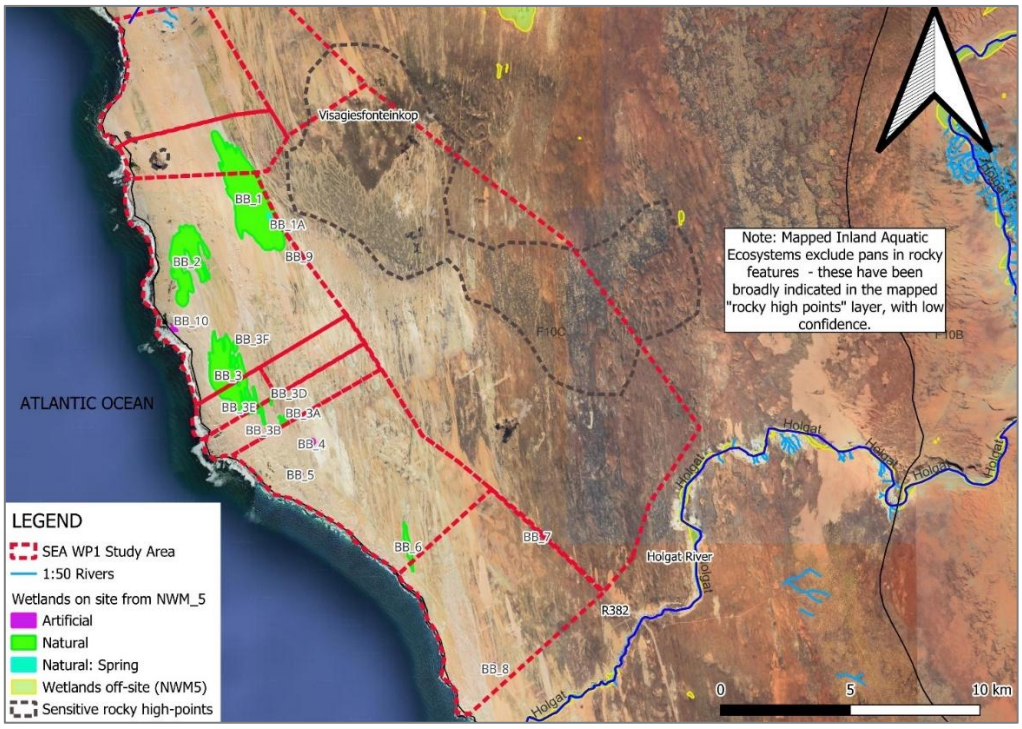


Figure E1

Coded, mostly ground-truthed inland watercourses in the study area, with extent based on that indicated in NWM Ver 5 (Van Deventer et al. 2018). Rocky high points mapped at desktop level with low confidence – the faunal specialist sensitivity layer should be prioritised for these areas.

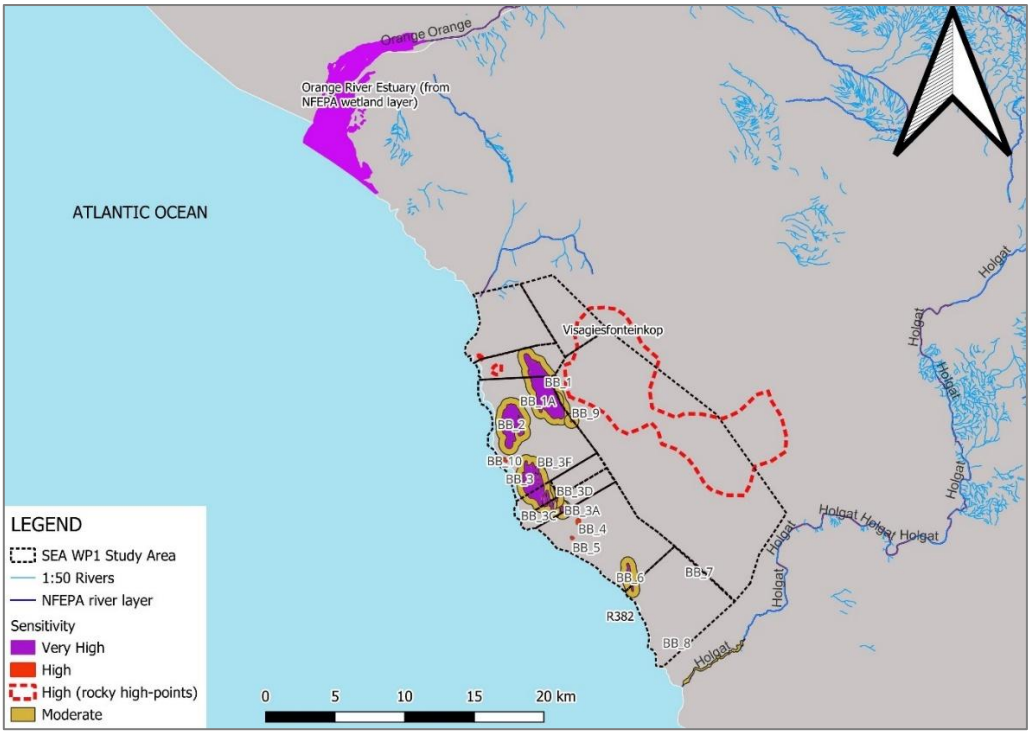


Figure E2

Inland and estuarine aquatic ecosystems sensitivity of the proposed Boegoebaai Port and SEZ study area. The figure includes recommended protective setbacks or buffer areas of 50 m and 500 m hydrological buffers, intended to protect recharge function, in the absence of more detailed information. Sensitivity assessments have been applied only to the watercourses on and immediately abutting the site. Grey areas have been rated as of Low sensitivity to the present proposed project

E4 Main Report findings

The proposed development would, in the conceptual layout presented for assessment in this study, result in potential loss of all of the inland aquatic ecosystems identified in the study area. Of these, natural pans and depression wetlands have been rated as Critically Endangered systems in the 2018 NBA (Van Deventer et al. 2018). The report thus recommends changes in development layout that could avoid these systems. It furthermore recommends the inclusion of ecological corridors that link between ecologically important terrestrial, coastal and (inland) aquatic areas across the site. Mitigation measures also include addressing potential impacts associated with concentrated stormwater flows through areas characterised by increasingly hardened surfaces, which could bypass dependent aquatic ecosystems.

Indirect impacts to the Orange River Estuary have also been flagged as potentially associated with the proposed development. The report recommends that, if the development were to be approved, it would need to allow (specifically) for increased human and financial resources at the Orange River Estuary, to control and police fishing, hunting and vehicle access and movement within the estuary, including its important saltmarshes. In addition, it would need to match any provision of fresh water from desalination plants to the Alexander Bay or other communities / urban areas with an equal increase in infrastructure and human resources capacity to treat the additional resultant waste water that would be generated from these areas, to a level that would not impact negatively on any receiving watercourse, and the Orange River Estuary in particular. This might mean far more stringent water quality treatment requirements than would normally be required.

Other required measures to address indirect impacts associated with expansion of urban areas as a result of the proposed development include the need for upgrading of solid waste management and attention to the design of new and/or upgraded external access roads, such that they do not result in downstream erosion or blockages of flows in flood conditions.

Finally, the report highlighted a number of information gaps that would need to be addressed if the proposed project is considered further and taken into Environmental Impact Assessment and/or Water Use License Application phases. These include detailed studies to unpack surface / groundwater interactions at the major pan / spring/ wetland areas (BB1, BB2 and BB3); wet-season assessment of ephemeral wetland invertebrate faunal communities; development of detailed stormwater management plans that take cognisance of the sensitivity of inland and estuarine aquatic ecosystems on and near the site; and details as to measures that can address the impact avoidance, mitigation and management measures outlined in the report.

The report concluded with a note that that there are no positive impacts to inland or estuarine aquatic ecosystems that would be associated with the proposed Boegoebaai Port and SEZ development, and substantial negative impacts could accrue, unless stringently addressed in development layout (avoidance), design and management.

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Figure E2 Inland and estuarine aquatic ecosystems sensitivity of the proposed Boegoebaai Port and SEZ study area. The figure includes recommended protective setbacks or buffer areas of 50 m and 500 m hydrological buffers, intended to protect recharge function, in the absence of more detailed information. Sensitivity assessments have been applied only to the watercourses on and immediately abutting the site. Grey areas have been rated as of Low sensitivity to the present proposed project 3

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1 INTRODUCTION

1.1 Background

Green hydrogen (GH_2), and its derivative products (e.g. green ammonia and green methanol) potentially provide an opportunity to decarbonise the South African energy economy, generate new revenues, create jobs and skills and facilitate a Just Energy Transition (Schreiner *et al*. 2024). As part of South Africa's ambition to become a player in the globally emerging green hydrogen market, a substantial programme of greenfield infrastructure has been proposed in the Northern Cape consisting of three main components:

1. A new deepwater port at Boegoebaai, dry and liquid bulk berths, and multi-purpose terminals;
2. A mixed-use Special Economic Zone (SEZ) located in the region adjacent to the proposed Boegoebaai port; and
3. Expansive regional renewable energy (wind and solar PV) generation and transmission infrastructure.

The production of GH_2 at the scale envisaged could have multiple direct and indirect impacts, including on local economies, infrastructure, communities and natural ecosystems and resources. In order to consider these potential impacts, the Council for Scientific and Industrial Research (CSIR) has been appointed to undertake an independent Strategic Environmental Assessment (SEA). The overarching purpose of the SEA is to develop an integrated decision-making framework to guide the planning of the proposed Boegoebaai Port, Special Economic Zone, and wider Namakwa region in a sustainable manner (Schreiner *et al*. 2024) (see **Figure 1.1**).

The SEA has two outputs:

1. **Boegoebaai Port and Special Economic Zone (Work Package 1):** Local-scale SEA report concerned with assessing the sensitivities of the receiving environment around the proposed port and Special Economic Zone.
2. **Namakwa Region (Work Package 2):** Regional-scale SEA report covering the main sustainability issues associated with an expansive Northern Cape Green Hydrogen economy covering parts of the Namakwa District, delineated by the Richtersveld, Nama Khoi, Kamiesberg and Khâi Ma Local Municipalities.

The present report falls under Work Package 1, and comprises a specialist assessment of the potential impacts of the proposed Boegoebaai Port and SEZ for aquatic ecosystems, including inland aquatic ecosystems and estuaries.

1.2 Terms of reference

The aquatic ecosystems assessment (estuaries and inland aquatic ecosystems) is primarily a desktop study, supplemented by limited time on site, intended to calibrate desk-top mapping and obtain a broad understanding of the types of aquatic systems that occur on the site. The report is intended to:

- Describe the key characteristics of aquatic ecosystems in the study area and their conservation and other importance; landscape connectivity and links to important terrestrial ecosystems; links to groundwater;
- Describe the land-use dynamics and change trends of the receiving environment and broader region as it relates to aquatic ecosystems;
- Describe the local receiving environment per SEZ subzone (where relevant);
- Define and identify areas of high, medium and low sensitivity, to inform site development plans;
- Complete an aspects / impacts register for each impact identified;
- Recommend strategic management actions to enhance positive impacts and reduce negative ones; guide future Port / SEZ planning and layout; and guide future site and project-specific Environmental Impact Assessments in the study area.

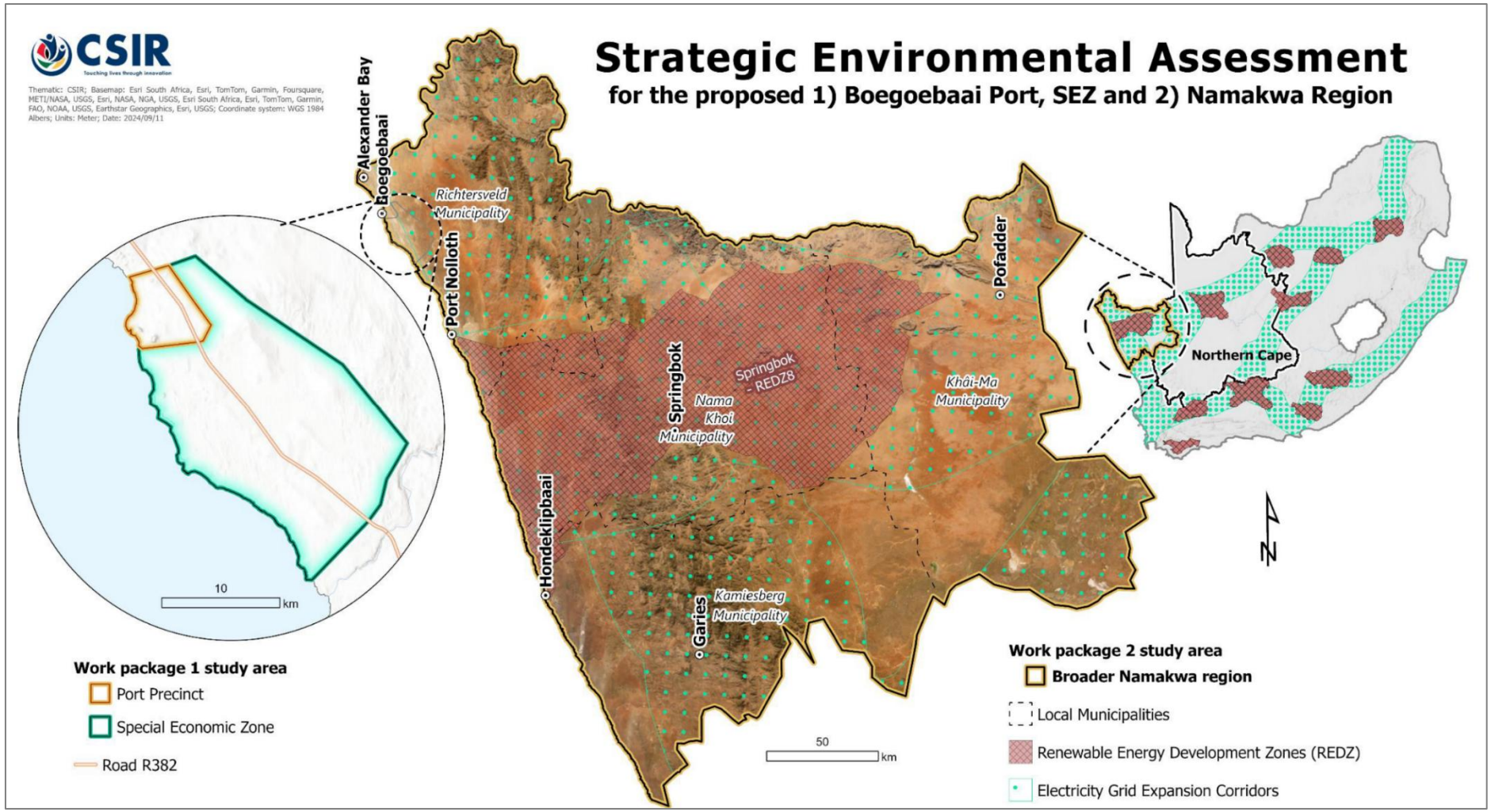


Figure 1.1
Spatial extent of the two work packages included in the GH_2 SEA (Figure after Schreiner *et al*. (2024).

1.3 Report informants

This assessment was informed by the following inputs and datasets:

- Spatial data:
    - National Freshwater Ecosystems Priority Area (NFEPA) project (Driver et al. 2011)
    - National Wetland Map (NWM Ver 5) (Van Deventer et al. 2018)
    - National Biodiversity Assessment (NBA) for aquatic ecosystem data (Van Deventer et al. 2018)
    - National 1:50 000 rivers and topographical GIS layers
    - National Strategic Surface and Groundwater Resources data
    - Ecoregion data
    - Bioregion and National Threat Status data (from the NWM dataset)
    - National Vegetation layer
    - The Northern Cape biodiversity spatial plan, including aquatic ecosystems
    - Boegoebaai disturbed and windblown sand layer (provided by CSIR)
- Relevant reports including (but not limited to):
    - Outputs from the (ongoing) Lower Orange River Classification and Resource Quality Objectives (RQOs)study
    - Geohydrological Impact Assessment for Alexkor Diamond Mine (Mavurayi 2014)
    - Surface water assessment (Hattingh 2016)
    - Ecological Water Requirement reporting for the lower Orange River (DWS 2017);
- A site visit (14-15th December 2023), during which watercourses highlighted during project ground-truthing were visited and a single water quality sample from a small spring within the study area was sampled and analysed for basic water quality parameters at BEMLAB laboratory in Somerset West.

1.4 Assumptions and limitations

- This report is primarily a broad-based desktop assessment, based on existing mapped data and available reports – no new biophysical data were collected as part of this study, other than once-off water quality data, of limited value.

- The assessment has relied on existing watercourse and estuary maps, included in the NFEPA and NWM Ver 5 datasets. These data are useful to inform broad conservation planning, but have not been ground-truthed sufficiently for high-confidence information of environmental impact assessments and for detailed development planning. This is a significant limitation in this assessment – the mapped extent of watercourses in the above datasets is not necessarily accurate.

- Although the current extent of most watercourses is discernible from aerial imagery, floodplain extent for major storm events is unknown.

- This report was not informed by a project-specific geohydrological report, which would have added considerably to the confidence with which surface/groundwater interactions were reported. Available geohydrological reports on the broader Alexkor Mining area (e.g. Mavurayi 2014) did not comment in any detail on groundwater interactions with any of the wetlands and/or springs within the current study area, making assessment of their hydrological drivers difficult and with low confidence.

1.5 Definitions

All reference to wetlands and watercourses in this document are based on the following definitions, taken from the National Water Act (NWA) (Act 36 of 1998):

"**watercourse**" means -

(a) a river or spring;

(b) a natural channel in which water flows regularly or intermittently;

(c) a wetland, lake or dam into which, or from which, water flows; and

(d) any collection of water which the Minister may, by notice in the Gazette, declare to be watercourse, and a reference to a watercourse includes, where relevant, its bed and banks;

"**wetland**" means -

land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

Government Notice (GN) 4167 of December 2023 furthermore defines:

"**Extent of a watercourse**" as:

(a) The outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; and

(b) Wetlands and pans: the delineated boundary (outer temporary zone) of any wetland or pan.

The National Environmental Management: Integrated Coastal Management Act, 2008 (as amended: 2015) defines an **estuary** as follows:

"estuary" means a body of surface water—

(a) that is permanently or periodically open to the sea;

(b) in which a rise and fall of the water level as a result of the tides is measurable at spring tides when the body of surface water is open to the sea; or

(c) in respect of which the salinity is higher than fresh water as a result of the influence of the sea, and where there is a salinity gradient between the tidal reach and the mouth of the body of surface water;

Aquatic ecosystems are defined in Ollis et al. (2013)'s National Classification System for wetlands and other aquatic ecosystems as including

- Inland systems (i.e. watercourses (as defined above) comprising rivers, wetlands, springs and pans
- Estuarine systems (as defined above); and
- Marine systems.

This report is concerned only with Inland and Estuarine aquatic ecosystems.

1.6 Study area location and extent

Figure 1.2 shows the location and extent of the area considered in this report (Work Package 1). The area includes a 33 500 ha area of land, comprising 3 378 ha for the proposed port and 30 122 ha for the proposed SEZ. The area is located some 14.75 km south of the small mining town of Alexander Bay, on the northern boundary of South Africa with Namibia. It is accessible off the R382 road to Alexander Bay, and via the Alexkor Mine, the entrance to which is located on the southern outskirts of Alexander Bay. The southern boundary of the site lies approximately 37 km north of the seaside town of Port Nolloth.

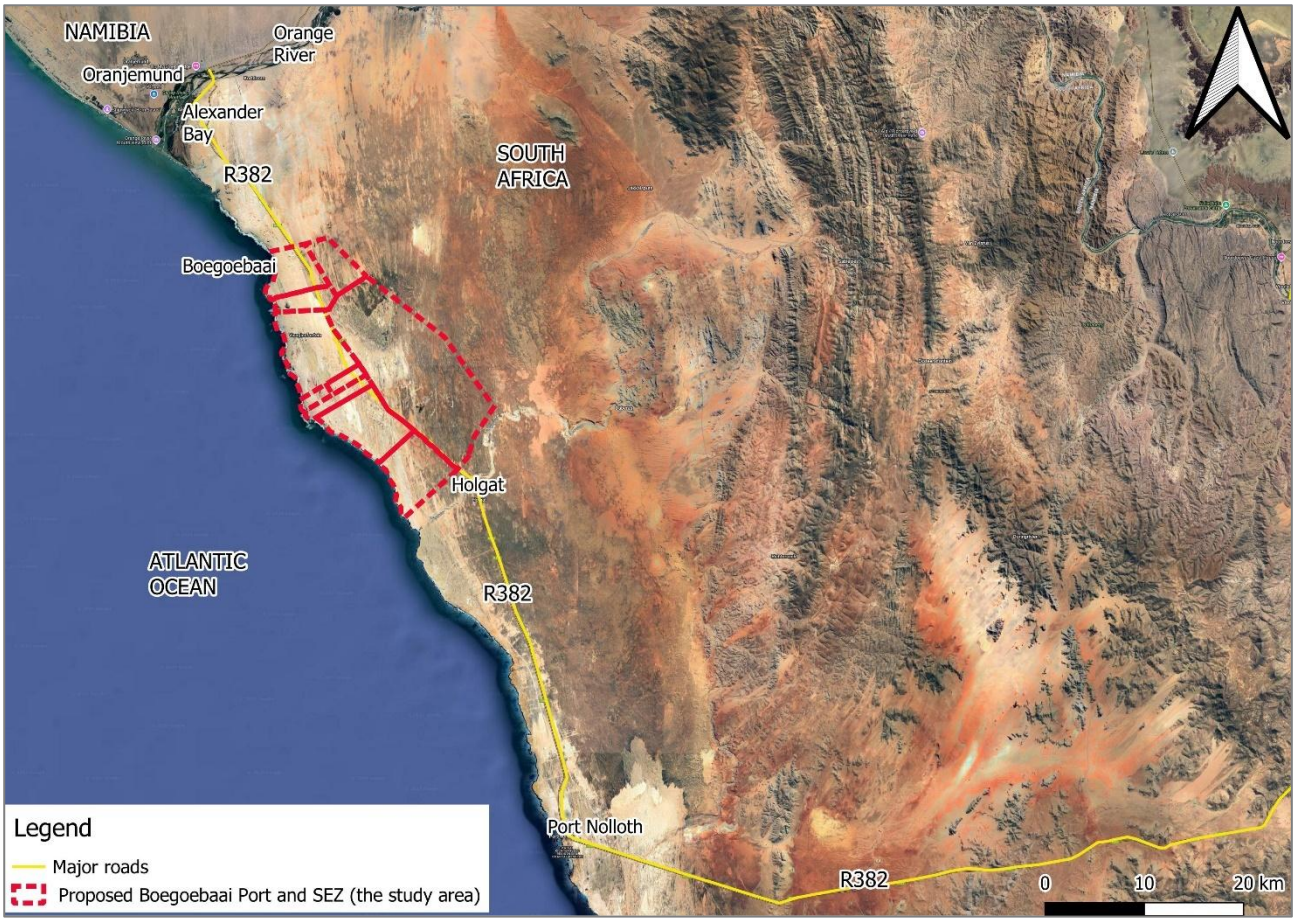


Figure 1-2
Study area for Work Package 1 of the Boegoebaai SEA.

2. DESCRIPTION OF THE RECEIVING ENVIRONMENT (INLAND AQUATIC ECOSYSTEMS AND ESTUARIES)

2.1 Overview

The study area is edged by a long rocky coastline, with large expanses of the inland areas having been disturbed by mining and other activities. Two rivers pass into the sea to the north and south of the site respectively, namely the Orange River, which enters the sea via its extensive estuary on the northern outskirts of Alexander Bay, and the ephemeral Holgat River, which opens into the sea some 2 km south of the boundary of the study area. Other drainage lines and watercourses within the study area peter out and dissipate into the sands, with no surface outlets into the sea. These are described in more detail in Section 2.11.

2.2 Climate

Climate is a major driver of inland aquatic ecosystems, and since freshwater flows are one of the key drivers of estuarine ecosystem function (Cadman 2016), climate is also an important consideration in estuarine assessment.

2.2.1 Rainfall

PRDW (2015) cites South African Weather Service (SAWS) data for Alexander Bay (noted as the driest station in South Africa at the time), with a mean annual rainfall of 46 mm per year. Hattingh (2016) confirms that rainfall is low and highly variable, with annual rainfall of around 41 mm, falling mainly during winter with no rain generally falling during summer months.

The above report also notes that there is some increase in rainfall with distance south, with Port Nolloth recording an average rainfall of 63 mm during the past few decades (data source not noted). Average annual evaporation rate is however high, and Hattingh (2016) cites an evaporation rate of 2 524 mm per year, resulting in extremely dry conditions across most of the site.

2.2.2 Fog

Fog contributes moisture that is an important water source to biota adapted to arid conditions (see terrestrial ecology reports) and may account for a greater volume of water than annual rainfall (Davis et al. 2016). Fog commonly occurs in the late afternoon till late morning (Hattingh 2016) . Data presented in PRDW (2015) indicate that fog appears to be most prevalent between January and May, with most fog periods lasting two to four hours, sometimes extending up to 10 hours.

2.2.3 Temperature

Hattingh (2016) cites average midday temperatures for Alexander Bay that range from 20.6°C in July to 27.5°C in January, noting that the region is coldest during July, with average night time minimum temperatures of 8.3°C. However, occasional hot, dry easterly katabatic winds in winter can result in increased temperatures up to 40°C, with daily temperature variations of up to 30°C.

2.2.4 Climate change context

Davis et al. (2016) assessed long-term weather data for five stations in Namaqualand, including Port Nolloth, just south of the current study area. With specific regard to data for Port Nolloth, which should be

interpreted cautiously, given that annual rainfall may be higher in this area than in the present study area, the research made the following findings:

- Trends in annual maximum temperature indicated a significant increase at the Port Nolloth station of 0.3 °C per decade;
- The rate of increase in seasonal minimum temperatures is greater than that of maximum temperatures;
- The annual rainfall time series for the weather station demonstrated no significant change in rainfall over the last 30 years with strong inter-annual variability but no significant trend in the coefficient of variation, suggesting that inter-annual rainfall variability has remained relatively constant over the past decades, although a decrease in summer rainfall was statistically significant over Port Nolloth;
- Port Nolloth also experienced a decline in the maximum consecutive 5 day rainfall event;
- Areas along the coastline generally experienced an increase in evapotranspiration of up to 30 mm per decade over the study period (1901-2009);
- The occurrence of warm extremes has increased and the occurrence of cold extremes has decreased over Namaqualand, while there has been an increase in warm spell duration;
- The increase in temperature combined with observed increases in evapotranspiration is of concern, while the impact of these on fog occurrence is poorly understood;
- In addition to the above, climate change is predicted likely to increase sea levels and storm surge heights (noted in PRDW 2015). These changes may impact on inland and/or estuarine ecosystems (see Section 4.3).

2.3 Topography and geology

The study area comprises mainly gently undulating sands towards the coast, with steep rocky drop-offs down to the coastal zone. Extensive low-lying depressions occur between low dunes in places, although large-scale mining disturbance in some areas on the western part of the site means that the actual natural topography is now difficult to determine, with some areas having been mined down to hard-pan areas and others clearly recipients of dumped mining spoil.

The topography varies from a maximum of 240 m amsl on a high point near the eastern site boundary (Visagiesfonteinkop), dropping gently down to sea level along the coastal zones to the west. Rocky outcrops / inselbergs occur in places (e.g. the Boegoeberg Twins and Visagiesfonteinkop, as well as other unnamed rocky outcrops, the bases of which are generally covered in windblown sands with the upper areas comprising exposed rock).

Mavurayi (2014) presents a simplified geological map that includes the present study area, showing that most of the site comprises quaternary deposits (sand and calcrete), with rocks of the Holgat Suite (schist, gneiss, arenite and limestone) underlying parts of the site and protruding above the surface in some areas (e.g. Boegoe Bay area, including the Boegoeberg Twins formations (see **Figure 2.1**) and a number of higher-lying areas east of the R382, including Visagiesfonteinkop. These formations characterise the lower reaches of the Holgat River, just south of the study area, with the deep Holgat Canyon / river valley having been incised predominantly into greywackes (Mavurayi 2014). Infilled fossil drainage valleys also occur within the study area, and the above author notes that they are currently indicated by the presence of pans including those in the Rietfontein area of the present study area. These are discussed in Section 2.6.

Desmet (1996) notes that the largest of these fossil channels is in the region of Rietfontein, citing a suggestion by Keyser (1972) that this represents the palaeo course of the Holgat River, which was diverted into its present course during the Middle to Lower Pleistocene (ca. 100 000 BP).

Mavurayi (2014) further notes that, in areas where beaches and embayments occur along the coastline and correspond to old river valleys, the earlier, darker coloured sediments are overlain by light-coloured dune sands of marine origin, which are generally loose and are aligned more or less parallel to the main wind direction (SE-NW). These marine sands derive from fluctuations in ocean level that resulted in the formation of sequences of wave cut marine terraces and more extensive sand accumulation on those areas of the coastal plain. During periods of sea level retreat, these unconsolidated sediments were exposed to aeolian mobilisation, leading to dune field formation.

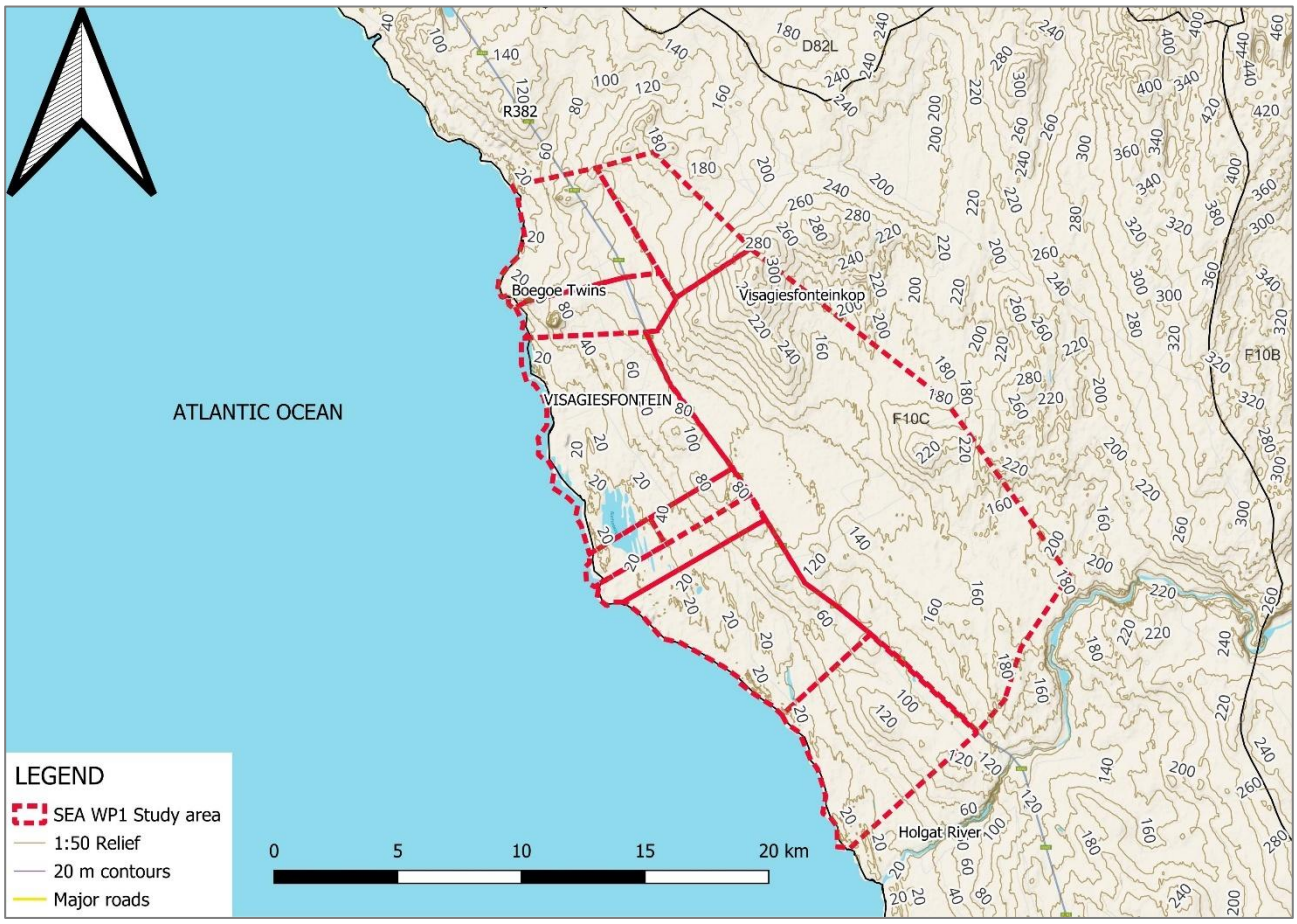


Figure 2.1
Map showing relief and main topographical features in and abutting the study area.

The conceptual cross-section shown in **Figure 2.2** shows that lenses of calcrete also occur in places on these old wave-cut platforms.

Calcrete formation is in fact linked to rainfall and evaporation in arid areas. When rain falls, it percolates into the soil, carrying with it dissolved minerals, including calcium carbonate from the soil and rocks, which react with carbon dioxide to form solutions of calcium carbonate. As the water moves through the soil it evaporates, increasing the concentration of calcium bicarbonate, which precipitates out as a a hard, crusty layer of calcium carbonate, over which water may collect. When these layers lie close to the surface, they can create perched wetlands.

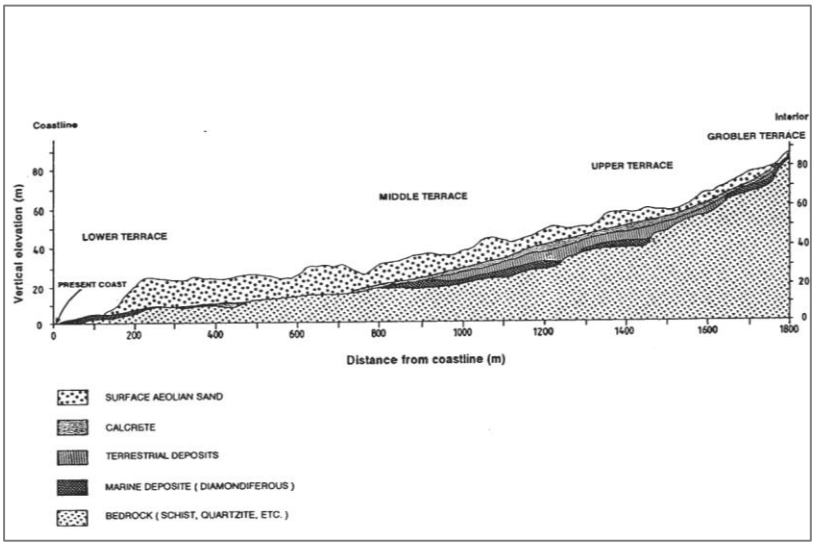


Figure 2.2
Conceptual cross-section (west to east) through the landscape in / near the present study area.
Figure after Burns (1994) as presented in Desmet (1996). Note that Rietfontein and Rietfonteinpan lies some 1 600 and 1 900 m from the coast, as estimated off Google Earth imagery.

2.4 Geohydrology

Background information provided in this section is based on reporting by Mavurayi (2014), who assessed the broader Alexkor mining site from a geohydrological perspective. However, in the absence of any boreholes within the current study area, the findings of that assessment can be broadly considered in this report, but do not assist with site-specific assessments of surface-groundwater interactions.

The report found that:

- As a result of the low rainfall, recharge of groundwater is limited (hence only small quantities can be abstracted on a sustainable basis);
- Primary aquifers are associated with the unconsolidated deposits comprising sand and gravel in the flood plain of the Orange River; and in paleao drainage channels and associated valleys. They vary in thickness from 0 m (bedrock outcrops) to about 30 metres below the surface;
- Secondary aquifers are associated with fractures and fissures in the bedrock of Gariep Complex consisting of schist, gneiss, arenite and limestone, in which secondary processes have improved their groundwater potential through fracturing and weathering;
- Groundwater quality is typical of arid regions and characterised by high salinity with electrical conductivity generally > 300 mS/m, attributed to:
    - Very low groundwater recharge (estimated at 0 to 5 mm per annum) and thus limited flushing out of old water,
    - Marine origin of gravels on terraces extending about 2 km inland and rising to about 90 m above mean sea level;
    - Leaching and dissolution of terrestrial salts originating from salt outfall from the sea;
    - Ancient water in palaeo-channels, recharged during periods of less arid regional climate in the past;
    - Excessive surface water evaporation relative to rainfall.
- A perched water-table is expected in the gravels in places where clay layers and other less permeable material exist.

The above information in part assists in explaining the presence of permanent but highly saline wetlands in parts of the site (see Section 2.7), which appear to occur, at least in part, in the infilled palaeo-channels described in Section 2.3. These wetlands include deep, permanent standing water areas, the persistence of which is not necessarily explicable by a perched primary aquifer, given the low rainfall and high evaporation rates, and might suggest a spring / link to the secondary aquifer. Geohydrological input is required in this regard.

2.5 Strategic surface and groundwater resources

No surface or groundwater Strategic Water Source Areas (SWSAs) are mapped within the study area (Le Maitre et al. 2018). The data presented in **Figure 2.3** indicate that the closest SWSA (groundwater) lies south of the study area, in the Port Nolloth area.

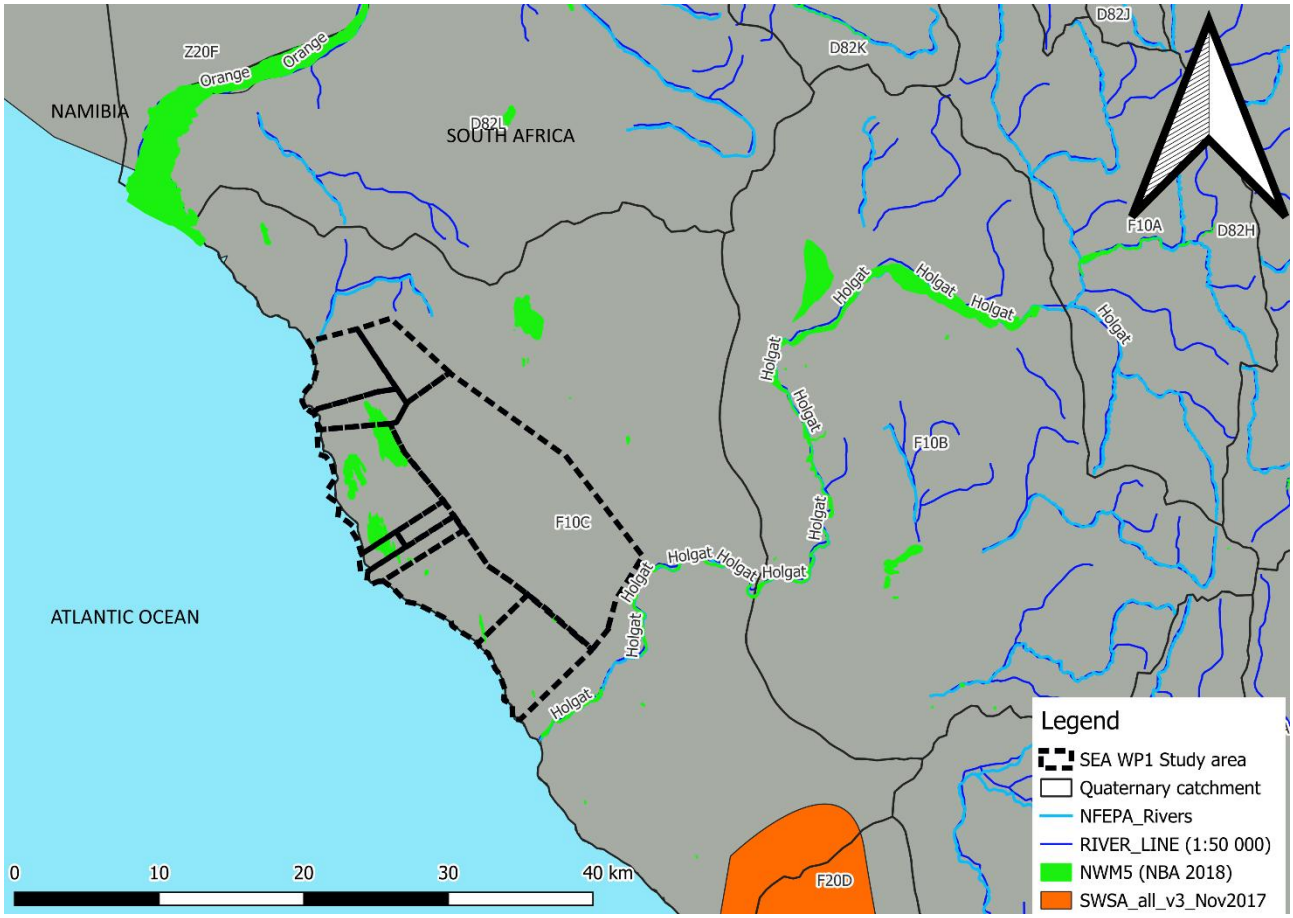


Figure 2.3
Study area in the context of the Strategic Water Source Area (surface and groundwater) data.
(Le Maitre et al. 2018).

2.6 Regional Vegetation types

Five vegetation units occur within the study area namely Namib Seashore Vegetation, Richtersveld Coastal Duneveld, Northern Richtersveld Yellow Duneveld, Richtersveld Sandy Coastal Scorpionstailveld and Western Gariep Plains Desert, the extents of which are indicated in **Figure 2.4**. Of these, two are listed as Critically Endangered (CR) under the revised Red List of Ecosystems (SANBI 2022b) (i.e. Namib Seashore Vegetation, Richtersveld Coastal Duneveld. The other three units are listed as of Least Concern(LC).

These units are described in detail in the terrestrial ecosystems reports for this study (Niemandt 2024) and are referred to in this report in the particular context of those that support wetlands or other aquatic ecosystems. Aquatic ecosystems are thus also indicated in **Figure 2.4**, and described later in Sections 2.9-2.11.

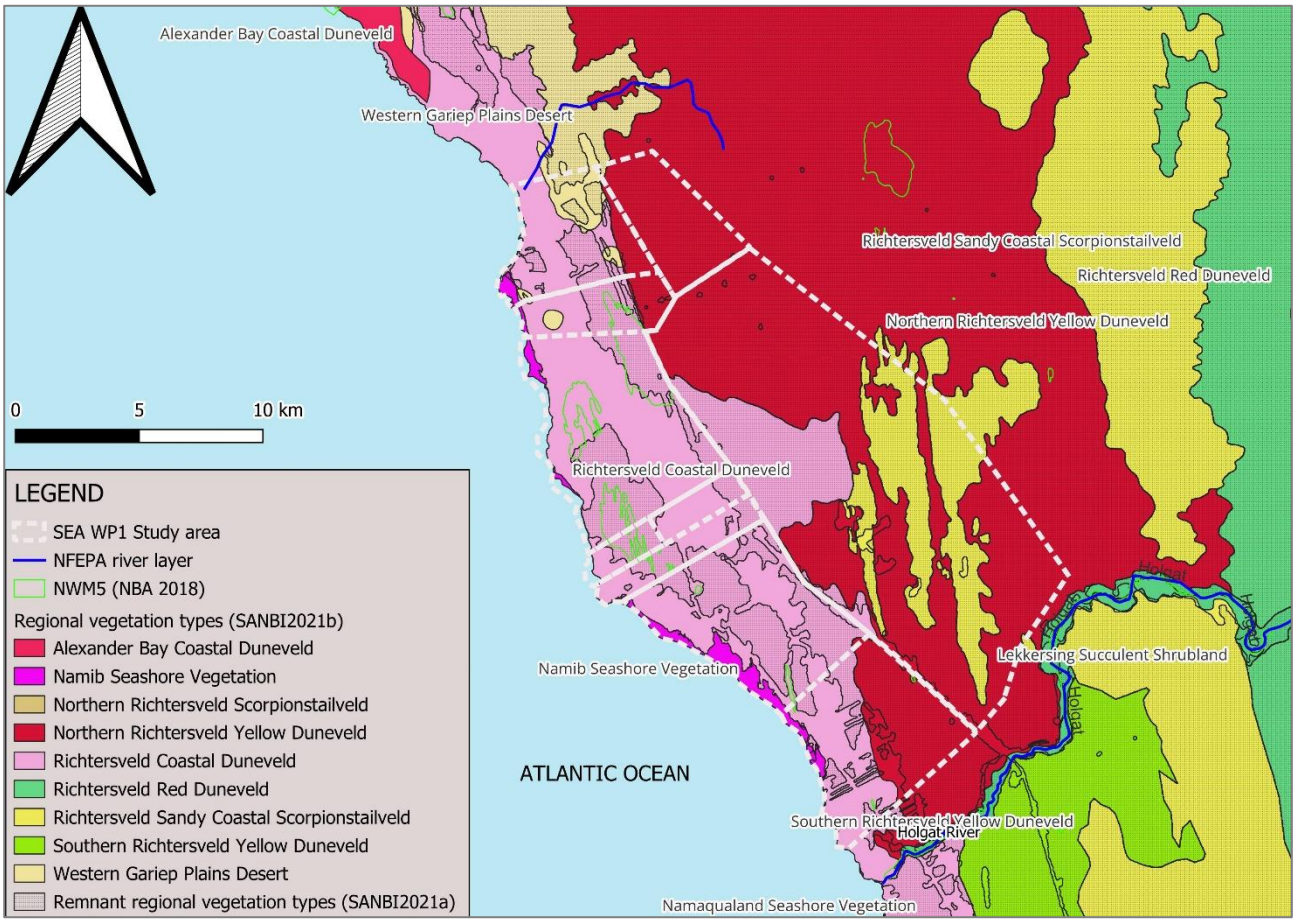


Figure 2.4
Regional vegetation types within and in the vicinity of the study area (data from SANBI 2022b), showing also inland and estuarine aquatic ecosystems from the NWM of the 2018 NBA (van Deventer et al. 2018). Hatched areas indicate remnant vegetation (SANBI 2022a).

The mapped wetlands shown in **Figure 2.4** occur almost wholly within the (Critically Endangered) Richtersveld Coastal Duneveld vegetation units. Other aquatic ecosystems not mapped in the National Wetland Map (NWM Ver 5) of Van Deventer et al. (2018) include ephemerally inundated depressions that occur in rocky outcrops.

2.7 Ecoregion context

An ecoregional classification produced by Kleynhans et al. (2005) divided the country's rivers into 31 distinct ecoregions, or groups of rivers which share similar physiography, climate, geology, soils and potential natural vegetation. **Figure 2.5** shows the present study area in the context of these ecoregions.

The figure indicates that the study area falls wholly within the Western Coastal Belt ecoregion.

The main characteristics of this ecoregion are summarised below (after Kleynhans et al. 2005), and not surprisingly correspond with the climatic data discussed in Section 2.2.

- **Western Coastal Belt ecoregion** characteristics:
    - Mostly low relief plains; some closed hills and mountains with moderate to high relief;
    - Vegetation consists mainly of Lowland Succulent Karoo;
    - Mean annual precipitation: Very low/arid (0-200 mm);
    - Coefficient of variation of annual precipitation: High to very high.
    - Drainage density: Low.
    - Stream frequency: Low/medium.
    - Slopes <5%: >80%.
    - Median annual simulated runoff: Very low.

The above characteristics suggest:

- Generally low rainfall (arid region);
- Few watercourses;
- High to very high variability in MAR between years;
- High discharge after rain events in some areas;
- Rainfall generally concentrated over a few months (winter).

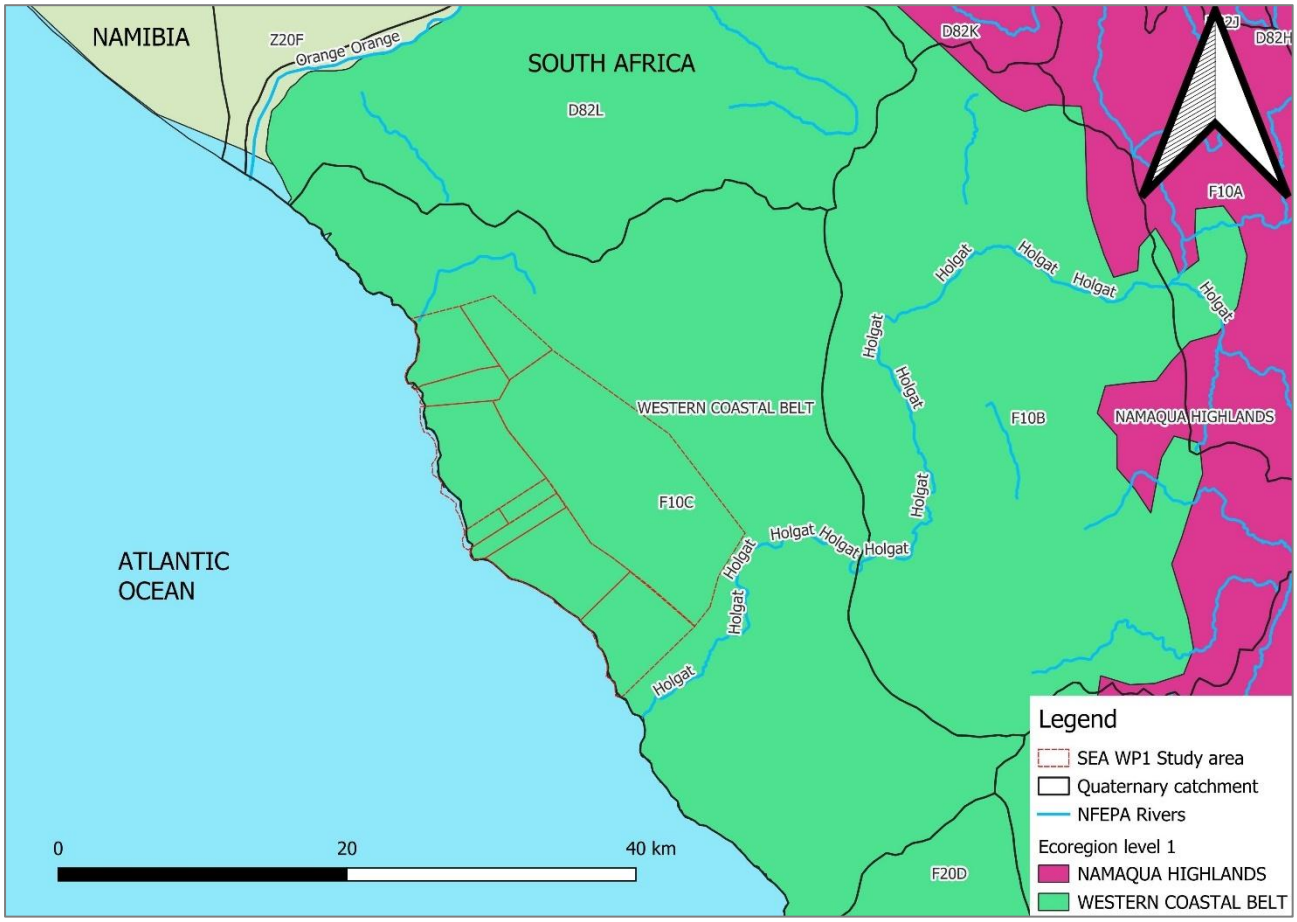


Figure 2.5
Ecoregion context of the study area. Data after Kleynhans et al. (2005).

2.8 Catchment[1] context

The study area lies wholly in the Department of Water and Sanitation (DWS)'s quaternary catchment F10C, within the Coastal Orange sub-Water Management Area (Sub-WMA), nested within the Lower Orange WMA, as shown in **Figure 2.6**. The Coastal Orange sub-WMA does not in fact drain into the Orange River, but drains west towards the coastline by way of multiple ephemeral watercourses (that is, rivers that are dry throughout most years, flowing irregularly and intermittently, without strong seasonal patterns). Most of these dissipate into the deep sands of the surrounding area.

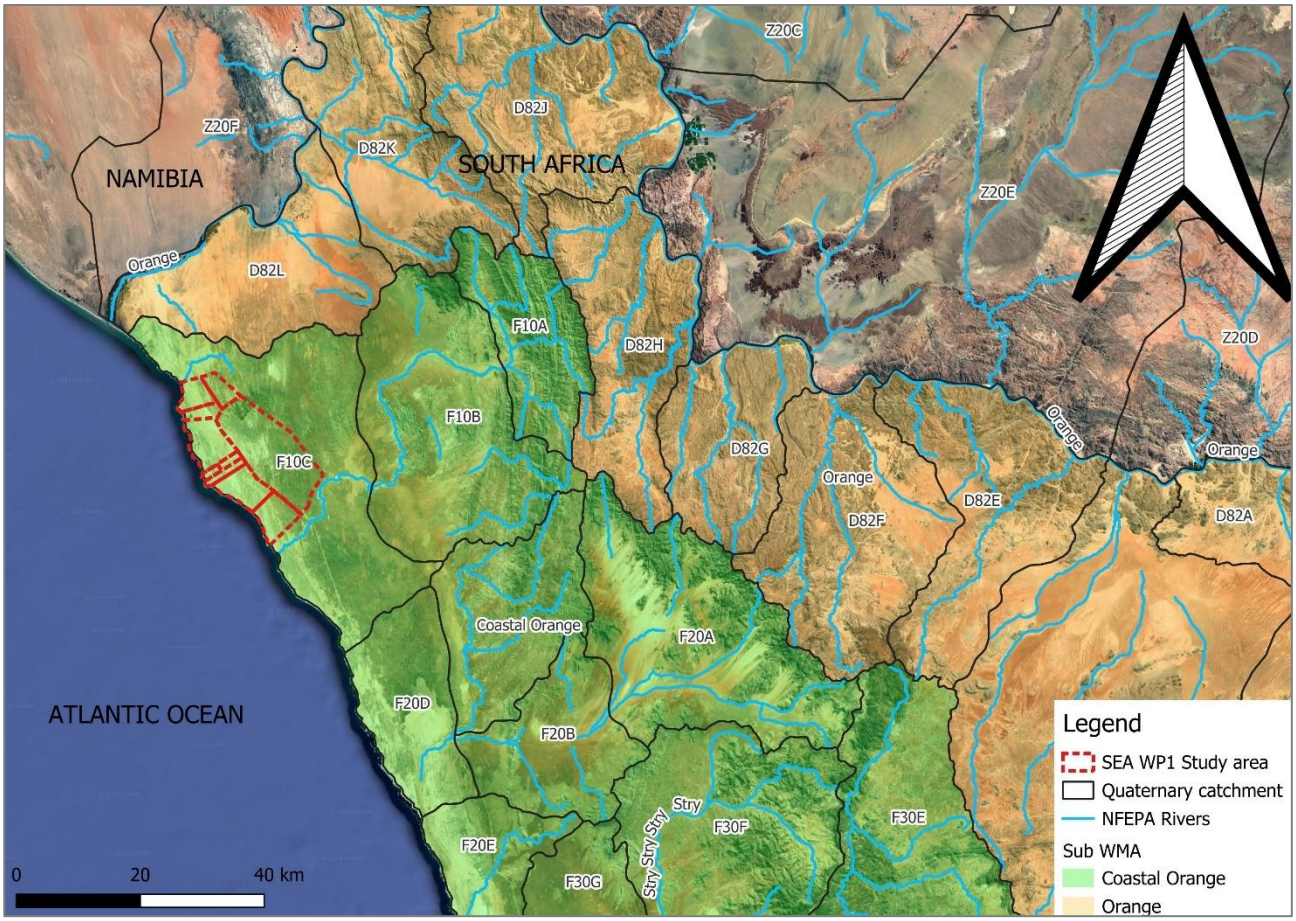


Figure 2.6
Catchment context of the proposed Boegoebaai Port and SEZ (the study area).

2.9 Inland aquatic ecosystem conservation planning context

2.9.1 FEPA status

The National Freshwater Ecosystem (NFEPA) Programme includes rated Freshwater Ecosystem Priority Areas (FEPAs). These are strategic priority subcatchments that are needed for conserving freshwater ecosystems and supporting the sustainable use of water resources (Driver et al. 2011). FEPAs have been determined for different river and wetland types throughout South Africa, on the basis of a number of

[1] The relevance of quaternary catchment identification is for purposes of water use licence authorisation and/or registration of water uses in future phases of the project. Identification of sub-WMAs contributes to an understanding of the broader water resources in the area.

criteria that included ensuring that there is an adequate extent of conservation of different river and wetland ecosystem types; that they represent adequate habitats to support threatened fish species and their migration corridors; that free-flowing rivers (i.e. rivers without major dams) are prioritised as FEPAs; that water supply areas in high-water yielding sub-quaternary catchments are maintained; and that ecological connectivity between systems is maintained as far as possible.

FEPAs are often tributaries or rivers that support "hard working" rivers downstream (that is, rivers that are heavily utilised or impacted by agricultural, industrial or other human activities). They need to stay (or get into) good condition to manage and conserve freshwater ecosystems and to protect downstream water resources for human use. Driver et al. (2011) stress however that FEPAs do not necessarily need to be protected from all human use. Rather, they should be supported by good planning, decision-making and management to ensure that human use does not impact on their condition or on the important resources they may protect downstream.

River FEPA ratings are important, because they assign different levels of conservation importance, associated with different requirements for the protection, rehabilitation and/or or management of aquatic resources within these sub-catchments.

FEPA ratings include the following categories:

- River FEPA and associated sub-quaternary catchment (FEPA): River FEPAs achieve biodiversity targets for river ecosystems and threatened fish species, and were identified in rivers that are currently in a good condition (A or B ecological category). Their FEPA status indicates that they should remain in a good condition in order to contribute to national biodiversity goals and support sustainable use of water resources;

- Fish sanctuary and associated sub-quaternary catchment (FishFEPA): Fish sanctuaries are rivers that are essential for protecting threatened indigenous freshwater fish. They comprise rivers in a good condition (A or B ecological category) and their whole associated sub-quaternary catchment;

- Fish Support Area and associated sub-quaternary catchment (FishFSA): Fish sanctuaries in lower than an A or B ecological condition are rated as Fish Support Areas – they include sub-quaternary catchments that are important for the migration of threatened fish species;

- Upstream Management Areas: These are sub-quaternary catchments in which human activities need to be managed to prevent degradation of downstream river FEPAs and Fish Support Areas;

- Phase 2 FEPA: Phase 2 FEPAs are rivers that should not be degraded further, as they may in future be considered for rehabilitation once FEPAs in good condition (A or B ecological category) have been fully rehabilitated and are well managed;

- Free-flowing river: Free-flowing rivers are rivers without dams.

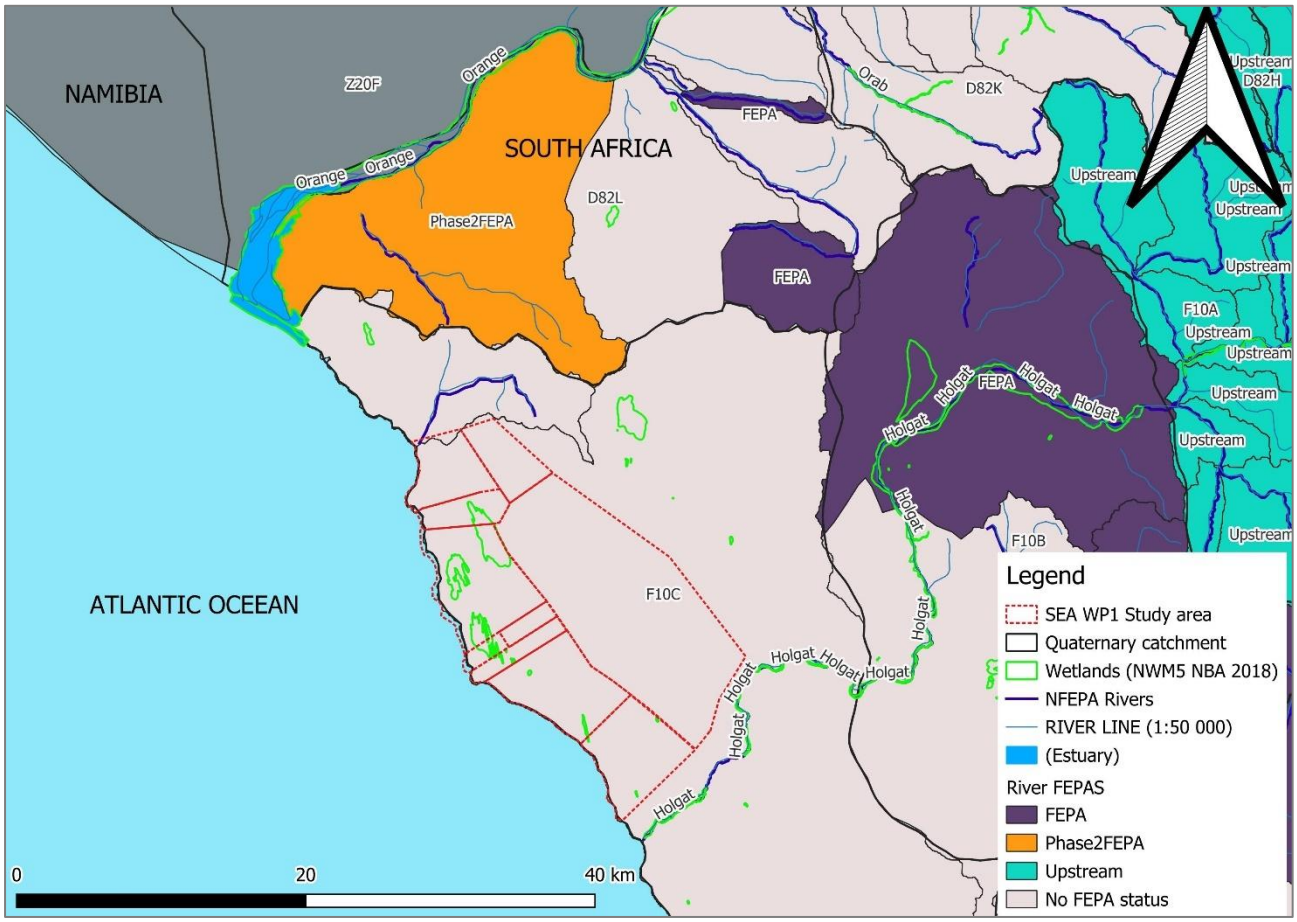


Figure 2.7
Study area in the context of rated FEPA sub-catchments (Driver et al. 2011).

Figure 2.7 shows the present study area in the context of river FEPAs. The figure indicates that:

- The entire site lies outside of any river FEPAs. This is not surprising, since the site drains towards the west, and there are no watercourses within the site that enter the sea – hence there is no downstream connectivity;

- A Phase 2 FEPA has been assigned to the sub-quaternary north of the study area, associated with and draining into the Orange River. The Orange River estuary has been accorded Ramsar wetland status, indicative of a wetland with extremely high conservation importance, at an international level.

2.9.2 Regional conservation planning data (Northern Cape Biodiversity Planning data)

Regional conservation planning data from the (draft) Northern Cape Biodiversity Planning dataset (Northern Cape Department of Environment and Nature Conservation 2018) were accessed for this assessment, and overlain as GIS data over the study area and surrounds. These data do not differentiate between aquatic and terrestrial ecosystems, as shown in **Figure 2.8**. However, the overlays of rivers and NBA (2018) wetlands do show where aquatic ecosystems may contribute to high conservation status in some areas.

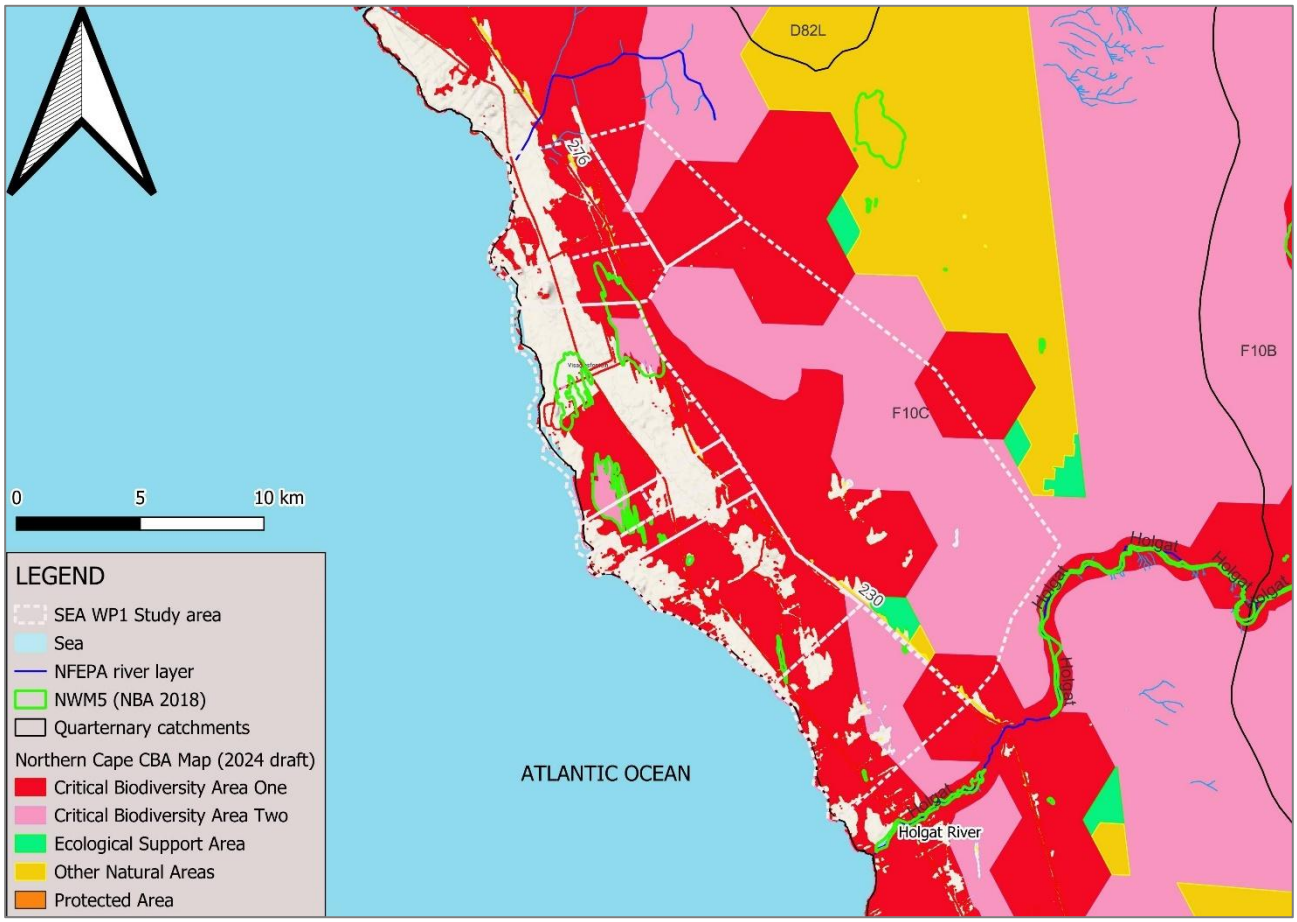


Figure 2.8
Study area in the context of Northern Cape Biodiversity Planning Data
(Northern Cape Department of Environment and Nature Conservation (2018).
Terrestrial and aquatic ecosystem data undifferentiated in dataset.

The data in **Figure 2.8** indicate that:

- Most of the study area lies in assigned CBA 1 and CBA 2 areas;
- Parts of the western portion of the study area, particularly along the coastal area in the north, has not been included among conservation priorities, presumably due to extensive mining in these areas;
- The mapped wetlands / pans within the study area that are indicated in the figure are all located within CBA 1 or CBA 2 areas, with the exception of the most north-westerly of the wetlands shown in the figure, the northern extent of which has been mapped outside of any conservation areas. This portion of the wetland lies outside of the mapped extant area of Critically Endangered Richtersveld Coastal Duneveld shown in **Figure 2.4** and is assumed to have been disturbed by mining. Its natural vegetation type is however still Richtersveld Coastal Duneveld;
- The Holgat River (outside of the study area) lies within a CBA 1 corridor – note that the river itself has been mapped as associated with wetlands in the reaches shown in the figure – ground-truthing indicates that this is not the case and the river lies within a deeply incised rocky gorge;
- The Orange River mouth and associated estuary and estuarine wetlands have all been mapped as CBA 1 areas.

2.10 Aquatic bioregions

Data from the National Biodiversity Assessment (NBA) of aquatic ecosystems (Van Deventer et al. 2018) show that aquatic ecosystems within the study area all fall within the **Namaqualand Sandveld Bioregion**.

All of the inland aquatic ecosystems mapped have been classified as wetland **depressions** in the dataset, as per the Level 4A hierarchical classification of Ollis et al. (2013) and are thus referred to **Namaqualand Sandveld Bioregion depressions**. Within the Namaqualand Sandveld Bioregion, depressions (including pans) have been rated as **Critically Endangered** with a protection status of **Not Protected**.

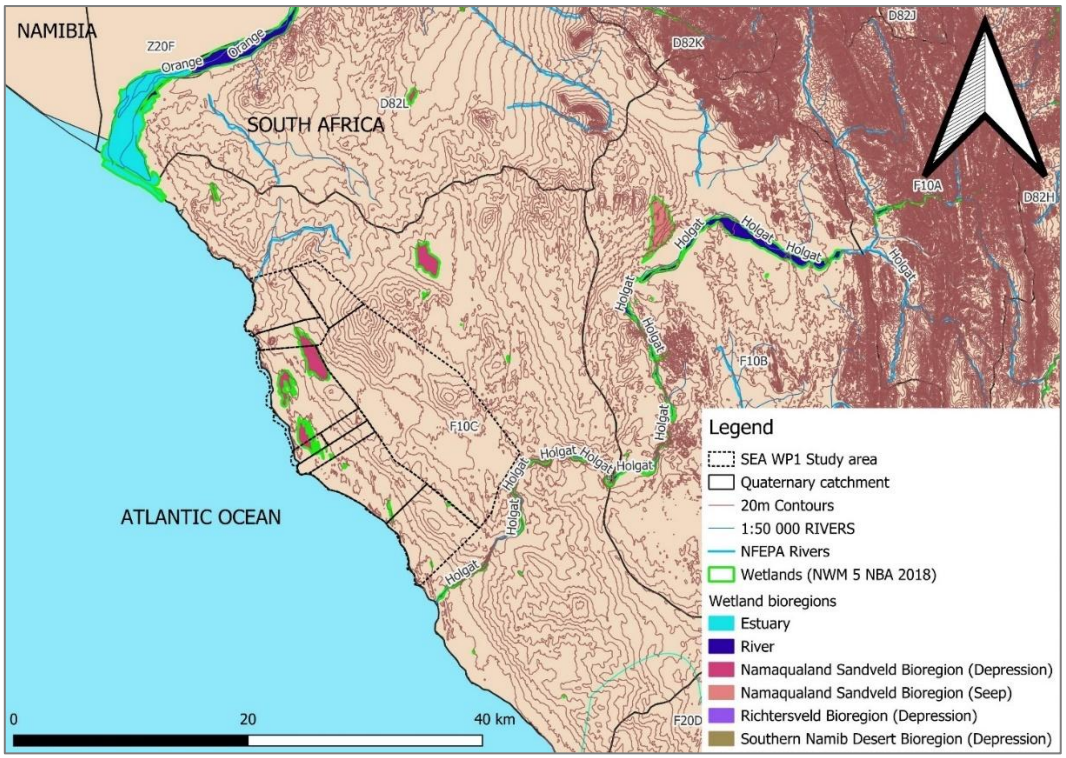


Figure 2.9
Study area in the context of the National Wetland Map (Version 5) (NWM Ver 5) (NBA 2018). All wetlands within the study area fall within the Namaqualand Sandveld Bioregion. Wetland types as classified in the NWM to Level 4A of the National Aquatic Ecosystem Classification system of Ollis et al. (2013).

2.11 Inland aquatic ecosystems on the site

2.11.1 Overview

The study area was visited in December 2024. This was in early summer, when seasonally inundated pans and other watercourses would not be expected to be inundated. The purpose of the site visit was primarily to ground-truth the presence, rough extent and type of wetlands indicated in the 2018 NBA data (NWM Ver 5) (Van Deventer et al. 2018). This wetland layer, shown in **Figure 2.10**, indicates three large wetland depressions in the north western quadrant of the study area, as well as a number of smaller depressions, all on the coastal side of the R382.

In total, 16 inland aquatic habitats have been mapped in **Figure 2.10**, using the NWM Ver 5 data as the basis for wetland extent, with ground-truthing eliminating a few of these mapped wetlands and adding one new wetland (BB5). Ground-truthing suggested that mapped wetland extent presented in the NWM may over-estimate wetland extent in some areas – in the absence of a detailed study including assessment of cyclic wet-period inundation in these ephemeral areas, the NWM data have however been assumed to

represent a generally conservative mapping output in the study area. Of the 16 mapped wetlands, BB8 was not ground-truthed in December 2024. Three new watercourses were added to the dataset, based on site ground-truthing, and comprised BB5 (artificial), BB11 (artificial) and BB9 (assumed to be natural).

2.11.2 Pans and wetlands

Ground-truthing confirmed the presence of indicators of seasonal to permanent wetland conditions including obligate wetland plants (e.g. *Phragmites australis*); standing water and saturated soils with black organic material in the top layers, indicative of poor decomposition under saturated anaerobic conditions; and the presence in at least parts of all of these mapped systems of indicators of periodic inundation, if not prolonged saturation, across more extensive areas (e.g. thin crusts on pan surfaces and, in some areas, muck layers indicative of shallow past inundation, and cracking – these abiotic indicators are listed in Day et al. (2010) among those suitable for the identification of ephemeral systems in dry-season conditions).

The mapped NWM wetlands are numbered in **Figure 2.10** and most are illustrated photographically in **Table 2.1**. Of the three largest mapped pans, the wettest (referred to as [2]Visagiespan in Desmet (1996)) was the most northerly (BB-1 in **Figure 2.10**), with trickle flow out of a small reed-edged pool, even in early summer, suggesting that this part of the system at least is fed by a perennial water source (mapped as BB-1A within BB-1). The presence of small [3]fish in the deepest parts of the wetland added weight to the suggestion that this part of the wetland is perennial, while the presence of *Juncus kraussii* plants (indicative of seasonally moist to saturated conditions) on the gentle southern dune slopes leading down to the wetland suggested possible "wet season" percolation through the dune sands, with rainwater that has infiltrated dune areas being exposed to reduced evaporative loss than surface water (Desmet 1996). Once-off water quality data for the inundated waterbody suggested a fresh to brackish water supply, offset by evapoconcentration in the wetland, with water electrical conductivity (EC) measured at 2 057 mS/m (and within the range for [4]saline wetlands). Spoor of small antelope around the pool suggested that, despite its high salinity at least in summer, it remains a source of water and /or grazing for local fauna.

The wetland was edged by dense stands of perennial *Phragmites australis* reeds and clusters of *Juncus kraussii*, both wetland indicators. *Sarcocornia cf. pillansii* occurred on the salt-encrusted drier margins of the permanent pooled habitat. Water in the pool in December 2024 was rich in orthophosphate phosphorus (above hypertrophic thresholds), suggesting a productive system (see data in Appendix A), while relatively low concentrations of total ammoniacal nitrogen relative to total oxidised nitrogen (TON) suggested adequate dissolved oxygen in the water to support chemical and biological oxygen demand, while the wetland soils were black and anoxic.

The other two large pans shown in **Figure 2.10** are Rietfontein and Rietfonteinpan (BB-2 and BB-3 respectively) (as labelled in Desmet 1996), both of which comprise a series of wide, roughly north-east to south-west running low-lying areas between low dunes. Rietfontein was similar in vegetation and aquatic habitat to Visagiespan, being dominated by *Phragmites australis* and *Juncus kraussii,* with *Sarcocornia cf. pillansii* on adjacent damp flats. It was however drier than the latter in December 2024, with hypersaline water (24 150 mS/m) overlying black anoxic soils. Water quality data (Appendix A) showed that water at that time was characterised by very high ammoniacal nitrogen and sulphate concentrations, suggestive of low dissolved oxygen compared with chemical and biological oxygen demand, and with high availability of phosphorus (almost entirely in its biologically available orthophosphate form), well above hypertrophic concentrations for aquatic ecosystems (DWAF 1996).

The Rietfonteinpan wetland was dry in December 2024, but areas of the flat, low-lying duneslacks were vegetated with *Sarcocornia cf. pillansii* and showed signs of shallow inundation (e.g. crusting, occasional organic muck) at least at times.

[2] Also referenced as Visagiesfontein in some reports (e.g. Niemandt 2024)
[3] Fish were not identified as they were confined to the deep parts of the pool and the need for fish sampling equipment had not been anticipated for the December site visit to an arid area
[4] That is, > 1 500 mS/m (USEPA: https://www.epa.gov/sites/default/files/documents/02_Godsey_-_Source_Options_508.pdf)

Desmet (1996) suggests that the Rietfonteinpan and Rietfontein section of the study area may in fact be **coastal salinas**, which are vestigial lagoons that have their own natural supply of ground water, usually in the form of sea water seepage (or vestigial sea water lenses from past sea levels) rather than rain runoff, and usually have local encrustations of gypsum or common salt. They would have been formed originally at higher sea levels, and were then abandoned as sea levels fell (see **Figure 2.2**).

In addition to these major pan systems, likely only to be inundated along their full mapped extent, if ever, after major rainfall events, a number of smaller wetlands were also noted. These are also indicated in **Figure 2.10** and include artificial scrapes / depressions, often excavated down to the hardpan or calcrete lens. Water pools in these areas after rainfall and the systems were variously characterised by *Phragmites australis* (wetter systems) and patches of *Sarcocornia cf. perenne*, indicating drier, more saline conditions.

Smaller stands of dense *Phragmites australis* in the Rietfontein and Rietfonteinpan areas may be indicative of wetlands that have formed in infilled paleochannels (e.g. Desmet 1996).

2.11.3 Minor Drainage channels / ephemeral watercourses

The 1:50 000 rivers layer for the study area and surrounds shows five drainage lines / sections of drainage lines that cut into the site along the northern boundary of the study area. Ground-truthing of these areas did not however show any discernible low points or indicators of even episodic drainage along these lines and they are thus not considered inland aquatic systems. An ephemeral drainage line was however noted some 1.3 km south of the northern boundary, crossing the R382. Upstream of the road the drainage line was barely visible, although concentration of flows under the road meant that a more defined drainage line was visible, as shown in Photo Q (**Table 2.1**). This petered out a few hundred meters downslope (west) of the road, and it is assumed that concentrated flows from the road culvert generally dissipate quite quickly into the deep sands in this area. The drainage line was ill-defined and not associated with any vegetation suggestive of access to additional moisture, and is treated in this assessment as an artefact of stormwater management rather than an aquatic ecosystem or other watercourse type.

Outside of the extensive pans mapped in **Figure 2.10**, within which there is certainly at times surface flows of water between depressions within these mosaics, no other defined drainage lines were observed on site during the site visit, and none are indicated in available river / watercourse spatial data. Given the aridity of the area and its characterisation by deep sands, this is not a surprising outcome, as it is assumed that surface water dissipates into the ground before forming overland flows.

The exception to the above is runoff from steep, rocky areas, where rainfall is likely to run as multiple fast flows or trickles to the sand below, dissipating quickly into the sand via small runnels at the base of these formations. These areas have been mapped in this report as the entire rocky structure and the area immediately surrounding it, as far as visible runnels extend (generally < 20 m from the base in the case of the Boegoeberg Twins). Similar runoff is likely off other steep, rocky terrain, including the Visagiesfonteinkop area in the north east of the study area. As a broad indicator of where concentrated surface flows are most likely to occur in this case, the terrain associated with the steepest slopes and visible runnels was mapped, with low confidence.

2.11.4 Other inland aquatic ecosystem habitat types within the study area

No other aquatic ecosystems were observed on the site, although it was noted that rocky outcrops in places on the site, including prominent features such as the Boegoeberg Twins, the high rocky outcrops north of Rietfontein and Visagiesfonteinkop, are likely to include hollows and depressions that would collect and retain water from rainfall events, and are thus assumed to play an important role in supporting plant and animal communities in these areas, at least at times. This aspect is discussed in more detail in Section 2.12.3.

2.11.5 The Holgat River

The Holgat River flows just south of the study area, within a deep, steep-sided rocky gorge or canyon. Harrison (1998) describes this system as having a catchment area of 1 635 km^2 and a river length of

102.4 km. Although mapped in the NWM Ver 5 as flowing through wetland areas in its reaches past the present study area, there are no wetlands associated with the river, although there is a narrow riparian fringe along the channel, at the bottom of the incised valley. NFEPA data (Driver et al. 2011) rate the river in these reaches as with a Present Ecological State (PES) Category B – "Largely natural". On the basis of the cursory site inspection, this rating is concurred with. The ephemeral nature of the river, coupled with its likely brackish to saline water quality in this arid region, as well as its isolation from major human settlements, mean that the river is largely undisturbed. Alien vegetation and limited tourism (e.g. 4x4 trails through the river in its lower reaches) may impose some impacts to this system under present landuse.

The features and aspects described in the above sections are illustrated in the photographs (December 2023) shown in **Table 2.1**.

Table 2.1
Photographic illustrations of key inland aquatic ecosystem habitats in the study area (December 2024)



Photo A
Defined high-lying ephemeral seep into BB1 (Visagiespan), with obligate wetland species *Juncus kraussii* suggesting broad mapped extent of BB1 is relatively accurate.



Photo B
Ephemerally inundated lower pan margins in BB1 (Visagiespan), on drier margins of mapped spring area (BB1A).



Photo C
Permanent deepwater pools at Visagiespan (BB1A), providing habitat to fish.



Photo D
Saltmarsh vegetation on saline drier pan margins (BB1A) with *Phragmites australis* dominating wetter, fresher areas along with *Juncus kraussii.*



Photo E
Bird tracks highlight local importance of Visagiespan for fauna in the study area.



Photo F
Crystalizing salt on the drier margins of Visagiespan (BB1A).



Photo G
Phragmites australis reedbed along wetter, fresher zones in the Rietfontein pan (BB2).



Photo H
Pooled hypersaline water in Rietfontein pan (BB2).



Photo I
Small antelope prints along the edge of BB2 (Rietfontein) indicate the value of even this hypersaline



Photo J
Hypersaline conditions in Rietfontein (BB2).

pan for local fauna (probably for grazing).



Photo K
Disturbed, possibly excavated and in part infilled depression within the broader mapped Rietfontein mosaic pan area (BB2), with *Phragmites australis* dominance suggesting fresher conditions than in other pans dominated by saltmarsh species.



Photo L
Ephemeral pans in BB3 (Rietfonteinpan)





Photos M
Duneslack pans between low rolling sand dunes characterise BB3 (Rietfonteinpan).



Photo N
Ephemeral pan (rarely inundated) (BB6).



Photo O
Excavated pan at BB7.



Ephemeral pan (BB9), dried out and with salt encrustantions in December 2024.



Excavated pan (BB4) with *Phragmites australis* reedbed.



Photo P
Holgat River at R382 crossing immediately south of the study area.



Photo Q
Barely discernible drainage line, downslope of R382, with concentrated flows dissipating quickly into the sands. Boegoeberg Twins visible in background.

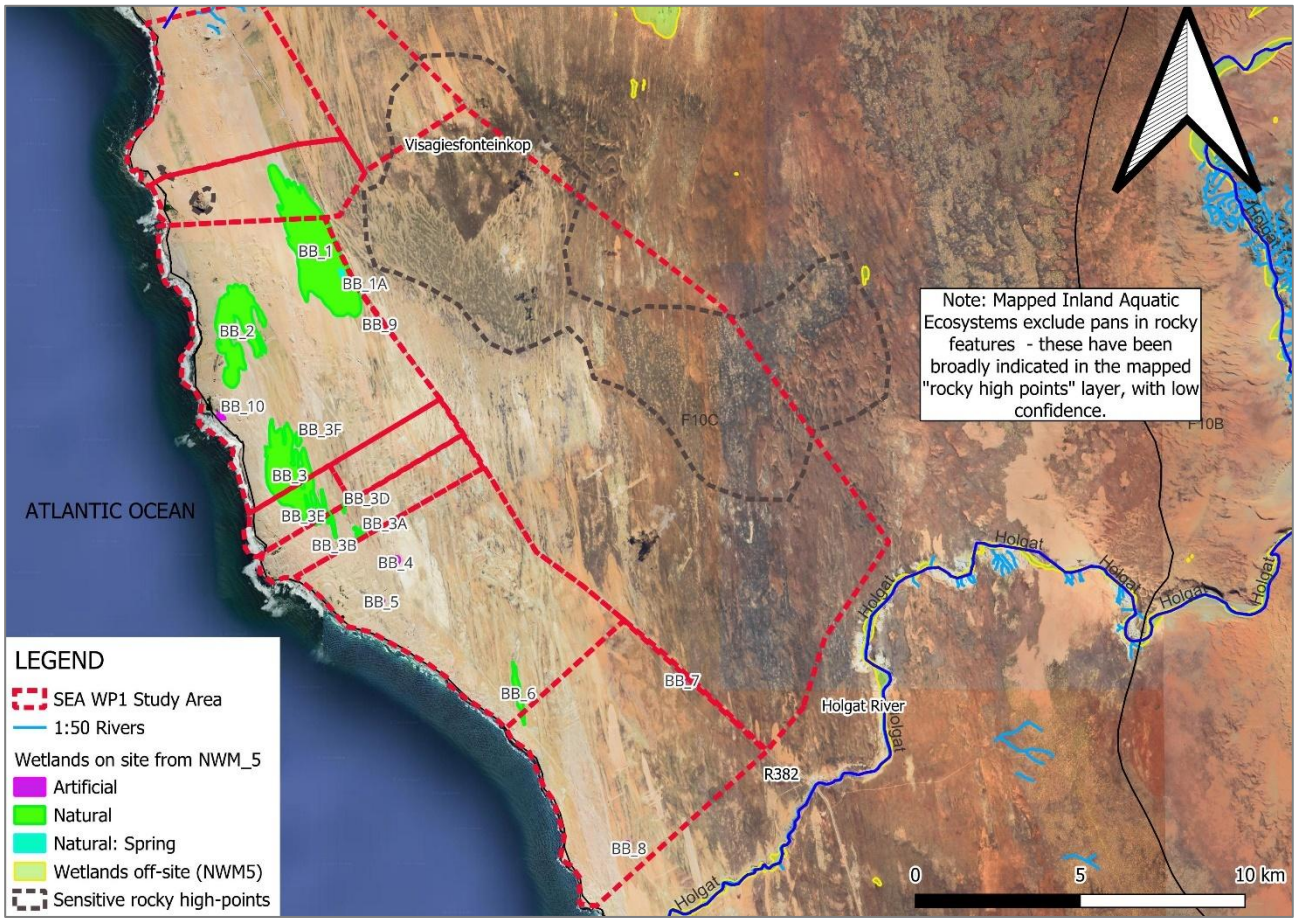


Figure 2.10
Coded, mostly ground-truthed inland watercourses in the study area, with extent based on that indicated in NWM VER 5. See text for names of major wetlands (e.g. BB1 = Visagiespan). Rocky high points mapped at desktop level with low confidence – faunal specialist sensitivity layer should be prioritised for these areas.

2.12 Inland aquatic fauna

2.12.1 Fish

At least one species of fish is supported in the (presumed permanent and, at least in summer, saline and eutrophic) waters of Visagiespan. The species is currently unconfirmed, as the fish could not be identified or photographed at distance and depth. Section 2.14.3 notes however the introduction of mullet (*Chelon richardsonii*) into excavated channels in the Holgat Estuary, and it is possible that these fish might also have been introduced into the spring environment. None of the other pans considered are likely to support fish as they all dry out in summer, with even Rietfontein, which still had some hypersaline hypertrophic pools in December 2024, being likely to dry out completely over summer.

2.12.2 Amphibians

Faunal biodiversity on the study area has been assessed in Niemandt (2025), who noted that, as a result of the scarcity of fresh water in the area, only four amphibian species are likely to occur there, namely:

- *Cacosternum namaquense* (Namaqua Caco);
- *Vandijkophrynus gariepensis* (Karoo Toad)

- *Vandijkophrynus robinsoni* (Paradise Toad)
- *Breviceps macrops* (Desert Rain Frog).

Of the above, only *C. namaquense* requires surface water for breeding and egg / tadpole habitat, as do the two *Vandijkophrynus* species, while *B. macrops* are largely independent of water, breeding in cavities that they excavate underground (du Preez and Carruthers 2009).

Rietfontein and Visagiespan are both likely to provide suitable habitat for these amphibians, although the high summer salinities and (at Rietfontein) drought mean that they are most likely to be suitable for amphibians during early wet season inundation only.

2.12.3 Aquatic invertebrates

Ephemeral pans and pools in the study area, including pans such as Visagiespan, Rietfontein, Rietfonteinpan; the various artificial scrapes noted in Section 2.11.2; and the temporary pools in rocky areas (Section 2.11.3) could all potentially support communities of invertebrate fauna that are adapted to life in transient aquatic conditions. Such fauna could include branchiopod crustaceans, with taxa from four orders all associated with temporary freshwater habitats (Conchostraca (clam shrimps); Cladocera (water fleas – e.g. *Daphnia*); Notostraca (tadpole shrimps of the genus *Triops* (Rayner and Bowland 19895)); and Anostraca (fairy shrimps)). Species richness in temporary waterbodies relates to the size and habitat diversity of the water body and to habitat duration (Ebert and Balko (1987); Hamer and Rayner (1996); and Mabidi et al. (2016)).

While no investigations into amphibians or aquatic invertebrate fauna in the current study area have informed this report, the above information highlights the potential importance of any aquatic habitat, from permanent to ephemeral, and ranging from natural water collectors such as pans and rock depressions to artificial roadside scrapes, borrow pits and reservoirs or dams.

2.13 Inland aquatic ecosystem drivers

Drivers of the inland aquatic ecosystems described above were poorly understood at the time of this report, at a level that could usefully inform development layout decision-making. However, at a conceptual level, the following main inland aquatic ecosystem drivers are likely to comprise:

- Climate (i.e. temperature, rainfall and evaporation rates) – by implication, climate change is also recognised as a significant driver of these ecosystems going forwards;
- In addition:
    - Links to palaeochannels – the exact mechanisms for the development of wetlands (e.g. *Phragmites australis* wetlands) in these areas is poorly understood;
    - Links to groundwater – some springs (e.g. Visagiespan spring) may link to groundwater and/or to vestigial perched ancient seawater lenses – Hattingh (2016) comments that groundwater daylights at Rietfontein, with the springs "probably fed by the secondary aquifer, but accommodated by the primary aquifer" – it is unclear whether this report includes the Visagiespan spring among the general "Rietfontein springs";
    - Links to primary aquifers in sand dunes (some pans may be fed by shallow subsurface flows from dune areas, with dunes acting as local infiltration zones);
    - Links to localised surface water flows, in perched (including artificial) pans, where inflowing water is trapped above impervious surfaces such as rock and/or calcrete; as well as where surface flows are artificially concentrated into channels (often downstream of roads).

2.14 Estuaries in the vicinity of the site

2.14.1 General

There are no estuaries in the present study area. Nevertheless, two estuarine systems lie in close proximity to the study area, and could potentially be affected by impacts associated with the proposed development. These estuaries comprise the Orange River Estuary (a Ramsar wetland site) to the north of the study area and the Holgat Estuary, immediately to the south.

2.14.2 The Orange River Estuary

The Orange River Estuary flows into the sea between the coastal towns of Alexander Bay (South Africa) and Oranjemund (Namibia). The estuary covers an area of about 2 700 ha, and comprises an (almost) permanently open river mouth; a 2 to 3 m deep tidal basin; a braided channel system (located between sand banks covered with pioneer vegetation) and a severely degraded saltmarsh on the south bank of the river mouth (DWS 2017a). It is a rare and unusual wetland type on the arid and semi-arid coastline of southern Africa, deriving its flows from a large catchment that begins in the Lesotho Highlands in Lesotho, some 2 432 km upstream of Alexander Bay. The estuary itself extends approximately 11 km upstream from the river mouth.



Figure 2.11
Section of the lower Orange River Estuary, December 2024.

Turpie et al. (2002) ranked the Orange as the seventh most important system in South Africa in terms of conservation importance. The prioritisation study calculated conservation importance on the basis of size, habitat diversity, zonal type rarity and biodiversity importance. Estuary importance is an expression of the value of a specific estuary to maintaining ecological diversity and functioning of estuarine systems on local and wider scales. The biodiversity importance score is in turn based on the assessment of the importance of the estuary for plants, invertebrates, fish and birds, using rarity indices.

Reflecting the above importance, the Orange River Estuary was designated a Ramsar Site (i.e. a wetland of international importance) in 1991 on the South African side and, following Namibia's ratification of the Ramsar Convention in 1995, on the Namibian side too. The on-line Ramsar description for this site (https://rsis.ramsar.org/RISapp/files/119/documents/ZA526lit.pdf?language=en) notes that the site is seasonally important for locally migrant water birds, including *Pelecanus onocrotalus, Phoenicopterus ruber roseus, P. minor, Recurvirostra avosetta* and *Charadrius pallidus*. Resident species include

Phalacrocorax carbo, P. capensis, P. africanus, Anhinga melanogaster, Ardea cinerea, Egretta garzetta, Alopochen aegyptiacus, Tadorna cana, Anas capensis, Oxyura maccoa, Charadrius marginatus, Vanellus armatus, Larus dominicanus, L. hartlaubii and *Sterna bergii.* Staging water birds include *Calidris minuta, C. ferruginea, Philomachus pugnax, Sterna hirundo* and *S. sandvicensi*s

Unfortunately, by 1995, the South African Orange River Estuary Ramsar site had been placed on the Montreux Record (a list of Ramsar Sites around the world that are in a degraded state) as a result of severe degradation of saltmarsh on the south bank of the estuary (DWS 2017b).

The estuary is subject to numerous factors that impact on its present condition, assessed as Present Ecological State (PES) Category D by Van Niekerk et al. (2013a, b), reflecting its assessment as a largely modified system. This was attributed to the following key factors, summarised in DWS (2017a) as:

- Significant freshwater flow modification – both loss of floods and increased base-flows, (damming and regulation of flows in catchment): water resource development in the Orange-Senqu River basin has reduced runoff to the Orange Estuary by more than 50%;
- Lack of estuary mouth closure and with this a reduction in associated (desirable) resulting back-flooding of salt marshes with fresher water;
- Road infrastructure such as the old causeway crossing the saltmarshes and old bridge supports;
- Nutrient input from the catchment;
- Gill netting of indigenous fish species and considerable fishing effort at the mouth on both sides of the estuary;
- Riparian infrastructure, with levees preventing back-flooding;
- Grazing and hunting;
- Mining activities; and
- Wastewater disposal (including previous sewage and mining return flows).

DWS (2017a) notes that while non-flow impacts play a significant role in the degradation of the Orange Estuary, modification of flows (both floods and base flows) remains the main cause of its degradation.

Despite its levels of degradation, the Orange River Estuary forms part of the core set of estuaries in need of formal protection to achieve biodiversity targets in the region (Van Niekerk and Turpie, 2012) and is one of only two estuaries on the Namibian coast (Orange and Kunene Rivers) (DWS 201b). On these and other bases, including its Ramsar status, the estuary is rated as 'highly important'. However, its best attainable state (Recommended Ecological Condition (REC)) has been estimated as only a Category C, based on reasonably reversible or mitigable pressures (DWS 2017a).

Measures recommended by specialists engaged in the Determination of Ecological Water Requirements for surface water (river, estuaries and wetlands) and Groundwater in the Lower Orange WMA (DWS 2017a) recommended the following measures to improve estuarine condition to its REC, namely:

- Flow related requirements:
    - To reduce present winter base flows sufficiently to allow for mouth closure and related back-flooding of the saltmarshes with brackish water to reduce soil salinities, but not to the point where the estuary mouth remains closed for longer than 2 to 4 times in 10 years by decreasing river inflow to less than 5 m^3/s;
    - To elevate base flows above 10 m^3/s from December onwards, to address habitat degradation from long periods of low flows;

- Non-flow related measures:
    - To control the fishing effort on both the South African and Namibian side through increased compliance and law enforcement;
    - To enhance nursery function for estuarine dependant fish species;
    - To remove the remnant causeway that still transects the saltmarshes to improve circulation during high flow and floods events and assist with increasing the water circulation into the lower marsh areas;
    - To decrease nutrient input from the catchment downstream of Vioolsdrift, through improved agricultural practices;
    - To control windblown dust and wastewater from mining activities; and
    - To reduce/remove grazing and hunting pressures.

The above issues are all of high relevance in the light of the proposed Boegoebaai Part and SEZ, in the close vicinity of the Orange River Estuary.

2.14.3 The Holgat Estuary

The Holgat River estuary enters the Atlantic Ocean immediately south of the present study area. The estuary was assessed by Harrison (1998), who noted that:

- The Holgat River flows only very occasionally (i.e. is ephemeral (the Harison (1997) report noted that the riverbed at that time had been virtually dry for some years, with the last record of it flowing being in 1925;
- The lower estuary has been artificially manipulated, with Bickerton (1981) describing an "L" shaped water trench (100 m x 70 m x 10 m wide), used for the maintenance of roads and the processing of diamond gravel at the mouth of the system – Google Earth imagery shows that the mouth now opens into a wide deep rectangular pool, filled with seawater, just above the beach;
- Bickerton (1981) also describes the past introduction of mullet into the seawater trenches – it is possible that the fish observed in the Viagiespan spring were also mullet;
- The Holgat Estuary is classified as a **micro-outlet** using the revised classification system for estuaries of Van Niekerk et al. (2020), signifying its small and highly ephemeral character.

3. PROPOSED DEVELOPMENT AND ASSOCIATED ACTIVITIES

Figure 3.1 shows the proposed development layout considered in this work package of the SEA. Inland aquatic ecosystems (as per **Figure 2.10**) have been overlaid on the figure, for context.

Drawing from information supplied in Schreiner *et al*. (2024), the overall development would comprise:

- **Boegoebaai Port**, of which the most relevant aspects to the present assessment (as in relating to areas that could affect inland or estuarine aquatic ecosystems) comprise:
    - Dust suppression (presumably using water);
    - Stormwater management, allowing for the separation of clean and dirty water, with clean water diverted around the site. The drainage system would separate clean and dirty water, with clean water runoff diverted around the site. High-risk dirty runoff water would flow into concrete-lined channels, and low-risk dirty runoff water would into block and vegetated channels. Pollution control ponds would be lined with HDPE, attenuated to the 1:50 year pre-development condition and discharged to the receiving natural environment, such as the ocean;
    - Fuel storage;
    - Internal and external roads;
- The **Boegoebaai SEZ area**, encompassing approximately 31 300 ha, would be developed in phases and is envisaged to consist of eight subzones (see **Figure 3.1**):
    - Conservancy area – 1 170 ha;
    - SASOL area (Green ammonia facility), including a desalination plant, with brines and lye solution being discharged to the sea – 4 508 ha;
    - SEZ Industrial Park, for mixed uses including manufacturing, logistics, offices and warehousing; a desalination plant:
        - Phase 1 – 499 ha
        - Phase 2 – 411 ha
        - Phase 3 – 833 ha
    - Future green hydrogen facility – 3 713 ha
    - Future green hydrogen expansion 01 – 3 408 ha
    - Future green hydrogen expansion 02 – 15 067 ha
    - Future tank farm – 1 704 ha.

Of the above, areas identified in Section 2 of this report as supporting pans and wetlands (all rated as Critically Endangered in the 2018 NBA (Van Deventer et al. 2018)) lie in the following SEZ zones:

- The Conservancy area
- The SASOL area
- Phases 1, 2 and 3 of the SEZ industrial Park
- The Future Green Hydrogen Facility
- The Future Green Hydrogen Expansion area – 01.

The Visagiesfonteinkop high-lying rocky areas have also been rated as important support areas for temporary pools and pans in this assessment, and this area lies in the area flagged for Future Green Hydrogen Expansion (02).

In addition to the above, it is assumed that indirect aspects of the proposed development would include:

- Expansion of settlements in the Alexander Bay area, to accommodate workers;
- Increased associated demand for water and sanitation in the area;
- Increased use of roads and possible expansion of existing roads.

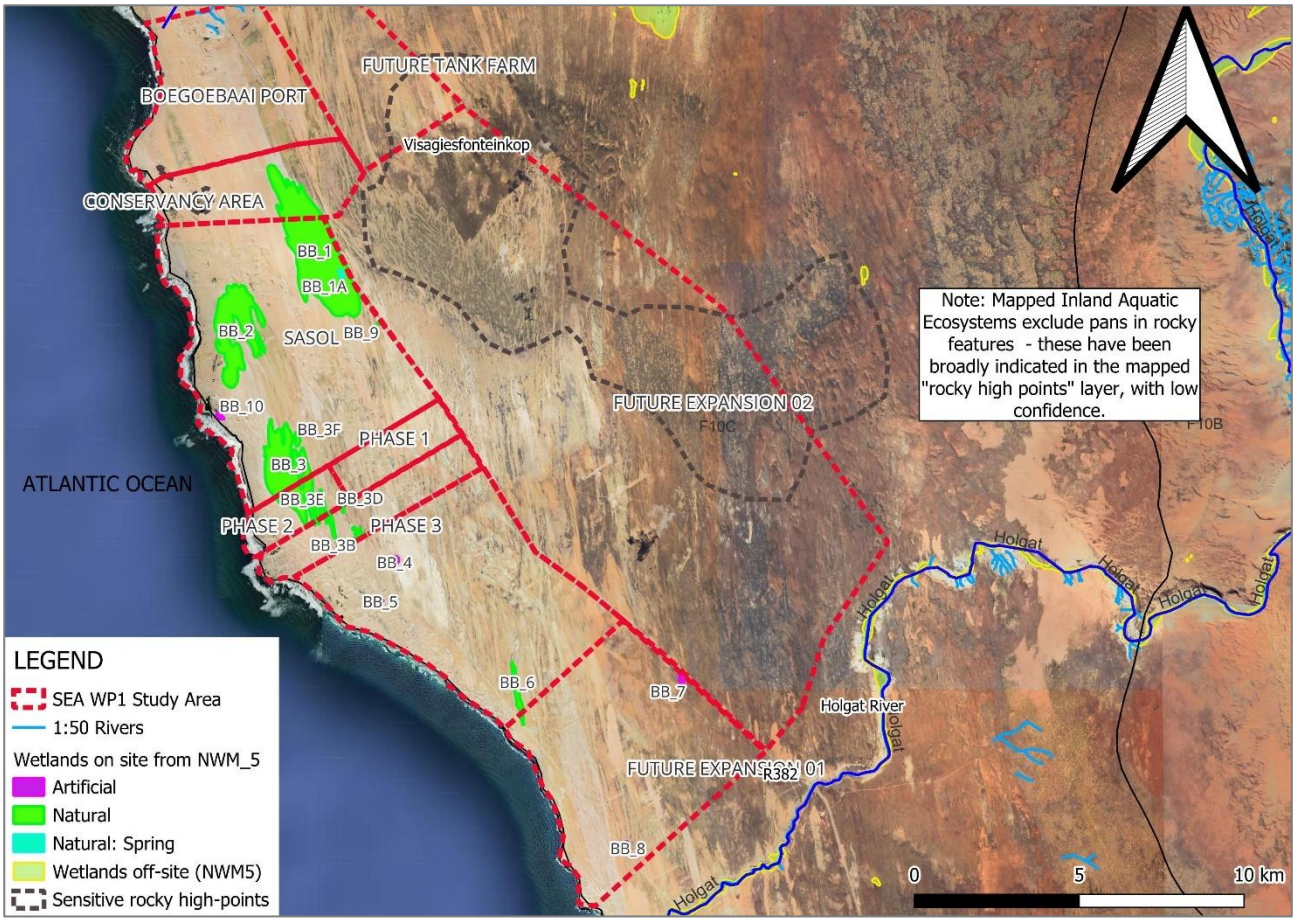


Figure 3.1
Proposed layout of Booegoebaai Port and SEZ for Work Phase 1 assessment, with overlay of inland aquatic ecosystems described in Section 2.

4. AQUATIC ECOSYSTEM SENSITIVITY RATINGS

4.1 Sensitivity defined

This section considers inland aquatic and estuarine ecosystems in the context of their likely sensitivity to the various activities associated with the proposed development, where aquatic sensitivity is defined as the capacity of an aquatic ecosystem (inland or estuarine) to tolerate disturbance. Sensitivity in this definition includes an element of ecological importance. That is, although some aquatic ecosystems may be "sensitive" (i.e. respond directly) to certain impacts, if they are of low ecological value, their sensitivity rating would not correspond to their actual response rating. Thus in this assessment, the term "sensitivity" includes elements of both the **ecological importance** and the **sensitivity** of the impacted system.

4.2 Issues likely to impact on aquatic ecosystems within the study area and its environs

4.2.1 Inland aquatic ecosystems

Section 2 identified a number of ephemeral pans, some of which include wetland habitat, comprising permanently to seasonally saturated areas, which support obligate wetland species such as *Phragmites australis* and *Sarcocornia cf. perenne*, and at least one of which includes a spring, fed by dune seepage, groundwater and/or relic lenses from past marine inundation. Some of the identified pans and wetlands comprise artificial systems, created by excavation during mining and, possibly, road construction, down to hardpan or calcrete lenses, on which water pools and provides ephemeral to seasonal aquatic habitat. All of the natural aquatic ecosystems in the study area have been categorised as Namaqualand Sandveld Bioregion depressions (including pans) and have been rated as Critically Endangered with a protection status of Not Protected.

These systems are considered highly sensitive to the following key issues, namely:

- Changes in hydroperiod:
    - Increases in hydroperiod (i.e. increased duration and frequency of inundation of the above systems could result in significant changes to habitat type and the biota that they support, potentially (and subject to water quality) increasing dominance by *Phragmites australis* reedbed, at the expense of biota including temporary pan zooplankton assemblages, adapted to life in ephemeral systems. In the absence of any data regarding the presence of such communities in these pans, a conservative approach has been taken, and it is assumed for the present that they occur in the study area;
    - Decreases in hydroperiod (i.e. interruption to the present sources of water into the pans and wetlands on the site would potentially also alter existing established aquatic ecosystems, potentially drying out existing sources of relatively fresh water on the site and the plants that they sustain, and thus impacting on food and/or water sources for terrestrial and aquatic fauna (see terrestrial ecosystem report for comments on the former) – disruption of existing water sources could stem from surface hardening (particularly of sand dunes that act as local aquifers) and diversion of stormwater systems past pans and wetlands usually linked to upstream seepage and flows;
- Changes in water quality:
    - "Freshening" of inflows into pans and wetlands (i.e. decreasing salinities) would potentially impact on natural / existing plant and animal communities that have adaptations to ecosystems that are characterised by brackish to saline conditions, increasing in some systems (e.g. BB2) to hypersaline periods. Freshening would be likely

to favour increasing dominance by freshwater-adapted species such as *Phragmites australis* at the expense of existing communities, particularly along the margins of permanent and seasonally inundated systems that currently support euryhaline and brackish plant species. Freshening could be associated with managed stormwater flows into pans and wetlands, if stormwater is piped or channelled such that it does not collect salts and minerals *en route* to receiving aquatic ecosystems;

- Nutrient enrichment: With the exception of aquatic ecosystems in pools and pans in rocky habitats, the identified pans and wetlands within the study area are probably least sensitive to nutrient enrichment, given that the permanent to seasonal systems (BB1 and BB2) were already in hypertrophic states in summer 2024, suggesting that these systems act as nutrient sinks, with nutrients contributing to the long-term build-up of organic layers in places that probably play a role in sustaining surface waters above these layers. However, all aquatic ecosystems would be assumed to have high sensitivity to pronounced and sustained nutrient enrichment, particularly in the forms of phosphorus and ammoniacal nitrogen, potentially associated with receipt of seepage or runoff from septic tanks, soakaways and treated sewage effluent;

- Physical disturbance:

  - The natural pans, wetlands and springs that occur in the study area all have high sensitivity to physical disturbance, which could disrupt subtle differences in topography, affecting inundation regime and also potentially exposing accumulations of organic material in seasonal wetland / spring areas, affecting rates of decomposition, nutrient cycling and aquatic ecosystem interactions. In the arid study area, physical disturbance (e.g. the creation of ruts and churning of surface sediments by machinery) would be unlikely to be re-set by natural processes such as flooding, and could result in permanent changes. In rocky outcrops, activities such as blasting or rock harvesting could destroy locally or regionally important ephemeral aquatic habitats and their biota;

  - Given their creation through excavation, artificial pans and depressions are assumed to have lower sensitivity to physical disturbance, although even artificial systems may support important biota - Bird (2012) for example found rare invertebrate fauna typical of ephemeral wetland habitat even in artificial roadside borrow pits in the region (e.g. notostracans of the genus *Triops*);

- Changes in surface runoff patterns:

  - All pans and other watercourses would be sensitive to changes in surface runoff velocities, potentially stemming from stormwater management systems for hardened surfaces including roads. Increased velocities would potentially lead to localised erosion, more importantly resulting in topographical changes in pans that alter inundation regime throughout the pan environment. Even subtle topographical change in these ephemeral systems could have significant ecological impacts;

- Fragmentation from other watercourses and supporting terrestrial areas:

  - Hydrological fragmentation: The wetland-associated pans (BB1, BB2, BB3 BB6 and spring area BB1-A) are most vulnerable to impacts of hydrological fragmentation, where this interrupts inflows into the systems or seepage from them. Such hydrological fragmentation could result from surface hardening of aquifer recharge areas, particularly in dune sands surrounding these pans and the spring area in particular, as well as from artificial diversion of stormwater flows past pans, wetlands and springs;

  - Physical (surface) fragmentation: The inland aquatic ecosystems identified in this study, particularly the larger pans BB1, BB2 and BB3 lie in relative proximity to each other and support birds, mammals, amphibian and invertebrate fauna and plants that rely on these areas at least at times. Isolation of these aquatic ecosystems from surrounding terrestrial areas and disruption of ecological corridors / links between pans could potentially

significantly disrupt broader ecosystem function (assessed in the terrestrial faunal report) and affect the critical contribution of local aquatic ecosystems to broader terrestrial biodiversity.

4.2.2 Estuarine aquatic ecosystems

4.2.2.1 Orange River Estuary

Section 2.14.2 highlighted the current major challenges to effecting the required rehabilitation of the estuary to its REC of Category C. Drawing on these, at a local level, the estuary would be highly sensitive to activities / impacts that resulted in:

- Changes in freshwater flows (as a result of increased demand for fresh water, with water demand in Alexander Bay being met at least in part by flows from the Orange River upstream of the estuary (Hattingh 2016) - such demand could increase with an increased population in Alexander Bay, as a result of actual and perceived increases in local employment opportunities;

- Increased road infrastructure across the estuary, affecting flows into the estuarine saltmarshes (such impacts seem unlikely);

- Increased nutrient input – this could be associated with increased treated sewage effluent discharge from the Alexander Bay Waste Water Treatment Works (WWTW), as a result of local population increases;

- Increased fishing, as a result of a locally increased population, leading to increases in gill netting of indigenous fish species and fishing effort in the estuary;

- Increased grazing and hunting activities, particularly linked with a likely influx of population into the Alexander Bay area as a result of perceived or real employment opportunities;

- Increase in physical disturbance as a result of vehicle and other traffic into the estuary for bird viewing and other recreational activities – if such activities resulted in increased traffic across saltmarsh areas and increased localised dumping of solid waste (already visible along the estuarine margins in December 2024), in a seemingly largely unpoliced area, then significant estuarine degradation could accrue.

4.2.2.2 Holgat River Estuary

The Holgat Estuary is classified as a micro-outlet (see Section 2.14.3). Although its catchment has been rated as near-natural, the estuary itself has been highly altered by mining-associated activities and this, coupled with its highly ephemeral character, means that it has little estuarine function. The estuary has been rated as of Medium sensitivity to impacts associated with the proposed development, although both the Holgat River and its estuary lie outside of the study area and in fact are unlikely to be directly impacted by the proposed development.

4.3 Additive impacts of climate change

Any development in the study area would take place against a backdrop of climate change, potentially increasing water scarcity, temperature and evapo-concentration rates, as well as being associated with increased sea level and storm-surge heights (see Section 2.2.4). This report has already noted uncertainty with regard to surface/groundwater interactions in the study area (Section 2.11.2) and this adds to the uncertainty of predicting whether and how sea level rise might impact on inland aquatic ecosystem water quality (e.g. groundwater-linked wetlands) and thus on habitat quality. Sea level rise is, however, more likely to affect estuarine water quality and existing estuarine saltmarsh habitat. The Orange River Estuary,

already impacted by reduced freshwater flows, would be particularly vulnerable to such changes. Increased surge heights could also result in increased vulnerability to erosion along the lower Orange River Estuary and its mouth. These kinds of impacts would be likely to affect aquatic ecosystem resilience, making them more sensitive to additional impacts associated with further development, and potentially increasing the magnitude of their response to these.

4.4 Sensitivity mapping

4.4.1 Approach

Drawing on the above sections, **Table 4.1** provides a structured approach to the rating of different aquatic ecosystems, from Very High to Low Sensitivity.

Table 4.1
Sensitivity rating categories for inland aquatic ecosystems

Sensitivity	Sensitivity Feature	Motivation
Very High	• Critically Endangered (CR) and Endangered (EN) wetland types from the NBA (Van Deventer et al. 2018) (i.e. depressions / pans) • Watercourses within CBA1 and CBA2 areas	These are highly threatened aquatic ecosystem types at both a regional and a national level These watercourses form part of the over-arching habitats that are required to ensure biodiversity conservation. [Note that with the exception of most of the Rietfontein wetlands (BB2), all of the present study area is included in CBA1 and CBA2 areas, and are rated as Critically Endangered watercourse types].
High	• FEPA sub-catchments • Upstream sub-catchments as identified in the NFEPA programme • All watercourses as mapped in 1:50 000 rivers layer and NFEPA river layer	These sub-catchments, including watercourses, need to be kept in good condition for the maintenance of important downstream river reaches Watercourses convey runoff into downstream reaches and therefore directly affect the condition of important downstream systems. They are also important corridors through the landscape and provide temporally rare and important habitat during wet periods. [In this assessment, artificial pans are rated as High sensitivity]
Medium	• All watercourse buffers / development setback areas	These areas are intended to provide protective space between the development edge (particularly hardened areas such as roads, buildings and solar panels) in which dissipation of stormwater and other impacts can take place. [In the absence of clear knowledge about surface/groundwater links between the larger pans (BB1, BB2 and BB3), 500m hydrological buffers have been allocated to accommodate recharge areas. 50 m setbacks have been allocated to all mapped wetlands, to accommodate low confidence in mapped extent and to provide protection from planned development activities].
Low	• Rest of site – i.e. non aquatic areas outside of recommended aquatic ecosystem buffer zones	Activities within these areas should have no impact on aquatic ecosystems and their dependent biota.

4.4.2 Assignment of sensitivity ratings

Drawing on the discussion in the previous section and **Table 4.1** in particular, inland and estuarine aquatic ecosystem sensitivity has been mapped, with specific regard to the proposed Boegoebaai Port and SEZ development. The results of this exercise are shown in **Figure 4.1**. In essence:

- Natural pans, associated wetlands and springs have been mapped as of Very High sensitivity;
- Artificial pans / excavations have been mapped as of High sensitivity;
- The Orange River Estuary has been mapped as of Very High sensitivity;
- The Holgat River Estuary (a micro-outlet) has been assessed as of Medium sensitivity – it is unlikely to be targeted as a water resource and lies outside of the proposed development;

- Pan / pool habitat assumed to be included in parts of rocky outcrops such as the Visagiesfonteinkop has been mapped as of High sensitivity – the mapped area corresponds to the mapped "sensitive rocky high points" data included in **Figure 2.10**;

- Buffer areas (50 m width outside of all mapped aquatic ecosystems have been included as protective setback areas that would help to ensure that mapped inland and estuarine aquatic ecosystems are protected from physical developmental impacts – these have been mapped as of Medium sensitivity;

- In addition, hydrological buffers, intended to improve confidence that hydrological linkages required for ensured ecosystem function can be maintained, have also been included and mapped as medium sensitivity – these have been conservatively set at 500 m for this assessment. This takes cognisance of the low confidence in this assessment as to some of the drivers of aquatic ecosystems in the study area, particularly with regards to BB1, BB2 and BB3. This conservative buffer area could be reduced, if there is future improved, data-driven understanding of surface/groundwater/interflow linages and processes in this area. These buffer areas have also been mapped as of Medium sensitivity

Note that **not** included in the sensitivity mapping below are corridors to allow for aquatic-to-aquatic and aquatic-to-terrestrial and coastal ecosystems, to ensure sustained ecological connectivity between different habitat types. This issue would need to be developed further during detailed development design, if such development was sanctioned for further consideration.

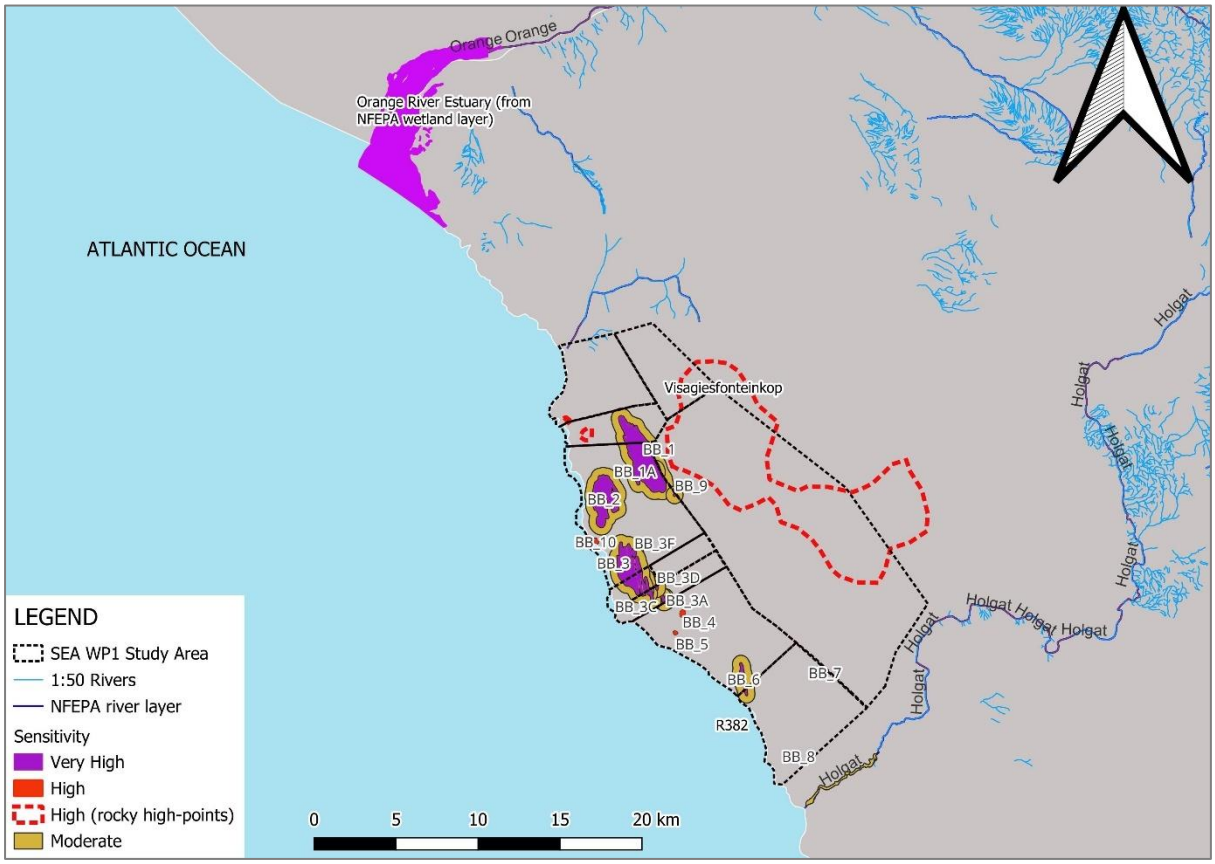


Figure 4.1
Inland and estuarine aquatic ecosystems sensitivity of the proposed Boegoebaai Port and SEZ study area (Work Package 1 of SEA assessment. Figure includes recommended buffer areas. Sensitivity applied only to the watercourses on and immediately abutting the site. Sensitivity layer assumes no mitigation measures. Grey areas on the site rated as of Low sensitivity to the present proposed project.

5. ASPECTS AND IMPACTS REGISTER

This section draws on information and commentary provided in the previous sections, and uses these to compile an aspects and impacts register that highlights the key factors / issues likely to affect aquatic ecosystems as a result of the proposed developments, looking at the Work Package 1 development proposals only.

5.1 Aspects and impacts specific to inland and estuarine aquatic ecosystems

Impacts and aspects are outlined in **Table 5.1**, focusing only on those relevant to inland and estuarine aquatic ecosystems.

Table 5.1
Impacts and aspects register for inland and estuarine aquatic ecosystems

Development zone	Development aspect	Potential impact	Aquatic ecosystems of concern
Boegoebaai Port	Development footprint	Given low certainty about hydrological drivers for Visagiespan, Rietfontein and Rietfonteinpan wetlands and/or pans, the development footprint of the planned development would extend into the postulated recharge area of these important systems, and could potentially threaten their sustainability. This is a low-confidence impact, and detailed assessments could reduce uncertainty.	Extends (marginally) into potential recharge area for BB1 pan and springs; Also includes northern Boegoeberg Twin structure, which could potentially support inland aquatic biota typical of temporary / ephemeral pools
Conservancy area	This includes the northern portion of BB1 (Visagiespan)	Inclusion of the upper section of the mapped pan in the proposed conservancy area would be considered a positive aspect of the proposed development, albeit not compared to the *status quo*. Conservation of this area would potentially protect recharge areas for the pan and its wetlands and associated spring – however, improved confidence in understanding of pan, wetland and spring drivers is required.	BB1 (including BB1A)
SASOL area	This area would extend across the three largest pan / wetland / spring areas in the study area. Aspects of concern include: • Development footprint • Stormwater management • Roads (and associated culverts)	Impacts would include: • Destruction of wetlands that have been rated as Critically Endangered, are rare and interesting wetland systems, about which there is limited information, and which also are likely to play a critical role in supporting terrestrial fauna, at least at times • Degradation of any watercourses (wetlands, pans, springs) not lost to the development footprint, as a result of stormwater management systems that contain and divert stormwater, reducing recharge and increasing concentration of	This area includes the largest and most important pans, associated springs and wetlands within the study area.

Development zone	Development aspect	Potential impact	Aquatic ecosystems of concern
		flows, as well as potentially "freshening" flows into receiving pans / wetlands, as a result of bypassing sands and other substrate that would normally contribute dissolved salts to runoff; • Degradation from physical disturbance such as vehicle access.	
SEZ Industrial Park Phases 1, 2 and 3	This area would extend across the Rietfonteinpan (BB3) pan / wetland / spring area, and its hydrological buffer (assumed recharge area). Aspects of concern include: • Development footprint • Stormwater management • Roads • Treated sewage effluent disposal through septic tanks and use of infiltration systems	Impacts would include: • Destruction of pan and wetland habitat (BB3) that have been rated as Critically Endangered, are rare and interesting wetland systems, about which there is limited information; • Degradation of remaining pan and wetland areas as a result of physical disturbance such as vehicle access; • Potential increases in inflows of stormwater and treated sewage effluent into remnant wetlands / pans, likely to result in increased nutrient enrichment and possible changes in hydroperiod (increased water inflows). These would be likely to result in changes in vegetation (increased *Phragmites australis* dominance and loss of conditions that support (assumed) important ephemeral pan biotic assemblages.	Watercourse BB3 (ephemeral pan with wetland elements)
Future Green Hydrogen Facility	Aspects of concern include: • Development footprint • Stormwater management • Roads • Treated sewage effluent disposal through septic tanks and use of infiltration systems	Impacts in this area would include: • Destruction of presumed natural pan and wetland habitat (BB6) as well as artificial pans BB4 and BB5. • Potential increases in inflows of stormwater into remnant wetlands / pans, likely to result in changes in hydroperiod (increased water inflows). These would be likely to result in changes in vegetation (increased *Phragmites australis* dominance and loss of conditions that support (assumed) important ephemeral pan biotic assemblages, even in artificial systems; • Degradation from physical disturbance such as vehicle	This area includes artificial pans/wetlands, as well as an (un-ground-truthed) natural pan (BB6) and its potential recharge area).

Development zone	Development aspect	Potential impact	Aquatic ecosystems of concern
		access.	
Future Expansion 01	• Stormwater management • Roads • Treated sewage effluent disposal through septic tanks and use of infiltration systems	Impacts in this area would include: • Some destruction of the southern extreme of presumed natural pan and wetland habitat (BB6) as well as artificial pans BB7 and BB8. • Potential increases in inflows of stormwater into remnant wetlands / pans, likely to result in changes in hydroperiod (increased water inflows). These would be likely to result in changes in vegetation (increased *Phragmites australis* dominance and loss of conditions that support (assumed) important ephemeral pan biotic assemblages, even in artificial systems.	This area includes artificial pans/wetlands (BB7 and BB8) as well as the southern extent of the (un-ground-truthed) natural pan (BB6). Of these, BB6 is rated as Critically Endangered and the artificial systems also have probable high ecological importance
Future Expansion 02	Aspects of concern in this area would include blasting of rocks for construction; the development footprint; and treatment of stormwater from the site, potentially impacting on downstream systems including those within the SASOL site and Phases 1-3 of the propose SEZ Industrial Park.	Impacts in this area would include: • Destruction of presumed natural temporary pools/pan habitat; • Possible eutrophication of pan habitat as a result of inflows of polluted water – it is however assumed that most of these flows would occur downstream of important rocky pans / pools and that this impact would be unlikely; • Degradation of downstream ecosystems as a result of concentration of flows from upslope areas and/or increased rate of surface flows as a result of stormwater management interventions • Biodiversity impacts as a result of loss of physical connectivity between these high-lying areas and downstream areas – these impacts would however be primarily applicable to terrestrial biodiversity and have been assessed separately in the terrestrial faunal and floral biodiversity reports for this study.	This area includes the high-lying rocky outcrops of the Visagiesfonteinkop, which have been mapped with low confidence as including areas of ephemeral pans and pool of (undetermined) high biodiversity importance.

5.2 Indirect impacts

The proposed Boegoebaai Port and associated SEZ development, if implemented, could give rise to several indirect impacts to aquatic ecosystems (inland and estuarine), not highlighted in the aspects and impacts register presented in **Table 5.1**. These are outlined below.

5.2.1 Impacts to the Orange River Estuary

The Orange River Estuary lies outside of the Boegoebaai Port and SEZ areas. However, if development of these were to commence, there would potentially be highly significant impacts to the estuary, including its capacity to achieve its required REC. Degradation of the estuary is most likely to be associated with the following aspects, linked to increased human settlement (formal and informal) in the Alexander Bay area, resulting from real and/or perceived increased employment and other opportunities in the vicinity of the SEZ:

- Expansion of both formal and informal settlement within the town and its surroundings, with the increased population potentially associated with increased levels of solid waste accumulation, hunting and fishing – unmanaged hunting and fishing have both been identified as significant issues affecting estuarine condition;

- Increased demand for sewage reticulation and treatment which, if not met, would result in increased sources of pollution into the estuary;

- Increased water demand – it is assumed that this demand would be met by desalination projects within the SEZ and Boegoebaai Port areas – however, the availability of water in an arid area is likely to attract more people into the area, potentially encouraging urban sprawl and spill-over into adjacent saltpan margins on the edge of the existing town;

- Increased pressures on the estuary resulting from an expanding population, potentially including increased human and vehicle access to the estuary, perpetuating berms that currently provide vehicle access to the estuary mouth.

5.3 Other concerns

Not necessarily impacting on existing identified watercourses, but potentially contributing to landscape degradation over time, would be impacts resulting from stormwater management systems, across all proposed development zones. These would include management of runoff from roads and hardened areas. If stormwater design, particularly of culverts, do not take cognisance of the vulnerability of parts of the site to erode, during infrequent but major storm events (potentially at recurrences of 50 to 100 years only), then significant erosion dongas and associated degradation might develop in areas where watercourses are not currently in evidence, as a result of effective and rapid dissipation of stormwater flows into the landscape, without downslope channelling.

Near-coastal wetlands may potentially be additionally affected by sea level rise, if this affects groundwater quality potentially feeding these systems, leading to general loss of quality and resilience.

6. RECOMMENDED STRATEGIC MANAGEMENT ACTIONS

6.1 General

The study area is not rich in inland aquatic ecosystems. However, given the aridity of the area, those ecosystems that do occur are likely to be of very high importance from a terrestrial faunal perspective (see Niemandt 2025), and the ephemeral pans in this area are assumed to support interesting and rare aquatic invertebrate communities, including crustacean zooplankton fauna. The larger pans (Visagiespan, Rietfontein and Rietfonteinpan) in particular afford substantial wetland and pan habitat, with (unquantified) links to primary and/or secondary aquifers.

The study area also abuts two estuaries, with the Orange River Estuary being an important estuary at both a national and international level (Ramsar status and one of only two estuaries on the Namibian coast). The condition of the Orange River Estuary currently falls well short of its REC, requiring active interventions to improve estuarine condition. Developments that further threaten its condition, directly or indirectly, will have direct negative implications for meeting the estuarine Resource Quality Objectives.

6.2 Recommendations to reduce or avoid impacts

If the proposed Boegoebaai Port and associated SEZ project are pursued in the present study area, then, from the perspective of reducing impacts to important inland and estuarine aquatic ecosystems, the following measures should be implemented, to reduce otherwise significant impacts on inland and/or estuarine aquatic ecosystems:

- Avoidance:
    - Development of the SASOL block; and Phases 2 and 3 (western portion) of the SEZ Industrial Park; as well as the south-western portion of the Future GH2 Facility; and the northern corner of Future Expansion Area 01 (over the recharge / buffer area of BB6) would not be compatible with the required (from a biodiversity conservation perspective) conservation of the important pans and associated wetlands in these areas;
    - Development involving rock blasting, flattening of slopes and/or loss of rocky outcrops that include ephemeral pool and pan habitat (e.g. Visagiesfonteinkop area) would also potentially impact on important mosaic pan habitat and should also be avoided;
- Impact mitigation:
    - The no-development areas outlined above would need to be actively managed / policed to prevent vehicle passage across pans and wetlands outside of existing roads / tracks;
    - The no-development areas outlined above would need to be tied in to terrestrial corridors that allowed for faunal connectivity within and between terrestrial and aquatic habitats;
    - Developed areas would need to be designed such that they did not include hardening of surfaces or diversion of surface flows from the 500 m proposed recharge area for natural pans;
    - Stormwater management design would need to be such that it:
        - Would not result in concentration of flows through the landscape, leading to the creation of erosion gulleys and resultant changes in the flow of water across and through the site – multiple smaller culverts would as a general rule result in less impact than single large culverts in these terrains, although they might require more maintenance;

        - Takes cognisance of the need for dissipation of stormwater flows into the substrate, rather than its rapid conveyance to the coast;

        - Does not bypass inland aquatic ecosystems or their buffer areas;

    - Waste water treatment and management from developments within the study area would need to ensure that waste streams from these activities do not pass, by way of seepage or flows, into pans, wetlands or their buffer area, unless treated to levels that would have negligible impact on aquatic habitat, as determined by an aquatic ecologist;

- Impact management:

    - Development in this area would need to allow (specifically) for increased resources at the Orange River Estuary, to control and police fishing, hunting and vehicle access and movement within the estuary, including its important saltmarshes;

    - Any provision of fresh water from desalination plants to the Alexander Bay or other communities / urban areas must be matched by an equal increase in infrastructure and human resources to treat the additional resultant waste water that would be generated from these areas, to a level that would not impact negatively on any receiving watercourse, and the Orange River Estuary in particular. This might mean far more stringent water quality treatment standards than those imposed by the General and Special Effluent Limits currently applicable to most WWTWs;

    - Provision would also need to be made for the management of solid waste in expanding urban settlements associated directly or indirectly with the proposed development, and in Alexander Bay in particular, where the greatest levels of urban expansion would be anticipated;

    - Upgrading of existing or new external roads to the study areas would need to be designed with particular attention paid to the design of bridges and culverts, such that they do not result in the concentration of flows into downstream areas, or alternatively block off flood flows in episodic flood conditions.

6.3 Information gaps

In the event that this project is considered further, and enters the required Environmental Impact Assessment (EIA) process and/or application phases for consideration for water use authorisation or registration, the following additional information would be needed to inform the necessary specialist aquatic ecosystem assessments:

- High-confidence investigation of surface / groundwater linkages in the Visagiespan, Rietfontein and Rietfonteinpan systems, potentially by way of a hydropedological study and/or geohydrological assessment;

- Identification and mapping of key temporary pan habitat in rocky outcrops;

- Wet-season assessment of ephemeral wetland invertebrate faunal communities;

- Detailed stormwater management plans;

- Details regarding the approach to dealing with the impact avoidance, mitigation and management measures outlined in Section 6.2.

7. CONCLUSIONS

This report has provided an overview of inland and estuarine aquatic ecosystems on and in the vicinity of the proposed Boegoebaai Port and SEZ areas, highlighting their importance and sensitivity to various development-related aspects. Overall, the assessment showed that the study area is not rich in inland aquatic ecosystems. However, given the aridity of the area, those ecosystems that do occur are likely to be of very high importance from a terrestrial faunal perspective (see Niemandt 2025), and the ephemeral pans in this area are assumed to support interesting and rare aquatic invertebrate communities, including crustacean zooplankton fauna. The larger pans (Visagiespan, Rietfontein and Rietfonteinpan) in particular afford substantial wetland and pan habitat, with (unquantified) links to primary and/or secondary aquifers, which form springs in at least Visagiespan, creating permanent standing water pools which are clearly utilised by terrestrial fauna, either directly as a (brackish to saline water source) or indirectly, for grazing of wetland plants that are supported by perennial water supply in places. Other inland aquatic ecosystems of assumed high biodiversity importance include ephemeral pans located in rocky outcrops across the site, some of which are likely to support communities of invertebrates adapted to ephemeral conditions and with high conservation importance. These systems have been mapped in this study with low confidence.

The proposed development would, in the conceptual layout presented for assessment in this study, result in potential loss of all of the inland aquatic ecosystems identified in the study area. Of these, natural pans and depression wetlands have been rated as Critically Endangered systems in the 2018 NBA (Van Deventer et al. 2018). The report recommends major changes in development layout that avoid these systems, and furthermore include ecological corridors that link between ecologically important terrestrial, coastal and (inland) aquatic areas across the site. Mitigation measures include addressing potential impacts associated with concentrated stormwater flows through areas characterised by increasingly hardened surfaces, which could bypass dependent aquatic ecosystems.

The study area also abuts two estuaries, namely the ephemeral Holgat River estuary, classified as a micro-outlet, and the Orange River Estuary. The latter is an important estuary at both a national and international level, having been accorded Ramsar Wetland status and being one of only two estuaries on the Namibian coast. The condition of the Orange River Estuary does however fall well short of its Recommended Ecological Category, requiring active interventions to improve estuarine condition. This is important, because new developments, such as that proposed, that further threaten its condition, directly or indirectly, would have direct negative implications for meeting the estuary's Resource Quality Objectives.

The report notes that development of the Boegoebaai Port and SEZ, if approved, would need to allow (specifically) for increased resources at the Orange River Estuary, to control and police fishing, hunting and vehicle access and movement within the estuary, including its important saltmarshes. In addition, it would need to match any provision of fresh water from desalination plants to the Alexander Bay or other communities / urban areas with an equal increase in infrastructure and human resources capacity to treat the additional resultant waste water that would be generated from these areas, to a level that would not impact negatively on any receiving watercourse, and the Orange River Estuary in particular. This might mean far more stringent water quality treatment requirements. Other required measures to address indirect impacts associated with expansion of urban areas as a result of the proposed development include the need for upgrading of solid waste management and attention to the design of new and/or upgraded external access roads, such that they do not result in downstream erosion or blockages of flows in flood conditions.

Finally, the report highlighted a number of information gaps that would need to be addressed if the proposed project is considered further and taken into Environmental Impact Assessment and/or Water Use License Application phases. These include detailed studies to unpack surface / groundwater interactions at the major pan / spring/ wetland areas (BB1, BB2 and BB3); wet-season assessment of ephemeral wetland invertebrate faunal communities; development of detailed stormwater management plans that take cognisance of the sensitivity of inland and estuarine aquatic ecosystems on and near the site; and details as to measures that can address the impact avoidance, mitigation and management measures outlined in the report.

It is further noted that there are no positive impacts to inland or estuarine aquatic ecosystems that would be associated with the proposed Boegoebaai Port and SEZ development, and substantial negative impacts could accrue, unless stringently addressed in development layout (avoidance), design and management.

8. REFERENCES

Bickerton, I.B., 1981, Report No. 5: Holgat (CW2). In: Estuaries of the Cape: Part II: Synopses of available information on individual systems. 12, CSIR Research Report. 412. Stellenbosch. South Africa.

Bird, M. 2012. Effects of Habitat Transformation on Temporary Wetlands in the South-Western Cape, South Africa. PhD Thesis. Zoology Department. University of Cape Town. Cape Town.

Cadman M. (ed). 2016. Ecosystem Guidelines for Environmental Assessment in the Western Cape, Edition 2. Cape Town: Fynbos ForumDavis C.L., Hoffman, M.T., Roberts, W. 2016. Recent trends in the climate of Namaqualand, a megadiverse arid region of South Africa. *S. Afr. J. Sci.* 2016;112(3/4), Art. 2015-0217, 9 pages. http:// dx.doi.org/10.17159/ sajs.2016/20150217

Day, J., Day. E. (Liz), Ross-Gillespie, V. and Ketley, A. 2010. The assessment of temporary wetlands during dry conditions. Report included in Water Research Commission project K5/1584: Wetlands Health and Importance Programme. Water Research Commission. Pretoria. South Africa.

Department of Water Affairs and Forestry (DWAF). 1996. South African Water Quality Guidelines (second edition), Volume 7: Aquatic Ecosystems

Department of Water and Sanitation (DWS), South Africa. 2017a. Determination of Ecological Water Requirements for surface water (river, estuaries and wetlands) and Groundwater in the Lower Orange WMA. *Report on consequences of scenarios*. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. DWS Report No: RDM/WMA06/00/CON/COMP/0117.

Department of Water and Sanitation (DWS), South Africa. 2017b. Determination of Ecological Water Requirements for Surface water (river, estuaries and wetlands) and Groundwater in the Lower Orange WMA. *Ecological Specifications and monitoring report*. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. DWS Report No: RDM/WMA06/00/CON/COMP/0217.

Desmet, P. 1996. The vegetation and restoration potential of the coastal belt between Port Nolloth and Alexander Bay, Namaqualand, South Africa. Masters Thesis. University of Cape Town.

Driver, A, Nel, J.L., Snaddon, K., Murray, K., Roux, D., Hill, L., Swartz, E.R., Manuel, J. and Funke, N. 2011. *Implementation Manual for Freshwater Ecosystem Priority Areas*. WRC Report No. 1801/1/11. ISBN 978-1-4312-0147-1. Pretoria.

Du Preez, L. and Carruthers, V. 2009. A complete Guide to the Frogs of southern Africa. Struik Nature. Cape Town. Pp 488.

Ebert,T. and Balko, M. 1987. Temporary pools as islands in space and in time: the biota of vernal pools in San Diego, Southern California, USA. Arch. Hydrobiol. 110. Pp101-123.

Hamer, M., Rayner, N.A. 1996. A note on the unusual crustacean community of a temporary pool in the Northern Cape. *South African Journal of Aquatic Science* 22(1): 100–104. doi:10.1080/10183469.1996.9631376

Harrison, T.D. 1998. A preliminary survey of coastal river systems on the South African west coast, Orange River—Groot Bberg, with particular reference to the fish fauna, Transactions of the Royal Society of South Africa, 52:2, 277-321.

Hattingh, J. 2016. *Surface and Groundwater Assessment.* Report to PHS Consulting for VAST Mineral Sands (Pty) Ltd.

Kleynhans, C.J., Louw, M.D., Thirion, C., Rossouw, N.J., and Rowntree, K. 2005. *River EcoClassification: Manual for EcoStatus determination* (Version 1). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. KV 168/05

Le Maitre, D.C., Seyler, H., Holland, M., Smith-Adao, L.B., Nel, J.L., Maherry, A. and Witthüser, K. 2018. Strategic Water Source Areas for groundwater (Vector data). One of the outputs of the identification, delineation and importance of the Strategic Water Source Areas of South Africa, Lesotho and Swaziland for Surface Water and Groundwater, WRC Report No TT 754/1/18, Water Research Commission, Pretoria, South Africa.

Mabidi A., Bird, M.S., Perissinotto, R., Rogers, D.C.. 2016. Ecology and distribution of large branchiopods (Crustacea, Branchiopoda, Anostraca, Notostraca, Laevicaudata, Spinicaudata) of the Eastern Cape Karoo, South Africa. *ZooKeys* 618: 15–38. doi: 10.3897/zookeys.618.9212

Mavurayi, A. 2014. *Geohydrological Impact Assessment for Alexkor Diamond Mine along the west coast between Port Nolloth and Alexander Bay, Northern Cape Province.* Report for Myezo Environmental ServicesReport Ref: 2014/ENV008.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., Van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L. and Nienaber, S. 2011. *Technical Report for the National Freshwater Ecosystem Priority Areas project.* WRC Report No. K5/1801

Niemandt, C. 2025. *Strategic Environmental Assessment (SEA) for the Proposed Boegoebaai Port and SEZ Fauna Desktop Assessment*. Report to CSIR.

Northern Cape Department of Environment and Nature Conservation. 2018. Northern Cape Critical Biodiversity Areas.

Ollis, D.J., Snaddon, C.D., Job, N.M. and Mbona, N. 2013. *Classification System for Rivers and other Aquatic Ecosystems in South Africa.* User Manual: Inland Systems.

PRDW. 2015. Boegoebaai Port Pre-Feasibility Study FeI2: PHASE 1 Study Report REV.00. 27 March 2015.

Rayner N.A. and Bowland, A.E. 1985. Notes on the taxonomy and ecology of *Triops granaries* (Lucas) (Notostraca: Crustacea) in South Africa. *South African Journal of Science* 81:500–505 .

Schreiner, G., Mqokeli, B., Snyman-van der Walt, L., Lochner, P., Louw, H., Modise, S., Ruthenavelu, M., Zukulu, T. and Maluleke, J. 2024. Strategic Environmental Assessment for the proposed Boegoebaai Port, SEZ and Namakwa Region: Briefing note for research partners. CSIR briefing report.

South African National Biodiversity Institute (SANBI). 2022a Red List of Ecosystems (RLE) for terrestrial realm for South Africa - remnants [Vector] 2021. Available from the Biodiversity GIS website, downloaded on Tuesday, January 21, 2025

South African National Biodiversity Institute (SANBI). 2022b Red List of Ecosystems (RLE) for terrestrial realm for South Africa - Original extent [Vector] 2021. Available from the Biodiversity GIS website, downloaded on Tuesday, January 21, 2025

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. and Snaddon, K. 2018. *South African National Biodiversity Assessment 2018: Technical Report*. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number. http://hdl.handle.net/20.500.12143/5847

Van Niekerk, L. and Turpie, J.K (Eds). 2012. National Biodiversity Assessment 2011: Technical Report. Volume 3: Estuary Component. CSIR Report Number CSIR/NRE/ECOS/ER/2011/0045/B. Council for Scientific and Industrial Research, Stellenbosch.

Van Niekerk, L., Adams, J., James, N., Lamberth, S., MacKay, C., Turpie, J., Rajkaran, A., Weerts,S. and Whitfield, A. 2020. An Estuary Ecosystem Classification that encompasses biogeography and a high diversity of types in support of protection and management. *African Journal of Aquatic Science* 45:1-2, 199-216, DOI: 10.2989/16085914.2019.1685934.

Van Niekerk, L., Adams, J.B., Bate, G.C., Forbes, N., Forbes, A., Huizinga, P., Lamberth, S.J., MacKay, F., Petersen, C., Taljaard, S., Weerts, S., Whitfield, A.K. and Wooldridge, T.H. 2013. Country-wide assessment of estuary health: An approach for integrating pressures and ecosystem response in a data limited environment. Estuarine, Coastal and Shelf Science 130: 239-251.

CHAPTER 3

Supplementary Material: Specialist Report

Avifauna report

Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone (SEZ)

WORK PACKAGE 1

Avifaunal Specialist Assessment

February 2025



Albert Froneman, Robin Colyn, Marietjie Oosthuizen, Megan Loftie-Eaton

AFRIAVIAN ENVIRONMENTAL

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1 EXECUTIVE SUMMARY

The Transnet National Ports Authority has embarked on the determination of the feasibility for the development, construction, and operation of a deep-water port with associated landside port facilities in Boegoebaai, Northern Cape. The proposed new port development is primarily for the enablement of the Northern Cape's Provincial Economic Development strategy including the Green Hydrogen Strategy and expanding the mining and industrial base in the Northern Cape.

A Strategic Environmental Assessment (SEA) has been initiated through a collaboration between the South African National Energy Development Institute (SANEDI), Northern Cape Economic Development Trade and Investment Promotion Agency (NCEDA), and Transnet National Ports Authority (TNPA) (the Project Steering Committee (PSC)). The Council for Scientific and Industrial Research (CSIR) has been appointed to undertake an independent SEA. The overarching purpose of the SEA is to develop an integrated decision-making framework to guide the planning of the proposed Boegoebaai Port, Special Economic Zone, and wider Namakwa region in a sustainable manner.

AfriAvian Environmental has been appointed by the CSIR to conduct the Avifaunal SEA for the Boegoebaai Port Special Economic Zone and wider Namakwa region.

Eighty-seven (87) bird species have been recorded in the Broader Area through the Second Southern African Bird Atlas Project (SABAP2). Of the 87 species, 47 are considered priority species. Priority species were defined as species that are particularly sensitive to displacement due to disturbance and/or habitat loss, endemic and near-endemic species, all Species of Conservation Concern (SCC), and range restricted species. Of the 87 bird species recorded in the Broader Area, 13 species were selected for further assessment. This selection includes species of conservation concern as well as those that are endemic or near-endemic to South Africa.

The Boegoebaai Port and SEZ SEA development site predominantly exhibits medium and high sensitivity from an avifaunal perspective. Although the region does not host a wide diversity of birds, it is home to range-restricted species such as Barlow's Lark, as well as potentially supporting Endangered Martial Eagle and Endangered Ludwig's Bustard. Additionally, dunes, freshwater pans, and estuarine habitats along the coast support various species of conservation concern, including the Critically Endangered Damara Tern. Consequently, all proposed developments within the SEZ should incorporate an avifaunal specialist study.

2 INTRODUCTION

The Transnet National Ports Authority has embarked on the determination of the feasibility for the development, construction, and operation of a deep-water port with associated landside port facilities in Boegoebaai, Northern Cape. The proposed new port development is primarily for the enablement of the Northern Cape's Provincial Economic Development strategy including the Green Hydrogen Strategy and expanding the mining and industrial base in the Northern Cape.

Green hydrogen production, at the scale envisaged, is a diverse and multifaceted process with many direct and indirect impacts, both positive and negative. All programme components (including their interconnected transport corridors) would require vast areas of land surface, as well as other resource intensive inputs, all proposed in a sparsely populated but ecologically sensitive arid region. Existing land uses in the study area include conservation, agriculture, tourism, and mining.

A Strategic Environmental Assessment (SEA) has been initiated through a collaboration between the South African National Energy Development Institute (SANEDI), Northern Cape Economic Development Trade and Investment Promotion Agency (NCEDA), and Transnet National Ports Authority (TNPA) (the Project Steering Committee (PSC)). The Council for Scientific and Industrial Research (CSIR) has been appointed to undertake an independent SEA. The overarching purpose of the SEA is to develop an integrated decision-making framework to guide the planning of the proposed Boegoebaai Port, Special Economic Zone, and wider Namakwa region in a sustainable manner.

AfriAvian Environmental has been appointed by the CSIR to conduct the Avifaunal SEA for the Boegoebaai Port Special Economic Zone and wider Namakwa region.

3 SCOPE OF STUDY

The purpose of this avifaunal study is to determine the main issues and potential impacts of the proposed project on avifauna based on existing information and field assessments. The scope of the study is as follows:

- Identify, describe, and map the land use dynamics and change trends of the receiving environment and broader region as it relates to avifauna, as well as the environmental sensitivities around the Boegoebaai Port and SEZ development.
- Assess the distribution and habitat requirements of avifaunal species of conservation concern (SCC) and the avifaunal communities in the area.
- The avifaunal component will form part of the overall Terrestrial Ecological Assessment within the SEA framework, with a strong focus on desktop and spatial data.
- Evaluate the conservation importance and significance of the site with special emphasis on the status of threatened species
- Discuss the expected impacts associated with the Boegoebaai Port Development and associated infrastructure.
- Identify potential sensitive environments and receptors that may be impacted on by the proposed development.

4 APPROACH & METHODOLOGY

To assess the avifaunal sensitivity of the broader area, various data sets were used to compile sensitivity layers for each species of conservation concern. The layers were ranked according to endemicity and conservation status, and fine scale habitat suitability to develop a four-tier sensitivity map.

The following information sources and methods were used to conduct this study:

- Bird distribution data from the Second Southern African Bird Atlas Project (SABAP2) was obtained (https://sabap2.birdmap.africa/), to ascertain which species occur in the pentads where the proposed Boegoebaai Port Development is to be located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5' × 5'). Each pentad is approximately 8 × 9 km. To get a more representative impression of the birdlife in the area, a consolidated data set was obtained for a total of 20 pentads some of which intersect and others which are near the proposed Development Site, henceforth referred to as the "**Broader Area**" (Error! Reference source not found.**1**). To date, a total of 43 full protocol checklists (i.e., intensive bird listing surveys lasting a minimum of at least two hours each) and 135 ad hoc protocol lists (surveys lasting less than two hours but still yielding valuable data) have been completed for the eight pentads where the Project is located.
- The SABAP2 data in this region is usually not as comprehensive as in the rest of South Africa due to decreased observer effort (fewer people living in the area and access difficulty), therefore the data was also supplemented by species distribution models and habitat suitability models as well as general knowledge of the area.
- A target species list was generated by assessing SABAP2 data, BirdLasser citizen science data and intersecting species distribution models with a 5km Proposed Area of Impact (PAOI) buffer around the Boegoebaai SEZ. This assessment of all available data yielded a priority list of 13 threatened and/or

endemic avian species that were included in the analysis. Species distribution models have been developed for more than >100 SCCs as part of a national assessment of avian sensitivity. Species distribution models were developed using a standardised methodology that is aligned with what was used to develop avian models for the DFFE National Screening Tool.

- A classification of the vegetation types at the Development Site was obtained from the First Atlas of Southern African Birds (SABAP1) and the 2018 National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006, SANBI 2018).
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red List Book of Birds of South Africa, Lesotho, and Swaziland (Taylor et al. 2015), and the latest authoritative summary of southern African bird biology (Hockey et al. 2005).
- The global threatened status of all priority species was determined by consulting the latest (2024) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- The database on the Key Biodiversity Areas (KBAs) of South Africa (Key Biodiversity Areas in South Africa - SANBI) was consulted for information on potentially relevant KBAs near the Development Site.
- An intensive internet search was conducted to source information on the impacts of the proposed development on avifauna.
- Satellite imagery (Google Earth © 2024) was used to view the Broader Area on a landscape level and to help identify bird habitat on the ground.
- The South African National Biodiversity BGIS map viewer was used to determine the locality of the Development Site relative to National Protected Areas.
- The DFFE National Screening Tool was used to determine the assigned avian sensitivity of the Development Site.
- A weighted sensitivity model will be used for all Species of Conservation Concern (SCC) & range restricted terrestrial endemics.
    - This model incorporated 13 species that were selected for further assessment in the proposed area of impact. This selection includes species of conservation concern as well as those that are endemic or near-endemic to South Africa.
- Data inputs included:
    - Species Distribution Models (SDMs) for each of the 13 selected species (see above)
    - Nest sites
    - Confirmed species presence (BirdLasser®, tracking data, SABAP2)
    - Freshwater body/aquatic ponding GIS layer
    - Habitat Suitability Models (HSMs)
- Fine scale habitat suitability models have been developed for two threatened species that are known to occur in the SEZ and are sensitive to habitat disturbance:
    - Black Harrier (EN) – breeding endemic within South Africa. A fine scale habitat suitability model was developed to identify any potential breeding habitat located within the PAOI.
    - Barlow's Lark (now lumped with Dune Lark – see section 6.3 below) - a large proportion of its global range is located between Port Nolloth and Alexander Bay in South Africa. A fine scale habitat suitability model was developed to identify and map core suitable habitat within the PAOI for this range-restricted species.

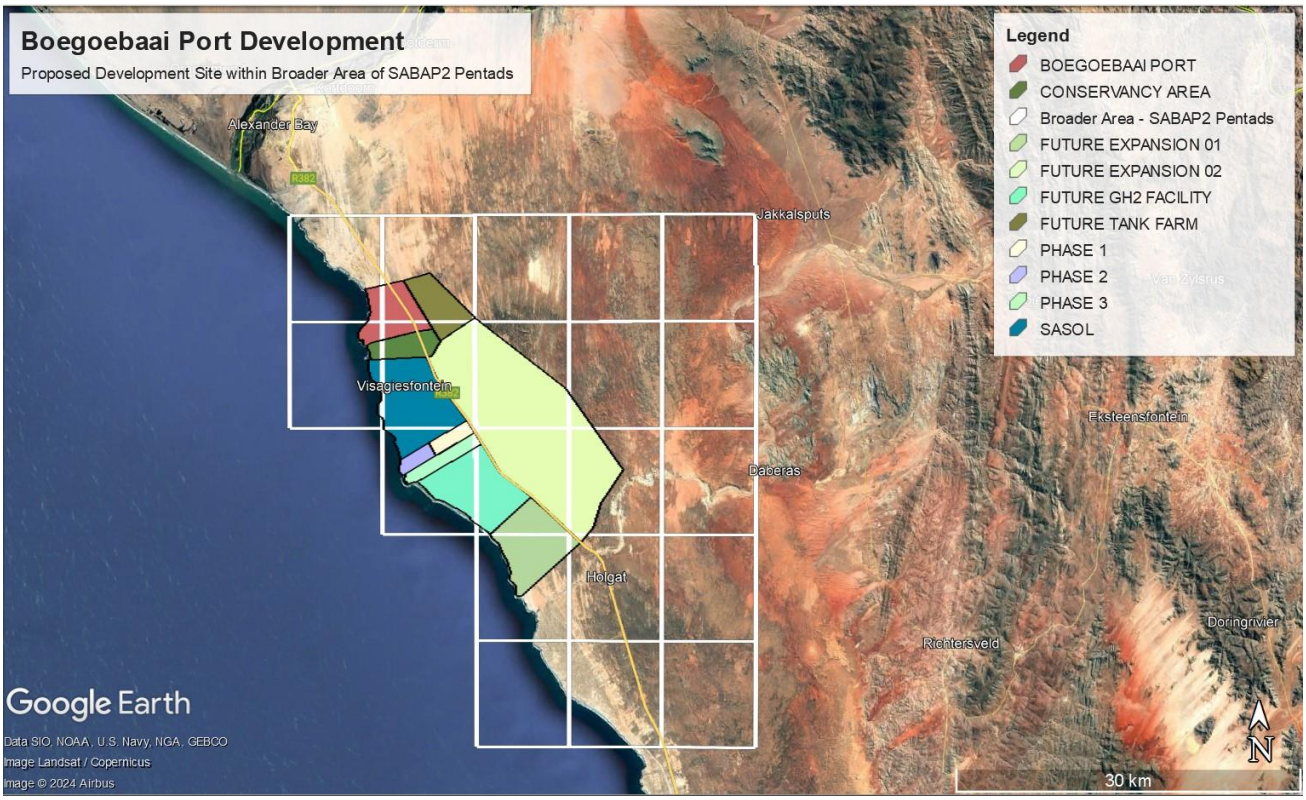


Figure 1: Proposed Development Site location within the Broader Area of 20 SABAP2 pentads.

5 ASSUMPTIONS & LIMITATIONS

This study assumed that the sources of information used in this report are reliable. In this respect, the following must be noted:

- The focus of the study is primarily on the potential impacts of the Project on priority species which were defined as follows:
  - South African Red List species (Species of Conservation Concern)
  - South African endemics and near endemics
  - Waterbirds; and
  - Raptors
  - Species vulnerable to disturbance and/or habitat loss
- The assessment of impacts is based on the baseline environment as it currently exists at the Development Site and nearby surrounding environment.
- Conclusions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will be valid under all circumstances.
- The **Development Site** is the area of 33,500 hectares where the proposed Boegoebaai Port and SEZ development and associated infrastructure is to be located.
- The **Broader Area** refers to the area covered by the 20 SABAP2 pentads within which the Boegoebaai Port and SEZ development is to be located (**Figure 1**).

6 RESULTS OF DESKTOP STUDY

6.1 Key Biodiversity Areas

Key Biodiversity Areas (KBAs) are 'sites that contribute significantly to the global persistence of biodiversity', which means they are the most important places in the world for species and their habitats – whether these be in terrestrial, freshwater, estuarine, or marine ecosystems.

The Global Standard for the Identification of Key Biodiversity Areas, published in 2016, sets out internationally agreed scientific criteria for the identification of KBAs worldwide. Sites qualify as global KBAs if they meet the specific standardised criteria and quantitative thresholds focused on one or more of five trigger aspects:

1. Threatened biodiversity;
2. Geographically restricted biodiversity;
3. Ecological integrity;
4. Biological processes; and
5. Irreplaceability through quantitative analysis.

The Development Site is located within the Namaqualand Sandveld North KBA (KBA ID 100876) (**Figure 2**). This site qualifies as a Key Biodiversity Area of international significance that meets the thresholds for ten (10) criteria described in the Global Standard for the Identification of KBAs (A1a, A1b, A1d, A2, B1, B2, B3a, B4, D1a and E). Based on current available information, 45 species meet one or more KBA criteria for this site. The KBA trigger species at this site include amphibians, birds, butterflies, mammals, plants, and reptiles. The site meets criterion A1 due to the presence of significant proportions of the global populations of 11 threatened species. The site regularly holds 35 individual geographically restricted species, therefore meeting criterion B1. Assemblages of co-occurring range-restricted species in the Amphibia, Caryophyllales, Reptilia, and Saxifragales taxonomic groups regularly present within the site meet criterion B2. An aggregation of at least 1% of the global population of one species is regularly present at the site, therefore it meets criterion D1. A quantitative analysis of irreplaceability indicates that the site is 100% irreplaceable for the global persistence of nine species, therefore meeting criterion E. The site holds significant proportions of the global extent of three threatened ecosystems (meeting criterion A2) and 7 geographically restricted ecosystems (meeting criterion B4).

Namaqualand Sandveld North is a large terrestrial site that is unprotected but has Other Effective Area-Based Conservation Measures (OECM) coverage, found in the Northern Cape, South Africa (Key Biodiversity Areas Partnership 2024). Mainly flat to slightly undulating landscape of coastal peneplain. The vegetation is a low species-rich shrubland dominated by a plethora of erect and creeping succulent shrubs (*Cephalophyllum, Didelta, Othonna, Ruschia, Tetragonia, Osteospermum, Zygophyllum*) as well as non-succulent shrubs (*Eriocephalus, Calobota, Pteronia, Salvia*). The annual vegetation, mixed with the perennial component can present spectacular flowering displays in wet years. Spiny grasses (*Cladoraphis*) are a common sight on wind-blown semi stable dunes, with 1-2 m erect to spreading shrubs, mostly with malacophyllous leaves, are found protected from the wind between dunes. Relatively homogeneous vegetation covers fairly stable sand sheets. Depth of sand and soil crust define the character of habitat types (Key Biodiversity Areas Partnership 2024). On the active dunes, depending on the aspects of the slopes and on the phase of deflation and sedimentation, different plant communities occur.

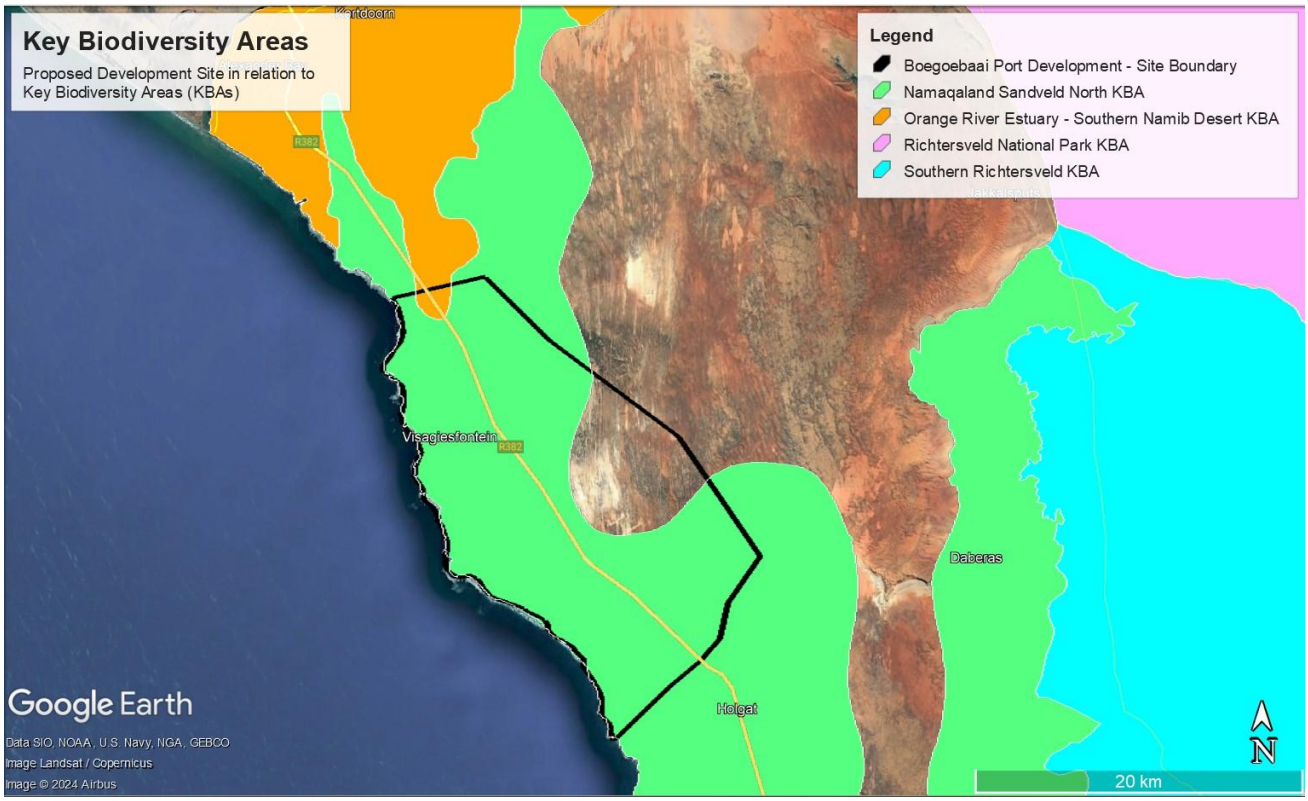


Figure 2: Proposed Boegoebaai Port and SEZ Development Site (boundary outlined in black) in relation to Key Biodiversity Areas.

6.2 Habitat Features

The proposed Development Site is mostly located within the Succulent Karoo Biome and Namaqualand Sandveld Bioregion with a small section in the north located within the Desert Biome (Mucina & Rutherford 2006, VegMap 2018). The two main vegetation types within the Development Site are Richtersveld Coastal Duneveld and Northern Richtersveld Yellow Duneveld (VegMap 2018) (**Figure 3**). Richtersveld Coastal Duneveld occurs in landscapes which are generally flat with some large, gently rolling hills. Only the Boegoeberg Twins south of Alexander Bay form steeper rocky slopes. Northern Richtersveld Yellow Duneveld is characterized by flat sand shields, often interrupted by dunes, which normally form flat whalebacks. Steep dune crests and dune valleys form only rarely—here the vegetation mirrors different topographic units: the dune tops are covered with *Stoeberia utilis*, while the interdune valleys are dominated by *Mesembryanthemum pseudoschlichtianum, M. arenosum, Cheiridopsis robusta* and *Cephalophyllum ebracteatum*.

Fairly stable sand sheets are covered by relatively homogeneous vegetation. The character of the habitat types is defined by the depth of the sand and soil crust. Different plant communities occur on active dunes, depending on the slope aspects and on phases of deflation and sedimentation. *Stoeberia utilis* often grows on the dune crests, while *S. beetzii* is found more on stabilised sand sheets. *Lampranthus hoerleinianus* and *Cladoraphis cyperoides* are pioneers settling in habitats created by recent sand deflation.

The climate in the area is known for extreme wind speeds and sand blasting from the south. There is a high storm frequency. Mean Annual Precipitation is 50–80 mm, with winter rains clearly predominant. The area also has a medium to high frequency of sea fog.

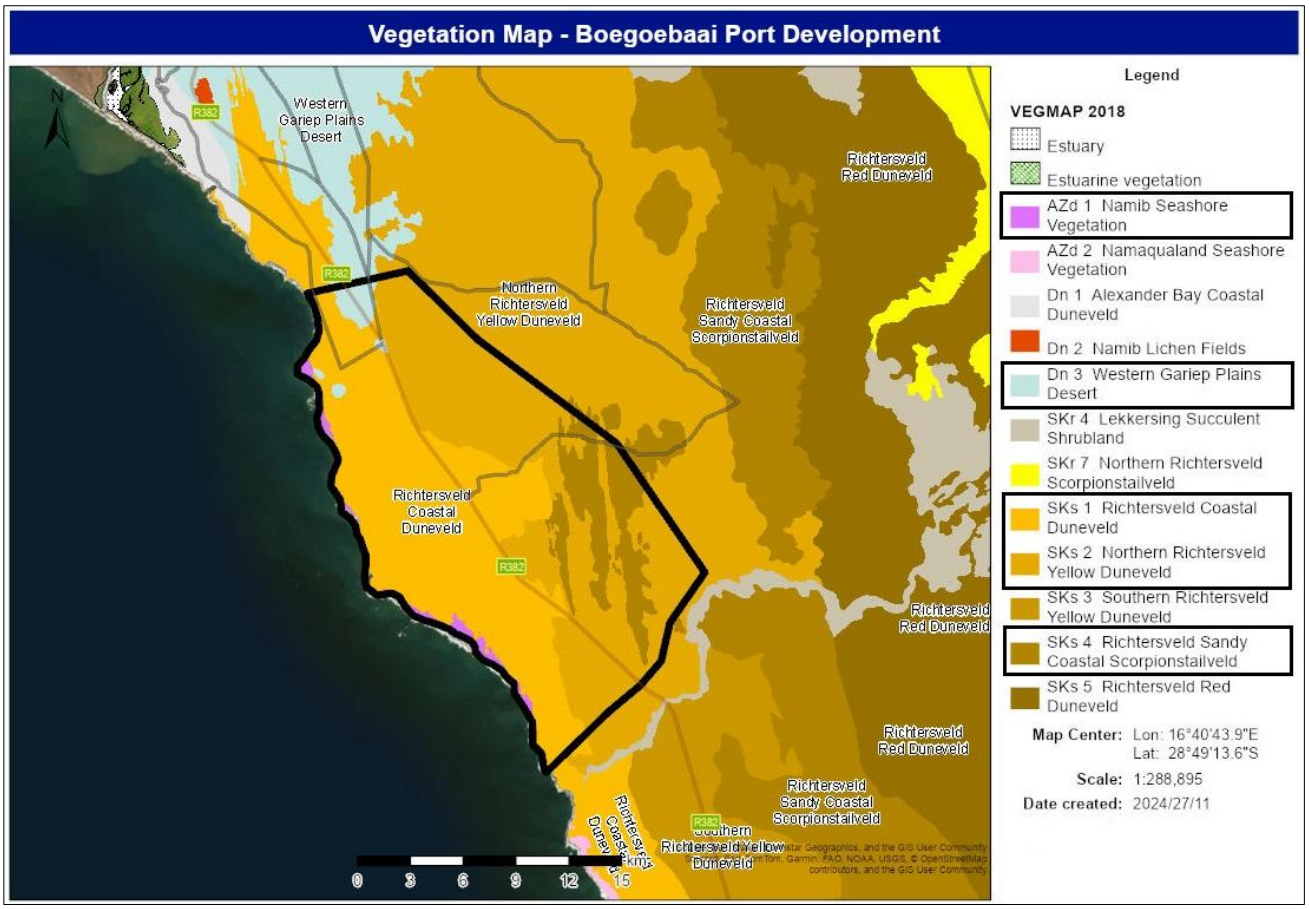


Figure 3: Vegetation Map of proposed Development Site.

6.2.1 Coastal Duneveld

The two main vegetation types within the Development Site are Richtersveld Coastal Duneveld and Northern Richtersveld Yellow Duneveld (**Figure 4**). Refer to Section 5.2 above.



Figure 4: Coastal Duneveld habitat at and near the proposed Development Site.

6.2.2 Rocky Outcrops

The Development Site and surrounding environment contains rocky outcrops with boulder-strewn slopes (**Figure 5**). Rocky outcrops can be vital habitat for avifauna, offering shelter, nesting sites, and feeding opportunities (BirdLife International 2021). The crevices, ledges, and overhangs within these rocky areas and boulder-strewn slopes can provide safe nesting locations, protected from predators and harsh weather conditions. These features also serve as roosting sites for various bird species, including raptors, songbirds (passerines), and ground-nesting birds. The microhabitats formed by rocky outcrops support a diversity of insects, seeds, and small vertebrates, which provides a food source for avian species (Newton 2010). Some birds, like swifts and cliff-nesting raptors, are specially adapted to exploit these environments, making rocky outcrops critical for their survival. The open vantage points and thermals associated with these areas are ideal for birds of prey to hunt and survey their surroundings (Debus 2001).



Figure 5: Rocky hills and outcrops at the proposed Development Site.

6.2.3 Surface Water

Depressions in the landscape and hollows in the granite boulders throughout the area hold water during the rainy season and acts as an important source of water for avifauna. The Holgat River is located just south of the proposed Development Site. Surface water is very important habitat for avifauna in this arid environment, especially waterbirds and waders including flamingos and terns. These areas will also attract raptors that prey on other bird species.

6.3 Bird Species in the Broader Area

Eighty-seven (87) bird species have been recorded in the Broader Area through the Second Southern African Bird Atlas Project (SABAP2). Of the 87 species, 47 are considered priority species. Priority species were defined as species that are particularly sensitive to displacement due to disturbance and/or habitat loss, endemic and near-endemic species, all Species of Conservation Concern (SCC), and range restricted species. Of the 87 bird species recorded in the Broader Area, 13 species were selected for further assessment. This selection includes species of conservation concern as well as those that are endemic or near-endemic to South Africa (**Table 1**).

It should be noted that observer effort in this area is generally low due to the sparseness of the human population and the remoteness (accessibility) of the area. Therefore, the SABAP2 species list is not necessarily fully comprehensive of the Broader Area.

Table 1: Species of Conservation Concern and/or endemic species that have been recorded in the Broader Area where the proposed Development Site is located. CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, E = Endemic, NE = Near Endemic.

Species Name	Scientific Name	Global Conservation Status	Regional Conservation Status	Endemism
Bank Cormorant[1]	*Phalacrocorax neglectus*	EN	EN	
Black Harrier	*Circus maurus*	EN	EN	NE
Cape Cormorant[2]	*Phalacrocorax capensis*	EN	EN	
Cape Long-billed Lark	*Certhilauda curvirostris*	-	-	E
Caspian Tern	*Hydroprogne caspia*	-	VU	
Curlew Sandpiper	*Calidris ferruginea*	NT	-	
Damara Tern	*Sterna balaenarum*	LC	CR	
Dune Lark (Coastal)*	*Calendulauda erythrochlamys patae*	-	-	NE
Eurasian Curlew	*Numenius arquata*	NT	NT	
Great White Pelican	*Pelecanus onocrotlus*	-	VU	
Greater Flamingo	*Phoenicopterus roseus*	-	NT	
Jackal Buzzard	*Buteo rufofuscus*	-	-	NE
Lanner Falcon	*Falco biarmicus*	-	VU	
Ludwig's Bustard	*Neotis ludwigii*	EN	EN	
Martial Eagle	*Polemaetus bellicosus*	EN	EN	

https://ebird.org/species/jacbuz1?siteLanguage=en_ZA

*See species account below regarding its taxonomic and red data status.

6.3.1 Summary descriptions of threatened and endemic species

Black Harrier *Circus maurus*

Black Harriers (Globally and Regionally Endangered) are one of southern Africa's most rare near-endemic raptors and have been uplisted from Vulnerable to Endangered in South Africa and Namibia in 2015. The regional population of the near-endemic Black Harrier has been quantified at less than 1 000 mature individuals with an estimated continuing decline of at least 20% within the next two generations (Taylor et al. 2015). Although Black Harriers are unlikely to breed within the PAOI, the presence of suitable foraging habitat is evident.

Black Harriers breed in the montane fynbos, renosterveld and strandveld habitats of the Western Cape and many individuals disperse into the karoo and grassland habitats during the autumn and winter months (Simmons et al. 2005).

The main threats facing this species include habitat loss and fire. The species is thought to have lost up to 50% of its core breeding habitat in the last century owing to extensive land transformation by agriculture

[1] Marine species have not been included in this Terrestrial Avifaunal Study. Marine species assessments are included in the Marine Specialist Study for the Boegoebaai SEA.
[2] Marine species have not been included in this Terrestrial Avifaunal Study. Marine species assessments are included in the Marine Specialist Study for the Boegoebaai SEA.

(particularly in the Overberg), invasive alien vegetation, and urbanisation within the Fynbos Biome (Curtis et al. 2004). An isolated population of about 10 mature individuals occurs in northern coastal Namibia, where they may breed.

Cape Long-billed Lark *Certhilauda curvirostris*

The Cape Long-billed Lark is near-endemic to South Africa, occurring from the extreme south of Namibia through to the western side of the Northern and Western Cape Provinces of South Africa. It generally prefers coastal scrub, such as sandplain fynbos, strandveld, renosterveld and dunes with sparse vegetation (Hockey et al. 2005). Cape Long-billed Lark could occur throughout the PAOI within scrubland habitat.

Their population is suspected to be in decline owing to the effects of agriculture and mining (BirdLife International 2025).

Caspian Tern *Sterna caspia*

The regional population of Caspian Tern (Regionally Vulnerable) is estimated to be <1 000 mature individuals. The species also has a restricted number of breeding locations which makes it prone to the effects of human activities (disturbance displacement) or stochastic events within a short period of time (Taylor et al. 2015). Within the region, it is concentrated at estuaries and sheltered bays along the coastline and at large, permanent inland waterbodies (Hockey et al. 2005). Within the PAOI Caspian Terns are likely to use freshwater pans and estuarine habitats along the coast.

Caspian Terns are highly susceptible to disturbance displacement particularly during their breeding period, some of these disturbances include egg collecting and predation by domestic dogs (Crawford et al. 2012). Extreme weather events such as heavy rainfall, droughts and heat waves can also impact on the breeding success of this species (du Toit et al. 2003). Lesser threats include the bioaccumulation of heavy metals, pesticides, and other chemical pollutants (to which this species may be particularly prone due to its diet which includes large fish). The bioaccumulation of pollutants may lead to eggshell thinning and other impacts on breeding success (Crawford et al. 2012).

Curlew Sandpiper *Calidris ferruginea*

Curlew Sandpipers (Globally Vulnerable) occur on coastal brackish lagoons, tidal mud- and sandflats, estuaries, saltmarshes, exposed coral, rocky shores and tidewrack on sandy beaches (Hockey et al. 2005). Inland they occur on the muddy edges of marshes, large rivers and lakes (both saline and freshwater), irrigated land, flooded areas, dams and saltpans (Dodman 2014). Within the PAOI Curlew Sandpiper are likely to use estuarine habitats along the coast.

Recent monitoring data suggest that this widely distributed species has likely declined by 30–49% over the past three generations (15 years) (BirdLife International (2025). While the exact causes remain uncertain, potential factors include habitat loss and degradation—especially in stopover and wintering areas—along with climate change impacts that may reduce breeding success (BirdLife International (2025). Additional threats such as disturbance and hunting may also contribute to the decline.

Damara Tern *Sterna balaenarum*

The Damara Tern (Globally Near Threatened and Regionally Critically Endangered) occurs along the western coast of Africa; within southern Africa it is locally common along the coast of Namibia and the Northern Cape Province of South Africa (Hockey et al. 2005). It generally prefers arid desert shores, especially with sheltered bays and reefs, while it mainly breeds on gravel plains between dunes and on salt pans (Hockey et al. 2005). Damara Terns are known to have bred in dune fields along the coast in the PAOI - the current status of these areas is however unknown (Taylor et al. 2015).

Off-road vehicles pose a significant threat to Damara Tern colonies by causing nest abandonment and directly leading to egg and chick fatalities through crushing of nests (Braby et al. 2009). The prohibition of off-road vehicles on South African beaches has helped mitigate these disturbances, resulting in improved breeding success (Williams et al. 2004). Additionally, semi-natural threats, including higher jackal and gull

populations driven by human activity, as well as the growing numbers of seals and seal colonies in South Africa and Namibia, have increased the risk of predation (Braby et al. 2011).

Dune Lark (Coastal) *Calendulauda erythrochlamys patae*

The regional subspecies of the Dune Lark that occurs in the coastal plain of Namaqualand in north-western Northern Cape, South Africa, was until very recently regarded as a unique species, Barlow's Lark *Calendulauda barlowi* (Ryan & Kirwan 2022). The Dune Lark is listed as Least Concern, and its distribution ranges into Namibia, however we treated this regional subspecies as a priority species because of its high local abundance and its distinct habitat requirements.

The species is distributed in a highly localised and constrained area within South Africa. It is largely restricted to coastal shrubland between Port Nolloth and Alexander Bay and as such is considered a range-restricted habitat specialist species. It is estimated that approximately 18% its overall distribution and 30% of its South African distribution falls with the PAOI. The regional subspecies of the Dune Lark occurs in karroid dwarf shrubland, sparse Succulent Karoo, coastal Duneveld and semi-desert areas with scattered *Euphorbia* clumps (Dean & Ryan 1997). The species can be found anywhere within the PAOI with suitable shrubland. Habitat loss in this key area could significantly impact the species population.

The population trend is suspected to be in decline (Taylor et al. 2015), possibly due to grazing pressure which leads to a lack of suitable vegetation. Populations in restricted-access diamond-mining zones may be relatively stable. The regional subspecies of the Dune Lark is restricted to natural habitats and are generally absent from transformed areas as they are sensitive to overgrazing (Ryan & Dean 2005).

Eurasian Curlew *Numenius arquata*

In the southern African region Eurasian Curlews frequent muddy coasts, bays and estuaries with tidal mudflats and sandflats (Snow and Perrins 1998), rocky and sandy beaches with many pools, mangroves, saltmarshes, coastal meadows and pastures (Navedo et al. 2013). They can also occur inland at lakes and rivers and utilise wet grasslands and arable fields during migration (del Hoyo et al. 1996). Curlews are likely to occur in estuarine habitats along the coast within the PAOI.

Several key populations of the Eurasian Curlew, classified as Near Threatened both globally and regionally, are suspected to be experiencing moderately rapid declines. This species is a non-breeding Palaearctic migrant, present in South Africa from September to March (Taylor et al. 2015).

Greater Flamingo *Phoenicopterus roseus*

In South Africa, the Greater Flamingo (Regionally Near Threatened) occurs mainly in the central and south-western regions. It generally prefers coastal mudflats, inland dams, sewage treatment works, small temporary pans and river mouths, while it exclusively breeds at recently flooded, large eutrophic shallow salt pans (Hockey et al. 2005). Within the PAOI flamingos are likely to use freshwater pans and estuarine habitats along the coast.

The southern African population of Greater Flamingo has undergone declines of >40% over the past three generations. Unfortunately, there are no data to support similar trends within the regional population although it is suspected to be approaching the 30% threshold qualifying this species as regionally Near Threatened. The population declines are largely due to lowering water tables at major breeding sites as well as collisions with powerlines. Collisions with wind turbines have also become a potential threat.

Great White Pelican *Pelecanus onocrotalus*

The regional population of Great White Pelican (Regionally Vulnerable) has been quantified at *c.* 2 500 pairs, restricted to less than 5 breeding locations, and is vulnerable to short-term human activities and stochastic events. For these reasons, the species is assessed as regionally Vulnerable. Freshwater pans and estuarine habitats along the coast are habitats along the coast that pelicans are likely to use.

In the Western Cape Province, South Africa, breeding sites are relatively secure, but reliance on offal from farms presents a significant concern. This feeding behaviour may lead to extreme fluctuations in food availability and increase the risk of avian pathogen transmission (Crawford et al. 1995), which could have

severe consequences (Kemper et al. 2007). The long-term impact of this foraging shift on the population remains uncertain, as does the continued availability of this food source. Lesser threats include human disturbance at breeding colonies (Berry et al. 1973), pollution, particularly plastic ingestion (Crawford et al. 1995), collisions with power lines, and the effects of drought, which can cause starvation and breeding failure.

Jackal Buzzard *Buteo rufofuscus*

The Jackal Buzzard is not regionally or globally threatened, but it is classified as near-endemic. Its range includes South Africa, Lesotho and Namibia, as well as the extreme southern, and southwestern parts of Mozambique and Botswana (Kemp & Kirwan 2020). Their main strongholds are the Eastern Cape, Lesotho, the Drakensberg and Midland regions of KwaZulu Natal. They are also abundant in the central and North-western Karoo (Tippett 2024).

Jackal Buzzards occur over a wide range of open grassland habitats, primarily above 100m in altitude. This species is primarily mountain dwelling but also occur in rocky areas and their range extends from sea level to mountain tops at 3 300m altitude. They are well adapted to diverse environments, from fairly wet habitats to semi desert coastal regions of Namibia.

This species maintains a stable population with relatively high numbers, and they have no major predators. Threats include habitat loss, and they are highly susceptible to collisions with man-made structures such as wind turbines, powerlines and steep-sided reservoirs (Nkomo et al. 2024). In addition, their scavenging behaviour exposes them to the risk of poisoned carcasses (Van den Heever et al. 2019), although they scavenge mainly roadkill and hunt small mammals, birds and reptiles.

Lanner Falcon *Falco biarmicus*

The Lanner Falcon (Regionally Vulnerable) is widely distributed across Africa, the Arabian Peninsula, and the Western Palearctic (Ferguson-Lees & Christie 2001). Within the southern African region, it is found throughout South Africa, Lesotho, and Swaziland, though in low densities, with the highest concentrations recorded in the Western Cape and KwaZulu-Natal.

Lanner Falcons mostly occur in open grassland, cleared woodlands and agricultural areas. Breeding pairs tend to favour cliffs as nesting and roosting sites; however, they will also use alternative structures such as trees, pylons and buildings (Hockey et al. 2005). Within the PAOI they would use the powerline in the west and could potentially hunt over the entire area.

The main threat to the Lanner Falcon is habitat loss and transformation within the Grassland Biome, driven by urbanization, agriculture, and afforestation. These changes have led to a decline in preferred prey species and reduced foraging opportunities (Barnes & Jenkins 2000).

Ludwig's Bustard *Neotis ludwigii*

Ludwig's Bustard (Globally and Regionally Endangered) is near-endemic to the region occurring in western Namibia and western South Africa, with some records from south-western Angola, Botswana and western Lesotho (Taylor et al. 2015). It generally prefers the semi-arid shrublands of the Karoo, Namib Desert and Nama Karoo, occasionally visiting cultivated land and the southern Kalahari. Ludwig's Bustards could occur throughout the PAOI within scrubland habitat.

The main threat to Ludwig's Bustards is mortalities originating from collisions with distribution and telephone lines. The power network in the region is extensive and increasing and causes high levels of mortality with unsustainable rates of 0.63 fatal collisions/km/year being recorded on transmission lines in the Karoo, which result in an estimated annual toll of 8 600 birds (Jenkins et al. 2011). Poisoning and displacement due to disturbance are also threats to this bird species.

Martial Eagle *Polemaetus bellicosus*

Martial Eagles (Globally Near Threatened and Regionally Endangered) occur in much of sub-Saharan Africa. In southern Africa, it is widespread but uncommon, generally preferring flat, open woodland, such as savanna, forest edges and drainage woodland in shrubland. It may move into open farmland with stands of

trees. Within the PAOI, they would utilize the powerline in the west and potentially cover the entire area for hunting.

Barnes (2000) identifies human activities outside protected areas as the primary drivers of Martial Eagle population decline. Key threats include direct persecution through shooting and trapping by small-stock farmers, indirect poisoning, drowning in sheer-walled farm reservoirs, loss of natural prey due to habitat degradation, nest site disturbance, and electrocution on electricity pylons. The process of rangeland modification and degradation (primarily by overgrazing) affects eagle populations, at least indirectly by influencing the distribution, abundance, and accessibility of prey (Taylor et al. 2015).

6.4 DFFE Screening Tool

The Development Site and immediate environment is classified partially as LOW and partially as HIGH sensitivity for avifauna according to the Animal Species Theme of the DFFE Screening Tool (**Figure 4**). The high sensitivity classification is linked to the possible occurrence of Lanner Falcon *Falco biarmicus* (Regionally Vulnerable). The Development Site contains confirmed habitat for species of conservation concern (SCC) as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020). SCCs are listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered, Near Threatened or Vulnerable.

The occurrence of SCC at the Development Site and within the Broader Area is confirmed by the SABAP2 data as indicated in **Table 1** (Section 5.3).

Based on the confirmed habitat, the SABAP2 data, and modelling outputs the classification of **HIGH** sensitivity for avifauna in the Screening Tool is supported.

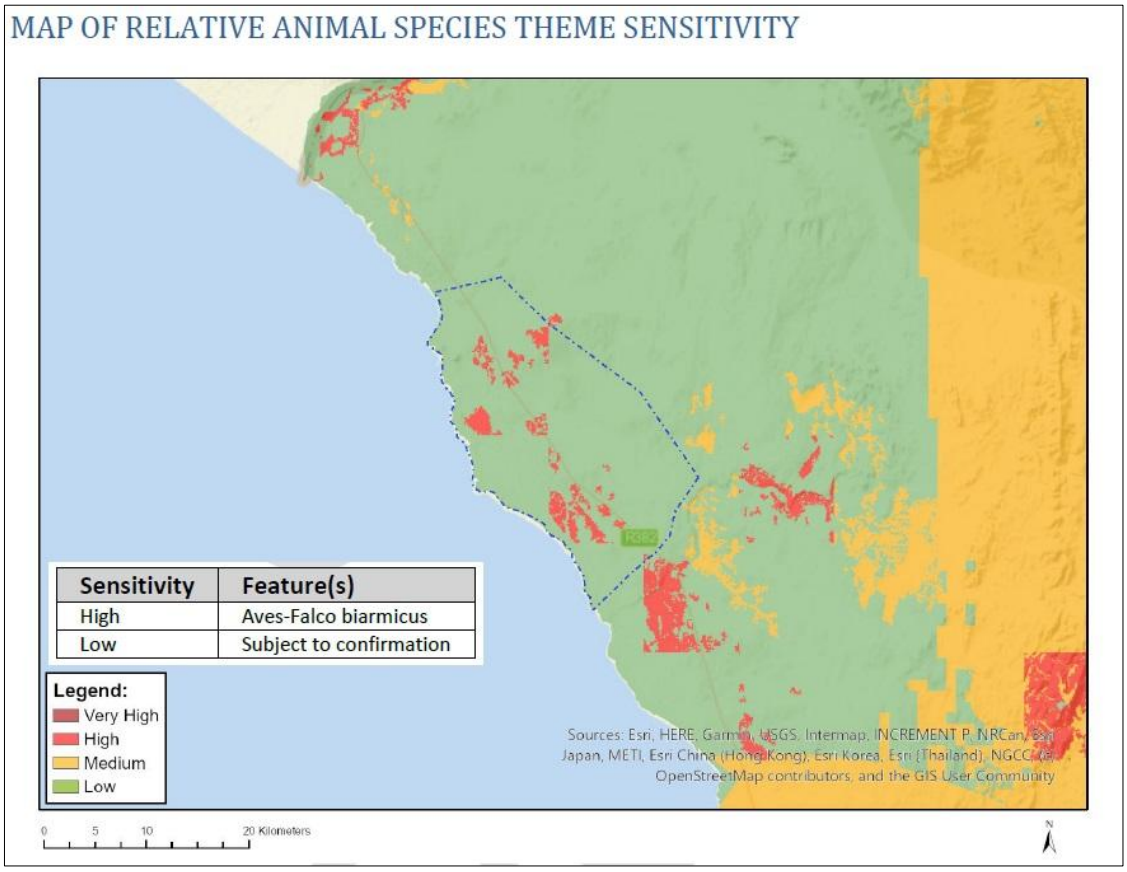


Figure 6: The National Web-Based Environmental Screening Tool map of the Development Site, indicating sensitivities for the Animal Species Theme.

6.5 Sensitivity Analysis

To achieve the categorisation of low, medium, high, and very high sensitivity classes, a rigorous methodology was employed. This methodology entailed the integration of various data sources, including remote sensing, topographical, land-cover, and climatic data.

Species selection:

A target species list was generated by assessing SABAP2 data, BirdLasser citizen science data and intersecting species distribution models with a 5 km Proposed Area of Impact (PAOI) buffer around the Boegoebaai SEZ. This assessment of all available data yielded a priority list of 13 threatened and/or endemic avian species that were included in the analysis. Species distribution models have been developed for more than >100 SCCs as part of a national assessment of avian sensitivity. Species distribution models were developed using a standardised methodology that is aligned with what was used to develop avian models for the DFFE National Screening Tool.

Habitat suitability and species distribution modelling:

We scripted and used an R workflow to prepare, pre-process, and analyse remote sensing, topographical, land-cover, and climatic data. A classification modelling framework, which included the use of an ensemble model, was used to assess habitat suitability for target species. An ensemble modelling approach incorporates the use of more than one classification algorithm, drawing on the strengths of each, and resisting any inherent bias that could be present in a single model. The modelling workflow included data partitioning, model training, variable selection, model testing, model optimization through hyperparameter tuning, and final model predictions. We partitioned the overall occurrence and pseudo-absence dataset into training (80%) and testing (20%) subsets. Subsequently, we trained the primary models using the Random Forest, ANN and Maxnet algorithms, followed by hyperparameter tuning and model optimization using the genetic algorithm (Vignali et al. 2020). Variable importance and partial dependence plots were generated for the final set of variables selected following initial model training and optimization.

Weighted sensitivity analysis:

A workflow utilising a weighted algorithm was scripted and implemented in Python. The weighted algorithm incorporated weights for red data status, endemic status, range size, and data (nest/roost sites, core area of occupancy, sightings, etc.), or model (distribution model vs fine-scale breeding habitat suitability model) type. The weighted algorithm applies greater sensitivity weights to species that are more threatened (e.g. Critically Endangered or Endangered) and are either endemic or highly range-restricted within South Africa. Furthermore, data types that included nests, roosts or/or areas of core occupancy received the highest weights for the respective data/model type criterion. Although there was no nest or roost site data[3], for terrestrial birds, within the Boegoebaai SEZ, the area does occur within a core occupancy area of the range-restricted Barlow's Lark. All distribution models, habitat suitability models and other data types are ingested into the weighted algorithm with species and data specific weights applied to generate an overall avian sensitivity map for the Boegoebaai SEZ.

[3] Roosting and nesting sites for a number of IUCN-listed seabirds are present, refer to WP1 Chapter 2.

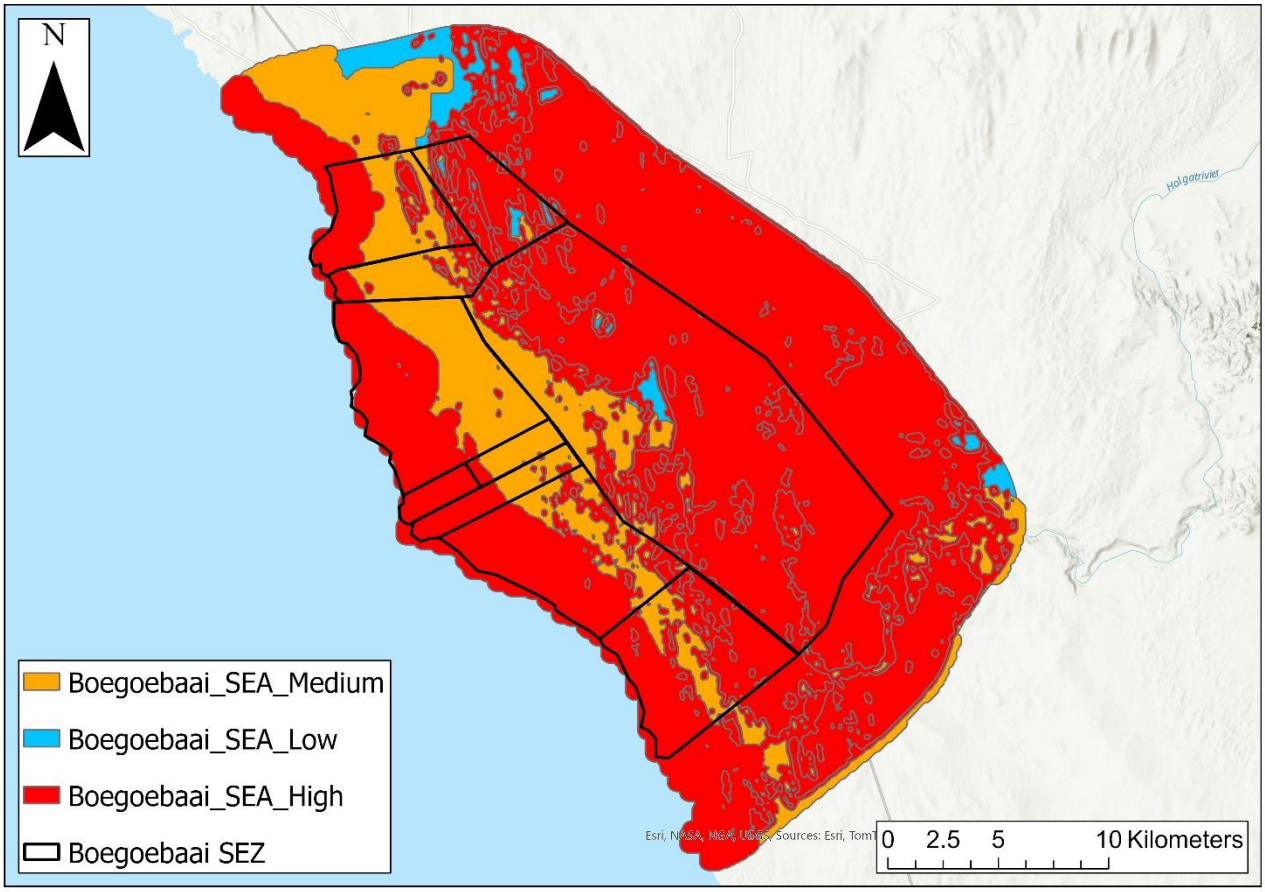


Figure 7: The avian sensitivity layer generated from the weighted analysis incorporating 13 avian species selected for further assessment.

6.6 Potential Impacts on Avifauna

6.6.1 Displacement due to Disturbance

The construction phase of the proposed Project can disturb bird populations and their habitats, particularly if construction activities occur in or near areas that birds rely on for nesting, feeding, or roosting. Birds are highly sensitive to changes in their environment, and the disruption caused by the construction and operation of the proposed Project can have several adverse effects.

The noise and activity associated with vehicles, machinery and construction operations can disturb birds, especially those sensitive to human presence or loud sounds. Species that require quiet and undisturbed environments for nesting or breeding may abandon their nests if they perceive the area as unsafe or stressful. This disturbance can disrupt breeding cycles, leading to reduced reproductive success and therefore population declines.

Additionally, the presence of machinery and vehicles can pose direct threats to birds through collisions or accidental disturbances. Birds, particularly ground-nesting species, or those flying low over the area, may be at risk of injury or mortality from these activities.

The construction and operation of the proposed Project may involve several activities aimed at excavating, processing, and utilizing materials for construction purposes. Some of the activities which could be associated with the proposed Project, which could cause species displacement due to disturbance, include:

- Site Selection and Preparation: This involves identifying suitable locations for the proposed Project based on proximity to construction sites needing materials and the quality of materials available. Site preparation may include clearing vegetation and levelling the area.

- Excavation: The primary construction activity could be excavation, where soil, gravel, sand, or other materials are extracted from the ground using heavy machinery such as excavators, bulldozers, or loaders. This activity will be a significant source of noise and movement disturbance.

- Material Processing: Excavated materials often need processing to meet specific size and quality requirements for construction. This can involve crushing, screening, or washing the materials to remove impurities and ensure consistency.

- Material Stockpiling: Processed materials are stockpiled onsite for storage and subsequent transportation to construction sites. Proper stockpiling techniques are important to prevent erosion, maintain material quality, and ensure safety.

- Transportation: Transporting materials for the proposed Project to construction sites is a significant part of operations. This may involve using trucks, conveyor belts, or other equipment to move materials efficiently and safely.

- Port activities introduce noise pollution, artificial lighting, and increased human presence, which can disturb birds' natural behaviours and deter them from utilizing the remaining habitats (Rodrigues et al. 2019).

6.6.2 Displacement due to Habitat Loss/Transformation

Construction activities and infrastructure, such as pipelines, powerlines and roads, can fragment habitats and restrict species movement/dispersal. Port developments can have significant impacts on avifauna, primarily through habitat loss and degradation. The construction and expansion of ports often involve land reclamation, dredging, and the destruction of wetlands and intertidal zones, which are critical habitats for many bird species (Dugan 1990; BirdLife International 2021). These areas serve as feeding, nesting, and roosting sites, particularly for migratory shorebirds that rely on undisturbed coastal habitats during their journeys (Goss-Custard & Verboven 1993).

The loss of vegetation and natural landscapes disrupts ecological balance, leading to reduced food availability and increased competition among avian species (Ma et al. 2014). Pollution from port operations, including possible oil spills and chemical runoff, can degrade water quality and affect the health of aquatic ecosystems, further impacting bird populations dependent on these areas (Boersma et al. 2001). Such habitat loss and fragmentation can result in declining bird populations, threatening the biodiversity of avian communities in and around the proposed Development Site.

6.6.3 Avifaunal Aspects and Impacts Register

Aspect	Potential Impact	Receiving Environment of Concern
Construction Noise and Activity	Disturbance to bird populations, particularly in nesting, feeding, or roosting areas	Areas near construction sites. 500 m – 2 km ~ species dependant.
Presence of Machinery and Vehicles	Risk of injury or mortality to birds, especially ground-nesting species	Construction sites and surrounding areas. Actual site extent.
Site Selection and Preparation	Clearing of vegetation, leading to habitat loss	Selected construction site. Actual site extent.
Excavation	Noise disturbance and movement disruption	Excavation sites. 500 m to 1 km – species dependant.
Material Processing	Further noise and activity	Processing sites. 500 m to 1 km –

Aspect	Potential Impact	Receiving Environment of Concern
	disturbance	species dependant.
Material Stockpiling	Potential erosion and habitat disruption	Stockpiling areas. 500 m to 1 km – species dependant.
Transportation of Materials	Increased noise pollution and habitat disturbance	Transportation routes. Actual site extent.
Port Activities	Noise pollution, artificial lighting, and increased human presence deterring natural bird behaviours	Port areas and surrounding habitats. 500 m to 1 km – species dependant.
Habitat Loss/Transformation	Fragmentation of habitats, restricted species movement, and reduced food availability	Pipeline, powerline, and road areas; coastal habitats. 500 m to 1 km – species dependant.
Pollution from Port Operations	Degraded water quality affecting aquatic ecosystems and bird populations	Areas near port operations and aquatic ecosystems. 500 m to 1 km – species dependant.

7 AVIFAUNAL ASSESSMENT STRATEGIES FOR EIA STUDIES

7.1 Agreements & Conventions

Table 2 below lists agreements and conventions which South Africa is party to, and which are relevant to the conservation of avifauna.

Table 2: Agreements and conventions which South Africa is party to, and which are relevant to the conservation of avifauna

Convention Name	Description	Geographic Scope
African-Eurasian Waterbird Agreement (AEWA)	The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is an intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland, and the Canadian Archipelago. Developed under the framework of the Convention on Migratory Species (CMS) and administered by the United Nations Environment Programme (UNEP), AEWA brings together countries and the wider international conservation community in an effort to establish coordinated conservation and management of migratory waterbirds throughout their entire migratory range.	Regional
Convention on Biological Diversity (CBD), Nairobi, 1992	The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has three main objectives: The conservation of biological diversity The sustainable use of the components of biological diversity The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.	Global
Convention on the Conservation of Migratory Species of Wild Animals, (CMS), Bonn, 1979	As an environmental treaty under the aegis of the United Nations Environment Programme, CMS provides a global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.	Global
Convention on the International Trade in	CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between	Global

Convention Name	Description	Geographic Scope
Endangered Species of Wild Flora and Fauna, (CITES), Washington DC, 1973	governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	
Ramsar Convention on Wetlands of International Importance, Ramsar, 1971	The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.	Global
Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia	The Signatories will aim to take co-ordinated measures to achieve and maintain the favourable conservation status of birds of prey throughout their range and to reverse their decline when and where appropriate.	Regional

7.2 National Legislation

7.2.1 Constitution of the Republic of South Africa, 1996

The Constitution of the Republic of South Africa provides in the Bill of Rights that: Everyone has the right –

(a) to an environment that is not harmful to their health or well-being; and

(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –

  (i) prevent pollution and ecological degradation;

  (ii) promote conservation; and

  (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

7.2.2 The National Environmental Management Act 107 of 1998 (NEMA)

The National Environmental Management Act 107 of 1998 (NEMA) creates the legislative framework for environmental protection in South Africa and is aimed at giving effect to the environmental right in the Constitution. It sets out a number of guiding principles that apply to the actions of all organs of state that may significantly affect the environment. Sustainable development (socially, environmentally, and economically) is one of the key principles, and internationally accepted principles of environmental management, such as the precautionary principle and the polluter pays principle, are also incorporated. NEMA also provides that a wide variety of listed developmental activities, which may significantly affect the environment, may be performed only after an environmental impact assessment has been done and authorization has been obtained from the relevant authority. Many of these listed activities can potentially have negative impacts on bird populations in a variety of ways. The clearance of natural vegetation, for instance, can lead to a loss of habitat and may depress prey populations, while erecting structures needed for generating and distributing energy, communication, and so forth can cause mortalities by collision or electrocution.

NEMA makes provision for the prescription of procedures for the assessment and minimum criteria for reporting on identified environmental themes (Sections 24(5)(a) and (h) and 44) when applying for environmental authorisation. The Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020) is applicable in the case of this proposed development.

7.2.3 The National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA) and the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations)

The most prominent statute containing provisions directly aimed at the conservation of birds is the National Environmental Management: Biodiversity Act 10 of 2004 read with the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations). Chapter 1 sets out the objectives of the Act, and they are aligned with the objectives of the Convention on Biological Diversity, which are the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of the benefits of the use of genetic resources. The Act also gives effect to CITES, the Ramsar Convention, and the Bonn Convention on Migratory Species of Wild Animals. The State is endowed with the trusteeship of biodiversity and has the responsibility to manage, conserve and sustain the biodiversity of South Africa.

7.3 Provincial Legislation

The current legislation applicable to the conservation of fauna and flora in the Northern Cape is the Northern Cape Nature Conservation Act No 9 of 2009. It provides for the sustainable utilisation of wild animals, aquatic biota and plants; the implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora; describes offences and penalties for contravention of the Act; provides for the appointment of nature conservators to implement the provisions of the Act; provides for the issuing of permits and other authorisations; and provides for matters connected therewith.

7.4 Guidelines

The following sources were consulted to determine the investigation protocol that is required for the site:

- Protocol for the specialist assessment and minimum report content requirements for environmental impacts on animal species (Government Notice 1150 30 October 2020, as amended by Government Notice 3717 28 July 2023); and

- Guidelines for the Implementation of the Terrestrial Flora (3c) & Terrestrial Fauna (3d) Species Protocols for EIAs in South Africa produced by the South African National Biodiversity Institute on behalf of the Department of Environment, Forestry and Fisheries (2020).

7.5 Avifaunal Monitoring Plan

For all proposed developments in the Boegoebaai Port or SEZ, an EIA specialist avifaunal assessment will be required. The avifaunal specialist studies should adhere to the following monitoring recommendations:

- Consult existing avifaunal data resources such as SABAP2 and Birdlasser® to obtain known records of avifauna for the specific area of influence (PAOI).
- Perform comprehensive baseline monitoring within the proposed development footprint to establish the avian species composition with specific reference to species of conservation concern as listed in section 5.3.
- In high and very high sensitivity areas multiple surveys spanning different seasons to account for migratory and seasonal variations in abundance and species diversity would be required.
- Surveys to be designed in line with best practise guidance and in line with assessing the potential impacts of the proposed development. E.g. applicable guidelines for renewable energy developments should apply when such projects are being assessed.
- Data collected to be submitted to SABAP2 (refer to Species assessment guidelines *SANBI 2020*).
- Consultation with species specialists and NGO's (such as BLSA) for information and refinement of assessments and species-specific guidance or guidelines is recommended.

8 CONCLUSIONS & RECOMMENDATIONS

The Boegoebaai Port and SEZ SEA development site predominantly exhibits medium and high sensitivity from an avifaunal perspective. Although the region does not host a wide diversity of birds, it is home to range-restricted species such as the Dune Lark (Coastal), as well as potentially supporting Endangered Martial Eagle and Endangered Ludwig's Bustard. Additionally, dunes, freshwater pans, and estuarine habitats along the coast support various species of conservation concern, including the Critically Endangered Damara Tern. Consequently, all proposed developments within the SEZ should incorporate an avifaunal specialist study.

9 REFERENCES

Barnes, K.N. 2000. Martial Eagle *Polemaetus bellicosus*. In: Barnes, K.N. (Ed.), *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg, South Africa, pp. 83–85.

Barnes, K.N. & Jenkins, A.R. 2000. Lanner Falcon *Falco biarmicus*. In: Barnes, K.N. (Ed.), BirdLife South Africa, p. 141.

Berry, H.H., Stark, H.P. & Vuuren, A.S. 1973. White Pelicans *Pelecanus onocrotalus* breeding on the Etosha Pan, South West Africa, during 1971. *Madoqua* 7: 17–31.

BirdLife International. 2021. Habitat use and conservation of cliff-nesting birds. Available at: https://www.birdlife.org

BirdLife International. 2025. Species factsheet: Cape Long-billed Lark *Certhilauda curvirostris*. Available at: https://datazone.birdlife.org/species/factsheet/cape-long-billed-lark-certhilauda-curvirostris [Accessed 30 January 2025].

BirdLife International. 2025. Species factsheet: Curlew Sandpiper *Calidris ferruginea*. Available at: https://datazone.birdlife.org/species/factsheet/curlew-sandpiper-calidris-ferruginea [Accessed 30 January 2025].

Boersma, P.D., Reichard, S.H. & Van Buren, A. 2001. *Effects of habitat destruction on biodiversity*. Island Press.

Braby, J., Braby, S.J., Braby, R.J. & Altwegg, R. 2011. Immature survival and age at first breeding of Damara Terns: conservation from a non-breeding perspective. *Ardea* 99(2): 185–190.

Braby, J., Braby, R.J., Braby, N. & Simmons, R.E. 2009. Protecting Damara Terns *Sterna balaenarum* from recreational disturbance in the Namib Desert increases breeding density and overall success. *Ostrich* 80(2): 71–75.

Crawford, R.J.M., Cooper, J. & Dyer, B.M. 1995. Conservation of an increasing population of great white pelicans *Pelecanus onocrotalus* in South Africa's Western Cape. *South African Journal of Marine Science* 15(1): 33–42.

Crawford, R.J.M., Dyer, B.M., Kotze, P.G.H., McCue, S., Meÿer, M.A., Upfold, L. & Makhado, A.B. 2012. *Status of seabirds breeding in South Africa in 2011*. Oceans and Coasts, Department of Environmental Affairs.

Curtis, O., Simmons, R.E. & Jenkins, A.R. 2004. Black Harrier *Circus maurus* of the Fynbos biome, South Africa: a threatened specialist or an adaptable survivor? *Bird Conservation International* 14(4): 233–245.

Dean, W.R.J. & Ryan, P.G. 1997. Barlow's Lark *Certhilauda barlowi*. In: Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V. & Brown, C.J. (Eds.), BirdLife South Africa, pp. 22–23.

Debus, S.J.S. 2001. Surveys of the vertebrate fauna of rocky outcrop habitats in southeastern Australia. *Australian Zoologist* 31(3): 435–441.

del Hoyo, J., Elliott, A. & Sargatal, J. 1996. *Handbook of the Birds of the World, vol. 3: Hoatzin to Auks*. Lynx Edicions, Barcelona, Spain.

DFFE. 2022. *South Africa Protected Areas Database (SAPAD_OR_2021_Q4)*. Available at: http://egis.environment.gov.za.

Dodman, T. 2014. *Status, estimates and trends of waterbird populations in Africa: AEWA-listed African populations*. Wetlands International.

Dugan, P.J. 1990. *Wetland conservation: A review of current issues and required action*. IUCN.

Du Toit, M., Boere, G.C., Cooper, J., De Villiers, M.S., Kemper, J., Lenten, B., Petersen, S.L., Simmons, R.E., Underhill, L.G. & Whittington, P.A. 2003. *Conservation assessment and management plan for Southern African coastal seabirds*. Avian Demography Unit and Conservation Breeding Specialist Group.

Ferguson-Lees, J. & Christie, D.A. 2001. *Raptors of the World*. Houghton Mifflin Company.

Goss-Custard, J.D. & Verboven, N. 1993. Disturbance and feeding shorebirds on estuaries. *Wader Study Group Bulletin* 68: 59–66.

Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V. & Brown, C.J. (Eds.) 1997a. *The atlas of southern African birds. Vol. 1: Non-passerines*. BirdLife South Africa, Johannesburg, South Africa.

Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V. & Brown, C.J. (Eds.) 1997b. *The atlas of southern African birds. Vol. 2: Passerines*. BirdLife South Africa, Johannesburg, South Africa.

Hockey, P.A.R., Dean, W.R.J. & Ryan, P.G. (Eds.) 2005. *Roberts – Birds of Southern Africa, VIIth edition*. The Trustees of the John Voelcker Bird Book Fund, Cape Town, South Africa.

Jenkins, A.R., Shaw, J.M., Smallie, J.J., Gibbons, B., Visagie, R. & Ryan, P.G. 2011. Estimating the impacts of power line collisions on Ludwig's Bustards *Neotis ludwigii*. *Bird Conservation International* 21(3): 303–310.

Kemp, A. C. and G. M. Kirwan (2020). *Jackal Buzzard (Buteo rufofuscus*), version 1.0. In Birds of the World (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Kemper, J., Underhill, L.G., Crawford, R.J.M. & Kirkman, S.P. 2007. Revision of the conservation status of seabirds and seals breeding in the Benguela Ecosystem. In: Kirkman, S.P. (Ed.), Avian Demography Unit, University of Cape Town, pp. 697–704.

Ma, Z., Cai, Y., Li, B. & Chen, J. 2014. Managing coastal wetlands for birds in the face of climate change and sea-level rise: A review. *Wetlands Ecology and Management* 22: 89–103.

Mucina, L. & Rutherford, M.C. (Eds.). 2006. *The vegetation of South Africa, Lesotho and Swaziland*. Strelitzia 19. South African National Biodiversity Institute, Pretoria, South Africa.

Navedo, J.G., Arranz, D., Herrera, A.G., Salmón, P., Juanes, J.A. & Masero, J.A. 2013. Agroecosystems and conservation of migratory waterbirds: importance of coastal pastures and factors influencing their use by wintering shorebirds. *Biodiversity and Conservation* 22: 1895–1907.

Newton, I. 2010. *The Ecology of Bird Conservation*. Cambridge University Press.

Nkomo, M.N., Murgatroyd, M., Ralston-Paton, S. & Amar, A. 2024. Using stakeholder knowledge to co-produce research priorities for a raptor species vulnerable to impacts of wind energy facilities. *Ostrich* 95: 200-212.

Rodrigues, A.S.L., Brooks, T.M. & Gaston, K.J. 2019. Integrating development and conservation goals. *Science Advances* 5: eaau0743.

Ryan, P.G. & Dean, W.R.J. 2005. Barlow's Lark *Calendulauda barlowi*. In: Hockey, P.A.R., Dean, W.R.J. & Ryan, P.G. (Eds.), *Roberts Birds of Southern Africa*. The Trustees of the John Voelcker Bird Book Fund, p. 874.

Ryan, P.G. & Kirwan, G.M. 2022. Dune Lark (*Calendulauda erythrochlamys*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

SANBI. 2020. *Species Environmental Assessment Guideline. Guidelines for the implementation of the Terrestrial Fauna and Terrestrial Flora Species Protocols for environmental impact assessments in South Africa*. Version 3.1. South African National Biodiversity Institute, Pretoria.

SANBI. 2018. *The Vegetation Map of South Africa, Lesotho and Swaziland* (Mucina, L., Rutherford, M.C. & Powrie, L.W. (Eds.); Version 20). South African National Biodiversity Institute. Available at: http://bgis.sanbi.org/Projects/Detail/186.

Simmons, R.E., Curtis, O.E. & Jenkins, A.R. 2005. Black Harrier *Circus macrourus*. In: Hockey, P.A.R., Dean, W.R.J. & Ryan, P.G. (Eds.), *Roberts Birds of Southern Africa*. The Trustees of the John Voelcker Bird Book Fund, pp. 502–503.

Snow, D.W. & Perrins, C.M. 1998. *The Birds of the Western Palearctic, Volume 1: Non-Passerines*. Oxford University Press, Oxford.

Taylor, M., Peacock, F. & Wanless, R.M. (Eds.). 2015. *The 2015 Eskom Red Data Book of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg.

Tippett, R.M. 2024. Jackal Buzzard (*Buteo rufofuscus*). Biodiversity and Development Institute. Available online at https://thebdi.org/2024/07/02/jackal-buzzard-buteo-rufofuscus/

Van den Heever, L., Smit-Robinson, H., Naidoo, V. & McKechnie, A.E. 2019. Blood and bone lead levels in South Africa's *Gyps* vultures: Risk to nest-bound chicks and comparison with other avian taxa. Science of the Total Environment 669:471-480.

Vignali, S., Barras, A.G., Arlettaz, R. & Braunisch, V. 2020. SDMtune: An R package to tune and evaluate species distribution models. *Ecology and Evolution* 10: 11488–11506.

Williams, A.J., Ward, V.L. & Underhill, L.G. 2004. Waders respond quickly and positively to the banning of off-road vehicles from beaches in South Africa. *Bulletin of the Wader Study Group* 104: 79–81.

APPENDIX A – Bird Species List for the Broader Area (20 Pentads)

EN = Endangered, VU = Vulnerable, NT = Near Threatened

Species Name	Scientific Name	SABAP2 Reporting Rate % (across 20 pentads)		Global Status	Regional Status
		Full Protocol	Ad Hoc Protocol		
Acacia Pied Barbet	*Tricholaema leucomelas*	0,00	0,75	-	-
African Oystercatcher	*Haematopus moquini*	0,00	11,19	-	-
African Sacred Ibis	*Threskiornis aethiopicus*	0,00	2,24	-	-
African Stonechat	*Saxicola torquatus*	65,12	5,22	-	-
Alpine Swift	*Tachymarptis melba*	16,28	2,24	-	-
Bank Cormorant	*Phalacrocorax neglectus*	0,00	1,49	EN	EN
Barlow's Lark	*Calendulauda barlowi*	74,42	17,16	-	-
Barn Swallow	*Hirundo rustica*	4,65	0,00	-	-
Black Harrier	*Circus maurus*	11,63	1,49	EN	EN
Black-chested Snake Eagle	*Circaetus pectoralis*	11,63	6,72	-	-
Black-eared Sparrow-Lark	*Eremopterix australis*	18,60	2,24	-	-
Black-headed Canary	*Serinus alario*	0,00	1,49	-	-
Black-necked Grebe	*Podiceps nigricollis*	0,00	2,24	-	-
Black-winged Stilt	*Himantopus himantopus*	0,00	2,24	-	-
Bokmakierie	*Telophorus zeylonus*	62,79	3,73	-	-
Booted Eagle	*Hieraaetus pennatus*	2,33	0,00	-	-
Bradfield's Swift	*Apus bradfieldi*	23,26	0,00	-	-
Cape Bunting	*Emberiza capensis*	20,93	2,24	-	-
Cape Cormorant	*Phalacrocorax capensis*	2,33	9,70	EN	EN
Cape Crow	*Corvus capensis*	51,16	17,16	-	-
Cape Long-billed Lark	*Certhilauda curvirostris*	58,14	9,70	-	-
Cape Penduline Tit	*Anthoscopus minutus*	2,33	1,49	-	-
Cape Sparrow	*Passer melanurus*	58,14	9,70	-	-
Cape Teal	*Anas capensis*	4,65	2,24	-	-
Cape Wagtail	*Motacilla capensis*	4,65	3,73	-	-
Capped Wheatear	*Oenanthe pileata*	46,51	11,19	-	-
Chat Flycatcher	*Melaenornis infuscatus*	4,65	0,75	-	-
Cinnamon-breasted Warbler	*Euryptila subcinnamomea*	0,00	0,75	-	-
Common Ostrich	*Struthio camelus*	11,63	4,48	-	-
Dusky Sunbird	*Cinnyris fuscus*	37,21	0,00	-	-

Species Name	Scientific Name	SABAP2 Reporting Rate % (across 20 pentads)		Global Status	Regional Status
		Full Protocol	Ad Hoc Protocol		
Eurasian Whimbrel	*Numenius phaeopus*	0,00	1,49	-	-
Familiar Chat	*Oenanthe familiaris*	11,63	1,49	-	-
Greater Crested Tern	*Thalasseus bergii*	0,00	2,24	-	-
Greater Flamingo	*Phoenicopterus roseus*	0,00	2,99	-	NT
Greater Kestrel	*Falco rupicoloides*	32,56	8,96	-	-
Greater Striped Swallow	*Cecropis cucullata*	2,33	0,00	-	-
Grey Heron	*Ardea cinerea*	2,33	8,96	-	-
Grey Tit	*Melaniparus afer*	30,23	1,49	-	-
Grey-backed Cisticola	*Cisticola subruficapilla*	76,74	3,73	-	-
Grey-backed Sparrow-Lark	*Eremopterix verticalis*	41,86	1,49	-	-
Grey-headed Gull	*Chroicocephalus cirrocephalus*	0,00	0,75	-	-
Hadada Ibis	*Bostrychia hagedash*	2,33	0,00	-	-
Hartlaub's Gull	*Chroicocephalus hartlaubii*	0,00	2,99	-	-
Jackal Buzzard	*Buteo rufofuscus*	32,56	10,45	-	-
Karoo Chat	*Emarginata schlegelii*	20,93	2,99	-	-
Karoo Lark	*Calendulauda albescens*	60,47	6,72	-	-
Karoo Long-billed Lark	*Certhilauda subcoronata*	6,98	1,49	-	-
Karoo Prinia	*Prinia maculosa*	67,44	0,75	-	-
Karoo Scrub Robin	*Cercotrichas coryphoeus*	53,49	5,22	-	-
Kelp Gull	*Larus dominicanus*	0,00	11,19	-	-
Kori Bustard	*Ardeotis kori*	0,00	1,49	NT	NT
Lanner Falcon	*Falco biarmicus*	18,60	2,99	-	VU
Large-billed Lark	*Galerida magnirostris*	9,30	0,75	-	-
Lark-like Bunting	*Emberiza impetuani*	48,84	3,73	-	-
Lesser Flamingo	*Phoeniconaias minor*	0,00	0,75	NT	NT
Long-billed Crombec	*Sylvietta rufescens*	0,00	1,49	-	-
Ludwig's Bustard	*Neotis ludwigii*	44,19	3,73	EN	EN
Malachite Sunbird	*Nectarinia famosa*	9,30	2,24	-	-
Martial Eagle	*Polemaetus bellicosus*	2,33	2,24	EN	EN
Mountain Wheatear	*Myrmecocichla monticola*	6,98	0,00	-	-
Namaqua Dove	*Oena capensis*	13,95	0,75	-	-
Namaqua Sandgrouse	*Pterocles namaqua*	32,56	4,48	-	-
Namaqua Warbler	*Phragmacia substriata*	4,65	0,00	-	-

Species Name	Scientific Name	SABAP2 Reporting Rate % (across 20 pentads)		Global Status	Regional Status
		Full Protocol	Ad Hoc Protocol		
Pale Chanting Goshawk	*Melierax canorus*	58,14	23,13	-	-
Pied Avocet	*Recurvirostra avosetta*	0,00	2,24	-	-
Pied Crow	*Corvus albus*	65,12	26,12	-	-
Red-capped Lark	*Calandrella cinerea*	41,86	2,24	-	-
Rock Kestrel	*Falco rupicolus*	39,53	8,21	-	-
Rock Martin	*Ptyonoprogne fuligula*	27,91	3,73	-	-
Rufous-eared Warbler	*Malcorus pectoralis*	55,81	5,97	-	-
Sandwich Tern	*Thalasseus sandvicensis*	0,00	0,75	-	-
Sickle-winged Chat	*Emarginata sinuata*	4,65	0,00	-	-
South African Shelduck	*Tadorna cana*	0,00	0,75	-	-
Southern Fiscal	*Lanius collaris*	18,60	2,24	-	-
Speckled Pigeon	*Columba guinea*	25,58	0,75	-	-
Spike-heeled Lark	*Chersomanes albofasciata*	37,21	2,99	-	-
Spotted Eagle-Owl	*Bubo africanus*	0,00	2,24	-	-
Spotted Thick-knee	*Burhinus capensis*	2,33	4,48	-	-
Tractrac Chat	*Emarginata tractrac*	83,72	13,43	-	-
Western Barn Owl	*Tyto alba*	0,00	1,49	-	-
White-breasted Cormorant	*Phalacrocorax lucidus*	0,00	5,97	-	-
White-fronted Plover	*Charadrius marginatus*	0,00	5,22	-	-
White-throated Canary	*Crithagra albogularis*	39,53	2,24	-	-
White-throated Swallow	*Hirundo albigularis*	2,33	0,00	-	-
Yellow Canary	*Crithagra flaviventris*	58,14	8,96	-	-
Yellow-bellied Eremomela	*Eremomela icteropygialis*	2,33	1,49	-	-
Yellow-billed Kite	*Milvus aegyptius*	0,00	0,75	-	-

CHAPTER 3

Supplementary Material: Specialist Report

Bat report

Bat Specialist Assessment

for the

Strategic Environmental Assessment

of the

Proposed Boegoebaai Port and SEZ (Special Economic Zone), Northern Cape, South Africa



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APPOINTMENT OF SPECIALIST

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Report done by:	Werner Marais
Appointed by:	Council for Scientific and Industrial Research (CSIR)

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1. INTRODUCTION

Animalia Consultants (Pty) Ltd (hereafter 'Animalia') has been appointed by the Council for Scientific and Industrial Research (CSIR) to conduct a bat sensitivity assessment for determination of the feasibility for the development, construction, and operation of a deep-water port with associated landside port facilities in Boegoebaai, Northern Cape. The proposed new port development is primarily for the enablement of the Northern Cape's Provincial Economic Development strategy including the Green Hydrogen Strategy and expanding the mining and industrial base in the Northern Cape.

A Strategic Environmental Assessment (SEA) has been initiated through a collaboration between the South African National Energy Development Institute (SANEDI), Northern Cape Economic Development Trade and Investment Promotion Agency (NCEDA), and Transnet National Ports Authority (TNPA) (the Project Steering Committee (PSC)). The Council for Scientific and Industrial Research (CSIR) has been appointed to undertake an independent SEA. The overarching purpose of the SEA is to develop an integrated decision-making framework to guide the planning of the proposed Boegoebaai Port and Special Economic Zone covered in this report, and the wider Namakwa region (covered in the future Work Package 2 report).

1.1 Terms of reference

The objectives and terms of reference for the impact assessment are undertake the following:

- Describe the existing baseline characteristics of the study area, including existing impacts on the site, and place this in a regional context;
- Identify and assess each potential impact of the project, including impacts associated with the construction and operation phases;
- Recommend mitigation measures to avoid and/or minimise impacts and/or optimise benefits associated with the proposed project.

1.2 The bats of South Africa

Bats form part of the order Chiroptera and are the second largest group of mammals after rodents. They are the only mammals to have developed true powered flight and have undergone various skeletal changes to accommodate this. The forelimbs are elongated, whereas the hind limbs are compact and light, thereby reducing the total body weight. This unique wing profile allows for the manipulation of wing camber and shape, exploiting functions such as agility and manoeuvrability. This adaption surpasses the static design of bird wings in function and enables bats to utilise a wide variety of food sources, including, but not limited to, a large diversity of insects (Neuweiler 2000). Species-based facial features may differ considerably as a result of differing lifestyles, particularly in relation to various feeding and echolocation navigation strategies. Most South African bats are insectivorous and are capable of consuming vast quantities of insects on a nightly basis (Taylor 2000, Tuttle and Hensley 2001) however, they have also been found to feed on amphibians, fruit, nectar and other invertebrates. As a result, insectivorous bats are the predominant predators of nocturnal flying insects in South Africa and contribute greatly to the suppression of these numbers. Their prey also includes agricultural pests such as moths and vectors for diseases such as mosquitoes (Rautenbach 1982, Taylor 2000).

Urban development and agricultural practices have contributed to the deterioration of bat populations on a global scale. Public participation and funding of bat conservation are often hindered by negative public perceptions and unawareness of the ecological importance of bats. Some species choose to roost in domestic residences, causing disturbance and thereby decreasing any esteem that bats may have established. Other species may occur in large communities in buildings, posing as a potential health hazard to residents in addition to their nuisance value. Unfortunately, the negative association with bats obscures their importance as an essential component of ecological systems and their value as natural pest control agents, which actually serves as an advantage to humans.

Many species of bats roost in large communities and congregate in small areas. Therefore, any major disturbances within and around the roosting areas may adversely impact individuals of different communities concurrently (Hester and Grenier 2005). Secondly, nativity rates of bats are much lower than those of most other small mammals. This is because, for the most part, only one or two pups are born per female per annum. Under natural circumstances, a population's numbers may accumulate over long periods of time. This is due to the longevity of up to 30 years (O'Shea *et al*. 2003) and the relatively low predation of bats when compared to other small mammals. However, bat populations are not able to adequately recover after mass mortalities and major roost disturbances.

1.3 Bats and Green Hydrogen and Ammonia facilities

Currently there is no evidence of these facilities posing a direct threat of fatality impact on bats during operation. However, roosting and foraging habitats may be destroyed during the construction phase. This is primarily due the fact that such facilities require areas of land to be cleared, and in some cases, earthworks are required for levelling purposes. This can result in habitat that is suitable for micro roosts, such as rocky outcrops being destroyed, which can also be fatal to bats residing in such roosts. Natural vegetation can support higher insect food quantities and diversity than cleared land, therefore foraging habitat can also be displaced.

The presence of security lights on and around these facilities creates significant light pollution that can impact bat feeding habits and species compositions negatively, by artificially discouraging photophobic (light averse) species and favouring species that readily forage around insect-attracting lights.

2. ASSESSMENT METHODOLOGY

The site was evaluated by considering man-made structures, surface rock (possible roosting space), topography (influencing surface rock in most cases), climate (can influence insect numbers), and presence of surface water and drainage areas (influences insects and acts as a source of drinking water) to identify habitats that may be frequently used by bat species. These considerations principally involved studying the literature, available satellite imagery and vegetation descriptions. One site visits was conducted on 18 February 2025 to provide an understanding of the environmental setting of the site.

Species probability of occurrence based on the above-mentioned factors were estimated for the site and the surrounding larger area, but species historically confirmed on site as well as surrounding areas were also considered.

With regards to the sensitivity map, Google Earth satellite imagery and verifications during a site visit were used to spatially demarcate areas of the site with Very High, High and Medium sensitivities relating to bat species ecology and habitat preferences (refer to **Figure 4-1**). The map considers man-made structures and habitat alterations (such as dams), as well as natural terrain features that are likely to offer roosting and foraging opportunities for bat species found in the broader site area. With regards to hydrology features, distinction has been made between permanent and seasonal water sources.

2.1 Assumptions and Limitations

As with any environmental study, there are certain assumptions and limitations that exist around the current knowledge we possess regarding bats and their behaviour, movements and distribution. Some important points are discussed briefly below:

- Distribution maps of South African bat species still require further refinement, thus the bat species listed as occurring on the site (but not detected in the area yet) should be considered precautionary. If a species has a known distribution proximal to the site, it was assumed to occur in the area.

- The sensitivity map is based partially on satellite imagery and one site visit. There is always the possibility that what has been mapped may differ slightly to what is on the ground.

3. BASELINE DESCRIPTION OF THE RECEIVING ENVIRONMENT

3.1 Land Use, Vegetation, Climate and Topography

The project area's land use type is predominantly mining and to a lesser degree livestock farming practices. Modification due to mining activities are more pronounced closer to the coastal regions than inland. Vegetation units and geology are of great importance to a study such as this, as these provide insight on suitable sites for the roosting of bats and support of their foraging habits (Monadjem *et al.* 2020). The sparse buildings may also serve as suitable roosting spaces (Taylor 2000; Monadjem *et al.* 2020). The general area has a winter rainfall regime with a Mean Annual Precipitation (MAP) of 50–80 mm. Frequent sea fog at night contributes significantly to more frequently available moisture in the ecology. High wind speeds and moving sand dunes (especially in disturbed areas) play significant ecological roles.

Two dominant vegetation units are present within the site boundaries, the Richtersveld Coastal Duneveld and Northern Richtersveld Yellow Duneveld, (VegMap 2018), within the Succulent Karoo Biome and Namaqualand Sandveld Bioregion (Mucina & Rutherford 2006, VegMap 2018).

Richtersveld Coastal Duneveld on site is generally flat terrain, with the exception of the Boegoe Twins koppies. Northern Richtersveld Yellow Duneveld has undulating dune terrain with interspersed flat sand shields.

3.2 Previously recorded as well as literature-based bat species of occurrence

Table 3-1. Table of species that have been previously recorded in the area and may be occurring based on literature. Possible roosting or foraging habitats in the study area are also briefly described (Monadjem *et al.* 2020; ACR, 2020).

Species	Common name	Occurrence in area	Conservation status (2016 Regional Listing)	Possible roosting habitat on or near site	Possible foraging habitat utilised on or near site
Tadarida aegyptiaca	Egyptian free-tailed bat	Confirmed within 100km of site	Least Concern	Roosts in rock crevices of exposed rocky cliffs. The species has also taken to roosting in roofs of buildings.	It forages over a wide range of habitats; its preferences of foraging habitat seem independent of vegetation. It seems to forage in all types of natural and urbanised habitats.
Laephotis capensis	Cape serotine	Confirmed within 100km of site	Least Concern	Roosts in the roofs of houses and buildings.	It appears to tolerate a wide range of environmental conditions from arid semi-desert areas to montane grasslands, forests, and savannahs. But is predominantly a medium height clutter edge forager.
Miniopterus natalensis	Natal long-fingered bat	Not confirmed	Near Threatened (2004 National Listing)	Cave and hollow dependent, closest possible known cave roost over 21km from site. Will also roost in small groups or individually in culverts and other hollows such as in culverts. Upon inspection no bats or roosting space were found in the Holgat road culvert.	Clutter-edge forager. May forage in more open terrain during suitable weather.
Cistugo seabrae	Angolan wing-gland bat	Not confirmed	Near Threatened (2004 National Listing)	May roost in building structures, the Holgat rocky ravine, or the Boegoe Twins koppies, but little is known about roosting habits. Restricted to arid regions of the country.	Clutter edge forager preferring terrain near open water, may therefore possibly be found at the open water near the Boegoe Twins koppies, or in the Holgat rocky ravine.
Eptesicus hottentotus	Long-tailed serotine	Not confirmed	Least Concern	It is a crevice dweller roosting in rock crevices, as well as other crevices in buildings. Exposed rocky cliffs.	It generally seems to prefer foraging on the clutter edge of vegetation, such as the vegetated drainage areas and also over open water sources such as pans.

Species	Common name	Occurrence in area	Conservation status (2016 Regional Listing)	Possible roosting habitat on or near site	Possible foraging habitat utilised on or near site
Sauromys petrophilus	Roberts's flat-headed bat	Confirmed within 100km of site	Least Concern	It is a crevice dweller roosting in rock crevices, as well as other crevices in buildings. Exposed rocky cliffs.	Open air forager.
Myotis tricolor	Temmink's myotis	Not confirmed	Near Threatened (2004 National Listing)	Cave and hollow dependent, closest possible known cave roost over 21km from site. Will also roost in small groups or individually in culverts and other hollows such as in culverts. Upon inspection no bats or roosting space were found in the Holgat road culvert.	Clutter-edge forager. May forage in more open terrain during suitable weather.
Rhinolophus clivosus	Geoffroy's horseshoe bat	Not confirmed	Least Concern (2016 Regional Listing)	Cave and hollow dependent, closest possible known cave roost over 21km from site. Will also roost in small groups or individually in culverts and other hollows such as in culverts. Upon inspection no bats or roosting space were found in the Holgat road culvert.	Vegetation clutter forager, not much vegetation clutter on site.
Rhinolophus capensis	Cape horseshoe bat	Confirmed within 100km of site	Near Threatened (2004 National Listing)	May utilise man-made hollows, Aardvark burrows or hollows formed by rocky boulder koppies.	Vegetation clutter forager, not much vegetation clutter on site.
Nycteris thebaica	Egyptian slit-faced bat	Confirmed within 100km of site	Least Concern (2016 Regional Listing)	Roosts in hollows, aardvark burrows and culverts under roads. Upon inspection no bats or roosting space were found in the Holgat road culvert.	It appears to occur throughout the savannah and karoo biomes, but avoids open grasslands. Not much vegetation clutter on site.

4. RESULTS AND DISCUSSION

4.1 Specialist Sensitivity Mapping

Figure 4-1 depicts the sensitive areas of the site, based on features identified to be important (Table 4-1) for foraging and roosting of the species that most commonly occur in the area. Table 4-22 describes the implications of the sensitivity criteria. Thus, the sensitivity map is based on species ecology and habitat preferences. Details regarding the buffers of the sensitivity features identified in the map are provided in

Table 4-3.

Table 4-1. Description of parameters used in the construction of the sensitivity map

Sensitivity	Sensitivity Feature	Motivation
Very High Sensitivity	Rocky outcrops and rocky Holgat drainage ravine	Rocky habitat can offer bat roosting habitat in the form of crevices and hollows. Additionally, they provide shelter from wind and adverse weather, allowing insect congregations and thereby attracting insectivorous bats.
	Aquatic water sources with exposed surface water	These areas can hold water and moisture longer and may therefore also attract insect food. Additionally, they can serve as a source of drinking water for bats in an arid environment.
High Sensitivity	Temporal water sources capable of holding more water	Available water and moisture will attract insect food seasonally.
Medium Sensitivity	Non-perennial washes, pans and other seasonal water sources	Some seasonally available moisture may attract limited insect food. Sensitivity layers compiled by an aquatic specialist were consulted for guidance.
	Livestock aggregation areas and kraals	The presence of livestock with associated dung and urine promotes insect activity, and thereby bat activity temporarily when in use for livestock.
	Terrain with regular undulating dunes, interspersed livestock aggregations and occasional high points	Terrain, vegetation and insect activity can be higher in such areas. Promoting bat activity.

Table 4-2. The significance of sensitivity map categories for each infrastructure component for the WEF

Sensitivity	All infrastructure (except roads, underground cables and pipes)	Roads, underground cables and pipes
Very High Sensitivity and buffers	These areas are 'no-go' zones and infrastructure may not be placed in these areas and their buffers.	Allowed, but preferably keep to a minimum within these areas where practically feasible.
High Sensitivity and buffers	Only infrastructure with no artificial lighting may be placed in these areas	Allowed inside these areas.
Medium Sensitivity and buffers	Keep to a minimum in these areas, preferably no outside lighting in these areas if practically feasible.	Allowed inside these areas.

Table 4-3. Specific buffer details of features highlighted in the sensitivity map.

Sensitivity Feature	Details
Very High sensitivity	Assigned a 200m no-go zone buffer
High sensitivity	Assigned a 200m buffer
All Medium sensitivities	Assigned a 150m buffer

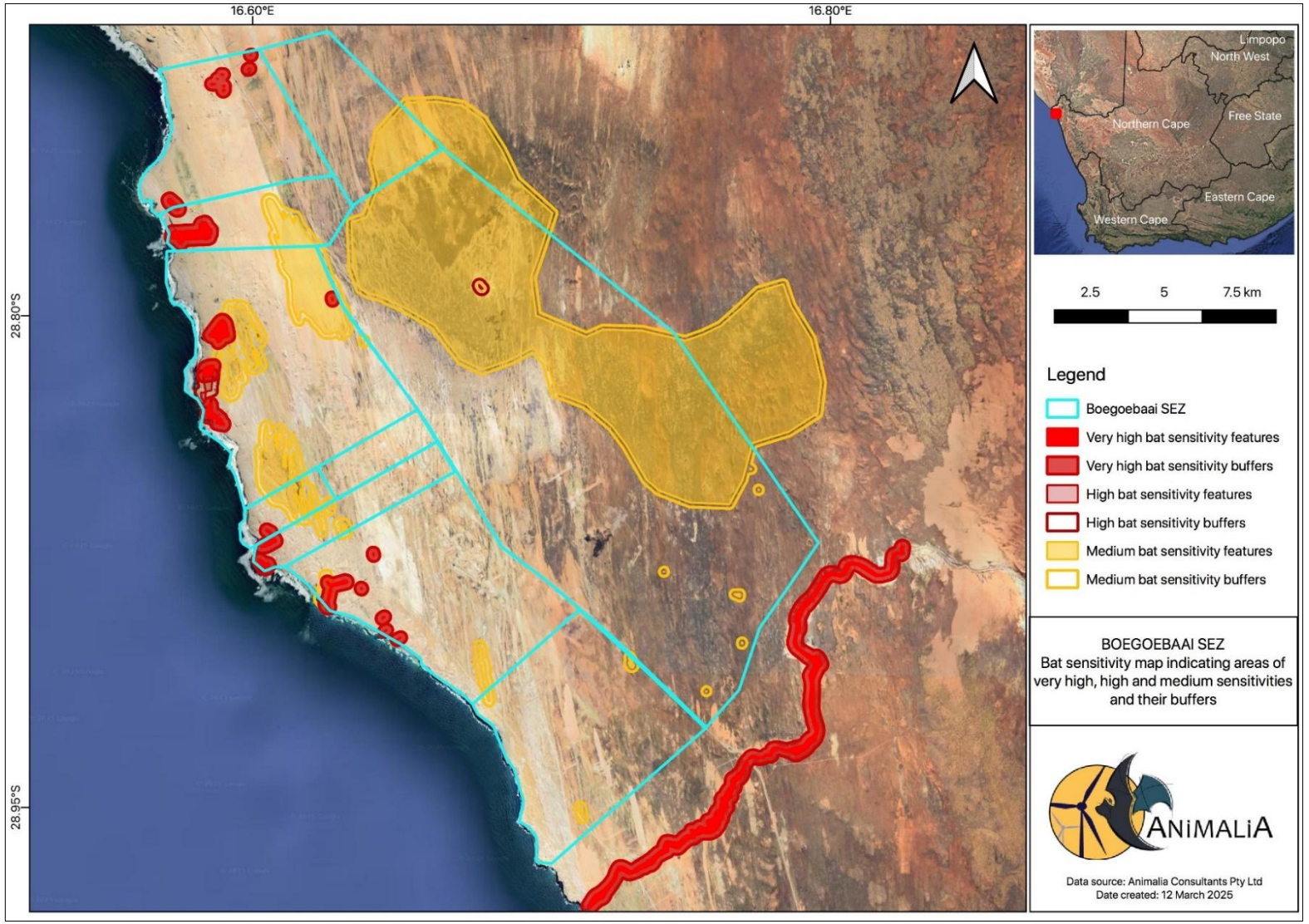


Figure 4-1. Bat sensitivity map of the proposed Boegoebaai Port and SEZ development.

5. BAT IMPACT ASSESSMENT

An outline of the potential impacts the Boegeoebaai Port and SEZ development may have on bats is provided below. Four impacts have been identified and assessed for the construction and operational phases.

Table 5-1. Identified potential impacts during construction and operation of the Boegoebaai Port and SEZ.

Infrastructure aspect / SEZ subzone	Potential impact	Spatial extent of receiving environment of concern
Operational phase		
Outside lights and floodlights in the Port and SEZ	Light pollution affecting light averse bat species	The SEZ development area as well as directly adjacent areas
Green Ammonia (GH2) water cooling tower blowdown, after demineralisation of seawater	Possible bat mortalities/injuries due to hot steam discharge	Acute localised impacts at water cooling towers
Construction phase		
Earthworks during construction in the Port and SEZ	Foraging habitat destruction	Areas marked as Very High, High and Medium in the bat sensitivity map, as well as their demarcated buffer zones.
Earthworks during construction in the Port and SEZ	Roosting habitat destruction	Areas marked as Very High in the bat sensitivity map, as well as their demarcated buffer zones.

5.1 Light pollution affecting light averse bat species and creating artificial foraging habitats

Light pollution will impact bat feeding habits and species compositions negatively, by artificially discouraging photophobic (light averse) species and favouring species that readily forage around insect-attracting lights. Therefore, during the operational phase strong artificial lights will alter the bat species composition and insect food resource availability for the Port, SEZ and directly adjacent areas, favouring certain species of bats and being disadvantageous to other species.

5.2 Possible bat mortalities/injuries due to hot steam/water discharge at Green Hydrogen water cooling tower blowdown

This impact is only applicable if the design and mechanism of the water-cooling towers are allowing for exposed wind cooled radiators which receives steam/hot water. The specialist has personally observed bat mortalities due to such a design for a Concentrated Solar Plant (CSP) water cooling system. If the radiator design is exposed, bats can move in-between the radiator fins overnight and once hot steam/water is released onto/in the radiator, bat mortalities and injuries can occur in acute large numbers.

5.3 Foraging habitat destruction

Foraging habitat will be permanently lost by construction of the Port and SEZ infrastructure. Temporary foraging habitat loss will occur during construction due to storage areas and movement of heavy vehicles.

5.4 Roosting habitat destruction

Probable roosting spaces on site are mostly in the form of rocky outcrops and man-made structures, as well as the rocky ravine of the Holgat drainage system to the south-east of the site. Such roosting spaces can be destroyed during construction by earthworks, causing harm or injury to bats residing on site.

6. MITIGATION TO MINIMISE THE PREDICTED IMPACTS

6.1 Avoidance of creating artificial foraging habitat

Artificial foraging habitat can unintentionally be created by the presence of outside lights attracting insects.

A mitigation to apply in the design of the Port and SEZ is to keep artificial lighting to a minimum on the infrastructure, while still adhering to safety and security requirements. For example, this can be achieved by having floodlights down-hooded, installing passive motion sensors onto lights around buildings and possibly utilising lights with lighting colours (also referred to as lighting temperatures) that attract fewer insects. Such lights generally are "warm white", yellow or amber and have a colour temperature below 4000k (Kelvin).

6.2 Possible bat mortalities/injuries due to hot steam/water discharge at Green Hydrogen water cooling tower blowdown

If the design and mechanism of the water-cooling towers are allowing for exposed wind cooled radiators which receives steam/hot water, this potential impact will be applicable. In such cases the water cooling radiators must be closed up with mesh/grid with a diameter of 10mm or less, to prevent bats and other wildlife from taking refuge inside radiator spaces. Mild latent heat in such structures can also attract many species of wildlife during cold weather conditions.

6.3 Bat foraging habitat destruction

Adhering to the bat sensitivity map as a mitigation is adequate. Additionally, keep to designated areas when storing building materials, resources, components and/or construction vehicles and keep to designated roads with all construction vehicles. Damaged areas should be rehabilitated by an experienced vegetation succession specialist after construction.

6.4 Bat roosting habitat destruction

Adhering to the bat sensitivity map as a mitigation is adequate. Additionally, if undiscovered bat roosts are encountered during construction, the Environmental Compliance Officer (ECO) on site must be notified immediately and a bat specialist consulted to advise the appropriate action.

7. CONCLUSION

Overall, the impacts on bat species for the proposed development are expected to be low and limited to the four impacts identified in Section 5, with light pollution being the most significant. However, if the water cooling towers are equipped with exposed radiator designs, acute and high bat mortality impacts may occur. **It is critical that a bat specialist be notified of and consulted in the intended design of the water cooling towers.** The outlined mitigation measures must be adhered to, and the sensitivity map respected by the applicable infrastructure components.

According to available information consulted during this study and up to date, there are no fatal flaws from a bat sensitivity perspective which should prevent the proposed development from proceeding towards the Environmental Impact Assessment process.

8. REFERENCES

ACR, 2020. African Chiroptera Report 2020. V. Van Cakenberghe and E.C.J. Seamark (Eds). *African Bats NPC*, Pretoria. i-xviii + 8542 pp.

Hester, S. G. and Grenier, M.B. 2005. *A conservation plan for bats in Wyoming*. Lander, WY: Wyoming Game and Fish Department, Nongame Program.

IUCN. 2024. The IUCN Red List of Threatened Species. Version 2024-1. https://www.iucnredlist.org. Accessed on 27062024.

Monadjem, A., Taylor, P.J., Cotterill, F.P.D. & Schoeman, M.C. 2020. Bats of southern and central Africa – (Second Edition) A biogeographic and taxonomic synthesis, Wits University Press.

Mucina, L. and Rutherford, M. C. 2018. The Vegetation of South Africa, Lesotho and Swaziland-*Strelitzia 19,* South African National Biodiversity Institute, Pretoria.

Neuweiler, G. 2000. *The Biology of Bats*. Oxford University Press.

O'Shea, T. J., Bogan, M. A. and Ellison, L. E. 2003. Monitoring trends in bat populations of the United States and territories: Status of the science and recommendations for the future. *Wildlife Society Bulletin*, 31: 16-29.

Rautenbach, I.L. 1982. *Mammals of the Transvaal*. Pretoria: Ecoplan.

SANBI (South African National Biodiversity Institute), EWT SA (Endangered Wildlife Trust). 2016. The Red List Mammals of South Africa, Swaziland and Lesotho.

Taylor, P. J. 2000. Bats of southern Africa, University of Natal Press, Pietermaritzburg.

Tuttle, M. D. and Hensley, D. L. 2001. *The Bat House Builder's Handbook*. (BCI) Bat Conservation International.

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Specialist Qualifications:	MSc Biodiversity & Conservation			
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APPENDIX 2: SPECIALIST CURRICULUM VITAE

WERNER CRISTIAAN MARAIS

Summary of qualifications

2008 *University of Johannesburg,* **MSc (Biodiversity and Conservation) – Cum laude**

2006 *University of Johannesburg,* **Hons (Biodiversity and Conservation)**

2005 *University of Johannesburg,* **BSc (Zoology and Botany)**

Affiliations to professional bodies and societies

- Pr.Sci.Nat.– SACNASP (South African Council for Natural Scientific Professions) in the field of Zoological Science, registration number 400169/10.
- Serves on the steering committee panel of the SABAA (South African Bat Assessment Association).
- Served on the research committee of the Gauteng and Northern Regions Bat Interest Group (GNoRBIG).
- **Served on the steering committee of the Zoological Society of the University of Johannesburg.**

Experience

2008 – Current Founder of Animalia Consultants (Pty) Ltd (conversion from Closed Corporation to Private Company in 2015)

Animalia has completed more than **600 specialist reports and numerous large-scale projects in the renewable energy sector**, as specialist consultants in the EIA process and energy facility operational phase, under the supervision and lead of Werner Marais.

2015 – Current Founder of Lightbulb Innovation (Pty) Ltd.

Lightbulb Innovation is developing new inventions and products invented by Werner Marais.

2008 University of Johannesburg

- Sensitivity and biodiversity surveys of five caves in the Cradle of Humankind World Heritage Site (COHWHS) and Pretoria areas.
- Preliminary survey to investigate the correlation between insectivorous bats and prey insects in the Krugersdorp Game Reserve.

2007, 2008 Bertie van Zyl (Pty) Ltd. (ZZ2 Tomato Farms), UJ

Two-year project to research the biological pest control method of utilizing

insectivorous bats in agriculture. Required to conduct an in-depth study of bat (Microchiroptera) behavior and ecologically important factors.

2006 University of Johannesburg

Six-month survey of cave dwelling arthropods in the Cradle of Humankind World Heritage Site.

Additional:

- Invited by the EWT (Endangered Wildlife Trust) and ESSA (Exploration Society of Southern Africa) to deliver presentations on current ecological issues regarding bats and wind energy.
- Co-author for the: "South African Bat Fatality Threshold Guidelines for Operational Wind Energy Facilities – ed 1. South African Bat Assessment Association. Sept 2017"
- Co-author for the: "South African Good Practice Guidelines for Operational Monitoring of Bats at Wind Energy Facilities. First Edition July 2014"; and draft edition October 2019
- Contributing editor for the: "South African Good Practice Guidelines for Surveying Bats at Wind Energy Facility Developments – Pre-construction; Edition 4.1, 2017"
- As a co-author, received the Dow Greeff price for best annual scientific publication: "Die karst-ekologie van die Bakwenagrot (Gauteng)" published in the Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie, Vol. 31(1), 2012.

Presented the following papers at conferences:

- The potential of using insectivorous bats (Microchiroptera) as a means of insect pest control in agricultural areas. The Zoological Society of Southern Africa's 50th Anniversary Conference. July 2009.
- Inseketende vlermuise (Microchiroptera) en vlermuishuise in landbougebiede. Suid Afrikaanse Akademie vir Wetenskap en Kuns se 100 jaar Eufees kongres. October 2009.

Interviewed for two popular magazine articles on ecological aspects of biological pest control utilising bats; published in two consecutive issues of Farmers Weekly. Interviewed on radio discussion about ecology and biology of bats.

Education

MSc (Biodiversity and Conservation)

- The potential of using insectivorous bats (Microchiroptera) as a means of insect pest control in agricultural areas – Passed with distinction
- Involved a large scale in-depth survey of the bat diversity in the Tzaneen and

Waterpoort areas, Limpopo.

- Understanding and observing the biology and behavior of local bat species.
- Designing and experimenting with artificial bat roosts.

Hons Biodiversity and Conservation

- Research project: Preliminary study of the terrestrial Arthropoda associated with caves of the Cradle of Humankind World Heritage Site – Passed with distinction
- Introduction to Environmental Management
- Herpetology
- Terrestrial and conservation ecology
- Resource management (incl. forestry, fire ecology, animal behavior)
- Practical fieldwork methodology (4X4, boat training and mapping)
- Mammalogy
- Population genetics and biosystematics
- Philosophy and research methodology: Zoology Nature conservation
- Parasitology
- Molecular evolution

BSc Zoology and Botany

- One-year course in animal diversity and identification
- Six-month course in basic and marine ecology
- Limnology and terrestrial ecology
- Coastal diversity excursion (Marine ecology)
- Introduction to SASS Freshwater pollution monitoring methodology
- Applied freshwater ecotoxicology
- Waterborne diseases
- Integrated animal physiology and processes
- General parasitology
- Cytology

- Six-month course in the identification and diversity of South African flora
- Ethno and economical plants
- Biotechnology
- Plant physiology
- Plant pathology
- Cellular and molecular biology
- Introduction to organic and physical chemistry
- General chemistry
- Mineralogy and earth dynamics

Additional:

- Experienced report writing skills, sufficient computer skills.
- Bioacoustics analysis.
- Sufficient in GIS.
- Fall Arrest Technician and Rescue qualification (for working at heights).
- First Aid Level 1 and Basic Firefighting.
- Autodesk Inventor Fundamentals course, and 3D modeling skills.
- Intermediate 3D printing skills.
- Snake Identification and Handling Course.
- Multiple training courses in bat related topics - Gauteng and Northern Regions Bat Interest Group (GNoRBIG).
- Advanced driving course in 4x4 off-road driving.
- Self-taught artist in the fine arts.
- Inventing, prototyping and product development skills.

Languages	Afrikaans / English – Full professional proficiency in both.

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CHAPTER 3

Supplementary Material: Specialist Report

Fauna: mammal, reptile and amphibian report

Strategic Environmental Assessment (SEA) for the Proposed Boegoebaai Port and SEZ Fauna Desktop Assessment

May 2025

For:
South African National Energy Development Institute (SANEDI), Northern Cape Economic Development Trade and Investment Promotion Agency (NCEDA) and
Transnet National Ports Authority (TNPA)

Appointed Consultant: CSIR

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Disclaimer by specialists

I, Corné Niemandt, declare, that the work presented in this report is our own and has not been influenced in any way by the developer or the EAP. At no point has the developer asked me as specialists to manipulate the results in order to make it more favourable for the proposed development. I consider myself bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP) and the EIA Regulations (2014, as amended). I have the necessary qualifications and expertise in conducting this specialist report.



Corné Niemandt

Executive Summary

The Fauna Desktop Assessment for the Boegoebaai Strategic Environmental Assessment (SEA) provides a regional screening of terrestrial ecological sensitivities for the proposed Port and Special Economic Zone in the Northern Cape, South Africa, across a project area of approximately 33,500 ha. Reflecting the strategic purpose of an SEA, the assessment focuses on mammals (excluding bats), reptiles, and amphibians, with birds and bats treated in separate specialist chapters[1]. At this coarse, decision-support scale, a habitat- and ecosystem-based approach is applied that mainly integrates Critical Biodiversity Areas (CBAs), threatened-ecosystem status, and vegetation mapping to proxy the likely distribution and sensitivity of fauna taxa and Species of Conservation Concern.

This proxy-based method is appropriate for SEA-level planning: it identifies relative sensitivity zones, ecological constraints and opportunities, and priority areas for avoidance or further study, while explicitly recognising uncertainty inherent to a desktop study. Consistent with the precautionary principle, the results are intended to guide sustainable spatial planning, inform mitigation at concept design, and define data gaps and triggers for project-level, species-specific field surveys and protocols during subsequent EIAs.

This fauna desktop assessment relies on secondary data sources for mammals, reptiles and amphibians, including GIS mapping, literature reviews, and biodiversity databases, which inherently present spatial and temporal limitations. Data gaps include the underrepresentation of cryptic or nocturnal species and the limited resolution of habitat maps for site-specific assessments. To address these limitations, targeted field surveys are recommended to validate findings and refine sensitivity maps. These surveys should focus on confirming the presence of species of conservation concern (SCC) and updating ecological data to ensure accuracy and comprehensiveness.

The Boegoebaai project area includes habitats of significant ecological importance, characterised by critical biodiversity features and a diversity of SCC. The area encompasses several vegetation units, including Critically Endangered ecosystems such as the Richtersveld Coastal Duneveld and Namib Seashore Vegetation. These habitats host unique fauna, some of which are highly specialized and endemic to the region. Species like De Winton's Golden Mole (*Cryptochloris wintoni*), Grant's Golden Mole (*Eremitalpa granti granti*), and the Desert Rain Frog (*Breviceps macrops*) rely on specific dune and sandy habitats for survival. In total, the faunal community includes a diverse array of mammals, reptiles, and amphibians, with notable representatives such as the Namaqua Dwarf Adder (*Bitis schneideri*) and the Namib Web-footed Gecko (*Pachydactylus rangei*). These species underscore the ecological significance of the area and highlight the potential risks posed by habitat loss and disturbance.

The proposed development poses various environmental risks that must be carefully managed. Habitat loss and alteration are significant concerns, particularly for species reliant on the specialised dune ecosystems, which are vulnerable to disturbance from construction and operational activities. The ecosystems in the project area provide critical ecological services, including supporting rare and endemic species, stabilising sandy substrates, and maintaining biodiversity corridors. Fragmentation of habitats due to infrastructure development, such as roads, pipelines, and buildings, can restrict species movement, disrupt breeding patterns, and isolate populations. These impacts are especially critical for fossorial species, such as moles and reptiles, that depend on undisturbed sandy habitats.

[1] It must be noted that Terrestrial invertebrates are not assessed in this chapter; given their importance in this region, they are to be addressed through a dedicated assessment and sensitivity layer that complements the vertebrate outputs.

Disturbance from increased human activities such as noise, light pollution, and dust could have long-term implications for biodiversity. During construction, impacts are expected to be most severe due to the direct transformation of natural ecosystems, specifically, these activities can disturb nocturnal and crepuscular species, reducing their activity and altering natural behaviours. The introduction of invasive plant species, facilitated by soil disturbances and human movement, can outcompete native vegetation, further degrading habitat quality. Additionally, the risk of roadkill from increased traffic on access roads presents a tangible threat to slow-moving species such as tortoises and frogs. The operational phase may see reduced activity, but residual impacts such as wind erosion and alien plant invasions may persist unless mitigated effectively. The risk of inadequate rehabilitation during the decommissioning phase could leave behind a degraded and vulnerable ecosystem.

To address these challenges, this desktop assessment identifies a suite of mitigation measures aimed at minimising ecological harm. Avoiding development in very high-sensitivity areas, such as the remnants of Critically Endangered ecosystems which support fauna SCCs, is a primary recommendation. Strategic site selection can help protect key habitats while maintaining connectivity between biodiversity corridors. During the construction phase, implementing best practices, such as minimising vegetation clearance, species-specific conservation actions and avoiding sensitive periods for breeding and foraging, can reduce impacts. Habitat restoration plans should focus on re-establishing native vegetation and stabilising disturbed soils to prevent erosion.

Specific mitigation measures for fauna include translocating individuals of SCCs, where feasible, to suitable habitats outside the impact zone. For species such as the Desert Rain Frog and Namib Web-footed Gecko, avoiding disturbance of breeding habitats is critical. To reduce roadkill, speed limits and wildlife crossings should be established on access roads. Noise and light pollution can be mitigated by limiting construction hours and using directional lighting to minimise spillover into natural areas. Post-construction monitoring programs are essential to evaluate the effectiveness of these measures and adapt strategies as needed.

Monitoring programs are essential for assessing the effectiveness of mitigation measures and ensuring long-term ecological sustainability. During the construction and operational phases, management plans must prioritise maintaining ecological stability in the area. Ongoing monitoring of invasive species and regular habitat assessments will help ensure that ecological functions are preserved. Mitigation strategies should include training programs for staff to minimise inadvertent impacts on fauna and promoting community involvement in conservation initiatives.

In conclusion, the Boegoebaai Project Area represents a region of high ecological sensitivity with unique and irreplaceable biodiversity features. The findings of this assessment highlight the importance of adopting a precautionary approach to development, balancing economic objectives with the preservation of ecological integrity. With informed planning, avoidance of critical habitat features and robust mitigation strategies, along with ongoing ecological monitoring, it is possible to achieve some form of sustainable development.

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Breviceps branchi Branch's Rain Frog – Data Deficient 35

The global distribution of *Breviceps branchi* is currently restricted to its type locality on the arid west coast of the Northern Cape. The holotype was collected approximately 600 m west of the Holgat River bridge along the Port Nolloth–Alexander Bay Road, at low elevation (~120 m a.s.l.). It must be emphasised, however, that this narrow-recorded range likely reflects inadequate survey effort rather than a definitively known range; nonetheless, until further records are obtained, impact assessment must assume that the species may be extremely range-restricted. 35

Branch's Rain Frog *Breviceps branchi* is an elusive described frog species endemic to the west coast of the Northern Cape, South Africa. It is currently assessed as Data Deficient (DD) on available red list assessments, reflecting the very limited information on its distribution, population size and trends, and ecological requirements. The species is known only from a single specimen (the holotype) collected near the Holgat River between Port Nolloth and Alexander Bay (Channing 2012). Despite several subsequent targeted surveys in the vicinity of the type locality, only three other records have been made in the same proximity of the type locality. 35

Although the formal listing is DD, from a specialist perspective the species should be treated as of very high conservation concern. The combination of an extremely restricted known range, apparent rarity, and overlap with areas subject to current and proposed industrial and mining activities creates a plausible risk that localised habitat loss could translate into a significant or even global reduction in conservation status. In the absence of robust distribution and population data, the precautionary principle is strongly applicable and B. *branchi* should effectively be managed as if it were a highly range-restricted (its extent of occurrence (EOO) is 10 km^2), threatened micro-endemic. 36

At the type locality, the frog was collected on deep red sands within vegetation classified as Northern Richtersveld Yellow Duneveld, part of the Succulent Karoo biome. The habitat comprises low, open duneveld with scattered shrubs on loose to semi-consolidated sands. Based on habitat at the type locality and the ecology of congeners, *Breviceps branchi* is inferred to be a fossorial, soil-dependent species occupying scrub-covered sandy areas.

Members of the genus *Breviceps* typically spend most of their lives underground in burrows within loose soils, emerging mainly during or after rainfall events to forage and breed. ____ 36

Much of the immediate terrestrial footprint falls within arid coastal Succulent Karoo and associated duneveld systems that are structurally and bioclimatically similar to those at the *B. branchi* type locality. The receiving environment therefore includes potential habitat for this species, although its actual presence at Boegoebaai has not yet been confirmed or ruled out through systematic amphibian surveys. If *B. branchi* is confirmed within the development footprint or its immediate buffer, direct loss of habitat would translate into a proportional loss of local population size, with limited opportunity for recolonisation from adjacent areas due to poor dispersal ability and intervening barriers. ____ 36

A detailed assessment is required during the EIA application phase to record suitable habitat and understand the extent of the species distribution throughout the PA. The impact of the proposed development on the species needs to be assessed in detail to identify if any residual impacts may remain. If recorded, the presence of the species likely represents a fatal flaw to the project. ____ 36

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Glossary

Critical Biodiversity Area (CBA): an area that must be maintained in a good ecological condition (natural or semi-natural state) in order to meet biodiversity targets. CBAs collectively meet biodiversity targets for all ecosystem types, as well as for species and ecological processes that depend on natural or semi-natural habitat that have not already been met in the protected area network. CBAs are identified through a systematic biodiversity planning process in a configuration that is complementary, efficient and avoids conflict with other land uses where possible.

Cumulative impact: in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to the existing and reasonably foreseeable impacts eventuating from similar or diverse activities.

Ecosystem: a dynamic complex of animal, plant and micro-organism communities and their non-living environment interacting as a functional unit.

Ecosystem threat status – A measure of how threatened an ecosystem is, based on how much of the ecosystem's original area remains intact relative to three different thresholds or "tipping points". These thresholds indicate the points at which it is estimated that the ecosystem would undergo fundamental change, either in terms of biodiversity pattern or ecological processes. Ecosystems are categorised as critically endangered, endangered, vulnerable or least threatened.

Endemic: Restricted or exclusive to a particular geographic area, occurring nowhere else. Endemism refers to the occurrence of endemic species.

Extent of occurrence (EOO): the area contained within the shortest continuous imaginary boundary that can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy; and in short is the species' contemporary distribution range.

Habitat: The area or environment occupied by a species or groups of species, due to the particular set of environmental conditions that prevails there.

IUCN Red List Categories and Criteria: the threatened species categories used in Red Data Books and Red Lists have been in place for almost 30 years. The IUCN Red List Categories and Criteria provide an easily and widely understood system for classifying species at high risks of global extinction, so as to focus attention on conservation measures designed to protect them.

IUCN Red List status: the conservation status of species, based on the IUCN Red List categories and criteria.

Mitigation: means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible.

Range-restricted species – the presence of terrestrial flora, vertebrate and invertebrate fauna with a global population extent of occurrence (EOO) of 10 000 km^2 or less.

Species of conservation concern (SCC): includes all species that are assessed according to the IUCN Red List Criteria as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Data Deficient (DD) or Near Threatened (NT), as well as range-restricted species which are not declining and are nationally listed as Rare or Extremely Rare [also referred to in some Red Lists as Critically Rare].

Threatened species: species that are facing a high risk of extinction. Any species classified in the IUCN categories Critically Endangered, Endangered or Vulnerable is a threatened species. In terms of section 56(1) of NEMBA, 'threatened species' means indigenous species listed under the Act as critically endangered, endangered or vulnerable species.

1. INTRODUCTION AND PROJECT BACKGROUND

This Desktop Fauna Assessment for the **Boegoebaai Strategic Environmental Assessment (SEA)** specifically addresses the terrestrial ecological assessment with a focus on fauna (mammals, reptiles, and amphibians)[2]. The SEA is intended to assess the environmental sensitivities of the proposed **Boegoebaai Port and Special Economic Zone (SEZ)** development (hereafter Project Area – PA) over a spatial area of approximately 33 500 ha in Boegoebaai (Figure 1-1). The primary outcome will inform the planning and decision-making processes for the port and SEZ, while also providing reference data for future project-specific Environmental Impact Assessments (EIAs).

As part of South Africa's ambition to become a player in the globally emerging green hydrogen market, a substantial programme of greenfield infrastructure has been proposed in the Northern Cape consisting of three main components:

i. New deepwater port at Boegoebaai, dry and liquid bulk berths, and multi-purpose terminals;

ii. Mixed-use SEZ located in the region adjacent to the proposed Boegoebaai port; and

iii. Expansive regional renewable energy (wind and solar PV) generation and transmission infrastructure.

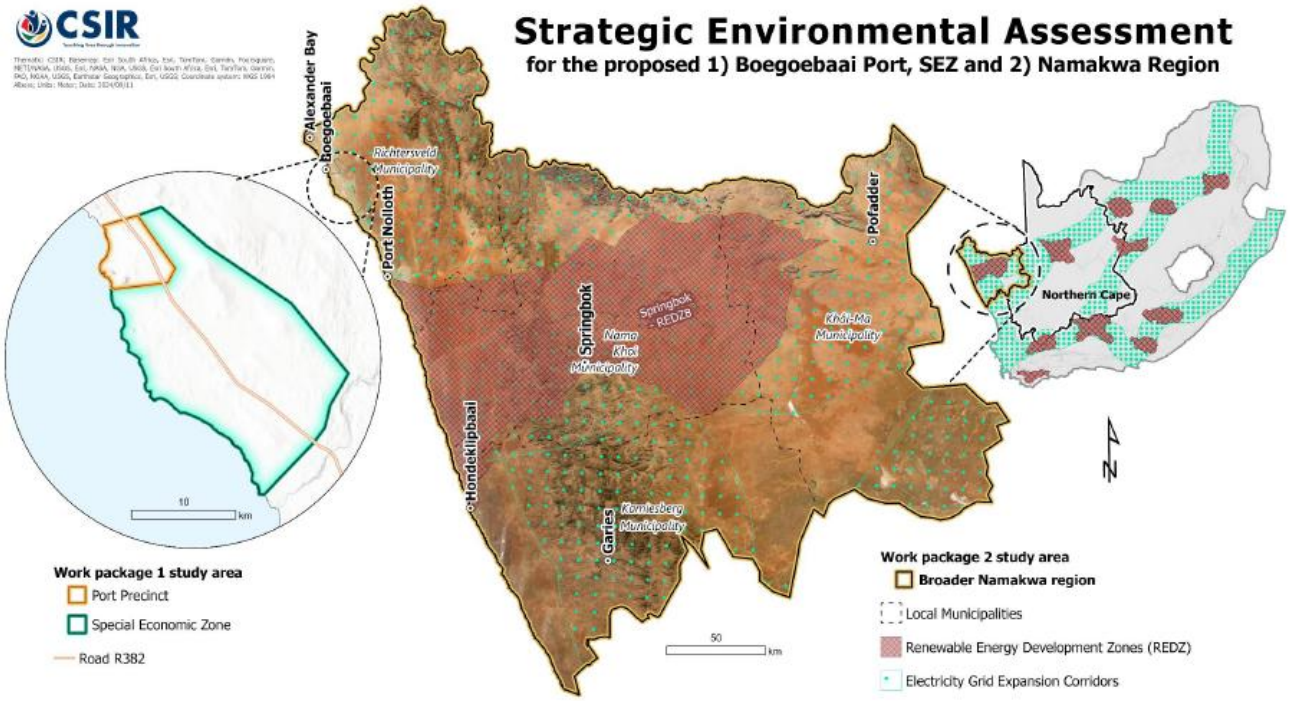


Figure 1-1: The spatial extent of the two SEA Work Packages (source: CSIR briefing note).

A SEA has been initiated through a collaboration between the South African National Energy Development Institute (SANEDI), Northern Cape Economic Development Trade and Investment Promotion Agency (NCEDA), and Transnet National Ports Authority (TNPA) (the Project Steering Committee (PSC)). The Council for Scientific and Industrial Research (CSIR) has been appointed to undertake an independent SEA. The overarching purpose of the SEA is to develop an integrated decision-making framework to guide the planning of the proposed Boegoebaai Port, SEZ, and wider Namakwa region in a sustainable manner.

This SEA Fauna report will cover the PA at a local-scale, which will spatially focus on identifying sensitivities around the proposed development covering ~33 500 ha. The outcome will inform the planning of the Port

[2] Avifauna and bats are addressed in separate chapters; invertebrates are scoped outside this chapter and are to be assessed via dedicated EIA studies.

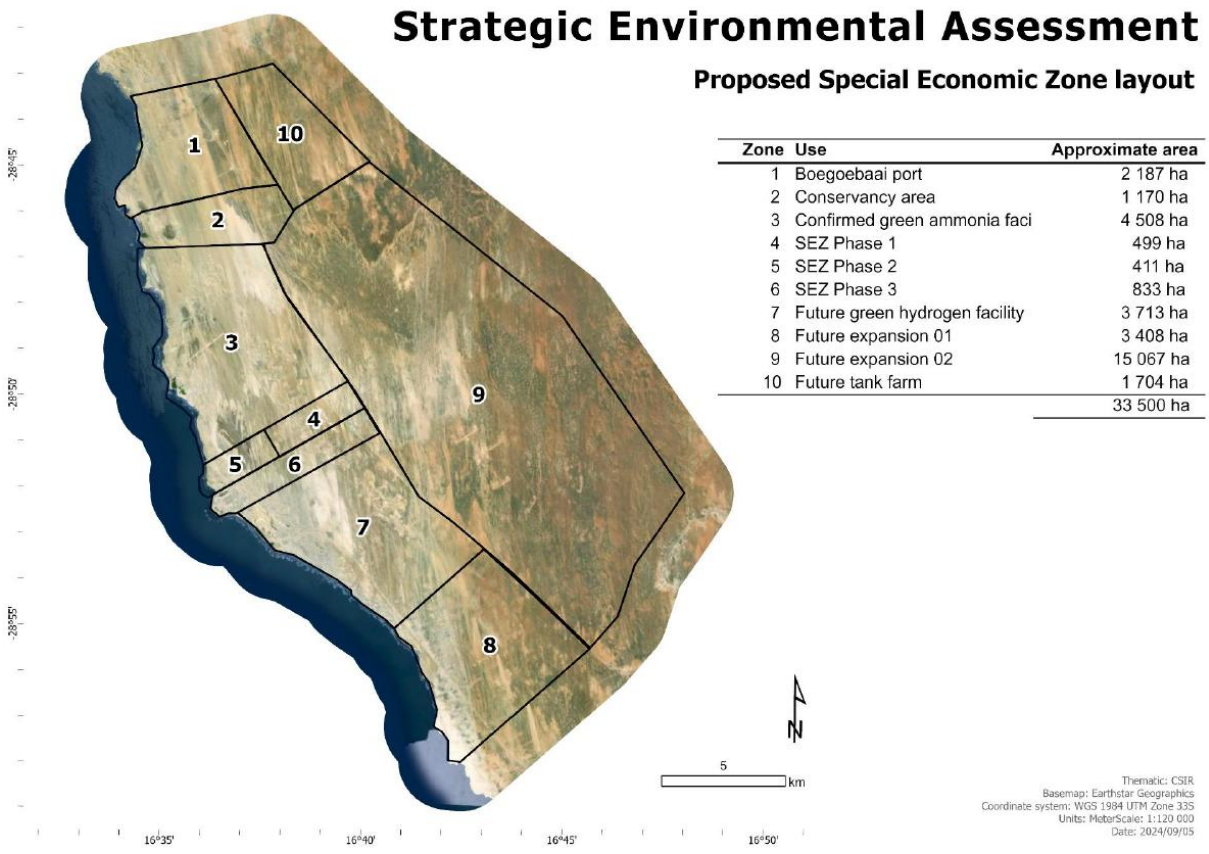
and SEZ, as well as provide references and recommendations for future project-specific Environmental Impact Assessments.

1.1 Proposed Special Economic Zone layout

The proposed Boegoebaai Port and Special Economic Zone (SEZ) consists of:

- Port precinct (3 378 ha), with a focus on the short-term (Phase 1A) port layout. The proposed short-term port layout, indicated within the 2 187 ha port precinct boundary (Figure 1-2), is intended to accommodate bulk liquid items such as green ammonia and diesel oil, dry bulk materials such as manganese and iron ore, and assorted break bulk cargo, which arrives in bulk and is then separated into individual components, such as lead and zinc. A phased approach will be followed for constructing the infrastructure and facilities for the Boegoebaai port development layout. This approach includes a short-term (Phase 1A) and long-term (Phase 1B) development plan for the port. The future expansion is currently envisaged within the confines of the currently proposed port precinct.

- SEZ (30 122 ha), focussing on both shorter term and future development zones.



Zone	Use	Approximate area
1	Boegoebaai port	2 187 ha
2	Conservancy area	1 170 ha
3	Confirmed green ammonia faci	4 508 ha
4	SEZ Phase 1	499 ha
5	SEZ Phase 2	411 ha
6	SEZ Phase 3	833 ha
7	Future green hydrogen facility	3 713 ha
8	Future expansion 01	3 408 ha
9	Future expansion 02	15 067 ha
10	Future tank farm	1 704 ha
		33 500 ha

Figure 1-2: The port footprint and Boegoebaai Special Economic Zone Layout, showing the TNPA Port Precinct, initial phases of the SEZ on the coastal side of the R382 road and commencing from closest to the Port precinct. (Source: NCEDA, 2024).

2. RESEARCH APPROACH AND METHODOLOGY

2.1 Defining the Research Problem

- **Objective**: Identify, describe and map the land use dynamics and change trends of the receiving environment and broader region as it relates to fauna as well as the environmental sensitivities around the Boegoebaai Port and SEZ development.

- **Focus**: Assess the distribution and habitat requirements of fauna species of conservation concern (SCC) and fauna communities. Focus is on mammals, reptiles and amphibians, and will exclude avifauna, bats and water-dependent marine species which are addressed in separate assessments.

- **Scope**: Fauna component as part of the overall Terrestrial Ecological Assessment within the SEA framework, with a strong focus on desktop and spatial data.

2.2 Research Design

The study will adopt a spatially focused assessment to ensure high-resolution environmental sensitivity mapping. The design will include:

- **GIS Mapping**: Integration of spatial data from existing surveys and secondary sources into a Geographic Information System (GIS).

- **Literature review**: Review of existing fauna assessments and databases.

- **Expert Input**: Collaboration with fauna specialists to validate ecological data and provide key insights on habitat sensitivity and conservation value.

2.3 Data Collection

2.3.1 Primary Data Requirements

No detailed on-site fauna assessments were undertaken but based on the habitat and vegetation descriptions produced by the botanists, key habitats for fauna can be described. Coupled with secondary data collection, sensitive areas were mapped for SCC.

2.3.2 GIS

Existing data layers from various sources were incorporated into QGIS (open source) to establish how the proposed developments and associated activities interact with important terrestrial features. Emphasis was placed on the following spatial datasets:

- Vegetation Map of South Africa, Lesotho and Swaziland (SANBI, 2018 – as amended);

- Northern Cape Critical Biodiversity Areas (Northern Cape Department of Environment and Nature Conservation, 2016);

- National Protected Area Expansion Strategy (NPAES, 2018);

- Red List of Ecosystems (RLE) for terrestrial realm for South Africa - Original extent (SANBI, 2022[a]);

- RLE for terrestrial realm for South Africa – remnants (SANBI, 2022[b]); and
- Protected and Conservation areas of South Africa (South Africa Protected Areas Database-SAPAD; South Africa Conservation Areas Database-SACAD)[3].

2.3.3 Literature Review and Secondary Data

- Review of existing environmental and ecological datasets, biodiversity databases, and scientific literature.
- Relevant books and publications providing information on distribution ranges and/or conservation status of fauna species were consulted to review predictions of SCC occurrence at local scale.
- Review of previous SEA and EIA reports related to the PA.
- Information relating to mammal SCC was obtained from the National Red List (Child *et al*. 2016)[4] for regional conservation status of mammals in South Africa.
- The National Red List[5] was utilised to provide the most current account of the regional conservation status of reptiles and amphibians. **Take note: the National Red List 2025 is due for publication November 2025, and where relevant specific species details and updates have been shared by SANBI, EWT and BLSA.**
- The IUCN Red List of threatened species (IUCN, 2025) for global conservation statuses was consulted[6].
- Spatial data from the South African National Biodiversity Institute (SANBI), provincial biodiversity conservation authorities (Northern Cape Department of Environment and Nature Conservation), and related institutions were consulted.
- iNaturalist, the Global Biodiversity Information Facility (GBIF), the Virtual Museum (VM) of African Mammals, Frog Atlas of Southern Africa and Reptile Atlas of Africa were used to source observation data in the area to generate expected species lists[7].

2.4 Species of Conservation Concern

The Red List of threatened species generated by the IUCN provided the global conservation status of mammals, reptiles and amphibians. However, regional conservation status assessments performed following the IUCN criteria are generally the most relevant and sourced for each group as follows:

- Reptiles: Bates *et al.* (2014, as amended);
- Amphibians: Southern African Frog Re-Assessment Group (SA-FRoG) (2015); Du Preez & Carruthers (2017); and
- Mammals: Child *et al.* (2016).

Take Note: This version of the report represents the final version in terms of recent information being made available on the unpublished 2025 National Red List. The listing of threatened fauna and/ or fauna SCC are based on information received up until and including 7 May 2025. Any further changes will not be reflected in this report.

[3] http://dea.maps.arcgis.com/apps/MapTools/index.html?appid=2367540dd75148e8b6eaeab178a19d3a
[4] https://www.ewt.org.za/resources/resources-mammal-red-list/
[5] http://speciesstatus.sanbi.org/
[6] https://www.iucnredlist.org/
[7] It must be noted that the VM closed its operations at the end of 2024.

The conservation status categories defined by the IUCN (Figure 2-1), which are considered here to represent species of conservation concern[8] (SCC), are the "threatened" categories defined as follows:

- **Critically Endangered (CR)** - Critically Endangered refers to species facing immediate threat of extinction in the wild.
- **Endangered (EN)** - Endangered species are those facing a very high risk of extinction in the wild within the foreseeable future.
- **Vulnerable (VU)** - Vulnerable species are those facing a high risk of extinction in the wild in the medium-term.

Other measures of conservation status include species listed under the following:

- National listed threatened or protected species (TOPS) in terms of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004).
- Convention on International Trade in Endangered Species (CITES; International).

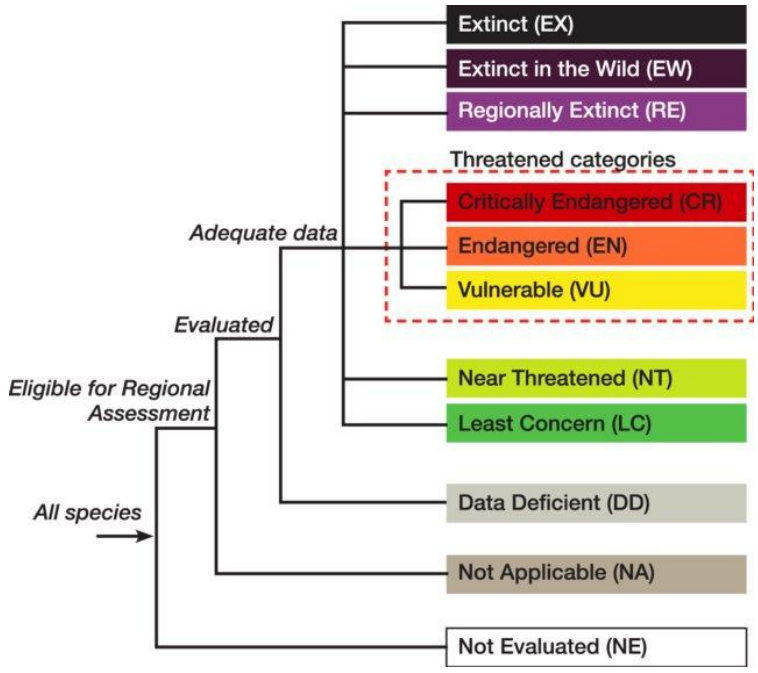


Figure 2-1: Schematic representation of the structure of the IUCN Red List Categories (IUCN 2012).

2.5 Data Analysis and Interpretation

- Analyse habitat preferences and conservation status of ecosystems and species.
- Identify and map high-priority areas for conservation, habitat corridors, and zones of potential conflict with the proposed port and SEZ development.

[8] Species of conservation concern have a high conservation importance in terms of preserving South Africa's high diversity and include not only threatened species, but also those classified in the categories Extinct in the Wild (EW), Regionally Extinct (RE), Near Threatened (NT), Critically Rare, Rare, Declining and Data Deficient - Insufficient Information (DDD).

- Provide key findings on fauna sensitivities and offer recommendations for future EIAs and project-specific mitigation strategies for the proposed development.

2.6 Assumptions and Limitations

Using secondary data for a fauna desktop assessment, especially in a remote region like the west coast of the Northern Cape where the proposed development is located, involves several limitations and assumptions. These can impact the reliability and applicability of the assessment findings:

General Project Details

- It is assumed that all third-party information acquired is correct (e.g., GIS data and scope of work).
- Focus is on mammals, reptiles and amphibians, and will exclude avifauna, bats, invertebrates and water-dependent marine mammals which are addressed in separate assessments.
- It is assumed the proposed development's scale and scope are unlikely to shift significantly during the study period.

Data Gaps and Incompleteness:

- Access to reliable secondary data sources in the absence of field surveys;
- Available secondary data might not cover all species or habitats in the area, especially lesser-studied or cryptic species;
- Historical data may lack recent trends or population dynamics due to environmental changes or human activities; and
- Potential lack of up-to-date or detailed secondary data, particularly for less-studied species or habitats in the region.

Spatial Resolution Issues:

- Full coverage of the 33 500-ha area is constrained in the databases, particularly in remote areas. Accordingly, there may be gaps in the secondary data.
- Secondary data may have broad spatial scales that do not align with the finer resolution required for site-specific assessments.
- Habitat or species distribution maps may not accurately reflect microhabitats present in the area.

Temporal Limitations:

- Older datasets may not reflect current conditions due to climate change, habitat destruction, or ecological shifts.
- Migration or seasonal variations in species distribution may not be captured in static datasets.

Bias in Data Sources:

- Secondary data may overrepresent certain areas or species due to researcher interest or accessibility.

- Surveys may exclude nocturnal, fossorial, or migratory species, leading to underrepresentation.

Lack of Contextual Information:

- Secondary data often lack behavioural, ecological, or physiological context needed to assess the specific impacts on fauna.

Inconsistency in Data Quality:

- Differences in data collection methods, accuracy, and sampling effort across studies can lead to inconsistencies.

Static Conditions:

- It is assumed ecological and environmental conditions have remained relatively stable since the data were collected.

Species-Habitat Relationships:

- Documented species-habitat relationships are valid for the region at the time of the assessment, despite potential variations in habitat quality or connectivity.

To mitigate against these limitations, it is recommended that the desktop review be complemented with targeted field surveys for site-specific validation. In addition, cross-check findings with taxa experts with local knowledge as well as recent regional studies. Furthermore, a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions.

3. DESKTOP RESULTS

3.1 Regional Vegetation

Five vegetation units occur within the PA (Figure 3-1) of which two are listed as Critically Endangered (CR) under the revised Red List of Ecosystems (2022): Namib Seashore Vegetation (CR) – AZd 1, Richtersveld Coastal Duneveld (CR) – SKs 1, Northern Richtersveld Yellow Duneveld – SKs 2, Richtersveld Sandy Coastal Scorpionstailveld – SKs 4, Western Gariep Plains Desert – Dn 3.

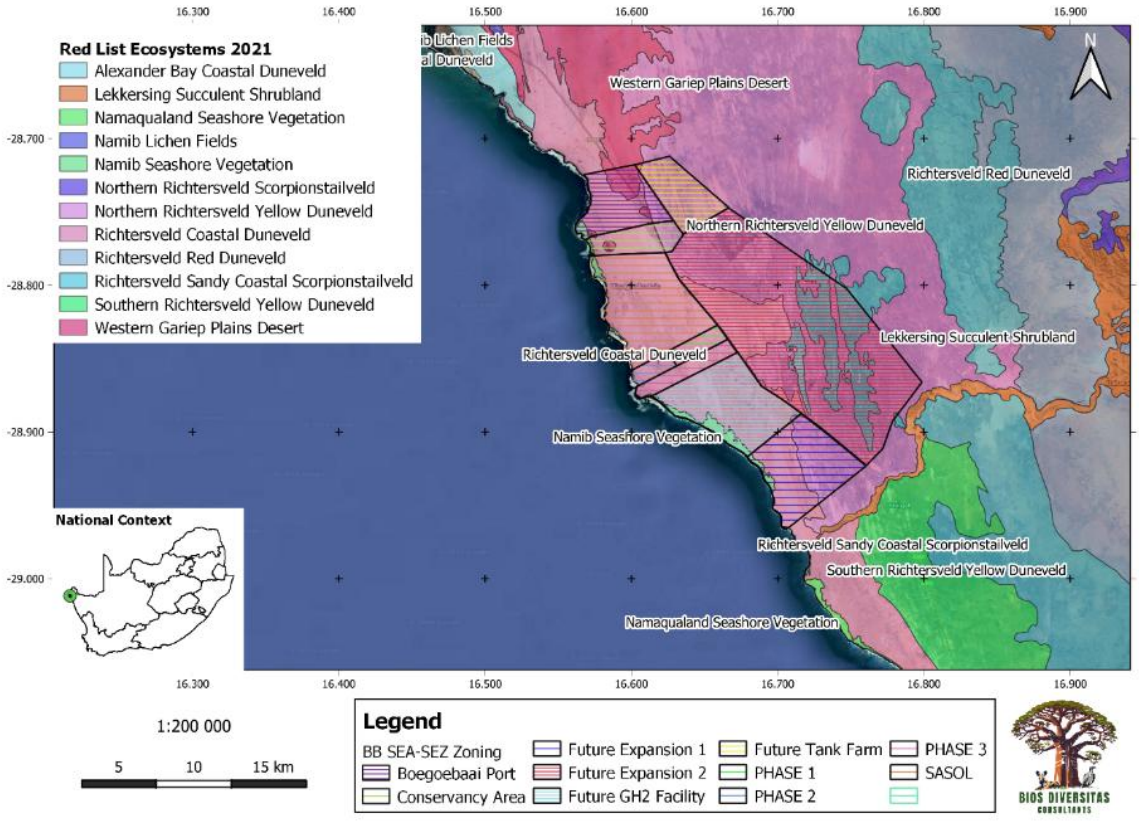


Figure 3-1: The Project Area in relation to regional vegetation and terrestrial Red List Ecosystems (RLE, 2022).

Namib Seashore Vegetation AZd 1 – Critically Endangered [A3, B1(i), B2(i)]

The Namib Seashore Vegetation occupies a narrow strip along the southern Namib Desert (one of the oldest and most arid deserts of the world), extending into the Northern Cape province of South Africa only marginally where it reaches its southernmost distribution limit on the Holgat River (just south of the PA). This ecoregion is characterised by its unique adaptations to a harsh coastal environment, where the Atlantic Ocean meets one of the driest terrestrial ecosystems on Earth.

The landscape is dominated by slightly sloping sandy beaches and adjacent moving and fixed coastal dunes (Strandveld Formation) and occasional coastal cliffs. Vegetation is dominated by dwarf shrubs up to 1 m tall and spiny grasses on the windblown dunes and small succulent dwarf shrubs dominating exposed rocky cliffs on the seafront. Adaptations such as to obtain moisture from the frequent coastal fogs rather than from rainfall are key in this environment.

The Namib seashore vegetation supports a variety of wildlife adapted to extreme conditions, potentially including:

- Grant's Golden Mole (*Eremitalpa granti granti*): A rare and highly specialised burrowing mammal that navigates through sandy dunes.
- Cape Fur Seals (*Arctocephalus pusillus pusillus*): Found along the coast, especially near rocky outcrops and beaches.
- Reptiles: Fog-dependent geckos and lizards, including the Web-footed Gecko (*Pachydactylus rangei*), a desert specialist.

National land cover data show that Namib Seashore Vegetation has experienced extensive spatial declines of approximately 95% since 1750. Namib Seashore Vegetation is narrowly distributed with high rates of habitat loss in the past 28 years (1990-2018), mainly due to diamond mining and coastal development, placing the ecosystem type at risk of collapse.

Richtersveld Coastal Duneveld SKs 1 – Critically Endangered [B1(i)]

The Richtersveld Coastal Duneveld (SKs 1) is a unique and ecologically significant landscape along the Atlantic Ocean coast from a point between the Boegoe (Buchu) Twins and Alexander Bay to about halfway between Port Nolloth and Kleinzee along a broad belt of 1–12 km within the Northern Cape province of South Africa. The north-south extension is 104 km. It forms part of the globally recognised Succulent Karoo Biome, a biodiversity hotspot known for its remarkable array of endemic species. It is characterised as generally flat with some large, gently rolling coastal dunes. On the active dunes, depending on the aspects of the slopes and on the phase of deflation and sedimentation, different plant communities occur.

Despite its arid conditions, the Richtersveld Coastal Duneveld supports an array of fauna uniquely adapted to its challenging environment:

- Namaqua Chameleon (*Chamaeleo namaquensis*): A desert-adapted chameleon that thrives in sandy habitats.
- Brown Hyena (*Parahyaena brunnea*): An elusive predator that roams the coastal areas, scavenging for food.
- Cape Fur Seals (*Arctocephalus pusillus pusillus*): Found along the coastal edge, particularly in rocky zones and sand dunes.
- Geckos and lizards: Fog-dependent reptiles like the Web-footed Gecko (*Pachydactylus rangei*) and desert-adapted skinks inhabit the sandy dunes.

Diamond mining is a key pressure on this ecosystem type, with 176.68 km^2 of the ecosystem directly impacted by mining activity. The vegetation unit is narrowly distributed with high rates of habitat loss in the past 28 years (1990-2018), placing the ecosystem type at risk of collapse. Sustained conservation efforts are essential to protect its unique landscapes and species for future generations.

Northern Richtersveld Yellow Duneveld SKs 2 – Least Concern

The Northern Richtersveld Yellow Duneveld forms a band approximately 5–25 km wide, running parallel to the coastline. It extends over 45 km, from south of Brandkaros in the north to the Holgat River in the south. The unit's altitude ranges from about 50 to 300 meters. At present no major threat to the unit has been identified and it is only slightly transformed by mining.

The landscape is predominantly composed of flat sand shields, occasionally interrupted by dunes that typically take the form of broad, flat "whale-back" structures. Steep dune crests and valleys are rare, but where they occur, the vegetation reflects the variation in topography.

The sands in this region are primarily yellow, wind-blown sediments of coastal origin, predating the white dune sands found further west. These sands are remnants of an ancient mobile dune field that stabilised over time due to climatic improvements and increased vegetation cover following the last glaciation. Despite stabilisation, the structure of the south-north-oriented dune ridges and associated valley systems remains discernible. Local erosion and sedimentation processes have created saline valleys with silty or loamy soils, enhancing habitat diversity. Currently, wind erosion occurs only minimally.

This region experiences a high frequency of coastal fog, which provides vital moisture to sustain life in this arid environment. Extreme wind speeds and sand-blasting winds from the south are common, with frequent storms shaping the landscape and influencing ecological dynamics. The unit is characterised by high beta diversity due to dune structures, especially high differences between mobile and fixed sand areas (the latter are partly covered by heuweltjies). It has experienced minimal transformation, only slightly transformed by mining.

Richtersveld Sandy Coastal Scorpionstailveld SKs 4 – Least Concern

This vegetation unit is a fragmented band that runs parallel to the coast, 8 to 28 km inland. Its northern boundary lies at the southwestern corner of the Annisvlakte, extending southward along the Holgat River and for approximately 30 km further south. The unit also stretches from just north of the Alexander Bay and Oograbies road in a southern direction to a point halfway between Port Nolloth and Kleinzee. Covering a length of 103 km along its north-south axis, the unit spans altitudes of 100–400 m.

The terrain is slightly flatter compared to the SKr 7 Northern Richtersveld Scorpionstailveld, with distinct boundaries that are evident in satellite and aerial imagery. These boundaries are marked by darker coloration caused by the presence of dense biological soil crusts. Habitat variability within this unit is driven primarily by differences in soil types and vegetation age, which are in turn influenced by the proportion of wind-blown sands. Additionally, grazing and mining activities contribute to local variability.

The area experiences coastal fog, which provides essential moisture for vegetation and biological processes, alongside high wind speeds. However, the winds are less frequent and weaker compared to the SKs 2 Northern Richtersveld Yellow Duneveld. This unique combination of factors shapes the ecological dynamics and visual characteristics of the region. Very little of the area has been transformed and there is no information available allowing for an estimation of the past and present role of small stock grazing.

Western Gariep Plains Desert Dn 3 – Least Concern

On the plains from east of Alexander Bay and south of Grootderm, extending about 15 km to the east and south. The unit borders on Succulent Karoo Biome to the south. The landscape is primarily flat to undulating, consisting of expansive plains interspersed with occasional rocky outcrops and low hills. The soils are typically shallow, sandy to gravelly, and often alkaline, reflecting the arid conditions. The sparse vegetation plays a critical role in stabilising the soil and providing food and shelter for desert-adapted fauna.

It is hardly transformed, almost half of it by road networks. The unit is highly sensitive to mechanical destruction of the soil surface. From a South African perspective, this vegetation has a high conservation value as it houses the main populations of some near-endemic species that are more frequently found in Namibia.

The sparse yet diverse vegetation supports a variety of desert-adapted fauna, including:

- Mammals: Herbivores like *Oryx gazella* (Gemsbok) and rodents such as *Gerbillurus spp.*
- Reptiles: A rich diversity of reptiles, including geckos, skinks, and snakes like the *Bitis schneideri* (Namaqua Dwarf Adder).

3.2 Northern Cape Critical Biodiversity Areas

The Northern Cape CBA Map (2016) identifies biodiversity priority areas, called Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs), which, together with protected areas, are important for the persistence of a viable representative sample of all ecosystem types and species as well as the long-term ecological functioning of the landscape as a whole (Holness & Oosthuysen, 2016). Priorities from existing plans such as the Namakwa District Biodiversity Plan, the Succulent Karoo Ecosystem Plan, National Estuary Priorities, and the National Freshwater Ecosystem Priority Areas (NFEPA) were incorporated.

CBA's and ESA's are terrestrial and aquatic features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services. The primary purpose of CBAs is to inform land-use planning in order to promote sustainable development and protection of important natural habitat and landscapes. Biodiversity priority areas are described as follows:

- CBA's are areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. In other words, if these areas are not maintained in a natural or near-natural state then biodiversity conservation targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity-compatible land uses and resource uses. For CBAs the impact on biodiversity of a change in land-use that results in a change from the desired ecological state is most significant locally at the point of impact through the direct loss of a biodiversity feature (e.g. loss of a populations or habitat). All FEPA prioritised wetlands and rivers have a minimum category of CBA1, while all FEPA prioritised wetland clusters have a minimum category of CBA2.

- ESAs are areas that are not essential for meeting biodiversity representation targets/thresholds but which nevertheless play an important role in supporting the ecological functioning of critical biodiversity areas and/or in delivering ecosystem services that support socio-economic development, such as water provision, flood mitigation or carbon sequestration. The degree of restriction on land use and resource use in these areas may be lower than that recommended for critical biodiversity areas. For ESAs a change from the desired ecological state is most significant elsewhere in the landscape through the indirect loss of biodiversity due to a breakdown, interruption or loss of an ecological process pathway (e.g. removing a corridor result in a population going extinct elsewhere). All natural non-FEPA wetlands and larger rivers have a minimum category of ESA.

According to the CBA Map, the study area is located mainly in CBA 1 (irreplaceable) and CBA 2 (optimal) (Figure 3-2). The sensitivity features evaluated include the Namib Seashore Vegetation, Northern Richtersveld Yellow Duneveld, Richtersveld Coastal Duneveld, Richtersveld Sandy Coastal Scorpionstailveld, Namaqualand Salt Pans, Western Gariep Plains Desert, Conservation Areas, Threatened species, Namakwa CBA 1 and CBA 2 and associated, NPAES PA and Focus, Skep expert areas, all rivers and natural wetlands, and Large high value climate resilience areas.

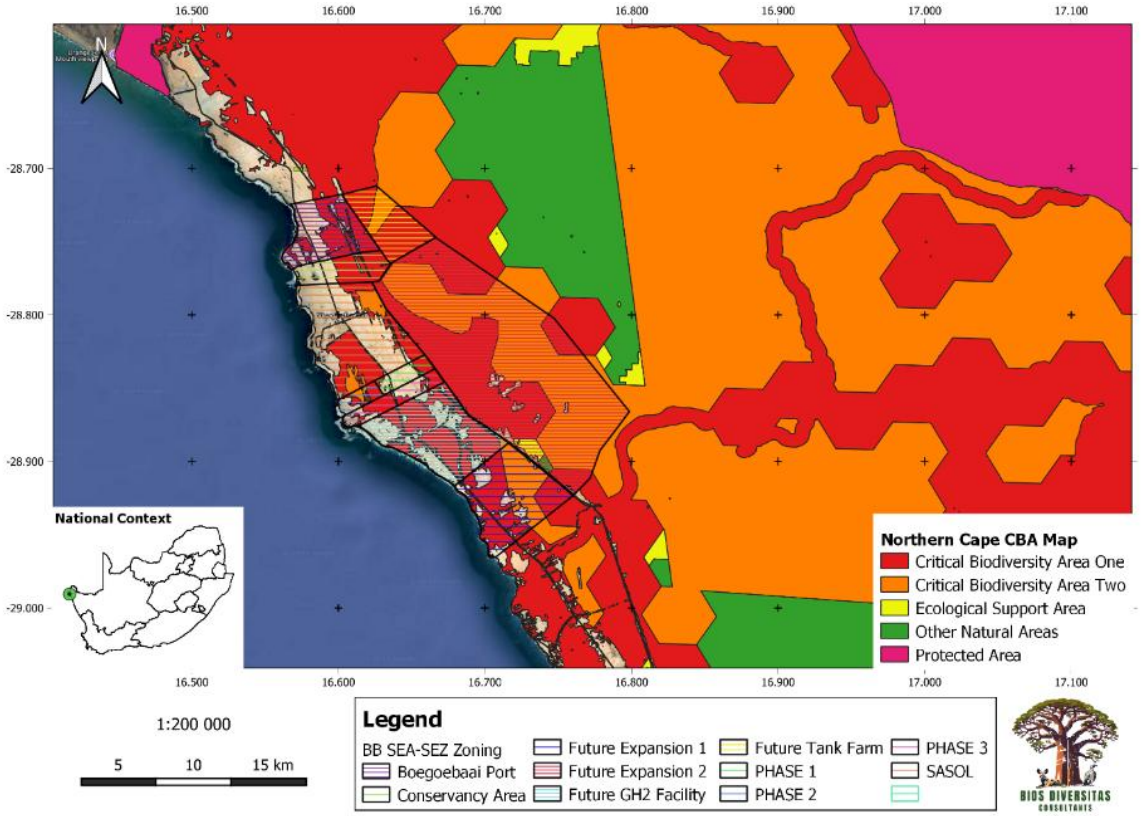


Figure 3-2: The Project Area in relation to Northern Cape CBA MAP (2016).

CBA 1: Irreplaceable are areas required to meet targets and with irreplaceability values of more than 80%, critical linkages or pinch-points in the landscape that must remain natural and Critically Endangered Ecosystems.

CBA 2: Optimal are areas selected to optimally meet biodiversity targets. Although these areas have a lower irreplaceability value than the CBA 1: Irreplaceable category, collectively they reflect the smallest area required to meet biodiversity conservation targets.

3.3 Fauna Habitats / Plant Communities

The botanists appointed for this project identified several habitats / plant communities after completing a site visit in August 2024. Overall, soil depth, texture and sand mobility appear to be the dominant drivers of vegetation composition at the site. For fauna habitats, these will be simplified into utilisation of habitat features.

3.3.1 Rocky outcrops

This habitat occurs where the basement geology is exposed, most notably on the outcrops such as the Boegoeberg (Buchu)Twins (Figure 3-3a), Namakwakop (note this is the Namakwakop on site, there is another Namakwakop to the north of the site on the topocadastral map) and around the telecommunications tower (Figure 3-3b). Parts of the lower slopes are covered by wind-blown sand and the vegetation of these areas resembles the sandy dunes. The rocky outcrop is considered a sensitive environment owing to the novel habitat it provides in a generally flat, sandy landscape and the unique vegetation associated with it.

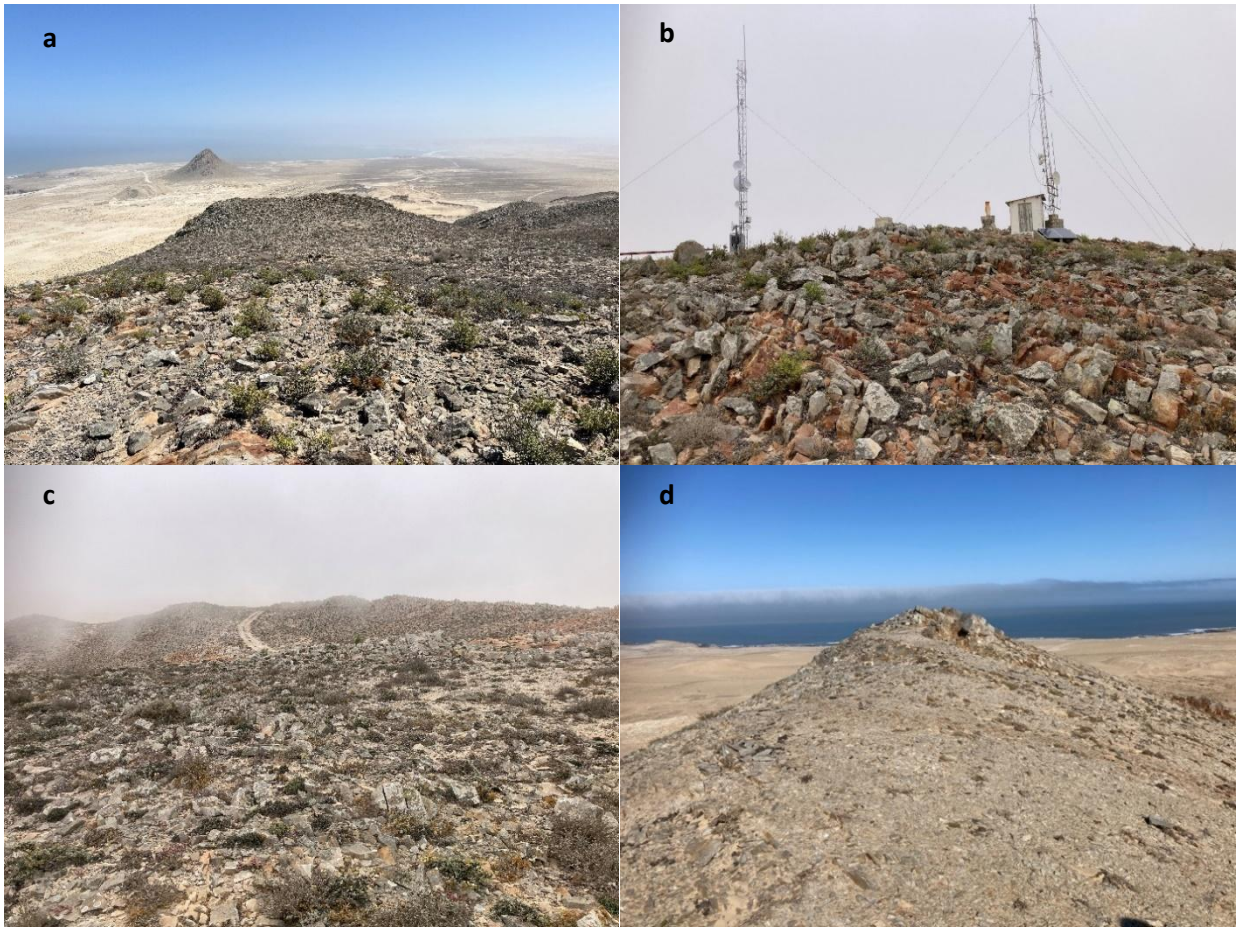


Figure 3-3: Rocky outcrop habitat at the Project Area. Photographic record of a. Boegoeberg North and South; b. telecommunications towers; c. on top of Boegoeberg South; d. Namakwakop.

3.3.2 Coastal Duneveld

The species composition recorded in this unit during the site visit agrees well with the description of the Richtersveld Coastal Duneveld provided in Mucina & Rutherford (2006). It consists of plains with low hills and rocky ridges. The sand dunes consist of both tall relatively steep dunes and low flat dunes which are well vegetated and are not mobile.

Species associated with sandy habitats are likely to occur in the dunes while those which require a firmer substrate are likely to occur in the granitic outcrops as well as on the plains. Several listed species potentially occur in the PA, these include Grant's golden mole *Eremitalpa granti granti* which is likely to occur in the dunes on the site and De Winton's golden mole *Cryptochloris wintoni* which occurs in sandy areas of the Namaqualand coastal plain and may occur within the western parts of the site. Refer to Section 3.4 below for a description of the species.

This habitat is considered of High Sensitivity as a result of the steep nature of the dunes and the potential for wind erosion in disturbed areas.



Figure 3-4: Photographic evidence of the Coastal Duneveld. Some areas still have intact vegetation, while other were disturbed historically.

3.3.3 Waterbodies

Waterbodies in the PA are scarce, but sources of water for fauna coming from Rietfontein and Visagiesfontein, embedded in the Richtersveld Coastal Duneveld, are cricital in this arid landscape (Figure 3-5). Furthermore, hollows in outcrops of granite boulders, embedded in either the Northern Richtersveld Yellow Duneveld or the Richtersveld Sandy Coastal Scorpionsveld, are filled with water during the rainy season and act as important sources of water for fauna.



Figure 3-5: Photographic evidence of waterbodies within the Project Area. a. Rietfontein; b. Visagiesfontein; c. and d. Granite outcrop known as the Klipbakke where water accumulates in hollows.

3.3.4 Plains Habitat

This habitat occurs in the south-central part of the SEZ around Duikerkop, as well as the southern and northern parts of the area mapped as Northern Richtersveld Yellow Duneveld. Based on geology and topography, it can be separated into the Lowlands- and Uplands plains habitat. Lowlands occur roughly below 100 masl which is more representative of the Richtersveld Coastal Duneveld, while the upland section is more representative of the Northern Richtersveld Yellow Duneveld occurring above 100 masl. It could be important for fauna owing to the stability of the substrate and presence of burrow systems.



Figure 3-6: Upland habitat characteristic of the Northern Richtersveld Yellow Duneveld.

3.3.5 *Transformed Areas*

These are areas that have been entirely transformed by mining activities and represent modified habitat according to IFC Performance Standard 6 (IFC, 2012, updated 2019). Very few homesteads and major road networks occur within the PA, but surface mining infrastructure and associated activities are probably the main cause of habitat loss.



Figure 3-7: Transformed habitat owing to mining activities. a. & b. mining activities; c. the modified mined habitat; d. sand dune rehabilitation.

3.4 Faunal Communities

Due to the moderate diversity of habitats and environments present, the site has a fairly rich faunal community. Several unique vegetation features within the PA, including Heuweltjies (termite mounds) associated with the Richtersveld Sandy Coastal Scorpionstailveld, shape the landscape and attribute to the faunal assemblages found within the PA. These are believed to be the oldest termite mounds in the world and serve as valuable records of prehistoric climate conditions. In addition, they also offer two mechanisms to sequester CO_2. The southern harvester termite, *Microhodotermes viator,* inhabit these Heuweltjies and play a critical role as ecosystem engineers in regulating ecosystem services by influencing the distribution of natural resources such as water and nutrients in the landscape and consequently the diversity of soil microbes, plants and animals[9].

[9] Invertebrates are scoped outside this chapter and are to be assessed via dedicated studies.

3.4.1 Mammals

Based on available information for the larger area, approximately 40 mammal species could occur at the PA (refer to sections 0 and 0). Due to the relatively moderate diversity of habitats available, not all of these are likely to occur at the PA. For example, rocky habitats are limited within the PA for medium sized mammals associated with this habitat. This is less significant for small mammals which are likely to utilise rocky outcrops in this arid landscape. Due to the mobility and broad habitat tolerances of larger mammals, they are not likely to be highly sensitive to the development of the area. The site is ideal for smaller mammal communities and a relatively large number of rodents, shrews, moles and mole rats occur in the surrounding area. Common species observed in and within the vicinity of the PA include *Parotomys brantsii*, *Micaelamys namaquensis* and *Otomys unisulcatus* and some medium to larger species such as *Oryx gazella, Parahyaena brunnea and Felis lybica* (refer to sections 0 for iNaturalist records). According to Pieter van Wyk, the largest population of Brant's whistling rats (*P. brantsii*) in South Africa likely occurs within the PA, just north of Duikerkop. This is significant from an ecosystem services perspective as *P. brantsii* act as an ecosystem engineer, playing a vital role in the plant community composition and structure.

Species associated with sandy habitats are likely to occur in the coastal duneveld while those which require a firmer substrate are likely to occur in the rocky outcrops as well as in the uplands. At least four SCC potentially occur in the PA (refer to section 3.6), including De Winton's Golden Mole *Cryptochloris wintoni* (listed as Critically Endangered) which occurs on coastal dunes and adjacent sandy areas in Strandveld of the Namaqualand coastal plain and Grant's Golden Mole *Eremitalpa granti granti* (listed as Vulnerable) which is likely to occur in the coastal duneveld. Refer to section 3.5.2 for species description.

3.4.2 Reptiles

As many as 58 reptiles may occupy the PA (refer to sections 0 and 0), indicating that the area has a high reptile diversity. The reptiles comprise two orders (Testudines – turtles, and Squamata – lizards and snakes), consisting of three tortoises, two chameleons, 15 snakes and 38 lizards (including geckos and skinks). This indicates that the area is particularly rich in lizards and snakes, verified by the presence of 21 species at the PA. Even though tortoises prefer the rocky outcrops to the east of the PA, records of *Chersina angulata* indicate that they frequent the PA, especially along the R382 where they are vulnerable to collisions with motor vehicles (current impact). Accordingly, tortoises may be negatively impacted by the proposed development from vehicle collisions as well as predation by avian predators while traversing open areas.

Attractive species such as chameleons, lizards and tortoises are also vulnerable to collection for use as pets or trade, and the increased accessibility resulting from the new roads that will be constructed as part of the development would raise the risk for these species.

Five SCC may occur in the area (refer to section 3.6), of which two are listed as Critically Endangered, two as Endangered and one Near Threatened. Only two species, *Pachydactylus rangei* and *Bitis schneideri*, are likely to occur at the PA owing to sparse rocky outcrops for tortoises and limited sandy beaches for turtles. These species are associated with sandy habitats (dunes) and are likely to be most affected by proposed developments. The impact of the port development on turtles needs to be investigated.

3.4.3 Amphibians

As a result of the scarcity of fresh water in the area, only three species are likely to occur at the site. The Namaqua Caco *Cacosternum namaquense* is dependent to a greater or lesser degree on surface water for habitat or breeding purposes. The remaining species are either largely independent of water such as *Breviceps macrops* or well adapted to arid conditions such as the two *Vandijkophrynus* species.

The desert rain frog *Breviceps macrops* occurs in Strandveld vegetation up to 10 km from the coastline and has recently been uplisted from Near Threatened to Vulnerable. The species has been recorded on site (Van Wyk, 2024) and between the PA and the Holgat River towards the south. Waterbodies in the PA are scarce but areas like Rietfontein and Visagiesfontein provide suitable habitat for amphibians, even if just temporary or seasonally.

3.4.4 Database searches: iNaturalist

As a crowdsourced species identification system, iNaturalist is an online social network of people sharing biodiversity information to help each other learn about nature. It helps you to identify the plants and animals around you while generating data for science and conservation. It also operates as an organism occurrence recording tool where access to observational data collected by iNaturalist users can be utilised by members. It is not a repository for external data, and as such there are limitations to its use. If the PA is undersampled owing to its location from major cities/towns, accessibility or observer bias, the quality and quantity of data should be considered in this context. Accordingly, a larger area should be searched for to obtain an observed and expected list of species which could intersect the PA.

For this project, a boundary was drawn from Oranjemund, Namibia, in the North to Port Nolloth in the South (Figure 3-8). Filters applied included selecting only amphibians, reptiles and mammals to obtain an observed list of 56 species for the PA (Figure 3-9). Of these, approximately 15 mammal species, 37 reptile species and 4 amphibian species distribution ranges potentially intersect the PA.

For fauna SCC, the extent was increased to the east towards Richtersveld and Jakkalsputs as observations of sensitive species are obscured and the point locality is therefore not accurate (Figure 3-10). From this, nine fauna SCC have been observed within the larger area (Figure 3-11).

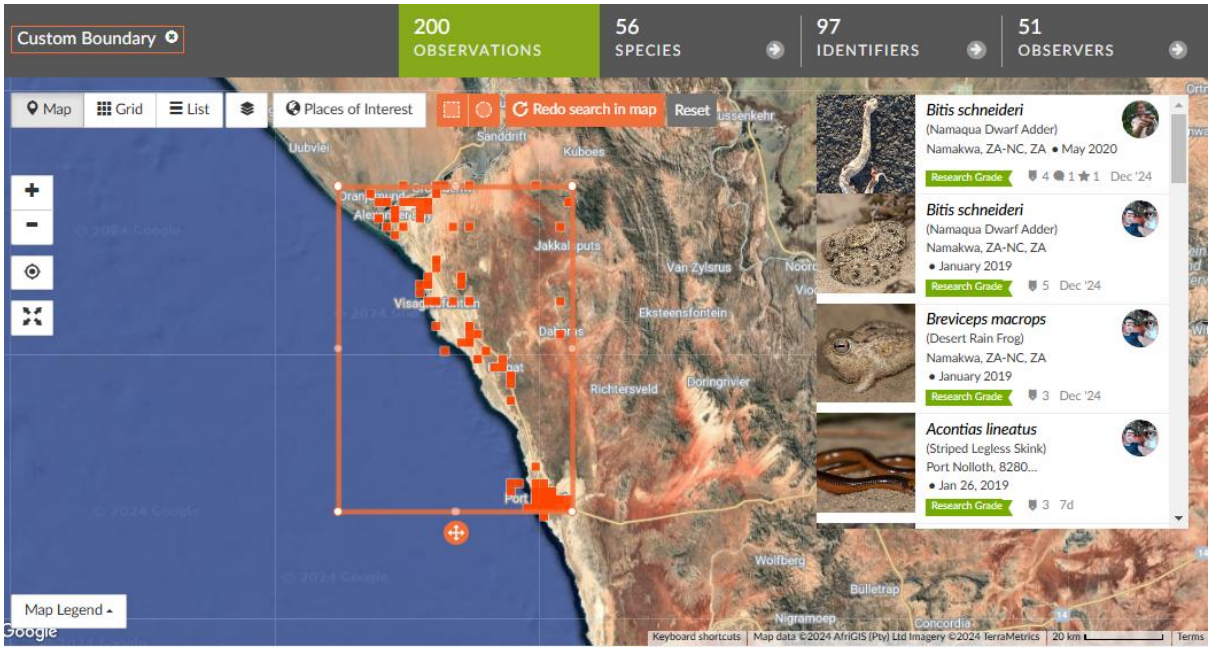


Figure 3-8: Fauna species records for the local Boegoebaai Port and SEZ (Source: iNaturalist:).

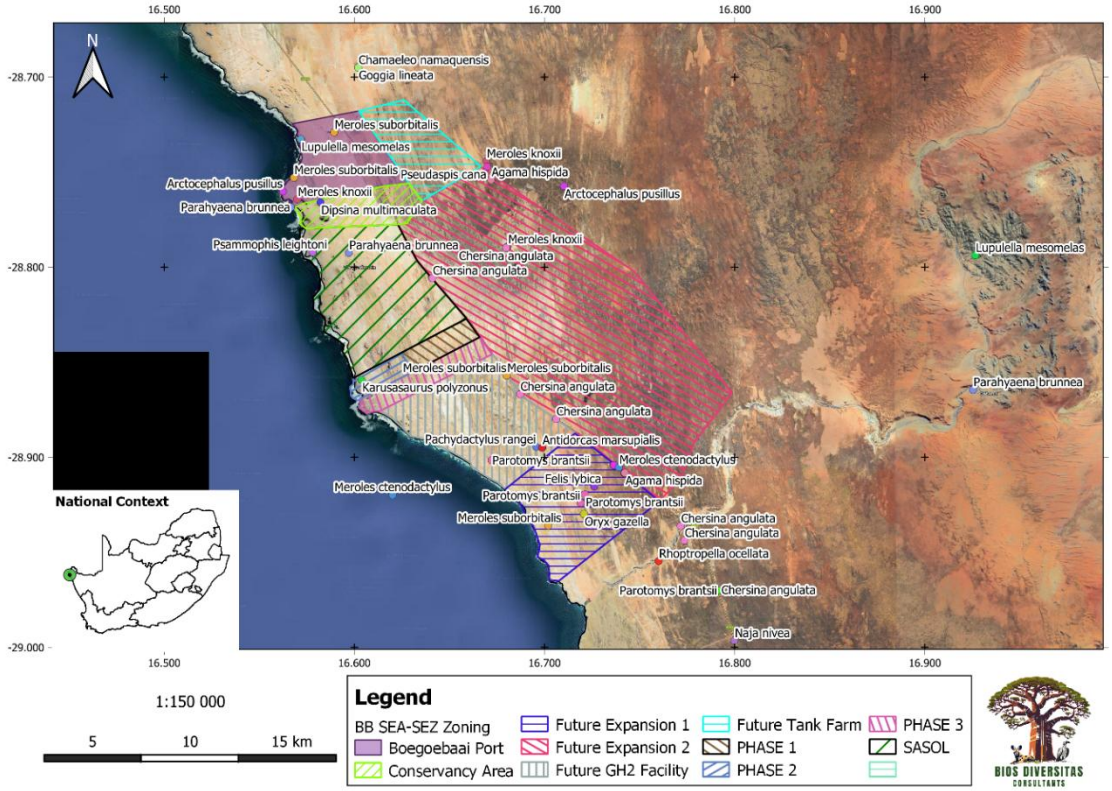


Figure 3-9: Map indicating the records of 56 species as per iNaturalist observations for the Project area.

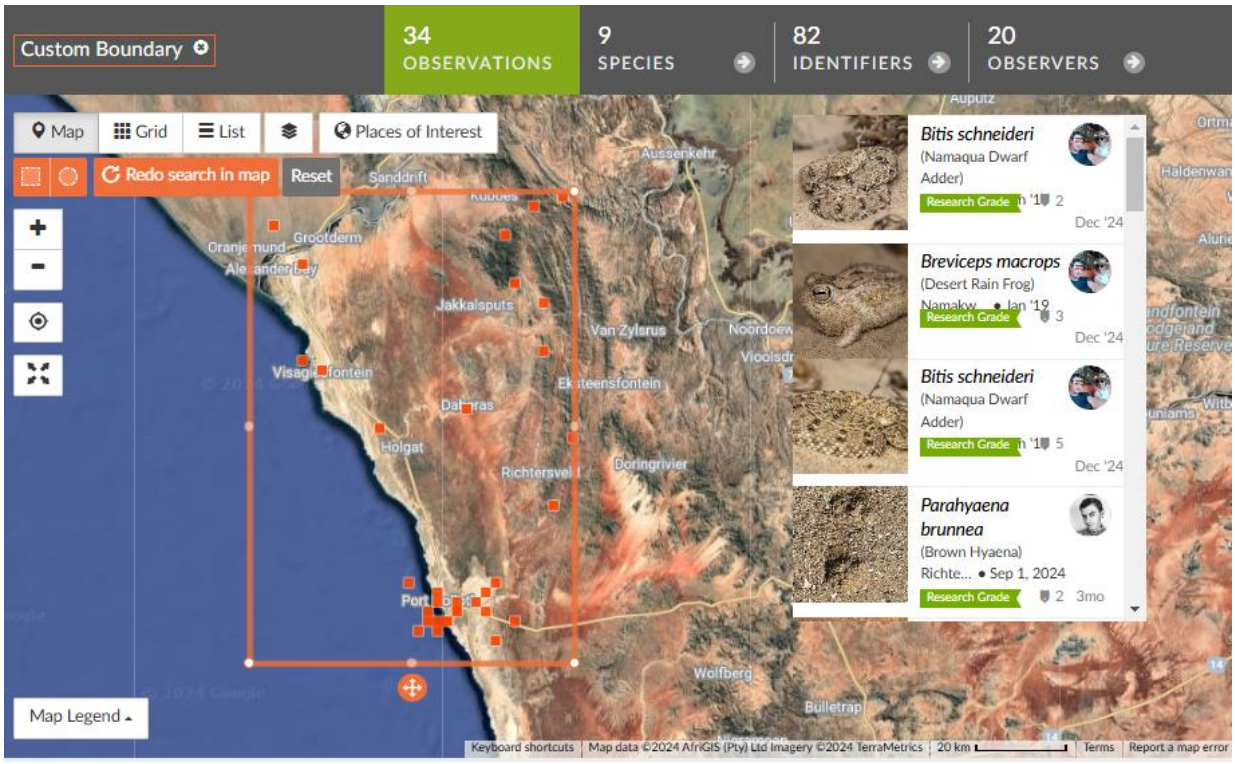


Figure 3-10: Fauna species of conservation concern records for the local Boegoebaai Port and SEZ (Source: iNaturalist).

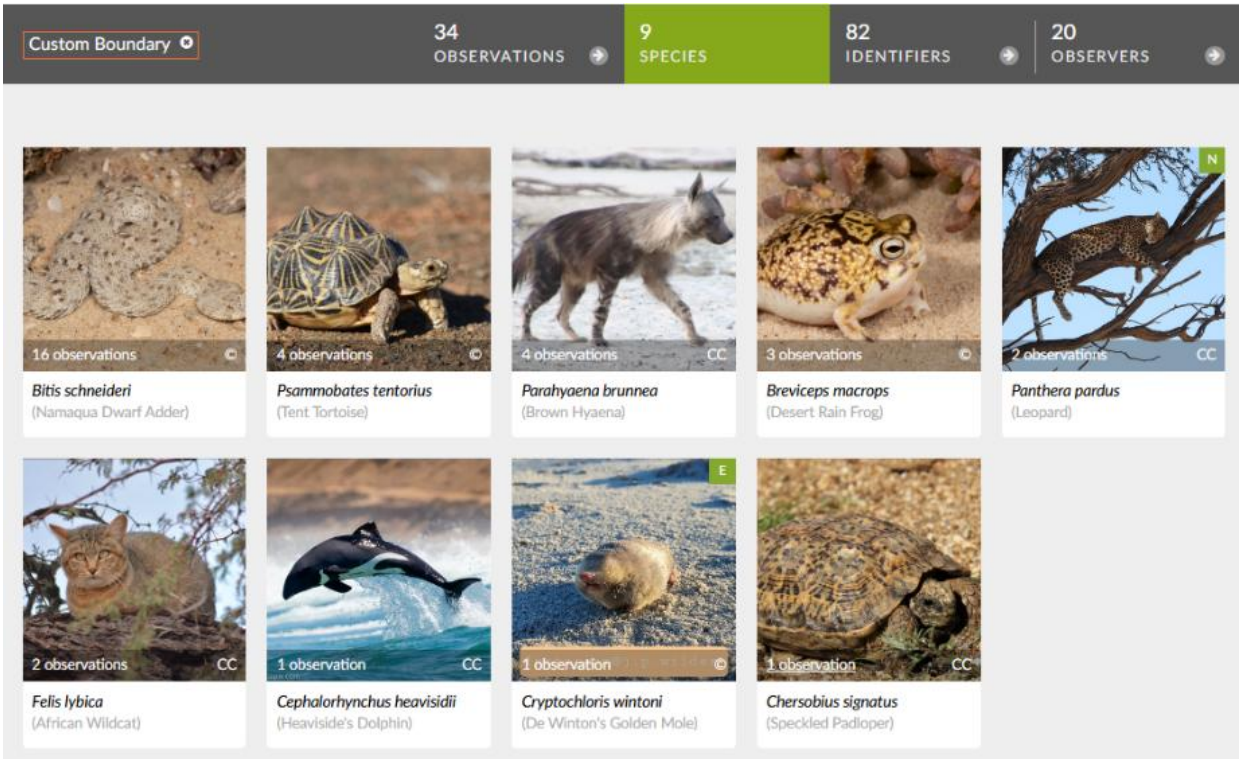


Figure 3-11: Nine fauna species of conservation concern observed at a local scale (Source: iNaturalist).

3.5 Threatened Fauna and Species of Conservation Concern

A list of 12 fauna SCC was generated based on available secondary data for the region, as indicated in Table 3-1. Of these, five (5) are reptiles (indicated in light orange), five (5) are mammals (indicated in light blue) and two amphibians (indicated in light green). Three (3) species are listed regionally as Critically Endangered (CR), three (3) species as Endangered (EN), two (2) species as Vulnerable (VU), three (3) species as Near Threatened (NT) and one Data Deficient (DD) species.

Table 3-1: Expected List of Fauna Species of Conservation Concern for the Project Area. Red List based on Regional (R)[10] and IUCN Global (G) status. (Status: NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered).

Scientific Name	Common Name	Red List Status	Likelihood
Chersobius signatus	Speckled Cape Tortoise	EN (R, G)	Moderate to Low
Psammobates tentorius trimeni	Western Tent Tortoise	EN (R, G)	Moderate
Pachydactylus rangei	Namib web-footed gecko	CR (R)	High
Bitis schneideri	Namaqua Dwarf Adder	NT (R)	High
Dermochelys coriacea	Leatherback Sea Turtle	CR (R); VU (G)	Moderate
Cryptochloris wintoni	De Winton's Golden Mole	CR (R)	High
Eremitalpa granti granti	Grant's Golden Mole	VU (R)	High
Hyaena (Parahyaena) brunnea	Brown Hyaena	NT (R)	High
Panthera pardus pardus	African Leopard	VU (G)	Moderate
Bathyergus janetta	*Namaqua* Dune Mole-rat	Uplisted to Endangered	High
Breviceps macrops	Desert Rain Frog	VU (R, G)	High
Breviceps branchi	Branch's Rain Frog	DD (R, G)	High

[10] Mammals, Amphibians and Reptiles

3.5.1 Herpetofauna

Psammobates tentorius trimeni Western Tent Tortoise – Endangered A4ce

P. t. trimeni is restricted to the winter-rainfall region dominated by dwarf succulent shrubs and annuals, concentrated in the Namaqualand Sandveld and Richtersveld Bioregions and extends peripherally into the Namaqualand Hardeveld Bioregion (Figure 3-12, Figure 3-13). This subspecies is assessed to be **Endangered** under criterion A4ce (Hofmeyr *et al*. 2018[a]) owing to continuous detrimental impacts on its sensitive habitat as discussed below.

The range of *P. t. trimeni* is small and restricted to a few vegetation units of the western Succulent Karoo, which are under continued pressure from multiple impacts from overgrazing, destructive or illegal mining, and unsustainable land use involving ploughing of natural veld for fodder cropping, uncontrolled harvesting of natural products, and irresponsible tourism activities in sensitive areas (Bourne *et al*. 2012).

Furthermore, predictions are that climate change will bring an increase in temperature and a decrease in rainfall, with increased aridity in the western Succulent Karoo (Bourne *et al*. 2012). Such changes would increase grazing pressure in this region, which is expected to affect the status of *P. t. trimeni* adversely. It is estimated that >30% of the taxon's habitat has been destroyed over the past 40 years (1.5 generations) and that future changes in habitat over the next 40 years (1.5 generations) will be at least of equal proportions, with a total reduction in population size in excess of 50%. Available information indicates that Pied Crow (*Corvus albus*) predation on this taxon is increasingly severe, with anthropogenic facilitation having led to increased abundance of this species in western South Africa over the past three decades (Cunningham *et al*. 2016), making increased predation on *P. t. trimeni* highly likely, especially in conjunction with the current (and predicted) prevailing South African drought.

P. tentorius is included in CITES Appendix II and is protected in South Africa by provincial nature conservation ordinances and biodiversity laws at regional level. Conservation measures to protect the habitat of *P. t. trimeni* are essential, as well as basic research on the taxon's demographics, ecology, and status.

Based on IUCN range data for the higher taxon group and observational records (Figure 3-13), the species is likely to occur in the PA but is found mainly towards the east of the PA in the Richtersveld (this could be due to a lack of observational data). Accordingly, the PA has suboptimal suitable habitat for the species and it is likely to occur in lower numbers. The rocky areas including Boegoeberg North and South and Visagiesfonteinkop could be important climate refugia for the species in the future, but less likely than the Richtersveld towards the east of the PA. The species is considered to have a medium sensitivity for the PA.

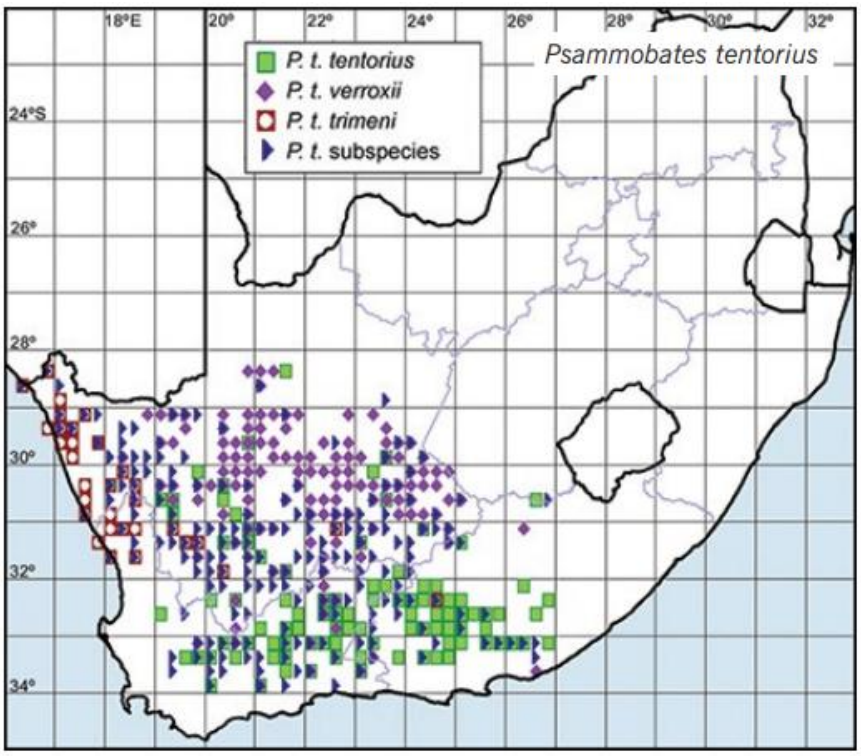


Figure 3-12: Distribution maps based on museum and other records for all *Psammobates tentorius* subspecies (Source: Bates et al. 2014).

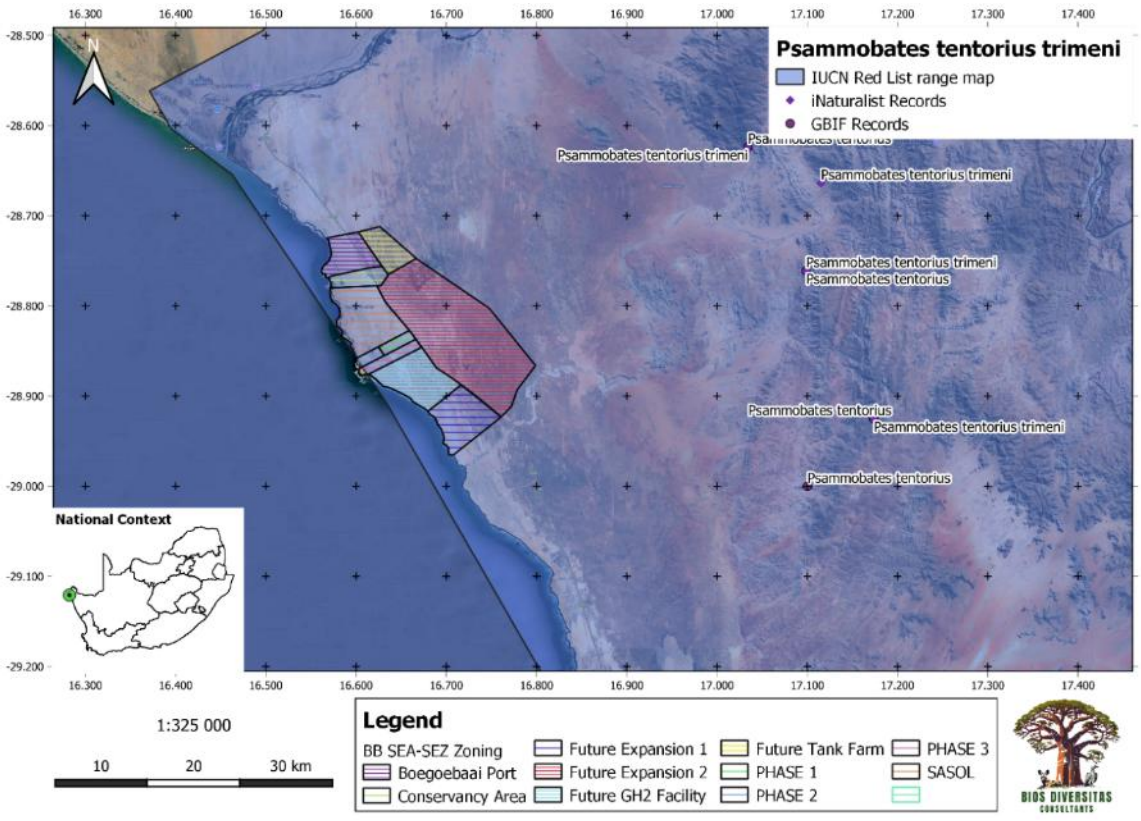


Figure 3-13: IUCN distribution range, iNaturalist and GBIF records for *Psammobates tentorius trimeni* in relation to the Project Area.

Dermochelys coriacea Leatherback Sea Turtle – Critically Endangered (Regionally); Vulnerable (Globally)

Leatherbacks are distributed circumglobally, with nesting sites on tropical sandy beaches and migratory and foraging ranges that extend into temperate and sub-polar latitudes (see Eckert *et al*. 2012 for review). The Southwest Indian subpopulation nests along the Indian Ocean coast of South Africa and Mozambique, and marine habitats extend through the Agulhas Current around the Cape of Good Hope in the Indian and Atlantic Oceans. Accordingly, the Southwest Indian Ocean distribution range of the Leatherback Sea Turtle overlaps the PA (Figure 3-14).

Considering the small number of mature individuals (estimated 148 adult males and females total in this subpopulation) and the evidence of a small but continuing decline, assessment of available data under Criterion C resulted in a **Critically Endangered** classification C2a(ii) (Wallace *et al*. 2013).

Even though the PA is not identified as a nesting beach, historical tracking records indicate the species presence in the marine habitat of the Atlantic Ocean, but no observations of the species have been recorded along the west coast between Alexander Bay and Port Nolloth. The rocky cliff areas and diamond mining at the PA are a hinderance for the species to gain access to the sandy beaches, while small patches of the Namib Seashore Vegetation could be utilised by the species.

It is recommended during the EIA application phase to survey the remnant patches along the coast to establish sightings and suitable habitat for the species. It is unlikely that the species could represent a fatal flaw to the project, but in the absence of sufficient field data the precautionary principle must be followed.

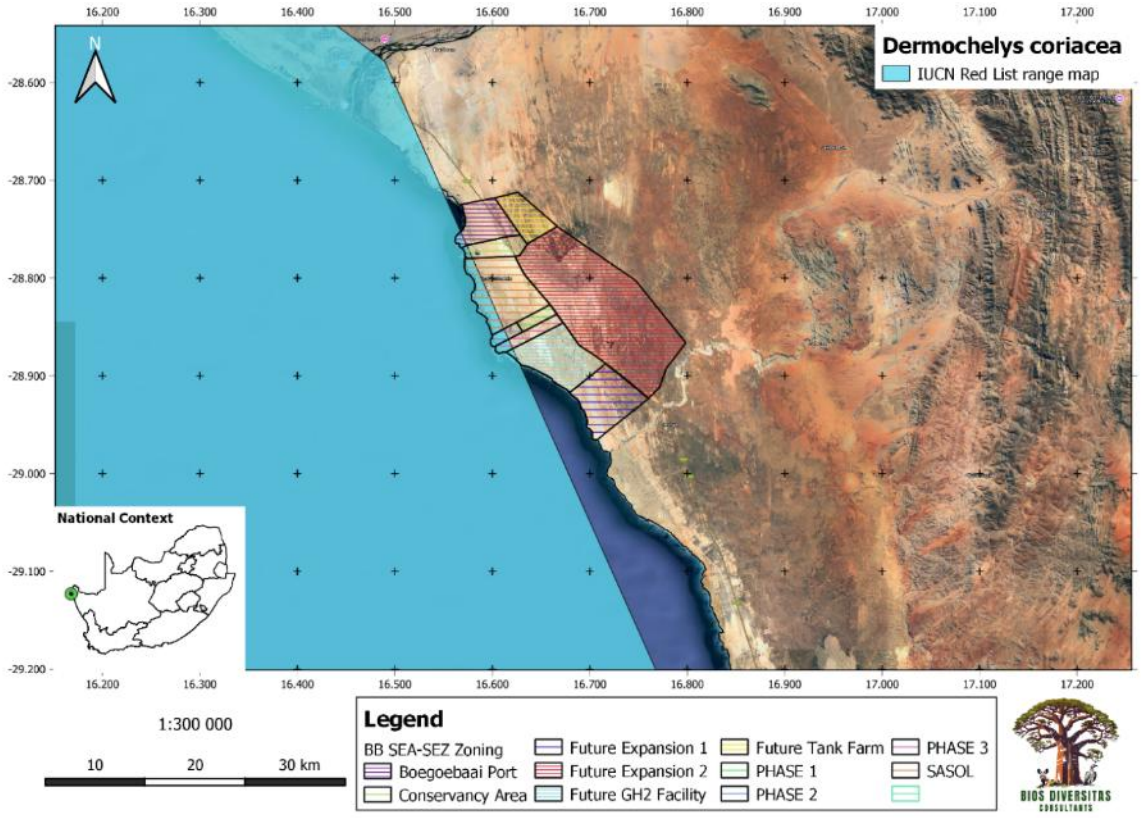


Figure 3-14: IUCN distribution range for *Dermochelys coriacea* in relation to the Project Area.

Chersobius signatus Speckled Cape Tortoise – Endangered A4ace

Previously included in the genus *Homopus*, this species is now considered to be in the genus *Chersobius* as adopted by Turtle Taxonomy Working Group (TTWG, 2017) and subsequently verified by morphological analysis (Hofmeyr and Branch 2018). *C. signatus* is endemic to South Africa, mainly present along the West Coast region. The most northerly records are from the Richtersveld (Bauer and Branch 2001; iNaturalist record 507286, May 2018). The species occurs predominantly in the winter rainfall region of the northwestern Succulent Karoo and Fynbos biomes from a few metres above sea level on the West Coast to elevations of around 1,000 m in the interior at Springbok, Loeriesfontein-Calvinia, and the Cederberg Range. It can be found in low to medium-high Namaqualand succulent blomveld and heuweltjieveld, and fynbos and strandveld shrub vegetation. The species shows a particular preference for rocky terrain (Loehr 2002), which includes typical Namaqualand and Hardeveld granite koppies in the north.

Based on IUCN range data and iNaturalist records (Figure 3-15), the species is unlikely to occur in the PA as it prefers rocky terrain towards the east of the PA in the Richtersveld. Accordingly, the PA has suboptimal suitable habitat for the species and is unlikely to frequent the PA. The species is considered to have a low to medium sensitivity for the PA.

It is estimated that a population reduction of at least 30-40% over the past 25-50 years (1-2 generations) is likely due to anthropogenic land transformation and other threats, where the causes of destruction have not ceased. The reduction in population size is based on surveys that showed habitat destruction and degradation, fragmentation, and the extirpation of populations, a decline in area of occupancy (AOO) and habitat quality (Hofmeyr *et al.*, 2018), as well as an increase in predation by invasive Pied Crows, further amplified by climate change where the western Succulent Karoo is expected to increase in temperatures and decrease in rainfall, causing an increase in aridity which could affect growth rates and fecundity of females and ultimately the survival of the species (Bourne *et al*. 2012; Loehr & Henen 2007, 2009, Loehr *et al*. 2011). Accordingly, the species qualifies as **Endangered** under criteria A4ace.

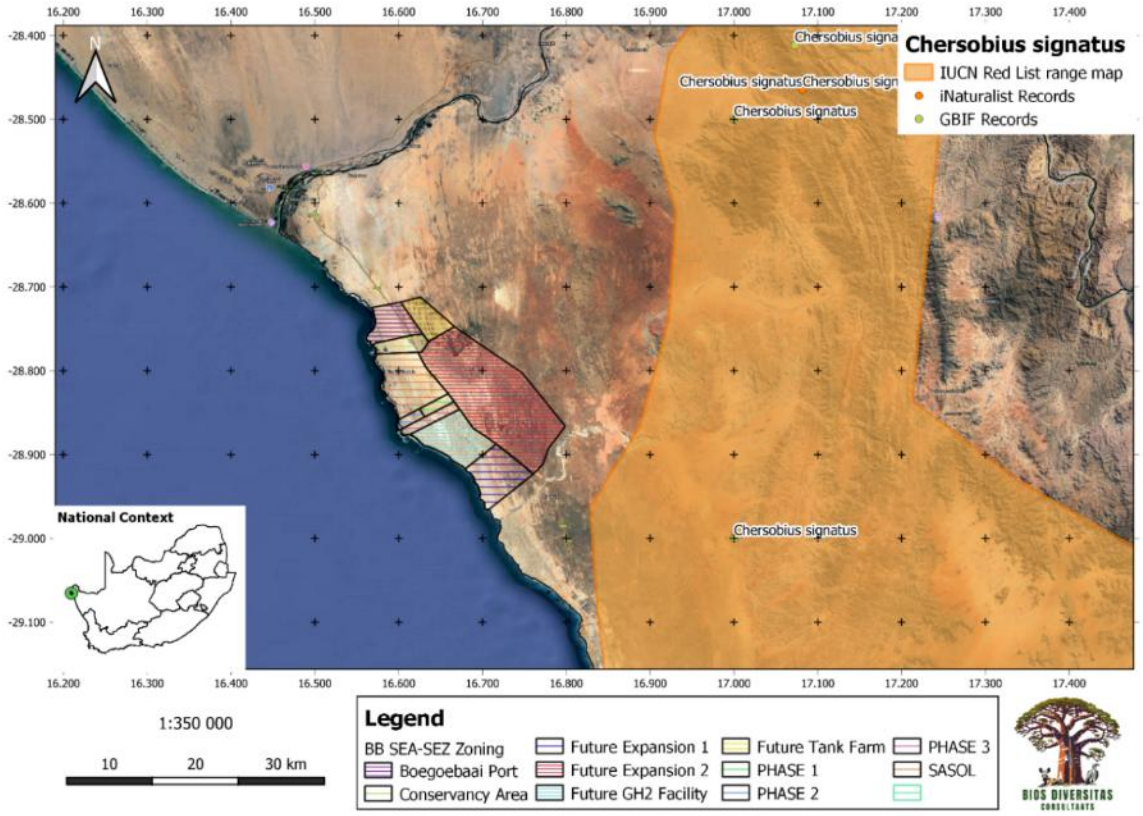


Figure 3-15: IUCN distribution range, iNaturalist and GBIF records for *Chersobius signatus* in relation to the Project Area.

Pachydactylus rangei Web-footed Gecko – Critically Endangered (Regionally); Least Concern (Globally)

The Namib Web-footed Gecko, *P. rangei*, is a nocturnal dune-dwelling gecko endemic to southern Africa. Little is known about the population characteristics and spatial ecology of the species. Home range analyses are crucial for providing information on species movement patterns and habitat preferences (Buchanan *et al*. 2023). It is however known *P. rangei* females lay eggs mainly between November and March, sometimes as late as May (Goldberg, 2008; Haacke, 1976) which is important for proposed developments to reduce construction phase impacts during this period.

It occurs in Desert and Coastal Sand Dune habitats in the Northern Cape of South Africa and northwards along the coast of Namibia into southern Angola. It is typically associated with wind-blown sands along the coast and desert (Branch 1998). They are nocturnal, spending the day in a tunnel in the sand (Branch 1998). This terrestrial species has a marginal extension into South Africa where it is threatened by alluvial diamond mining and is considered **Critically Endangered** (Bates *et al*. 2014). Elsewhere, it has an extensive range in the desolate dune seas of the Namib Desert in Namibia and Angola (where it is abundant, with a stable population) where it is listed globally as **Least Concern** (Baptista *et al*. 2020). The regional assessment might have to be reevaluated considering the species abundance and extensive range as well as taking into consideration the continuous detrimental impacts on the species habitat, especially within the coastal duneveld habitats along the coast owing to diamond-mining in South Africa.

The PA intersects with the species distribution range, with one iNaturalist record and two additional records from GBIF (Figure 3-16). Accordingly, the presence of the species in the PA, especially within the coastal duneveld habitat is considered of high sensitivity. Additional mitigation measures will be required during the species breeding period for the construction phase.

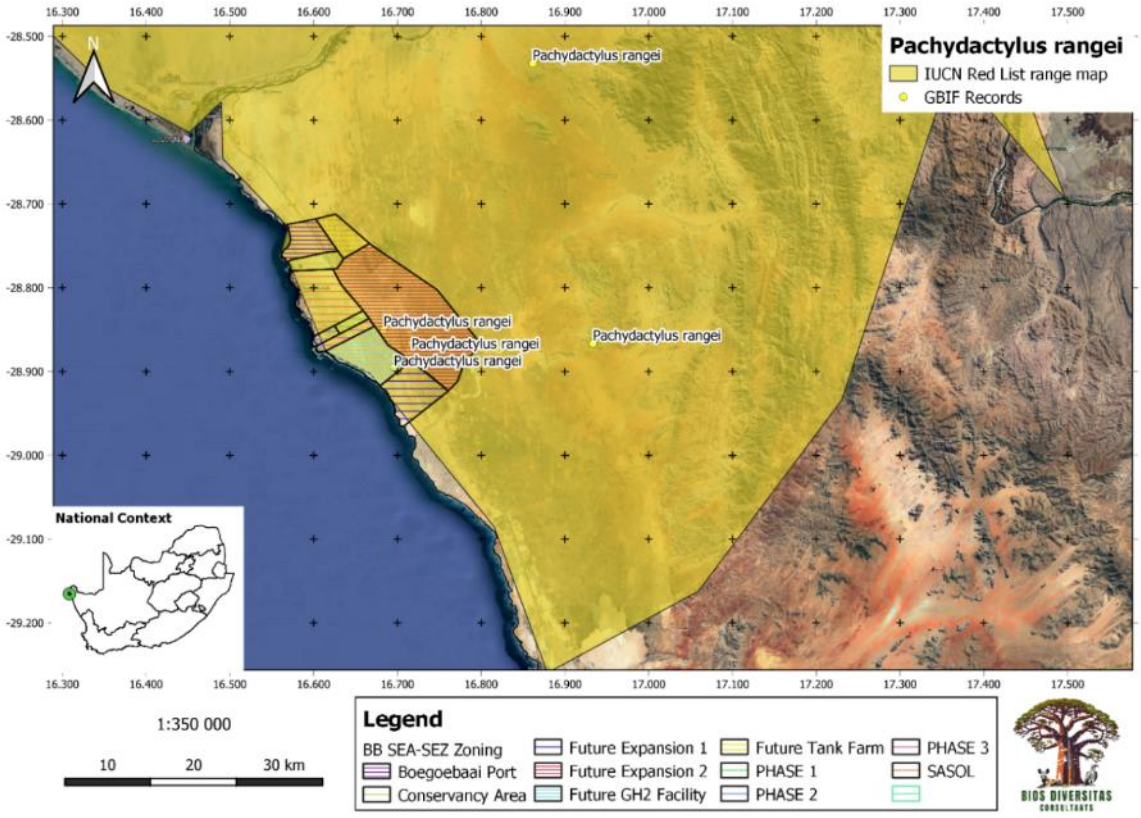


Figure 3-16: IUCN distribution range and observation records of *Pachydactylus rangei* in relation to the Project Area.

Bitis schneideri Namaqua Dwarf Adder – Near Threatened (Regionally); Least Concern (Globally)

The species is endemic to southern Africa and found from the mouth of the Olifants River in the Western Cape, South Africa, northwards to Lüderitz Bay in southwestern Namibia (Branch 1998, Bates et al. 2014). The species is considered well protected, has a moderately sized distribution (15,300 km^2) and a large extent of occurrence (EOO = 27,100 km^2) that shows no evidence of decline in extent.

The species is a habitat specialist with a small distribution across a region of South Africa that is impacted by habitat transformation due to mining and urbanisation, but the habitat loss is relatively small compared to the species overall range. Accordingly, the species is considered Least Concern globally (Tolley *et al*. 2019). It inhabits semi-vegetated sandy desert areas, mostly close to the coast. These snakes occur at high population densities, experience relatively high annual mortality (Maritz and Alexander 2012), which is counter-balanced by frequent reproduction (Maritz and Alexander 2013). They are generalist predators that consume a wide range of small-bodied vertebrates (Maritz and Alexander 2014).

The PA intersects with the species distribution range, and several iNaturalist and GBIF records occur within the vicinity of the PA (Figure 3-17). It is likely that the species could occur in the PA and the species is considered moderate sensitivity for the PA. Appropriate mitigation measures will be required to reduce negative impacts and to enhance the species habitat and movement.

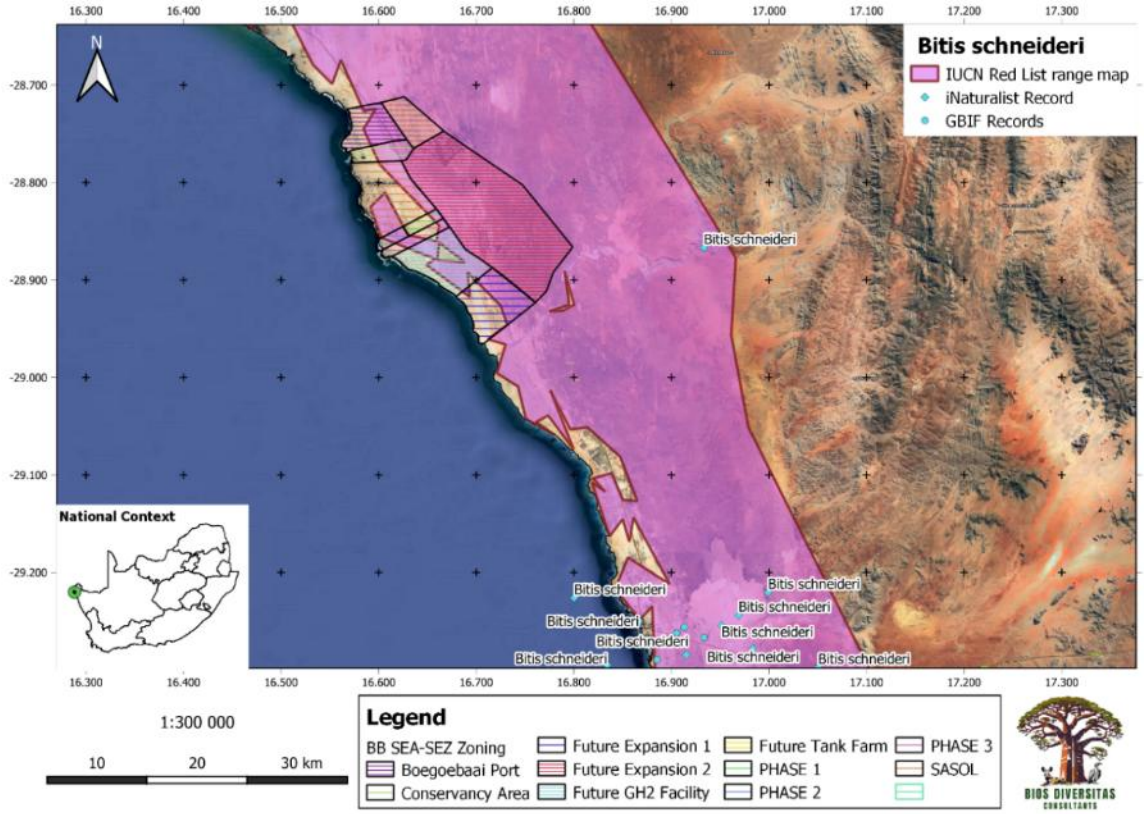


Figure 3-17: IUCN distribution range and observation records of *Bitis schneideri* in relation to the Project Area.

Breviceps macrops Desert Rain Frog – Uplisted to Vulnerable

B. macrops has recently been uplisted from Near Threatened to **Vulnerable** owing to changes in government policy that will increase approved mining in the region. The species occupies a narrow coastal strip along the northwestern Namaqualand coast, from Alexander Bay (2816CB) southward as far as the farm Skulpfontein north of Koingnaas (3017AB). Distribution data for this species are scarce, as much of the area it occupies lies within diamond-mining concessions and is not easily accessible. The available data are restricted mainly to areas lying outside the mining concessions and are therefore incomplete.

The species is restricted to Richtersveld Coastal Duneveld (SKs 1) and Namaqualand Coastal Duneveld (SKs 8), in the Succulent Karoo Biome, where it inhabits sand dunes vegetated by low, succulent shrubs and other xerophytes. These plants usually cover the crests of the dunes which are separated by open areas of bare sand. The dunes are mostly formed by white, calcareous sand, but reddish dunes occur at some localities where the species is known to occur. This species appears to be only active during dense fog conditions.

The PA intersects with the species distribution range, and several GBIF records indicate the species presence adjacent the PA (Figure 3-18). It is highly likely that the species occur in the larger PA, as Van Wyk (2024) confirmed the presence of a large colony at Visagiesfontein hill. A detailed assessment is required during the EIA application phase to record suitable habitat and understand the extent of the species distribution throughout the PA. The impact of the proposed development on the species needs to be assessed in detail to identify if any residual impacts may remain.

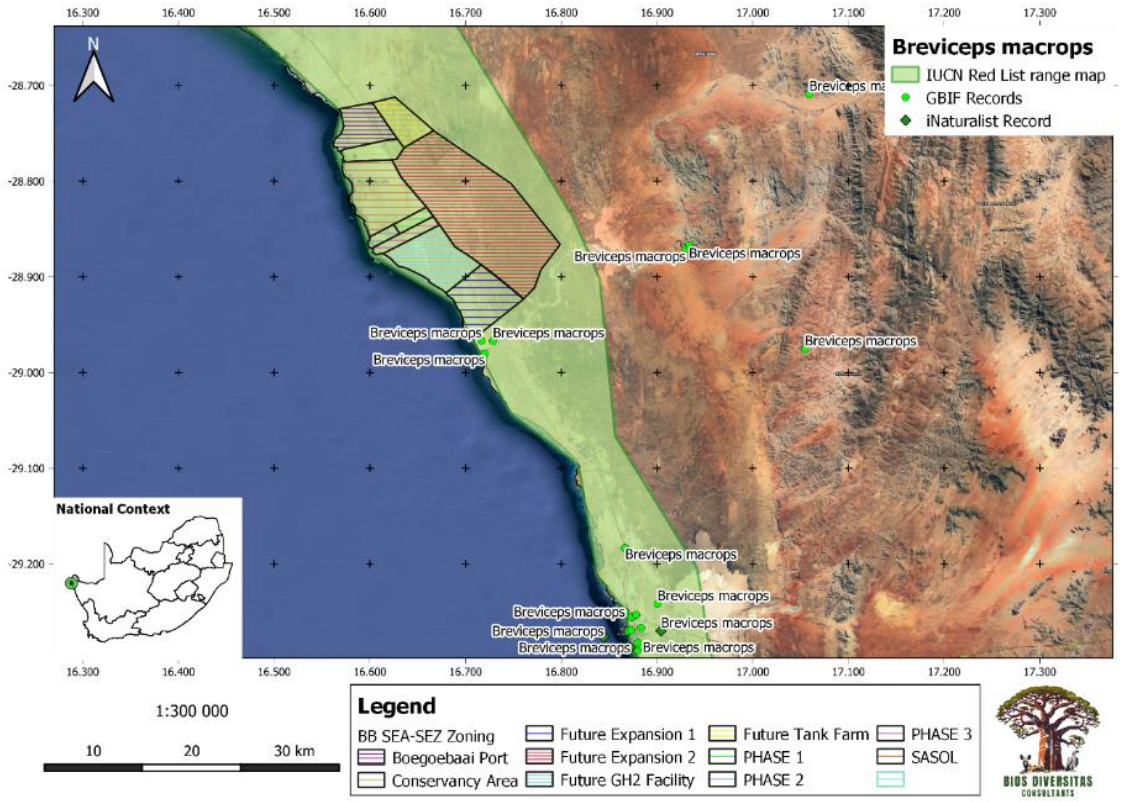


Figure 3-18: IUCN distribution range and observation records for *Breviceps macrops* in relation to the Project Area.

Breviceps branchi Branch's Rain Frog – Data Deficient

The global distribution of *Breviceps branchi* is currently restricted to its type locality on the arid west coast of the Northern Cape. The holotype was collected approximately 600 m west of the Holgat River bridge along the Port Nolloth–Alexander Bay Road, at low elevation (~120 m a.s.l.). It must be emphasised, however, that this narrow-recorded range likely reflects inadequate survey effort rather than a definitively known range; nonetheless, until further records are obtained, impact assessment must assume that the species may be extremely range-restricted.

Branch's Rain Frog *Breviceps branchi* is an elusive described frog species endemic to the west coast of the Northern Cape, South Africa. It is currently assessed as Data Deficient (DD) on available red list assessments, reflecting the very limited information on its distribution, population size and trends, and ecological requirements. The species is known only from a single specimen (the holotype) collected near the Holgat River between Port Nolloth and Alexander Bay (Channing 2012). Despite several subsequent targeted surveys in the vicinity of the type locality, only three other records have been made in the same proximity of the type locality.

Although the formal listing is DD, from a specialist perspective the species should be treated as of very high conservation concern. The combination of an extremely restricted known range, apparent rarity, and overlap with areas subject to current and proposed industrial and mining activities creates a plausible risk that localised habitat loss could translate into a significant or even global reduction in conservation status. In the absence of robust distribution and population data, the precautionary principle is strongly applicable and B*. branchi* should effectively be managed as if it were a highly range-restricted (its extent of occurrence (EOO) is 10 km^2), threatened micro-endemic.

At the type locality, the frog was collected on deep red sands within vegetation classified as Northern Richtersveld Yellow Duneveld, part of the Succulent Karoo biome. The habitat comprises low, open duneveld with scattered shrubs on loose to semi-consolidated sands. Based on habitat at the type locality and the ecology of congeners, *Breviceps branchi* is inferred to be a fossorial, soil-dependent species occupying scrub-covered sandy areas. Members of the genus *Breviceps* typically spend most of their lives underground in burrows within loose soils, emerging mainly during or after rainfall events to forage and breed.

Much of the immediate terrestrial footprint falls within arid coastal Succulent Karoo and associated duneveld systems that are structurally and bioclimatically similar to those at the *B. branchi* type locality. The receiving environment therefore includes potential habitat for this species, although its actual presence at Boegoebaai has not yet been confirmed or ruled out through systematic amphibian surveys. If *B. branchi* is confirmed within the development footprint or its immediate buffer, direct loss of habitat would translate into a proportional loss of local population size, with limited opportunity for recolonisation from adjacent areas due to poor dispersal ability and intervening barriers.

A detailed assessment is required during the EIA application phase to record suitable habitat and understand the extent of the species distribution throughout the PA. The impact of the proposed development on the species needs to be assessed in detail to identify if any residual impacts may remain. If recorded, the presence of the species likely represents a fatal flaw to the project.

3.5.2 Mammals

Cryptochloris wintoni De Winton's golden mole – Critically Endangered

The De Winton's Golden Mole occurs on coastal dunes and adjacent sandy areas in Strandveld of the Namaqualand coastal plain of the Northern Cape (Bronner 2013). The species is known from only the type locality at Port Nolloth, Northern Cape Province and has recently been rediscovered after 86 years. The species was last seen in 1937 on the north-western coast of South Africa, and later declared "lost" to science, presumably extinct.

In July 2021, a team of conservationists and geneticists[11] began an expedition along the west coast to Port Nolloth (Mynhardt et al. 2024), the only site where De Winton's Golden Mole had ever been found. Several sites along a 300 km stretch of coastline, from the Groen River mouth northwards to Alexandra Bay were surveyed. In November 2022, after tracking its environmental DNA through the sand dunes, the species was found (Figure 3-19). Mynhardt et al. (2024) indicated that this species may be widespread in the area, ranging from Lambert's Bay in the south to Visagiesfontein (which is part of the study area), beyond Port Nolloth in the north, giving an indication that the species may be more widespread (Figure 3-20). Nevertheless, this cannot be taken to mean that the species is abundant across this distribution.

[11] from the Endangered Wildlife Trust, Stellenbosch University and the University of Pretoria



Figure 3-19: Recent Photographs of *Cryptochloris wintoni* taken by JP le Roux in November 2022 (Source: iNaturalist - Photo 337842824).

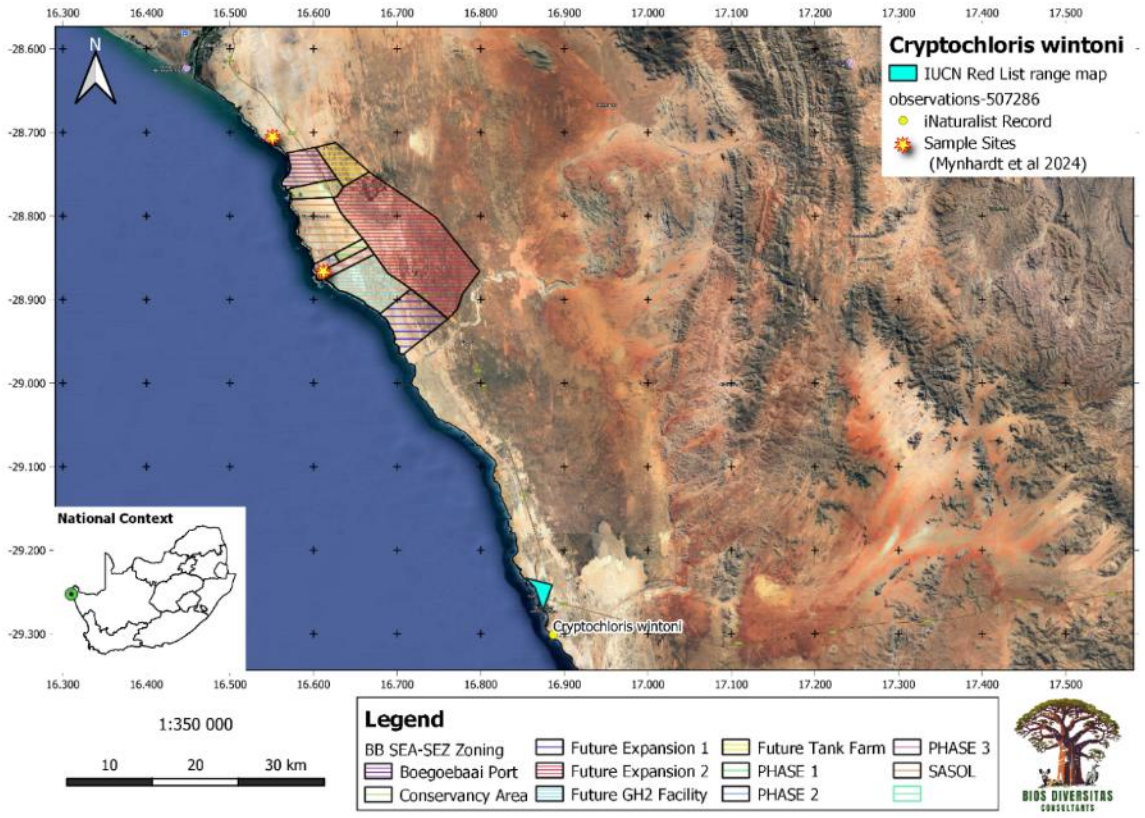


Figure 3-20: *Cryptochloris wintoni* current range map (IUCN), 2022 iNaturalist record and DNA samples sites taken by Mynhardt et al. (2024).

De Winton's Golden Mole occurs in an area of high threat owing to radical habitat transformation by alluvial diamond mining on the South African west coast and it is suspected that the population has declined substantially over the past century. Accordingly, it is listed as **Critically Endangered** under criteria B1ab(iii)+2ab(iii).

The species has been recorded by eDNA samples along the coast at Visagiesfontein (Mynhardt et al. 2024). Accordingly, the presence of the species must be established through appropriate survey techniques during the EIA application phases for the project. **If recorded, the presence of the species likely represents a fatal flaw to the project, especially the Coastal Duneveld habitat.**

Eremitalpa granti granti Grant's Golden Mole – Vulnerable

Grant's Golden Mole is endemic to southern Africa, with its distribution primarily focused on the arid and semi-arid regions of the western parts of the Northern Cape and Namibia. Within the Northern Cape, its range is concentrated in the Succulent Karoo Biome and along coastal dunes. Its range overlaps with sandy habitats extending into desert-like environments, including the Namaqualand coastal areas (Port Nolloth and possibly as far north as Alexander Bay) and parts of the Sperrgebiet in Namibia.

Grant's Golden Mole does not construct permanent burrows like many other moles. Instead, the species "swims" through the sand, utilising loose, dry soils to forage for invertebrates such as termites and beetle larvae. This species avoids hard or compact soils and relies on habitats with adequate prey availability and minimal soil disturbance.

E. g. granti is highly specialised for sandy environments, preferring:

- Coastal dunes with loose, sandy soils that allow easy tunnelling;
- Sandy plains with sparse vegetation, often dominated by grasses, succulents, and small shrubs; and
- Semi-arid areas where rainfall is infrequent, and temperatures are extreme, requiring adaptive strategies for survival.

Grant's Golden Mole is a remarkable example of adaptation to extreme environments, but its narrow habitat requirements and sensitivity make it vulnerable to human and environmental changes. The species has been recorded with eDNA samples along the coast at Visagiesfontein (Mynhardt *et al*. 2024) and south of the PA (Figure 3-21). Accordingly, the presence of the species must be established through appropriate survey techniques during the EIA application phases for the project. **If recorded, the presence of the species likely represents a fatal flaw to the project, especially the Coastal Duneveld habitat.**

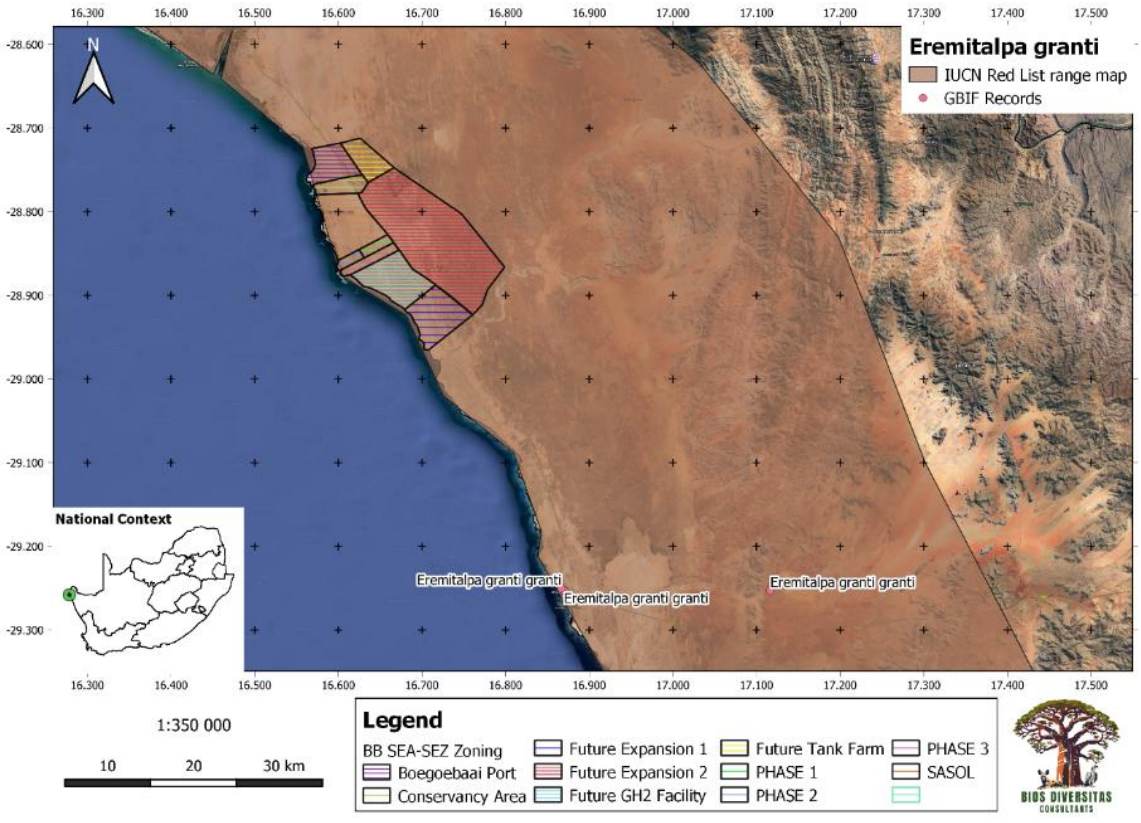


Figure 3-21: IUCN distribution range and observation records for *Eremitalpa granti granti* in relation to the Project Area.

The species demonstrates high sensitivity to environmental and anthropogenic pressures such as:

- Habitat Loss and Fragmentation due to urbanisation, agriculture, and mining activities which reduce available sandy habitats and prey abundance. Coastal dune development for tourism or industry significantly impacts populations by destroying suitable primary habitats.

- Activities that compact soil, such as off-road vehicle use, grazing, and heavy machinery operations, can render habitats unsuitable for the mole.

- Rising temperatures and shifting rainfall patterns may exacerbate desertification, impacting prey availability and habitat suitability.

Panthera pardus pardus African Leopard – Vulnerable

The African Leopard (*Panthera pardus pardus*) is widely distributed across southern Africa but occurs at low densities in the Northern Cape province. It has the widest habitat tolerance of any African felid and is the only species occupying both rainforest and desert habitats. Leopards are most abundant in woodland, grassland savanna and all forest types, but also occur widely in montane habitats, coastal scrub, shrubland, semi-desert and desert.

In the Northern Cape, Leopards are most commonly found in mountainous regions such as the Namaqualand escarpment, parts of the Cederberg adjacent to the Northern Cape, and the rugged landscapes of the Augrabies Falls National Park. In the Kalahari, including areas in the Kgalagadi Transfrontier Park, the leopards are adapted to semi-arid environments. They also inhabit unprotected areas, though their populations are fragmented due to habitat degradation and human activity, including persecution. Sixty eight percent (68%) of leopard habitat is currently outside of protected areas, and leopard conservation efforts should be focused on these areas, where leopards are most at risk.

Leopards have lost 63–75% of their historic range globally and 80% of their former range within South Africa. As a result, the species has recently been uplisted to *Vulnerable* on both the global IUCN Red List and the Red List of Mammals of South Africa, Swaziland, and Lesotho, underscoring growing concerns about its conservation status. Like other large carnivores, leopard populations are declining throughout their range. South Africa's National List of Threatened or Protected Species (ToPS 2007, as amended) lists the leopard as Vulnerable and the Convention on the International Trade Endangered Species (CITES) placed it in Appendix I.

The primary threats to leopards are ongoing and include habitat loss and fragmentation, prey depletion, human-wildlife conflict, unsustainable trophy hunting, poaching for skins and body parts, and indiscriminate killing. In South Africa, the illegal skin trade poses the greatest threat to leopard survival. Data from the South African Leopard Monitoring Project indicate an alarming annual population decline of 8% nationally. Significant reductions in leopard density were recorded in five of the 18 surveyed sites in 2017.

The species has not been recorded on or surrounding the PA but does occur eastwards towards the Richtersveld (Figure 3-22). Should the species utilise the site, it does not represent a fatal flaw to the project as the necessary mitigation measures can be implemented to reduce impacts on the species.

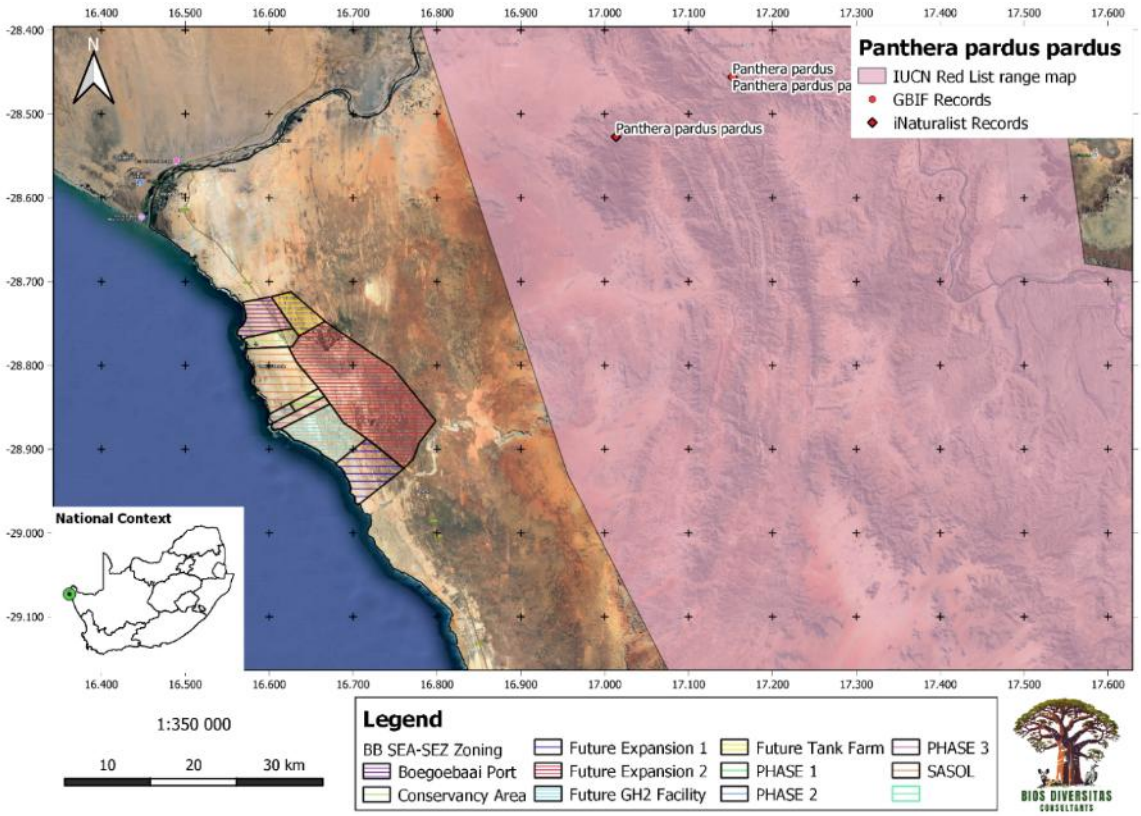


Figure 3-22: IUCN distribution range and observation records for *Panthera pardus pardus* in relation to the Project Area.

Leopards are highly adaptable and occupy diverse habitats, provided sufficient cover, prey, and water is available. In the Northern Cape, their habitat preferences include:

- Mountainous Areas: Rugged terrains with rocky outcrops and dense vegetation offer excellent cover for hunting and denning.
- Arid and Semi-Arid Areas: Leopards in the Kalahari and Namaqualand are well-adapted to semi-desert conditions, relying on sparse vegetation and sand dunes for concealment.
- Riparian Zones: Leopards are drawn to areas along rivers, such as the Orange River, which provide higher prey density and vegetation cover.
- Savanna and Shrubland: In open habitats, they depend on patches of dense vegetation or rocky areas for stalking prey.

Conservation Recommendations

- Secure key habitats and corridors through land-use planning, including connecting protected areas and maintaining wildlife-friendly landscapes.
- Minimise habitat destruction from mining, agriculture, and urban expansion.
- Strengthen enforcement against illegal hunting and trafficking of leopard parts.
- Use camera traps and GPS tracking to monitor leopard movements and identify key areas of utilisation in relation to the PA.

Leopards in the Northern Cape are resilient predators but face significant threats due to human pressures, habitat loss, and prey depletion. Effective conservation strategies must prioritise conflict mitigation, habitat connectivity, and community involvement to ensure the long-term survival of this iconic species.

Parahyaena brunnea Brown Hyena – Near Threatened (2015)

The Brown Hyena, *Parahyaena brunnea*, occurs across southern Africa, with a significant presence in the arid and semi-arid regions of the Northern Cape, South Africa. This species primarily occupies the western parts of the province, including areas within the Succulent Karoo Biome and Namaqualand subregion. It is associated with protected areas such as the Kgalagadi Transfrontier Park but also roams extensively across unprotected private lands, particularly in areas with low human density. Although its range can extend into communal and farmlands, its distribution is fragmented due to habitat degradation and human activity. The species distribution range (as per IUCN) does not intersect the PA, but several records of the species occur on the PA (Figure 3-23).

The species has been recorded on and surrounding the PA. Accordingly, appropriate mitigation measures are required to reduce direct and indirect impacts on the species and its habitat for foraging. The presence of the species does not represent a fatal flaw to the project.

Brown Hyenas are highly adaptable carnivores, thriving in a variety of arid and semi-arid habitats:

- Deserts: Particularly in the Kalahari, they favour open landscapes that provide opportunities for scavenging.
- Coastal Environments**:** In parts of Namaqualand, they forage along the coastline for marine carrion such as seals and fish.
- Rocky Outcrops and Hills**:** Often used as denning sites, providing shelter from predators and human disturbance.

This species is less dependent on permanent water sources, as it obtains most of its moisture from prey and carrion. The Brown Hyena is a resilient yet vulnerable species, relying heavily on effective management of human impacts and habitat conservation to ensure its long-term survival in the Northern Cape. Brown Hyenas face several ecological and anthropogenic threats in the Northern Cape:

- They are often persecuted by farmers who perceive them as a threat to livestock, despite their scavenging tendencies and limited predation on domestic animals.
- Poisoning, trapping, and shooting are common threats in agricultural landscapes.
- Expansion of human settlements, agriculture, and mining reduces suitable habitat.
- Fragmentation limits their range and isolates populations, reducing genetic diversity.
- Increased road networks in the vicinity of the PA can lead to direct collisions with vehicles.
- Changes in prey availability and ecosystem dynamics due to shifting rainfall patterns and increasing temperatures could affect scavenging opportunities.

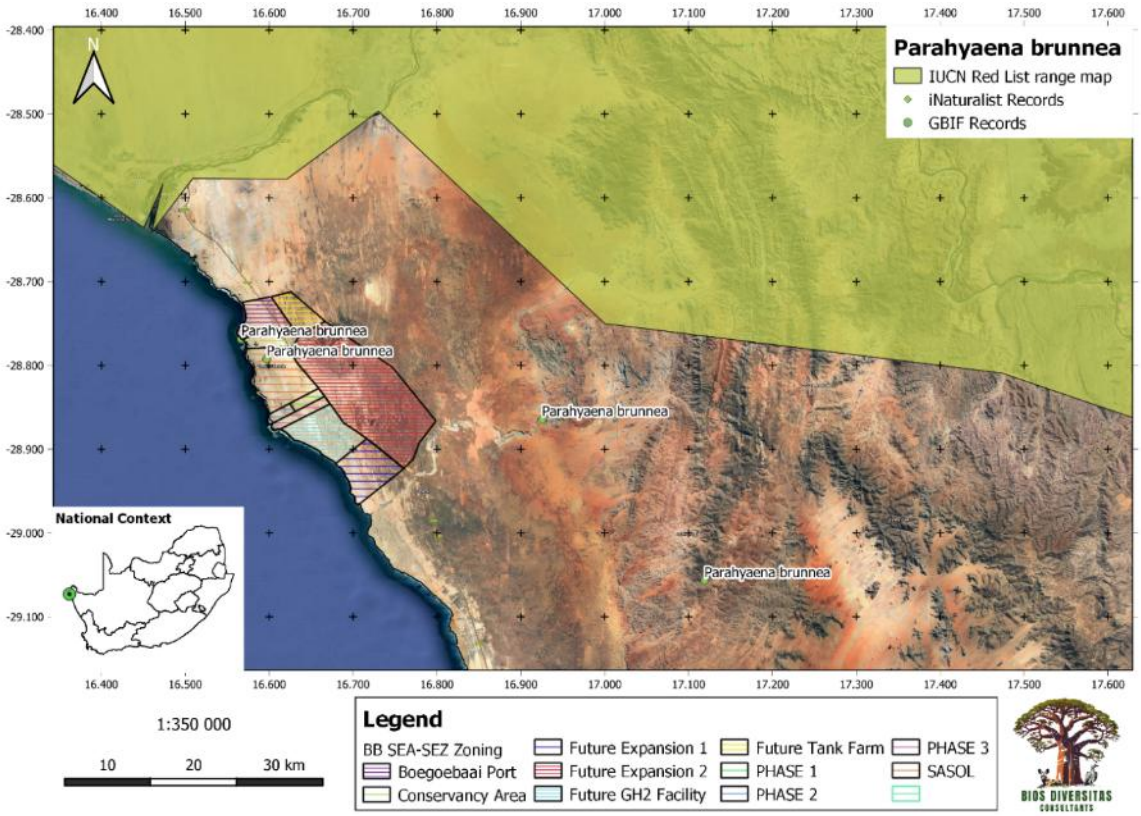


Figure 3-23: IUCN distribution range and observation records for *Hyaena brunnea* in relation to the Project Area.

Bathyergus janetta Namaqua Dune Mole-rat – Uplisted to Endangered A4(a)

Based on the unpublished 2025 National Red List, the Namaqua Dune Mole-rat has been **uplisted to Endangered** owing to climate change and the threat of continued habitat destruction of three isolated subpopulations. The species is not directly impacted by the proposed developments as the Project Area it is not located in the global range and there are no known records from the area (Figure 3-24). A number of isolated populations have been identified in the following areas of South Africa: Alexander Bay on the Orange River, from Port Nolloth to Groenrivier, from Steinkop to Kamieskroon, and in the red dunes of Klawer. Accordingly, the species is not considered threatened by the proposed Boegoebaai Port and SEZ.

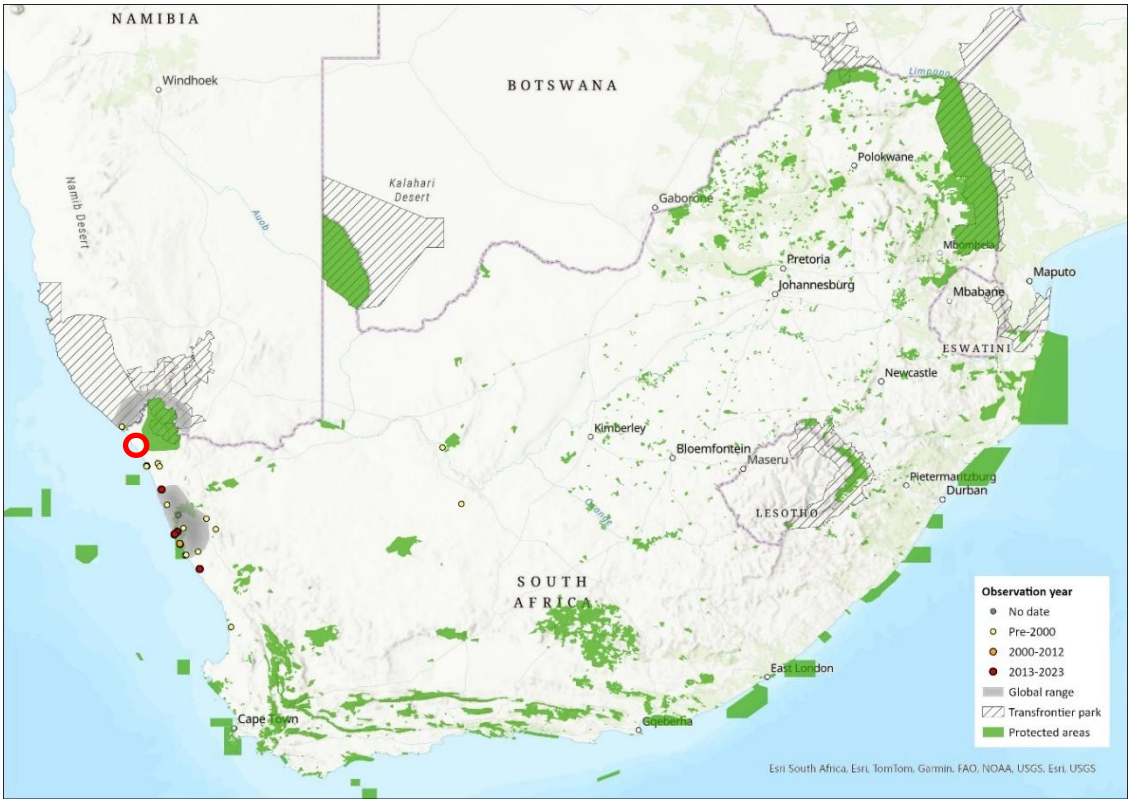


Figure 3-24: Unpublished 2025 National Red List map for *Bathyergus janetta* in relation to the Project Area (indicated in red circle).

3.6 Sensitive Habitats and Features

A preliminary sensitivity map is produced based on the precautionary principle and the available secondary data for the area (refer to Figure 3-25). It must be noted that species-specific baseline assessments are required to verify and update this sensitivity map, based on species presence and suitable habitat with appropriate buffer zones.

Development within Very High and High sensitivity areas should be avoided as far as possible due to the sensitive nature of these areas and potential negative impacts the development might have on the listed species which could occur in this part of the site. The sandy dunes are classified as Medium to High Sensitivity, as the sandy substrate makes these areas vulnerable to disturbance within the context of the aridity and high winds which characterise the West Coast. The overall implications of the sensitivity map include that fact that the site is generally a sensitive environment in terms of vulnerability to disturbance and that there appears to be fewer options with regards to finding alternative lower sensitivity placements of infrastructure.

The following sensitivities have been applied to the PA (Figure 3-25):

- Very High sensitivity:
    - Remnants of the Richtersveld Coastal Duneveld and Namib Seashore Vegetation which are Critically Endangered ecosystems and potentially harbour several fauna SCC.
    - Suitable habitat for several fauna SCC, including *Pachydactylus rangei, Bitis schneideri, Breviceps macrops, Cryptochloris wintoni, Eremitalpa granti granti* and *Parahyaena brunnea.*
    - Several unique and important features within the PA, including the Boegoeberg Twins, Visagiesfonteinkop, and sandy beaches.

- Medium to High sensitivity:
  - Important and unique features of the Northern Richtersveld Yellow Duneveld.
  - Remaining natural habitat and Namaqualand Salt Pans and Western Gariep Plains Desert.
  - The Swartbank Heuweltjies, part of the Richtersveld Sandy Coastal Scorpionstailveld.
  - Connecting the coastal to the inland habitats, several SCC could utilise this area which overlaps their distribution range.
  - Include focus areas for protected areas of expansion which intersect sensitive features.
- Medium sensitivity:
  - This represents the remaining natural habitat of the Northern Richtersveld Yellow Duneveld and Richtersveld Sandy Coastal Scorpionstailveld, excluding the Swartbank Heuweltjies which is considered more sensitive.
  - Very few fauna SCC have suitable habitat in this region, but it could be important ecological corridors and act as large high value climate resilience areas (to be confirmed).
- Low sensitivity:
  - Transformed or modified habitat due to mining and other human activities.
  - Fauna species will still access these areas for movement between intact habitats, but it is less suitable for breeding and foraging.

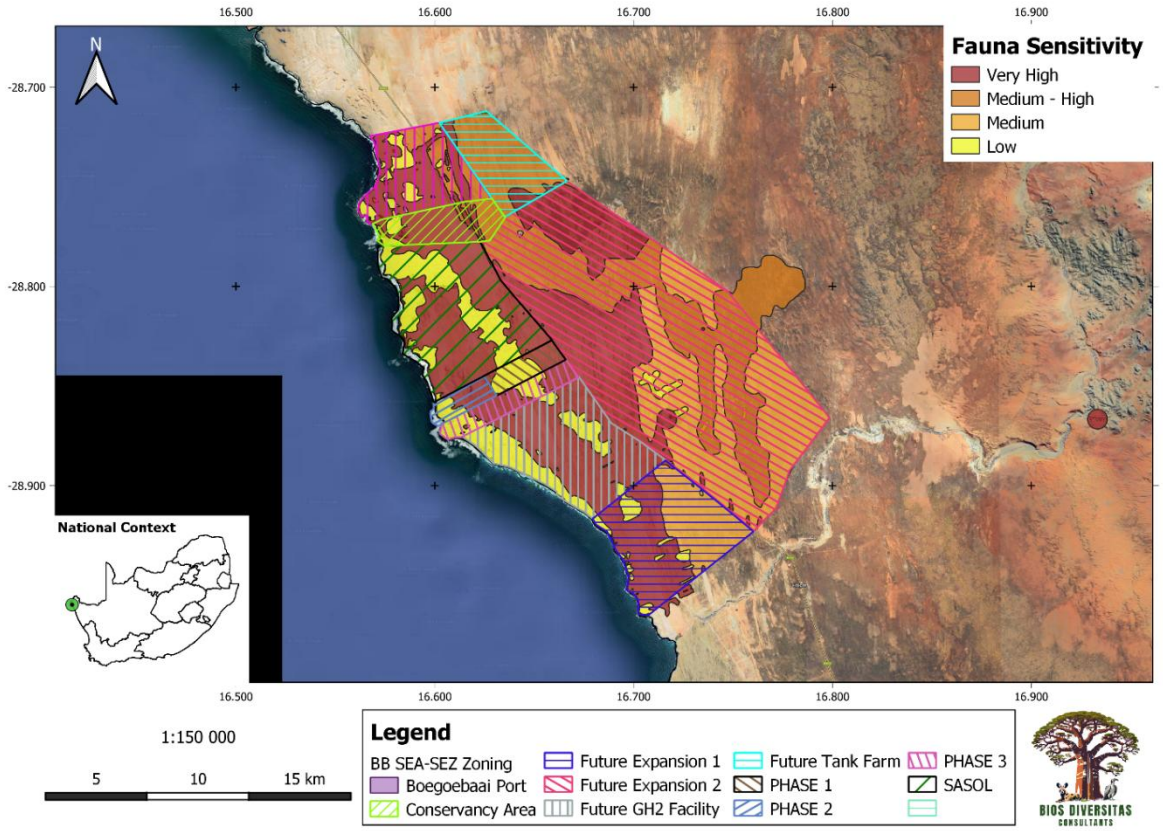


Figure 3-25: Preliminary fauna sensitivity map based on secondary data collection and current impacts (especially mining) for the proposed Boegoebaai Port and SEZ development.

3.7 Anticipated impacts on fauna

The proposed Boegoebaai Port and SEZ development along the west coast of the Northern Cape poses several potential risks to fauna. Refer to the Aspects and Impacts Register in Table 3-2 that describes the impacts that may occur for the identified infrastructure aspect / SEZ subzone and cite the primary receiving environment of concern.

The major impact associated with the development will occur during the construction phase of the project, with significant impacts being the loss of natural vegetation and transformation and disturbance of natural ecosystems at the PA.

During the operational phase, human activity and disturbance levels at the site should be relatively low as compared to the construction phase. During the operational phase, the major impacts are likely to be related to maintenance activities and carry-over effects resulting from the construction phase. In particular the site will remain highly vulnerable to wind erosion and alien plant invasion for some time following construction.

Should decommissioning be required for the project or parts thereof, it is likely to face similar issues generated by the construction phase; that is negative impacts related to disturbance and human presence at the site. The decommissioning phase should attempt to rehabilitate the site with as little disturbance as possible.

The major risk associated with the project post-construction and decommissioning would be that the site is not adequately rehabilitated to a functioning system and a degraded, vulnerable and disturbed ecosystem is left behind.

Table 3-2: Aspects and Impacts Register for the proposed Boegoebaai Port and SEZ.

Port infrastructure aspect / SEZ subzone	Potential impact	Receiving environment of concern (spatially explicit)
Jetty, Admin Craft Basin and Breakwaters Includes a transverse beam supported by an anchored concrete abutment on the land side.	Loss of important / unique habitat on the beach for SCC. Degradation and fragmentation of CR ecosystem. Decrease in ecosystem services and meeting biodiversity targets.	Areas mapped Very high sensitivity as in Figure 3-25. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
Dry Bulk Material Handling and Conveyor Belts Manganese stored in closed stockpiles including dust suppression systems	Vegetation clearance of critical habitat for SCC. Decrease in ecosystem services and meeting biodiversity targets. Barriers to animal movement.	Areas mapped Very high sensitivity as in Figure 3-25. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
Main Buildings (Port Access Gateway, Induction Centre, Port Authority Building, Terminal Operator's Building)	Vegetation clearance of critical habitat for SCC. Decrease in ecosystem services and meeting biodiversity targets. Increased habitat fragmentation. Mortality owing to trenching and foundation layers. Fences act as barriers to animal movement.	Areas mapped Very high sensitivity as in Figure 3-25. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
Internal Port Roads and Bridges	Vegetation clearance of critical habitat for SCC. Decrease in ecosystem services and meeting biodiversity targets. Increased habitat fragmentation. Mortality owing to increased traffic. Barriers to animal movement.	Areas mapped Very high sensitivity as in Figure 3-25. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
External Roads Attract mining ore transported by trucks along the R382, serving as the primary route for transporting mining commodities until rail transport viability is considered for future port expansion phases.	Existing Impact, but increased traffic volume. Mortality owing to increased traffic of mining transport trucks. Barriers to animal movement.	The R382 splits CR ecosystems and primary habitat for SCC.
Bulk Services: Pipeline with treatment plant	Vegetation clearance of critical habitat for SCC. Decrease in ecosystem services and meeting biodiversity targets. Increased habitat fragmentation. Barriers to animal movement if above ground.	Areas mapped Very high sensitivity as in Figure 3-25. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
Bulk Services: Onsite desalination plant	Vegetation clearance of critical habitat for SCC. Decrease in ecosystem services and meeting biodiversity	Areas mapped Very high sensitivity as in Figure 3-25. Medium to High areas need to minimise impacts

Port infrastructure aspect / SEZ subzone	Potential impact	Receiving environment of concern (spatially explicit)
	targets. Mortality owing to trenching and foundation layers.	through appropriate mitigation measures and ensure sustainable development.
Bulk Services: Sewer	Vegetation clearance of critical habitat for SCC. Decrease in ecosystem services and meeting biodiversity targets. Increased habitat fragmentation. Barriers to animal movement for above ground infrastructure. Spillage and contamination into the ocean, beachfront, CR ecosystems and inland watercourses.	Areas mapped Very high sensitivity as in Figure 3-25. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
Stormwater	Increased erosion and degradation of CR ecosystem and important habitat for SCC if not implemented and managed appropriately.	Areas mapped Very high sensitivity as in Figure 3-25. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
Substations	Vegetation clearance of critical habitat for SCC. Decrease in ecosystem services and meeting biodiversity targets. Fences act as barriers to animal movement.	Areas mapped Very high sensitivity as in Figure 3-25. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
Liquid bulk storage facility including tanker loading facilities	Spillage and contamination into the ocean, beachfront, CR ecosystems and inland watercourses.	Areas mapped Very high sensitivity as in Figure 3-25. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
Confirmed green ammonia facility – 4 508 ha Sasol's green ammonia facility, including 188 ML/day desalination plant, will be located near the TNPA port precinct to minimize pipeline length and enhance efficiency.	Source of nitrogen pollution. Excess nitrogen can lead to deterioration of ecosystems, photochemical smog, acid rain and health problems such as respiratory illnesses. Loss of ecosystem services as it is in critically endangered ecosystems and CBA1. Vegetation clearance causing loss of important / unique habitat for SCC. Loss of fauna SCC. Spillage and contamination into the ocean, beachfront, CR ecosystems and inland watercourses.	Areas mapped Very high sensitivity as in Figure 3-25 as well as regional area if spillage and contamination takes place. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
Conservancy Area (1170 ha) Includes Boegoeberg koppies, Swartvygie Heuweltjie Strandveld and seal colony on the Boegoebaai point, including interesting archaeological site.	*Pros* • Protection of remnant intact patches. • Protection of CR ecosystem and refugia for animal	The direct area indicated in the map. Other important features such as Visagiesfonteinkop and Namaqualand Salt Pans not included. Cumulative impacts need to be investigated for this

Port infrastructure aspect / SEZ subzone	Potential impact	Receiving environment of concern (spatially explicit)
	species. • Opportunity for rehabilitation of mining areas. *Cons* • Unrepresentative of all habitats and sensitive features within the Project Area. • Loss of biodiversity - only partially protecting CBA1 and CR ecosystem – will not meet biodiversity targets. • Create isolated island effect due to increased habitat fragmentation. • Increased edge effects. • Reduced ecological corridors. • Not sufficient for biodiversity offset elsewhere in the PA. • Crosses the R382 – increased mortality of SCC without appropriate crossings for fauna.	protected area surrounded by potential destructive operations. Entire area needs to be considered and a network of corridors to the surrounding natural areas need to be explored.
SEZ Industrial Park Zones 4-6 / Phases 1-3 Mixed-use purposes, including a manufacturing cluster, logistics and warehousing, offices. 2.7 ML/day desalination plant, including pump station, supply pipelines, feeder pipelines.	Loss of ecosystem services as it is in CR ecosystems and CBA1, especially Zones 5 and 6; unlikely to meet biodiversity targets. Vegetation clearance causing loss of important / unique habitat for SCC. Loss of fauna SCC. Increased habitat fragmentation and edge effects. Barriers to animal movement for above ground infrastructure.	Areas mapped Very high sensitivity as in Figure 3-25 as well as regional area if spillage and contamination takes place. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
Future green hydrogen facility 3 713 ha Water treatment unit and water reservoir; Containerised units for the electrolysers; Air separation unit; Liquid air energy system (LAES) for nitrogen storage; Hydrogen and oxygen storage; Ammonia processing unit and liquid ammonia storage tank; pipelines required.	Source of nitrogen pollution. Excess nitrogen can lead to deterioration of ecosystems, photochemical smog, acid rain and health problems such as respiratory illnesses. Loss of ecosystem services as it is in critically endangered ecosystems and CBA1. Vegetation clearance causing loss of important / unique habitat for SCC. Loss of fauna SCC. Spillage and contamination into the ocean, beachfront, CR ecosystems and inland watercourses. Barriers to animal movement for above ground infrastructure.	Areas mapped Very high sensitivity as in Figure 3-25 as well as regional area if spillage and contamination takes place. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
Future expansion 01 – 3 408 ha	Loss of ecosystem services as it is in critically endangered ecosystems and CBA1.	Areas mapped Very high sensitivity as in Figure 3-25 as well as regional area if spillage and contamination

Port infrastructure aspect / SEZ subzone	Potential impact	Receiving environment of concern (spatially explicit)
	Vegetation clearance causing loss of important / unique habitat for SCC. Loss of fauna SCC. Barriers to animal movement for above ground infrastructure.	takes place. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
Future expansion 02 – 15 067 ha	Loss of ecosystem services as it is in critically endangered ecosystems and CBA1. Vegetation clearance causing loss of important / unique habitat for SCC. Loss of fauna SCC. Barriers to animal movement for above ground infrastructure	Areas mapped Very high sensitivity as in Figure 3-25 as well as regional area if spillage and contamination takes place. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.
Future tank farm – 1 704 ha	Only small sections within CR ecosystem and CBA1 - loss of ecosystem services due to direct loss and indirect due to increased edge effects. Vegetation clearance causing loss of important / unique habitat for SCC. Loss of fauna SCC. Barriers to animal movement for above ground infrastructure.	Areas mapped Very high sensitivity as in Figure 3-25 as well as regional area if spillage and contamination takes place. Medium to High areas need to minimise impacts through appropriate mitigation measures and ensure sustainable development.

Below is an expanded analysis of the key anticipated impacts based on the provided information:

3.7.1 Habitat Loss and Alteration

Impacts: Large-scale habitat removal or modification can eliminate essential habitats, particularly for SCC such as De Winton's Golden Mole (*Cryptochloris wintoni*), Grant's Golden Mole (*Eremitalpa granti granti*), the Desert Rain Frog (*Breviceps macrops*) and Web-footed Gecko (*Pachydactylus rangei)* which rely on specific sand dune environments. Loss of these habitats may lead to population declines and local extinctions if alternative suitable habitats are unavailable.

Mitigation: Minimising habitat disturbance through careful site selection and restricting development to less sensitive areas can reduce these impacts. Habitat restoration and translocation of affected species may be necessary in extreme cases, but this should be assessed on a species-specific basis as some species do need to be protected *in situ*.

3.7.2 Habitat Fragmentation and Movement Restrictions

Impacts: Construction activities and infrastructure, such as pipelines, powerlines and roads, can fragment habitats and restrict movement, particularly for range restricted and fossorial species (those that burrow or live underground). Barriers to movement disrupt normal behaviour such as foraging, mating, and dispersal. This is especially critical for species like tortoises, which are slow-moving and less adaptable to fragmented landscapes.

Mitigation:

- Ensuring pipelines and powerlines are buried or elevated to allow animal movement underneath can help maintain connectivity. Designing wildlife corridors (underpasses and overpasses) at strategic points and other barriers would be vital.
- Maintain strips of natural vegetation across fragmented areas to facilitate dispersal and reduce isolation effects.
- During construction, provide temporary safe pathways for fauna.

3.7.3 Increased Predation by Corvids

Impacts: Corvids (e.g., crows and ravens) are opportunistic predators often attracted by human activities and infrastructure - most impactful in remote areas where other infrastructure is limited. If the proposed development continues, it will create habitat for the species to nest and breed. These birds can heavily predate on reptiles, especially small, cryptic, or slow-moving species like the Speckled Cape Tortoise (*Chersobius signatus*). Sustained predation pressure can lead to local population declines or extinctions.

Mitigation:

- Measures to manage waste and reduce food availability for corvids, combined with habitat design that minimises perching and nesting opportunities, can help mitigate this risk.
- As a last resort, work with wildlife authorities to manage corvid populations if they pose a severe risk to vulnerable reptile species.

3.7.4 Roadkill from Increased Traffic

Impacts: Increased vehicular movement, combined with new and expanded road networks, raises the likelihood of roadkills. Many reptiles are ectothermic and may use warm road surfaces for thermoregulation, putting them at greater risk. This issue disproportionately affects species like tortoises and snakes. In addition, roads can fragment the landscape and act as barriers which restrict movement of species, or even worse act as a death trap for slow moving mammals, amphibians and reptiles. Data from the Endangered Wildlife Trust's National Roadkill Database for South Africa reveals that mammals account

for the highest proportion of reported roadkill (50%), followed by birds (18%), reptiles (6%), and amphibians (1%), with 24% of cases involving unidentified species.

Mitigation:

- Implement wildlife crossings.
- Implement educational campaigns for workers.
- Enforce strict speed limits in areas of high fauna activity.
- Install wildlife crossing signage to alert drivers.
- Use low fencing or similar to guide fauna toward designated crossings.
- Increase awareness and monitoring during breeding or migratory seasons when fauna activity is highest.

3.7.5 Disturbance from Noise, Dust, and Lights

Impacts: Construction and operational activities generate noise, dust, and artificial lighting, which can disrupt the natural behaviour of fauna, such as breeding, foraging, and predator avoidance. Sensitive nocturnal species may be particularly affected by light pollution.

Mitigation:

- Use low-intensity, motion-activated and directional lighting,
- Implement dust control measures by watering or soil stabilisation techniques.
- Schedule activities to minimise noise during critical periods for wildlife (e.g., breeding seasons).
- Use noise barriers or muffling equipment around high-intensity activity zones.
- Adjust light spectra to wavelengths less likely to disturb nocturnal species (e.g., red lighting instead of white).

3.7.6 Wildlife interactions with infrastructure

Impacts:

- Reptiles, being ectothermic, rely on external heat sources to regulate their body temperature. Electrical infrastructure, such as transformers and substations, generates substantial heat, making it an attractive basking site for these animals. Reptiles may be drawn to substations, not only for thermoregulation but also for foraging, as prey species like rodents and birds are likely to nest in these areas. Contact with live components, such as exposed bushings, jumpers, and phases, significantly increases the likelihood of reptile electrocution. It also raises the risk of damage to substation components causing operational disruptions in electrical systems.
- Small mammals, such as squirrels and mongooses, are also attracted to the sheltered environments offered by infrastructure such as substations and other buildings where they create large burrows under infrastructure. Extensive burrowing may alter soil integrity and vegetation patterns, affecting other ground-dwelling species. Small mammals climbing transformers or entering live areas can cause short circuits by bridging the gap between live components and the ground, resulting in equipment damage and power outages as well as increased mortality. Porcupines may dig under transmission towers in areas with less compacted soil, compromising foundation stability and increasing maintenance costs.

Mitigation:

- Ensure electrical components are insulated or enclosed to prevent contact by wildlife.

- Regularly inspect infrastructure for burrows and other animal activity to identify and address risks proactively.

- Incorporate wildlife corridors and minimise habitat fragmentation by maintaining natural linkages between critical habitats.

- Employ measures to discourage opportunistic predators from nesting or hunting near infrastructure, such as waste management and anti-perching devices.

- Implement appropriate buffer zones around critical habitats to protect them from direct disturbance.

- Use compacted soil or foundation reinforcement around towers to deter burrowing mammals like porcupines.

- Add physical barriers around tower bases to prevent digging.

- Could establish burrowing refuges (artificial habitats) for fossorial species in safe zones to prevent them from seeking shelter near hazardous infrastructure.

3.7.7 Broader Implications for Biodiversity

- The cumulative impacts of these disturbances may lead to shifts in local faunal community structures, favouring generalist species over specialists. This could result in reduced biodiversity and changes in ecosystem functioning.

- The resilience of fauna to these impacts depends on the availability of nearby undisturbed habitats and the implementation of effective mitigation strategies.

4. DISCUSSION

The proposed Boegoebaai Port and SEZ development presents a range of potential environmental impacts, particularly on fauna and SCC. The potential presence of sensitive species such as *Pachydactylus rangei, Cryptochloris wintoni, Breviceps macrops,* and *Eremitalpa granti granti* combined with CBA 1 and CBA 2, and two threatened ecosystems (both listed as CR) underscores the ecological sensitivity of the project area. While comprehensive mitigation measures can reduce the severity of some impacts, avoidance of highly sensitive features should be the first and best option.

The project has potential benefits, including renewable energy production and economic development. These must however be weighed against the irreversible nature of biodiversity loss and the potential loss of ecosystem services provided by ecosystems and biodiversity hotspots, which are vital for the maintenance of regional biodiversity and ecosystem services and support local fauna communities.

Some of the proposed mitigation measures, e.g., habitat offsets, wildlife corridors, predator deterrence, are effective in theory but challenging to implement in practice for several reasons:

- Species-Specific Needs: Many SCC, such as De Winton's Golden Mole and the Desert Rain Frog, have specific microhabitat requirements that are difficult to replicate or restore.

- Long-Term Monitoring: Ensuring the success of mitigation measures requires sustained monitoring and adaptive management, which may not always be feasible or adequately resourced.

- Residual Risks: Despite mitigation, residual impacts on fauna and habitats are likely, particularly in highly sensitive areas.

Furthermore, the fine-resolution spatial data generated through on-site ground-truthing will play a crucial role in shaping the future planning of the proposed development and will serve as a key reference for future Environmental Impact Assessments (EIAs).

Given the high ecological sensitivity of the PA and the presence of fauna SCC, the proposed development poses significant risks to biodiversity. While mitigation can reduce some of these risks, it cannot fully eliminate the impacts on critical habitats and species, where avoidance is the only option.

The proposed development needs to consider site and technological alternatives, as well as designs which reduce impacts on the receiving environment. Sites with lower ecological sensitivities can achieve development goals with minimal environmental trade-offs. The project requires a cautious approach with a strong emphasis on biodiversity conservation. It should only proceed if it can demonstrate net ecological benefit or neutrality through rigorous mitigation strategies.

4.1 Applicable Legislation and Guidelines

Going forward, any aspect of the project which requires environmental authorisation will have to adhere to the following legislation and guidelines, as relevant at the time of the assessments:

- National Environmental Management Act (NEMA) (Act No 107, 1998): NEMA requires that measures are taken that "prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development." The disturbance of ecosystems and loss of biological diversity should be avoided, or where they cannot be altogether avoided, are minimised and remedied.

- The National Environmental Management: Biodiversity Act (NEMBA) (Act 10 of 2004) provides for listing of endangered, threatened and otherwise controlled species (ToPS) as well as threatened or protected ecosystems (latest 2022 Ecosystem Status). Should the transformation or removal of indigenous vegetation in a critically endangered or endangered ecosystem take place, activities

under Listing Notice 3 of the EIA Regulations are triggered. Focus areas for protected area expansion are identified in the NPAES.

- The National Protected Area Expansion Strategy (NPAES 2016) falls under NEMBA and is South Africa's national strategy for expansion of the protected area network.

- The National Biodiversity Assessment (NBA) is the primary tool for monitoring and reporting on the state of biodiversity in South Africa. It is used to inform policies, strategies and actions in a range of sectors for managing and conserving biodiversity more effectively.

- The minimum report content requirements for environmental impacts on animal species in terms of sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998 (Act No. 107 of 1998)[12] will be applicable.

- Guidance for the implementation of the above-mentioned protocol is followed according to SANBI (2020, as amended), hereafter referred to as "the animal species protocol guidelines".

4.2 Field Guides and other resources for EIA assessments

Mammals

- Skinner & Chimimba (2005) and Stuart & Stuart (1998) should be consulted in order to provide baseline ecological information to inform the conclusions regarding SCC.

Herpetofauna

- All available books and publications providing information on the distribution ranges and for identification purposes of South African herpetofauna should be utilised for the PA, including Branch 1998; Bates *et al*. 2014; du Preez & Carruthers 2017; Channing & Rödel 2019.

- Reptile species nomenclature should follow Reptile Database (Uetz *et al*. 2023), and amphibian nomenclature should follow Frost (2024), as these online resources provide more updated nomenclature than printed reference material.

4.3 Weather monitoring

All herpetofauna are ectothermic and their behaviour is strongly influenced by temperature and the presence of rain. To interpret survey data more comprehensively, it is necessary to present herpetofauna survey data in the context of the prevailing weather conditions. A temperature & relative humidity logger should be placed at a relevant trap location to record the prevailing temperature and relative humidity at 30-minute intervals.

4.4 Recommendations

To assess baseline studies which should include site sensitivity verification and data collection, the next steps and activities are recommended:

- Comprehensive baseline biodiversity surveys are required for impacted SCC as part of the EIA process.

[12] GOVERNMENT GAZETTE, No. 43855, 30 OCTOBER 2020. Available from: https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/Gazetted_Animal_Species_Assessment_Protocols.pdf

- Given their importance in this region, terrestrial invertebrates are to be addressed through dedicated assessments and sensitivity layer that complements the vertebrate outputs.

- Monitoring faunal populations during and after construction to assess the effectiveness of mitigation measures.

- Modify management practices based on monitoring outcomes and emerging challenges.

- Collaboration with taxa specific specialists and conservation organisations (such as EWT) to refine impact assessments and conservation actions.

- Acquisition of all observation data from participating specialists and inclusion into the final complete dataset.

- Review of field reports from other disciplines and in particular, habitat descriptions and delineations of the botanical and soil specialists to more accurately and consistently describe and map fauna habitats.

- Obtain revised infrastructure layout from developer based on all defined habitat sensitivities and logistical considerations – developer is advised to plan infrastructure layout to avoid as much of the sensitive habitats as possible.

- Workshop with all participating specialists and developer to share understanding of project and discuss all potential impacts. Of particular importance is the necessity to understand the requirements of the developer related to SCC and their assumed versus actual occurrences. Should the developer wish to demonstrate a high degree of confidence for the absence of particular species in habitats within the PA then additional surveys will be required and must be included in the impact assessment. At this stage it is recommended that it is better to assume the presence of SCC under the precautionary principle and develop appropriate mitigation and management considerations to limit any anticipated impacts, with avoidance mitigation being the best possible approach.

5. REFERENCES

- Baptista, N., Bauer, A.M., Becker, F., Conradie, W. & Ceríaco, L.M.P. 2020. *Pachydactylus rangei*. *The IUCN Red List of Threatened Species* 2020: e.T196947A120595584. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T196947A120595584.en.

- Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & De Villiers, M.S. (eds) 2014. *Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland*. Suricata 1. South African National Biodiversity Institute, Pretoria.

- Bauer A.M. & Branch W.R. 2001. The herpetofauna of the Richtersveld National Park and the adjacent northern Richtersveld, Northern Cape Province, Republic of South Africa. *Herpetological Natural History* 8(2): 111–160.

- Bourne, A., Donatti, C., Holness, S. & Midgley, G.F. 2012. Climate change vulnerability assessment for the Namakwa District Municipality: Full technical report. Conservation South Africa, Cape Town.

- Branch, B. 2008. *Tortoises, terrapins & turtles of Africa*, New Holland Publishing, Cape Town.

- Branch, W.R. 1998. *Field Guide to Snakes and other Reptiles of Southern Africa. Third Edition*. Struik Publishers, Cape Town.

- Bronner, G.N. 2013. *Cryptochloris wintoni*. In: J. Kingdon, D. Happold, T. Butynski, M. Hoffmann, M. Happold and J. Kalina (eds), *Mammals of Africa, Volume I: Introductory Chapters and Afrotheria*, pp. 250-251. Bloomsbury Publishing, London.

- Bronner, G.N. & Asher, R. 2016. A conservation assessment of *Cryptochloris wintoni*. In: Child, M.F.R.L., Do Linh San, E., Raimondo, D. & Davies-Mostert, H.T. (eds). *The Red List of Mammals of South Africa.* South African National Biodiversity Institute and Endangered Wildlife Trust, Swaziland and Lesotho South Africa.

- Buchanan, C.A., Eifler, M.A., Kanyanga, M.K., Utsumi, K.L., Liu, E.F., Luyanda, B., Muradzikwa, T.E. & Eifler, D.A. 2023. The lizard with kaleidoscope eyes: Population characteristics of the Namib web-footed gecko, *Pachydactylus rangei*. *Journal of Arid Environments* 214, https://doi.org/10.1016/j.jaridenv.2023.104985.

- Channing, A. & Wahlberg, K. 2011. Distribution and conservation status of the desert rain frog *Breviceps macrops*. *African Journal of Herpetology* 60(2): 101-102.

- Channing, A. & Rödel, M.O. 2019. *Field guide to the frogs and other amphibians of Africa*. Struik Nature, Cape Town.

- Child, M.F., Roxburgh, L., Do Linh San, E., Raimondo, D. & Davies-Mostert, H.T. (Eds). 2016. *The Red List of Mammals of South Africa, Swaziland and Lesotho.* South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

- Cunningham, S.J., Madden, C.F., Barnard, P. & Amar, A. 2016. Electric crows: powerlines, climate change and the emergence of a native invader. *Diversity and Distributions* 22(1): 17-29.

- du Preez, L.H. & Carruthers, V.C. 2017. *Frogs of Southern Africa: A Complete Guide*. 2nd Revised edition, Struik Nature.

- Eckert, K.L., Wallace, B.P., Frazier, J.G., Eckert, S.A. & Pritchard, P.C.H. 2012. *Synopsis of the biological data on the leatherback sea turtle* (*Dermochelys coriacea*). U.S. Department of Interior, Fish and Wildlife Service, Biological Technical Publication BTP-R4015-2012. Washington, DC.

- FitzPatrick Institute of African Ornithology. 2024. MammalMAP Virtual Museum. Accessed at https://vmus.adu.org.za/?vm=MammalMAP.

- FitzPatrick Institute of African Ornithology. 2024. FrogMAP Virtual Museum. Accessed at https://vmus.adu.org.za/?vm=FrogMAP.

- FrogMAP. 2024. *Breviceps macrops* Boulenger, 1907. Animal Demography Unit. Accessed from http://frogmap.adu.org.za/?sp=190.

- Frost, D.R. 2024. Amphibian Species of the World: An Online Reference. Version 6.2. Electronic Database accessible at https://amphibiansoftheworld.amnh.org/index.php. American Museum of Natural History, New York, USA. doi.org/10.5531/db.vz.0001.
- GBIF.org (02 December 2024) GBIF Occurrence Download https://doi.org/10.15468/dl.7bax2v.
- Goldberg, S.R., 2008. Note on reproduction of the web-footed gecko, *Pachydactylus rangei* (Squamata: Gekkonidae) from Namibia. *Bull. MDHS* (Md. Herpetol. Soc.) 44, 15–17.
- Haacke, W.D., 1976. The burrowing geckos of southern Africa, 2 (Reptilia: Gekkonidae). *Ann. Transvaal Mus.* 30, 13–29.
- Hofmeyr, M.D. and Branch, W.R. 2018. The padloper's tortuous path (Chelonia: Testudinidae): Two genera, not one. African Journal of Herpetology: DOI:10.1080/21564574.2017.1398187.
- Hofmeyr, M.D., Leuteritz, T. & Baard, E.H.W. 2018[a]. *Psammobates tentorius* ssp. *trimeni*. *The IUCN Red List of Threatened Species* 2018: e.T121936835A121936853. https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T121936835A121936853.en.
- Hofmeyr, M.D., Loehr, V.J.T. & Baard, E.H.W. 2018[b]. *Chersobius signatus*. The IUCN Red List of Threatened Species 2018: e.T10241A115650943. http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T10241A115650943.en
- Holness, S. & Oosthuysen, E. (2016). *Critical Biodiversity Areas of the Northern Cape:* Technical Report.
- IUCN. 2012. IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp.
- IUCN SSC Amphibian Specialist Group & South African Frog Re-Assessment Group (SA-FRoG). 2017. *Breviceps macrops*. *The IUCN Red List of Threatened Species* 2017: e.T3070A2794989. https://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T3070A2794989.en.
- Kot, C.Y., Fujioka, E., DiMatteo, A.D., Bandimere, A., Wallace, B.P., Hutchinson, B.J., Cleary, J., Halpin, P.N. & Mast, R.B. 2023. The State of the World's Sea Turtles Online Database: Data provided by the SWOT Team and hosted on OBIS-SEAMAP. Oceanic Society, Conservation International, IUCN Marine Turtle Specialist Group (MTSG), and Marine Geospatial Ecology Lab, Duke University. http://seamap.env.duke.edu/swot.
- Loehr V.J.T. 2002. Population characteristics and activity patterns of the Namaqualand speckled padloper (*Homopus signatus signatus*) in the early spring. *Journal of Herpetology* 36: 378–389.
- Loehr M.D. & Henen B.T. 2007. Annual variation in the body condition of a small, arid-zone tortoise, *Homopus signatus signatus*. *Journal of Arid Environments* 71: 337–349.
- Loehr M.D. & Henen B.T. 2009. Small and sensitive to drought: consequences of aridification to the conservation of *Homopus signatus signatus*. *African Herpetology* 58: 116–125.
- Loehr B.T. & Hofmeyr M.D. 2011. Reproductive responses to rainfall in the smallest tortoise, *Homopus signatus signatus*. *Copeia* 2011: 278–284.
- Lynch, K. & Tarrant, J. 2025. *Breviceps branchi*. *The IUCN Red List of Threatened Species* 2025: e.T19520513A247840604. https://dx.doi.org/10.2305/IUCN.UK.2025-2.RLTS.T19520513A247840604.en.
- Maree, S. & Bronner, G.N. 2016. A conservation assessment of *Eremitalpa granti granti*. In: Child, M.F., Roxburgh, L.D.L.S.E., Raimondo, D. & Davies-Mostert, H.T. (eds). *The Red List of Mammals of South Africa, Swaziland and Lesotho.* South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.
- Maritz B., Alexander G.J. (2012). Population density and survival estimates of the African viperid, *Bitis schneideri*. *Herpetologica*, 68(2): 195–202.
- Maritz B., Alexander G.J. (2013). Namaqua dwarf adders must breed frequently: the problem with being small. *Journal of Zoology*, 289(1): 27–31.

- Maritz B., Alexander G.J. (2014). Namaqua Dwarf Adders are generalist predators. *African Journal of Herpetology*, 63(1): 79–86.

- Mucina, L. & Rutherford, M.C. (eds). 2006. The vegetation of South Africa, Lesotho and Swaziland, in *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

- Mynhardt, S., Matthew, E., le Roux, J.P., Little, I., Bloomer, P. & Theron, C. 2024. Environmental DNA from soil reveals the presence of a "lost" Afrotherian species. *Biodiversity and Conservation* 33:31–50. https://doi.org/10.1007/s10531-023-02728-2.

- Mynhardt, S. 2023. Golden mole that swims through sand is rediscovered in South Africa after 86 years. Published in *The Conversation*, December 5, 2023. https://theconversation.com/golden-mole-that-swims-through-sand-is-rediscovered-in-south-africa-after-86-years-219022.

- Northern Cape Department of Environment and Nature Conservation. (2016[a]). Northern Cape Critical Biodiversity Areas [Vector] 0. Available from the Biodiversity GIS website.

- Northern Cape Department of Environment and Nature Conservation. (2016[b]). Northern Cape Critical Biodiversity Areas Reason [Vector] 2016. Available from the Biodiversity GIS website.

- ReptileMAP. 2024. The Southern African Reptile Conservation Assessment (SARCA, now ReptileMAP. http://vmus.adu.org.za/.

- South African National Biodiversity Institute. (2006-2018). The Vegetation Map of South Africa, Lesotho and Swaziland, Mucina, L., Rutherford, M.C. & Powrie, L.W. (Editors). Online, http://bgis.sanbi.org/Projects/Detail/186, Version 2018.

- South African National Biodiversity Institute (SANBI). 2020. Species Environmental Assessment Guideline. Guidelines for the implementation of the Terrestrial Fauna and Terrestrial Flora Species Protocols for environmental impact assessments in South Africa. South African National Biodiversity Institute, Pretoria. Version 3.1. 2022.

- Tolley K.A. & Burger, M. 2007. *Chameleons of Southern Africa*. Struik, Cape Town.

- Tolley, K.A., Alexander, G.J., Weeber, J., Maritz, B. & Turner, A.A. 2019. *Bitis schneideri*. *The IUCN Red List of Threatened Species* 2019: e.T2818A147708662.

  https://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T2818A147708662.en.

- TTWG (Turtle Taxonomy Working Group: Rhodin, A.G.J., Iverson, J.B., Bour, R. Fritz, U., Georges, A., Shaffer, H.B. and van Dijk, P.P.). 2017. Turtles of the World: Annotated Checklist and Atlas of Taxonomy, Synonymy, Distribution, and Conservation Status (8th Ed.). In: Rhodin, A.G.J., Iverson, J.B., van Dijk, P.P., Saumure, R.A., Buhlmann, K.A., Pritchard, P.C.H., and Mittermeier, R.A. (eds), Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group, pp. 1-292. Chelonian Research Monographs.

- Uetz, P., Freed, P, Aguilar, R., Reyes, F. & Hošek, J. (eds.). 2024. The Reptile Database, http://www.reptile-database.org.

- Wallace, B.P., Tiwari, M. & Girondot, M. 2013. *Dermochelys coriacea (Southwest Indian Ocean subpopulation)*. *The IUCN Red List of Threatened Species* 2013: e.T46967863A46967866.

  https://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T46967863A46967866.en.

Appendices

Appendix A – iNaturalist records for Mammals, Amphibians and Reptiles

Table 5-1: Species records submitted on iNaturalist within the larger Project Area. Species of Conservation Concern are indicated in Bold. Status: NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered.

Order	Family	Scientific Name	Common Name	Red List Status[13]
Mammalia				
Afrosoricida	**Chrysochloridae**	***Cryptochloris wintoni***	**De Winton's Golden Mole**	**CR**
Artiodactyla	Bovidae	*Antidorcas marsupialis*	Springbok	LC
Artiodactyla	Bovidae	*Oryx gazella*	South African Oryx	LC
Artiodactyla	Bovidae	*Raphicerus campestris*	Steenbok	LC
Carnivora	Canidae	*Lupulella mesomelas*	Black-backed Jackal	LC
Carnivora	Felidae	*Felis lybica cafra*	African Wildcat	LC
Carnivora	**Hyaenidae**	***Parahyaena brunnea***	**Brown Hyaena**	**NT**
Eulipotyphla	Talpidae	*Talpidae*	Moles and Desmans	LC
Eulipotyphla	Soricidae	Myosorex varius	Forest Shrew	LC
Rodentia	Muridae	*Otomys unisulcatus*	Karoo Bush Rat	LC
Rodentia	Muridae	*Parotomys brantsii*	Brants's Whistling Rat	LC
Rodentia	Muridae	*Parotomys brantsii brantsii*		LC
Rodentia	Nesomyidae	*Malacothrix typica*	Large-eared Mouse	LC
Amphibia				
Anura	**Brevicipitidae**	***Breviceps macrops***	**Desert Rain Frog**	**NT[14]**
Anura	Bufonidae	*Vandijkophrynus gariepensis*	Karoo Toad	LC
Anura	Bufonidae	*Vandijkophrynus robinsoni*	Paradise Toad	LC
Anura	Pyxicephalidae	*Cacosternum namaquense*	Namaqua Caco	LC
Reptilia				
Testudines	Testudinidae	*Chersina angulata*	Angulate Tortoise	LC
Testudines	**Testudinidae**	***Chersobius signatus***	**Speckled Cape Tortoise**	**EN (2017)**
Testudines	**Testudinidae**	***Psammobates tentorius trimeni***	**Western Tent Tortoise**	**NT[15], EN[16]**
Squamata	Agamidae	*Agama hispida*	Common Spiny Agama	LC
Squamata	Chamaeleonidae	*Bradypodion occidentale*	Namaqua Dwarf Chameleon	LC
Squamata	Cordylidae	*Karusasaurus polyzonus*	Karoo-gordelakkedis	LC
Squamata	Elapidae	*Naja nivea*	Cape Cobra	LC
Squamata	Gekkonidae	*Pachydactylus labialis*	Calvinia Thick-toed Gecko	LC
Squamata	Gekkonidae	*Pachydactylus austeni*	Austen's Thick-toed Gecko	LC
Squamata	**Gekkonidae**	***Pachydactylus rangei***	**Namib Sand Gecko / Namib Web-footed gecko**	**CR* (2014)**
Squamata	Gekkonidae	*Ptenopus garrulus maculatus*	Spotted Barking Gecko	LC
Squamata	Gekkonidae	*Rhoptropella ocellata*	Spotted Day Gecko	LC

[13] Based on available information at the time of sourcing the data in December 2024.
[14] IUCN SSC Amphibian Specialist Group & SA-FRoG (2017).
[15] Regional status applied from a higher-level taxon (Hofmeyr *et al.* 2017).
[16] Assessed to be Endangered under criterion A4ce.

Order	Family	Scientific Name	Common Name	Red List Status[13]
Squamata	Lacertidae	*Meroles ctenodactylus*	Smith's Desert Lizard	LC
Squamata	Lacertidae	*Meroles knoxii*	Knox's Ocellated Sand Lizard	LC
Squamata	Lacertidae	*Meroles suborbitalis*	Spotted Desert Lizard	LC
Squamata	Psammophiidae	*Dipsina multimaculata*	Dwerghaakneusslang	LC
Squamata	Psammophiidae	*Psammophis leightoni*	Cape Sand Snake	LC
Squamata	Pseudaspididae	*Pseudaspis cana*	Mole Snake	LC
Squamata	Scincidae	*Acontias lineatus*	Striped Legless Skink	LC
Squamata	Scincidae	*Scelotes sexlineatus*	Striped Dwarf Burrowing Skink	LC
Squamata	Scincidae	*Trachylepis variegata*	Variegated Skink	LC
Squamata	Scincidae	*Trachylepis spilogaster*	Kalahari Tree Skink	LC
Squamata	Scincidae	*Typhlosaurus vermis*	Boulenger's Legless Skink	LC
Squamata	**Viperidae**	***Bitis schneideri***	**Namaqua Dwarf Adder**	**NT**

Appendix B – Virtual Museum for Mammals, Amphibians and Reptiles

Expected species lists for Mammals (Table 5-2), Amphibians (Table 5-3) and Reptiles (Table 5-4) were obtained from the Virtual Museum for Quarter Degree Squares (QDS) 2816DC[17], 2816DD, 2916BB, 2916BD and 2816DA.

Table 5-2: Expected mammals species lists from the MammalMAP (take note: bats and marine species are excluded from the list). Red list status: LC = Least concern, NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered).

Family	Species	Red List Status[18]	2816DA	2816DC	2816DD	2916BB	2916BD
Bathyergidae	*Bathyergus janetta*	LC **(EN)**[19]				X	X
Bathyergidae	*Georychus capensis*	LC				X	
Bovidae	*Oryx gazella*	LC	X		X		
Bovidae	*Raphicerus campestris*	LC			X		
Canidae	*Canis mesomelas*	LC			X	X	
Canidae	*Otocyon megalotis*	LC		X	X		
Canidae	*Vulpes chama*	LC			X		
Cercopithecidae	*Chlorocebus pygerythrus*	LC	X				
Chrysochloridae	*Chrysochloris asiatica*	DD			X		
Chrysochloridae	*Cryptochloris wintoni*	CR					X
Chrysochloridae	*Eremitalpa granti*	VU		X		X	X
Felidae	*Caracal caracal*	LC			X		
Felidae	*Felis silvestris*	LC			X	X	
Herpestidae	*Cynictis penicillata*	LC				X	
Herpestidae	*Herpestes pulverulentus*	LC			X		
Herpestidae	*Suricata suricatta*	LC			X	X	X
Hyaenidae	*Hyaena brunnea*	NT	X		X	X	
Hystricidae	*Hystrix africaeaustralis*	LC			X	X	
Leporidae	*Lepus capensis*	LC	X	X	X		
Leporidae	*Pronolagus rupestris*	LC			X		
Macroscelididae	*Elephantulus edwardii*	LC		X			
Macroscelididae	*Elephantulus rupestris*	LC			X		
Macroscelididae	*Macroscelides proboscideus*	LC		X	X		
Muridae	*Micaelamys namaquensis*	LC	X				
Muridae	*Gerbilliscus paeba*	LC	X				X
Muridae	*Mus musculus musculus*	LC					X
Muridae	*Mus (Nannomys) minutoides*	LC	X				
Muridae	*Otomys unisulcatus*	LC	X	X	X	X	X
Muridae	*Parotomys brantsii*	LC	X		X	X	X
Muridae	*Rhabdomys pumilio*	LC	X	X		X	X
Mustelidae	*Ictonyx striatus*	LC			X	X	X
Mustelidae	*Mellivora capensis*	LC			X		

[17] Main area covering the Project Area around Visagiesfontein
[18] Based on the relevant information at the time, December 2024.
[19] recently uplisted to Endangered (2025 National Red List)

Family	Species	Red List Status[18]	2816DA	2816DC	2816DD	2916BB	2916BD
Nesomyidae	*Petromyscus collinus*	LC	X				
Orycteropodidae	*Orycteropus afer*	LC			X		
Petromuridae	*Petromus typicus*	LC	X				
Soricidae	*Myosorex varius*	LC			X		
Soricidae	*Suncus varilla*	LC				X	X

Table 5-3: Expected Amphibians species lists from the FrogMAP. Red list status: LC = Least concern, NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered).

Family	Species	Status	2816DC	2816DA	2816DD	2916BB	2916BD
Brevicipitidae	*Breviceps macrops*	LC (VU) [20]	X	X	X	X	X
Brevicipitidae	*Breviceps namaquensis*	LC	X	X	X	X	
Bufonidae	*Vandijkophrynus gariepensis gariepensis*	LC		X			

Table 5-4: Expected Reptile species lists from the ReptileMAP. Red list status: LC = Least concern, NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered).

Family	*Species*	Status	2816DA	2816DC	2816DD	2916BB	2916BD
Agamidae	*Agama anchietae*	LC					X
Agamidae	*Agama atra*	LC	X		X		X
Agamidae	*Agama hispida*	LC	X	X	X	X	X
Chamaeleonidae	*Bradypodion occidentale*	LC		X	X	X	X
Chamaeleonidae	*Chamaeleo namaquensis*	LC	X	X	X	X	X
Colubridae	*Dasypeltis scabra*	LC			X	X	X
Colubridae	*Dipsina multimaculata*	LC	X			X	X
Cordylidae	*Cordylus macropholis*	NT					X
Cordylidae	*Karusasaurus polyzonus*	LC	X	X	X	X	X
Elapidae	*Aspidelaps lubricus lubricus*	LC					X
Elapidae	*Naja nivea*	LC				X	X
Gekkonidae	*Afrogecko porphyreus*	LC				X	
Gekkonidae	*Chondrodactylus angulifer*	LC	X		X		X
Gekkonidae	*Chondrodactylus bibronii*	LC		X	X	X	X
Gekkonidae	*Goggia lineata*	LC		X	X	X	X
Gekkonidae	*Lygodactylus bradfieldi*		X				
Gekkonidae	*Pachydactylus amoenus*	LC				X	
Gekkonidae	*Pachydactylus austeni*	LC		X	X	X	X
Gekkonidae	*Pachydactylus barnardi*	LC			X	X	X
Gekkonidae	*Pachydactylus labialis*	LC				X	X
Gekkonidae	*Pachydactylus macrolepis*	LC			X		
Gekkonidae	*Pachydactylus punctatus*	LC	X		X		
Gekkonidae	*Pachydactylus rangei*	CR	X	X	X		
Gekkonidae	*Ptenopus garrulus*	LC	X		X	X	X

[20] 2025 National Red List

Family	*Species*	Status	2816DA	2816DC	2816DD	2916BB	2916BD
	maculatus						
Gekkonidae	*Rhoptropella ocellata*	LC					X
Gerrhosauridae	*Gerrhosaurus typicus*	LC			X		
Lacertidae	*Meroles ctenodactylus*	LC	X	X	X	X	X
Lacertidae	*Meroles cuneirostris*	LC	X	X	X		
Lacertidae	*Meroles knoxii*	LC		X	X	X	X
Lacertidae	*Meroles suborbitalis*	LC	X	X	X		X
Lacertidae	*Nucras tessellata*	LC				X	X
Lacertidae	*Pedioplanis lineoocellata pulchella*	LC			X		
Lacertidae	*Pedioplanis namaquensis*	LC			X		
Lamprophiidae	*Boaedon capensis*	LC			X	X	X
Lamprophiidae	*Homoroselaps lacteus*	LC				X	
Lamprophiidae	*Prosymna frontalis*	LC					X
Lamprophiidae	*Psammophis crucifer*	LC				X	X
Lamprophiidae	*Psammophis leightoni*	VU	X		X	X	X
Lamprophiidae	*Psammophis notostictus*	LC	X			X	X
Lamprophiidae	*Psammophylax rhombeatus*	LC		X			X
Lamprophiidae	*Pseudaspis cana*	LC		X	X	X	X
Scincidae	*Acontias litoralis*	LC	X		X	X	X
Scincidae	*Acontias namaquensis*	LC				X	X
Scincidae	*Acontias tristis*	LC		X	X	X	X
Scincidae	*Scelotes sexlineatus*	LC	X		X		X
Scincidae	*Trachylepis capensis*	LC			X	X	X
Scincidae	*Trachylepis occidentalis*	LC	X				
Scincidae	*Trachylepis sulcata sulcata*	LC			X		X
Scincidae	*Trachylepis variegata*	LC		X	X	X	X
Scincidae	*Typhlosaurus vermis*	LC	X		X	X	X
Testudinidae	*Chersina angulata*	LC	X	X	X	X	X
Testudinidae	*Chersobius signatus*	VU					X
Testudinidae	*Psammobates tentorius trimeni*	EN			X		X
Typhlopidae	*Rhinotyphlops lalandei*	LC				X	X
Varanidae	*Varanus niloticus*	LC			X		
Viperidae	*Bitis arietans arietans*	LC	X		X	X	

CHAPTER 3

Supplementary Material: Specialist Report

(A) Vegetation and flora report

Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone, Northern Cape, South Africa

Work Package 1

(A) VEGETATION AND FLORA REPORT

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May 2025

Report prepared for:

Council for Industrial and Scientific Research

Executive Summary

From a vegetation ecology and flora perspective the major source of impacts from the Boegoebaai Port and SEZ development will result directly or indirectly from vegetation clearance with the associated species loss, habitat loss and transformation.

The Boegoebaai Port and SEZ site is located in the Desert and Succulent Karoo Biomes of South Africa. Compared to other deserts with the same level of aridity globally, the Desert Biome in South Africa is exceptionally rich in plant species and also hosts a large number of endemic plant species. The Succulent Karoo Biome is recognised as an IUCN global hotspot of diversity and one of only two global hotspots that are entirely arid. To qualify as a hotspot, an area must have a high level of species diversity, a high percentage of endemic species and a substantial number of threatened species. Due to the high levels of biodiversity in both the Succulent Karoo and Desert vegetation, the Boegoebaai Port and SEZ site encompasses many features of High or Very High sensitivity.

The provisional checklist for the site contains 390 plant species that have been confirmed as occurring on site. The confirmed on-site checklist includes eight plant species with a Critically Endangered IUCN status, nine plant species classified as Endangered, 15 as Vulnerable, seven as Near Threatened, six as Data Deficient and one as Rare. Thus, in total 46 species on site are classified as SCC, representing 11.8% of all species on site. It is likely that this provisional checklist, as well as the SCC list, is not yet complete since the mined area to the west of the R382 has been poorly collected because of the restricted access to the area.

The receiving environment in the Boegoebaai Port and SEZ site hosts many features that indicate priority habitat for biodiversity conservation, such as:

- Two **Critically Endangered** ecosystems, the **Richtersveld Coastal Duneveld** and the **Namib Seashore Vegetation**.
- Large areas are classified as **irreplaceable CBA 1s** or as **optimal CBA 2s**;
- Habitat to **Critically Endangered** plant species;
- Portions are included in the **National Protected Area Expansion Strategy** (NPAES);
- Inclusion into an internationally recognised **Key Biodiversity Area** (KBA); and
- The **Critically Endangered Namib Lichen Fields**, *ca.* 13 km north of the site, a small ecosystem type at risk of collapse due to high rates of habitat loss in the past. These lichen fields are extremely sensitive to air pollution and care must be taken that the proposed development does not negatively impact this unique ecosystem.

A broad-scale, screening level, on-site reconnaissance and evaluation of the vegetation was conducted. The field evaluation was supported by available data. A small number of surveys were done during the reconnaissance visit. These data were classified and nine plant communities identified and described and a broad-scale vegetation map produced.

The Terms of Reference for the vegetation and flora component of the SEA required the ground-truthing of the environmental sensitivities indicated by the Screening Tool. The available information used to produce the sensitivity maps for the current assessment of the Boegoebaai SEA is at a coarse scale. The sensitivity

ratings were applied per plant community and relied on the presence of various features within a plant community.

The Screening Tool rated the sensitivity of the Plant Theme as being **Medium** based on the presence of model-derived suitable habitat for threatened and/or rare species. Using currently available databases, 46 SCC have been noted on site and consequently an upscaling of the Plant Theme to **Very High** is recommended with ca. 75% of the site having a Very High sensitivity (Figure Aa). The Screening Tool rated the sensitivity of the Relative Terrestrial Biodiversity Theme as **Very High**. The current assessment supported a **Very High** sensitivity for most of the site (75%; Figure Ab) and although the plant community that was previously mined is located within the area mapped as a Critically Endangered ecosystem (Richtersveld Coastal Duneveld) it was classified as transformed in the current assessment and could thus be used for development provided that areas of priority habitat are not negatively impacted by the development. The transformed areas from a botanical perspective cover 15% of the site.

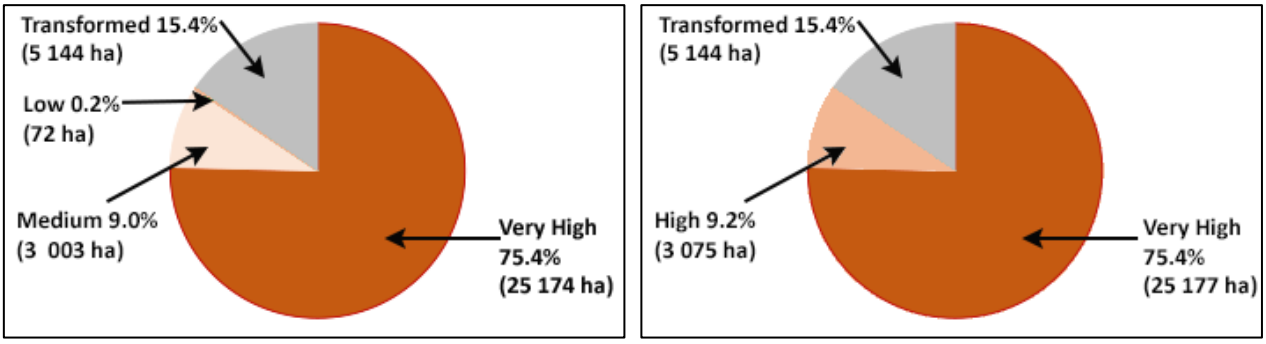


Figure A: Areas covered by the various sensitivity classes in (a) the Plant Theme (High sensitivity is too small to indicate in the figure and covers 0.01% of the total area = 3 ha) and (b) the Relative Terrestrial Biodiversity Theme as assessed during the current evaluation.

The sensitivity maps provided in this vegetation and flora report represent screening level baseline maps that need to be updated when detailed studies of the site become available or when major revisions of the data layers, are produced. It is strongly recommended that as a priority the current coarse-scale vegetation map is refined to inform the planning and layout of the Port and SEZ. **Considering the large areas with a Very High sensitivity rating, it would be prudent to conduct an in-depth, fine-scale analysis of the vegetation to produce a detailed vegetation map of the entire area as soon as possible, rather than conducting multiple EIAs at different levels of detail by an array of botanical specialists over a long period of time. Such a map will significantly contribute towards planning the layout of the port and SEZ and could potentially avoid placing footprints in areas that could possibly not receive Environmental Authorization.**

During the planning phase, areas of **Very High sensitivity should be avoided**, and as far as possible areas of **High** sensitivity should also be avoided. Residual impacts on irreplaceable biodiversity (Very High sensitivity) cannot be offset since that would prevent national biodiversity targets from being met. Avoidance would in the first place imply revisiting the alternative port and SEZ options. For possible alternative sites, consult Botha & Desmet (2022) or the presentation given by TNPA (meeting 10 October 2024), where a site approximately 18 km north of Port Nolloth was identified (p. 6) (https://www.csir.co.za/sites/default/files/Documents/Appendix%20C_Overview%20of%20Boegoebaai%20Site%20Selection%20process.pdf). Although offset options are not applicable to impacts of Very High sensitivity, offsets may be required for impacts of High or Medium sensitivity.

The potential benefits of the Boegoebaai Port and SEZ development must be evaluated against the irreversible loss of plant and vegetation diversity and ecosystem services. The current high-level evaluation of the botanical component of the site has demonstrated a Very High sensitivity for the Plant as well as

Relative Terrestrial Biodiversity Themes and consequently the proposed development requires a cautious approach with a strong emphasis on the conservation of the botanical diversity. **Mitigation measures cannot eliminate irreversible losses of critical habitats or Critically Endangered species and avoidance will be the only option.** Alternative sites where the impacts on the receiving environment have lower ecological sensitivities could potentially achieve development goals with minimal environmental trade-offs.

Abbreviations and Acronyms

Acronym	Explanation
AIS	Alien Invasive Species
AOO	Area of Occupancy
CBA	Critical Biodiversity Area
CBD	Convention on Biodiversity
CR	Critically Endangered
CSIR	Council for Scientific and Industrial Research
DFFE	Department of Forestry, Fisheries and Environment
DEA	Department of Environmental Affairs
EGI	Electricity Grid Infrastructure
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EN	Endangered
EOO	Extent of Occurrence
ESA	Ecological Support Area
EWT	Endangered Wildlife Trust
GHG	Greenhouse gas
GIS	Geographic Information System
IDP	Integrated Development Plan
IFC	International Finance Corporation
IEMP	Integrated Environmental Management Plan
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act (107/1998)
NEM:BA	National Environmental Management: Biodiversity Act (10/2004)
NEM:PAA	National Environmental Management: Protected Areas Act (57/2003)
NFA	National Forest Act (84/1998)
NFEPA	National Freshwater Ecosystem Priority Areas
NHS	National Heritage Site
NPAES	National Protected Area Expansion Strategy
NT	Near Threatened
ONA	Other Natural Area
PA	Protected Area
SACAD	South African Conservation Areas Database
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SAPAD	South African Protected Areas Database
SCC	Species of Conservation Concern
SDF	Spatial Development Framework
SEA	Strategic Environmental Assessment
TNPA	Transnet National Ports Authority
ToPS	Threatened or Protected Species Regulations (2013)
TOR	Terms of Reference
VU	Vulnerable
WHS	World Heritage Site

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Terms of Reference

Deliverables:

Preparation of an electronic report (in English), which will be integrated as a Chapter in the overall SEA report. Provide spatial data in .shp or .kmz format.

Meetings / feedback sessions:

Attend occasional virtual meetings to plan work, discuss findings with the broader research team and present findings to the Project Steering Committee and Working Group.

Data sharing and reference library:

CSIR will make available a reference library containing useful literature, planning documents and spatial data. Other parties undertake to consult and use such documentation as needed. No distribution of this information to external parties without permission.

Scope summary:

A local-scale, spatially focused SEA report identifying sensitivities within the proposed port and SEZ development covering ~33 500 ha ("Boegoebaai Port and SEZ SEA"). Expert on-site, ground-truthing of environmental sensitivities of the Screening Tool by a broad-scale, on-site evaluation supported by existing data and preparation of updated spatial data. The outcome will inform the planning of the Port and SEZ, as well as provide references and recommendations for future project specific Environmental Impact Assessments.

Role:

Integrating (Lead) Author on the Terrestrial and Aquatic Ecology chapter (WP 1 Report). Incorporate findings from Contributing Authors on flora, fauna, avifauna, bats and aquatic ecology, for WP1.

Specific tasks:

1. *Plan of Study:*

   Outline the approach, data requirements, assumptions, limitations and timeframe of tasks.

   Provide report / chapter framework.

2. *Description of the receiving environment:*

   Describe the land use dynamics and change trends of the receiving environment and broader region as it relates to your topic. This will feed into the dynamic baseline scenario (Sc0) used in WP2 "Regional SEA" as needed – "how is the ecological system changing even if a GH_2 economy does not realise?".

   Describe the key characteristics of the receiving environment as it pertains to your area of expertise - "What, where, why is it important?" Spatially explicit as far as possible.

3. *Site visit / ground-truthing:*

   Site visit to augment the receiving environment description, and to map and verify environmental sensitivity.

4. *To the extent possible, provide additional data / actions required for assessment as related to biodiversity offsets, using existing data, satellite imagery and what is observed within the constraints of the fieldwork:*

   Identify areas with natural sand movement or recent blowouts (due to disturbance such as from mining) should be categorized differently, possibly as "rehab possible," indicating potential for rehabilitation.

   Gather data on the occurrence of SCC within the port and SEZ footprint areas.

   Unique occurrences, such as those on the Boegoeberg Twins, are particularly important to note.

5. *Sensitivity analysis:*

Spatial layers distinguishing relative sensitivity of the receiving environment (Low, Medium, High, Very High).

Verified and refined based on site visit / ground-truthing.

6. *Aspects and impacts register:*

Potential impacts (negative and positive) that may arise from the planned activities and infrastructure (based on a project description provided by CSIR).

7. *Recommendations for planning and future EIA:*

Practical recommendations to inform the planning and layout of the Port and SEZ.

Practical recommendations for future EIA studies.

Practical recommendations to enhance positive impacts and reduce negative impacts.

Assumptions, limitations and uncertainties

This is a strategic-level, predominantly desktop assessment, aimed at identifying potential, botanically related environmental sensitivities based on existing spatial data at a high level. No detailed fieldwork was done and limited raw data were collected and analysed. Species records obtained from P. van Wyk were used and supplemented by existing databases, e.g. NewPosa (SANBI) and iNaturalist and SANBI (2024). It should, however, be noted that the entire Port and SEZ site has not been intensively sampled or surveyed in the past because of the limited access to the mining area. Consequently, some areas may have no botanical records in existing biodiversity databases. Species records used in this study are therefore more common in areas that were easy to access. Furthermore, species data sets are seldom comprehensive and the absence of species records is not equivalent to the absence of SCC.

The site visit was conducted from 31 August – 3 September 2024, which is normally the most favourable time of year for field work in the Succulent Karoo. Most of the Richtersveld as well as the current assessment area suffered from an extreme drought from 2011 to 2022 (peak in 2019) which killed many plants and entire populations. Recovery may take many years and it is likely that the complete species pool was not present in 2024. Furthermore, the low rainfall during the winter of 2024 was not ideal for annual and geophytic plant species.

The available information used to derive the sensitivity maps is at a coarse scale. Sensitivity ratings relied on an assessment of various features within the plant communities that were distinguished. The ratings were applied per community due to a lack of point data covering the area. Because many of the plant communities are large, the current analysis and mapping of sensitive features is at a broad scale and many small or localised features were not mapped although they may be present.

This predominantly desk-top approach used here was regarded as adequate for the purpose of an SEA. The disadvantage, however, is that the level of detail is not sufficient for biodiversity offset planning. It has been proposed that a detailed assessment of the vegetation and flora has to be made for each site-specific development proposal during the EIA phase. Alternatively, an in-depth, fine-scale analysis of the entire port and SEZ site could be scheduled as soon as possible to guide the footprint planning and to avoid areas that could possibly not receive environmental authorisation. These field surveys must be done in the appropriate season or preferably seasons to capture the geophytic and annual plant species component of the flora.

Gaps in knowledge: The Boegoebaai Port and SEZ area, particularly the section to the west of the tar road (R382), has not been subject to a detailed vegetation analysis. Because impacts on threatened species, natural and critical habitats and ecosystem on site are likely, the baseline data collection should include in-depth, fine-scale field surveys over multiple seasons to produce a fine-scale vegetation map that could be used to plan the layout of the port and SEZ. The field survey data should be recent and done in the appropriate season or preferably seasons. It could be considered to contract a consortium of specialists including the fields of botany, avifauna, herpetology, mammals (including bats as separate study) and invertebrates (invertebrates not assessed for current SEA) to produce fine-scale maps.

Disclaimer 1: The final update on the red list status of plant species (supplied by SANBI) was on 18 December 2024. At the time of finalising this report (20 May 2025) no further red list status updates had been received. We kindly acknowledge SANBI for the use of their data. This work forms part of the Boegoebaai Strategic Environmental Assessment (CSIR project EEMS086). The scientific material for this publication was developed through a collaborative effort involving various stakeholders and datasets contributed by the South African National Biodiversity Institute. It should be noted that the redlist status of some species indicated in this report differs from the report by Van Wyk (2025) because he has access to data that is not yet publicly available on the website of the Threatened Species Programme.

Disclaimer 2: This report is based on the 2016 Northern Cape Critical Biodiversity Areas map available from the SANBI Biodiversity GIS website. The 2024 Northern Cape CBA map has undergone several revision, but at the time of finalising this report (20 May 2025), the latest version was not yet publicly available on SANBI BGIS.

1. INTRODUCTION

In 2015, at the 21st Conference of Parties (COP), 195 countries signed an agreement to implement national strategies to keep global warming below 2°C above pre-industrial levels. Energy is one of the most carbon-intensive sectors and to achieve this target a radical change in energy production and consumption will be needed. Hydrogen produced from clean, renewable sources is termed "green hydrogen (GH_2)" and could potentially provide an opportunity to decarbonise the South African energy economy while also generating new revenues, creating jobs and developing skills.

From production to consumption the GH_2 value chain consists of many interlinked elements, each with its own barriers, challenges and risks. The production of green hydrogen is accomplished by electrolysis (either alkaline, proton exchange membrane (PEM), anion exchange membrane (AEM) or solid oxide), which is fuelled by electricity produced from renewable resources such as wind, solar or nuclear. Because hydrogen has a low energy density by volume it has to be treated to reduce its volume when being transported. Hydrogen is therefore either compressed or liquefied, or further synthesized into other energy carriers, such as ammonia, methane, methanol, liquid organic molecules, or liquid hydrocarbons, which have a higher energy density. The transport of hydrogen can be either by truck, ship or pipeline. Transporting compressed hydrogen by truck is viable for short distances and for low volumes. For longer distances, hydrogen is usually transported in liquid form, at low temperature.

Alternatively, hydrogen can be synthesised into ammonia. If ammonia is synthesized by the Haber-Bosch process it has the advantage that the non-hydrogen part of the molecule does not contain carbon and after dehydrogenation the nitrogen is returned to the atmosphere. Ammonia can be transported by truck, rail or ship, either compressed or liquefied, at conditions that are more favourable than those for pure hydrogen. Alternatively, methanol can be synthesized from green hydrogen by the addition of carbon dioxide.

The Boegoebaai Port and Special Economic Zone (SEZ), i.e. the study site, in the Northern Cape has been proposed to advance South Africa's GH_2 strategy. A Strategic Environmental Assessment (SEA) was initiated by a collaborative effort between the South African National Energy Development Institute (SANEDI), Northern Cape Economic Development Trade and Investment Promotion Agency (NCEDA), and Transnet National Ports Authority (TNPA). The Council for Scientific and Industrial Research (CSIR) has been appointed to undertake the independent SEA. The objective of the Boegoebaai SEA is to develop an integrated decision-making framework to guide the planning of the proposed Boegoebaai Port, Special Economic Zone (SEZ) and wider Namakwa region in a sustainable manner (Schreiner *et al.,* 2024). The conceptual layout of the project site to be assessed for Work Package 1 is shown in Figure 1 and includes the Port precinct (Zones 1 & 2) at 3 357 ha and the SEZ at 30 143 ha (Zones 3 – 10).

A phased approach has been proposed for constructing the infrastructure and facilities for the Boegoebaai Port and SEZ. This approach includes a short-term (Phase 1A) and long-term (Phase 1B) development plan for the port. The Boegoebaai SEZ is seen as a multifaceted hub, primarily focusing on the GH_2 project's downstream activities and facilitating the export of commodities through the proposed Boegoebaai Port. The SEZ will also be developed in phases and is envisaged to consist of eight subzones (Zones 3 – 10; Figure 1):

1. Port – 2 187 ha
2. Conservancy area – 1 170 ha
3. Confirmed green ammonia facility – 4 508 ha
4. SEZ Phase 1 – 499 ha
5. SEZ Phase 2 – 411 ha
6. SEZ Phase 3 – 833 ha
7. Future green hydrogen facility – 3 713 ha
8. Future expansion 01 – 3 408 ha
9. Future expansion 02 – 15 067 ha
10. Future tank farm – 1 704 ha

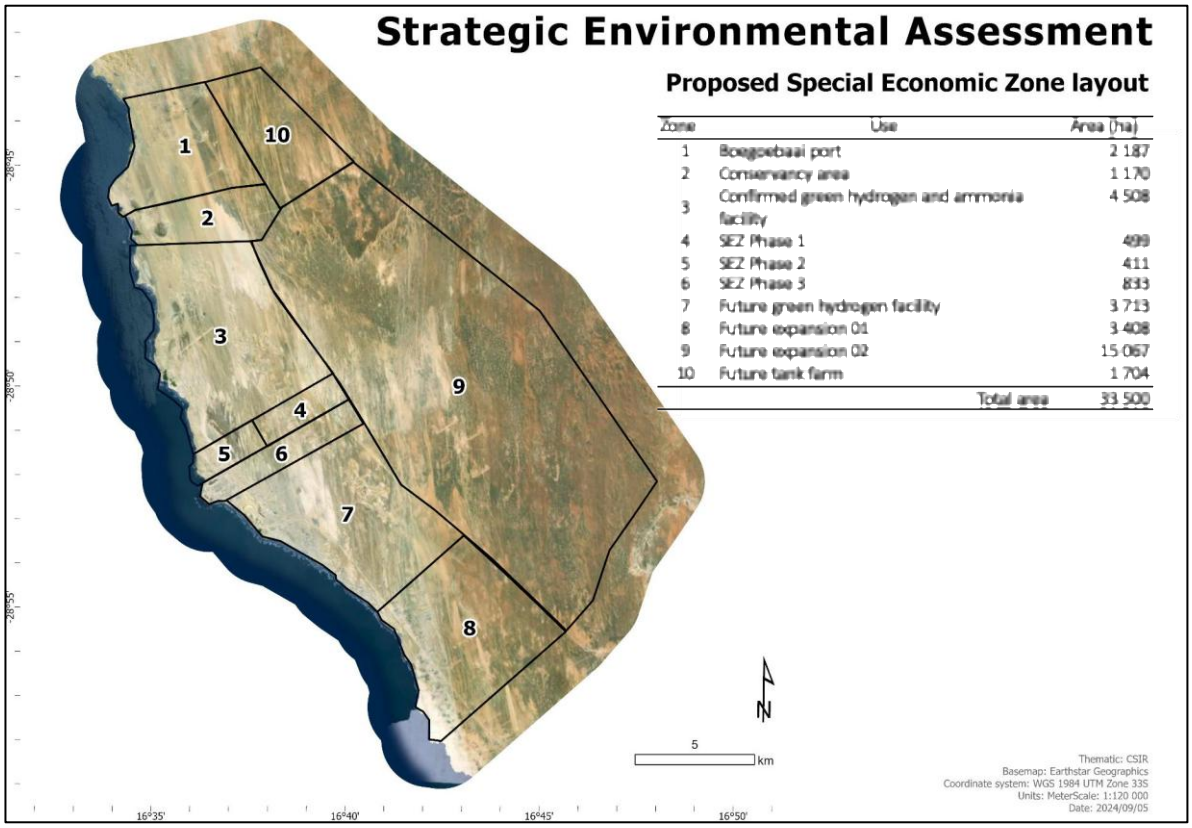


Figure 1: Layout of the Boegoebaai Port and Special Economic Zone (source: Schreiner *et al.,* 2024).

2. METHODOLOGY

In this section the methodology to conduct the SEA for the vegetation and flora component is outlined detailing the steps taken to ensure the satisfactory completion of the scope of work.

2.1 Approach

The study commenced as a desktop study, followed by a site visit at the end of August, beginning September 2024. The focus of the site visit was to undertake a site sensitivity evaluation to support or contradict the environmental sensitivity as identified in the Screening Tool provided by the Department of Forestry, Fisheries and Environment (DFFE) (Screening Tool, 2024). No provision was made for a detailed analysis of the vegetation in the scope of work. However, any Species of Conservation Concern (SCC) that was encountered during the site visit was recorded.

2.2 Data Sources

Sources of information for the vegetation and flora component included:

- Screening Tool Report generated for the revised Boegoebaai Port and SEZ layout on 20 August 2024 from the DFFE website (https://screening.environment.gov.za/screeningtool/#/pages/process). As per the best practise guideline that accompanies the Animal and Plant Species Protocol for the screening tool, please note that the **name of the sensitive species may not appear in the final EIA report nor any of the specialist reports released into the public domain**. It should be referred to as *sensitive plant* or *sensitive animal* and its threat status may be included, e.g. *critically endangered sensitive plant* or *endangered sensitive animal*.
- Descriptions of the vegetation types found in the area were obtained from Mucina & Rutherford (2006). The map was of the vegetation types was the revised national vegetation map produced by the South African National Biodiversity Institute (SANBI, 2012–2024 as amended).
- Conservation status of the vegetation types was obtained from the National List of Threatened Ecosystems (Skowno *et al.,* 2019; National Environmental Management: Biodiversity Act (NEM:BA) (10/2004), 2022).
- Information on endemic species per national vegetation type was obtained from Mucina & Rutherford (2006).
- The Northern Cape Critical Biodiversity Area Map (2016) was consulted for the occurrence of Critical Biodiversity Areas, Ecological Support Areas or Other Natural Areas (biodiversityadvisor.sanbi.org: accessed April 2024) to verify the Screening's Tool sensitivity of the Relative Terrestrial Biodiversity Theme. The 2024 Northern Cape CBA map has undergone several revision, but at the time of finalising this report (20 May 2025), the latest version was not yet publicly available on SANBI BGIS.
- Protected Areas were obtained from the Department of Forestry, Fisheries and Environment (DFFE). (https://egis.environment.gov.za/data_egis/data SAPAD_IR_2024_Q2_01 accessed October 2024).
- The National Protected Areas Expansion Strategy (NPAES 2010, 2018) was consulted for possible inclusion of the site into a protected area in the future (biodiversityadvisor.sanbi.org: accessed April 2024).
- A plant species checklist of the immediate environs of the site was obtained from the NewPosa database of the South African National Biodiversity Institute (SANBI) (Appendix A) (www.newposa.sanbi.org).

- The IUCN Red List Category (IUCN, 2021) for plant species was extracted from the Red List of South African Plants version 2024.1 (www.redlist.sanbi.org; Accessed on 2024/11/22) as provided by SANBI (2024) or from the website of the Threatened Species Programme of SANBI.
- The geology was obtained from the Geological Map 2816 Alexander Bay (Council for Geoscience, 2011).
- Land types were obtained from the Land Type Map 2816 Alexander Bay (Land Type Survey Staff, 1986).
- The following topocadastral maps were consulted: 2816DA Grootderm; 2816DB Rooibank; 2816DC Visagiesfontein; 2816DD Holgat (Chief Directorate of Surveys and Mapping, 2007).
- The Northern Cape National Conservation Act (NCNCA, 2009) was consulted to establish provincially protected and specially protected status of plant species.
- The National Protected tree list of the National Forestry Act (NFA, 2024) was checked for the occurrence of any protected tree species.
- Van Wyk & Smith (2001) and Jürgens (1991, 1997) were consulted for inclusion in a Centre of Endemism.
- The Key Biodiversity Area (KBA) website was accessed to identify the presence of a KBA on site.

2.3 Site visit and mapping

In preparation for the site visit a habitat map of the Port and SEZ site was prepared based on the geology, terrain and areas transformed by mining. Additionally, a satellite image of the site was stratified into homogeneous terrain/ vegetation units or habitats and as many of these units as feasible were visited and species lists of the most prominent species compiled. As backdrop for the mapping of the homogeneous units a 2024 Sentinel natural colour satellite image with a 10 m resolution over Copernicus Hill-shading was used. The image was a 24-bit composite image of bands 4,3,2 as RGB. The image was imported into Adobe Photoshop® for the habitat mapping. The study area was then stratified into habitat units by hand drawing on the Sentinel image. Mapping of habitats units was guided by:

- terrain/topography of the image;
- vegetation cover;
- background colour of the image;
- texture of the image;
- geology; and
- areas transformed by deep surface mining.

Fieldwork was conducted by P. van Wyk, accompanied by N. van Rooyen and G. van Rooyen and limited to recording the most prominent plant species at 37 sites spread across the study site. The species data were classified into groups of associated species representing various plant communities or habitats on site.

For the vegetation and sensitivity maps, the Photoshop layer, containing the mapped paths (lines), was exported and incorporated into a GIS environment. This map was cleaned of line annotations in a raster environment and then converted to a vector map.

2.4 Sensitivity mapping

The methodology used to compile sensitivity maps for the Boegoebaai Port and SEZ is explained in detail in Section 5. The sensitivity maps are compared to those for the Plant Theme and Relative Terrestrial Biodiversity Theme generated by the Screening Tool (2024).

2.5 Provisional plant species checklist

The checklist of plant species (Appendix A) was compiled from data provided by (i) P. van Wyk, (ii) species recorded during the site visit, (iii) supplemented by data from iNaturalist (https://www.inaturalist.org/taxa/) and (iv) from the NewPosa database of the South African National Biodiversity Institute (www.newposa.sanbi.org) and SANBI (2024). Additionally, data provided by P. van Wyk for a somewhat larger area in the Richtersveld, which could potentially be affected by the Boegoebaai development has also been included. Appendix A also includes species listed by Desmet (1996) although his study area stretched from Alexander Bay to Port Nolloth. Desmet's study area was thus substantially larger than the current Boegoebaai Port and SEZ site. However, no coordinates for the species were provided by Desmet to confirm their presence on site.

The IUCN, conservation and protected status of all plant species provided in Appendix A were determined from available literature and Acts, e.g. SANBI (2024), Red list database (www.redlist.sanbi.org); NEM:BA (ToPS list) (2023); NCNCA (2009); NFA (2024) and CITES (2024, https://cites.org/sites/default/files/eng/app/2024/E-Appendices-2024-05-25.pdf).

3. DESCRIPTION OF THE RECEIVING ENVIRONMENT

The proposed Boegoebaai Port and SEZ site is located in the Namaqualand District, Richtersveld Local Municipality, on the West Coast in the northwestern corner of the Northern Cape province, approximately 18 km south of the small mining town of Alexander Bay. It includes parts of the farms Rietfontein (portion 0), Korridor Wes 1 (portions 0 & 1) and Korridor Wes 2 (portions 0, 3, 4, 6 & 8). The highest point on site is Visagiesfonteinkop at 319.2 m. Several depressions occur on site, with the most noteworthy being Visagiespan and Rietfonteinpan (Figure 2).

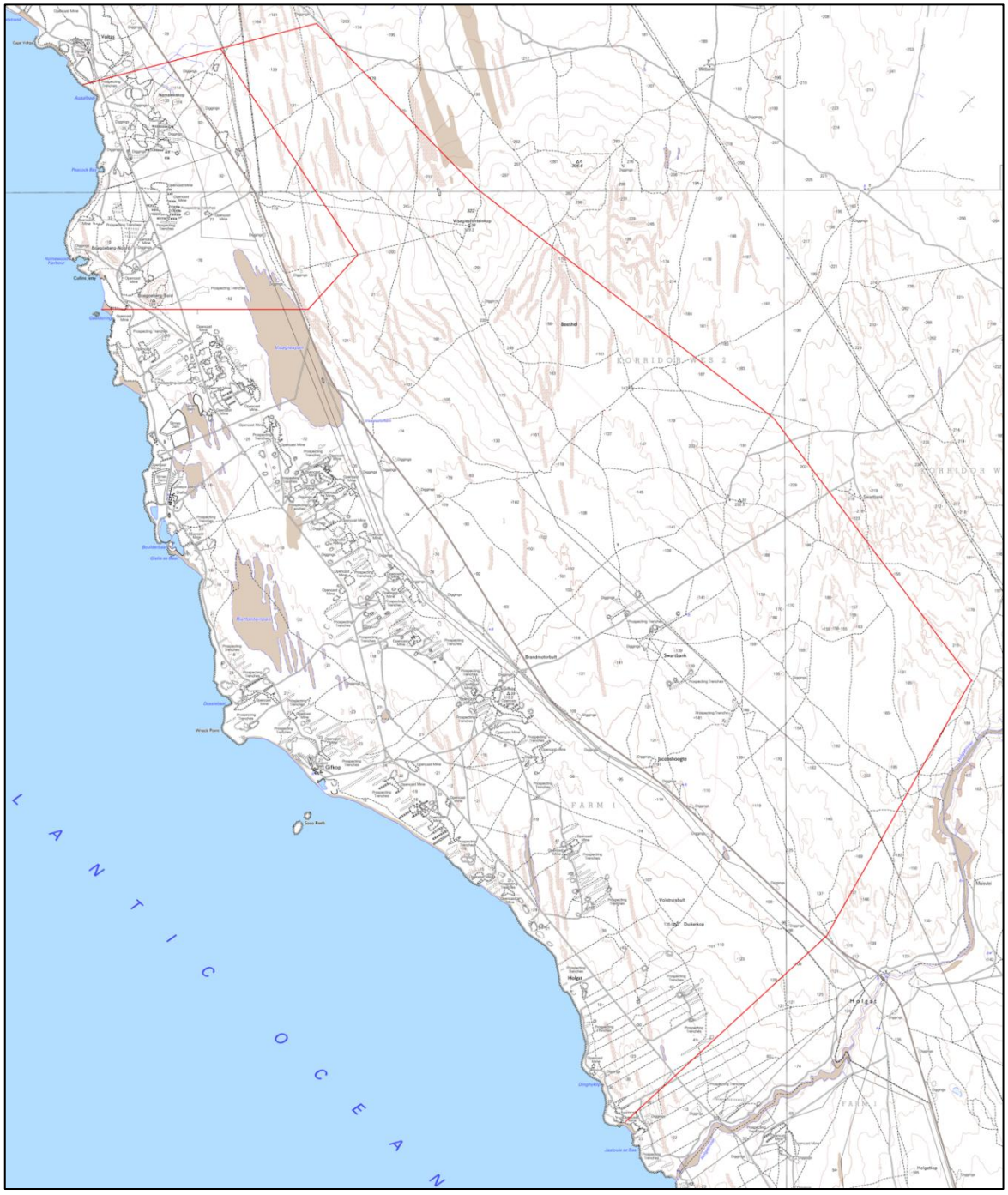


Figure 2: Topocadastral map indicating the Boegoebaai Port and SEZ site outlined in red (source: Topocadastral maps: 2816DA Grootderm; 2816DB Rooibank; 2816DC Visagiesfontein; 2816DD Holgat; Chief Directorate of Surveys and Mapping, 2007).

3.1 Abiotic environment

3.1.1 Climate

Vegetation patterns and processes depend on the climate and to understand these patterns and processes a knowledge of the climate is essential. According to the Köppen-Geiger climate classification both Alexander Bay and Port Nolloth have a BWk climate i.e. a cool, desert climate with a winter rainfall. The aridity of this coastal area can be ascribed to the South Atlantic anticyclone and the cold Benguela current. There is a general decrease in rainfall from south to north along the West Coast, with a concomitant increase in the unreliability of the rainfall expressed as the co-efficient of variation of the mean annual rainfall. The mean annual temperature and rainfall recorded in Alexander Bay, approximately 18 km to the north of the proposed Boegoebaai Port site, is 16.5°C and ca. 80 mm respectively, whereas the mean annual temperature and rainfall recorded in Port Nolloth, approximately 60 km to the south of the Port site, is 16.9°C and ca. 94 mm respectively (Figure 3). Due to the moderating effect of the Atlantic Ocean the mean monthly temperatures show only a 5°C range at Alexander Bay and a 5.4°C range at Port Nolloth during the course of a year. At both Alexander Bay and Port Nolloth, January is the month with the highest mean relative humidity and July the lowest.

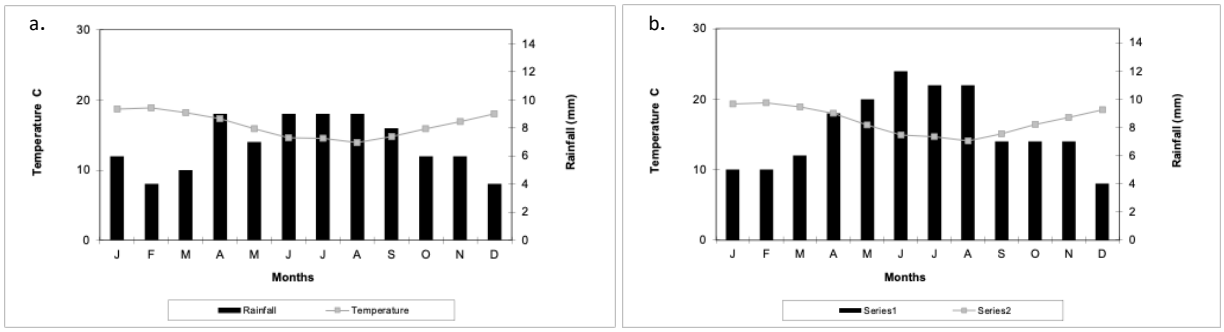


Figure 3: Mean monthly rainfall and temperature for (a) Alexander Bay and (b) Port Nolloth (https//en.climate-data.org).

A distinctive feature of the desert climate at the study site is the occurrence of fog. The sea fog results from the advection of relatively warm moist air over the cold water of the Benguela-upwelling zone (Olivier, 2002). The extent of this upwelling zone varies seasonally and depends on prevailing climatic conditions. High fog occurrence along the West Coast of South Africa is most often on the coastal plain, generally at elevations <200 m a.s.l. The highest fog day frequency is found at the coast and there is a decrease with distance from the sea. The main fog season at Port Nolloth is during the summer-autumn period, however, at Alexander Bay the fog season occurs more during an autumn-winter regime (Olivier, 2002). The mean annual fog day frequency at Alexander Bay is 84 days (maximum 145; minimum 49) and at Port Nolloth 139 days (maximum 180; minimum 64). Fog supplements the meagre rainfall in the region and is a more reliable source of moisture than rainfall (Gottlieb, 2019). Heavy dew further supplements the mean annual rainfall.

The area experiences strong winds that cause dust and sand storms with associated erosion of topsoil material and sandblasting, which has a destructive effect on the vegetation. This destructive wind action is particularly prominent in areas where the vegetation has been degraded and is sparse (Desmet, 1996). Hot, dry easterly berg winds blowing off the interior plateau, roughly at right angles to the coast occur mainly in winter. These berg winds, with associated sand storms, cause a rapid increase in temperature and have a desiccating effect on the vegetation.

3.1.2 Terrain types

A terrain type describes the terrain or relief of an area by means of the percentage level land and local relief. The Port section is covered mostly by 'level plains with some relief' with small segments of 'plains

with open high hills or ridges' and 'plains with open low hills or ridges' (Figure 4). Along the coast and in the northeastern part of the SEZ section, the terrain type consists primarily of 'plains with open high hills or ridges', while the largest area of the SEZ section is covered by 'plains with open low hills or ridges'.

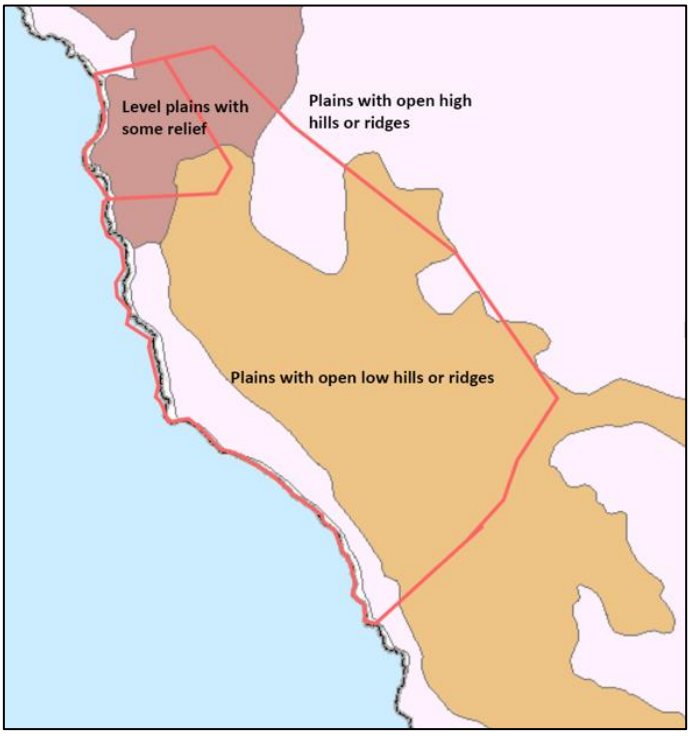


Figure 4: Terrain types in the Boegoebaai Port and SEZ site (source: https://ndagis.nda.agric.za/).

3.1.3 Drainage

There are no major drainage lines on site. The Orange River is the only perennial river in the region and is located approximately 20 km to the north of the site. The Holgat River lies approximately 2 km south of the site and is ephemeral, flowing only after high rainfall events mostly occurring in its upper catchment, which is remote from the coast. The Boegoebaai Port and SEZ site lies in the Orange River Management Area, in the F10C Quaternary catchment (https://ndagis.nda.agric.za/).

3.1.4 Geology

There is generally a close relationship between the occurrence of plant communities and the geological substrate as well as the soils derived from these substrates.

Geologically, the Namaqualand coast consists of Precambrian rock overlain by Cenozoic sediments. The basement geology, dating back to the Precambrian is visible in a few rocky outcrops in the study area (Desmet, 1996). The Port and SEZ site falls in the Gariep Supergroup, Holgat Formation, which lies to the south of the Schakalsberge Thrust (Figure 5) (Council for Geoscience, 2011). To the north of the thrust lie the Oranjemund and Grootderm Formations. The most prominent outcrops in the study site, consisting of schist, greywacke, quartzite and arkose (Nho) of the Holgat Formation, are the Boegoeberg Twins (i.e. Boegoeberg North and Boegoeberg South). Other examples where the basement geology is exposed are the low outcrops in the north of the study site and east of Cape Voltas (e.g. Namakwakop); near Rietfonteinpan; Gifkop; and Volstruisbult; as well as the exposed bedrock along the rocky shore. The canyon of the Holgat River, where the basement geology is also exposed, lies south of the study area. To the east of the R382 tar road some coarse-grained porphyritic granite outcrops occur (ϵsw).

The Cenozoic sediments of the coastal shelf are represented by an array of sediments of Tertiary and Quaternary age. Among the Quaternary sediments on site are: Q-s2 = white aeolian sand; Q-s3 = red

aeolian sand; Q-s4 = saline soil; Q-s5 = surficial sandy soil; Qsw = white to grey dune sand; Qkk = young aeolian, reddish, mobile, vegetated sediment; and Qcu = coarse gravels (Figure 5). Large areas of saline soils (Q-s4) occur at Visagiespan and Rietfonteinpan and near Rietfontein. The surface of the pans is a white to grey silt and clay soil (Mucina & Rutherford 2006) which is underlain by a layer of compacted green sand (De Villiers & Söhnge, 1959 as cited in Desmet 1996). The salt pans are nearly permanently dry.

The Tertiary sediments are represented by three shoreline terraces also referred to as 'packages': Th = 30 m shoreline terrace (or Hondeklip Bay Member); Tav = 50 m terrace (or Avontuur Member); and Tkl = 90 m shoreline terrace (or Kleinsee Member) (Figure 5). These three marine units, containing warm-water molluscan assemblages, are consistently represented along the West Coast (Roberts *et al.,* 2006). The sediments of the 90 m package comprise a basal gravel with abundant silcrete clasts and overlying, reddened sands with heavy-mineral-rich laminae. The 50 m package was laid down when the sea regressed from a maximum of 50 m a.s.l. It consists of fine-grained, green, lower shoreface sands overlying basal gravels. The 30 m package forms another regressional marine sequence. Its lower contact can be traced as a seaward-inclined horizon of pebbles and scattered cobbles (Roberts *et al.,* 2006).

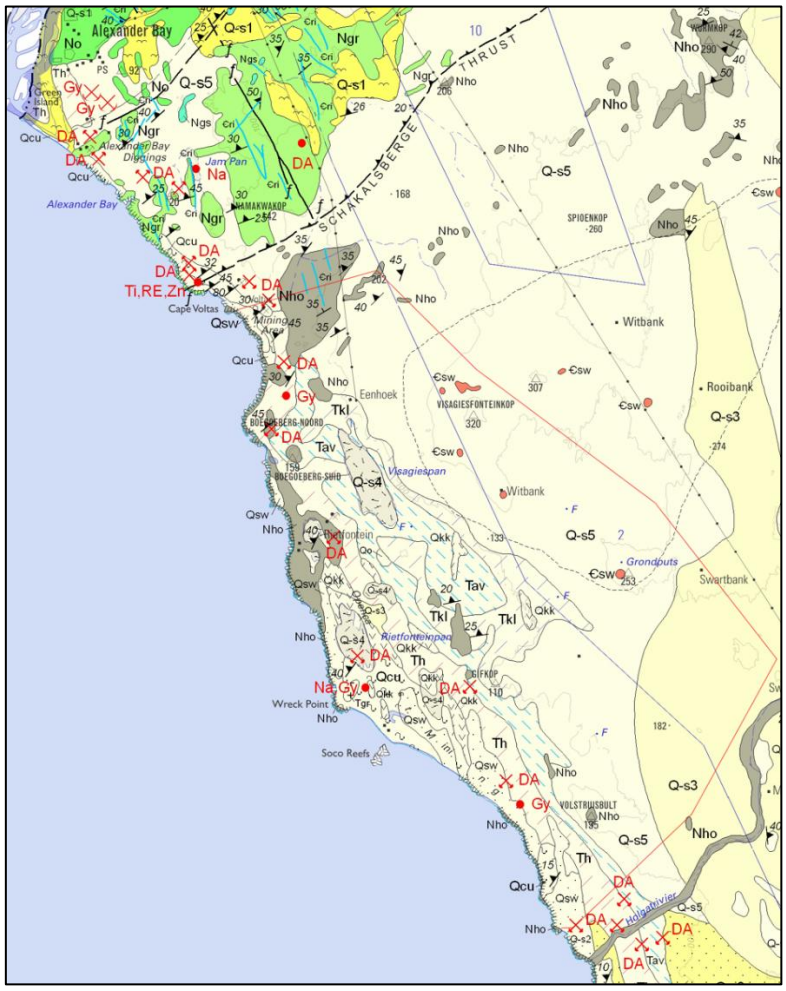


Figure 5: Detailed geology in the Boegoebaai Port and SEZ site (Council for Geoscience, 2011).

3.1.5 Soils

Soils on site are sandy with little or no profile development. The soils are well-aerated and well-drained with loosely packed sand particles. These soils are poor conductors of heat and temperature drops rapidly with increasing soil depth. The sandy soils have a low clay and silt content. The lack of fine-grained particles results in a low water holding capacity and a low nutrient content. These sands are thus not favourable for

plant growth and consequently also have a low organic matter content. Below a 30 cm depth in dune sand there is little evaporative loss and this water is available to deep-rooted perennial plants.

Mobile dune soils have little or no vegetation mainly because of the sandblasting associated with the strong winds. Once plains become vegetated, soil particles may be trapped by plant canopies and gradually lead to the development of phytogenic mounds. Once the silt and clay content of the top sand layer reaches a certain level, a biological crust can develop.

Replacement commonly occurs in the sandy soils along the West Coast when soluble components are eluviated and later crystallised in the subsoil to form cemented hardpan formations (Desmet, 1996). Calcrete, dorbank and silcrete are the most prominent replacement products. Along the West Coast of South Africa, calcrete occurs as an almost ever-present layer under the surface sand of the dune landscape up to the edge of the near shore zone. Calcrete is formed when calcium bicarbonate in the soil solution is precipitated and later crystallised as calcium carbonate in a lower horizon. It is a slow process and rainfall dependent. Plant roots cannot penetrate calcrete. Dorbank is another common replacement product and is usually found lying above the calcrete layer. It is a hard subsurface horizon, generally with a red or reddish brown colour. Dorbank is associated with soils developed from unconsolidated parent materials. Unconsolidated material underlying the dorbank is generally weakly structured and highly calcareous or gypsic. The third type of replacement product encountered on the West Coast is silcrete. Silcrete occurs at or near the soil surface and can range in thickness from less than 1 m up to 5 m.

Various soil hazards have been identified in the Boegoebaai Port and SEZ sections. These hazards relate to wind and water erosion susceptibility, crusting susceptibility and soil compaction susceptibility (Figure 6).

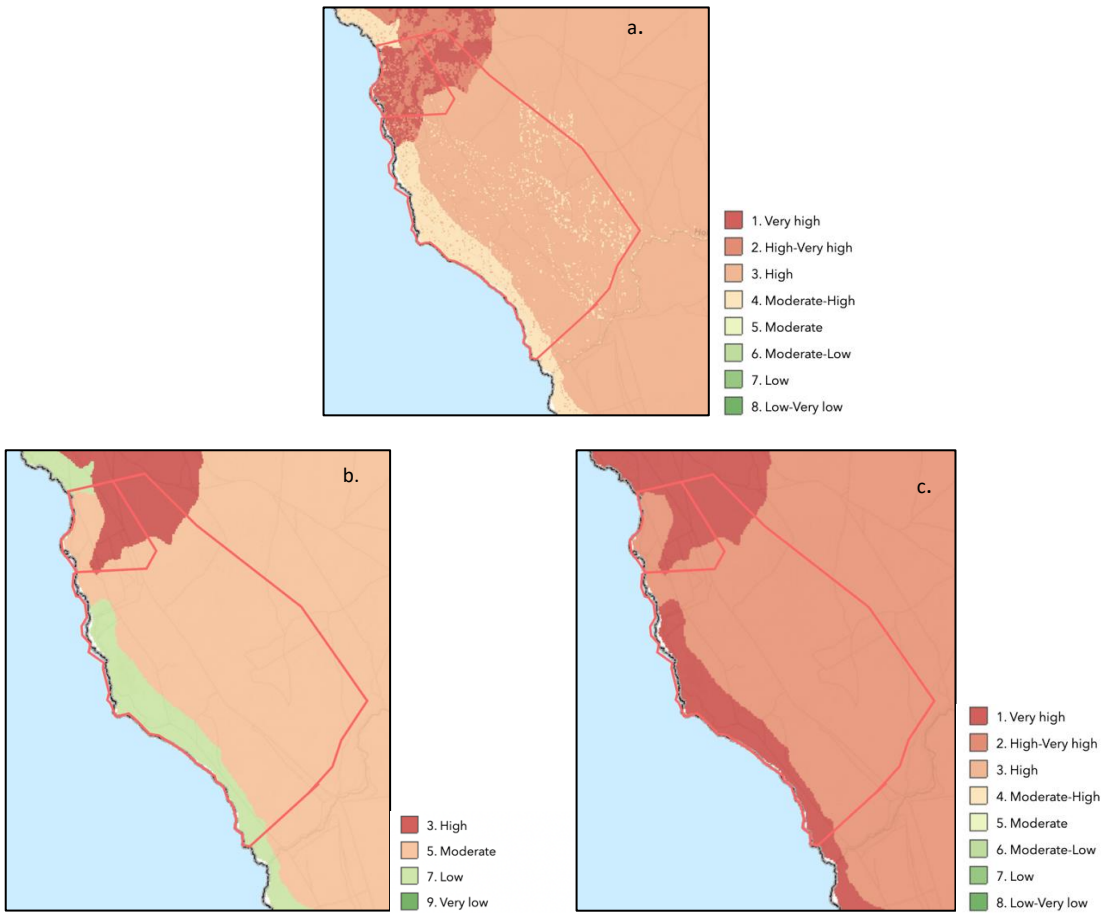


Figure 6: Soil hazard susceptibility in the Boegoebaai Port and SEZ site (a) water erosion susceptibility; (b) crusting susceptibility; and (c) soil compaction susceptibility (https://ndagis.nda.agric.za/).

- *Wind erosion susceptibility:* Soils in the entire site have a **Very High** susceptibility to wind erosion.
- *Water erosion susceptibility:* The water erosion susceptibility of almost the entire Port section is rated as **Very High** or **High-Very High**. The coastal zone's soil in the SEZ section has a **Moderate-High** susceptibility to water erosion, whereas the susceptibility of soils of the inland part of the SEZ section is mostly **High**, but **Very High** or **High-Very High** in the northern part (Figure 6a).
- *Crusting susceptibility:* The crusting susceptibility of the soil is generally **Low** along the coast except in the Port section where it is **Moderate**. Most of the inland area of the SEZ has a **Moderate** crusting susceptibility but in the eastern part of the Port and northeastern part of the SEZ it is rated as **High** (Figure 6b)**.**
- *Soil compaction susceptibility:* Soil compaction susceptibility is rated as **Very High** along the coast in the SEZ section and in the inland part of the Port and northeastern area of the SEZ. The soil's susceptibility to compaction in the remainder of the study site is **High-Very High** Figure 6c).

3.1.6 Land Types

Land types are areas with a uniform climate, terrain form and soil pattern. Within a land type, terrain unit 1 represents a crest; 2 = scarp; 3 = midslope; 4 = footslope; and 5 = valley bottom. The study area falls in the Ah, Ai, Fc, and Ha Land Types (Du Plessis, 1987) (Figure 7).



Figure 7: Land types in the Boegoebaai Port and SEZ site (https://ndagis.nda.agric.za/).

- The Ah Land Type comprises red and yellow apedal, freely drained soils with a high base status and usually <15% clay, whereas the Ai Land Type comprises yellow apedal, freely drained soils with a high base status and usually <15% clay. The following A Land Types occur on site:
    - Land Type Ah35 occurs on yellow and red, Tertiary to Recent wind-blown sands. Terrain units 1, 3, 4 and 5 cover 20%:45%:30%:5% of the terrain respectively.
    - Land Type Ah36 occurs on red and yellow Tertiary to Recent wind-blown sands. Terrain units 1, 3, 4 and 5 cover 25%:35%:38%:2% of the terrain respectively.

    - Land Type Ai10 occurs mainly on greywacke, schist and arkose of the Holgat Suite, Gariep Complex covered by young aeolian sands. Terrain units 1, 3, 4 and 5 cover 20%:30%:40%:10% of the terrain respectively.

- Map units Fa - Fe accommodate pedologically young landscapes that are not predominantly rock and not predominantly alluvial or aeolian and in which the dominant soil forming processes have been rock weathering, the formation of orthic topsoil horizons and clay illuviation, typically giving rise to lithocutanic horizons. Fc refers to land where lime is generally present in the entire landscape

    - Land Type Fc129 occurs mainly on greywacke, schist and arkose of the Holgat Suite, Gariep Complex. Terrain units 1, 3, 4 and 5 are present on site and cover 15%:30%:50%:5% of the terrain respectively.

- The Ha Land Type refers to grey, regic sands and accommodates areas where deep, grey sands are dominant.

    - Land Type Ha32 occurs on young aeolian sands. Terrain units 1, 3, 4 and 5 are present and cover 30%:40%:15%:15% of the terrain respectively.

3.1.7 Land Cover

According to the 2022 land cover map of South Africa (SANLC) (DFFE, 2022), the western portion of the Port section running along the coast is covered predominantly by mine tailings and dumps with some patches of 'other bare areas' (Figure 8a). Further inland the Port section consists mostly of 'other bare areas' with a band of mine tailings and dumps running along the tar road R382. Only a small fraction of the Port section is covered by low shrubland of the Succulent Karoo. The Conservancy Area additionally contains the dry Visagiespan and an artificially flooded mine dam. The SEZ is dominated by mine tailings and dumps as well as other bare areas to the west of the tar road (R382), while to the east of the tar road, the land cover is primarily low succulent shrubland and other bare areas. Small areas of mine infrastructure, dry pans and coastal sand and dunes (mostly in the southwest) are also present in the SEZ section.

Comparing the 2022 land cover map to the 2020 and 2018 land cover maps (Figure 8a, 8b & 8c), the most prominent change is the increase in the area mapped as bare area and this has mostly been to the detriment of low succulent shrubland. This trend could probably largely be attributed to the severe drought conditions that the region had experienced since the early 2010s.

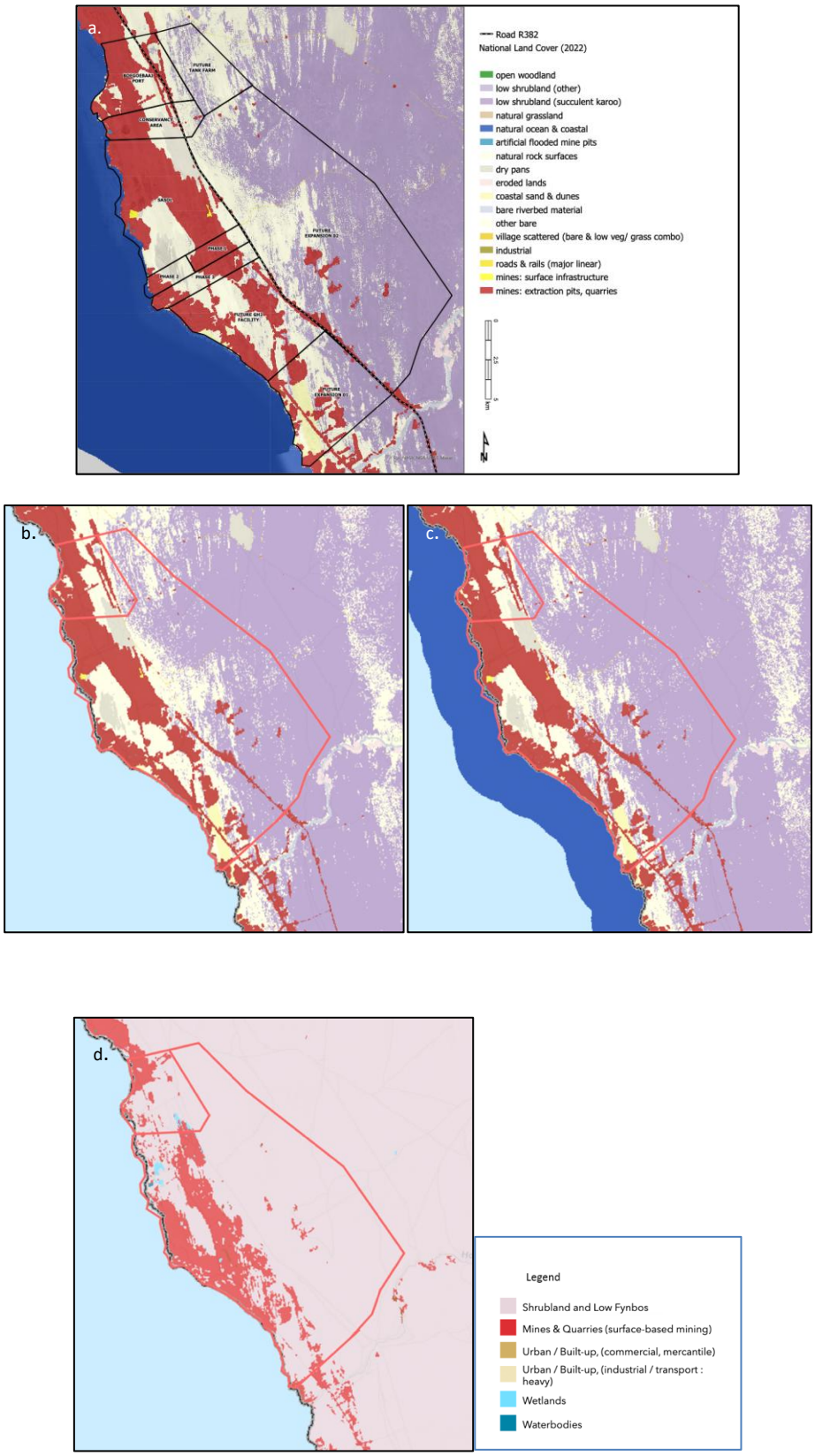


Figure 8: Land cover maps of the Boegoebaai Port and SEZ site of (a) 2022 (DFFE, 2022); (b) 2020; (c) 2018; and (d) 2000 (https://ndagis.nda.agric.za/).

The land cover map of 2000 (Figure 8d) used a different legend to the later versions. Although the areas classified as mines and quarries were somewhat smaller in 2000 than in 2018, 2020 and 2022, particularly in the Port Section, the most prominent change is that the entire area not affected by mining activities, was classified as low shrubland or fynbos with no bare areas identified. Furthermore, the pans/depressions were partly classified as wetlands.

3.2 Biodiversity attributes

3.2.1 Vegetation and flora

The study of the vegetation in South Africa has evolved over time and various authors have interpreted the vegetation in different ways. Vegetation maps of South Africa compiled in the nineteenth and early twentieth century were mostly of a phytogeographical nature with most geographers relying on descriptions of early explorers to compile their maps. The earliest maps were quite simple with more detail being added gradually. Many of these early phytogeographers agreed that the northwestern part of the country was part of the so-called Karroo, Karroo Region or Karroo Desert (Marloth, 1908) (note earlier spelling of Karoo). In a revised map Bolus (1905, in Marloth, 1908) termed it the 'Western Region', whereas Marloth (1908) labelled it 'Western Littoral'.

More detailed mapping of the vegetation types in South Africa started in the 1930s. Pole Evans (1936) produced the first vegetation map of South Africa in which he recognised 12 vegetation types in total. The study area is located in the so-called 'Succulent Desert Plants & Desert Grass' unit of Pole Evans (1936). In 1938, Adamson produced a vegetation map in which he recognised 14 vegetation types with the study area located in the so-called 'Coastal Succulent Bush' unit. Acocks's (1953) map of the Veld Types of South Africa was intended to depict the distribution of the agro-economic divisions of the vegetation in the country. He defined a veld type as a 'unit of vegetation whose range of variation is small enough to permit the whole of it to have the same farming potential'. According to Acocks (1953) the study area falls in the Strandveld of the West Coast as well as in the Succulent Karoo, whereas Low & Rebelo (1998) classified the study area as part of the Strandveld Succulent Karoo and the Lowland Succulent Karoo.

Phytogeographically, the study area lies in the Namaqualand-Karoo Domain as delineated by Lebrun (1947). Monod (1957) was the first to recognise the Karoo-Namib Region consisting of the Namaqualand, Karoo and Namib Domains, with the study area lying in the Namib Domain. Later phytogeographical studies by Volk (1966), Werger (1978) and White (1983) all recognised the Karoo-Namib Region, but differed in their delineation of the region. In 1983, White published his seminal work on the vegetation of Africa, which is currently accepted as the reference work on African phytogeography. According to White (1983), the study area is phytogeographically part of the Karoo-Namib Regional Centre of Endemism. In his phytogeographic sub-division of the Namib-Region, Jürgens (1991) recognised a Greater Cape Flora and a Palaeotropis (Palaeotropical Kingdom). The Boegoebaai site falls in the Succulent Karoo Region of the Greater Cape Flora.

The current mapping of the national vegetation types is an updated version (SANBI 2012-2024) of Mucina & Rutherford (2006). Descriptions of the national vegetation types appear in Mucina & Rutherford (2006).

3.2.2 Biomes

The study area includes two biomes, *viz*. the Desert and Succulent Karoo Biomes.

- *Desert Biome*

The Desert Biome in South Africa is defined on the basis of a mean annual rainfall of <80 mm and a sparse perennial vegetation cover of 10% and consists of a western and eastern section. The western section or Southern Namib Desert Bioregion is characterised by winter rainfall and a high incidence of fog, whereas the eastern section or Gariep Desert Bioregion is characterised by summer rainfall and the absence of fog. The Southern Namib Desert Bioregion shows floristic affinities and evolutionary links to the Succulent Karoo Biome and is part of the Greater Cape Floristic Region (Jürgens, 1991).

When compared to other deserts with the same level of aridity globally, the Desert Biome in South Africa is exceptionally rich in plant species and also hosts a large number of endemic plant species (Mucina & Rutherford, 2006).

The main land use in the Desert Biome is communal farming with severe degradation occurring around stockposts. Invasions by alien plant species is limited, with the most prominent species being *Neltumia glandulosa* (=*Prosopis glandulosa), Nicotiana glauca, Atriplex lindleyi* subsp. *inflata* and *Ricinus communis*. Mining has degraded large areas along the West Coast and along the Orange River, leaving scars that cannot be restored easily.

- *Succulent Karoo Biome*

The Succulent Karoo Biome in South Africa extends from the Desert Biome south of the Orange River through the western parts of the Northern Cape and Western Cape to the Little Karoo in the south. It is an arid region with a low winter rainfall (mean annual rainfall ranging from approximately 100 – 200 mm) with the percentage of summer rainfall gradually increasing eastwards. Fog is frequent in the coastal region. The incidence of frost increases with distance from the coast.

The Succulent Karoo is renowned for its unrivalled levels of diversity and endemism for an arid region (Cowling & Hillton-Taylor, 1999; Cowling *et al.*, 1999; Desmet & Cowling, 1999; Desmet, 2007). It is recognised by the International Union for Conservation of Nature (IUCN) as a global hotspot of diversity (CEPF, 2003; Mittermeier *et al*., 2000; Myers *et al.,* 2000), and one of only two hotspots that are entirely arid (https://www.cepf.net/our-work/biodiversity-hotspots). To qualify as a hotspot, it has to be shown that the area contains a high level of species diversity, a high percentage of endemic species and a substantial number of threatened or endangered species. Springtime mass flowering displays of annual plants draws thousands of tourists annually and is a valuable source of income to the region.

Most of the biome is used for livestock farming. Crop farming is limited due to the low rainfall and nutrient-poor soils. Severe overgrazing has led to widespread land degradation and a reduction in the overall species diversity (Jürgens *et al.*, in press; Le Maitre *et al.*, 2009; Mucina & Rutherford 2006; Walker *et al.,* 2018;). Due to the harsh environment in the Succulent Karoo, a limited number of alien invasive plant species (AIPS) occur. The most prominent AIPS are *Arundo donax*, *Atriplex lindleyi* subsp*. inflata*, *Atriplex nummularia*, *Nerium oleander*, *Cenchrus setaceus (=Pennisetum setaceum)*, *Neltumia glandulosa* (=*Prosopis glandulosa)* and *Tamarix ramosissima* (Milton *et al.*, 1999; Mucina & Rutherford, 2006; Van Wilgen *et al.,* 2008).

Mining for diamonds along the West Coast has irreversibly transformed some landscapes because ecological restoration is extremely challenging in this arid region (Desmet, 1996). Conservation efforts in the Succulent Karoo are furthermore threatened by illegal harvesting of plants for the medicinal and horticultural trades. Furthermore, climate change has been identified as a significant threat to the region because of the high levels of biodiversity and the dependence of the population on natural resources, livestock production and dryland agriculture (Davis *et al.,* 2016; Rutherford *et al.,* 2000; Walker *et al*., 2018). A study by Broennimann *et al*. (2006) found that geophytes and succulents, which make up over half of the plant species in Namaqualand, were particularly vulnerable to climate change.

3.2.3 National Vegetation Types and their threatened status

Five National Vegetation Types are represented in the study area, belonging to two different biomes and an Azonal Coastal Vegetation Type (Mucina & Rutherford, 2006 as revised by SANBI in 2024) (Figure 9).

- Succulent Karoo Biome:
  - Richtersveld Coastal Duneveld (SKs 1)
  - Northern Richtersveld Yellow Duneveld (SKs 2)
  - Richtersveld Sandy Coastal Scorpionstailveld (SKs 4)
- Desert Biome:
  - Western Gariep Plains Desert (Dn 3)

- Azonal Coastal Vegetation Type:
  - Namib Seashore Vegetation (AZd 1)

Richtersveld Coastal Duneveld (SKs 1)

This vegetation type occurs as a belt of 1–12 km broad along the Atlantic coast from approximately Alexander Bay to halfway between Port Nolloth and Kleinzee. In the Port and SEZ site this vegetation type is underlain by the Holgat Formation of the Gariep Supergroup which is covered with wind-blown, white sands (Mucina & Rutherford, 2006). The landscape is generally flat. The various habitat types are defined primarily by the depth of the soil and the presence of a soil crust (Mucina & Rutherford, 2006).

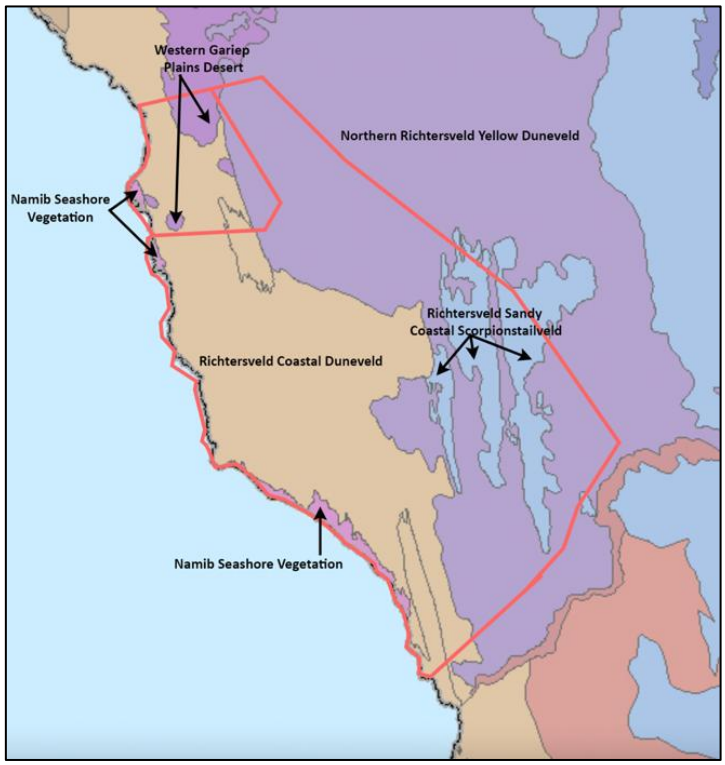


Figure 9: National Vegetation Types in the Boegoebaai Port and SEZ site (Mucina & Rutherford, 2006 as revised by SANBI in 2024).

The dominant succulent shrub species are *Cephalophyllum ebracteatum* (VU), *Euphorbia mauritanica, Crassothonna sedifolia, Salsola nollothensis* and *Roepera morgsana.* Other noteworthy succulents include *Amphibolia rupis-arcuatae, Drosanthemum luederitzii, Euphorbia caput-medusae, Jordaaniella cuprea, Lampranthus stipulaceus, Manochlamys albicans, Stoeberia utilis* and *Roepera cordifolia*. Non-succulent shrubs include *Asparagus capensis, Atriplex vestita* and *Pteronia glabrata* and herbs are represented by *Grielum grandiflorum, Mesembryanthemum dinteri* and *Fenestraria rhopalophylla*. The most prominent graminoids are *Cladoraphis cyperoides, Chaetobromus involucratus* and *Stipagrostis ciliata*. Biogeographically important taxa include the Namaqualand endemics *Stoeberia beetzii* and *Arctotis decurrens*, whereas *Amphibolia succulenta* (NT) is a Richtersveld endemic species.

The Richtersveld Coastal Duneveld has a **Critically Endangered** status with a conservation target of 26%. It is currently poorly protected.

Northern Richtersveld Yellow Duneveld (SKs 2)

This vegetation unit occupies the land 5–25 km from the coast from southern Namibia to the Holgat River. These yellow, wind-blown sands are older than the white dune sands closer to the ocean. The more-or-less south-north orientated dune ridges and accompanying valley systems of the ancient dune fields are still

partly visible, but erosion and sedimentation have shaped a landscape of relatively saline valleys with silty or loamy soil. Heuweltjies may be present in this vegetation type (Mucina & Rutherford, 2006).

The Northern Richtersveld Yellow Duneveld is a diverse vegetation unit. The dominant succulent shrub species are *Euphorbia burmannii, Euphorbia rhombifolia, Euphorbia mauritanica, Crassothonna cylindrica* and associated species such as *Cephalophyllum ebracteatum* (VU)*, Cheiridopsis robusta, Didelta carnosa, Jordaaniella cuprea, Lampranthus stipulaceus, Salsola tuberculata* and *Roepera morgsana*. Low shrubs include *Asparagus capensis, Calobota cinerea* and *Calobota angustifolia* and herbs are represented by *Grielum humifusum, Oncosiphon piluliferum* and *Mesembryanthemum schlichtianum*. The most prominent graminoid is *Cladoraphis cyperoides*. Biogeographically important taxa include the Namaqualand endemic *Mesembryanthemum decurvatum*, while *Amphibolia succulenta* (NT) is a Richtersveld endemic and *Mesembryanthemum pseudoschlichtianum, Mesembryanthemum pellitum* and *Eberlanzia sedoides* are Gariep endemic species.

The Northern Richtersveld Yellow Duneveld has a **Least Concern** status with a conservation target of 26%. The vegetation type is not protected.

Richtersveld Sandy Coastal Scorpionstailveld (SKs 4)

Within the Port and SEZ study site, SKs 4 occurs in the southeastern corner as three north-south trending bands. The unit is clearly visible on satellite images due to the darker colour caused by the biological soil surface crusts (Mucina & Rutherford, 2006). Habitat variability is largely a function of soil type and vegetation age, which are controlled by the proportion of wind-blown sand as well as severity of grazing. Soils are sandy loams partly covered by yellow and red wind-blown sands which are in turn covered by a well-developed soil crust.

The dominant succulent shrub species are *Mesembryanthemum pseudoschlichtianum, Cephalophyllum ebracteatum* (VU), *Stoeberia beetzii* and *Crassothonna cylindrica* with associated species such as *Mesembryanthemum serotinum, Cheiridopsis robusta, Euphorbia burmannii, Euphorbia rhombifolia, Euphorbia mauritanica* and *Roepera morgsana*. Low shrubs are represented by *Calobota angustifolia* and *Asparagus capensis* and herbs include *Oncosiphon piluliferum* and *Trachyandra falcata*. The most prominent graminoid is *Cladoraphis cyperoides.* Overall, prominent species in the Richtersveld Sandy Coastal Scorpionstainveld agree well with the prominent species in the Northern Richtersveld Yellow Duneveld. The old, stabilised vegetation is dominated by *Mesembryanthemum pseudoschlichtianum* (locally known as groot skerpioenbos)*, Crassothonna cylindrica, Stoeberia beetzii, Cephalophyllum ebracteatum* (VU)*, Calobota angustifolia* and *Mesembryanthemum decurvatum.* Biogeographically important taxa include the Namaqualand endemics *Mesembryanthemum decurvatum, Mesembryanthemum pellitum* and *Stoeberia beetzii,* while *Eberlanzia ebracteate* and *Mesembryanthemum pseudoschlichtianum* are Gariep endemic species.

The Richtersveld Sandy Coastal Scorpionstailveld (SKs 4) has a **Least Concern** status with a conservation target of 26%. The vegetation type is represented in the Richtersveld Cultural and Botanical Heritage Landscape.

Western Gariep Plains Desert (Dn 3)

This vegetation types occurs predominantly in the northeastern Port section, with a few other small patches. The landscape is dominated by plains with undulating hills and rocky outcrops, the most notable of which are the Boegoeberg Twins with steep rocky slopes. The underlying rocks in this unit are mainly metasediments and metavolcanics of the Gariep Supergroup which are covered with young surficial deposits. The rocks consist of quartz-feldspar, gneiss, schist, subordinate amphibolite and minor ultramafic rock (Mucina & Rutherford, 2006).

The dominant succulent shrubs are *Mesembryanthemum marlothii, Cephalophyllum ebracteatum* (VU)*, Othonna lasiocarpa, Crassothonna sedifolia, Stoeberia beetzii, Mesembryanthemum dinteri, Amphibolia rupis-arcuatae, Cheiridopsis brownii* (EN), *Conophytum saxetanum* (EN)*, Crassula deceptor, Dracophilus dealbatus* (CR)*, Drosanthemum luederitzii, Euphorbia stapelioides, Euphorbia caput-medusae, Monsonia patersonii* (VU)*, Psammophora modesta* (VU)*, Pteronia glabrata* and *Tylecodon schaeferianus* (VU). Low shrubs include *Asparagus capensis, Hermannia gariepina* and *Lycium decumbens*. Herbs are represented by *Pelargonium sibthorpiifolium* (CR) and the most prominent graminoid is *Cladoraphis cyperoides.*

The Western Gariep Plains Desert is not statutorily protected. It has a **Least Concern** status with a conservation target of 28%. However, the threatened status of the Richtersveld Vegetation Types are currently being re-assessed. The current **Least Concern** status for the Western Gariep Plains Desert is inadequate and it is likely that it will be upgraded by the responsible authority.

Namib Seashore Vegetation (AZd 1)

This vegetation type is located along the coast between the Orange River mouth and the Holgat River. The beaches are slightly sloping and bordered by mobile as well as fixed sand dunes. Both beaches and dunes are formed by recent, marine, sandy sediments. The dominant succulent shrubs are *Lycium tetrandrum* and *Tetragonia fruticosa* together with *Didelta carnosa* and *Roepera clavata*. Low shrubs include *Asparagus capensis* and *Hebenstretia cordata* and the most prominent graminoid is *Cladoraphis cyperoides*. Biogeographically important taxa in this unit are the West Coast endemics *Salsola nollothensis, Amphibolia rupis-arcuatae, Arctotis decurrens, Drosanthemum luederitzii, Kewa angrae-pequenae* and *Fenestraria rhopalophylla*, whereas *Lycium decumbens* and *Mesembryanthemum marlothii* are Gariep endemic species.

The Namib Seashore Vegetation has a **Critically Endangered** status with a conservation target of 26%. It is not protected and almost totally transformed by mining.

3.2.4 Centres of Endemism

The Boegoebaai Port and SEZ site falls within the Gariep Centre of Endemism as defined by Van Wyk and Smith (2001). This centre of endemism is a combination of two quite distinct climatic, biogeographic and evolutionary units (Jürgens, 1991, Jürgens *et al.,* 1997; Mucina & Rutherford, 2006). Jürgens (1991, 1997) studied the distribution ranges of a very large number of species and proposed to split the Gariep Centre of Endemism into 'East Gariep Centre' for the palaeotropical summer rainfall elements in the east and a 'West Gariep Centre' for the Greater Cape winter rainfall elements, incidence of fog and floristic affinities with the Succulent Karoo Biome. The study area lies in the western section of the Gariep Centre of Endemism that is characterised by a winter rainfall, the incidence of fog and floristic affinities with the Succulent Karoo Biome. This western section is part of the Southern Namib Desert Bioregion (part of the Namib Desert) as opposed to the eastern part that belongs to the Gariep Desert Bioregion (part of the Gariep Desert) (Mucina & Rutherford, 2006).

At a lower hierarchical level within the West Gariep Centre, a "Western Gariep Circle" has been identified as a local centre of endemism stretching from Alexander Bay to Sendelingsdrift/Lorelei. Several SCC on site are endemic to South Africa, although a large proportion of SCC are distributed from southern Namibia into the northwestern Richtersveld.

3.2.5 Flora

A provisional checklist of the Boegoebaai Port and SEZ site appears in Appendix A. This provisional checklist contains 390 plant species that have been confirmed occurring on site from data collected by P. van Wyk, the current site visit in 2024, iNaturalist; the SANBI NewPosa website and data supplied by SANBI (2024). According to SANBI's (SANBI, 2020) definition of Species of Conservation Concern (SCC), these are species that have a high conservation importance in terms of preserving South Africa's high floristic and faunal diversity and include not only threatened species, but also those classified as Extinct in the Wild (EW), Regionally Extinct (RE), Near Threatened (NT), Critically Rare, Rare, Declining, Data Deficient - Insufficient Information (DDD) and Data Deficient – Taxonomic (DDT) (www.redlist.SANBI.org). The confirmed on-site checklist includes eight species with a Critically Endangered IUCN status (2.0% of all species confirmed for the site); nine species classified as Endangered (2.3% of all species); 15 species as Vulnerable (3.8% of all species); seven species as Near Threatened (1.8% of all species); six species as Data Deficient (1.5% of all species); and one species as Rare (0.3% of all species). Thus, in total 46 species are classified as SCC representing 11.8% of all species confirmed for the site. Twenty one species that fall within the Boegoebaai and associated infrastructure development footprint are currently listed as Least Concern, but could potentially become SCC should the Boegoebaai development proceed. Moreover, 163 Northern Cape provincially protected or specially protected and 20 CITES-listed species were also recorded on site.

Considering the limited access to the mining area to the west of the R382, the on-site checklist probably does not represent a full inventory of plant species occurring on site. The species list by Desmet (1996) comprises a list of species recorded in an approximately 10 km strip along the coast from Port Nolloth to Alexander Bay. Although Desmet's study area included a large portion of habitat that could be regarded as similar to the Boegoebaai site, it does include several additional habitats and vegetation types not present on the Boegoebaai site. Nevertheless, some additional species on Desmet's list (1996) could potentially also occur on site should small pockets of similar habitat be present (no coordinates were provided to check for species on site).

The impacts of such a large development such as the Boegoebaai Port and SEZ will generally not be limited to the site but will be more widespread and land adjoining the site will likely also be affected. The second list by P. van Wyk in Appendix A was compiled after the first preliminary location of the project became available. This preliminary layout stretched to Kortdoorn and Grootderm along the Orange River, an area in the Richtersveld with a particularly high concentration of SCC. This list of Van Wyk adds 29 SCC (some also listed by Desmet (1996)) that are at present not listed for the site as currently delineated. Although habitats closer to the Orange River differ from those on the current site, these areas could be targeted by plant poaching activities due to increased human activities as a result of the development.

Aliens were not common on site. The only alien species recorded for the site were *Atriplex lindleyi* subsp. *inflata*, *Nicotiana glauca* and *Opuntia ficus-indica*.

3.2.6 Critical Biodiversity areas (CBAs), Ecological Support Areas (ESAs), Other Natural Areas (ONAs)

Critical Biodiversity Areas (CBAs) are areas required to meet biodiversity targets for ecosystems, species or ecological processes. CBAs are regarded as areas of high biodiversity and ecological value and need to be kept in a natural or near-natural state, with no further loss of habitat or species to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. The definitions for CBAs are (SANBI, 2018):

- CBA 1: Areas that are irreplaceable for meeting biodiversity targets. There are no other options for conserving the ecosystems, species or ecological processes in these areas.
- CBA 2: Areas that are the best option for meeting biodiversity targets, in the smallest area, while avoiding conflict with other land uses.

Permissible land uses within Critical Biodiversity Areas are those that are compatible with maintaining the natural vegetation cover of CBAs in a healthy ecological state, and that do not result in loss or degradation of natural habitat (Pool-Stanvliet *et al*., 2017). In general, undesirable land uses in terrestrial CBAs are those that cause a loss of natural habitat or ecosystem functionality, such as: (i) industrial, commercial or residential developments; (ii) mining or prospecting; (iii) linear infrastructure that disrupts the connectivity of CBA corridors; and (iv) extensive or intensive grazing that results in species diversity being lost through selective grazing or over-grazing. In the Northern Cape incompatible land-uses in CBAs include business areas, mixed-use development areas, industrial development zones and the extractive industry (Oosthuyzen & Geldenhuys, 2024). It is thus clear that the Boegoebaai development constitutes an undesirable land use that would not be permissible in a CBA.

An Ecological Support Area (ESA) is not essential for meeting biodiversity targets, but plays an important role in supporting the ecological functioning in a CBA. ESAs need to be maintained in at least a functional and often natural state, but some limited habitat loss may be acceptable. Other Natural Areas (ONAs) have not been identified as a priority and retain most of their natural character and perform a range of biodiversity and ecological functions. Other Natural Areas (ONAs) are not required to meet biodiversity targets.

In the 2016 version of the Northern Cape CBA map, almost the entire Port and SEZ sections not affected by mining has been classified as CBA, either CBA 1 or CBA 2, with a single small ESA and ONA occurring near the southern boundary of the site along the tar road (Figure 10). All areas that have been transformed by mining were not classified.

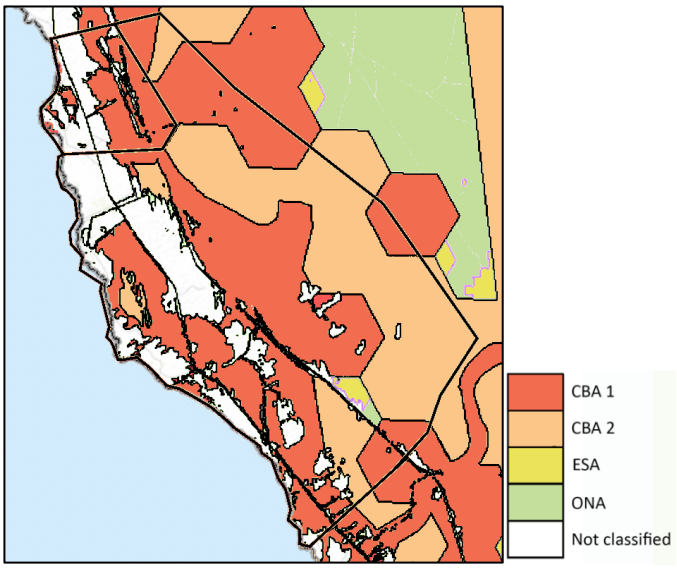


Figure 10: 2016 Northern Cape Critical Biodiversity Area map of the Boegoebaai Port and SEZ site.

3.2.7 Protected Areas and National Protected Area Expansion Strategy

The study site is not part of a protected area (https://egis.environment.gov.za/data_egis/data SAPAD_IR_2024_Q2_01) (Figure 11). The closest protected area to the site is the Richtersveld Cultural & Botanical Landscape, which has a Natural Heritage Site status declared in terms of the World Heritage Convention Act.

To the north of the site lie the Orange River Mouth Nature Reserve and the Orange River Mouth Wetland, the latter is classified as a Ramsar Site (https://rsis.ramsar.org/ris/526).

Although the Port section has not been included in the Protected Areas Expansion Strategy, a substantial portion of the SEZ has been included as Focus Areas in the National Protected Areas Expansion Strategy (NPAES, 2018) (Figure 12).

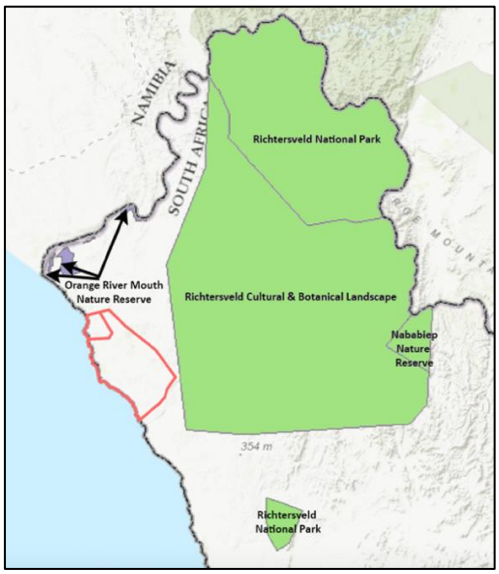


Figure 11: Protected Area map in the environs of the Boegoebaai Port and SEZ (https://ndagis.nda.agric.za/).



Figure 12: National Protected Areas Expansion Strategy around the Boegoebaai Port and SEZ (NPAES, 2018).

3.2.8 Key Biodiversity Areas

The Key Biodiversity Area (KBA) Partnership (https://www.keybiodiversityareas.org/about-kbas) strives to prevent the rapid loss of biodiversity by supporting nationally led efforts to identify KBAs that are of global importance for the maintenance of biodiversity (KBA, 2024). The KBA Programme assists in identifying, mapping, monitoring and conserving these areas. It also provides background information on the biodiversity to assist governments and other stakeholders in decision-making on where to avoid development and how best to manage the land. A site qualifies as a global KBA if it meets one or more of 11 internationally agreed scientific criteria relating to (i) threatened biodiversity, (ii) geographically restricted biodiversity, (iii) ecological integrity, (iv) biological processes, and (v) irreplaceability.

The Boegoebaai Port and SEZ site is located in the Namaqualand Sandveld North KBA (Figure 13), which is a flat to slightly undulating coastal peneplain. The area is not protected but the site is managed primarily by a regional conservation authority responsible for enforcing statutory regulations. The species-rich vegetation is dominated by succulent dwarf shrubs as well as non-succulent dwarf shrubs or shrubs. The Namaqualand Sandveld North KBA met 10 criteria (A1a[1], A1b, A1d, A2, B1, B2, B3a, B4, D1a and E) to qualify as KBA.

The rationale for qualifying as KBA was set out as follows: *'Based on current available information, 45 species meet one or more KBA criteria for this site. The KBA trigger species at this site include amphibians, birds, butterflies, mammals, plants and reptiles. The site meets criterion A1 due to the presence of significant proportions of the global populations of 11 threatened species. The site regularly holds 35 individual geographically restricted species, therefore meeting criterion B1. Assemblages of co-occurring range-restricted species in the Amphibia, Caryophyllales, Reptilia, and Saxifragales taxonomic groups regularly present within the site meet criterion B2. An aggregation of at least 1% of the global population of one species is regularly present at the site, therefore it meets criterion D1. A quantitative analysis of irreplaceability indicates that the site is 100% irreplaceable for the global persistence of 9*

[1] A1a: ≥0.5% of the global population size AND ≥5 reproductive units of a CR or EN species; A1b: ≥1% of the global population size AND ≥10 reproductive units of a VU species; A1d; ≥0.2% of the global population size AND ≥10 reproductive units of a species assessed as VU due only to population size reduction in the past or present; A2; hold a significant proportion of the global extent of an ecosystem type facing a high risk of collapse; B1: Site regularly holds ≥10% of the global population size AND ≥10 reproductive units of a species; B2: Site regularly holds ≥1% of the global population size of each of a number of restricted-range species in a taxonomic group, determined as either ≥2 species OR 0.02% of the global number of species in the taxonomic group, whichever is larger; B3a: ≥0.5% of the global population size of each of a number of ecoregion-restricted species within a taxonomic group, determined as either ≥5 species OR 10% of the species restricted to the ecoregion, whichever is larger; B4: Site holds ≥20% of the global extent of an ecosystem type; D1a: An aggregation representing ≥1% of the global population size of a species, over a season, and during one or more key stages of its life cycle; E: Site has a level of irreplaceability of ≥0.90 (on a 0–1 scale), measured by quantitative spatial analysis, and is characterised by the regular presence of species with ≥10 reproductive units known to occur (or ≥ 5 units for EN or CR species).

species, therefore meeting criterion E. The site holds significant proportions of the global extent of 3 threatened ecosystems (meeting criterion A2) and 7 geographically restricted ecosystems (meeting criterion B4)'.

Additionally, 80 more potential trigger species meet minimum population parameter thresholds, but presence and/or minimum reproductive units required to meet KBA criteria cannot be confirmed with the available data.

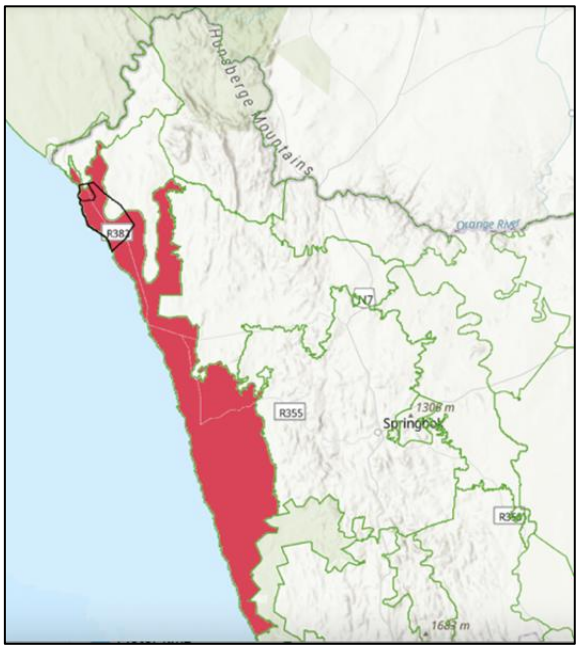


Figure 13: Location of the Namaqualand Sandveld North Key Biodiversity Area (https://www.keybiodiversityareas.org).

3.2.9 Areas with high concentrations of threatened species

Over the past years the South African National Biodiversity Institute (SANBI) has been re-evaluating the red list status of the flora from the region and produced a map depicting areas within the Richtersveld with a high concentration of threatened species (Van Wyk, 2024; Figure 14). Two areas with a high concentration of threatened species occur on site corresponding to the Boegoeberg Twins and Visagiesfonteinkop.

Most of the areas with a concentration of threatened species occur further north of the site in the environs of the Orange River at Kortdoorn and Grootderm (Figure 14). No indication has been given as to where employees for the green hydrogen project would be accommodated. Should accommodation be provided in Alexander Bay, this would encroach on the areas with a high concentration of threatened species. The influx of people to the broader region will increase the level of air pollution from road traffic and the region will likely experience increased pressure of illegal harvesting of plants for the medicinal and horticultural trades.

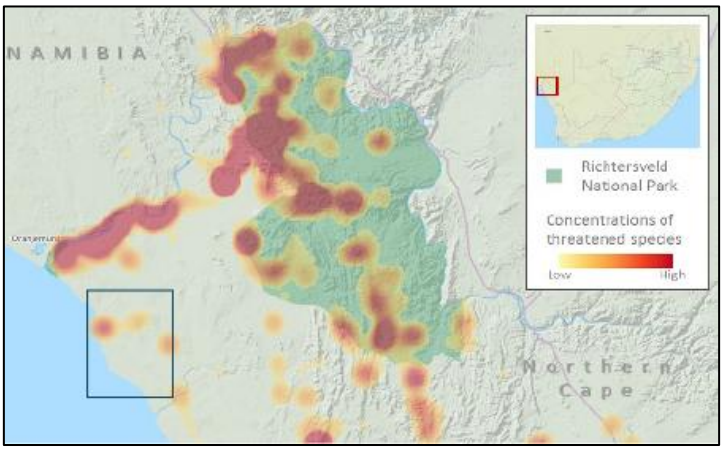


Figure 14: Map indicating areas with a concentration of threatened species in the Richtersveld with the Boegoebaai Port and SEZ shown as a rectangle (source: Van Wyk, 2024).

3.2.10 Lichen fields

Approximately 13 km to the north of the Boegoebaai Port and SEZ site, lies a Critically Endangered vegetation type, the Namib Lichen Fields. This small unit, covering less than 80 ha represents a globally unique habitat and has been proclaimed as a Natural Heritage Site. Compared to the lichen fields in Namibia, the fields near Alexander Bay, the only in South Africa, have a higher diversity as well as higher biomass of lichens. These lichen fields thus merit a very high conservation status (Jürgens & Niebel, 1991; Jürgens & Niebel-Lohmann, 1995).

Several environmental elements can be detrimental to lichens e.g. mobile sands (Jürgens & Niebel, 1991; Jürgens & Niebel-Lohmann, 1995); as well as dust and air pollution produced by road traffic. Most species live for decades and because they take up water and nutrients directly from the atmosphere they are exposed to the cumulative effects of pollutants (Nash, 2008). The Boegoebaai development is likely to exacerbate the negative effects of pollution and mobile sand.

3.2.11 Sensitive areas as indicated by local knowledge

The following localities (Figures 15 & 16) were identified as sensitive for the reasons provided below:

- It is critical that the **Boegoeberg Twins**, are fully conserved in the Conservation Area (No 1, Figure 15a). According to the current delineation of the Conservation Area, Boegoeberg North is not entirely included. These two mountains host many threatened higher plant taxa and the lichen richness is exceptional (Van Wyk, 2024). Lichens are sensitive to air pollution and with the predominant southerly winds, air pollution coming from the SEZ may negatively impact the lichens on the Boegoeberg Twins. Boegoeberg South has already been severely impacted by the mining with a road that was built to erect telecommunication towers and sand that has accumulated onto the northern slopes. The green zone in Figure 15a should not be considered for development, as it will have detrimental negative impacts on areas of **High** sensitivity (Van Wyk, 2024).

- **Namakwakop** (No 2, Figure 15a) is a small hill with a lower species richness than the Boegoeberg Twins, but shares some species with them.

- **The coastline north of Collins Jetty** (no 3, Figure 15), is the most sensitive section of shoreline from both a biodiversity and heritage point of view. It includes rocky sections containing the highest concentration of Sensitive species 305 **(CR)** within the species' distribution range. It also includes sections of the **CR** Namib Seashore Vegetation. Furthermore, it is home to a breeding population of the Cape fur seal, a protected species.

- **Visagiesfonteinkop** (No 4, Figure 15b) is the highest point in the study area and is located to the east of the tar road (R382). It is an important habitat for desert rain frogs, *Breviceps macrops* (VU). It is also habitat to an undescribed species of *Pelargonium;* a new species of *Crassula*; important populations of *Ruschia pallens;* Sensitive species 720 (VU); *Ceropegia pulvinata (=Stapelia pulvinata);* Sensitive species 734 (VU); unique lichen flora, with several species not found on the Boegoeberg Twins nor in the Alexander Bay lichen fields. Visagiesfonteinkop is also home to unique insects that have not been recorded elsewhere on the coastal plains.

- The **Rooibank** (No 5b) **& Swartbank Heuweltjies** (No 5a) (Figure 15b) represent, the Richtersveld Sandy Coastal Scorpionstailveld where heuweltjies abound. Heuweltjies are associated with termites and evidence has been provided that some of the termite nests at the Buffels River in Namaqualand, have been occupied for up to 34 000 years (Francis *et al*., 2024) making these the oldest active termite features ever dated. Termites are ecosystem engineers creating nutrient rich loamy soil, which is favourable habitat for certain plant species.

- A large colony of **Brant's Whistling Rats** (*Parotomys brantsii*) (No 6, Figure 15b) was found on the SEZ site. Although these rats to do not alter species richness, they do reduce the vegetation cover. Their presence is often associated with an increase in reptile, raptor and small predator species.

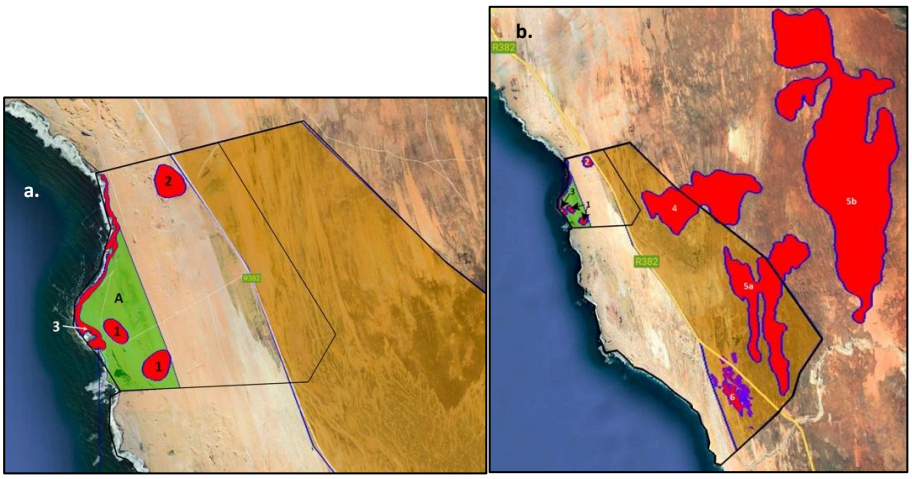


Figure 15: (a) Detail of the Port facility showing areas of **High** sensitivity as indicated by local knowledge; and (b) Areas of **High** sensitivity in the Boegoebaai Port and SEZ site. 1 = Boegoeberg Twins; 2 = Namakwakop; 3 = Rocky coastline; 4 = Visagiesfonteinkop; 5a = Swartbank heuweltjies; 5b = Rooibank heuweltjies; 6 = Brant's whistling rat colonies. Green zone (A) should not be considered for development (source: Van Wyk, 2024).

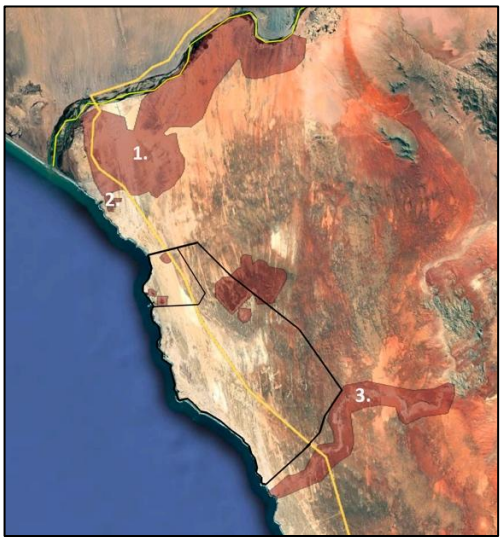


Figure 16: Some additional sensitive areas in the environs of the site. 1. Pagvlei, Grootderm and Brandkaros; 2. outcrops near Alexander Bay; and 3. Holgat River.

In Figure 16, some additional sensitive areas in the environs of the site are indicated e.g. Pagvlei, Grootderm and Brandkaros (no 1, Figure 16); some outcrops near Alexander Bay (no 2, Figure 16); and the lower course of the Holgat River (no 3, Figure 16). The area around Pagvlei, Grootderm and Brandkaros corresponds largely to one of the areas with a concentration of threatened species in the Richtersveld areas (Section 3.2.9, Figure 14).

3.2.12 Areas with a Low sensitivity

Habitats with a Low sensitivity (Van Wyk, 2024) are mainly as a result of past and present mining impacts, although some areas have a low sensitivity due to overgrazing. There are large areas where no more than 10 plant species occur, of which none has a threatened status. These areas trigger no environmental conservation concerns and could be chosen for future development (Figure 17) (see SEA Workpackage 2).

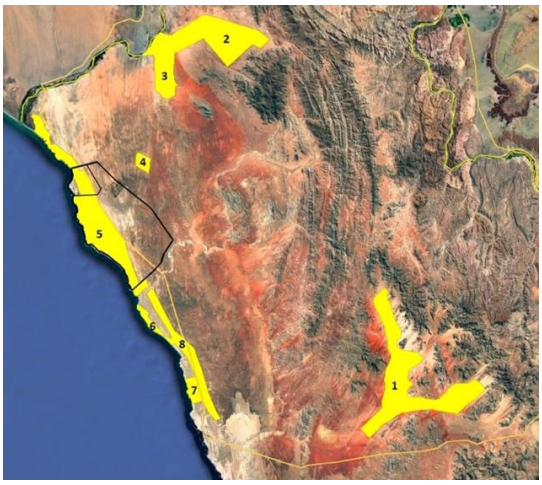


Figure 17: Areas of **Low** sensitivity in the environs of the Boegoebaai Port and SEZ site. 1. Grasvlakte; 2. Anniesvlakte; 3. Skilpadsand; 4. Witbank Expansion; 5. Phase 1 Development area 1; 6. Transformed coastal area south of site 1; 7. Transformed coastal area south of the proposed site; and 8. Transformed inland area south of site (Van Wyk, 2024).

3.2.13 Development proposals that have been approved for the site

There are currently two approved development proposals within the Boegoeberg Port and SEZ site (green boundaries in Figure 18) and another prospecting proposal has been submitted (light blue line in Figure 18):

- The 225 MW Richtersveld Wind Energy Facility (dark blue line in Figure 18); and
- The Namakwa Prospecting proposal (green line in Figure 18) to establish the presence of economic deposits of heavy minerals by non-invasive and invasive prospecting over a period of five years.

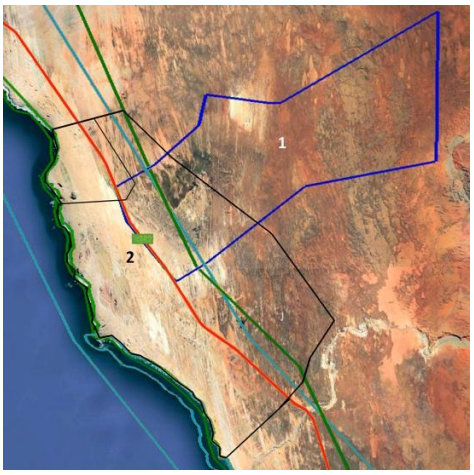


Figure 18: Location of the approved Richtersveld Wind Energy Facility (1) and the prospecting proposal (2).

Other development applications/proposals include: the prospecting proposal (light blue line, **Error! Reference source not found.**18), mining right application by Whale Head Minerals (not indicated in Figure 18) and construction of a water supply pipeline between Alexanderbaai and Port Nolloth (not indicated in Figure 18).

3.2.14 Current land use

The main land uses in the region are mining and livestock farming. The Boegoebaai Port and SEZ land is owned by the Richtersveld Sida !Hub Community Property Association (CPA) (MDT, 2018). Alexkor SOC Limited (Alexkor) and the Richtersveld Mining Company (Pty) Ltd have formed a Pooling and Sharing Joint Venture (PSJV) to oversee mining activities relating to Alexkor's mining rights. The PSJV outsources most of the marine prospecting and mining operations to contractors.

Currently, mine dust/sand due primarily to soil disturbance by past diamond mining activities probably poses the greatest environmental threat to the natural environment both in the mining area and on adjacent land. The dust/sand plume development can be ascribed to prevailing winds and sand supply as well as coast line form. Early in this century a distinction could still be made between natural coastal sand plumes and mining-induced plumes, however, at present this distinction is lost and natural and mine-induced plumes have merged. A major cause for concern is the sand dune threatening Boegoeberg South.

Severe overgrazing in many areas of the Richtersveld has led to widespread land degradation and a reduction in the overall species diversity. Signs of overgrazing are particularly noticeable around stockposts. Some vegetation types are more vulnerable than others to overgrazing with heuweltjieveld being one of the vulnerable types. In recent years, the illegal collection of plants or plant poaching has escalated and has become a serious threat to many threatened succulent plant species in the Aizoaceae, Anacampserotaceae and Crassulaceae.

In a recent publication by Jürgens *et al.* (in press) the observed vegetation degradation in the Richtersveld (as well as in the current assessment area) was interpreted as a combination of anthropogenic causes and climate change. Jürgens *et al*. (in press) presented a conceptual model of how the vegetation in the coastal region of the Richtersveld is degraded by the anthropogenic impacts of farming (e.g. overgrazing), mining and roads. These human activities all degrade or reduce the vegetation cover and thereby trigger either the erosion of silt or the mobilisation of aeolian sand which is associated with sand abrasion and the development of sand plumes. In the original vegetation state the silty soils are stable and often covered by a biological surface crust. Long-term heavy grazing, trampling, drought and sandblasting causes the development of an entirely new vegetation state composed of a different complement of species. There is thus a retrogression from a species-rich, stable and productive Succulent Karoo vegetation state to a species-poor, unstable and less productive grassy Desert vegetation state.

3.2.15 Ecosystem processes

The Boegoebaai Port and SEZ site lies in a hyper-arid region and years with below average annual rainfall are a common occurrence. Terrestrial ecosystems in the study area are subject to high wind speeds that result in severe aeolian erosion, transport and sedimentation (Jürgens *et al.,* in press). These processes have been exacerbated by the extreme transformation of the land by mining as well as overgrazing. The destructive action of the wind is particularly prominent in areas where the vegetation has been degraded and is sparse (Desmet, 1996). The sandblasting reduces photosynthetic activity and affects plant reproduction with young plants being particularly vulnerable. Eventually the vegetation becomes buried under the aeolian sand.

It is critical that the trajectories of sand and dust transport as well as air pollution from the proposed development is modelled. Mitigation measures to stabilise the sand before it impacts on priority ecosystems (e.g. the Namib Lichen Fields and the Orange River Estuary) further north are crucial. Mitigation measures would also be needed to prevent air pollution from the development.

Ecological processes such as primary production, decomposition, nutrient cycling and fluxes of nutrients and energy will all be altered by the clearing of the vegetation at the footprints of the infrastructure. Disruption of broad-scale ecological processes such as dispersal, migration or the ability of fauna to respond to fluctuations in climate or other conditions will depend on the presence of ecological corridors and the size of the disturbed area in relation to the adjacent landscape where no change to the ecological processes is anticipated.

Plant families contributing most species to the provisional on-site checklist were the Aizoaceae and Asteraceae. Seed dispersal in the Aizoaceae is generally quite restricted in space and time. The plants possess fruits that open when moistened to allow the seeds to escape and close again during dry weather. Primary dispersal is usually over very short distances. However, seed dispersal occurs only when it rains and conditions for germination should be suitable. In an area where moisture is a limiting factor, linking dispersal with water availability should have an advantage. In contrast, the seeds (fruits) of the Asteraceae are often well equipped with mechanisms that aid wind dispersal (e.g. wings or plumes). Habitat fragmentation will therefore have a greater negative effect on the Aizoaceae than the Asteraceae and recolonisation after a major disturbance will be slower in the Aizoaceae.

Psammophytes are plants or animals that thrive in sandy environments. Psammophilous plants exhibit many survival strategies such as mechanisms to reduce water loss by having small leaves or the shedding of plant parts. A noteworthy adaptation of some Namib psammophytes is their ability to harvest fog, while other species produce succulent leaves, stems and/or roots. Some psammophilous plants survive wind erosion due to the possession of a thick sheath around their roots that have the ability to withstand root exposure and sandblasting, whereas others produce a thick bark or wax layers. Some psammophilous species exhibit epidermal adaptations that allow them to fix a protective layer of sand grains to the leaf surface. Yet other species disappear seasonally below the sand surface by shrinking their succulent tissue during the dry summer months, and re-emerging during the rainy season. A unique set of psammophilous animals has also evolved in the Namib dunes, with sand moisture being the most important driver of their adaptations (Henschel & Jürgens, in press).

3.2.16 Climate change

Depending on the model parameterisation and climate scenarios used, widely divergent projections are produced for the Succulent Karoo Biome. The early projections predicted a substantial contraction of the Succulent Karoo (Midgley *et al.,* 2001), while more recent models suggest that the biome will be resilient to climate change and will not differ substantially in the future from its current distribution (Driver *et al.,* 2012). Studies by means of repeat photography suggest that modelled projections differ significantly from observed measurements of vegetation change (Davis *et al*., 2016, Hoffman *et al.,* 2019). For most southern African biomes, there is little evidence yet of the catastrophic shifts in ecosystem structure and function that are predicted for the future due to climate change.

The Desert Biome has not yet expanded into large parts of the Succulent Karoo Biome nor has the Nama-Karoo Biome extended its range into the more mesic Grassland Biome. The 2018 National Biodiversity Assessment projected a limited switch from Succulent Karoo to Desert in its northern reaches and its expansion in the southern coastal region to replace parts of the Fynbos Biome (Skowno *et al.,* 2019). Some biomes are recovering from past over-exploitation and others are regenerating following a reduction in livestock numbers and the abandonment of agricultural land. Still others appear resilient to the warming trends that have been experienced thus far (Davis *et al.,* 2016).

A study by Broennimann *et al.* (2006) found that geophytes and succulents, were particularly vulnerable to climate change and Midgley & Thuiller (2007) also contended that succulents could be susceptible to the impacts of climate change. The risk to dwarf succulents, in particular *Conophytum* spp., was highlighted by Young *et al*. (2016).

4. SITE ASSESSMENT

According to the Terms of Reference received from the CSIR, a detailed field assessment of the vegetation was not necessary at the level required for the SEA and no field surveys were needed. However, a broad-scale, high-level, on-site reconnaissance and evaluation of the vegetation was deemed necessary to ground-truth the environmental and flora sensitivities listed by the Screening Tool (Screening Tool, 2024). The vegetation and flora assessment relied heavily on the expert knowledge of Pieter van Wyk, a Richtersveld botanical specialist, and was supported by available data. Although no surveys were required, a limited number of surveys were done during the site visit. Lists of the most prominent plant species were compiled at 37 sampling points and supplemented with data for the Telkom hill generated from the report by Todd (2011) (Figure 19).

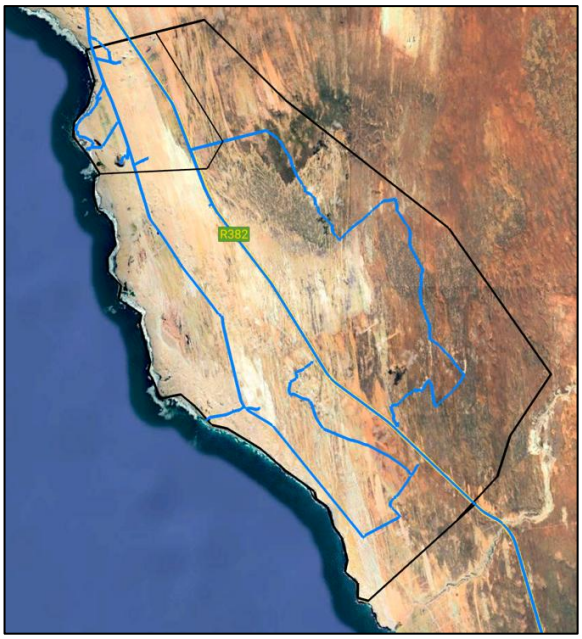


Figure 19: Tracks (blue line) followed during the site visit.

The vegetation data gathered during the site visit were classified following phytosociological procedures and plant communities (habitats) were identified (Appendix B). The vegetation could be subdivided into three distinct clusters:

- Cluster 1: Vegetation associated with the rocky outcrops (Plant Community 1);
- Cluster 2: Vegetation occurring on the coastal lowlands, i.e. predominantly to the west of the tar road (R382) (Plant Communities 2, 3 & 4);
- Cluster 3: Vegetation occurring on the uplands within the site, i.e. predominantly to the east of the tar road (R382) (Plant Communities 6, 7 & 8); and
- Additionally, there was a transitional Plant Community 5 and the wetland vegetation (Plant Community 9).

4.1 Description of plant communities

Plant Community / Habitat 1 (C1)

This plant community occurs where the basement geology is exposed, most notably on the outcrops such as the Boegoeberg Twins, Namakwakop (note this is the Namakwakop on site, there is another

Namakwakop to the north of the site on the topocadastral map in Figure 2) and around the Telkom tower (near Visagiesfonteinkop) (Figure 20). Small outcrops were not all mapped.

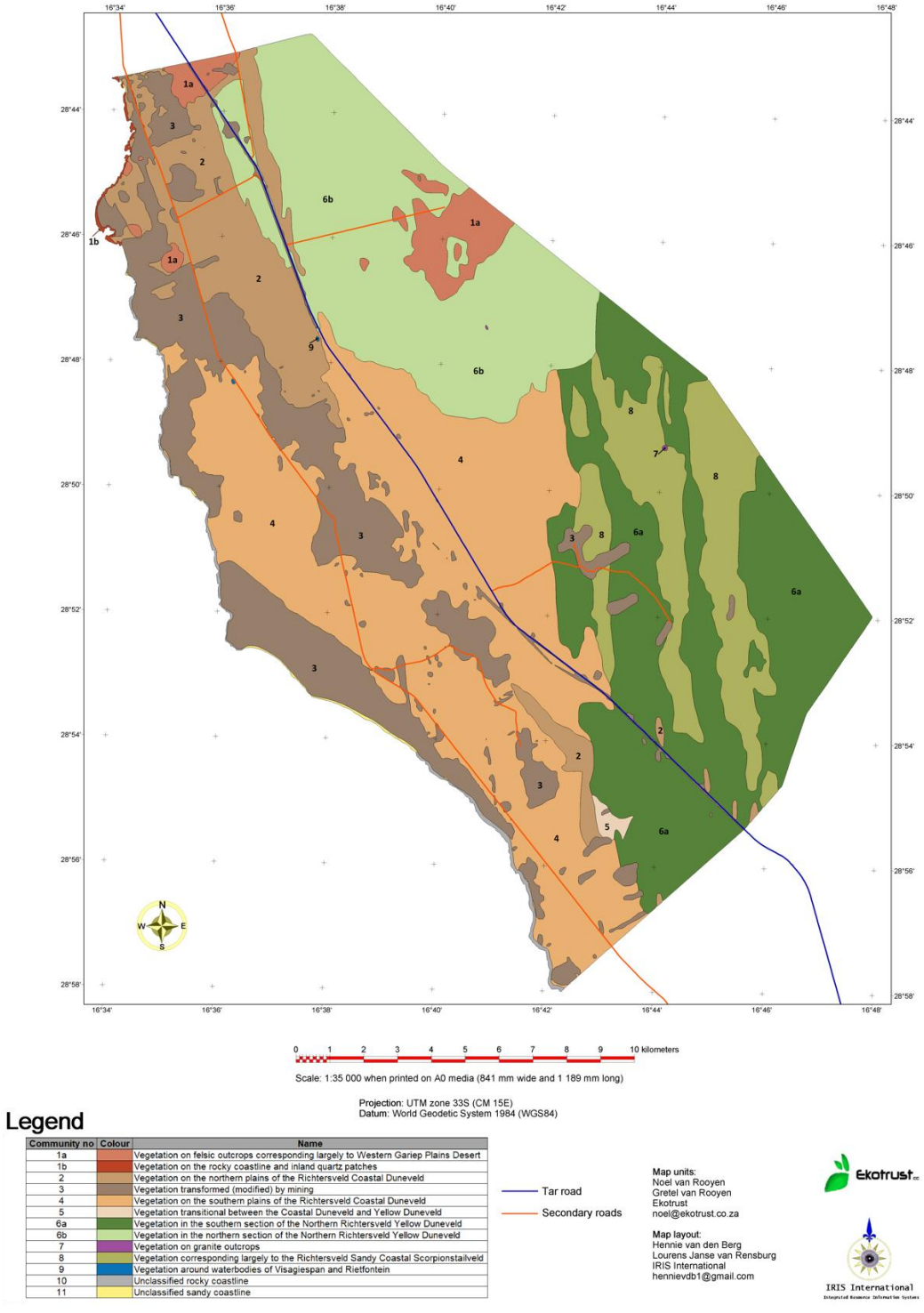


Figure 20: Broad-scale vegetation map indicating the location of the plant communities distinguished in this report.

Plant Community 1 also occupies the coastline from the northern site boundary to approximately Wreck Point (see Figure 2 for place names). The rocky shores in the south of the site were not visited and thus mapped as unclassified. Species that are diagnostic for Community 1 are listed in Species Group 2 (Appendix B), e.g. *Cephalophyllum ebracteatum* (VU), *Conophytum saxetanum* (EN), Sensitive species 305 (CR) and *Monsonia patersonii* (VU). Prominent species commonly found in this habitat include *Asparagus*

capensis, Crassothonna sedifolia, Mesembryanthemum crystallinum, Roepera cordifolia, Stoeberia beetzii and various *Salsola* spp. Two subcommunities (SC) were distinguished, with SC1a defined by Spesies group 1 and SC1b having no diagnostic species group. SC1b contains the highest concentration of Sensitive species 305 (CR) within the species' distribution and removal of this population will have a detrimental impact on this species.

Land use in Plant Community 1 falls partly within the mining area and to the east of the R382 the land is currently used for livestock farming. The Richtersveld Wind Energy Facility has been approved, and this proposed WEF will include sections of Plant Community 1.

- ***Presence of SCC:*** Plant Community / Habitat 1 contained a wealth of SCC:

Dregeochloa pumila	**CR**
Drimia barbata	**CR**
Gazania schenckii	**CR**
Anacampseros cf. *gariepensis*	**CR**
Bassia dinteri	**CR** (SANBI)
Sensitive species 305	**CR**
Calobota acanthoclada	EN
Conophytum saxetanum	EN
Adromischus montium-klinghardtii	VU
Sensitive species 720	VU
Monsonia patersonii	VU
Cephalophyllum ebracteatum	VU
Sensitive species 1187	VU
Lapeirousia macrospatha	VU (SANBI)
Crassula ammophila	NT
Crotalaria meyeriana	NT
Curio crassifolius	DDT
Curio sulcicalyx	DDT
Ifloga lerouxiae	Rare

- ***Occurrence of threatened ecosystems:*** Although C1 is typical of the Western Gariep Plains Desert, which has a Least Concern status sections of C1 occur in areas mapped as Namib Seashore Vegetation as well as in the Richtersveld Coastal Duneveld, both of which have a **Critically Endangered** status.

- ***Occurrence in a CBA (2016 CBA map):*** Large portions of Plant Community 1, e.g. the Boegoeberg Twins, Namakwakop, and Visagiesfonteinkop, have been mapped as part of a **CBA 1**.

- ***Located in a Focus Area of the NPAES:*** To the west of the tar road (R382) this plant community does not fall in the NPAES, however, to the east of the R382 (i.e. Visagiesfonteinkop) it has been included in the **NPAES**.

- ***Degree of disturbance versus intact vegetation:*** In some parts the vegetation is still fairly intact, although some areas are severely degraded, e.g. the wind-blown sand covering the northern footslopes of Boegoeberg South.

- ***Time needed for the vegetation to recover:*** Once disturbed the vegetation in Plant Community 1 will take very long (many decades) to recover.

Plant Community / Habitat 2 (C2)

This plant community occurs on level plains with some relief and covers large parts of the port section and the north-central part of the SEZ (Figure 20). The land use in Plant Community 2 has been mining. These wind-swept plains appear to be a degraded, species-poor variant of Plant Community 4, because it lacks

species in Species Groups 3, 7 and 14 (Appendix B). The floristic affinities between C2 & C3 are shown by the shared presence of Species Groups 4, 5, 8 and 15. Common species found in this plant community include *Cladoraphis cyperoides, Drosanthemum luederitzii, Mesembryanthemum crystallinum, Othonna furcata, Stoeberia beetzii* and *Tetraena clavata*.

- ***Presence of SCC:*** Plant community 2 contained the following SCC (some species from iNaturalist):

Dregeochloa pumila	**CR**
Lachenalia klinghardtiana	**CR**
Monsonia patersonii	VU

- ***Occurrence of threatened ecosystem:*** For the most part this plant community falls into the Richtersveld Coastal Duneveld, which has a **Critically Endangered** status.

- ***Occurrence in a CBA (2016 CBA map):*** The unit is largely mapped as a **CBA 1**.

- ***Located in a Focus Area of the NPAES:*** The area has not been included in the NPAES.

- ***Degree of disturbance versus intact vegetation:*** The vegetation is considered to be a degraded variant of the Richtersveld Coastal Duneveld.

- ***Time needed for the vegetation to recover:*** Without stabilising the sand and other rehabilitation measures, the vegetation in Plant Community 2 will take very long to recover after a major disturbance.

Plant Community / Habitat 3 (C3)

Plant Community 3 has been transformed by mining and currently represents modified habitat *sensu* IFC Performance Standard 6 (IFC, 2012, updated 2019) (Figure 20). It is floristically strongly related to C2, but differs in the level of transformation. C3 differs markedly from C4 due to the absence of species in Species Groups 3, 7 and 14, but shares Species Groups 4, 5 and 8 with C2 and C4. Prominent perennial dwarf shrubs in this plant community are *Amphibolia rupis-arcuatae, Didelta carnosa, Drosanthemum luederitzii, Lycium tetrandrum, Stoeberia beetzii* and *Tetraena clavata,* while some conspicuous short-lived species include *Oncosiphon* spp., *Mesembryanthemum crystallinum* and *Mesembryanthemum hypertrophicum*. The unit is located within the area mapped as Richtersveld Coastal Duneveld, but due to the level of disturbance might never return to its original state.

- ***Presence of SCC:*** No SCC were recorded during the site visit.

- ***Occurrence of threatened ecosystems:*** For the most part this unit falls into the Richtersveld Coastal Duneveld, which has a Critically Endangered status. However, due to the transformed nature of this unit, it does not warrant a threatened ecosystem status.

- ***Occurrence in a CBA (2016 CBA map):*** The habitat was not classified in the CBA map.

- ***Located in a Focus Area of the NPAES:*** The area has not been included in the NPAES.

- ***Degree of disturbance versus intact vegetation:*** The vegetation is entirely transformed.

- ***Time needed for the vegetation to recover:*** Considering the permanent transformation, C3 can return to its current transformed state, however, it might never return to its original state.

Plant Community / Habitat 4 (C4)

The species composition recorded in this plant community during the site visit agrees well with the description of the Richtersveld Coastal Duneveld provided in Mucina & Rutherford (2006). Plant Community 4 occupies plains with low hills and ridges. The portion of the community to the west of the tar

road is located in the mining area, whereas the section east or the tar road is used for livestock farming. Diagnostic species in this unit are listed in Species Group 3, e.g. *Atriplex vestita, Crassothonna cylindrica, Hebenstretia* sp., *Osteospermum oppositifolium* and *Ruschia* sp. Prominent species include *Amphibolia rupis-arcuatae*, *Crassothonna cylindrica*, *Didelta carnosa, Mesembryanthemum crystallinum, Oncosiphon* spp., *Roepera cordifolia, Stoeberia beetzii, Stoeberia utilis* and *Salsola* spp. This plant community shows floristic affinities with C1, C2 and C3 through the shared species in Species Groups 4 and 5, but also to the vegetation to the east of the R382 tar road *viz.* Community 6 through the shared species in Species Groups 7, 8, 14 and 15.

- ***Presence of SCC:*** Several SCC were recorded during the site visit, with some additional records obtained from iNaturalist:

Lachenalia klinghardtiana	**CR**
Sensitive species 305	**CR**
Sensitive species 293	EN
Sensitive species 734	VU
Monsonia patersonii	VU (SANBI)
Amphibolia succulenta	NT

- ***Occurrence of threatened ecosystems:*** This plant community falls mainly in the Richtersveld Coastal Duneveld, which has a **Critically Endangered** status.

- ***Occurrence in a CBA (2016 CBA map):*** The unit has for the most part been classified as **CBA 1**.

- ***Located in a Focus Area of the NPAES:*** Only a small section has been included in the NPAES.

- ***Degree of disturbance versus intact vegetation:*** C4 is interspersed with mine trenches, diggings and dumps. Although by no means pristine, there are some areas with intact vegetation and other areas that were disturbed a very long time ago.

- ***Time needed for the vegetation to recover:*** Considering the harsh environment, C4 will take a long time to recover after a major disturbance.

Plant Community / Habitat 5 (C5)

Plant Community 5 represents a transition from the vegetation characteristic of the Richtersveld Coastal Duneveld to the vegetation typically found in the Northern Richtersveld Yellow Duneveld and occurs in the south-central part of the SEZ around Duikerkop (Figures 20). A large colony of Brant's whistling rats was present in the plant community. The land use in Plant Community 5 has been mining. The unit has no diagnostic species, but its transitional nature is illustrated by the presence of Species Group 5 linking it to C1 – C4 (west of the R382) and Species Groups 7, 8 and 13 linking it to the vegetation units to the east of the tar road (R382) i.e. C6, C7 and C8. Common species in C5 include *Amphibolia rupis-arcuatae, Asparagus capensis, Cephalophyllum rigidum, Cheiridopsis robusta, Eberlanzia sedoides, Lycium tetrandrum, Oncosiphon* spp., *Mesembryanthemum crystallinum, Mesembryanthemum schlichtianum, Roepera cordifolia, Senecio aloides, Stoeberia beetzii* and *Tetraena clavata.*

- ***Presence of SCC:*** No SCC were recorded in Plant Community 5 during the site visit.

- ***Occurrence of threatened ecosystem:*** This habitat falls into the area mapped as Northern Richtersveld Yellow Duneveld, which has a Least Concern status.

- ***Occurrence in a CBA (2016 CBA map):*** Plant Community 5 has been mapped as **CBA 2**.

- ***Located in a Focus Area of the NPAES:*** The area has not been included in the NPAES.

- ***Degree of disturbance versus intact vegetation:*** C5 is largely intact vegetation.

- ***Time needed for the vegetation to recover:*** Considering the harsh environment, C5 will take a very long time to recover after a major disturbance.

Plant Community / Habitat 6 (C6)

This plant community as a whole is defined by the species in Species Group 9, e.g. *Asparagus graniticus, Asparagus undulatus, Babiana hirsuta, Calobota spinescens, Jordaaniella clavifolia* (VU) and *Ruschia* sp. The plant community can be subdivided into two subcommunities. SC6a is found in the southern part of the area mapped as Northern Richtersveld Yellow Duneveld in the Boegoeberg Port and SEZ site (SANBI, 2024), whereas SC6b is found in the northern part of the Northern Richtersveld Yellow Duneveld occurring on site (Figure 20). C6 is currently used for livestock grazing.

SC6a is floristically related to C2 to C5 through the shared species in Species Group 8, whereas SC6b is not as closely related to C2 and C3 but shares some species with C5 (Species Group 13) and C4 (Species group 14). SC6a was the only subcommunity characterised by a diagnostic species group (Species Group 6) containing species such as *Euphorbia burmannii, Euphorbia ephedroides, Heliophila lactea, Othonna undulata, Ruschia* sp., *Pelargonium* sp. nov. *and Veltheimia capensis*. Prominent species for the community as a whole included *Amphibolia succulenta* (NT), *Asparagus capensis, Cephalophyllum rigidum, Cheiridopsis robusta, Crassothonna sedifolia, Didelta carnosa, Euphorbia mauritanica, Euphorbia rhombifolia, Foveolina dichotoma, Jordaaniella cuprea, Jordaaniella spongiosa, Lampranthus otzenianus, Lampranthus stipulaceus, Mesembryanthemum crystallinum, Mesembryanthemum schlichtianum, Pteronia glabrata, Roepera cordifolia, Roepera morgsana, Senecio aloides, Stoeberia utilis* and *Trachyandra falcata.*

- ***Presence of SCC:***

Lachenalia klinghardtiana	**CR**
Dregeochloa pumila	**CR** (Todd, 2011)
Sensitive species 305	**CR** (SANBI)
Sensitive species 720	VU
Jordaaniella clavifolia	VU
Sensitive species 734	VU
Monsonia patersonii	VU
Adromischus montium-klinghardtii	VU (SANB)
Schlechteranthus holgatensis	VU (SANBI)
Cephalophyllum ebracteatum	VU
Amphibolia succulenta	NT
Crassula ammophila	NT
Aloe framesii	NT

- ***Occurrence of threatened ecosystem:*** This plant community falls into the area mapped as Northern Richtersveld Coastal Duneveld with a Least Concern status.

- ***Occurrence in a CBA (2016 CBA map):*** C6 has been mapped partly as **CBA 1** and partly as **CBA 2**.

- ***Located in a Focus Area of the NPAES:*** The area has largely been included in the **NPAES**.

- ***Degree of disturbance versus intact vegetation:*** C6 is largely intact vegetation. It is used for livestock grazing.

- ***Time needed for the vegetation to recover:*** Considering the harsh environment, C6 will take a long time to recover after a major disturbance.

Plant Community / Habitat 7 (C7)

Plant Community 7 is a small plant community representing a unique habitat, occurring on and around outcrops of granite boulders. It is embedded in either the Northern Richtersveld Yellow Duneveld or the

Richtersveld Sandy Coastal Scorpionstailveld (Figure 20). During the rainy season, the hollows in the granite boulders are filled with water providing an important source of water for wildlife. Plant community 7 is currently used for livestock grazing. The diagnostic species for this unit are listed in Species Group 10 and include *Antimima varians, Cotula coronopifolia, Colchicum albomarginatum, Cynodon dactylon, Drosanthemum inornatum, Opuntia ficus-indica, Gladiolus arcuatus, Lachenalia punctata, Lessertia frutescens, Manochlamys albicans, Melolobium adenodes* and *Oxalis inconspicua.*

- ***Presence of SCC:*** The following SCC were recorded during the site visit:

Adromischus montium-klinghardtii	VU
Sensitive species 734	VU
Amphibolia succulenta	NT

- ***Occurrence of threatened ecosystems:*** This unit falls into both the Northern Richtersveld Yellow Duneveld and Richtersveld Sandy Coastal Scorpionstailveld, both of which have a Least Concern status.

- ***Occurrence in a CBA (2016 CBA map):*** The unit has been mapped as **CBA 2**.

- ***Located in a Focus Area of the NPAES:*** The area has been included in the **NPAES**.

- ***Degree of disturbance versus intact vegetation:*** C7 represents natural habitat and shows signs of disturbance by humans as well as livestock.

- ***Time needed for the vegetation to recover:*** C7 will take a very long time to recover after a major disturbance.

Plant Community / Habitat 8 (C8)

Plant Community 8 (Figure 20) agrees with the area mapped as Richtersveld Sandy Coastal Scorpionstailveld and was characterised by the heuweltjies occurring in the unit. In the study site, the heuweltjies lack the typical surface mounding and appear as flat, rather barren patches (see McAuliffe *et al.,* 2019). In the arid extremes of the distribution of heuweltjies, the central soils also have an elevated N and P content, but the vegetation cover and height in the surrounding areas are often substantially reduced and perennial plants may be entirely absent. Termites play an important role in the carbon cycle and their activities could be assisting carbon sequestration (Francis *et al.,* 2024). When a heuweltjie landscape is overgrazed, the heuweltjies are typically the first places to be denuded of vegetation. Plant Community 8 is currently used for livestock grazing.

C8 had a weak diagnostic Species Group (Species Group 12). Prominent species in this plant community included *Amphibolia succulenta* (NT)*, Asparagus capensis, Cheiridopsis robusta, Euphorbia* spp.*, Foveolina dichotoma, Lampranthus otzenianus, Mesembryanthemum crystallinum, Mesembryanthemum schlichtianum, Pteronia glabrata, Roepera cordifolia, Senecio aloides* and *Stoeberia beetzii.* C8 is floristically related to C5 and C6 through the shared species in Species Group 13. It also shares some species with C4 (Species Group 14).

- ***Presence of SCC:*** The following SCC was recorded during the site visit:

Amphibolia succulenta	NT

- ***Occurrence of threatened ecosystems:*** This unit falls into the Richtersveld Sandy Coastal Scorpionstailveld with a Least Concern status.

- ***Occurrence in a CBA (2016 CBA map):*** The unit is mostly mapped as **CBA 2**, with sections within a **CBA 1.**

- ***Located in a Focus Area of the NPAES:*** Most of C8 has been included in the **NPAES**.

- ***Degree of disturbance versus intact vegetation:*** Plant Community 8 represents natural habitat and shows signs of disturbance by humans and livestock.

- ***Time needed for the vegetation to recover:*** C8 will take a very long time to recover after a major disturbance.

Plant Community / Habitat 9 (C9)

Plant Community 9 represents the vegetation around the waterbodies on Visagiespan and Rietfonteinpan (Figure 20). These waterbodies fall in the mining lease area and are embedded in the **CR** Richtersveld Coastal Duneveld. The most prominent species were *Atriplex vestita, Drosanthemum luederitzii, Juncus* sp., *Phragmites australis* and *Salicornia natalensis*.

- ***Presence of SCC:*** No SCC were recorded in Plant Community 9 during the site visit.

- ***Occurrence of threatened ecosystems:*** This unit falls in the Richtersveld Coastal Duneveld which has a **Critically Endangered** status.

- ***Occurrence in a CBA (2016 CBA map):*** While Rietfontein's waterbody was mapped as **CBA 1**, the waterbody at Visagiespan was not classified.

- ***Located in a Focus Area of the NPAES:*** The area has not been included in the NPAES.

- ***Degree of disturbance versus intact vegetation:*** The waterbody at Visagiesfontein is apparently man made, however, Rietfonteinpan appears to be a natural wetland.

- ***Time needed for the vegetation to recover:*** Plant Community 9 will take a very long time to recover after a major disturbance.

5. SITE SENSITIVITY

The first environmental screening for the Boegoebaai Port area was undertaken in 2018 (MDT, 2018 https://publishedetenders.blob.core.windows.net/publishedetenderscontainer/9083/Annexure%20C%20-%20Environmental %20Screening%20Report%20Rev%201%20-%202018%2004%2024%20-%20Final.pdf). The report mentioned various sensitive features e.g. the presence of the Endangered Namib Seashore Vegetation and that any impact on this ecosystem should be avoided. The report also mentioned the occurrence of CBA 1s, 'Vulnerable and Rare plants species on the Boegoeberg Inselbergs, an ancient hyaena lair site and grave sites' as well as the seal and cormorant colonies in the port site. Since the MDT report the Namib Seashore Vegetation has been upscaled to Critically Endangered and the Richtersveld Coastal Duneveld has been upscaled from Least Concern to Critically Endangered.

The Terms of Reference for the vegetation and flora component of the SEA required the ground-truthing of the environmental sensitivities indicated by DFFE's Screening Tool (Screening Tool, 2024). The available information used to produce the sensitivity maps for the current assessment of the Boegoebaai SEA is at a coarse scale. Sensitivity ratings relied on an assessment of various features within each plant community that was distinguished e.g. presence of CR ecosystems, SCC, CBAs, and NPAES. Ratings were applied per plant community, based on the occurrence of a feature. Because many of the plant communities are large, the current analysis and mapping of sensitive features is at a broad scale and many small or localised features may not have been mapped. This highlights the importance of conducting an in-depth, fine-scale analysis of the vegetation for a detailed sensitivity and ecological impact analyses.

5.1 Screening Tool

5.1.1 Plant Theme

The Screening Tool rated the sensitivity of the Plant Theme as **Medium** and provided a list of 19 plant species with all species rated as of medium sensitivity (Table 1, Figure 21a). The Screening Tool's **Medium** sensitivity refers to the presence of model-derived suitable habitat for threatened and/or rare species. The areas in green in Figure 21a correspond to areas that were transformed by mining.

Table 1: Species of Conservation Concern (SCC) listed for the proposed Boegoebaai Port and SEZ site in the Screening Tool and whether their presence could be confirmed on site

Sensitivity	Feature(s)	IUCN Status	Confirmed on site
Medium	*Bassia dinteri*	CR	Yes (SANBI)
Medium	Sensitive species 305	Was VU; now CR	Yes
Medium	*Mesembryanthemum occidentale (= Aridaria vespertina)*	EN	
Medium	Sensitive species 282	EN	
Medium	Sensitive species 407	Was VU; now EN	Yes
Medium	Sensitive species 293	EN	Yes
Medium	Sensitive species 1110	EN	Yes
Medium	*Calobota acanthoclada*	EN	Yes
Medium	Sensitive species 827	VU	Yes
Medium	Sensitive species 435	VU	
Medium	Sensitive species 734	VU	Yes
Medium	Sensitive species 1187	VU	Yes
Medium	Sensitive species 720	VU	Yes
Medium	*Adromischus montium-klinghardtii*	VU	Yes
Medium	*Nemesia saccata*	VU	Yes
Medium	*Helichrysum dunense*	VU	Yes
Medium	Sensitive species 744	VU	
Medium	*Manulea cinerea*	VU	
Medium	Sensitive species 1090	RARE	

The presence of 13 of these species were confirmed on site either during the current site visit or from records provided by P. van Wyk, iNaturalist or SANBI (2024) for the site. An additional 33 SCC were confirmed for the site (Appendix A). In total, there are thus **46 confirmed SCC on site**. Moreover, 163 Northern Cape provincially protected/specially protected and 20 CITES-listed species are also present on site.

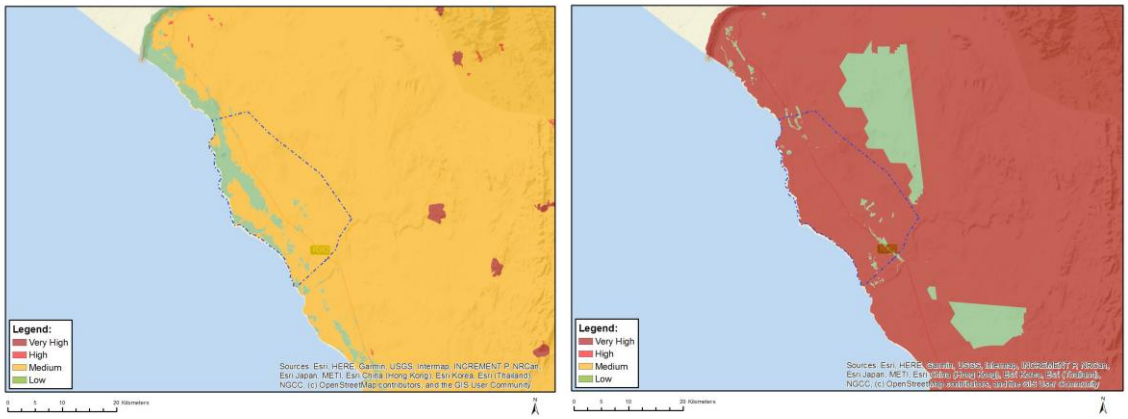


Figure 21: Site sensitivity of the (a) Plant Theme; and (b) Relative Terrestrial Biodiversity Theme as provided by the Screening Tool.

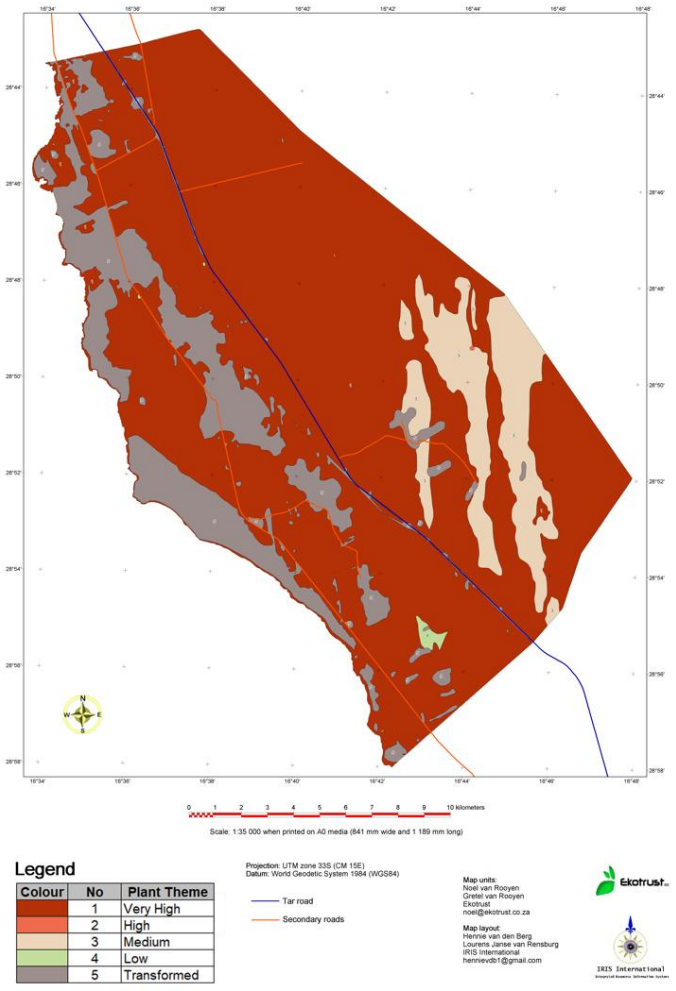


Figure 22: Site sensitivity of the Plant Theme as assessed during the site visit. Areas in grey correspond to areas that have been transformed by mining.

The criteria used for the current site sensitivity assessment per plant community were as follow:

- A plant community was rated as **Very High** if it was habitat for a Critically Endangered species
- A plant community was rated as **High** if it was habitat for an Endangered or Vulnerable species
- A plant community was rated as **Medium** if it was habitat for a Near Threatened, Data Deficient or Rare species
- A plant community was rated as **Low** if it was not habitat for any SCC.

On the basis of these criteria it is recommended that the sensitivity of the Plant Theme should be upscaled to **Very High** (Figure 22). Plant Community 3, representing the areas transformed by mining, was rated as modified or transformed habitat and no SCC were reported for this unit.

5.1.2 Relative Terrestrial Biodiversity Theme

The Screening Tool rated the sensitivity of the Relative Terrestrial Biodiversity Theme as **Very High** based on the features listed in Table 2 (Figure 21b). Because the 2016 CBA map was used in the Screening Tool the same version was used for the current comparison. The desktop evaluation confirmed the presence of all these features listed by the Screening Tool and **if the same sensitivity ratings as the Screening Tool were applied and the same CBA map (2016) is used, the current assessment would confirm the rating of Very High.**

Table 2: Features used by the Screening Tool to assess the Relative Terrestrial Biodiversity Theme and the sensitivity rating used by the Screening Tool as well as the adjusted ratings used in the current assessment

Feature(s)	Sensitivity (Screening Tool)	Sensitivity used in the current assessment
Low Sensitivity	Low	
CBA 1	Very High	Very High
CBA 2	Very High	High
ESA	Very High	Medium
National Protected Area Expansion Strategy (NPAES)	Very High	High
CR Namib Seashore Vegetation	Very High	Very High
CR_Richtersveld Coastal Duneveld	Very High	Very High
CR plant species	-	Very High

To compare the Screening Tool's site sensitivity with the assessment made during the current study (Figure 23), the sensitivity ratings were modified to correspond more closely with the 'Best Practice Guidelines for Implementing the Mitigation Hierarchy in South Africa' (EWT, 2023) which agree well with the National Biodiversity Offset Guideline of DFFE (2023). These guidelines use the principles of Limits of Acceptable Change/Threshold of Concern. These limits for changes in environmental quality define the ceiling that would be considered to be acceptable.

It has to be emphasized that the current assessment represents a site sensitivity, whereas the EWT guidelines refer to impact significance, where significance is a combination of the (i) extent (scale); (ii) duration; (iii) intensity; and (iv) likelihood of an impact. In this study sensitivity was regarded as equivalent to impact. If the current assessment confirmed the presence of a feature in a plant community, the following ratings were applied.

Sensitivity is considered **Very High** if it would include:

- a **Critically Endangered ecosystem**;
- an irreplaceable Critical Biodiversity Area (**CBA 1**);

- confirmed habitat of a **Critically Endangered species**;
- impacts on **range-restricted species** which are **nationally listed as Rare or Extremely Rare**;
- a natural or near-natural part of a **formally protected area**; and
- loss of **key ecological corridors** recognised as important for evolutionary processes and climate change adaptation where no spatial options to safeguard these processes exist. Key ecological corridors for evolutionary processes and climate change adaptations are generally incorporated into CBA 1 classifications.

According to the mitigation hierarchy (EWT, 2023) a **Very High** impact rating would indicate that the proposed development must be avoided/prevented, since these changes cannot be remedied and offsets or compensation would not be feasible because of the high threat status or irreplaceability of the affected biodiversity or ecosystem services.

Sensitivity is considered **High** if it would include:

- an optimal Critical Biodiversity Area (**CBA 2**);
- an **Endangered ecosystem**;
- presence of the **National Protected Area Expansion Strategy** (NPAES) or buffer zones around protected areas;
- confirmed habitat of an **Endangered species**, or impacts leading to an increase in their threat status; and
- impacts on **range-restricted endemic** species that are not nationally listed as Rare, Extremely or Critically Rare.

Where residual negative impacts of **High** significance remain, biodiversity offsets/compensation can be considered.

Sensitivity is considered **Medium** if it would include:

- an Ecological Support Area (**ESA**);
- irreversible impacts on Priority Focus Areas in the **National Protected Areas Expansion Strategy (NPAES);**
- **Strategic Water Source Areas** (see Aquatic report);
- areas within **32 meters of a watercourse** (see Aquatic report);
- **Vulnerable ecosystems and/or species**, or endemic (but not range-restricted) or protected species;
- or impacts on ecosystems or species which would result in them being listed as threatened;
- degradation of ecological infrastructure providing highly valued or important ecosystem services; and
- loss of, or reduction in important ecological process areas or landscape corridors.

Avoidance or minimisation of impacts is essential and restoration of degraded areas must be undertaken when the impact rating is **Medium**. Should significant negative impacts of medium significance remain, biodiversity offsets/compensation can be considered.

Sensitivity is considered **Low** if it would include:

- loss of vegetation in an **ONA** or biodiversity of **Least Concern** supporting no threatened ecosystems or species, and not constituting important ecological process areas or corridors, or providing important ecosystem services.

Should the impact have a **Low** rating, impacts should as far as possible be avoided and minimised and rehabilitation/ restoration would minimise residual negative impacts and biodiversity offsets or compensation would not be required.

Should any features be present in a plant community, the feature with the highest status overrides the lesser status, a principle that agrees with the viewpoint applied by the Screening Tool. Using these criteria the current sensitivity would be **Very High** for most of the site with Plant Community 8 rated as **High**. Plant Community 3 representing the habitat that has been transformed/modified by mining could be used for development.

The **Very High** sensitivity of the Relative Terrestrial Biodiversity Theme found using the criteria in the current assessment agrees well with the sensitivity generated by the Screening Tool. It does however point out a weakness in scoring the environmental sensitivity of the Boegoebaai Port during the port selection stage (MDT, 2018; Transnet National Ports Authority, 2024; https://www.csir.co.za/sites/default/files/Documents/Appendix%20C_Overview%20of%20Boegoebaai%20Site%20Selection%20process.pdf).

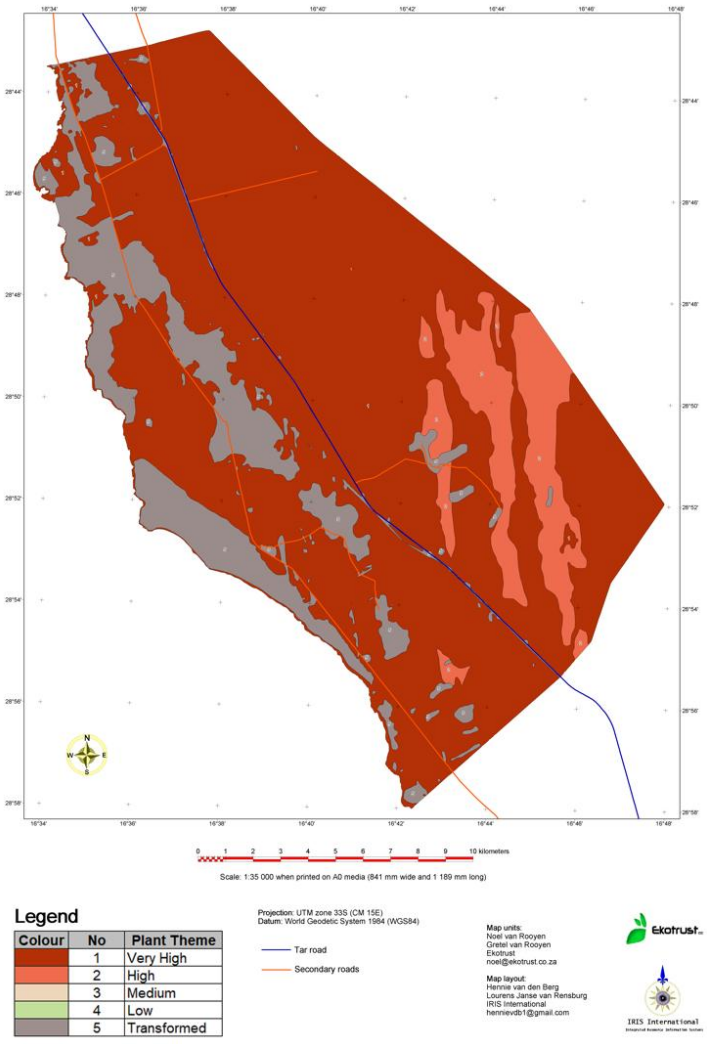


Figure 23: Sensitivity of the Relative Terrestrial Biodiversity Theme as assessed during the site visit.

5.2 International Finance Corporation (IFC)

The following section is a brief outline of the Guidance Notes of the IFC (IFS PS6, 2019), to compare the principle of Limits of Acceptable Change/Threshold of Concern proposed in the mitigation hierarchy by the Endangered Wildlife Trust (EWT, 2023) to those provided by the IFC. The IFC Performance Standards provide guidance to clients on how to avoid, mitigate and manage risks and impacts in a sustainable way. In Guidance Note 6 of the 'Biodiversity Conservation and Sustainable Management of Living Natural Resources' the concept of '**Critical habitat'** is introduced. Critical habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes. These habitats would therefore have a **Very High** sensitivity. The critical habitat definition as applied by the IFC is in line with criteria used to identify priority habitat for biodiversity conservation. These habitats must include one or more of the criteria referred to as critical habitat criteria. Each of these criteria are established based on some features.

Criterion 1: Critically Endangered (CR) and Endangered (EN) Species

Thresholds for Criterion 1:

- Areas that support globally important concentrations of an IUCN Red-listed CR or EN species (≥0.5% of the global population and ≥5 reproductive units.
- Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR.
- As appropriate, areas containing important concentrations of a **nationally or regionally listed CR or EN species**.

Criterion 2: Endemic and Restricted-range Species (i.e. Extent of Occurrence (EOO) less than 50,000 km^2)

Threshold for Criterion 2:

- Areas that regularly hold ≥10% of the global population size and ≥10 reproductive units of a species.

Criterion 3: Migratory and Congregatory Species

This criterion is not applicable to plant species.

Criterion 4: Highly Threatened or Unique Ecosystems

Thresholds for Criterion 4:

- Areas representing ≥5% of the global extent of an ecosystem type meeting criteria for IUCN status of CR or EN.
- Other areas not assessed by IUCN but determined to be of **high priority for conservation by regional or national systematic conservation planning**.

Criterion 5: Key Evolutionary Processes:

Examples:

- Landscapes with high spatial heterogeneity are a driving force in speciation, as species are naturally selected based on their ability to adapt and diversify.

- Environmental gradients producing transitional habitat, which has been associated with the process of speciation and high species and genetic diversity.
- Edaphic interfaces are specific juxtapositions of soil types, which have led to the formation of unique plant communities characterized by both rarity and endemism.
- Connectivity between habitats (corridors) ensures species migration and gene flow, which is important in fragmented habitats and for conserving metapopulations.
- Sites of demonstrated importance to climate change adaptation for either species or ecosystems.

The IFC Performance Standards stipulates that in areas of critical habitat, the client will not implement any project activities unless all of the following can be demonstrated:

- No other viable alternative within the region exists for development of the project on modified or natural habitats that are not critical;
- The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values;
- The project does not lead to a net reduction in the global and/or national/regional populations of any CR or EN species over a reasonable period of time;
- A robust, appropriately designed and long-term biodiversity monitoring and evaluation program is integrated into the client's management program.

Should a client be able to meet the requirements above, the project's mitigation strategy must be described in a Biodiversity Action Plan and be designed to achieve net gains of those biodiversity values for which the critical habitat was designated. In instances where biodiversity offsets are proposed as part of the mitigation strategy, the client must demonstrate through an assessment that the project's significant residual impacts on biodiversity will be adequately mitigated to meet the requirements.

6. ASPECTS AND IMPACTS REGISTER

An aspects and impacts register (Table 3) was compiled based on the project description provided by the CSIR (Schreiner *et al*., 2024).

Table 3: Aspects and impacts register applicable to the vegetation in the proposed Boegoebaai Port and SEZ

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
PORT		
Zone 1: Infrastructure *Any structure to be built or covering land related to the port facility e.g.:* • buildings; • bulk material stockpiles, warehouses & handling facilities; • ship loaders; • conveyor belt structures; • water reservoirs; • sewage systems; • stormwater drainage systems; • electrical substations; • fuel storage facilities; and • roads.	***Infrastructure:*** ***Vegetation clearance:*** Natural vegetation will be cleared for various structures related to the port facility. Vegetation clearance will cause a loss of a portion of (i) a **CR ecosystem**; (ii) an **irreplaceable CBA 1** or **optimal CBA 2**; or (iii) the **NPAES** if the structure is located in such an area. The removal of indigenous vegetation will likely cause a loss of individuals of threatened, protected and/or endemic plant species since several CR, EN, VU, protected and endemic species are present in the port precinct. Vegetation clearance will cause a loss of parts of a Key Biodiversity Area (KBA) because almost the entire port is located in a KBA. Vegetation clearance is also accompanied by a loss of faunal habitat. Vegetation clearance will also be associated with increased sand movement and erosion of topsoil material. Transported sand may accumulate and smother adjacent vegetation, affecting in particular small plant species. Sand storms may intensify as a result of vegetation clearance and the effects of sandblasting on the vegetation may increase. Vegetation clearance will decrease ecosystem services supplied by the botanical component.	Except for areas that have been mapped as transformed habitat, the rest of the Port area has been assigned a **Very High** sensitivity and should thus be avoided (Figure 23). In support of the avoidance as the only option, are the presence of the following: • **CR Namib Seashore Vegetation** as well as **Richtersveld Coastal Duneveld** which are irreplaceable and cannot be offset (Figure 9); • irreplaceable **CBA 1s** (Figure 10); • **CR plant species** (Plant Community 1 & 2, Figure 20); • optimal **CBAs 2s**; • focus areas of the **NPAES** (Figure 12); and • a **Key Biodiversity Area** (Figure 13).
Zone 1: Dry bulk material handling Manganese: Manganese will be stored in closed stockpiles, with dust suppression using water spraying.	***Dry bulk material handling:*** ***Manganese:*** Manganese is an essential micronutrient for plants but in excess it can be toxic. The type of closed stockpile was not specified. It is recommended to store manganese in a warehouse or specialised silo and move via piped conveyor. Wind can disperse fine particles from stockpiles leading to contamination of the soil, which can affect the vegetation. Water is such a scarce commodity in the area that an alternative method for dust suppression must be sought. Using water for dust suppression is expensive and inefficient and the water will become contaminated. No indication has been given of how the impurities will be extracted or how the water will be disposed of or reused.	Location of the manganese stockpile can impact vegetation and species negatively and all areas listed for **Zone 1: Infrastructure** must be avoided. The stockpile can only be located in habitat that has been intensively modified by mining i.e. Plant Community 3 (Figure 20). Implement an Air Quality Monitoring Plan to monitor and manage atmospheric emissions around stockpiles and warehouses and ensure that monitoring equipment is adequately maintained.

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
Lead and zinc: Lead and zinc will be stored in enclosed warehouses.	***Zinc and lead:*** Zinc is an essential micronutrient for plants but in excess it can be toxic. Lead is a toxic heavy metal which negatively affects plant growth. The bulk storage warehouses need to be fully contained to protect against chemical spillage.	
Zone 1: Conveyor belts Systems handling zinc and lead must be fully enclosed, while those handling manganese require arched coverage. Elevated belt conveyors are designed with handrailed walkways for safe access and maintenance.	***Conveyor belts:*** ***Manganese:*** In faulty systems dust can contain manganese particles and other pollutants which may affect plant life if they enter the soil in large amounts. ***Lead and zinc:*** Runoff from the conveyor can lead to leaching of lead/zinc into groundwater.	Implement an Air, Soil and Water Quality Monitoring Plan to monitor and manage atmospheric emissions around the conveyor system and ensure that monitoring equipment is adequately maintained.
Zone 1: Dust control Dust suppression and collection systems are incorporated with all material handling equipment designed to prevent material accumulation outside the dust collection system.	***Dust control:*** It has not been specified how and where the material accumulated in the dust collection system will be discarded.	Dust control systems should avoid the areas mentioned in ***Zone 1: Infrastructure.*** Material collected in the dust suppression system should be disposed of at a registered waste facility.
Zone 1: Bulk services – Water Option 1: Pipeline from Alexander Bay with water treatment plant. It has been assumed that the water treatment plant for this option would be at Alexander Bay. Option 2 (preferred): On-site desalination plant with 1 ML capacity. Elevated reservoirs will provide pressure for fire suppression discharge.	***Desalination of water:*** Vegetation clearance - **see Zone 1: Infrastructure** ***Option 1: Pipeline:*** Pipeline from Alexander Bay is not assessed since no on-site route was provided. ***Option 2: Desalination:*** Reverse osmosis will be used to desalinate seawater. See the Marine Ecology Report to discuss negative effects. In summary: (i) the intake of seawater can harm marine life by impingement and entrainment; (ii) concentrated brine produced can harm marine ecosystems when discharged into the ocean, especially if done without the necessary diffusion; (iii) chemicals used in the desalination process can enter the marine environment; and (iv) brine should also not be discharged at temperatures that are too high for the ecosystem. The possibility to use the brine solution to produce salt can be investigated. The salt needs to be purified to achieve the desired quality. Careful management of the process is required to minimise ecological disruption to surrounding areas. New advances in technology may allow for a nearly waste-free zero liquid discharge desalination which crystalises salt and chemicals.	Desalination plants may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** ***Option 2: Desalination:*** Marine ecologists should assist with the site of the seawater intake. Brine discharge demands careful selection of the site and method of discharge. Discharge points must be located away from sensitive marine ecosystems – see Marine Ecology report. Continuous monitoring of the discharge site is needed to allow for adjustment if unacceptable negative impacts are found. Observe compliance with local and international regulations to ensure that discharge practices meet environmental standards.
Zone 1: Bulk services – Sewage The site will be divided into separate drainage areas with isolated reticulation systems, on-site treatment and disposal. Drainage areas will use a combination of waste-water treatment plants, septic tanks and soak-away systems.	***Bulk services – Sewage:*** For vegetation clearance - see ***Zone 1: infrastructure*** Positive impacts could arise if nutrients are recovered and used as fertilizers. Investigate if wastewater could be used for industrial purposes. Negative impacts include the use of chemicals for disinfection that can lead to residual pollutants in	Waste water treatment plants, septic tanks and soak-away systems may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** Groundwater contamination by these sewage systems must be avoided.

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
	treated water; sludge disposal can lead to soil and water contamination; and inadequate treatment of sewage water leaves pathogens that pose health risks.	
Zone 1: Stormwater drainage systems The drainage system will separate clean and dirty water, with clean water runoff diverted around the site. High-risk dirty runoff water will flow into concrete-lined channels to the pollution control pond and low-risk dirty runoff water will flow into block and vegetated channels. Pollution control ponds will be lined with HDPE (high density polyethylene), attenuated to the 1:50 year pre-development condition and discharged to the receiving natural environment.	***Stormwater drainage systems:*** For vegetation clearance - see ***Zone 1: Infrastructure*** Changing the natural water flow could affect aquatic habitats and diversion of water can concentrate pollutants into some areas. Favourable habitat for invasive species could be created. Poorly maintained systems become clogged and ineffective, possibly causing flooding. Positive impacts could result if (i) diverting stormwater can minimise runoff of pollutants into water bodies; (ii) controlling water flow can reduce soil erosion; and (iii) floods are prevented.	The storm water treatment structures, may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** Pollutants may not enter the groundwater.
Zone 1: Electrical: The internal network will include an intake substation, primary and secondary substations and distribution substations.	***Electrical:*** For vegetation clearance - see ***Zone 1: Infrastructure.*** Electrical infrastructure will not be limited to substations. Powerlines need to carry electricity from the renewable source to the intake substation and from there to the other substations. Some lines may be buried which will add to the vegetation clearance. A lifecycle assessment must include all emissions associated with the construction of renewable energy structures, generation and transport. A life cycle assessment clearly indicates the use of carbon during infrastructure manufacturing, thus the renewable energy is not entirely carbon free.	None of the substations may be located in any of the areas mentioned in ***Zone 1: Infrastructure.***
Zone 1: Fuel storage (Phase 1) A liquid bulk storage facility with two 35 000 m³ tanks and tanker loading facilities is included. Tanker vessels will discharge into storage tanks via pipeline.	***Fuel storage (Phase 1):*** For vegetation clearance - see ***Zone 1: Infrastructure*** Fuel spills can contaminate soil or water bodies and potentially enter the groundwater which will affect plant life and aquatic systems. Volatile organic compounds, other pollutants and strong odours are emitted, reducing air quality. Inadequate management and monitoring will lead to increased risks of contamination and pollution. Flammable fuels pose a risk of fire and explosions.	The bulk fuel storage structures and loading facilities, may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** Lichens are particularly sensitive to pollution. A study needs to be conducted on the dominant movement of air from the planned port and SEZ site, to ensure that pollutants from the port and SEZ are not carried onto the Namib Lichen Fields or the Boegoeberg Twins that are also rich in lichens.
Zone 1: Internal port roads and bridges: Port Access Interchange for large volumes of heavy vehicles Port Access Control: access gateways and weighbridge Truck Offloading Area: Three offloading terminals	***Internal port roads and bridges:*** For vegetation clearance - see ***Zone 1: Infrastructure*** Roads can (i) cause habitat fragmentation and disrupt movement of wildlife; (ii) lead to soil erosion; (iii) facilitate the spread of alien invasive species; (iv) change natural water flow patterns; and (v) runoff can carry pollutants affecting water quality. Vehicle emissions degrade air quality and	The internal port roads and bridges should avoid the areas mentioned in ***Zone 1: Infrastructure*** wherever possible. A study needs to be conducted on the dominant movement of air from the planned port and SEZ site, to ensure that pollutants from the vehicle emissions are not carried onto the Namib Lichen Fields or the Boegoeberg Twins that are also rich in lichens.

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
	negatively affect lichens and some plant species. Gravel roads lead to the production of dust.	
Zone 1: External roads: In the short-term mining ore will be transported by trucks along the R382, until rail transport viability is considered and established.	***External roads:*** For vegetation clearance - see ***Zone 1: Infrastructure and Zone 1: Internal port roads.*** The R382 will have to be widened to accommodate traffic volumes. This will increase the area where vegetation is cleared.	The external port roads and bridges should avoid the areas mentioned in ***Zone 1: Infrastructure.***
Zone 2: Conservancy area: An conservancy area (ca. 1 170 ha) has been set aside based on conservation priorities such as the presence of the Boegoeberg Twins and seal colony. There is also an archaeological site *viz.* the Boegoebaai cave/ lair.	***Conservancy area:*** Air pollution from the neighbouring SEZ could negatively affect the lichens in the Conservation Area.	**The boundary of the conservation area must be revised to include the entire Boegoeberg North. The Cape fur seal colony should also be included in the Conservancy area. The CSIR will provide a new delineation of the Conservation area.** All development must avoid the Conservancy area. A study needs to be conducted on the dominant movement of air from the planned port and SEZ site, to ensure that pollutants are not carried onto the Boegoeberg Twins that are rich in lichens.
SPECIAL ECONOMIC ZONE (SEZ)		
Zones 3 – 10: Infrastructure *Any structure to be built or covering land related to the SEZ e.g.:* • Offices, warehouses, ammonia facilities, desalination plants & electrolyser; • Manufacturing infrastructure; • Gas storage facilities; • Wastewater treatment plants; • Firewater tanks; and • Lye solution purges	For vegetation clearance - see ***Zone 1: Infrastructure***	The SEZ infrastructure should avoid the areas mentioned in ***Zone 1: Infrastructure.***
Zone 3: Desalination plant: Desalination plant and associated infrastructure (including seawater intake infrastructure and discharge pipeline) Water reservoirs	***Desalination plant:*** For vegetation clearance - see ***Zone 1: Infrastructure.*** See discussion on desalination in ***Zone 1: Bulk services - water***	Desalination plants may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***
Zone 3: Electrolyser: Electrolyser will split water into hydrogen and oxygen to produce green H_2. Hydrogen and oxygen storage Lye solution purge from the GH_2 plant will be discharged with the other return streams to the sea.	**Electrolyser:** For vegetation clearance for electrolyser unit and associated infrastructure - see ***Zone 1: Infrastructure*** Electrolysers require large amounts of demineralised water to produce hydrogen; Desalination of seawater is costly and discharge of the brine is environmentally harmful; Some electrolysis processes involve the use of chemicals, which need to be managed to avoid further risks. Large areas of land are needed to generate renewable power by wind and solar for the desalination of seawater and subsequent electrolysis. The alternative would be to use small nuclear power reactors as carbon-free source, however these systems are expensive and also come with risks.	The electrolyser may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
	In many systems the lye solution can be recycled. If the lye solution is to be discharged it must be treated to neutralise its alkalinity and remove contaminants before releasing it. Hydrogen is a very light, non-toxic, flammable gas. When released into the atmosphere and it is not dispersed it will probably ignite. Because hydrogen is colourless and odourless, sensors must be appropriately positioned to detect leakages. It burns with a pale blue flame that is nearly invisible in daylight, so detection by human senses is difficult.	
Zone 3: Ammonia facility: The green ammonia facility will be located near the TNPA port and adjacent to the coast and desalination plant. ***Associated infrastructure:*** Air separation unit Liquid air energy system (LAES) for nitrogen storage Ammonia processing unit and liquid ammonia storage tank Pipelines required for hydrogen, its derivatives and by-products, and a control room Cooling tower blowdown Gasses (oxygen and small quantities of other gas) expected to be safe to vent to the atmosphere	***Ammonia facility:*** For vegetation clearance - *see* ***Zone 1: Infrastructure & Zone 3: Electrolyser*** for hazards associated with hydrogen. Positive impacts of the ammonia facility include: (i) a reduction in fossil fuel use; (ii) production of green ammonia as fertiliser without contributing to greenhouse gas emissions; (iii) ammonia is an energy carrier enabling storage and transport of renewable energy; (iv) production from GH_2 produces less harmful pollutants than traditional ammonia production. Negative impacts of the ammonia facility include: (i) electrolysis and ammonia production require substantial energy from renewable resources; (ii) large areas of land are used to generate renewable energy by wind and solar; (iii) large amounts of water are needed for electrolysis; (iv) ammonia is toxic and poses risks during handling and transportation; (v) strict safety measure to prevent leaks and accidents are essential. Ammonia is a hazardous substance and leaks can cause air pollution and can pose serious health risks. Ammonia can contaminate groundwater. Although the production of ammonia using renewable energy is cleaner that using fossil fuel, a lifecycle assessment must include all emissions associated with the construction of renewable energy infrastructure, generation and transport. Cooling tower blowdown may contain dissolved solids (minerals) that accumulate due to evaporation. Proper treatment of blowdown prior to release is thus essential. Ammonia can contaminate the soil, although it would act as fertiliser to plants.	The ammonia facility and associated infrastructure may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** It is essential to monitor the atmospheric emissions around the ammonia facility. A study needs to be conducted on the dominant movement of air from the planned SEZ, to ensure that pollutants from the SEZ are not carried onto the Namib Lichen Fields or the Boegoeberg Twins that are also rich in lichens.
Zone 3: Firewater: Firewater will be stored in firewater tanks. There is an opportunity to combine firewater and desalinated water storage on site. Seawater will be used as backup source when stored firewater is not adequate.	***Firewater:*** Firewater (i) runoff can introduce pollutants into the soil and water bodies and could potentially disrupt habitats; (ii) if firefighting foams are used, toxic substances can persist in the environment; (iii) when using seawater, the discharge will have a high salinity and increased pollutant load; and (iv) intake of seawater can harm marine life by impingement and entrainment.	Firewater infrastructure may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.*** The location of the point of seawater intake needs to be carefully selected – see Marine Ecology report.
Zone 4 – 6: Industrial Park The Industrial Park will be designated for	For vegetation clearance for the Industrial Park - see ***Zone 1: Infrastructure***	The Industrial Park may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***

PORT INFRASTRUCTURE ASPECT / SEZ SUBZONE	POTENTIAL IMPACT	RECEIVING ENVIRONMENT OF CONCERN
mixed-use purposes; a manufacturing cluster; logistics; warehousing; and offices. It will also include a desalination plant, pump station, supply pipelines, feeder pipelines.	See discussion on desalination in ***Zone 1: Bulk services - water***	
Zone 7. Future GH_2 facility: *Replication of Green Ammonia Facilities*	***See Zone 3: Ammonia facility***	The future GH_2 facility may not be located in any areas mentioned in ***Zone 1: Infrastructure.***
Zone 8. Future GH_2 facility: *Replication of Green Ammonia Facilities*	***See Zone 3: Ammonia facility***	The future GH_2 facility may not be located in any areas mentioned in ***Zone 1: Infrastructure.***
Zone 9. Future GH2 facility: *Replication of Green Ammonia Facilities*	***See Zone 3: Ammonia facility***	The future GH_2 facility may not be located in any areas mentioned in ***Zone 1: Infrastructure.***
Zone 10. Future tank storage: Proposed area of approximately 1 704 ha inland of the R382 road.	***See Zone 1: Fuel storage***	The bulk fuel storage structures and loading facilities, may not be located in any of the areas mentioned in ***Zone 1: Infrastructure.***

7. CONCLUSIONS AND RECOMMENDATIONS

The potential benefits of the Boegoebaai development must be evaluated against the irreversible loss of plant and vegetation diversity and ecosystem services. The current high-level evaluation of the botanical component demonstrated a **Very High** sensitivity and consequently the proposed development requires a cautious approach with a strong emphasis on the conservation of botanical diversity. Mitigation measures cannot eliminate irreversible losses of critical habitats and species and in such instances avoidance will be the only option. Therefore, the proposed development will need to revisit alternative sites where impacts on the receiving environment have lower sensitivities.

The Boegoebaai Port and SEZ site is located in the Desert and Succulent Karoo Biomes. Compared to other deserts with the same level of aridity globally, the Desert Biome in South Africa is exceptionally rich in plant species and also hosts a large number of endemic plant species. The Succulent Karoo Biome is recognised as one of the IUCN global hotspots of biodiversity and one of only two global hotspots that are entirely arid. To qualify as a hotspot, the area must contain a high level of species diversity, a high percentage of endemic species and a substantial number of species that are threatened. Due to the high levels of biodiversity in both the Succulent Karoo and Desert vegetation, the proposed Boegoebaai Port and SEZ site encompasses many features of **High** or **Very High** sensitivity.

The provisional checklist for the Boegoebaai Port and SEZ site contains 390 plant species that have been confirmed occurring on site. The confirmed on-site checklist includes eight plant species with a Critically Endangered IUCN status, nine plant species classified as Endangered, 15 as Vulnerable, seven as Near Threatened, six as Data Deficient and one as Rare. Thus, in total 46 species on site could be classified as SCC, representing 11.8% of all species on site. It is likely that this provisional checklist is not yet complete since the mined area to the west of the R382 has been poorly surveyed by plant collectors because of the historically restricted access to the area.

The receiving environment in the proposed Boegoebaai Port and SEZ site hosts many features that indicate priority habitat for biodiversity conservation, such as:

- Two **Critically Endangered ecosystems**, the Richtersveld Coastal Duneveld and the Namib Seashore Vegetation;
- Large areas classified as **irreplaceable CBA 1s** or as **optimal CBA 2s** (2016 Northern Cape CBA map);
- Habitat for **Critically Endangered plant species**;
- Portions included in the **National Protected Area Expansion Strategy** (NPAES);
- Inclusion into an internationally recognised Key **Biodiversity Area** (KBA); and
- The **Critically Endangered Namib Lichen Fields**, *ca* 13 km north of the site, is a small unique ecosystem at risk of collapse due to high rates of habitat loss in the past. Lichens are extremely sensitive to air pollution and sand movement. Care must be taken that the proposed development does not negatively impact this ecosystem.

On the positive side, the level of infestation by alien invasive plant species in the proposed Boegoebaai Port and SEZ is low. A large proportion of the site was previously mined and the vegetation in these areas is transformed (modified habitat *sensu* IFC). Furthermore, mine-induced sand plumes cover large sections of land. These transformed habitats could be used for development provided that areas of priority habitat are not negatively impacted by the development.

A broad-scale, high-level, on-site reconnaissance and evaluation of the vegetation was conducted. The field assessment relied heavily on the expert knowledge of a Richtersveld botanical specialist, and was supported by available data. A small number of surveys were done during the reconnaissance visit. These data were classified and nine plant communities identified, described and a broad-scale vegetation map produced.

From a vegetation ecology and flora perspective the major source of impacts of the proposed Boegoebaai Port and SEZ development will result directly or indirectly from vegetation clearance which will lead to habitat loss and transformation and loss of the priority diversity features mentioned above.

The ToR for the vegetation and flora component of the SEA required the ground-truthing of the environmental sensitivities indicated by the Screening Tool. Although the Screening Tool rated the sensitivity of the Plant Theme as Medium, the current assessment recorded 46 SCC on site and an upscaling of the Plant Theme to **Very High** is recommended. The Screening Tool rated the sensitivity of the Relative Terrestrial Biodiversity Theme as **Very High**. The current assessment supported a **Very High** sensitivity for most of the site. Although the plant community that was previously mined was located within the area mapped as a Critically Endangered ecosystem (Richtersveld Coastal Duneveld), it was classified as transformed in the current assessment and could be used for development.

The available information used to produce the sensitivity maps for the current assessment of the Boegoebaai SEA is at a coarse scale. The sensitivity ratings were applied per plant community and relied on the presence of various features within a plant community. The screening level sensitivity maps in this report therefore need to be improved over time when major revisions of the underlying data (e.g. national vegetation types, threatened ecosystems, CBA maps, NPAES or other fine-scale conservation planning products) are produced or when detailed studies of the site become available. **Considering the large areas with a Very High sensitivity rating, it would be prudent to conduct an in-depth, fine-scale analysis of the vegetation to produce a detailed vegetation map of the entire area as soon as possible, rather than conducting multiple EIAs at different levels of detail over a long period of time. Such a map will significantly contribute towards planning the layout of the port and SEZ and could potentially avoid placing footprints in areas that could possibly not receive Environmental Authorization.**

It is recommended that such detailed, fine-scale vegetation and sensitivity maps are used for planning purposes. During the planning phase, areas of **Very High** sensitivity should be avoided, and as far as possible areas of **High** sensitivity should also be avoided. Residual impacts on irreplaceable biodiversity cannot be offset since that would prevent national biodiversity targets from being met. Avoidance would in the first place imply revisiting the alternative site options. For possible alternative sites, consult Botha & Desmet (2022) or the presentation given by TNPA (meeting 10 October 2024), where a site approximately 18 km north of Port Nolloth was identified (p. 6) (https://www.csir.co.za/sites/default/files/Documents/Appendix%20C_Overview%20of%20Boegoebaai%20Site%20Selection%20process.pdf). Although offset options are not applicable to impacts of Very High sensitivity, offsets may be required for impacts of High or Medium sensitivity. Should offsets be required, biodiversity offset studies have to be conducted.

Should the proposed development proceed, it is strongly recommended to establish all planned infrastructure in the already transformed mining landscapes, west of the tar road, **provided adjacent areas of priority habitat are not negatively impacted by the development.** Transformed areas within the Namib Seashore Vegetation type should preferably be avoided, since this a very small Critically Endangered vegetation type. The impacts of such a large development, such as the Boegoebaai Port and SEZ, will generally not be limited to the site but will be more widespread and land adjoining the site will likely also be affected. Neighbouring areas could thus be targeted by plant poaching as a result of increased human activities due to the development.

Because hyper-arid areas are very difficult to rehabilitate successfully, a major risk would be that the site is not adequately rehabilitated to a functioning system and a degraded, vulnerable and disturbed ecosystem is left behind.

Practical recommendations for future EIA studies:

All EIA studies must adhere to the following legislation and guidelines, as relevant at the time of the assessments:

- National Environmental Management Act (NEMA) (Act No 107, 1998): NEMA requires that measures are taken to "prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development." The disturbance of ecosystems and loss of

biological diversity should be avoided, or where they cannot be altogether avoided, are minimised and remedied.

- The National Environmental Management: Biodiversity Act (NEMBA) (Act 10 of 2004) (NEM:BA, 2004) provides for listing of endangered, threatened and otherwise controlled species (ToPS) and threatened or protected ecosystems.
- The National Protected Area Expansion Strategy falls under NEMBA and is South Africa's national strategy for expansion of the protected area network (NPAES, 2018).
- The National Biodiversity Assessment is the primary tool for monitoring and reporting on the state of biodiversity in South Africa. It is used to inform policies, strategies and actions in a range of sectors for managing and conserving biodiversity more effectively.
- The reports have to be prepared in terms of the Environmental Impact Assessment (EIA) Regulations under the National Environmental Management Act (Act No. 107 of 1998) (NEMA 2014, 2017) and the gazetted *Procedures for the assessment and minimum requirements for reporting on identified environmental themes in terms of Sections 24(5) (a) and (h) and 44 of the National Environmental Management Act, 1998,* when applying for environmental authorisation, specifically the *'Protocol for the Specialist Assessment and Minimum Report Content Requirements of Environmental Impacts on Terrestrial Biodiversity' (GG 43110 / GN R320, 20 March 2020; NEMA, 2020a and Government Gazette 43855, GN R1150, 30 October 2020; NEMA, 2020b).* Guidance for the implementation of the above-mentioned protocols must be followed according to SANBI (2020, as amended).

It is recommended that the specialist studies should provide:

- A description of the biodiversity at ecosystem level including (i) main vegetation types and environmental determinants; (ii) CBAs, ESAs and 'reasons' for CBA mapping; (iii) threatened ecosystems; (iv) NPAES Focus Areas; and (v) NFEPA Priority Catchments, rivers, wetlands and estuaries within the site.
- A fine-scale map of plant communities/habitats, wetlands, rivers and estuaries that occur on site.
- A description of the plant communities/habitats, including environmental features, common species and SCC.
- A fine-scale 4-tier sensitivity map with criteria for allocating units to the different sensitivity classes.
- A description of species biodiversity including (i) distribution of threatened fauna and flora; (ii) if possible, viability and estimated population size of threatened species; and (iii) the likelihood of other SCC occurring.
- If possible, the potential impact of the development on SCC in terms of the likely reduction in population size and viability.
- A description of other noteworthy landscape features such as (i) rocky outcrops; (ii) seasonal wetlands; (iii) quartz patches; (iv) lichen fields; (v) salt marshes; (vi) rare or important vegetation.
- An assessment of the level of alien invasive plant infestation.
- An assessment of site condition based on current or previous land uses.
- A description of biodiversity patterns and processes and the potential impacts of the proposed development and related activities on these patterns and processes.
- Recommendations to prevent, mitigate or restore disturbed vegetation, aquatic features, or ecological processes. Mitigation measures from the specialist studies are to be incorporated into the EMPr.
- Evidence of how the layout of the development incorporated biodiversity considerations.
- A list of all relevant legislation, permits and standards that would apply to the development.
- If applicable, list additional studies that should be conducted to avoid/ameliorate impacts to sensitive features.

- Recommendations on monitoring.

Recommendations to enhance positive impacts and reduce negative impacts

Rehabilitation: Rehabilitation aims to ensure the long-term stability of soils, landforms and hydrology required to establish and sustain a natural ecosystem that supports the approved future land use. Rehabilitation also aims to partially or fully repair the capacity of ecosystems to provide habitats for biota and services for people. Hyper-arid areas such as the Richtersveld are very difficult to rehabilitate successfully. A rehabilitation specialist, with expertise in the rehabilitation and ecological restoration along the West Coast of South Africa (e.g. Nurture, Restore, Innovate), should be consulted to advise on the possibilities of rehabilitating and potentially even restoring the vegetation. The rehabilitation specialist should be able to advise on setting rehabilitation targets and objectives and which locally occurring species of different functional types could be used in rehabilitation. Other topics to include in the rehabilitation recommendations are (i) landscaping; (ii) soil properties to consider; (iii) availability of topsoil and the presence of a seed bank; (iv) water erosion; (v) wind erosion; and (vi) whether the use of restoration packs or transplanting would be feasible (Desmet, 1996; De Villiers *et al.,* 2004; Carrick, 2022). The rehabilitation process should be initiated as soon as possible after an area has been disturbed. This can be done immediately after the construction phase of the Boegoebaai development has been completed, except if old mining scars are to be rehabilitated.

Sand stabilisation: Sand stabilisation should be addressed by biological, chemical or mechanical means or the use of geotextiles. The aim of the sand stabilisation would be to prevent sand from reaching priority habitat to the north of of the proposed development.

Monitoring requirements: The monitoring protocol must be developed during the EIA phase. (i) Populations of key plant SCC, that could potentially be impacted by the proposed development, should be monitored throughout construction and operation to ensure that these SCC are not negatively impacted by the development or being poached. Should negative impacts due to the development be identified, they must be mitigated.

Monitoring frequency will depend on the phenology and life cycle of the particular species. The rehabilitation progress should be monitored annually. A monitoring program for the early detection of alien invasive plant species should also be implemented and a control program to combat declared alien invasive plant species must be employed.

8. REFERENCES AND BIBLIOGRAPHY

Acocks, J.P.H. 1953. Veld types of South Africa. *Memoirs of the Botanical Survey of South Africa* 28: 1–130.

Adamson, R.S. 1938. *The vegetation of South Africa*. Monographs of the British Empire Vegetation. London: British Empire Vegetation Committee.

Alexkor EMP, 2008. Revised Environmental Management Programme. Prepared by Site Plan Consulting.

Botha, M. 2025. Strategic Environmental Assessment: Boegoebaai Port & SEZ, Biodiversity Offset Perspectives. Report to CSIR by Conservation Strategy Tactics & Insight.

Botha, M. & Desmet, P. 2022. *Boegoebaai Port & Namakwa Satellite SEZ Biodiversity Offset Strategic Perspective*. Report to NCEDA by Conservation Strategy Tactics & Insight.

Broennimann, O., Thuiller, W., Hughes, G., Midgley, G.F., Alkemade, J.R. & Guisan, A. 2006. Do geographic distribution, niche property and life form explain plants' vulnerability to global change? *Global Change Biology* 12:1079–1093.

Carrick, P.J., Botha, M.S. & Krüger, R. 2022. *Ecological restoration in Namaqualand: a practical guide. (Ekologiese restourasie in Namaqualand: 'n praktiese gids.)* Cape Town: Nurture, Restore, Innovate.

De Villiers, A.J., Van Rooyen, M.W. & Theron, G.K. 2004. The restoration of Strandveld Succulent Karoo degraded by mining: an enumeration of topsoil seed banks. *South African Journal of Botany* 70: 717–725.

Council for Geoscience. 2011. Geological Map 2816 Alexander Bay. Pretoria: Government Printer.

Cowling, R.M., Esler, K.J. & Rundel, P.W. 1999. Namaqualand, South Africa – an overview of an unique winter-rainfall desert ecosystem. *Plant Ecology* 142: 3–21.

Cowling, R.M. & Hilton-Taylor, C. 1999. Plant biogeography, endemism and diversity. Pp 42–56. In: Dean, W.R.J. & Milton, S.J. (Eds). *The Karoo, ecological patterns and processes.* Cambridge: Cambridge University Press.

CEPF (Critical Ecosystem Partnership Fund). 2003, *Ecosystem Profile: The Succulent Karoo hotspot*, Namibia and South Africa, Critical Ecosystem Partnership Fund report.

Davis, C.L., Hoffman, M.T. & Roberts, W. 2016. Recent trends in the climate of Namaqualand, a megadiverse arid region of South Africa. *South African Journal of Science* 112: Art. 2015–0217, 9 pp.

Department of Forestry, Fisheries and the Environment. 2023. National Environmental Management Act, 1998 (Act No. 107 of 1998). The National Biodiversity Offset Guideline. *Government Gazette No.* 48841, Government Notice No. 3569. 23 June 2023.

Desmet, P.G. & Cowling, R.M. 1999. Biodiversity, habitat and range-size aspects of a flora from a winter-rainfall desert in north-western Namaqualand, South Africa. *Plant Ecology* 142: 23–33.

Desmet, P.G. 1996. *The vegetation and restoration potential of the vegetation of the arid coastal belt between Port Nolloth and Alexander Bay, Namaqualand, South Africa.* MSc dissertation. Cape Town: University of Cape Town.

Desmet, P.G. 2007. Namaqualand—A brief overview of the physical and floristic environment. *Journal of Arid Environments* 70: 570–587.

Driver, A., Sink, K.J., Nel, J.L., Holness, S.H., Van Niekerk, L., Daniels, F., Jonas, Z., Majiedt, P.A., Harris, L. & Maze, K. 2012. National Biodiversity Assessment 2011: An assessment of South Africa's biodiversity and ecosystems. Synthesis report. Pretoria: SANBI & DEA.

Du Plessis, H.M. (Ed.) 1987. Land Types of the maps: 2816 Alexander Bay; 2818 Warmbad; 2916 Springbok; 2918 Pofadder; 3017 Garies; 3018 Loeriesfontein. *Memoirs on the Agricultural Natural Resources of South Africa* 9. Pretoria: Soil and Irrigation Research Institute.

EWT (Endangered Wildlife Trust). 2023. *Best Practice Guidelines for Implementing the Mitigation Hierarchy in South Africa*. Endangered Wildlife Trust

Francis, M.L., Palcsu, L., Molnár, M., Kertész, T., Clarke, C.E., Miller, J.A. & Van Gend, J. 2024. Calcareous termite mounds in South Africa are ancient carbon reservoirs. *Science of the Total Environment* 926: DOI:10.1016/j.scitotenv.2024.171760.

Gottlieb, T.R., Eckardt, F.D., Venter, Z.S. & Cramer, M.D. 2019. The contribution of fog to water and nutrient supply to *Arthraerua leubnitziae* in the central Namib Desert, Namibia. *Journal of Arid Environments* 161:35–46.

Hoffman, M.T., Rohde, R. & Gillson, L. 2019. Rethinking catastrophe? Historical trajectories and modelled future vegetation change in southern Africa. *Anthropocene* 25. *https://doi.org/10.1016/j.ancene.2018.12.003.*

IFC PS6. 2019. *International Finance Corporation's Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources*. International Finance Corporation. World Bank Group. ww.ifc.org/ps6.

IUCN. 2021. *IUCN Red List Categories*. Prepared by the IUCN Species Survival Commission. Gland: Switzerland.

Jürgens, N. 1991. A new approach to the Namib Region: Phytogeographic subdivision. *Vegetatio* 97: 21–38.

Jürgens, N., Burke, A., Seeley, M.K. & Jacobsen, 1997. Desert. In: Cowling, R.M., Richardson, D.M. & Pierce, S.M. (eds). *Vegetation of southern Africa* pp. 189-214. Cambridge: Cambridge University Press.

Jürgens, N., Burke, A., Van Wyk, P., Gröngröft, A. & Oldeland, J. in press. A perfect storm: Unprecedented expansion of the Namib Desert and cascading desertification processes in the northernmost Succulent Karoo (Richtersveld, South Africa, Namibia). https://ssrn.com/abstract=5189871 or http://dx.doi.org/10.2139/ssrn.5189871

Jürgens, N. & Niebel, A. 1991. The unknown lichen hill. *Journal of the Botanical Society of South Africa* 77: 24–26.

Jürgens, N. & Niebel-Lohmann, A. 1995. Geobotanical observations on lichen fields of the Southern Namib Desert. *Mitteilungen aus dem Institut für Allgemeine Botanik in Hamburg* 25, 135–156.

KBA. 2024. Key Biodiversity Areas factsheet: Namaqualand Sandveld North. Extracted from the World Database of Key Biodiversity Areas. Key Biodiversity Areas Partnership. https://keybiodiversityareas.org<.

Land Type Survey Staff, 1986. Land Type Map 2816 Alexander Bay.

Le Maitre, D., O'Farrell, P., Milton, S., Atkinson, D., De Lange, W., Egoh, B., Reyers, B., Colvin, C., Maherry, A. & Blignaut, J. 2009. *Assessment and Evaluation of Ecosystem Services in the Succulent Karoo Biome.* Report 27 prepared by CSIR for the Succulent Karoo Ecosystem Programme (SKEP) Coordination Unit, SANBI.

Lebrun, J. 1947. *La végétation de la plaine alluviale au sud du lac Édouard.* Exploration du Parc National Albert. Inst. Parcs National de Congo Belge, Bruxelles, Nat. Congo Belge, Bruxelles, Fasc. 1: 1–800.

Low, A. & Rebelo, A. 1998. *Vegetation of South Africa, Lesotho and Swaziland*. Pretoria: Department of Environmental Affairs & Tourism.

Marloth, R. 1908. *Das Kapland insonderheit das Reich der Kapflora, das Waltgebiet und die Karoo, pflanzengeographisch dargestellt.* Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition, Waldivia 1898–1899. Jena: Fischer.

McAuliffe, J.R., Hoffman, M.T., McFadden, L.D., Jack, S., Bell, W. & King, M.P. 2019. Whether or not heuweltjies: Context-dependent ecosystem engineering by the southern harvester termite, *Microhodotermes viator*. *Journal of Arid Environments* 163: 26-33.

MDT 2018. Boegoebaai Environmental Screening Report.

Midgley, G.F., Rutherford, M.C., Bond, W.J. & Barnard, P. 2001. The heat is on – impacts of climate change on plant diversity in South Africa. Pretoria: South African National Botanical Institute.

Midgley, G.F. & Thuiller, W. 2007. Potential vulnerability of Namaqualand plant diversity to anthropogenic climate change. *Journal of Arid Environments* 70: 615–628.

Milton, S.J., Zimmermann, H.G. & Hoffmann, J.H. 1999. Alien plant invaders of the Karoo: attributes, impacts and control. In: Dean, W.R.J. & Milton, S.J. (Eds). *The Karoo: Ecological Patterns and Processes.* Cambridge University Press.

Mittermeier, R.A., Myers, N., Robles, G.P. & Mittermeier, C.G. 2000. *Hotspots: Earth's biologically richest and most endangered terrestrial ecoregions*, CEMEX, Mexico.

Monod, T. 1957. *Les grands divisions chorologiques de I' Afrique*. London: C.C.T.A./C/S/A Publication 24.

Mucina, L. & Rutherford, M.C. (Eds). 2006. Vegetation of South Africa, Swaziland and Lesotho. *Strelitzia* 19. Pretoria: South African National Biodiversity Institute (SANBI).

Myers, N., Mittermeier, R.A., Mittermeier, C.G., De Fonseca, G.A.B. & Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 402: 853–858.

Nash, T.H. 2008. Lichen Biology. 2nd Edition, Cambridge: Cambridge University Press.

National Environmental Management: Biodiversity Act (10/2004). 2022: Revised national list of ecosystems that are threatened and in need of protection (Government Gazette No. 47526 – Government Notice No. 2747).

NCNCA. 2009. *Northern Cape Nature Conservation Act (Act No. 9 of 2009).* Provincial Gazette Extraordinary, Vol 17, No. 1374, Kimberley: 21 January 2010.

NEMA. 2014. Environmental Impact Assessment Regulations*,* 2014. National Environmental Management Act (Act No. 107 of 1998). *Government Gazette* Vol. 594, No. 38282 of 4 December 2014. Government Notice R. 982 and Listings Notices R. 983, R. 984 & R.985.

NEMA. 2017. Amendments to the Environmental Impact Assessment Regulations, 2014. Listing Notices GRN 324, 325, 326 & 327. *Government Gazette* No. 40772, 7 April 2017. Department of Environmental Affairs, Pretoria.

NEMA. 2020a. Procedures for the assessment and minimum criteria for reporting on identified environmental themes in terms of Sections 24(5)(a) and (h) and 44 of the NEMA 1998, when applying for Environmental Authorisation. *Government Gazette* 43110, No 320, 20 March 2020.

NEMA. 2020b. Procedures for the assessment and minimum criteria for reporting on identified environmental themes in terms of Sections 24(5)(a) and (h) and 44 of the NEMA 1998, when applying for Environmental Authorisation. *Government Gazette* 43855, No. 1150, 30 October 2020.

NEM:BA. 2004. *National Environmental Management: Biodiversity Act (Act No. 10 of 2004).* Pretoria: Government Printer.

NPAES. 2018. *National Protected Area Expansion Strategy for South Africa*. DFFE.

NFA. 2024. The publication of the annual list of all tree species which are protected under Section 12 of the National Forest Act, 1998 (Act No. 84 of 1998). *Government Gazette No.* 50291, Government Notice No. 4496. 13 March 2024. Pretoria: Government Printer.

Olivier, J. 2002. Fog-water harvesting along the West Coast of South Africa: a feasibility study. *Water SA* 28: 349–360.

Oosthuysen, E. & Geldenhuys, L. 2024. *Northern Cape Biodiversity Spatial Plan: Technical Report.* Springbok: Northern Cape Department of Agriculture, Environmental Affairs, Rural Development and Land Reform.

Pole Evans, I.B. 1936. A vegetation map of South Africa. *Memoirs of the Botanical Survey of South Africa* 15: 1–23.

Pool-Stanvliet, R., Duffel-Canham, A., Pence, G. & Swart, R. 2017. *Western Cape Biodiversity Spatial Plan Handbook.* Stellenbosch: CapeNature.

Roberts, D.L., Botha, G.A., Maud, R.R. & Pether, J., 2006, Coastal Cenozoic deposits. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J., eds., *The geology of South Africa.* Johannesburg: Geological Society of South Africa, pp. 605–628.

Rutherford, M.C., Midgley, G.F., Bond, W.J., Powrie, L.W., Roberts, R.& Allsopp, J. 2000. Plant biodiversity: Vulnerability and adaptation assessment. In: Kiker G, (Ed.). *Climate change impacts in southern Africa*. Report to the National Climate Change Committee. Pretoria: Department of Environment Affairs and Tourism.

SANBI (2012-2024). *The Vegetation Map of South Africa, Lesotho and Swaziland*, Mucina, L., Rutherford, M.C. & Powrie, L.W. (Eds), Online, http://bgis.sanbi.org/Projects/Detail/186, Version 2024.

SANBI. 2018. *Using CBA Maps to support land-use planning and decision-making*. SANBI Factsheet Series. Pretoria: South African National Biodiversity Institute.

SANBI 2020. *Species Environmental Assessment Guideline.* Guideline for the implementation of the Terrestrial Fauna and Terrestrial Flora Species Protocols for Environmental Impact Assessments in South Africa. Pretoria: SANBI.

SANBI. 2024. Red List of South African Plants version 2024.1. Accessed on 2024/11/22.

Schreiner, G., Mqokeli, B., Snyman-van der Walt, L., Lochner, P., Louw, H., Modise, S., Ruthenavelu, M., Zukulu, Y. & Maluleke, J. 2024. Strategic Environmental Assessment for the proposed Boegoebaai Port, SEZ and Namakwa Region: Briefing note for research partners. Note produced by CSIR, NCEDA and TNPA.

Screening Tool. 2024. Screening Report for an Environmental Authorization as required by the 2014 EIA Regulations – Proposed Site Environmental Sensitivity. Department of Forestry, Fisheries and the Environment.

Skowno, A.L., Poole, C.J., Raimondo, D.C., Sink, K.J., Van Deventer, H., Van Niekerk, L., Harris, L.R., Smith-Adao, L.B., Tolley, K.A., Zengeya, T.A., Foden, W.B., Midgley, G.F. & Driver, A. 2019. *National Biodiversity Assessment 2018: The status of South Africa's ecosystems and biodiversity. Synthesis Report*. Pretoria: South Africa. 214 pp.

Swart, E. & Geldenhuys, L. 2020. Preliminary Report: Environmental concerns associated with the proposed Boegoebaai Harbour and refinery developments. Internal departmental report No. 4/2020. Confidential.

Todd, S. 2011. Ecological and Biodiversity Assessment: Terrestrial vertebrate fauna and botanical Specialist Study. Report to G7 Renewable Energies for Richtersveld Wind Farm.

Transnet National Ports Authority, 2024. Boegoebaai Port and Rail Development Site Selection.

Van Wilgen, B.W., Reyers, B., Le Maitre, D.C., Richardson, D.M. & Schonegevel, L. 2008. A biome-scale assessment of the impact of invasive alien plants on ecosystem services in South Africa. *Journal of Environmental Management* 89: 336 –349.

Van Wyk, A.E. & Smith, G.F. 1998. *Regions of Floristic Endemism in southern Africa*. Pretoria: Umdaus Press.

Van Wyk, P. 2024. *Boegoebaai Strategic Environmental Assessment; Report 1; exploring the floral richness of the Boegoebaai Port development site and surrounding areas, Richtersveld Municipal Area, Western Gariep Desert, Northern Cape, South Africa.* Report to CSIR.

Volk, O.H. 1966. Die Florengebiete von Südwestafrika. *J.S.W.A. Wissenschaftliche Gesellschaft* 20: 25–58.

Walker, C., Milton, S.J., O'Connor, T.G., Maguire, J.M. & Dean, W.R.J. 2018. Drivers and trajectories of social and ecological change in the Karoo, South Africa. *African Journal of Range and Forage Science* 35:157–177.

Werger, M.J.A. 1978. The Karoo-Namib Region. In: Werger, M.J.A. (Ed.) *Biogeography and Ecology of southern Africa.* The Hague: Junk. pp. 231–299.

White, F. 1983. *The vegetation of Africa. A descriptive memoir to accompany the* UNESCO/AETFAT/UNSO vegetation map of Africa. Paris: UNESCO.

Young, A.J., Guo, D., Desmet, P.G. & Midgley, G.F. 2016. Biodiversity and climate change: Risks to dwarf succulents in Southern Africa. *Journal of Arid Environments* 129: 16–24.

Appendix A: Provisional checklist of plant species in the Boegoebaai Port and SEZ site and close environs

National criteria for allocation the IUCN status given to those SCC confirmed on site are given below the table.
**Plant names provided in Desmet (1996) could not be confirmed as occurring on site.
***NCNCA (Northern Cape Nature Conservation Act) Protected and Specially Protected species.

Species are colour coded according to their IUCN status listed in the Threatened Species Programme of SANBI (marked with #) or SANBI (2024).

Family	Species	IUCN#	**Study area combined**	Study area P van Wyk	2024 Site visit	Study area iNaturalist	SANBI: NewPOSA	Van Wyk: Larger area	Desmet (1996)**		NCNCA ***	CITES	ToPS-listed species	Alien invasive species
Acanthaceae	*Justicia crassiuscula*	VU	x				x							
Acanthaceae	*Justicia incana*	LC	x				x							
Aizoaceae	*Aizoon africanum*	LC	x				x				x			
Aizoaceae	*Aizoon collinum*	LC							x		x			
Aizoaceae	*Aizoon crystalinum*	LC	x	x	x		x	x	x		x			
Aizoaceae	*Aizoon fruticosum*	LC	x	x			x	x			x			
Aizoaceae	*Aizoon pruinosum*	LC	x	x	x			x			x			
Aizoaceae	*Aizoon sarcophyllum*	LC	x	x	x			x			x			
Aizoaceae	*Aizoon squamulosum*	LC							x		x			
Aizoaceae	*Amphibolia rupis-arcuatae*	LC	x	x	x	x	x	x	x		x			
Aizoaceae	*Amphibolia succulenta*	NT	x	x	x		x	x			x			
Aizoaceae	*Antimima buchubergensis*	-						x			x			
Aizoaceae	*Antimima maleolens*	LC							x		x			
Aizoaceae	*Antimima paripetala*	LC	x	x		x	x		x		x			
Aizoaceae	*Antimima perforata*	-	x	x	x			x	x		x			
Aizoaceae	*Antimima* sp. nov.	-	x	x	x				x		x			
Aizoaceae	*Antimima cf. varians*	LC	x		x						x			
Aizoaceae	*Astridia lutata = Astridia velutina*	DDD						x			x			
Aizoaceae	*Cephalophyllum ebracteatum*	VU	x	x	x	x	x	x	x		x			
Aizoaceae	*Cephalophyllum rigidum*	LC	x	x	x	x					x			
Aizoaceae	*Cheiridopsis brownii*	EN						x			x			
Aizoaceae	*Cheiridopsis robusta*	LC	x	x	x	x		x	x		x			
Aizoaceae	*Cheiridopsis verrucosa*	CR						x	x		x			
Aizoaceae	*Conicosia elongata*	LC	x	x	x			x	x		x			
Aizoaceae	*Conicosia pugioniformis* subsp. *alborosea*	LC	x	x				x			x			
Aizoaceae	*Conophytum saxetanum*	EN	x	x	x	x		x	x		x	iii		
Aizoaceae	*Dicrocaulon spissum*	LC					x				x			
Aizoaceae	*Dracophilus dealbatus*	CR				x		x	x		x			
Aizoaceae	*Drosanthemum curtophyllum*	LC	x	x					x		x			
Aizoaceae	*Drosanthemum hispidum*	LC	x	x							x			
Aizoaceae	*Drosanthemum inornatum*	LC	x	x	x			x			x			
Aizoaceae	*Drosanthemum luederitzii*	LC	x	x	x	x	x				x			
Aizoaceae	*Drosanthemum salicola*	LC						x			x			
Aizoaceae	*Eberlanzia cyathiformis*	LC	x	x	x				x		x			
Aizoaceae	*Eberlanzia ebracteata*	LC							x		x			
Aizoaceae	*Eberlanzia sedoides*	LC	x	x	x	x		x			x			
Aizoaceae	*Enarganthe octonaria*	EN						x			x			
Aizoaceae	*Fenestraria rhopalophylla* subsp. *aurantiaca*	LC	x	x	x	x	x	x	x		x			
Aizoaceae	*Jordaaniella clavifolia*	VU	x	x	x						x			
Aizoaceae	*Jordaaniella cuprea*	LC	x	x	x	x	x	x	x		x			
Aizoaceae	*Jordaaniella spongiosa*	LC	x	x	x	x		x	x		x			
Aizoaceae	*Jordaaniella uniflora*	EN	x	x				x			x			
Aizoaceae	*Juttadinteria deserticola*	CR						x	x		x			
Aizoaceae	*Lampranthus godmaniae*	LC						x			x			
Aizoaceae	*Lampranthus hoerleinianus*	LC							x		x			
Aizoaceae	*Lampranthus otzenianus*	LC	x	x	x	x		x			x			
Aizoaceae	*Lampranthus stipulaceus*	LC	x	x	x		x				x			
Aizoaceae	*Leipoldtia frutescens*	VU					x				x			

Family	Species	IUCN#	**Study area combined**	Study area P van Wyk	2024 Site visit	Study area iNaturalist	SANBI: NewPOSA	Van Wyk: Larger area	Desmet (1996)**		NCNCA ***	CITES	ToPS-listed species	Alien invasive species
Aizoaceae	*Leipoldtia uniflora*	LC	x	x		x		x	x		x			
Aizoaceae	*Lithops herrei*	VU				x		x	x		x			
Aizoaceae	*Malephora purpureo-crocea*	LC				x					x			
Aizoaceae	*Mesembryanthemum barklyi*	LC	x	x	x	x		x	x		x			
Aizoaceae	*Mesembryanthemum brevicarpum*	LC	x	x				x			x			
Aizoaceae	*Mesembryanthemum cf. coriarium*	LC	x		x						x			
Aizoaceae	*Mesembryanthemum crystallinum*	LC	x	x	x	x			x		x			
Aizoaceae	*Mesembryanthemum deciduum*	LC	x	x				x			x			
Aizoaceae	*Mesembryanthemum dinteri*	LC	x	x	x	x	x	x	x		x			
Aizoaceae	*Mesembryanthemum guerichianum*	LC						x			x			
Aizoaceae	*Mesembryanthemum hypertrophicum*	LC	x	x	x			x	x		x			
Aizoaceae	*Mesembryanthemum marlothii*	LC	x	x	x			x	x		x			
Aizoaceae	*Mesembryanthemum noctiflorum*	LC	x	x	x			x	x		x			
Aizoaceae	*Mesembryanthemum occidentale*	EN						x			x			
Aizoaceae	*Mesembryanthemum oculatum*	LC	x	x	x			x	x		x			
Aizoaceae	*Mesembryanthemum pseudoschlichtianum*	LC	x	x				x			x			
Aizoaceae	*Mesembryanthemum quartziticola*	LC	x	x					x		x			
Aizoaceae	*Mesembryanthemum schlichtianum = M. arenosum = Brownanthus arenosus*	LC	x	x	x			x	x		x			
Aizoaceae	*Mesembryanthemum serotinum*	LC	x	x				x			x			
Aizoaceae	*Mesembryanthemum spinuliferum*	LC							x		x			
Aizoaceae	*Mesembryanthemum subnodosum*	LC	x	x	x				x		x			
Aizoaceae	*Mesembryanthemum tetragonum*	LC	x	x										
Aizoaceae	*Meyerophytum meyeri*	LC				x			x		x			
Aizoaceae	*Psammophora modesta*	VU						x	x		x			
Aizoaceae	*Ruschia crassa*	LC					x				x			
Aizoaceae	*Ruschia fugitans*	DDT	x	x				x	x		x			
Aizoaceae	*Ruschia pallens*	LC	x	x	x	x		x			x			
Aizoaceae	*Ruschia pollardii*	-	x	x		x					x			
Aizoaceae	*Ruschia senaria*	LC						x			x			
Aizoaceae	*Ruschia* sp. 1 (possibly new)	-	x	x							x			
Aizoaceae	*Ruschia* sp. 2	-	x	x	x						x			
Aizoaceae	*Ruschia cf. variabilis*	-	x	x										
Aizoaceae	*Ruschia cf. viridifolia*	LC	x		x						x			
Aizoaceae	*Schlechteranthus diutinus*	LC					x				x			
Aizoaceae	*Schlechteranthus holgatensis*	VU	x	x		x		x			x			
Aizoaceae	*Stoeberia beetzii*	LC	x	x	x	x		x	x		x			
Aizoaceae	*Stoeberia frutescens*	LC	x	x	x	x		x			x			
Aizoaceae	*Stoeberia gigas*	CR						x	x		x			
Aizoaceae	*Stoeberia utilis*	LC	x	x	x	x	x	x	x		x			
Aizoaceae	*Tetragonia echinata*	LC	x	x	x			x			x			
Aizoaceae	*Tetragonia fruticosa*	LC	x	x			x	x	x		x			
Aizoaceae	*Tetragonia glauca*	LC	x				x				x			
Aizoaceae	*Tetragonia microptera*	LC							x		x			
Aizoaceae	*Tetragonia namaquensis*	LC	x				x				x			
Aizoaceae	*Tetragonia robusta*	LC							x		x			
Amaranthaceae	*Atriplex cinerea* subsp. *bolusii*	NE							x					
Amaranthaceae	*Atriplex eardleyae*	NE							x					
Amaranthaceae	*Atriplex lindleyi* subsp. *inflata*	NE							x					1b
Amaranthaceae	*Atriplex vestita* var. *appendiculata*	NE	x	x	x		x	x						
Amaranthaceae	*Atriplex vestita* var. *inappendiculata*	NE					x							
Amaranthaceae	*Bassia dinteri*	CR	x				x	x						
Amaranthaceae	*Chenopodiastrum murale = Chenopodium murale*	NE	x	x				x						
Amaranthaceae	*Manochlamys albicans*	LC	x	x	x			x						
Amaranthaceae	*Salsola angolensis*	LC	x				x							
Amaranthaceae	*Salsola aphylla (= Caroxylon aphyllum)*	LC	x	x			x							
Amaranthaceae	*Salsola merxmuelleri*	DDD	x				x							
Amaranthaceae	*Salsola nollothensis*	LC	x	x	x		x		x					

Family	Species	IUCN#	**Study area combined**	Study area P van Wyk	2024 Site visit	Study area iNaturalist	SANBI: NewPOSA	Van Wyk: Larger area	Desmet (1996)**		NCNCA ***	CITES	ToPS-listed species	Alien invasive species
Amaranthaceae	*Salsola* sp.	-	x	x				x						
Amaranthaceae	*Salsola zeyheri = Caroxylon zeyeri*	LC	x	x			x	x	x					
Amaranthaceae	*Sarcocornia natalensis* var. *affinis*	LC	x	x	x			x						
Amaranthaceae	*Sarcocornia pillansii*	LC	x				x							
Amaranthaceae	*Suaeda fruticosa*	LC							x					
Amaranthaceae	*Suaeda plumosa*	?	x	x				x						
Amaryllidaceae	*Ammocharis longifolia*	LC						x			x			
Amaryllidaceae	*Boophone* sp.	-							x		x			
Amaryllidaceae	*Gethyllis grandiflora*	LC	x	x		x			x		x			
Amaryllidaceae	*Gethyllis linearis*	LC	x	x				x			x			
Amaryllidaceae	*Gethyllis* sp.	-	x		x						x			
Amaryllidaceae	*Haemanthus pubescens* subsp. *arenicola*	EN							x		x			
Amaryllidaceae	*Strumaria bidentata*	CR						x	x		x			
Anacampserotaceae	*Anacampseros albissima*	LC					x		x		x	ii		
Anacampserotaceae	*Anacampseros filamentosa* ssp. *namaquensis = A. namaquensis*	LC	x	x	x	x		x			x	ii		
Anacampserotaceae	*Anacampseros cf. gariepensis*	CR	x		x			x			x	ii		
Anacampserotaceae	*Anacampseros retusa*	LC	x	x		x		x			x	ii		
Anacardiaceae	*Searsia longispina*	LC	x	x	x			x						
Anacardiaceae	*Searsia undulata*	LC				x			x					
Apiaceae	*Anginon* sp.	-	x		x						x			
Apiaceae	*Capnophyllum leiocarpon*	LC	x	x				x			x			
Apiaceae	*Cynorhiza typica*	LC	x	x	x	x			x		x			
Apiaceae	*Dasispermum hispidum*	LC	x	x	x			x			x			
Apiaceae	*Dasispermum tenue*	LC							x		x			
Apiaceae	*Deverra denudata* subsp. *aphylla*	LC	x	x			x	x	x		x			
Apocynaceae	*Ceropegia herrei = Huernia namaquensis*	LC				x	x		x		x			
Apocynaceae	*Ceropegia marlothii = Larryleachia marlothii*	NT					x	x	x		x			
Apocynaceae	*Ceropegia pachyrrhiza*	LC						x	x		x			
Apocynaceae	*Ceropegia pulvinata = Stapelia pulvinata*	-	x	x										
Apocynaceae	*Cynanchum meyeri*	VU						x			x			
Apocynaceae	*Cynanchum viminale* subsp. *thunbergii*	LC						x			x			
Apocynaceae	*Ectadium virgatum*	NT						x			x			
Apocynaceae	*Gomphocarpus fruticosus*	LC						x			x			
Apocynaceae	*Microloma sagittatum*	LC	x	x		x		x	x		x			
Apocynaceae	*Quaqua armata* subsp. *maritima*	LC	x	x			x		x		x			
Apocynaceae	*Quaqua inversa = Ceropegia inversa*	LC	x	x							x			
Apocynaceae	*Quaqua parviflora* subsp. *parviflora*	LC	x		x			x			x			
Apocynaceae	*Rhyssolobium dumosum*	EN						x	x		x			
Apocynaceae	*Stapelia hirsuta* var. *gariepensis*	CR						x			x			
Apocynaceae	*Stapelia similis*	LC						x			x			
Apocynaceae	*Tridentea pachyrrhiza*	LC	x	x	x	x					x			
Asparagaceae	*Asparagus acocksii*	LC							x					
Asparagaceae	*Asparagus asparagoides*	LC							x					
Asparagaceae	*Asparagus capensis*	LC	x	x	x	x	x	x	x					
Asparagaceae	*Asparagus declinatus*	LC	x	x				x						
Asparagaceae	*Asparagus exuvialis*	LC	x	x				x						
Asparagaceae	*Asparagus fasciculatus*	LC							x					
Asparagaceae	*Asparagus graniticus*	LC	x	x	x			x						
Asparagaceae	*Asparagus juniperoides*	LC	x	x	x			x	x					
Asparagaceae	*Asparagus* sp.	LC	x		x		x							
Asparagaceae	*Asparagus retrofractus*	LC							x					
Asparagaceae	*Asparagus undulatus*	LC	x	x	x			x	x					
Asphodelaceae	*Aloe arenicola*	EN	x	x				x	x		x	ii		
Asphodelaceae	*Aloe framesii*	NT	x	x	x	x			x		x	ii		
Asphodelaceae	*Aloe gariepensis*	VU						x			x	ii		
Asphodelaceae	*Aloe krapholiana*	LC						x			x	ii	prot	
Asphodelaceae	*Aloe microstigma*	LC									x	ii		
Asphodelaceae	*Aloidendron ramosissimum*	EN						x			x			

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Asphodelaceae	*Bulbine abyssinica*	LC	x	x	x			x			x			
Asphodelaceae	*Bulbine* aff. *succulenta*	-							x		x			
Asphodelaceae	*Bulbine frutescens*	LC				x			x		x			
Asphodelaceae	Sensitive species 1110	EN	x	x				x			x			
Asphodelaceae	Sensitive species 407	EN	x	x				x			x			
Asphodelaceae	*Bulbine sedifolia*	LC				x								
Asphodelaceae	*Chlorophytum* sp.	-							x		x			
Asphodelaceae	*Chlorophytum viscosum*	LC	x	x	x			x			x			
Asphodelaceae	*Trachyandra bulbinifolia*	LC	x	x	x			x			x			
Asphodelaceae	*Trachyandra ciliata*	LC	x	x				x			x			
Asphodelaceae	*Trachyandra falcata*	LC	x	x	x	x		x	x		x			
Asteraceae	*Amellus epaleaceus*	LC							x					
Asteraceae	*Amellus flosculosus*	LC							x					
Asteraceae	*Amellus microglossus*	LC							x					
Asteraceae	*Amellus nanus*	LC	x	x			x	x						
Asteraceae	*Amellus tenuifolius*	LC	x	x					x					
Asteraceae	*Arctotheca calendula*	LC						x						
Asteraceae	*Arctotis canaliculata*	-	x	x	x	x								
Asteraceae	*Arctotis decurrens*	DDT							x					
Asteraceae	*Arctotis diffusa*	LC							x					
Asteraceae	*Arctotis fastuosa*	LC	x	x		x		x						
Asteraceae	*Arctotis hirsuta*	LC							x					
Asteraceae	*Arctotis* sp. nov.	-	x	x	x			x						
Asteraceae	*Arctotis stoechadifolia*	LC	x			x								
Asteraceae	*Berkheya fruticosa*	LC				x			x					
Asteraceae	*Chrysocoma ciliata*	LC	x	x				x						
Asteraceae	*Chrysocoma microphylla*	LC	x			x								
Asteraceae	*Cotula anthemoides*	LC	x	x										
Asteraceae	*Cotula coronopifolia*	LC	x		x									
Asteraceae	*Crassothonna clavifolia*	EN						x	x			iii		
Asteraceae	*Crassothonna cylindrica*	LC	x	x	x	x	x	x	x					
Asteraceae	*Crassothonna opima*	CR							x					
Asteraceae	*Crassothonna sedifolia*	LC	x	x	x	x	x	x	x					
Asteraceae	*Crassothonna sparsiflora*	-	x	x										
Asteraceae	*Curio citriformis*	DDT							x					
Asteraceae	*Curio corymbifer = Senecio sarcoides*	LC	x	x		x	x	x						
Asteraceae	*Curio crassulifolius*	DDT	x	x	x			x						
Asteraceae	*Curio pinguifolius = Kleinia pinguifolia*	DDT							x					
Asteraceae	*Curio radicans*	LC	x	x	x			x	x					
Asteraceae	*Curio sulcicalyx*	DDT	x	x	x			x						
Asteraceae	*Didelta carnosa* var. *tomentosa*	LC	x	x	x	x	x	x	x					
Asteraceae	*Dimorphotheca polyptera*	LC	x	x				x						
Asteraceae	*Dimorphotheca sinuata*	LC	x	x				x						
Asteraceae	*Eriocephalus brevifolius*	LC	x	x				x	x					
Asteraceae	*Eriocephalus racemosus*	LC							x					
Asteraceae	*Felicia microsperma*	LC	x	x				x						
Asteraceae	*Felicia muricata*	LC						x						
Asteraceae	*Felicia namaquana*	LC	x	x				x						
Asteraceae	*Felicia* sp.	-	x	x	x									
Asteraceae	*Foveolina dichotoma*	LC	x	x	x			x	x					
Asteraceae	*Gazania* aff. *heterochaeta*	-							x					
Asteraceae	*Gazania lichtensteinii*	LC						x	x					
Asteraceae	*Gazania schenckii*	CR	x	x	x	x	x	x	x					
Asteraceae	*Gazania tenuifolia*	LC	x	x				x	x					
Asteraceae	*Gorteria diffusa* var. *diffusa*	LC						x						
Asteraceae	*Helichrysum* aff. *oxybelium /asperum*	-							x					
Asteraceae	*Helichrysum dunense*	VU	x	x			x	x						
Asteraceae	*Helichrysum gariepinum*	LC						x						
Asteraceae	*Helichrysum hebelepis*	LC	x	x				x						

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Asteraceae	*Helichrysum herniarioides*	LC	x	x	x			x						
Asteraceae	*Helichrysum leontonyx*	LC	x	x				x						
Asteraceae	*Helichrysum marmarolepis*	LC	x	x			x	x	x					
Asteraceae	*Helichrysum micropoides*	LC	x				x		x					
Asteraceae	*Helichrysum obtusum*	LC	x	x			x	x						
Asteraceae	*Helichrysum pumilio* subsp. *pumilio*	LC							x					
Asteraceae	*Ifloga lerouxiae*	Rare	x		x									
Asteraceae	*Lasiospermum brachyglossum*	LC	x				x							
Asteraceae	*Myxopappus acutilobus*	LC	x	x										
Asteraceae	*Oncosiphon grandiflorum*	LC	x	x				x	x					
Asteraceae	*Oncosiphon piluliferum*	LC	x		x									
Asteraceae	*Oncosiphon sabulosus*	LC				x								
Asteraceae	*Oncosiphon* sp.	-	x		x									
Asteraceae	*Oncosiphon suffruticosum*	LC	x	x				x	x					
Asteraceae	*Osteospermum incanum*	LC	x	x	x			x	x					
Asteraceae	*Osteospermum microcarpum*	LC	x	x				x	x					
Asteraceae	*Osteospermum oppositifolium*	LC	x	x	x	x		x	x					
Asteraceae	*Osteospermum polycephalum*	LC	x	x	x			x	x					
Asteraceae	*Othonna arbuscula*	LC	x				x							
Asteraceae	*Othonna bulbosa*	LC							x					
Asteraceae	*Othonna cuneata*	LC							x					
Asteraceae	*Othonna furcata*	LC	x	x	x	x		x	x					
Asteraceae	*Othonna graveolens*	LC							x					
Asteraceae	*Othonna lasiocarpa*	LC	x				x		x					
Asteraceae	*Othonna lobata*	LC	x				x							
Asteraceae	*Othonna pachypoda*	DDT	x	x		x								
Asteraceae	*Othonna perfoliata*	LC				x								
Asteraceae	*Othonna quercifolia*	LC	x	x				x						
Asteraceae	*Othonna sp.*	LC	x		x									
Asteraceae	*Othonna undulosa*	LC	x	x	x			x						
Asteraceae	*Pteronia ciliata*	LC				x								
Asteraceae	*Pteronia divaricata*	LC							x					
Asteraceae	*Pteronia glabrata*	LC	x	x	x		x	x	x					
Asteraceae	*Pteronia onobromoides*	LC	x	x				x	x					
Asteraceae	*Pteronia paniculata*	LC	x	x				x	x					
Asteraceae	*Rhynchopsidium pumilum*	LC	x	x				x						
Asteraceae	*Senecio abruptus*	LC	x	x										
Asteraceae	*Senecio aloides*	LC	x	x	x	x	x	x	x					
Asteraceae	*Senecio arenarius*	LC							x					
Asteraceae	*Senecio cardaminifolius*	LC							x					
Asteraceae	*Senecio piptocoma*	LC	x				x							
Asteraceae	*Ursinia calenduliflora*	LC							x					
Asteraceae	*Ursinia speciosa*	LC	x			x								
Boraginaceae	*Heliotropium tubulosum*	LC						x						
Boraginaceae	*Trichodesma africanum*	LC							x					
Brassicaceae	*Heliophila carnosa*	LC	x				x		x					
Brassicaceae	*Heliophila cornuta* var. *squamata*	NE	x	x				x						
Brassicaceae	*Heliophila lactea*	LC	x	x	x	x	x	x	x					
Brassicaceae	*Lepidium africanum*	LC							x					
Cactaceae	*Opuntia ficus-indica*	NE	x		x	x								1b
Campanulaceae	*Wahlenbergia androsacea*	LC	x	x				x						
Campanulaceae	*Wahlenbergia annularis*	LC	x	x			x	x						
Campanulaceae	*Wahlenbergia asparagoides*	NT	x	x				x						
Campanulaceae	*Wahlenbergia erophiloides*	-						x						
Campanulaceae	*Wahlenbergia prostrata*	LC	x	x				x						
Campanulaceae	*Wahlenbergia psammophila*	LC							x					
Caryophyllaceae	*Dianthus namaensis*	LC	x	x	x		x	x	x		x			
Caryophyllaceae	*Pollichia campestris*	LC							x					
Caryophyllaceae	*Spergularia bocconi*	LC	x	x	x	x		x						

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Caryophyllaceae	*Spergularia media*	NE	x	x	x			x						
Colchicaceae	*Colchicum albomarginatum*	LC				x					x			
Colchicaceae	*Colchicum irroratum*	LC	x	x	x			x			x			
Colchicaceae	*Hexacyrtis dickiana*	EN						x						
Colchicaceae	*Ornithoglossum dinteri*	LC	x	x				x						
Colchicaceae	*Ornithoglossum parviflorum* var. *parviflorum*	NE	x	x	x			x						
Colchicaceae	*Ornithoglossum vulgare*	LC	x	x				x	x					
Crassulaceae	*Adromischus marianiae* var. *hallii*	NE	x	x		x	x		x		x			
Crassulaceae	*Adromischus montium-klinghardtii*	VU	x	x	x	x		x	x		x			
Crassulaceae	*Cotyledon orbiculata* var. *orbiculata*	LC	x	x	x			x	x		x			
Crassulaceae	*Crassula ammophila*	NT	x	x	x	x		x			x			
Crassulaceae	*Crassula atropurpurea* var. *cultriformis*	LC	x	x	x	x	x	x	x		x			
Crassulaceae	Sensitive species 720	VU	x	x	x	x		x			x			
Crassulaceae	*Crassula columnaris*	LC				x		x	x		x			
Crassulaceae	*Crassula columnaris* subsp. *prolifera*	LC	x	x	x	x		x			x			
Crassulaceae	*Crassula corallina* subsp. *macrorrhiza*	LC						x			x			
Crassulaceae	*Crassula cotyledonis*	LC							x		x			
Crassulaceae	*Crassula deceptor*	LC	x	x		x		x	x		x			
Crassulaceae	*Crassula elegans*	LC	x	x	x	x		x	x		x			
Crassulaceae	*Crassula expansa*	LC	x		x		x	x	x		x			
Crassulaceae	*Crassula expansa* subsp. *pyrifolia*	LC	x	x				x			x			
Crassulaceae	*Crassula fusca*	NT						x			x			
Crassulaceae	*Crassula grisea*	LC	x				x	x			x			
Crassulaceae	*Crassula macowaniana*	LC							x		x			
Crassulaceae	*Crassula mesembrianthemopsis*	LC						x			x			
Crassulaceae	*Crassula muscosa* var. *muscosa*	NE	x	x		x		x			x			
Crassulaceae	*Crassula muscosa* var. *obtusifolia*	NE	x	x				x			x			
Crassulaceae	*Crassula natans*	LC	x	x							x			
Crassulaceae	*Crassula nudicaulis*	LC				x					x			
Crassulaceae	*Crassula pallens*	LC							x		x			
Crassulaceae	Sensitive species 305	CR	x	x	x	x		x	x		x			
Crassulaceae	*Crassula pseudohemisphaerica*	LC	x	x		x		x	x		x			
Crassulaceae	*Crassula rudolphii*	LC	x	x	x						x			
Crassulaceae	*Crassula sericea* var. *sericea*	NE	x		x			x			x			
Crassulaceae	*Crassula sladenii*	EN						x	x		x			
Crassulaceae	*Crassula subaphylla*	LC	x	x	x			x	x		x			
Crassulaceae	*Crassula tetragona*	LC	x	x							x			
Crassulaceae	*Crassula tomentosa* var. *tomentosa*	LC	x	x		x		x			x			
Crassulaceae	*Tylecodon buchholzianus* subsp. *fasciculatus*	DDT						x			x			
Crassulaceae	*Tylecodon decipiens*	RARE							x		x			
Crassulaceae	*Tylecodon fragilis*	EN							x		x			
Crassulaceae	*Tylecodon paniculatus*	LC	x	x	x			x	x		x			
Crassulaceae	*Tylecodon racemosus*	LC						x			x			
Crassulaceae	*Tylecodon reticulatus*	LC	x	x	x	x		x	x		x	iii		
Crassulaceae	Sensitive species 1187	VU	x	x	x	x		x	x		x			
Crassulaceae	*Tylecodon similis*	LC	x	x		x		x	x		x			
Crassulaceae	*Tylecodon wallichii* subsp. *ecklonianus*	LC	x	x	x			x			x			
Crassulaceae	*Tylecodon wallichii* subsp. *wallichii*	LC				x		x	x		x			
Curcurbitaceae	*Kedrostis psammophila*	LC	x	x	x			x	x		x			
Curcurbitaceae	*Kedrostis ramosissima*	-	x	x										
Cyperaceae	*Afroscirpoides dioeca*	LC				x								
Cyperaceae	*Cyperus marginatus*	LC	x	x										
Cyperaceae	*Isolepis marginata*	LC	x	x										
Didieriaceae	*Portulacaria fruticulosa*	LC						x				ii		
Didieriaceae	*Portulacaria pygmaea*	CR						x				iii		
Ebenaceae	*Diospyros lycioides* var. *lycioides*	LC						x						
Euphorbiaceae	*Euphorbia angrae**	LC	x	x	x						x	ii		
Euphorbiaceae	*Euphorbia burmannii*	LC	x	x	x	x			x		x	ii		
Euphorbiaceae	*Euphorbia caput-medusae*	LC	x	x	x			x	x		x	ii		

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Euphorbiaceae	*Euphorbia celata*	LC							x		x	ii		
Euphorbiaceae	*Euphorbia dregeana*	LC	x	x				x			x	ii		
Euphorbiaceae	*Euphorbia ephedroides*	LC	x		x	x	x	x	x		x	ii		
Euphorbiaceae	*Euphorbia ephedroides* var. *ephedroides*	NE	x	x				x			x	ii		
Euphorbiaceae	*Euphorbia ephedroides* var. *imminuta*	NE	x	x				x			x	ii		
Euphorbiaceae	*Euphorbia gummifera*	LC						x			x	ii		
Euphorbiaceae	*Euphorbia hamata*	LC	x	x				x			x	ii		
Euphorbiaceae	*Euphorbia mauritanica*	LC	x	x	x			x	x		x	ii		
Euphorbiaceae	*Euphorbia melanohydrata*	EN						x			x	ii		
Euphorbiaceae	*Euphorbia rhombifolia*	LC	x	x	x	x		x	x		x	ii		
Euphorbiaceae	*Euphorbia stapelioides*	LC	x	x	x	x		x	x		x	ii		
Fabaceae	*Calobota acanthoclada*	EN	x		x			x						
Fabaceae	*Calobota angustifolia*	LC	x	x					x					
Fabaceae	*Calobota cinerea*	LC	x	x				x	x					
Fabaceae	*Calobota halenbergensis*	LC	x	x	x			x						
Fabaceae	*Calobota sericea*	LC							x					
Fabaceae	*Crotalaria meyeriana*	NT	x	x	x		x	x	x					
Fabaceae	*Cullen* sp. nov.	-						x						
Fabaceae	*Indigofera exigua*	LC							x					
Fabaceae	*Lessertia candida*	LC	x	x				x	x		x			
Fabaceae	*Lessertia diffusa*	LC							x		x			
Fabaceae	*Lessertia frutescens* subsp. *frutescens*	LC	x	x	x	x		x			x			
Fabaceae	*Lotononis strigillosa*	NT						x						
Fabaceae	*Lotonotis falcata*	LC	x	x				x	x					
Fabaceae	*Medicago polymorpha*	NE							x					
Fabaceae	*Melolobium adenodes*	LC	x	x	x	x		x						
Frankeniaceae	*Frankenia pomonensis*	-	x	x										
Frankeniaceae	*Frankenia pulverulenta*	LC	x	x			x	x						
Geraniaceae	*Monsonia ciliata*	LC	x	x										
Geraniaceae	*Monsonia crassicaulis*	LC							x					
Geraniaceae	*Monsonia flavescens*	VU	x					x						
Geraniaceae	*Monsonia luederitziana*	LC	x	x				x						
Geraniaceae	*Monsonia multifida*	CR						x	x			ii		
Geraniaceae	*Monsonia patersonii*	VU	x	x	x	x	x	x	x			ii		
Geraniaceae	*Monsonia salmoniflora*	LC	x	x										
Geraniaceae	Sensitive species 734	VU	x	x	x	x								
Geraniaceae	*Pelargonium albersii*	CR						x						
Geraniaceae	*Pelargonium carnosum*	LC				x		x	x					
Geraniaceae	*Pelargonium carnosum = Pelargonium parviflorum*	LC	x	x		x								
Geraniaceae	*Pelargonium ceratophyllum*	LC							x					
Geraniaceae	*Pelargonium crithmifolium*	LC				x			x					
Geraniaceae	*Pelargonium echinatum*	LC	x	x		x		x	x					
Geraniaceae	*Pelargonium fulgidum*	LC	x	x	x	x	x	x	x					
Geraniaceae	*Pelargonium grandicalcaratum*	LC	x	x	x	x			x					
Geraniaceae	*Pelargonium klinghardtense*	LC						x						
Geraniaceae	*Pelargonium minimum*	LC	x	x	x			x						
Geraniaceae	*Pelargonium moniliforme*	LC	x	x				x						
Geraniaceae	*Pelargonium sibthorpiifolium*	CR	x	x				x	x					
Geraniaceae	*Pelargonium* sp. nov.	-	x	x	x			x						
Hyacinthaceae	*Albuca acuminata*	LC	x				x							
Hyacinthaceae	*Albuca canadensis*	LC	x	x					x					
Hyacinthaceae	*Albuca cooperi*	LC	x	x	x			x						
Hyacinthaceae	*Albuca flaccida*	LC	x	x				x						
Hyacinthaceae	*Albuca grandis*	LC	x	x	x			x						
Hyacinthaceae	*Albuca hallii*	LC	x			x		x						
Hyacinthaceae	*Albuca maxima*	LC	x	x										
Hyacinthaceae	*Albuca sabulosa*	LC						x						
Hyacinthaceae	*Albuca* sp. nov.	-	x	x					x					

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Hyacinthaceae	*Albuca suaveolens*	LC	x	x	x			x						
Hyacinthaceae	*Dipcadi cf. crispum*	LC	x	x			x	x						
Hyacinthaceae	*Drimia barbata*	CR	x	x	x	x		x						
Hyacinthaceae	*Drimia elata*	LC	x	x				x						
Hyacinthaceae	*Drimia occultans*	-	x	x	x			x						
Hyacinthaceae	*Drimia physodes*	LC						x						
Hyacinthaceae	*Lachenalia anguinea*	LC	x	x				x			x			
Hyacinthaceae	*Lachenalia buchubergensis*	LC						x			x			
Hyacinthaceae	*Lachenalia klinghardtiana*	CR	x	x	x	x	x	x	x		x			
Hyacinthaceae	*Lachenalia punctata*	LC	x		x	x					x			
Hyacinthaceae	*Lachenalia xerophila*	LC	x	x										
Hyacinthaceae	*Ledebouria undulata*	LC	x	x				x						
Hyacinthaceae	*Massonia sessiliflora*	LC						x						
Hyacinthaceae	*Massonia* sp.	-							x					
Hyacinthaceae	*Ornithogalum deltoideum*	LC						x			x			
Hyacinthaceae	*Ornithogalum falcatum*	-	x	x				x			x			
Hyacinthaceae	*Ornithogalum xanthochlorum*	LC							x		x			
Hyacinthaceae	*Trachyandra falcata*	LC	x	x		x								
Hyacinthaceae	*Veltheimia capensis*	LC	x	x	x			x	x		x			
Hydnoraceae	*Hydnora africana*	LC	x	x				x						
Hydnoraceae	*Hydnora triceps*	LC						x						
Iridaceae	*Babiana hirsuta*	LC	x	x	x		x	x	x		x			
Iridaceae	Sensitive species 827	VU	x	x					x		x			
Iridaceae	*Ferraria divaricata*	LC							x		x			
Iridaceae	*Ferraria schaeferi*	LC	x	x	x			x	x		x			
Iridaceae	*Ferraria variabilis*	LC	x	x	x			x			x			
Iridaceae	*Gladiolus orchidiflorus*	LC							x		x			
Iridaceae	*Gladiolus saccatus*	LC	x	x	x	x		x			x			
Iridaceae	*Gladiolus viridiflorus*	LC	x	x		x		x	x		x			
Iridaceae	*Lapeirousia arenicola*	LC	x	x				x			x			
Iridaceae	*Lapeirousia barklyi*	EN	x	x			x		x		x			
Iridaceae	*Lapeirousia macrospatha*	VU	x	x			x	x			x			
Iridaceae	*Moraea fugax*	LC							x		x			
Iridaceae	Sensitive species 293	EN	x	x	x			x			x			
Juncaceae	*Juncus acutus subsp. leopoldtii*	LC	x	x										
Juncaceae	*Juncus* sp.	-	x		x									
Kewaceae	*Hypertelis spergulacea*	LC						x						
Kewaceae	*Kewa angrae-pequenae*	LC	x	x	x				x					
Kewaceae	*Kewa salsoloides*	LC	x	x	x			x	x					
Labiatae	*Salvia aurea = Salvia africana-lutea*	LC	x	x				x						
Labiatae	*Salvia lanceolata*	LC							x					
Limeaceae	*Limeum africanum*	LC							x					
Limeaceae	*Limeum fenestratum*	LC	x	x				x						
Loranthaceae	*Septulina glauca*	LC	x	x				x						
Malvaceae	*Hermannia cf. cuneifolia*	LC	x		x									
Malvaceae	*Hermannia gariepina*	LC						x						
Malvaceae	*Hermannia heterophylla*	LC							x					
Malvaceae	*Hermannia macra*	LC	x	x				x						
Malvaceae	*Hermannia paucifolia*	LC	x	x				x						
Malvaceae	*Hermannia pfeilii*	LC	x	x				x	x					
Malvaceae	*Hermannia* sp. nov.	-	x	x				x						
Malvaceae	*Hermannia trifurca*	LC							x					
Malvaceae	*Lavatera arborea*	NE	x	x				x						
Malvaceae	*Malva* cf. *parviflora*	-	x		x									
Malvaceae	*Radyera urens*	LC	x	x				x						
Menispermaceae	*Antizoma miersiana*	LC	x	x				x						
Molluginaceae	*Adenogramma glomerata*	LC	x	x				x						
Molluginaceae	*Coelanthum semiquinquefidum*	LC	x	x				x						
Molluginaceae	*Pharnaceum albens*	LC	x				x							

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Molluginaceae	*Pharnaceum confertum* var. *brachyphyllum*	LC							x					
Molluginaceae	*Pharnaceum croceum*	LC	x	x	x				x					
Molluginaceae	*Pharnaceum exiguum*	LC	x	x					x					
Molluginaceae	*Pharnaceum lanatum*	LC	x				x		x					
Molluginaceae	*Pharnaceum microphyllum* var. *microphyllum*	LC	x	x			x	x	x					
Neuradaceae	*Grielum grandiflorum*	LC	x	x	x	x	x	x	x					
Neuradaceae	*Grielum humifusum*	LC	x	x	x	x		x						
Neuradaceae	*Grielum humifusum* var. *humifusum*	LC					x	x	x					
Neuradaceae	*Grielum humifusum* var. *parviflorum*	LC	x				x		x					
Ophioglossaceae	*Ophioglossum polyphyllum*	LC	x	x	x			x			x			
Orchidaceae	*Holothrix* cf. *schlechteriana* (possibly new sp.)	-	x	x							x			
Orchidaceae	*Holothrix filicornis*	LC	x	x							x			
Orchidaceae	*Holothrix grandiflora*	DDD	x			x					x	ii		
Orobanchaceae	*Harveya squamosa*	LC	x	x							x			
Orobanchaceae	*Hyobanche sanguinea*	LC	x	x				x	x		x			
Oxalidaceae	*Oxalis bullulata*	LC	x	x	x	x		x			x			
Oxalidaceae	*Oxalis copiosa*	LC	x	x		x		x			x			
Oxalidaceae	*Oxalis inconspicua*	LC	x		x	x					x			
Oxalidaceae	*Oxalis psammophila*	LC	x	x				x			x			
Oxalidaceae	*Oxalis pulchella*	LC					x				x			
Oxalidaceae	*Oxalis sonderiana*	LC	x	x										
Plumbaginaceae	*Limonium dregeanum*	LC							x					
Plumbaginaceae	*Limonium dyeri*	-	x	x	x			x						
Plumbaginaceae	*Limonium scabrum*	LC	x				x							
Plumbaginaceae	*Limonium* sp.	-	x		x									
Poaceae	*Centropodia glauca*	LC	x	x				x	x					
Poaceae	*Chaetobromus involucratus* subsp. *dregeanus*	LC	x	x	x									
Poaceae	*Chaetobromus involucratus* subsp. *involucratus*	LC						x	x					
Poaceae	*Chaetobromus involucratus* subsp. *sericeus*	LC	x				x							
Poaceae	*Cladoraphis cyperoides*	LC	x	x	x			x	x					
Poaceae	*Cladorapis spinosa*	LC	x	x				x						
Poaceae	*Cynodon dactylon*	LC	x	x	x			x						
Poaceae	*Dregeochloa pumila*	CR	x	x	x	x	x	x	x					
Poaceae	*Ehrharta brevifolia* var. *cuspidata*	LC							x					
Poaceae	*Ehrharta cf. calycina*	LC	x		x				x					
Poaceae	*Ehrharta cf. delicatula*	LC	x		x		x		x					
Poaceae	*Ehrharta* sp.	-	x		x									
Poaceae	*Enneapogon scaber*	LC	x	x				x						
Poaceae	*Hordeum geniculatum*	NE							x					
Poaceae	*Odyssea paucinervis*	LC	x	x	x									
Poaceae	*Phragmites australis*	LC	x	x	x				x					
Poaceae	*Schismus schismoides*	LC	x	x	x			x	x					
Poaceae	*Schmidtia kalahariensis*	LC							x					
Poaceae	*Stipagrostis ciliata*	LC						x	x					
Poaceae	*Stipagrostis ciliata* var. *capensis*	LC	x	x				x						
Poaceae	*Stipagrostis dregeana*	LC	x				x		x					
Poaceae	*Stipagrostis geminifolia*	CR						x	x					
Poaceae	*Stipagrostis lutescens*	LC						x	x					
Poaceae	*Stipagrostis obtusa*	LC	x	x			x	x	x					
Poaceae	*Stipagrostis schaeferi*	-	x	x				x						
Poaceae	*Stipagrostis subacaulis*	LC						x	x					
Polygalaceae	*Polygala leptophylla*	LC	x	x				x						
Polygalaceae	*Polygala mossii*	NT	x	x				x	x					
Rhamnaceae	*Ziziphus mucronata*	LC	x	x				x						
Rubiaceae	*Anthospermum dregei*	LC	x	x			x	x						
Rubiaceae	*Anthospermum spathulatum* subsp. *spathulatum*	LC	x	x				x						
Rubiaceae	*Kohautia caespitosa* subsp. *brachyloba*	LC						x						
Rubiaceae	*Kohautia cynanchica*	LC							x					

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Rubiaceae	*Kohautia ramosissima*	-	x	x				x						
Ruscaceae	*Eriospermum currorii = Eriospermum rautanenii*	-						x						
Ruscaceae	*Eriospermum namaquanum*	LC	x	x				x						
Ruscaceae	*Eriospermum* sp. (possible new)	-						x						
Santalaceae	*Thesium elatius*	LC							x					
Santalaceae	*Thesium lacinulatum*	LC						x						
Scrophulariaceae	*Aptosimum viscosum*	LC	x	x				x						
Scrophulariaceae	*Dischisma leptostachyum*	NT	x				x							
Scrophulariaceae	*Dischisma spicatum*	LC	x	x				x	x					
Scrophulariaceae	*Hebenstretia cordata*	LC							x					
Scrophulariaceae	*Hebenstretia integrifolia*	LC	x	x										
Scrophulariaceae	*Hebenstretia parviflora*	LC	x	x		x		x	x					
Scrophulariaceae	*Hebenstretia repens*	LC	x	x					x					
Scrophulariaceae	*Hebenstretia robusta*	LC	x	x	x	x			x					
Scrophulariaceae	*Jamesbrittenia fruticosa*	LC	x	x	x	x	x	x	x		x			
Scrophulariaceae	*Jamesbrittenia maxii*	LC									x			
Scrophulariaceae	*Jamesbrittenia merxmuelleri*	LC	x	x		x		x	x		x			
Scrophulariaceae	*Lyperia tristis*	LC	x	x	x			x	x					
Scrophulariaceae	*Manulea altissima*	LC	x	x				x			x			
Scrophulariaceae	*Manulea androsacea*	LC	x	x			x	x	x		x			
Scrophulariaceae	*Manulea aridicola*	VU							x		x			
Scrophulariaceae	*Manulea minuscula*	LC	x	x				x	x		x			
Scrophulariaceae	*Nemesia anisocarpa*	LC							x		x			
Scrophulariaceae	*Nemesia arenifera*	LC	x	x			x	x			x			
Scrophulariaceae	*Nemesia bicornis*	LC	x	x				x	x		x			
Scrophulariaceae	*Nemesia saccata*	VU	x	x			x	x			x			
Scrophulariaceae	*Nemesia viscosa*	LC							x		x			
Scrophulariaceae	*Peliostomum virgatum*	LC	x	x				x	x					
Scrophulariaceae	*Phyllopodium hispidulum*	EN	x	x				x			x			
Scrophulariaceae	*Phyllopodium namaense*	VU	x	x				x			x			
Scrophulariaceae	*Phyllopodium pumilum*	LC							x		x			
Scrophulariaceae	*Selago angustibractea*	LC	x	x										
Scrophulariaceae	*Selago centralis*	LC						x						
Scrophulariaceae	*Selago* cf. *dinteri*	LC	x		x									
Scrophulariaceae	*Selago namaquensis*	LC	x	x										
Scrophulariaceae	*Selago pinguicula*	LC							x					
Scrophulariaceae	*Zaluzianskya affinis*	LC	x	x	x	x		x	x					
Scrophulariaceae	*Zaluzianskya benthamiana*	LC	x	x	x			x	x					
Solanaceae	*Lycium bosciifolium*	LC	x	x				x						
Solanaceae	*Lycium cinereum*	LC							x					
Solanaceae	*Lycium decumbens*	-	x	x				x	x					
Solanaceae	*Lycium ferocissimum*	LC	x	x				x	x					
Solanaceae	*Lycium horridum*	LC				x								
Solanaceae	*Lycium tetrandrum*	LC	x	x	x	x	x	x						
Solanaceae	*Lycium villosum*	LC						x						
Solanaceae	*Nicotiana glauca*	NE	x			x								1b
Solanaceae	*Solanum burchellii*	LC	x	x				x						
Tecophilaeaceae	*Cyanella ramosissima*	VU						x	x		x			
Thymelaeaceae	*Gnidia* sp.	-							x					
Thymelaeaceae	*Lasiosiphon microphyllus =Gnidia suavissima*	LC	x	x				x						
Urticaceae	*Forsskaolea candida*	LC				x								
Zygophyllaceae	*Augea capensis*	LC						x	x					
Zygophyllaceae	*Roepera cordifolia*	LC	x	x	x	x	x	x	x					
Zygophyllaceae	*Roepera fusiforma*	?	x	x				x						
Zygophyllaceae	*Roepera morgsana*	LC	x	x	x		x	x	x					
ophyllaceae	*Roepera sp. nov.*	-	x	x										
Zygophyllaceae	*Tetraena clavata*	LC	x	x	x	x	x	x	x					
Zygophyllaceae	*Tetraena microcarpa*	LC						x						
Zygophyllaceae	*Tetraena patenticaula*	?	x	x	x			x						

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Zygophyllaceae	*Tetraena prismatocarpa*	LC	x				x	x	x					
Zygophyllaceae	*Tetraena simplex*	LC	x			x								
Zygophyllaceae	*Tetraena stapffii*	LC				x								

National criteria for allocation of the IUCN status given to those Species of Conservation Concern that were confirmed on site

Species	IUCN	National Criteria
Bassia dinteri	CR	B1ab(i,ii,iii,iv,v)
Anacampseros cf. gariepensis	CR	A3bc+4abc
Gazania schenckii	CR	C2a(i)
Sensitive species 305	CR	A3ce+4ace
Pelargonium sibthorpiifolium	CR	B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)
Drimia barbata	CR	A3ce+4ace
Lachenalia klinghardtiana	CR	A3c+4ac
Dregeochloa pumila	CR	A2ac+4ac
Conophytum saxetanum	EN	A4c
Jordaaniella uniflora	EN	B2ab(iii,v)
Aloe arenicola	EN	A2acd; B2ab(iii,v)
Sensitive species 1110	EN	A4ac; B1ab(iii,v)+2ab(iii,v)
Sensitive species 407	EN	A2ac
Calobota acanthoclada	EN	A4ac; B1ab(iii,v)+2ab(iii,v)
Lapeirousia barklyi	EN	A3c+4ac
Sensitive species 293	EN	B1ab(iii)+2b(iii)
Phyllopodium hispidulum	EN	B1ab(iii,v)+2ab(iii,v)
Justicia crassiuscula	VU	B1ab(iii,v)
Cephalophyllum ebracteatum	VU	A3ce+4ace
Jordaaniella clavifolia	VU	D2
Schlechteranthus holgatensis	VU	D1+2
Helichrysum dunense	VU	B1ab(ii,iii,v)
Adromischus montium-klinghardtii	VU	B1ab(iii,v)+2ab(iii,v)
Sensitive species 720	VU	B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)
Sensitive species 1187	VU	B1ab(iii,v)+2ab(iii,v)
Monsonia flavescens	VU	B1ab(i,ii,iii,iv,v)
Monsonia patersonii	VU	A4acde
Sensitive species 734	VU	B1ab(ii,iii,iv,v)
Sensitive species 827	VU	B1ab(ii,iii,v)+2ab(ii,iii,v)
Lapeirousia macrospatha	VU	A4c
Nemesia saccata	VU	B1ab(iii,v)
Phyllopodium namaense	VU	B1ab(iii,v)+2ab(iii,v)
Amphibolia succulenta	NT	B1ab(iii,v)+2ab(iii,v)
Aloe framesii	NT	A2ac+4ac; B2ab(i,ii,iii,iv,v)
Wahlenbergia asparagoides	NT	B1b(ii,iii)
Crotalaria meyeriana	NT	B1ab(iii,v)+2ab(iii,v)
Polygala mossii	NT	B1ab(iii,v)+2ab(iii,v)
Crassula ammophila	NT#	B1ab(ii,iii)
Dischisma leptostachyum	NT#	B1ab(ii,iii,iv,v)
Ifloga lerouxiae	Rare	-
Salsola merxmuelleri	DDD	-
Holothrix grandiflora	DDD#	-
Ruschia fugitans	DDT#	-
Curio crassulifolius	DDT#	-
Curio sulcicalyx	DDT#	-
Othonna pachypoda	DDT#	-

Lower taxa recorded on site

Acarospora gypsi-deserti
Acarospora luederitzensis
Acarospora ochrophaea
Arthothelium desertorum
Buellia follmannii
Buellia halonia
Buellia incrustans
Buellia inturgescens
Buellia procellarum
Buellia sipmanii
Buellia stellulata
Caloplaca bonae-spei
Caloplaca cinnabarina
Caloplaca elegantissima
Caloplaca gyalectoides
Caloplaca namibensis
Caloplaca renatae
Caloplaca rubelliana
Chrysothrix granulosa
Combea mollusca
Dimelaena radiata
Diploschistes actinostomus
Dploicia canescens
Ramalina melanothrix
Ramalina sp.
Ramalina sp.
Roccella montagnei
Santessonia hereroensis
Santessonia lagunebergii
Santessonia namibensis
Staurothele dendritica
Teloschistes capensis
Teloschistes chrysocarpoides
Teloschistes chrysophthalmus
Teloschistes puber
Tephromela austrolitoralis
Tephromela nashi
Toninia australis
Tornabea scutellifera
Flavoparmelia soredians
Gloeocapsa sp.
Grimmia laevigata
Heterodermia namaquana
Lecanographa subcaesioides
Lecanora panis-erucae
Lecanora sphaerospora
Lecanora substylosa
Lecidea sarcogynoides
Lecidella crystallina
Lecidella placodina
Niebla cephalota
Opegrapha culmigena
Parmotrema perlatum
Parmotrema reticulatum
Pertusaria pseudomelanospora
Pertusaria velata
Peterjamesia circumscripta
Placidium squamulosum
Polytrichum sp.
Ramalina angulosa
Ramalina canariensis
Ramalina fimbriata
Tortula atrovirens
Trentepohlia sp.
Xanthodactylon flammeum
Xanthodactylon inflatum
Xanthodactylon turbinatum
Xanthoparmelia arrecta
Xanthoparmelia dregeana
Xanthoparmelia equalis
Xanthoparmelia hottentotta
Xanthoparmelia hueana
Xanthoparmelia incomposita
Xanthoparmelia namibiensis
Xanthoparmelia tentaculina
Xanthoparmelia walteri
Xanthoria sipmanii

Appendix B: Synoptic table of broad-scale plant communities in the Boegoebaai Port and SEZ site

Numbers used in table:
1 indicates the species occurs in 1-20% of all sample plots in the (sub)community;
2 indicates the species occurs in 21-40% of all sample plots in the (sub)community;
3 indicates the species occurs in 41-60% of all sample plots in the (sub)community;
4 indicates the species occurs in 61-80% of all sample plots in the (sub)community;
5 indicates the species occurs in 81-100% of all sample plots in the (sub)community

Plant community/subcommunity		1a	1b	2	3	4	5	6a	6b	7	8	9
Species Group 1												
Sensitive species 1187	VU	4										
Sensitive species 720	VU	3						2				
Adromischus montium-klinghardtii	VU	2								3		
Cotyledon orbiculata var. *orbiculata*		2										
Albuca sp. nov.		2										
Crassula columnaris subsp. *prolifera*		3										
Crassula sericea		2										
Crassula atropurpurea var. *cultriformis*		3										
Euphorbia stapelioides		2										
Crassula muscosa		2								3		
Tetraena pterocaulis		2									3	
Drimia barbata	CR	1										
Crotalaria meyeriana	NT	1										
Calobota acanthoclada	EN	1										
Anacampseros cf. *gariepensis*	CR	1										
Curio sulcicalyx	DDT	1										
Crassula ammophila	NT	1						1				
Curio crassifolius	DDT	1										
Ifloga lerouxiae	RAR	1										
Species Group 2												
Sensitive species 305	CR	5	4									
Conophytum saxetanum	EN	4	4									
Monsonia patersonii	VU	4	2	2					3			
Cephalophyllum ebracteatum	VU	3	4						3			
Dregeochloa pumila	CR	2	2	2								
Gazania schenckii	CR	1	2									
Mesembryanthemum marlothii		2	2	2								
Crassula elegans		2	2					1				
Antimima perforata		1	1									
Euphorbia angrae		1	2									
Species Group 3												
Osteospermum oppositifolium			2			4		2		3		
Crassothonna cylindrica		1				4				3		
Atriplex vestita						3						3
Tetragonia sp. (narrow leaf)						3						
Ruschia pallens						2						
Hebenstretia sp.						2						
Sensitive species 293	EN					1						
Species Group 4												
Othonna furcata		4	4	4		1						
Mesembryanthemum hypertrophicum		1		2	3	2						
Cladoraphis cyperoides		2		5		3		1				
Ferraria schaeferi		2		3		1						
Euphorbia caput-medusae		1		2		2						
Chrysanthemoides incana				2		2						
Limonium sp.			2	2		1						
Species Group 5												
Lycium tetrandrum		3	2	3	3	4	5					
Tetraena clavata		3	2	4	3	2	5					
Fenestraria rhopalophylla subsp. *aurantiaca*		2	2	2		1	3					
Euphorbia hereroensis		1				1						
Species Group 6												
Aloe framesii	NT							2				
Lachenalia klinghardtiana	CR			2				1				

Plant community/subcommunity		1a	1b	2	3	4	5	6a	6b	7	8	9
Heliophila lactea								4				
Euphorbia burmannii		1		2		1		5				
Othonna undulata								3				
Veltheimia capensis								3				
Ruschia sp. 1						1		3				
Euphorbia ephedroides		1						3				
Pelargonium sp. nov.								3				
Pelargonium grandicalcaratum								2				
Antimima sp.								2				
Calobota spinescens								2	3			
Lycium sp. 1								2				
Mesembryanthemum brevicarpum								2				
Tetragonia sp. 1								2				
Lyperia tristis								2				
Species Group 7												
Roepera morgsana						4	3	4				
Grielum humifusum		1				2		2				
Stoeberia utilis		1				3		4	3			
Tetragonia pillansii						1		1				
Ehrharta sp.						1		1				
Species Group 8												
Oncosiphon spp.				2	5	3	5	2				
Hermannia cuneifolia		1		2		3		1				
Amphibolia rupis-arcuatae		2			5	4	3	2				
Species Group 9												
Jordaaniella clavifolia	VU							1	3			
Euphorbia rhombifolia						1		3	3		3	
Euphorbia mauritanica						1		5	3	3	3	
Ruschia sp. 2 (white flower)						1		2	3			
Asparagus graniticus								2	3			
Babiana hirsuta								1	3			
Asparagus undulatus								2	3			
Species Group 10												
Cynodon dactylon										5		
Asparagus sp.								1		3		
Opuntia ficus-indica										3	3	
Manochlamys albicans										5		
Boraginaceae										3		
Arctotis sp.										3		
Cotula coronopifolia										3		
Drosanthemum inornatum										3		
Antimima varians										3		
Oxalis inconspicua										3		
Pelargonium minimum										3		
Malva parviflora										3		
Colchicum albomarginatum										3		
Gladiolus arcuatus										3		
Lachenalia punctata										3		
Lessertia frutescens										3		
Lycium sp. 2										3		
Melolobium adenodes										3		
Ophioglossum polyphyllum										3		
Species Group 11												
Sensitive species 734	VU							2	3	3		
Arctotis canaliculata								3	3	3		
Jordaaniella spongiosa								4		3		
Trachyandra falcata		1						3	3	5		
Lampranthus stipulaceus						1		3	3	3		
Mesembryanthemum barklyi								2	3	3		
Kedrostis psammophila								1	3	3		
Aizoon sarcophyllum								2		3		
Asparagus juniperoides								1		3		
Species Group 12												
Mesembryanthemum sp. (*Psilocaulon)*											3	
Ruschia viridifolia											3	
Eberlanzia cyathiformis											3	
Species Group 13												
Crassula expansa							3	1		3	3	

Plant community/subcommunity		1a	1b	2	3	4	5	6a	6b	7	8	9
Cheiridopsis robusta							5	2	3		5	
Foveolina dichotoma		1					3	2	3		5	
Lampranthus otzenianus							3	3		3	3	
Mesembryanthemum sp. *(Prenia)*							3	3	3			
Zaluzianskya affinis				2		1	3	1		3		
Cephalophyllum rigidum							5	3		3	3	
Species Group 14												
Amphibolia succulenta	NT					2		4	3	5	5	
Jordaaniella cuprea						3		4	3	3	3	
Aizoon crystallinum		1				3		1	3	3		
Pteronia glabrata		1				2	3	3	3	3	3	
Species Group 15												
Mesembryanthemum crystallinum		5	4	4	3	5	5	5	5	3	5	
Stoeberia beetzii		4	2	3	5	3	5	1	3	3	5	
Asparagus capensis		2	4	3		3	5	5	3	5	3	
Crassothonna sedifolia		3	2	2	3	2	3	5	3	3		
Didelta carnosa		3	2	3	3	3	3	4		3		
Roepera cordifolia		4	2			2	5	2	3		5	
Salsola spp. (incl *S. nollothensis)*		3	4	4		4	3	4	3		3	
Kewa salsoloides		3					3	1		3		
Calobota halenbergensis		1		2		2		3		3		
Antimima sp. nov.		2					3	1			3	
Mesembryanthemum dinteri		1	2	2		1		1	3		3	
Eberlanzia sedoides		2					5	1	3		3	
Mesembryanthemum subnodosum		1					3				3	
Albuca cooperi		1	2						3	3		
Grielum grandiflorum						1			3			
Jamesbrittenia merxmuelleri				2						3		
Kewa angrae-pequenae				2		1						
Searsia longispina						1				3		
Chaetobromus involucratus						1			3			
Species Group 16												
Limonium sp. (coastal type)												3
Phragmites australis												3
Juncus sp.												5
Salicornia natalensis												3
Species Group 17												
Drosanthemum luederitzii		2	4	4	3	1		1	3	3	3	5
Species Group 18												
Trachyandra bulbinifolia		2					3	1				
Pharnaceum sp.		1		2				1				
Mesembryanthemum oculatum				2				1				
Aizoon pruinosum						1						3
Spergularia sp.		1										3
Ornithoglossum parviflorum		1						1				
Pelargonium fulgidum		1								3		
Cynorhiza typica		1						1				
Osteospermum polycephalum		1										
Dianthus namaensis		1										
Selago cf. *dinteri*		1										
Albuca longipes		1										
Rubiaceae		1										
Bulbine abyssinica		1										
Anacampseros namaquensis		1										
Chlorophytum viscosum		1										
Drimia occultans		1										
Othonna retrofracta		1										
Tetragonia microptera		1										
Curio radicans		1										
Helichrysum sp.		1										
Oxalis bullulata		1										
Calobota sp. 1		1										
Tylecodon reticulatus		1										
Mesembryanthemum coriarium		1										
Jamesbrittenia maxii/fruticosa				2								
Tetragonia praemosa				2								
Tridentea pachyrrhiza				2								
Felicia sp.				2								
Dasispermum sp.					3							

Plant community/subcommunity	1a	1b	2	3	4	5	6a	6b	7	8	9
Crassula elegans hybrid	:	:	:	:	1	:	:	:	:	:	:
Odyssea paucinervis	:	:	:	:	1	:	:	:	:	:	:
Calobota sp. 3	:	:	:	:	1	:	:	:	:	:	:
Spergularia sp. (woolly)	:	:	:	:	1	:	:	:	:	:	:
Albuca grandis	:	:	:	:	1	:	:	:	:	:	:
Poaceae	:	:	:	:	1	:	:	:	:	:	:
Helichrysum herniarioides	:	:	:	:	1	:	:	:	:	:	:
Trachyandra laxa	:	:	:	:	:	3	:	:	:	:	:
Hebenstretia parviflora	:	:	:	:	:	:	1	:	:	:	:
Mesembryanthemum sp. (*Psilocaulon* high capsule)	:	:	:	:	:	:	1	:	:	:	:
Helichrysum sp. *(*annual)	:	:	:	:	:	:	1	:	:	:	:
Zaluzianskya benthamiana	:	:	:	:	:	:	1	:	:	:	:
Anginon sp.	:	:	:	:	:	:	1	:	:	:	:
Crassula sp. climbing	:	:	:	:	:	:	1	:	:	:	:
Gethyllis sp.	:	:	:	:	:	:	1	:	:	:	:
Stoeberia fruticosa	:	:	:	:	:	:	1	:	:	:	:
Tylecodon wallichii	:	:	:	:	:	:	1	:	:	:	:
Quaqua parviflora	:	:	:	:	:	:	1	:	:	:	:
Tylecodon paniculatus	:	:	:	:	:	:	1	:	:	:	:
Crassula rudolfii	:	:	:	:	:	:	1	:	:	:	:
Ehrharta calycina	:	:	:	:	:	:	1	:	:	:	:
Ehrharta delicatula	:	:	:	:	:	:	1	:	:	:	:
Schismus sp.	1	:	:	:	:	:	1	:	:	:	:
Conicosia elongata	:	:	:	:	:	:	:	3	:	:	:
Ferraria sp.	:	:	:	:	:	:	:	3	:	:	:

Appendix C: Photographic record of plant communities

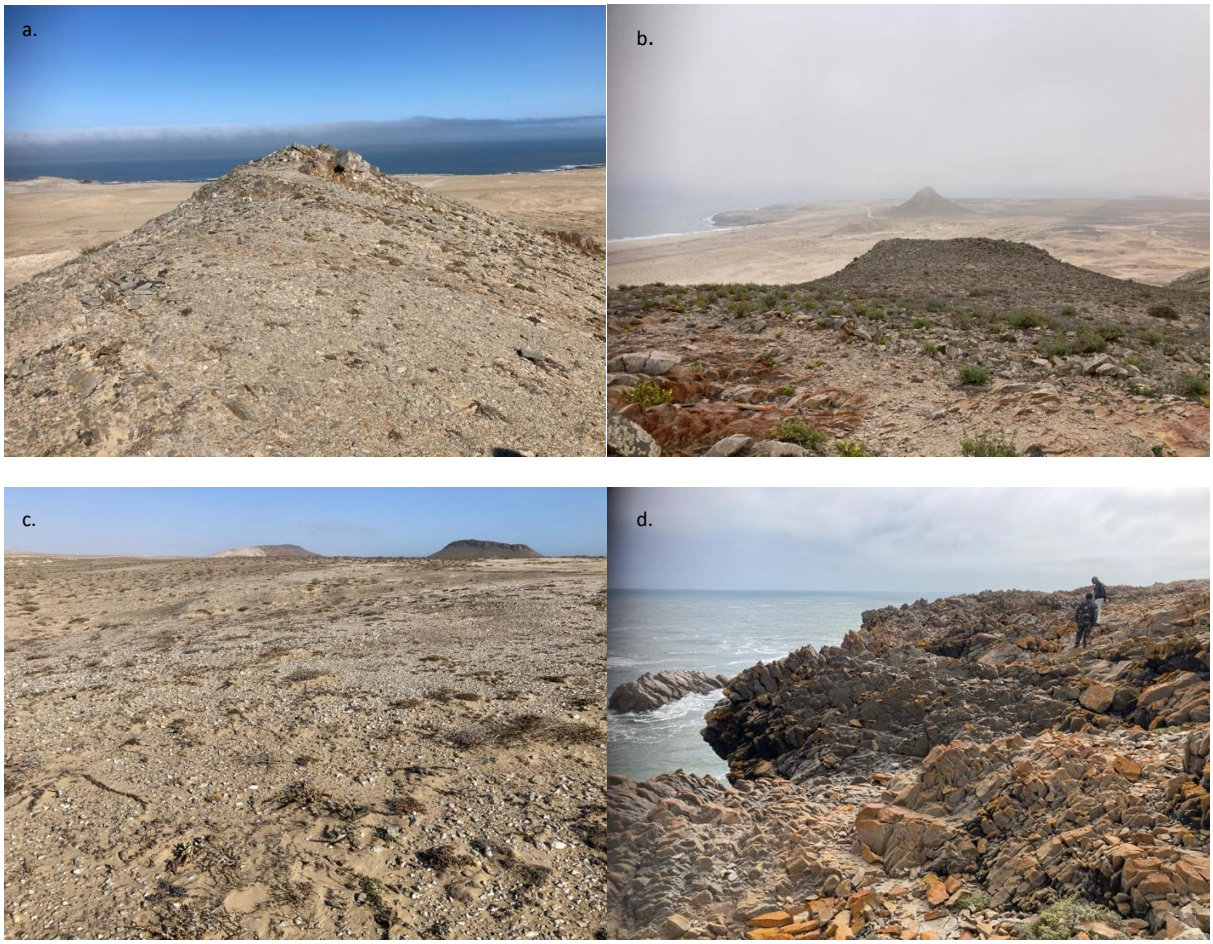


Figure C1: Plant Community 1. a. Namakwakop; b. Boegoeberg South; c. Quartz plains along the coast; and d. Rocky coastline.



Figure C2: Plant Community 2. a. Coastal vegetation; b. Near Visagiespan; c. Degraded sandy plains south of Boegoeberg South; and d. Visagiespan in the background.

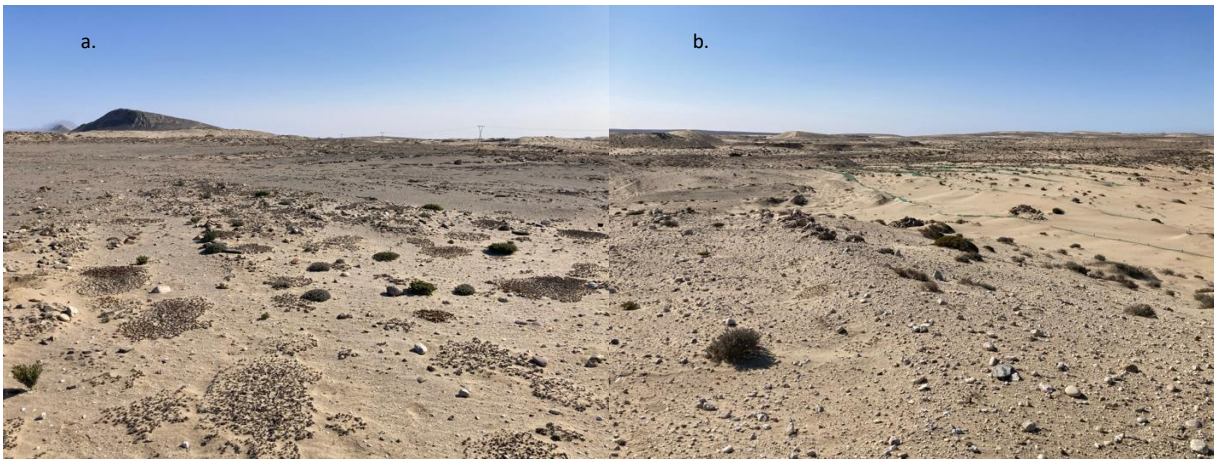


Figure C3: Plant Community 3. a. The modified mined habitat and b. shade nets almost buried by moving sand.



Figure C4: Plant Community 4. a. Around Rietfonteinpan; b. Area with intact vegetation; c. An area that was disturbed very many years ago; and d. Natural vegetation on yellow sand.



Figure C5: Plant Community 5. a. Vegetation at site with Brant's whistling rats; and b. Vegetation on quartz at Duikerkop.



Figure C6: Plant Community 6. a. & b. Subcommunity 6a; and c. Subcommunity 6b.

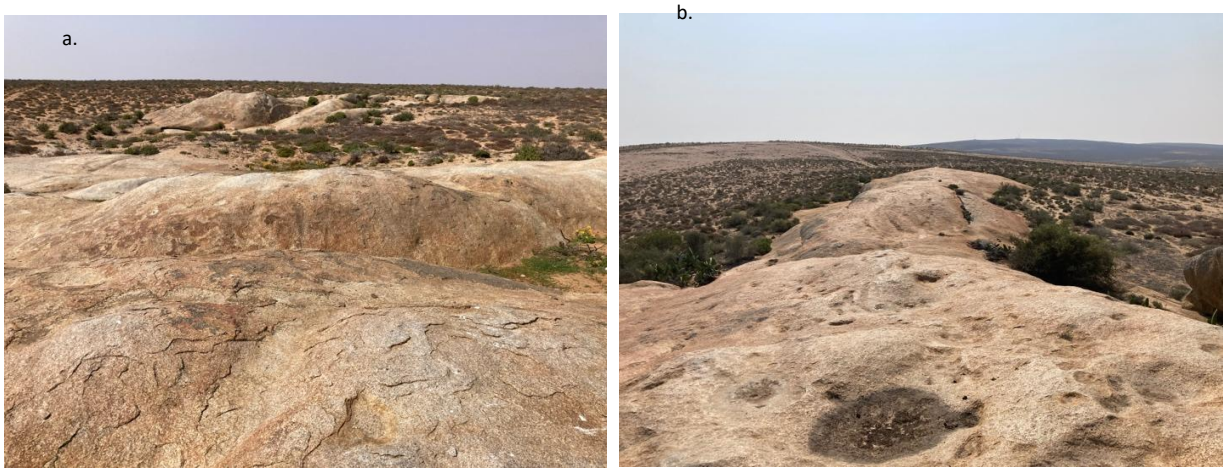


Figure C7: Plant Community 7. a. Granite outcrop at Swartbankkop; and b. Granite outcrop known at the Klipbakke.



Figure C8: Plant Community 8.



Figure C9: Plant Community 9. a. Visagiesfontein; and b. Rietfonteinpan.

CHAPTER 3

Supplementary Material: Specialist Report

(B) Vegetation and flora report

BOEGOEBAAI STRATEGIC ENVIRONMENTAL ASSESSMENT

FLORA OBSERVATIONS OF THE BOEGOEBAAI PORT DEVELOPMENT SITE AND SURROUNDING AREAS, RICHTERSVELD MUNICIPALITY, NORTHERN CAPE, SOUTH AFRICA

(B) VEGETATION AND FLORA REPORT

Report compiled by:

Pieter C.V. Van Wyk

May 2025

Report prepared for:

Council for Industrial and Scientific Research

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INTRODUCTION

The Richtersveld region already contained 336 known endemic plant taxa by 1999 (Cowling et al. 1999), however continuous new discoveries proofs that this figure is exceeded by far (Van Wyk et al. 2024). It is acknowledged as one of the richest desert floras of the planet (Cowling et al. 1998) and forms part of a 'biodiversity hotspot' defined to set conservation priorities (Meyers et al. 2000).

The introduction of the Biome concept, based largely on a classification of growth forms and major climatic determinants has led to the description of South Africa's 7 biomes. Of these biomes Fynbos, Succulent Karoo and Nama Karoo Biomes occupy southern Africa's southwest winter and summer rain fall region (Rutherford & Westfall 1986) and a later introduced biome, the Desert Biome (Rutherford & Westfall 1994). A map introducing the seven biomes of South Africa, namely: Savanna, Thicket, Grassland, Forest, Fynbos, Nama Karoo, Succulent Karoo, and Desert were introduced later (Rutherford & Westfall 1994; Low & Rebelo 1996; Mucina and Rutherford 2006). The Richtersveld is unique in that it is situated within four of these biomes, namely the Succulent Karoo Biome, Desert Biome, Fynbos Biome and Nama Karoo biome (Jüergens 1991), and this is possibly the main reason for the unusual high biodiversity found within the area, even though the aridity and harsh climate. Of these biomes the Fynbos and Succulent Karoo biomes have recognition as two of Earth's biologically richest and most endangered terrestrial Eco regions (Mittermeier et al. 1999). The Boegoebaai Port project falls within the Succulent Karoo Biome.

Looking past the biome level and more towards a human introduced border, such as a municipal area, the Richtersveld Municipal area has a figure of endemic flora, total number of flora and endangered flora as well as vegetation units, exceeding by far, any municipal area in the Northern Cape Province (Van Wyk et. al. in prep.). Even though the Richtersveld Municipal area has the lowest annual average rainfall of any municipal area in the province, the biodiversity is unlikely elsewhere and this is greatly contributed towards the complexity of the region's geology, topography, climate, and long climate as well as geological stability. Keeping this in mind, should there have been a scale for rating districts and municipal areas according to their importance to biodiversity, the Namakwa district and the Richtersveld Municipal Area (see Image 1) would have rated as the most important in the Northern Cape Province.

Of all the species and ecosystems found within the Richtersveld Municipal Area, the Alexander Bay Lichen Fields is by far thee-most extraordinary ecosystem, not only in the region but on earth. The Alexander Bay Lichen fields falls under the Namib Lichen Fields and is a South African Heritage Site It is also one of the most threatened habitats in the world! The lichen fields are the largest and richest of its kind in the world, and they are considered an ecological wonder by scientist across the world, due to their density and species richness. Due to its uniqueness the Alexander Bay Lichen Fields, they have received a conservation aim of being conserved 100% (Mucina and Rutherford 2006). Not well documented but of equal importance and uniqueness are the lichen fields found on the Boegoeberg South and Boegoeberg North hills.

Over the past years rare and new endemics species are still being discovered in the Richtersveld whilst at the same time species are disappearing (Van Wyk et al. 2024). More than 90 years of mining, bad agriculture practices and land use transformation has let to what scientist referred to as the perfect storm (Jurgens et al. 2025). Mass_desertification are causing extinction, this desertification are anthropogenic. One can clearly see how species are becoming more endangered by looking at the species listed for the Richtersveld Municipal area on the SANBI Red List (see table 4). It is this also a fact that the Richtersveld Municipal area is the most threatened municipal area in regard to biodiversity of any municipal area in the Northern Cape Province. The level of threats can also be seen in the recent publication of species richness of the Richtersveld National Park, which proved that the Richtersveld National Park has the highest number of red listed species, of any of South Africa's National Parks.

As a result of the threats, in 2015 the South African National Biodiversity Institute (SAMBI) joined forces together with South African National Parks (SANParks) to reassess the endemic flora of the Richtersveld. A first up-listing of plant taxa from this region, where completed in 2015, which was published on the South African Red List of Endangered species (Raimondo et al. 2015) (see image 3). A second phase of updating the red list statuses of flora from the region commenced in 2022 and several species were up listed on the red list in 2023 (Raimondo et al. 2023), mostly due to new threats mining posed along the Orange River. The need for a third up-listing of species, due to threats becoming more, was commence in 2024, as a result of the Boegoebaai Port related developments, and the impacts this development will have on species (Raimondo et al. in prep. 2025).

This report is a local-scale, spatially focused SEA report identifying sensitivities within and surrounding the proposed port and affiliated developments, including the SEZ development area covering ~33 500 ha ("Boegoebaai Port and SEZ SEA") as well as the surrounding area, the Richtersveld Municipal Area and sections of the Nama Koi Municipal area (Image 1 & 2).

Furthermore, this report was conducted using expert on-site, ground-truthing to produce high resolution spatial data, which are overlapped with existing database of plant species occurrence within the study area. From this data sensitive and non-sensitive areas could be pointed out. From the data collected for this report, unique habitat was also documented and mapped, of the most unique habitats, includes, lichen fields and plant communities associated with brant's whistling rats and heuweltjies. This report also explored the species richness of the Richtersveld Municipal area and includes a graph showing the number of threatened plant species as listed on the SANBI red list (Table 4, towards the end of the document) annually, and how the number of species becoming threatened are growing.

STUDY AREA

The Study area includes the Richtersveld Municipal area and a small section of Nama Koi Municipal areas (Image 1 & 2). Both Municipal areas falls within a region known as the Richtersveld and Northern Namaqualand. The border of the study area in the east is the tar road between Steinkopf and Vioolsdrif, in the north the Orange River from Vioolsdrif towards Alexander Bay, in the west the shoreline between Port Nolloth and Alexander Bay and the southern border of the study area for this report is the tar road between Port Nolloth and Steinkopf. The core area of this report is the proposed port and SEZ development area covering 33 500ha known as the "Boegoebaai Port and SEZ SEA" (*Image 2*). The area is situated within the Richtersveld Municipality area, in the north-western corner of South Africa (*Image 1*), close to the small mining town of Alexander Bay and partly falls within South Africa's Succulent Karoo and Desert Biomes.

Image 1: Districts and Municipalities of the Northern Cape Province.

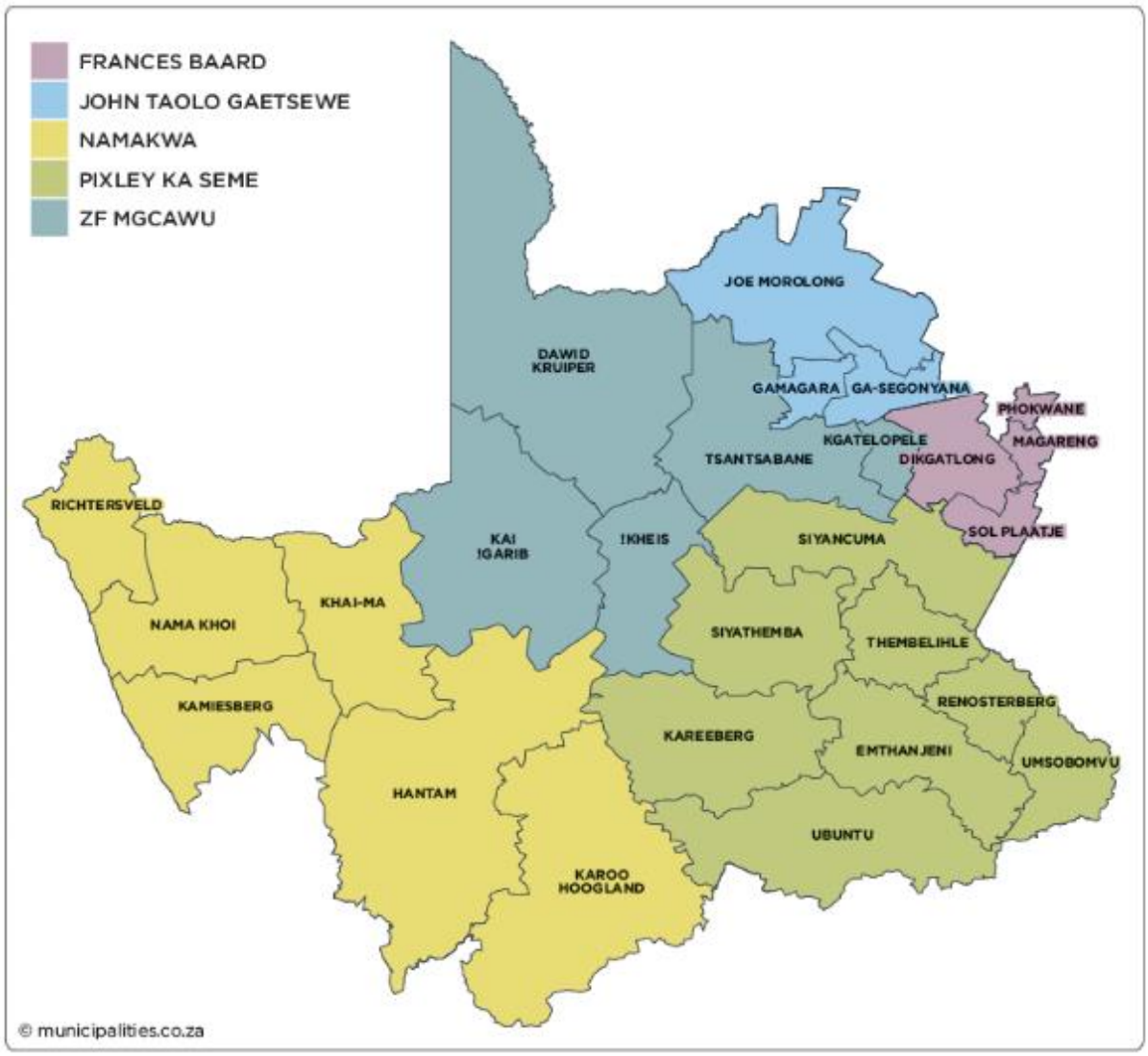


Image 2: Close up map of the 33 500ha study area (Image: © Google Earth 2023).

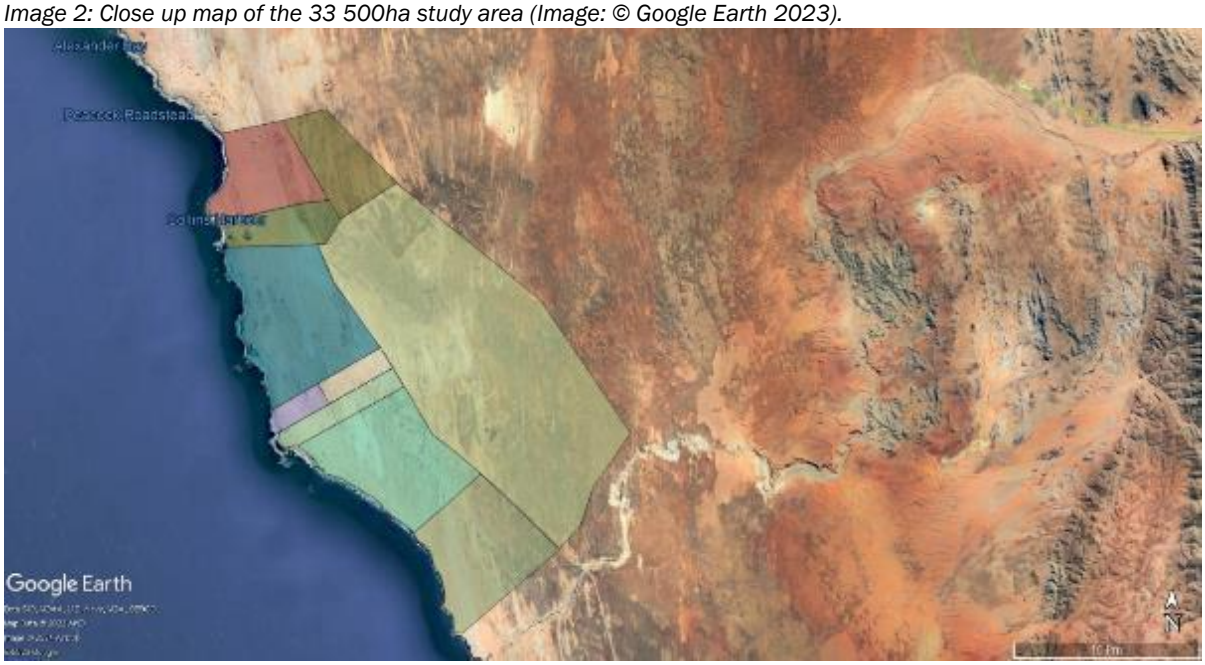
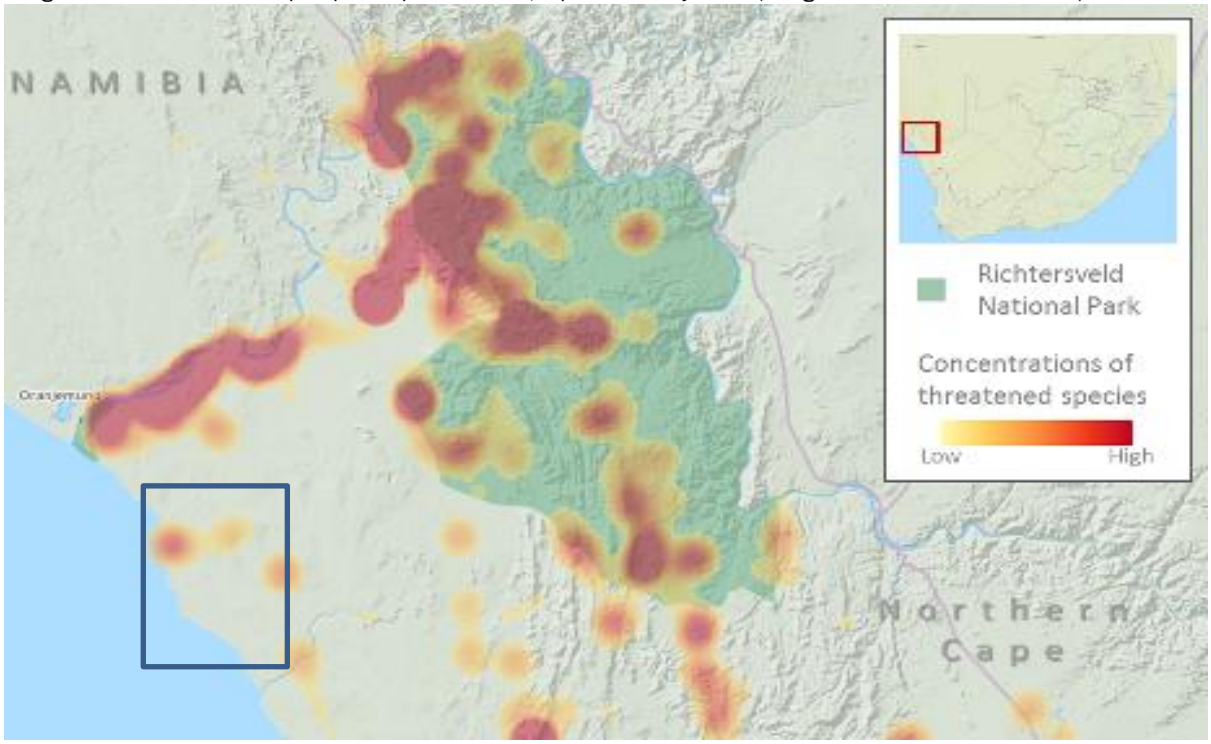


Image 3: SANBI Red List map of plant species 2015, square = study area. (Image: © SANBI Red List 2015)



METHODS AND MATERIAL

Before doing site visits, high resolution satellite images and the vegetation map of South Africa were studied. From this desktop activity, strategic points were chosen as samples sites within all land types of the core study area and some sampling surrounding this area. Hereafter, site visits were conducted. Whilst visiting strategic sites, any area which visually seemed unusual regarding plant communities, whilst on the site, were also visited.

When data was collected two methods of sampling were done, one was point sampling of individual species, uploaded onto iNaturalist or for which herbarium vouchers were collected and two, collective data collection within a 10m x 10m (100m^2) plot.

Sampling method one: data was gathered by taking photos of species, together with GPS and uploading the photos onto iNaturalist as well as adding the photos to a private photo herbarium for the Richtersveld bio region belonging to the author of this report). Encase species could not be identified, using photos, herbarium voucher collections were made, but only outside the restricted mining area, as no permission was obtained to collect herbarium vouchers within the mining area. When voucher specimens were collected, the following information was also collected using a standard Herbarium Collection Form: GPS coordinates, Altitude, Vegetation Type, Substrate, Moisture regime, Soil type, Lithology, Exposure, Aspect, Slope, Biotic effect, and Plant Features which included: growth form, height, flowering, or fruiting. Herbarium voucher of plants were pressed, frozen at -15°c after which it was dried at 65°c. Also included encase of species of special concern, counts of the species were done within a radius of 50m of the individual GPS point.

Sampling method two: data was gathered in a 100m^2 square plot of 10m x 10m, this was done several times within all land types, as well within various altitudes of the study site. Within each plot the following information was gathered: GPS, altitude, soil type, lithology, all floral taxa including higher plant taxa as well as lower, estimation crown coverage in percentage per species, overall percentage of vegetation cover, and counts of species of special concern. This methodology was used to compare the various plant communities within the land types.

Plant species identifications was done by comparing herbarium material at Compton, Bolus, Stellenbosch, and SANBI, Pretoria Herbariums, or contacting taxonomic specialist where applicable. A Nikon SMZ800 microscope was used to examine finer detail.

Herbarium vouchers of Lichens and Mosses was also made from outside the mining area. When voucher specimens were collected, the following information was also collected using a standard Herbarium Collection Form: GPS coordinates, Altitude, Vegetation Type, Substrate, Moisture regime, Soil type, Lithology, Exposure, Aspect, Slope, Biotic effect, and Plant Features which included: growth form, height, fruiting and photographs for colour references of species. When sampling the lichen, mosses, and liverworts they were collected within 100m² quadrants. Within these quadrants all lichens & bryophytes seen were sampled, those on rock were chiselled from the rock with a piece of substrate still attached, those on plant material were sampled with the plant material be it branch or leaf and those on soil were gently removed from the soil and wrapped in acid free toilet paper (to prevent crumbling of the thallus and the soil which keeps the lichen in one piece). These were then placed in plastic containers to prevent damage to the voucher specimens. Processing of the voucher specimens were done at a later stage, for this they were carefully removed and sorted. Soil lichen was treated by brushing 20% cold glue mixed with 80% water on the lower part to prevent them from crumbling. The fruticose specimens were dipped in water and gently pressed to enable better mounting and storing of specimens.

Lichen species identification was done by observing them under a dissecting microscope (10x magnification eyepiece and 0.65 to 4.5x magnification, thus 6.5 to 45 x magnifications). The lichens are then separated into the same species within a sampling area and each species is then further identified by means of spot tests using iodine, a 10% solution of potassium hydroxide, and bleach. During a spot test a certain part of the lichen is tested, for example, the medulla or apothecia and its reaction to a certain chemical. Colour change or lack of colour change is noted and compared to keys for lichen identification. Lichens of the Namib Desert (Wirth, 2010) was used for identification of the voucher specimens. Some lichen specimens were given to lichenologist to examine and identify.

The conservation status was obtained by searching the SANBI Red List for each species (http://redlist.sanbi.org/). Photos were also taken of different habitats, and notes made on any unique forms of fauna, soil, micro habitats ext., which contributes to any unique plant species or communities' existence.

RESULTS

Species

In total 69 10m x 10m plots were completed for this study (Image 26) and over 8 000 individual points of species were collected.
In total 331 higher plant taxa were recorded for the 33 500ha "Boegoebaai Port and SEZ SEA" planned development site (Table 1 & see Image: 2 for study area) and in total over 3 000 higher plant taxa and over 300 lower plant taxa for the Richtersveld Municipal area (Van Wyk personal observation). Lower plant taxa recorded were an astonish amount of 91 taxa, even though this was not the primary focus of this study. Most of the lower taxa were lichens, highlighting the richness and importance of the locality as a 'centre of diversity' for lichens, likely of global importance (Table 2). In combination the total floral taxa, including Spermatophyta, Bryophyta, Fungi and Lichens totalled at an astonishing 422 taxa for the 33 500ha "Boegoebaai Port and SEZ SEA" development area. In total 36 red listed taxa were recorded and in additional 15 species which will become of conservation concern should this development footprint not be shifted to west of the tar road between Alexander Bay and Port Nolloth, were recorded, this in total 51 plant species of conservation concern were recorded (Table 3). Of the red listed plant species within the study site, 4 species are already listed as endangered, and 5 species are listed as critically endangered.

Image 4: ±95% lichen cover of all strata on the south-western slopes of Boegoeberg South.



Vegetation

This report does not include land types, but rather a brief description of some plant communities. From the various sampling sites of species in plots, it became clear that altitude as well as broader land types plays a much less important role in the distribution of species within the study site, it is rather soil chemistry and exposure to wind and fog that plays the more important roles. It became clear that looking at satellite images does not help much in defining the vegetation units of the study area. This said, looking at the vegetation types as described in South Africa for the study site, in the field made no sense. According to the vegetation types of South Africa, only 4 vegetation units are found within the core study area, however there are at least 8 main plant communities within the study site, which can be considered as "vegetation types". These communities are however interwoven in a complex matter making mapping a mess. Furthermore, during the research for this study, the difference in vegetation according to altitude was also explored, in the sense of highlands areas vs lowland areas, and again, this made no sense as over and over plant communities were found in the lowland and highland areas of the study site, depending on the soil conditions rather.

Here are a brief description and names of the various plant communities recorded within the study site:

Alexkor Moon Landscape

This vegetation exists out of two perennial species, a species of *Caroxylon* (ganna) and *Osteospermum polycephalum* (janneper se kaneel), which are extremely sparsely distributed within vast sections of the mining area south Alexander Bay. Where these species are found in combination, the previous plant communities have been 100% destroyed by the mines, this waist land has zero chance of recovery and in

comprises most of the yellow areas marked in Image 22 of the report. Plots including this plant community: AL11; AL29-AL32.

Boegoeberg Strandveld

This vegetation is poor in species generally, with one to two species of special concern. It comprises of a combination of vegetation found on bright white dunes, which are dominated by *Cladoraphis cyperoides* (steekbiessiegras) and *Tetraena clavata.* The poor species cover within this vegetation is likely due to exstreme sand blasting caused by unrehabilitated mine quarries and comprises of 50% of the area west of the tar road between Port Nolloth and Alexander Bay. Plots including this community: AL8-9; AL14-16; AL18; AL27-28; AL66.

Boegoeberg Dwarf Succulent Shrubland

All quarzitic rocky outcrops within the study area shares the same plant community structure. These communities are uniquely different to the plains east of Alexander Bay and any rocky areas elsewhere in the Richtersveld. This is also the smallest plant communities even though the most species rich. Several narrow endemics and two localized endemics are found on these. The most dominant features are the presence of *Antimima perforata, Conophytum saxetanum* and various dwarf species of *Crassula* such as *C. plegmatoides*. Plots including this plant community: AL1-7 and AL67-68.

Silty Plains Scorpiontail Succulent Shrubland

This is the most widespread plant community within the study area. Even though much poorer than the yellow and red dunes as well as rocky areas, this unit still host several unique species. The most dominant species in this unit is *Mesembryanthemum pseudoschlichtianum* (skerpioenangel), *Lampranthus otzenianus, Amphibolia succulenta* and *Mesembryanthemum dinteri*. Plots including this plant community: AL13; AL21-23; AL37-38; AL44-48; AL53-58; AL60-63.

Rooi T'kooi Succulent Shrubland

This plant community is found on yellow dune sand throughout the study site and predominantly dominated by *Stoeberia utiles* (rooi t'kooi). It host the highest species numbers and tallest vegetation within the coastal plains of the region. Plots including this plant community: AL19-20; AL24; AL35-36; AL39-43; AL49-52; AL59; AL64-65.

Vaal T'kooi Dwarf Succulent Shrubland

This plant community consist out of dwarf succulents, of which *Stoeberia beetzii* (vaal t'kooi) is most dominant and *Drosanthemum luederitzii.* This combination of plant species are found on pale loamy soils, sometimes with calcrete and quartz pebbles and are extremely spotty, sometimes appearing as if heuweltjies, however these are likely remnants of old brant's whistling rats nests. Plots including this plant community: AL10; AL25-26.

Salt Marsh

Plant community which grows in high salinity and damp soil, with three springs which include sedges such as *Juncus acutus* subsp. *leopoldii*, and salt pans with *Limonium dyeri* and *Frankenia pomonea*. Plots including this plant community: AL12.

Namib Lichen Fields

This included areas where there are high presence of *Caloplaca* and *Xanthoparmelia* species on the soil and small stones which are typically associated with the same type of habitats and species within the Namib Desert. Plots including this plant communities: AL17; AL23.

Image 5: Unique combination of succulents on Boegoeberg North.



Image 6: Unique lower plant taxa, lichens and moss species on Boegoeberg North.



Image 7: Boegoeberg endemic, undescribed species of Antimima.



Image 8: possible new species of soil orchid from Boegoeberg belonging to the genus Holothrix.



Most significant are the Boegoeberg North and Boegoeberg South plant communities, which in combination of succulents and lichen cover should be considered of global uniqueness (*see Images 4-8*). Furthermore, the several localities of Namib desert lichen fields, which has a very limited distribution in South Africa, are also unique of the core study area (*see Images 9-11*). Other unique vegetation containing high density of lichen cover on shrubs, was also observed, some of these sites might potentially hold the highest % of lichen cover biomass for any vegetation units on the coast of South Africa (*see Images 12-13*).

A unique discovery was also made during this study. Thousands of active Brant's Whistling Rats (*Parotomys brantsii*) nests which are active where discovered. The positive reaction of plants to the activities of these rodents made it clear that they are important ecosystem engineers, which has been transforming the plant community structure, possibly for hundreds if not thousands of years. Each den may have several rats, and there are thousands of dens within a large section of the planned Boegoeberg development area (*see Images 14-16*).

Another unique vegetation feature within the footprint area which has a fauna component attached to it, is large sections of heuweltjies, where Harvester Termites (*Hederotermis*) are ecosystem engineers, creating special nutrient rich loamy soils, which create habitats for certain plant species. A paper was published in 2024 about the importance of heuweltjies and evidence provided by the Stellenbosch University that some of these termite colonies has been occupied for tenth of thousands of years and are carbon zincs of global importance (*see Images 17-19*).

The study area includes a newly discovered, species of *Pelargonium*, which made headlines in media, 2023 (*see Image 20-21*). There might still be several unknown species, especially geophytes within this study site.

Image 9: Caloplaca elegantissima



Image 10: Xanthoparmelia walteri



Image 11: Stony flats at Duikerkop, containing several Namib Desert Lichen species.



Image 12: Strandveld vegetation covered with over 60% Xanthodactylon species on woody shrubs.



Image 13: Xanthodactylon turbinatum densely covering wood, and a green Ramalina fimbriata.



Image 14: Google Earth Image of Brant's whistling rats nest/dens north of Duikerkop, showing unique patterns of vegetation associated with these rats.



Image 15: Ground view of Brant's whistling rats nest/dens.



Image 16 © Google Earth: map showing distribution of brant's whistling rats dens and accociated vegetation within the development site. This is likely the largest population of the rat species in South Africa.

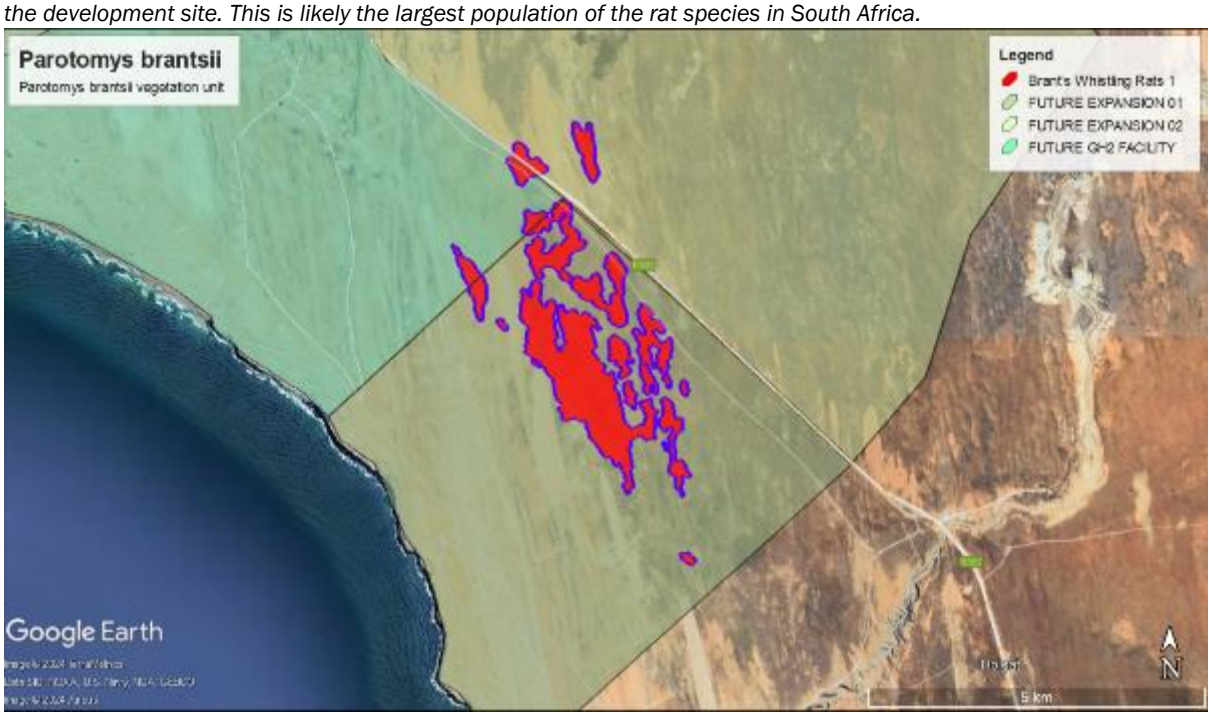


Image 17: picture showing less vegetated area of Heuweltjie, always associated with Mesembryanthemum and Eberlanzia plant species.



Image 18 © Google Earth: map showing distribution of heuweltjies, which forms par of the Richtersveld Scorpiontail vegetation units. This area is of high sensitivity, and found on the Swartbank to Holgat River area.

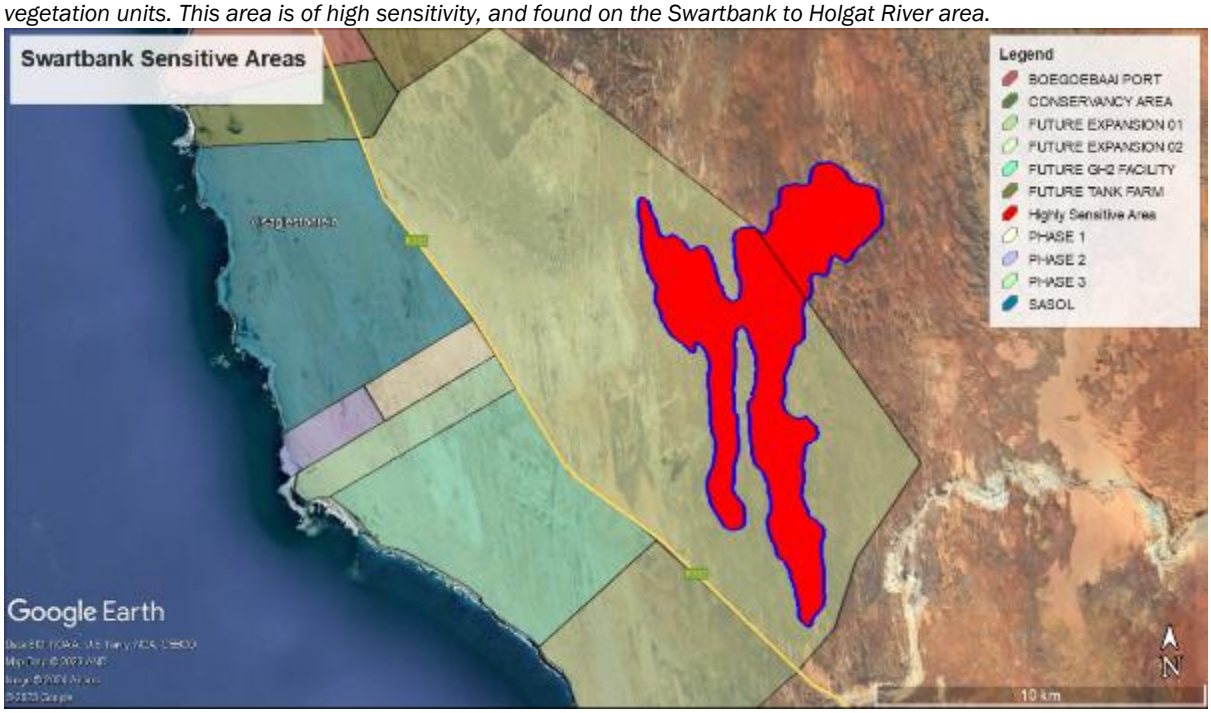


Image 19: dark material are termite fras always found in the centre of active heuweltjies.



Image 20: map of highly sensitive vegetation on Visagiesfontein hill.

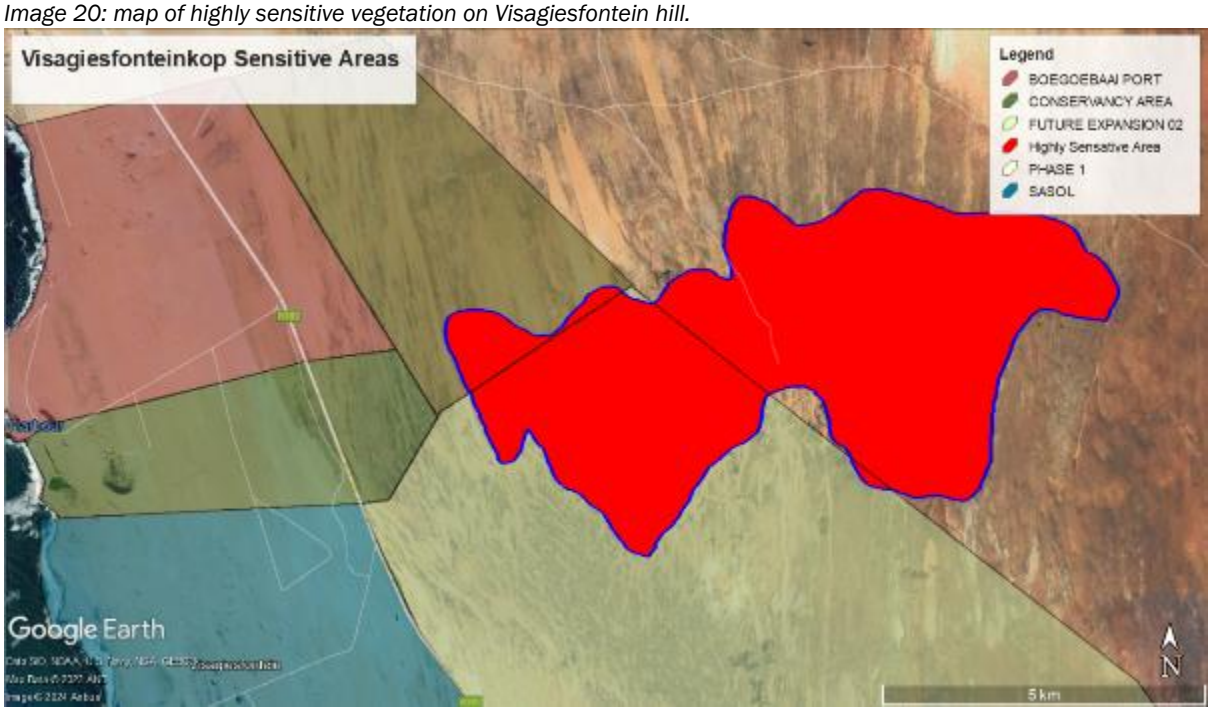


Image 21: Newly discovered Pelargonium from Visagiesfontein hill by the author of this report.



DISCUSSION: SENSITIVITY OF THE DEVELOPMENT SITE

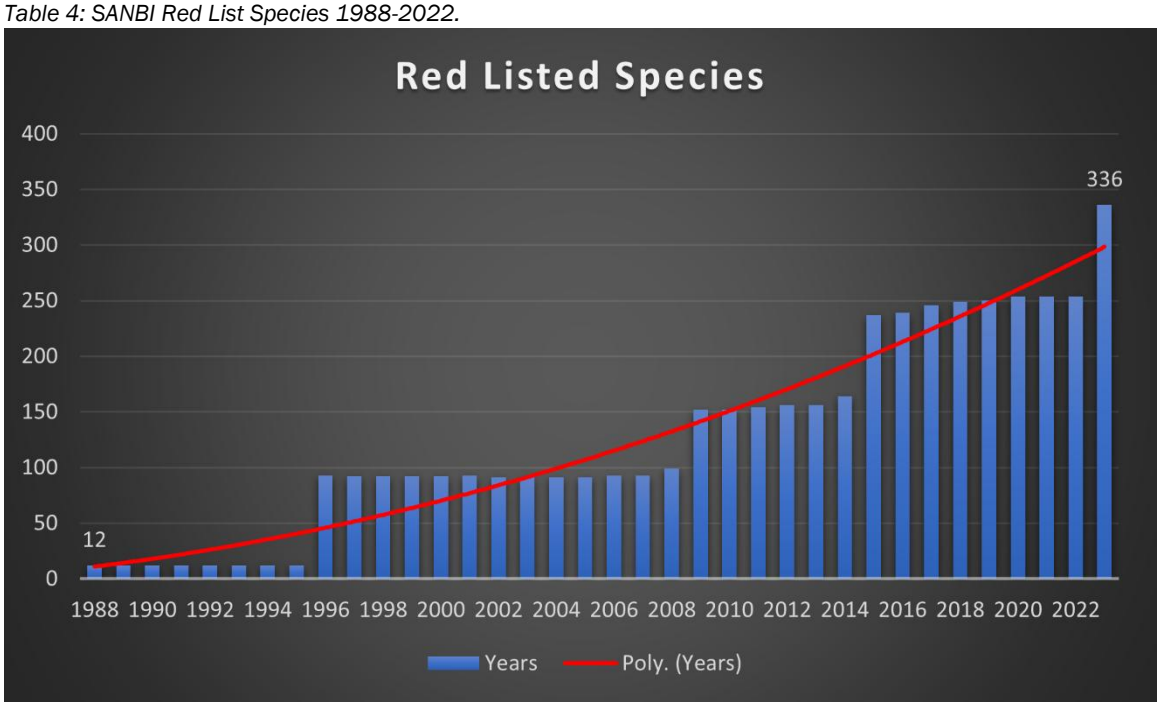
During the botanical survey several new and rare discoveries were made on both fauna and flora. From the data collected I was able to map sensitive habitats as well as habitats which are not sensitive. Habitats with low sensitivity is because of past and present mining impacts. There are large sections of vegetation, where not more than 10 species of plants occur, of which non has threatened status, and in some cases, there are large areas in the mine which has no plants, insects nor birds, due to past mining damage. These areas trigger no environmental conservation red tape and should be chosen for development in the future (*see images 22-24*).

Combining my data from the recent survey with that of 22 years of collecting data in the Richtersveld area, I could create a map showing the medium to high sensitivity areas of the whole Richtersveld region, which should not be considered for any further development or human induces stresses, in red, and the areas in yellow, are biodiversity-dead areas due to past disturbances, with little to no chance of ever recovering (*see image 25*).

The high plant taxa within this study site, as well as the high number of species of conservation concern, highlights the importance of this site for conservation. The areas not destroyed by mining directly or indirectly are still of high sensitivity and should not be developed. Overall keeping in consideration the high species numbers, any form of development in a region such as this can be devastating to the environment.

Important to note is the overall sensitivity of the landscape chosen for this large-scale development. The Richtersveld Municipal area already suffered a lot under land use changes and climate change. In Table 4 are an example of how the number of species being threatened has grown for the Richtersveld between 1988-2022. Due to the development of the Boegoebaai Port and green energies, including all secondary developments because of the future establishment of the port, more than 100 species additionally will be listed, making the Richtersveld the locality with the highest number of threatened species on the African continent (Van Wyk personal observation).

Table 4: SANBI Red List Species 1988-2022.



Regarding sensitivity of the lichen fields, even if not within the direct foot print of the port, are the following case study: In the 1800s independent observations in England, Munich, and Paris documented that lichens were already disappearing from urban areas. By the early 1900s this “city” effect was a widely recognized phenomenon in Europe and was first attributed to coal dust, which was emitted by most homes as well as many industries. Only later did the colourless gas, sulphur dioxide, become recognized as a

principal phytotoxic agent. Today the list of air pollutants is much longer and includes oxidants, hydrogen fluoride, some metals (Section 12.7), acid rain, and organics. Certainly, the list of potentially toxic substances is not yet fully circumscribed. The high sensitivity of lichens is related to their biology. Most species live for decades or hundreds of years and a few longer; thus, as perennials, they are subject to the cumulative effect of pollutants. Lichens have no vascular system for conducting water or nutrients; as a consequence, they have developed efficient mechanisms for taking up water and nutrients from atmospheric sources. Fog and dew are major water sources for lichens, often have much higher pollutant concentrations than precipitation, and the lichens' nutrient concentration mechanisms also will concentrate pollutants. Unlike many vascular plants, lichens have no deciduous parts, and hence cannot avoid pollutant exposure by shedding such parts (Hawksworth 1971; Nimiset al. 2002, Nash, T.H., III 2008). There is evidence that the nearby tar road between Port Nolloth and Alexander bay has had a negative effect on the Alexander bay Lichen Fields due to air pollution by vehicles (Jurgens, Mucina and Rutherford 2006). An unknown lichen fields of almost equal importance also occurs on the south-western slopes of Boegoeberg hills which are currently being negatively impacted by mining. The proposed refineries of Oil and other mineral, as well increase air pollution by sea vessels, trains and more vehicle traffic could have a devastating effect on the lichen fields of the region.

The importance of biodiversity within the Richtersveld Municipality and some sections of the northern Nama Koi Municipality of the Northern Cape Province, cannot be stretched far enough. Scientific explorations especially over the past few decades provided evidence that vast areas of this region are of global importance due to high levels of endemism unlike elsewhere on earth. Regardless of the importance, recent research showed that this biodiversity hotspot is under immense pressure of degradation due to bad anthropogenic land use practices (Jurgens et al. 2025), which should raise great concerns for the region. Should mega developments such as the Boegoebaai port, railway, green energies and other developments roll out, not only in the Richtersveld Municipal area but also in the Sperrgebiet of Namibia.

Given the low rainfall, aridity and past damaged caused by the mines within the core development area, the higher plant taxa are still significantly high, indicating the uniqueness of the chosen locality for this development. Most species were recorded on rocky outcrops and in the area east of the Port Nolloth – Alexander Bay tar road, where mining impacts has been way less.

CONCLUSIONS

The Boegoebaai development area falls within a highly sensitive habitat, already severely impacted by 99 years of diamond mining. The locality for the ‘harbour’ or ‘port’, close to the Boegoeberg twin hills, should be shifted either to the north or south of these two mountains. The reason being that there is still natural vegetation between these two hills which contains unique endemic vegetation. The area between the two mountains, likely form a unique microclimate, due to the two hills forming a wind shelter, this could be observed by the high presence of lichens and snake species such as dwarf beaked snakes on the northern side of Boegoeberg South. Furthermore, the rocky areas overlooking the ocean, at the planned harbour wall site, contains the highest concentration of *Crassula plegmatoides* within the species distribution, removal of this population will have a detrimental impact on the species, as well as decrease in Namib Desert Lichen Fields within South Africa.

The rich lichen fields on the Boegoeberg twins and some other localities, as well as the Alexander Bay Lichen Fields, are of the most sensitive and bizarre habitats on earth, they are especially sensitive to air pollution. A study needs to be done on the dominant movement of air from the planned port site, to ensure that it does not move onto the Alexander Bay Lichen Fields, and what scale of air pollution will be created by this development, as this might also negatively impact all the western side of the Namib desert.

All areas with rocky outcrops within the development site, including the Boegoeberg twins, contains high concentrations of endemic plants as well as unique lichen communities and should not be touched. Some of these areas is of such importance, that the erecting of towers on them should not be considered at all.

A large section in the southern part of the scope area for this development host the largest colonies of brant’s whistling rats south of the Orange River, which has unique vegetation associated with them. Disturbances to these areas can lead to total collapse of ecosystems and should be avoid at all costs.

Furthermore, in the eastern side of the scope area, are unique vegetation associated with harvester termites, called heuweltjies. These ancient colonies of termites have slowly been driving unique evaluation of flora in the area and should not be disturbed at all costs.

The Visagiesfontein hill is the highest point in alleviation on the coastal plains of the Richtersveld. The hills have an ancient underlying dune, densely covered with vegetation, including lichens, which together forms a fog oasis, allowing such dense vegetation to exist in the arid northern coastline of South Africa. This vegetation hosts several endangered species, including some rare species only recently discovered. The dense vegetation on this hill also allows for high concentrations of fauna to survive, including one of the largest colonies of desert rain frogs (*Breviceps macrops*).

It is important to pay attention to the publication "A Perfect Storm" (Jurgens et al. 2025) which explains how easily small disturbances in a windy area such as Boegoeberg planed port area, can become catastrophic. At all costs, development should be limited only to the yellow areas as indicated in Image 22, to prevent an environmental catastrophe. Developing the yellow areas, could actually be of conservation importance and prevent the movement of sand from these areas into non disturbed areas east of the mines. It is however of great importance that air pollution needs to be limited, to prevent major die backs of lichens not only on Boegoeberge but all of the Namib Desert which air potentially could be impacted by Boegoebaai.

Image 22: map of low biodiversity areas which solely should be considered for future development.

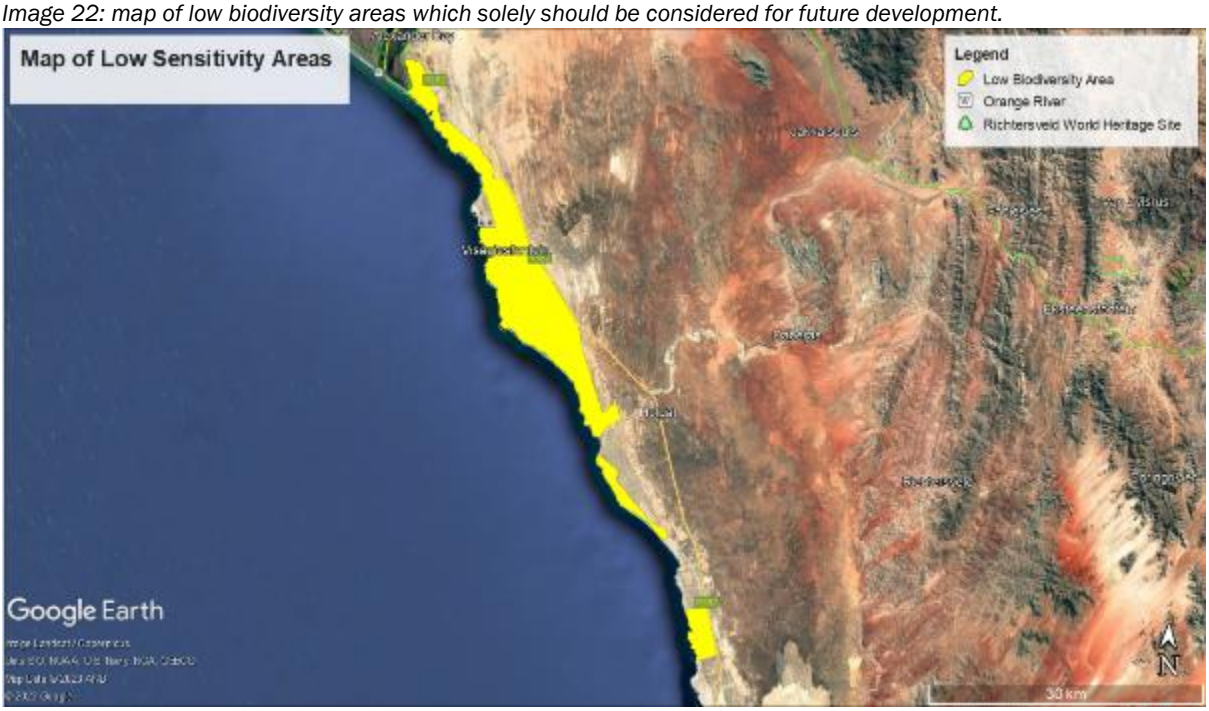


Image 23: map how high sensitive habitats which should not be considered for future development.

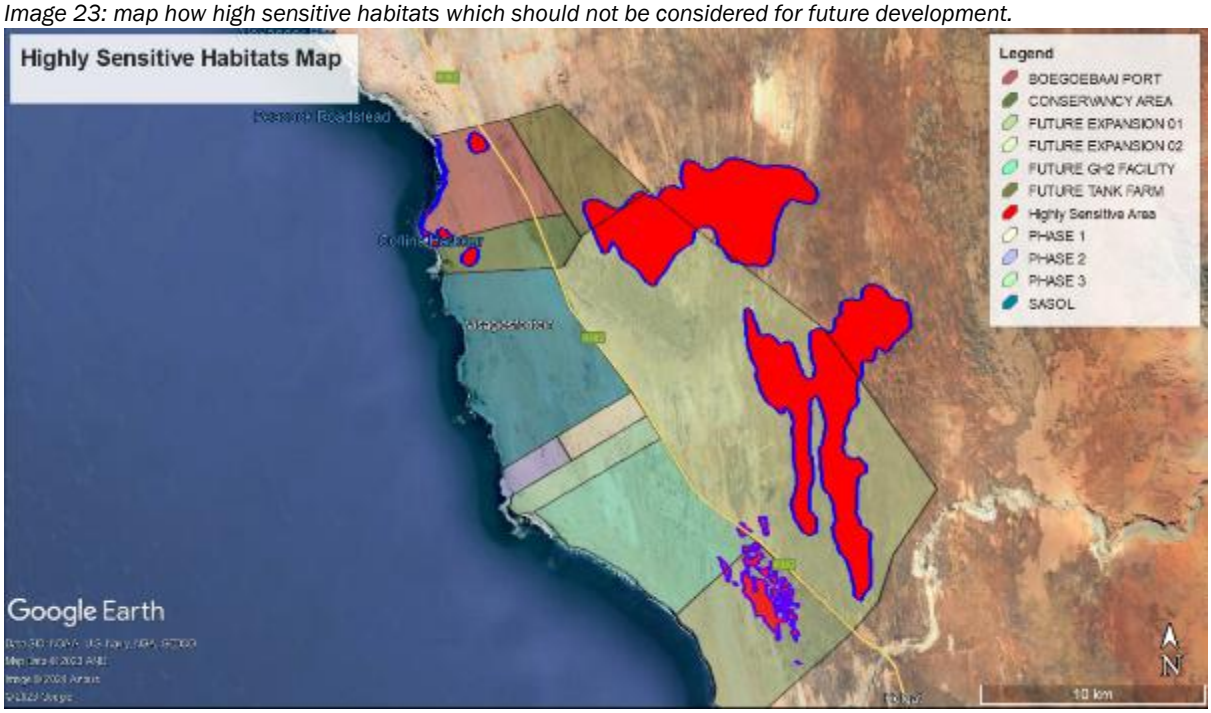


Image 24: map showing section of development area, in green which is medium sensitive, however needs to be compared with image 23 in this document. This green zone should not be considered for development, as it will have detrimental negative impacts on the high sensitivity areas.

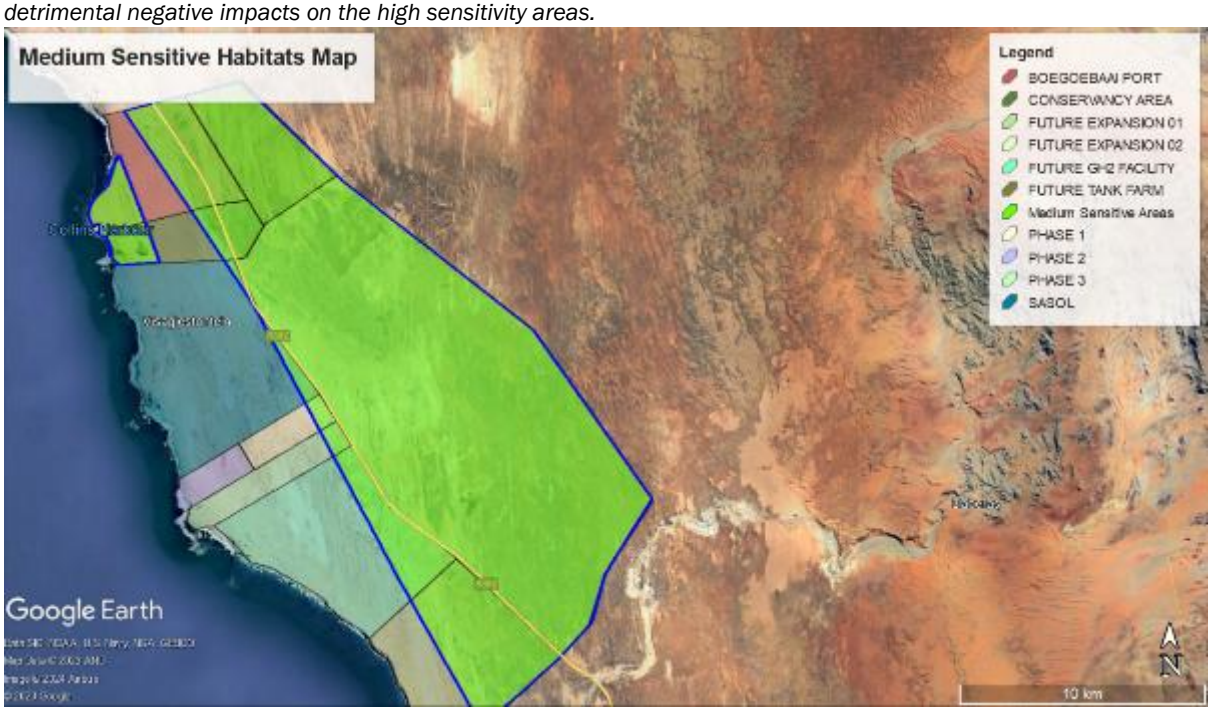


Image 25: Sensitivity map of the Richtersveld.

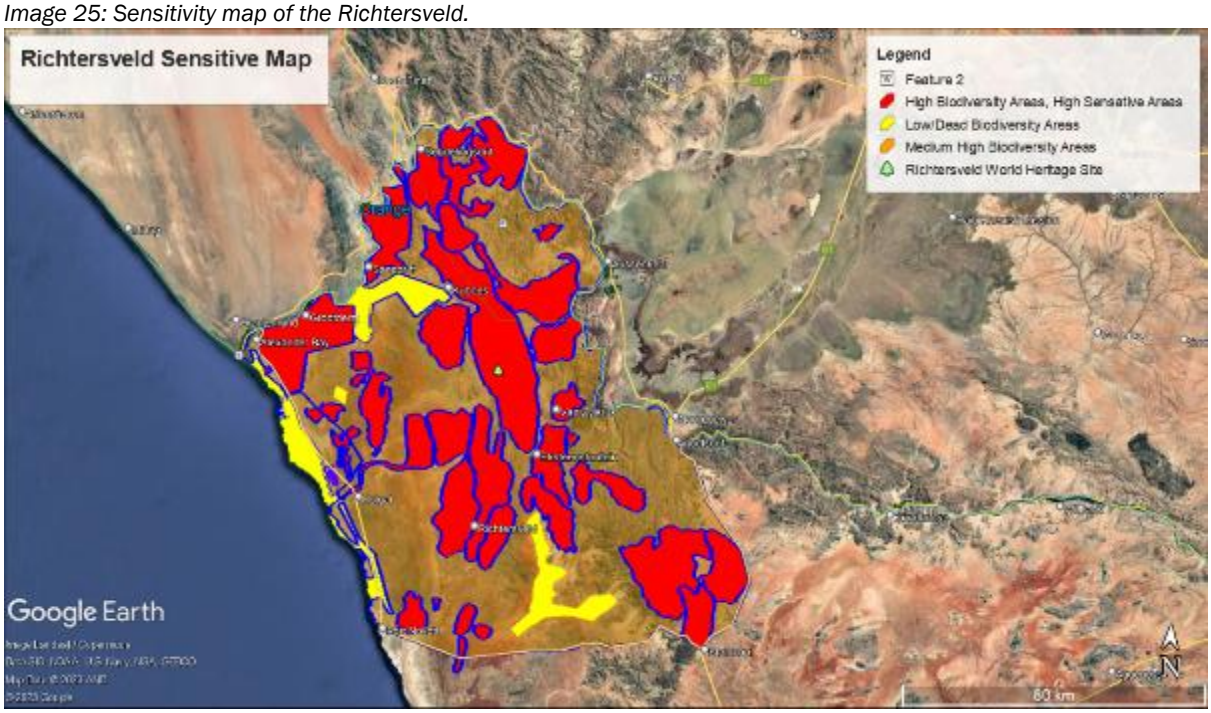
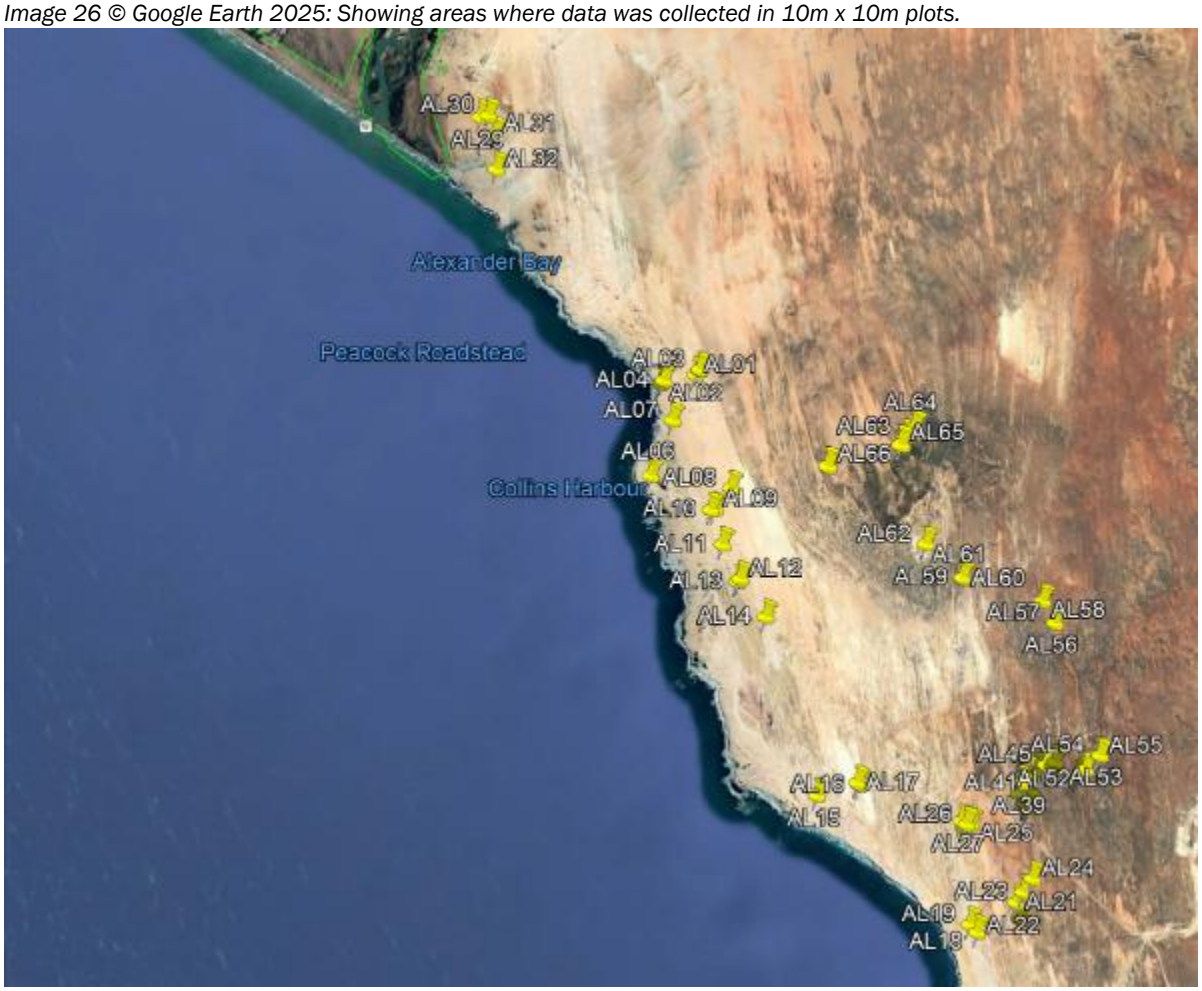


Image 26 © Google Earth 2025: Showing areas where data was collected in 10m x 10m plots.



REFERENCES

Vegetation Types of South Africa, Swaziland and Lesotho (Mucina and Rutherford, 2006).

Enchanted Wilderness of the Richtersveld (G. Williamson 2000)

Plants of the Greater Cape Floristic Region 2: The Extra Cape Flora (D.A.Snijmann 2013)

Acocks, J.P.H., 1988. Veld types of South Africa, third ed. Memoirs of the Botanical Survey of South Africa, 57. Department of Agriculture and Water Supply, Pretoria.

Bruyns, P.V., 2005. Stapeliads of southern Africa and Madagascar, vol. 2. Umdaus Press, Pretoria.

Conservation International, 2013. Succulent Karoo. http://www.conservation.org/where/priority_areas/hotspots/africa/Succulent-Karoo/Pages/biodiversity.aspx (accessed on 21/05/2013).

Convention on Biological Diversity, 2012. Report of the Sixteenth Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (http://www.cbd.int/doc/meetings/cop/cop-11/official/cop-11-03-en.pdf (accessed on 22/01/2013)).

Cowling, R.M., Hilton-Taylor, C., 1994. Patterns of plant diversity and endemism in southern Africa: an overview. In: Huntley, B.J. (Ed.), Botanical

Diversity in Southern Africa. Strelitzia, 1. National Botanical Institute, Pretoria, pp. 31–52.

Desmet, P., Cowling, R.M., 2004. Succulent Karoo. In: Mittermeier, R.A., Gil, P.R., Hoffman, M., Pilgrim, J., Brooks, T., Mittermeier, C.G.,

Lamoreux, J., Da Fonseca, G.A.B. (Eds.), Hotspots Revisited. CEMEX, Mexico, pp. 134–138.

Gibbs Russell, G.E., 1987. Preliminary floristic analysis of the major biomes in southern Africa. Bothalia 17, 213–227.

Gibbs Russell, G.E., Retief, E., Smook, L., 1984. Intensity of plant collecting in southern Africa. Bothalia 15, 131–138.

Goldblatt, P., Manning, J.C., 2007. A revision of the southern African genus Babiana, Iridaceae: Crocoideae. Strelitzia, 18. South African National Biodiversity Institute, Pretoria.

Hartmann, H.E.K. (Ed.), 2001. Illustrated Handbook of Succulent Plants: Aizoaceae F-Z. Springer-Verlag, Berlin.

Hilliard, O.M., 1994. The Manulea: A Tribe of Scrophulariaceae. Edinburgh University Press, Edinburgh 331 (506).

Hilton-Taylor, C., Le Roux, A., 1989. Conservation status of the fynbos and karoo biomes. In: Huntley, B.J. (Ed.), Biotic Diversity in Southern Africa: Concepts and Conservation. Oxford University Press, Cape Town, pp. 202–223.

Holmgren, P.K., Holmgren, N.H., Barnett, L.C., 1990. Index Herbariorum, Part 1: The Herbaria of the World, eighth ed. New York Botanical Garden, New York.

Low, A.B., Rebelo, A.G. (Eds.), 1996. Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs & Tourism, Pretoria.

Magee, A.R., VanWyk, B.-E., Tilney, P.M., Downie, S.R., 2009. Generic delimitations and relationships of the Cape genera Capnophyllum, Dasispermum, and Sonderina, the North African genera Krubera and Stoibrax, and a new monotypic genus of the subfamily Apioideae (Apiaceae). Systematic Botany 34 (3), 580–594.

Milton, S.J., Yeaton, R.I., Dean,W.R.J., Vlok, J.H.J., 1997. Succulent Karoo. In: Cowling, R.M., Richardson, D.M., Pierce, S.M. (Eds.), Vegetation of Southern Africa. Cambridge University Press, Cambridge, pp. 131–166.

Minnaar, H. 2006. Die geologie van die Richtersveld Nasionale Park in Suid Afrika. Internal report for SANParks, Council for Geoscience, Upington.

Mucina, L., Rutherford,M.C. (Eds.), 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Land Type Survey Staff. 1987. Land types of the map 2816 Alexander Bay, 2818 Warmbad, 2916 Springbok, 2918 Pofadder, 3017 Garies, 3018 Loeriesfontein. Memoirs on the Agricultural Natural Resources of South Africa. No. 9. ARC-Institute for Soil, Climate and Water, Pretoria.

NEMBA (National Environmental Management: Biodiversity Act), 2004. DRAFT NEMBA REGULATIONS, Gazetted: 3 April, 2009.

Red list of South African plants version 2013.1. http://redlist.sanbi.org/ (accessed 05/2013).

Snijman, D., 1984. A revision of the genus Haemanthus L. (Amaryllidaceae). Journal of South African Botany Supplementary 12, 1–139.

Soil Classification Working Group. 1991. Soil classification: A taxonomic system for South Africa. Memoirs on the Agricultural Natural Resources of South Africa. 15: 1–262.

Von Staden, L., Raimondo, D., Foden, W., Von Staden, L., Raimondo, D., Foden, W., 2009. Introduction. In: Raimondo, D., Von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kamundi, D.A., Manyama, P.A. (Eds.), Red List of South African plants.

Van Jaarsveld, E. 1980. 'n Voorlopige verslag oor die plantegroei van die Richtersveld met spesifieke verwysing na die bome en struike van die gebied. Trees in South Africa Oct.-Dec. 1980, 58-84. Strelitzia, 25. South African National Biodiversity Institute, Pretoria, pp. 1–5.

White, A., Dyer, R.A., Sloane, B.L., 1941. The Succulent Euphorbieae, vol. 1. Abbey Garden Press, Pasadena.

A socio-ecological study on natural resource use by pastoralids in and around the Richterveld National Park Lena Michler 2016

An updated plant checklist for Tankwa Karoo National Park, South Arica H.M.Steyn, S.P.Bester, H. Bezuidenhout 2013

Four new species of Ursinia (Asteraceae, Anthemideae) from South Africa, with an updated key to the genus in Namaqualand Anthony R. Magee, James S. Boatwright & Ladislav Mucina 2014

Taxonomic notes on the Acanthopsis disperma-hoffmannseggiana complex (Acanthaceae, tribe Acantheae), with an interim key to members of the genus Hester M Steyn & Abraham E. Van Wyk 2015

New species, combinations and range extensions in Hesperantha Ker Gawl. (Iridaceae: Crocoideae) from western South Africa P. Goldblatt, J.C.Manning, P.C.V van Wyk 2015

New relatives of Oxalis pes-caprae (Oxalidaceae) from South Africa F. Roets, K.C. Oberlander, L.L. Dreyer 2014

Discovery of substantial Oxalis (Oxalidaceae) diversity and endemism in an arid biodiversity hotspot Kenneth C. Oberlander, Francois Roets & Leanne. L. Dreyer 2014

Two new Oxalis species (Oxalidaceae) from the Ai-Ais / Richtersveld Transfrontier Park, South Africa F. Roets, K.C. Oberlander, L.L. Dreyer 2013.

The genus Pauridia (Hypoxidaceae) amplified to include Hypoxis sect. Ianthe, Saniella and Spiloxene, with revised nomenclature and typification. Deirdre A. Snijman & Alexander Kocyan 2013

New combination and a complete list of Asparagus species in southern Africa (Asparagaceae) A.C. Fellingham and N.L. Meyer 1995

A revision of the South African species of Anthericum, Chlorophytum and Trachyandra by A. Amelia Obermeyer.

The Relevance of fog and dew precipitation to succulent plant hydrology in an arid South African Ecosystem Ignatious Matimati 2009

Winter growth phenology and leaf orientation in Pachypodium namaquanum (Apocynaceae) in the succulent karoo of the Richtersveld, South Africa P.W.Rundel, R.M.Cowling, K.J.Esler, P.M.Mustart, E.van Jaarsveld, H.Bezuidenhout 1995.

Namaqualand, South Africa – an overview of a unique winter-rainfall desert ecosystem R.M. Cowling, K.J.Esler & P.W. Rundel 1999

Hartmann, HEK (2001). Illustrated Handbook of Succulent Plants. Berlin, Germany: Springer.

Lichen sensitivity to air pollution, Nash, T.H., III, DOI: 10.1017/CBO9780511790478.016 (2008)

Appendix 1 Checklist of Plant Taxa Observed

Table 1: A List of the higher plant taxa observed. Total taxa observed = 331.

Taxon Name	Taxon Name	Taxon Name
Adenogramma glomerata	*Drosanthemum hispidum*	*Monsonia ciliata*
Adromischus marianiae var. *hallii*	*Drosanthemum inornatum*	*Monsonia luederitziana*
Adromischus montium-klinghardtii	*Drosanthemum luederitzii*	*Monsonia patersonii*
Aizoon crystallinum	*Eberlanzia cyathiformis*	*Monsonia patersonii*
Aizoon fruticosum	*Eberlanzia sedoides*	*Monsonia salmoniflora*
Aizoon pruinosum	*Enneapogon scaber*	*Moraea namibensis*
Aizoon sarcophylla	*Eriocephalus brevifolius*	*Myxopappus acutilobus*
Albuca cooperi	*Eriospermum namaquanum*	*Nemesia arenifera*
Albuca flaccida	*Euphorbia angrae*	*Nemesia bicornis*
Albuca grandis	*Euphorbia burmanii*	*Nemesia saccata*
Albuca maxima	*Euphorbia caput-medusae*	*Odyssea paucinervis*
Albuca sp. nov	*Euphorbia dregeana*	*Oncosiphon grandiflorum*
Albuca suaveolens	*Euphorbia ephedroides* var. *ephedroides*	*Oncosiphon suffruticosum*
Aloe arenicola	*Euphorbia ephedroides* var. *imminuta*	*Ophioglossum polyphyllum*
Aloe framesii	*Euphorbia ephedroides* var. *imminuta*	*Ornithogalum falcatum*
Amellus nanus	*Euphorbia hamata*	*Ornithoglossum dinteri*
Amellus tenuifolius	*Euphorbia mauritanica*	*Ornithoglossum parviflorum* var. *parviflorus*
Amphibolia rupis-arcuatae	*Euphorbia rhombifolia*	*Ornithoglossum vulgare*
Amphibolia succulenta	*Euphorbia stapelioides*	*Osteospermum microcarpum*
Anacampseros namaquensis	*Felicia microsperma*	*Osteospermum oppositifolium*
Anacampseros retusa	*Felicia namaquana*	*Osteospermum polycephalum*
Anthospermum dregei	*Fenestraria rhopalophylla* subsp. *aurantiaca*	*Othonna furcata*
Anthospermum spathulatum subsp. *spathulatum*	*Ferraria schaeferi*	*Othonna quercifolia*
Antimima paripetala	*Ferraria variabilis*	*Othonna undulosa (filicaule)*
Antimima perforata	*Foveolina dichotoma*	*Oxalis bullulata*
Antimima sp. *nov Boegoeberg*	*Frankenia pomonensis*	*Oxalis copiosa*
Antizoma miersiana	*Frankenia pulverulenta*	*Oxalis psammophila*
Apiaceae sp.	*Gazania schenckii*	*Oxalis sonderiana*
Aptosimum viscosum	*Gazania tenuifolia*	*Pelargonium adriaanii*
Arctotis canaliculata	*Gethyllis grandiflora*	*Pelargonium echinatum*
Arctotis sp. *nov*	*Gethyllis linearis*	*Pelargonium fulgidum*
Asparagus capensis var. *capensis*	*Gladiolus saccatus*	*Pelargonium grandicalcaratum*
Asparagus capensis var. *litoralis*	*Gladiolus viridiflorus*	*Pelargonium minimum*
Asparagus declinatus	*Grielum grandiflorum*	*Pelargonium moniliforme*
Asparagus exuvialis	*Grielum humifusum*	*Pelargonium parviflorum*
Asparagus graniticus	*Harveya squamosa*	*Pelargonium sibthorpiifolium*
Asparagus juniperoides	*Hebenstretia integrifolia*	*Pelargonium sp. nov*
Asparagus undulatus	*Hebenstretia parviflora*	*Peliostomum virgatum*
Atriplex vestita var. *appendiculata*	*Hebenstretia repens*	*Pharnaceum croceum*
Babiana hirsuta	*Hebenstretia robusta*	*Pharnaceum exiguum*
Babiana namaquensis	*Helichrysum dunense*	*Pharnaceum microphyllum*
Bulbine abyssinica	*Helichrysum hebelepis*	*Phragmites australis*
Bulbine ophiophylla	*Helichrysum herniarioides*	*Phyllopodium hispidulum*
Bulbine rhopalophylla	*Helichrysum leontonyx*	*Phyllopodium namaense*
Calobota angustifolia	*Helichrysum marmarolepis*	*Polygala leptophylla*
Calobota cinerea	*Helichrysum obtusum*	*Polygala mossii*
Calobota halenbergensis	*Heliophila cornuta* var. *squamata*	*Pteronia glabrata*
Capnophyllum leiocarpon	*Heliophila lactea*	*Pteronia onobromoides*
Caroxylon aphyllum	*Hermannia macra*	*Pteronia paniculata*
Caroxylon cf. pillansii	*Hermannia paucifolia*	*Quaqua armata* subsp. *maritima*
Caroxylon nollothensis	*Hermannia pfeilii*	*Quaqua inversa*
Caroxylon sp.	*Hermannia sp. nov*	*Radyera urens*
Caroxylon zeyheri	*Holothrix filicornis*	*Rhynchopsidium pumilum*
Centropodia glauca	*Holothrix cf. schlechteriana (possible new spec.)*	*Roepera cordifolia*

Taxon Name	Taxon Name	Taxon Name
Cephalophyllum compressum	*Hydnora africana*	*Roepera fusiforme*
Cephalophyllum ebracteatum	*Hyobanche sanguinea*	*Roepera morgsana*
Cephalophyllum rigidum	*Isolepis marginata*	*Roepera sp. nov*
Chaetobromus involucratus subsp. *dregeanus*	*Jamesbrittenia fruticosa*	*Ruschia cf. variabilis*
Cheiridopsis robusta	*Jamesbrittenia merxmuelleri*	*Ruschia fugitans*
Chenopodium murale	*Jordaaniella clavifolia*	*Ruschia pallens*
Chlorophytum viscosum	*Jordaaniella cuprea*	*Ruschia pollardii*
Chrysanthemoides incana	*Jordaaniella spongiosa*	*Ruschia* sp. (possible new)
Chrysocoma ciliata	*Jordaaniella uniflora*	*Salvia africana-lutea*
Cladoraphis cyperoides	*Juncus acutus* subsp. *leopoldii*	*Sarcocornia natalensis* var. *affinis*
Cladorapis spinosa	*Kedrostis psammophila*	*Schismum schismoides*
Coelanthum semiquinquefidum	*Kewa angrae-pequenae*	*Searsia longispina*
Colchicum irroratum	*Kewa salsoloides*	*Selago angustibractea*
Conicosia elongata	*Kohautia ramosissima*	*Selago namaquensis*
Conicosia pugoiniformis subsp. *alborosea*	*Lachenalia anguinea*	*Senecio abruptus*
Conophytum saxetanum	*Lachenalia klinghardtiana*	*Senecio aloides*
Cotula anthemoides	*Lachenalia xerophila*	*Senecio sarcoides*
Cotyledon orbiculatum subsp. *orbiculatum*	*Lampranthus otzenianus*	*Septulina glauca*
Crassothonna cylindrica	*Lampranthus stipulaceus*	*Solanum burchellii*
Crassothonna sedifolia	*Lapeirousia arenicola*	*Spergularia bocconi*
Crassothonna sparsiflora	*Lapeirousia barklyi*	*Spergularia media*
Crassula ammophila	*Lapeirousia macrospatha*	*Stapelia pulvinata*
Crassula atropurpurea var. *cultriformis*	*Lasiosiphon microphyllus*	*Stipagrostis ciliata* var. *capensis*
Crassula brevifolia subsp. *psammophila*	*Lavatera arborea*	*Stipagrostis obtusa*
Crassula columnaris subsp. *prolifera*	*Ledebouria undulata*	*Stipagrostis schaeferi*
Crassula deceptor	*Leipoldtia uniflora*	*Stoeberia beetzii*
Crassula elegans subsp. *elegans*	*Lessertia candida*	*Stoeberia frutescens*
Crassula expansa subsp. *pyrifolia*	*Lessertia frutescens* subsp. *frutescens*	*Stoeberia utilis*
Crassula muscosa var. *muscosa*	*Limeum fenestratum*	*Suaeda plumosa*
Crassula muscosa var. *obtusifolia*	*Limonium dyeri*	*Teloschistes capensis*
Crassula natans	*Lotononis falcata*	*Teloschistes puber*
Crassula plegmatoides	*Lycium bosciifolium*	*Tetraene clavata*
Crassula pseudohemisphaerica	*Lycium decumbens*	*Tetraene patenticaula*
Crassula rudolfii	*Lycium ferocissimum*	*Tetragonia cf. fruticosa*
Crassula subaphylla subsp. *subaphylla*	*Lycium tetrandrum*	*Tetragonia decumbens*
Crassula tetragona	*Lyperia triste*	*Tetragonia echinata*
Crassula tomentosa var. *tomentosa*	*Manochlamys albicans*	*Tetragonia fruticosa*
Crotalaria meyeriana	*Manulea altissima*	*Trachyandra bulbinifolia*
Curio crassicaulis	*Manulea androsacea*	*Trachyandra ciliata*
Curio radicans	*Manulea minuscula*	*Trachyandra falacata*
Curio sulcicalyx	*Melolobium adenodes*	*Tridentea pachyrrhiza*
Cynodon dactylon	*Mesembryanthemum arenosum*	*Tylecodon paniculatus*
Cynorhiza typica	*Mesembryanthemum barklyi*	*Tylecodon reticulatus* subsp. *reticulatus*
Cyperus marginatus	*Mesembryanthemum brevicarpum*	*Tylecodon schaeferianus*
Dasispermum hispidum	*Mesembryanthemum cf. subnodosum*	*Tylecodon similis*
Deverra denudata subsp. *aphylla*	*Mesembryanthemum crystalinum*	*Tylecodon wallichii* subsp. *eclonianus*
Dianthus namaensis	*Mesembryanthemum deciduum*	*Veltheimia capensis*
Didelta carnosa var. *tomentosa*	*Mesembryanthemum dinteri*	*Veltheimia capensis*
Dimorphotheca polyptera	*Mesembryanthemum hypertrophicum*	*Wahlenbergia androsacea*
Dimorphotheca sinuata	*Mesembryanthemum marlothii*	*Wahlenbergia annularis*
Dipcadi crispum	*Mesembryanthemum noticflorum*	*Wahlenbergia asparagoides*
Dischisma spicatum	*Mesembryanthemum occulatum*	*Wahlenbergia prostrata*
Dregeochloa pumila	*Mesembryanthemum pseudoschlichtianum*	*Zaluzianskya affinis*
Drimia barbata	*Mesembryanthemum quartziticus*	*Zaluzianskya benthamiana*
Drimia elata	*Mesembryanthemum serotinum*	*Ziziphus mucronata*
Drimia occultans	*Mesembryanthemum tetragonum*	
Drosanthemum curtophyllum	*Microloma sagittatum*	

Table 2: Checklist of lower plant taxa observed. Total taxa observed = 91.

Acarospora gypsi-deserti	*Heterodermia namaquana*	*Santessonia namibensis*
Acarospora luederitzensis	*Lecanographa subcaesioides*	*Staurothele dendritica*
Acarospora ochrophaea	*Lecanora panis-erucae*	*Teloschistes capensis*
Arthothelium desertorum	*Lecanora* sp.	*Teloschistes chrysocarpoides*
Buellia cf. *follmannii*	*Lecanora sphaerospora*	*Teloschistes chrysophthalmus*
Buellia cf. *stellulata*	*Lecanora substylosa*	*Teloschistes puber*
Buellia follmannii	*Lecanorsa* cf. *substylosa*	*Tephromela austrolitoralis*
Buellia halonia	*Lecidea sarcogynoides*	*Tephromela nashii*
Buellia incrustans	*Lecidella crystallina*	*Toninia australis*
Buellia inturgescens	*Lecidella placodina*	*Tornabea scutellifera*
Buellia procellarum	*Ledidea sarcogynoides*	*Tortula atrovirens*
Buellia sipmanii	*Niebla cephalota*	*Trentepohlia* sp.
Buellia sp.	*Opegrapha culmigena*	*Usnea* sp.
Buellia stellulata	*Parmotrema perlatum*	*Xanthodactylon alexanderbaaii*
Caloplaca bonae-spei	*Parmotrema reticulatum*	*Xanthodactylon flammeum*
Caloplaca cinnabarina	*Parmotrema* sp.	*Xanthodactylon inflatum*
Caloplaca elegantissima	*Pertusaria pseudomelanospora*	*Xanthodactylon turbinatum*
Caloplaca gyalectoides	*Pertusaria velata*	*Xanthoparmelia arrecta*
Caloplaca namibensis	*Peterjamesia circumscripta*	*Xanthoparmelia cf. dregeana*
Caloplaca renatae	*Placidium squamulosum*	*Xanthoparmelia cf. incomposita*
Caloplaca rubelliana	*Podaxis* sp.	*Xanthoparmelia dregeana*
Caloplaca sp.	*Polytrichum* sp.	*Xanthoparmelia equalis*
Chrysothrix granulosa	*Ramalina angulosa*	*Xanthoparmelia hottentotta*
Combea mollusca	*Ramalina canariensis*	*Xanthoparmelia hueana*
Dimelaena radiata	*Ramalina fimbriata*	*Xanthoparmelia incomposita*
Diploschistes actinostomus	*Ramalina lacera*	*Xanthoparmelia namibiensis*
Dploicia canescens	*Ramalina melanothrix*	*Xanthoparmelia tentaculina*
Flavoparmelia soredians	*Ramalina* sp.	*Xanthoparmelia walteri*
Flavoparmelia sp.	*Roccella montagnei*	*Xanthoria sipmanii*
Gloeocapsa sp.	*Santessonia hereroensis*	
Grimmia laevigata	*Santessonia lagunebergii*	

Table 3: List of Species of Conservation Concern. Status = SANBI Red Data status. Total Species of Conservation Concern = 51. Total Red List species observed = 36.

Taxon Name	Status	Taxon Name	Status
Adromischus marianiae var. *hallii*		*Jordaaniella clavifolia*	VU
Adromischus montium-klinghartii	VU	*Jordaaniella uniflora*	NT
Albuca sp. *nov*		*Lachenalia klinghardtiana*	VU
Aloe arenicola	NT	*Lapeirousia barklyi*	VU
Aloe framesii	NT	*Lapeirousia macrospatha*	VU
Amphibolia succulent	NT	*Lasiosiphon microphyllus*	
Antimima perforata	CR	*Leipoldtia uniflora*	
Antimima sp. *nov*		*Mesembryanthemum marlothii*	
Arctotis canaliculata		*Monsonia ciliata*	
Babiana namaquensis	VU	*Monsonia pattersonii*	VU
Bulbine ophiophylla	EN	*Moraea namibensis*	EN
Bulbine rhopalophylla	VU	*Nemesia arenifera*	
Crassula ammophila	NT	*Nemesia saccata*	VU
Crassula brevifolia subsp. *psammophila*	VU	*Pelargonium adriaanii*	VU
Crassula plegmatoides	VU	*Pelargonium* sp. *nov*	
Crotalaria meyeriana	NT	*Phyllopodium hispidulum*	EN
Dregeochloa pumila	CR	*Phyllopodium namaense*	VU
Drimia barbata	CR	*Polygala mossii*	NT
Drimia occultans		*Quaqua armata* subsp. *maritima*	
Eberlanzia sedoides		*Quaqua inversa*	
Euphorbia angrae		*Stapelia pulvinata*	
Frankenia pomonensis	VU	*Tridentea pachyrrhiza*	CR
Gazania schenckii	CR	*Tylecodon schaeferianus*	VU
Helichrysum dunense	VU	*Wahlenbergia asparagoides*	NT
Helichrysum tricostatum	NT	*Wahlenbergia erophiloides*	
Jamesbrittenia merxmuelleri	EN		

CHAPTER 4

Biodiversity offset framework

CHAPTER 4:
Biodiversity offset framework

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Peer Reviewer	Susie Brownlie[2]

Disclaimer: The scope of this Offset framework is limited to the terrestrial environment – although some of the largest impacts are likely to be coastal and marine. This framework is limited by the challenges of framing offset implications from a series of planned developments with poor spatial resolution and in an area of extreme biodiversity sensitivity and transformation. Although an offset framework for the port precinct is the focus, there are large adjacent and regional impacts which almost certainly will be required for economic viability but difficult to predict. Ostensibly, there is sufficient mining damaged land on which to locate industrial infrastructure - and some of the renewable energy installations to power it - with minimal biodiversity impact and hence no requirement for offsets. In practice, however, the nature of the development and the ancillary industries' impacts are almost certain to be of a scale and nature as to result in significant widespread biodiversity loss that is difficult to circumscribe with current knowledge. All areas are approximate.

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Recommended citation: Botha, M. (2025). *Chapter 4: Biodiversity offset framework* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR

Executive Summary

Any large-scale infrastructure development in a recognised biodiversity hotspot is likely to need significant effective ecological compensation if it is to advance sustainability or claim regulatory compliance with biodiversity offset guidelines. This study explores the required compensation from the proposed Boegoebaai port and associated Special Economic Zone (SEZ). Usually, SEA identifies development constraints or opportunities and explores alternative locations for impacts. However, the Boegoebaai site locale appears to be fixed (although previous work has looked at alternatives (e.g. Botha & Desmet 2022). In this study, only terrestrial features and applicable offset type mitigation are considered. The scale of impact varies from just over 21 000 ha for a small GH2 scenario (Sc1) to >144 000 ha for a big GH2 scenario (Sc2), although smaller areas are likely to be impacted within the SEZ (Sc1 ≈420 ha; Sc2 ≈3400 ha). Spatial resolution of the impacts for either scenario is insufficient to provide concrete guidance. Instead, considerations for project specific offset assessment, location and implementation are offered.

Several biodiversity features likely to be impacted are threatened, range restricted or of conservation concern and have corresponding high offset ratios. Currently, restrictive statutory planning features (CBAs, listed threatened ecosystems), internationally listed designations (e.g. KBAs) and habitat for many species of conservation concern (SCC) cover large parts of the SEZ and its immediate vicinity see Figure S.1) which imply fatal flaws and/or that offsets will be triggered. Refining sensitivities at site scale has been done by various specialists (Day et al 2025). There is some overlap between local community identified priority sites and expert identified sensitive areas. This provides insight into areas for developments to avoid and where to optimally locate offsets.

Many features have biodiversity planning targets that cannot be met, bringing impact acceptability into question. Strict avoidance of biodiversity loss is the only defensible way forward. Further, any appropriate impact mitigation is framed as 'Ecological Compensation' in regulatory guidelines. Where features aren't CR or currently protected, offsets might still be possible. Implementation modalities for compensation or offsets can be similar, and the terms are used interchangeably in this context.

The receiving environment along large stretches of the coast is degraded by mining and mobilised sand scour plumes. Where possible, all developments should be located on disturbed mining areas, as this would not violate the mitigation hierarchy and would not trigger offsets. However, it is unwise to designate windblown and sand plume areas as similarly transformed and thus not triggering offsets. Low offset multipliers are proposed for these areas as restoration may still be possible (and desirable from a GH2 facility and infrastructure management view).

Ratios are proposed for impacted features, aligned to regulatory requirements and the expert-assessed sensitivities (Table 4-1). If these could be confirmed by authorities and applied in project-specific offsets, it would remove much uncertainty or contentiousness from specific offset studies. Applying these ratios to the likely impacts from Sc1 (small GH2) indicates that around 40 000 ha of offsets might be required.

There are dangers of project-level offset assessment and ad hoc implementation of offsets – as suitable sites may become unavailable over time or costs are driven unacceptably high. The primary task for project level EIAs here is to identify, negotiate and secure access to suitable offset sites and the most appropriate and durable implementation or management arrangements – not just the technical calculus of loss:gain metrics. Proactive schemes are better at addressing cumulative impacts, managing threats and ensuring implementation and outcomes achieved.

Three large scale offset receiving environments are proposed for offsetting the impacts associated with the port and SEZ. It is plausible that most of the SEZ impacts can be offset in these receiving environments. Sufficient area exists within identified and approved protected area (PA) expansion priority focus areas to offset impacts from regional RE developments. This is explored in WP2.

A proactive offset scheme pilot exists around Namaqua National Park, and this could be expanded to the receiving environments close to the SEZ for local impacts - and other parks or reserves to cater for regional impacts. Much of the renewable energy (RE) generation will happen regionally across the district (or even province) and will need to be offset in affected ecosystems.

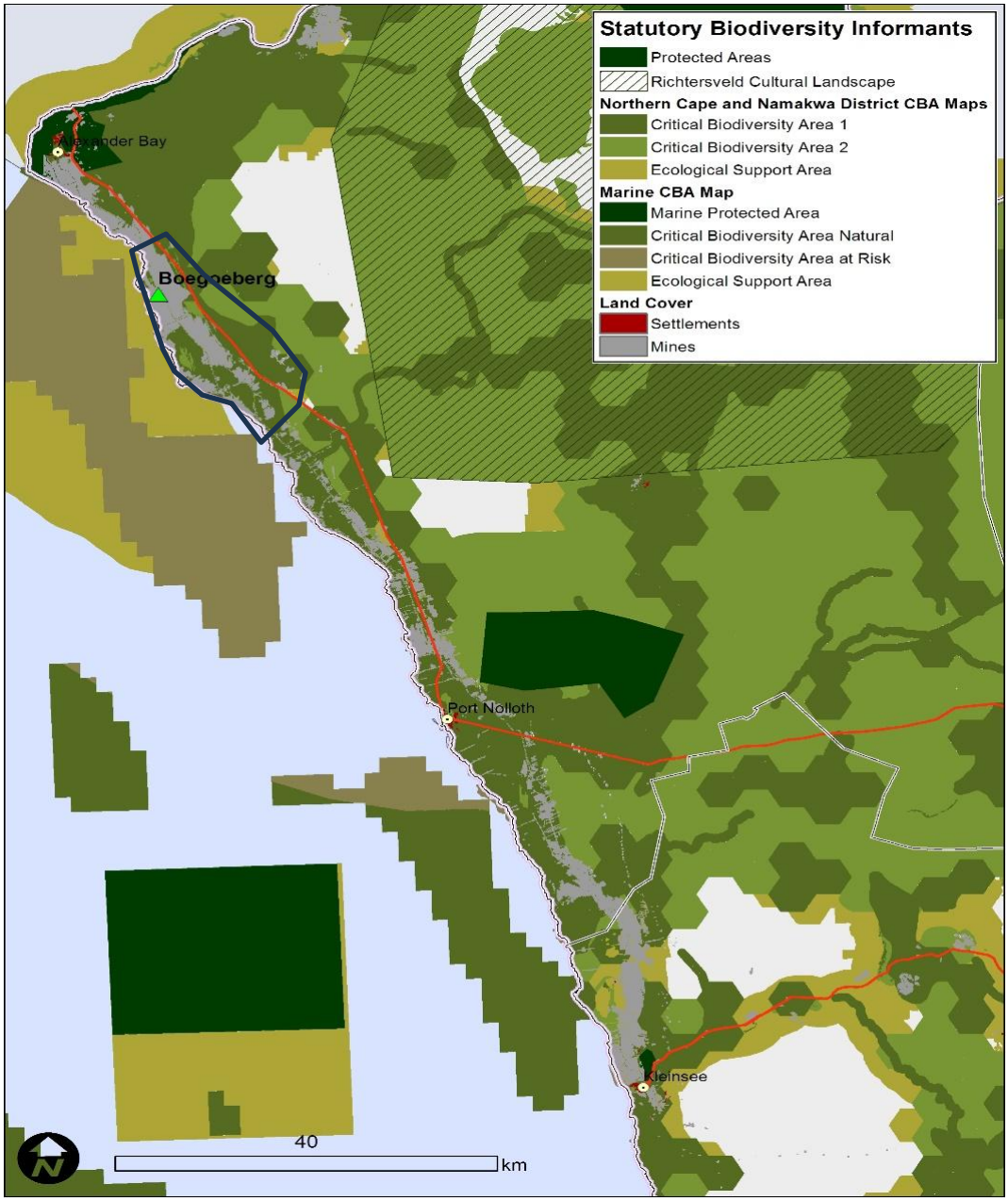


Figure S.1: Previously identified CBA (DENC 2016) potentially affected by development impacts at Boegoebaai and the SEZ (Blue outline). Offsets for impacts on these statutory planning features, if they are possible, would be substantial. Ecological compensation would be required if biodiversity targets cannot be met, or features are irreplaceable.

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Figures

Figure S.1: Previously identified CBA (DENC 2016) potentially affected by development impacts at Boegoebaai and the SEZ (Blue outline). Offsets for impacts on these statutory planning features, if they are possible, would be substantial. Ecological compensation would be required if biodiversity targets cannot be met, or features are irreplaceable. 4-3

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Definitions[1]

"**Biodiversity Offset**" *the measurable outcome of compliance with a formal requirement contained in an environmental authorisation to implement an intervention that has the purpose of counterbalancing the residual negative impacts of an activity, or activities, on biodiversity, through increased protection and appropriate management, after every effort has been made to avoid and minimise impacts, and rehabilitate affected areas*.

"**Ecological Compensation**" - *the outcome of measurable actions to protect, restore and manage priority biodiversity, aimed at compensating for residual negative impacts on irreplaceable biodiversity and ecological infrastructure where these impacts cannot be offset and which should, instead and in the first instance, be avoided.*

"**Trade-off**" - *in the biodiversity context involves exchanging a negative outcome for biodiversity with another positive outcome, which does not necessarily benefit biodiversity. Trading off biodiversity for other positive outcomes is not a form of mitigation, like biodiversity offsetting. It falls outside of the scope of the mitigation hierarchy*.

[1] Readers are advised to consult the full list of definitions in in the National Biodiversity Offset Guideline (DFFE 2023)

Acronyms

CBA	Critical Biodiversity Area	NCEDA	Northern Cape Economic Development and Investment Promotion Agency
CPA	Community Property Association	NPAES	National Protected Area Expansion Strategy
CR	Critically Endangered – a Red List category for ecosystems or species	NEMA	National Environmental Management Act (Act 101 of 1998) as amended
DAERL	Department of Agriculture, Environment, Rural Development & Land Reform – N Cape.	NEMBA	National Environmental Management Biodiversity Act (Act 10 of 2004)
DBCM	De Beers Consolidated Mines	NEMPA	National Environmental Management Protected Areas Act (Act 57 of 2003)
DEDAT	Department of Economic Development & Tourism. Parent of NCEDA – N Cape	PA	Protected Area
DFFE	Department Forestry, Fisheries & the Environment. (Previously DEA) - National	PBO	Public Benefit Organisation
DMPR	Department of Mineral & Petroleum Resources - National	PFA	Priority Focus Area (of the National Protected Area Expansion Strategy)
DTSL	Department Transport, Safety and Liaison – N Cape	PV	Photovoltaic
EGI	Electricity Grid Infrastructure	REDZ	Renewable Energy Development Zone
EIA	Environmental Impact Assessment	REIPPP	Renewable Energy Independent Power Producer Programme
EN	Endangered - a Red List category for ecosystems or species	SCC	Species of Conservation Concern
ESA	Ecological Support Area	SDF	Spatial Development Framework
GH2	Green Hydrogen – being H_2 produced and transported with renewable energy	SEZ	Special Economic Zone
KBA	Key Biodiversity Area	WEF	Wind Energy Facility
mtpa	Million tons hydrogen equivalent per annum		

CHAPTER 4: BIODIVERSITY OFFSET FRAMEWORK

4.1 BACKGROUND

Biodiversity offsets are outcomes-focused mitigation measures designed to safeguard features of conservation concern in areas where they would be protected from threatening processes and future direct impacts. In South Africa, offset implementation is framed by a regulatory Guideline (DFFE 2023), issued by the National Minister under the National Environment Management Act (Act 101 of 1998). Several provinces have issued Information Documents or less formal Guidelines on biodiversity offsets, but only the National Guideline is currently applicable in the N Cape.

Biodiversity offsets have had some success in the Northern Cape, and in the Namaqualand District specifically. Examples are to be found around Aggeneys (Gamsberg Zinc Mine), Springbok (Kangnas Wind Farm), and Namaqua National Park (Eskom – Gromis line). Several others are in various implementation stages. Implementation agreements for proactive offset schemes have been concluded for wind farms and heavy metals mines. Most of these offsets have been possible due to the availability of readily-purchased private land and willing implementing agents.

Offsets are not typically framed in the context of an SEA and South Africa has had mixed results from strategic offset frameworks for large industrial developments. This chapter builds on a Strategic Offset Perspective for NCEDA (Botha & Desmet 2022 and see Figure 4-1) but focuses on the terrestrial components only. Some of the largest impacts on most important biodiversity features will likely be in the marine and coastal realms – for which guidance is sorely needed – but which are unfortunately out of scope for this study. Offsets for residual freshwater biodiversity impacts are poorly developed in the dry west where improving wetland ecosystem function is challenging (due to the episodic and ephemeral nature of the systems).

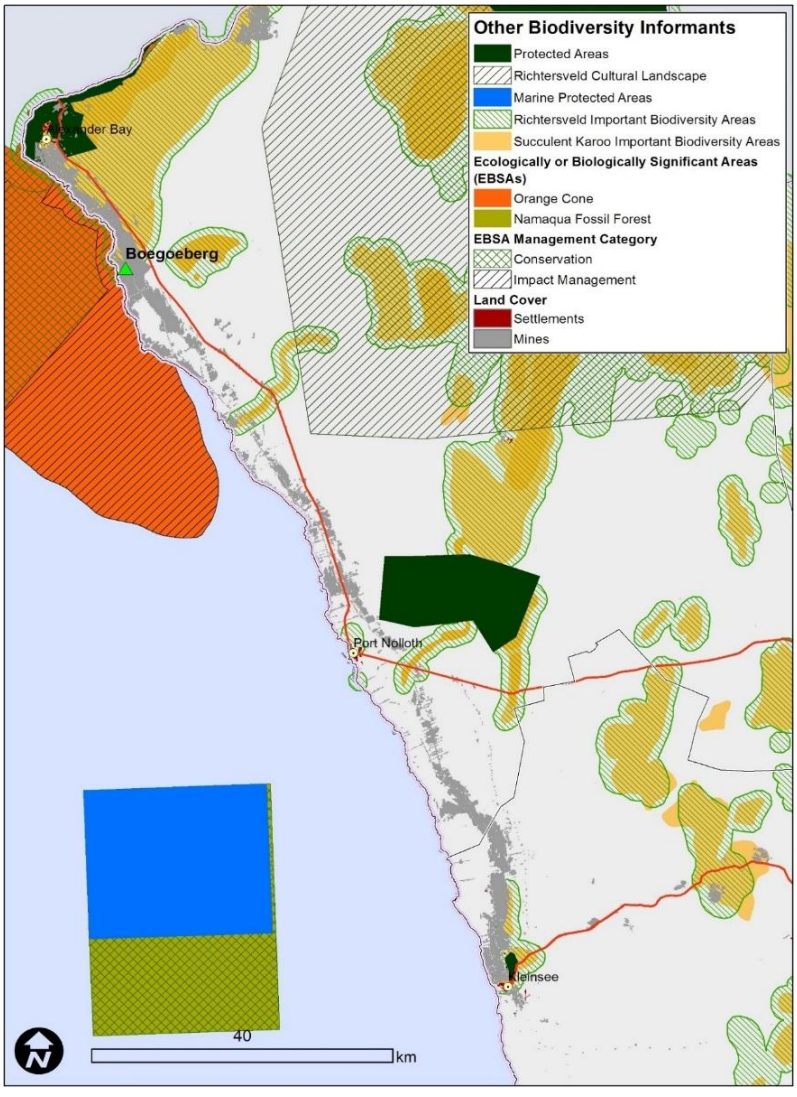


Figure 4-1: Previous guidance on avoidance and mitigation for potential impacts at Boegoebaai. From Botha & Desmet (2022). Note, the current study refines and augments the important biodiversity areas with site-specific data and community-mapped priorities, but their locations have not shifted much.

SEA usually relies on sound foundational data and assumes a certain degree of flexibility of potential impacting activities and management of threatening processes. This is not the case with Boegoebaai where detailed biodiversity knowledge informing current statutory planning tools is low, and the primary impact (the harbour and precinct) is seemingly fixed. There is flexibility around locating the energy generation and modest flexibility for the ancillary industries in the SEZ. However, the scale of potential impact is unclear at this stage – and it may end up being gargantuan. Several impacts are possibly not adequately captured in current planning (e.g. additional housing, services - See Section 4.7). Cumulative biodiversity impacts at this scale are difficult to forecast and mitigate. Scenarios have been developed to explore this – a Baseline (with no GH2 and SEZ development; Sc 1 being a small GH2 roll out (1 mtpa) and Sc2 being a big GH2 (7 mtpa) roll out. Indirect and induced impacts are similarly unclear, but may be very large, especially considering weak land use control in the area.

Furthermore, the ToRs for the study require framing offset requirements against a baseline scenario of no development at Boegoebaai or the SEZ. This implies taking a view on the continued degradation of the landscape through mining activities, the likelihood of mine rehabilitation success, continued sand plume movement and further plume initiation from overgrazing and/or climate factors. Other nearby developments (WEF, PV) have already been approved – their development may help manage impacts (through e.g. physical barriers to wind) or could exacerbate them (through new unforeseen disturbance). Technically, it is unwise to discount potential offset liabilities for new developments by assuming an ongoing background rate of loss of biodiversity and ecosystem integrity, and designing offsets to somehow slow this rate. Project-specific offset investigations should not assume a dynamic (declining) baseline as this most often leads to ongoing erosion of biodiversity.

Technically, several of the features likely to be impacted by even a modest GH2 development are designated as “Critically Endangered” or the impacts will preclude conservation targets being met due to extreme range restriction or low conservation “optionality” of impacted species or features. This implies that impact significance could be rated as Very High or represents a Fatal Flaw for which offsets are inappropriate. Further, following the Offset Guide (DFFE 2023) the correct terminology for addressing these impacts is “Ecological Compensation” as it focuses on unrelated biodiversity features being conserved elsewhere.

Although implementation of Ecological Compensation could be methodologically similar to biodiversity offsetting, it usually involves “trading-up” or “out-of-kind” compensation. This introduces a level of judgement and contestability into project-level offset metrics and locations. It’s possible that the only way to avoid this challenge is by proactive offsetting and/or the implementation of clear SEZ mitigation rules prior to any development initiation. This chapter explores some of these issues, noting that proactive schemes still cannot address irreversible loss of biodiversity, and should not be used to circumvent the need to avoid impacts wherever possible.

Implementation constraints may end up being more challenging than offset metrics, site selection and design for ensuring adherence to offset principles, long term biodiversity outcomes and the persistence of certain natural features and processes:

- Key informants (especially the existence of mining or prospecting rights) are not publicly available and may frustrate attempts to secure offset sites. Existing information is aggregated at the cadastre level which isn’t helpful in this landscape (due very large cadastres) see Figure 4-5.

- The state agencies best placed to pursue securing, managing and stewarding the ecosystems are under financial strain, and have limited capacity for proactive extension and conservation management. Additional resources will have to be made available to build the offset implementation capacity timeously and may well be better placed with third party private contractors.

- Although ten specific areas have been proposed by community structures for biodiversity (and cultural site) protection (VVVT 2024), the surrounding communities have a long and difficult relationship with conservation (as well as mining and other interlopers) – and may not be receptive to conservation land use outcomes on the scale required to offset the impacts. The remoteness of the site, lack of clear community governance arrangements and supporting NGOs makes conservation challenging here. There is little concrete guidance that this framework can offer without deeper consultation with affected communities that was not possible in this SEA. This is key in project level EIAs.

Although an exhaustive study of other SEZ and IDZ proactive offset frameworks isn't in the scope of work, there are some useful emerging lessons. These include: the challenge of sequential decision making (SEZs and IDZs evolve and grow) and the perils of path dependency created by initial offset metrics, criteria or requirements that don't sufficiently address the impacts; difficulty of assigning direct, indirect and induced impacts to the initial establishment/layout or specific SEZ components and quantifying appropriate mitigation; catering for background rates of biodiversity loss and unauthorised impacts or landuse conflicts in offset receiving areas; and the political imperatives of pursuing specific projects with potentially attractive economic or political prospects but significant biodiversity impacts overriding environmental safeguards. All these lessons point to recommending an offset framework for Boegoebaai that is comprehensive, averse to risking further erosion of biodiversity, and as pre-emptive and proactive as possible. This informs the proposed offset framework for the Boegoebaai Port Precinct and SEZ.

4.2 THE ECOLOGICAL-SOCIAL-LEGAL RECEIVING ENVIRONMENT

The National Guideline on Biodiversity Offsets (DFFE 2023) under the National Environmental Management Act (Act 107 of 1998) sets out the offset process, how project-level studies must be conducted and the key criteria and choice of metrics for offset quantification and implementation arrangements. Any development project triggering listed activities would likely need to compile a specific offset report for considering by the competent authority. Although the guideline refers to certain strategic aspects such as considering candidate offset location, choice of implementing partner, funding and implementation agreements, the guideline is not overly prescriptive. Importantly, it recognises that proactive schemes may be developed within 'offset receiving areas', and that authorities may approve such schemes. This approach seems preadapted for large scale planned industrial developments such as the Boegoebaai Port and SEZ.

The Boegoebaai port and SEZ would be in a complex and contested region. Decades of poorly managed mining and a legacy of little to no rehabilitation and little benefit sharing with local communities has left a degraded environment. Large areas with poor regulatory control and low habitation have resulted in 'wild cat' or unregulated mining and declining ecosystem integrity over at least the last three decades. Historic drought and mobilised sand plumes are damaging extensive areas in this fragile yet biodiverse region. Liability for rehabilitation and restoration of much of the landscape now lies with government (especially Alexkor – the state mining company), yet little concrete progress has been made.

The regional perspective in Work Package 2 (WP2) of the SEA will frame appropriate mitigation for two scenarios: a small GH2 roll out (Sc1 of 1 mtpa - triggering impact of ≈21 400 ha) and a big GH2 (Sc 2 of 7 mtpa impact of ≈144 00 ha) against a 'no-go' scenario. The difference in the scenarios isn't catered for in this local-scale offset framework for the port surrounds, but would create vastly different offset implications and implementation arrangements.

Although detailed parameters of footprints are not available, it can be assumed that the following impacts would materialise at the local and regional scales:

- Direct loss of listed ecosystems, CBAs, protected area expansion priority focus areas, and expert-identified sensitive features.
- Habitat loss of SCC.
- Direct mortality of SCC, especially large, range-restricted and slow-maturing species.
- Disruption or severance of key ecological functioning and connectivity, including for adaptation.

4.2.1 Ecosystems, CBAs, Protected Areas and other sensitive features impacted

The preliminary list of biodiversity features and desktop informants of the region is illustrated in Figure 4-2 and summarised in Day *et al (*2025). The current extent of these features is set out in the terrestrial ecology (Van Rooyen et al Chapter 3e), avifauna, (Froneman et al Chapter 3b) and fauna components (Niemandt Chapter 3d). The following ecosystems/ vegetation types occur in the precinct and SEZ: Richtersveld Coastal Duneveld (CR); Namib Seashore Vegetation (CR); Northern Richtersveld Yellow Duneveld (LC); Oograbies

Plains Sandy Grassland (LC); Richtersveld Sandy Coastal Scorpionstailveld (LC); and Western Gariep Plains Desert (LC) (Botha & Desmet 2022, Van Rooyen et al Chapter 3e)[2].

The SEZ project area hosts multiple CBAs, significant impacts on which may be viewed as fatal flaws by I&APs during project-level EIAs (See Figure 4-2). Further, the site lies within the Namaqualand Sandveld North Key Biodiversity Area (KBA), implying that there will be international implications arising from adverse impacts.

The only notable Protected Areas (PAs, see Figure 4-3) in the immediate vicinity of the SEZ are the Orange River Mouth Nature Reserve (DAERL – 11km to the Northwest) and the Oograbies Wes Section of the Richtersveld National Park (SANParks – 37 km to the Southeast) - the actual declared area of which is unclear. The Richtersveld Cultural and Botanical Landscape World Heritage Site lies just East of the precinct and SEZ, while the WHS Core and Richtersveld National Park are >40 km to the Northeast of the proposed Port. No significant impacts could be permitted in these PAs and they couldn't host offset receiving areas (except possibly the Cultural and Botanical Landscape outside of the core National Park – although this requires policy confirmation from the DFFE).

SANParks' historic PA expansion priorities are codified in the Richtersveld Park Management Plan and focus around Oograbies Wes and up the coast almost to the Holgat River (although this is not favoured by current SANParks Management as it will be costly, doesn't enhance any tourism opportunities in the National Park, and distracts attention from other important expansion initiatives). Current National Protected Area Expansion Priority Focus Areas (DFFE 2018) indicate consolidating areas along the Orange River and around Oograbies Wes Section, and building a corridor along the mountain spine towards the main section of the Richtersveld National Park in the Northeast (Figure 4-3). There is little opportunity to expand the main section of the Park towards the SEZ and Port due to mining and agricultural activities. (see Van Rooyen *et al* Chapter 3_5A figure 12).

Local expertise and community groups have identified a range of finer scale priority areas based on known intact assemblages of species of conservation concern, remnant habitat condition and community interest and desirability (VVVT 2024), which have been augmented by field work for this SEA (van Wyk 2024 Chapter 3_5B, and see Van Rooyen et al Chapter 3_5A). Whether impacts on these features (Figure 4-4) should be designated as Very High is unclear, but adopting the highest significance rating seems to be a prudent departure point for any project level planning.

[2] After this chapter was compiled, the National Biodiversity Assessment 2025 data were made available by SANBI. See WP2 for updates.

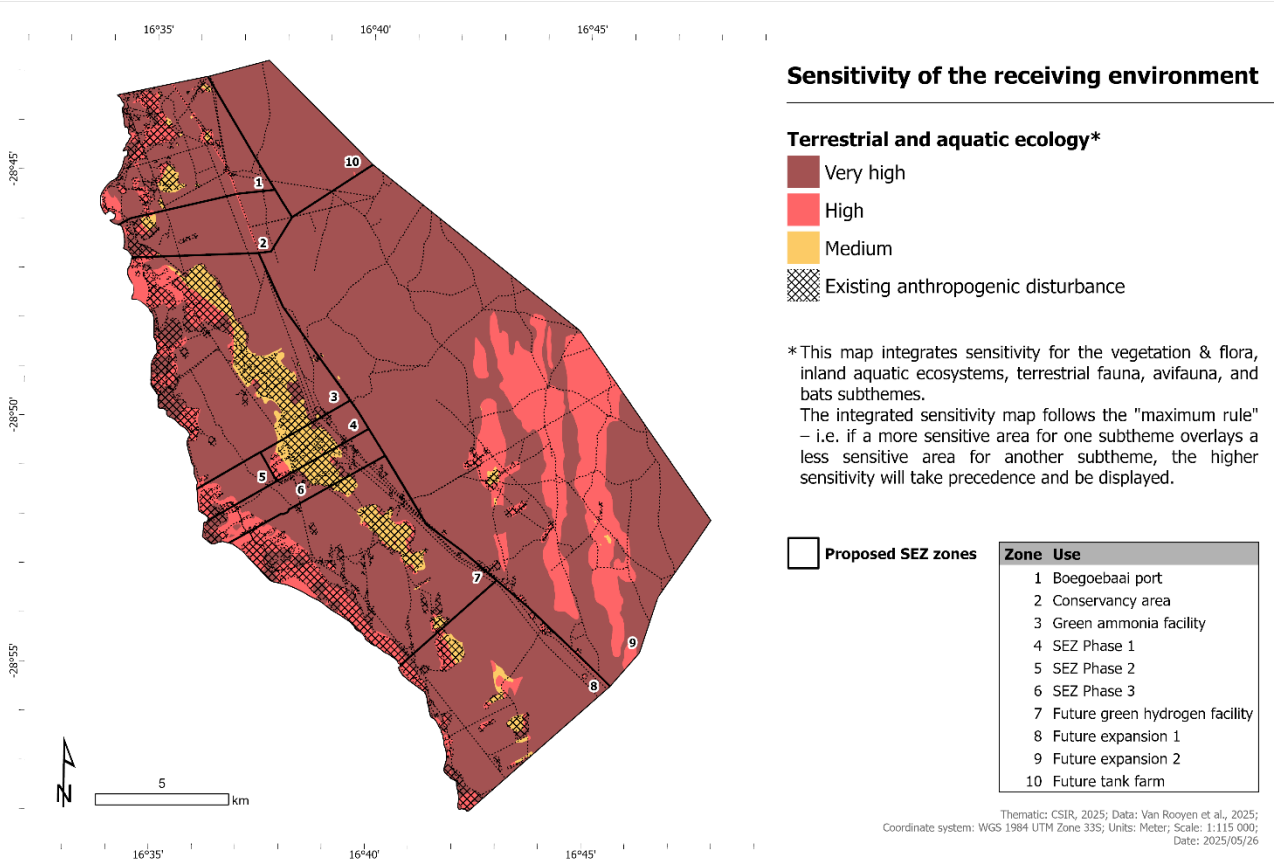


Figure 4-2: Major biodiversity informants for spatial planning, including vegetation types, wetlands, avian habitats, listed ecosystems, expert mapped important biodiversity areas. Some features not shown at this scale. (compilation by L Snyman-van der Walt May 2025).

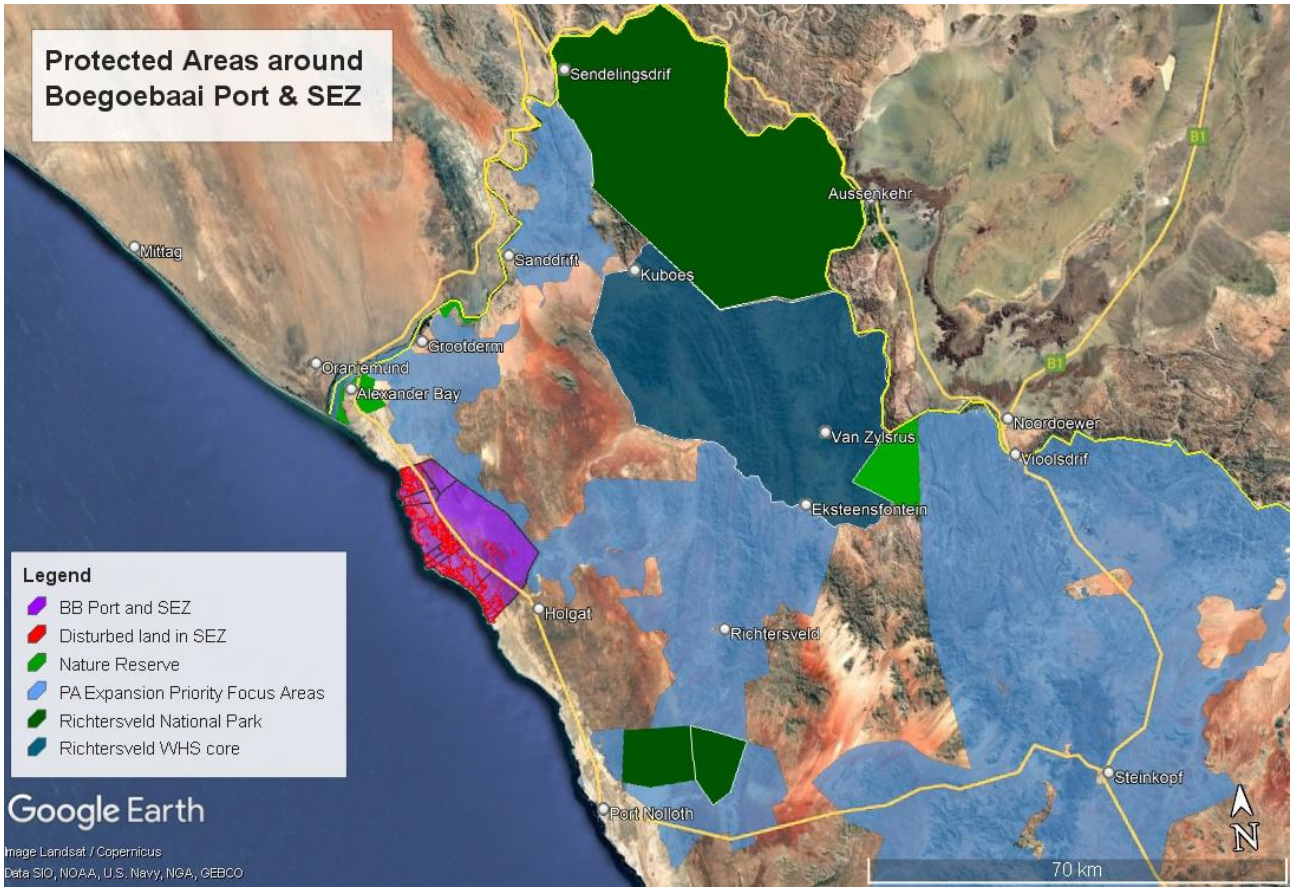


Figure 4-3: The protected areas and PA expansion priority focus areas around the SEZ. This does not show the Cultural and Botanical Landscape component of the Richtersveld WHS as its implications for the SEZ and offsetting are unclear. Note that the Western portion of the Oorgabies Wes Section of Richtersveld National Park is not effectively declared or recorded in the Protected Areas Register but is ostensibly managed as part of the Park.

4.2.2 Potentially impacted species and offset-type mitigation

At least 44 plant species of conservation concern[3] are recorded from the SEZ and may potentially be impacted by a large-scale industrial development (Van Rooyen *et al* Appendix 1). Of these, six are listed as CR, and nine as EN, with the balance as VU, rare or data deficient. It is difficult to offset species-level impacts without considering the microsite characteristics, specific mutualisms or other relationships that maintain these extremely range restricted populations. It cannot be assumed that these species would be effectively conserved through vegetation type offsets alone.

At least 10 avifauna species occurring in the broader area around the SEZ are considered SCC, although four of these are marine (Froneman et al, Chapter 3b). Of these, the primary impacts of significance from the SEZ could be expected on Ludwig's Bustards (*Neotis ludwigii*), Black Harrier (*Circus maurus*), both due to powerline and energy infrastructure collisions, and on Barlow's Lark (*Calendulauda barlowi*) due to habitat loss and disturbance. Unfortunately, as they are mobile, it is challenging to integrate spatial sensitivity maps for avifauna into offset guidance at this stage. It is assumed that philopatric, habitat generalist species like larks would be catered for in ecosystem-focused offsets. This must be determined in project-level EIA studies.

The fauna chapter indicates that of the 10 potentially occurring terrestrial fauna species of conservation concern, only three (the gecko *Pachydactylus rangei*, and two golden mole species *Cryptochloris wintoni* and *Eremitalpa granti granti*) would likely indicate offset-type mitigation as any significant impacts would be considered at minimum of medium significance. It is assumed that these fauna species are found in the

[3] Note that this is almost certain to increase substantially with new assessments being conducted by SANBI (*D. Raimondo – pers comm May 2025)*

expert-identified sensitive areas (Van Rooyen et al. chapter 3e) – which needs to be confirmed. The national guideline does not adequately cater for species-specific offsets, although recent workshops have initiated the process to develop this for avifauna.

4.2.3 Landcover, transformed areas, mobilised sand plumes

It is prudent in planning tools, and good practice in offset analyses, to set out which areas are likely less sensitive and may not require offset mitigation. The local surrounds are replete with old mining scars (>15 000 ha, see Section 4.8). Given the sensitivity, uniqueness and species richness of the region, it is problematic that such widespread damage from mining (lawful and illicit) has been allowed or that so little rehabilitation has been required by authorities. Theoretically, these transformed areas provide ample opportunity to locate infrastructure and impacts without needing to offset terrestrial systems. However, ecological compensation type offsets are almost certainly still going to be required by individual projects or the SEZ establishment phase given that:

1- Mobilised sand from new disturbance and linear infrastructure has and will continue to massively increase biodiversity loss beyond actual footprint impacts on previously damaged areas.

2- Layouts, industrial efficiency and electrolyser design imperatives will dictate fine-scale siting making it very hard to exclusively utilise linear mining scars.

3- The sheer scale of RE and industrial development will have scale-dependent impacts that existing scars cannot accommodate.

4- The extensive transmission lines required (coupled with the wind turbines) will almost certainly lead to impacts on mobile species (e.g. mortality of large birds with high wing-loading (primarily Ludwig's Bustards)) which requires mitigation beyond mining scars; and

5- Rehabilitation of this landscape has had limited visible success and may often be prohibitively expensive – implying that offset type mitigation and trading out-of-kind is necessary for ecosystems where targets cannot still be met.

Given the nature of the receiving environment, the lack of publicly available information on the extent of regulatory compliance by current mining rights holders and opportunistic mining operations, and the observed widespread non-compliance with rehabilitation requirements, it is philosophically difficult to treat the damaged areas as being legitimately deserving of 'modified habitat' status. Further, in theory and according to law, for the last 3 decades, mining operations should have planned and set aside financial provision for, rehabilitation of their impacts. Acknowledging that this rehabilitation may not have been perfect, it should still have stabilised ongoing loss of ecosystem function and allowed ecosystems to gradually re-establish themselves. This indicates that some mining disturbed areas cannot be completely discounted from impact consideration purposes – but it is impossible to predict which ones at this scale of analysis.

It will be challenging to claim adherence to the mitigation hierarchy when large areas of damaged land exist around a project, but which still relies (or insists) on green field impacts on threatened biodiversity. Project level studies will need to document carefully why certain layouts and configurations were required if they result in biodiversity loss.

The region is also replete with large areas of mobilised sand plumes. The impact of sand movement scour is significant – stunting growth and drowning entire ecosystems. Some of the most important and sensitive sites are at risk from sand. Some of these plumes have certainly been triggered by unmanaged and unrehabilitated mining activities (see Figures 8a-8d in Chapter 3_5A), while others seem to arise from stock posts and over-grazing. A confounding factor has been the historic 2016-9 drought and long-term temperature increase, which has undoubtedly also contributed to greater mobilised sand. There are also likely synergistic effects between all the drivers of mobilised sand. However, recent wet years have seemingly allowed some greening of many plumes visible in satellite imagery. Whether this is sufficient to allow permanent establishment is unclear, but it is conceivable that some sandveld vegetation could reestablish on these plumes (see Carrick & Krüger (2007) for limitations). Thus, sand plumes cannot be considered as

completely transformed and therefore impacts on them should still be considered as loss of the sandveld ecosystem for quantifying offset liabilities. This will need fine grain analysis in project EIAs.

4.2.4 Features requiring biodiversity offsets

It would be hard for a project to justify further impacts on the specific listed ecosystems Richtersveld Coastal Duneveld (CR) and Namib Seashore Vegetation (CR) – both should be treated as no-go areas. Similarly, the expert identified portions of existing CBAs (Figure 4-4) and possibly also the community identified priorities (Figure 4-6) could be defensibly treated as being irreplaceable. Similarly, it would be difficult to see how the various direct and induced impacts from the SEZ would be at all compatible with the Richtersveld Cultural and Botanical Landscape WHS. Any impacts on the features, if tolerated by the owners or authorised due to "overwhelming economic and political importance" (DFFE 2023) would necessitate substantial ecological compensation.

For both small and big GH2 development scenarios, any impacts in natural, semi-natural or lightly transformed vegetation in the following ecosystems/ vegetation types would likely require biodiversity offsets. Project specific EIAs should also assess indirect and induced impacts, and design appropriate and commensurate mitigation measures.

The following ecosystems/ vegetation types in the precinct and SEZ would likely require biodiversity offset type mitigation for substantial impacts, especially where they overlap with locally or expert identified priority areas: Northern Richtersveld Yellow Duneveld (LC); Oograbies Plains Sandy Grassland (LC); Richtersveld Sandy Coastal Scorpionstailveld (LC); and Western Gariep Plains Desert (LC) (Botha & Desmet 2022). Specialist studies would need to establish SCC occurrence and assess population viability and likelihood of persistence, and whether they would be adequately catered for in ecosystem offsets in the various candidate sites selected.

Any interventions to offset SCC impacts would need to target known population and distribution limiting factors – which may not be well known for some species. Project-level EIAs encountering these species would need additional investment in life-history studies and monitoring to determine opportunities to improve survival. These could be calibrated by what proportion of the breeding population may be impacted, and population -recruitment/survival interventions planned accordingly. Ideally, these interventions need to be planned and executed prior to the Port and SEZ impacts materialising to ensure that any failure can be adequately rectified prior to the impact. Experienced taxon and geographic experts are required to develop these interventions with regional conservation officials.

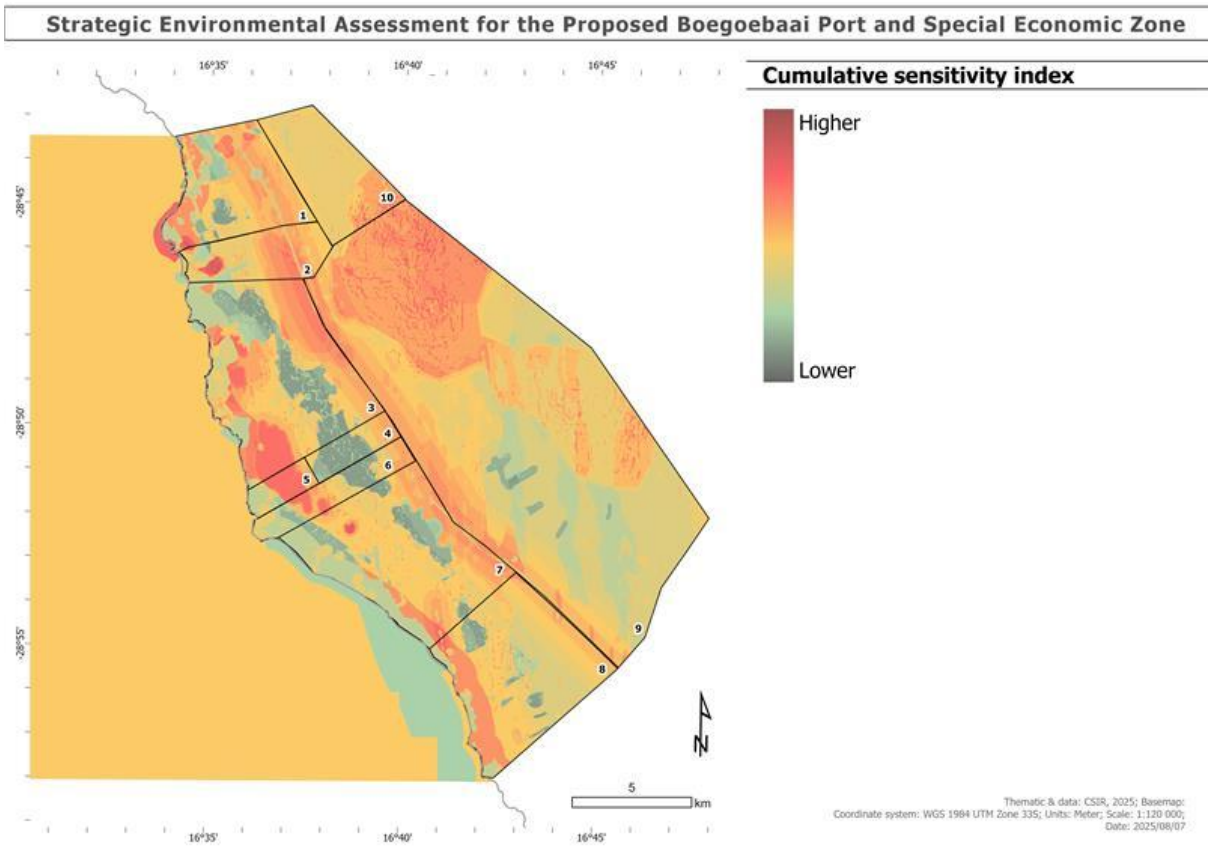


Figure 4-4: A cumulative sensitivity score map for all biodiversity themes (compilation by L Snyman-van der Walt May 2025).

For offset calculation, the specialists will need to calculate the likely residual impact on each of these features, as well as any specific constituent habitats of importance that may need to be offset or mitigated explicitly. Applicable ratios for ecosystems were developed from the Offset Guideline (DFFE 2023) and are proposed in Table 4-1. Terrestrial specialists will need to determine relatively accurate feature distribution, and especially delineating the best remaining examples of each feature in the region – to proactively identify offset candidate sites. The SEA Botanical Assessment (Van Wyk 2024; Van Rooyen et al Chapter 3_5A) delineated specific areas known to harbour concentrations of SCC or other unique features (Figure 4-4). In most cases, these overlap with designated CBAs (DENC 2016 and DAERL 2024) and PA expansion priority areas (DEA 2018). Impacts on expert identified priority sites should be avoided wherever possible.

If any investor or partner is likely to require IFC Performance Standard 6 compliance, these features (Ecosystems, special habitats and species) need to be unpacked into the (rather inappropriate in this context) IFC hierarchy of 'Critical' and 'Natural Habitat' – with appropriate ecological compensation parameters to determine a No-net loss or net gain approach. It is difficult to see how any loss of CR ecosystems or impacts on CR or range-restricted EN species could be effectively compensated for to achieve net gain outcomes in the large expanses of Critical Habitat that will undoubtedly be determined on site.

4.3 DETERMINING OFFSET METRICS, CRITERIA & IMPLEMENTATION OPTIONS

4.3.1 Quantifying residual impacts

Experience has shown the planned and realised impacts are often wildly different – there are always scope creep, collateral damage and displacement effects. Without a clear layout it is prudent to take the outer

boundary of the various precincts as the total residual footprint. Remnant pockets inside the SEZ are not going to survive in the industrial landscape being contemplated and must be disregarded as counting positively towards any offset liabilities. Hence the requirement to offset the entire footprint of the planned impacts – and that fine scale determination (to the nearest m^2) is unnecessary. It is appropriate to offset the entire footprint impact of the planned development – and not only those features of "medium/high and very high" sensitivity or fine scale mapping in each precinct. In the South African context, it is better to use significance ratings as a trigger for offsetting the entire project footprint, and not as a determinant of which features should be offset.

This understanding indicates that even rough planning envelopes can be adequate for estimating the scale of offsetting required, which can then be used to factor into project planning timelines and cost estimates. From information provided (See Table 4-3 in the Annexes) over 21 000 ha can be expected from even a small GH2 Scenario, although only 420 ha of this is likely to be located within the SEZ, with the balance being regionally distributed WEF and PV installations. Recall, however, that this offsetting will not be sufficient to address impacts on irreplaceable features, and project-level assessment should always promote avoidance of impacts where possible.

4.3.2 Determining applicable metrics for biodiversity features

Beyond residual footprint and other impact determination, a key feature of offsets are the ratios and exchange rules that must apply. National guidance for the impacted ecosystems listed as Least Concern is unhelpful, as there will be significant impacts on many species of conservation concern and on areas designated as CBA and recognised as a KBA. The policy proposal of requiring default offsets for all footprint impacts in LC ecosystems is further supported as it aligns with SA's commitments to the GBF and the adopted NPAES, would address the intent behind the WHS Landscape designation and CPA's stated intention, as well as addressing the likely induced and cumulative impacts from a massive SEZ development. It would seem prudent to require a minimum offset ratio of 1:5 for every hectare of intact vegetation and not less than a 1:2 for every hectare of degraded sand plume area lost. This would recognise the regional significance of the impacted area and contribute greatly to securing the undamaged portions that remain, as well as cater for the extensive cumulative, indirect and induced impacts. Areas totally transformed by mining could be freed from any offset liability if they don't complete crucial local ecological corridors or provide other ecosystem services or rehabilitation opportunities between CR remnants.

Table 4-1: Proposed offset ratios that should apply in project level EIA or for proactive comprehensive offset scheme development for the SEZ.

Feature	Description	Proposed Ratio	Modifiers
Listed CR ecosystem	Currently natural or near-natural remaining ecosystem listed as CR under NEMBA	1:30	
Listed EN ecosystem	Currently natural or near-natural remaining ecosystem listed as EN under NEMBA	1:10	
Listed VU ecosystem	Currently natural or near-natural remaining ecosystem listed as VU under NEMBA	1:5	
CBA1[4]	Currently natural or near-natural remaining ecosystem identified as CBA in the N Cape CBA Map	1:30	This ratio to apply if defensible rationale for CBA designation exists
ESA	Currently natural or near-natural remaining ecosystem identified as ESA in the N Cape CBA Map	1:5	
Expert identified sensitive areas	Fine scale delineation of local priority sites housing significant SCC, in good condition. Overrides VU and ESA designation and should be used as an overlay zone	1:10	Can increase if likely to be designated CBA in future

[4] This designation is complicated in the N Cape as areas in the province, especially in Namaqualand District, inadequately reflect local conditions and state of biodiversity. It is thus risky to require the maximum offset ratio for any impact on an area designated as CBA in the 2016 version. A revision is underway but is not available to inform this offset framework.

Feature	Description	Proposed Ratio	Modifiers
Sand Plume	Any area of above features impacted by mobilised sand plume with moderate to high likelihood of rehabilitation	1:2	Can increase if indications of stabilisation
Heavily degraded	Natural area overgrazed, trampled or otherwise impacted but still capable of natural rehabilitation	1:1	
Mining scar		None required	

Assuming that most of the WEF and some of the infrastructure can be established on mining scars (see Section 4.8) this still leaves 12 000 ha of PV impacts and roughly 4 000 ancillary infrastructure impacts to be offset. Assuming this can be done in the mostly sand plume or least concern ecosystems, a minimum offset of >40 000 ha might be required.

Forecasting what infrastructure is to be developed in the different phases is difficult – although this is often required for strategic offset frameworks. More importantly, postponing the setting aside and implementation of ecological compensation until the phase when a particular precinct is commenced with is inadvisable. A better approach would be to establish as much of the offset site upfront as possible to avoid loss to other land uses, rogue actors, and other vicissitudes. If any scaling must apply, it could be for the management costs of the larger offset site.

4.3.3 Other criteria for effective offsets in the SEZ

The offset component requires information on both the biophysical features to be offset and the outcomes to be obtained, as well as the location and most feasible implementation modalities to rehabilitate, protect and manage the offset sites.

Biophysical input data include:

- A detailed list of features impacted, including the local and landscape level impacts on ecological processes maintaining biodiversity;
- a conservative estimate of impact area and other relevant parameters of each feature (such as required condition, orientation or connectivity for the process to function);
- the species of conservation concern impacts, especially if quantifiable as a proportion of breeding populations, or foraging area lost etc that can be used to quantify mitigation/or population level interventions;
- consensus on the most important interventions to address population recruitment and/or improvement in forage area and breeding success; and
- delineated candidate sites to explicitly meet the offset requirements for the full list of impacted features, as well as those areas to pursue proactive recruitment, breeding or forage improvements.

Information Implementation arrangements required to give effect to reaching the biodiversity outcomes include:

- Whether the landowners and land users have agreed to the offset site being established, and what their needs for access, use etc might be?
- Whether existing rights (e.g. mining or prospecting) have been issued over the property or applications for development (for e.g. renewable energy) have been approved. Rights conflicts would prevent an area from being considered for offset purposes?

- Which agency or organisation is able to assume responsibility for the offset site, especially if it is outside the SEZ area, and has consented to this role?

- What budget, resources and capacity the organisation requires to discharge this conservation function?

- What financing mechanisms and governance structures exist or would have to be developed to oversee the investment of offset management funds and maintenance of outcomes?

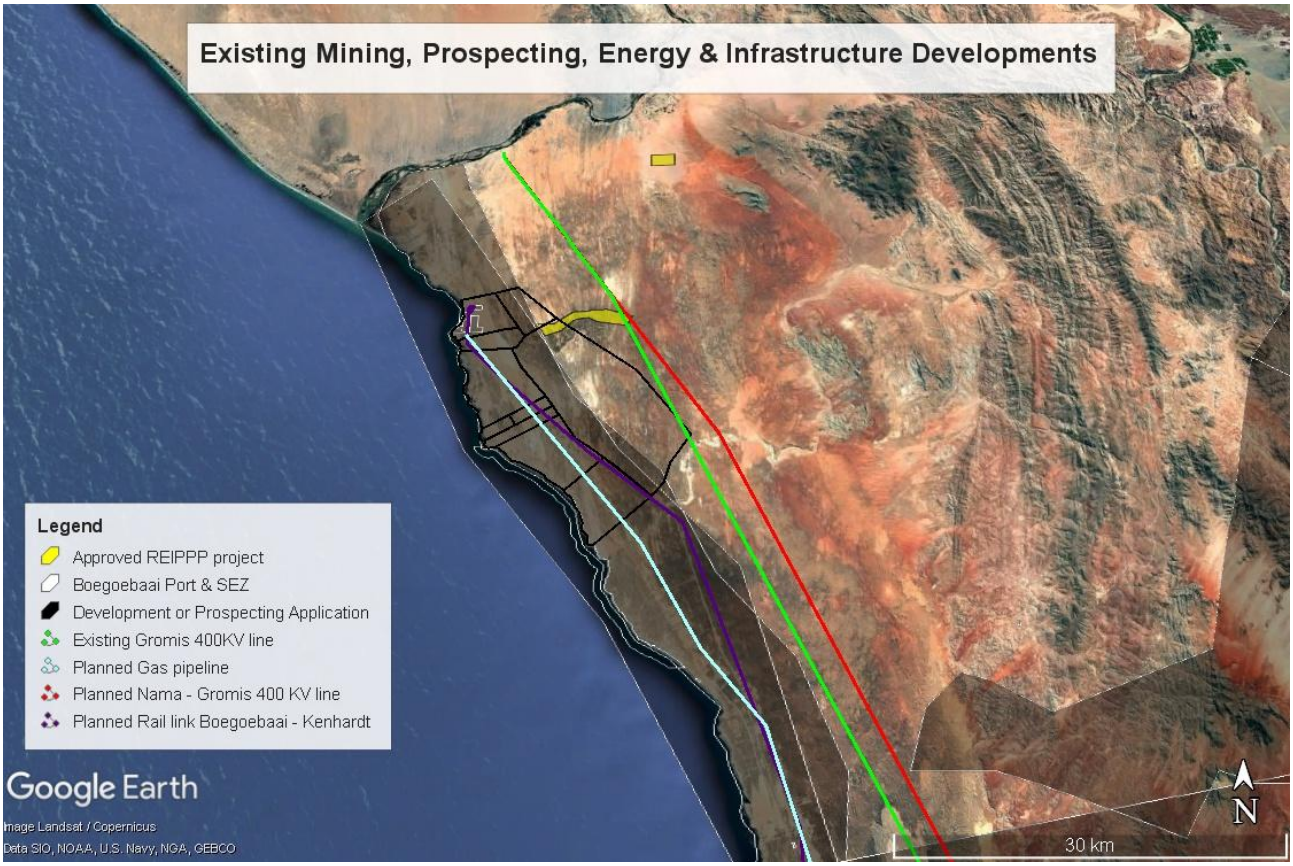


Figure 4-5: Current knowledge of existing mining right, petroleum exploration applications, energy and infrastructure developments in the region between Alexander Bay and Port Nolloth. Existing mining rights and other incompatible developments preclude effective offset establishment.

Specific rules (ratio multipliers or discounts) are proposed for each feature and ecosystem type (Table 4-1), however this seems insufficient and unsuitable for impacts at the proposed scale of a big GH2 roll out. Landscape scale criteria for defensible regional-level and long-term biodiversity outcomes are required to guide assessment of offset type ecological compensation.

4.3.4 Offset receiving areas

A previous study (Botha & Desmet 2022) identified the optimum places to locate terrestrial offsets as being in the two already published and approved National Park Expansion Zones, and the new (proposed in Botha & Desmet 2022) protected area expansion corridor from Richtersveld National Park (Klein Duin section) to Harras mountains along the R382 towards Steinkopf. Further areas in which to locate offset receiving sites are the expert identified sensitive areas displayed in Figure 4-4 (Van Wyk 2024), and the local community identified priorities captured in Figure 4-6 (VVVT 2024) and summarised in Table 4-2. This must be tested by the Terrestrial specialists and confirmed by the Conservation Planner in WP2.

In addition to these areas, around 560 ha of expert identified priority areas is found around Namakwakop, Boegoeberge, and the other smaller priority sensitive areas around the Port. These could effectively count as set asides towards offset liabilities if they are actively protected and the surrounding buffers restored (van Wyk 2024). However, as they are already identified as "irreplaceable" they are best not viewed as offsets per se.

Table 4-2: Potential offset receiving areas for developments at Boegoebaai, the SEZ and specific regional renewable energy projects. Note that only local features are likely to be suitable for Port & SEZ linked offsets. Regional features could provide for SC2 big GH2 impacts. Although sufficient area might seem available, not all the impacted ecosystems are protected by these receiving areas. Note that substantial constraints prevent the Sanddrif-Kuboes focus area from realistically being available due to poorly regulated mining and agricultural activities.

Regional Feature	*Area (ha)*		*Local Feature/Priority*	*Area (ha)*
NPAES focus area of Kleinduin Section Richtersveld NP	130 000		Pagvlei-Grootderm-Brandkaros	19 600
NPAES surrounding Namaqua NP	300 000		Rooibank heuweltjies	14 000
NPAES Vioolsdrif-Steinkopf-Buffelsrivier	500 000		Swartbank heuweltjies	3 500
			Holgat river & catchment	7 400
NPAES focus area main Section Richtersveld NP. Sanddrif-Kuboes	*34 000*		Visagiefontein & Kop	3 300
			Farm 1 (natural portion) NW of Kleinduin Section	16 200
Total	***964 000***		***Total***	***64 000***

Using the basic assumptions in Section 4.3.2, offsetting the small GH2 scenario might entail as much as 40 000 ha of offsets. This would require two thirds of all the local offset receiving areas to be secured.

The proposed "conservancy area" (1170 ha) immediately South of the port is not a suitable offset receiving area. It is too small and doesn't house most of the SCC or threatened ecosystems. Its potential contribution to mitigating the impacts from any development is relatively low given that most of the site West of the R382 tar road has been transformed by mining and sand movement and supports little native vegetation. Although it houses the larger inselberg of the "Boegoeberg twins" this would not strictly qualify as an offset as it should be considered irreplaceable and should be set aside. Beyond this feature, and the potential for arresting South-North sand movement through active rehabilitation, the conservation value is questionable. Any redesign of the Port & SEZ to accommodate a conservancy should prioritise the specialist and community identified sensitive areas, sites optimal for securing faunal communities, and to reduce or reverse the impact of sand movement.

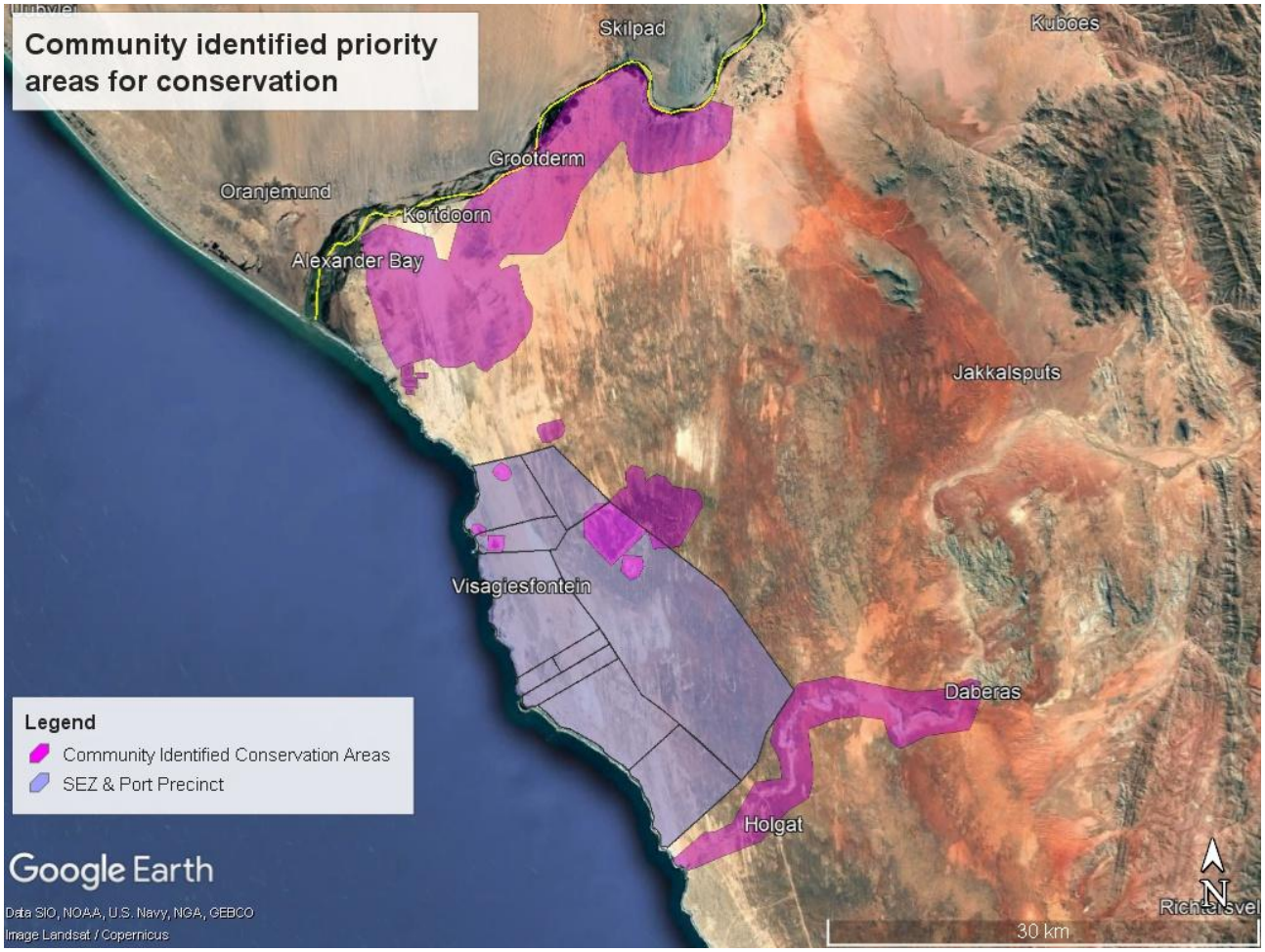


Figure 4-6: Areas identified by community consultation structures as deserving of conservation action and cultural and biodiversity heritage protection. These would be obvious candidates for offset receiving areas as the consent for their long-term protection, rehabilitation and management by the SEZ should be relatively easy to secure.

There is risk in identifying prime candidate offset sites in public facing documents such as an SEA – especially if good sites are few or constrained. If in private ownership, their identification can seriously impact property values. If in communal ownership, this allows third parties the ability to hold development projects to ransom, or to extract unjustifiable concessions from the proponents or statutory entities trying to advance conservation. Both options can easily jeopardize successful offset implementation. However, in this study it seems unavoidable to not show where the most suitable offset receiving sites are.

Project-level Offset studies need to include negotiations with owners or users of candidate sites to secure access and offset use consent. Preferably, the state or SEZ developers must proactively secure the full anticipated offset upfront (prior to project level EIAs) to avoid risk of offset negotiation or implementation failure. The costs of the entire offset portfolio could be borne by the developers (as an incentive for tenants in the SEZ) or passed on to the tenants through capital claw backs or levies or similar financial means. If negotiations to secure offset sites don't succeed, the state has the option of expropriation to ensure alignment with regulatory or investor requirements. However, this could further strain relationships in this region and impose long term challenges and poor neighbour relations for the entities involved.

4.3.5 Conservation authorities' perspectives on Offset Implementation

SANParks[5] has indicated that its priorities in the region do not focus on expansion in the Richtersveld, and they would not be able to facilitate much offset implementation around the SEZ – even if budget was made available. There is understandable caution in further expansion when existing seemingly unlawful impacts

[5] Ex-Regional manager Lucius Moolman – now retired

from mining are occurring within existing Parks, and managing grazing and other landuses is very difficult in this landscape. The only local Park expansion priority is Vyftienmylseberg, adjacent to the Kleinduin section of Richtersveld Park – but this would not be an eligible offset for impacts within the SEZ as it houses a completely different ecosystem type. The SANParks regional manager is broadly supportive of the areas identified by the local community for protection.

Although SANParks are being vested with managing the WHS core area[6], this rugged terrain is mostly inaccessible and only suitable for restricted ecotourism. However, they would be well positioned to assist with implementation of regional offsets for RE development (WP2) especially if the offsets overlapped with park expansion plans for Namaqua and Augrabies.

Scientists from Northern Cape DAERL are broadly supportive of establishing offset receiving areas along the Holgat river (it performs a key ecological corridor function in the region especially for predator movement) and to consolidate the Orange River Mouth Nature Reserve. However, they cautioned that land use pressure and further sand mobilisation or disturbance is a real risk to biodiversity persistence. There is a need to understand the reasons for other expert mapped priority areas before they should be codified as offset receiving areas, including whether they contribute to connectivity and long-term ecosystem function.

DAERL's experience with offset site management is rather limited (the Department is responsible for implementing the offset from the Gamsberg Zinc mine) which has not been without challenges. Given the inflexibilities of government procurement and financial management systems, and the ongoing risk of budget substitution, it seems prudent to propose that private sector contractors or even NGOs be engaged to manage offsets sites in the medium to long term.

4.4 BIODIVERSITY OFFSET RECOMMENDATIONS

The likely severity and significance of impacts by the Boegoebaai port and GH_2 fleet on several threatened, rare or otherwise conservation-worthy biodiversity features on land and at sea, most of which are likely to be strictly "not offsetable", indicate that appropriate mitigation is better framed as Ecological Compensation (and not offsets *sensu strictu).* This clarifies upfront to investors, clients and product markets that the biodiversity impacts are such as to prevent explicit targets being reached and thus will compromise nature's persistence in this region.

Compliance with the mitigation hierarchy is imperative, which demands that "Avoidance" (alternative sites are exhaustively explored), "Minimisation"[7] (alternative technologies and other mitigation measures are deployed) and even "Rehabilitation" be attempted before offsetting can be considered. All these steps will be challenging for project level assessments.

Offset investigations in project specific EIAs will need to:

- Verify the likely underlying ecosystem being impacted (even if currently affected by mobile sand plumes) and apply the proposed ratios if approved by authorities.

- Locate suitable offset sites within the receiving areas, preferably with similar ecosystem characteristics. Multiple candidate sites are likely required. Note that whole cadastres are unlikely to be available, so complex land demarcation, use and consent agreements will be required. Wherever feasible, identify explicit areas/contributions to proactive schemes to achieve offset requirements.

- Engage with community structures to negotiate access to and use of the site. Explore rehabilitation requirements, appropriate methodologies and local teams to undertake it. If acceptable, pursue protected area declaration requirements and stipulations to inform procedures and requirements

[6] Lucius Moolman – *pers comm February 2025*

[7] The are very limited opportunities for rehabilitation of impacts in this environment on ecologically meaningful timescales. This is evidenced by the extensive nature of damage from mining activities, some of which must have been subject to regulatory "rehabilitation". The forecast increasing heat and wind, and reduced precipitation will make rehabilitation even more challenging.

in any authorisation conditions proposed. If sites adjacent to statutory PAs, then negotiations with the management authorities will also be needed.

- Negotiate implementation agreements (and associated financial implications) as far as possible prior to submission of EIAs to authorities.

- Structure comprehensive, but tractable, conditions of authorisation for inclusion in Offset Reports or as part of the EIR, for consideration by the competent authority.

4.4.1 Alternative sites and technologies with less impact and easier mitigation

The primary opportunity is to locate the proposed port in areas with substantially lower terrestrial, coastal and marine impacts. Such a site seems to exist just North of Port Nolloth (see Figure 4-9) and there may be others which could be identified in WP2/Regional study. This specific area has no biodiversity features likely to trigger exclusionary thresholds – on land or at sea. The site(s) are mostly disturbed and are situated within 10 km of an existing harbour and old marine mining operations, with significantly less likelihood of unacceptable impacts. There is a confluence of environmental, geophysical, social, and economic advantages to Port Nolloth, and the analysis of its unsuitability presented in the DTSL business case (DTSL 2020) does not appear to be fair or comprehensive.

The primary drawback a new port North of Port Nolloth is the cost of entirely new port planning process. If the primary function and design constraint of the Port is berthing of heavy ore carriers, then this needs to be weighed against the alternatives for GH2 (and derivatives) export. Even if the ore terminal is not possible at Port Nolloth for some reason, it seems eminently suitable for a GH_2 production and export facility as a port might be too expensive to justify for GH2 alone.

4.4.2 Regional view on optimal sites for renewable energy generation.

Assuming the desalination, electrolyser and liquefaction plants or other components of the SEZ are relatively small (Scenario 1 is 420 ha; Scenario 2 is 3400 ha), and can be flexibly located on already damaged, degraded within the SEZ, the next key alternative to consider is optimal sites for renewable energy production. Sufficient renewable energy generation has already been approved in the District (13 GW) and Province (78 GW) to cover the needs of small and big GH2 scenarios, respectively (CSIR data February 2025). However, this would entail significantly more high Voltage power lines spanning the landscape to Boegoebaai than are currently assumed in the footprint assumptions (Table 4-3). Although there is insufficient available area within the SEZ or within 100 km of Boegoebaai port for RE for Sc2, large areas of relatively low biodiversity sensitivity have been identified for regional power production which would not require substantial biodiversity offsets (see Botha & Desmet 2022). This is explored further in WP2.

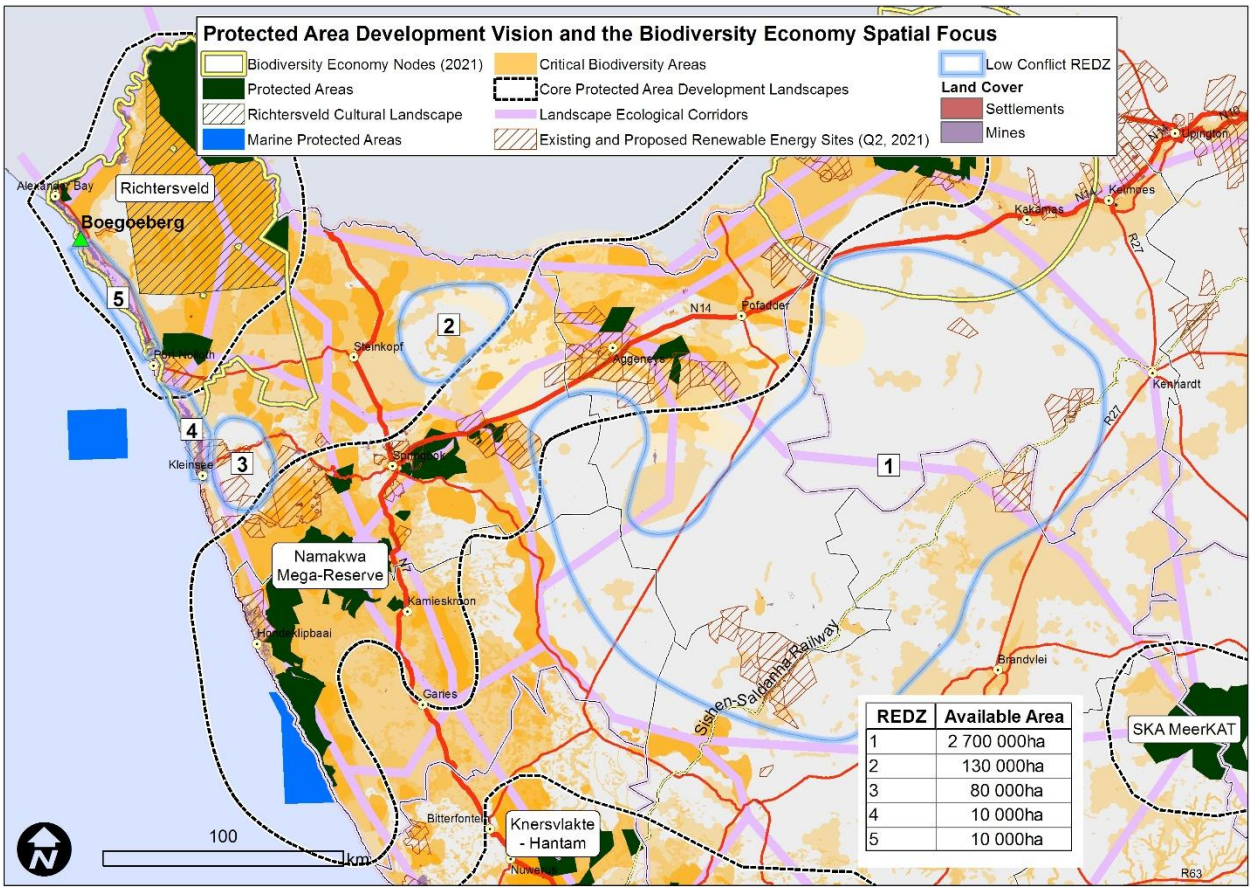


Figure 4-7: The three large areas able to accommodate especially PV production (1-3) to augment power from 2 large areas for WEF (4,5) on coastal mining scars. In a ratio of 60%PV:40%Wind for optimal operation. Note REDZ is used in a descriptive and not regulatory sense. (From Botha & Desmet 2022). An updated regional view is presented in WP2

If it is decided that the Port and SEZ must proceed on the Boegoebaai site, then the following components of a biodiversity offset framework should be pursued.

4.4.3 Port and SEZ Planning implications

It is understood that the current layout of the SEZ, and the "conservancy" area, has been done to accommodate cultural priorities and some sensitive biodiversity features. The conservancy would be more effective if it was redesigned to include:

- The fine scale sensitive sites identified in van Wyk (2024) and Van Rooyen et al (chapter 3e & 3f);
- Greater area of intact vegetation in the Very High sensitivity zones, including most of the region to the East of the R382, and West of R328 in the Future Tank Farm and Future Expansion 01 zones; and
- Areas of intact coastal vegetation, especially where they abut the near shore, instead of where it currently is with high levels of mining damage right down into the coastal zone. Unfortunately, it seems if the intact areas are mostly in the area designated for Port development, and some trade-off is necessary.

4.4.4 Proactive offsetting vs ad hoc project level sequential offset attempts

Project-level offsets are assessed, designed and implemented in a fragmented and piecemeal way, which often precludes outcomes being achieved, and complicates future offsetting actions and land use decisions in the impacted region. Scale and rate of loss of prospective offset sites implies that if pursued sequentially, there might be limited options to achieve suitable offsets in the affected ecosystems. This would necessitate ecological compensation in un-related ecosystems further away – which may raise legal challenges and approval delays. The best way to avoid this (apart from abandoning the port project and SEZ in this location) is to proactively secure the relevant offset area, effectively protect and rehabilitate it, and provide for its long-term management through an endowment. This is something that could easily be done for a fraction of capital cost if the port and SEZ. It would provide some surety to regulators, commenting authorities, local communities and interested and affected parties that proportional, effective offset-type mitigation was delivered.

To require sequential offsets for evolving developments is risky. It may lead to land use conflicts or sub-optimal conservation outcomes of connectivity, external threat abatement, and increased use of trade-offs if sufficient extent of impacted features is not available. Trade-offs increase potential for contested outcomes and government budget substitution. Further, proactive offsets allow a coordination body to engage with a single implementation entity – streamlining arrangements and processes and reducing costs and contestation. The constitution of any coordination body requires careful thought and requires separation of governance (regulators and landowners) from implementation (entities – state or private).

4.4.5 Focus on securing large landscape conservation outcomes

Even if it is possible to locate much of the non-energy generating infrastructure (Sc1 420 ha; Sc 2 3400 ha) on disturbed or low sensitivity sites within, the likely impacts realised impacts of the Port and SEZ amplified by the relevant biodiversity offset ratios imply that an offset of possibly 4 000 ha (port and Sc1) or even up to 34 000 ha (Sc2) would be required in various vegetation types. PV & WEF impacts (Sc1 20 000 ha; Sc2 140 000 ha) outside the SEZ may trigger between 30 000 and 180 000 ha of additional offset liability. Nothing on this scale has been attempted in South Africa.

Just the Port and Sc1 impacts in the SEZ imply that to achieve requisite outcomes for Namib Seashore Vegetation and any other Ecosystem listed as CR or EN indicates that both restoration and protection efforts are needed as ecological compensation to satisfy offset principles and biodiversity targets. Acknowledging the local community priority sites combined with expert mapping, these protection and restoration efforts are best focused on:

1- Expanding the existing Orange River Mouth Nature Reserve to join the disparate sections along the lower Orange River around Grootderm and to create and rehabilitate buffers around the most sensitive features (such as the Namib Lichen Fields). Arresting the mobilised sand is of primary importance. (this could reach **19 000 ha**);

2- Establishing a new PA along the Holgat river from Daberas to the coast, potentially as a contractual extension of the Richtersveld National Park (up to **7 400 ha**). In theory, this could be linked up to the existing Oograbies Wes/Klein Duin section through the inland portion of Farm 1 as per the existing SANParks Land Inclusion Plan (although there is little appetite or capacity within SANParks to pursue this currently as it creates an unwieldy PA with low tourism potential and high management costs); and

3- Securing and managing future impacts on the larger expert identified priority areas of Visagiesfontein, Swartbank, Rooibank, and the unique Whistling Rat colony. Further alignment between experts and conservation authorities is required to agree on the rationale and specifics of this priority, but at least **20 000 ha** would be available for offset purposes.

Further, the SEZ could be redesigned to cater for internal set asides and minimisation interventions by:

4- Redesigning the “conservancy” in the SEZ to set aside the Boegoeberg twins, as much of the intact coastal vegetation as possible, and other smaller unique, reasonably intact sites with suitable

buffers. Further, the zone East of the R382 and intact areas around a large Whistling Rat colony in South could be set aside in the conservancy.

5- Pursuing significant interventions, coupled with prudent infrastructure layouts, to arrest the mobile sand plumes threatening further inundation of unique remnants on the inselbergs and coastal vegetation.

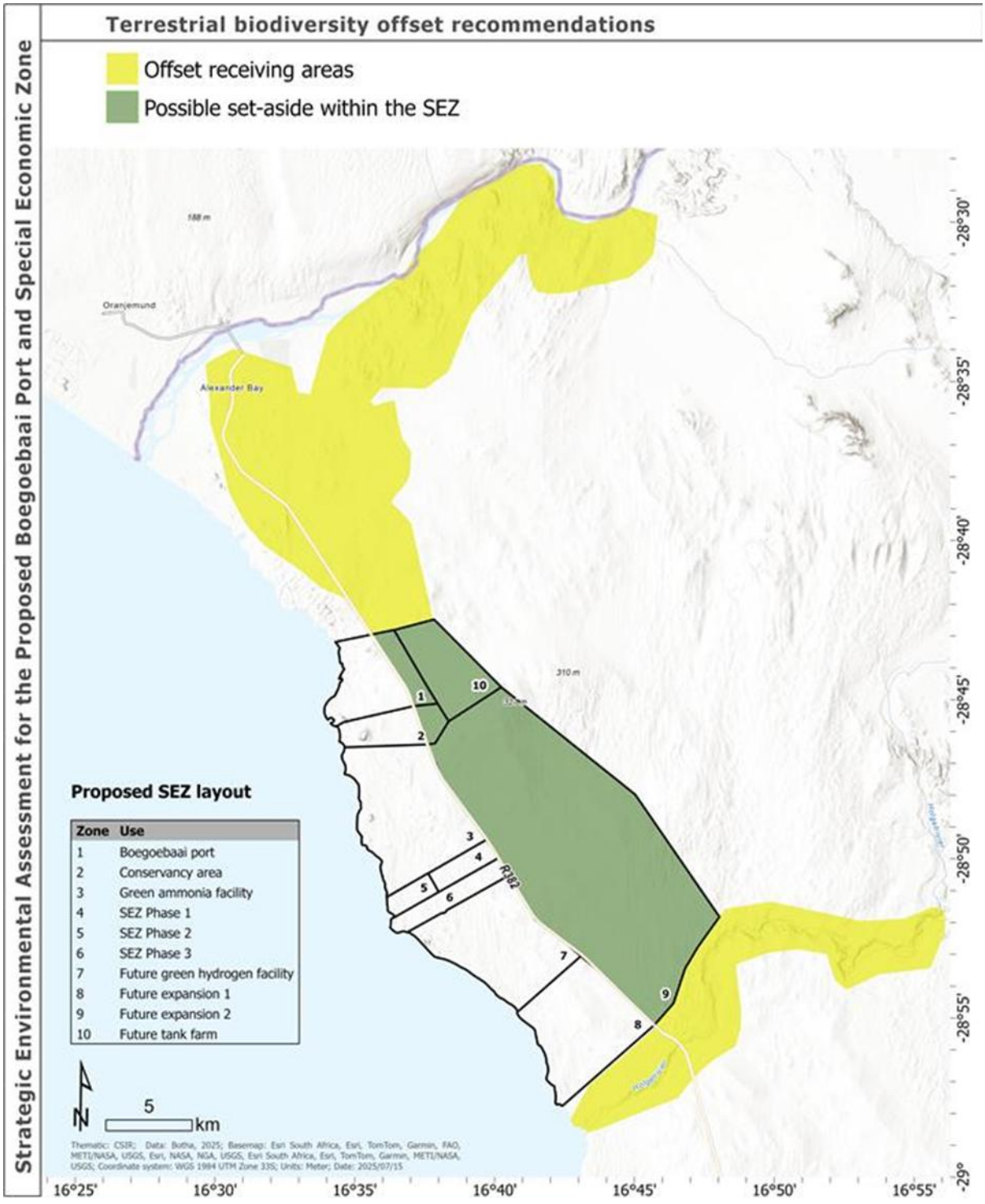


Figure 4-8: Prospective Offset receiving areas around the SEZ. Note the Possible set-asides within the SEZ, East and West of the R382, are also included in this figure, in line with recommended areas where development should be avoided. No attempt to redesign the "conservancy" zone as an Offset receiving area is made.

All told, these priority areas may meet the aerial target for offsets, but may not quite capture all the SCC and the local ecological processes that need to be maintained for long term biodiversity persistence. Additional smaller sites for SCC or important features may need to be secured and managed as isolated PAs. Smaller and isolated areas invariably increase offset implementation and long term costs.

4.4.6 Institutional options for offset implementation

In the South African context, there is a desire for Offset sites to enter the Protected Area estate wherever possible. However, there is a confusing array of management authorities for regional protected areas which may complicate easy offset implementation arrangements. The NC DAERL is responsible for the Orange River Mouth Nature Reserve, but it is unclear if a permanent manager has been appointed, and the reserve may be being managed remotely from over 150km away. The National DFFE manages the Orange River estuary, while the coastal zone falls under the Provincial Coastal Committee with different departments being responsible for different functions. Until recently, the Northern Cape Department of Sports, Arts & Culture was the authority for the Richtersveld WHS core area. This role is apparently transferring to SANParks in 2025 although it won't be designated as a National Park[8]. SANParks manages the various sections Richtersveld National Park, although the large distances involved finding suitable accommodation and offices in the region is challenging.

Both SANParks and DAERL indicated constraints in taking on new areas, unless there were compelling tourism or related objectives overlapping with biodiversity priorities. Even with dedicated budgets for managing offset sites for the SEZ, there is no certainty that any statutory entity will be able to take on their management, effectively. This implies that the most dependable route for a SEZ related offset site would be to appoint a third party/private contractor as managing entity. This arrangement would need to be properly scoped and negotiated during any project-specific offset development.

It is vital that the landowners (Richtersveld CPA) and land users are engaged upfront in the acceptability, design and implementation of any offset. They need to believe in and benefit from clear, credible plans – which is much easier to achieve pro-actively than piece-meal in project EIAs. Clear statutory protection designations (for at least the priority areas identified by the communities) would seem to be an obvious pre-requisite to give effect to an offset. Given the contestation within the CPA, the general illicit activities (diamond mining, smuggling etc) and lawlessness in the region with weak, reactive 'enforcement', it is unclear if a South African identified OECM could work. However, the legal nature of the offset mechanism is likely less important than the political and bureaucratic will to enforce the agreed upon required outcomes.

[8] Lucius Moolman – SANParks Regional Manager, pers comm.

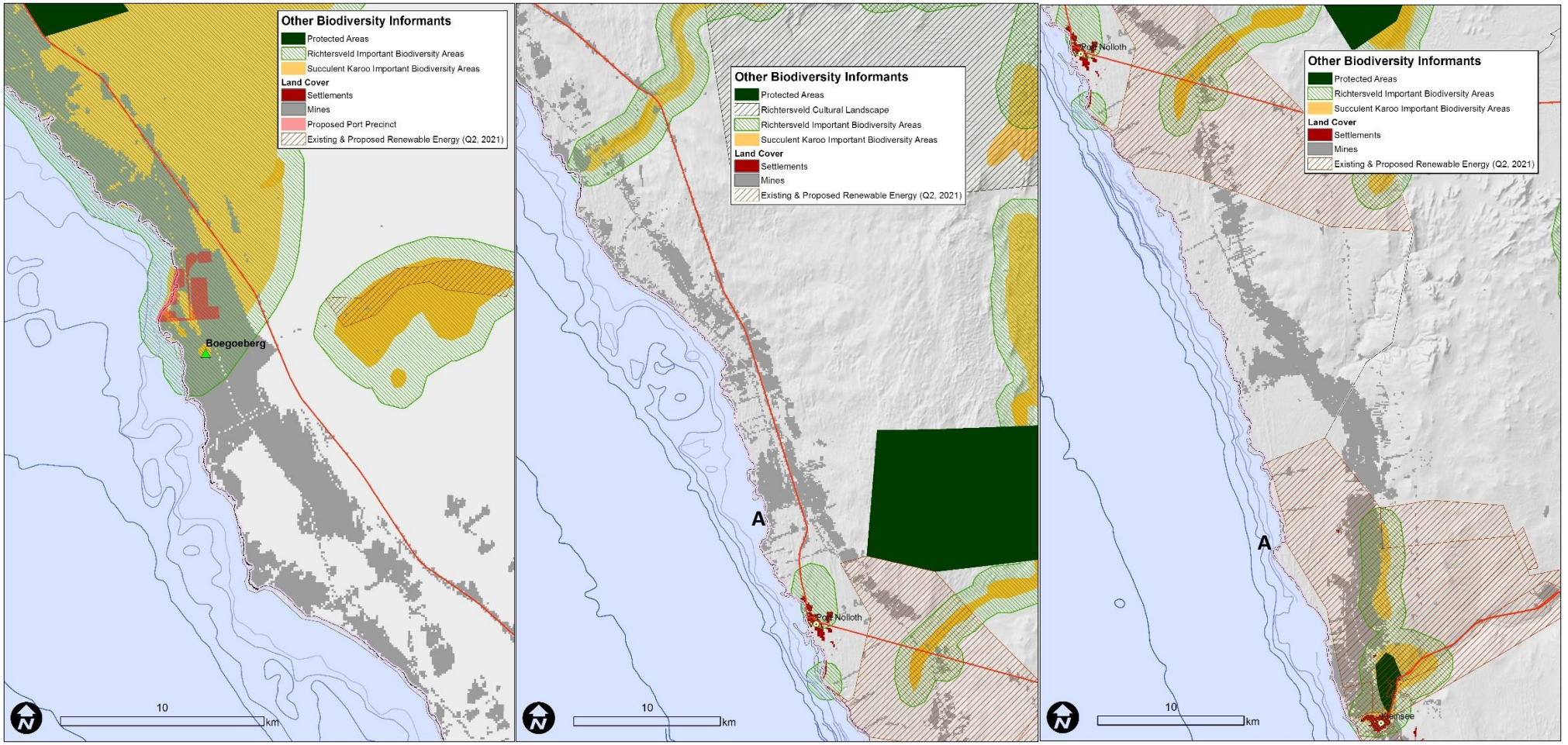


Figure 4-9: Coastal bathymetry, broad scale biodiversity informants and mining scars, indicating potential alternative sites ("A") for a port and Hydrogen loading facility, and location of desalination, electrolysers, liquid storage, and other industrial and renewable impacts from Alexander Bay down to Kleinsee. Isobaths are at 5m intervals, The dark blue -20m isobath comes close inshore in several places. There are few to no areas of terrestrial biodiversity importance Immediately N of Port Nolloth or Kleinsee, and the marine environment has been significantly transformed by diamond dredging (from Botha & Desmet 2022).

4.5 REFERENCES & BIBLIOGRAPHY

Botha M & Desmet P (2022). *Namakwa Satellite SEZ Boegoebaai Port Biodiversity Offset Strategic Perspective.* Report prepared for NCEDA. January 2022

Carrick P & Kruger R (2007). *Restoring degraded landscapes in lowland Namqualand: Lessons from the mining experience and from regional ecological dynamics.* Journal of Arid Environments. 70:4 pp 767-781

DEA (2017). *Draft National Biodiversity Offset Policy*, Published in the Government Gazette on 31 March 2017

DEA (2018). *National Protected Areas Expansion Strategy for South Africa 2016*. Department of Environmental Affairs, Pretoria. Published in the Government Gazette.

DFFE (2023). *National Biodiversity Offset Guideline*. Under S24J of NEMA. Department of Forestry, Fisheries, and the Environment.

DENC (2008) Namakwa District Biodiversity Sector Plan. Available at http://bgis.sanbi.org/Projects/Detail/113 or DAERL.

DENC (2016). The Critical Biodiversity Areas Map for the Northern Cape. Available at http://bgis.sanbi.org/Projects/Detail/203

DTSL (2020). *Boegoebaai Port Business Case.* TA1 Application. Boegoebaai Deep Water Port Feasibility Study, May 2020. Department Transport, Safety & Liaison, Northern Cape Government.

EWT (2021). *Mitigation hierarchy guideline* – Submission to DFFE. Endangered Wildlife Trust, Johannesburg.

Froneman A, Colyn R & Loftie-Eaton M. (2025). Avifauna Specialist Assessment. This volume Chapter 3b.

Holness S and Oosthuysen E (2016). *Critical Biodiversity Areas of the Northern Cape: Technical Report*. DAERL, Kimberly.

Niemandt C (2025). Desktop Fauna Assessment. This volume Chapter 3d.

SANBI (2019). *The National Biodiversity Assessment.* SANBI, Pretoria

SANBI (2021). *The South African Red List of Ecosystems*. May 2021

SANParks (2019). Richtersveld Development Programme and Conservation Development Framework.

Van Rooyen G, Van Rooyen N, & Van Wyk P (2025). *Terrestrial Ecology: Vegetation & Flora Component*. SEA Chapter 3e and 3f

Van Wyk, P. 2024. *Boegoebaai Strategic Environmental Assessment; Report 1; exploring the floral richness of the Boegoebaai Port development site and surrounding areas, Richtersveld Municipal Area, Western Gariep Desert, Northern Cape, South Africa*. Report to CSIR.

VVVT ((2024). *Submission to the Boegoebaai SEA working group & CSIR.* 18 October 2024.

WFA (2018). *Streamlining Biodiversity Offset Implementation in the Northern Cape. A Proposal to DENC*. Wilderness Foundation Africa, Port Elizabeth. Ver 2, September 2018.

4.6 BRIEF

"*The purpose of the Biodiversity Offset study is therefore to proactively assess the potential scale of biodiversity offsets required for the two development scenarios in and to generate a proactive framework for phased implementation of biodiversity offsets for WP1 and in the broader regional context. The Biodiversity Offset study will engage with and draw on the outcomes of the Terrestrial Ecology study any other existing data to identify and examine key biodiversity features at risk that would trigger offset planning.*

Role:

- *Integrating (Lead) Author on the **Biodiversity Offset Framework** chapter (WP 1 Report).*
- *Identify additional co-Authors on the Biodiversity Offset Framework, in consultation with the CSIR SEA team.*
- *Incorporate findings from Contributing Authors on Terrestrial Ecology and Aquatic Ecology.*
- *Liaison with Work Package 1 Authors on "Terrestrial Ecology", with possible specific or high-level input as required.*
- *Liaison with key stakeholders involved in biodiversity planning and protection such as SANParks and provincial conservation bodies.*

Specific tasks:

1. *Plan of Study:*
    - *Outline the approach, data requirements, assumptions, limitations and timeframe of tasks.*
    - *Provide report / chapter framework.*
2. *Description of the receiving ecological-social-legal environment with regards to biodiversity protection and biodiversity offsets planning:*
    - *Describe the land use dynamics and change trends of the receiving terrestrial ecological environment with regards to biodiversity offsets planning and if the proposed port and SEZ do not proceed. This will feed into the dynamic baseline scenario (Sc0) used in WP2 "Regional SEA" as needed – "how is the social-ecological system changing even if a GH2 economy does not realise?". (Note: this can build on the baseline description in the Terrestrial Ecology study and does not need to repeat findings from that study).*
    - *Describe the legal framework for biodiversity offsets planning and key characteristics of the receiving environment as it pertains to biodiversity offsets planning - "What, where, why is it important?"*
    - *Spatially explicit as far as possible (drawing on spatial data from Terrestrial Ecology and Aquatic Ecology studies).*
3. *Additional specific data and actions required for assessment around the associated development project as related to biodiversity offsets:*
    - *Identify what biodiversity features within the port and SEZ footprint and surrounding areas, would trigger the need for biodiversity offsets (linking with the Terrestrial Ecology study findings and engaging with key stakeholders such as SANParks and provincial authorities).*
    - *Collate, review and interpret data on local priority sites or unique biodiversity features within the port and SEZ footprint and surrounding areas.*
    - *Utilise the outcomes of the Terrestrial Ecology study, and other biodiversity planning information, to summarise the biodiversity planning and management context for the region and evaluate the feasibility of offset areas to compensate for the potential loss of the biodiversity features within the port and SEZ.*
4. *Sensitivity analysis:*
    - *Outline the spatial extent of biodiversity features that would trigger offsets*
        i. *Spatial layers distinguishing relative sensitivity or offset categories of the receiving environment (Low = Biodiversity offsetting not required, Medium/High = Biodiversity offset required, Very High = Biodiversity offset not possible).*
5. *Aspects and impacts register:*
    - *Utilise existing studies and data sourced for the project area to predict the potential impacts (negative and positive) that may arise from the planned activities and infrastructure (based on a project description provided by CSIR) on biodiversity.*
    - *Using the scenarios provided and biodiversity sensitivity mapping, identify key biodiversity features that are expected to require offsets, evaluate the potential level of offset planning required level and identify priority features for offset planning.*
6. *Recommendations for planning and future EIA:*
    - *Practical recommendations on how biodiversity offsets could be used to reduce negative impacts and generate benefits, with the aim of no net loss and/or ideally a net gain in biodiversity within the wider region.*

- *Practical recommendations to inform the planning and layout of the Port and SEZ, such as the spatial factors to take into account when planning biodiversity offsets and how to minimise the need for biodiversity offsets (within the Port, SEZ and regional context).*
- *Practical recommendations for proactively developing a biodiversity offsets mechanism for the Port and SEZ.*
- *Practical recommendations for how biodiversity offsets planning can be incorporated into future EIA studies.*

Work Package 2:

Scope summary:
A regional-scale, desktop SEA report covering the main sustainability issues associated with Northern Cape green hydrogen development scenarios ("Namakwa Region SEA"). The study area extent is defined as the Kamiesberg, Khâi-Ma, Nama Khoi and Richtersveld Local Municipalities which covers an area of ~5.8 million ha. The primary objective of the Biodiversity Offsets Framework chapter for the regional-scale development scope is to outline the required offsets, where required, for mitigating the biodiversity impacts of development proposals linked to the Northern Cape green hydrogen economy and identify opportunities for proactive biodiversity offset planning in the region. The chapter will also provide recommendations or guidelines to streamline the process in offset assessment, design, and approval at the subsequent project level.

Role:

- *Liaison with Work Package 2 Author on "Regional Ecology, Biodiversity and Conservation Planning", with possible specific or high-level input as required.*
- *Review of the Work Package 2 report chapter on "Regional Ecology, Biodiversity and Conservation Planning".*

Specific tasks:

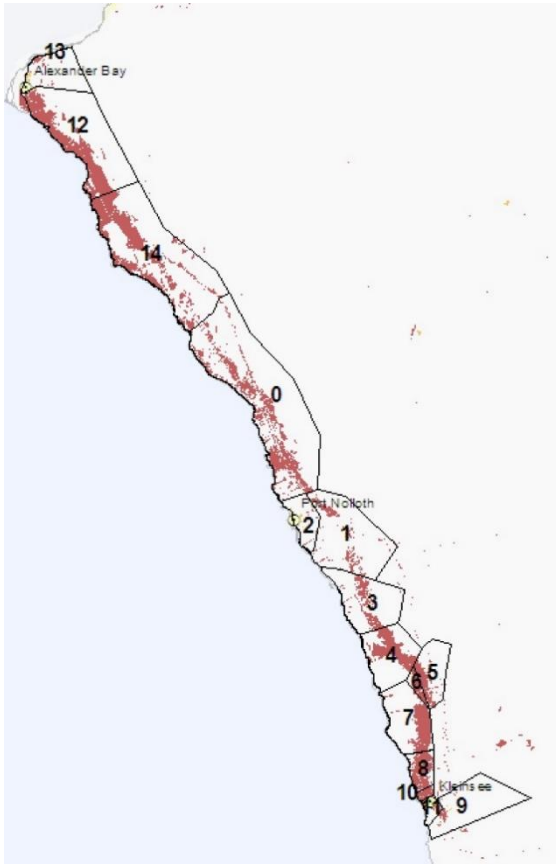
1. *Plan of Study*
    - *Outline the approach, data requirements, assumptions, limitations and timeframe of tasks.*
    - *Provide report / chapter framework.*
2. *Description of the receiving environment:*
    - *Describe the land use dynamics and change trends of the receiving environment and broader region as it relates to your topic. This will feed into the dynamic baseline scenario (Sc0) – "how is the social-ecological system changing even if a GH2 economy does not realise?".*
    - *Describe the key characteristics of the receiving environment as it pertains to your area of expertise – "what, where, why is it important?"*
    - *Spatially explicit as far as possible.*
3. *Sensitivity analysis:*
    - *Outline the spatial extent of biodiversity features that would trigger offsets*
        i. *Spatial layers distinguishing relative sensitivity or offset categories of the receiving environment (Low = Biodiversity offsetting not required, Medium/High = Biodiversity offset required, Very High = Biodiversity offset not possible).*
4. *Aspects and impacts register*
    - *Potential impacts (negative and positive) on biodiversity that may arise from the planned activities and infrastructure, based on a project description provided by CSIR.*
    - *Identify key biodiversity features at risk, where applicable, and prioritise them for offset planning.*
    - *Consider cumulative impacts in the region, across three scenarios using a risk framework methodology that will be provided by CSIR.*
        i. *Scenarios will include Sc0 = dynamic baseline considering inevitable dynamics and trends (e.g. climate, land use, societal); Sc1 = "small H2"(1mtpa); Sc2 = "big H2" (7 mtpa). Sc1 and Sc2 will be elaborated and provided by CSIR based on the project description.*
5. *Offset requirements definition and selection of offset receiving areas*
    - *Define the specific biodiversity offset requirements necessary to mitigate identified impacts.*
    - *Develop criteria or mechanisms for determining and implementing appropriate offsets.*
    - *Identify potential offset receiving areas within the regional study area that can compensate for biodiversity losses.*
6. *Recommended strategic management actions*
    - *Develop practical recommendations or guidelines for future EIA studies, design and approval of biodiversity offsets at the project level.*
    - *Practical recommendations to inform and align with national policy and regional planning.*
    - *Recommend strategies for integrating offsets into broader land-use planning and conservation initiatives. "*

4.7 FOOTPRINT PROJECTIONS FOR SMALL AND BIG GREEN HYDROGEN SCENARIOS

Table 4-3: Impact quantifications for small and big Green Hydrogen scenarios. (as at Sept 2024). Note, this is probably a minimum footprint and excludes indirect and induced impacts. For instance, a 600km pipeline to Saldanha with a 20m servitude would impact at least 1200 ha (not 600). Prieska is another 600km.

	Aspect	Unit	Sc1: Small GH_2	Sc2: Big GH_2	*Assumptions*
SEZ	Electrolyser capacity	GW	5	40	Northern Cape Green Hydrogen Master Plan ambition
	Electrolyser footprint	ha	75	600	15 ha per 1 GW
	GH2 volume	mtpa	0,5	4,0	10 GW electrolyser = 1 mpta GH2
	GH2 storage footprint	ha	250	2 000	10 ha per 20 000 tpa (500 ha for 1 mpta)
	Ammonia volume	mtpa	2,8	22,7	1 mt H2 for 5,67 mt NH3 (1Mt of ammonia contains 176.5 kg (just 17.65%))
	Ammonia footprint	ha	57	454	1 ha per 50 000 tpa NH3 (e.g. Enertrag Hendrina) (20 ha for 1 mtpa)
	Ammonia storage footprint	ha	28	227	0,5 ha per 50 000 tpa NH3 (e.g. Enertrag Hendrina) (10 ha for 1 mpta)
	Desalination output volume	Ml/day	36	286	25 kg water per 1 kg GH2 (considering electrolysis and cooling). 1Mtpa GH2 output required 25 Mtpa (=25000 MLpa) water / 350 operational.
	Desalination footprint	ha	7	57	5 Ml/day output needs 1 ha
	Desalination discharge	Ml/day	48	387	Ratio of desalinated water to brine discharge water to be 42.5:57.5. (i.e 42.5% of intake sea water is converted to desalinated water and 57.5% is discharged as brine).
	Pipeline intake volume	Ml/day	84	672	Output + discharge
REGION	RE capacity total	GW	10	80	1 Mt/yr of H2 needs 10 GW electrolyser, that is powered by 20 GW
	RE capacity - solar	*GW*	*6*	*48*	60 % solar : 40 % wind
	RE footprint - solar	*ha*	*12 000*	*96 000*	0,5MW/ha
	RE extent - solar		*12 000*	*96 000*	Footprint = extent
	RE facilities - solar	*no of facilities*	*6*	*48*	Clusters of 1 GW facilities
	RE capacity - wind	*GW*	*4*	*32*	60 % solar : 40 % wind
	RE footprint - wind	*ha*	*4 000*	*32 000*	1 MW/ha
	RE extent - wind	*ha*	*40 000*	*320 000*	0,1 MW/ha
	RE facilities - wind	*no of facilities*	*3*	*21*	Clusters of 1,5 GW facilities
	Road length	km	300	600	New roads and upgrades same distances / routes as pipelines
	Road footprint	ha	1 200	2 400	40 m (Rural class 2 road 40-70 m. TRH26 Road Classification and Access Management)
	Rail length	km	550	550	Boegoebaai – Kenhardt. New rail direction south-east to connect to the existing Saldanha-Sishen route.
	Rail footprint	ha	1 600	1 650	30 m for rail and service track
	Pipeline length	km	300	600	Sc1: NAM<BB>SB (300km); Sc2: BB>Prieska (300km)
	Pipeline footprint	ha	600	600	20 m servitude
	Powerline length	km	260	1 387	Assume grid strengthening / shared infrastructure 30 km TX associated with each RE cluster.
	Powerline footprint	ha	1 300	6 933	50 m servitude (TRH 27 South African Manual for Permitting Services in Road Reserves)
	Main infrastructure components footprint	**ha**	**21 082**	**142 240**	
Units: GW = gigawatt; mtpa = million tonne per annum; ha = hectare; Ml/day = million litres per day; km = kilometre					

4.8 MINING-DAMAGED LAND INVENTORY



Block ID	ERF_CODE	FARM_NO	SURVEY	OWNER	Mine scars (ha)
0	C05300000000000100000		STATE LAND: FARM 1	ALEXKOR LTD	5364
1	C05300000000015500000	155	STATE LAND: FARM 155	ALEXKOR LTD	1134
3	C05300000000017300000	173	OUBEEP	WCR	1125
4	C05300000000017600000	176	TWEE PAD	WCR	2072
5	C05300000000017700000	177	KAREEDOORN VLEI	WCR	1087
6	C05300000000017700001	177/1	RONJOE	WCR	507
7	C05300000000019200000	192	DREYERS PAN	WCR	1802
8	C05300000000019300000	193	KLEIN ZEE		1555
9	C05300000000032200000	322	SAND KOP	WCR	264
10	C05300000000019300001	193/1			359
11	C05300000000019400002	194/2	KLEIN ZEE	WCR	202
12	C05300000000000100000		STATE LAND: FARM 1	ALEXKOR LTD	4797
13	C05300000000000100000		STATE LAND: FARM 1	ALEXKOR LTD	264
14	C05300000000000100000		STATE LAND: FARM 1	ALEXKOR LTD	6177
				TOTAL	**26709**

CHAPTER 5

Heritage resources

CHAPTER 5:
Heritage resources

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Recommended citation: Orton, J., Webley, L., Pether., J. & Maitland, V. (2025). *Chapter 5: Heritage resources* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR

Executive Summary

This review considers the nature and distribution of various heritage resources within the proposed Boegoeberg Port and SEZ. The locations and names, of the various Zones referred to in the text are shown in Figures S.1 & S.2 along with survey tracks, key findings and the more highly sensitive areas.

Summary of Findings

Palaeontology

- The SEZ is of generally low sensitivity, although excavations could intersect the buried late Pliocene Hondeklipbaai Formation in Zone 1 (Port Precinct). This area is considered to be of medium sensitivity, with the rest of the study area rated low sensitivity.
- Bone accumulations from hyena lairs could be recovered along any cliff (whether exposed or buried) where the geology is favourable. They can be of high significance if they date to the Pleistocene.

Terrestrial Archaeology

- Isolated occurrences of Early Stone Age material have been identified in deflated areas such as pans (Zones 3, 4, 6 & 7).
- A Middle Stone Age occurrence has been identified at Namakwakop in Zone 1 (Port Precinct). The hyena lair and the MSA shelter excavated near Boegoeberg South in Zone 2) highlight the possibility of MSA sites in buried shelters. If these shelters contain pre-modern human remains, they assume high significance.
- Significant occurrences of Later Stone Age shell middens and other occupation debris, likely spanning the period from the mid-Holocene to the most recent past, occur along the coast (Zones 1, 3, 7 & 8 but likely occur in other zones too), at the pans (Zones 3, 4, 6 & 7) and at inland locations at water sources (Zone 9). These areas are generally of very high (within 0.5 km of the coast) or high (0.5-4.5 km from the coast) sensitivity with the remaining land being low sensitivity.
- Impacts are likely to occur throughout the Port and SEZ study area but will be more concentrated closer to the coastline.

Graves

- Three known graves occur in Zone 2 at the western foot of Boegoeberg South. Oral history refers to the grave of the original Paul (Bierkaptein) Links, at the Boegoeberg, and the significance of the area for the Nama people (Zones 1 & 2). Unmarked (and hence unmappable) pre-colonial burials (particularly LSA graves) can occur anywhere in the study area, but they are generally far more common in coastal dunes than inland. It is therefore possible that graves could be uncovered anywhere in the study area during construction. Known graves are allocated very high sensitivity, but the rest of the area is not rated due to the impossibility of mapping unknown graves and very low likelihood of occurrence.

Maritime Heritage

- Many shipwrecks have been reported off the Namaqualand coast. Location data is often poor and wrecks often drift between the place of foundering and finally settling. One pre-1965 wreck is very highly likely to fall within the sea adjacent to the SEZ study area, while four others are highly likely to do so. Areas mentioned in the literature are accorded medium sensitivity, while the remainder of the area is of low sensitivity.

- Although impacts are unlikely to occur, any impact to a historical shipwreck has the potential to be highly significant, such as the 16th century Portuguese wreck, the Bom Jesus, found on the Namibian coast.

Living Heritage

- Oral information (Land Claims Court Case) emphasises that, before the erection of security fences, Nama herders from the Richtersveld followed a transhumance cycle that included Boegoeberg, Rietfontein, Visagiespan, Swartbank and Witbank, effectively encompassing the entire study area.
- Although herders were prevented from accessing the mining area after the discovery of diamonds in 1925, they still continued to use Portions 4 and 6 of Farm 2 (the Korridor Wes farms) as confirmed by 1937 aerial photographs. *Soon after 1925 the mining area was fenced off*, with Farm 2 following in the mid-1950s. After Portions 4 and 6 of Korridor Wes were returned to the community in 2007, stock owners returned to the areas termed Swartbank and Witbank during the winter months, although the storage of water in drums at their stockposts seems to extend the annual period of use for some herders. Seasonal stockposts, constructed using modern materials, are still found in these areas and also in that part of Farm 1 outside the mine area, confirming the continued association of the site with living heritage (Zones 2, 9 & 10). These areas used by small-scale herders are rated as high sensitivity with the remaining land outside the mine being medium sensitivity and land within the mine being low sensitivity (Figure 5-43).
- Development would prevent access to this land, impacting the traditional transhumance cycle of the local herders re-established on it after 2007.

Cultural Landscape

- Immediately to the east of the study area is the buffer zone of the **Richtersveld Cultural and Botanical Landscape World Heritage Site (RCBL).** It was proclaimed in 2007 because "*as a cultural landscape, it reflects the long-standing and persistent traditions of the Nama, the indigenous community. The cultural landscape comprises all the elements linked to the transhumance lifestyle of the Nama pastoralists* ".
- The area is a relatively flat plain, sloping downhill from east to west. The landscape is open, windswept and desolate. West of the R382, prospecting trenches and mine dumps litter the landscape. East of the R382 are sparsely vegetated arid coastal lowlands with far sparser evidence of mining. The Boegoeberg Twins form an important element of the landscape between Port Nolloth and Alexander Bay and have historical significance.
- The proposed industrial development for the SEZ will be highly visible for a considerable distance along the coast and will impact on the sense of place due to its strong contrast with the existing landscape.
- The R382 is identified as a scenic route because it provides access to the RCBL World Heritage Site, the Richtersveld National Park, the Orange River and Namibia.
- From a purely visual point of view, the coastline, R382 corridor, Boegoeberg Twins and the pans are the main highly sensitive areas.

Recommendations

A Heritage Impact Assessment (HIA) will be required for every Environmental Impact Assessment. Notwithstanding the heritage resources on site, HIAs will be needed in order to satisfy the requirements of the National Heritage resources Act (No. 25 of 1999). A separate Visual Impact Assessment must be included in every EIA process.

Palaeontology

- There are no areas of highly sensitive fossiliferous strata in the SEZ Project Area that require protection as NO-GO areas.
- Every project MUST be evaluated by a palaeontologist to determine the need for a palaeontological specialist study despite the known low surface sensitivity because, depending on depth of excavation, significant impacts could still arise below surface.

Terrestrial Archaeology

- Archaeological specialist studies will be required in all EIAs and detailed surveys of each project footprint must take place.
- Due to the density and distribution of archaeological sites recorded during the initial field surveys, it will not be feasible to mitigate all impacts. The appointed archaeologists will need to determine which archaeological sites best characterize each development footprint in order to sample the most appropriate sites. This may include some sites of lower significance.
- It is likely that monitoring of development may be required in the coastal areas where middens can be buried within sand dunes or under recent wind-blown sand.

Maritime Heritage

- A Maritime Heritage specialist study will need to be included in the heritage application for the Port development, as well as any other developments that might require, for example, undersea pipelines.

Graves

- Graves would be considered along with archaeology in any EIA process that occurs in the Port and SEZ areas.
- Given the size of the Port and SEZ, it is possible that a number of graves could be uncovered. Discussions with SAHRA, the Northern Cape Heritage Resources Authority and representatives of local communities must be initiated in advance of the development to determine whether reburial of human remains – perhaps in Zone 2 (the conservancy area) – should be considered.

Living heritage

- The local herder community should be consulted to determine their response to the loss of their winter grazing lands, specifically those areas termed Swartbank and Witbank. Among other things, consultation should aim to understand:
    - Why these areas were chosen for grazing;
    - The value of the pasturage in terms of seasonal grazing requirements;
    - Any alternative options; and
    - How nature and culture are intertwined within their world view.

- The local community should be consulted to determine ways to enhance their connection with the coastline, especially with regards to fishing as a traditional livelihood.

Cultural landscape / sense of place

- The R382 and surrounding area are significant for a number of reasons, largely tourism-related. Further consideration should be given to the appropriateness of the site, and the local community, SANParks, UNESCO, SAHRA and local tourism operators should all be engaged in this process. Although the proposed development lies outside the buffer zone of the RCBL Heritage Site (Figure 5-36), the potential indirect impacts (visual and increased movement of sand) cannot be disregarded. Discussions will need to be initiated with the South African Government and the UNESCO commission regarding the potential impact of the proposed Boegoebaai Port and SEZ development on the World Heritage status of the RCBL.



Figure S.1: Map of the Port and SEZ study area (red polygon with black internal divisions) showing field survey tracks (blue), all archaeological sites recorded during the surveys (yellow and white circles), recent transhumant herder

camps (green symbols) and all areas regarded as of high or very high sensitivity (red and dark red shading) for any aspect of heritage. The pink line separates Farm 1 (to the west) from the Korridor Wes farm portions (to the east) and the RCBL World Heritage Site buffer zone lies east of the green line. Note that all place names are from modern maps except Witbank which is referred to as Visagiefonteinkop on modern maps.

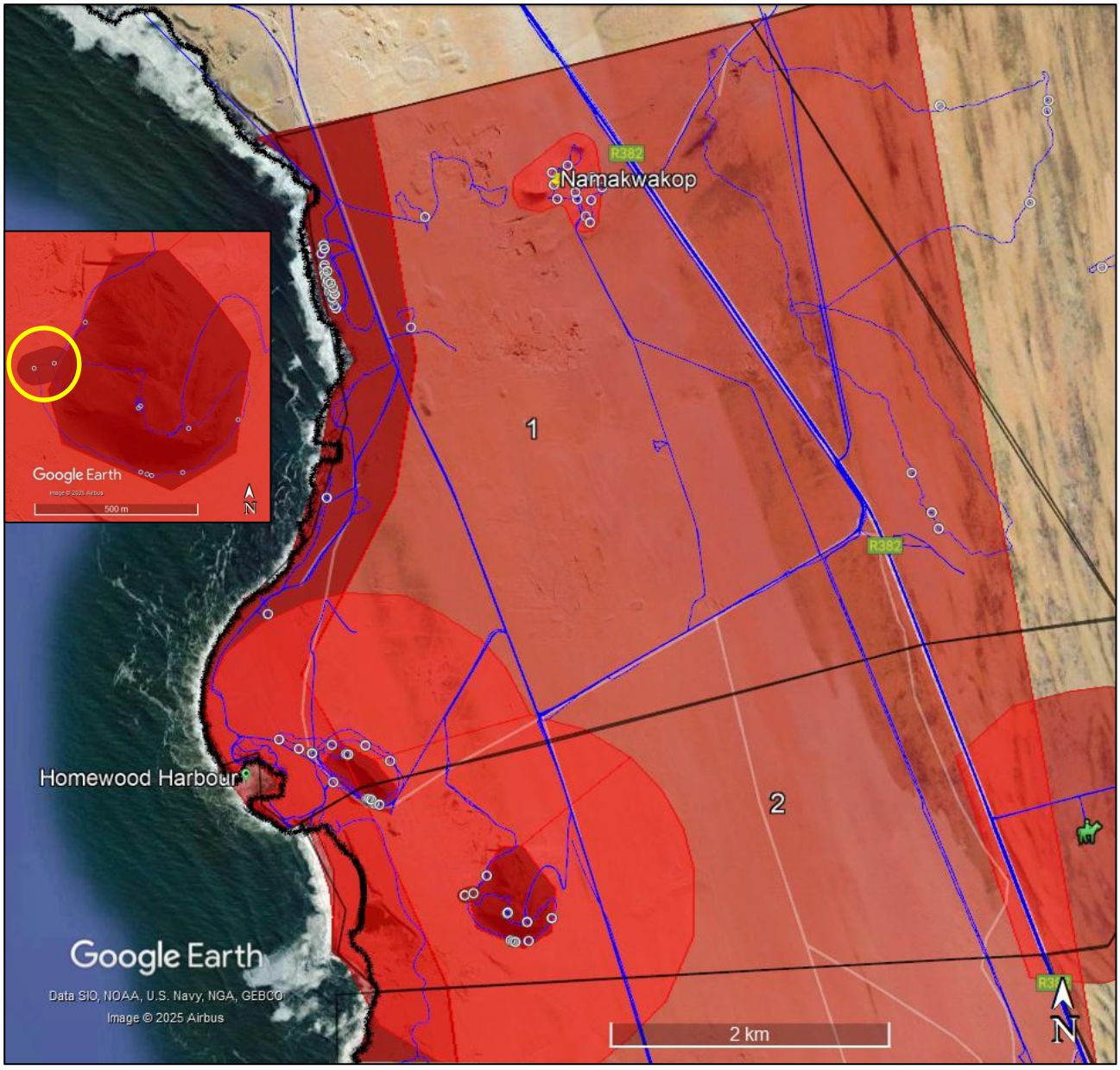


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CHAPTER 5. HERITAGE

5.1 BRIEF LEGISLATIVE CONTEXT

The National Heritage Resources Act No. 25 of 1999 (NHRA) protects a variety of heritage resources as follows:

- Section 34: structures older than 60 years;
- Section 35: prehistoric and historical material (including ruins) more than 100 years old as well as military remains more than 75 years old, palaeontological material and meteorites;
- Section 36: graves and human remains older than 60 years and located outside of a formal cemetery administered by a local authority; and
- Section 37: public monuments and memorials.

While landscapes with cultural significance do not have a dedicated Section in the NHRA, they are protected under the definition of the National Estate (Section 3). Section 3(2)(d) lists "landscapes and natural features of cultural significance" as part of the National Estate.

Development in the Port and SEZ would require assessment under the NHRA with the following being the primary triggers:

- Section 38(1)(a): Any development that involves a linear feature more than 300 m long; and
- Section 38(1)(c)(i): Any development that involves changes the character of a site exceeding 5000 m^2.

However, Section 38(8) of the NHRA states that if an impact assessment is required under any legislation other than the NHRA then it must include a heritage component that satisfies the requirements of S.38(3) of the NHRA. Furthermore, the comments of the relevant heritage authority must be sought and considered by the consenting authority prior to the issuing of a decision. The responsible heritage authority in this instance is the South African Heritage Resources Agency (SAHRA) which has a Development Applications Unit to comment on all applications submitted under Section 38(8).

5.2 THE BOEGOEBAAI STUDY AREA

The study area lies on the semi-arid West Coast in northern Namaqualand, an area known as the Richtersveld. The coastal stretch is characterised by an extensive sandy plain that rises gently from the coast towards the east (Figure 5-1 & Figure 5-2). Rock is exposed in a few places; the most notable of these are the Boegoeberg Twins (Figure 5-3), but a few small outcrops occur in the north of the study area and some bedrock exposures are evident on the high ridge running northwest to southeast just inside the eastern edge of the study area (Figure 5-4). Although much of the area is covered by sparse vegetation, there are areas of exposed mobile dunes in places, largely due to recent disturbance from mining (Figure 5-5). In the past – as indicated by 1937 aerial photography – mobile dunes were far less frequent and were located primarily close to the coast. The result of the sand mobilisation is that there is very little visibility of the pre-mining land surface and archaeological visibility in these areas is consequently low (Figure 5-6). This issue is pervasive within about 5 km of the coast, but in the far north the disturbed area is less than 3 km wide.



Figure 5-1: View towards the east through the centre of the study area from near the coast and showing the sandy coastal plain.



Figure 5-2: View towards the west through the northern part of the study area from near its eastern boundary.



Figure 5-3: View towards the west across the sandy coastal plain towards the rocky Boegoeberg Twins.



Figure 5-4: View of one of the granite outcrops on the high lying ground in the east of the study area.

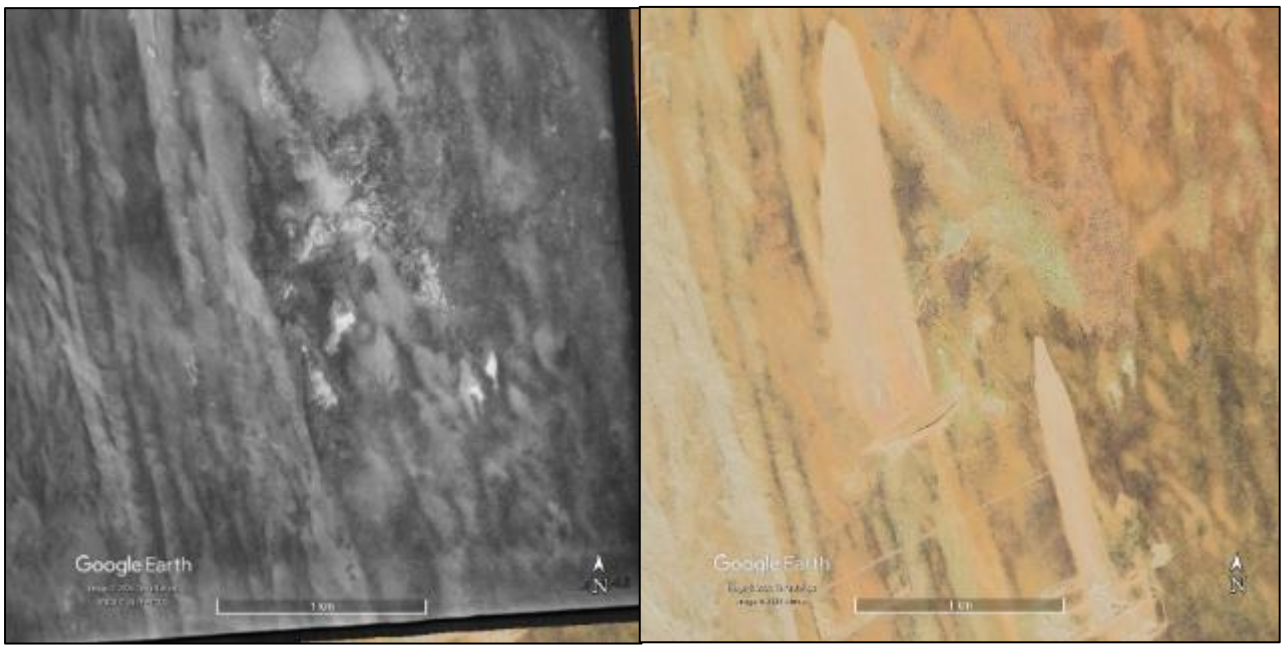


Figure 5-5: Identical 1937 (aerial photograph 122_052_47642 from 1937) and 2023 (Google Earth 2024) showing recent sand mobilisation owning to mine disturbance near the southern end of the study area.



Figure 5-6: Recently mobilised sand obscuring the pre-mining land surface in an unmined area.

5.3 METHODOLOGY

5.3.1 Palaeontology

The palaeontological study was done entirely from the desktop and is based on published scientific literature and the specialist's extensive field experience of the formations involved and their fossil content. The new stratigraphic terminology proposed by De Beer (2010) is mainly used, but is elaborated and modified according to the specialist's own observations. The observations of De Villiers & Söhnge (1959), Keyser (1972) and Gresse (1988) in the SAD/Alexkor diamond mining open pits are important sources.

Field observations were also made during the archaeological surveys, and were incorporated. It is assumed that the fossil potential of the various geological formations in the study area will be similar to that in nearby areas where records exist. One palaeontological site in Zone 2, a hyena lair named Boegoeberg 1, has been excavated as a research project (Klein 1999).

A limitation on predictive capacity exists in that it is not possible to predict the buried fossil content of an area or formation other than in general terms due to the absence of localised subsurface palaeontological investigations in the area. Note that different types of fossils occur in a single formation and can differ in their scientific/palaeontological importance.

5.3.2 Terrestrial Archaeology and History

The terrestrial archaeological study was a combined desktop and field study. While extensive data are available from the Port Nolloth to Hondeklipbaai coastline and other surrounding areas, archaeological work within the Alexkor Mine is limited to two brief field surveys (Parkington 1993; Kaplan 2008), and a single research excavation at a site close to the Boegoeberg Twins (known as Boegoeberg 2; although not published, it is mentioned in Klein *et al.* 1999). For this reason, new fieldwork was carried out within the mine as well as in the adjacent hinterland with the aim of providing more detailed data for the area and confirming that expectations from further south would remain true there.

The field study was limited as follows:

- A full, detailed survey of the approximately 33 km^2 study area was not feasible as this would take many months to complete. Figure 5-7 shows the survey tracks.

- For the sake of time on site, the records made during the survey are brief and not intended to allow for full mitigation requirements to be determined. Rather, they provide an indication of the distribution and extent of archaeological sites and allow for planning of further work as may be needed during subsequent EIA studies.

- Substantial disturbance has occurred due to historical and ongoing mining, and it was not always possible to determine whether an area had been mined and rehabilitated or if it had never been mined. One small area that looked mined on aerial photography was found during the site visit to contain intact archaeological sites.

- Some areas have been recently covered by wind-blown sand originating from topsoil dumps and surface examination of such areas is meaningless.

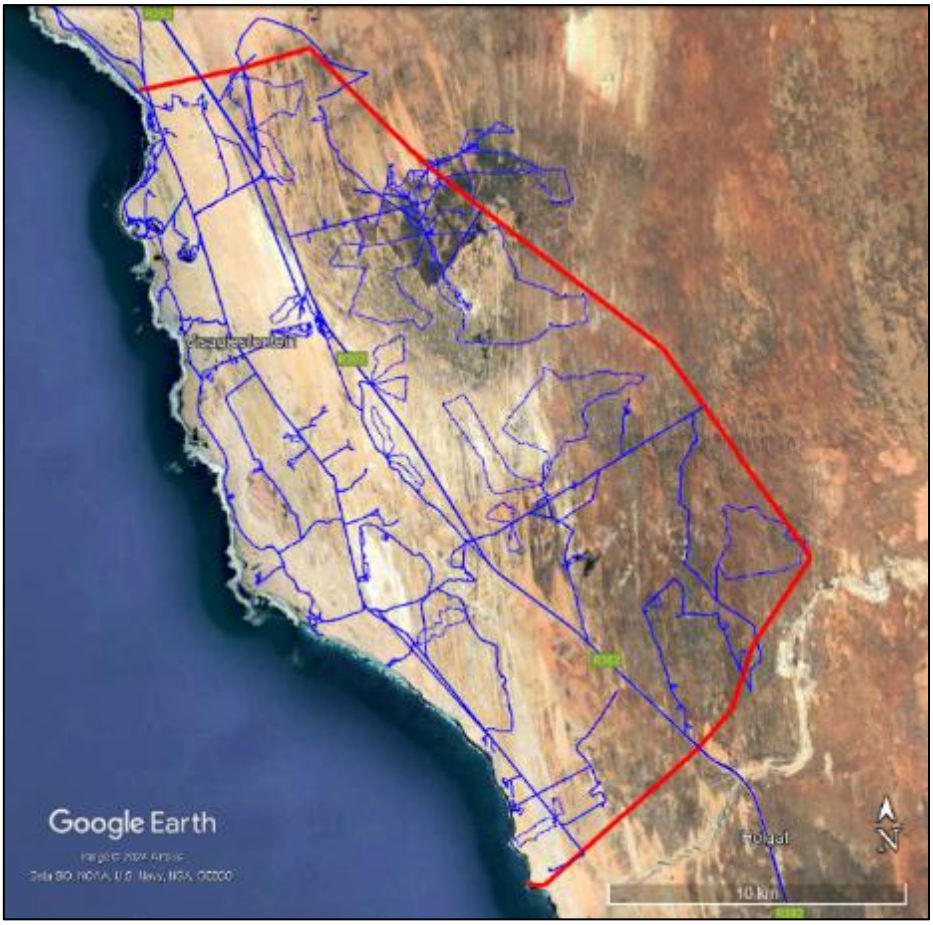


Figure 5-7: Aerial view showing the archaeological survey coverage (blue lines).

5.3.3 *Maritime Heritage*

A shipwreck database was compiled from the available written and oral sources and interrogated for the assessment. The study was limited as follows:

- The database is a research tool that is constantly evolving as information is discovered and added.
- Locational data are often scarce and/or inaccurate. Shipwrecks are therefore allocated to an area based on limited information and certain assumptions regarding the dynamic nature of the environment; and
- The wreckage of ships foundering at sea outside the study area may drift many kilometres on or just below the surface after being abandoned. For precautionary reasons, these are also included in the project-specific database.

5.3.4 *Living Heritage*

A desktop review of living heritage practices in the wider Richtersveld area is supplemented with observations from historical and modern aerial photography and on-site observations of modern small-scale herders. Use was made of the proceedings of the Richtersveld Community versus Alexkor Limited and Government of the Republic of South Africa case in the Lands Claims Court in 2000. The Court Proceedings (2000) revealed information on traditional land use patterns that occur in the study area.

The study is limited by the fact that no oral information was collected from the herders as to their pastoralist strategies.

5.3.5 Cultural landscape

The cultural landscape was assessed using the authors' collective knowledge of the Namaqualand environment along with visual sensitivity mapping commissioned especially to inform the landscape study. The latter was undertaken by visual specialists (Oberholzer & Lawson 2024), but it is noted that no visual chapter was included in the SEA. The visual sensitivity mapping was based on available spatial datasets (Table 5-1) with sensitivity assigned as shown in Table 5-2.

Table 5-1: Sources of Information for visual sensitivity mapping. Source: Oberholzer & Lawson (2024).

Feature Class	Data Source	Data Description
Topographic features	CD NGI 1:500 000 topographic map series; Google Earth (2024) with terrain; and steep slopes data.	Topographic maps for prominent elevations, ridgelines, scarps, ravines and geological features, particularly where these occur in combination with steep slopes to create complex landscapes.
Steep slopes	SRTM DEM (NASA SRTM GL1 v003 (Shuttle Radar Topography Mission).	Two categories of slopes used: steeper than 1:4 and 1:4 to 1:10. Areas with high geographic density of steep slopes.
Rivers and water bodies	OSM (Open Street Map) Rivers and Wetlands SANBI NFEPA Rivers and Wetlands 2011	Major perennial rivers, estuaries, lagoons, lakes, wetlands, and pans.
Ramsar sites	DFFE SACAD Q2 2024	Database of conservation areas.
Coastal zone	1:250 000 and 1:50 000 topographic map series; NGI shapefiles (latest version).	A 1 km strip of coastline. Sections of coastlines differentiated where these are distinct.
National Parks	DFFE SAPAD Q2 2024	Database of protected areas. Some parks have viewshed protection areas.
Protected Areas	DFFE SAPAD Q2 2024 SANBI Protected Areas Database	Includes proclaimed / protected nature reserves, biosphere reserves, game reserves and wilderness areas.
Private reserves and game farms.	DFFE SAPAD Q2 2024 SANBI Protected Areas Database, Google Maps.	Includes guest farms, resorts and tourism destinations, where known.
Towns and villages	CD NGI 1:250 000 topo-cadastral map series	Digitised Spatial Data of towns and settlements.
National Roads	OSM (Open Street Map) Roads	Routes as mapped.
Provincial Roads	OSM (Open Street Map) Roads	Includes main arterial routes.
Scenic routes	1:250 000 and 1:50 000 topographic map series; Google Maps with terrain.	Includes mountain passes, poorts and coastal routes with intact landscapes.

Table 5-2: Visual Sensitivity Mapping Categories and Recommended Buffers for the Port and Mixed-use Special Economic Zone (SEZ). Source: Oberholzer & Lawson (2024).

Scenic Resources	Very high visual sensitivity	High visual sensitivity	Medium visual sensitivity	Legislative framework
Topographic feature: prominent scarps, peaks and ridges	within 100 m	within 200 m	-	NEMA, DFFE Screening Tool. NHRA
Steep slopes	Slopes > 1:4	-	-	NEMA, DFFE Screening Tool.
Coastal zones, estuaries	within 1 km	-	-	ICM Act
Scenic water features (major rivers, wetlands, pans)	within 100 m	within 200 m		NEMA DFFE Screening Tool.
Cultural landscapes	Feature	within 200 m		NHRA
Protected Landscapes / Sensitive Receptors				
National Parks	within 1 km	within 1,5 km	within 2 km	National Parks Act
RAMSAR sites	within 1 km	within 1,5 km	within 2 km	RAMSAR Convention
Nature Reserves, Botanical Gardens	within 500 m	within 1 km	within 1,5 km	Provincial ordinances
Private reserves, game farms, guest farms, resorts	within 500 m	within 1 km	within 1,5 km	PSDFs and MSDFs.
Settlements, towns, villages	within 500 m	within 1 km	within 1,5 km	MSDFs, zoning schemes and bylaws.
Scenic routes, passes, poorts	within 1 km	within 1,5 km	within 2 km	NHRA
National routes (rural)	within 500 m	within 1,5 km	within 2 km	
Provincial / arterial routes	within 500 m	within 1 km	within 1,5 km	
Main district roads (rural)	within 250 m	within 500 m	Within 1 km	

5.4 DESCRIPTION OF THE RECEIVING ENVIRONMENT

5.4.1 Palaeontology

The geological map of the proposed Port and SEZ is complex, when compared with adjacent geological maps which map the surface geology (Figure 5-8). This is because the map attempts to depict the subsurface formations as well. The geology of the area is briefly described below.

The various bedrock formations underlying the coast belong to the GARIEP SUPERGROUP, which is a suite of volcanic and sedimentary rocks, deposited between 770 and 550 Ma (million years ago). The highly deformed bedrock underlying the Port and SEZ is the Holgat Formation. Although early microfossils appear at times in these rocks, they are not of palaeontological concern.

The bedrock is overlain by much younger formations deposited during the last 66 million years of the Cenozoic Era. The various formations comprising the Cenozoic deposits, between the Orange River and Elands Bay, are termed the **West Coast Group** (Roberts *et al.* 2006).

Table 5-3: Namaqualand Coastal Stratigraphy – The West Coast Group.

Formation Name	Deposit type	Age
Witzand	Aeolian pale dunes & sandsheets.	Holocene, <~12 ka.
Curlew Strand, Holocene High	**Marine, 2-3 m Package.**	**Holocene, 7-4 ka.**
Swartlintjies & Swartduine	Aeolian dune plumes.	Latest Quat., <20 ka.
Hardevlei	Aeolian, semi-active surficial dunes, >100 m asl.	Latest Quat., <25 ka.
Koekenaap	Aeolian, surficial red aeolian sands.	later late Quat., 80-30 ka.
Local Coastal Aeolianites*	Aeolianites, limited pedogenesis, weak pedocrete	Mid-late Quat., ~250-80 ka.
Curlew Strand, MIS 5e, LIG.	**Marine, 4-6 m Package.**	**earliest late Quat., ~125 ka.**
Fossil Heuweltjiesveld palaeosurface on Olifantsrivier & Dorbank fms.		
Dorbank*	Aeolian, reddened, semi-lithified.	later mid-Quat., ~400-140 ka.
Curlew Strand, MIS 11.	**Marine, 8-12 m Package.**	**mid Quat., ~400 ka.**
Olifantsrivier	Aeolianite, colluvia, pedocrete.	early-mid Quat., ~2-0.4 Ma.
Graauw Duinen Member 2	Aeolianite, colluvia, pedocrete.	latest Plio-early Quat.
Hondeklipbaai	**Marine, 30 m Package, LPWP.**	**late Pliocene, ~3 Ma.**
Graauw Duinen Member 1	Aeolianite, colluvia, pedocrete.	mid Pliocene.
Avontuur	**Marine, 50 m Package, EPWP.**	**early Pliocene, ~5 Ma.**
Later Miocene Aeolianites*	Aeolianites, weathered.	later Miocene (14-5 Ma)
Kleinzee	**Marine, 90 m Package, MMCO.**	**mid Miocene, ~16 Ma.**
Unnamed*	Aeolianites, leached, faulted.	Oligocene
Koingnaas	Fluvial, kaolinized gravels, sands, plant fossils.	late Eocene
De Toren	Silcreted colluvial palaeosurfaces 200-400 m asl.	Paleocene - Eocene
* - Informal		
MMCO – Mid-Miocene Climatic Optimum. EPWP – Early Pliocene Warm Period. LPWP – Late Pliocene Warm Period. MIS – Marine Isotope Stage.		

The **Early Coastal Plain**, including the **De Toren** and **Koingnaas Formations** (44-34 Ma), contain fossil pollens (Table 5-3). Notably, the Koingnaas pollen assemblage, with many extinct types of uncertain affinity and no analogues elsewhere, indicates that the uniqueness of the Cape Floristic Region is rooted in "deep time" (De Villiers & Cadman 2002). The Koingnaas Formation deposits are remainders of a fossil landscape when the tropical wooded Namaqualand coast more nearly resembled the forests of the south coast.

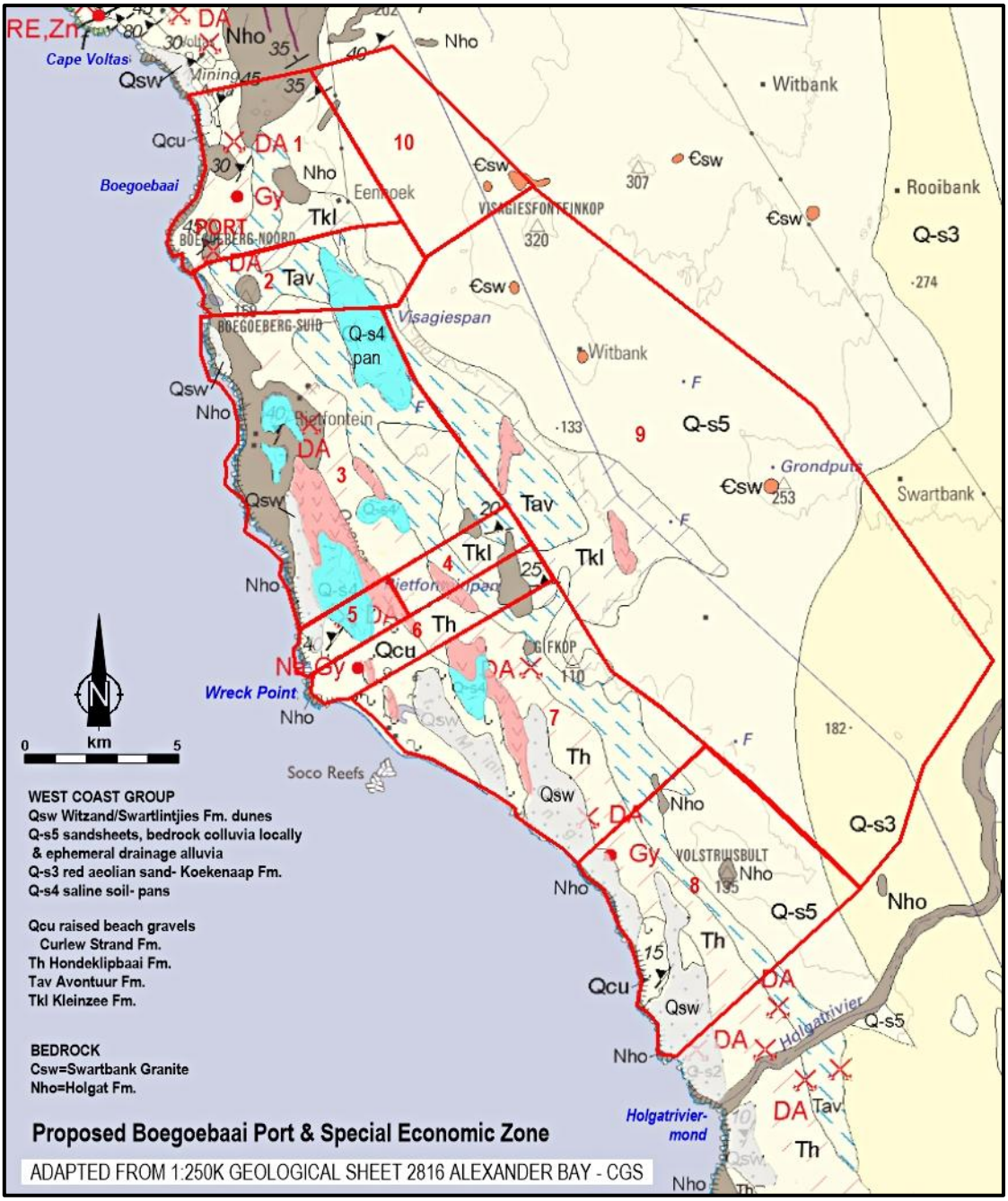


Figure 5-8: Geological context of the Boegoebaai Port and SEZ. The map attempts to depict the subsurface formations as well. Thus, the polygons Tkl, Tav, Th and Qcu are marine formations which are beneath the aeolian formations and are not currently exposed. The turquoise polygons are pans.

The **Fossiliferous Marine Deposits**, including the **Kleinzee, Avontuur** and **Hondeklipbaai Formations**, relate to periods when part of the coastal plain was occupied by the sea, but marine deposits from these times have eroded away, or remain as buried residual patches beneath the thick cover (Table 5-3). Fossil shells are found in places in these Miocene and Pliocene marine formations, and each contains warm-water species and also important extinct fossil shell species which are characteristic of that formation, and which facilitate correlation of formations over wide regions. Rare, scientifically important petrified bones and teeth of marine and terrestrial mammals occur in the basal gravels and sometimes in the overlying marine sands. These finds have been vital to the dating of the formations.

The pre-Quaternary marine deposits of the Alexkor mine are mostly decalcified (J. Pether, pers. obs.) and the preservation of fossil shells is very patchy, with the exception of the ubiquitous, calcitic, thick oyster shells. These Mio-Pliocene fossil shells are therefore of LOW sensitivity. Fossil bones are exceedingly sparse in the

main thickness of the marine deposits, with scattered whale and seal bones most common. Although occasional teeth have been rescued in the mines, most excavated scientifically significant material is now hidden in oversize dumps. Due to the scarcity and rare recovery of vertebrate fossil material from the deposits, any finds of identifiable bones such as teeth, jaws, skulls, ear-bones and limb bones with their articulating ends are of HIGH significance, even if found out of context on mine dumps.

Close to the coast, the Hondeklipbaai Formation is eroded and overlain by the younger, Quaternary "raised beaches". The name **Curlew Strand Formation** has been proposed for this composite of raised beaches, and three successive raised beaches are recognized at 8-12, 4-6 and 2-3 m asl., with ages of ~400 ka (ka = thousand years ago), ~125 ka and 7-4 ka, respectively (Table 3). The fossil shells in these raised beaches are predominantly the cold-water fauna of modern times.

The shelly raised beach deposits of the Curlew Strand Fm. are dominated by extant shell species still living today and are of LOW sensitivity with respect to shell fossils (Figure 5-9). The areas of low bedrock elevation close to the coast and now occupied by pans would have been sheltered embayments/lagoons during the higher sea levels, with the warmer water hosting "extralimital" tropical shell species, "guests" of Angolan/West African origin. These are of scientific interest, but such finds have not been reported, possibly because these deposits may have been deflated away, or dissolved in fresh waters during wetter periods such as the Last Ice Age.



Figure 5-9: Mid-Holocene raised beach at waypoint 141.

The **Aeolian Formations** (Table 5-3) comprise a number of terrestrial deposits. These include the **Later Miocene Aeolianites** which are older Aeolian deposits of the marine Kleinzee Formation which have been eroded and reworked. The **Graauw Duinen Formation** comprises three main, distinct aeolian formations. The overlying **Olifantsrivier Formation** is a reddened aeolianite with interbedded palaeosols, pedocretes, abundant root casts and termite burrows. Isolated Early Stone Age (ESA) artefacts are found in this formation and Middle Stone Age (MSA) artefacts are found on the eroded surfaces. The lower part of the Formation is older than 1.9 Ma while the upper part, in which the ESA occurs, dates to the early Quaternary/earliest middle Quaternary.

Overlying these deposits one finds yellow-brown to red-brown, semi-cemented beds of aeolian sand colloquially called "dorbank" and lumped together into the **Dorbank Fm**. The occurrence of Middle Stone Age (MSA) artefacts within its upper deposits indicates an age younger than about 400 ka, while dates obtained from the upper deposits constrain its age to older than about 130 ka.

For the most part the overlying aeolian formations (*i.e.* **Koekenaap, Hardevlei, Swartlintjies & Witzand fms**.) have a sparse fossil bone content. Most commonly seen is the ambient fossil content of dune sands: land snails, tortoise shells and mole bones. Other palaeosurfaces are formed by wind deflation exposing and concentrating fossils, sometimes with associated archaeology (Figure 5-10). Importantly, the bones of larger

animals (*e.g.* antelopes) are also more persistently present along the major palaeosurface formed on top of the eroded marine deposits and the palaeosurfaces which separate the major aeolianite units.

The most spectacular and highly significant bone concentrations found in aeolianites are due to the bone-collecting behaviour of hyaenas. These could occur in any geologically appropriate settings. Out-of-context fossil bones originating in these formations and found in dumps are of low significance because they are generally of extant taxa but, occasionally, unexpected or recently extinct species may occur and would be more significant.



Figure 5-10: Fossil bones in association with archaeological materials at waypoint 603.

Pans located further inland have distinctly different deposits such as pan limestones, evaporites (for example gypsum and salt), muds of unusual compositions, diatomaceous layers, and organic-rich, peaty beds, with interbedded windblown sand layers. Palaeontological finds around these pans are expected to be fossil bones of late Quaternary age and to be those of extant species. These are accorded a LOW palaeontological sensitivity. However, rare bones of recently extinct or unexpected species can sometimes also be found.

In summary, the yellow to white, unconsolidated dunes and sandsheets (Hardevlei and Witzand Fms west of the R382) are mainly of Holocene age. The reddened soils of the Koekenaap Fm., mainly east of the R382, were deposited episodically during the late Quaternary. These surficial formations overlie the calcrete capping aeolian and colluvial deposits which are preliminarily attributed to the early and mid-Quaternary Olifantsrivier Fm. The accuracy of these predictions is based on fairly comprehensive analyses of the geology of the area.

5.4.2 Terrestrial archaeology

The field data is appended as **Appendix 5-1**.

5.4.2.1 Desktop study

Archaeological sites are extremely common along the Namaqualand coast (Dewar 2008; Dewar & Orton 2013; Orton 2012) but research along the coastal section of the Richtersveld, between Alexander Bay and Port Nolloth, has been very sparse. Only two very brief field surveys have been undertaken within the Alexkor mining area. Kaplan (2008) recorded just fifteen sites along 73 km of coastline. The report stressed that

large numbers of sites had likely been destroyed by mining. Although regular pre-disturbance surveys were recommended, these were not implemented. Parkington (1993) had earlier commented that some of the sites he saw were "extremely valuable archives and require(d) immediate and urgent attention". One of these sites was located south of the proposed SEZ and contained fossil animal bones and "superabundant" ESA and MSA artefacts. He also mentions seeing many shell middens but spatial data were not provided. As a result of the continued lack of archaeological mitigation in the mine, widespread destruction of sites has occurred with just one having been (partially) rescued from destruction within the mining area (Klein *et al.* 1999). Located in a buried rock shelter and known as BOG2, it contained the remnants of an MSA deposit substantially disturbed by mining. This observation highlighted the possibility of finding MSA sites in buried rock shelters but also in the open. Their importance is elevated if they are stratified. The possibility of pre-modern human remains at such sites, while extremely low, is not impossible.

Just five other surveys are known to have taken place close to the study area. A survey at Alexander Bay showed that shell middens occur along the Orange River, becoming more frequent towards the coast (Orton 2010). Just inland of Alexander Bay Hart (2015) found a small LSA scatter with stone artefacts and ostrich eggshell. Within and just beyond the eastern part of the WP1 study area, Hart (2010) reported some ephemeral stone artefact scatters of Pleistocene age as well as a Holocene Later Stone Age (LSA) site associated with a granite outcrop. In the same area, Hart (2013) reported MSA artefacts in a deflation area with fossil bone and ostrich eggshell, and Orton (2024) found similar Pleistocene finds and some small LSA shell and artefact scatters. Rudner (1968) has reported on pottery to the north and south of the study area but he did not visit the area between the Orange River mouth and a point just north of the town. To the south, around Port Nolloth, several surveys have revealed hundreds of LSA archaeological sites (Kaplan 2011a, 2011b, 2011c; Orton 2021; Webley 2009a). Excavations at a few of them have revealed deposits dating to 2670 ± 30 BP calibrated to 331 BC – AD 10 (UGAMS-6607) and containing many stone tools, ostrich eggshell beads and some engraved ostrich eggshell fragments (Orton 2017; Webley & Orton 2013).

Some 28 km inland of the WP2 study area, recent work at Spitzkloof has revealed *in situ* LSA and MSA deposits in rock shelters, the latter extending back to pre-Still Bay times (>70 000 BP) (Dewar & Stewart 2012; Dewar *et al.* 2023; Hopper & Dewar 2023). A survey inland of Port Nolloth revealed Pleistocene-aged stone artefacts (Küsel *et al.* 2009). In the northern Richtersveld a number of LSA sites have been recorded (Halkett 1999; Orton & Webley 2009; Van der Walt 2010) and some excavated (Brink & Webley 1996; Halkett 2001; Miller & Webley 1994; Orton 2007; Orton & Halkett 2001, 2010; Smith *et al.* 2001; Webley 1997, 2001; Webley *et al.* 1993). Early Stone Age (ESA) artefacts are also known to occur in Namaqualand but, in the Sandveld, are generally located below the surficial aeolian sands and are only seen where the underlying deposits are exposed through processes such as natural erosion, on pans or in mining areas. Such finds are far better documented in southern Namaqualand (Orton 2022) but a handaxe was found in the salt pan at Port Nolloth (J. O. personal observation).

5.4.2.2 Site visit

Despite the extensive disturbance of the coastal part of the study area, particularly along the coast, numerous archaeological sites were recorded during the surveys (Figure 5-11 and Appendix 5-1).



Figure 5-11: Aerial view showing the archaeological sites on record in and close to the WP1 study area. Yellow symbols represent sites previously recorded by others, white represent new finds. The cluster of finds at Namakwakop in the north is arrowed.

The vast majority of sites was expected to lie along the coast and, where undisturbed areas were found, the surveys proved this to be true. However, dense clusters of sites were also found as far as 4.5 km inland. These sites are mostly shell middens and scatters with associated finds including stone artefacts, ostrich eggshell fragments, flask mouths and beads, pottery, crayfish mandibles and occasionally animal bones (these last do not preserve well in this environment). Some sites were found to have been partly destroyed by mine-related activities and there is no doubt that intact sites lie buried beneath recently mobilised sand.

Nonetheless, it is clear from the surveys that many culturally significant shell middens and scatters are present along the coastline of the WP1 study area. Figures 14 to 20 illustrate these shell midden sites.



Figure 5-12: Ostrich eggshell fragments on a shell midden at waypoint 4944.



Figure 5-13: A coastal shell midden at waypoint 4949.



Figure 5-14: CCS artefacts, ostrich eggshell fragments and a partly made bead at waypoint 219.



Figure 5-15: Flaked tone artefacts, hammerstones and ostrich eggshell beads at waypoint 688.



Figure 5-16: Decorated (incised at left and impressed at right) potsherds at waypoint 4954.



Figure 5-17:Pierced lug at waypoint 4954.



Figure 5-18: Unpierced boss at waypoint 087.

Other interesting observations from the coastal part of the survey are as follows:

- At a series of four small koppies in the north known as Namakwakop there is some dark rock that appears to have been used for making MSA artefacts (Figure 5-11, Figure 5-19 & Figure 5-20).



Figure 5-19: Outcrop of very dark brown rock at Namakwakop (waypoint 658)



Figure 5-20: MSA stone artefacts at waypoint 658.

- Around the southern slopes of Boegoeberg North (Zone 2 or Conservancy) there are scatters of glass and shellfish in association with stone features and rusting iron. Although these scatters could represent 20th century Nama pastoralist settlements, their association with nearby mining debris suggests that early European and/or Nama miners were utilizing the coastal resources. These are likely early mining camps (i.e. late 1920s/early 1930s) and, if so, are not currently protected as archaeology (Figure 5-21) as they are younger than 100 years (see Section 2(ii) of the NHRA).



Figure 5-21: Glass and shellfish near the base of Boegoeberg North at waypoint 672.

- Occasional ESA handaxes and other ESA and MSA artefacts were seen in deflated areas such as at and close to Visagiefontein (Figure 5-22 & Figure 5-23).



Figure 5-22: Handaxe at waypoint 683 located 480 m northwest of Visagiefontein.



Figure 5-23: Broken handaxe and other artefacts at waypoint 555 at Visagiefontein.

It is notable that most sites occurred on dune tops. However, only some dunes hosted sites. Of particular note were some very dense clusters of sites located several kilometres inland and likely associated with water sources. It is important to stress that this is not a comprehensive account of all the sites and further surveys will definitely reveal many more sites throughout the study area.

Highlights from the surveys are as follows (see Figure 5-11 for Zone references):

- The MSA artefacts from Namakwakop in the far north of **Zone 1**.
- A stretch of the coast in Zone 1 (Port Precinct) with many shell middens, has not been impacted by mining.
- Further south, in **Zone 2** (Conservancy), are a number of sites (including potential historical archaeological sites and graves) around the Boegoeberg Twins.

- There are dense concentrations of shell middens in the pan areas of **Zone 3**. They contain permanent water sources and are likely to have attracted LSA herder groups.

- Visagiepan in **Zone 3** contains a very dense spread of shell middens, some extremely large and of high local significance. Despite information about historic settlement at the pan, no evidence for this was found. The pan is of archaeological interest because of the nearby permanent water. A few isolated ESA handaxes were found in the pan.

- Further south in **Zone 3** is Rietfonteinpan which also contains many shell middens. At its southern end, there is an historic kraal dating to 1911 (see also Pieter van Wyk pers comm.).

- In **Zone 7** there is shell midden with many decorated potsherds that is of high local significance.

- Inland, within the eastern part of **Zone 9**, are two areas of particular interest: Witbank and Grondputs. These comprised diffuse scattered middens with archaeological material around rocky outcrops (approximately 11 km from the coast).

- Finally, in the far south, in **Zone 8**, is a dense distribution of shell middens along the coast. Further north, the coast is sandy (and also heavily mined) and no middens were recorded.

Apart from the potential historical archaeological material recorded at the Boegoeberg North hill, no evidence was found for any 19th century European settlement at either Homewood Harbour or Peacock Bay in Zone 1. These all appear to have been destroyed by mining.

5.4.3 Maritime Heritage

A list of shipwrecks that may occur within or close to the study area is attached as **Appendix 5-2.**

The north-western coastline of South Africa has long featured in maritime texts and maps with Cape Voltas, lying just north of the study area, featuring quite prominently (Figure 5-24). However, the accuracy of the records is often questionable. A historical description of Cape Voltas is as follows: "… is 2 leagues to the southward of Orange or Gariep River. According to Capt. Morrell, Cape Voltas is a high bluff point, projecting into the sea; and there are several rocks lying about half a mile to the West of it, beyond which there are no dangers. About 1 mile North of the Cape there is a small bay [Alexander Bay], not more than 2 miles in length, and 1½ in width; within which the anchorage is not safe, as the ground is foul, and heavy rollers are continually heaving in from the westward at all seasons of the year. Ships, however, which are in want of fire-wood, may lie off and on, and obtain any quantity from the head of the Bay, where they will find immense quantities piled up on the beach, which come down the Orange or Gariep River" (Purdy & Findlay 1844).



Figure 5-24: An excerpt of Diego Homen's chart of southern Africa, Cape Voltas or Cabo das Voltas is circled (1561).

5.4.3.1 Shipwreck database

The nature of the environment in which foundered vessels can drift a long way before settling, poor historical reporting, and the length of time since the wrecks occurred means that maritime cultural heritage sites are hard to locate with any accuracy. It is important to have a database, because if maritime archaeological sites are uncovered during development of the project, it will be easier to identify the wreck and thus assess its cultural and historical significance. Figure 5-25 & Figure 5-26 map the known wrecks, while Table 5-4 summarises the data as they pertain to the SEA study area.

There are several points to bear in mind when compiling and using the database.

- There are thousands of reported wrecks around the South African coastline and thousands more that disappeared mid-ocean.
- Shipwrecks in the historical reports were often assigned to the nearest landmark, even if that landmark was many miles away.
- There is some anecdotal evidence that the Phoenicians circumnavigated Africa (Herodotus 1954). However, if this is true, these ships had to stay close to the coastline and therefore are unlikely to be far offshore.
- There is increasing evidence that the Chinese voyages of the 1400s explored parts, if not all, of the African coast (Paine 2013). However, the archival evidence to date, and availability to Western researchers, limits this knowledge.
- The first recorded European voyages down the west coast of Africa were by the Portuguese. When the Portuguese first sent out their explorers, they stayed close to the coastline, in order to map the land. The present-day Cape Voltas may be a survival of the Portuguese name Volta

das Angras. Dias and his fleet passed the Orange River Mouth in 1487/1488 (Axelson, 1973). Thereafter, the rate of exploration and trade increased exponentially, as is evidenced by the increase in shipwrecks over the centuries.

- These early voyages were not well documented, and the archives often merely report that a fleet of a certain number of vessels left and only a certain number returned. Often only vague reference is made to their place and manner of loss. Additionally, it seems that there were often private vessels that accompanied the fleets, these are underreported (Subrahmanyam 1997).

- While the Vereenigde Nederlandsche Geoctroyeerde Oostindische Compagnie or Dutch East India Company (VOC) kept detailed records of their voyages and this information is freely available online (Huygens Instituut 2023), there is evidence of a vast unofficial Dutch trade, specifically in the trans-Atlantic slave trade, of which there are fewer records. Additionally, there was a rich history of pirates and privateers operating along the coast of which there are few records except brief newspaper articles referring to unsuccessful attacks (Sutton 2009).

The Shipwreck Database uses conventions to indicate the likelihood of a wreck being in a given area as follows:

Very high:	More than 90% sure that wreck is within study area
High:	More than 70% sure that wreck is within study area
Medium:	More than 40% sure that wreck is within study area
Low:	Less than 40% sure that wreck is within study area



Figure 5-25**:** West Coast Shipwrecks within approximately 50 km of the study area (Google Earth 2024; Hocking 1969; Levine 1989; Maitland 2023; Reocities 2022; SAHRA 2022; Turner 1988; U-boat.net 2022; van den Bosch 2009).



Figure 5-26**:** Shipwrecks near the study area (Google Earth 2024; Hocking 1969; Levine 1989; Maitland 2023; Reocities 2022; SAHRA 2022; Turner 1988; U-boat.net 2022; van den Bosch 2009).The area shaded red represents Zone 1, the Port Precinct.

Table 5-4: Shipwreck database summary table as it applies to the WP1 study area.

Likelihood of wrecks falling in study area	N heritage (pre-1965)	N other (1965 onwards)
Very High (>90% certainty):	1	2
High (>70% certainty):	4	0
Medium (>40% certainty):	1	0
Low (<40% certainty):	43	1
Total	49	3

5.4.4 Graves

Pre-colonial graves (and specifically LSA graves) are often found in coastal dune contexts where the sand is easy to excavate by hand and population densities were generally higher than inland because of the readily available marine food supply. However, graves are only rarely reported from Namaqualand with most of those on record being from the Kleinsee to Hondeklipbaai area (Dewar 2008; Dewar & Orton 2013). Morris's (1992) catalogue of human remains lists a few burials from the mouth of the Orange River and further inland in the Richtersveld, but none are reported from the study area. However, according to Kaplan (2008), a human burial, likely that of a LSA hunter-gatherer was exposed in a dune cutting, during prospecting operations at Muisvlakte several years ago. The skeleton was subsequently removed by SAPS in Port Nolloth but unfortunately the whereabout of the skeleton remains unknown.

Two, or possibly three, graves were seen along the western margins of Boegoeberg South within Zone 2 (originally recorded by Kaplan 2008 but revisited by us). The graves consist of large piles of stone on the sandy plain (Figure 29). They have no headstones or footstones and have no grave goods, such as marine shell, glass jars etc. It is clear that they have not been maintained for many years. According to oral history related during the Land Claims Court Case of 2000, *"Buchuberg[1] is a sacred place for the aboriginal inhabitants of the Richtersveld. It is also reputed to contain the grave of Kaptein Paul Links"* (Court Proceedings 2000).

The next nearest known graves, belonging to shipwreck victims, were reported by Kaplan (2008) just south of Alexander Bay Harbour and outside the SEZ study area.

[1] The spelling 'Buchuberg' was used during the Land Claim Court Case of 2000 whereas the Afrikaans spelling 'Boegoeberg' is used in the SEZ report and other literature.



Figure 5-27: A stone cairn, which may represent a burial, at the foot of Boegoeberg South. It is situated in Zone 2, the Conservancy area.

5.4.5 History

Information on the history of the area is limited to the navigation charts of early seafarers and the accounts of early travellers. Very little is known on the region prior to the 19th century. The earliest reference to the Boegoeberg Twins was by Robert Jacob Gordon on 16th August 1779. He wrote: "Saw the two little rocky mountains mentioned before at a distance. I went up with Paterson. The easterly one is the larger. We named them 'De Twee Gebroeders (i.e. the two brothers)". Gordon also named the Orange River after the Prince of Orange (Raper & Boucher 1988). Subsequently, in the map by Bell, drawn in 1855, they are labelled as 'The Twins'. Thereafter the labelling for the two hills has varied (Buchuberg, Buchuberg Twins, etc.). The current naming is Boegoeberg North and Boegoeberg South, and they fall in Zone 2 (Conservancy).

According to Penn (1995), not a great deal is known about the territory along the lower Orange River in the 18th century although he speculates that the poor grazing would not have been able to support large Khoekhoen herder groups. He considered it more likely that the San were the chief inhabitants of the area. During his mid-1830s trip, James Alexander (1838) heard that the Namaqua Khoekhoen living in the area swam to an island at Port Nolloth to catch seals. Charles Bell, who visited the region in 1854, also met with Paul Links, and his seasonal movements are reported to include Boegoeberg (Simons 1988). Dr E. Richter, of the Rhenish Mission Society, visited the area in 1830 and it was subsequently named after him. A mission station was established at Kuboes in the mid-19th century (Strassberger 1969). The beams of the church at Kuboes are reported to have been made with the wood from a wreck in the Wreck Point/Holgatpunt area (Court Proceedings 2000). After the annexation of 1847, the Richtersveld was considered by the Colonial Government to be Crown Land.

- Later reports suggest that hunters, traders and early prospectors were present in the area by the mid-19th century although the full extent of European settlement is less known. Alexander (1838) described that the Namaqua had collected some four to five hundred seal skins on Robbe Island (situated off the coast between Port Nolloth and Alexander Bay) and were trading them in 1835. Further, they are reported to have subsisted off the dry flesh of the seals they caught.

By the end of the 19th century (Figure 5-28), the coastline between Cape Voltas and the Holgat River, included: Peacock Bay/Roadstead, Harrison's Cove, Homewood Harbour and Wreck Point. The two inland salt pans are Visaghifontein (sic) and Rietfontein, and the inland hills are called Wittebankberg, Witbank and Zwart Bank, with the very low rise between the latter and the coast being named Duiker Kop. A trader called Captain Wiliam Homewood is reported to have anchored his boat in Homewood Harbour in the mid-19th C. When Cornell (1910) visited the area, there were apparently the "*ruins of substantial buildings, boatslips etc., standing deserted today…*".

Visagiepan was apparently named after a farmer who had a house on the edge of the pan where he obtained water from a number of wells.



Figure 5-28: The 1907 Reconnaissance Series maps of the Orange River Mouth and Port Nolloth & Okiep maps (948 D) indicating the topography and local names which had been attached to places.

By the 1890s, the inhabitants of the Richtersveld demanded clarity regarding their ownership of the land. At this stage there were about eight or ten Dutch families living along the Orange River between the mouth and Aris.

In 1925 diamonds were discovered near Port Nolloth. Claims for diggings were awarded by the Government as they considered the land to be unalienated Crown lands. The Certificate of Reservation of land known as the Richtersveld, measuring 350 000 morgen, was promulgated in 1930. The subject land (i.e. coastal strip) and the corridor farms were not included. Eventually in 1934 a formal "ticket of occupation" was issued by the government giving the indigenous groups communal rights to the land which was technically still held in trust by the state. The Richtersveld then became a Reserve under a Management Board. In 1957, a fence was erected along the boundary between the Richtersveld Reserve and the Corridor farms although Boegoeberg itself, was only fenced off in 1963. Farm 2 (Korridor Wes) was sub-divided into a number of smaller portions (Court Proceedings 2000).

The fences prevented the Richtersveld people from using those portions for grazing and watering their stock. In 1989, the Alexander Bay Development Corporation was established, and the alluvial diggings were de-proclaimed. Three years later, through the Alexkor Limited Act, the Alexander Bay Development Corporation was converted into a company under the Companies Act, to be known as Alexkor Limited. In 1998, the community applied through the Land Claims Court for restitution of land which included land mined by Alexkor as well as state-owned land (Court Proceedings 2000). The Constitutional Court awarded the land and mineral rights to the community of the Richtersveld in 2007.

5.4.6 Living heritage

Desktop

According to the National Policy document on Living Heritage (2009), citing the National Heritage Resources Act, No. 25 of 1999 (NHRA), "living heritage is defined as: cultural tradition, oral history, performance, ritual, popular memory, skills and techniques, indigenous knowledge systems; and the holistic approach to nature, society and social relationships" (Section 2(xxii)). Although living heritage is not specifically protected by the NHRA, places associated with living heritage are.

The Boegoeberg Port and SEZ study area was historically used by indigenous groups moving across the landscape from the mountains to the coast. When the first explorers, traders, hunters, and prospectors arrived in the Richtersveld during the 19th century, they encountered various indigenous groups, including Bushmen hunter-gatherers and Nama speaking herders.[2] When James Alexander (1838) visited the area in 1834/5, he encountered Chief Paul Lynx (Links) and a group of around 100 people living at Aris on the Orange River. The illustration of their dwellings suggests that they were Namaqua Khoekhoen. Detailed descriptions of the nomadic herders were provided by Winifred Hoernlé who visited the Richtersveld in 1912 and 1923/4 (Hoernlé 1985; Carstens *et al.* 1987). A camp or kraal consisted of male members of the same patrilineal clan, with their wives and children. They were under the nominal authority of the chief or 'kaptein'. Their boundaries were not fixed but changed with environmental and social conditions. They were predominantly herders, with cattle, sheep and goats. However, they also relied on a variety of other sources of sustenance such as game, wild fruit, plant foods and honey. However, by the time Boonzaaier (1980) commenced with his anthropological studies in the area in 1977, only 37% of economically active males were full time herders. The figure is likely to be less now. Many families may keep livestock, but they are often combined into a single herd and cared for by an employed shepherd.

The transhumance cycles of the Nama herders in the Richtersveld have been documented by various anthropologists (Boonzaaier 1980, Moolman 1981, Mussgunug 1995, Hendricks *et al*. 2004). Due to the extremely dry climate, seasonal mobility was essential. Most farmers live in permanent dwellings in Kuboes or elsewhere, while their herds move in an annual orbit, following summer and winter grazing areas under the care of a shepherd. During the summer months, the livestock need to drink water every day or two, and herders tend to move along the banks of the Orange River. During the winter months, they move to the mountainous areas in the east of the Richtersveld, or into the Sandveld in the west. Herders often leave their huts or frameworks behind after they have moved, indicating that they may return. Although communal land ownership is practiced, a herder may be associated with a particular camp site on the basis of continued or repeated use.

Historical transhumant land use patterns were discussed during the proceedings of the Land Claim Court in 2000. The broader Richtersveld was considered to consist of four (overlapping) areas. It was asserted that by the 19th century:

- The North-Western area was from Kuboes to the Garib[3] River (Orange River) mouth and southward to The Cliffs – the winter grazing in the Sandveld included the coastal areas of **Buchuberg, Rietfontein, Holgat** and inland to **Witbank and Swartbank**.

[2] They were descendants of the Namaqua Khoekhoen.
[3] During the Court Case (2007) the Orange River was termed the Garib River. The spelling Gariep is also used.

- The Middle area was from Lekkersing to the coast and from Rietfontein in the north to Port Nolloth in the south (Court Proceedings 2000: chapter 2, page 21). In the winter it included **Holgat, Rietfontein, Witbank and Swartbank.**

- The Eastern and Southern areas are not relevant to this report.

The repeated reference to **Witbank** and **Swartbank**, points to the importance of these two locations for winter grazing (i.e. mainly Zone 9 but possibly also Zone 10).

These temporary settlements are called "veeposte" (directly translated as stockposts) although people often talk of a "staaning" (Mussgunug 1995). These stockposts consist of a temporary dwelling and, in the case of winter stockposts, also a kraal or two. The duration of stay at a stockpost depends on the grazing and water. During the winter months, the stock spends the night in the kraal, and after being milked in the morning, they are taken out for grazing. They are returned to the stockpost in the evenings. Herders often place their stockposts near rocky outcrops in winter, so that the stock are provided with protection against the rain and cold wind. The lambs and kids are kept in a small kraal (*lammerhok*) often attached to the large kraal for the first two months after they are born, after which they are allowed to go out into the veld. This allows the herder to control the milking of the livestock. Many herders send their livestock out into the veld in a different direction every day, as this prevents overgrazing.

The stockpost structure comprises various elements. These have been described by Webley (1982 and 2009b), Mussgunug (1995) and Mills (1995). There has been considerable variability in the design and layout of stockposts with accelerated change over the last 50 years. We describe the historical and modern forms, illustrating the latter from the study area.

The "matjieshuise" (mat house or !haru-oms) comprised a lathe framework of about 40 to 60 poles which were covered by up to 16 reed mats. The house had a single door facing eastward. The decline in the use of such huts relates to a lack of suitable rush. It is also time-consuming to make the mats, and the majority of women no longer know how to make them. The herders therefore use hessian, plastic sheeting, cardboard and other bits of material to cover the frame. Hut frames are also made of modern materials (Figure 5-29 & Figure 5-30), with caravans also sometimes used (Figure 5-31). Nearby was the "kookskerm" (cooking shelter) which traditionally comprised a semi-circle of bushes enclosing a central hearth. This allowed the herder to keep an eye on his livestock while he sat at the fire. However, today, cooking shelters are composed of any available raw material, such as sheets of metal (Figure 5-29). The cooking shelter had a wood pile, an ash heap and a "haakstok" (forked branch or n//a pole).



Figure 5-29: A stockpost hut in the study area with barrels of water standing outside. The 'kookskerm' is between the door and barrels.



Figure 5-30: The framework of a modern herder hut made from wood and the canopy of a bakkie.



Figure 5-31: The 'hut' of a modern stockpost. This was temporarily out of use with bales of straw stored inside the caravan.

Kraals are typically constructed in the winter months to provide the livestock with protection from the cold and predators. They are generally positioned some 20 m from the house and often on the slopes of a rocky outcrop. The kraal facilitated the milking of the ewes as the lambs were born in winter and spring. Kraals (made of wire, poles, bushes or stone) therefore often had lamb kraals (Figure 5-32). The thick dung accumulation is sometimes all that is visible after a stockpost has moved.



Figure 5-32: Lamb kraal in the corner of the main kraal.

The connection between those Nama who have subsisted from the sea is also acknowledged. Currently the mining area breaks this connection in the vicinity of the study area. Fishing has, and continues to be, part of Nama culture but, given the given the dearth of fish bones in coastal archaeological sites (Dewar 2008; Orton 2012), the time depth of this tradition is currently unknown.

5.4.7 Fieldwork and Historical Aerial Photography

A number of modern stockposts were recorded to the east of the R382 (Figure 5-29 to Figure 5-33).

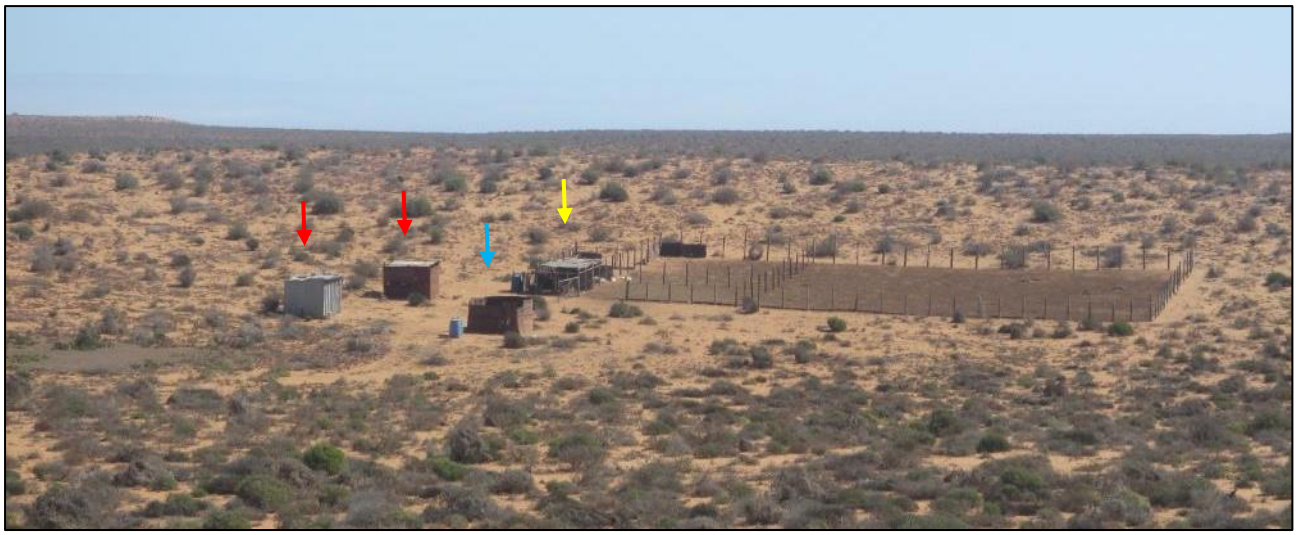


Figure 5-33: Modern stockpost with two huts (red arrows) a cooking shelter (turquoise arrow), roofed lamb kraals (yellow arrow) and a main kraal with three enclosures.

In addition, aerial photographs were also consulted to identify historical and modern stockposts in the study area and to plot their distribution. Rectangular shapes, which are likely to indicate kraals, are seen on the 1937 aerial photographs (Figure 5-34) and current (8 September 2023) Google Earth imagery of the study area. Many of the latter were verified in the field.

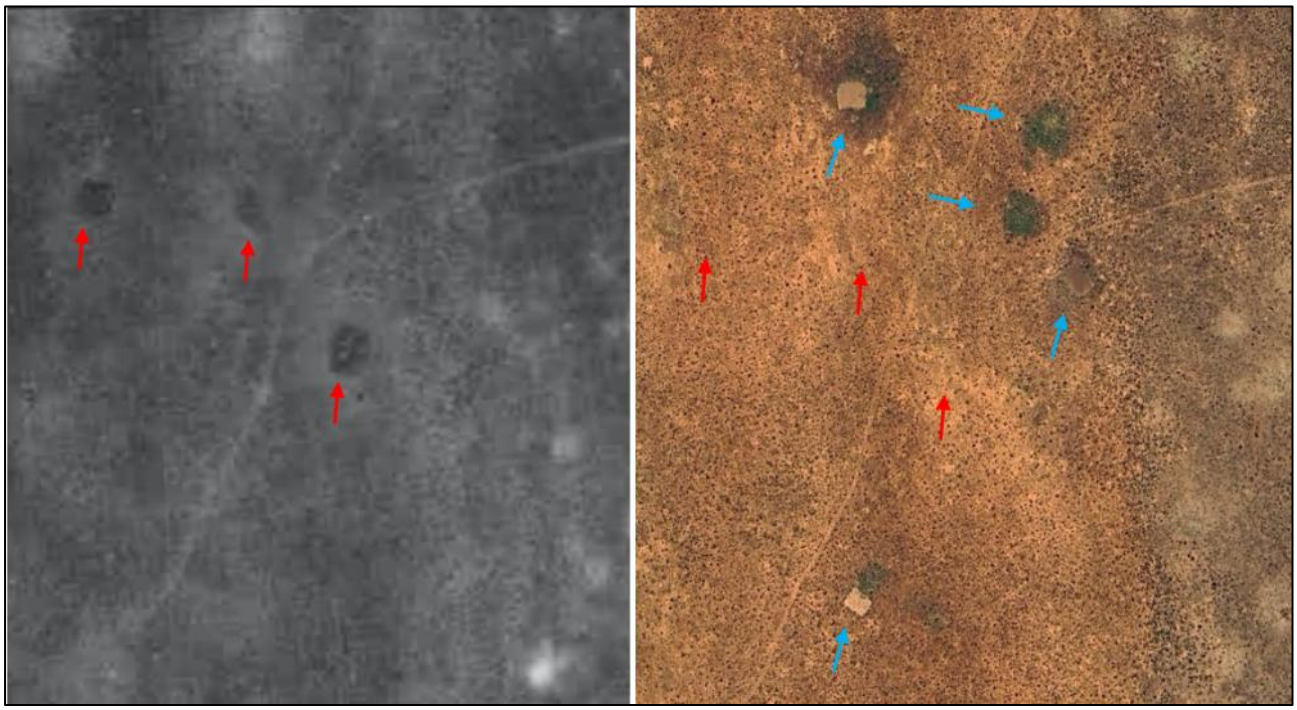


Figure 5-34: Equivalent 1937 (122_046_47776) and 2023 (Google Earth) aerial images showing the locations of historical (red arrows) and recent – but now abandoned – stockposts (turquoise arrows).

Although there are oral records of pastoralists utilizing the grazing around Boegoeberg, Rietfonteinpan and Visagiepan (as noted above), no stockposts were visible on the 1937 aerial photography within the mining area (i.e. Zones 1 – 8). It should be noted that diamond mining commenced in 1925 and pastoralists were evicted from the area soon afterwards so it is possible that their settlements are no longer visible. Also, it is clear from modern settlement pattern that the higher lying ground away from the sandier lowlands are preferred, likely due to the better quality grazing there.

All visible current and recently abandoned stockposts visible on Google Earth (images dating to 8 September 2023) are shown on Figure 37. They are usually identified by the rectangular kraal footprint.

However, it is difficult to determine whether the stockpost is currently in use, temporarily out of use, or recently abandoned from aerial photography. Over time the kraal loses its rectangular shape and after some years becomes a darker patch on the landscape comprised of pioneer species colonising the more fertile sand.

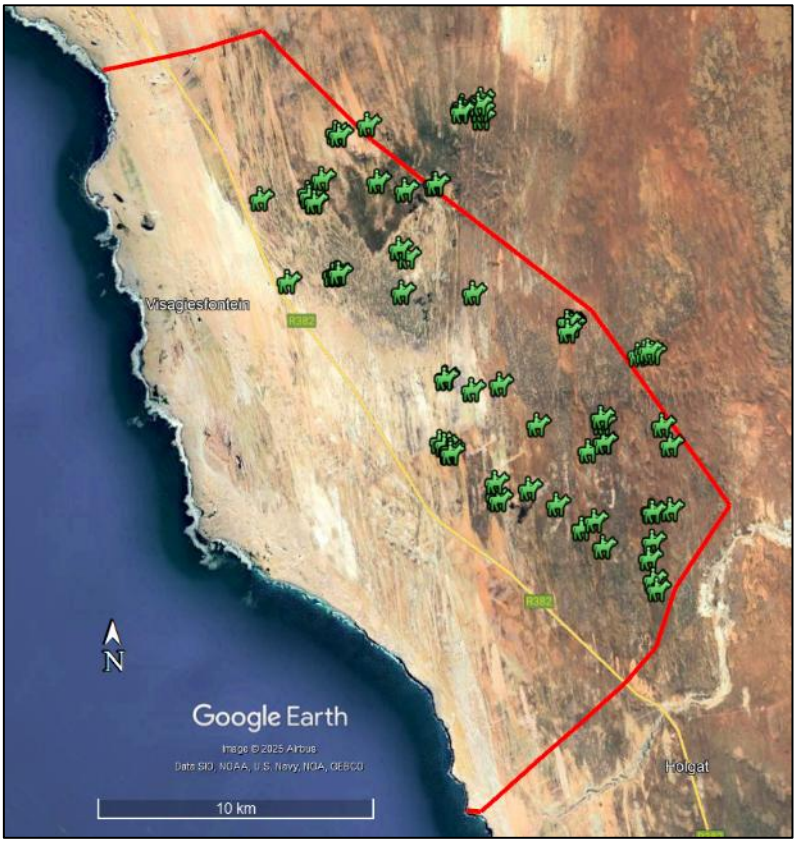


Figure 5-35: The location of the stockposts as identified from 2023 imagery on Google Earth (2024). They are clearly arranged in two groups, approximately around Witbank in the north, and Swartbank in the south.

This modern distribution is supported by historic sources and oral history which emphasise the use of **Witbank** (also spelled Witte Bank) and **Swartbank** (also spelled Zwart Bank) for grazing purposes (Figure 5-35). It is difficult to determine how many herders are currently using the land as grazing for their animals. An examination of the area using Google Earth (2024), suggests at least 10-15 herders are likely to be using the land on a seasonal basis. This figure is increasing annually, as more pressure is placed on the land within the Richtersveld Reserve.

5.4.8 Cultural landscape /Sense of place

The most significant aspect of the cultural landscape is the Richtersveld Cultural and Botanical Landscape (RCBL) World Heritage Site which lies some 27 km northeast of the WP1 study area (Figure 5-36). Its buffer

zone, however, comes to within 1.3 km of the eastern edge of the study area. The description of the RCBL is as follows (Republic of South Africa 2007):

> The 160,000 ha Richtersveld Cultural and Botanical Landscape sustains the semi-nomadic pastoral livelihood of the Nama people, reflecting seasonal patterns that may have persisted for as much as two millennia in southern Africa. It is the only area where the Nama still construct portable rush-mat houses (*haru om*) and includes seasonal migrations and grazing grounds, together with stock posts. The pastoralists collect medicinal and other plants and have a strong oral tradition associated with different places and attributes of the landscape.

A buffer zone has been created around the RCBL in order to further control impacts on it (Figure 5-36). It must be noted that the transhumant lifestyle practiced by the Nama includes the lands of the buffer zone as well as the land within the present WP1 study area as described above. Although Townsend (2015:1) comments that "the World Heritage Site and its buffer zone, together, comprise the declared Richtersveld Provincial Heritage Site" (PHS), no evidence of such a PHS could be located. It is understood, however, that this zone is a Heritage Area (https://sahris.org.za/node/103454).

The area is a relatively flat plain, sloping from east to west. It comprises a desolate and windswept landscape. West of the R382 prospecting trenches and spoil heaps litter the landscape. East of the R382 are arid coastal lowlands which are sparsely vegetated and stretch into the buffer zone of the RCBL. Notably, there is an area of high ground just inside the eastern edge of the study area which visually separates the coastline from the interior.

The R382 is considered a scenic route and the main access to the Orange River. It is the gateway to the Richtersveld National Park, as well as the RCBL and receives tourists who are drawn to its arid landscape. It also provides access into Namibia via the bridge at Oranjemund and the pont at Sendelingsdrif.

Hart (2010) notes that tourists travelling on the R382 are likely to focus on the coastal area and the views towards the Boegoeberg which are the most "significant and scenic features on the landscape between Alexander Bay and Port Nolloth".

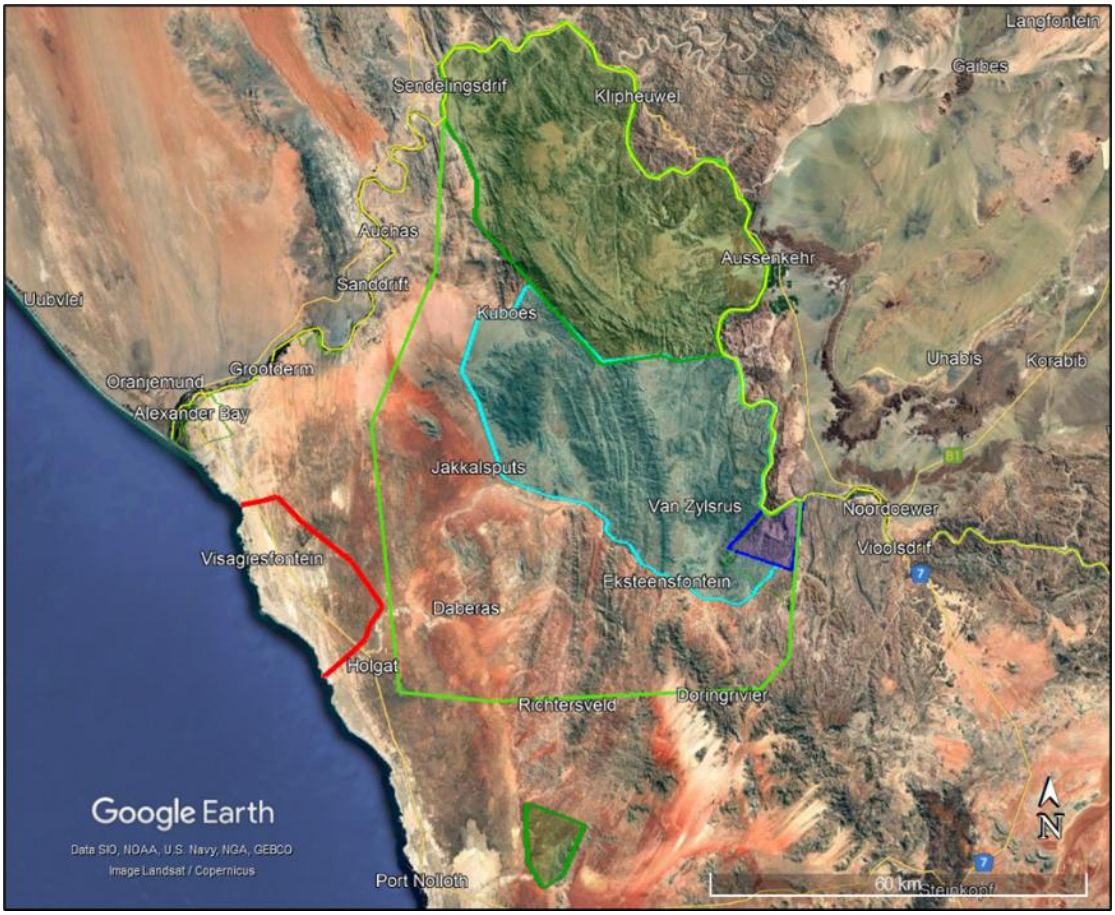


Figure 5-36: Aerial view showing Richtersveld National Park (green shading), Richtersveld WHS (turquoise shading), Nababeep Nature reserve (blue shading), and the WHS buffer zone (green polygon). The WP1 study area is the red polygon.

5.5 SENSITIVITY MAPPING

5.5.1 Palaeontology

The theoretical palaeontological sensitivity of the study area is taken from the Palaeosensitivity Map at the South African Heritage Resources Information System (SAHRIS n.d.). The subsurface geology, i.e. the buried marine formations, are rated as Very High sensitivity (Figure 5-35). However, this "very high" sensitivity mapping is anomalous because, despite the presence of such marine formations elsewhere in the region, the sensitivity map only classifies the surficial *in situ* aeolian sands which are deemed as being of low palaeontological sensitivity (Figure 5-35 inset). The pans of the area may have once been embayments with scientifically interesting warmer water species in them, but given the current lack of evidence for such species being present, they are also considered as of low sensitivity.

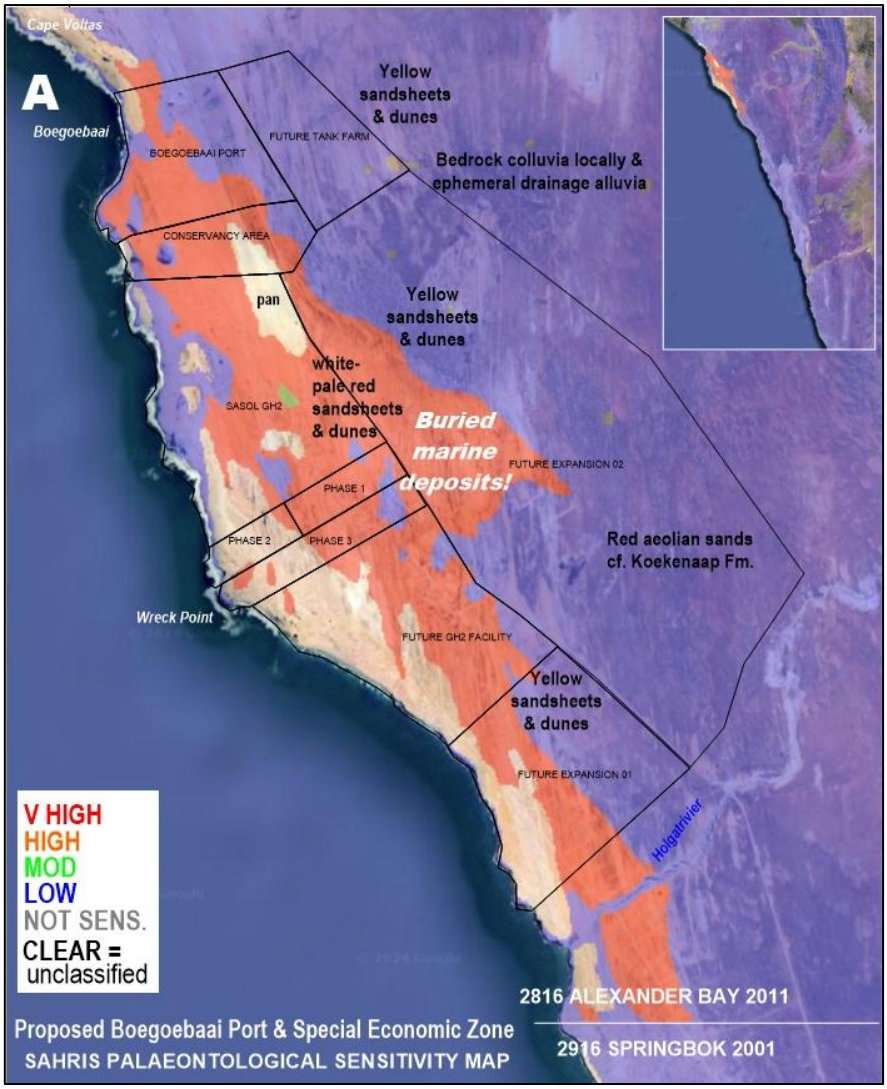


Figure 5-37: The SAHRIS palaeontological sensitivity classification (SAHRA n.d.). The inset shows that the depiction of buried marine formations (VERY HIGH) is anomalous when compared with surrounding areas.

Because these more sensitive formations are deeply buried, a sensitivity of low is appropriate throughout the study area, but with one exception. The exception is in the south-western part of Zone 1 (Port area) where any remaining *in situ* underlying late Pliocene Hondeklipbaai Fm. is considered likely to have a thinner overburden and could easily be exposed during development. This area is considered to be of medium sensitivity (Figure 5-38). However, the status of unmined marine gravels in that area is currently unknown. No other area in the SEZ is considered to be worthy of more than low sensitivity.

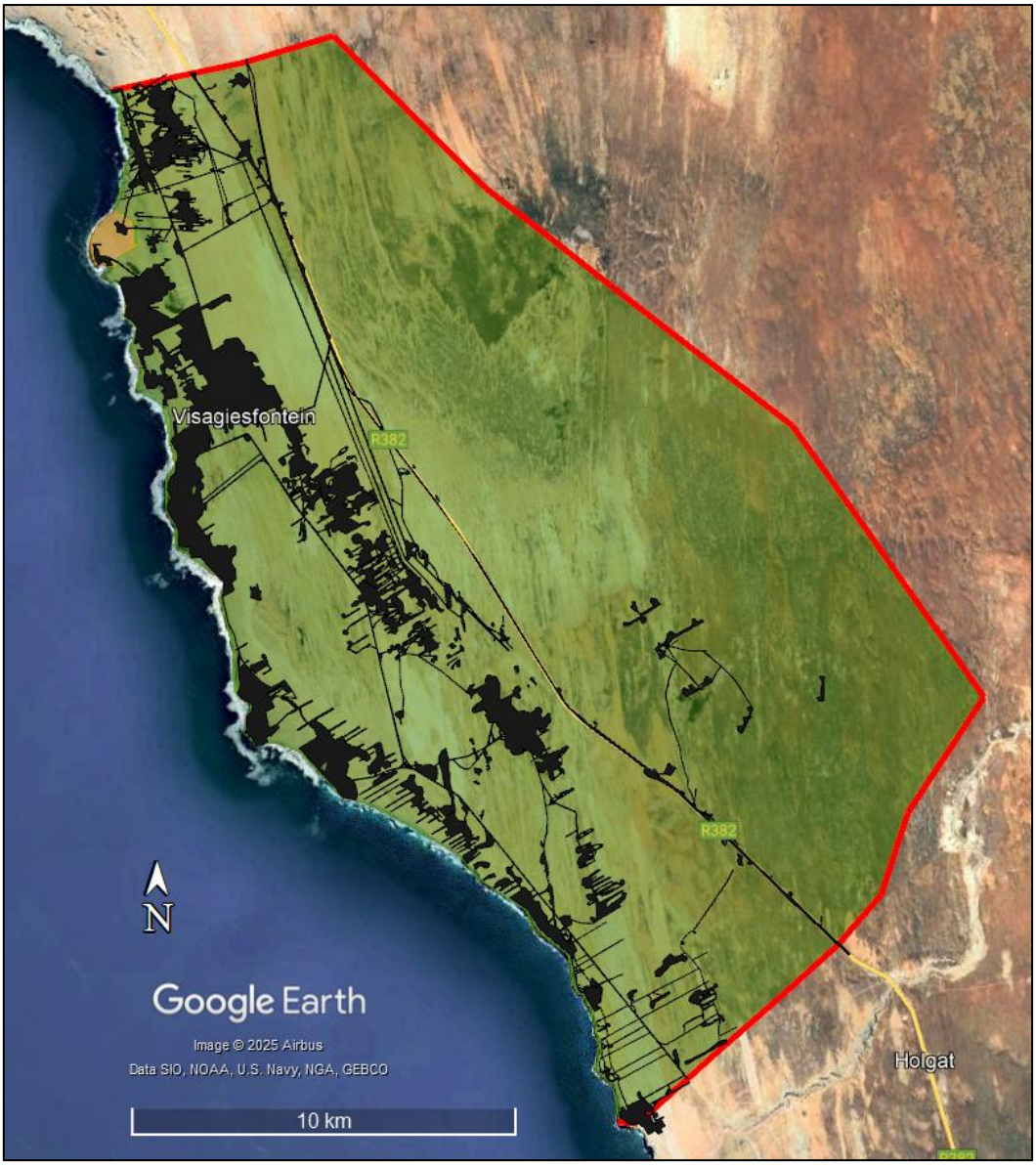


Figure 5-38*:* *Sensitivity map for palaeontology. Orange = medium sensitivity,* green = low sensitivity. Black areas are disturbed and generally of zero sensitivity, but areas that are unmined but just recently buried will still retain their underlying sensitivity.

5.5.2 Terrestrial Archaeology

The identification of definitive sensitivity zones is entirely dependent on detailed field surveys. Sites may vary in cultural significance from very low (and not worthy of sampling) to very high (potential provincial significance). For this reason, only tentative suggestions can be made based on the survey data obtained. Figure 5-39 illustrates a generalised sensitivity map which does not account for specific areas of high or very high sensitivity encountered during the fieldwork but rather extrapolates zones of sensitivity based on where high sensitivity areas were noted relative to the shoreline and inland rock outcrops. The reason specific highly sensitive areas have not been individually delineated is to avoid creating the idea that they are the only such areas in the proposed Port and SEZ footprint. The density of sites (white circle symbols on Figure 41) does, however, give an indication of where some of these highly sensitive areas lie (there will be others). It should also be noted that, *in general*, sites located further inland are more ephemeral and thus have lower cultural significance. Some specific areas of known high sensitivity are, however, noted here:

- The presence of buried sites like the hyena lair (BOG1, actually palaeontological) and MSA site (BOG2) excavated in Zone 2 (conservancy area) (Klein et al. 1999) suggest the possibility of further, buried sites particularly near the coastal cliffs.

- The high significance of the MSA at Namakwakop relates to MSA sites found both on marine terraces (Dewar & Orton 2013) and further inland, i.e. Spitzkloof (Dewar *et al.* 2023). Parkington (1993) comments: "The potential contribution of these sites to our understanding of human prehistory and mid- to upper Pleistocene environments should not be underestimated".

- The large number of LSA shell midden sites, some with pottery, around the Visagiefontein and Rietfontein pans indicate the importance of water in this arid area. It would have been a strong drawcard for nomadic/transhumant groups wishing to utilise the coastal resources. Some of these sites have high scientific significance and may contribute to our understanding of the advent of LSA pastoralism (Dewar & Marsh 2018).

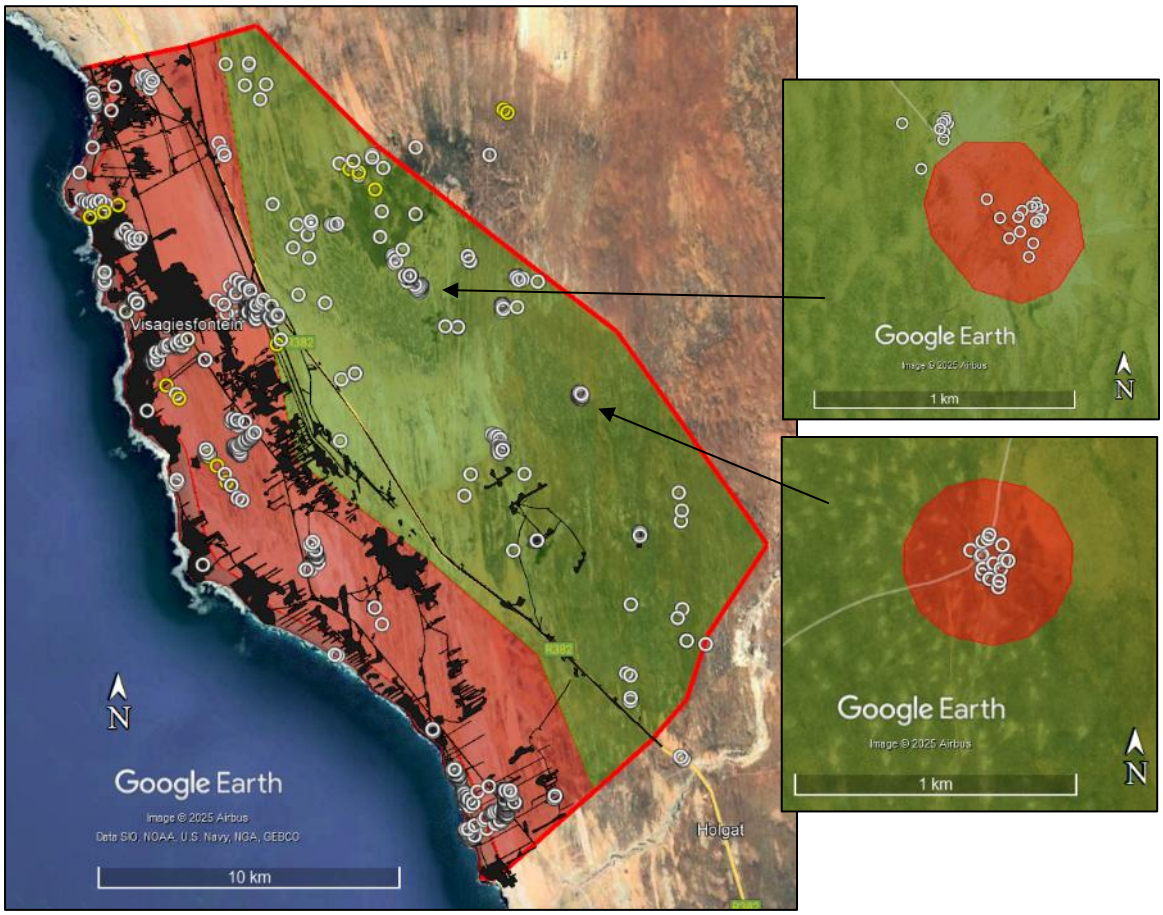


Figure 5-39: Sensitivity mapping for terrestrial archaeology. Dark red = very high (within 0.5 km of the shoreline), red = high sensitivity (0.5-4.5 km from the shore), green = low sensitivity. Black areas are disturbed and of zero or low sensitivity depending on whether they are mined or just recently buried respectively. White circles indicate sites recorded during our 2024 surveys, yellow circles are sites previously reported by others.

5.5.3 Maritime Heritage

Because of the low likelihood of actually encountering shipwrecks, the majority of the sea area adjacent to the proposed SEZ has been rated as of low sensitivity. However, Cape Voltas (just north of the study area), Wreck Point and Soco Reefs are all mentioned in the shipwreck database as foundering localities which means that these places have a slightly higher likelihood of hosting wrecks. These latter areas are indicated in Figure 5-40 as medium sensitivity and are within 2 km of the coastline.

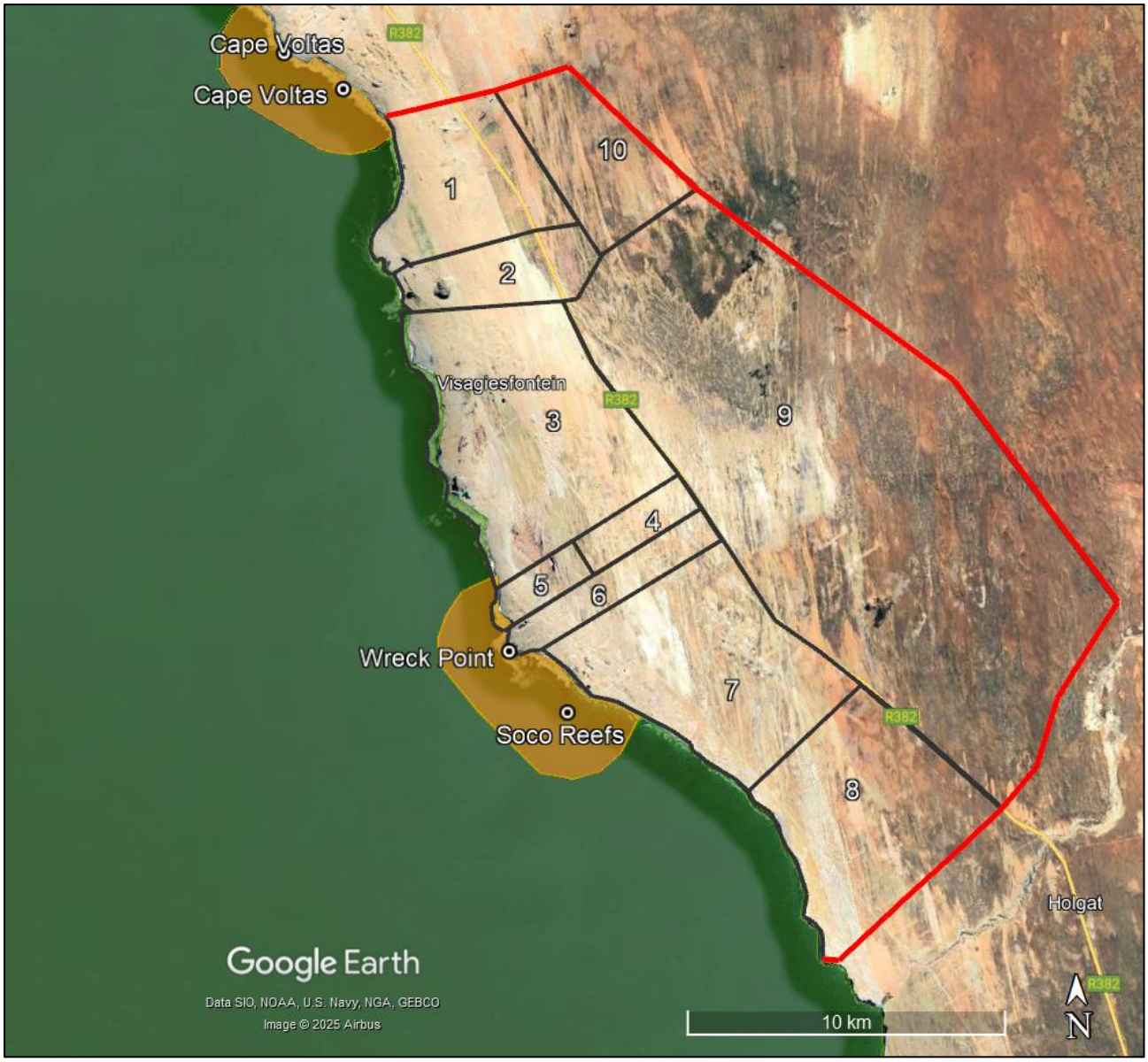


Figure 5-40: Sensitivity mapping for maritime heritage. Orange = medium, green = low.

5.5.4 Graves

It is likely that LSA graves will occur in some of the archaeological shell middens identified during the survey along the coast. Graves have **high local cultural significance** and are automatically of very high sensitivity. Known graves occur at the western foot of Boegoeberg South. Oral history refers to the grave of Paul (Bierkaptein) Links, who was "kaptein" of the Nama people in the 19th century, at the Boegoeberg. The grave location is unknown but would have **very high significance** if found. This falls within the area designated as a Conservancy but further protection measures may be required, such as fencing. No overall sensitivity mapping for graves is provided for the Port and SEZ since the locations of graves cannot be determined and the actual probability of impacts occurring in any one place is very low. However, the known graves at Boegoeberg South are mapped in Figure 5-41.



Figure 5-41: Sensitivity mapping for graves (dark red = very high sensitivity) to the west of Boegoeberg South in Zone 2 (the Conservancy area).

5.5.5 Living Heritage

The **Richtersveld Cultural and Botanical Landscape World Heritage Site (RCBL)** is situated to the east of the study area. It one of the few areas in southern Africa where transhumance pastoralism is still practiced; as a cultural landscape it reflects long-standing and persistent traditions of the Nama, the indigenous community.

This study has confirmed that transhumant herders, from the Richtersveld, have utilized the land within the study area historically and have a centuries old tradition with respect to the landscape and settlement patterns. They have reintroduced this practice to the eastern part of the study area after the land was returned to the community in 2007. The land outside the mine thus has **a high cultural significance** with respect to maintenance of the pastoralist tradition of the Nama peoples. For practical purposes, we have buffered all visible stockposts (presumably all dating between 2007 and the present) by 1 km as high sensitivity to indicate areas favoured for settlement and in which living heritage traditions are being – or have recently been – practiced (Figure 5-42). Other areas are generally more sandy and less favourable for transhumant settlement and grazing and are accorded medium sensitivity, although they are still important to the overall success of the transhumance lifestyle. Within the mine area the land is heavily disturbed and even less favourable for small stock rearing. This area is accorded low sensitivity.

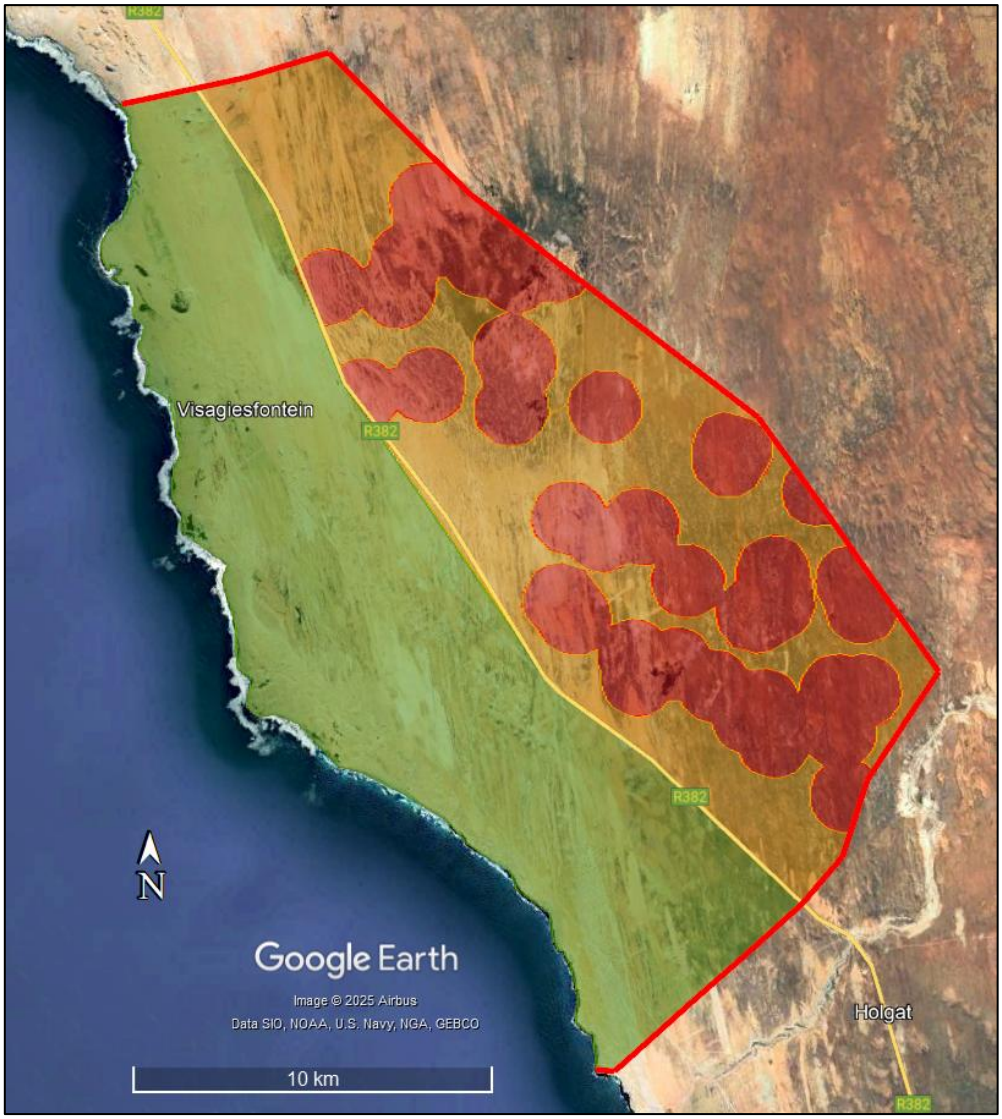


Figure 5-42: Sensitivity mapping for living heritage. Red = high (1 km buffer around recent/current stockposts as seen on the 2023 Google earth imagery, orange = medium (all other land east of R382, green = low).

5.5.6 Cultural Landscape / sense of place

From a purely visual point of view, the following features are identified as highly sensitive: the WHS buffer zone, the coastline, the R382 which links Port Nolloth in the south to Alexander Bay in the north, and the pans (Figure 5-43). From a cultural perspective (largely aesthetics) we add the Boegoeberg Twins (very high sensitivity) with a 1 km buffer of high sensitivity, Namakwakop as high sensitivity, but with a far smaller buffer, and the two areas of higher-lying ground in the east (here taken as above 175 m.a.s.l.) as medium sensitivity (Figure 5-44).

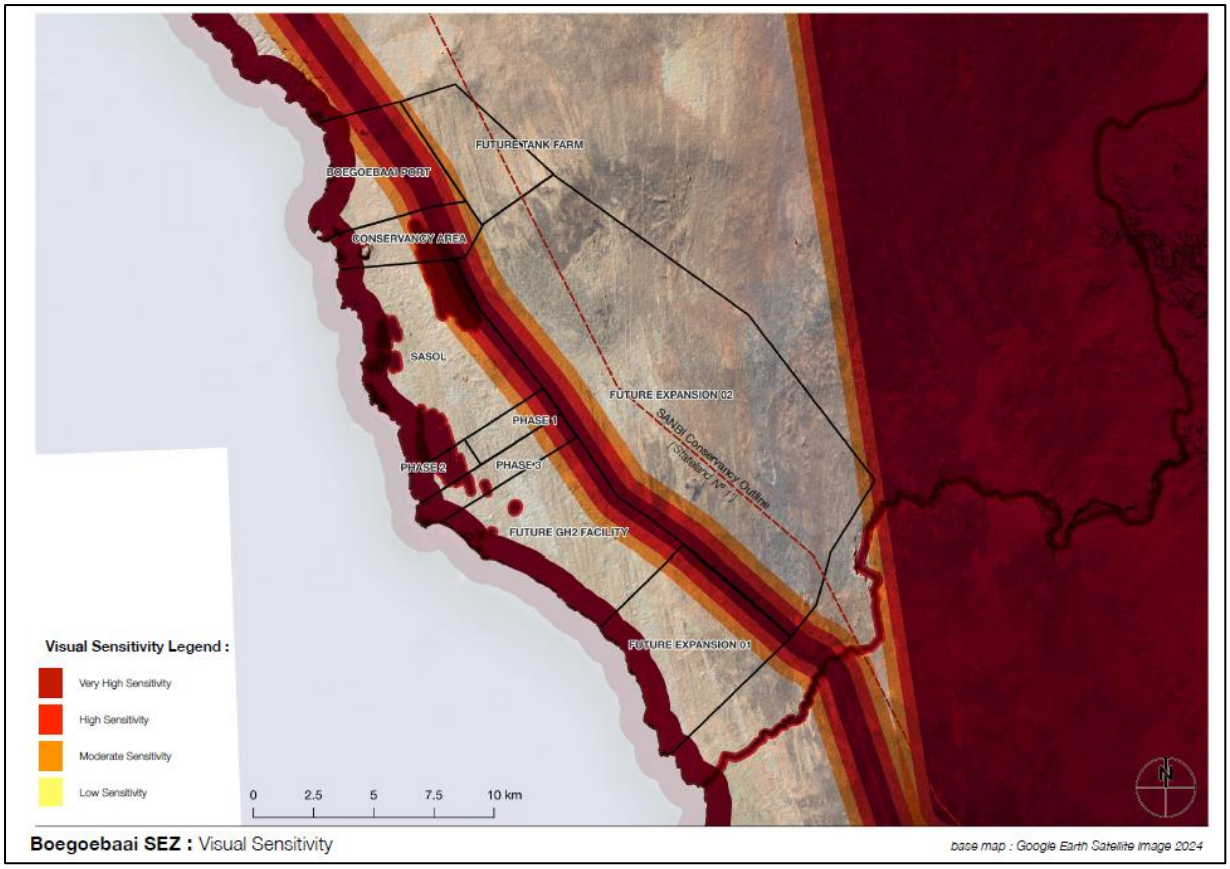


Figure 5-43: Visual Sensitivity mapping for the Boegoebaai Port and SEZ. Source: Oberholzer & Lawson (2024).



Figure 5-44: Visual sensitivity mapping for the cultural landscape. Red = high sensitivity; orange = medium sensitivity and green = low sensitivity.

5.6 ASPECT AND IMPACT REGISTER

Table 5-5: Aspect and Impact Register for heritage

Port infrastructure aspect / Port and SEZ subzone	Potential Impact	Receiving environment of concern (spatially explicit)
Palaeontology		
Zone 1 (Port)	Construction could expose and/or destroy fossils	Marine deposits of late Pliocene Hondeklipbaai Fm. behind cliffs in proposed port area
All zones	Construction could expose and/or destroy fossils	All unmined areas, but higher likelihood on coastal lowlands
All zones	Backfilling of soils from dumps could expose fossils	Mine dumps used to backfill mine pits
Zones 1, 2, 3, 5, 6, 7 & 8	Construction could expose and/or destroy raised beach deposits	Areas where raised beaches of the Curlew Strand Fm are preserved
Terrestrial archaeology		
Zones 1, 2, 3, 4, 5, 6, 7 & 8	Construction could expose and/or destroy MSA sites in old sea cliffs buried by wind blown sand	All areas along the coast which have rocky outcrops, whether visible or buried
Zones 1, 2, 3,4, 5, 6, 7 & 8	Construction could expose and/or destroy LSA shell scatters and middens	All areas where archaeological shell middens occur along undisturbed coastline
Zone 1	Construction could expose and/or destroy MSA artefact scatters	The rocky outcrops of Namakwakop in the NE of Zone 1
Zones 3, 4, 6 & 7	Construction could expose and/or destroy LSA shell scatters and middens	Around and within Visagiepan and Rietfontein Pan
Zone 9	Construction could expose and/or destroy LSA shell scatters and contact period/historical scatters	High sensitivity areas around granite outcrops in the eastern part of the SEZ
Graves		
Zone 2	Construction could impact known graves	Identified graves at western foot of Boegoeberg South
All zones	Construction could expose and/or destroy unknown graves	Unmarked graves could occur anywhere that has not been mined
Maritime Heritage		
Zone 1	Offshore construction work for the breakwater and other port facilities may expose and/or destroy submerged shipwrecks	Any areas where seabed impacts would occur through construction of foundations or dredging
Zones 2, 3, 5, 6, 7, & 8	Offshore construction work for any other ancillary infrastructure may expose and/or destroy submerged shipwrecks	Any areas where seabed impacts would occur through construction of, for example, intake or discharge pipelines
Living Heritage		
Zones 2, 9 & 10	Development would disrupt transhumant settlement patterns and prohibit access to the area	All areas used by small-scale pastoralists outside the mine area, especially areas known as Witbank/ Visagiesfonteinkop, Swartbank and Grondputs/ Zwartwater
All zones	Development of the Port and SEZ would massively alter the landscape context in which small-scale herding occurs through the addition of industrial facilities	Entire Port and SEZ study area
All zones	Development of the Port and SEZ could alter the connection between the local community and the coastline.	Entire Port and SEZ study area
Cultural Landscape		

All zones	Despite the existing mining, development will irrevocably alter the sense of place of the region through the addition of industrial facilities	Entire Port and SEZ study area

5.7 RECOMMENDED STRATEGIC MANAGEMENT ACTIONS

A Heritage Impact Assessment (HIA) will be required for every Environmental Impact Assessment. Notwithstanding the heritage resources on site, HIAs will be needed in order to satisfy the requirements of the National Heritage resources Act (No. 25 of 1999). A separate Visual Impact Assessment must be included in every EIA process.

5.7.1 Palaeontology

- There are no areas of highly sensitive fossiliferous strata in the SEZ Project Area that require protection as NO-GO areas.
- Every project MUST be evaluated by a palaeontologist to determine the need for a palaeontological specialist study despite the known low surface sensitivity because, depending on depth of excavation, significant impacts could still arise below surface.

5.7.2 Terrestrial Archaeology

- Archaeological specialist studies will be required in all EIAs and detailed surveys of each project footprint must take place.
- Due to the density and distribution of archaeological sites recorded during the initial field surveys, it will not be feasible to mitigate all impacts. The appointed archaeologists will need to determine which archaeological sites best characterize each development footprint in order to sample the most appropriate sites. This may include some sites of lower significance.
- It is likely that monitoring of development may be required in the coastal areas where middens can be buried within sand dunes or under recent wind-blown sand.

5.7.3 Maritime Heritage

- A Maritime Heritage specialist study will need to be included in the heritage application for the Port development, as well as any other developments that might require, for example, undersea pipelines.

5.7.4 Graves

- Graves would be considered along with archaeology in any EIA process that occurs in the Port and SEZ areas.
- Given the size of the Port and SEZ, it is possible that a number of graves could be uncovered. Discussions with SAHRA, the Northern Cape Heritage Resources Authority and representatives of local communities must be initiated in advance of the development to determine whether reburial of human remains – perhaps in Zone 2 (the conservancy area) – should be considered.

5.7.5 Living heritage

- The local herder community should be consulted to determine their response to the loss of their winter grazing lands, specifically those areas termed Swartbank and Witbank. Among other things, consultation should aim to understand:

  - Why these areas were chosen for grazing;
  - The value of the pasturage in terms of seasonal grazing requirements;
  - Any alternative options; and
  - How nature and culture are intertwined within their world view.
- The local community should be consulted to determine ways to enhance their connection with the coastline, especially with regards to fishing as a traditional livelihood.

5.7.6 Cultural landscape / sense of place

- The R382 and surrounding area are significant for a number of reasons, largely tourism-related. Further consideration should be given to the appropriateness of the site, and the local community, SANParks, UNESCO, SAHRA and local tourism operators should all be engaged in this process. Although the proposed development lies outside the buffer zone of the RCBL Heritage Site (Figure 5-36), the potential indirect impacts (visual and increased movement of sand) cannot be disregarded. Discussions will need to be initiated with the South African Government and the UNESCO commission regarding the potential impact of the proposed Boegoebaai Port and SEZ development on the World Heritage status of the RCBL.

5.8 REFERENCES

Alexander, JE. 1838. Expedition of discovery into the interior of Africa, Part 1. Henry Colburn: London. (Facsimile reproduction 1967 Cape Town).

Boonzaaier, E. 1980. Social Differentiation in the Richtersveld, a Namaqualand Rural Area. MA thesis: University of Cape Town.

Brink, J. & Webley, L. 1996. Faunal evidence for pastoralist settlement at Jakkalsberg, Richtersveld, northern Cape Province. *Southern African Field Archaeology* 5: 70–78.

Carstens, P., Klighardt, G. & West, M. 1987. Trails in the Thirstland: The anthropological field diaries of Winifred Hoernlé. Centre for African Studies: University of Cape Town.

Court Proceedings. 2000. The Proceedings of the case between the Richtersveld Community, the Kuboes Community, the Sanddrift Community, the Lekkersing Community, the Eksteenfontein Community and the Adult Members of the Richtersveld Community versus Alexkor Limited and the Government of the Republic of South Africa in the Land Claims Court of South Africa in October 2000.

De Beer, C.H. 2010. The geology of the Garies area. Explanation: 1:250000 Sheet 3017 Garies. Council for Geoscience South Africa. 100 pp

De Villiers, J. & Söhnge, P.G. 1959. Geology of the Richtersveld. *Memoir of the Geological Survey of South Africa* **48**: 1295.

De Villiers, S. E. & Cadman, A. 2002. An analysis of the palynomorphs obtained from Tertiary sediments at Koingnaas, Namaqualand, South Africa. *Journal of African Earth Sciences* 33:17–47.

Dewar, G. 2008. *The archaeology of the coastal desert of Namaqualand, South Africa: a regional synthesis*. Oxford: British Archaeological Reports International Series 1761.

Dewar, G. & Stewart, B. 2012. Preliminary results of excavations at Spitzkloof Rockshelter, Richtersveld, South Africa. *Quaternary International*. Online version doi:10.1016/j.quaint.2011.04.046.

Dewar, G. & Orton, J. 2013. Subsistence, settlement and material culture on the central Namaqualand coastline. In: Jerardino, A., Malan, A. & Braun, D. (eds) The Archaeology of the West Coast of South Africa: 109-123. Oxford: Archaeopress.

Dewar, G. & Marsh, E.J. 2018. The comings and goings of sheep and pottery in the Coastal Desert of Namaqualand, South Africa. The Journal of Island and Coastal Archaeology. Online version DOI: 10.1080/15564894.2018.1438538

Dewar, G. Mackay, A. & Stewart, B.A. 2023. Spitzkloof A Rockshelter, South Africa. In: Beyin, A., Wright, D.K., Wilkins, J., Olszewski, D.I. (eds) Handbook of Pleistocene Archaeology of Africa: 177-1690. Cham: Springer.

Google Earth. 2024. *Google Earth Pro.* Google.

Gresse, P.G. 1988. Washover boulder fans and reworked phosphorite in the Alexander Bay Formation. *South African Journal of Geology* **91** (3): 391-398.

Halkett, D. 1999. A Phase One Archaeological assessment of heritage resources in the Trans Hex diamond concession Richtersveld. Report for Trans Hex Group Ltd. University of Cape Town: Archaeology Contracts Office.

Halkett, D. 1999. An Archaeological assessment of power line routes between Muisvlak and Eksteenfontein, Richtersveld. Unpublished report for Niham Shand. ACO, University of Cape Town.

Halkett, D. 2001. A Report on Archaeological Excavations on the Orange River Floodplain between Jakkalsberg and Sendelingsdrift: Richtersveld. Report for Trans Hex Mining Limited. University of Cape Town: Archaeology Contracts Office.

Hart, T. 2010. Proposed Richtersveld Wind Farm. Report prepared for G7 Renewable Energies (Pty) Ltd. St James: ACO Associates.

Hart, T. 2013. Proposed Richtersveld Wind Farm: Findings of supplementary heritage survey 2013. Unpublished report for G7 Renewable Energies (Pty) Ltd. St James: ACO Associates cc.

Hart, T. 2015. Archaeological Impact Assessment: Proposed Richtersveld Solar Farm. Richtersveld Community Reserve. Unpublished report prepared for Cape EAPrac on behalf of Richtersveld Sunspot (Pty) Ltd. ACO Associates.

Hendricks, H.H., Midgley, W.J., Bond, W.J. and Novellie, P.A. 2004. Why Communal Pastoralists do what they do in the Richtersveld National Park. *African Journal of Range and Forage Science* 21 (1): 29-36.

Herodotus. 1954. *The Histories.* Harmondsworth: Penguin Books Ltd.

Hoernlé, W. 1985. (ed). The Social Organization of the Nama and other essays. Centenary Volume: a collection of nine previously published essays edited by Carstens, P. Witwatersrand University Press: Johannesburg.

Hocking, C. 1969. *Dictionary of Disasters at Sea during the Age of Steam: Including sailing ships and ships of war lost in action 1824 – 1962: A-L.* (Vol. 1). London: Lloyd's Register of Shipping.

Homen, D. 1561. *Portuguese Chart of the southern part of Africa.* Map.

Hopper, C. & Dewar, G. 2023. A preliminary report of the excavation at Spitzkloof D Rockshelter, Namaqualand, South Africa. *Southern African Field Archaeology* 18: article 2667.

Huygens Instituut. 2023. The Dutch East India Company's shipping between the Netherlands and Asia 1595-1795 Database. *The Dutch East India Company's Shipping between the Netherlands and Asia 1595-1795*. Available at: https://resources.huygens.knaw.nl/das/search

Kaplan, J. 2008. Report: The Archaeological and Palaeontological Importance of the Alexkor Diamond Mining Area Northern Cape Province. Report for Site Plan Consulting. Riebeek West: Agency for Cultural Resource Management.

Kaplan, J. 2011a. Archaeological Impact Assessment Proposed Desalination Plant Port Nolloth Northern Cape. Unpublished report prepared for Bvi Consulting Engineers. Rondebosch: Agency for Cultural Resource Management.

Kaplan, J. 2011b. Archaeological Impact Assessment proposed Port Nolloth oxidation ponds and sewer pipeline Northern Cape. Unpublished report prepared for Bvi Consulting Engineers. Rondebosch: Agency for Cultural Resource Management.

Kaplan, J. 2011c. Archaeological impact assessment the proposed Port Nolloth waste site Northern Cape. Unpublished report prepared for Bvi Consulting Engineers. Rondebosch: Agency for Cultural Resource Management.

Klein, R.G., Cruz-Uribe, K., Halkett, D., Hart, T. & Parkington, J. 1999. Paleoenvironmental and human behavioral implications of the Boegoeberg 1 Late Pleistocene hyena den, Northern Cape Province, South Africa. *Quaternary Research* 52: 393–403.

Küsel, U., Van der Ryst, M. & Ecotone, S.K. 2009. Cultural Heritage Resources Impact Assessment of a Portion of the Farm Kannikwa Vlakte 157 within the winter rainfall region of the Namaqualand Division ± 15 from Port Nolloth. Report for unknown client. Magalieskruin: African Heritage Consultants CC.

Levine, M. 1989. *Shipwreck History of Southern Africa: A Chronology of Shipping Disasters 1488-1989.* Unpublished.

Maitland, V. 2023. *Maritime & Underwater Cultural Heritage Database.* Shipwreck and MUCH Database - In Progress.

Miller, D. & Webley, L. 1994. The metallurgical analysis of artefacts from Jakkalsberg, Richtersveld, Northern Cape. *Southern African Field Archaeology* 3: 82–93.

Mills, G. 1995. Dwellings and Domestic groups: architectural design at the Richtersveld. In Einiqualand: studies of the Orange River Frontier (ed) A.B. Smith. Page 209 - 235. UCT Press: Rondebosch

Moolman, E. 1981. Die huidige stand van kleinveeboerdery in 'n Richtersveldse Gemeenskap. Khoisis: Occasional Papers of the University of Stellenbsoch 2: 1-19.

Mussgunug, U. 1995. An ethno-archaeological study of pastoralism along the Orange River at the Richtersveld. In Einiqualand: studies of the Orange River Frontier (ed) A.B. Smith. Page 165-208. UCT Press: Rondebosch.

Morris, A.G. 1992. A Master Catalogue of Holocene Human Skeletons from South Africa. Witwatersrand University Press: Johannesburg.

Oberholzer, B. & Lawson, Q. 2024. Regional Visual Sensitivity Proposed Boegoebaai Port, Mixed-use Special Economic Zone (SEZ), including wind and solar energy facilities, Namakwa Region. Report prepared for ASHA Consulting. Bernie Oberholzer & Quinton Lawson.

Orton, J. 2007. Excavations at four sites near Jakkalsberg in the Richtersveld. *The Digging Stick* 24(1): 9–13.

Orton, J. 2010. Heritage Impact Assessment for the services upgrade in Alexander Bay, Namakwa Magisterial District, Northern Cape. Unpublished report prepared for Doug Jeffery Environmental Consultants (Pty) Ltd. Archaeology Contracts Office, University of Cape Town.

Orton, J.D.J. 2012. Late Holocene archaeology in Namaqualand, South Africa: hunter-gatherers and herders in a semi-arid environment. Unpublished D. Phil. thesis. Oxford: University of Oxford.

Orton, J. 2017. Permit Report: Mitigation of PN2011/001 at Port Nolloth, Namakwaland Magisterial District, Northern Cape. Report for BVI Consulting Engineers. Lakeside: ASHA Consulting (Pty) Ltd.

Orton, J. 2021. Heritage Impact Assessment: Proposed Prospecting on Plots 516, 678 and 668, Port Nolloth, Richtersveld Magisterial District, Northern Cape. Report for N.J. van Zyl. Lakeside: ASHA Consulting (Pty) Ltd.

Orton, J. 2022. Phase 1 Archaeological Survey of Approved Mining Areas at the Namakwasands Mine, Brand-Se-Baai, Vredendal Magisterial District, Western Cape. Report prepared for Tronox Mineral Sands (Pty) Ltd. Lakeside: ASHA Consulting (Pty) Ltd.

Orton, J. 2024. Archaeological Preconstruction Survey: Proposed Richtersveld Wind Energy Facility on Portions 2 and 3 of Korridor Wes 2, Namaqualand, Northern Cape. Report for HCV Africa. Lakeside: ASHA Consulting (Pty) Ltd.

Orton, J.D.J. & Halkett, D.J. 2001. Mid-Holocene denticulates in the Richtersveld. *Southern African Field Archaeology* 10:19–22.

Orton, J. & Halkett, D. 2010. Stone tools, beads and a river: two Holocene microlithic sites at Jakkalsberg in the northwestern Richtersveld, Northern Cape. *South African Archaeological Bulletin* 65: 13–25.

Orton, J. & Webley, L. 2009. Phase 1 archaeological impact assessment of mining areas in the Oena Mine, Richtersveld, Namakwaland Magisterial District, Northern Cape. Unpublished report prepared for Surf Zone Diamonds Pty (Ltd). University of Cape Town: Archaeology Contracts Office.

Paine, L. 2013. *The Sea and Civilization.* London: Atlantic Books.

Parkington, J. 1993. Archaeological Importance of the Alexkor Mining Area. Environmental Management Programme Report (EMPR) for Alexkor.

Penn, N. 1995. The Orange River Frontier Zone, C.1700-1805. In Einiqualand: studies of the Orange River Frontier (ed) A.B. Smith. Page 21-109. UCT Press: Rondebosch.

Purdy, J. & Findlay, A. G. 1844. *The New Sailing Directory for the Ethiopic or Southern Atlantic Ocean; including the Coasts of Brazil, &c. to the Rio de la Plata, the Coast thence to Cape Horn, and the African Coast to the Cape of Good Hope, &c. ... Composed and arranged from a great variety of documents.* (3rd ed., rev.corrected, by A.G. Findlay). London: R.H. Laurie.

Raper, P & Boucher, M. 1988. (eds) Robert Jacob Gordon: Cape Travels, 1777 to 1786. Brenthurst Press: Johannesburg.

Republic of South Africa. 2007. *Government Gazette* No. 30043, 4 July 2007.

Reocities. 2022. Reocities Web. Accessed online at: http://www.reocities.com/Heartland/ridge/2216/text/MARITIME.TXT on 01 October 2017.

Roberts, D.L., Botha, G.A., Maud, R.R. & Pether, J. 2006. Coastal Cenozoic Deposits (Chapter 30). In: Johnson, M. R., Anhaeusser, C. R. and Thomas, R. J. (eds.), *The Geology of South Africa*. Geological Society of South Africa, Johannesburg/Council for Geoscience, Pretoria: 605-628.

Rudner, J. 1968. Strandloper pottery from South and South West Africa. Vol 49 Part a: Annals of the South African Museum. Cape Town.

SAHRA. n.d. SAHRIS Palaeo Map. Accessed at: https://sahris.sahra.org.za/ on 8 December 2024.

Simons, P.B. 1998. The life and work of Charles Bell: an appraisal. Fernwood Press: Cape Town.

Smith, A.B., Halkett, D., Hart, T. & Mütti, B. 2001. Spatial patterning, cultural identity and spatial integrity on open sites: evidence from Bloeddrift 23, a pre-colonial herder camp in the Richtersveld, Northern Cape province, South Africa. *South African Archaeological Bulletin* 56: 23–33.

Strassberger, E. 1969. The Rhenish Mission Society in South Africa. 1830-1950. Cape Town: Struik Ltd.

Subrahmanyam, S. 1997. *The Career and Legend of Vasco da Gama.* Cambridge: Cambridge University Press.

Sutton, A. 2009. *'Infested with Pyratts': Piracy and the Atlantic Slave TRade.* MA. Vanderbilt University.

Townsend, S. August 2015. Heritage Impact Assessment (Basic Assessment): A proposed solar energy power plant at Portion 10 (Arris) of Farm No 2, Korridor Wes, Namakwaland, Northern Cape. Unpublished report for Richtersveld Sunspot (Pty) Ltd.

Turner, M. 1988. *Shipwrecks and Salvage in South Africa: 1505 to the Present.* Cape Town: C. Struik.

U-boat.net. 2022. U-boat.net Database. U-Boat.Net. Accessed online at: https://uboat.net on 18 October 2022.

UNESCO. 2024. Richtersveld Cultural and Botanical Landscape. Accessed online at https://whc.unesco.org/en/list/1265/ on 27 December 2024.

Van den Bosch, F. 2009. *South African Shipwreck Database.* CD-ROM. Cape Town:

Webley, L. 1982. Settlement studies among descendants of Nama herders: an ethno-archaeological approach. Khoisis: Occasional Papers of the University of Stellenbosch 3: 1-26.

Webley, L. 1997. Jakkalsberg A and B: the cultural material from two pastoralist sites in the Richtersveld, Northern Cape. *Southern African Field Archaeology* 6: 3–19.

Webley, L., 2001. Excavations at /hei-/khomas (Vaalhoek) in the Richtersveld, Northern Cape. *Southern African Field Archaeology* 10: 46–74.

Webley, L. 2009a. Archaeological impact assessment: Port Nolloth Borrow Pits, Richtersveld Municipality, Northern Cape. Unpublished report prepared for Richtersveld Municipality. Archaeology Contracts Office, University of Cape Town.

Webley, L. 2009b. The Namaqualand stockpost. Vernacular Architecture Society of South Africa 21: 21-35.

Webley, L., Archer, F. & Brink, J. 1993. Die Toon: a late Holocene site in the Richtersveld National Park, northern Cape. *Koedoe* 36 (2): 1–9.

Webley, L. & Orton, J. 2010. Port Nolloth. Phase 2 archaeological impact assessment: Port Nolloth Borrow Site 1 (PN001), Richtersveld Municipality, Northern Cape. Unpublished report prepared for Richtersveld Municipality. Archaeology Contracts Office, University of Cape Town.

Webley, L. & Halkett, D. 2011. Heritage Impact Assessment: proposed Aggeneis-Oranjemund 400kV powerline and substation upgrade, Northern Cape Province. Unpublished report for Savannah Environmental (Pty) Ltd.

Webley, L. & Orton, J. 2013. Excavations of two shell middens at Port Nolloth on the Namaqualand coastline, Northern Cape Province. The South African Archaeological Bulletin 68 (197): 86-92.

5.9 DIGITAL APPENDICES 5-1 & 5-2

SEPARATE DIGITAL DOCUMENT

Appendix 5-1:	Field Data
Appendix 5-2:	A list of shipwrecks that may occur within or close to the study area

DIGITAL APPENDIX 5-1 & 5-2

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Shipwrecks with medium likelihood of being within the Impact Zone _____ 29

Shipwrecks with low likelihood of being within the Impact Zone _____ 30

Appendix 5-1: Field Data

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
BOG1	S28 46 06.40 E16 34 12.58																		Estimated location. Klein *et al.* 1991 location is clearly incorrect.
BOG2	S28 46 07.20 E16 34 11.95																		Estimated location. Kaplan (2008) lists site as A16 but no co-ordinates provided.
A1																			Kaplan 2008.
A2																			Kaplan 2008.
A3																			Kaplan 2008.
A4																			Kaplan 2008.
A5																			Kaplan 2008.
A6																			Kaplan 2008.
A7																			Kaplan 2008.
A8																			Kaplan 2008.
A9																			Kaplan 2008.
A10																			Kaplan 2008.
A11																			Kaplan 2008.
A12																			Kaplan 2008.
A13																			Kaplan 2008.
A14																			Kaplan 2008.
A15																			Kaplan 2008.
Site 1																			Hart 2010. OES only, not archaeology.
Site 3		?	x	x	x					x						x	x		Hart 2010. Ephemeral.
Site 4										x		x							Hart 2010. Ephemeral background scatter.
4929	S28 43 47.3 E16 34 42.5	3	x	x	x												x		Ephemeral.
4930	S28 44 12.8 E16 34 38.4	5																	Small 20th century glass and ceramic scatter
4931	S28 45 18.8 E16 33 59.7	n/a								x									Isolated quartz core.
4932	S28 45 50.1 E16 34 07.5	15	x	x	x	x							x						Shell midden.
4933	S28 45 47.9 E16 34 02.2	5	x		x														Ephemeral.
4934	S28 45 49.2 E16 34 16.2	n/a																x	Isolated whale bone
4935	S28 45 51.3 E16 34 20.5	5																x	Ephemeral shell and bone in front of rock shelter.
4936	S28 45 51.2 E16 34 20.0	5																x	Ephemeral shell and bone in front of rock shelter.
4937	S28 45 51.0 E16 34 10.7	10	x	x	x														Shell north of rock outcrop.
4938	S28 45 51.1 E16 34 11.0	2																	Small tone-walled windbreak north of rock outcrop.
4939	S28 47 05.3 E16 34 30.2	15	x	x	x			x			x								Possibly disturbed?

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
																			Lower grindstone.
4940	S28 47 06.5 E16 34 30.2	30	x	x	x			x		x									
4941	S28 47 06.3 E16 34 27.7	110	x	x	x	x	x	x		x	x						x		4941-4942 all one site.
4942	S28 47 09.5 E16 34 28.4																		Deflating out of dunes along edge of mine pit.
4943	S28 47 11.2 E16 34 28.5	20	x	x	x					x									
4944	S28 47 12.6 E16 34 28.8	110	x	x	x		x			x							x		See 4950-4952.
4945	S28 47 14.4 E16 34 27.3	10	x	x	x														
4946	S28 47 15.1 E16 34 27.0	10	x	x	x		x												
4947	S28 47 15.7 E16 34 27.3	10	x	x	x		x												
4948	S28 47 16.3 E16 34 28.1	?	x	x	x		x												Widespread shell scatter .
4949	S28 47 17.7 E16 34 29.8	20	x	x	x	x				x									
4950	S28 47 14.9 E16 34 30.7	110	x	x	x		x			x							x		4944, 4950-4952 all one site.
4951	S28 47 13.6 E16 34 30.0																		Multiple middens deflating out of dunes along edge of mine pit.
4952	S28 47 12.8 E16 34 29.1																		
4953	S28 47 45.0 E16 34 55.3	50	x	x	x		x			x					x	x	x		Complex of shell middens.
4954	S28 47 45.8 E16 34 55.0																		2x pot lugs. Decorated pottery (incised & impressed).
4955	S28 47 46.6 E16 34 55.1																		
4956	S28 47 46.4 E16 34 54.1																		
4957	S28 47 45.4 E16 34 54.2																		
4958	S28 47 47.4 E16 34 56.5	65	x	x	x		x	x		x	x				x		x		Complex of shell middens.
4959	S28 47 47.5 E16 34 55.7																		
4960	S28 47 48.6 E16 34 56.2																		
4961	S28 47 48.5 E16 34 55.6																		
4962	S28 47 49.1 E16 34 55.0																		
4963	S28 47 48.1 E16 34 54.9																		
4964	S28 47 47.2 E16 34 55.6																		
4965	S28 48 40.3 E16 35 27.9	15	x	x	x														
4966	S28 48 39.3 E16 35 28.0	60	x	x	x														4966-4969 all one site.
4967	S28 48 40.0 E16 35 29.5																		
4968	S28 48 38.9 E16 35 29.3																		
4969	S28 48 38.6 E16 35 28.6																		
4970	S28 48 35.5 E16 35 31.0	20	x	x	x	x													
4971	S28 48 35.6 E16 35 31.9	20	x	x	x	x													
4972	S28 48 35.7 E16 35 32.4	10	x	x	x														
4973	S28 48 34.7 E16 35 33.0	5	x	x	x	x													
4974	S28 48 34.4 E16 35 31.9	10	x	x	x														
4975	S28 48 36.1 E16 35 32.0	3	x	x	x														
4976	S28 48 38.3 E16 35 33.7	40	x	x	x														4976-4980 all one site.
4977	S28 48 38.5 E16 35 34.3																		
4978	S28 48 39.0 E16 35 34.6																		
4979	S28 48 39.5 E16 35 34.3																		

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
4980	S28 48 39.2 E16 35 33.7																		
4981	S28 48 40.1 E16 35 34.3	10	x	x	X														
4982	S28 48 40.2 E16 35 33.7	15	x	x	x														
4983	S28 48 41.2 E16 35 33.1	40	x	x	x														4983-4988 all one site.
4984	S28 48 40.8 E16 35 33.1																		
4985	S28 48 40.8 E16 35 33.6																		
4986	S28 48 41.1 E16 35 34.2																		
4987	S28 48 41.9 E16 35 34.1																		
4988	S28 48 41.6 E16 35 33.1																		
4989	S28 48 43.2 E16 35 30.9	10	x	x	x														
4990	S28 48 30.9 E16 35 33.5	5	x	x	x														
4991	S28 48 29.1 E16 35 40.1	5	x	x															
4992	S28 48 24.5 E16 35 47.2	?	x	x	x					x									Disturbed along edge of mine road.
4993	S28 48 23.9 E16 35 45.2	5	x	x	x														
4994	S28 48 23.7 E16 35 44.8	10	x	x	x														
4995	S28 48 23.1 E16 35 48.4	10	x	x	x		x												
4996	S28 48 20.7 E16 35 57.4	?	x	x	x														Disturbed along edge of mine road.
4997	S28 48 23.0 E16 35 58.1	5	x	x															Ephemeral.
4998	S28 48 24.7 E16 35 58.7	10	c	c															Ephemeral.
4999	S28 48 25.9 E16 35 59.3	20	x	x															Ephemeral.
5000	S28 48 24.0 E16 35 59.3	10	x	x															Ephemeral.
001	S28 48 23.4 E16 35 58.9	10	x	x															
002	S28 48 22.8 E16 35 58.9	10	x	x															
003	S28 48 22.1 E16 35 58.7	10	x	x	X														
004	S28 48 21.9 E16 35 58.2	20	x	x	x					x						X			
005	S28 48 18.6 E16 36 02.8	10	x	x	x					x							x		
006	S28 48 23.4 E16 36 05.4	5	x	x	x	x													
007	S28 48 24.4 E16 36 05.3	5	x		x														Ephemeral.
008	S28 48 19.8 E16 36 03.5	?	x	x	x												x		Disturbed by bulldozing.
009	S28 48 38.6 E16 36 31.4	35	x	x	x														009-012 all one site.
010	S28 48 38.6 E16 36 31.8																		Disturbed.
011	S28 48 38.4 E16 36 32.2																		
012	S28 48 39.2 E16 36 32.8																		
013	S28 49 56.5 E16 37 33.1	5	x	x	X														
014	S28 49 57.2 E16 37 33.3	10	x	x	X														
015	S28 49 59.8 E16 37 30.3	10	x	x															Ephemeral.
016	S28 50 00.7 E16 37 30.0	25	x	x	x					x							x		
017	S28 50 01.8 E16 37 29.4	5	x	x						x									Ephemeral.
018	S28 50 03.0 E16 37 25.8	5	x	x															Ephemeral.
019	S28 50 03.5 E16 37 25.8	5	x	x												x			Ephemeral.
020	S28 50 04.0 E16 37 25.8	10	x	x	x					x	x								Ephemeral.

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
021	S28 50 04.8 E16 37 25.5	20	x	x	x												x		
022	S28 50 07.3 E16 37 21.7	?	x	x						x									Widespread ephemeral scatter in deflated valley between dunes.
023	S28 50 07.7 E16 37 21.8	n/a																	Isolated 20th century glass bottle.
024	S28 50 08.1 E16 37 18.8	15	x	x	x		x	x				x							
025	S28 50 12.9 E16 37 15.0	20	x	x			x	x									x		
026	S28 50 13.6 E16 37 13.5	?																	Widespread ephemeral scatter in deflated valley between dunes.
027	S28 50 13.1 E16 37 12.1	10	x	x	x														
028	S28 50 13.4 E16 37 11.2	15	x	x	x														Ephemeral.
029	S28 50 13.9 E16 37 10.2	15	x	x	x		x												
030	S28 50 14.5 E16 37 09.6	?																	Widespread light scatter
031	S28 50 15.3 E16 37 09.5	370	x	x	x		x						x			x			033-077 all one site.
032	S28 50 15.0 E16 37 08.9																		Dunetop site.
033	S28 50 14.2 E16 37 08.0																		
034	S28 50 14.2 E16 37 08.5																		
035	S28 50 14.2 E16 37 08.9																		
036	S28 50 14.1 E16 37 09.3																		
037	S28 50 14.5 E16 37 10.1																		
038	S28 50 14.8 E16 37 10.4																		
039	S28 50 15.2 E16 37 10.8																		
040	S28 50 15.4 E16 37 11.4																		
041	S28 50 15.8 E16 37 12.2																		
042	S28 50 15.8 E16 37 12.6																		
043	S28 50 16.0 E16 37 13.1																		
044	S28 50 16.4 E16 37 13.7																		
045	S28 50 16.5 E16 37 14.5																		
046	S28 50 17.1 E16 37 15.0																		
047	S28 50 17.8 E16 37 15.0																		
048	S28 50 18.4 E16 37 15.6																		
049	S28 50 19.0 E16 37 15.8																		
050	S28 50 19.6 E16 37 15.7																		
051	S28 50 20.4 E16 37 15.9																		
052	S28 50 19.7 E16 37 15.2																		
053	S28 50 18.5 E16 37 14.9																		
054	S28 50 18.1 E16 37 13.6																		
055	S28 50 17.5 E16 37 14.0																		
056	S28 50 16.5 E16 37 13.2																		
057	S28 50 16.5 E16 37 12.6																		
058	S28 50 17.1 E16 37 12.6																		
059	S28 50 17.5 E16 37 12.7																		
060	S28 50 17.9 E16 37 13.0																		
061	S28 50 17.2 E16 37 12.2																		

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
062	S28 50 16.6 E16 37 11.6																		
063	S28 50 16.2 E16 37 11.3																		
064	S28 50 16.0 E16 37 10.6																		
065	S28 50 15.6 E16 37 10.2																		
066	S28 50 14.6 E16 37 09.4																		
067	S28 50 13.2 E16 37 08.0																		
068	S28 50 13.2 E16 37 08.6																		
069	S28 50 13.3 E16 37 09.5																		
070	S28 50 12.6 E16 37 09.5																		
071	S28 50 12.5 E16 37 08.6																		
072	S28 50 12.4 E16 37 08.0																		
073	S28 50 11.7 E16 37 08.0																		
074	S28 50 11.5 E16 37 08.5																		
075	S28 50 11.4 E16 37 09.0																		
076	S28 50 10.4 E16 37 09.2																		
077	S28 50 10.3 E16 37 09.7																		
078	S28 50 09.7 E16 37 12.5	?	x	x	x											x			Widespread ephemeral scatter in deflated valley between dunes.
079	S28 50 09.9 E16 37 13.9	15	x	x	x		x												
080	S28 50 07.4 E16 37 17.3	5	x	x															
081	S28 50 06.3 E16 37 19.5	15	x	x															
082	S28 50 04.9 E16 37 21.4	?	x	x	x														Widespread ephemeral scatter in deflated valley between dunes.
083	S28 49 59.7 E16 37 29.4	30	x	x	x												x		
084	S28 49 58.6 E16 37 30.2	20	x	x															Ephemeral.
085	S28 53 21.3 E16 40 08.5	15	x	x	x														Deflated in valley between dunes.
086	S28 56 14.6 E16 42 19.0	10	x	x	x					x									
087	S28 56 40.7 E16 42 40.3	30	x	x												x			Pot lug.
088	S28 56 43.7 E16 42 41.4	15	x	x			x		x								x		
089	S28 56 44.3 E16 42 39.8	130	x	x	x	x	x	x							x	x	x		089-107 all one site.
090	S28 56 43.7 E16 42 39.8																		Fragment of flat iron.
091	S28 56 43.2 E16 42 39.9																		093 may be a separate scatter.
092	S28 56 42.6 E16 42 39.5																		
093	S28 56 42.2 E16 42 39.0																		
094	S28 56 42.7 E16 42 38.9																		
095	S28 56 43.2 E16 42 38.5																		
096	S28 56 43.7 E16 42 39.0																		
097	S28 56 43.9 E16 42 38.6																		
098	S28 56 44.4 E16 42 38.4																		
099	S28 56 44.4 E16 42 38.4																		
100	S28 56 44.8 E16 42 38.0																		
101	S28 56 44.8 E16 42 38.6																		
102	S28 56 45.3 E16 42 39.5																		

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
103	S28 56 45.0 E16 42 40.0																		
104	S28 56 45.4 E16 42 40.5																		
105	S28 56 45.9 E16 42 40.7																		
106	S28 56 46.2 E16 42 40.1																		
107	S28 56 46.4 E16 42 41.1																		
108	S28 56 50.6 E16 42 32.8	10	x	x															
109	S28 56 51.9 E16 42 33.5	15	x	x	x														Piece of harmonica.
110	S28 56 52.6 E16 42 33.9	15	x	x	x	x													
111	S28 56 54.5 E16 42 27.2	10	x	x			x			x							x		
112	S28 57 00.1 E16 42 16.6	15	x	x	x		x			x									
113	S28 57 07.3 E16 42 01.9	10	x	x	x														Ephemeral.
114	S28 57 07.2 E16 42 01.1	15	x	x	x				x		x								
115	S28 57 07.0 E16 42 00.7	10	x	x	x		x										x		
116	S28 57 09.0 E16 41 59.8	10	x	x	x			x		x							x		
117	S28 57 11.2 E16 41 55.5	15	x	x	x				x	x				x			x		
118	S28 57 10.5 E16 41 54.8	5	x	x	x														
119	S28 57 10.0 E16 41 54.8	5	x	x	x														
120	S28 57 09.4 E16 41 54.2	?	x	x	x					x					x				Disturbed.
121	S28 57 08.8 E16 41 54.4	10	x	x	x			x		x									
122	S28 57 08.2 E16 41 54.4	5	x	x	x										x				
123	S28 57 06.8 E16 41 54.4	15	x	x	x		x								x				
124	S28 57 06.3 E16 41 54.2	10	x	x	x					x					x				
125	S28 57 05.6 E16 41 54.0	5	x	x	x					x									
126	S28 57 04.9 E16 41 53.4	10	x	x	x														
127	S28 57 04.6 E16 41 53.1	5	x	x	x									x					
128	S28 57 04.3 E16 41 52.8	5	x	x	x										x				
129	S28 57 05.4 E16 41 51.9	50	x	x	x					x				x					129-134 all one site.
130	S28 57 05.8 E16 41 52.2																		
131	S28 57 05.2 E16 41 52.3																		
132	S28 57 04.6 E16 41 51.8																		
133	S28 57 05.2 E16 41 51.1																		
134	S28 57 04.4 E16 41 51.0																		
135	S28 57 03.3 E16 41 52.0	35	x	x	x					x									135-137 all one site.
136	S28 57 03.3 E16 41 51.4																		
137	S28 57 02.9 E16 41 52.1																		
138	S28 57 02.3 E16 41 51.4	5	x	x	x					x					x				
139	S28 57 01.9 E16 41 51.3	10	x	x	x	x		x						x					
140	S28 57 02.0 E16 41 50.7	10	x	x	x										x				
141	S28 57 00.3 E16 41 50.6	n/a																	Palaeo-beach deposit a few m above sea level.
142	S28 57 00.8 E16 41 51.0	10	x	x	x					x					x				
143	S28 57 00.7 E16 41 51.5	2	x	x	x					x									

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
144	S28 57 00.4 E16 41 54.0	?	x	x	x		x								x				Deflated in track through dunes.
145	S28 56 56.4 E16 42 01.7	5	x	x															
146	S28 56 50.7 E16 42 13.1	5	x	x				x											Ephemeral.
147	S28 56 48.2 E16 42 15.4	5	x	x															
148	S28 56 43.6 E16 42 22.1	15	x	x	x		x												
149	S28 56 43.4 E16 42 23.3	15	x	x	x			x		x	x								
150	S28 56 42.8 E16 42 24.4	20	x	x	x														150-154 all one site.
151	S28 56 42.3 E16 42 24.3																		
152	S28 56 42.6 E16 42 24.7																		
153	S28 56 42.6 E16 42 25.1																		
154	S28 56 43.0 E16 42 24.8																		
155	S28 56 41.7 E16 42 26.8	10	x	x	x	x	x							x					
156	S28 56 40.8 E16 42 30.3	10	x	x	x														
157	S28 56 39.5 E16 42 33.5	5	x	x	x	x													
158	S28 56 39.6 E16 42 34.2	5	x	x	x														
159	S28 56 39.3 E16 42 38.5	5	x	x	x		x	x											
160	S28 56 39.3 E16 42 38.9	5	x	x	x		x			x							x		
161	S28 56 38.9 E16 42 41.0	60	x	x	x														161-164 all one site.
162	S28 56 39.9 E16 42 42.0																		Deflating along the edge of a mine road.
163	S28 56 39.3 E16 42 41.6																		
164	S28 56 38.4 E16 42 40.7																		
165	S28 56 37.6 E16 42 39.8	10	x	x	x		x										x		
166	S28 56 37.6 E16 42 40.5	5	x	x	x		x												
167	S28 56 36.8 E16 42 39.8	30	x	x	x		x												167-169 all one site.
168	S28 56 36.7 E16 42 39.2																		
169	S28 56 36.3 E16 42 39.0																		
170	S28 56 34.6 E16 42 39.7	15	x	x	x														170-172 all one site.
171	S28 56 34.7 E16 42 40.1																		
172	S28 56 35.0 E16 42 39.9																		
173	S28 56 34.9 E16 42 40.7	10	x	x	x														
174	S28 56 34.3 E16 42 40.9	10	x	x	x														
175	S28 56 33.1 E16 42 40.0	50	x	x	x														175-184 all one site.
176	S28 56 32.7 E16 42 39.8																		
177	S28 56 32.9 E16 42 40.4																		
178	S28 56 32.7 E16 42 40.7																		
179	S28 56 32.4 E16 42 40.8																		
180	S28 56 32.4 E16 42 40.1																		
181	S28 56 32.1 E16 42 39.9																		
182	S28 56 31.9 E16 42 39.4																		
183	S28 56 31.5 E16 42 39.7																		
184	S28 56 31.7 E16 42 39.3																		

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
185	S28 56 29.8 E16 42 39.1	20	x	x	x		x												185-188 all one site.
186	S28 56 29.9 E16 42 39.5																		
187	S28 56 29.4 E16 42 39.6																		
188	S28 56 29.4 E16 42 39.2																		
189	S28 56 28.6 E16 42 39.0	20	x	x	x		x												
190	S28 56 27.5 E16 42 39.0	15	x	x	x		x												
191	S28 56 24.3 E16 42 39.2	15	x	x	x		x												
192	S28 56 23.3 E16 42 39.2	85	x	x	x		x	x		x							x		192-207 all one site.
193	S28 56 22.6 E16 42 39.0																		
194	S28 56 22.6 E16 42 38.6																		
195	S28 56 22.9 E16 42 38.2																		
196	S28 56 23.0 E16 42 38.6																		
197	S28 56 22.5 E16 42 39.2																		
198	S28 56 22.3 E16 42 38.7																		
199	S28 56 22.4 E16 42 38.4																		
200	S28 56 22.0 E16 42 38.3																		
201	S28 56 21.9 E16 42 38.8																		
202	S28 56 21.4 E16 42 38.4																		
203	S28 56 21.1 E16 42 38.3																		
204	S28 56 21.1 E16 42 37.9																		
205	S28 56 21.5 E16 42 37.7																		
206	S28 56 20.7 E16 42 38.0																		
207	S28 56 21.0 E16 42 38.7																		
208	S28 56 18.5 E16 42 37.2	5	x	x	x														
209	S28 56 18.1 E16 42 37.2	10	x	x	x		x												
210	S28 56 18.5 E16 42 38.6	5	x	x	x														
211	S28 56 18.9 E16 42 38.3	25	x	x	x		x	x											211-216 all one site.
212	S28 56 19.0 E16 42 38.1																		
213	S28 56 19.4 E16 42 38.2																		
214	S28 56 19.1 E16 42 37.8																		
215	S28 56 18.8 E16 42 37.5																		
216	S28 56 18.8 E16 42 37.9																		
217	S28 56 18.7 E16 42 39.3	10	x	x	x		x										x		
218	S28 56 19.1 E16 42 39.6	50	x	x	x							x					x		218-226 all one site.
219	S28 56 19.4 E16 42 39.4																		IIIA bead.
220	S28 56 19.4 E16 42 39.1																		
221	S28 56 19.6 E16 42 39.9																		
222	S28 56 19.9 E16 42 39.7																		
223	S28 56 20.2 E16 42 39.8																		
224	S28 56 20.6 E16 42 39.7																		
225	S28 56 20.6 E16 42 40.2																		

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
226	S28 56 19.8 E16 42 40.1																		
227	S28 56 18.9 E16 42 44.8	15	x	x	x					x									
228	S28 56 20.3 E16 42 45.4	5	x	x	x														
229	S28 56 23.1 E16 42 46.2	5	x	x															Ephemeral.
230	S28 56 31.6 E16 42 49.9	35	x	x	x			x		x					x				230-234 all one site.
231	S28 56 31.5 E16 42 50.1																		Lots of Burnupena at waypoint 232.
232	S28 56 31.6 E16 42 50.4																		
233	S28 56 32.1 E16 42 50.4																		
234	S28 56 32.5 E16 42 50.7																		
235	S28 56 33.5 E16 42 51.1	15	x	x	x		x												235-236 all one site.
236	S28 56 33.9 E16 42 51.3																		
237	S28 54 39.2 E16 45 10.5	5	x	x						x									Ephemeral. Hilltop.
238	S28 54 42.7 E16 45 10.3	10								x									Ephemeral. Vegetated deflation hollow.
239	S28 54 15.4 E16 45 10.1	?								x									Ephemeral scatter along edge of trench.
240	S28 54 13.0 E16 45 05.1	10	x	x	x														
241	S28 52 59.3 E16 45 09.8	?								1									Ehemeral background scatter on hardpan.
242	S28 53 13.8 E16 46 06.7	5	x	x						x							x		
243	S28 53 04.3 E16 46 12.3	?								x									Ehemeral background scatter on hardpan.
244	S28 53 37.8 E16 46 17.2	10	x	x															
245	S28 53 38.1 E16 46 17.7	5	x	x	x														
246	S28 53 41.6 E16 46 40.7	20	x	x	x														Ephemeral. Hilltop.
247	S28 51 30.5 E16 46 10.7	?								x									Ephemeral. Hilltop deflation.
248	S28 51 19.3 E16 46 11.7	?	x	x	x												x		Ephemeral. Hilltop.
249	S28 51 00.3 E16 46 07.8	?								x									Ephemeral. Hilltop deflation.
250	S28 51 43.3 E16 45 21.1	?								x								x	Exposed hardpan along edge of mine trench.
251	S28 51 43.9 E16 45 21.0																		
252	S28 51 45.2 E16 45 20.9																		
253	S28 51 46.2 E16 45 20.9																		
254	S28 51 44.6 E16 45 20.8																		
255	S28 46 26.4 E16 38 36.4	2																	Scatter of glass on rocky hilltop. Likely modern.
256	S28 46 14.7 E16 38 41.2	90	x	x	x														256-257 all one site.
257	S28 46 11.8 E16 38 40.6																		Small scatter at 256 but ephemeral extension to 257.
258	S28 46 28.8 E16 40 04.1	10	x	x						x							x		
259	S28 46 48.6 E16 40 19.9	15	x	x	x											x	x		
260	S28 46 50.6 E16 40 21.3	10	x	x						x	x								Ephemeral.
261	S28 46 54.4 E16 40 23.7	?	x	x	x														Ephemeral. Exposed in jeep track.
262	S28 47 10.7 E16 40 39.8	5	x		x						x								
263	S28 47 11.1 E16 40 40.4	10	x	x	x					x							x		
264	S28 47 09.9 E16 40 40.2	110			x					x	x					x	x		Hilltop deflation. Also transfer=printed white refined earthenware.
265	S28 47 09.4 E16 40 40.6	5	x							x	x						x		
266	S28 47 09.7 E16 40 40.6	10	x	x	x						x	x					x		

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
267	S28 47 10.0 E16 40 40.9	10	x	x	x			x		x	x		x				x		
268	S28 47 12.0 E16 40 40.3	n/a																	A few fragments of an octagonal glass bottle. Also fragment of same plate as waypoint 264.
269	S28 47 19.3 E16 40 46.4	?			x					x							x		Ephemeral. Exposed in jeep track. The cluster of sites at 269-282 was also recorded by Hart (2013) as L002-L003 and D003.
270	S28 47 21.6 E16 40 48.3	5			x					x							x		Ephemeral scatter behind granite boulder. Just 1x S. argenvillei shell.
271	S28 47 23.3 E16 40 51.1	20	x	x	x					x	x					x	x		
272	S28 47 21.5 E16 40 50.9	30	x	x	x					x			x				x		Also lined industrial white refined earthenware.
273	S28 47 20.8 E16 40 51.4	5	x	x	x								x				x	x	Might be a pastoralist dump?
274	S28 47 20.2 E16 40 52.8	5	x	x	x					x							x		
275	S28 47 19.8 E16 40 53.4	10	x	x	x					x								x	
276	S28 47 20.3 E16 40 53.5	10	x	x	x					x	x		x						
277	S28 47 20.6 E16 40 54.4	10	x	x	x					x									
278	S28 47 21.8 E16 40 54.0	40	x	x	x			x		x	x					x	x		Also *C. compressa*.
279	S28 47 22.1 E16 40 53.4																		
278B	S28 46 42.1 E16 40 31.4																		Isolated 20th century glass bottle.
280	S28 47 24.7 E16 40 53.0	5	x	x	x												x		Ephemeral.
281	S28 47 26.4 E16 40 52.3	5	x	x	x					x									
282	S28 47 24.1 E16 40 49.6	10	x	x	x					x							x		
283	S28 47 15.6 E16 40 37.2	10	x	x						x							x		
284	S28 47 10.0 E16 40 34.6	10	x	x	x												x		Ephemeral.
285	S28 46 56.3 E16 40 21.9	10	x	x															
286	S28 46 49.8 E16 40 19.4	5	x	x													x		Ephemeral.
287	S28 45 23.2 E16 39 37.6	10	x	x	x												x		Lower grindstone.
288	S28 44 01.4 E16 37 39.1	n/a																	Isolated stone ware with dragon motif.
289	S28 43 45.7 E16 37 46.2	n/a																	2x isolated sponge-print refined white earthenware
290	S28 45 53.3 E16 37 54.3	10	x		x														About 30x *S. argenvillei* and 1x large *S. granatina*.
553	S28 45 02.3 E16 39 53.8	5								x	x	x	x	x			x		In sandy area at the edge of an area of exposed calcrete.
554	S28 45 04.8 E16 39 54.1									x		x	x						Ephemeral background scatter on exposed calcrete.
555	S28 47 34.8 E16 37 43.5									x		x	x						Ephemeral background scatter including a broken silcrete handaxe
556	S28 47 50.8 E16 37 56.5	5	x	x						x									Ephemeral
557	S28 47 51.0 E16 37 57.9	30	x	x	x		x			x	x		x				x	x	557 & 558 are ends of same site
558	S28 47 51.9 E16 37 58.1																		
559	S28 47 51.8 E16 37 58.4	10	x	x	x		x			x								x	
560	S28 47 51.7 E16 37 59.1	5	x	x						x									
561	S28 47 51.2 E16 38 01.0	x	x	x						x									
562	S28 47 52.7 E16 38 01.2	20	x	x	x					x			x					x	
563	S28 47 52.9 E16 38 01.7	15	x	x	x					x	x			x			x		FGB sidescraper. Four OES frags had a single engraved line (none refitted).
564	S28 47 57.3 E16 37 55.0	25	x	x	x					x	x				x		x		Disturbed
565	S28 55 42.0 E16 46 11.6	50	x	x	x					x					x				Ephemeral scatter in large deflation started from R382 road edge.

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
																			Hammerstone seen. Just outside southeast edge of study area.
566	S28 55 43.4 E16 46 12.8	15								x									Above R382 road cutting and site has been truncated. Just outside southeast edge of study area.
567	S28 55 44.1 E16 46 13.7	10	x	x	x		x		x	x									Above R382 road cutting and site has been truncated. Also glass and stoneware. Just outside southeast edge of study area.
568	S28 55 44.6 E16 46 14.7	15	x	x	x				x	x	x	x					x	x	Above R382 road cutting and site has been truncated. CCS curve-backed flake seen. Just outside southeast edge of study area.
569	S28 43 24.0 E16 36 57.2	5															x		This is an OES flask cache that has become exposed and broken up with time. Five mouth fragments from a thin (normal) and wide mouth were found, but none of them refit.
570	S28 43 23.2 E16 37 25.4	15	x	x	x					x									Ephemeral. Also brown glass and plain refined white earthenware.
571	S28 43 25.6 E16 37 25.1	15								x									Light scatter in a deflation between dunes.
572	S28 43 46.4 E16 37 20.6	15	x	x	x			x		x									Also a *Fissurella* sp. shell in a deflation between dunes.
573	S28 50 18.2 E16 42 31.0	5			x														Light scatter in a deflation between dunes
574	S28 50 16.7 E16 42 29.7	15								x				x			x	x	Other = fine-grained black rock. Bone is mineralised. Site in deflated area.
575	S28 50 15.0 E16 42 29.2	10								x				x			x	x	Other = fine-grained black rock. Bone is mineralised. Site in deflated area.
576	S28 50 13.8 E16 42 29.4	20								x	x		x				x	x	Bone is mineralised. Site in deflated area.
577	S28 50 14.2 E16 42 33.8																		An isolated clear 20th century glass bottle with metal top and that is slightly oxidised. Site in deflated area.
578	S28 50 14.7 E16 42 34.1	20								x	x		x				x	x	578 & 579 are ends of same site. One OES fragment was burnt.
579	S28 50 15.1 E16 42 34.2																		Mineralised bone, includes much tortoise and a large tooth (large-medium bovid [ID by Dr Teresa Steele]). Site in deflated area.
580	S28 50 13.7 E16 42 34.5	15								x	x		x				x	x	Mineralised bone. Lower grindstone. Site in deflated area.
581	S28 50 11.4 E16 42 34.7	20									x			x					Other = quartz porphyry. Site in deflated area.
582	S28 50 00.0 E16 42 25.8	3x7																	The remains of a small building foundation. Inside looks like a calcrete floor and rocks are falling away to the sides due to wind erosion. The cement base of a corrugated iron reservoir lies 100 m northwest and some modern rubbish (glass, metal, ceramics, a battery, part of a plastic pen, some asbestos and a spring mattress) lies 35 m southwest.
583	S28 50 00.5 E16 42 27.7	8	x		x												x	x	Just a single *C. granatina* shell. Mineralised bone. Site in deflated area.
584	S28 50 03.6 E16 42 31.0									x									Extensive light quartz scatter in deflated area.
585	S28 50 10.4 E16 42 29.3									x			x				x		Ephemeral scatter in deflated area.
586	S28 51 52.0 E16 43 14.4									x	x							x	Fossil tortoise in deflated area along mine trench. Also ephemeral artefacts. CCS backed blade fragment seen. Presumably MSA.
587	S28 51 51.4 E16 43 16.0																	x	Scatter of fossil long bone fragments in deflated area along mine trench.
588	S28 51 51.5 E16 43 15.2									x									Light scatter in deflated area along mine trench.
589	S28 46 04.4 E16 40 47.2																	x	Two fragments of a fossil bone in a sandy area.

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
590	S28 46 48.8 E16 41 51.1	20	x	x						x							x		Some ostrich eggshell is burnt
591	S28 46 53.8 E16 41 53.4	20	x	x	x					X									
592	S28 46 54.4 E16 41 54.6	10	x	x			X												
593	S28 47 11.4 E16 42 49.4	10	x	x												x	x		Six potsherds, some quite large
594	S28 47 11.4 E16 42 50.8	5	x	x						x									Ephemeral scatter
595	S28 47 10.8 E16 42 51.3	5	x	x	x														Ephemeral scatter
596	S28 47 10.3 E16 42 51.1	10	x	x	x					x	x					x			Pottery with very thin walls
597	S28 47 10.7 E16 42 50.5	15	x	x	x					x			x			x	x		Pottery with very thin walls
598	S28 47 13.9 E16 42 53.0	10								x	x						x		
599	S28 47 12.9 E16 42 57.7	10	x	x	x					x							x		Dunetop site
600	S28 47 15.7 E16 43 16.1									x			x				x		Light scatter of Pleistocene material on exposed calcrete
601	S28 47 43.1 E16 42 51.2									x		x						x	Light scatter of Pleistocene material on exposed calcrete. Fossilised bone.
602	S28 47 44.6 E16 42 34.7									x		x		x			x	x	Light scatter of Pleistocene material on exposed calcrete. Fossilised bone. Also some metal here from historical/recent farming activity. Cement reservoir 40 m to the west. This site (602-607) was also recorded by Hart (2013) as D007.
603	S28 47 42.7 E16 42 33.5																	x	Fossil bone fragments on exposed calcrete
604	S28 47 42.0 E16 42 33.5									x	x						x	x	Light scatter of Pleistocene material on exposed calcrete. Fossilised bone.
605	S28 47 41.4 E16 42 33.3																	x	Fossil bone fragments on exposed calcrete. Also a quartzite hammerstone just southeast of here.
606	S28 47 40.5 E16 42 33.0									x			x	x					Also a quartzite lower grindstone/anvil. Light scatter of Pleistocene material on exposed calcrete.
607	S28 47 40.3 E16 42 33.1																	x	Fossil bone fragments on exposed calcrete. Many fragments occur over about 3-4 m^2.
608	S28 47 47.3 E16 42 33.1									x	x		x						Light scatter of Pleistocene material on exposed calcrete
609	S28 48 04.6 E16 41 39.8	20	x	x				x											
610	S28 48 04.1 E16 41 39.2	10	x	x															
611	S28 48 03.3 E16 41 24.1	5	x	x													x		Ephemeral
612	S28 51 03.7 E16 41 47.7	5	x		x														Scatter of S. argenvillei with just 1 or 2 large granatina shells
658	S28 43 48.1 E16 35 24.5	20												x					Cores & flakes in dark-brown semi-smooth grained material.
659	S28 43 49.5 E16 35 25.7	5											x	x					Ephemeral. semi-smooth grained material.
661	S28 43 44.5 E16 35 26.0	5												x			x		Ephemeral. semi-smooth grained material.
662	S28 43 41.5 E16 35 28.9	5												x					Ephemeral. semi-smooth grained material.
664	S28 43 39.1 E16 35 26.4	10												x					Flakes of a semi-smooth grained material.
667	S28 45 51.0 E16 34 10.9	10	x	x	x														
672	S28 46 01.8 E16 34 25.2	10	x		x														Also some clear and green glass fragments.
674	S28 45 57.8 E16 34 16.4	5											x						
676	S28 46 27.8 E16 35 01.6	1.5		x															A small overhang of 1.5m wide and 1.7m high. Animal lair, but the shells likely originate from occupation of the adjoining larger shelter at waypoint 677.

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
677	S28 46 27.6 E16 35 01.8	6	x		x					x	x		x				x	x	A rock shelter of about 6m long x 3m wide x 4m high with walling at the entrance on the western side of Boegoeberg south. Burned faunal bones.
678	S28 47 16.2 E16 37 15.5	5								x									Ephemeral
679	S28 47 17.4 E16 37 14.4	20									x		x	x					Semi-smooth grained material.
680	S28 47 20.6 E16 37 20.0	10											x	x					Semi-smooth grained material.
681	S28 47 21.0 E16 37 21.2	5											x				x		
682	S28 47 28.2 E16 37 28.1	5											x						1x Core and 3x flakes.
683	S28 47 27.2 E16 37 28.1	n/a										x							Hand axe.
684	S28 47 24.7 E16 37 27.4	5											x						Ephemeral
685	S28 47 24.5 E16 37 27.2	n/a										x							Hand axe, broken in three but one small piece is missing.
686	S28 47 23.3 E16 37 26.7	5											x						Ephemeral.
687	S28 47 22.9 E16 37 26.7	10									x						x		Some OES are burned.
688	S28 43 53.4 E16 34 15.6	20	x	x	x		x	x		x			x	x			x	x	A dense shell midden with at least 3x OES beads (8mm). Semi-smooth grained material.
689	S28 43 59.5 E16 34 16.5	2	x	x	x					x			x						Ephemeral.
690	S28 44 01.6 E16 34 16.4	5			x														Ephemeral.
691	S28 44 01.8 E16 34 16.6	10	x		x														Ephemeral.
692	S28 44 02.3 E16 34 17.3	20	x		x		x												
693	S28 44 03.4 E16 34 17.9	5	x	x	x								x						Ephemeral.
694	S28 44 04.4 E16 34 17.9	5	x		x					x			x						Ephemeral.
695	S28 44 04.8 E16 34 18.0	5	x		x								x						Ephemeral.
696	S28 44 04.8 E16 34 18.4	10	x	x	x					x									Ephemeral.
697	S28 44 52.0 E16 34 15.6	15									x	x	x	x					
698	S28 50 40.6 E16 43 00.6	5								x									Ephemeral flakes at a pan.
699	S28 49 16.5 E16 44 06.0	50			x					x	x	x					x	x	Granite outcrop with wire fencing, fragments of glass (lighter olive green, emerald green, clear, aquamarine), some burned shells.
700	S28 49 18.1 E16 44 06.1	10			x											x	x		Undecorated pottery, thin-walled with blackening.
701	S28 49 18.7 E16 44 05.9	5											x		x			x	Burned animal bones.
702	S28 49 19.2 E16 44 06.9	5	x	x	x					x	x						x		Some shells are burned.
703	S28 49 17.5 E16 44 07.5	5										x							Fragments of emerald green glass and beef tins possibly from early diamond miners. Also 2x silcrete cores.
704	S28 49 17.2 E16 44 09.3	5														x			Undecorated pottery, thin-walled with blackening.
705	S28 49 15.4 E16 44 08.6	10		x	x					x	x						x		Some shells are burned.
706	S28 49 14.6 E16 44 06.7	5			x					x			x						
707	S28 49 15.0 E16 44 06.0	n/a																	Sponged ceramic.
708	S28 47 38.6 E16 35 10.5	5			x														Ephemeral.
709	S28 47 37.8 E16 35 09.9	8	x	x	x					x			x						Lower grind stone & upper grindstone with hammer marks.
710	S28 47 35.2 E16 35 06.0	5	x		x														
711	S28 47 34.9 E16 35 05.8	10	x	x	x														Hammer stone.
712	S28 47 34.5 E16 35 06.0	10	x		x														
713	S28 47 34.4 E16 35 07.0	10	x		x											x			2x fragments of undecorated, thin-walled pottery.

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
714	S28 47 34.0 E16 35 07.0	15	x	x	x	x													
715	S28 50 51.9 E16 35 56.7	10	x													x			8x fragments of undecorated, thin-walled, blackened pottery.
716	S28 51 09.1 E16 37 17.8	10	x		x														
717	S28 51 06.5 E16 37 12.7	30	x	x	x		x			x			x				x		1x OES bead 7mm. Hammer stone.
718	S28 50 53.0 E16 37 04.7	12																	A circular stone kraal (8m) with a dipping passage inside and two adjoining rectangular stone kraals (4m wide x 8m long in total). Wood fragments in the doorways and glass (clear, lighter olive green & emerald green) fragments. This is in Rietfontein pan.
719	S28 50 40.9 E16 36 56.7	5			x														Ephemeral.
720	S28 50 20.9 E16 36 36.0	5	x		x														Ephemeral.
721	S28 50 21.2 E16 36 34.6	20	x	x	x														Ephemeral.
722	S28 50 18.3 E16 36 32.9	15	x	x	x														
723	S28 50 18.3 E16 36 34.3	10	x		x														
724	S28 50 18.4 E16 36 34.7	5	x	x	x														Ephemeral.
725	S28 50 18.3 E16 36 35.4	20	x	x	x					x						x		x	A dense midden with minimal *S. argenvillei*. Decorated pottery with blackening. Burned faunal remains.
726	S28 50 16.9 E16 36 35.1	5			x					x									Ephemeral.
729	S28 52 23.0 E16 38 35.8	5			x														Ephemeral.
730	S28 52 09.9 E16 38 49.1	5	x	x	x					x							x		730 – 732 all one site.
731	S28 52 09.6 E16 38 49.1	5		x	x														
732	S28 52 09.5 E16 38 49.1	5	x	x	x					x									
733	S28 52 09.2 E16 38 49.3	20	x	x	x		x										x		Light scatter.
734	S28 52 09.0 E16 38 48.8	5	x	x	x		x										x		
735	S28 52 08.7 E16 38 48.7	20	x	x	x		x			x							x		Light scatter of mostly *C. meridionalis*.
736	S28 52 08.2 E16 38 48.6	10	x	x	x					x							x		Ephemeral with some burned shell.
737	S28 52 06.3 E16 38 47.8	50	x	x	x		x			x	x						x		Moderately dense shell midden with burned shell.
738	S28 52 05.6 E16 38 47.6	20	x	x	x		x			x									Burned shell.
739	S28 52 05.2 E16 38 47.5	10	x	x	x		x										x		Ephemeral.
740	S28 52 04.6 E16 38 47.4	5	x		x												x		Ephemeral.
741	S28 52 03.4 E16 38 47.1	5	x	x	x		x												Ephemeral.
742	S28 52 03.2 E16 38 47.2	5	x	x	x		x												Ephemeral.
743	S28 52 02.7 E16 38 47.6	20	x		x		x							x					Core made from almost black, fine-grained material.
744	S28 52 01.6 E16 38 47.4	20	x		x	x	x												
745	S28 52 02.8 E16 38 44.1	5	x																Ephemeral.
746	S28 51 53.5 E16 38 44.1	5	x		x														Ephemeral.
747	S28 49 48.7 E16 37 12.7	70	x	x	x							x	x	x			x		Most shell is highly fragmented.
748	S28 49 45.5 E16 37 12.0	10	x	x	x							x	x				x		Ephemeral. Most shells are highly fragmented.
749	S28 49 44.4 E16 37 11.5	5	x		x					x									Ephemeral. Most shells are highly fragmented.
750	S28 49 43.6 E16 37 11.5	10	x	x	x							x	x				x		Ephemeral. Most shells are highly fragmented.
751	S28 49 43.1 E16 37 11.6	10		x	x							x	x				x		Ephemeral. Burned shell.
752	S28 53 54.0 E16 39 10.9	n/a																	Modern shipwreck.
753	S28 53 55.0 E16 39 14.3	10																	A pile of turret shells and some white bivalves (Venerupis?) with

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
																			broken wood fragments. Shell may be palaeontological but the small exposure and association with wood are puzzling.
754	S28 53 03.7 E16 39 59.6	10	x	x	x												x		754 – 755 all one site.
755	S28 53 03.8 E16 39 59.2	5	x	x	x														
756	S28 55 13.8 E16 41 10.4	5	x		x														
757	S28 55 15.6 E16 41 10.9	40	x	x	x		x												Partly destroyed by road.
758	S28 56 01.9 E16 41 37.3	40	x	x	x	x	x	x		x	x		x	x		x	x		A dense shell midden, partly destroyed by a road. Also hammer stones, lower & upper grind stones. There is also a few of fragments thin-walled pottery and ostrich eggshell.
759	S28 56 01.9 E16 41 38.1	30	x	x	x			x											
760	S28 56 02.4 E16 41 38.1	30	x	x	x		x	x									x	x	
761	S28 56 02.8 E16 41 37.9	10	x	x	x			x		x		x					x		
762	S28 56 03.2 E16 41 37.9	20	x	x	x		x	x		x									Partly destroyed by road.
763	S28 56 03.5 E16 41 37.8	5	x	x	x		x	x		x									Partly destroyed by road.
764	S28 56 04.3 E16 41 38.6	30	x	x	x		x			x									Heavily weathered
765	S28 56 04.9 E16 41 38.8	5	x	x	x											x			8x fragments of undecorated pottery.
766	S28 56 04.9 E16 41 39.7	10	x	x	x					x									
767	S28 56 05.5 E16 41 39.6	5	x	x	x					x									
768	S28 56 05.6 E16 41 40.0	5	x		x					x									
769	S28 56 06.2 E16 41 41.0	5			x			x											Few *S. argenvillei,* the rest is all *Burnupena sp.*
770	S28 56 06.0 E16 41 41.4	5	x	x	x					x									
771	S28 56 06.9 E16 41 41.2	20	x	x	x		x	x								x			A moderately dense shell midden of about 20m, partly destroyed by a road. Has 5x undecorated, thin-walled pottery fragments.
772	S28 56 07.2 E16 41 41.8	10			x	x	x			x							x	x	Whale bone
773	S28 56 07.1 E16 41 42.4	20	x	x	x	x	x				x		x						A moderately dense shell midden.
774	S28 56 07.5 E16 41 43.0	2	x	x	x		x												
775	S28 56 06.1 E16 41 42.7	5	x		x												x		Partly destroyed by road.
776	S28 56 04.4 E16 41 40.5	10	x	x	x					x							x		Ephemeral.
777	S28 56 03.9 E16 41 40.6	15			x		x												
778	S28 56 02.9 E16 41 41.1	10			x		x												
779	S28 56 02.2 E16 41 40.9	5	x		x					x									
780	S28 56 28.2 E16 41 55.6	15	x		x		x												
781	S28 56 28.2 E16 41 54.8	5			x		x						x						
782	S28 56 28.6 E16 41 54.4	5			x			x											
783	S28 56 28.6 E16 41 54.2	10	x	x	x			x		x							x		
784	S28 56 30.3 E16 41 50.1	5			x	x							x						
785	S28 56 29.9 E16 41 50.0	5			x	x													
786	S28 56 29.2 E16 41 49.9	5	x		x	x				x									
787	S28 56 27.4 E16 41 50.4	30	x	x	x		x			x									Partly destroyed by road.
788	S28 56 26.2 E16 41 51.7	30	x	x	x	x	x			x				x		x			A moderately dense shell midden. Fragments of thin-walled, undecorated pottery with blackening.
789	S28 56 26.2 E16 41 50.3	20	x	x	x						x		x	x					A light shell scatter with burned shell. Hammer stone.

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
790	S28 56 26.6 E16 41 49.9	30	x	x	x	x	x	x		x			x	x			x	x	A moderately dense shell midden with fish bone.
791	S28 56 26.8 E16 41 49.1	30	x		x	x				x						x			A light shell scatter. Thin-walled, undecorated pottery. Partly destroyed by road.
792	S28 56 27.4 E16 41 48.3	15	x	x	x					x				x					An ephemeral shell scatter. Partly destroyed by road.
793	S28 56 26.0 E16 41 49.0	5	x		x														
794	S28 56 21.0 E16 41 47.1	30	x		x	x	x	x		x	x		x						Shell highly fragmented.
795	S28 56 20.2 E16 41 47.0	20	x		x			x		x				x					
796	S28 56 19.4 E16 41 46.8	30	x	x	x		x	x						x			x		
797	S28 56 20.0 E16 41 47.8	10			x	x	x			x									
798	S28 56 20.4 E16 41 48.3	5		x	x														
799	S28 56 21.1 E16 41 48.0	20	x	x	x		x	x		x									A moderately dense shell scatter. Partly destroyed by road.
800	S28 56 21.6 E16 41 49.0	20	x	x	x		x			x						x	x		Ephemeral. 2x thin, undecorated pottery fragments present.
801	S28 56 22.3 E16 41 49.1	30	x		x	x				x									
802	S28 56 22.7 E16 41 49.7	15			x			x		x							x		Ephemeral, highly fragmented.
803	S28 56 25.0 E16 41 53.4	5	x		x					x									
804	S28 56 26.8 E16 43 38.5	20	x	x	x	x					x		x				x	x	A light shell scatter with burned animal bones. Hammer stone on the edge of a pan.
805	S28 56 24.5 E16 43 39.5	5								x									A moderately dense scatter of quartz and quartzite hammer stones next to a pan.
807	S28 48 17.5 E16 38 04.6	n/a																	Old water reservoir and water troughs next to the old Alexander bay road.
808	S28 47 52.9 E16 37 09.5	2	x	x													x		Ephemeral.
809	S28 47 53.1 E16 37 14.1	1	x	x															Ephemeral.
810	S28 47 48.9 E16 37 24.9	80	x	x	x	x	x			x	x		x				x		IIIA
811	S28 47 47.8 E16 37 23.6																		810 – 813 all one site.
812	S28 47 47.1 E16 37 23.3																		A dense shell midden with a very compacted lower levels suggest repeated site use. Artefacts include blades, bladelets, scrapers, upper & lower grindstones, hammer stones.
813	S28 47 46.8 E16 37 22.8																		
814	S28 47 46.1 E16 37 23.6	60	x	x	x	x	x			x	x		x				x		814-818 all one site.
815	S28 47 45.6 E16 37 23.2																		
816	S28 47 45.1 E16 37 23.7																		
817	S28 47 44.3 E16 37 23.3																		
818	S28 47 44.6 E16 37 22.6																		
819	S28 47 44.0 E16 37 22.3	15	x	x	x					x	x						x		A light shell scatter.
820	S28 47 43.9 E16 37 22.9	5			x														Ephemeral.
821	S28 47 46.2 E16 37 24.5	70	x	x	x	x	x			x	x		x				x		821-824 all one site.
822	S28 47 46.8 E16 37 24.8																		
823	S28 47 47.5 E16 37 25.5																		
824	S28 47 48.0 E16 37 25.7																		
825	S28 47 51.9 E16 37 33.5	100	x	x	x	x	x			x	x		x				x		825-830 all one site. A collection of dense shell middens overlapping. Artefacts incliude blades, scrapers, Upper & lower
826	S28 47 51.3 E16 37 33.2																		

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827	S28 47 50.3 E16 37 33.1																		grindstones, hammer stones.
828	S28 47 50.0 E16 37 32.8																		
829	S28 47 49.5 E16 37 33.0																		
830	S28 47 49.1 E16 37 32.7																		
831	S28 47 48.7 E16 37 32.6	5	x	x	x						x								A light shell scatter.
832	S28 47 41.0 E16 37 35.0	50	x	x	x		x			x	x		x				x		IIIA
833	S28 47 40.6 E16 37 34.1																		832-836 all one site.
834	S28 47 40.4 E16 37 34.7																		A collection of dense shell middens overlapping. It is about 1.5m high. Artefacts include blades, scrapers, lower & upper grindstones, hammer stones.
835	S28 47 39.9 E16 37 33.8																		
836	S28 47 39.7 E16 37 34.3																		
837	S28 47 42.3 E16 37 34.1	5	x	x	x					x	x								A light shell scatter.
838	S28 47 50.3 E16 37 36.5	20	x	x	x		x			x	x								838 – 839 all one site. Two dense shell middens overlapping. Artefacts include blades, scrapers, lower & upper grindstones, hammer stones.
839	S28 47 50.8 E16 37 36.7																		
840	S28 47 53.5 E16 37 33.9	100	x	x	x	x	x			x	x		x				x		840-848 all one site.
841	S28 47 54.1 E16 37 33.7																		A collection of light shell scatters overlapping. Quartzite cores and hammer stones, lower grindstone.
842	S28 47 54.9 E16 37 34.0																		
843	S28 47 55.3 E16 37 34.6																		
844	S28 47 56.0 E16 37 34.6																		
845	S28 47 55.5 E16 37 34.3																		
846	S28 47 55.0 E16 37 33.7																		
847	S28 47 54.1 E16 37 33.4																		
848	S28 47 53.0 E16 37 33.2																		
849	S28 47 56.2 E16 37 32.3	10								x									Many quartz flakes and one quartzite hammer stone on the eastern edge of a pan.
861	S28 45 10.6 E16 39 14.7												x						A quartzite core and two flakes.
864	S28 45 08.4 E16 39 31.4	5			x														Ephemeral
865	S28 45 01.7 E16 39 35.3									x									Heavily weathered quartz flake.
866	S28 45 15.8 E16 40 07.2	10									x		x						Small deflation hollow with a quartzite flake and core and a CCS bladelet.
867	S28 46 01.8 E16 40 05.8	10									x		x						A calcrete patch with four flakes of CCS and quartzite.
868	S28 47 53.1 E16 37 51.8	100	x	x	x	x	x				x	x	x	x	x		x		Waypoints 868 – 872 are part of the same site. A substantial shell midden of about 100m long with several shell peaks. Artefacts include cores, flakes, bladelets, scrapers, upper and lower grind stones, and hammer stones. One incised ostrich eggshell fragment seen. There are also lumps of dark pigment.
869	S28 47 53.0 E16 37 51.2																		
870	S28 47 53.3 E16 37 49.4																		
871	S28 47 51.7 E16 37 48.7																		
872	S28 47 52.4 E16 37 50.4																		
873	S28 48 59.9 E16 39 18.3	5	x		x														Ephemeral
874	S28 48 53.7 E16 39 34.8	5	x																Ephemeral
875	S28 48 52.8 E16 39 34.5	5	x																Ephemeral
876	S28 44 48.0 E16 36 49.0	5	x		x														Ephemeral
877	S28 44 57.2 E16 36 54.1	5								x			x						Ephemeral heavily weathered quartz core and two quartzite flakes.
878	S28 45 00.9 E16 36 55.8	n/a								x		x	x						Ephemeral background scatter of quartzite, silcrete and smoky

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																			quartz.
879	S28 50 41.1 E16 41 55.4	10	x	x							x					x	x		Ephemeral shell scatter of about 10m with *C. granatina, S. granularis,* one CCS flake, ostrich eggshell fragments and one fragment of *decorated* pottery.
880	S28 52 02.4 E16 42 47.4	5	x	x	x														Ephemeral
881	S28 47 38.4 E16 38 58.3	5	x		x														Ephemeral
882	S28 47 29.7 E16 38 25.8	5			x					x									Ephemeral
883	S28 46 50.7 E16 38 38.5	5	x																Ephemeral
884	S28 46 39.7 E16 38 19.0	10	x	x	x														Ephemeral
885	S28 46 15.3 E16 38 23.6	20	x	x	x								x		x				Light shell scatter
886	S28 46 15.3 E16 39 04.7	5	x	x	x	x													Ephemeral
887	S28 46 15.5 E16 39 05.5	10		x	x														Ephemeral
888	S28 46 15.9 E16 39 07.8	10	x	x	x					x									Ephemeral
889	S28 46 14.7 E16 39 11.8	10	x	x	x														Ephemeral
890	S28 50 05.6 E16 39 17.0	5															x		A small concentration of ostrich eggshell fragments with incised marks; possibly a flask.
2001	S28 43 44.18 E16 35 22.34													x					Isolated diagnostic MSA flake out of unusual black rock on Namakwakop
2002	S28 43 44.12 E16 35 17.06	n/a																	1929 Beacon for State Alluvial Diamond Diggings
2003	S28 43 40.86 E16 35 16.25												x						Scatter stone artefacts
2004	S28 43 37.97 E16 35 15.83																	x	Fossilized bone?
2005	S28 43 37.97 E16 35 15.83									x									Scatter stone artefacts, MSA components
2006	S28 43 37.97 E16 35 15.83												x	x					Scatter stone artefacts
2007	S28 43 37.97 E16 35 15.83	2	x		x					x									Small, ephemeral scatter
2008	S28 45 53.04 E16 34 31.50												x						Quartzite on talus for Boegoeberg North used as factory site? Handaxe present.
2009	S28 46 03.13 E16 34 28.55	4																	3 sides of rectangular outline rocks, base of possible corrugated house? 3 x 4m in size? Badly impacted by mining.
2010	S28 46 02.85 E16 34 27.23		x	x														x	Large rubbish dump including food tins and mining debris of iron; green, brown, aqua glass – early 20th century? Shell.
2011	S2846 02.19 E16 34 26.66	3	x	x	x														Also aqua glass. Unknown whether glass and shell are contemporary?
2012	S28 46 02.19 E16 34 26.66	3			x														Also some glass
2013-2014	S28 46 01.92 E16 34 26.37	5	x																Ephemeral. Also some glass.
2015	S28 46 01.70 E16 34 25.80	?			x														Ephemeral
2016	S28 46 01.72 E16 34 25.74	3x2																	Collapsed rectangular stone feature of unknown function
2017	S28 44 06.06 E16 34 17.93	4x1	x		x								x						
2018	S28 44 05.67 E16 34 17.68	2x1			x		x												
2019	S28 44 05.65 E16 34 17.66	?	x		x														Ephemeral
2020	S28 44 04.29 E16 34 17.36	50	x	x	x						x		x					x	2020 and 2021 are ends of same site. Very large, damaged midden, whale bone.
2021	S28 44 03.34 E16 34 16.90																		
2022	S28 44 02.66 E16 34 16.72	50	x	x	x		x												2022 and 2023 are ends of same site. Very large midden, whale

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2023	S28 44 02.28 E16 34 16.22																		bone. IIIB
2024	S28 46 29.63 E16 35 06.70	?								x	x	x	x	x					Large scatter of stone artefacts on top of Boegoeberg South
2025	S28 46 29.47 E16 35 13.52	2	x		x					x									Shell scatters in sandy hollows. Damaged?
2026	S28 46 34.73 E16 35 07.36	2	x		x									x					Shell scatter. Red ochre. Damaged.
2027	S28 46 35.05 E16 35 03.91	2	x		x											x			Deflated shell scatter.
2028	S28 46 34.92 E16 35 03.41	2	x		x										x				Large lower grindstone.
2029	S28 46 34.72 E16 35 02.71	2	x		x														
2030	S28 46 24.28 E16 34 50.79																		Very large pile of rocks, identified by Kaplan (2008) as a grave and listed as A14 above. IIIA
2031	S28 46 23.78 E16 34 53.04																		Second cairn of rocks 60 m east of 2030 and assumed to be Kaplan's (2008) second grave. IIIA
2032	S28 46 19.72 E16 34 56.60																		A third, smaller cairn 160 m northeast of 2031. IIIA
2033	S28 47 13.43 E16 37 10.32									x	x		x	x					Light scatter of stone tools on Visagiepan
2034	S28 47 20.58 E16 37 02.72													x					Large black rock with in-situ flaking
2035	S28 47 35.44 E16 36 46.20		x	x	x														
2036	S28 47 39.88 E16 36 55.41	15	x		x					x							x		Large midden on western edge of pan. IIIB
2037	S28 47 39.56 E16 36 55.92									x	x		x	x					Scatter of stone tools on floor pan
2038	S28 47 31.98 E16 37 08.53	5	x								x						x		Deflated shell midden
2039	S28 47 30.52 E16 37 08.62	10	x		x						x								Smaller of 2 middens next each other on floor of pan
2040	S28 47 29.77 E16 37 08.77	30	x		x					x	x								Large midden with in-situ deposit. IIIB
2041	S28 47 28.29 E16 37 09.42	?	x		x														Dispersed shell
2042	S28 47 27.90 E16 37 10.40	20	x	x	x					x									
2043	S28 43 53.41 E16 34 15.60	30	x		x		x			x			x	x			x	x	Continuation of same line of middens as 020 &022. Oes beads, large quartzite scrapers? Large flat shale blocks. IIIB
2044	S28 43 54.25 E16 34 15.82	40	x		x						x			x		x			Also large shale blocks. Continuation of the same middens, partially destroyed by road along coast.
2045	S28 43 55.34 E16 34 14.99	30	x		x						x						x		
2046	S28 43 58.00 E16 34 15.80	3	x		x														
2047	S28 43 58.68 E16 34 15.56		x	x	x														
2048	S28 43 59.72 E16 34 15.64		x	x	x												x		Very long, dispersed shell scatter
2049	S28 44 00.06 E16 34 15.77		x		x					x									Also shale slabs
2050	S28 44 00.84 E16 34 15.97		x		x					x									Ridge of shell, dropping around 10m to the road below.
2051	S28 44 04.21 E16 34 16.80		x	x	x														The edge of site 2020?
2052	S28 44 07.38 E16 34 18.20		x	x	x														Many shale slabs. Midden damaged by road
2053	S28 44 08.09 E16 34 18.63		x	x	x														Badly damaged midden
2054	S28 49 16.64 E16 44 05.78		x	x	x												x		Grondputs – water seepage next to large rocks. Settlement around 30m in all directions. Shell, stone artefacts and glass near the rocks. IIIB
2055	S28 49 18.06 E16 44 08.36	4	x		x		x	x								x			Thin walled pottery. IIIB
2056	S28 49 17.09 E16 44 08.79		x	x	x					x	x	x						x	Burnt tortoise bone.
2057	S28 49 19.43 E16 44 08.19	35	x	x	x			x											2057, 2058, 2060 all same site

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2058	S28 49 19.43 E16 44 19.22																		
2060	S28 49 19.22 E16 44 08.08		x	x	x														
2059	S28 49 15.99 E16 44 06.95	2 x 4							x		x		x				x		Part of site exposed in road, including ostrich egg, bead, pieces of china. Site is width of road
2061	S28 49 14.19 E16 44 06.86				x						x		x				x		Another scatter to the north of Grondputs.
2062	S28 47 39.48 E16 35 10.50		x	x	x														Scattered/destroyed shell midden over large area
2063	S28 47 37.82 E16 35 09.81	3			x											x			The pottery has unusual bubbles on surface
2064	S28 47 36.98 E16 35 08.15	3	x		x					x									Flakes on a smoky quartz
2065	S28 47 36.92 E16 35 07.46	5	x		x											x	x		2065 and 2066 are same site. Thin walled, badly fired pottery.
2066	S28 47 36.58 E16 35 07.29																		
2067	S28 47 36.28 E16 35 07.34	50	x	x	x											x	x		Lug of pottery.
2068	S28 47 36.14 E16 35 07.04	10	x	x	x											x	x		Potsherds include rim and neck with red burnish.
2069	S28 47 36.72 E16 35 04.54	?	x	x	x				x	x							x		Badly destroyed midden
2070	S28 49 33.32 E16 35 21.93	?	x		x	x													Demolished midden
2071	S28 50 49.23 E16 35 59.14	?	x		x					x									Only small fragments of shell but seems like a site buried by recent wind-blown sand.
2072	S28 50 47.26 E16 35 58.18	3	x		x					x									Only small fragments of shell but seems like a site buried by recent wind-blown sand.
2073	S28 51 06.72 E16 37 12.53	30	x		x					x	x						x		OES bead. Road goes through this midden
2074	S28 50 53.19 E16 37 04.66									x									Stone dipping kraal with 2 adjoining kraals for livestock. Shale like rock, double skin, remnants of wood at entrance. Surrounded by broken glass. Recorded by Kaplan (2008) as A7. IIIB
2075	S28 50 20.03 E16 36 34.97	30	x	x	x														Large midden overlooking pan.
2076	S28 50 19.11 E16 36 37.39	8	x		x														Small compact midden
2077	S28 50 14.61 E16 36 33.74			x												x			Decorated pottery
2078	S28 50 14.36 E16 36 33.99	3	x		x					x									
2079	S28 50 15.42 E16 36 57.51	3																	
2080	S28 47 37.75 E16 37 41.64									x									Quartz chunks and chips around spring
2081	S28 47 41.43 E16 37 53.34		x		x														Large midden near the spring, destroyed by the tar road.
2082	S28 52 23.49 E16 38 35.74	5	x	x	x					x		x					x		
2083	S28 52 21.78 E16 38 37.24									x									Quartz artefact scatter
2084	S28 52 23.20 E16 38 40.93																		Historic glass on edge of pan
2085	S28 52 15.84 E16 38 50.38	?	x	x	x					x									Partially destroyed by mining
2086	S28 51 56.47 E16 38 41.09	50	x	x	x		x			x						x			Light scatter
2087	S28 52 17.89 E16 36 30.02		x	x						x							x		Impacted by mining
2088	S28 49 45.27 E16 37 21.11	3			x					x			x				x		Light scatter shell
2089	S28 49 43.81 E16 37 12.00	30	x	x	x			x		x	x			x			x		Large scatter. Including CCS scraper
2090	S28 49 43.37 E16 37 10.92		x	x	x		xx												Fragmented shell on top of dune
2091	S28 49 41.99 E16 37 06.80									x									Flaked outcrop in base of pan, quarry site
2092	S28 49 41.84 E16 37 05.93	3-4																	Semi-circle of rocks including a lower grindstone. May be a mining related feature.

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2093	S28 49 44.45 E16 37 04.65									x									
2094	S28 49 45.44 S16 37 06.55		x	x	x														Shell scatter of destroyed midden
2097	S28 56 01.91 E16 41 37.32	50	x	x	x		x			x			x	x	x				2097 and 2098 appear to be the same site. Large midden with road through the middle
2098	S28 56 01.08 E16 41 37.49		x	x	x		x						x						
2099	S28 56 01.19 E16 41 36.66	3			x														Small dense midden
2100	S28 56 01.34 E16 41 36.30	?	x		x					x			x	x					Dispersed shell
2101	S28 56 01.29 E16 41 35.62	2	x	x	x										x				
2102	S28 56 00.52 E16 41 35.43	20	x		x					x									Large midden in the dunes
2103	S28 56 00.10 E16 41 35.61	15	x		x								x						Long line of shells, partially hidden by sand
2104	S28 55 58.58 E16 41 36.88	20	x	x	x					x						x			Scatter of shell over a big area
2105	S28 55 57.89 E16 41 36.97	20	x	x	x					x				x	x				In situ material at 2105, more at 2106 but continuous scatter from 2105 to 2107. IIIB
2106	S28 55 57.58 E16 41 38.10	10	x	x	x			x					x	x					
2107	S16 41 38.62 E28 55 57.68	?	x	x	x														
2108	S28 55 57.10 E16 41 38.45	?	x	x	x														Midden eroding out of dune
2109	S28 55 56.66 E16 41 37.31	?			X														Ephemeral scatter of shell
2110	S28 55 56.73 E16 41 35.75	?	x		x														Thin scatter
2111	S28 55 56.88 E16 41 35.06	15	x	x															
2112	S28 56 04.64 E16 41 40.33	3	x		x														
2113	S28 56 04.36 E16 41 40.62	?	x	x	x			x											Two heaps of shell
2114	S28 56 02.43 E16 41 41.53	20	x	x	x														Thin scatter
2115	S28 56 02.32 E16 41 40.78	30	x	x	x														Shell covered in lichen. Tyre marks through midden
2116	S28 56 01.85 E16 41 39.96	30	x		x														Midden spread in semi-circle around knoll
2117	S28 56 01.38 E16 41 39.52	30	x	x	x			x		x					x	x	x		Large, flattened midden
2118	S28 56 20.16 E16 42 05.31	?	x	x	x														Midden bisected by road
2119	S28 56 29.37 E16 41 54.25	?	x		x					x					x				Black rock used in flaking
2120	S28 56 32.32 E16 41 52.68	?	x	x	x														2020 and 2021 are same site. Ephemeral scatter of shell, disturbed by mining
2121	S28 56 32.69 E16 41 54.03																		
2122	S28 56 35.99 E16 41 56.13	5	x		x														Shells covered in lichen
2123	S28 56 32.86 E16 41 59.66	?	x	x	x														2023 and 2024 are same site. Ephemeral scatter of shell, disturbed by mining
2124	S28 56 32.84 E16 41 59.92																		
2125	S28 56 31.33 E16 41 51.00	4			x					x									Flattened midden
2126	S28 56 30.96 E16 41 50.55	?	x		x														Fragments of shell
2127	S28 56 29.43 E16 41 50.45	?	x		x														
2128	S28 56 26.88 E16 43 38.42	?	x		x									x			x		Midden eroding out of dune overlooking pan.
2129	S28 56 24.47 E16 43 39.42	15								x				x					Quartz factory site bottom of pan
2130	S28 47 52.27 E16 37 49.02	80	x	x	x		x	x		x	x		x	x			x		2130 to 2132 are all same site. Unusually large midden for Namaqualand. Very dense. There are several lower and upper grind stones and hammer stones.
2131	S28 47 53.16 E16 37 51.09																		
2132	S28 47 53.26 E16 37 51.78																		
2133	S28 47 49.47 E16 36 58.86									x			x	x					Scatter of stone artefacts
2135-2150	S28 47 47.14 E16 37 18.81	138	x	x	x		x	x		x	x		x	x			x		Unusually large midden for Namaqualand. North-south. Very dense and high.

Waypoint	Location	Size (m)	C. granatina	S. granularis	S. argenvillei	S. barbara	C. meridionalis	Burnupena sp.	Kreef	Quartz	CCS	Silcrete	Quartzite	Other	Manuports	Pottery	OES	Bone	Notes
2154	S28 47 46.54 E16 37 32.71	152	x	x	x		x	x		x	x		x		x		x		2154 to 2166 are all same site. Unusually large midden for Namaqualand. Running north-south. Very dense.
2155	S28 47 45.88 E16 37 32.87																		
2156	S28 47 45.11 E16 37 32.67																		
2157	S28 47 44.93 E16 37 32.66																		
2158	S28 47 44.58 E16 37 32.66																		
2159	S28 47 44.48 E16 37 32.53																		
2160	S28 47 44.30 E16 37 32.25																		
2161	S28 47 43.88 E16 37 31.90																		
2162	S28 47 43.02 E16 37 31.12																		
2163	S28 47 44.63 E16 37 32.95																		
2164	S28 47 44.96 E16 37 33.15																		
2165	S28 47 45.65 E16 37 33.53																		
2166	S28 47 46.54 E16 37 32.71																		
2168	S28 47 41.64 E16 37 34.41	3	x	x	x						x								Small midden
2169	S28 47 41.14 E16 37 34.76	40	x	x	x		x	x		x	x		x		x		x		2168 to 2175 are all one site. Unusually large midden for Namaqualand. Very dense.
2170	S28 47 40.67 E16 37 34.22																		
2171	S28 47 39.94 E16 37 33.82																		
2172	S28 47 39.78 E16 37 34.09																		
2173	S28 47 39.88 E16 37 34.56																		
2174	S28 47 40.47 E16 37 34.61																		
2175	S28 47 40.88 E16 37 34.77																		
2176	S28 47 41.39 E16 37 30.31																		Small shell scatter (details not captured)

Appendix 5-2: A list of shipwrecks that may occur within or close to the study area

SHIPWRECKS WITH VERY HIGH LIKELIHOOD OF BEING WITHIN THE IMPACT ZONE

These are wrecks that have reliable information regarding their locations. Two of them are younger than 60 years and are therefore not protected by the NHRA.

Record #	Ship Name	Date Lost	Nation
1	*Hamille Mitchell*	1844-12-08	Britain
Ship Type		Build Material	Tonnage
Brig		Wood	167
Location		Certainty	Casualties
Either Wreck Point or Soco Reef		Low	2
Details of Wrecking			
"*Hamilla Mitchell*, from Antigua to Ichaboe, 8th Sept., lat. 30, long. 43," (Glasgow Courier 1844-11-16) "Ichaboe. - The following is an extract of a letter received by Messrs. Sinclair & Boyd, Belfast, from Captain Mackay, of the brig *Emulous*:-"Ichaboe, Monday, 2d December, 1844. - On Saturday evening, the Captain, mate, and eight of the crew of the British brig *Amelia Mitchell*, came alongside in the long-boat, having been cast away about Cape Voltas, in a very exhausted state, so much so, that when I threw them a rope, they were not able to hold it. I immediately sent my boat to their assistance. There are at present about four hundred and sixty sail of shipping lying here, many of then having received great damage; some with masts gone, others sunk and cut down to the water's edge in consequence of the waves, or rollers, as they are called, being so very destructive. When I was coming into the anchorage, the shipping looked like a large forest of trees. I had nearly forgotten to mention, that there was one man drowned, and one died, when the *Amelia Mitchell* was lost." - Whig." (Newry Telegraph 1845-01-30) "On the 8th instant, at 5, p. m. observed a brig, called the *Hamille Mitchell*, on shore on a reef about two leagues to the south of Cape Voltas , her masts and yards all standing, and all sails loose. The crew were all saved, with the exception of one boy drowned in crossing the Orange River." (Cape of Good Hope Almanac 1846) "The 175-ton British brig HAMILLA MITCHELL, was reported aground on a reef two leagues [5.556 km] south of Cape Voltas, south of Oranjemund. All the crew were saved except one boy, who was drowned crossing the Orange River." (Levine 1989)			

Record #	Ship Name	Date Lost	Nation
2	*Trident*	1985-11-25	RSA
Ship Type		Build Material	Tonnage
Fishing			391
Location		Certainty	Casualties
Homewood Harbour		Low	Unknown
Details of Wrecking			
"The 391-ton fishing vessel TRIDENT was lost on the fishing grounds off South Africa at 28 48 S, 16 34 E." (Levine 1989) Except these coordinates are not at sea but rather close to shore.			

Record #	Ship Name	Date Lost	Nation
3	*Kien Chang No. 6*	1997-06-02	Taiwan
Ship Type		Build Material	Tonnage
Trawler		Steel	500
Location		Certainty	Casualties
5.27 km south of Wreck Point		High	0
Details of Wrecking			

There was a fire on the bridge and the crew beached the vessel. Repeated attempts to refloat the vessel failed. Fuel and salvageable items were removed.

"The Department of Transport has instructed that more than 60 tonnes of oil from the Taiwanese fishing trawler, which ran aground on a sandbar in a guarded diamond barrier area at Alexander Bay, be drained off immediately. A spokesman for the department's marine division in Saldanha yesterday denied that the oil posed a pollution risk and said it was simply to make the trawler lighter to facilitate its towing. The harbour master in Port Nolloth, Mr. Don Bridge, however, added that the oil could indeed create a danger in the long run if it is not possible to succeed in removing the trawler.

Pentow Marine withdrew its salvage vessel the day before yesterday after repeated attempts to rescue the stranded trawler Kein Chang no. 6 from the sandbar where he has been sitting since last Monday, failed.

The fact that it is currently deadlock contributed to the failure of the project, Mr. Godfrey Needham of Pentow Marine said. He would not comment on the cost of the nearly week-long operation or who settled the bill.

The 500-ton trawler with 26 crew members ran aground last Monday after being damaged by a fire on board. The fire broke out on the trawler on 27 May only a few days after it left Cape Town. A work team from Cape Diving was sent to the scene by Shepstone & Wylie in Durban to transfer the oil into tanks, Mr. Shane Dwyer, senior partner of Shepstone and Wylie, said. The approximately 200 tons of frozen fish can also possibly be removed from the ship to make it lighter. Renewed efforts to tow the trawler from the sandbar may be made by June 20, if it is spring tide again, Dwyer said. Shepstone & Wylie agents were appointed by the trawler's insurance company, United Kingdom Mutual Protection and Indemnity Association in London, to act on their behalf." (Die Burger 1997-06-13 in van den Bosch 2022, Afrikaans article translated by Google Translate)

SHIPWRECKS WITH HIGH LIKELIHOOD OF BEING WITHIN THE IMPACT ZONE

These are wrecks that are reported as outside the area of consideration or their location data are unreliable.

Record #	Ship Name	Date Lost	Nation
4	*Bristolian*	1844-05-26	Britain
Ship Type		Build Material	Tonnage
Brig		Wood	
Location		Certainty	Casualties
Cape Voltas		Low	0
Details of Wrecking			

Although I have placed this wreck at Cape Voltas because the historical newspaper reports it as the location, I believe it may be further north. This is based on the distance the captain believed he was from Ichaboe (100 miles), as well as the speed with which they reached Possession Island (1,5 days). However, there are no tall mountains further north, ergo the wreck may be south of Cape Voltas.

"St. Helena, July [12] - The *Bristolian*, of Bristol, was lost near Cape Voltas, West Coast of Africa, previous to 28th ult. - crew saved and arrived at Ichaboe." (Northern Whig 1844-09-12)

"The *Achilles*, arrived here from Angra Pequina, had on board the crew of the *Bristolian*, wrecked 80 miles to the

southward." (Evening Mail 1844-09-16)

"Ichaboe, July 4 - The *Achilles*, arrived here from Angra Pequena, has on board the crew of the *Bristolian*, wrecked 30 miles to the southward." (Morning Herald - London 1844-09-16)

"Wreck of the "*Bristolian*."

In our Journal of the 14th instant we briefly announced the loss of this vessel. The *Bristolian* belonged to this port, which she left on the 27th of March, under the command of Captain Cooke, making a rapid voyage up to the time when she was wrecked, within a short distance of her destination. The wreck took place on the 26th May, and the unfortunate crew were on a wild part of the African coast until the 24th June. Captain Cooke kept a daily log, from which we extract the most important portions, believing they will be of much interest, not only as exhibiting the courage and perseverance of British seamen in dangerous and novel situations but affording some particulars of a coast now extensively visited by our shipping:-

Sunday, May 26th, 1844. - Noon: fresh breezes and thick foggy weather, the same we had experienced for several days, the fog was so dense we were unable to obtain any sights. We considered ourselves at this time in lat. 28, S and long. 14 10 East. At 4 p.m. heard breakers a-head, put the helm down, but the ship missed stays; tried to wear her, but in doing so run among the breakers and struck, the first sea hove the ship upon the rocks and dashed the quarter boat to pieces, we, at the time, supposing it to be an outer reef. At 4, 15 p.m, tremendous seas running, driving the ship among the rocks; saw the main land, but no possibility of escape, until her keel hung and her bows swung round upon a rock, the sea now making heavy breaches over the fore and aft. We immediately cut away the spars, and launched one of them over the bows; sent one hand down the spar with a rope, but he was immediately washed off, and with great difficulty obtained the rocks; he then made fast the rope to a rock, by which, after considerable effort, some got on shore; the remainder we hauled on shore in bowling knots through the breakers. In five minutes after I landed the sea drove the ship broadside on the rocks, swept the decks, and stove in her larboard broadside, she having fallen deck out to the sea, washing the long boat, and a quantity of bread and water puncheons on shore. At 5 30 p.m. dark foggy weather, dense and thick like rain, and extremely cold, picked up the long-boat's covering, and rigged a tent in the best way we could, and passed a wretched night on the sand in our wet clothes.

Monday, 27th. - At daylight found the beach strewed with pieces of the wreck for miles; found a puncheon of bread and two puncheons of water, partly damaged. This was indeed a great blessing, otherwise we must have perished surrounded with nothing but sand-hills, the weather continuing very thick, not able to dry our clothes, or procure any fire; gathering all the clothes we could find along the beach and also a few pieces of beef and pork that were washed ashore. Discovered several tracks of wild beasts.

Tuesday, 28th. - Weather more moderate; visited the wreck, it being low water, the ship nearly dry upon the rocks; found all her larboard side and decks completely gone, and most of the things washed out of her; found a keg of powder, all wet; dried a little, with which we procured a fire and dried our clothes. In the night we saw several large animals on the beach. Got the long-boat in the sand to endeavour to repair her, she being bilged in several places, and part of her keel gone, so that should the sea go down, by the blessing of God, we may be enabled to leave this place in her; if not, our only alternative will be to walk to Angra Pequina, or Ichaboe, which we suppose to be about one hundred miles distant.

Wednesday, 29th. - This day we visited the wreck, and found a barrel of flour and several useful articles for repairing the boat, and a compass; put several pieces in the boat's bottom, and repaired her keel; during the night saw several animals along the beach, some very large; kept up a fire to keep them away; found a spaniel dog we had on board to be very useful to us at night in keeping watch. Thurday, 30th. - Finished repairing the boat and got her along the beach, with planks and rollers, for a distance of half a mile, to a spot where we hope to be able to get her off as soon as the surf shall decrease; got some small casks and filled them with water and rolled them up to the boat, in readiness to put into her. Saved two top-gallant studding-sails from the wreck for boat's sails. Throughout the night the animals continued to come close to the tent; increased our fire to keep them away.

Monday, June 3. - Thick foggy weather, with a fresh breeze from the N.W.; the surf more moderate. At noon got the boat as near as possible to the sea, in readiness to launch her at high water. At 3 p.m., the tide rising, made every exertion to launch her, but heavy rollers coming suddenly in baffled all our attempts to do so; the first heavy roller striking her, drove her broadside on the beach and filled her with water, which deprived us of many useful things and left us in a much worse state than we were before we attempted it, having destroyed our bread and wetted everything in her, which caused us to spend another wretched night in our wet clothes. Got the boat back again on the beach without damage.

Tuesday, June 4. - Fresh breeze from the southward, and thick gloomy weather. Prepared the boat for another start, putting less bread and water in her than before. At 4 p.m., tide rising, made another attempt to launch the boat, but heavy rollers coming in prevented us from doing so; took out our provisions from the boat, and hauled her up the beach, clear of the surf, and rebuilt our tent, having found one of the topsails washed on shore.

Wednesday, June 5. - Passed a most miserable night, being very cold and wet. At daylight strong northerly breeze with a tremendous surf and dark thick weather. Found it impossible to launch the boat this day. Took a long walk into the interior of the country, in the direction of the Nameequaio's village, as laid down in the chart; saw several snakes and rats, and the bones of some very large animals, but no sign of inhabitants.

Thursday, June 6. - Dense thick fog, like rain; daylight northerly winds and thick weather, with a very high surf. Found it impossible to attempt to get the boat off this day. At eleven a.m. took a long walk in a northerly direction towards a

high mountain, which we ascended; discovered several large caves and skeletons of large beasts outside; came along the beach on our return, and found a barrel of pork nearly buried in the sand, about three miles from our tent; brought as much as we possibly could with us.

Monday, June 10. - Midnight: the surf still the same and thick wet weather. Daylight: the surf more moderate prepared the boat for another start, but the sea coming in more violent, abandoned it this day. We find ourselves getting more miserably situated every day, having nothing but bare boards to lie upon at night, and our provisions getting very small, thought it prudent to prepare to walk to Angra Pequina; and if we should not find any vessels there to walk on to Ichaboe, which we anticipate a very difficult task, having nothing but quick-sands and sand-hills to encounter. At 4 p.m. a very high surf; the sea coming in suddenly nearly washed us out of our tent. Removed further back behind a sand-hill.

Tuesday, June 11. - Midnight: wind off the land with an increasing surf. Find it quite impossible to launch the boat as yet, but we hope to have one more chance to do so before we attempt to walk. Noon: fine warm weather; the only warm day we have had since we have been here. Sunday, June 16. - Midnight: strong winds from the south-west. Daylight: increasing winds. Ascertained that we are to the south of the Namerquay village, about fifteen to twenty miles, and not knowing what treatment we may receive from them, thought it prudent to abandon walking to day. Went several miles along the beach to try if we could see anything of them, but without effect.

Monday, June 17. - Midnight: blowing very hard from the south-west. Daylight: still the same weather, with a very high surf. We intend to wait a day or two to see if we can launch the boat before we venture among those people. Friday, June 21. - Midnight: light winds and fine weather with a high surf. Daylight: rather low surf; got the boat down the beach close to the breakers, in readiness to launch her. At 10 a.m. sent two men and a boy in the boat to haul on the line as the rest launched her, and at last succeeded in getting her off, although with great difficulty and danger. The first breaker made a fair breach over her and nearly capsized her, which would have been the case had it not been for the line which, thank God! Saved us, and we hauled her out safely; rigged her with two top-gallant studding sail booms for masts, two top-gallant studding sails for fore and main sails; and proceeded on towards Ichaboe. It was a great blessing that we launched her this day, as our water and provisions could not have lasted us more than two days.

Saturday, June 22. - Midnight: fine and clear, running along the land. Daylight: light winds and fine weather. Noon: passed Albatross rock, with Possession island in sight. At 4 p.m. a windy appearance, and having no ballast in the boat thought it prudent to run under the lee of the island for the night, and came to anchor in two fathoms water, in a snug little bay close in.

Sunday, June 23. - At daylight got under weigh from Possession island and stood toward Angra Pequina. Noon: light winds and hazy weather; pulled towards Pedestal Point. At sun-set saw two vessels lying under Seal island came to anchor under Pedestal Point for the night.

Monday, June 24. - At daybreak got under weigh and pulled towards the shipping. At 11 30 came alongside the barque *Achilles*, of London, Capt. Nicholas, and were treated with great kindness by him, and also by Captain Day of the brig *Wellington*, of Bideford; who divided the crew among them, taking seven in the brig, and the other six remained on board the *Achilles*." (Bristol Mercury 1844-09-28)

Record #	Ship Name	Date Lost	Nation
5	*Eliza Ann*	1846-01-12	Britain
Ship Type		Build Material	Tonnage
Cutter		Wood	
Location		Certainty	Casualties
Orange River		Medium	
Details of Wrecking			
"The cutter, *Eliza Ann*, was wrecked near Orange River 12th ult.; crew saved" (Caledonian Mercury) "The ELIZA ANN was wrecked near the Orange River." (Levine 1989)			

Record #	Ship Name	Date Lost	Nation
6	*Shrimp*	1854-06	Britain
Ship Type		Build Material	Tonnage
Schooner		Wood	45
Location		Certainty	Casualties
Alexander Bay		Medium	0

Details of Wrecking

"Cape of Good Hope - June 23: By a cutter, which arrived in Table Bay the 12th, a report was received of the loss of the *Shrimp*, Mr. J.O. Smith's schooner, with a cargo of copper, in Alexander Bay. The report was received at Hondeklip Bay just previous to the departure of the cutter which brings the intelligence. Beyond this nothing certain has been received on the subject.

The *Diving Bell*, in the employ of the S.A. Mining Company, arrived from Alexander Bay, after a passage of 55 hours, on Monday morning. She confirms the abovementioned report of the loss of the *Shrimp*, which, however, had no copper on board at the time, as she dragged her anchors and went on shore the night she arrived. She was a total wreck, and has been sold." (Shipping and Mercantile Gazette 1854-08-04)

"Cape Town, (C.G.Hope), 23rd June. The *Shrimp*, parted her anchors, drove on shore in Alexander Bay, and was wrecked, previous to 12th June." (Lloyds List 1854-08-05)

"*Shrimp*, schooner, was wrecked in Alexander Bay (Cape of Good Hope) previous to the 12th June. - 4" (Shipping and Mercantile Gazette 1854-09-05)

Record #	Ship Name	Date Lost	Nation
7	*Stranger*	1878-08-26	Britain
Ship Type		Build Material	Tonnage
Barque		Wood	288
Location		Certainty	Casualties
Abandoned off Cape Voltas, 40 miles NWW of Port Nolloth		Low	0

Details of Wrecking

"A telegram from Lloyd's agent at Madeira, dated 30th Sept., reports that the British barque Stranger, Captain Bindon, from London to Port Nolloth, laden with coal and a general cargo, has been burnt at sea. The crew took to the boats and landed at Port Nolloth on 27th August. The fire was caused by spontaneous combustion." (Greenock Telegraph and Clyde Shipping Gazette 1878-10-01)

"The Loss of the Stranger

The following is the judgement of the Court of Inquiry, held at East London, into the circumstances attending the loss of the Stranger, burnt at sea. The Court consisted of J.W.H. Roussouw, Esq., Acting Resident Magistrate, and D. Day, Staff Commander, R.N., Nautical Assessor.

It appears that the barque Stranger left London on the 11th June last, bound to Port Nolloth, with a cargo consisting principally of coal and oil (with other things) amidships on the coal. Light winds were generally experienced until Aug. 5, when she had reached about 30 S. and 20 W., when she experienced strong head winds, and knocked about a good deal. On the 7th oil was pumped up, indicating that some of the casks had broken. On the 18th the ship had reached 32 S. and 5 E., and smoke first appeared coming up from the forecastle hatch. This grew worse as the ship proceeded on her voyage, until the 26th, when flames burst out, and the ship was abandoned 40 miles N.W. by W. from Port Nolloth. The Court concurs in the opinion of the Master, as corroborated by the witnesses, that the fire arose from spontaneous combustion; and is further of opinion that the Master did not display judgement or energy to ascertain the locality and to suppress the smouldering, but it is also of opinion that he acted to the best of his judgement and ability, and that prosecuting his voyage as he did, when the smoke first appeared, was the best course then open to him, and therefore returns him his certificate. The Mate's certificate is returned, but the Court is of opinion that he, an old Master, failed to give judicious counsel under the critical circumstances." (Shipping and

Mercantile Gazette 1878-11-04)

"The 288-ton barque STRANGER, Captain Bendon was bound from London for Port Nolloth with a general cargo. She caught fire and was abandoned at sea on 27 August 1878. Captain and crew arrived in Port Nolloth two days later." (Levine 1989)

SHIPWRECKS WITH MEDIUM LIKELIHOOD OF BEING WITHIN THE IMPACT ZONE

Record #	Ship Name	Date Lost	Nation
8	*Jessie Smith*	1853-08-23	Britain
Ship Type		Build Material	Tonnage
Brig		Wood	226
Location		Certainty	Casualties
Alexander Bay		Medium	4

Details of Wrecking

"(From the Graham's Town Journal, Sept. 17.) Information has reached town this morning of the loss of the *Jessie Smith*, the property of Mr. J.O. Smith, of Port Elizabeth, one of the finest vessels employed in the trade of this colony. Our readers will probably be aware that this vessel left Port Elizabeth some weeks ago for the west coast, having the owner on board as passenger and some labouring men, in addition to the crew. It appears that she made the mouth of the Orange River about the 20th inst., and came to anchor in a small indentation called Alexander's Bay, on the 22d. The next day a tremendous swell set in without wind, and in a short time three of the men were washed overboard by the enormous rollers and drowned. Another was thrown on the rocks, and so severely bruised that he died from the injuries received. The vessel was speedily driven on the coast, where she soon became a total wreck. The owner, Mr. Smith, had a narrow escape - his preservation, under Providence, being attributed to his having provided himself with a life-preserver, by means of which he reached the beach, at the expense of a few bruises, having afterwards to travel on foot, in his dripping-wet clothes, a distance of 15 miles in search of assistance. The vessel, it is understood, is insured but the cargo is a total loss." (Morning Herald London 1853-10-26)

"The 226-ton British brig JESSIE SMITH, Captain W. Baxter, was engaged in the copper trade from the Namaqualand coast and ores mined in the Richtersveld. Driven from her anchorage in Alexander Bay by a storm she became a total wreck. Four men were drowned, but the owner, captain and part of the crew reached shore with 'great difficulty'." (Levine 1989).

“The graves of two shipwreck victims are situated alongside a long, shallow trench, very close to the rocky shoreline, about 1 kilometre south of the Alexander Bay Harbour. The two graves are covered with large slabs of mudstone and shale (Figure 1 and Figure 2). Some skeletal remains have already eroded from one of the graves. No grave goods, or shipwreck material was found. The sites are very visible and the surrounding area is severely disturbed and degraded. According to Mr Jonathan Sharfman (pers. comm.), maritime archaeologist at the South African Heritage Resources Agency (SAHRA), it is unclear which historical shipwrecks occur in the Alexander Bay area. According to a mining contractor historical shipwreck material, including brass items, glass and porcelain, has been recovered from the rocks near the harbour at Alexander Bay.” (Kaplan 2008)

The location of these graves, as well as the historical reports solidifies that the wreck is in Alexander Bay.



Figure 1: Shipwreck Graves (Kaplan 2008)



Figure 2: Shipwreck Graves(Kaplan 2008)

SHIPWRECKS WITH LOW LIKELIHOOD OF BEING WITHIN THE IMPACT ZONE

9	*Abberkerk*	Wrecked		1779	Wrecked between Cape and Holland. Voyage 8033.2	Off South Africa
10	*Admiral Collingwood*	Foundered	Britain	1858	This 360-ton barque under Captain Smith was bound from London for Algoa Bay when she apparently foundered 320km off St Helena Bay. (Levine 1989) This may put her in the West Coast area.	West Coast
11	*Aegeus*	Torpedoed, sank	Greece	1842	This 3 792-ton steamship left Trinidad for Saldanha Bay and then Durban. She never arrived. After WWII, German records indicated that she was torpedoed by the U-177 at 32° 30´ s 16° 00´ E. (Levine 1989; van den Bosch 2009) These co-ordinates are just west of the area and is where the U-boat reports torpedoing the vessel, not necessarily where she sank. In addition, the co-ordinates mentioned are subject to the technical limitations of the period.	West Coast
12	*Alblass Edwaard*	Fire and abandoned		1881	Caught fire and abandoned on 28-11-1881.	Off South Africa
13	*Australia*	Fire, sank	Britain?	1840	This 250-ton brig, under Capt. A. Yule was built in Dundee, Scotland in 1839. She was on her maiden voyage to Australia with passengers and cargo when the vessel caught fire and sank, apparently 9.6 nautical miles (NM), north of the Olifants River Mouth. However, she was 800 km west of the Cape of Good Hope when the fire broke out. The twenty-eight passengers and crew entered the lifeboats shortly before she was overwhelmed by the flames. A boy died at sea and a man died after they made land at Olifants River after nine days at sea. Farmers helped the survivors to reach Cape Town. (van den Bosch 2009) Ergo this vessel could be in the concession area.	West Coast
14	*Berea*	Disappeared		1933	This steam whaler disappeared after leaving Table Bay.	West Coast?
15	*British Monarch*	Fire, abandoned	Britain	1889	The 1262-ton iron barque under Captain Morrow was on a voyage from Hamburg to Sydney with a general cargo. She was abandoned at 37°58´ S 05°20´ E. The crew took to the boats and stayed with the burning vessel until she exploded and sank. One of the boats with six crew aboard disappeared. Two days later some of the surviving crew were picked up by an American whaler, the *Canton*. The whaler took them to within 50km of Cape Town, where apparently, they were reloaded into their boats and had to make their own way to Cape Town. Their entire ordeal lasted 18 days. (Levine 1989; van den Bosch 2009) This vessel is left in the database as the co-ordinates are not necessarily very accurate	West Coast

					and by staying with the burning vessel, drift needs to be taken into account.	
16-19	*Cabral Fleet*	Lost	Portugal	1500	Levine (1989) states: "Thirteen vessels under command of Pedro Alvares Cabral – the first Portuguese fleet which sailed annually to the Indies – and found Brazil. Twenty days after the fleet sailed from Brazil, it was struck by storms and four ships, including the one under command of Bartolomeu Dias, foundered. Duffy [Shipwrecks and Empire, 1955] writes that the ships were lost off the Cape of Good Hope, but, according to Axelson [Levine cites personal correspondence], the fleet could not have been off the Cape of Good Hope then; they would have been in the vicinity of the shortly-to-be-discovered islands of Tristao da Cunha." There is such scant and contradictory information regarding the loss of these four vessels that I am including them in this database.	Disappeared
20	*Catterina D.*	Fire, abandoned	Austria	1887	This 610-ton barque from Liverpool for Cape Town with a cargo of coal caught fire. She was apparently abandoned before she sank, 480km west of Hottentot Point. The Captain and crew reached Walvis Bay in the lifeboats. (Levine 1989) As she was abandoned before she sank, this vessel is included in the database.	West Coast
21	*Chios Merchant*	Leaking, sank	Greek	1982	It was leaking but under control when the leak worsened dramatically. After sending out an SOS, the crew abandoned the vessel in a sinking condition at 520.9 NM west of the Orange River Mouth. (van den Bosch 2009) It may have drifted quite far from its original reported position.	Approximately 520.9 NM west of the Orange River Mouth
22	*Columbine*	Torpedoed, sank	South Africa	1944	This 3 268-ton steamship owned by the South African government was initially a German vessel. She was seized at the start of WWII. On 16 June 1944, she had 52 people on board when she was torpedoed by the U-198. 23 people died when their lifeboat capsized, including two naval officer wives. The co-ordinates for her torpedoing are 32º 44´ S and 17º 22´ E. (Levine 1989; van den Bosch 2009) These co-ordinates are in the southern end of the SASA and is where the U-boat reports torpedoing the vessel, not necessarily where she sank. In addition, the co-ordinates mentioned are subject to the technical limitations of the period.	West Coast
23	*Discovery*	Disappeared	Britain	1644	Lost between India and Britain	Disappeared
24	*Earl of Abergavenny*	Disappeared	Britain	1805	This English East Indiaman, under Captain J. Wordsworth was lost "off the Cape Coast" (van den Bosch 2009).	Disappeared off Cape Coast
25	*Elizabeth Jane*	Unknown		1834	This vessel seems to be a whaler that operated in Tasmania and the southern oceans. Although I can find no further information on her status at this time, I have left her in the database.	Unknown

26	*Ellen*	Capsized		1915	Capsized by a wave. None of the databases list a location. However, the West Coast was a prime fishing spot so it is left in the database.	Unknown
27	*Juno*	Fire, abandoned	Sweden	1885	The 1274-ton schooner, under Captain T. Keyller was bound from Norway for Melbourne with a cargo of deals (timber). She caught fire and was abandoned at approximately 37 24.00S,11 30.00E. the 22-man crew took to the lifeboats and set off towards the Cape. The currents washed them towards the Orange River. They attempted to beach the lifeboat 32km south of the river but capsized and there were only four survivors. These four were picked up by the *Namaqua* and taken to Cape Town. (Levine 1989; van den Bosch 2009). It follows that if the current brought the lifeboat towards the Orange River, that the same principle could apply to the abandoned schooner.	Abandoned
28	*Florence Barclay*	Fire, abandoned	Britain	1872	This 243-ton barque was built in 1866. Under Captain J.H. Voller, she was bound from Hull for Table Bay and Mauritius. Somewhere off the west coast, the vessel caught fire and was abandoned. The crew were in three lifeboats, one of which disappeared during the first night at sea. The other two boats arrived at Pomona Island (Namibia) three days later. The survivors were taken to Table Bay by the *Lilla.* (Levine 1989) As the crew beached only 120km north of the concession areas, I have included this vessel.	West Coast
29	*Glenogle*	Fire, abandoned	Britain	1901	According to van den Bosch (2009), this 914-ton steel barque caught fire and was abandoned at 34 38.00S,03 40.00E. The Equatorial current which runs west to east here could have pulled the abandoned vessel into the Benguela current and up the west coast.	Abandoned
30	*Good Hope*	Fire, sank	Cape?	1863	I have very little information on this wreck. Only that she was a Cape trader and burned at sea. (van den Bosch 2009)	Burnt at sea
31	*Haab*	Abandoned	Norway	1897	This 861-ton wooden barque was according to Levine (1989) grounded on Dassen Island. However, according to van den Bosch (2009), she was abandoned 260.5 NM off Table Bay and may be off Dassen Island. The problem with this assumption, is that Dassen Island is only c. 35 NM from Table Bay (i.e the Port). 260.5 NM means that the vessel was abandoned in the SASA, near concession 4B.	Co-ordinates worked out on 260.5 NM, however this is an **approximation** 29° 48.222'S 16° 45.125'E **
32	*Hartfield*	Fire, sank	Britain	1895	According to van den Bosch (2009) and Levine (1989), this 852-ton iron barque caught fire at 34 30.00S,11 30.00E, 259 NM west of Table Bay.	West Coast

					The Equatorial current which runs west to east here could have pulled the abandoned vessel into the Benguela current and up the west coast.	
33	*Honcoop / Hencoop*		Netherlands / Britain	c.1796	This vessel was taken from the Dutch by the British at The Battle of Saldanha (1871), she was being sailed at a prize back to England when she disappeared (The London Gazette: 1796)	Disappeared
34	*Hope*			1836	Possibly lost on the West Coast	West Coast?
35	*India*	Abandoned	Sweden	1881	Abandoned at 7° E. Could be on the West Coast.	West Coast?
36	*Joachim*	Fire, abandoned	German	1868	Apparently the 763-ton barque under Captain Helenmeyer was on a voyage from Bremen to Rangoon with a cargo of coal. When she "burnt off the Cape". Her crew were rescued by the American vessel, *China* and brought to Cape Town (Levine 1989).	Off the Cape
37	*Kalewa*	Collision, sank	Britain	1942	This 4389-ton steamship collided with the *Boringa*. Hocking's (1969) co-ordinates are 30° 16´ S 13° 38´ E; van den Bosch's (2009) co-ordinates are 30 14.00S,12 50.00E. As this position is near the SASA, and due to the inaccuracy of geographic positioning in the middle of the 20th century, I have included this vessel in the database.	Approximately: 30° 16´ S 13° 38´ E **or** 30 14.00S,12 50.00E**
38	*Laporte / La Porte*		London	1904	This 2448-ton steamer belonging to the Colorado Steamship Company, was built in 1902 at the Grangemouth & Greenock Dockyard Company. Under Captain H.J. Hill, she was on a voyage from Cardiff for Cape Town with coal when she foundered in a north-westerly gale. The surviving crew report that she was approximately 160km from shore and 80km north of Port Nolloth. Of the 23 crew, only 12 made it to Port Nolloth in a lifeboat. (Levine 1989). According to van den Bosch (2009), the vessel suffered an explosion 43.2 NM north of Port Nolloth and 100m from shore. According to the Miramar Ship Index (2009), she sank 50 NM west of Port Nolloth. As can be seen, although the available information is contradictory, Position 2 falls near 1A and 1B. Position 1 and 3 fall far beyond the Mining Right areas.	All **approximations** Position 1: 28° 35.691'S 14° 48.532'E **Position 2:** **28° 37.133'S 16° 24.555'E** Position 3: 29° 17.078'S 15° 55.764'E**
39	*Leonine Mary*	Disappeared	Cape	1859	This Cape coaster disappeared somewhere off the Cape coast.	Cape Coast
40	*Luba / Luban*	Fire, abandoned	Cape	1864	This barque was on her way from Leith for Cape Town with a cargo of coal and coal tar when she caught fire and sank 86.3 NM off Table Bay. Her crew were rescued. (Levine 1989; van den Bosch 2009)	West Coast

					This puts the wreck in the SASA.	
41	*Mariner*	Leaking, abandoned	Britain?	1826	This vessel was having a hard time of it, the month before she was abandoned, she lost her topmasts and a man was swept overboard. Two weeks later she lost her rudder and started leaking. Despite pumping the water from her holds continuously, the water continued to rise. When it was over a metre deep, the vessel hoisted a distress signal. The *Harriet* came to their rescue and the vessel was abandoned in "the latitude of the Cape of Good Hope". The crew were landed in Mauritius. (Levine 1989) As the vessel was abandoned near the Cape Peninsula, it could have drifted north on the currents into the SASA.	Abandoned
42	*Mary*	Disappeared	Britain	1870	Under Captain Anderson, this vessel left Simon's Bay for Falmouth and disappeared. (Levine 1989) As the intended route goes up the west coast, I have included this vessel.	Disappeared
43	*Mistress of the Seas*	Fire, lost	?	1869	Built in 1863, this 1241-ton ship, on a voyage from India to Havre with a cargo of cotton, was reported as "lost by fire off the Cape". (Levine 1989). However, an entry in Record of Canadian Shipping (Wallace 1929: 191), "...ship, 1241 tons, 190.0 x 38.0 x 24.0 Built 1863, Miramichi, N.B. Sold Greenock. Foundered Indian Ocean, 1870, ten drowned." This vessel could be anywhere off the Cape Coast. More probably the southern Cape coast.	Off the Cape
44	*Mona*	Fire, abandoned	Britain	1887	The 1045-ton barque under Captain Pearson was on a voyage from Grimsby to Durban with coal when she caught fire at 27° 14´ S 24° 55´ W. The following day the crew took to the lifeboats. After a week, the crew were picked up by the German barque, *Livingstone* and landed at Mossel Bay. (Levine 1989) The current was clearly pushing the survivors towards the Cape coast and, so it follows that their vessel, abandoned before sinking, may also have been pulled by the currents towards the west coast.	Abandoned
45	*Nortun*	Torpedoed	Panama	1943	This 3 663-ton ship was bound from Table Bay to Bahia when she was torpedoed and sunk by the U-516 about 130km south-west of Lüderitz at 28° 00´ S 14° 55´ E. (Levine 1989; van den Bosch 2009). These co-ordinates are just north of the SASA and is where the U-boat reports torpedoing the vessel, not necessarily where she sank. In addition, the co-ordinates mentioned are subject to the technical limitations of the period.	**Approximately:** 28° 00´ S 14° 55´ E.**
46	*Oliver Cromwell*	Fire, abandoned	Britain	1874	This vessel, on a voyage from Newcastle to Aden with a cargo of coal, caught fire. The crew were rescued by the barque *Saxon* and brought to Table Bay. (Levine 1989).	Abandoned

					There is very little information on this vessel, so she is included in the database.	
47	*Orissa*	Fire, abandoned	Britain	1869	This 634-ton, three-masted, wooden ship was built in 1862. Under Captain R. Adams, bound for Mauritius with a cargo of coal, she caught fire and was abandoned 343.2 NM west of Table Bay. (Levine 1989; van den Bosch 2009). The Equatorial current which runs west to east here could have pulled the abandoned vessel into the Benguela current and up the west coast.	Abandoned
48	*Oswin*	Leaking, abandoned	Britain	1819	According to Captain Ray, the commander of the vessel, the ship had sprung a leak in the vicinity of Cape Agulhas and while the pumps were working 24 hours a day, they were unable to make any headway on the leak. By the next day, there was 1.5m of water in the hold and this was increasing. The crew launched the longboat and filled her with supplies. "Embarking in the boat the commander and crew steered for Saint Helena, and were from the 31st Jan. to the 12th Feb. exposed to great sufferings and anxiety, until they reached Saint Helena. During this time they ran about 1400 miles and were particularly fortunate in making the Island to a mile." (The Asiatic Journal 1820: 388) Depending on whether this newspaper report was using nautical miles or statute miles, makes a difference to the location of the wreck. Statute miles puts the vessel near Lüderitz, nautical miles puts the wreck in the vicinity of the SASA.	West Coast
49	*Prins Wilhelm van Zeeland*		Netherlands	1659?	The only reference to this vessel I could find was the Prins Willem which sank near Madagascar in 1662. However, as it is from a period with few records, I am leaving it in the database for now.	Unknown
50	*Senator*	Abandoned		1859	Crew landed at Table Bay on 23 November 1859 by the Norwegian brig Favourita.	Cape Coast
51	*Typhoon*	Leaking, abandoned	Britain	1860	Built in 1852 by Cannon & sons in Glasgow, this 965-ton ship under Captain J. Brown was bound for India from Liverpool when she was abandoned in a leaking condition, "off the Cape". (Levine 1989; van den Bosch 2009).	Abandoned
52	*U-179*	Depth charges	Germany	1942	U-179 was responsible for torpedoing the British steamship *City of* Athens, about 45km to the south-east on the same day as the U-boat was surprised on the surface by *H.M.S. Active*. As she dived, the British vessel launched depth charges. Van den Bosch (2009) gives her co-ordinates as 33 25.00S,17 10.00E. All hands were lost (61 crew). (Levine 1989; U-boat.net 2017) These co-ordinates are just south of the SASA and is where the vessel reports depth charging the U-boat, not necessarily where she sank. In addition, the co-ordinates mentioned are subject to the technical limitations of the period.	**Approximately**: 33 25.00S,17 10.00E.**

CHAPTER 6

Fisheries and coastal livelihoods

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Fisheries and coastal livelihoods

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Recommended citation: Gammage, L.C., Zeeman Z., Mpala, A., Norton, M., Ortega-Cisnero, K. & Ward, C. (2025). *Chapter 6: Fisheries and coastal livelihoods* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR

Executive Summary

The coastal waters along the Northern Cape support small-scale and nearshore fisheries that remain essential to local livelihoods. Operating predominantly from Port Nolloth, Hondeklipbaai, and Kleinzee, fishers use small vessels or shore-based methods to harvest a diverse range of species. Fishers target linefish (mainly for snoek and Cape seabream), although fishers face increasing pressure from ecological change and regulatory constraints. West coast rock lobster fishery has been another major source of income, with small-scale, nearshore and offshore commercial rights allocated to several of these communities. However, the stock is heavily depleted, and illegal harvesting poses an ongoing threat. Netfishing using gillnets plays a limited role in supporting local food security and household incomes, particularly for multi-activity households. Aquaculture – particularly abalone and kelp farming – has emerged as an important and growing alternative, offering formal employment and entry into value-added markets.

Commercial fisheries operating offshore along the west coast of South Africa such as small pelagic purse seine, demersal trawl, and hake longline sectors, are critical to national seafood production and export. These fisheries target sardine, anchovy, hake, and horse mackerel – many of which rely on the west coast's inshore waters as vital spawning and nursery areas. The stretch of coastline between St Helena Bay and the Orange River is especially important, functioning as the main nursery zone for small pelagic species. Shallow waters north of Port Nolloth are key juvenile habitats for shallow-water hake.

The area surrounding Boegoebaai is not only ecologically significant but also culturally important. It contains ancestral graves, sacred natural features, and culturally significant plants used by Nama communities in traditional practices. These landscapes predate mining activities and are deeply embedded in local oral histories and cultural identity. The area also includes traditional fishing grounds historically used by small-scale fishers, many of whom have lost access due to mining-related restrictions. This convergence of ecological value and cultural heritage highlights the importance of inclusive and careful development planning in the area – ensuring that the foundations of community identity, spiritual practice, and livelihood are not compromised by industrial expansion. Four towns form the primary coastal communities adjacent to the proposed Boegoebaai development: Alexander Bay, Port Nolloth, Kleinzee, and Hondeklipbaai.

- Alexander Bay is a small, formerly prosperous mining town situated on the Orange River near the Namibian border. Historically reliant on diamond extraction through Alexkor, the town has experienced economic decline, deteriorated infrastructure, and limited local employment as mining has scaled down. The area holds deep cultural significance for Nama communities, with ancestral graves and culturally important plants like Buchu (Agathosma spp) found near Boegoebaai. While agriculture and tourism are emerging as alternative livelihoods, opportunities remain scarce, and the town is marked by rising unemployment and social vulnerability. Fishing is not a key livelihood activity, although recreational fishing is popular with the mouth of the Orange River a popular fishing spot among recreational fishers. Key stakeholder interviews revealed that many were positive were positive due to the possibility of improved local employment.

- Port Nolloth is a traditional fishing community with deep intergenerational ties to the sea. Once a hub for copper and diamond exports, it now supports several rights holders which include Hake longline, Hake handline, Hake deep-sea trawl, netfish, small pelagics, linefish, west coast rock lobster (WCRL) nearshore, WCRL commercial, and a fish processing facility. The Aukotowa small-scale cooperative was established in 2018 and hold small-scale fishing rights (primarily targeting Snoek and Cape Bream), as well as commercial rights for WCRL and offshore hake offshore although they do not have the capacity to utilise these offshore rights. These small-scale fishers traditionally use bakkies and operate close to shore. Access to traditional fishing grounds in the area has become increasingly restricted due to marine mining activity, while high fuel costs, stock depletion, and limited infrastructure (i.e., only one jetty remains operational) pose additional challenges. Persistent water shortages have further weakened the town's tourism potential and broader development prospects. Interviews with key stakeholders has revealed that business owners have a positive attitude towards the proposed development as they see the value for job creation,

although the fishing cooperative take a negative view due to impacts related to ocean squeeze due to reduced areas of operation and potential negative impacts on the local ecosystem.

- **Kleinzee**, a former De Beers mining town, has transitioned toward aquaculture and seasonal tourism. It now hosts abalone and seaweed farming operations that provide formal employment and skills development opportunities. With intact infrastructure and relatively high service delivery, Kleinzee is more stable than neighbouring towns and is seen as a pilot site for marine-based economic diversification and over the past years, aquaculture has been the primary employer in Kleizee. Seasonal tourism, driven by wildflowers, birdwatching, and shipwreck trails, also contributes to the local economy. Recreational fishing has always been a way of life in Kleinzee; however, stakeholder report it has been severely impacted by siltation caused by mining operations. Stakeholder interviews further reveal positive and negative sentiments expressed regarding the proposed development. Tourism stakeholders from Kleinzee are generally positive as they feel this could lead to increased revenue, although some stakeholders expressed concerns about pollution on the coast due to increased vessel traffic.

- **Hondeklipbaai** is a small, traditional fishing village historically linked to copper exports and commercial fishing. Today, its residents depend on small-scale fishing and increasingly on tourism-related activities. The community faces numerous constraints, including declining west coast rock lobster stocks, limited fishing rights, competition from larger fleets, and poor infrastructure – particularly road access, water supply, and sanitation. Nonetheless, fishing remains central to local identity, and tourism is gradually growing through flower season visitors and 4x4 trails. The Longtime Hondeklipbaai Fishing primary cooperative was established in 2018. These fishers primarily use handlines to catch linefish, focusing on species like snoek and Cape seabream, and hoop nets for WCRL. During the snoek season, many fishers from Cape Town come to the area to catch snoek. Additionally, the fishers have the rights to harvest beachcast kelp and live kelp, which they have subcontracted. Stakeholders in Hondeklipbaai, especially the fisheries cooperative take a neutral position on the proposed development due to their distance from Boegoebaai.

Potential Benefits of the Proposed Development:

The Boegoebaai Port and SEZ development presents an important opportunity to stimulate inclusive economic growth and promote strategic investment in the Northern Cape. If designed and implemented with sustainability, equity and local participation at its core, the project could offer a range of environmental, economic and social benefits:

- **Fisheries-linked economic diversification and job creation.** The project could unlock substantial employment and livelihood opportunities directly and indirectly linked to the fisheries sector and beyond (e.g. tourism). Aquaculture operations may also benefit from expanded water access, energy supply, and downstream support services. The diversification of income streams may reduce vulnerability in communities currently reliant on declining or seasonal fisheries and could mitigate some of the negative impacts associated to ocean squeeze.

- **Improved infrastructure for small-scale fisheries and coastal livelihoods.** Upgrades to marine and land-based infrastructure will improve operational efficiency and safety for fishers in towns like Port Nolloth. Improved service delivery could support new or underutilised value chains such as dried fish products, kelp processing and marine tourism. Expanded water supply and electrification may also enable shore-based aquaculture activities and provide opportunities for co-operative-led enterprises to scale up production. Improved harbour infrastructure may reduce post-harvest losses and improve the quality and shelf life of landed catch.

- **Local skills development and capacity building in marine sectors.** Technical training and mentorship programmes offer the potential to build capacity within fishing and coastal communities. This includes upskilling in marine safety, vessel maintenance, post-harvest handling, seafood processing, aquaculture operations, environmental monitoring, and marine stewardship. Targeted training for youth and women may broaden access to previously male-dominated or capital-intensive sectors, supporting inclusive local development. Skills development linked to port and SEZ operations may also enable intergenerational transfer of knowledge and provide pathways into formal marine employment sectors.

- **Strengthening of community-based fisheries governance and co-management.** If implemented inclusively, the development could catalyse improved local governance arrangements, offering a platform to strengthen fisher cooperatives and associations through improved access to finance, business support services, and policy engagement spaces.

- **Support for aquaculture-driven livelihood expansion.** Access to better-quality water, energy, and transport systems could significantly strengthen the viability of coastal aquaculture initiatives, particularly in towns like Kleinzee. Formalised support may enable pilot projects in integrated multi-trophic aquaculture (IMTA), seaweed farming, or small-scale mariculture to grow into sustained livelihood opportunities. Infrastructure could also enable greater value addition through local processing, packaging, and cold storage, increasing income retention within communities.

- **Enhanced fisheries compliance and marine resource protection.** The port may improve the logistical feasibility of deploying patrol vessels and monitoring crews to combat illegal, unreported, and unregulated (IUU) fishing in the northwest of the EEZ. Strengthened surveillance and compliance capacity may benefit both conservation objectives and local fishers, by protecting their resource base from overexploitation and ensuring more equitable access to shared stocks.

- **Foundations for fisheries-linked tourism and heritage economies.** By improving transport, utilities and market access, niche tourism offerings that include local fisheries culture (e.g. seafood festivals, fisher-for-a-day experiences, or heritage boat tours) could be established. Infrastructure upgrades may also allow communities to monetise intangible heritage and cultural assets (e.g. traditional knowledge, coastal landscapes, artisanal crafts), particularly during the flower season.

- **Increased resilience to climate and market shocks.** Diversified income opportunities and improved infrastructure may help coastal communities adapt to environmental and economic volatility. With fisheries increasingly impacted by climate change (e.g. shifting stocks, marine heatwaves) and market pressures (e.g. rising fuel costs), support for improved aquaculture, tourism and seafood value chains together with opportunities to diversity skills beyond fisheries, could enhance household resilience by reducing reliance on any single resource or season.

Potential Negative Impacts of the Proposed Development:

The benefits discussed are contingent on addressing the risks and impacts identified. Key negative impacts identified include:

- **Marine ecosystem degradation.** Construction and operation pose threats to critical marine ecosystems. The development site lies adjacent to key nursery and spawning grounds for commercially important species such as sardines and hake. Disruption of these habitats through dredging, sedimentation, and noise pollution could lead to larval mortality, recruitment failure, and long-term population declines, undermining ecological stability and the viability of west coast fisheries.

- **Ocean squeeze and spatial conflict.** Spatial competition in an already congested marine zone will be intensified. This will negatively impacts already marginalised coastal and small-scale fishers who already face increasing displacement due to overlapping claims from mining, offshore oil and gas, conservation, and industrial shipping activities. Access to traditional fishing areas has already been reduced by mining security restrictions (e.g., fishers are no longer able to trailer vessels to Boegoebaai), and further limitations threaten the sustainability of small-scale livelihoods. Climate change impacts, such as sea-level rise and altered species distributions, exacerbate these pressures.

- **Pollution and habitat disturbance.** Port construction activities, including dredging and increased vessel traffic, are likely to elevate pollution levels and degrade water quality. Sediment resuspension may smother benthic habitats and affect filter-feeding organisms, while hydrocarbon leaks and ballast water discharge may introduce contaminants and invasive species. Underwater noise from heavy machinery and ships could disturb fish behaviour and migration patterns. These impacts may reduce local biodiversity, impair ecosystem functioning, and decrease the availability of fish for both commercial and subsistence fishers.

- **Gentrification and community displacement.** As infrastructure improvements and new employment opportunities attract outside investors and higher-income groups, gentrification pressures on the existing communities will increase. This could risk raising property values and living costs, pricing out long-standing residents, and eroding traditional livelihoods. In towns like Port Nolloth and Alexander Bay, where unemployment is high and services are limited, such shifts could deepen socio-economic inequalities and displace vulnerable populations. Social cohesion may be disrupted, particularly if communities perceive that development benefits are externally captured.

- **Marginalisation of local stakeholders.** Perceptions from local stakeholders are that current governance arrangements and stakeholder engagement processes are dominated by government and private sector interests, with limited inclusion of small-scale fishers, Nama communities, women, and informal resource users. This reproduces a legacy of inadequate consultation linked to previous development efforts in the region, contributing to community frustration and mistrust. Moreover, current frameworks fail to recognise indirect and hidden stakeholders or the complexity of the marine and coastal social-ecological systems, leading to poorly tailored interventions and reduced legitimacy.

- **Cultural heritage loss.** The Boegoebaai area holds deep spiritual and cultural importance for local Nama communities. At least 17 ancestral gravesites and several sacred or historically significant sites, including the ruins of the Rietfontein farmhouse, exist within or near the project footprint. The coastline also includes traditional WCRL fishing grounds and landscapes that form part of oral history and cultural identity. Without proper protection and recognition, these sites risk being disturbed or destroyed by construction and associated industrial activity, severing connections between communities and their heritage.

- **Fragmented impact assessment and governance gaps.** The current approach to environmental and social impact assessment is fragmented, with separate assessments required for individual projects that comprise the development. This siloed approach risks underestimating the cumulative and long-term impacts on fisheries, ecosystems, and coastal communities. Furthermore, regulatory scale mismatches between national frameworks (such as the National Environmental Management Act, the Marine spatial Planning framework and the Marine Living Resources Act) complicate coordination and undermine holistic planning. Without developing an cross-cutting, integrated assessment and governance mechanism for the proposed development, key risks will be overlooked, and mitigation measures rendered ineffective.

Key Recommendations:

The proposed development presents an opportunity to advance South Africa's economic ambition and just energy transition whilst addressing regional social and economic disparities. The following recommendations are made in relation to fisheries and coastal communities:

- **Commission a comprehensive fisheries impact study.** An expanded, independent specialist study should assess the cumulative, cross-sectoral impacts of the proposed development on fisheries – must be commissioned in support of the Environmental and Social Assessment processes related to the various projects undertaken as part of the development. This must include spatial and temporal overlap with oil and gas, marine mining, shipping, and aquaculture, along with ecological, socio-economic and cultural dimensions.

- **Establish a multi-stakeholder marine governance platform.** A formal, cross-sectoral platform that is representative of all stakeholders should be created to facilitate early warning, spatial planning, conflict mediation, and joint decision-making in the area. Special effort should be made to involve historically excluded or hidden stakeholders, especially women, youth, and customary right holders.

- **Design transparent, inclusive and ongoing stakeholder engagement processes.** Stakeholder engagement must shift from extractive consultation to pro-active co-creation where communities are seen as collaborators. This includes early engagement during project scoping, participatory identification of risks, shared oversight of monitoring, and mechanisms for sustained involvement over the life of the development. Engagement should be culturally appropriate, multilingual, and accessible. Grievance mechanisms should be responsive and legally supported.

- **Integrate cumulative impact assessment and regulatory harmonisation.** Current impact assessments are fragmented. The Environmental and Social Assessments must be coordinated with the various marine, coastal and environmental governance frameworks to capture cumulative and transboundary effects. Scale mismatches in governance should be addressed by facilitating regulatory alignment through interdepartmental processes and shared data systems.

- **Invest in skills development and just transition support.** Training and education programmes should be developed in partnership with local institutions to support local community members, including youth and women, to capitalise on the opportunities for diversification of livelihood activities within and beyond the marine sectors. Programmes must be flexible and localised to address educational barriers.

- **Secure affordable housing and basic services for coastal residents.** Gentrification risks linked to inward migration and infrastructure growth should be anticipated. The development of affordable, climate-resilient housing and essential services in the effective towns must be considered in the planning process. Avoiding the displacement of already vulnerable households is essential to social sustainability in the area.

- **Develop an integrated monitoring, evaluation and learning framework.** Develop a participatory monitoring, evaluation and learning framework to track local ecological indicators (e.g. fish stock health, habitat condition, pollution levels) and socio-economic indicators (e.g. income stability, participation in governance, displacement).

- **Prioritise access to benefits for disadvantaged and historically marginalised groups.** Deliberate mechanisms should be built into the SEZ governance structure to ensure that benefits – such as job creation, contracts, or training – are accessible to those with the least existing opportunity. This includes fisherwomen, Indigenous groups, and informal workers. Procurement and hiring policies should favour local co-operatives and small enterprises.

- **Integrate ecosystem-based Marine Spatial Planning.** Marine spatial planning linked to the SEZ should prioritise ecosystem function, fisheries nursery areas, and connectivity. Special attention must be given to ensuring spatial justice by maintaining or restoring access corridors for small-scale fishers and reducing encroachment by incompatible marine industries.

It is crucial to ensure the development's benefits are equitably shared among all stakeholders, fostering resilient and empowered coastal communities. Aligning the Boegoebaai development with South Africa's broader sustainability goals can set a benchmark for future marine and coastal projects if done well.

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Abbreviations and Acronyms

BCLME	Benguela current large marine ecosystem
CSIR	Council for Scientific and Industrial Research
DFFE	Department of Forestry, Fisheries and the Environment
EEZ	Exclusive economic zone
EBSA	Ecologically or Biologically Significant Marine Area
ESIA	Environmental and Social Impact Assessments
GDP	Gross Domestic Product
GIS	Geographic information system
MLRA	Marine Living Resources Act of 1998 (South Africa)
NCEDA	Northern Cape Economic Development Trade and Investment Promotion Agency
NEMA	National Environmental Management Act
NGO	Non-governmental organisation
NPO	Nonprofit organization
NSRI	National Sea Rescue Institute
SANEDI	South African National Energy Development Institute
SEA	Strategic Environmental Assessment
SEZ	Special Economic Zone
SIA	Social Impact Assessment
SP	Sub place
StatsSA	Statistics South Africa
TAC	Total Allowable Catch
TAE	Total Applied Effort
TNPA	Transnet National Ports Authority
PUCL	Precautionary Upper Catch Limit
WCRL	West coast rock lobster

CHAPTER 6. FISHERIES AND COASTAL LIVELIHOODS

6.1 OVERVIEW

Sustainable development planning in South Africa's marine and coastal systems is both complex and critically important due to the convergence of diverse ecological, social, and economic pressures within these vital socio-ecological systems. These biodiverse coastal regions are vital economic zones supporting tourism, fisheries, and other marine industries. The complexity of planning is underscored by complicated the governance framework, which includes 23 international and 26 national legal frameworks, along with 51 associated norms and standards (Taljaard *et al.*, 2019) This complexity often results in uneven application and implementation of regulations, resulting in governance gaps. Addressing the various pressures requires coordinated governance that acknowledges the complexity and scale of interactions within marine social-ecological systems (Sowman and Sunde, 2024).

Scientific research and technological innovation are pivotal in informing sustainable coastal and marine management. Adaptive governance frameworks are essential to address the dynamic nature of these environments through collaborative, system-based approaches involving multiple and diverse stakeholders (e.g. Cvitanovic *et al.*, 2015; Jarre *et al.*, 2018; Stephenson *et al.*, 2021). In South Africa, the Integrated Coastal Management (ICM) Act of 2010 emphasizes sustainable practices tailored to local contexts, promoting community-based models that empower stakeholders in decision-making regarding coastal resources (McCarthy and Thomas, 2017; Rebelo, 2021). Similarly, the Marine Living Resources Act (MLRA) No. 18 of 1998 advocates for equitable marine resource management through the establishment of forums and councils, ensuring sustainability and inclusive participation via co-management frameworks (Cochrane et al., 2015). Although the requirement for transparent and inclusive processes are embedded within South African legislation, government has historically not been able to effectively execute these processes (e.g. (Rivers *et al.*, 2022).

South Africa's Marine Spatial Planning (MSP) Framework reinforces these principles by focusing on co-management and collaboration with local communities. It promotes transparent, inclusive processes to balance economic, social, and ecological objectives for sustainable marine resource management. This framework integrates area-based plans across sectors, agencies, and government levels to achieve diverse management objectives at the ocean-coastal interface. Ecosystem-based MSPs are required to maintain ecosystem services while achieving sustainable development goals (Lombard *et al.*, 2019; DFFE, 2021).

As the country advances toward its sustainable development goals, integrated coastal management is crucial for ensuring the long-term viability of coastal ecosystems and the communities that depend on them (Goble *et al.*, 2014; Malan, 2018). Effective management requires holistic strategies that integrate scientific knowledge, meaningful community participation, and policy alignment to address challenges such as climate change, resource depletion, and socio-economic inequality.

This report focuses on the intersection of fisheries and people. Our impacts and recommendations are centred on mitigating potential negative impacts on people who live in communities adjacent to the proposed development, as well as leveraging potential opportunities that this development may hold for them. This report should be read in conjunction with Annex Report 1 and 2 (see Appendix), as well as the Marine Ecology Expert and Socioeconomic specialist reports for the SEA with the socio-economic report providing detail information on the benefits and potential negative impacts related to livelihoods.

6.1.1 Terms of reference

The Fisheries and Coastal Livelihoods Expert Group conducted a mixed-methods assessment of fisheries and coastal livelihoods in the context of the development. This component is important for understanding complexities related to fisheries and coastal livelihoods, ensuring that recommendations promote long-term full-spectrum sustainability (Foley *et al.*, 2020) within the linked marine social-ecological system (e.g. Ostrom, 2009). Researchers conducted a situational analysis by developing stakeholder typologies and community profiles to examine current fisheries and coastal livelihoods in the area of interest and immediately adjacent communities. This involved a review of secondary data, semi-structured interviews with key scientific experts and select local stakeholders, and ground-truthing through fieldwork. Findings

were integrated to identify potential positive and negative impacts of the planned development and propose evidence-based recommendations for future Environmental and Social Impact Assessments (ESIAs). This study aimed to deepen understanding of fisheries and coastal livelihoods in the area of interest and make high-level recommendations that can strengthen stakeholder engagement and guide strategic planning as it relates to fisheries and coastal livelihoods for the proposed development.

6.1.2 Conceptual framing

The dynamic nature of human-environmental factors informs our overarching approach, and we take a social-ecological systems lens, explicitly recognising the coupled nature of social, economic, and environmental interactions. Using this approach, we first identify current fisheries and livelihood activities in the area of interest before determining the potential consequences the proposed development holds for fisheries and coastal livelihoods on these activities by taking a mixed methods approach.

Social-ecological systems in support of sustainable development

Social-ecological systems are complex, integrated systems that view humans as part of nature, emphasising the interconnectedness of the social, economic, and environmental dimensions (Berkes and Folke, 1998). We adopt Bouamrane *et al.*'s (2016) definition: 'interdependent and linked systems of people and nature that are nested across scales.' Fisheries are complex, adaptive social-ecological systems (e.g. Ostrom, 2009), vital to the socio-economic fabric of coastal communities, as they are essential sources of food, income, and cultural traditions. Despite the ever-increasing recognition that achieving sustainability depends on integrated, system-based approaches linking human and natural systems, governance frameworks and management approaches remain sector-based and discipline specific (Virapongse *et al.*, 2016).

The social-ecological system approach has been linked with various applications, including ecosystem services (Daily, 1997; Partelow and Winkler, 2016), resilience (Berkes and Folke, 1998) and numerous other governance theories (Folke *et al.*, 2005; Cox *et al.*, 2016). It remains important to consider the role of scale within social-ecological systems and in the governance of ocean-based activities such as fisheries. In social-ecological systems, system dimensions that drive decisions and the levels at which they are taken affect other system dimensions in unintended and often destructive ways (Vervoort *et al.*, 2012). Governance issues in the Anthropocene are often multilevel and cut across jurisdictional scales while linking decision-makers horizontally and vertically (Berkes, 2017). Human environmental activities have causes and consequences measured at different levels and scales. The challenge presented by scale issues is a key characteristic of the complexity of the human-environmental system, especially where multi-level decision-making is required (Gibson *et al.*, 2000; Cash *et al.*, 2006; Vervoort *et al.*, 2012). At the same time, whilst scale issues have been addressed more explicitly in the system's ecological (natural) components, social scales are often ill-defined (Vervoort *et al.*, 2012). A targeted approach to social scales is crucial, particularly in recognising and addressing disparities in community resource access, decision-making authority, and traditional knowledge integration (Strand *et al.*, 2022).

The South African marine environmental social-ecological system is no different. Whilst the large-scale ecology is relatively well-understood (Moloney *et al.*, 2013; Blamey *et al.*, 2015; Jarre *et al.*, 2015; Dorrington *et al.*, 2018; Sink *et al.*, 2019), our knowledge of the interactions within the social system needs attention. Whilst much work has recently been done in terms of understanding the social contexts in fisheries (Jarre *et al.*, 2018; Duggan *et al.*, 2020; Gammage and Jarre, 2020; Sowman, 2020), ocean and coastal mining; (Petrova and Marinova, 2013; Roche and Bice, 2013; Baker *et al.*, 2016) and MSP (Kidd and Shaw, 2014; Dorrington *et al.*, 2018; Zaucha and Gee, 2019; Saunders *et al.*, 2020), this knowledge is fragmented at best. At the same time, work carried out in fisheries (e.g. Blamey *et al.*, 2015; Jarre *et al.*, 2018; Gammage *et al.*, 2021) highlight the challenges associated with system-based governance where scale mismatches are pervasive. While South Africa has embraced the concept of the blue economy as a new economic frontier, this has raised concerns on the country's approach to blue growth where social justice and environmental sustainability principles are not centred in the ocean economy (Sowman and Sunde, 2024). When it comes to the marine space, the network of interested or potentially impacted stakeholder communities expands to include other coastal communities, national governments, neighbouring states, researchers, industry and civil society (Roche and Bice, 2013).

In addition, the global food system has become increasingly intricate, connecting food production, processing, and consumption across great geographical distances (Gaasland *et al.*, 2020). These

connections, or couplings, facilitate the flow of commodities like food products, information, and technology from where they are produced to where they are consumed, with financial and other resources returning to entities involved throughout the value chain (Plieninger and Bieling, 2012). Telecoupling[1] within the fishery system is important for this study as marine impacts that affect fisheries within the bounds of the proposed development could potentially have distant implications for South African fishery fleets (and consequently livelihoods), far beyond the reach of the immediate impact of the proposed development.

6.1.2.1 Overarching approach

Figure 6-1 illustrates a theory of change developed for the study. Infrastructure development and the Boegoebaai Port and SEZ's associated long-term activities will have direct and indirect impacts on the local scale. Direct impacts primarily concern impacts related to the physical components of social-ecological systems as they relate to marine ecosystems and coastal zones (determined by the Marine Ecology expert group in this SEA), while indirect impacts are related to the human/social components and manifest as consequences of the development. These potentially include competing space (ocean and coastal squeeze), impacts on commercial and small-scale fisheries (and value chains) and local industry (discussed in the Socio-economic specialist study). The stakeholder typology (Annex Report 1) and ensuing community profiles (Annex Report 2) inform the impact assessment. Our overarching aim in this report is to generate recommendations for the proposed development as it relates to coastal livelihoods and fisheries. This approach was supported by a collaborative, reflexive, and mixed-methods framework, drawing on the expertise of researchers and stakeholders to develop informed, context-specific recommendations.

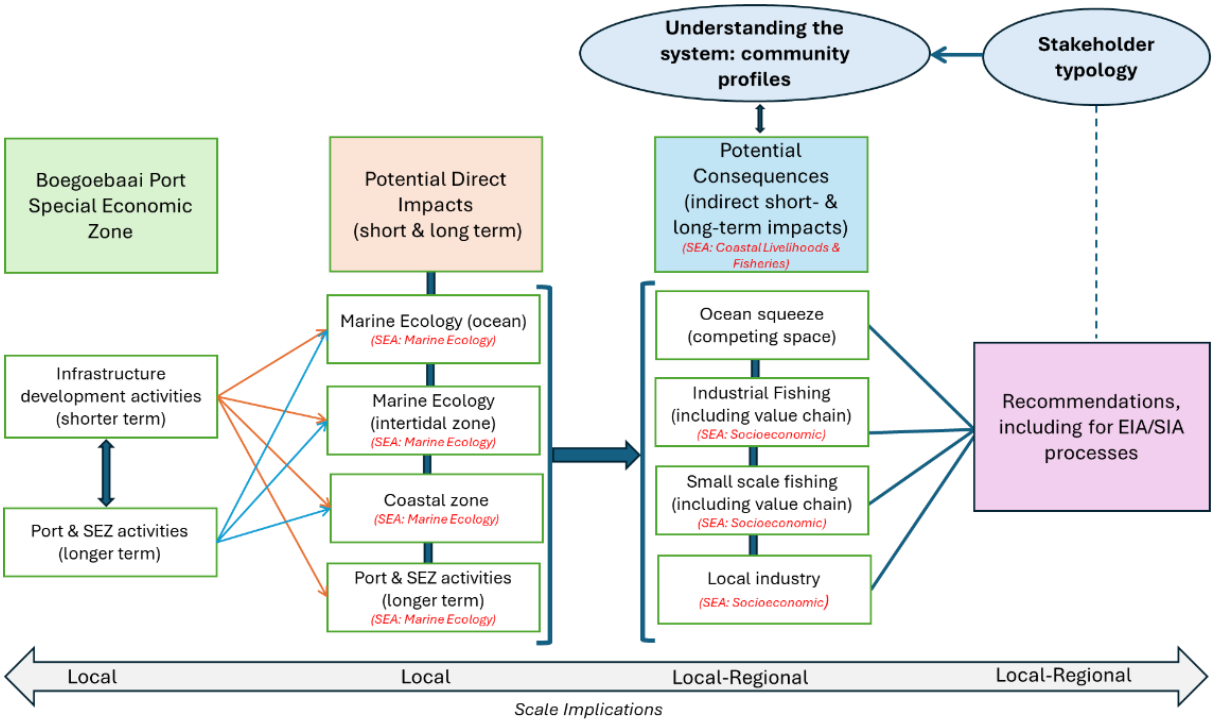


Figure 6-1: The theory of change that informs the approach taken in this research

6.1.2.2 Area of interest

Under Work Package 1, the area of interest focuses on a local spatial scale (33 500 ha) covering the extent of the proposed port and SEZ largely from on a land use perspective. This area falls within the Northern Cape coastline which spans 313 kilometres alongside the Atlantic Ocean and extends over three (out of six) local

[1] Telecoupling is a concept that describes socioeconomic and environmental interactions over distances. It involves distant exchanges of information, energy, and matter (e.g., people, species, goods, ecosystem services, and financial capital) between the coupled social-ecological system (IPBES, 2018)

municipalities within the Namakwa District Municipality, namely the Richtersveld, Nama Khoi and Kamiesberg (Ramasar, 2004). Looking seaward and extending beyond the immediate boundary of Work Package 1, lies the southern Benguela – this larger, interconnected ocean space and its fishery resources play a critical role in supporting the economic and cultural stability of local communities along the west coast. Therefore, this chapter considers fisheries operating at multiple scales, focusing on fisheries operating in South Africa's Exclusive Economic Zone along the west coast, to the two main regional fishing nodes in the Northern Cape Province, namely Port Nolloth and Hondeklipbaai.

The immediate landward area of Boegoebaai under consideration for the SEA is under restricted access linked to diamond mining activities under Alexkor,[2] where the area is currently uninhabited. Therefore, the communities of interest to examine local coastal livelihoods are selected based on their proximity to Boegoebaai, prioritising existing fishing communities and fishery related activities where relevant. These communities of interest fall under the Namakwa District Municipality. Four towns were selected, namely Alexander Bay, Port Nolloth, Kleinzee and Hondeklipbaai. Table 6-1 below details municipal jurisdiction for the selected towns, as well as the primary reason to include the select towns as communities of interest.

Table 6-1: Communities of interest for fisheries and coastal livelihoods

District Municipality	Local Municipality	Community (based on Main Place)	Reason to include as a community of interest
Namakwa	Richtersveld	Alexander Bay	Closest proximity to Boegoebaai
		Port Nolloth	Traditional fishing community
	Nama Khoi	Kleinzee	Aquaculture activities
	Kamiesberg	Hondeklipbaai	Traditional fishing community

6.1.2.3 Methods

This study made used of a mixed-methods approach to develop a comprehensive stakeholder analysis that included developing a stakeholder typology (see Annex Report 1), developing a description of fisheries and community profiles for the communities of interest (see Annex Report 2), and determining potential impacts of the proposed development. Here we provide a broad overview of the methods used, where details are provided in the Annex reports. Table 6-2 outlines key methodological steps, approaches, data sources, and intended outcomes.

Table 6-2: The broad methods used throughout the Fisheries and Coastal livelihoods research

Method Step	Methods Used	Data Sources & Tools	Intended Outcome
Stakeholder Analysis Framework	Desktop review and research Expert validation through consultation	Publicly available data, literature, conceptual frameworks (Reed et al. 2009, Gammage & Strand 2021) Published research, government directories, socio-economic and environmental reports, news articles, tourism/community profiles, and online industrial workshops Inputs from CSIR, Transnet, higher education & research institutions, DFFE, SANParks, and fishery community representatives	Holistic identification of interconnected stakeholders Preliminary stakeholder landscape and draft stakeholder list Identification of previously overlooked or marginalised stakeholders; refining the stakeholder list

[2] See https://alexkor.co.za/

Method Step	Methods Used	Data Sources & Tools	Intended Outcome
Stakeholder Categories	Desktop research drawing on results from Stakeholder Analysis	Master typology (Gammage & Strand 2021)	Clear differentiation of stakeholder groups by scale and type (government, NGO/NPO, civil society, private sector)
Stakeholder Relationships	Social network analysis drawing on results from Stakeholder Analysis	Third-party sources and expert inputs	Stakeholder interests and preferred engagement methods to inform potential impacts
Description of Fisheries	Desktop review Expert validation through consultation	Peer-reviewed publications and relevant published grey literature – such as journal publications, government documents and research documents Consultation of relevant subject matter experts	Overview of pertinent national fisheries in South Africa, west coast fisheries and fisheries in the Northern Cape Province
Community Profiles	Coastal livelihood typologies Desktop literature review Ground truthing through fieldwork and interviews	Drawing on the stakeholder analysis, typologies of coastal livelihoods for communities of interest were developed Review of relevant peer-reviewed publications and published grey sources Fieldwork (4–6 Sept 2024) in all communities of interest; Semi-structured interviews (12 local stakeholders), Microsoft Forms for data capture, bilingual interview guides (English/Afrikaans) Consultation of relevant subject matter experts	In-depth understanding of community composition, diversity, and key livelihood activities (agriculture, conservation, fisheries, mining, tourism)
Aspects and Impacts	Desktop research Expert validation through consultation	Consolidation of findings from stakeholder analysis; description of fisheries; and community profiles Integration of findings from sensitivity analyses from marine ecology and socioeconomic expert groups under Work Packages 1 and 2	Potential positive and negative impacts of the proposed development High level evidence-based recommendations to strengthen stakeholder engagement processes and guide strategic planning as it relates to fisheries and coastal livelihoods.

6.2 DESCRIPTION OF THE RECEIVING ENVIRONMENT

Drawing on the Annex reports, this section provides a summary of the description of the receiving environment in relation to the proposed development by providing an overview of fisheries and coastal livelihoods, the area and communities of interest (Annex Report 2) and stakeholder typology (Annex Report 1).

6.2.1 Fisheries[3]

The southern Benguela is one of the most productive marine ecosystems globally because of its nutrient-rich upwelling system. This upwelling supports a high plankton biomass, which forms the foundation of the marine food web, leading to abundant fish populations, particularly small pelagic species such as sardines and anchovies. These species are crucial for commercial fisheries and the overall health of marine ecosystems (Hutchings *et al.*, 2009). The southern Benguela fisheries are vital to coastal communities' livelihoods, providing direct employment in fishing, processing, and distribution and supporting thousands of households (Griffiths *et al.*, 2010; Isaacs, 2013; Sowman *et al.*, 2013; Norton, 2015; Hara *et al.*, 2017; Jarre *et al.*, 2018). The importance of these fisheries transcends economic value, being deeply interwoven with the cultural and social identities of these communities, contributing to both food security and the preservation of traditional practices. This evolution highlights the critical role of these resources in supporting the economic and cultural stability of local communities).

Beyond their local importance, the economic contributions of these fisheries extend nationally, with fisheries playing a key role in South Africa's gross domestic product (GDP), contributing although less than 1%, also generating foreign exchange earnings through exports (Brick and Hasson, 2016). The South African fishing industry comprises two main components: wild capture fisheries and aquaculture. The former includes the commercial, small-scale, subsistence, and recreational sub-sectors. Nationally, the commercial sector provides direct employment to 28,000 individuals and supports indirect employment for between 100,000 and 130,000 people (Brick and Hasson, 2016). The commercial and recreational fisheries are reported to catch over 250 marine species, although fewer than 5% of these are actively targeted by commercial fisheries, which comprise 90% of the landed catch (Wilkinson and Coppin, 2024).

The small-scale sector, established through the Small Scale Fisheries Policy (SSFP) (DAFF, 2012), was created to acknowledge those fishers who depend on marine living resources for direct food security or those using traditional fishing methods (e.g. Sowman, 2011; Sowman and Sunde, 2021). Nationally, there are more than 169 small-scale fishing communities that support approximately 8027 active small-scale fishers with an estimated 85% of them harvesting linefish (DFFE, 2023a). The informal nature of smalls scale fisheries pre-SSFP makes determining exact trends in catches and trends difficult, although this is expected to improve in future. Various sources that the number of small-scale fisheries have remained relatively constant over the last 3 decades. Small-scale fisheries commonly use small, open boats generally less than 10 m in length that mainly operate close to the shore and are only allowed access to nearshore target species. In addition to commercial (including linefishery) and small-scale sectors, recreational fishing occurs along the coastline comprising shore angling and boat-based fishing.

The southern Benguela ecosystem is increasingly vulnerable to external pressures such as climate change, overfishing, and habitat degradation. These pressures present significant threats to fish stocks, with potentially severe consequences for the livelihoods that rely on them (Allison *et al.*, 2005; FAO, 2014; Ortega-Cisneros *et al.*, 2021). Climate change affects both fish populations and their ecosystems, resulting in shifts in species distribution and abundance (e.g. Ortega-Cisneros *et al*., 2021). Variations in climate, such as rising sea surface temperatures and changing oceanographic conditions, can disrupt traditional fishing practices and reduce the availability of key species (Gammage *et al.*, 2017; Jarre *et al.*, 2018; Martins *et al.*, 2019; Gammage and Jarre, 2020). Furthermore, overfishing, including illegal, unreported and unregulated (IUU)[4] fishing exacerbates these challenges by depleting fish populations, thereby threatening the sustainability of fisheries (Jarre *et al.*, 2018; Gammage and Jarre, 2020). Other anthropogenic pressures on the west coast marine social-ecological system include mining which restricts coastal access and offshore oil and gas exploration, which restricts ocean access (Masterson, 2021; Masson, 2022).

[3] See Annex Report 2, pages 10-33 for the complete Fisheries description.

[4] South Africa has historically permitted very limited foreign fishing access, preferring to reserve its fisheries for domestic vessels. Some evidence suggests that in recent years, foreign industrial fleets have been detected operating inside South Africa's EEZ, especially off the west coast of the country. It must be noted that the origin of foreign fleets in South African waters is not limited to illicit entrants. Some foreign-flagged longliners operate legally under agreements for tuna and swordfish, landing their catch in South African ports under the auspices of regional tuna management organisations (ICCAT and IOTC) using issued licenses or joint-venture rights to a small number of foreign vessels for highly migratory species. (Standing, 2017).

6.2.1.1 Fish and fisheries in the area of interest

Both the small pelagic fisheries and the hake fisheries operate south of Boegoebaai, with the demersal hake longline, large pelagic longline and demersal trawl fisheries operating further offshore. Figure 6-2 shows the fishing intensity in the Exclusive Economic Zone (EEZ) of South Africa for selected fisheries important to the area of interest, along the west and southwestern coasts, whilst Figure 6-3 shows the proposed development in relative to these fishery areas.

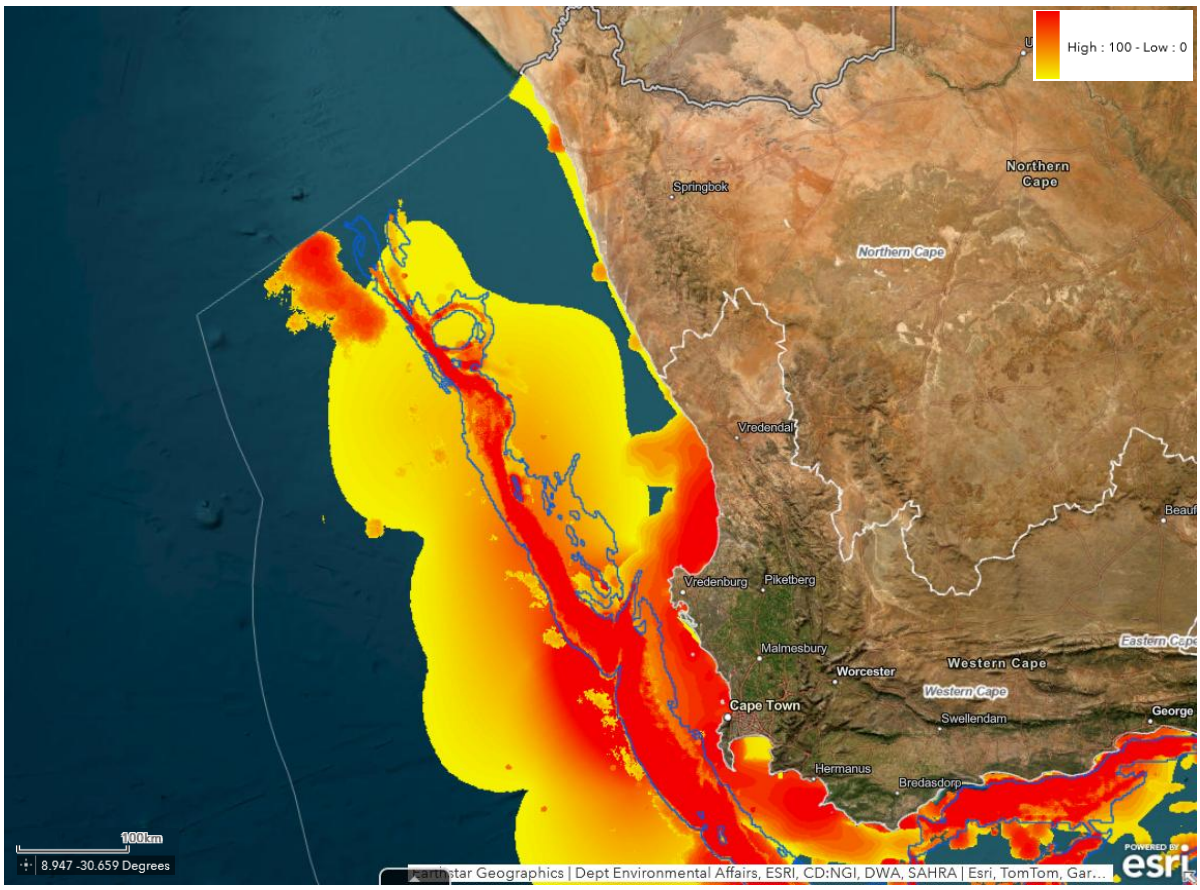


Figure 6-2: Fishing intensity of fisheries (trawl, hake longline, small pelagics, pelagic longline, tuna pole, linefish, net fish, kelp harvesting, West Coast Rock Lobster) with a focus on the west coast of South Africa (extracted from OCIMS Coastal Viewer; DFFE, 2024)

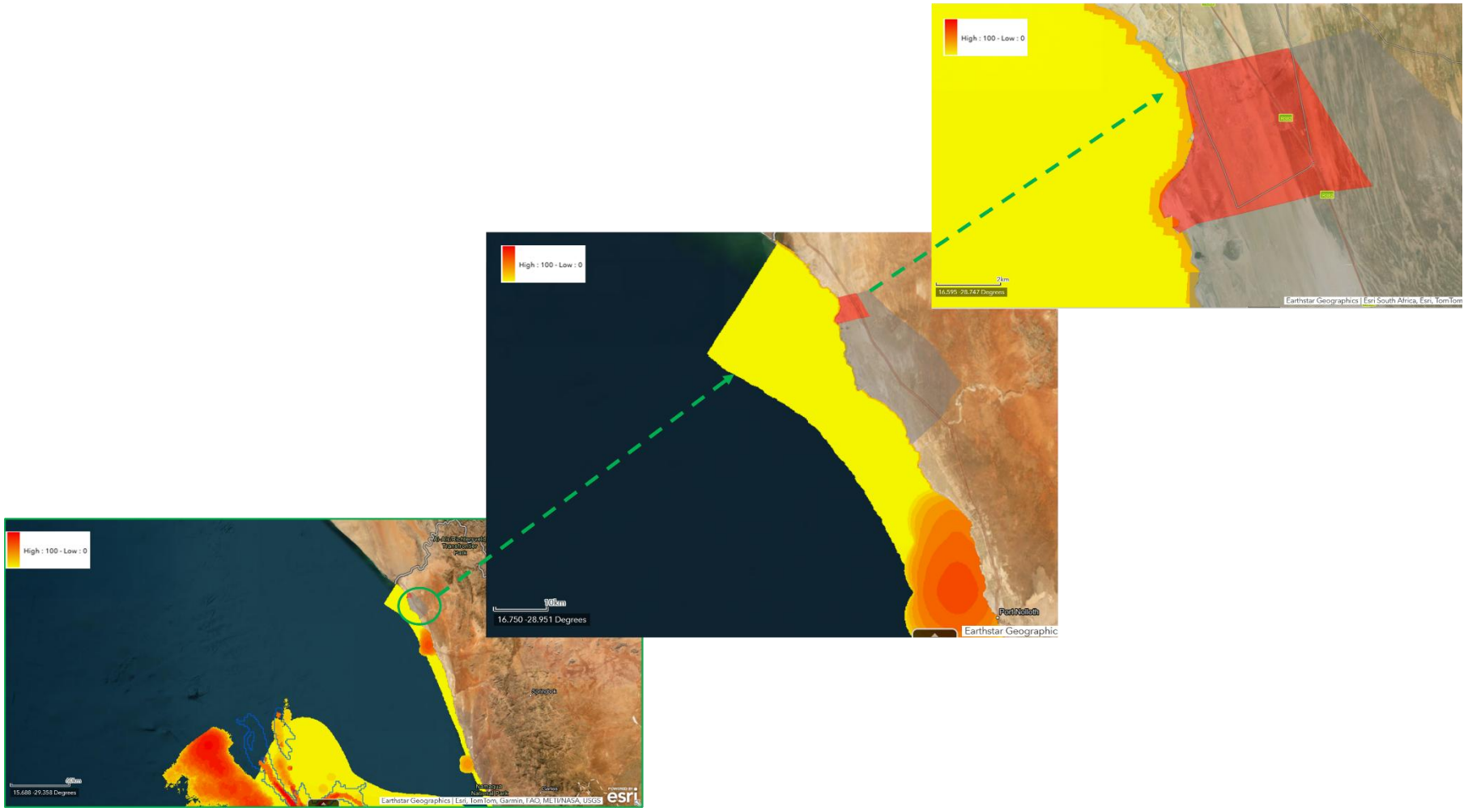


Figure 6-3: Map showing the Proposed development in relation to fishing intensity in the immediately adjacent area. The activity close to the coast is mostly related to linefish, net fish, kelp harvesting and West Coast Rock Lobster).

Fishing intensity is higher closest to Port Nolloth, immediately adjacent to the proposed development (shown in the middle panel). The grey polygon represents the SEZ, whilst the red polygon represents the proposed port precinct (extracted from OCIMS Coastal Viewer; DFFE, 2024)

Notably, the area between St Helena Bay and the Orange River is an important nursery ground and the main area for recruitment of all small pelagic species on the Southern African coastal shelf (Hutchings et al. 2002; Coetzee et al., 2008). Therefore, the small pelagic fisheries may be adversely affected by the development, with the potential of impacting the small pelagic fishing fleet further south. The same caution applies to the commercial hake fisheries as the coastal area around Boegoebaai serves as nursery grounds for these species (Hutchings et al., 2002; Grüss et al., 2016). The area north of Port Nolloth is also known to have a high average density (kg nautical-mile-2) of shallow water hake (Merluccius capensis) (DFFE, 2023a).

- Stock distribution, spawning and recruitment of key species

Spawning, the process through which fish release and fertilize eggs, is essential for sustaining and replenishing fish populations. Environmental factors such as water temperature, light intensity, and ocean currents significantly influence when and where spawning occurs for many fish species. Recruitment refers to the stage when juvenile fish grow and eventually integrate into the adult population. This developmental phase is crucial in the fish life cycle, as the survival and maturation of juveniles directly affect the overall health and stability of fish populations. The South African coastline is dominated by seasonally variable and sometimes strong currents and most species have evolved highly selective reproductive patterns to ensure that eggs and larvae can enter suitable nursery grounds situated along the coastline. Coastal oceanographic dynamics in southern Africa, including eddies, filaments, retroflections, and offshore Ekman transport,[5] often lead to the dispersal and loss of nutrient-rich shelf waters to the open ocean. These processes create challenges for the retention of planktonic eggs and larvae produced by broadcast spawners, thereby limiting successful spawning outcomes, despite the region's wide shelf edge and productive waters (Fowler and Boyd, 1998; Huggett *et al.*, 1998; Roy and Fréon, 2001; Hutchings *et al.*, 2002; Sink *et al.*, 2019). Consequently, many fish species in this area have evolved specific reproductive strategies to ensure that larvae remain in or return to coastal nursery grounds.

The inshore waters along South Africa's West coast serve as vital nursery areas for numerous pelagic and demersal fish species. While the central Namibian shelf also functions as a nursery ground, its importance is considered less critical. Additional nursery grounds in South Africa include the Natal Bight on the East Coast and the Agulhas Bank on the South Coast. Each of these nursery areas is closely associated with a corresponding spawning region, as well as mechanisms for transport, recirculation, and nutrient-rich upwelling along the coast or at the shelf edge (Hutchings *et al.*, 2002, 2009).

Figure 6-4 highlights the main reproductive habitats of southern African fisheries. Species such as hake, sardine, anchovy, and horse mackerel are broadcast spawners that release large quantities of eggs, which are then dispersed by ocean currents (Hutchings et al., 2002). These species primarily spawn on the central and western Agulhas Bank. Coastal upwelling and the north-eastward flow of surface waters create a coastal jet current originating from the Agulhas Bank and extending along the West coast. This current is instrumental in transporting eggs and larvae to nursery areas along the West coast. At Cape Columbine, the jet diverges, forming offshore, alongshore, and inshore flow components (Hutchings *et al.*, 2002, 2009). Importantly, the coast immediately adjacent to the area of interest serve as important nursery grounds for commercially important west coast fisheries (Hutchings *et al.*, 2002, 2009). Any seaward disturbance in this area will likely have a large negative impact on these nursery grounds (L. Shannon, pers. comm.).

[5] Eddies, filaments, retroflections and offshore Ekman transport are complementary mesoscale-to-basin ocean-circulation processes—swirling rings, narrow jet-like plumes, boundary-current loops and wind-driven cross-shore drift—that move, mix and redistribute water, heat, nutrients and organisms between coasts and the open sea, shaping marine ecosystems and climate interactions (Woods Hole Oceanographic Institution, 2025).

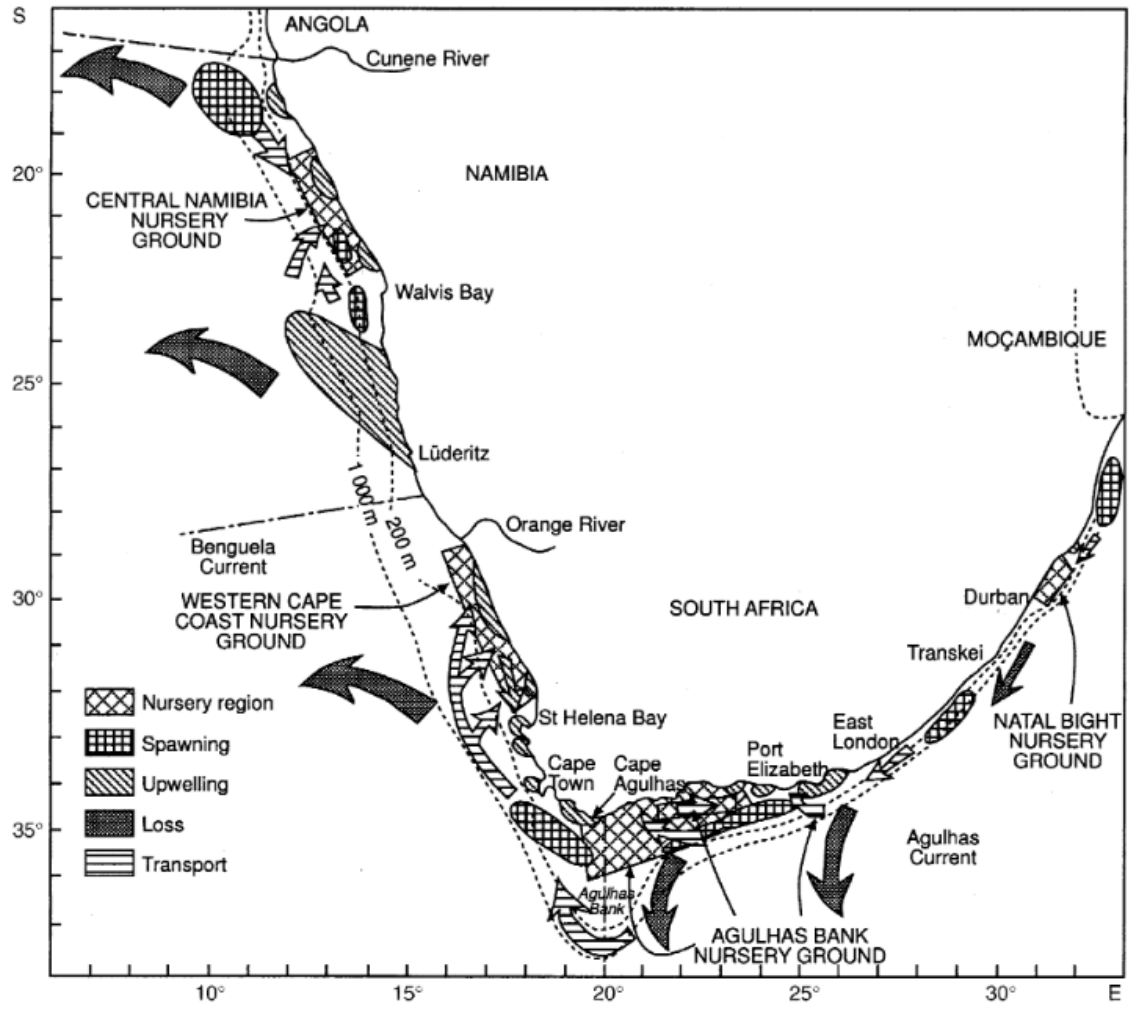


Figure 6-4: Spawning, transport and nursery grounds for pelagic fish in the southern African region. Pelagic fish use strong convergent flow on the western Agulhas Bank and the jet currents outside the upwelling cells to transport eggs and larvae from the Agulhas spawning grounds to the west coast nursery grounds (Hutchings et al., 2002)

Table 6-3 below highlights the fish species that are key to fisheries of interest. This table provides a summary of their distribution, habitat, spawning areas and seasons, and movement patterns and recruitment.

Table 6-3: A summary of stock distribution, spawning and recruitment of fish species important for the fisheries of interest

Species / Group	Distribution & Habitat	Spawning Areas & Seasons	Movement Patterns & Recruitment	Additional Notes
Sardine *(Sardinops sagax)*	Coastal waters within the 200 m isobath along most of South Africa's coastline, including cool-temperate west coast and warm-temperate south coast areas (Coetzee *et al.*, 2019)	West coast: Year-round spawning, peak Aug–Mar (Mhlongo *et al.*, 2015); Some eggs from south coast transported to west coast nursery grounds	Juveniles from south coast migrate back there to spawn; west coast juveniles move to the south-east Coast (Jun–Nov) Complex population structure with prolonged spawning, diverse reproductive strategies, and various recruitment mechanisms (Sink *et al.*, 2019)	Multiple population groups (west coast, south coast, mixed origin) (Teske *et al.*, 2021)
Anchovy (*Engraulis capensis*)	Continental shelf of the southern Benguela system, overlapping with sardines	Spawns primarily on the Agulhas Bank (Oct–Mar, peak mid-summer: Nov–Dec) (van der Lingen and Huggett, 2003); occasionally on west coast when warm Agulhas waters pass Cape Point	Migrate from west coast nursery areas to stable spawning grounds on the Agulhas Bank between Jul–Sep. Eggs and larvae transported by coastal jets to west coast nursery areas where juveniles settle. Since 1994, a shift in spawning distribution toward the east-central Agulhas Bank (van der Lingen *et al.*, 2001)	Similar habitat and transport mechanisms to sardines
Cape Horse Mackerel (*Trachurus t. capensis*)	West coast, across the Agulhas Bank, extending east to Gqeberha, within the 500 m isobath (Barange *et al.*, 1998)	Year-round spawning with two main peaks: May–Aug and Oct–Jan; predominantly on the Agulhas Bank (Barange *et al.*, 1998). Eggs may remain inshore on the western Agulhas Bank or be transported to West coast nursery grounds	Juveniles inshore; adults migrate offshore as they mature. In winter, adults in the west coast region move inshore and southward toward the Agulhas Bank to spawn.	Form large shoals; diurnal vertical migration (near seabed by day, ascending at night to feed on zooplankton)

Species / Group	Distribution & Habitat	Spawning Areas & Seasons	Movement Patterns & Recruitment	Additional Notes
Hake (*Merluccius capensis & M. paradoxus*)	Dominant demersal species in the Benguela ecosystem. *M. capensis*: ~100–450 m depth; M. *paradoxus*: ~300–1,000 m depth (Jansen *et al.*, 2015)	Year-round serial spawners, peaks in Oct/Nov & Mar/Apr (Jansen *et al.*, 2015). *M. capensis*: Spawns on the continental shelf in SA and Namibia (notably near Cape Columbine and western Agulhas Bank); In Namibia, spawning between 25°S and 20°S peaks Jul–Sep. *M. paradoxus*: Primarily spawns between western Agulhas Bank & Elands Bay at depths 200–650 m; eggs found 340–1,500 m (Stenevik *et al.*, 2008).	Both species migrate vertically (demersal by day, mid-water at night) to feed. *M. paradoxus* migrate northward into Namibia and return south to spawn, but do not spawn in Namibian waters (Kainge *et al.*, 2007; Stenevik *et al.*, 2008; Strømme *et al.*, 2016). Eggs/larvae occur in deeper waters, reducing offshore Ekman transport (Hutchings *et al.*, 2002).	Backbone of South African and Namibian fisheries. Depth and environment influence spawning patterns.
Snoek (*Thyrsites atun*)	West & south coasts of South Africa, including the Agulhas Bank; shallow waters, coastal shelves, and depths up to 500 m, also near seamounts (Griffiths, 2002)	Spawns along the shelf break (150–400 m), mainly on the western Agulhas Bank and the west coast, from Jun–Oct (Griffiths, 2002)	Seasonal inshore migration (Apr–Jul, "snoek run") increases availability, linked to recruitment of sardine and anchovy. Eggs/larvae transported by currents to nursery areas north of Cape Columbine on the west coast and east of Danger Point on the south coast. Juveniles remain in nursery grounds until maturity.	Predators of small pelagics (sardine, anchovy), exerting top-down influence on prey and zooplankton. Targeted year-round by linefish and small-scale fishers. Also caught by demersal trawl fisheries offshore in winter (spawning season), and by tuna-pole vessels during periods of low albacore availability. West coast females move inshore to feed between spawning events, while those on the Agulhas Bank remain offshore (Griffiths, 2002).
Large Pelagic Species (Albacore/Longfin Tuna, Yellowfin, Bigeye, Swordfish, etc.)	Widely distributed in offshore waters of South Africa; species-specific thermal and spatial preferences	Albacore (Longfin): Spawn in equatorial waters >24°C (Manning, 1998). Bigeye: Spawn in east-central Atlantic, north of 5°N, and in the Gulf of Guinea during warm seasons(DFFE, 2023a). Yellowfin: Found between 10°S and 40°S in the South Atlantic; spawn in the central Atlantic near Brazil during	Albacore prefer 16–20°C waters and aggregate near Tripp Seamount (high-catch area) with peak availability late summer–early autumn (Manning, 1998). Yellowfin and Bigeye juveniles feed year-round in the Benguela; mature individuals migrate to spawning grounds in central Atlantic (Crawford *et al.*,	Albacore primarily targeted by tuna-pole fishery, Bigeye and Yellowfin key for longline fishery. Seasonal availability, weather conditions, and small pelagic prey abundance influence fisheries. Although catch volumes are relatively low off the

Species / Group	Distribution & Habitat	Spawning Areas & Seasons	Movement Patterns & Recruitment	Additional Notes
		austral summer(Penney *et al.*, 1992). Swordfish: Spawn in warm tropical/subtropical waters.	1987). Swordfish move to cooler temperate zones during summer/autumn. Albacore (longfin) availability increases during the summer upwelling season.	west coast, high market value compensates (Manning, 1998).
Southern mullet (*Chelon richardsonii*)	Endemic to southern Africa, widely distributed in nearshore marine environment, surf-zone, estuaries and lower freshwater reaches of river systems (Lamberth and Whitfield, 2013)	Spawns during austral spring and summer, with early and late summer peaks, in the nearshore or surf-zone in the Western Cape (Lamberth and Whitfield, 2013)	Juveniles found in estuarine and surf-zone nursery habitats, adults inhabit inshore marine systems, specifically sandy beach surf-zones (Horton *et al.*, 2019)	Main target species of beach-seine and gillnet fisheries on the west coast. Stock status noted as heavily depleted (DFFE, 2023a)

- Fishery sectors potentially impacted by the proposed development

Based on the 2018 fishing rights register (DEFF, 2018), fishers in Port Nolloth was allocated the following fishing rights: Hake longline, Hake handline, Hake deep-sea trawl, netfish, small pelagics, linefish, west coast rock lobster (WCRL) nearshore, WCRL commercial, and a fish processing facility. In Kleinzee, seaweed harvesting rights were allocated to rightsholders, and in Hondeklipbaai, linefish and WCRL nearshore rights were assigned to rightsholders. Additionally, there is an abalone aquaculture facility in Kleinzee. According to the draft Wild Fisheries Sector Plan, currently open for public comment, the area between Alexander Bay and Port Nolloth is zoned as II: Fisheries High Use Areas; III: Fisheries Moderate Use Areas and IV: Fisheries Limited Use Areas.

Below, Table 6-4 provides an overview of the wider fishery sectors that may be impacted by the proposed development.

Table 6-4: An overview of fishery sectors in South Africa that may be impacted by the proposed development.

Fishery / Sector	Distribution & Key Habitat	Target Species & Catch Trends	Management & Regulations	Gear & Operations	Additional Notes & References
Small Pelagic Purse Seine	Primarily along South Africa's west and south-west coasts; main landing harbours include St Helena Bay, Laaiplek, Saldanha Bay, and Hout Bay; smaller number operating from Gansbaai, Mossel Bay, and Gqeberha	Targets sardines, anchovies, and round herring (*Etrumeus whiteheadi*); ~80% of annual catch from sardines & anchovies; declining trends from 2016–2019 (down 45% in total combined catch), recovery in anchovy in 2020, but low catches persisted despite high TACs in 2021–2022; sardine considered depleted, anchovy & round herring abundant but below historical peaks (van der Lingen, 2021; DFFE, 2023) small pelagic fishery subject to environmental variability and long-term abundance shifts	Managed via Total Allowable Catches (TACs) for sardine and anchovy; round herring regulated by a Precautionary Upper Catch Limit; spatial overlap of proposed Boegoebaai harbour with support areas could reduce stock and profitability, impacting coastal communities (Hutchings *et al.*, 2002; Grüss *et al.*, 2016; DFFE, 2023a)	Purse seine vessels (~100) range from 11–48 m; fishing concentrated inshore, up to ~100 km from shore; seasonal activity patterns (e.g. anchovy-directed fishery most active Mar–Sep; round herring targeted Jan–Mar); gear and effort linked to processing facilities along coastline	Second most valuable (after demersal trawl) by volume; subject to natural fluctuations due to environmental variability; long-term changes in sardine–anchovy dominance noted locally & globally (van der Lingen *et al.*, 2001; DFFE, 2023a).
Demersal Trawl	West and south coasts; offshore sector along shelf edge at 200–1,000 m depth (most effort 300–800 m on west coast); inshore sector in shallower waters on Agulhas Bank	Targets deep-water hake (offshore sector), shallow-water hake, and Agulhas sole (inshore sector), plus bycatch: monkfish, kingklip, snoek. Generates over R5.2 billion annually (DFFE, 2023a)	Global TAC set for both hake species combined (DFFE, 2021), with 80% allocated to offshore trawl; ring fence established to limit footprint since 2005; MSC-certified with sustainability measures in place; 2024 TAC at 145,700 t hake, and precautionary limits for monkfish and kingklip	Fleet includes 61 offshore trawlers (wetfish & freezer vessels); inshore sector has 26 vessels mainly in Mossel Bay & Gqeberha; fishing done along depth contours, targeting aggregations around seamounts and canyons	Most valuable SA fishery (~half national revenue); measures to avoid further habitat expansion; supports major port economies (DFFE, 2023a)
Hake Demersal Longline	West and south-east Coasts, similar areas as demersal	Targets Cape hakes (shallow-water & deep-	Subject to same global hake TAC as trawl; spatial	Wetfish vessels (~6 days at sea) preserving catch on ice;	Contributes to total hake supply; overlaps spatially

Fishery / Sector	Distribution & Key Habitat	Target Species & Catch Trends	Management & Regulations	Gear & Operations	Additional Notes & References
	trawl but restricted from <110 m depth or <5 nm from coast	water), with kingklip as frequent bycatch; accounts for ~5–6% of annual total hake catch; most recent catches mainly on west coast (DFFE, 2021)	closures (e.g. kingklip box); ~109 rights holders, 40–50 operating vessels; compliance with depth and area restrictions (DFFE, 2021)	operates from major harbours (Cape Town, Hout Bay, Mossel Bay, Gqeberha, and smaller ports); vessels licensed under linefish effort regulations	with trawl sectors but differentiated gear and operations
Linefish	Coastal fishing mainly within 15 km of shore, extending up to 40 nm offshore for vessels certified to do so; key areas: Zone A (Port Nolloth to Cape Infanta) dominant	Targets snoek, yellowtail, Cape bream, geelbek, dusky kob, and others. Traditional linefishery is third most important fishery by tonnage and economic contribution (R105.5 million in 2022) (McGrath, 2024). Some stocks historically overexploited (DFFE, 2023a)	Regulated via Total Applied Effort (TAE) with capped vessel numbers since 2006; linefish emergency declared in 2000 due to overfishing; overlapping species targeted by multiple fisheries; 2022 FRAP allocated 281 vessels to commercial linefish & 59 to small-scale (DFFE, 2023b)	Boat-based (4.5–11 m vessels), hook & line gear; seasonal availability, with snoek and yellowtail catches varying annually; competition with other fisheries (trawl, tuna pole, beach seine) for same species	Long history (since 1500s); small-scale and commercial overlap; recent legal frameworks recognize small-scale rights; in Northern Cape, snoek is main target, plus Cape seabream, geelbek, kob, yellowtail (Isaacs, 2013; Japp and Wilkinson, 2021; McGrath, 2024)
West Coast Rock Lobster (WCRL)	Concentrated close inshore (few nautical miles) along entire west coast, from south of Alexander Bay to north of Kleinzee, including near Port Nolloth and Hondeklipbaai	High-value fishery (~R500 million/yr), important for coastal livelihoods (~4,300 jobs); currently overexploited and heavily depleted. 2023/24 TAC reduced by 16.43% to 460 tons (DFFE, 2023a)	Managed by annual TACs allocated by zones; divided into five subsectors (commercial offshore/nearshore, recreational, small-scale); closed seasons imposed by zone; WCRL is overfished and faces poaching issues (Eggers *et al.*, 2022; DFFE, 2023a)	Offshore sector uses traps at 30–100 m depth; nearshore sector uses hoop nets at 15–30 m; vessels operate from nearby harbours, mostly small-scale and close inshore	Third most valuable fishery; overlaps with proposed development areas; management aimed at stock recovery and maintaining coastal employment (Capmarine, 2017)
Tuna Pole Fishery	West coast shelf break and beyond 200 m isobath, from just south of Alexander Bay southwards; main bases: Cape Town, Hout Bay, Saldanha Bay	Targets juvenile/sub-adult albacore (longfin) tuna, with bycatch of yellowfin, bigeye, skipjack. Seasonal (Nov–May) with peak Nov–Jan. No Northern Cape rightsholders, but some fishing in area (DFFE, 2023a)	Managed under a TAE system (150 vessels for 15 years allocated in 2021/22 FRAP); must comply with RFMO measures; bag limits on yellowtail bycatch; no retention of swordfish, billfish, sharks. Historically part of linefishery until 2003 (DFFE, 2023a)	Vessels 10–20 m without freezing facilities stay up to 1 week; larger freezer vessels >3 weeks at sea; opportunistic targeting of snoek & yellowtail inshore when tuna unavailable	High-value seasonal fishery; supported by international RFMO membership; can supplement catches with other species to offset seasonal tuna availability

Fishery / Sector	Distribution & Key Habitat	Target Species & Catch Trends	Management & Regulations	Gear & Operations	Additional Notes & References
Netfish (Beach Seine & Gillnet)	West coast from Port Nolloth to False Bay, divided into 15 zones: shallow waters (<50 m depth), nearshore (surf zone for beach seining)	Targets mullet (harders), St Joseph shark, and species on 'bait list'; beach seine & gillnet historically overlapped areas targeting linefish species; Harders (*Chelon richardsonii*) and St Joseph (*Callorhynchus capensis*) main Northern Cape targets (da Silva et al., 2015; DFFE, 2023a)	Regulated by TAE system with fixed number of operators and zones; rights issued for 28 beach seine & 162 gillnet holders; gear dimensions and set times regulated (DFFE, 2023a); spatial overlap of proposed Boegoebaai harbour with support areas could reduce stock and profitability, impacting coastal communities	Beach seines: labour-intensive, pulling nets ashore. Gillnets: surface-set (for mullet) or bottom-set (for St Joseph shark), limited to specified lengths/depths	Part of small-scale fishery allocation; overlaps with other sectors. Long history dating back to mid-1600s
Small-Scale Fisheries	West & South-West coasts, mainly nearshore; motorised vessels for subtidal resources; intertidal harvesting more common on East Coast. In Northern Cape they operate small boats from the shore and do not go very far due to gear restrictions and the lack of proper jetties to launch from.	Multi-species approach (>30 species), mainly linefish, WCRL, and abalone nearshore on west and south-west coasts. Historically marginalised sector now legally recognized (Sowman and Sunde, 2021; DFFE, 2023a)	Governed by Small-Scale Fisheries Policy (2012) and MLRA amendment (2014), community-based co-management, 15-year rights granted to cooperatives; overlaps with commercial and recreational sectors; TAE/TAC shared with other fisheries (DFFE, 2023a)	Traditional artisanal methods, small boats ("bakkies"), handlines, hoop nets for WCRL; basket of species allocated based on local availability. In the Northern Cape mainly targeting WCRL nearshore and linefish such as Snoek, Cape seabream. Beachcast Kelp is also harvested.	Aims to redress historical inequalities; Northern Cape cooperatives established in Port Nolloth (Aukotowa primary cooperative) & Hondeklipbaai (Longtime Hondeklipbaai fishing cooperative) with 103 declared SSF and between 10-50 working in associated supply chain; challenges with basket allocation and integration with other sectors (Clark *et al.*, 2002; Sowman and Sunde, 2021; DFFE, 2023a).
Recreational Fishing	Coastal waters throughout South Africa; small boats and shore-based angling close inshore	Targets similar species to commercial linefish, lobsters, squid, abalone; subject to seasonal and bag-limit regulations. Data limited, often uses commercial linefishery data as a proxy	Requires permits and adherence to bag/seasonal limits; restricted by vessel certification categories	Hook and line, similar gear to commercial linefish; small vessels usually remain <15 km from shore	Non-commercial, non-profit activity widespread; important for tourism and leisure; no exact catch-effort data available (DAFF, 2016; DFFE, 2023a)

Fishery / Sector	Distribution & Key Habitat	Target Species & Catch Trends	Management & Regulations	Gear & Operations	Additional Notes & References
Aquaculture	Mainly in Western Cape, some production in Northern Cape; nearshore and onshore facilities	Produces abalone, mussels, oysters, dusky kob, yellowtail, salmonids. Total marine aquaculture output ~6,134 t in 2022; Northern Cape contributed ~70.7 t of national output (mostly from inland aquaculture (mostly African sharptooth catfish and tilapia) (DFFE, 2023a)	Subject to permits and environmental regulations; potential for job creation; expansion into abalone ranching in Northern Cape concession areas	Onshore farms (abalone, kelp), offshore mussel/oyster cultivation; hatcheries supply seed stock; kelp harvested as feed for abalone	Growing sector; SA largest abalone producer outside Asia; abalone ranching pioneered at (Britz *et al.*, 2000; Sales and Britz, 2001; Troell *et al.*, 2006; DFFE, 2023a); Port Nolloth Sea Farms pioneered abalone ranching (Capmarine, 2017).
Seaweed Harvesting	Northern & Western Cape coasts; kelp beds (*Ecklonia maxima*, *Laminaria pallida*) and red seaweed (*Gelidium* spp.); most productive areas between Doringbaai & Langebaan	Produces ~5,233 t in 2021 (DFFE, 2023a); Northern Cape MSY for 2023/24: 7,246 t whole kelp & 3,624 t kelp fronds; Boegoebaai in zone 19 with MSY of 765 t whole kelp & 383 t fronds	Allocated rights with one right-holder per seaweed type per designated area; MSY limits apply	Harvesting beach-cast & cutting fresh kelp; mainly small-scale, labour-intensive operations	~400 employed; kelp used as abalone feed, creating additional jobs; integral part of coastal economy (Troell *et al.*, 2006; Capmarine, 2017; DFFE, 2023a)

6.2.2 Coastal livelihoods[6]

The Namakwa District Municipality, running along the coastline of the Northern Cape, is the largest district in the province with the smallest population size (approximately 148 935) (StatsSA, 2022). While the Namakwa District Municipality has the lowest poverty rate (38.2% in 2022) in relation to the other district municipalities, poverty rates have increased over time across the district (Northern Cape Provincial Government, 2024). Agriculture and tourism are key economic sectors across the Namakwa District Municipality (Municipalities of South Africa, 2024); however, this differs across the three local municipalities running along the Northern Cape coastline. The local municipality of the Richtersveld is the smallest municipality in the district and the primary economic activities include agriculture, fisheries, mining and tourism (Municipalities of South Africa, 2024). While diamond mining activities played a central role in economic activities in the past of the Nama Khoi Local Municipality, tourism is now viewed as the new frontier for economic development (Municipalities of South Africa, 2024). In the Kamisberg Local Municipality, agriculture employs the highest number of people in rural communities of this local municipality (Namakwa District Municipality, 2023).

Changes in climate along the coastline of the Namakwa District Municipality are projected to negatively impact marine and terrestrial systems through variable rainfall patterns, drying trends and expected temperature increases. In particular, issues around water scarcity and quality are prevalent across this district municipality, where changes in climate are expected to exacerbate this problem through drought, reduced runoff, increased evaporation and an increase in flood events (Namakwa District Municipality, 2023). While agriculture plays a key role in local livelihoods, where small stock sheep and goat farming is the main economic activity and land use across the Namakwa District Municipality, projected changes in climate are set to negatively impact these rural communities dependent on small-scale agriculture (Namakwa District Municipality, 2023). Mining activities are also prominent drivers of change along the coastline of the Northern Cape with alluvial diamonds extracted from the beaches and the sea between Alexander Bay and Port Nolloth (Britz *et al.*, 2000; Municipalities of South Africa, 2024). Prospecting and mining activities for diamonds and heavy mineral sands in the ocean space off the Northern Cape take place on the coastal land, beaches, the nearshore environment and in the deep-sea (Masson, 2022).

6.2.2.1 Communities of interest

Coastal livelihoods in the four communities of interest (Alexander Bay, Port Nolloth, Kleinzee and Hondeklipbaai) are influenced by the historical development of each town, which was primarily driven by mining interests. Both Alexander Bay and Kleinzee were established as mining towns due to the discovery of diamonds in the area from the 1920s (Marais, 2023; Gadd, 2024). However, diamond mining has become less significant for coastal livelihoods over the last decade – notably due to the mine closure in Kleinzee and the greatly reduced mining activities of Alexkor in Alexander Bay (Britz *et al.*, 2000). Some smaller companies have been given concessions to mine diamonds in the area, but systemic issues linked to illegal mining and marginalisation of small-scale miners remain widespread (Masson, 2022). The port towns of Port Nolloth and Hondeklipbaai were initially founded for the export of materials such as copper ore in the mid-1800s, after which the diamond industry became a prominent feature in both towns until the 1990s. Commercial fisheries were also a prominent industry from the 1920s to the 1990s in the northern part of the west coast, where Port Nolloth and Hondeklipbaai subsequently transitioned to fishing villages between the 1920s to 1950s (Britz *et al.*, 2000; Christiansen, 2021; Namakwa-Info, 2024). However, overfishing by commercial fisheries in the 1960s and environmental changes in the late 1990s/early 2000s along the west coast altered the availability of small pelagics – resulting in the closure of many factories along the west coast (Jarre *et al.*, 2013). Both the Namaqua canning company in Hondeklipbaai and the John Ovenstone fish factory in Port Nolloth closed in the mid-1990s and early-2000s respectively, which had significant negative ramifications for coastal livelihoods dependent on fisheries (Human, 2021; Soudens, 2022).

Today, the Boegoebaai area is under mining concessions owned by Alexkor, where the area south of Alexander Bay until just south of Boegoebaai has access restrictions. There are currently no formal dwellings or permanent inhabitants in the Boegoebaai area and land use activities are restricted to diamond mining – where the natural harbour (known as Alexander Bay harbour) is accessed by sea and used as a shelter during winter storms by diamond boats from Port Nolloth (Local Stakeholder Interview, pers. comm.). However,

[6] See Annex Report 2, pages 34-56 for the complete community profiles.

according to local stakeholders, this area does hold historical and cultural significance to surrounding local communities predating the current mining activities. Local stakeholders account that there are 17 grave sites belonging to the Nama people in the Boegoebaai area, as well as scarce *Buchu* plants that hold cultural and medicinal significance to the Nama people (Nortje and van Wyk, 2019). This area also contains grave sites of early colonial settlers (1890s) that are linked to the original Rietfontein farmhouse, which predates the mining activities and subsequent restrictions (Local Stakeholder Interview, pers. comm.). Furthermore, the Boegoebaai coastal area also historically formed part of traditional fishing grounds for small-scale fishers based in the neighbouring community of Port Nolloth (M. Sowman, pers. comm.). Predating mining activities, Boegoebaai was an important traditional fishing area for WCRL (Local Stakeholder Interview, pers. comm.) – where small-scale fishers have subsequently lost road access to these fishing grounds over time due to closures linked to mining restrictions (M. Sowman, pers. comm.).

At present, the livelihoods of the four coastal communities of interest are intricately tied to marine resources (also see Table 6-5 & Table 6-6). Port Nolloth and Hondeklipbaai are traditional fishing hubs where small-scale fishers rely on linefish species and alternative activities linked to the ocean, such as kelp harvesting, to supplement livelihoods dependent on fishing through off-seasons (Local Stakeholder Interview, pers. comm.). Traditional fishers based in Port Nolloth and Hondeklipbaai are deeply connected to the sea in terms of legacy (i.e., intergenerational fishing families) and culturally, where fishing is deeply personal and central to their coastal livelihoods – reflecting not only a profession but a way of life for the communities (Local Stakeholder Interview, pers. comm.). Diamond mining activities are still present in Port Nolloth, where the harbour is used to support coastal and offshore mining operations. Meanwhile, Kleinzee has seen a transition towards aquaculture, including seaweed farming and abalone cultivation, as mining activities have declined (Local Stakeholder Interview, pers. comm.). Alexander Bay, historically dependent on diamond mining, has a mixed economic profile but retains ties to coastal livelihoods through its proximity to marine resources.

According to local stakeholders based in Alexander Bay and Port Nolloth, the social fabric and infrastructure of these two towns have eroded over time, where unemployment and associated social ills have raised concerns locally. Ocean squeeze has resulted in traditional fishing communities in Port Nolloth to increasingly lose land and sea access to their fishing grounds – where (for example) in the past, they could move their small boats (i.e., *bakkies*[7]) over land via trailer to fish north of Port Nolloth but can no longer do so as this access has been closed off due to mining restrictions (Merle Sowman pers. comm.). Other cumulative stressors on the traditional fishing communities of Port Nolloth and Hondeklipbaai include the rising cost of fuel that limits how far the fishers can travel at sea to their traditional fishing grounds; climate variability and change within the marine environment that limits days at sea; and decreases in fish stocks due to environmental and anthropogenic pressures (Merle Sowman pers. comm). The cumulative stressors of competition in the ocean space with mining and oil and gas operations continue to hamper the livelihoods of these coastal fishing communities (Christiansen, 2021). Due to water shortages due to drought over the last two years, Port Nolloth also lost most of its income from tourism. Meanwhile, tourism activities have increased in Kleinzee and Hondeklipbaai over the last few years (Local Stakeholder Interview, pers. comm.).

Key coastal livelihood activities identified for each community of interest are detailed in Table 6-5 below – see Annex Report 2 for further details. These include agriculture, fisheries, mining and tourism. While conservation was also identified as a key activity, it did not play a central role in terms of contributing directly to livelihood activities in the communities of interest, but rather linked to and supported tourism activities. Thus, wider conservation activities were discussed in relation to tourism activities taking place in the communities of interest.

[7] A traditional style of small fishing boat (i.e., two-people boats running on a motor or being rowed) with the colloquial name originating on the west coast of South Africa.

Table 6-5: Key coastal livelihood activities for each community of interest

District Municipality	Local Municipality	Community of interest	Key coastal livelihood activities	
			Primary importance	Secondary importance
Namakwa	Richtersveld	Alexander Bay	Mining	Agriculture, tourism (including conservation)
		Port Nolloth	Fisheries, mining	Tourism (including conservation)
	Nama Khoi	Kleinzee	Fisheries (aquaculture)	Mining, tourism (including conservation)
	Kamiesberg	Hondeklipbaai	Fisheries	Tourism (including conservation)

Table 6-6 below provides a summarised overview of profiles developed for each community of interest - detailing location, demographics, key features and main livelihood activities. Detailed community profiles for Alexander Bay, Port Nolloth, Kleinzee and Hondeklipbaai can be found in Annex Report 2.

Table 6-6: A summary of community profiles created for the four communities of interest: Alexander Bay, Port Nolloth, Kleinzee and Hondeklipbaai

Location	Population (StatsSA 2011)	Demographics (StatsSA 2011)	Key Features	Main Livelihoods	Comments on Livelihoods
Alexander Bay					
Northwesternmost town in the Northern Cape, on the Orange River bordering Namibia.	1,736	75.7% working age, 21.9% young, 2.3% elderly; predominantly Coloured (83%) and Afrikaans-speaking (90%).	Mining town with formal dwellings; erosion of infrastructure; key facilities include schools, health clinic, police station, recreational facilities (Golf Club, Tennis Courts); historical significance as a mining town founded in 1925.	Mining - Diamond mining through Alexkor.	Mining employs contractors: benefits to locals are limited.
			The town has declined in population and industrial activity due to reduced mining. Infrastructure is aging, and basic services remain stable but show signs of deterioration.	Agriculture - Richtersveld Growers operate farms.	Richtersveld Growers boost local employment and support agricultural education at the local high school.
			The Orange River Mouth is a Ramsar site and significant ecological area; potential for eco-tourism.	Tourism - Focused on Orange River Mouth.	Tourism opportunities (Ramsar wetland and unique landscape) remain underdeveloped.
Port Nolloth					
86 km south of Alexander Bay on the Northern Cape coast.	6,092	69.4% working age, 24.1% young, 6.5% elderly; predominantly Coloured (97%) and Afrikaans-speaking (88%).	Fishing, mining, and tourism hub with limited water access (piped water 78%); facilities include schools, businesses, clinics; part of Operation Phakisa's Oceans Economy program; historical importance as a copper export hub turned fishing village.	Fisheries - Small-scale fishers face challenges.	Fishing communities face restricted access to traditional grounds, rising costs, and reduced fish stocks.
			Infrastructure challenges: only one jetty operational; limited access to larger vessels due to shallow waters; declining water availability exacerbates economic and social issues.	Mining - Diamond divers and offshore vessels.	Mining provides limited employment, with a mix of local and contractor jobs.

Location	Population (StatsSA 2011)	Demographics (StatsSA 2011)	Key Features	Main Livelihoods	Comments on Livelihoods
			McDougall's Bay offers recreational activities and a Blue Flag beach, but tourism faces hurdles from deteriorating infrastructure and unemployment.	Tourism - Seasonal focus on flower season.	Tourism is impacted by poor infrastructure, limited water access, and social challenges like unemployment.
Kleinzee					
62 km south of Port Nolloth.	728	86.3% working age, 12.1% young, 1.6% elderly; predominantly Coloured (61%) and Afrikaans-speaking (90%).	Former diamond mining town: all formal dwellings with high basic services (99% piped water, refuse removal); key facilities include schools, police station, and clinic; seasonal tourism focuses on birdwatching, flower season, and shipwreck trails.	Aquaculture - Abalone and oyster farming.	Aquaculture is the primary employer, including innovative practices like multi-trophic systems.
			The town's economy shifted from mining to aquaculture; Viking Aquaculture employs a large portion of residents through abalone and seaweed production.	Tourism - Seasonal activities.	Tourism focuses on birdwatching, shipwreck trails, and flower season but is constrained by water scarcity and road conditions.
Hondeklipbaai					
Coastal village, 95 km southwest of Springbok.	543	67.4% working age, 24.7% young, 7.9% elderly; predominantly Coloured (81%) and Afrikaans-speaking (97%).	Small fishing village; limited basic services (flush toilets 29%, piped water 60%); facilities include police station, clinic, and shops; historical significance as a copper export hub and fishing village.	Fisheries - Small-scale fishers.	Fishing remains central but is impacted by declining lobster stocks, limited fishing rights, and competition from Cape Town fishers.
			The cooperative model supports community development but faces challenges like funding shortages for VMS monitoring and operational costs.	Tourism - Activities include 4x4 routes.	Tourism is growing with activities like shipwreck exploration and flower season drives, but infrastructure remains a challenge.
			Agriculture in surrounding areas focuses on subsistence farming, with livestock grazing being the primary activity.	Agriculture - Subsistence farming.	Agriculture focuses on goats and sheep in surrounding rural areas but remains small-scale due to challenging environmental conditions.

6.2.2.2 Stakeholders of interest[8]

The proposed development represents both opportunities for alternative livelihoods and sustainable economic growth in the Namakwa District Municipality, as well as potential challenges around the representation and inclusion of marginalised communities, such as small-scale fishers, Indigenous groups, and local residents in the project development and planning process. Although project planning is supported by regulatory frameworks such as the National Environmental Management Act (NEMA) that mandates stakeholder engagement with Interested and Affected parties, these are often not robust enough in promoting equity or to safeguard the voices of marginalised stakeholders. As part of this study, we set out to understand the typology of stakeholders (direct and indirect) that could be identified. A broad spectrum of stakeholders were identified (detailed in Annex Report 1): 87 government stakeholders, 65 private enterprises, 27 civil society organisations, and 19 NGOs – each contributing to shaping the regions trajectory (see Figure 6-6 below). These identified stakeholders were linked to the four communities of interest (Alexander Bay, Port Nolloth, Kleinzee and Hondeklipbaai) through either a physical presence in these areas or through regional projects or societal affiliations. Figure 6-5 shows the percentage distribution of identified stakeholders in these communities.

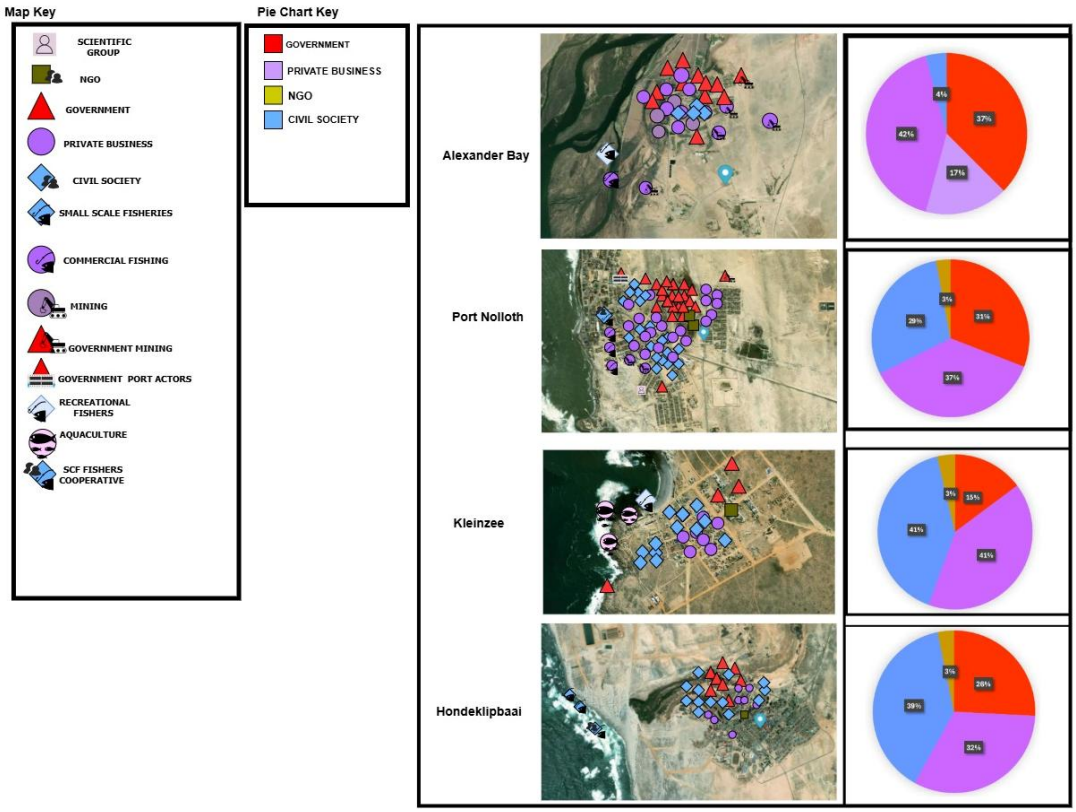


Figure 6-5: An overview of the percentage distribution of stakeholders identified in the four communities of interest: Alexander Bay, Port Nolloth, Kleinzee and Hondeklipbaai

The stakeholder analysis (see Annex Report 1) revealed that government entities represent the largest and most influential stakeholder group. Government stakeholders play a pivotal role in offering policy alignment, regulatory support, and resource allocation, with agencies such as Transnet and the Department of Forestry, Fisheries, and Environment (DFFE) playing pivotal roles. However, increasingly complicated governance systems also presents risks of bureaucratic delays due to conflicting objectives and complicated regulations, power imbalances, and the potential marginalisation of smaller stakeholders. The dominance of government actors suggests a top-down development approach, prioritising national economic goals over localised socio-

[8] See Annex Report 1, pages 6-24 for the complete Stakeholder analysis.

environmental concerns. While this may streamline decision-making and attract foreign investment, it risks sidelining the voices of communities directly impacted by the project.

The private sector, comprising industries ranging from tourism and logistics to energy and construction, emerged as the second-largest stakeholder group. Private sector involvement is expected to drive investment, innovation, and efficiency. However, this may also introduce profit-driven priorities, power disparities and short-term outlooks that could neglect long-term sustainability and conflict with equitable resource distribution required for the project to succeed holistically. Private sector dominance may also sideline marginalised groups.

Civil society and local community organisations, though numerous, are comparatively underrepresented in decision-making processes. Civil society and NGOs are essential in advocating for transparency, social justice, and environmental conservation, ensuring that community interests and marginalised voices are represented. However, it can also lead to conflicts, particularly when their interests clash with those of the government or private sector. Environmental advocacy groups have already voiced concerns about the potential displacement of coastal livelihoods and the destruction of marine ecosystems linked to the proposed Boegoebaai project. While these groups play a crucial role in holding project proponents accountable, their influence is limited compared to the dominant government and private sector stakeholders.

Small-scale fishers, who depend on the marine environment to sustain their livelihoods, potentially face the most immediate threats from the proposed Boegoebaai project. The encroachment of industrial activities on traditional fishing grounds may jeopardise both livelihoods and cultural heritage of surrounding fishing communities. Marginalised by structural inequities (Sowman and Sunde, 2021), these stakeholders lack the power to shape project outcomes, often leaving their concerns unaddressed.

When government and private sector stakeholders hold the majority representation in the Boegoebaai port development, and civil society and NGOs hold less influence, this suggests a development model driven primarily by economic and political interests rather than social or environmental considerations. This scenario reveals several critical dynamics that may influence the outcome of the proposed Boegoebaai development, with far-reaching implications for civil society – particularly fishing communities whose livelihoods may be directly impacted by the development (see Figure 6-6).

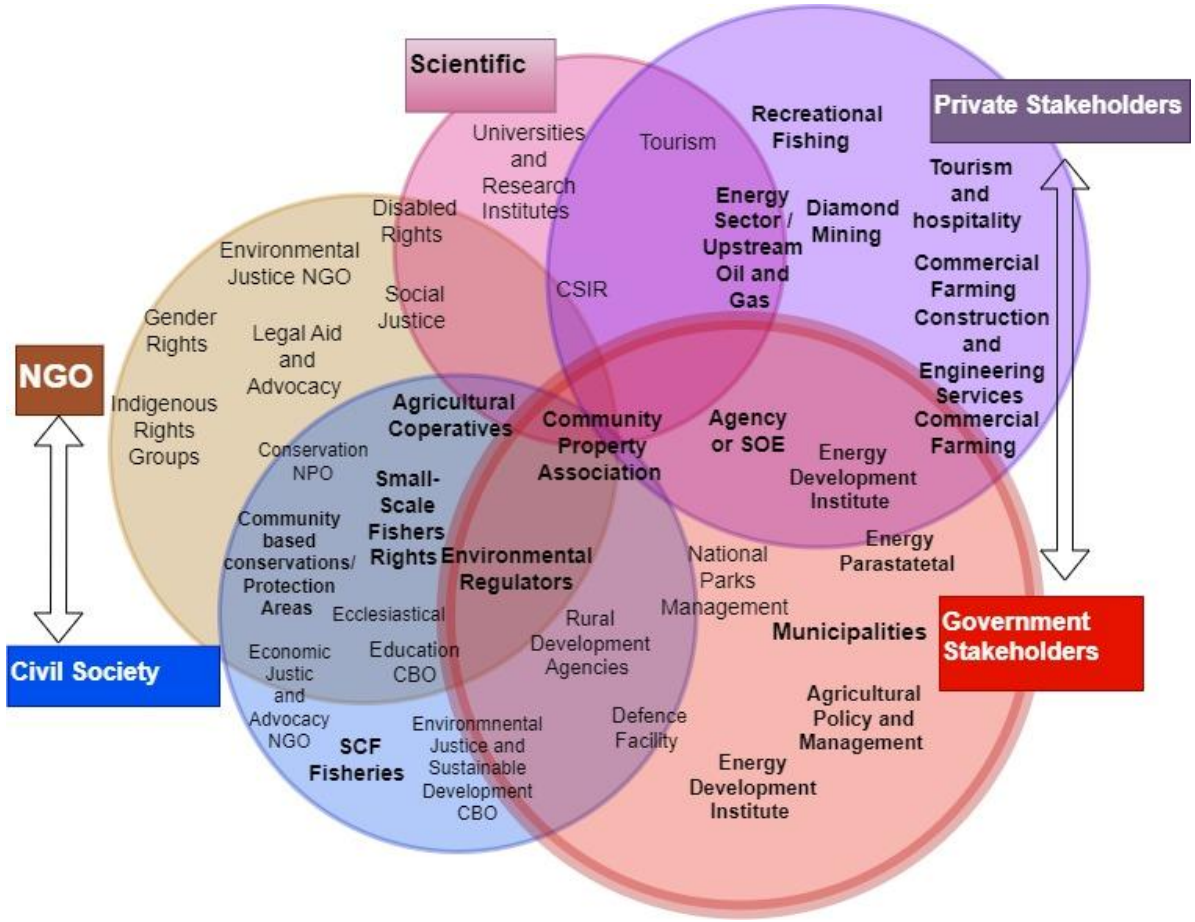


Figure 6-6: Venn Diagram illustrating overlap and interplay of various potential stakeholders related to the proposed development

Key challenges include power imbalances that may further marginalise impacted communities, while negative environmental impacts could undermine the region's ecological integrity. Conflicting stakeholder interests and potential resistance from civil society may add further complexity. However, this proposed project also presents opportunities. By prioritising inclusive meaningful engagement and addressing the concerns of marginalised groups, the initiative could foster initial community buy-in that is required for meaningful inclusive engagement, and at the same time enhance its legitimacy. Sustainable practices and equitable resource allocation would not only mitigate resistance but also align the project with global standards for socially responsible development.

6.2.2.3 Emerging Impacts and Aspects related to the proposed development

Several impacts and aspects emerge from both the stakeholder analysis (Annex Report 1) and community profiles (Annex Report 2) for each community of interest (see Table 6-7). Stakeholder analysis and interactions with key stakeholders reveal shortcomings in communication, inclusivity, and representation in earlier stakeholder processes that will impede project success if not explicitly addressed. Challenges such as fragmented communication channels, inadequate involvement of marginalised groups, and imbalanced power dynamics have eroded trust and hindered effective collaboration among stakeholders. Furthermore, the traditional absence of robust feedback mechanisms, accountability structures, and cultural sensitivity has exacerbated tensions and limited equitable participation. These insights highlight the urgent need for a strategic approach to enhance stakeholder engagement, ensuring that all voices are heard, respected, and integrated into project development and implementation.

Table 6-7: Emerging Impacts and aspects related to the proposed development emerging from stakeholder (Annex 1) and community profile (Annex 2) reports

Focus Area	Recommendation
Alexander Bay	
Socio-Economic Opportunities	Ensure equitable access to port employment opportunities, particularly for marginalised groups.
	Transition skills and infrastructure from mining to industrial activities.
Environmental and Social Impacts	Evaluate cumulative environmental impacts of mining and port activities.
	Engage conservation organisations to monitor and mitigate degradation.
Stakeholder Engagement	Facilitate multi-stakeholder dialogues.
	Provide clear communication channels for community participation.
Port Nolloth	
Fisheries and Livelihoods	Protect small-scale fishing livelihoods from industrial disruptions.
	Strengthen marine resource management to prevent overfishing and displacement.
Infrastructure and Accessibility	Ensure port infrastructure does not restrict fishing grounds or harm marine habitats.
	Develop alternative income initiatives, such as eco-tourism.
Stakeholder Engagement	Collaborate with fishing co-operatives and conservation groups to design mitigation measures.
	Create transparent platforms for fishing rights decisions.
Kleinzee	
Aquaculture and Tourism	Integrate aquaculture into environmental planning to prevent water and habitat degradation.
	Promote conservation-aligned tourism opportunities.
Resilience and Diversification	Expand aquaculture through capacity-building initiatives and financial assistance.
	Foster synergies between tourism and aquaculture to diversify the economy.
Stakeholder Engagement	Strengthen collaboration with aquaculture enterprises and tourism operators.
	Involve local businesses in long-term planning and resource discussions.
Hondeklipbaai	
Fisheries and Vulnerabilities	Maintain access to traditional fishing grounds for small-scale fishers.
	Offer skill-building for alternative livelihoods like eco-tourism and aquaculture.
Infrastructure Development	Minimise disruptions to livelihoods and cultural practices in infrastructure projects.
	Collaborate with NGOs to advocate for marginalised groups.
Stakeholder Engagement	Engage fishing communities in co-management frameworks.
	Ensure women's perspectives are included in consultations.
Cross-cutting Themes	
Inclusive Governance	Establish community advisory boards for ongoing decision participation.
	Strengthen co-management frameworks for resource management.
Environmental Stewardship	Prioritise marine spatial planning to protect habitats.
	Implement monitoring systems (that could also include citizen science monitors) to track environmental and social impacts.
Capacity Building and Advocacy	Provide financial and technical support for adapting to socio-economic changes.
	Partner with NGOs and private sector for equitable resource allocation and decision-making.
Transparent Communication	Develop culturally appropriate communication strategies. This includes ensuring that technical reports are communicated in an understandable language and using different formats. Explore innovative ways to communicate potentially complex concepts around negative and positive impacts.
	Create mechanisms for feedback and grievance redressal.

6.3 IMPACTS AND RECOMMENDATIONS

The proposed development holds the promise of economic growth and expanded infrastructure, although stakeholders and experts have voiced profound concerns for the communities whose livelihoods, cultures, and complex environments cannot simply be regarded as either terrestrial or marine, but rather as an interface of both. Four overarching, and interlinked, themes have emerged from this analysis: the potentially devastating impacts on large commercial fisheries' nursery areas; the gradual but persistent closure of operating space for small-scale fishers; the threat of gentrification[9] pressures that may undermine the socio-cultural fabric of communities adjacent to the area of interest and fractious stakeholder engagement processes that leave local communities feeling excluded and unheard. These interlinked issues underscore the importance of careful, transdisciplinary[10] development planning that places community engagement and environmental stewardship at its core. In particular, the project-specific impact assessment framework mandated by the National Environmental Management Act (NEMA) risks neglecting c cross-cutting cumulative impacts that would be devastating to local fisheries and coastal livelihoods.

We here outline the strategic direction for future ESIAs and highlight impacts, as per themes that emerged from our research. The mitigation approaches and recommendation should be regarded as being supportive of each other and as such cannot be implemented in isolation. We must underscore that these impacts are by no means exhaustive and further, directed studies with primary fieldwork and extensive stakeholder engagement are needed. Instead, this analysis provides strategic guidance, acknowledging that detailed ESIAs will be required for each project.

Here, we have drawn on both Annex reports in determining impacts and recommendations as well as key experts and established literature. The Marine Ecosystem specialist study was not available at the time of submission (December 2024), their relevant inputs will be added before finalising this report in February 2025.

6.3.1 Physical marine ecosystem impacts

Impact/Aspect: The proposed port development has the potential to negatively impact fish and invertebrate's habitat, and in turn the fisheries livelihoods by decreasing both overall catch and catch per unit effort of target species. This decline can lead to increased costs and reduced profits, resulting in negative socio-economic consequences for communities and businesses involved in fishing. This will impact businesses and communities involved in fisheries along the entire west coast, from Port Nolloth to Cape Town.

The proposed construction and ongoing operations of the port pose serious threats to marine ecosystems and fisheries. Direct mortality of target fish and invertebrate species, encompassing all life stages from eggs to adults, is a primary concern associated with harbour development. The direct impacts on the nursery grounds along the coast would severely affect the large industrial South African fisheries. Our recommendation is that a specialist fishery study is commissioned as part of the ESIA for the Boegoebaai Port development. Additionally, the destruction or degradation of critical marine habitats—such as feeding and nursery grounds, migration routes, and essential habitats for prey species—could substantially reduce the abundance of key fishery species. Notably, the proposed harbour site overlaps spatially with support areas for two of South Africa's most important fisheries, namely the small pelagic and hake fisheries (Hutchings et al., 2002; Grüss et al., 2016).

It is also important to consider that if large-scale commercial fisheries and nursery grounds are impacted by this development, the scope of who are deemed 'interested and affected parties' must be expanded to include amongst others, representatives from the Fishing Industry as well as communities along the coast

[9] Gentrification is a "process in which formerly declining, under-resourced, neighborhoods experience reinvestment and in-migration of increasingly affluent new residents, with understudied implications for individual health and health-protective community resources for low-income and minority residents" (Tulier et al., 2019, p 1).

[10] Transdisciplinary refers to approaches that integrate knowledge and methods from multiple disciplines and stakeholders to address complex real-world problems holistically. It transcends traditional academic boundaries to create innovative, comprehensive solutions.

all the way to Cape Town, including key communities such as Saldanha Bay. As part of this process, the fishing industry must be consulted as key stakeholders in the project.

Moreover, the construction activities are likely to disrupt and alter fish behaviour, interfering with annual spawning events and migration patterns. Such disturbances may lead to reduced biological fitness and a decline in lifetime reproductive output, further jeopardising fish populations. Siltation resulting from harbour construction and regular operations can cause shading or smothering of vital seaweeds, including kelp beds. This will affect local livelihoods dependent on kelp harvesting but also WCRL as the latter depend on kelp beds for recruitment. In addition, dredging activities have been shown to cause changes in marine currents and damage benthic habitats and organisms, which are a key food source for many linefish species.

Mitigation approach: Measures such as the establishment of traffic exclusion zones around the harbour could result in a reduction of productive fishing areas. While this may limit access for local fishers, these zones have the potential to create protected habitats for resident species. Such protection could lead to an increase in the biomass of spawners, potentially enhancing catches in adjacent fishing areas through a spill-over effect. However, the overall impact on fisheries depends on the balance between reduced fishing space and the benefits derived from protected habitats. Comprehensive mitigation measures are essential to address these multifaceted impacts, ensuring the sustainability of both marine ecosystems and the fisheries that depend on them. The exact mitigation approach must be explored in a specialist fisheries study that must be commissioned (see Overarching Recommendations).

Overarching Recommendations: A specialist fishery impact study must be commissioned to examine the cumulative impacts of the proposed development. This study needs to include the impact of all stages of port development, including port operation, the latter with potential impacts such as increased vessel traffic, ship discharges and emissions, cargo handling and storage (e.g., potential introduction of extrinsic pollutants, such as spilled nurdles or medicines that end up on the beaches, and hazardous materials). The impact of increased vessel traffic, resulting in increased ship discharges and emissions, spills and underwater noise, on the five Ecologically or Biologically Significant Marine Areas (EBSAs) surrounding the proposed development area also needs to be examined. These EBSAs are key in terms of their biological diversity, and support threatened species and ecosystem types (Harris *et al.*, 2022). In particular, the Orange Seamount and Canyon Complex EBSA, approximately 30 km due west off the coast is a 'hotspot of demersal fish biodiversity', the proximity of this EBSA to the development area is concerning and should be carefully considered.

The study should be commissioned in a way that it can be referenced in all the different environmental impact assessments conducted for the various stages of the project and consider the impacts of port development from water quality and coastal hydrology to socio-cultural impacts (United Nations, 1992). For instance, changes in local hydrodynamics due to the port construction and dredging should be accounted for by conducting modelling studies that can advise on the best design for developing port infrastructure and minimise potential impacts. Similarly, particle tracking simulations should be performed to evaluate the potential trajectories of oil spills, chemical and other potential pollutants (e.g. nurdles) on the coastal and marine ecosystem. The impacts of climate change also need to be considered. Climate change is expected to increase sea level rise and the frequency and intensity of extreme events (Seneviratne *et al.*, 2023), which will directly impact port infrastructure but can also increase cargo loss at sea. Pollution due to cargo spills (e.g., nurdles) has been shown to have profound negative impacts on coastal and marine ecosystems (de Vos *et al.*, 2022).

We make specific recommendations related to the consequences for fisheries from the physical environmental impacts of the proposed development, which are outlined in Table 6-8.

Table 6-8: Specific recommendations related to consequences for fisheries from physical environmental impacts

Aspect	Impact	Benefit	Potential Negative Impact	Recommendation	Scale of Impact
Fisheries	Habitat destruction affects nursery grounds and migration routes.	-	Long-term fish population reduction impacts fisheries.	Conduct fisheries-specific EIAs and co-design mitigation measures.	Regional, National
	Construction and operations lead to direct mortality or sublethal damage of target fish species.	-	Disruption of fish behaviour, spawning, and migration patterns reduces reproductive success.	Create protected zones to minimize operational impacts and enhance fish stock resilience.	Regional, National
Siltation	Marine vegetation smothered, affecting biodiversity and livelihoods (e.g., kelp beds, seaweed harvesting).	-	Degradation of habitats essential for species survival and marine biodiversity.	Monitor impacts and rehabilitate marine ecosystems.	Local, Regional
Pollution	Water quality declines due to dredging and operations.	Enhances regulatory frameworks for pollution control.	Ecosystem health deteriorates, affecting fisheries and biodiversity.	Enforce strict monitoring of discharges and maintain water quality standards.	Regional, National
Exclusion Zones	Traditional fishing activities restricted by exclusion zones around port.	Potential creation of de facto marine protected areas, enhancing biodiversity.	Reduced space for traditional fishers impacts livelihoods and socio-economic stability.	Incorporate exclusion zones into marine spatial planning to balance industrial and fisheries needs. Work with the community to establish OMPs for these new “de facto” protected areas, planning both temporally and spatially for how these changes could be allocated to the benefit of the local community.	Local, Regional

6.3.2 Consequences of ocean squeeze

Impact/Aspect: A key theme highlighted throughout this report is the cumulative pressures playing out in the sea space that is significantly impacting local coastal communities and their respective livelihoods, particularly in relation to small-scale fisheries. This “slow” ocean squeeze on traditional fishers and the associated adverse environmental impacts on coastal and marine ecosystems should be taken into serious consideration when planning future activities that impact the Namaqualand coastline. The systemic erosion of socio-cultural values, traditions and access of local fishing communities linked to the sea and associated environmental degradation of coastal and marine ecosystems due to historical and current mining and oil and gas activities, should be a main concern when planning blue economy activities – which need to consider blue justice and just transitions to sustainable livelihoods for local communities (e.g. Sowman and Sunde, 2021). Furthermore, the interlinked nature of the ocean space in terms of impacts on sensitive marine habitats that have much wider regional and transboundary implications for both the ocean and socio-

economic dependencies is very important to consider when planning ocean-based activities, particularly under the current regime of global climate change and currently uncertain-yet-anticipated impacts.

Our work has shown that fisheries and coastal communities are at risk of negative impacts, especially from phenomena like ocean squeeze, where the seaward-facing side of the coast is becoming increasingly competitive with fishers' operating space already greatly diminished. The proposed development poses a high risk for further closing down of available space leading to less space to fish and more competition for space and resources leaving their ability to sustain livelihoods severely negatively impacted. It is also critical to acknowledge that the future impact of resource scarcity (fish) and the looming threat of climate change will exacerbate the impact of ocean squeeze, underscoring the need to consider how we can build resilient communities that are prepared for the future.

Mitigation approach: To address issues around ocean squeeze, it is necessary to consider and manage cumulative impacts across the various projects that is associated with the proposed development. Mechanisms for cross-cutting project planning and meaningful community engagement must be explored. Accurate measurement of cumulative effects is essential for assessing the short and long-term impacts of proposed developments. Unlike infrastructure projects with straightforward physical impacts, such as relocating a port or altering a jetty's location, the introduction of new developments into a social-ecological system affects system dynamics in complex ways. These must be carefully understood at the small and large scale before any mitigation measure is suggested.

Recommendations: Comprehensive spatial and cumulative impact assessments must underpin all planning processes and must be explicitly included in the specialist fisheries study and cross-cutting ESIAs related to the development. Meaningful, equitable and collaborative engagements are required with commercial, small-scale and traditional fishers to integrate their perspectives into decision-making and using advanced modelling tools to predict and manage potential conflicts over resource use (also see section 3.4). Additionally, an explicit analysis of how infrastructure and vessels related to this development will interact with other marine industries such as the various mining concessions granted in the area in the context of a marine spatial plan for the area. This analysis is crucial to understanding the ultimate consequences for fisheries and coastal livelihoods beyond the scope of the study.

Table 6-9 outlines specific recommendations related to the consequences of ocean squeeze for small-scale fishing communities in the area of interest.

Table 6-9: Specific recommendations related to consequences of ocean squeeze for (particularly) small-scale fishers

Aspect	Impact	Benefit	Potential negative impact	Recommendation	Scale of Impact
Cumulative Pressures on Fisheries	Increased competition and space limitations for traditional fishers due to industrial expansion and exclusion zones lead to loss of livelihoods	-	Reduced fishing areas exacerbate socio-economic vulnerabilities for small-scale fishers including loss of livelihoods.	Implement (co-managed) marine spatial planning that recognises and integrates traditional fisheries. The first step would be for potential developments to support government to support, capacitate and resource existing Coastal Management Committees to function effectively. Facilitate dialogues marine stakeholders (including fishers) to balance interests and mitigate conflicts.	Regional, National

Aspect	Impact	Benefit	Potential negative impact	Recommendation	Scale of Impact
				Improve engagement with fisheries in project planning processes to ensure that livelihood activities are preserved. Introduce adaptive fishing practices and diversified livelihood options to build resilience to environmental and economic pressures.	
	Socio-cultural values and traditional fishing activities further erode under cumulative pressures (e.g., mining, oil and gas, port activities).	Promotes collaboration on just transitions and blue justice principles for local communities.	Loss of cultural heritage linked to fisheries and marine resource access.	Develop co-management frameworks to ensure cultural practices are protected and integrated into planning.	Local, Regional
	Resource competition driven by overlapping marine activities limits access to critical fishing areas.	-	Conflict between industrial users (e.g., mining and port activities) and traditional fishers may escalate.	Establish stakeholder dialogue platforms to resolve conflicts and align resource access priorities. Use GIS mapping to identify overlapping concessions and assess their impact on small-scale fishers. Develop marine zoning plans that prioritise access for traditional fishing communities. Create community-led monitoring initiatives to track spatial use changes and their impacts on fisheries. Establish feedback loops to refine zoning and management practices based on observations	Regional, National

6.3.3 Gentrification pressures

Impact/Aspect: The primary coastal livelihoods in the communities of interest near the proposed Boegoebaai development include agriculture, fishing, mining, and tourism (linked to conservation). While the building of infrastructure around the proposed SEZ may lead to the growth of secondary economic activities and possibly increase job opportunities, it could also have negative impacts on existing livelihoods and communities. Economic development of an area, without the concomitant growth of skills, capacities and opportunities for the resident population, could result in gentrification of the existing settlements, thereby squeezing and

potentially fragmenting communities. Should skilled, long-term labour be outsourced, it will likely then be these employees and newcomers to the area that will benefit the most from new flows of capital and become the focus of the new markets. Further, the squeeze on available ocean and coastal space (discussed in Section 3.2) may further constrain movement and activity of those who are dependent on coastal and ocean spaces for activities that sustain livelihoods, cultural practices and well-being (e.g. Van Zyl, 2009; Williams, 2021). Any development or new streams of income must maintain the established spaces and routes of movement for the resident community, as well as maintain this community as the focus for new service provision, housing expansion and job creation. This must be done to ensure that any benefits accrue directly to them and not be left to the idea of "trickle down" economics to benefit them indirectly and inconsistently.

The proposed development could affect existing coastal livelihoods in multiple, interrelated ways. Ecologically sensitive marine ecosystems may be disrupted, threatening key species such as WCRL and snoek, and diminishing the viability of downstream small-scale fisheries. Overlapping land use could limit available grazing land for local farmers, while continued restrictions on access to the Boegoebaai area risk perpetuating a legacy of land dispossession for the Richtersveld community. Although improved infrastructure may enhance market access and strengthen economic opportunities in agriculture, livestock, and resource extraction, the actual benefits depend on how goods are transported and whether they extend beyond energy-related industries. Additionally, an influx of newcomers drawn by employment prospects could boost local housing markets and service providers, but if skills development and local sourcing are neglected, local communities may be marginalised, facing rising costs for housing and services and potential displacement. Tourism might also experience both gains and losses: while greater accessibility could spur hospitality and retail growth, environmentally sensitive areas like the lichen fields near Alexander Bay may be harmed, undermining the region's long-term tourism appeal. The impact of these pressures on the socio-cultural fabric of these communities must not be overlooked, with a real risk of irreversibly transforming the nature of the community.

Mitigation approach: Focus on protecting traditional coastal access, strengthening local skill sets, integrating affordable housing solutions, preserving cultural heritage, and safeguarding sensitive marine ecosystems. This includes creating protected zones for traditional livelihoods, fostering local capacity-building initiatives, securing land rights for indigenous and local populations, and ensuring that infrastructure and tourism developments adhere to ecological standards. Through inclusive community engagement and participatory planning, decision-making processes will incorporate local voices, uphold socio-cultural integrity, and maintain equitable access to resources, ensuring that ongoing economic growth aligns with the long-term interests of coastal communities.

Recommendations: Explore how to establish transparent governance frameworks within the scope of cross-cutting planning processes. These frameworks must prioritise community well-being, designing benefit-sharing mechanisms that reinvest economic gains into local education, healthcare, and infrastructure, and promote sustainable, eco-friendly activities that preserve cultural landscapes and marine habitats. Here, the implementation of long-term, people-centred policies and practices that value local knowledge, protect resource rights, and guide development agendas towards inclusive and environmentally responsible outcomes must be prioritised (also see Section 3.4).

Table 6-10 outlines specific recommendations related to gentrification pressures potentially stemming from the proposed development in the communities of interest.

Table 6-10: Specific recommendations related to gentrification pressures on local communities in the area of interest*.

Aspect	Impact	Benefit	Potential Negative Impacts	Recommendation	Scale of Impact
Infrastructure Development	Increased tourism and new employment opportunities may attract external investors and newcomers.	Potential boost for local businesses (hospitality, retail, crafts) if integrated with existing communities.	Without inclusive development, local traditions and vulnerable ecosystems may be overlooked, reducing the long-term viability of tourism and limiting local benefit.	Preserve ecologically sensitive areas and promote sustainable tourism strategies that integrate local cultural identity. Ensure training and hiring prioritise local residents, preventing external labour displacement.	Local, Regional
Equitable Housing Policies	Enhanced demand for housing due to economic growth can push property prices and rental costs beyond the reach of long-term residents.	Stabilised and affordable housing can maintain community cohesion and ensure locals benefit from development. Increased property values can benefit existing property owners.	Gentrification – increasing pressure on existing residents (especially in related to rising costs) can force people to sell and move eroding social networks and cultural heritage.	Implement rent stabilisation, accessible housing schemes, and policies prioritising local residents in new developments to mitigate gentrification pressure on housing. Encourage and capacitate community participation in housing decisions to maintain socio-cultural integrity.	Local, Regional
Market Access	Improved infrastructure can enhance access to wider markets for locally produced goods.	Greater economic viability for small-scale producers and coastal livelihoods if inclusion is ensured.	Large-scale industry interests may sideline small local businesses, reducing their market share and weakening community resilience.	Design SEZ infrastructure with local economic participation requirements, including training and capacity-building for local producers. Provide direct support to small businesses to prevent marginalisation.	Regional, National
Community Identity	Influx of newcomers may dilute local traditions, practices, and socio-cultural identity.	Inclusive growth can foster cultural exchange and economic integration if managed responsibly.	Marginalisation occurs if new opportunities primarily benefit outsiders, causing loss of cultural practices and community cohesion.	Conduct comprehensive assessments of cultural traditions, integrate these into spatial planning, and ensure decision-making processes involve local voices. Preserve cultural assets through heritage programmes and community-led planning.	Local, Regional
Coastal Livelihoods	Overlapping SEZ development can restrict access to traditional coastal and grazing lands.	Improved infrastructure could broaden economic opportunities if local needs are prioritised. Additional fresh water supply required for the towns and municipalities should the development go ahead presents an	Loss of access undermines traditional practices (e.g., fishing, small-scale farming), leading to reduced incomes and cultural erosion.	Include local farmers and fishers in SEZ planning; guarantee safe, equitable public access to coastal public property by designating and maintaining coastal access land and integrating access routes and points into municipal by-laws and zoning; secure all-weather access to landing and market	Local

Aspect	Impact	Benefit	Potential Negative Impacts	Recommendation	Scale of Impact
		opportunity for alternative and supplementary livelihoods activities that such as on-land freshwater aquaculture.		points; protect ecosystems and coastal water quality; and consider alternative livelihood opportunities such as aquaculture.	

**These recommendations are explicitly framed to be consistent with South Africa's Draft National Coastal Management Programme 2025–2030 (DFFE, 2025).*

6.3.4 Communities as collaborators

Impact/Aspect: Effective and equitable development planning in complex social-ecological contexts requires a transdisciplinary development planning[11] approach that engages communities as active collaborators rather than passive recipients. Early, proactive, and responsive participation ensures that decision-making processes incorporate local priorities and knowledge systems, rather than imposing top-down interventions that risk overlooking or ignoring underlying social and environmental challenges. This approach is particularly relevant for marginalised groups - such as fishing, agricultural, and mining communities - whose livelihoods and cultural practices depend on equitable resource access and long-term sustainability. Importantly, it is crucial for building equitable, resilient communities[12].

Mitigation approach: We advocate for an approach that goes beyond the reactive stakeholder engagement process mandated by ESIAs to consider communities as collaborators. Communities should be included from the project design stage, where their needs must be specifically incorporated in planning processes. It is important to recognise that community needs differ, and there is no one-size-fits-all approach. Nuanced strategies must be introduced into the development planning process to ensure flexibility and reflection in project design, planning and execution. This collaborative process should begin at the scoping stage. By integrating local perspectives, diverse knowledge systems, and priorities from the outset, decision-making becomes more inclusive, context-appropriate, and resilient to socio-environmental uncertainties. Embedding meaningful community engagement early on also enables project planning to more effectively balance economic, social, and environmental objectives.

Practical measures include taking a transdisciplinary development planning approach by establishing multi-stakeholder platforms that bring together government agencies, private sector partners, civil society organisations, and local communities. These forums facilitate ongoing dialogue, transparent decision-making, and shared accountability mechanisms, ensuring that resource allocation and benefit distribution are both equitable and well-founded. Additionally, grievance redressal systems, capacity-building

[11] Transdisciplinary development planning is a collaborative approach to planning that transcends traditional disciplinary silos by engaging directly with societal stakeholders in knowledge co-production to address complex, multi-dimensional development challenges in an integrated, holistic manner.(Toomey *et al.*, 2015; Craps, 2020)

[12] Resilient and empowered coastal community communities are characterised by inclusive, adaptive governance where diverse local actors participate in decision-making processes and influence outcomes ((Jentoft and Chuenpagdee, 2009; Bennett *et al.*, 2019). Livelihoods are diversified and not overly reliant on extractive resource use, supporting economic resilience through complementary activities such as small-scale aquaculture, ecotourism, and value-added production (Allison and Ellis, 2001; Blythe *et al.*, 2020). Social cohesion, traditional knowledge systems, and strong local institutions foster collective action and shared stewardship of marine and coastal ecosystems (Adger, 2003; Ostrom, 2009).

Empowerment in these communities extends beyond access to resources and includes political voice, tenure security, and the ability to shape the terms of engagement with state and market actors (Coulthard *et al.*, 2011). Communities are actively involved in ecosystem-based management and restoration, such as through locally managed marine areas and co-management frameworks that blend scientific and local knowledge (Olsson *et al.*, 2004; Gutiérrez *et al.*, 2011). Infrastructure and risk preparedness are designed with long-term climate risks in mind, supported by early warning systems, disaster plans, and social protection (Levine *et al.*, 2012). In essence, resilient and empowered coastal communities do not merely cope with change—they shape it, through agency, learning, and collective action.

programmes, and inclusive environmental monitoring frameworks can prevent conflicts, incorporate local expertise, and strengthen trust. In practice, this type of transdisciplinary development planning involves acknowledging and integrating traditional and indigenous knowledge into project strategies from the outset, thereby enhancing cultural relevance and resilience(Lang *et al.*, 2012; Norström *et al.*, 2020). Tailored engagement with different stakeholder groups – whether supportive, uncertain, or oppositional – can pre-empt misunderstandings and disputes. Frequent monitoring, coupled with adaptive management, ensures that stakeholder perspectives continually inform the project's direction.

An integrated approach leads to more equitable, effective, and sustainable outcomes.

Recommendations: Creating a sustainable and inclusive project framework requires a comprehensive approach to stakeholder engagement. By viewing communities as genuine partners throughout planning and implementation, local buy-in and ensuing collaborative engagement is enhanced, benefits are distributed more fairly, and development pathways become more enduring and appropriate to the specific social-ecological context. We suggest, in Table 6-11 key strategies and specific recommendations related to fostering meaningful collaboration within the communities of interest. This is to ensure a stakeholder engagement process that ensures that all voices are heard and respected, fostering collaboration and trust while achieving meaningful outcomes.

Table 6-11: Specific recommendations related to fostering meaningful collaboration with communities.

Aspect	Impact	Benefit	Recommendation	Scale of Impact
Limited representation of marginalised groups in stakeholder Engagement	Marginalised communities are disproportionately negatively impacted.	Strengthens democratic processes through inclusivity.	Establish multi-stakeholder platforms such as community advisory councils to co-design, consult with and monitor projects; ensuring these bodies are structured to support shared authority, mutual accountability, and recognition of diverse knowledge systems.	Local, Regional
Miscommunication and mistrust among stakeholders due to lack of transparency	Mistrust leads to resistance and dissatisfaction.	Clear, accessible communication builds trust and ensures inclusivity.	Use public forums, newsletters, and translated materials for effective engagement, ensuring materials are accessible, culturally relevant, and delivered through trusted communication channels that support broad understanding and participation.	Local, Regional, National
Stakeholder rights unprotected without legal support (need for legal advocacy).	Vulnerable & marginalised stakeholders remain exploited.	Equitable treatment through advocacy and legal safeguards.	Provide pro bono legal services, training, and collaboration with NGOs to strengthen community agency, build legal literacy, and ensure that marginalised groups can access representation, assert their rights, and participate fully in	Local, Regional

Aspect	Impact	Benefit	Recommendation	Scale of Impact
			regulatory and governance processes.	
Requirement for cultural sensitivity as a there is a lack of respect for local customs and practices.	Cultural misunderstandings create tensions and resistance.	Aligning project strategies with community values enhances trust.	Conduct cultural impact assessments and integrate traditional decision-making processes to ensure proposed development respects spiritual, cultural and historical values whilst aligning with existing governance structures that reflect Indigenous and local worldviews.	Local, Regional
Lack of grievance mechanisms undermines project legitimacy and accountability.	Stakeholder dissatisfaction grows due to unaddressed concerns.	Transparency and clear accountability mechanisms build stakeholder trust.	Establish independent monitoring committees and third-party mediators for conflict resolution to ensure neutrality, transparency, and accountability in addressing disputes, while respecting local conflict resolution practices.	Local, Regional
Need to establish long-term partnerships as short-term engagement erodes stakeholder confidence	Lack of sustained dialogue weakens community trust	Ongoing collaboration supports project sustainability beyond its duration.	Develop resilience programs and maintain continuous dialogue post-project completion. This can be done by institutionalising long-term support mechanisms that address social, environmental and economic vulnerability, and ensuring that communities remain engaged in adaptive governance processes.	Local, Regional
Marginalised groups remain unheard without effective intermediaries (requirement for bridging stakeholders)	Partnering with bridging organizations fosters inclusive participation.	Gaps between powerful and underrepresented groups persist.	Leverage bridging organisations to mediate disputes and amplify marginalised voices, drawing on their capacity to connect communities with decision-makers, translate across knowledge systems, and support inclusive governance structures	Local, Regional, National
Emerging stakeholder concerns are ignored without effective feedback mechanisms	Regular feedback ensures responsiveness to stakeholder needs.	Ignoring concerns reduces trust and satisfaction among stakeholders.	Conduct periodic surveys, focus groups and adapt plans based on ongoing feedback, ensuring that development remains	Local, Regional

Aspect	Impact	Benefit	Recommendation	Scale of Impact
without clear and continuous feedback			responsive to emerging needs, values and concerns through cyclical and participatory learning mechanisms.	
Lack of clear accountability mechanisms undermines stakeholder trust	Transparent governance ensures equitable resource allocation and project support.	Unaddressed accountability concerns erode confidence in project outcomes.	Introduce public reporting, community-led monitoring, and independent audits of governmental and private actions to foster transparency, enhance credibility, and institutionalise accountability through participatory oversight structures.	Local, Regional

6.4 SUMMARY

The proposed Boegoebaai Port and SEZ development represents both an economic opportunity for South Africa's Northern Cape and a critical test of how to achieve truly equitable and sustainable marine and coastal development. Although the initiative aligns with national efforts to facilitate a just energy transition, it also highlights the complexities of balancing economic growth with the preservation of (marine) ecosystems, cultural integrity, and the livelihoods of local communities. The interplay between ecological conservation, socio-economic equity, and cultural heritage preservation emerges as central to the project's long-term success.

While the proposed development offers potential benefits, it also introduces notable potential negative impacts, particularly for often marginalised and vulnerable groups such as small-scale fishers. Disruptions to traditional livelihoods, habitat degradation, and the intensification of competition for marine resources pose serious challenges to this group. These negative impacts are amplified by existing governance gaps caused by complicated marine legislative framework that gives rise to implementation gaps and a tendency for ESIAs to focus narrowly on individual projects rather than adopting a holistic, cumulative perspective that examines cross-cutting impacts and social-ecological system interactions. Aligning the requirements for stakeholder engagement in ESIAs as mandated by various regulatory frameworks are essential, as is the need to move beyond minimum legal standards and address the cumulative, system-wide implications of large-scale infrastructure projects.

To navigate these challenges, the development requires an integrated governance framework that harmonises national objectives with local priorities. This requires ensuring that those directly affected by the project have a meaningful voice throughout planning and decision-making processes, including the incorporation of Indigenous knowledge and the protection of cultural traditions. Interventions such as co-management arrangements, habitat restoration initiatives, and support for alternative and supplementary livelihoods can help mitigate negative outcomes while strengthening resilience. Equally important is the establishment of transparent and inclusive engagement mechanisms that build trust and capacity, address power imbalances, and reinforce the project's legitimacy.

Moving forward, the proposed development must ensure that efforts to promote economic growth are matched by robust measures to safeguard environmental integrity, social cohesion, and cultural continuity. By adopting holistic planning strategies, closing governance gaps, and embedding equity into all aspects of environmental and social assessment, the project can serve as a benchmark for sustainable marine and coastal development. This approach is vital to achieving just outcomes and ensuring that the benefits of the Boegoebaai development are both enduring and equitably shared.

6.5 REFERENCES

Adger, W. N. 2003. Social Capital, Collective Action, and Adaptation to Climate Change. Economic Geography, 79: 387–404.

Allison, E. H., and Ellis, F. 2001. The livelihoods approach and management of small-scale fisheries. Marine Policy, 25: 377–388.

Allison, E. H., Adger, W. N., Badjeck, M. C., Brown, K., Conway, D., Dulvy, N. K., Halls, A., *et al.* 2005. Effects of climate change on the sustainability of capture and enhancement fisheries important to the poor: analysis of the vulnerability and adaptability of fisherfolk living in poverty. Final Technical Report. Marine Resources Assessment Group, London, UK.

Baker, E., Gaill, F., Karageorgis, A. P., Lamarche, G., Narayanaswamy, B., Parr, J., Raharimananirina, C., *et al.* 2016. Offshore Mining Industries. *In* The United Nations (UN) integrated marine assessment. United Nations.

Barange, M., Pillar, S. C., and Hampton, I. 1998. Distribution patterns, stock size and life-history strategies of Cape horse mackerel *Trachurus trachurus capensis*, based on bottom trawl and acoustic surveys. South African Journal of Marine Science, 19: 433–447. Taylor & Francis.

Berkes, F., and Folke, Carl. 1998. Linking Social and Ecological Systems: Management Practices and Social mechanisms for building resilience. Cambridge University Press.

Berkes, F. 2017. Environmental governance for the Anthropocene? Social-ecological systems, resilience, and collaborative learning. Sustainability, 9.

Blamey, L. K., Shannon, L. J., Bolton, J. J., Crawford, R. J. M., Dufois, F., Evers-King, H., Griffiths, C. L., *et al.* 2015. Ecosystem change in the southern Benguela and the underlying processes. Journal of Marine Systems, 144: 9–29.

Blythe, J., Armitage, D., Alonso, G., Campbell, D., Esteves Dias, A. C., Epstein, G., Marschke, M., *et al.* 2020. Frontiers in coastal well-being and ecosystem services research: A systematic review. Ocean and Coastal Management, 185: 105028. Elsevier Ltd.

Bouamrane, M., Spierenburg, M., Agrawal, A., Boureima, A., Cormier-Salem, M. C., Etienne, M., Le Page, C., *et al.* 2016. Stakeholder engagement and biodiversity conservation challenges in social-ecological systems: some insights from biosphere reserves in Western Africa and France. Ecology and Society, 21. Resilience Alliance.

Brick, K., and Hasson, R. 2016. Valuing the socio-economic contribution of fisheries and other marine uses in South Africa. Cape Town: University of Cape Town.

Britz, P., Sauer, W., Mather, D., and Philips, L. 2000. Towards equity, sustainability and stability: a sector planning approach to fishing and mariculture development in the Northern Cape Province, South Africa. *In* Proceedings of the Tenth Biennial Conference of the International Institute of Fisheries Economics and Trade. Oregon, USA.

Capmarine. 2017. Spatial distribution of West Coast fisheries in relation to Alexkor's marine mining concession areas. Capricorn Marine Environmental (Pty) Ltd. https://sahris.sahra.org.za/sites/default/files/additionaldocs/Appendix2_4_Fisheries_Spatial_Distribution.pdf (Accessed 7 October 2024).

Cash, D. W., Adger, W. N., Berkes, F., Garden, P., Lebel, L., Pritchard, L., Young, O., *et al.* 2006. Scale and Cross-Scale Dynamics: Governance and Information in a Multilevel World. Ecology and Society, 11: 8.

Christiansen, B. 2021, October 13. The slow squeeze on Port Nolloth's fishermen — walled in and fenced out by mining. https://www.dailymaverick.co.za/article/2021-10-13-the-slow-squeeze-on-port-nolloths-fishermen-walled-in-and-fenced-out-by-mining/ (Accessed 24 August 2024).

Clark, B. M., Hauck, M., Harris, J. M., Salo, K., and Russell, E. 2002. Identification of subsistence fishers, fishing areas, resource use and activities along the South African coast. African Journal of Marine Science, 24: 425–437.

Coetzee, J. C., de Moor, C. L., and Butterworth, D. S. 2019. A summary of the South African sardine (and anchovy) fishery. MARAM/IWS/2019/Sardine/BG1. University of Cape Town, Rondebosch. https://open.uct.ac.za/server/api/core/bitstreams/1373fadb-9d9c-4e33-92e3-d026f94e8fa6/content.

Coulthard, S., Johnson, D., and McGregor, J. A. 2011. Poverty, sustainability and human wellbeing: A social wellbeing approach to the global fisheries crisis. Global Environmental Change, 21: 453–463.

Cox, M., Villamayor-Tomas, S., Epstein, G., Evans, L., Ban, N. C., Fleischman, F., Nenadovic, M., *et al.* 2016. Synthesizing theories of natural resource management and governance. Global Environmental Change, 39: 45–56. Elsevier Ltd.

Craps, M. 2020. Transdisciplinary Processes for Sustainable Development. *In* Encyclopedia of Sustainability in Higher Education, pp. 1–9. Ed. by W. Leal Filho. Springer International Publishing, Cham. https://doi.org/10.1007/978-3-319-63951-2_102-1.

Crawford, R., Shannon, L., and Pollock, D. 1987. The Benguela ecosystem. Part IV: the major fish and invertebrate resources. Oceanogr. Mar. Biol. Ann. Rev.: 353–505.

Cvitanovic, C., Hobday, A. J., Kerkhoff, L. V., Wilson, S. K., Dobbs, K., and Marshall, N. 2015. Improving knowledge exchange among scientists and decision-makers to facilitate the adaptive governance of marine resources: A review of knowledge and research needs. Ocean & Coastal Management, 112: 25–35.

DAFF. 2012. Policy for the small-scale fisheries sector in South Africa. 474.

DAFF. 2016. Status of the South African Marine Fishery Resources 2016. Pretoria, South Africa.

Daily, G. 1997. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington D.C. 392 pp.

de Vos, A., Aluwihare, L., Youngs, S., Di Benedetto, M. H., Ward, C. P., Michel, A. P. M., Colson, B. C., *et al.* 2022. The M/V X-Press pearl nurdle spill: contamination of burnt plastic and unburnt nurdles along Sri Lanka's beaches. ACS Environmental Au, 2: 128–135. American Chemical Society.

DEFF. 2018. Fishing Rights Register for all Commercial Fishing Sectors. https://www.dalrrd.gov.za/Branches/Fisheries-Management/-Fishing-Rights-Allocation-Process-FRAP 20 October 2021.

DFFE. 2021. National Framework for Marine Spatial Planning in South Africa. Department of Forestry, Fisheries and the Environment, Cape Town, South Africa. https://www.dffe.gov.za/sites/default/files/docs/strategy.framework/oceans/marinespatialplanning_nationalframework2021.pdf.

DFFE. 2023a. Status of the South African Marine Fishery Resources 2023. Department of Forestry, Fisheries and the Environment. https://api.odp.saeon.ac.za/catalog/SAEON/go/10.15493/DFFE.10000006 (Accessed 12 October 2024).

DFFE. 2023b. General published reasons for decisions on appeal: Traditional Linefish sector Fishing Right Allocation Process 2021/2022.

DFFE. 2025. The National Coastal Management Programme of South Africa: 2025-2030.

Dorrington, R. A., Lombard, A. T., Bornman, T., Adams, J. B., Cawthra, H. C., Deyzel, S., Goschen, W. S., *et al.* 2018. Working together for our oceans: a Marine Spatial Plan for Algoa Bay, South Africa. South African Journal of Science, 114: 1–6.

Duggan, G. L., Jarre, A., and Murray, G. 2020. Alternative Seafood Marketing in a Small-Scale Fishery: Barriers and Opportunities in South Africa's Southern Cape Commercial Linefishery. Maritime Studies, 19: 193–205. Maritime Studies.

Eggers, J., Cochrane, K., and Sauer, W. 2022. Estimating the economic income and social contributions derived from the South African west coast rock lobster fishery. African Journal of Marine Science, 44: 255–269.

FAO. 2014. Voluntary guidelines for securing sustainable small-scale fisheries in the context of food security and poverty eradication. Food and Agricultural Organisation, Rome. 18 pp.

Foley, P., Pinkerton, E., Wiber, M., and Stephenson, R. 2020. Full-spectrum sustainability: an alternative to fisheries management panaceas. Ecology and Society, 25. The Resilience Alliance. https://www.ecologyandsociety.org/vol25/iss2/art1/.

Folke, C., Hahn, T., Olsson, P., and Norberg, J. 2005. Adaptive governance of social–ecological systems. Annual Review of Environment and Resources, 30: 441–473.

Fowler, J. L., and Boyd, A. J. 1998. Transport of anchovy and sardine eggs and larvae from the western Agulhas bank to the west coast during the 1993/94 and 1994/95 spawning seasons. African Journal of Marine Science, 19: 23–38.

Gaasland, I., Straume, H.-M., and Vårdal, E. 2020. Agglomeration and trade performance–evidence from the Norwegian salmon aquaculture industry. Aquaculture Economics & Management, 24: 181–193. Taylor & Francis.

Gadd, A. 2024. History of Kleinzee, Northern Cape, South Africa. https://southafrica.co.za/history-kleinzee.html (Accessed 5 November 2024).

Gammage, L., and Jarre, A. 2020. Using structured decision-making tools with marginalised fishers to promote system-based fisheries management approaches. Frontiers in Marine Science, 7.

Gammage, L., Jarre, A., and Mather, C. 2021. Failing to plan is planning to fail: lessons learned from a small-scale scenario planning process with marginalized fishers from South Africa's southern Cape. Ecology and Society, 26. The Resilience Alliance.

Gammage, L. C., Jarre, A., and Mather, C. 2017. A case study from the southern Cape linefishery 1: The difficulty of fishing in a changing world. South African Journal of Science, 113: 1–8. Academy of Science of South Africa.

Gibson, C., Ostrom, E., and Ahn, T. K. 2000. The Concept of Scale and the Human Dimensions of Global Change. Ecological Economics, 32: 217–239.

Goble, B. J., Lewis, M., Hill, T., and Phillips, M. R. 2014. Coastal Management in South Africa: Historical perspectives and setting the stage of a new era. Ocean & Coastal Management, 91: 32–40.

Griffiths, C. L., Robinson, T. B., Lange, L., and Mead, A. 2010. Marine Biodiversity in South Africa: An Evaluation of Current States of Knowledge. PLoS ONE, 5: e12008.

Griffiths, M. H. 2002. Life history of South African snoek, *Thyrsites atun* (Pisces: Gempylidae): a pelagic predator of the Benguela ecosystem. Fishery Bulletin, 100: 690–711. National Marine Fisheries Service.

Grüss, A., Yemane, D., and Fairweather, T. 2016. Exploring the spatial distribution patterns of South African Cape hakes using generalised additive models. African Journal of Marine Science, 38: 395–409.

Gutiérrez, N. L., Hilborn, R., and Defeo, O. 2011. Leadership, social capital and incentives promote successful fisheries. Nature, 470: 386–389.

Hara, M., Greenberg, S., Thow, A. M., and Chimarito, S. 2017. Trade and investment in fish and fish products between South Africa and the rest of SADC: implications for food and nutrition security'. Working Paper 47. PLAAS, UWC, Cape Town. https://uwcscholar.uwc.ac.za:8443/server/api/core/bitstreams/1b603071-714c-41fb-b73f-49f95ff9970d/content.

Harris, L. R., Holness, S. D., Finke, G., Amunyela, M., Braby, R., Coelho, N., Gee, K., *et al.* 2022. Practical marine spatial management of ecologically or biologically significant marine areas: emerging lessons from evidence-based planning and implementation in a developing-world context. Frontiers in Marine Science, 9: 1–25.

Horton, M., Parker, D., Winker, H., Lamberth, S., Hutchings, K., and Kerwath, S. 2019. Age, growth and per-recruit stock assessment of southern mullet *Chelon richardsonii* in Saldanha Bay and Langebaan Lagoon, South Africa. African Journal of Marine Science, 41: 313–324.

Huggett, J. A., Boyd, A. J., Hutchings, L., and Kemp, A. D. 1998. Weekly variability of clupeoid eggs and larvae in the Benguela jet current: implications for recruitment. African Journal of Marine Science, 19: 153–164.

Human, L. 2021, December 15. Meet the woman at the centre of Port Nolloth's crayfish trade. https://groundup.org.za/article/meet-the-woman-at-the-centre-of-port-nolloths-crayfish-trade/ (Accessed 1 December 2024).

Hutchings, L., Beckley, L. E., Griffiths, M. H., Roberts, M. J., Sundby, S., and Van Der Lingen, C. 2002. Spawning on the edge: spawning grounds and nursery areas around the southern African coastline. Marine and Freshwater Research, 53: 307–318.

Hutchings, L., van der Lingen, C. D., Shannon, L. J., Crawford, R. J. M., Verheye, H. M. S., Bartholomae, C. H., van der Plas, A. K., *et al.* 2009. The Benguela Current: An ecosystem of four components. Progress in Oceanography, 83: 15–32. Pergamon.

IPBES. 2018. The IPBES regional assessment report on biodiversity and ecosystem services for Africa. Zenodo. https://zenodo.org/records/3236178 (Accessed 16 May 2025).

Isaacs, M. 2013. Small-scale fisheries governance and understanding the Snoek (*Thyrsites atun*) supply chain in the Ocean View fishing community, Western Cape, South Africa. Ecology and Society, 18: 17.

Jansen, T., Kainge, P., Singh, L., Wilhelm, M., Durholtz, D., Strømme, T., Kathena, J., *et al.* 2015. Spawning patterns of shallow-water hake (*Merluccius capensis*) and deep-water hake (*M. paradoxus*) in the Benguela Current Large Marine Ecosystem inferred from gonadosomatic indices. Fisheries Research, 172: 168–180.

Japp, D., and Wilkinson, S. 2021. Environmental impact assessment for marine prospecting activities in South African sea areas 14B, 15B and 17B West Coast, South Africa. Commercial fisheries assessment, Belton Park Trading: Concession 14b, 15b, 17b. SLR.

Jarre, A., Ragaller, S. M., and Hutchings, L. 2013. Long-term, ecosystem-scale changes in the southern Benguela marine pelagic social-ecological system: Interaction of natural and human drivers. Ecology and Society, 18: 55. Resilience Alliance Inc.

Jarre, A., Hutchings, L., Kirkman, S. P., Kreiner, A., Tchipalanga, P., Kainge, P., Uanivi, U., *et al.* 2015. Synthesis: Climate effects on biodiversity, abundance and distribution of marine organisms in the Benguela. Fisheries Oceanography, 24: 122–149.

Jarre, A., Shannon, L. J., Cooper, R., Duggan, G. L., Gammage, L. C., Lockerbie, E. M., McGregor, E. S., *et al.* 2018. Untangling a Gordian knot that must not be cut: Social-ecological systems research for management of southern Benguela fisheries. Journal of Marine Systems, 188: 149–159. Elsevier.

Kainge, P., Kjesbu, O., Thorsen, A., and Salvanes, A. 2007. *Merluccius capensis* spawn in Namibian waters, but do *M. paradoxus*? African Journal of Marine Science, 29: 379–392. Taylor & Francis.

Kidd, S., and Shaw, D. 2014. The social and political realities of marine spatial planning: Some land-based reflections. ICES Journal of Marine Science, 71: 1535–1541. Oxford University Press.

Lamberth, S., and Whitfield, AK. 2013. Southern mullet (*Liza richardsonii*). *In* Southern African marine linefish species profiles., pp. 125–127. Oceanographic Research Institute, Durban.

Lang, D. J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M., *et al.* 2012. Transdisciplinary research in sustainability science: practice, principles, and challenges. Sustainability Science, 7: 25–43.

Levine, S., Pain, A., Bailey, S., and Fan, L. 2012. The relevance of 'resilience'. Overseas Development Institute. https://www.rcrc-resilience-southeastasia.org/wp-content/uploads/2016/08/HPG_Policy_Brief_The_Relevance_of_Resilience.pdf.

Lombard, A. T., Ban, N. C., Smith, J. L., Lester, S. E., Sink, K. J., Wood, S. A., Jacob, A. L., *et al.* 2019. Practical Approaches and Advances in Spatial Tools to Achieve Multi-Objective Marine Spatial Planning. Frontiers in Marine Science, 6: 1–9. Frontiers Media S.A.

Malan, N. 2018. Review of Progress with Integrated Coastal Management in South Africa Since the Advent of Democracy. African Journal of Marine Science, 40: 121–136.

Marais, C. 2023. Alexander Bay: Memories of a diamond dorp on the West Coast. https://www.dailymaverick.co.za/article/2023-04-04-diamond-rush-the-precious-memories-of-a-diamond-dorp-on-the-west-coast/ (Accessed 11 December 2024).

Martins, I. M. M., Gammage, L. C. C., Jarre, A., and Gasalla, M. A. 2019. Different but similar? Exploring vulnerability to climate change in Brazilian and South African small-scale fishing communities. Human Ecology, 47: 515–526.

Masson, E. 2022, July 3. War for diamonds: toil and triumph on the rich barren plains. https://mg.co.za/news/2022-07-03-war-on-diamonds-toil-and-triumph-on-the-rich-barren-plains/ (Accessed 20 September 2024).

Masterson. 2021, October 10. The West Coast's oil and gas frenzy. https://protectthewestcoast.org/post/the-west-coasts-oil-and-gas-frenzy/ (Accessed 6 December 2024).

McCarthy, J., and Thomas, M. 2017. International and National Principles and Area Based Local Application for Sustainable Coastal Development. Journal of Coastal Zone Management, 20.

McGrath, A. 2024. Fisheries Specialist Assessment. *In* ESIA for Exploration Drilling in Block Northern Cape Ultra Deep, South Africa, p. 130. SLR Consulting (South Africa) Proprietary Limited. https://cdn.sanity.io/files/b0ecix6u/production/ab6b9a01ca0078658a6f52081bcf8144357371a4.pdf (Accessed 4 December 2024).

Mhlongo, N., Yemane, D., Hendricks, M., and van der Lingen, C. D. 2015. Have the spawning habitat preferences of anchovy (*Engraulis encrasicolus*) and sardine (*Sardinops sagax*) in the southern Benguela changed in recent years? Fisheries Oceanography, 24: 1–14.

Moloney, C. L., Fennessy, S. T., Gibbons, M. J., Roychoudhurye, A., Shillington, F. A., von der Heydene, B. P., and Watermeyer, K. 2013. Reviewing evidence of marine ecosystem change off South Africa. African Journal of Marine Science, 35: 427–448.

Municipalities of South Africa. 2024. Municipalities of South Africa: Northern Cape Municipalities. https://municipalities.co.za/provinces/view/7/northern-cape (Accessed 19 September 2024).

Namakwa District Municipality. 2023. Municipality Vulnerability Assessment and Climate Change Response Plan. Local Government Climate Change Support Program. https://www.namakwa-dm.gov.za/wp-content/uploads/2023/04/Northern-Cape-Climate-Change-Response-Plan-Namakwa-2023.pdf.

Namakwa-Info. 2024. Hondeklip Bay Travel Information. https://www.namakwa-info.co.za/region/town/521 (Accessed 29 October 2024).

Norström, A. V., Cvitanovic, C., Löf, M. F., West, S., Wyborn, C., Balvanera, P., Bednarek, A. T., *et al.* 2020. Principles for knowledge co-production in sustainability research. Nature Sustainability, 3: 182–190. Nature Publishing Group.

Northern Cape Provincial Government. 2024. Northern Cape Socio-Economic Review 2024.

Nortje, J. M., and van Wyk, B.-E. 2019. Useful plants of Namaqualand, South Africa: a checklist and analysis. South African Journal of Botany, 122: 120–135.

Norton, M. 2015. The militarisation of marine resource conservation and law enforcement in the Western Cape, South Africa. Marine Policy, 60: 338–344.

Olsson, P., Folke, C., and Berkes, F. 2004. Adaptive Comanagement for Building Resilience in Social–Ecological Systems. Environmental Management, 34: 75–90.

Ortega-Cisneros, K., Cochrane, K. L., Rivers, N., and Sauer, W. H. H. 2021. Assessing South Africa's Potential to Address Climate Change Impacts and Adaptation in the Fisheries Sector. Frontiers in Marine Science, 8. https://www.frontiersin.org/articles/10.3389/fmars.2021.652955 (Accessed 17 September 2023).

Ostrom, E. 2009. A General Framework for Analyzing Sustainability of Social-Ecological Systems. Science, 325: 419–423.

Partelow, S., and Winkler, K. J. 2016. Interlinking ecosystem services and Ostrom's framework through orientation in sustainability research. Ecology and Society, 21.

Penney, A. J., Krohn, R. G., and Wilke, C. G. 1992. A description of the South African tuna fishery in the. ICCAT Col. Vol. Sci. Pap 29, no. 1: 247–253.

Petrova, S., and Marinova, D. 2013. Social impacts of mining: Changes within the local social landscape. *In* Rural Society, pp. 153–165.

Plieninger, T., and Bieling, C. 2012. Resilience and the cultural landscape: understanding and managing change in human-shaped environments. Cambridge University Press.

Ramasar, V. 2004. Northern Cape State of the Environment Report 2004: Marine and Coast Specialist Report. Department of Tourism, Environment & Conservation, Pretoria, South Africa.

Rebelo, X. 2021. Sustainability, Disaster Risk Reduction and Climate Change Adaptation: Building From the Bottom Up – A South African Perspective from the Small-Scale Fisheries Sector: 151–181.

Rivers, N., Truter, H. J., Strand, M., Jay, S., Portman, M., Lombard, A. T., Amir, D., *et al.* 2022. Shared visions for marine spatial planning: Insights from Israel, South Africa, and the United Kingdom. Ocean & Coastal Management, 220: 106069.

Roche, C., and Bice, S. 2013. Anticipating social and community impacts of deep sea mining'. *In* Deep Sea Minerals and the Green Economy. Ed. by E. Baker and Y. Beaudoin. Secretariat of the Pacific Community (SPC), New Caledonia.

Roy, C., and Fréon, P. 2001. An empirical model of anchovy recruitment variability in the southern Benguela. Small pelagic fishes and climate change programme, GLOBEC Report No.16. Cape Town, South Africa.

Sales, J., and Britz, P. 2001. Research on abalone (*Haliotis midae L.*) cultivation in South Africa. Aquaculture Research, 32: 863–874.

Saunders, F., Gilek, M., Ikauniece, A., Tafon, R. V., Gee, K., and Zaucha, J. 2020. Theorizing social sustainability and justice in marine spatial planning: Democracy, diversity, and equity. Sustainability (Switzerland), 12. MDPI AG.

Seneviratne, S. I., Zhang, X., Adnan, M., Badi, W., Dereczynski, C., Di Luca, A., Ghosh, S., *et al.* 2023. Weather and climate extreme events in a changing climate. *In* Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)], 1st edn, pp. 1513–1766. Cambridge University Press, United Kingdom and New York.

https://www.cambridge.org/core/product/identifier/9781009157896/type/book (Accessed 13 December 2024).

Sink, K. J., Van Der Bank, M. G., Majiedt, P. A., Harris, L. R., Atkinson, L. J., Kirkman, S. P., and Karenyi, N. F. 2019. South African National Biodiversity Assessment 2018 Technical Report Volume 4: Marine Realm. South African National Biodiversity Institute. http://hdl.handle.net/20.500.12143/6372.

Soudens, C. 2022. Dear Barbara Creecy, how can we celebrate Women's Day when our women's and environmental rights are violated? https://www.dailymaverick.co.za/article/2022-08-04-dear-barbara-creecy-our-womens-and-environmental-rights-are-violated/ (Accessed 1 December 2024).

Sowman, M. 2011. New Perspectives in Small-Scale Fisheries Management: Challenges and Prospects for Implementation in South Africa. African Journal of Marine Science, 33: 297–311.

Sowman, M., Scott, D., Green, L. J. F., Hara, M. M., Hauck, M., Kirsten, K., and Paterson, B. 2013. Shallow waters: social science research in South Africa' s marine environment. African Journal of Marine Science: 37–41.

Sowman, M. 2020. Participatory and rapid vulnerability assessments to support adaptation planning in small-scale fishing communities of the Benguela current large marine ecosystem. Environmental Development: 100578. Elsevier B.V.

Sowman, M., and Sunde, J. 2021. A just transition? Navigating the process of policy implementation in small-scale fisheries in South Africa. Marine Policy, 132: 104683.

Sowman, M., and Sunde, J. 2024. Integrating environmental sustainability and social justice principles into South Africa's blue economy initiative: re-imagining the political economy of our ocean. Frontiers in Ocean Sustainability, 2. Frontiers. https://www.frontiersin.org/journals/ocean-sustainability/articles/10.3389/focsu.2024.1459496/full (Accessed 13 December 2024).

Standing, A. 2017. Criminality in Africa's Fishing Industry: A Threat to Human Security. Africa Center for Strategic Studies. http://www.africacenter.org/.

StatsSA. 2022. Statistics South Africa | Census Dissemination. https://census.statssa.gov.za/#/province/3/2 (Accessed 28 October 2024).

Stenevik, E. K., Verheye, H. M., Lipinski, M. R., Ostrowski, M., and Strømme, T. 2008. Drift routes of Cape hake eggs and larvae in the southern Benguela Current system. Journal of Plankton Research, 30: 1147–1156.

Stephenson, R. L., Hobday, A. J., Allison, E. H., Armitage, D., Brooks, K., Bundy, A., Cvitanovic, C., *et al.* 2021. The Quilt of Sustainable Ocean Governance: Patterns for Practitioners. Frontiers in Marine Science, 8.

Strand, M., Rivers, N., and Snow, B. 2022. Reimagining Ocean Stewardship: Arts-Based Methods to 'Hear' and 'See' Indigenous and Local Knowledge in Ocean Management. Frontiers in Marine Science, 9. Frontiers. https://www.frontiersin.org/journals/marine-science/articles/10.3389/fmars.2022.886632/full (Accessed 16 May 2025).

Strømme, T., Lipinski, M. R., and Kainge, P. 2016. Life cycle of hake and likely management implications. Reviews in Fish Biology and Fisheries, 26: 235–248.

Taljaard, S., van Niekerk, L., and Weerts, S. P. 2019. The legal landscape governing South Africa's coastal marine environment – helping with the 'horrendogram'. Ocean & Coastal Management, 178: 104801.

Teske, P. R., Emami-Khoyi, A., Golla, T. R., Sandoval-Castillo, J., Lamont, T., Chiazzari, B., McQuaid, C. D., *et al.* 2021. The sardine run in southeastern Africa is a mass migration into an ecological trap. Science Advances, 7: 34524856.

Toomey, A. H., Markusson, N., Adams, E., and Brockett, B. 2015. Inter- and Trans-disciplinary Research: A Critical Perspective. GSDR Brief.

Troell, M., Robertson-Andersson, D., Anderson, R. J., Bolton, J. J., Maneveldt, G., Halling, C., and Probyn, T. 2006. Abalone farming in South Africa: An overview with perspectives on kelp resources, abalone feed, potential for on-farm seaweed production and socio-economic importance. Aquaculture, 257: 266–281.

Tulier, M. E., Reid, C., Mujahid, M. S., and Allen, A. M. 2019. "Clear action requires clear thinking": A systematic review of gentrification and health research in the United States. Health & Place, 59: 102173.

United Nations. 1992. Assessment of the Environmental Impact of Port Development: A Guidebook for EIA of Port Development. New York. https://www.unescap.org/sites/default/files/pub_1234_fulltext.pdf.

van der Lingen, C. D., Hutchings, L., Merkle, D., Van der Westhuizen, J. J., and Nelson, J. 2001. Comparative spawning habitats of anchovy (Engraulis capensis) and sardine (Sardinops sagax) in the southern Benguela upwelling

ecosystem. Spatial processes and management of marine populations, 185, p.209. *In* Spatial Processes and Management of Marine Populations. University of Alaska Sea Grant., Anchorage, USA.

van der Lingen, C. D., and Huggett, J. A. 2003. The role of ichthyoplankton surveys in recruitment research and management of South African anchovy and sardine. *In* Proceedings of the 26th Annual Larval Fish Conference (Eds H.I. Browman & A. B. Skiftesvik), pp. 303–343. Institute of Marine Research, Bergen, Norway.

Van Zyl, M. 2009. Ocean, time and value: Speaking about the sea in Kassiesbaai. Anthropology Southern Africa, 32: 48–58. Taylor & Francis.

Vervoort, J. M., Rutting, L., Kok, K., Hermans, F. L. P., Veldkamp, T., Bregt, A. K., and van Lammeren, R. 2012. Exploring dimensions, scales, and cross-scale dynamics from the perspectives of change agents in social-ecological systems. Ecology and Society, 17.

Virapongse, A., Brooks, S., Metcalf, E. C., Zedalis, M., Gosz, J., Kliskey, A., and Alessa, L. 2016. A social-ecological systems approach for environmental management. Journal of Environmental Management, 178: 83–91. Elsevier Ltd.

Wilkinson, S., and Coppin, R. 2024. Specialist Fisheries Assessment. *In* Impact assessment for a prospecting right application for sea areas 11A,12A, West Coast, South AFrica. SLR Consulting.

Williams, S. 2021. 'I fish because I am a fisher': Exploring livelihood and fishing practices to justify claims for access to small scale fisheries resources in South Africa. HTS Teologiese Studies/Theological Studies, 77.

Woods Hole Oceanographic Institution. 2025. Currents, Gyres, & Eddies - Woods Hole Oceanographic Institution. https://www.whoi.edu/know-your-ocean/ocean-topics/how-the-ocean-works/ocean-circulation/currents-gyres-eddies/ (Accessed 16 May 2025).

Zaucha, J., and Gee, K. 2019. Maritime spatial planning: past, present, future. Palgrave Macmillan, Cham, Switzerland.

6.6 DIGITAL APPENDICES 6-1 & 6-2

SEPARATE DIGITAL DOCUMENTS

Appendix 6-1:	Stakeholder Typologies
Appendix 6-2:	Fisheries and Coastal Livelihoods

DIGITAL APPENDIX 6-1

Annex Report 1: Stakeholder Typology Report

Fisheries and Coastal Livelihoods Expert Group

Work Package 1

Boegoebaai Port Development and Special Economic Zone (SEZ) Strategic Environmental Assessment (SEA)

October 2024

Authors: Annastacia Mpala

Amethyst Independent Facilitation

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Abbreviations and Acronyms

ARMSCOR	Armaments Corporation of South Africa
BCLME	Benguela Current Large Marine Ecosystem
CEF	Central Energy Fund
CPA	Community Property Association
CRLS	Centre for Rural Legal Studies
CSIR	Council for Scientific and Industrial Research
CSO	Civil Society Organisations
DALRRD	Department of Agriculture, Land Reform and Rural Development
EIA	Environmental Impact Analysis
EMG	Environmental Monitoring Group
FPIC	Free, Prior and Informed Consent
GH2	Green Hydrogen
HDA	Housing Development Agency
LRC	Legal Resources Centre
Mintek	Council for Mineral Technology
NACI	National Advisory Council on Innovation
NCEDA	Northern Cape Economic Development, Trade and Investment Promotion Agency
NCHRA	Northern Cape Heritage Resources Authority
NDA	National Development Agency
NGO	Non-governmental Organisation
NPO	Non-profit Organization
RMC	Richtersveld Mining Company
TNPA	Transnet National Port Authority
NSRI	National Sea Rescue Institute
NYDA	National Youth Development Agency
OCM	Ocean and coastal mining
PSJV	Pooling and Sharing Joint Venture
SAASTA	South African Agency for Science and Technology Advancement
SAFCEI	Southern African Faith Communities Environment
SANDF	South African National Defence Forces
SANEDI	South African National Energy Development Institute
SDCEA	South Durban Community Environmental Alliance
SEZ	Special Economic Zone
SNA	Social Network Analysis
VEJA	Vaal Environmental Justice Alliance
WRC	Water Research Commission

CHAPTER 1: INTRODUCTION

Green hydrogen (GH2) is produced through electrolysis of water using renewable energy, offering a sustainable alternative to traditional hydrogen production methods reliant on fossil fuels like natural gas and coal. 96% of the 120 million tonnes of hydrogen produced annually is generated through carbon-intensive processes such as steam methane reforming and coal gasification (Bhagwat and Olczak, 2020; Vidas and Castro, 2021). Transitioning to carbon-neutral GH2 represents a significant step toward decarbonizing hydrogen-intensive industries like refining and ammonia production. Replacing "grey" hydrogen with GH2 could substantially reduce global CO2 emissions (Reda *et al.*, 2024). Beyond its existing applications, GH2 could serve as a versatile fuel for various transport sectors, including aviation, shipping, and heavy-duty vehicles. Its potential to supply heat to hard-to-abate industries positions GH2 as a key player in the transition to a sustainable energy future.

Globally, the European Union (EU) actively seeks collaborations with renewable-energy-rich regions, such as Africa, to meet its decarbonization targets. An estimated 24% of its total energy demand is projected to come from hydrogen by 2050 (Bhagwat and Olczak, 2020). Africa's vast renewable energy resources position it as a major player in the green hydrogen market. Joint projects between Germany and Morocco exemplify the potential for a hydrogen economy that supports local development, creates jobs, enhances energy security, and addresses sustainable development challenges (AbouSeada and Hatem, 2022). However, water availability remains a critical factor for GH2 production in Africa, given its significant water consumption.

While green hydrogen presents an opportunity to boost African economies, civil society organisations in South Africa have expressed concerns regarding potential negative impacts (H2 Watch SA, 2023). Key issues include implications for climate change, ecosystem sustainability, traditional livelihoods, and marine resources strain. The need for inclusive and participatory approaches that ensure fair and equitable outcomes for all stakeholders, particularly marginalised communities, is paramount. The proposed Boegoebaai Port and Special Economic Zone (SEZ) development has ignited significant concerns among local communities and civil society organisations. These groups have expressed deep reservations about the rapid expansion of GH2 projects in South Africa and their potential adverse effects on the marine environment, local fisheries, and coastal livelihoods.

In South Africa, the National Environmental Management Act No. 107 of 1998 mandates stakeholder inclusion in environmental governance, through engagement with Interested and Affected parties who will be impacted by a development. It is essential that interested and affected parties actively engage in evaluating project impacts on both communities and ecosystems (Maphanga *et al.*, 2023). This legislative framework is not merely a procedural requirement but a potential catalyst for positive change, strengthening democratic processes and addressing the disproportionate ecological burdens often borne by marginalised populations (Maphanga *et al.*, 2023). However, despite these legal provisions, significant concerns persist regarding the depth and effectiveness of stakeholder participation. Marginalised groups, particularly those within coastal and inland communities, frequently argue that public consultation processes in Social and Environmental Impact Assessments are inadequately conducted, leading to the continued marginalisation of their perspectives (Maphanga *et al.*, 2023).

1.1 Methodological approach

The development of stakeholder typologies and associated high-level stakeholder analysis underpins the situational analysis. This analysis was undertaken through a desktop approach using publicly available data and literature, which will be further supplemented with semi-structured key-expert interviews and ground-truthed through fieldwork where required.

1.1.1 Stakeholder analysis

For the stakeholder analysis, a systems-based approach (see Figure 1) was used as the project is embedded within a complex and interconnected system encompassing multiple factors:

- ***Social factors:*** encompassing local communities, Indigenous groups, labour unions, and social equity considerations.
- ***Economic factors:*** involving investors, financial institutions, supply chain partners, and regional economic development.
- ***Environmental factors*:** comprising regulatory bodies, environmental groups, and natural resource management agencies.
- ***Technological factors*:** encompassing equipment suppliers, research institutions, and technology developers.
- ***Political factors*:** including government agencies, policymakers, and regulatory bodies.

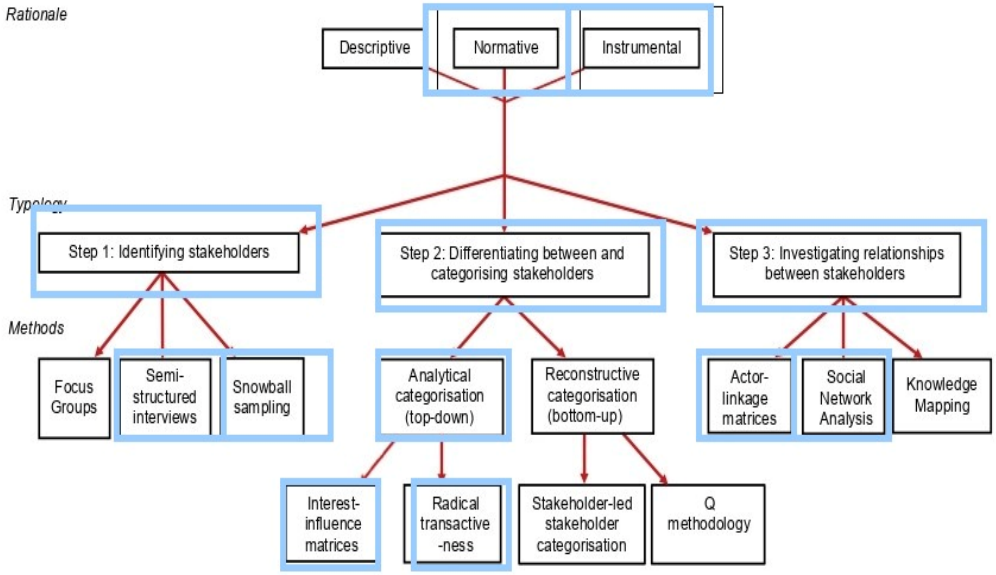


Figure 1. General methodological approach for the stakeholder analysis process (adopted from Reed et al. (2009))

Adopting a systems-based perspective enables a comprehensive approach to stakeholder identification, facilitating the recognition of interconnected groups that may not be immediately apparent (Gammage and Strand, 2021). This holistic view allows for a detailed analysis of stakeholder interactions, influences, and the project's broader potential impacts. By understanding these complex dynamics, tailored engagement strategies can be developed to address various stakeholder groups' diverse needs and interests. Ultimately, a systems-based approach enhances the capacity to effectively manage stakeholder relationships and navigate the challenges inherent in green hydrogen project development (see Figure 2 and Figure 3 below).

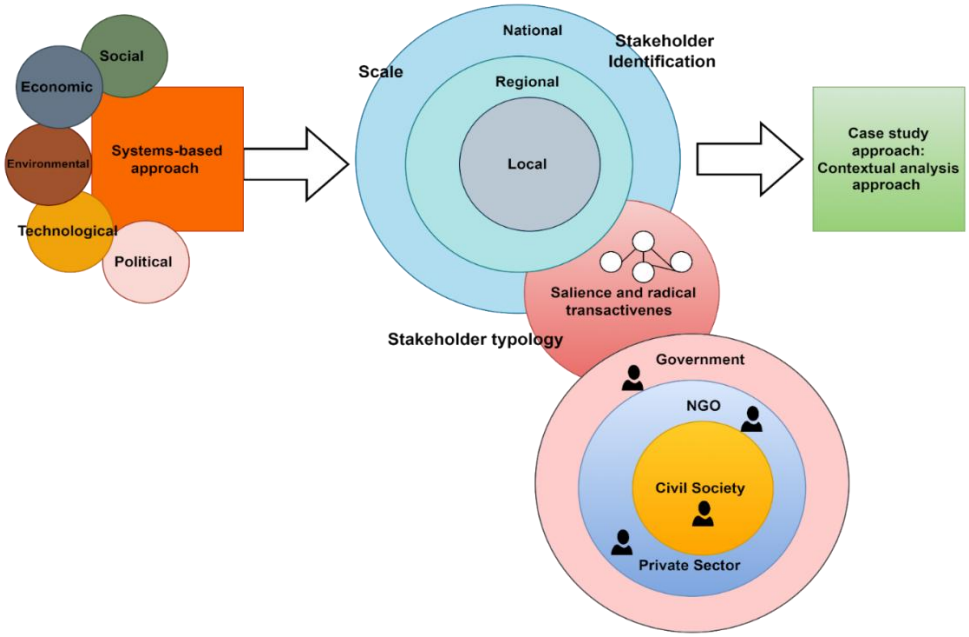


Figure 2. A systems-based approach to stakeholder identification and mapping

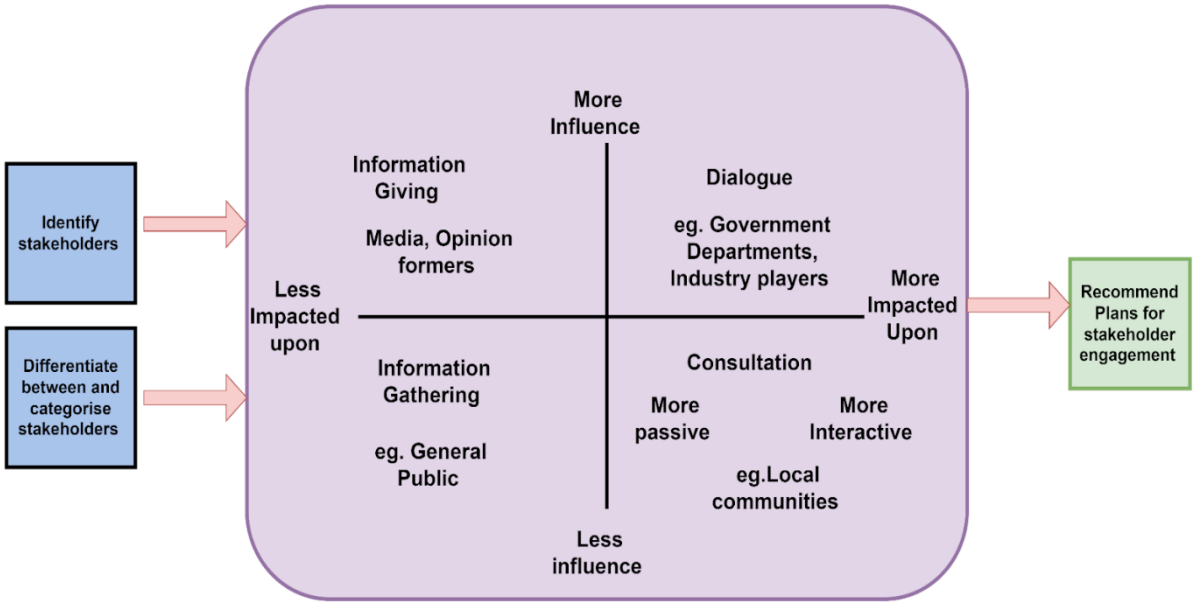


Figure 3. Identification of stakeholders and stakeholder analysis grid. Adapted from Golder and Gawler (2005) and Reed et al. (2009)

This research was conducted with a conscious and critical examination of our role, biases, and assumptions throughout the research process. It was a continuous reflection and critical analysis process to ensure the research was as objective and rigorous as possible. Data collection was mainly constrained by the limitations inherent in a desktop study. Here, we provide an overview of the key methodological steps, focusing on stakeholder identification and categorisation.

1.1.2 Stakeholder identification

The first step was to identify relevant governmental entities (national, provincial, and local levels), corporate and industrial actors, community groups, indigenous populations, environmental organisations, economic development bodies, educational and social service providers, labour unions, and civil society organisations within communities of interest (Alexander Bay, Port Nolloth, Kleinzee, and Hondeklipbaai).

Data sources: A preliminary data collection phase was conducted to develop a comprehensive stakeholder landscape, drawing on third-party sources. These sources included published research, government directories, national and provincial socio-economic and environmental reports, a master stakeholder typology designed by Gammage and Strand (2021), district-level municipal environmental and community plans, industry reports from business chambers, online industrial workshops, news articles addressing the towns' fishing challenges (SABC), insights from coastal establishments, social media platforms featuring tourism or community profiles, and key expert opinions.

To identify potential stakeholders overlooked in initial desktop research, Environmental Impact Assessments (EIAs), and databases, we engaged with green hydrogen project partners, including the Council for Scientific and Industrial Research (CSIR) and Transnet, to source expert input. This network also included experts from higher education and research institutions, the Department of Forestry, Fisheries, and the Environment (DFFE), and South African National Parks (SANParks). Snowball sampling and telephonic interviews were conducted with these experts, inviting them to contribute or suggest additional groups based on their specific knowledge. This collaborative approach facilitated the identification of previously unconsidered stakeholders, including marginalised communities.

By combining these methods, we were able to create a more comprehensive and inclusive stakeholder map, ensuring that a diverse range of individuals and organizations were considered in the project's development.

Draft stakeholder list: A preliminary stakeholder list was compiled following a comprehensive desktop review and consultation with relevant colleagues. This preliminary list, provided in Appendix 1, offers an initial overview of the different stakeholder groups. While serving as a foundational step in any stakeholder engagement process, a significant challenge arises from the persistent omission of local-level and other concealed stakeholders. Although the list demonstrates greater comprehensiveness at national and regional levels, substantial data deficiencies are evident at the local level. It is crucial to emphasise the need for a more comprehensive approach in identifying and engaging relevant stakeholders, as this list illustrates the stakeholder spectrum within the west coast of the Namaqualand region and highlights the inherent complexities associated with stakeholder categorisation. By recognising the limitations of this preliminary list, we aim to ensure that all relevant stakeholders are identified and engaged in the project's development.

1.1.3 Stakeholder categorisation

Using broad and narrow classifications, we developed a stakeholder categorisation model that differentiates stakeholder groups according to scale (see Table 1). We recognise and thoroughly address the inherent complexity in identifying and categorising stakeholders within the social-ecological systems framework. The categorisation of stakeholders presents limitations, as stakeholders may have multiple roles, and their significance can vary across different contexts and projects. As previously noted, it is imperative that we remain aware of and critically reflect on our roles, biases, and assumptions throughout the research process. In identifying and analysing these stakeholders, many intersect across categories and can be classified under several headings depending on the specific context or project.

Table 1. Stakeholder Categorisation (adopted from Gammage and Strand (2021))

Government	NGO/NPOs	Civil Society	Private Sector
Department/ Agency	Legal Aid and Advocacy	Small-Scale fishers Co-operatives	Commercial Fishing Aquaculture
Military	Conservation Groups	Indigenous Rights Groups	Energy Sector
Administration	Social Justice	Ecclesiastical	Mining and Construction
Conservation Authority	Disabled and Gender Rights	Agricultural Production and Development /Agricultural Co-operative	Tourism and Hospitality

Scale: Stakeholders were identified at national, provincial, and local levels where applicable. A primary focus was on stakeholders within the west coast of South Africa in the Namaqualand region.

Broad Categorisations: Broad stakeholder categories were adapted from existing South African stakeholder mapping studies, including work done by Gammage and Strand (2021) and the DFFE (2023) status of the South African marine fisheries resources. Drawing on their categorisation framework, the following broad groups were established: government, NGOs, civil society and the private sector.

Narrow Categorisations: To facilitate targeted engagement strategies, stakeholders were grouped into distinct categories. These classifications evolved throughout the identification process, introducing new categories to accommodate diverse stakeholder profiles. The complex and multifaceted roles of stakeholders often defied strict categorisation, necessitating the inclusion of an 'uncertain' category within both broad and narrow classifications. Recognising that these categories are context-specific and may vary across different green hydrogen projects is crucial.

CHAPTER 2: STAKEHOLDER ANALYSIS

Stakeholder identification and categorisation are crucial for addressing inequities in project management, particularly those arising from power asymmetries and the exclusion of certain groups. These disparities can manifest across various dimensions, including stakeholder interests, resource characteristics, governance challenges, property rights, externalities, social equity, and representation. Large-scale projects involve a multitude of stakeholders at local, regional, national, and international levels. The scope of the proposed green hydrogen port in Boegoebaai will likely impact or interest various stakeholders in the Northern Cape, encompassing governmental bodies, industry players, civil society organisations, and local residents. The proposed port development project encompasses a comprehensive range of infrastructure components. These include:

- New deepwater port in Boegoebaai that includes dry, liquid, and break-bulk terminals.
- Mixed-use SEZ located in the region adjacent to the proposed Boegoebaai port.
- Expansive regional renewable energy (wind and solar PV) generation and transmission infrastructure.

A comprehensive stakeholder analysis is indispensable for understanding the power dynamics and vested interests within the project environment. Engaging marginalised groups, particularly local fisheries and coastal communities in Namaqualand, South Africa, is essential for advancing social justice and equity. Stakeholder analysis is a cornerstone for any developmental initiative, offering a structured framework to understand the intricate dynamics between project proponents and key stakeholders across various scales. By assessing stakeholder power, legitimacy, and urgency, environmental managers can prioritize those with the most substantial influence while mitigating potential ethical issues. This holistic approach facilitates informed decision-making, incorporating a broad spectrum of perspectives that enhance project legitimacy and sustainability.

2.1 Stakeholder analysis and mapping review

Stakeholder analysis involves examining complex systems, their constituent parts, and the interrelationships between them (Yang *et al.*, 2011). It directly impacts the development of strategies for engaging stakeholders in decision-making processes (Yang *et al.*, 2011). In the context of green hydrogen development, stakeholder analysis aims to identify key stakeholders, understand their interests and perspectives, assess their influence, and examine their relationships with the project.

The rise of stakeholder analysis coincides with the growing emphasis on participatory methodologies in data collection, analysis, and project design. Both approaches share a commitment to amplifying the voices of marginalised groups (Grimble and Chan, 1995). However, it is crucial to recognise that simply including diverse voices does not guarantee project success. Effective outcomes necessitate considering the interests of all stakeholders, including those who may not be directly involved but can significantly influence the project. Balancing public and private interests require a collaborative approach that goes beyond purely formal participatory methods.

The lack of standardised methodologies for stakeholder analysis remains a significant challenge (Balane *et al.*, 2020). Numerous tools and techniques are available for stakeholder analysis, each with its strengths and suitability for different project types. These include snowball sampling (Brugha and Varvasovszky, 2000); power/interest matrices (Olander, 2007); three-dimensional stakeholder matrix cube (Murray-Webster and Simon, 2006); actor-linkage matrices, radical transactiveness, Q-methodology, salience analysis, and stakeholder-led categorisation (Reed *et al.*, 2009).

Grimble (1998) outlines distinct phases within the stakeholder analysis process: objective clarification, establishing the system context, identifying stakeholders and decision-makers, exploring stakeholder interests and agendas, and analysing interaction patterns, including conflicts, synergies, trade-offs, and compatibilities. Reed *et al.* (2009) proposes a structured three-step identification, differentiation, and relationship investigation approach. While these frameworks offer valuable guidance, a standardised

methodology for conducting stakeholder analysis taking a social-ecological systems lens remains elusive. Nonetheless, the importance of stakeholder identification, categorisation, and engagement within environmental management is universally acknowledged (Talley *et al.*, 2016).

This review highlights the multifaceted nature of stakeholder analysis. It emphasises the need for comprehensive stakeholder identification, consideration of diverse interests, and the selection of appropriate tools depending on the specific project context. Future research efforts could focus on developing a standardised methodology for desk-based stakeholder analysis within SES, particularly in relation to green hydrogen development.

2.1.1 Social network analysis

a) Ties and nodes with network actors

According to (Lin *et al.*, 2022), Social network analysis (SNA) conceptualises individuals or groups as nodes within a network, with relationships between them represented as ties. By examining the patterns formed by these connections, SNA seeks to understand the structure and dynamics of social interactions. Through mathematical and visual analysis, researchers can assess the influence of network structure on individuals and organisations. Essentially, SNA transforms the abstract concept of social relationships into a quantifiable model for analysis.

According to Scott (2012), three key concepts and measures are fundamental to understanding social networks: nodes, ties, centrality, and density. The three key concepts are:

1. Diffusion of Ideas and Practices- It examines how the structure of a network influences the flow of information and resources.

2. Scholarly Networks: This is about mapping the intellectual spaces.

3. Corporate power: The analysis of interlocking directorships and the relationship between centrality and corporate power explored.

In simple terms, SNA can be applied to assess stakeholder relationships within the green hydrogen project by conceptualising project participants as nodes and their interactions as ties (see Figure 4). This approach allows for identifying key stakeholders (central nodes) and mapping influence networks. By examining the structure of these networks, insights can be gained into the flow of information, decision-making processes, and potential collaboration opportunities. Moreover, SNA can help identify marginalised stakeholders who may be disconnected from the core network, facilitating targeted engagement strategies.

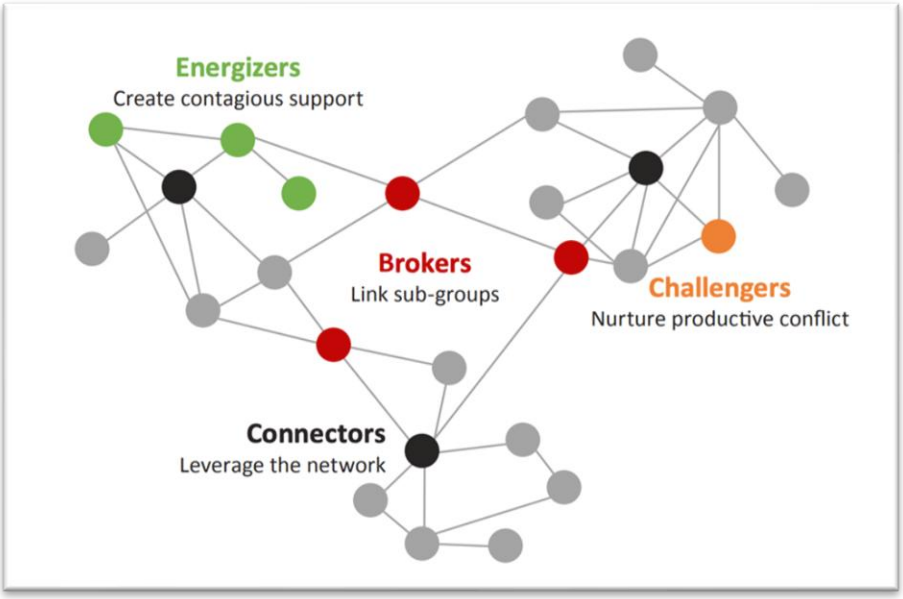


Figure 4. A social network analysis highlighting the structure-based roles of network actors (Cross et al., 2001)

Scott (2012) highlights six factors that can affect social relations and network dynamics, and these include:

1. Strength of ties—The intensity and strength of relationships, which can vary from strong to weak, influence how information and resources flow within the network.

2. Centrality- The position of an individual or organisation within the network, which can determine their influence and access to resources.

3. Multiplexity- The complexity of relationships where individuals may have multiple roles affecting how they interact within the network.

4. Network structure- The overall configuration of the network, including factors like density and connectivity, can shape interactions and relationships.

5. Boundary Decisions- This criterion defines who is included in the network and the relationships considered insignificant, which can influence analysis and outcomes.

6. Contextual factors—External influences such as cultural, social, and economic contexts can impact how relationships are formed and maintained.

Brokers are considered one of the most essential variables in social network studies. In Figure 5, the broker is the black circle. They are defined as connecting two separate areas of the network. An actor will connect with unconnected actors or fill the gaps or network holes in the social structure (Gould and Fernandez, 1989; Burt, 1995). A broker acts as a bridge, connecting disparate network segments across social, economic, or political domains. This unique position provides them exclusive access to valuable information and resources from diverse network areas (Stovel *et al.*, 2011). Brokerage is the sole mechanism facilitating information and resource exchange, enabling previously isolated actors to engage in economic, political, and social interactions (Halevy *et al.*, 2019).



Figure 5. Example of the brokers (adopted from Chaudhary and Warner (2015))

Lin *et al.* (2022) posit that social ties can be classified as strong or weak, determined by factors such as frequency of interaction, emotional closeness, time invested, and mutual support (see Figure 6). Strong ties tend to exist within tightly knit social circles, while weak ties bridge disparate social groups. Granovetta (1973) work highlights the significance of weak ties in facilitating information flow, as they often connect individuals from distinct social contexts. The concept of structural holes, representing gaps in social networks, further elucidates the role of weak ties as bridges between disconnected groups. While traditionally associated with weak ties, strong ties can also occupy bridge positions, underscoring the importance of network structure rather than tie strength in generating information benefits.

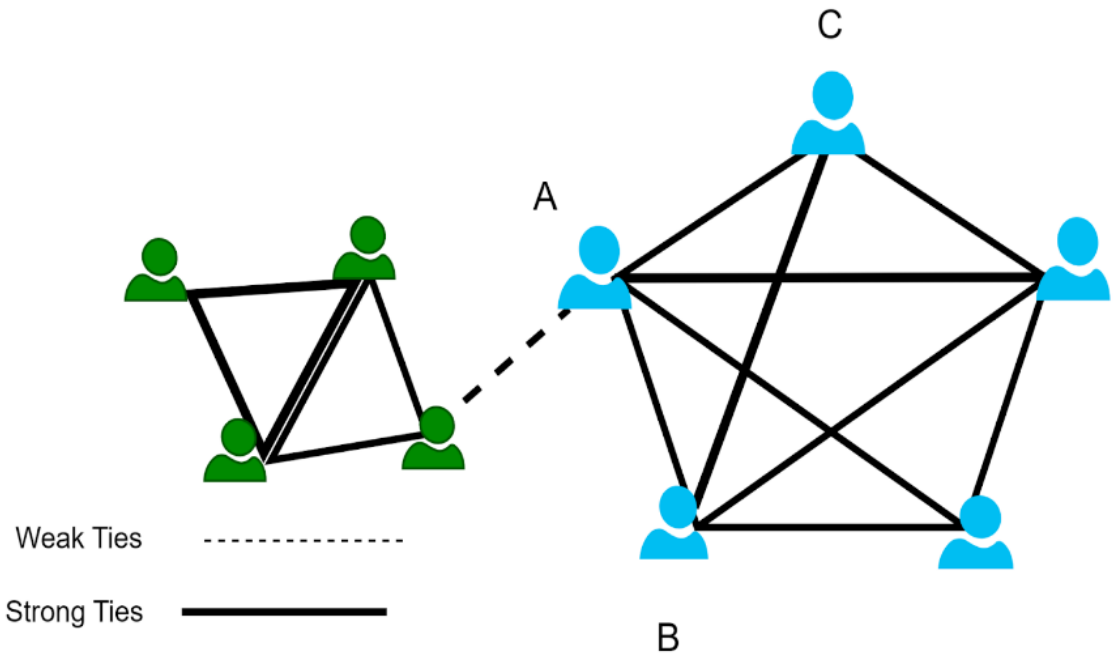


Figure 6. Weak Ties and Strong Ties in Social Networks (adapted from Lin et al. (2022))

Social network analysis integrates qualitative and quantitative methods to examine the structure and dynamics of social relationships. This approach will help identify influential actors, resource distribution patterns, and critical intermediaries by mapping interactions between individuals or organisations involved in the green hydrogen development project. This analysis reveals collaboration barriers and opportunities, providing insights into the factors that facilitate or hinder partnerships within a network. Such interactions in Figure 6 are crucial to understanding why collaborative relationships emerge between certain players and not others, how individuals operate within the network affect how they engage with others, and how power dynamics emerge within coalitions of groups in the network.

Kumar *et al.* (2023) demonstrated the utility of SNA in enhancing EIAs. By examining online interactions, collaborations, and information sharing among stakeholders, they employed network analysis, machine learning, and statistical modelling to extract valuable insights. These insights enabled the development of predictive models to anticipate potential environmental impacts, facilitating proactive mitigation strategies. This approach highlights the significance of understanding underlying social dynamics in effectively addressing environmental challenges.

b) Stakeholder network analysis attributes

Prell *et al.* (2009) outlined six attributes influencing stakeholder relationships that need to be considered in natural resource management stakeholder analysis:

1. **Strong Ties:** Stakeholders with strong ties are likely to influence each other, share similar views, trust each other, and communicate effectively. While beneficial for information sharing, strong ties can limit diversity of perspectives.

2. **Weak Ties:** Stakeholders with weak ties interact less frequently but can provide access to diverse information and ideas. These ties are crucial for network resilience but can be fragile.

3. **Homophily:** Stakeholders with similar opinions, ideas, or interests tend to form networks. While these networks can facilitate communication and trust, they can also exclude minority views.

4. **Centralization:** In centralized networks, a few stakeholders hold most of the connections. While this can help identify key representatives, it can also lead to a lack of representation for certain groups.

5. **Degree Centrality:** Measures the number of connections a stakeholder has within a network.

6. **Betweenness Centrality:** Measures a stakeholder's ability to connect different groups within a network.

2.1.2 Stakeholder typology: Power-Interest-Attitude Matrix

According to Murray-Webster and Simon (2006) the initial assessment of stakeholders is typically conducted using a technique based on some variation of a stakeholder grid or map, of which numerous iterations exist. Some grids or maps are one-dimensional, for instance, illustrating stakeholders' (whether individuals or groups) about their areas of interest within the project or program. However, Murray-Webster and Simon's (2006) experience suggest that most are two-dimensional, with axes labelled according to aspects of stakeholder status or behaviour and the intervening grid populated with the names of relevant individuals or groups. It is becoming increasingly clear that a more comprehensive stakeholder assessment technique is needed.

1. **Power vs. Interest:** While conceptually straightforward, the utility of identifying whether a stakeholder is both powerful and interested (and hence likely to be active) is limited if their stance towards the project—whether supportive or oppositional—is not considered.

2. **Interest vs. Attitude:** Again, while simple in theory, understanding that a stakeholder is either an active supporter or blocker is less meaningful without evaluating their level of influence, which is determined by their power.

This analysis strongly advocates for incorporating a third dimension into the stakeholder grid. This enhancement will significantly improve the technique's ability to stimulate meaningful reflection and provide more comprehensive insights for project or program managers, addressing the limitations of the current two-dimensional approach.

According to Murray-Webster and Simon (2006), three primary and essential dimensions that are vital when considering stakeholders are:

1. **Power:** An individual or group's capacity to influence organizational outcomes. This may stem from formal position, resource control, or personal credibility.

2. **Interest:** The level of engagement or concern exhibited towards a project or programme.

3. **Attitude:** The stance adopted towards a project or programme, ranging from support to opposition.

4. **Impact:** involves assessing the potential or actual influence of stakeholders on a project's outcomes.

A two-dimensional analysis provides an incomplete and less informative representation of stakeholder dynamics. While a three-dimensional grid is more complex to visualise, it offers a comprehensive

framework for considering all relevant stakeholder attributes (see Figure 7). It facilitates a more nuanced understanding during stakeholder analysis and management.

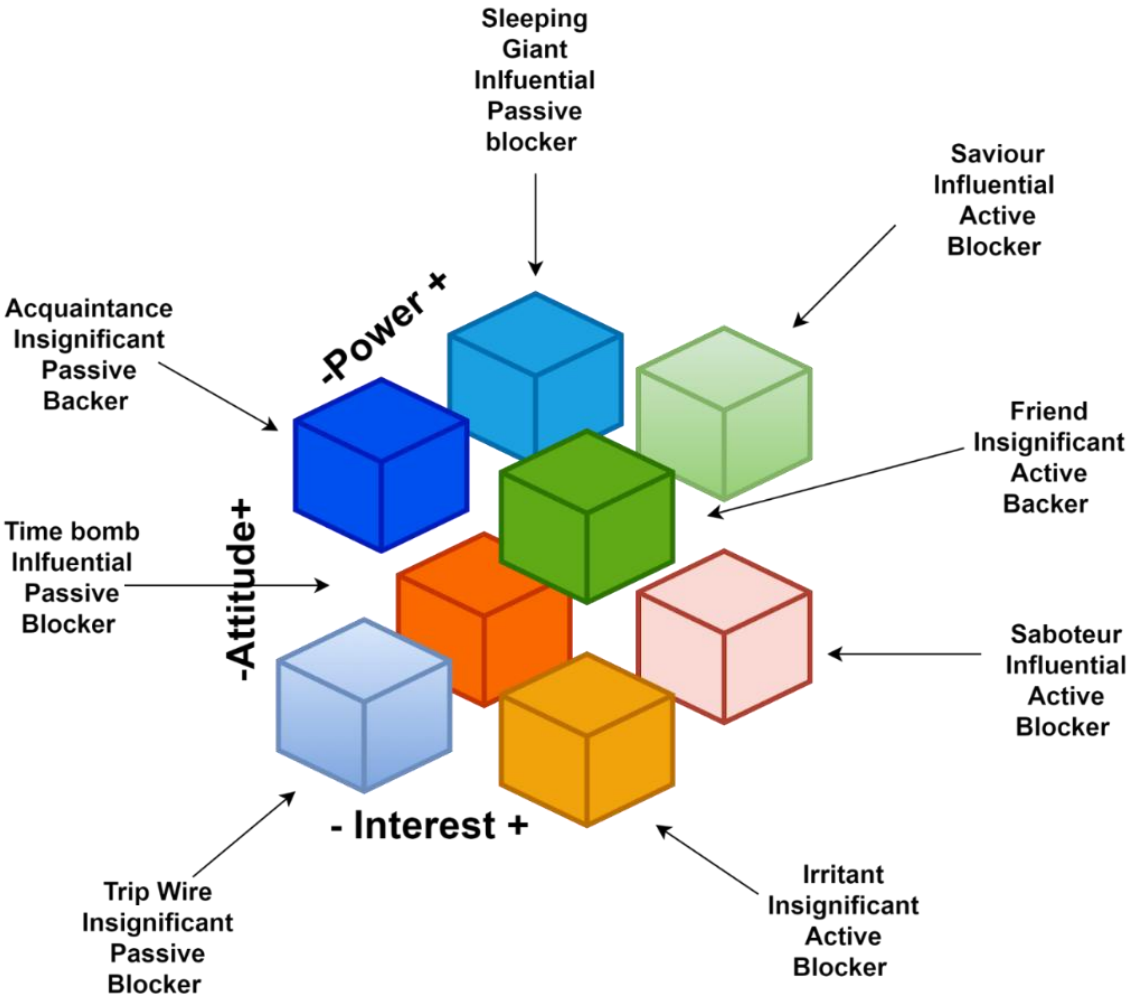


Figure 7. Power, Interest, and Attitude Matrix in analysing stakeholders (adapted from Murray-Webster and Simon (2006))

Based on our analysis, we categorized stakeholders into the following groups:

1. **Key Stakeholders**: High influence, high impact, high power, and supportive attitude.
2. **Major Stakeholders**: High influence, high impact, high power, but neutral or opposed attitude.
3. **Minor Stakeholders:** Low influence, low impact, low power, and neutral or opposed attitude.

Employing this framework, eight stakeholder archetypes (Murray-Webster and Simon, 2006; Bernstein *et al.*, 2020) emerge:

1. **Saviour:** High-influence supporters requiring proactive engagement to maintain alignment.
2. **Friend:** Enthusiastic supporters with limited influence, valuable as confidants.
3. **Saboteur:** High-influence opponents demanding strategic engagement to mitigate potential damage.

4. **Irritant:** Low-influence opponents requiring minimal engagement to neutralise their impact.
5. **Sleeping Giant:** High-influence, passive supporters necessitating activation.
6. **Acquaintance:** Low-influence, passive supporters requiring fundamental information dissemination.
7. **Time Bomb:** High-influence, passive opponents requiring proactive monitoring and management.
8. **Trip Wire:** Low-influence, passive opponents demanding circumspection to avoid unforeseen challenges.

The utility of any stakeholder grid, including three-dimensional models, is contingent upon practical application. While the initial placement of individuals or groups on the grid provides a foundational understanding, subsequent engagement is crucial. Mis-categorisation poses risks to both the project and stakeholder relationships. To mitigate these risks, direct dialogue with key stakeholders is imperative to validate assumptions and uncover underlying motivations and concerns.

2.2 Stakeholder analysis results

2.2.1 Categorisation findings

Appendices 3A-F provide a comprehensive overview of stakeholders primarily engaged in fisheries, agriculture, and community development within the west coast of the Namaqualand region. Appendix 2A presents a tabular summary of all potential stakeholders on the west coast. Appendix 2B categorises the stakeholders within the region, while Appendices 2C-F focus on specific localities: Alexander Bay, Port Nolloth, Kleinzee, and Hondeklipbaai. It's essential to note that the stakeholders identified either have a physical presence in these areas or are linked to them through regional projects or societal affiliations.

a) Government stakeholders (Majority Stakeholders)

Approximately 87 government stakeholders were identified within the Namaqualand region. Among these, Transnet, South African National Energy Development Institute (SANEDI), Alexkor, the Community Property Association, and Northern Cape Economic Development, Trade and Investment Promotion Agency (NCEDA) were particularly prominent in Port Nolloth and Alexander Bay, the closest sites to Boegoebaai. Some stakeholders are not directly involved in the project but are operating within the region. Several key stakeholder government categories emerge and are detailed in the box below.

Central Government Departments

1. **Economic Development and Infrastructure:** Department of Mineral Resources and Energy, Department of Trade, Industry, and Competition, Department of Public Works and Infrastructure, National Ports Authority (NPA)
2. **Environmental Management**: Department of Forestry, Fisheries, and Environment, Department of Water and Sanitation, National Parks (SANParks)
3. **Social and Economic Development:** Department of Social Development, Department of Small Business Development, National Development Agency (NDA)
4. **Regulatory Bodies**: Department of Cooperative Governance, National House of Traditional Leaders

Provincial Government Departments

1. **Economic Development:** Northern Cape Economic Development, Trade, and Investment Promotion Agency (NCEDA)
2. **Infrastructure:** Roads and Public Works
3. **Environmental Management:** Northern Cape Heritage Resources Authority (NCHRA)
4. **Social Development:** Northern Cape Arts and Culture Council, Northern Cape Gambling Board, Northern Cape Tourism Authority

Parastatals and State-Owned Enterprises

1. **Energy:** Eskom, Central Energy Fund (CEF)
2. **Infrastructure**: Transnet, National Ports Authority (NPA)
3. **Mining:** Alexkor Limited, Kalahari Kid Corporation
4. **Defence:** Armaments Corporation of South Africa (ARMSCOR), South African National Defence Forces (SANDF)

Other Government Entities

1. **Regulatory Bodies:** National Advisory Council on Innovation (NACI), National Agricultural Marketing Council, National Sea Rescue Institute (NSRI), National Youth Development Agency (NYDA) and Community Property Association.
2. **Research and Development:** Council for Mineral Technology (Mintek), South African Agency for Science and Technology Advancement (SAASTA), Water Research Commission (WRC).

Given that the project is mainly backed up by government and private funding, the prominence of government stakeholders in the Boegoebaai port development project suggests a number of positive and negative implications for the project and surrounding stakeholders:

Positive Implications:

1. **Enhanced Project Support:** Government stakeholders will provide legitimacy and credibility to the project to attract additional investment and interest of other stakeholders, especially those of the private sector that provide engineering infrastructure support, which is already highlighted in Appendix 2B by the two different engineering groups (Boegoebaai Development Consortium, Boegoebaai Port and Rail Consortium and Project Elephant Consortium).

2. **Policy alignment and Regulation:** Government stakeholders will shape the regulatory framework for the project, potentially fast-tracking processes like permits, approvals, and compliance with legal standards in the Boegoebaai port development. This can facilitate smoother project operations, especially with acquiring approval to construct jetty structures, breakwaters, admin craft basins, buildings, external roads for mining, etc. Government agencies listed in Appendix 2B with their involvement will ensure that their project aligns with national policies and priorities, reducing regulatory hurdles and facilitating project implementation.

3. **Responsible for equitable resource allocation of resources:** Government agencies will allocate resources, especially with how they will handle water access and allocation in Boegoebaai along with fishing rights, funding, land, or transport and housing infrastructure, to support the community and the project's development.

Negative Implications:

1. **Government Accountability and Oversight:** With significant government involvement, there is likely to be heightened scrutiny in terms of financial accountability, adherence to public policy, and transparency. The project is expected to align with governmental objectives, such as public welfare, economic development, or sustainability goals.

2. **Policy and Regulation:** Government stakeholders will shape the regulatory framework for the project, potentially fast-tracking processes like permits, approvals, and compliance with legal

standards. This can facilitate smoother project operations but may also mean more stringent oversight to ensure public funds are used responsibly.

3. **Political Influence and Bureaucracy:** Increased government involvement can lead to bureaucratic delays and decision-making processes. A government-funded project may be subject to shifts in political agendas and may overlook or disregard the needs of marginalised groups that are largely affected. Furthermore, stakeholders with high government influence might shift priorities, especially during political transitions, which could affect the direction or continuation of the project.

4. **Public Perception**: Since public resources are being used, civil society and the general public will expect a higher level of engagement, transparency, and social benefit. More government involvement could heighten public expectations and increase pressure for the project to succeed.

5. **Dependency on Public Funding:** Since the project is government-backed, funding is likely secured, but this also means dependency on government budgets. Any changes in national or regional fiscal policy could impact project continuity, expansion, or delays.

6. **Power Imbalances:** Government dominance could create power imbalances and limit the influence of other stakeholders, particularly the Fisheries, agricultural and mining community groups categorised under civil society that advocate their rights and interests.

b) Private business and private sector stakeholders (Major Stakeholders)

A total of 65 private business and sector stakeholders were identified in Appendix 2B. They are the second largest group of stakeholders in this project with the members of the Boegoebaai Development Consortium, Boegoebaai Port and Rail Consortium and Project Elephant Consortium in the front line of spearheading the process Boegoebaai Development. Several key sectors and categories emerge:

1. **Tourism and Hospitality:** This sector is heavily represented, indicating a significant reliance on tourism and related industries in the region. The majority of them are local businesses. This means that any development within the areas will directly have an impact on them.

2. **Commercial Fishing, Farming, and Aquaculture:** Given the coastal location of Boegoebaai, fishing and aquaculture are important economic sectors in Port Nolloth, Kleinzee, Alexander Bay and Hondeklipbaai that need to be considered.

3. **Energy Sector:** The presence of upstream oil and gas companies suggests potential synergies or competition with the green hydrogen project.

4. **Construction and Engineering:** The project will require significant infrastructure development, making construction and engineering firms key stakeholders.

5. **Minerals Exploration and Production:** Mining companies might have interests in the region and could potentially be involved in the project.

6. **Logistics and Transportation:** Companies involved in transportation and logistics will be essential for the project's success.

7. **Finance and Investments:** Funding and investment firms could play a role in financing the project or providing financial support. The box below lists the stakeholders we found in the area.

Local Businesses: Tourism, Farming and Commercial Fishing (Previous and Current)

- John Livestock PTY (Livestock Farming)
- Josmel Construction (Construction Company)
- Kleinzee Angling Club (Angling and Sport Fishing)
- Kleinzee Airfield FAKZ (Airstrip)
- Kleinzee Beach Cottage (Tourism and Hospitality)
- Kleinzee Caravan Park (Tourism and Hospitality)
- Kleinzee Golf Club (Tourism and Hospitality)
- Lewensdroom Gastehuis (Tourism and Hospitality)
- Mcdougallsbaai Akkomodasie (Tourism and Hospitality)
- Namaqua Coastal Expeditions (Tourism and Hospitality)
- Peaceful Place (Tourism and Hospitality)
- Port Nolloth Beach Shack (Tourism and Hospitality)
- Richtersveld Experience (Tourism and Hospitality)
- Richtersveld Tours (Tourism and Hospitality)
- Rooi Spinnekop (Tourism and Hospitality)
- Sea View Holiday House (Tourism and Hospitality)
- Seaway backpackers and Function Avenue (Tourism and Hospitality)
- Spoelklippie Gastehuis (Tourism and Hospitality)
- Visbeen Lodge (Tourism and Hospitality)
- Voetbaai Gastehuis (Tourism and Hospitality)
- Vori Klip (Tourism and Hospitality)
- WCRL commercial fishing rightsholder (Commercial Fishing and Aquaculture)
- Three local companies (hake longline rights)
- One hake handline rightsholder (revoked)
- Two local companies (hake deep-sea trawl rights)
- VM Young Visserye BK (small pelagic rights)
- Thirteen West Coast Rock Lobster (WCRL) nearshore rights holders
- Six companies (WCRL commercial long-term rights)
- Yield House and Cottages (Tourism and Hospitality)

International and National Businesses:

- Afcon Infrastructure Limited (Construction and Engineering)
- Afrimat Limited (Mid-tier mining and materials company)
- AP. Moller and Capital (Funding and Investments)
- Bouygues TP (Construction Group)
- Coega Development Co-operation (Construction Group)
- CPRDW- Consulting Port and Coastal Engineers (Design of Marine Infrastructure)
- DB Scheneker (Logistics)
- Diamond Coast Aquaculture (Pty) Ltd (Fish Farming)
- Gibb Consulting Engineers (Engineering Consulting)
- Green Hydrogen South Africa (H2.SA) (Energy Sector)
- Meridium SAS (Asset Management Firm)
- Mota-Engil (Engineering and Construction)
- Naka Iliso (Consulting and Engineering)
- Nako Systra (Transportation and Engineering)
- Newlyn Group's Briardale Trading (Property Developer)
- Pembani Remgro Infrastructure Managers (Infrastructure Fund)
- Port of Rotterdam (Port Development)
- Raubex Group (Infrastructure Development)
- Thelo (Transport and Logistics)
- Traxtion Sheltam (Rail Infrastructure)
- Vinci Construction (Construction)
- WBHO (Construction)
- WSP Consulting Engineers (Engineering Consulting)
- Yapi Merkezi Insaat ve Sanayi Anonim Sirketi (Construction Holding)

Below we look at potential implications of having Private Sector Dominance in the Boegoebaai Green Hydrogen Project.

Positive Implications:

1. **Investment and Economic Growth:** Private sector involvement can bring significant investment to the project, driving economic growth and job creation in the region.

2. **Innovation and Efficiency:** Private sector companies often have expertise and resources that can contribute to the project's efficiency and innovation.

3. **Risk Management:** Private sector entities are generally more risk-averse and have experience in managing complex projects, which can benefit the green hydrogen initiative in South Africa and in the Northern Cape.

4. **Market-Driven Approach:** Private sector involvement can ensure that the project is aligned with market demand and commercial viability.

Negative Implications:

1. **Profit-Driven Focus:** Private sector companies may prioritise profit over other objectives, potentially leading to trade-offs in terms of environmental sustainability, social equity, or community benefits.

2. **Power Imbalances:** The dominance of private sector stakeholders could create power imbalances and limit the influence of other stakeholders, especially the civil society organisations that work with marginalised local communities in the surrounding areas.

3. **Short-Term Focus:** Private sector entities might have a shorter-term focus, which could lead to neglecting long-term sustainability or environmental impacts.

4. **Potential for Exploitation:** Without proper safeguards, private sector involvement could lead to exploitation of natural marine resources or unfair labour practices.

c) Civil Society stakeholders (Major and Minor Stakeholders)

We identified 27 civil society stakeholders (Appendix 2), with Aukotowa, Longtime, Masifundise, and members of H2 Watch SA being the active groups. Civil society in the Boegoebaai port region appears to be primarily comprised of organisations focused on environmental advocacy, community development, social justice, and economic empowerment. The box below identifies specific important civil society stakeholder categories.

Environmental Advocacy and Conservation (Major)

- Earthlife Africa – H2 Watch SA
- GroundWork
- Kuthala Environmental Care Movement
- Mining Affected Communities in Action (MACUA-WAMUA) – H2 Watch SA
- The Green Connection
- Environmental Monitoring Group (EMG)- H2 Watch SA
- Natural Justice
- Southern African Faith Communities Environment (SAFCEI)- (H2 Watch SA)
- Vaal Environmental Justice Alliance (VEJA) (H2 Watch SA)

Small-Scale fisheries, Community Development Societies and Social Justice (Major)

- Coastal Livelihoods Foundation
- EkSteenSkuil
- Migratory Nama People
- Aukotowa Small-scale Fisheries Cooperative (103 members, supporting 75 households)
- Premier Fishing and Brands Limited (Pty) Ltd (contracted for WCRL and hake offshore rights)
- Two fish processing facilities (Noordkaap Visserman Onderneming BK, Port Lobster (Pty) Ltd)
- Diamond Coast Aquaculture (Pty) Ltd (seaweed harvesting and abalone farm)
- Port Nolloth Sea Farms (abalone ranch)
- Kleinzee Angling Club (recreational)
- Small-scale fishermen (involved in WCRL harvesting)
- Longtime Hondeklipbaai Fishing Primary Cooperative (supports 14 active fishermen and 70 households)
- Skipper's Training Program (community development initiative)
- Individual fishermen (Traditional linefish, WCRL nearshore rights)
- House of Bread Outreach Ministries
- Integrated Serviced Land Project
- Kaikai Richtersveld Residental Coastal Reserve
- Masifundise Development Trust
- Port Nolloth Primary School
- Pulls Full Gospel Church
- Richtersveld Community Conservancy
- The Economic Justice Network- H2 Watch SA
- WoMIN- H2 Watch SA

Economic Development and Sustainability (Minor)

- Richtersveld Growers
- Co-operative Sustainable Network of Enterprising Communities NPC
- Agricultural Cooperative

Religious and Cultural Organisations (Minor)

- AGS AFM Nollothville Church
- Ecclesiastical
- Pulls Full Gospel Church
- Southern African Faith Communities Environment (SAFCEI) – H2 watch SA

These organisations often have a strong presence in local communities and are actively involved in addressing various social and environmental issues. They represent diverse interests, including agriculture, education, conservation, fisheries, tourism, and gender equity.

Having that many civil society stakeholders as the second key stakeholder group in the proposed development project creates a balance between development goals and social, environmental, and ethical concerns. While this may lead to more comprehensive and inclusive decision-making, it could also introduce complexities, delays, and increased costs. The project's success will depend on how well developers and government entities can collaborate with civil society to align the project's goals with the broader public interest. The most important groups that are directly affected are highlighted in bold as they represent the fisheries, farming and other coastal livelihoods operating there.

Below are a number of preliminary positive and negative implications of having civil society as the third key stakeholder group:

Positive Implications:

1. **Public Accountability and Transparency:** Civil society organisations (CSOs) play a crucial role in promoting transparency and holding decision-makers accountable. Their active involvement can ensure that the development process follows ethical guidelines, legal compliance, and sustainability principles, mitigating corruption or misuse of public funds. We have seen this with H2 Watch SA, Ground Up and Masifundise Development Trust.

2. **Advocacy for Social Justice:** CSOs often advocate for marginalised and vulnerable groups, ensuring that the interests of local communities, indigenous populations, and disadvantaged groups are represented in the project. Some of the groups listed, especially with Aukotowa and Longtime SCF, will voice out for a more inclusive and socially equitable development process by integrating Free, Prior, and Informed Consent (FPIC) in stakeholder negotiations, especially where their traditional livelihoods are at stake.

3. **Community Engagement and Participation**: Civil society groups often facilitate direct engagement with local communities. Their involvement can improve communication between developers and affected communities, leading to a more participatory process where local concerns are integrated into the project planning. This could enhance community buy-in, reducing resistance to the project and increasing local support.

4. **Promotion of Long-Term Benefits:** Civil society can ensure that development does not only benefit short-term economic interests but also promotes long-term social, environmental, and economic sustainability. Their influence could lead to the implementation of sustainable business models that focus on local employment, social services, and sustainable livelihoods.

Negative Implications

1. **Delays Due to Protests and Legal Challenges**: CSOs often act as watchdogs or, as (Murray-Webster and Simon, 2006) may call them, Trip wires or Time bombs as they are heavily demanded for community rights and environmental protections. In cases where the Boegoebaai project may negatively affect the environment or local populations in Alexander Bay, Port Nolloth and Hondeklipbaai. CSOs might organise protests, file legal challenges, or lobby against the development. This could delay the project timeline and lead to cost overruns if disputes are not resolved quickly.

2. **Conflicting Interests**: Civil society stakeholders can have diverse and sometimes conflicting agendas. While some CSOs might focus on environmental concerns, others may prioritise local economic development. Balancing these diverse priorities can complicate decision-making and lead to conflicts or delays in the implementation of the project.

3. **Increased Scrutiny and Bureaucratic Hurdles**: The presence of a strong civil society presence can lead to increased scrutiny from the media, public opinion, and regulatory bodies (we have seen this from Ground Up and H2 Watch SA articles). This, by nature, has already forced more extensive environmental impact assessments, additional consultations, and meeting challenging legal requirements. While these safeguards are positive, they can also increase project costs and delay approvals.

4. **Potential for Misinformation**: Civil society organisations can sometimes create friction or resistance based on misinformation or misconceptions about the project. If the CSOs have incomplete or incorrect data about the project's impacts, this could lead to unnecessary resistance or pushback from communities, creating a hostile environment for project proponents.

5. **Pressure for Higher Community Compensation**: With a significant presence of civil society, there may be increased pressure on the Boegoebaai port developers to offer higher compensation to local communities, not just in financial terms but also in terms of socio-economic benefits, particularly with housing and education, environmental remediation for the damage to marine ecosystems, and social development. While this can lead to positive outcomes for communities, it could place additional financial burdens on the project and affect its profitability.

d) NGO stakeholders

A total of 19 NGO stakeholders were identified, making them the fourth key stakeholder on the west coast of the Namaqualand region in the Northern Cape.

We identified the main interest categories that the stakeholders mainly signify (listed below), followed by actual stakeholders identified in the box below.

1. Environmental Advocacy and Conservation
2. Social Justice and Human Rights
3. Gender rights NGO
4. Disabled rights NGO
5. Legal Aid and Advocacy
6. Social justice NGO
7. Indigenous Rights and Community Representation
8. Indigenous rights group
9. Small-scale Fishers Rights

Environmental Advocacy and Conservation

- Benguela Current Commission
- Benguela Current Large Marine Ecosystem (BCLME)
- Birdlife
- Centre for environmental rights
- Greenpeace
- Oceans not Oil
- SDCEA
- Environmental Monitoring Group (EMG)- H2 Watch SA
- Natural Justice – H2 Watch SA

Social Justice and Human Rights

- Kgatelopelo Association for the Blind
- Legal Resources Centre (LRC)
- Northern Cape Society for the Blind
- Re Tlameleng Special School
- South African Fisheries Development Fund
- Indigenous Rights and Community Representation
- Indigenous Peoples of Africa Co-ordinating Committee
- African Gender Institute
- Centre for Rural Legal Studies (CRLS)
- Gender Education and Training Network
- Institute for Justice and Reconciliation
- Ikamva Labantu

Below are a number of possible positive and negative implications of having NGOs as the fourth key stakeholder group:

Positive Implications:

1. Community Representation: NGOs often represent the interests of local communities, ensuring that their voices are heard and their concerns are addressed.

2. Environmental Advocacy: NGOs can play a crucial role in advocating for environmental sustainability and ensuring that the project minimizes negative impacts on ecosystems.

3. Social Justice: NGOs can promote social justice and equity, ensuring that the project benefits marginalised communities and addresses social inequalities.

4. Transparency and Accountability: NGOs can help to hold project developers accountable and ensure that the project is implemented transparently and ethically.

5. Innovation and Alternative Perspectives: NGOs can bring innovative ideas and alternative perspectives to the project, contributing to its overall success.

Negative Implications:

1. Conflicts of Interest: Some NGOs may have conflicting interests or agendas that could hinder project progress.

2. Delay Tactics: NGOs might employ tactics that delay project implementation, such as legal challenges or public protests.

3. Lack of Expertise: Some NGOs may lack the technical expertise or resources to effectively participate in the project development process.

4. Power Imbalances: NGOs might face power imbalances with government or corporate stakeholders, limiting their influence and decision-making power.

5. Divisions Within Civil Society: There might be divisions or disagreements within the civil society sector, leading to conflicting perspectives and hindering collaboration.

e) Scientific groups

Only four stakeholders were identified operating in the area, and below are the preliminary positive and negative implications.

Positive Implications:

1. Focused Expertise: A smaller number of scientific research stakeholders can allow for more concentrated expertise and in-depth analysis of specific project areas related to Boegoebaai.

Negative Implications:

2. Limited Perspectives: A small number of research stakeholders may lead to a limited range of perspectives and potential biases in research findings.

3. Knowledge Gaps: Fewer researchers might result in gaps in knowledge or understanding of certain project-related issues.

4. Limited Public Trust: If the scientific research is not perceived as diverse or representative, it may erode public trust in the project.

f) Fisheries stakeholders

While several fisheries stakeholders were initially identified within the study sites, some are no longer operational (see Table 2 below).

Table 2. Fisheries stakeholders (past and present) in Alexander Bay, Port Nolloth, Kleinzee and Hondeklipbaai

Fisheries stakeholders (past and present) in communities of interest			
Alexander Bay	***Port Nolloth***	***Kleinzee***	***Hondeklipbaai***
Oyster farm: Previously functioned as a hatchery for the Pacific oyster (*Crassostrea gigas*) but it has since closed down	Fish processing factory: Opened in 1960, but closed down in 1993, leading to widespread unemployment.	No stakeholders explicitly mentioned as defunct apart from infrastructural issues like the slipway, which is unfit for use.	Hondeklipbaai West Coast Rock Lobster (WCRL) processing factory: Closed in 1996 due to declining WCRL numbers.
	Two traditional linefish rights: Both were revoked after being valid from 2014 to 2020		
	Noordkaap Visserman Onderneming BK: One of the two fish processing facilities, which is no longer in operation.		
	One hake handline rightsholder: The fishing right was allocated but later revoked.		

g) Deeper Analysis: Government and Private Sector Dominance in Boegoebaai Port Development

When government and private sector stakeholders hold the majority representation in the Boegoebaai port development, with civil society and NGOs holding less influence, it suggests a development model driven primarily by economic and political interests rather than social or environmental considerations. This scenario reveals several critical dynamics that influence the outcome of the project and have far-reaching implications for civil society, particularly small-scale fishing cooperatives whose livelihoods are directly impacted by the development (see Figure 8).

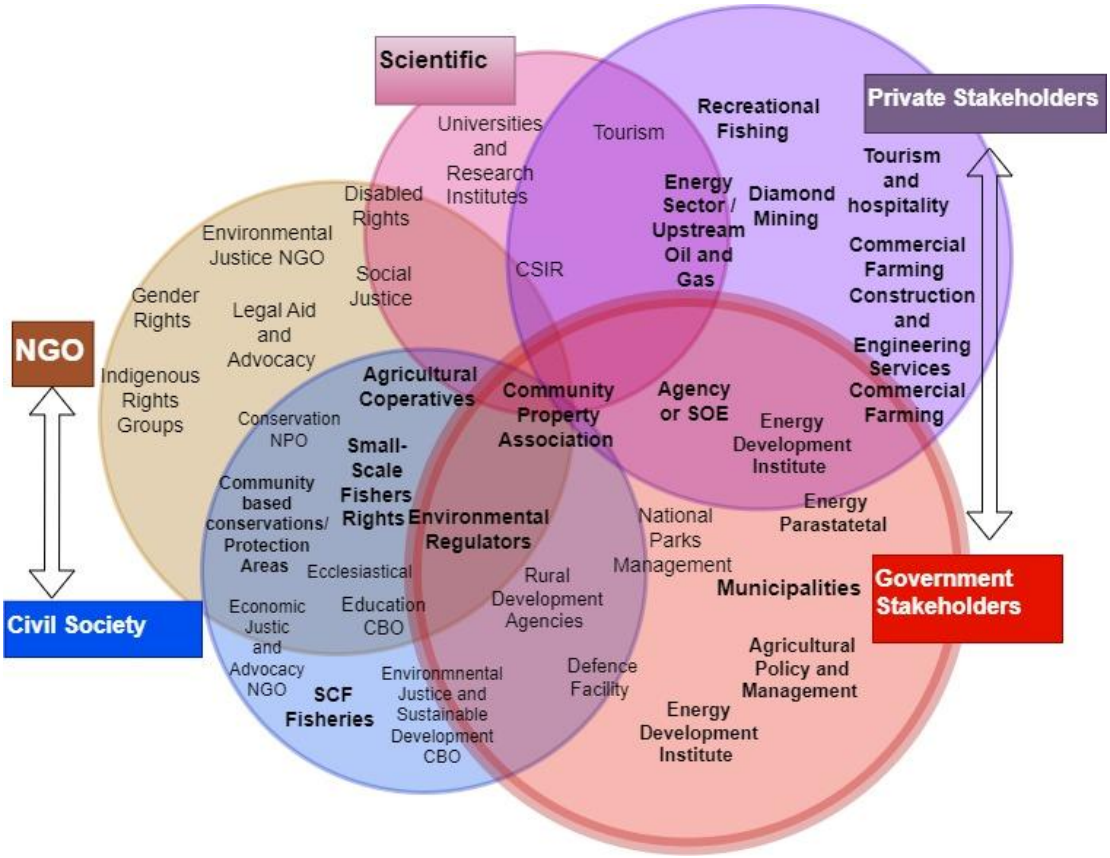


Figure 8. Venn Diagram illustrating overlap and interplay of operating in the proposed Boegoebaai Port and SEZ Development

The dominance of government and private sector stakeholders indicates that the project is likely being framed as a national strategic priority focused on economic growth, infrastructure expansion, and foreign investment attraction. Governments typically seek to boost the economy through such projects, driven by the need for job creation, increased trade capacity, and enhanced international competitiveness.

The private sector, particularly large corporations, tends to prioritise profitability, focusing on the economic benefits the port will bring through increased exports, improved logistics, and potential resource exploitation, such as mining or energy infrastructure. This suggests that economic imperatives, rather than socio-environmental concerns, are steering the project.

Civil society, NGOs, and local communities are significantly underrepresented in this configuration. This often signals that the voices of those directly affected by the development – such as small-scale fishers and local cooperatives – may not be adequately considered in the decision-making process. The lack of representation means civil society may struggle to influence key decisions around environmental sustainability, community compensation, and long-term social impacts. This imbalance raises concerns about a lack of meaningful community consultation, as the development may proceed without adequately addressing local concerns or integrating traditional livelihoods into the development model. There are potentially perceived social and environmental risks. When civil society has limited influence, environmental risks associated with large-scale developments, such as the destruction of marine habitats, water pollution, or displacement of local fishing zones, may not be sufficiently mitigated. Small-scale fishing cooperatives, already vulnerable due to resource depletion and climate change, could be disproportionately impacted. Civil society organisations often act as watchdogs to ensure that environmental impact assessments are conducted thoroughly and that sustainability measures are put in place. Without strong representation, the environmental safeguards may be weak, leading to long-term ecological degradation that threatens local livelihoods.

The dominance of government and private sector stakeholders in the Boegoebaai port development suggests a project driven primarily by economic growth and political considerations, with possible limited emphasis on social and environmental impacts.

2.2.2 Murray-Webster Stakeholder Matrix findings

We adopted the Murray-Webster Stakeholder Matrix to analyse stakeholder engagement by categorising stakeholders based on their power, interest, impact and attitude towards a project. This approach helped in identifying the level of attention and strategies needed for different stakeholder groups.

The analysis of stakeholder data using Murray-Webster's cube matrix reveals a complex and multifaceted landscape for the Boegoebaai Green Hydrogen project, with a wide range of stakeholders representing different interests, power levels, and attitudes. This is highly illustrated in Appendix 2G, H and I). Here's a detailed analysis based on the categories and their potential implications for agricultural, fishing, tourism, and mining livelihoods in Port Nolloth, Kleinzee, Hondeklipbaai and Alexander Bay:

a) Largest Stakeholder Groups

Observers (23.7%): As the largest group, observers are stakeholders who will typically watch the project's progress without actively participating. In Appendix 2G and H, they are categorised as private business and civil society stakeholders, mainly comprised of tourism and hospitality in Port Nolloth, Kleinzee, Alexander Bay and Hondeklipbaai. These stakeholders typically are normally hidden or bypassed and *have* medium to low power and influence, but their interests can vary. Their impact is often minimal unless they choose to become more active, particularly if the project significantly affects their business or livelihood interests. This indicates that many of these stakeholders may be cautiously monitoring the Boegoebaai project without fully committing to a stance. For stakeholders involved in agricultural, fishing, tourism, and mining livelihoods, this could mean they are uncertain about the project's impacts and are waiting to see how it unfolds before acting.

Possible implications include:

- Limited Power and Influence: These stakeholders are unlikely to directly influence decision-making or outcomes, which means they won't be major drivers of change or resistance.

- Potential Shifts in Engagement: Observers may become more active if they perceive threats or opportunities arising from the project, leading to shifts in their categorisation, especially if project developments begin to impact them more directly.

- Opportunity for Awareness and Engagement: As private business and civil society observers, there's a chance to convert them into more supportive roles through effective engagement strategies, as they might be swayed by the project's benefits if properly informed.

- Risk of Underestimation: While currently passive, a large observer group means Transnet must keep them informed, as neglecting their concerns could lead them to align with more active opposition groups if the project negatively impacts their interests.

Saviours (21.9%): This group is highly supportive of the project and see it as beneficial, possibly viewing it as a way to improve economic opportunities, create jobs, or introduce sustainable practices in the nearby sites. The Saviours, comprised mainly of government and private sector stakeholders, typically have high power, influence, impact, and interest in the project. Their strong presence suggests there's optimism about the project's potential benefits, which might include housing and transport infrastructure, social and town development or new investment in these sectors. Government stakeholders possess regulatory authority, making them pivotal in decision-making, project approvals, and policy setting. Their influence can shape the project's trajectory, ensuring it aligns with broader economic or political goals. Private sector stakeholders, as financiers and implementers, have significant sway over project execution, resource allocation, and operational strategies.

Possible implications include:

- This concentration of power might streamline decision-making, potentially accelerating project progress. However, it could also lead to top-down decision-making, sidelining smaller stakeholder groups, such as local communities, small-scale fishers, or agricultural cooperatives.

- As direct investors and implementers, these stakeholders have a vested interest in the project's success. Their focus will likely be on ensuring financial returns, meeting strategic objectives, and showcasing the project as a developmental milestone.

- These stakeholders are committed to overcoming obstacles, but it might lead to prioritising financial gains or infrastructure goals over social, environmental, or community concerns. Their actions and decisions will have profound effects on the project's direction, outcomes, and how benefits and risks are distributed among other stakeholders.

- The project's success or failure largely rests in their hands. There's a risk that if these stakeholders do not fully engage with or understand local dynamics, communities dependent on fishing, agriculture, and tourism could be adversely affected.

- The prominence of government and private sector stakeholders (Saviours) means the project has strong institutional and financial backing, increasing its likelihood of reaching completion. However, this dynamic can lead to power imbalances, were smaller, less influential stakeholders' voices may be drowned out.

- There's a potential risk of the project focusing more on macro-level objectives (e.g., economic growth, energy production) at the expense of micro-level concerns (e.g., local livelihoods, environmental sustainability). Therefore, ensuring an inclusive approach that actively incorporates feedback and concerns from smaller stakeholder groups is crucial to mitigate negative socio-economic and environmental impacts.

b) Potential Risks and Opposition

Saboteurs (10.1%): This group could actively work against the project, viewing it as a threat to existing traditional livelihoods or ecosystems. Their presence indicates possible resistance from stakeholders who are concerned about how the project might disrupt fishing, agriculture, tourism, or mining activities. In Appendix 2G and H, the stakeholders are mainly comprised of advocacy groups, small-scale fishers, commercial fishers, and environmental NGOs who feel threatened by the project. These stakeholders have a high interest and are highly impacted but have low to moderate power. They normally lack formal authority but may wield considerable influence through collective action, advocacy, or strategic alliances. Their influence can be heightened if they gain public or media attention, form alliances with other stakeholders, or leverage legal or regulatory mechanisms to challenge project activities, and this has already been seen with H2Watch SA and Ground Up.

Possible implications include:

- If their power is underestimated, they could disrupt the project, either through legal challenges, protests, or campaigns that draw public and media attention. This could lead to delays, increased costs, or reputational damage for the project.

- They are highly interested in the project due to perceived threats to community livelihoods, environmental concerns, or potential displacement. For example, small-scale fishers may view the project as a direct threat to their fishing grounds, while environmental groups may fear ecosystem destruction.

- Such stakeholders will actively seek opportunities to oppose or derail the project unless their concerns are addressed. This can lead to sustained resistance, requiring proactive engagement and mitigation strategies to prevent escalation.

- The Saboteurs' actions can have a significant impact, especially if they succeed in mobilising public support, leveraging legal channels, or creating negative publicity. Their impact is often disruptive, aiming to halt or delay the project to protect their interests.

- Their potential impact means they cannot be ignored. If the project proceeds without considering their concerns, it could face operational disruptions, regulatory challenges, or reputational harm, which could slow down or jeopardise progress.

- The presence of 10.1% Saboteurs indicates there is notable resistance or concern about the project's impact on local communities, the environment, or existing livelihoods. This could reflect legitimate fears about displacement, loss of access to resources, or environmental degradation.

- The project's success will hinge on how effectively it addresses these stakeholders' concerns. Engaging in transparent communication, offering compensation or alternative livelihood opportunities, and involving Saboteurs in decision-making processes can help reduce their opposition.

- Ignoring or dismissing this group could lead to escalated conflicts, legal challenges, or community unrest, undermining the project's long-term sustainability. Therefore, adopting a more inclusive, participatory approach is essential to balance the needs of Saboteurs with project objectives, reducing the potential for conflict and fostering a more equitable development process.

Unknowns (6.5%): The significant proportion of unknown stakeholders means there's uncertainty about their stance, which can lead to unpredictable outcomes. Unknown stakeholders are those whose positions, intentions, or interests regarding the Boegoebaai project remain unclear. They might not have expressed their views, or there might be insufficient data about them. These stakeholders could either oppose, support, or remain neutral, depending on how the project progresses and addresses their concerns. Depending on their eventual alignment, they could become influential allies, neutral observers, or even active opponents. Their potential to form alliances with other stakeholder groups can also shift their level of influence. The types of stakeholders highlighted in Appendix 2H and G are categorised as a few government entities, particularly tourism agencies, a few environmental groups and local businesses within Port Nolloth, Kleinzee, Hondeklipbaai, and Alexander Bay.

Possible implications include:

- The representation of 6.5% as Unknowns indicates a lack of clarity in the stakeholder landscape, which could either be an opportunity or a risk. Their uncertainty could be due to limited communication, incomplete stakeholder mapping, or stakeholders themselves being undecided about the project.

- If left unaddressed, these Unknowns could unexpectedly sway the project's trajectory, especially if they align with more influential groups like Saboteurs or Saviours. Conversely, engaging with them could reveal new partnerships, resources, or insights that support the project's success.

- To manage this ambiguity, the project team should prioritize outreach, engagement, and information-gathering strategies. This could include conducting further research, building relationships, and creating forums for dialogue to better understand and incorporate the Unknowns' perspectives.

c) Ambiguity and Multiple Roles

Saboteur or Saviour (5.3%): These stakeholders are complex and dualistic in nature, as they could either hinder or help the project. Their power and influence range from moderate to high. This duality might reflect communities or groups who have mixed feelings, seeing both risks and opportunities in the project. Their power comes from the fact that they can pivot between opposing and supporting positions, which can

sway other stakeholders or alter project dynamics. They have been categorised as potential government and civil society stakeholders. These stakeholders might have resources, networks, or expertise that can be critical to the project's success, making their position highly influential, especially if they decide to act collectively or align with other groups. For example, a local cooperative might fear losing fishing grounds but also recognise the potential job opportunities that come with the Boegoebaai Project.

Acquaintances (4.7%): Acquaintances represent those who maintain a distant but respectful awareness of the Boegoebaai Green Hydrogen Project. They may have some level of interest or potential influence but are not actively engaged in the project's development. They often operate in an observational capacity, staying informed but not deeply involved.

Observer or Saboteur (4.1%): This group is likely to oppose the project if they feel their interests are threatened. Their position can change from passive to active opposition if the project's impacts are deemed negative for their livelihood.

Possible implications include:

- The presence of 5.3% Saboteur or Saviour stakeholders suggests a significant level of uncertainty in stakeholder alignment, reflecting broader ambivalence towards the Boegoebaai Green Hydrogen Project. These stakeholders represent those who see both potential opportunities and threats in the development, possibly stemming from how the project could alter existing power dynamics, resources, or environmental conditions.

- For example, a local business in Alexander Bay and Port Nolloth might be attracted to new economic opportunities presented by the project while simultaneously fearing the loss of traditional livelihoods or environmental degradation.

- The critical challenge lies in converting this group into advocates by addressing their concerns, demonstrating the project's benefits, and ensuring transparent, inclusive decision-making processes. Their dual potential means that early engagement is essential, with efforts to understand and mitigate any perceived risks or threats they might face.

- Failure to manage this group could lead to powerful opposition, as their shift toward the "saboteur" side could bring significant resources and influence against the project. However, if nurtured and aligned, they could transform into some of the project's most effective champions, using their resources and networks to advance project goals.

d) Marginalised Voices and Decision-Making (Important Groups)

Trip Wires (3.6%): This group, primarily representing fisheries, mining and community stakeholders, is crucial despite their relatively small representation. Although their representation is small (3.6%), they could exert a considerable impact if their interests are threatened or overlooked, especially in the context of the fisheries sector. Being "Trip Wires" suggests they are highly sensitive to changes or disruptions caused by the project, meaning they could trigger significant backlash if their concerns are not addressed. The low percentage indicates they have minimal influence in decision-making processes, highlighting their marginalisation. However, their importance cannot be underestimated, as any negative impact on their livelihoods (such as restricted access to fishing grounds or reduced marine resources) could lead to substantial resistance and community unrest.

Possible implications include:

- Marginalisation of Fisheries Stakeholders: The fact that Trip Wires, especially those representing fisheries, form only 3.6%, suggests that this group is significantly underrepresented in the decision-making process. This could lead to heightened tensions, as their concerns about the sustainability of their livelihoods may not be adequately addressed.

- Potential for Escalation: If their concerns are not acknowledged or addressed, they might become more vocal or align with other groups, such as NGOs or environmental organisations, to amplify their stance. This could evolve into active resistance, potentially disrupting the project.

- Risk of Project Delays: Overlooking or underestimating Trip Wires could result in unexpected challenges that might delay the project, especially if they begin to mobilise opposition based on the project's perceived threats to their livelihoods or the environment.

e) Latent Power and Potential Surprises (See Appendix 2G and H)

Sleeping Giants (1.2%): Though small in number, this group holds the potential to exert significant influence if awakened or provoked. These stakeholders might not currently be engaged in active discussions but could have substantial power, resources, or connections. For the Boegoebaai Green Hydrogen Project, this means there's an underlying risk of sudden and potent opposition, especially if their interests (e.g., land rights, water resources, or access to fishing areas) are threatened. Ignoring this group could lead to unanticipated challenges.

Time Bombs (1.2%): These stakeholders have a latent potential to become highly disruptive if certain conditions are triggered. For example, if the project adversely affects their livelihoods, they could mobilise quickly and create significant obstacles. Their low percentage doesn't diminish their potential impact, as they could incite widespread resistance or legal challenges, especially if they represent broader community concerns or grievances.

2.3 Social network analysis results

The aim of the SNA was to conceptualise the project participants as nodes and their interactions as ties. This approach allowed us to identify key stakeholders as central nodes and map out their influence networks. By examining the structure of these networks, insights can be gained into the flow of information, decision-making processes, and potential collaboration opportunities. Moreover, we used SNA to highlight the marginalised stakeholders who may be disconnected from the core network so that targeted engagement strategies can be facilitated.

2.3.1 Relationship A: H2 Watch SA, Ground Up, Aukotowa small-scale fishing cooperative and Longtime Hondeklipbaai SCF

Degree Centrality Analysis:

- **Here, the aim was to** measure the number of direct connections a stakeholder has within the network.

- **We identified that the Members of the H2Watch SA group** appear to have a relatively high degree centrality since they maintain active connections with multiple small-scale fishing cooperatives (Aukotowa and Longtime Hondeklipbaai) and have engaged with Ground Up to amplify their concerns. https://groundwork.org.za/south-africas-hydrogen-economy-benefits-for-who/

- **Implication**: This suggests that H2Watch SA is a well-connected stakeholder in this issue, indicating its potential to play a significant role in voicing concerns and rallying support regarding the negative impacts of the Green Hydrogen project in Boegoebaai.

Betweenness Centrality Analysis:

- **Here, we found that members of the H2Watch SA group seem to function as bridging stakeholders between small-scale fishing cooperatives and the** external media (Ground Up NGO media agency). This means they can act as a conduit of information and influence between these groups.

- **Implication**: As a bridging stakeholder, H2Watch SA has the potential to facilitate communication between isolated or less influential stakeholders (e.g., the fishing cooperatives and mining groups) and broader audiences or decision-making bodies, thus giving the fishing communities a voice.

Closeness Centrality Analysis:

- **Closeness Centrality** assesses how quickly a stakeholder can reach all other stakeholders within the network.

- Given H2Watch SA's established connections with both the fishing cooperatives and Ground Up, their closeness centrality is relatively high, meaning they can disseminate information efficiently across the network.

- **Implication**: This indicates that H2Watch SA is well-positioned to swiftly gather and disseminate information, making them a crucial player in raising awareness or mobilising efforts.

Influencers Analysis:

- **Influencers**: H2Watch SA emerges as an influential stakeholder, given its role in bridging and amplifying the concerns of marginalised groups.

- The **small-scale fishing cooperatives** (Aukotowa and Longtime Hondeklipbaai) are gaining influence through their association with H2Watch SA and media platforms like Ground Up.

Isolated Stakeholders Analysis:

- The small-scale fishing cooperatives, in isolation, might have limited direct influence or access to broader platforms. However, their engagement with H2Watch SA and Ground Up helps connect them to larger networks.

- **Implication**: Without these bridging stakeholders, these cooperatives might struggle to have their voices heard.

Strength of Relationships Analysis:

- **Strong Relationships**: The established communication between H2Watch SA, the fishing cooperatives, and Ground Up reflects strong ties, enabling more cohesive efforts in raising concerns or advocating for change.

- **Weak Relationships**: If H2Watch SA or Ground Up were to weaken their engagement, the fishing cooperatives might lose this vital platform, reducing their ability to influence the project.

Overall Analysis: The involvement of H2Watch SA as a bridging and influential stakeholder is crucial for amplifying the concerns of marginalised groups like small-scale fishing cooperatives. This dynamic highlights the importance of advocacy and media platforms in ensuring that less influential stakeholders have their voices heard in decision-making processes. The strong connections also suggest potential opportunities for forming alliances or coalitions that could pressure project developers to consider the implications for fishing livelihoods. This analysis underlines the significance of maintaining and strengthening these connections to ensure that marginalised groups remain part of the discourse surrounding the proposed Boegoebaai Green Hydrogen Project.

2.3.2 Relationship B: Transnet, SANEDI, NCEDA, SASOL, SCFs, Boegoebaai Port and Rail Consortium, Boegoebaai Development Consortium and Project Elephant group

Degree Centrality Analysis: Transnet, as a government player, has high degree centrality, as it maintains numerous direct relationships with multiple stakeholders, such as government (Northern Cape Economic Development Agency, private sector (SASOL), and major engineering consortiums (Boegoebaai Port and

Rail Consortium, Boegoebaai Development Consortium, and Project Elephant group). This suggests that Transnet is a central player with considerable connectivity in the network. Transnet's high degree centrality makes it a key influencer in decision-making processes, particularly concerning port development and rail infrastructure.

Betweenness Centrality Analysis: Transnet, for the Hydrogen project, acts as a crucial bridging stakeholder between government entities, private sector businesses, and small-scale fishing cooperatives, even if the ties with the latter are weak. It connects different clusters of stakeholders, such as linking engineering firms with different government agencies. This gives Transnet significant control over information flow and decision-making, enabling it to act as a gatekeeper. However, the weak ties with small-scale fishing cooperatives suggest that their concerns might be underrepresented or filtered when engaging with influential stakeholders.

Closeness Centrality Analysis: Transnet has relatively low closeness centrality with small-scale fishing cooperatives due to weak ties but high closeness with government and private sector stakeholders. The proximity to government and engineering groups implies faster access to information and influence over project outcomes. Transnet's strategic positioning allows it to efficiently reach key stakeholders for collaboration, but the distance from small-scale fishing cooperatives indicates a potential gap in understanding or addressing their needs.

Influencers Analysis: Transnet emerges as a primary influencer due to its strong connections with major consortiums and governmental bodies. This influence is amplified by its ability to access and coordinate resources across sectors. Transnet's influential role means its stance on project development could significantly shape project directions, with a bias toward infrastructure development over livelihood concerns.

Isolated Stakeholders Analysis: Small-scale fishing cooperatives (Aukotowa and Longtime Hondeklipbaai) appear to be relatively isolated from the core decision-making network due to weak ties with Transnet and other powerful stakeholders. This isolation suggests that their interests may be marginalised unless intermediaries like NGOs (e.g., Ground Up, Masifundise and H2Watch SA) advocate on their behalf, highlighting the potential risks to their livelihoods.

Bridging Stakeholders Analysis: Transnet serves as a critical bridge between different sectors, such as the government and private engineering companies, playing a vital role in integrating these diverse groups into the Boegoebaai project. Transnet's bridging role reinforces its power but also indicates that if it fails to adequately represent all stakeholders, such as the small-scale fishing cooperatives, their interests may be overlooked in project planning and execution.

Strength of Ties Analysis: The strong ties reinforce Transnet's alignment with large-scale infrastructure goals, while the weak ties suggest insufficient consideration of the socio-economic impact on vulnerable fishing communities.

- **Strong Ties**: Transnet has strong ties with government entities like the Northern Cape Economic Development Agency and private sector stakeholders (Boegoebaai Port and Rail Consortium, Boegoebaai Development Consortium, Project Elephant Group).

- **Weak Ties**: Transnet's relationship with small-scale fishing cooperatives is weak, reflecting a lack of engagement or prioritisation of these stakeholders.

Overall Analysis:

- **Power Imbalance**: The strong ties with major engineering and private sector stakeholders suggest that the project is likely driven by economic and infrastructural imperatives, potentially overshadowing social or environmental concerns.

- **Marginalisation of Small-Scale Fishing Cooperatives**: The weak relationship between Transnet and small-scale fishing cooperatives highlights a high risk of marginalisation. If this continues, the project could exacerbate existing inequalities and negatively impact local livelihoods.

- **Opportunity for Advocacy**: Bridging stakeholders or NGOs need to step in to strengthen the ties between Transnet and marginalised groups, ensuring that their voices are integrated into decision-making.

2.3.3 Relationship C: NCEDA, PJSV, SASOL, CPA, RMC and Alexkor

NCEDA and CPA: NCEDA engages with the Richtersveld's Community Property Association (CPA) in discussions that concern the community's land despite concerns about NCEDA's lack of a properly constituted board and legitimate authority. NCEDA has also been engaging with the CPA to negotiate an access agreement for the SEZ at Boegoebaai. However, the community feels that NCEDA lacks transparency and legitimacy in handling the project and the access agreement. This relationship is highly contentious and characterized by mistrust and lack of transparency, indicating a power imbalance where NCEDA holds significant authority but fails to engage the community inclusively.

CPA and Internal Factions of the Richtersveld Community: The CPA appears to be dysfunctional, with internal divisions over the access agreement, legitimacy of elections, and handling of the community's land rights. Some community members have called for the removal of government representatives from the CPA committee and are questioning the CPA's decisions. The CPA's internal divisions weaken its position, diminishing its ability to represent the community effectively. This fragmentation could lead to further marginalization of community voices in project negotiations.

CPA, NCEDA, and Government Departments (DALRRD): The Department of Agriculture, Land Reform and Rural Development (DALRRD) has previously placed the CPA under administration due to maladministration and conflict. The CPA's current operations and decisions regarding land and SEZ development remain under scrutiny, particularly in light of ongoing government plans for the SEZ and the Green Hydrogen Project. The CPA's relationship with these government agencies is characterised by oversight and distrust, further complicated by concerns about whether NCEDA's negotiations genuinely consider the community's best interests.

Alexkor, the PSJV, and the Richtersveld Community: Alexkor, a state-owned entity, holds a 51% interest in the Pooling and Sharing Joint Venture (PSJV), while the Richtersveld Mining Company (RMC), representing the community, holds 49%. However, due to dysfunctionality within the CPA and RMC, the community has not significantly benefited from the joint venture. The unequal distribution of power and ineffective management has left the Richtersveld community feeling exploited, perpetuating a sense of disenfranchisement despite their legal ownership stake in the PSJV.

SASOL, NCEDA, CPA and Richtersveld Community: The project has the support of national government and private entities like SASOL, who stand to benefit from the Green Hydrogen Project. However, their involvement appears top-down, with limited grassroots consultation. This dynamic could potentially reinforce the perception that government and private sector interests are driving the project, potentially at the expense of genuine community engagement and benefit-sharing.

Closeness Centrality Analysis:

- **NCEDA** exhibits high closeness centrality, directly engaging with key stakeholders (e.g., the Richtersveld CPA, government departments, and private sector entities). Despite this centrality, its actions are perceived as opaque and exclusionary by the community.

- **Implication**: NCEDA's position enables it to influence project decisions, but its lack of transparency may undermine trust and cooperation with the Richtersveld community.

Degree Centrality Analysis:

- **CPA** has a relatively high degree of centrality, interacting with multiple actors (NCEDA, DALRRD, community members, Alexkor, etc.). However, its dysfunctional state and internal divisions weaken its efficacy as a representative entity.

- **Implication**: The CPA's inability to consolidate community interests undermines its power and reduces its influence over critical decisions concerning land use and project implementation.

Betweenness Centrality Analysis:

- **Richtersveld** community members who advocate for more transparent and inclusive decision-making possess high betweenness centrality. They bridge the gap between community concerns and broader issues surrounding governance, transparency, and equitable benefit-sharing.

- **Implication**: These actors are crucial connectors who can amplify community voices, but their effectiveness hinges on the willingness of entities like NCEDA and the CPA to engage with them constructively.

Influencers, Connectors, and Isolated Stakeholders Analysis (see Table 3):

- **Influencers**: National Government, NCEDA, and SASOL wield significant influence due to their political and economic clout. Their support for the project shapes its trajectory, even if community concerns are not fully addressed.

- **Connectors**: The CPA, if functional, would serve as a key connector between the community and other stakeholders. However, due to its current dysfunction, actors like Willem Cloete and certain community groups serve as alternative connectors, attempting to bring attention to community grievances.

- **Isolated Stakeholders**: The Richtersveld community itself remains relatively isolated, as their direct influence over negotiations is limited. This isolation is exacerbated by internal divisions and the CPA's weakened legitimacy.

- **Bridging Stakeholders**: Entities like the Special Investigating Unit (SIU) and advocacy groups can act as bridges by scrutinizing potential corruption and maladministration, thereby holding entities like NCEDA accountable.

Table 3. Stakeholder categories analysis (ties and nodes)

Energisers	Challengers	Connectors	Brokers
Energisers are driving the project from the top-down, with the government's agenda and private sector interest providing momentum.	*Challengers represent grassroots concerns and act as checks on power, ensuring that community interests are not sidelined.*	*Connectors play a critical role in potentially bridging the gap between these energisers and challengers, although their effectiveness is currently compromised by internal dysfunction.*	*Brokers have the potential to mediate disputes and facilitate more equitable negotiations, but their effectiveness depends on their willingness to engage genuinely with community concerns.*
Transnet	Aukotowa SCF	CPA (despite dysfunction)	RMC
SANEDI	Longtime Hondeklipbaai	DALLRRD	Alexkor
SASOL	H2Watch SA	SPI	Department of Public Enterprises
NCEDA	Richtersveld Community	South African National Parks (SANParks)	Indigenous Peoples of Africa Co-ordinating Committee
Boegoebaai Port and Rail Consortium Boegoebaai Development Consortium and Project Elephant group	Masifundise	Oceans not Oil	Housing Development Agency (HDA)
	South African Fisheries Development Fund	Ground Up	Council for Scientific and Industrial Research (CSIR)

Strength and Weakness of Relationships Analysis:

- **Strong Relationships**: The government's relationship with NCEDA and the private sector (SASOL) is robust, suggesting a unified agenda to advance the Green Hydrogen Project. This strength comes from shared goals of economic development and investment attraction.

- **Weak Relationships**: The relationship between the Richtersveld community and the CPA is weak and contentious, characterized by mistrust, allegations of illegitimacy, and internal conflict. The community's distrust of NCEDA and government stakeholders further exacerbates this weakness.

Potential implications for the Boegoebaai Green Hydrogen Project:

- **Risk of Exclusion and Marginalisation**: The current dynamics suggest a high risk of the Richtersveld community being excluded from meaningful participation in decision-making. Their experiences with previous projects, coupled with internal CPA dysfunction, mean that unless proactive measures are taken, their voices may remain marginalized.

- **Transparency and Governance Issues**: The involvement of the SIU in investigating NCEDA's operations indicates potential governance and corruption issues. This adds to the community's scepticism and reinforces the need for transparent processes to avoid repeating past mistakes.

- **Potential for Conflict**: Given the community's historical struggles and dissatisfaction with previous agreements (e.g., the PSJV), there's a risk of resistance or legal challenges if the project proceeds

without adequately addressing their concerns. The contested legitimacy of the CPA, in particular, could escalate into more significant disputes.

- **Need for Independent Assessment and Consultation**: The demand for an independent environmental assessment by community members like Willem Cloete highlights a crucial need for impartial evaluation and consultation. Ensuring such assessments could help build trust and foster informed decision-making among all stakeholders.

Overall Analysis: This finding reinforces the complex web of relationships, power struggles, and historical grievances surrounding the Boegoebaai Green Hydrogen Project. NCEDA, government agencies, and private stakeholders hold significant power and influence, while the Richtersveld community remains vulnerable to exclusion.

CHAPTER 3: KEY MESSAGES

The Boegoebaai Green Hydrogen Project would benefit from a more inclusive and participatory approach that prioritizes the involvement of marginalized stakeholders, such as small-scale fishing, agricultural, and mining communities. Below are key messages based on the stakeholder categorisation database analysis and Cube Matrix Analysis.

3.1 Stakeholder categorisation

Inclusive Engagement Framework:

Establish a multi-stakeholder engagement platform that involves government, private sector, civil society, and NGOs to foster transparent and participatory decision-making. This platform should specifically include representatives from marginalised communities, ensuring their concerns and aspirations are voiced and integrated.

Strengthening Accountability Mechanisms:

Introduce clear accountability structures to monitor the actions of government and private sector stakeholders. This would include regular public reporting, audits, and community-led monitoring, particularly focusing on how public funds are utilised and whether the project aligns with sustainable development goals.

Addressing Power Imbalances:

Implement measures such as a grievance redressal mechanism where marginalised stakeholders, like small-scale fishers and local community groups, can raise concerns about project impacts. This mechanism should be accessible, transparent, and responsive.

Capacity Building and Empowerment:

Invest in capacity-building programmes for local communities and civil society organisations, enabling them to effectively participate in negotiations, advocacy, and decision-making. This empowerment will help counterbalance the influence of more powerful stakeholders.

Integrating Traditional Knowledge and Practices:

Recognise and integrate the traditional knowledge of local and indigenous communities into project planning, especially in areas related to environmental management, fisheries, and sustainable resource use. This would enhance the project's cultural and ecological relevance.

Promoting Benefit Sharing:

Develop a benefit-sharing model that ensures the fair distribution of economic gains from the project. This includes revenue-sharing, employment opportunities, infrastructure development, and social services for the local communities, especially those dependent on fisheries and agriculture.

Sustainable Environmental Management:

Prioritise environmental impact assessments with active participation from civil society and NGOs to identify and mitigate potential risks to marine and terrestrial ecosystems. Establish monitoring programmes to ensure ongoing compliance with environmental standards.

Long-term Sustainability Focus:

Encourage the involvement of private sector stakeholders in long-term sustainability goals, such as renewable energy investments, marine conservation, and community development projects, ensuring that profit-driven objectives do not override environmental and social considerations.

Overall implications for stakeholder engagement, especially with marginalised communities:

- Enhanced Representation: The recommendations aim to create avenues for marginalised communities to have a more significant voice and influence in the Boegoebaai project, ensuring that their concerns are acknowledged and addressed.
- Balancing Power Dynamics: By implementing accountability mechanisms and ensuring transparent engagement processes, power imbalances between dominant government/private stakeholders and marginalised groups can be mitigated.
- Fostering Trust and Collaboration: Transparent and inclusive engagement will help build trust between stakeholders, reducing the potential for conflict and fostering collaboration toward shared project goals.
- Mitigating Potential Conflicts: Engaging civil society and marginalised communities from the outset will minimise misunderstandings, delays, and resistance, promoting a smoother project implementation.
- Empowering Marginalised Groups: By investing in capacity-building and recognising traditional knowledge, the project can empower marginalised stakeholders to actively participate in decision-making, enhancing the overall socio-economic benefits for these communities.

3.2 Cube Matrix Analysis

Engage Observers Early and Transparently

- **Rationale:** Observers (23.7%) represent a significant portion of stakeholders who are currently passive but could potentially become active if they perceive threats or opportunities.
- **Recommendation:** Establish regular, transparent communication channels to keep Observers informed about project developments, potential benefits, and mitigation strategies for any negative impacts. This could **include** public forums, newsletters, or community meetings focusing on how the project might benefit tourism, agriculture, or fishing livelihoods.
- **Implication for Marginalised Stakeholders:** Engaging Observers, particularly those from marginalised communities, can convert passive monitoring into active participation, enabling them to advocate for their interests early in the project.

Empower Civil Society and NGO Involvement (Strengthening the Voice of Marginalised Stakeholders)

- **Rationale:** Civil society and NGOs currently have limited influence despite their potential role in representing **marginalised** communities.
- **Recommendation:** Encourage the formation of partnerships with NGOs, advocacy groups, and local cooperatives to ensure their concerns are integrated into the decision-making process. This can be achieved by including these groups in advisory committees, environmental monitoring, and socio-economic impact assessments.
- **Implication for Marginalised Stakeholders:** This approach would ensure that the voices of small-scale fishers, farmers, and mining **communities** are heard, increasing their influence and

advocating for their interests, particularly around issues like access to resources, compensation, *and livelihood sustainability.*

Address the Concerns of Saboteurs through Proactive Engagement and Collaboration

- **Rationale: Saboteurs** (10.1%) pose a potential risk to the project due to their active opposition, especially if they feel their livelihoods are threatened.

- **Recommendation:** Develop targeted engagement strategies to address the concerns of Saboteurs, such as **offering** alternative livelihood programs, compensation schemes, or co-management opportunities. Collaborating with these stakeholders in environmental monitoring and fisheries management could help reduce conflict.

- **Implication for Marginalised Stakeholders:** Small-scale fishing communities, agricultural cooperatives, and miners are more likely to shift from opposition to support if they see tangible benefits and assurances that their livelihoods are protected.

Leverage the Influence of Saviours to Advocate for Inclusive Development

- **Rationale:** Saviours (21.9%) possess significant power and influence, but their focus is often on economic gains rather than social or environmental concerns.

- **Recommendation:** Engage with government and private sector Saviours to advocate for a more inclusive **development** model that considers the needs of marginalised stakeholders. This could involve promoting Corporate Social Responsibility (CSR) initiatives that benefit local communities or incentivizing investment in local infrastructure, education, and health services.

- **Implication for Marginalised Stakeholders:** If Saviours can be encouraged to invest in community-**based** projects, fishing, agricultural, and mining communities could benefit from improved infrastructure, job opportunities, and social services, enhancing their long-term resilience.

Monitor and Engage Unknowns to Reduce Uncertainty and Potential Risks

- **Rationale: Unknowns** (6.5%) present an element of unpredictability in the stakeholder landscape.

- **Recommendation:** Proactively reach out to Unknowns through stakeholder mapping and engagement **strategies** to better understand their positions and interests. This may involve targeted surveys, interviews, or focus group discussions.

- **Implication for Marginalised Stakeholders:** Gaining clarity on the Unknowns' perspectives can help identify **additional** allies or potential opponents, allowing marginalised communities to form strategic partnerships that enhance their influence in the project.

Incorporate Trip Wires in Decision-Making Processes to Minimize Conflict

- **Rationale:** Trip Wires (3.6%) are critical despite their small representation and could cause significant **disruption** if their interests are ignored.

- **Recommendation:** Include representatives from Trip Wires (particularly fisheries, agricultural, and mining communities) in decision-making bodies and advisory groups. Ensure that their concerns about **resource** access, environmental impacts, and economic displacement are addressed in project planning and implementation.

- **Implication for Marginalised Stakeholders:** This inclusion would ensure that marginalised voices are **represented**, enabling these communities to advocate for policies that safeguard their livelihoods and mitigate potential disruptions.

Activate and Engage with Sleeping Giants to Pre-empt Disruptions

- **Rationale:** Sleeping Giants (1.2%) have latent power that could be activated if their interests are threatened.

- **Recommendation:** Conduct regular assessments to identify Sleeping Giants and engage them in dialogue to understand their **concerns**. Establish mechanisms to incorporate their feedback into the project's design and execution.

- **Implication for Marginalised Stakeholders:** By engaging Sleeping Giants early, the project can avoid sudden resistance or legal challenges that **could** arise if their interests align with those of marginalised communities, creating an opportunity for collaborative problem-solving.

Prepare Mitigation Strategies for Time Bombs and Potential Saboteurs

- **Rationale:** Time Bombs (1.2%) and potential Saboteurs have the capacity to cause significant disruption if certain **conditions** are met.

- **Recommendation:** Develop contingency plans to address potential conflicts, such as dispute resolution mechanisms, **compensation** frameworks, or rapid response teams that can engage with stakeholders experiencing adverse impacts.

- **Implication for Marginalised Stakeholders:** This proactive approach would help to address grievances promptly, preventing escalations that **could** disproportionately affect marginalised communities dependent on fisheries, agriculture, or mining.

Establish Multi-Stakeholder Platforms for Inclusive Dialogue and Decision-Making

- **Rationale:** The dominance of government and private sector stakeholders risks sidelining smaller stakeholder groups, **such** as marginalised communities.

- **Recommendation:** Create multi-stakeholder platforms that facilitate ongoing dialogue between all stakeholders, ensuring that marginalised communities can participate in discussions around project impacts, benefit-sharing, and long-term planning.

- **Implication for Marginalised Stakeholders:** This platform would provide an opportunity for marginalised voices to be heard and for their concerns to be integrated into decision-making, promoting equitable outcomes and fostering social cohesion.

Implement Social and Environmental Monitoring Mechanisms Involving Marginalised Stakeholders

- **Rationale:** Marginalised communities often suffer from environmental degradation and socio-economic disruptions caused by **large**-scale projects.

- **Recommendation:** Establish independent monitoring mechanisms that include representatives from fishing, **agricultural**, and mining communities to oversee the project's environmental and social impacts. This could involve community-based monitoring programs or partnerships with local NGOs.

- **Implication for Marginalised Stakeholders:** Involving marginalised communities in monitoring activities ensures that their concerns about environmental sustainability and livelihood protection are addressed, leading to more inclusive and equitable project outcomes.

These key messages emphasise the importance of engaging marginalised stakeholders, such as fishing, agricultural, and mining communities, in all stages of the proposed Boegoebaai Green Hydrogen Project. By fostering inclusivity, transparency, and collaboration, the project can balance economic, social, and environmental goals, thereby ensuring that the development benefits are equitably distributed and that marginalised voices are actively represented in decision-making processes.

REFERENCES

AbouSeada, N., and Hatem, T. M. 2022. Climate action: prospects of green hydrogen in Africa. Energy Reports, 8: 3873–3890.

Balane, M. A., Palafox, B., Palileo-Villanueva, L. M., McKee, M., and Balabanova, D. 2020. Enhancing the use of stakeholder analysis for policy implementation research: Towards a novel framing and operationalised measures. BMJ Global Health, 5: 1–12.

Bernstein, S. L., Weiss, J., and Curry, L. 2020. Visualizing implementation: contextual and organizational support mapping of stakeholders (COSMOS). Implementation Science Communications, 1: 48.

Bhagwat, S., and Olczak, M. 2020. Green hydrogen: bridging the energy transition in Africa and Europe. Technical Report, Florence School of Regulation, Energy, Research Reports (FSR Global). European University Institute, Florence, Italy. https://cadmus.eui.eu/handle/1814/68677.

Brugha, R., and Varvasovszky, Z. 2000. Stakeholder analysis: a review. Health Policy and Planning, 15: 239–246.

Burt, R. S. 1995. Structural holes: the social structure of competition. Harvard University Press, Cambridge, Mass. 313 pp.

Chaudhary, A. K., and Warner, L. A. 2015. Introduction to social network research: brokerage typology: AEC535 WC197, 3. EDIS, 2015: 4.

Cross, R., Parker, A., Prusak, L., and Borgatti, S. P. 2001. Knowing what we know: Supporting knowledge creation and sharing in social networks. Organizational Dynamics, 30: 100–120.

Gammage, L. C., and Strand, M. 2021. Exploring the social-ecological implications of ocean and coastal mining (OCM) from an ecosystem-based approach. Unpublished Report. University of Cape Town & Nelson Mandela University.

Gould, R. V., and Fernandez, R. M. 1989. Structures of mediation: a formal approach to brokerage in transaction networks. Sociological Methodology, 19: 89–126. [American Sociological Association, Wiley, Sage Publications, Inc.].

Granovetta, M. 1973. The strength of weak ties. The American Journal of Sociology, 78: 1360–1380.

Grimble, R., and Chan, M. -K. 1995. Stakeholder analysis for natural resource management in developing countries: Some practical guidelines for making management more participatory and effective. Natural Resources Forum, 19: 113–124.

Grimble, R. 1998. Stakeholder methodologies in natural resource management. *In* Socio-economic methodologies: Best practice guidelines. Natural Resources Institute, University of Greenwich, London.

H2 Watch SA. 2023. South Africa's Hydrogen Economy: benefits for who? https://groundwork.org.za/south-africas-hydrogen-economy-benefits-for-who/ (Accessed 9 October 2024).

Halevy, N., Halali, E., and Zlatev, J. J. 2019. Brokerage and brokering: an integrative review and organizing framework for third party influence. Academy of Management Annals, 13: 215–239.

Kumar, V., Mishra, M., Kr Pathak, A., Kr Dubey, D., and Singh, B. 2023. Environmental Impact Assessment using social network analysis and data mining. Ecology, Environment and Conservation, 29: 1736–1741.

Lin, Z., Zhang, Y., Gong, Q., Chen, Y., Oksanen, A., and Ding, A. Y. 2022. Structural Hole Theory in Social Network Analysis: A Review. IEEE Transactions on Computational Social Systems, 9: 724–739.

Maphanga, T., Shale, K., Gqomfa, B., and Zungu, V. M. 2023. The state of public participation in the EIA process and its role in South Africa: a case of Xolobeni. South African Geographical Journal, 105: 277–305.

Murray-Webster, R., and Simon, P. 2006. Making Sense of Stakeholder Mapping. Project Manager Today.

Olander, S. 2007. Stakeholder impact analysis in construction project management. Construction Management and Economics, 25: 277–287. Routledge.

Prell, C., Hubacek, K., and Reed, M. 2009. Stakeholder analysis and social network analysis in natural resource management. Society and Natural Resources, 22: 501–518.

Reda, B., Elzamar, A. A., AlFazzani, S., and Ezzat, S. M. 2024. Green hydrogen as a source of renewable energy: a step towards sustainability, an overview. Environment, Development and Sustainability. https://link.springer.com/10.1007/s10668-024-04892-z.

Reed, M. S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., *et al.* 2009. Who's in and why? A typology of stakeholder analysis methods for natural resource management. Journal of Environmental Management, 90: 1933–1949.

Scott, J. 2012. What is social network analysis? Bloomsbury Academic, London, UK.

Stovel, K., Golub, B., and Milgrom, E. M. M. 2011. Stabilizing brokerage. Proceedings of the National Academy of Sciences, 108: 21326–21332.

Talley, J. L., Schneider, J., and Lindquist, E. 2016. A simplified approach to stakeholder engagement in natural resource management: The Five-Feature Framework. Ecology and Society, 21. Resilience Alliance.

Vidas, L., and Castro, R. 2021. Recent developments on hydrogen production technologies: state-of-the-art review with a focus on Green-Electrolysis. Applied Sciences, 11.

Yang, J., Shen, G. Q., Bourne, L., Ho, C. M., and Xue, X. 2011. A typology of operational approaches for stakeholder analysis and engagement. Construction Management and Economics, 29: 145–162.

Appendix 1

Appendix 1A. Preliminary stakeholder list

Stakeholder/ Expert Name	Organisation/ Affiliation	Contact Information (email, phone number)	Role or Expertise	Involvement Level (primary, secondary, tertiary)	Notes/ Comments / Information to look for
Boegoebaai and Namakwa Region					
Government Agencies					
Pieter van Wyk	SANparks	Pieter.vanWyk@sanparks.org	Botanist at Richtersveld Transfrontier Park.	Key Expert	**Ecological conditions:** Information on the biodiversity, habitat conditions, and ecosystem health of the area. **Land use patterns**: Understanding of current and historical land use practices in the region. **Protected area management**: Insights into the management strategies and challenges of the Richtersveld Transfrontier Park. **Community interactions:** Information on the relationship between the park and local communities. Possibly knows about the Trans HEX mining operations within Richtersveld National Park Based in Alexander Bay. **Requires in-person meeting** to gain a situational view of the economic landscape and stakeholders within the area.
Ntombovuyo Madlokazi	Department of Forestry Fisheries and Environment	nmadlokazi@dffe.gov.za	Part of the organisation that is an environmental regulator and policymaker	Key Stakeholder	They could provide spatial data on environmental coastal resources, land use, and demographics. Overview of marine protected areas, species conservation programs. Status and health of marine resources Identification of relevant datasets, reports, and studies, i.e. registered fishers' profiles, biodiversity hotspots. Information on the impact of sectors like tourism, agriculture, and mining in Boegoebaai. Data on fishing quotas, species management plans, and

Stakeholder/ Expert Name	Organisation/ Affiliation	Contact Information (email, phone number)	Role or Expertise	Involvement Level (primary, secondary, tertiary)	Notes/ Comments / Information to look for
					challenges faced by the sector.
DMRE	Department of Mineral Resources and Energy DMRE	+27124068000	Regulatory Authority for the mining and energy sectors in Port Nolloth	Key Stakeholder	**They have information on the:** **Current Mining and energy activities**: Information on existing and planned mining or energy projects in the area. **Environmental impact assessments:** Access to EIAs for relevant projects. **Community engagement:** Details about the department's interactions with local communities.
NCEDA	Northern Cape Economic Development, Trade and Investment Promotion Agency (NCEDA)	087 086 0350	The agency acts as a bridge between investors and potential opportunities in the Northern Cape Region. Part of the SEA project Steering Committee	Secondary Stakeholder	While NCEDA is involved in economic development, their direct influence on environmental management might be limited compared to government departments like the DFFE. However, they have knowledge of the local economic landscape, including potential investors and businesses operating in the region. We could ask about the: **Economic development initiatives**: Information on economic development projects and programs in the region. **Investment climate:** Assessment of the investment potential of the area. **Infrastructure development:** Plans for improving transportation, energy, and communication infrastructure in Boegoebaai.
SANEDI	South African National Energy Institute	011 038 4300	Energy and Research Development	Key Stakeholder	The organisations know about the development of the Green Hydrogen Project. We can ask them about: **Energy access and consumption patterns**: Understanding how local communities access and utilize energy, including reliance on traditional fuels. **Renewable energy potential:** Assessment of the region's suitability for green hydrogen? **Energy efficiency initiatives:** Information on existing energy efficiency programs or projects in the area. **Challenges and opportunities:** Identifying their perspectives on the main barriers to and opportunities for energy development in the region.
TNPA	Transnet National Port Authority	Head Office +27 31 361 1150	TNPA is responsible for the development and maintenance of port infrastructure, which is vital for the functioning of the fishing industry and other economic activities. **Regulatory Role:** TNPA has authority over port operations and can	Key Stakeholder	**Port infrastructure and capacity:** Information on port facilities, equipment, and capacity constraints. **Port charges and tariffs**: Understanding the cost structure for using port facilities. **Trade facilitation initiatives**: Information on programs and projects to improve port efficiency and competitiveness. Understanding TNPA's environmental management policies and practices.

Stakeholder/ Expert Name	Organisation/ Affiliation	Contact Information (email, phone number)	Role or Expertise	Involvement Level (primary, secondary, tertiary)	Notes/ Comments / Information to look for
			influence access to port facilities.		
ALEXKOR	Department Public Enterprises	Tel: +27 11 ALEXKOR (253 9567) Fax: +27 11 788 8869 Website: www.alexkor.co.za	The core business of Alexkor is the mining of diamonds on land, along rivers, on beaches and in the sea along the north-west coast of South Africa.	Key Stakeholder	They are engaged in diamond mining 10km north of Port Nolloth and the mining has affected the fishers access to rock lobster, cray fish and firewood. They are building cofferdams in Alexander Bay which is affecting fishers access to several marine resources and has led to degradation of fishing grounds.
Atlantic Margin-focused oil & gas exploration company.					
Eco Atlantic (Gas and Oil)	Gas and Oil Company operating near Port Nolloth	Alice Carroll Tel: +44 (0) 7817295070 Email: alice@ecooilandgas.com	Atlantic Margin-focused oil & gas exploration company.	Secondary Stakeholder	Eco Atlantic has a strategic portfolio of offshore projects in Guyana (South America) and Namibia and South Africa (Africa) in partnership with major energy companies and large independents. However, according to this article https://www.dailymaverick.co.za/article/2022-10-06-fishers-and-environmental-activists-express-concern-over-proposed-drilling-off-sas-west-coast/ The Azinam/Eco Atlantic oil rig — which left the North Sea on 12 August 2022— arrived on South African shores to begin its exploratory drilling in Block 2B off the west coast. Drilling at Azinam's proposed offshore exploration well (the Gazania-1) will be conducted in relatively shallow depths of 50m to 200m. Walter Steenkamp, said he and his fellow fishers are against the exploration.
Fisheries					
Fishers					
Walter Steenkamp **John De Wet**	Aukotowa SCF Fisheries Cooperative in North Nolloth	aukotowafisheries@gmail.com	Works with West Coast Rock Lobster (WCRL) small-scale fishers in Port Nolloth.	Fisher Community Stakeholder	Walter is second-generation fisherman from Port Nolloth. He has been fishing for more than 38 years. Could provide us with details on **economic and social needs of coastal community small-scale fishers** in Port Nolloth. Provide insights to the fishers concerns regarding the green hydrogen project. https://www.youtube.com/watch?v=-QnErCaCaQc Walter appears on SBAC 3 and speaks about the abundance of snoek and lack of

Stakeholder/ Expert Name	Organisation/ Affiliation	Contact Information (email, phone number)	Role or Expertise	Involvement Level (primary, secondary, tertiary)	Notes/ Comments / Information to look for
					fishing quotas in North Polloth. John De Wet is another small-scale fisher in Port Nolloth.
Johny Fritz	Longtime Hondeklipbaai Fishing Primary Cooperative Ltd in the Northern Cape	longtimehkb@gmail.com 0715611879	Representative of the Hondeklipbaai fishing community	Key Stakeholder	Possible **Long-standing member of the community with deep knowledge of local fishing practice**s and challenges. He could provide us details about: **Fishing practices**: Details about traditional and modern fishing methods used by the community. **Catch statistics:** Historical and current data on fish species, catch volumes, and landing sites. **Market conditions:** Information about prices, demand, and distribution channels for fish products. **Community livelihoods:** Understanding the role of fishing in the community's economy and social well-being. **Challenges and opportunities:** Insights into the challenges faced by the fishing community and potential opportunities for development.
Morgan Johnson from Alexander Bay	Fisher	Aukotowa SCF Fisheries	Small-scale fisher specialised in Rock lobster in Port Nolloth.	Key Stakeholder	Fisherman for more than 32 years. Speaks about challenges with access, especially with rock lobster and is part of the Aukotowa SCF Fisheries Cooperative in North Polloth. https://www.barrychristianson.com/the-slow-squeeze-on-port-nolloths-fishers
Rosie Malan	Fisher	Fisher in Port Nolloth	Small-scale fisher specialised in crayfish	Key stakeholder	She has been working in the fishing industry for about 43 years. Worked as a fish gutter and then supervisor for Ovenstone crayfish processing factory before it closed down. She owns a fish shop by the Habour and provides storage for the fishers. She does the administrative work for the fishers. https://groundup.org.za/article/meet-the-woman-at-the-centre-of-port-nolloths-crayfish-trade/
Diamond Divers					
George Nicolaai	Diamond Diver	Worked for Alexkor	Diamond Diving Contractor in Port Nolloth	Key Stakeholder	Mines for nearshore marine diamonds using pumps on boats or the shore. According to Nicolaai, the initial construction plan for the cofferdams involved the use of beach sand. However, due to

Stakeholder/ Expert Name	Organisation/ Affiliation	Contact Information (email, phone number)	Role or Expertise	Involvement Level (primary, secondary, tertiary)	Notes/ Comments / Information to look for
					concerns about the structure's vulnerability to erosion, the builders opted for a more resilient approach using quarried rocks. Nicolaai expressed concerns about the environmental impact of this decision, citing the corrosion of the rocks and the subsequent release of silt into the marine environment. This process, he claims, has led to the destruction of crayfish habitats, resulting in a permanent loss of valuable fishing grounds. https://www.dailymaverick.co.za/article/2021-10-13-the-slow-squeeze-on-port-nolloths-fishermen-walled-in-and-fenced-out-by-mining/
Environmental NGO and NPAs					
Liziwe McDaid **Maia Nangle (SAFCEI)- Francesca de Gasparis (SAFCEI)**	Green Connection	liziwe@mweb.co.za maia@safcei.org.za francesca@safcei.org.za	Environmental advocacy and education	Key Stakeholder	https://safcei.org/ They could provide information on environmental challenges and issues, i.e. **Local environmental concerns**: Specific issues affecting the region, such as pollution, habitat loss, or resource depletion. **Community awareness:** Success stories and failures: Examples of effective or ineffective environmental initiatives in the area. **Socio-economic Factors** such as Community livelihoods: Dependence on natural resources, alternative income sources, and social impacts of environmental changes. **Social dynamics:** Understanding of community structures, power relations, and potential conflicts related to resource management. **Stakeholder relationships**: Insights into collaborations and partnerships between different stakeholders, including government, businesses, and communities. **They have had environmental campaigns in Saldanha Bay, Port Nolloth and Alexander Bay.**
IPACC	The Indigenous Peoples of Africa Co-ordinating Committee	27 021 674 3262 ipacc@iafrica.com 21 Palmer Rd, Muizenberg, Cape Town, South Africa 7945	NGO advocating for Indigenous peoples rights	Secondary Stakeholder	They work with a community organisation called Richtersveld Vereeniging. IPACC can provide insights into the specific challenges faced by indigenous communities in the region, including issues related to land rights, resource access, and cultural preservation.

Stakeholder/ Expert Name	Organisation/ Affiliation	Contact Information (email, phone number)	Role or Expertise	Involvement Level (primary, secondary, tertiary)	Notes/ Comments / Information to look for
					Traditional Knowledge: The organisation can share valuable traditional ecological knowledge (TEK) related to the environment and natural resource management.
Groundwork **Dinga Sikwebu (H2Watch) -** sikwebudinga@gmail.com	NPO involved in North Nolloth	avena@groundwork.org.za +27 (0)33 342 5662	GW is a NPO environmental justice service and developmental organisation working primarily in Southern Africa in the areas of Climate & Energy Justice, Coal, Environmental Health, Global Green and Healthy Hospitals, and Waste.	Secondary Stakeholder	**What they do:** They aim to improve the quality of life of vulnerable people in South Africa, and increasingly in Southern Africa, through assisting civil society to have a greater impact on environmental governance. **Community Engagement:** They have experience in working with local communities can provide valuable information about their needs, priorities, and challenges. **Environmental Justice Issues:** Groundwork can shed light on specific environmental injustices affecting the region, such as pollution, access to resources, or displacement. **Policy and Advocacy:** Their work in advocating for environmental policies can provide context for understanding the regulatory environment and potential opportunities for change. This is the article they wrote: https://groundwork.org.za/south-africas-hydrogen-economy-benefits-for-who/
Local Community Organisations					
Richtersveld Community Conservancy	Richtersveld	Khuboes: 027 8312013 Eksteenfontein: 027 8517108 info@richtersveldwhs.org	Local community	Key Stakeholder	Give us insights about the mining communities from Richtersveld, Concordia, Hondeklipbaai, Nababeep, Port Nolloth and Alexander Bay Areas of conservation that are of main importance to them.
Richtersveld Community **Kuboes, Sanddrif, Lekkersing, Eksteenfontein.**	Richtersveld	richtersveld2022@gmail.com	Local Community	Key Influencer	Found them on Facebook. Richtersveld local News Profile. Post information about social and environmental issues happening within these community regions.
Richtersveld Growers	Beauvallon Farm, Alexander Bay, South Africa	+27 27 831 1014 beauvallonfarm@gmail.com	Farmers Group	Key Stakeholder	Found them on Facebook. Provide us information on the farming communities. **Note:** Operates as a joint venture between the Richtersveld community and private investors. The primary focus of this entity is to promote agricultural development and social upliftment in the

Stakeholder/ Expert Name	Organisation/ Affiliation	Contact Information (email, phone number)	Role or Expertise	Involvement Level (primary, secondary, tertiary)	Notes/ Comments / Information to look for
					Richtersveld region. Provide Information on the registered farmers that are also registered fishers or miners in the same region.
Carmen Mannarino **Jonathan Julius**	Masifundise Development Trust	carmen@masifundise.org.za jonathan@masifundise.org.za	Advocacy organisation working to support small-scale fishing communities.	Key Expert and key influencer	Possess information on the rights and interests of fishing communities. Knowledge about the challenges (Access concerns and inequities faced by small-scale fishers in North Polloth.
Namakwa District Municipalities					
Khai-Ma Local Municipality	Namakwa District	21 New Street, Pofadder Tel. 054 933 1000/ 054 933 0040/ 054 9330 044	Government Entity	Secondary Stakeholder	Provide Community profiles on: Aggeneys, Pella, Pofadder. These communities are far from the coast, but they could feel some potential impacts.
Kamiesberg Local Municipality	Namakwa District	22 Main Street, Garies, 8220 Tel 027 652 8000	Government Entity	Key Stakeholder	Provide Community Profiles on: Garies, Hondeklipbaai, Kamieskroon, Koingnaas, Leliefontein/Kamiesberg.
Hantam Local Municipality	Namakwa District	12 Hope Street, Calvinia, 8190 Tel 027 341 8500	Government Entity	Secondary Stakeholder	Provide community profiles on: Brandvlei, Calvinia, Loeriesfontein, Middelpos, Nieuwoudtville, Onderste Doorns **Main Economic Sectors**: Agriculture
Karoo Hoogland Local Municipality	Namakwa District	2 Mulder Street, Williston Tel 053 285 0998	Government Entity	Secondary Stakeholder	Provide community profiles for Fraserburg, Sutherland, Williston. **Main Economic Sectors:** Community, social and personal services (42.5%), transport, storage and communication (15%), wholesale and retail trade, catering and accommodation (13.7%), agriculture, forestry and fishing (13%), finance, insurance, real estate and business services (8.8%), manufacturing (5.9%). Source: https://municipalities.co.za/
Nama Khoi Local Municipality	Namakwa District	4 Namakwa Street, Springbok Tel 027 718 8100	Government Entity	Key Stakeholder	Community Profiles on: Bulletrap, Carolusberg, Concordia, Kleinzee (is on the coastline with North Polloth), Komaggas, Nababeep, O'Kiep, Springbok, Steinkopf Main economic activities: Mining, fishing, tourism, government departments, private sector in those areas.
Richtersveld Local Municipality NC061	Namakwa District	169 Main Road, Port Nolloth. 027 851 1111	Government Entity	Key Stakeholder and Influencer	Provide community profiles on Alexander Bay, Eksteensfontein, Kuboes, Port Nolloth, Richtersveld, Sanddrift. Local Counsellors of the Areas:

Stakeholder/ Expert Name	Organisation/ Affiliation	Contact Information (email, phone number)	Role or Expertise	Involvement Level (primary, secondary, tertiary)	Notes/ Comments / Information to look for
					• A Bock (Ward Councillor) • F Mabala (Ward Councillor) • M Obies (Ward Councillor) • C Stuurman (Proportional) • R Thomas (Ward Councillor)
Academic Institutions					
Faculty of Law University of Cape Town	Mineral Law in Africa	mlia@uct.ac.za	Experts about the Adoption of the Green Hydrogen in South Africa	Key Expert	They have articles published by UCT faculty regarding green hydrogen and its potential role in South Africa's energy transition. This demonstrates their expertise in relevant legal and regulatory aspects of this technology. Valuable source of information on legal, regulatory, and policy issues surrounding green hydrogen development and implementation.
SA Media					
Liezl Human Journalist	Ground UP	info@groundup.org.za +270217889163	News Agency	Key expert	Wrote an article about the Hydrogen project splits Richtersveld community. https://www.moneyweb.co.za/news/south-africa/hydrogen-project-splits-richtersveld-community/ Provide us information on the community dynamics in Boegoebaai. Environmental issues investigated pertaining to the Hydrogen project. Stakeholder perspectives and point us to Industry officials and community members.

Appendix 2

Appendix 2A. Stakeholder Categorisation of all potential stakeholders

Broad Classification	Narrow classification
Civil Society	Conservation NPO
	Agricultural Cooperative
	Agricultural production and Development /Agricultural Co-operative
	Community-based conservation /Protection Areas
	Cultural and Natural Heritage
	Ecclesiastical
	Economic Justice and Advocacy NGO
	Education CBO
	Environmental Advocacy and Activism NPO
	Environmental and Human Rights Advocacy
	Environmental Education and Community Empowerment CPO
	Environmental Justice and Sustainable Development Advocacy NGO
	Primary Education
	SCF Co-operative
	Small-scale Fishers Rights
	Social justice CBO
	Sustainable network of Enterprising Communities NPC
	Tourism
Civil Society / Environmental Justice Organization	Environmental Advocacy and Community Action
Civil Society / Faith-Based Organization (FBO)	Community Advocacy and Environmental Justice
Civil Society / Social Movement	Environmental Justice and Sustainable Development Advocacy
Civil Society / Social Movement / Advocacy Network	Gender Equity and Mining Advocacy
Government	Defence Facility
	Agency or SOE
	Conservation authority
	Department
	Military Defence Operations
	Social Service
NGO	Indigenous rights group
	Conservation NGO
	Disabled rights NGO
	Environmental justice NGO
	Gender rights NGO
	Legal Aid and Advocacy
	Social justice NGO

Broad Classification	Narrow classification
Private Sector	Commercial Fishing and Aquaculture
	Energy Sector/ Upstream Oil and Gas
	Minerals Exploration and Production
	Diamond Mining
	Livestock Farming
	Recreational Fishing
	Construction Company
	Tourism and Hospitality
	Angling and Sport Fishing
	Airstrip
	Energy Sector
Scientific community	Research Institute

Appendix 2B. Stakeholder Categorisation of all stakeholders on the west coast of the Namaqualand region in the Northern Cape

Broad Classification	Name	Scale	Narrow classification
Civil society	AGS AFM Nollothville Church	Local	Ecclesiastical
	Aukotowa Small-scale fisheries co-operative	Local	SCF Co-operative
	Coastal Livelihoods Foundation	National	Sustainable network of Enterprising Communities NPC
	Earthlife Africa	National	Environmental Advocacy and Activism NPO
	EkSteenSkuil	Local	Agricultural Cooperative
	Equal education	National	Education CBO
	groundWork	National	Conservation NPO
	House of Bread Outreach Ministries	Local	Ecclesiastical
	Integrated serviced land project	National	Social justice CBO
	Kaikai Richtersveld Residental Coastal Reserve	Local	Tourism
	Kuthala Environmental Care Movement	Local	Environmental Education and Community Empowerment CPO
	Longtime Small-Scale Fisheries Co-operative Hondeklipbaai	Local	SCF Co-operative
	Masifundise Development Trust	National	Social justice CBO
	Mining Affected Communities in Action (MACUA-WAMUA)	National	Environmental Justice and Sustainable Development Advocacy NGO
	Port Nolloth Primary School	Local	Primary Education
	Pulls Full Gospel Church	Local	Ecclesiastical
	Richtersveld Community Conservancy	Local	Community based conservation /Protection Areas
	Richtersveld Growers	Local	Agricultural production and Development /Agricultural Co-operative
	Ritchtersveld Heritage Site	Local	Cultural and Natural Heritage
	South African Fisheries Development Fund	Local	Small-scale Fishers Rights
	The Economic Justice Network	Regional	Economic Justice and Advocacy NGO
	The Green Connection	National	Conservation NPO
	WoMIN	International	Environmental and Human Rights Advocacy
Civil Society / Environmental Justice Organization	Environmental Monitoring Group (EMG)	Local/ Regional	Environmental Advocacy and Community Action
Civil Society / Faith-Based Organization (FBO)	Natural Justice	Regional	Environmental Justice and Sustainable Development Advocacy

Civil Society / Social Movement	Southern African Faith Communities Environment (SAFCEI)	National	Community Advocacy and Environmental Justice
Civil Society / Social Movement / Advocacy Network	Vaal Environmental Justice Alliance (VEJA)	Regional	Gender Equity and Mining Advocacy
Government	Eskom	National	SOE
	Alexander Bay Centre Military Base	Local	Defence Facility
	Alexkor Limited	National	Agency or SOE
	Armaments Corporation of South Africa (ARMSCOR)	National	Agency or SOE
	Borderpost Swartkops Alexander Bay	National	Agency or SOE
	Breede-Gouritz CMA	National	Agency or SOE
	Central Energy Fund (CEF)	National	Agency or SOE
	Civilian Secretariat for Police services	National	Department
	Community Property Association	National	Department
	Co-operative Governance, Human Settlements and Traditional Affairs	Provincial	Department
	Council for Geoscience	National	Agency or SOE
	DEA	National	Department
	Department of Agriculture, Land reform and Rural development	National	Department
	Department of Basic Education	National	Department
	Department of Communications and Digital Technologies	National	Department
	Department of Cooperative Governance	National	Department
	Department of Defence	National	Department
	Department of Employment and Labour	National	Department
	Department of Forestry, Fisheries and Environment	National	Department
	Department of Health	National	Department
	Department of Higher Education and Training	National	Department
	Department of Human Settlements	National	Department
	Department of Internation Relations and Cooperations	National	Department
	Department of Mineral Resources and Energy	National	Department
	Department of Public Enterprises	National	Department
	Department of Public Works	National	Department
	Department of Public works and infrastructure	National	Department
	Department of Rural Development and Land Reform	National	Department
	Department of Science and Innovation	National	Department
	Department of Small Business	National	Department

	Development		
	Department of Social Development	National	Department
	Department of Tourism	National	Department
	Department of Trade, Industry and Competition	National	Department
	Department of Traditional Affairs	National	Department
	Department of Transport	National	Department
	Department of Water and Sanitation	National	Department
	Department of Women, Youth and Persons with disabilities	National	Department
	ESKOM	National	State-owned Agency
	Economic Development and Tourism	Provincial	Department
	Education	Provincial	Department
	Health	Provincial	Department
	Housing Development Agency (HDA)	National	Agency or SOE
	Independent Development Trust	National	Agency or SOE
	Industrial Development Corporation [Ltd] (IDC)	National	Agency or SOE
	Ingonyama Trust Board	National	Agency or SOE
	Kalahari Kid Corporation	Provincial	Agency or SOE
	Mintek (Council for Mineral Technology)	National	Agency or SOE
	National Advisory Council on Innovation (NACI)	National	Agency or SOE
	National Agricultural Marketing Council	National	Agency or SOE
	National Development Agency (NDA)	National	Agency or SOE
	National Empowerment Fund	National	Agency or SOE
	National House of Traditional Leaders	National	Agency or SOE
	National Ports Authority (NPA)	National	Agency or SOE
	National Sea Rescue Institute (NSRI)	National	Social Service
	National Youth Development Agency (NYDA)	National	Agency or SOE
	Northern Cape Arts and Culture Council	Provincial	Agency or SOE
	Northern Cape Economic Development, Trade and Investment Promotion Agency (NCEDA)	Provincial	Agency or SOE
	Northern Cape Gambling Board	Provincial	Agency or SOE
	Northern Cape Heritage Resources Authority (NCHRA)	Provincial	Agency or SOE
	Northern Cape Liquor Board	Provincial	Agency or SOE
	Northern Cape Tourism Authority	Provincial	Agency or SOE
	Roads and Public Works	Provincial	Department

	SAEON	National	Conservation authority
	SALGA	National	Conservation authority
	SAMSA	National	Conservation authority
	SANBI	National	Conservation authority
	SANCCOB	National	Conservation authority
	SANEDI	National	Energy Sector
	SANParks	National	Conservation authority
	Small Enterprise Development Agency (SEDA)	National	Agency or SOE
	Small Enterprise Finance Agency (SEFA)	National	Agency or SOE
	Social Development	Provincial	Department
	South Africa National Defence Forces (SANDF)	National	Military Defence Operations
	South African Agency For Science and Technology Advancement (SAASTA)	National	Agency or SOE
	South African Forestry Company (Ltd) (SAFCOL)	National	Agency or SOE
	South African Heritage Resources Agency	National	Agency or SOE
	South African Local Government Association (SALGA)	National	Agency or SOE
	South African National Parks (SANParks)	National	Agency or SOE
	South African National Road Agency	National	Agency or SOE
	South African Special Risk Insurance Association (SASRIA)	National	Agency or SOE
	SASOL	National	Fuel and Energy
	South African Tourism	National	Agency or SOE
	South African Weather Service (SAWS)	National	Agency or SOE
	Sport, Arts and Culture	Provincial	Department
	Trade and Investment South Africa (TISA)	National	Agency or SOE
	Transnet (Ltd)	National	Agency or SOE
	Transport, Safety and Liaison	Provincial	Department
	Water Research Commission (WRC)	National	Agency or SOE
	Transnet	National	SOE
NGO	African gender institute	National	Gender rights NGO
	Benguela Current Commission	National	Conservation NGO
	Benguela Current Large Marine Ecosystem (BCLME)	National	Conservation NGO
	Birdlife	National	Conservation NGO
	Centre for environmental rights	National	Environmental justice NGO
	Centre for Rural Legal Studies (CRLS)	National	Social justice NGO

	Coastal Justice Network	National	Social justice NGO
	Gender education and training network	National	Gender rights NGO
	Greenpeace	International	Conservation NGO
	Ikamva Labantu	National	Social justice NGO
	Indigenous Peoples of Africa Co-ordinating Committee	National	Indigenous rights group
	Institute for justice and reconciliation	National	Social justice NGO
	Kgatelopelo Association for the blind	Provincial	Disabled rights NGO
	Legal Resources Centre (LRC)	National	Legal Aid and Advocacy
	Northern Cape Society for the Blind	Provincial	Disabled rights NGO
	Oceans not Oil	National	Conservation NGO
	Re Tlameleng Special School	Provincial	Disabled rights NGO
	SDCEA (South Durban Community Environmental Alliance)	National	Environmental justice NGO
	South African Fisheries Development Fund	Local	Small-scale Fishers Rights
	Wild Oceans	National	Conservation NGO
Private Sector	Alexander Bay Diamond Company	Local/ Regional	Diamond Mining
	Aukotowa Tours	Local	Tourism
	Bedrock Lodge	Local	Tourism and Hospitality
	Bietjies Selfsorg	Local	Tourism and Hospitality
	Country Club Lodge	Local	Tourism and Hospitality
	De Swarte Mossel	Local	Tourism and Hospitality
	Die Baai Se Bek	Local	Tourism and Hospitality
	Die Honne Hokke Resort	Local	Tourism and Hospitality
	Dogstone Cottage	Local	Tourism and Hospitality
	DopENKreef	Local	Tourism and Hospitality
	Dougalls Rest	Local	Tourism and Hospitality
	Eco-Atlantic Oil and Gas	International	Energy Sector/ Upstream Oil and Gas
	Hake longline and small pelagics fishing rightsholder	Local	Commercial Fishing and Aquaculture
	Hake longline/Hake deepsea trawl/fish processing facility fishing rightholder	Local	Commercial Fishing and Aquaculture
	Hake longline/Hake deepsea trawl/WCRL commercial fishing rightholder	Local	Commercial Fishing and Aquaculture
	Port Lobster (Pty) Ltd Noordkaap Visserman Onderneming BK	Local	Commercial Fishing and Aquaculture
	John Livestock PTY	Local	Livestock Farming
	Josmel Construction	Local	Construction Company

	Kazera Global Plc (Deep Blue Minerals Mining)	International	Minerals Exploration and Production
	Kleinzee Angling Club	Local	Angling and Sport Fishing
	Kleinzee Airfield FAKZ	Local	Airstrip
	Kleinzee Beach Cottage	Local	Tourism and Hospitality
	Kleinzee Caravan Park	Local	Tourism and Hospitality
	Kleinzee Gold Club	Local	Tourism and Hospitality
	Lewensdroom Gastehuis	Local	Tourism and Hospitality
	Mcdougallsbaai Akkomodasie	Local	Tourism and Hospitality
	Namaqua Coastal Expeditions	Local	Tourism
	Peaceful Place	Local	Tourism and Hospitality
	Port Nolloth Beach Shack	Local	Tourism and Hospitality
	Recreational Fishers	Local	Recreational Fishing
	Richtersveld Experience	Local	Tourism and Hospitality
	Richtersveld Tours	Local	Tourism and Hospitality
	Rooi Spinnekop	Local	Tourism and Hospitality
	Sea View Holiday House	Local	Tourism and Hospitality
	Sea Mining	Local	Commercial Fishing and Aquaculture
	Seaway backpackers and Funtion Avenue	Local	Tourism and Hospitality
	Spoelklippie Gastehuis	Local	Tourism and Hospitality
	Visbeen Lodge	Local	Tourism and Hospitality
	Voetbaai Gastehuis	Local	Tourism and Hospitality
	Vori Klip	Local	Tourism and Hospitality
	WCRL commercial fishing rightsholder	Local	Commercial Fishing and Aquaculture
	Yield House and Cottages	Local	Tourism and Hospitality
	Afcon Infrastructure Limited,	International	Construction and Engineering
	Afrimat Limited	National	Mid-tier mining and materials company.
	AP. Moller and Capital	International	Funding and Investments
	Bouygues TP	International	Construction Group
	Coega Development Co-operation	International	Construction Group
	CPRDW- Consulting Port and Coastal Engineers	International	Design of Marine Infrastructure (Consulting and Construction)
	DB Scheneker	International	Logistics
	Diamond Coast Aquaculture (Pty) Ltd	Local	Fish Farming
	Gibb Consulting Engineers	National	Engineering Consulting
	Green Hydrogen South Africa (H2.SA)	International	Energy Sector

	Meridium SAS	International	Asset Management Firm Community and Infrastructure
	Mota-Engil,	International	Engineering and Construction
	Naka Iliso	International	Consulting and Engineering
	Nako Systra	International	Transportation and Engineering
	Newlyn Group's Briardale Trading	National	Property Developer
	Pembani Remgro Infrastructure Managers	National	Infrastructure Fund
	Port of Rotterdam	National	Port Development
	Raubex Group	National	Infrastructure Development (Road and Civil)
	Thelo	International	Transport and Logistics
	Traxtion Sheltam	National	Rail Infrastructure
	Vinci Construction	International	Construction
	WBHO	International	Construction
	WSP Consulting Engineers	International	Engineering Consulting
	Yapi Merkezi Insaat ve Sanayi Anonim Sirketi	International	Construction Holding
Scientific community	WildOceans	National	Research institute
	CSIR	National	Research institute
	Institute for security studies	National	Research Institute
	International Ocean Institute South Africa	National	Research Institute

Appendix 2C. Stakeholder Categorisation for Alexander Bay

Broad Classification	Name	Scale	Narrow Classification
Private Business	Angling Fishing	Local	Recreational Fishing
	Tuna Pole Fishing	Local	Commercial Fisheries
	Mine Wize - Mining supplies and solutions	National	Minerals Exploration and Production
	John Livestock PTY	Local	Commercial Farming
	Intertown Transport		Transport logistics
	Oppiestoep		Tourism
	Impressions		Tourism
	FGC Mans		Commercial Business
	Seed Oysters		Commercial Fishing Business (Closed Down)
	Engen		Commercial Business
Private Sector	Eco-Atlantic Oil and Gas	International	Energy Sector/ Upstream Oil and Gas
	Kazera Global Plc (Deep Blue Minerals Mining)		Minerals Exploration and Production
	Alexander Bay Diamond Company		Diamond Mining
	Globalnet Mining	National	Minerals Exploration and Production
Government	SAPS	National	Agency or SOE
	Alexkor Limited		Agency or SOE
	Department of Water and Sanitation		Water Resources Management/Sanitation Services
	SANparks		National Parks Management Agency
	Department of Agriculture		Agricultural Policy and Management
	Department of Rural Development and Land Reform		Rural Development and Land Reform
	Breede-Gouritz CMA	Regional	Agency or SOE
	Alexander Bay Centre Military Base	Local	Defence Facility
	Department of Forestry, Fisheries and Environment	National	Agency or SOE
Civil Society	Alexander Bay Highschool	Local	Education

Appendix 2D. Stakeholder Categorisation for Port Nolloth

Broad Classification	Name	Scale	Narrow Classification
Government	Alexkor Limited	National	Agency or SOE
	Transnet (Ltd)		Agency or SOE
	SASOL		Energy and Chemical Company
	Eskom		SOE
	Department of Forestry, Fisheries and Environment		Department
	South African National Parks (SANParks)		Agency or SOE
	Northern Cape Economic Development Trade	Provincial	Agency or SOE
	South African National Energy Development Institute (SANEDI)	National	Agency or SOE
	National Sea Rescue Institute (NSRI)		Social Service
	Department of Mineral Resources and Energy (DMRE)		Agency or SOE
	Civilian Secretariat for Police services		SAPS Department
	Borderpost Swartkops Alexander Bay		Agency or SOE
	Department of Trade, Industry and Competition (DTIC)		Department
	Richtersveld local municipality	Provincial	Department
	Community Property Association (CPA)	National	Department
	Department of Economic Development and Tourism		Department
	National Sea Rescue Institute (NSRI)		Department
	Department of Rural Development and Land Reform (DADLR)		Land Reform and Rural Development
	Ritchtersveld Local Municipality	Local	Municipal Administration and Services
	National Development Agency (NDA)	National	Eradication of Poverty in South Africa
	Independent Development Trust	National	Agency or SOE
Civil Society	Groundwork	National	Conservation NPO
	Masifundise Development Trust	National	Social justice CBO
	Aukotowa Small-scale fisheries co-operative and they possess WCRL commercial and hake offshore rights.	Local	Small-scale fisheries co-operative
	South African Fisheries Development Fund		Small-scale Fishers Rights
	Port Nolloth Primary School		Primary Education
	Pulls Full Gospel Church		Ecclesiastical

	AGS AFM Nollothville Church		Ecclesiastical
	Kaikai Richtersveld Residental Coastal Reserve		Tourism
	House of Bread Outreach Ministries		Ecclesiastical
	The Southern African Faith Communities' Environment Institute	National	Social justice CBO
	Earthlife Africa	National	Environmental Advocacy and Activism NPO
	The Economic Justices Network	Regional	Economic Justice and Advocacy NGO
	Kuthala Environmental Care Movement	Local	Environmental Education and Community Empowerment CPO
	Green Connection	National	Environmental Justice and Sustainable Development Advocacy NGO
	Mining Affected Communities in Action (MACUA-WAMUA) and Women Affected by Mining United in Action	National	Community Advocacy and Environmental Justice
	Southern African Faith Communities Environment (SAFCEI)	Regional	Environmental Justice and Sustainable Development Advocacy
	Natural Justice	International	Environmental and Human Rights Advocacy
	Women In Mining Network (WoMIN)	Regional	Gender Equity and Mining Advocacy
	Vaal Environmental Justice Alliance (VEJA)	Local/ Regional	Environmental Advocacy and Community Action
	Coastal Livelihoods Foundation	National	Sustainable network of Enterprising Communities NPC
Private Business	Small-scale Diamond Diving Contractors	Local	Mining Company
	Seaside Villas	Local	Tourism and Hospitality
	Country Club Lodge		
	Peaceful Place		
	Richtersveld Experience		
	Bedrock Lodge		
	Port Nolloth Beach Shack		
	Yield House and Cottages		
	Richtersveld Tours		
	Voetbaai Gastehuis		
	Bietjies Selfsorg		
	Mcdougallsbaai Akkomodasie		
	Dougalls Rest		
	Sea View Holiday House		
	Lewensdroom Gastehuis		

	VM Young Visserye BK Hake longline and small pelagic fishing rightsholder (2006-20200		Commercial Fishing and Aquaculture
	Hake longline/Hake Deepsea trawl/WCRL commercial fishing rightsholder from 2006 to 2020		
	Hake longline/Hake Deepsea trawl/fish processing facility fishing rightsholder		
	Traditional Line Fishing Operated from 2014 to 2020,		
	Noordkaap Visserman Onderneming BK and Port Lobster (Pty)Ltd. However, the former is no longer in operation		
	Spring Forest Trading		
	Lavender Moon Trading		
	Small-scale Diamond Diving Contractors		Commercial Mining
	Premiere Fishing and Brands Limited (Hout Bay) working with Aukotowa SCF		Commercial Fishing
	Copper Mining		Commercial Mining
	Rock Lobster Valid from 2013-2033		Commercial Fishing and Aquaculture
Scientific Group	CSIR	National	Scientific Research
NGO	Indigenous Peoples of Africa Co-ordinating Committee	National	Indigenous Rights Group
NGO	Oceans not Oil	National	Conservation

Appendix 2E. Stakeholder Categorisation for Kleinzee

Broad Classification	Name	Scale	Narrow Classification
Government	Northern Cape Economic Development Agency (NCEDA)	Provincial	Economic Development Agency
	Department of Economic Development and Tourism	Provincial	Economic Development and Tourism
	National Sea Rescue Institute (NSRI)	National	Maritime Rescue and Safety
	Department of Forestry, Fisheries and Environment	National	Department
Private Business	Diamond Coast Aquaculture (Pty) Ltd	Local	Seaweed Harvesting
	Kleinzee Angling Club		Angling and Sport Fishing
	Viking Aquaculture		Commercial Aquaculture
	Port Nolloth Sea Farms		Marine Mollusk Harvesting (Abalone Farming)
	Kleinzee Gold Club		Tourism and Hospitality
	Kleinzee Caravan Park		Tourism and Hospitality
	Kleinzee Beach Cottage		Tourism and Hospitality
	Seaway backpackers and Function Avenue		Tourism and Hospitality
	Spoelklippie Gastehuis		Tourism and Hospitality
	Namaqua Coastal Expeditions		Tourism
	Kleinzee Airfield FAKZ		Airstrip
Civil Society	Masifundise Development Trust	National	Social justice CBO
	Earthlife Africa	National	Environmental Advocacy and Activism NPO
	Mining Affected Communities in Action (MACUA-WAMUA)	National	Community Advocacy and Environmental Justice
	Kuthala Environmental Care Movement	local	Environmental Education and Community Empowerment CPO
	The Economic Justice Network	Regional	Economic Justice and Advocacy NGO
	Southern African Faith Communities Environment (SAFCEI)	Regional	Environmental Justice and Sustainable Development Advocacy
	Natural Justice	National	Environmental and Human Rights Advocacy
	WoMIN	National	Gender Equity and Mining Advocacy
	Vaal Environmental Justice Alliance (VEJA)	Local/ Regional	Environmental Advocacy and Community Action
	Green Connection	National	Environmental Justice and Sustainable Development Advocacy NGO
	South African Fisheries Development Fund	National	Small-scale Fishers Rights
NGO	Ground Up	National	Advocacy and Journalism

Appendix 2F. Stakeholder Categorisation for Hondeklipbaai

Broad Classification	Name	Scale	Narrow Classification
Government	Department of Mineral Resources and Energy	National	Agency/ Department
	Department of Rural Development and Land Reform	National	Agency/ Department
	Department of Forestry, Fisheries and Environment	National	Agency/ Department
	Kamiesberg Municipality	Local	Municipality
	Department of Economic Development and Tourism	National	Agency/ Department
	National Sea Rescue Institute (NSRI)	National	Agency/ Department
	Community Property Association	National	Agency/ Department
	Northern Cape Economic Development Agency (NCEDA)	Provincial	Agency/ Department
Private Business	Traditional Line Fishing	Local	Small-scale fisheries
	West coast rock lobster Fishery		Small-scale fisheries
	Die Baai Se Bek		Tourism and Hospitality
	Visbeen Lodge		Tourism and Hospitality
	Vori Klip		Tourism and Hospitality
	Die Honne Hokke Resort		Tourism and Hospitality
	De Swarte Mossel		Tourism and Hospitality
	Dogstone Cottage		Tourism and Hospitality
	DopENKreef		Tourism and Hospitality
	Rooi Spinnekop		Tourism and Hospitality
Civil Society	Masifundise Development Trust	National	Social Justice
	Longtime Hondeklipbaai Fishing Primary Cooperative	Local	Small-scale fishing Cooperative
	Coastal Links	National	Social Justice CBO
	Permanent Rights Tribunal	National	Social Justice CBO
	Earthlife Africa	National	Environmental Advocacy and Activism NPO
	The Economic Justices Network	Regional	Economic Justice and Advocacy NGO
	Green Connection	National	Environmental Education and Community Empowerment CPO
	Mining Affected Communities in Action (MACUA-WAMUA)	Regional	Environmental Justice and Sustainable Development Advocacy NGO
	Southern African Faith Communities Environment (SAFCEI)	Regional	Community Advocacy and Environmental Justice
	Natural Justice	National	Environmental Justice and Sustainable

			Development Advocacy
	WoMIN	National	Environmental and Human Rights Advocacy
	Vaal Environmental Justice Alliance (VEJA)	Local/ Regional	Gender Equity and Mining Advocacy
NGO	Groundup	National	Advocacy and Journalism

Appendix 2G. Detailed Stakeholder Murray Matrix Analysis Results

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
South African Fisheries Development Fund		M			M			M				NO	MP: MI:MI: NO	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Longtime Small-Scale Fisheries Co-operative Hondeklipbaai *			L	H			H					NO	LP: HI: HI: NO	Time Bombs	Influential Active Blockers	Time bomb: High-influence, passive opponents requiring proactive monitoring and management.
Aukotowa Small-scale fisheries co-operative Port Nolloth *			L	H			H					NO	LP: HI: HI: NO	Time Bombs	Influential Active Blockers	Time bomb: High-influence, passive opponents requiring proactive monitoring and management.
Indigenous Peoples of Africa Co-ordinating Committee *		M			M			M			N		MP: MI:MI: N	Sleeping Giant	Influential Passive Backers	Sleeping Giants: High-influence, passive supporters necessitating activation.
Agricultural Research Council (ARC)		M		H					L		N		HP: HI: LI: N	Saviour / Saboteur	Influential Active Backers / Influential Active Blocker	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
Alexkor Limited *	H			H			H				N		HP: HI: HI: N	Saviour	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
Breede-Gouritz CMA		M		H				M			N		HP: HI: MI: N	Saviour / Saboteur	Influential Active Backers / Influential Active Blocker	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
Central Energy Fund (CEF)		M		H			H			P			HP: HI: LI: P	Saviour	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
Council for Geoscience		M		H					L		N		HP: HI: LI: N	Observers	Influential passive Backers	Passive supporters are who are neither support nor oppose the port strongly
Housing Development Agency (HDA)																
Independent Development Trust		M		H					L		N		HP: HI: MI: N	Saviour	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
Industrial Development Corporation [Ltd] (IDC)	H			H					L	P			HP: HI: LI: N	Saviour	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
Mintek (Council for Mineral Technology)		M		H				M			N		MP: HI: MI: N	Friend	Insignificant Active Backers	Friends: Enthusiastic supporters with limited influence, valuable as confidants.
National Agricultural Marketing Council		M		H				M			N		MP: HI: MI: N	Friend	Insignificant Active Backers	Friends: Enthusiastic supporters with limited influence, valuable as confidants.

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
National Development Agency (NDA)	H			H				M			N		HP: HI: HI: N	Saviour	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
National House of Traditional Leaders and Khoi- San Leaders		M		H				M			N		MP: HI: MI: N	Saviour/ Friend	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. / Enthusiastic supporters with limited influence, valuable as confidants.
Ports Regulator of South Africa	H			H				M		P			HP: HI: HI: P	Saviour	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
National Youth Development Agency (NYDA)		M		H				M		P			MP: HI: MI: P	Saviour	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
Small Enterprise Finance Agency (SEFA)		M		H				M			N		MP: HI: MI: N	Friend	Insignificant Active Backers	Friends: Enthusiastic supporters with limited influence, valuable as confidants.
South African Heritage Resources Agency		M		H			H				N		MP: HI: HI: N	Saboteur/ Friend	Influential Active Backers or Influential passive blockers	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage. Friends: Enthusiastic supporters with limited influence, valuable as confidants.
South African Local Government Association (SALGA)		M		H			H				N		MI: HI: HI: N	Saviour / Friend	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
South African National Parks (SANParks)	H			H			H				N		HP: HI: HI: N	Saviour or Saboteur	Influential Active Backers / Influential Active Blocker	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
South African National Road Agency	H			H			H				N		HP: HI: HI: N	Saviour	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
South African Special Risk Insurance Association (SASRIA)																

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
South African Tourism		M		H				M			N		MI: HI: MI: N	Saviour	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
South African Weather Service (SAWS)		M		H			H				N		MP: HI: HI: N	Friend	Insignificant active backer	Friends: Enthusiastic supporters with limited influence, valuable as confidants.
Trade and Investment South Africa (TISA)	H			H			H			P			HP : HI: HI: P	Saviour	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
Water Research Commission (WRC)	H			H					L		N		HP: HI: LI: N	Sleeping Giant	Influential passive backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
Kalahari Kid Corporation		M		H				M		P			MP: HI: MI: P	Friend	Insignificant active backer	Friends: Enthusiastic supporters with limited influence, valuable as confidants.
Northern Cape Arts and Culture Council																
Northern Cape Economic Development, Trade and Investment Promotion Agency (NCEDA) *	H			H			H			P			HP: HI: HI: P	Saviour	Influential active Backer	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
Northern Cape Heritage Resources Authority (NCHRA)		M		H			H				N		MP: HI: HI: N	Friend	Insignificant active backer	Friends: Enthusiastic supporters with limited influence, valuable as confidants.
Northern Cape Tourism Authority		M		H			M			P			MP: HI: HI: P	Friend	Insignificant active backer	Friends: Enthusiastic supporters with limited influence, valuable as confidants.
SAEON		M		H			H				N		MP: HI: HI: N	Saviour	Influential active Backer	Saviour: High-influence supporters requiring proactive engagement to maintain alignment.

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
SAMSA	H			H			H				N		HP: HI: HI: N	Saviour / Saboteur	Influential Active Backers / Influential Active Blocker	Saviour: High-influence supporters requiring proactive engagement to maintain alignment./ Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
SANBI		M		H			H				N		MP: HI: HI: N	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
SAIIA																
SANCCOB		M		H				M			N		MP: HI: MI: N	Friend or Saboteur	Insignificant active backer/ Influential Active Blocker	Friends: Enthusiastic supporters with limited influence, valuable as confidants. / Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Benguela Current Commission		M		H				M			N		MP: HI: MI: N	Friend or acquaintance	Insignificant active backers	Friends: Enthusiastic supporters with limited influence, valuable as confidants.
Benguela Current Large Marine Ecosystem (BCLME)	H			H				M			N		HP: HI: MI: N	Friend or Acquaintance	Insignificant active backers	Friends: Enthusiastic supporters with limited influence, valuable as confidants.

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
Birdlife																
Greenpeace	H			H			H				N		HP: HI: HI: N	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Oceans not Oil		M		H			H				N		MP:HI:HI:N	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
groundWork		M		H			H					NO	MP: HI: HI:NO	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
The Green Connection		M		H				M				NO	MP: HI: MI: NO	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
DEA																
Department of Agriculture, Land reform and Rural development	H			H			H				N		HI: HI: HI: N	"Friend" or "Acquaintance"	Insignificant active backers	Friends: Enthusiastic supporters with limited influence, valuable as confidants.

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
Department of Basic Education	H			H				M			N		HI: HI: MI: N	"Friend" or "Saviour"	Insignificant active backer/ Influential Active Backer	Friends: Enthusiastic supporters with limited influence, valuable as confidants. Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
Department of Communications and Digital Technologies	H			H			H				N		HI: HI: Hi: N	"Friend" or "Saviour"	Insignificant active backer/ Influential Active Backer	Friends: Enthusiastic supporters with limited influence, valuable as confidants. Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
Department of Cooperative Governance	H			H			H				N		HI: HI: Hi: N	"Friend" or "Saviour"	Insignificant active backer/ Influential Active Backer	Friends: Enthusiastic supporters with limited influence, valuable as confidants. Saviour: High-influence supporters requiring proactive engagement to maintain alignment.
Department of Defence	H			H			H				N		HI: HI: Hi: N	"Saviour" or "Saboteur"	Influential Active Backers / Influential Active Blocker	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. / Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Department of Employment and Labour	H			H			H				N		HI: HI: Hi: N		Influential Active Backers / Influential Active Blocker	
Department of Forestry, Fisheries and Environment	H				M			M			N		HI: MI: MI: N	"Saviour" or "Saboteur"	Influential Active Backers / Influential Active Blocker	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. / Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Department of Health	H			H				M			N		HI: HI: MI: N	"Saviour" or "Saboteur"	Influential Active Backers / Influential Active Blocker	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. / Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Department of Higher Education and Training	H			H			H				N		HI: HI: Hi: N	Friend	Insignificant Active Backers	Friends: Enthusiastic supporters with limited influence, valuable as confidants.

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
Department of Human Settlements	H			H				M			N		HI: HI: MI: N	"Saviour" or "Saboteur"	Influential Active Backers / Influential Active Blocker	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. / Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Department of Internation Relations and Cooperations																
Department of Mineral Resources and Energy	H			H			H			P			HI: HI: HI: P	Saviour	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. /
Department of Public Enterprises	H			H			H				N		HI: HI: HI: N	Friend	Insignificant Active Backers	Friends: Enthusiastic supporters with limited influence, valuable as confidants.
Department of Public Works	H			H			H				N		HI: HI: HI: N	Friend	Insignificant Active Backers	Friends: Enthusiastic supporters with limited influence, valuable as confidants.
Department of Science and Innovation	H			H			H			P			Hi: HI: HI; P	Saviour	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. /
Department of Social Development	H				M			M			N		HI: MI: MI: N	Friend	Insignificant Active Backers	Friends: Enthusiastic supporters with limited influence, valuable as confidants.
Department of Trade, Industry and Competition	H			H			H			P			HI: HI: HI: P	Saviour	Influential Active Backers	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. /
Department of Traditional Affairs	H			H			H				N		Hi: HI: HI: N	Acquaintance	Insignificant Active Backers	Supporters that could assist the project depending on where they are needed.
Department of Transport	H			H			H				N		Hi: HI: HI: N	Acquaintance	Insignificant Active Backers	Supporters that could assist the project depending on where they are needed.

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
Department of Water and Sanitation	H			H			H				N		Hi: HI: HI: N	"Saviour" or "Saboteur"	Influential Active Backers / Influential Active Blocker	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. / Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Department of Women, Youth and Persons with disabilities		M			M			M			N		MI: MI: MI: N	Acquaintance	Insignificant Active Backers	Supporters that could assist the project depending on where they are needed.
Economic Development and Tourism	H			H			H				N		HI: HI: HI: N	Friend	Insignificant Active Backers	Friends: Enthusiastic supporters with limited influence, valuable as confidants.
Equal education		M			M				L		N					
Centre for environmental rights		M		H				M			N		MI: HI: MI: N	Friend or Saboteur	Insignificant Active Backers/ Influential Active Blocker	Friends: Enthusiastic supporters with limited influence, valuable as confidants. Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
International Ocean Institute South Africa		M		H				M			N		MI: HI: MI: N	Acquaintance or friend	Insignificant Active Backers	Supporters that could assist the project depending on where they are needed.
Wild Oceans		M		H				M			N		MI: HI: MI: N	Friend or Saboteur	Insignificant Active Backers/ Influential Active Blocker	Friends: Enthusiastic supporters with limited influence, valuable as confidants. Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
Centre for Rural Legal Studies (CRLS)		M		H				M			N		MI: HI: MI: N	Friend or Saboteur	Insignificant Active Backers/ Influential Active Blocker	Friends: Enthusiastic supporters with limited influence, valuable as confidants. Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Coastal Justice Network/ Masifundise Development Trust		M		h				M			N		MI: HI: MI: N	Saboteur	Insignificant Active Backers/ Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
National Sea Rescue Institute (NSRI)		M		H				M			N		MI: HI: MI: N	Acquaintance	Insignificant Active Backers	Supporters that could assist the project depending on where they are needed.
Eskom	H			H			H			P			HI: HI: HI: P	Saviour	Influential Active Backer	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. /
Transnet	H			H			H			P			Hi: Hi: HI: P	Saviour	Influential Active Backer	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. /
Community Property Association	H			H			H			P			HI: Hi: HI: P	Saviour	Influential Active Backer	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. /

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
Earth life Africa	H			H			H					NO	HI: HI; HI: NO	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
The Economic Justice Network		M		H				M			N		MI: HI: MI: N	Friend or Saboteur	Insignificant Active Backers/ Influential Active Blocker	Friends: Enthusiastic supporters with limited influence, valuable as confidants. Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Mining Affected Communities in Action (MACUA-WAMUA)		M		H			H					NO	MI: HI; HI: NO	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Southern African Faith Communities Environment (SAFCEI)		M		H				M				NO	MI: HI; MI: NO	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Natural Justice		M		H				M				NO	MI: HI; HI: NO	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
WoMIN		M		H				M				NO	MI: HI: MI: NO	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Vaal Environmental Justice Alliance (VEJA)		M		H				M				NO	MI: HI: MI: NO	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
Environmental Monitoring Group (EMG)	H			H			H					NO	HI: HI; HI: NO	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Legal Resources Centre (LRC)		M		H		M	H					NO	HI: HI; HI: NO	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Richtersveld Heritage Site		M			M			M			N		MI: MI: MI: N	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Richtersveld Community Conservancy		M			M			M				NO	MI: MI: MI: NO	Saboteur	Influential Active Blocker	Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Richtersveld Growers		M			M			M			N		MI: MI: MI: N	Acquaintance	Insignificant passive backer	Supporters that could assist the project depending on where they are needed.
South Africa National Defence Forces (SANDF)	H			H				M			N		MI: MI: MI: N	Acquaintance	Insignificant passive backer	Supporters that could assist the project depending on where they are needed.
Traditional Line Fish		M		H			H				N		MI: HI: HI: N	Trip Wires	Influential Passive Blockers	Trip wires: High-influence, passive opponents requiring proactive monitoring and management.
West Coast Rock Lobster		M			M		H				N		MI: MI: HI: N	Trip Wires	Influential Passive Blockers	Trip wires: High-influence, passive opponents requiring proactive monitoring and management.

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
Beach Seine		M			M		H				N		MI: MI: HI: N	Trip Wires	Influential Passive Blockers	Trip wires: High-influence, passive opponents requiring proactive monitoring and management.
Gillnet Fisheries		M			M		H				N		MI: MI: HI : N	Trip Wires	Influential Passive Blockers	Trip wires: High-influence, passive opponents requiring proactive monitoring and management.
Shipping			L			L	H				N		LI: LI: HI: N	Acquaintances	Insignificant passive backer	Supporters that could assist the project depending on where they are needed.
Seaweed Harvesting		M			M		H				N		MI: MI: HI : N	Trip Wires	Influential Passive Blockers	Trip wires: High-influence, passive opponents requiring proactive monitoring and management.
Coastal Livelihoods Foundation		M		H				M			N		MI: HI: MI: N	Friend or Saboteur	Insignificant Active Backers/ Influential Active Blocker	Friends: Enthusiastic supporters with limited influence, valuable as confidants. Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
EkSteenSkuil		M			M			M			N		MI: MI: MI: N	Acquaintances	Insignificant passive backer	Supporters that could assist the project depending on how it benefits them and where they are needed.
Eco-Atlantic Oil and Gas	H			H			H				N		HI: Hi: HI: N	Acquaintances/ Saboteur	Insignificant passive backer/ Influential Active Blocker	Supporters that could assist the project depending on how it benefits them and where they are needed. OR. Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
Kazera Global Plc (Deep Blue Minerals Mining)	H			H			H				N		HI: HI; HI: N	Observer or Saboteur	Insignificant passive backer	They neither support nor oppose it but are within the area. However, they might compete for resources such as water, and the port could indirectly impact their operations.
Alexander Bay Centre Military Base	H			H					L		N		HI: HI: LI: N	Observer	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Alexander Bay Diamond Company	H			H				M			N		HI: HI: MI: N	Acquaintances/ Observer	Insignificant passive backers	Supporters that could assist the project depending on how it benefits them and where they are needed.
John Livestock PTY			L			L			L		N		LI: LI: HI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Recreational Fishers			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Josmel Construction			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Port Nolloth Primary School			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Pulls Full Gospel Church			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
AGS AFM Nollothville Church			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Aukotowa Tours			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Kaikai Richtersveld Residential Coastal Reserve			L			L	H				N		LI: LI: HI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
House of Bread Outreach Ministries			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Seaside Villas			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.

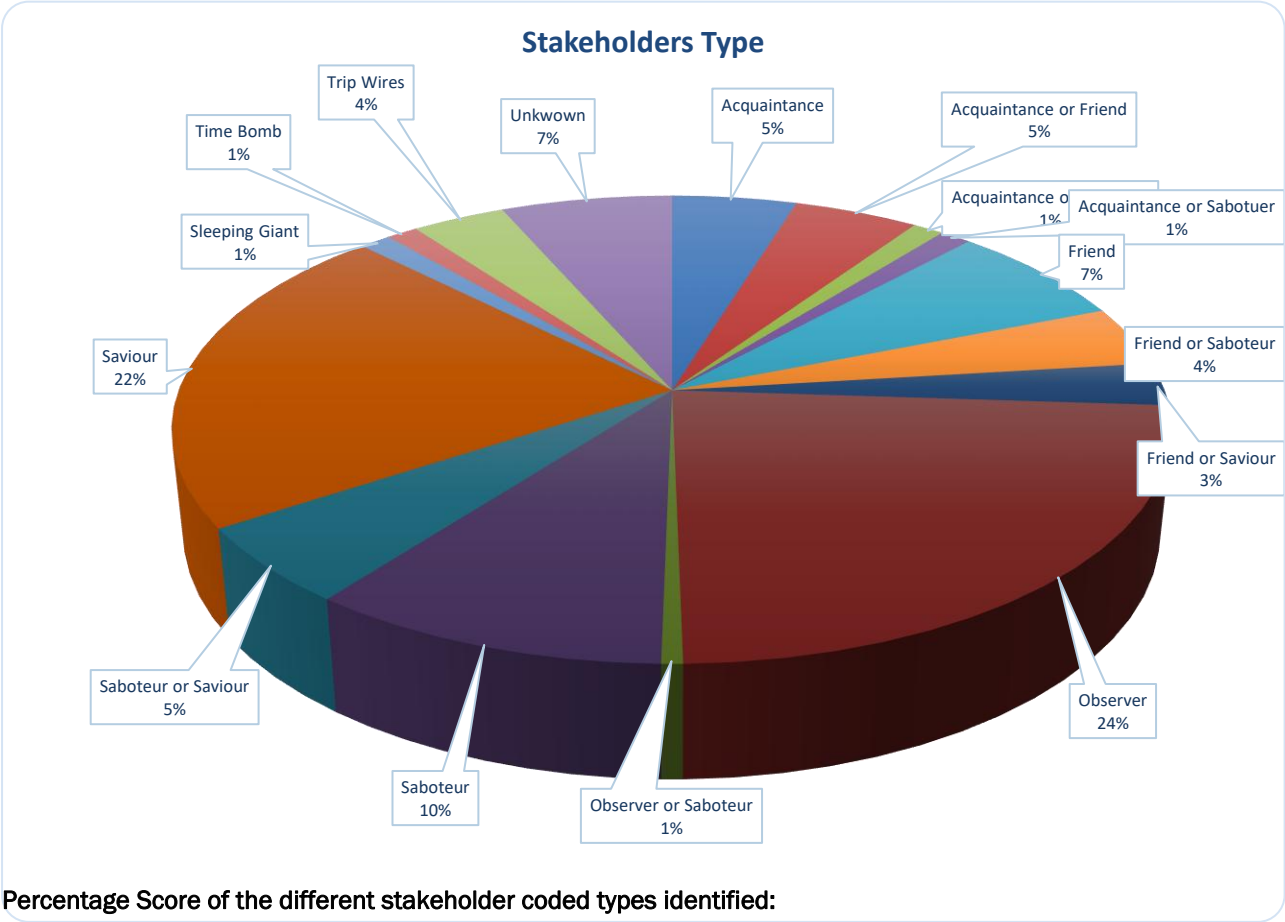
Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
Country Club Lodge			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Peaceful Place			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Richtersveld Experience			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Bedrock Lodge			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Port Nolloth Beach Shack			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Yield House and Cottages			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Richtersveld Tours			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Border post Swartkops Alexander Bay		M		H					L		N		MI: HI: LI: N	Observers or acquaintance	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Voetbaai Gastehuis			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Bietjies Selfsorg			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Mcdougallsbaai Akkomodasie			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Dougalls Rest			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Sea View Holiday House			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
																within the area.
Lewensdroom Gastehuis			L			L		M			N		LI: LI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Diamond Coast Aquaculture (Pty) Ltd		M		H			H				N		MI: HI: HI: N	Trip Wires	Influential passive blockers	Trip wires: High-influence, passive opponents requiring proactive monitoring and management.
Kleinzee Angling Club			L		M			M			N		LI: MI: MI: N	Acquaintance or Saboteur	Insignificant passive backer/ Influential Active Blocker	Supporters that could assist the project depending on how it benefits them and where they are needed. OR. Saboteur: High-influence opponents demanding strategic engagement to mitigate potential damage.
Kleinzee Golf Club			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Kleinzee Caravan Park			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Kleinzee Beach Cottage			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Seaway backpackers and Function Avenue			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Spoelklippie Gastehuis			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Kleinzee Airfield FAKZ	H				M				L		N		HI: MI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Namaqua Coastal Expeditions	H				M			M			N		HI: MI: MI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Die Baai Se Bek			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Visbeen Lodge			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Vori Klip			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
																within the area.
Die Honne Hokke Resort			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
De Swarte Mossel			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Dogstone Cottage			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
DopENKreef			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Rooi Spinnekop			L			L			L		N		LI: LI: LI: N	Observers	Insignificant passive backer	Not directly involved in the project. However, they are a stakeholder operating within the area.
Boegoebaai Port and Rail Consortium																
Port of Rotterdam	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. /
AP. Moller and Capital	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. /
Nako Systra	H			H			H			P			HI: HI: HI: P	Friend or Acquaintance	Insignificant Active Backer	Supporters that could assist the project depending on how it benefits them and where they are needed.
Nako Iliso		M		H			H			P			MI: HI: HI: P	Friend or Acquaintance	Influential Active Backer	Supporters that could assist the project depending on how it benefits them and where they are needed.
CPRDW- Consulting Port and Coastal Engineers	H			H			H			P			HI: HI: HI: P	Friend or Acquaintance	Influential Active Backer	Supporters that could assist the project depending on how it benefits them and where they are needed.
WBHO	H			H			H			P			HI: HI: HI: P	Friend or Acquaintance	Influential Active Backer	Supporters that could assist the project depending on how it benefits them and where they are needed.

Stakeholders in Alexander Bay, Port Nolloth, Kleinzee, Hondeklipbaai	Power			Influence			Impact			Attitude			Analysis	Murrays Cube Matrix Placement		
Name	High	Medium	Low	High	Medium	Low	High	Medium	Low	Positive (S)	Neutral	Negative (O)			Cube Code	Code Description
Thelo	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	Saviour: High-influence supporters requiring proactive engagement to maintain alignment./
DB Scheneker	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	Saviour: High-influence supporters requiring proactive engagement to maintain alignment. /
Boegoebaai Development Consortium																
Meridium SAS	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
Pembani Remgro Infrastracture Managers	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
Bouygues TP	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
Vinci Construction	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
Raubex Group	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
Coega Development Co-operation	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
Afrimat Limited	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
WSP Consulting Engineers	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
Gibb Consulting Engineers	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
Project Elephant Consortium	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
Newlyn Group's Briardale Trading	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
Afcon Infrastructure Limited,	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
Yapi Merkezi Insaat ve Sanayi Anonim Sirketi	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
Mota-Engil,	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	
Traxtion Sheltam	H			H			H			P			HI: HI: HI: P	Saviours	Influential Active Backer	

Appendix 2H. Distribution of Stakeholder Types



Percentage Score of the different stakeholder coded types identified:

Different Actors - Stakeholder	Number	Percentage
Acquaintance	8	4.7
Acquaintance or Friend	8	4.7
Acquaintance or Observer	2	1.2
Acquaintance or Saboteur	2	1.2
Friend	12	7.1
Friend or Saboteur	7	4.1
Friend or Saviour	5	3.0
Observer	40	23.7
Observer or Saboteur	1	0.6
Saboteur	17	10.1
Saboteur or Saviour	9	5.3
Saviour	37	21.9
Sleeping Giant	2	1.2
Time Bomb	2	1.2
Trip Wires	6	3.6
Unknown	11	6.5
Total	**169**	**100.0**

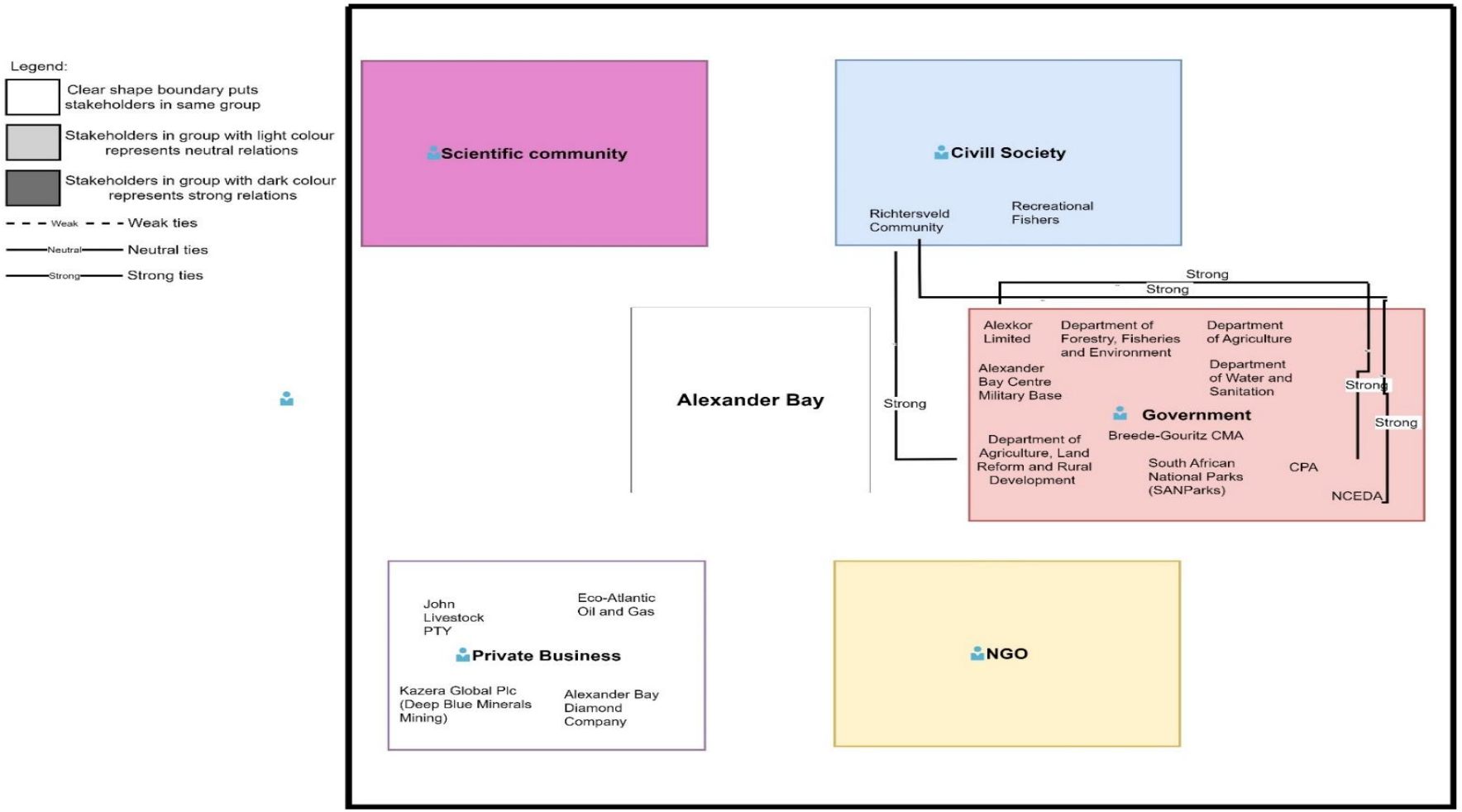
Appendix 2I. Stakeholders highlighted within the Murrays Coded Groups

Acquaintance	Department of Traditional Affairs	Observer	AGS AFM Nollothville Church	Saboteur	Coastal Justice Network/ Masifundise Development Trust	Saviour	Afcon Infrastructure Limited	Sleeping Giant	Indigenous Peoples of Africa Co-ordinating Committee *
	Department of Transport		Alexander Bay Centre Military Base		Earth life Africa		Afrimat Limited		Water Research Commission (WRC)
	Department of Women, Youth and Persons with disabilities		Aukotowa Tours		Environmental Monitoring Group (EMG)		Alexkor Limited *	Time Bomb	Aukotowa Small-scale fisheries co-operative Port Nolloth *
	EkSteenSkuil		Bedrock Lodge		Greenpeace		AP. Moller and Capital		Longtime Small-Scale Fisheries Co-operative Hondeklipbaai *
	National Sea Rescue Institute (NSRI)		Bietjies Selfsorg		groundWork		Bouygues TP	Trip Wires	Beach Seine
	Richtersveld Growers		Council for Geoscience		Legal Resources Centre (LRC)		Central Energy Fund (CEF)		Diamond Coast Aquaculture (Pty) Ltd
	Shipping		Country Club Lodge		Mining Affected Communities in Action (MACUA-WAMUA)		Coega Development Co-operation		Gilnet Fisheries
	South Africa National Defence Forces (SANDF)		De Swarte Mossel		Natural Justice		Community Property Association		Seaweed Harvesting
Acquaintance or Friend	Benguela Current Commission		Die Baai Se Bek		Oceans not Oil		DB Scheneker		Traditional Line Fish
	Benguela Current Large Marine Ecosystem (BCLME)		Die Honne Hokke Resort		Richtersveld Community Conservancy		Department of Mineral Resources and Energy		West Coast Rock Lobster
	CPRDW- Consulting Port and Coastal Engineers		Dogstone Cottage		Richtersveld Heritage Site		Department of Science and Innovation	Unknown	Birdlife
	Department of Agriculture, Land reform and Rural development		DopENKreef		SANBI		Department of Trade, Industry and Competition		Boegoebaai Development Consortium
	International Ocean Institute South Africa		Dougalls Rest		South African Fisheries Development Fund		Eskom		Boegoebaai Port and Rail Consortium
	Nako Iliso		House of Bread Outreach Ministries		Southern African Faith Communities Environment (SAFCEI)		Gibb Consulting Engineers		DEA

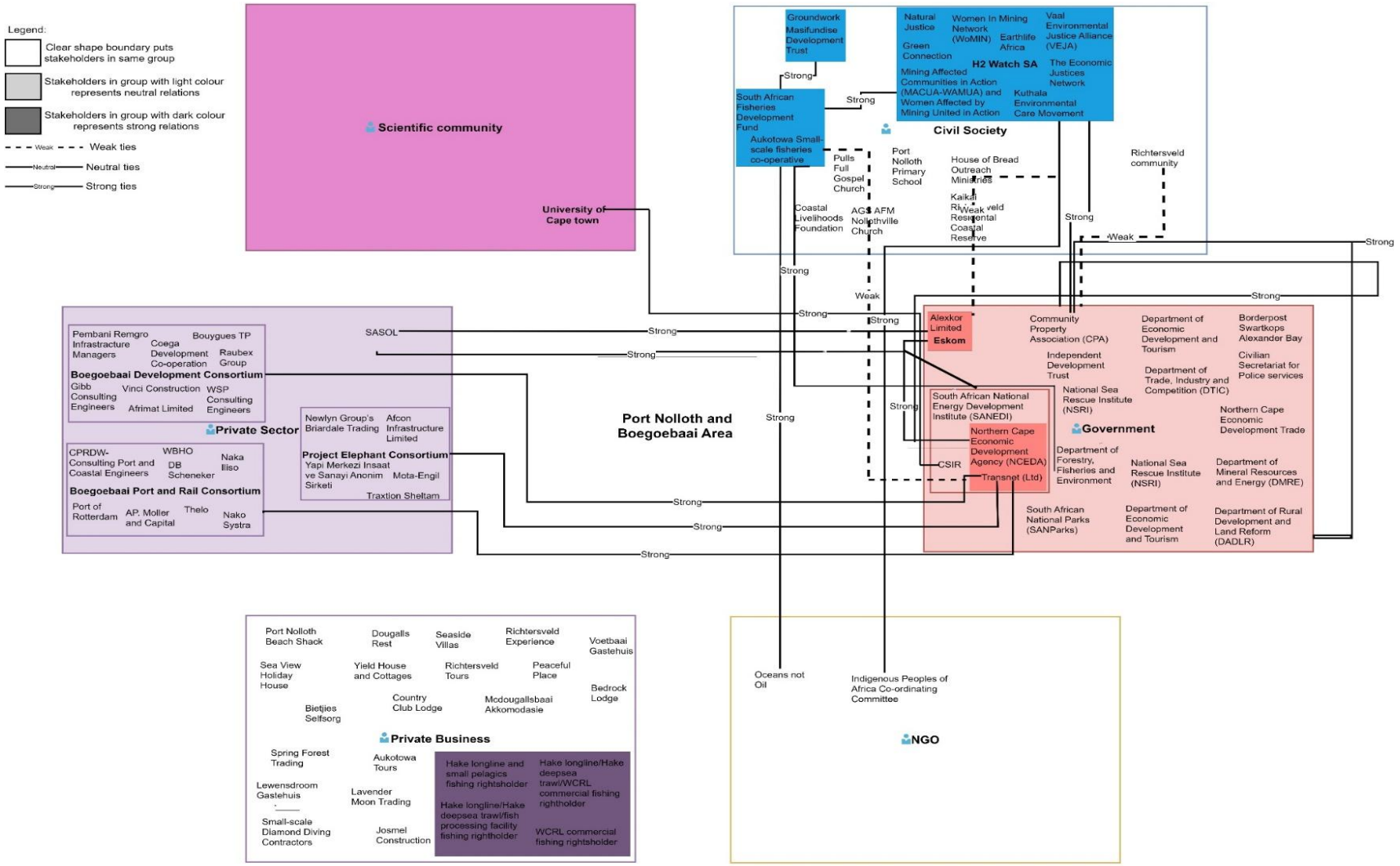
	Nako Systra		John Livestock PTY		The Green Connection		Independent Development Trust		Department of Employment and Labour
	WBHO		Josmel Construction		Vaal Environmental Justice Alliance (VEJA)		Industrial Development Corporation [Ltd] (IDC)		Department of Internation Relations and Cooperations
Acquaintance or Observer	Alexander Bay Diamond Company		Kaikai Richtersveld Residential Coastal Reserve		WoMIN		Meridium SAS		Equal education
	Border post Swartkops Alexander Bay		Kleinzee Airfield FAKZ		Agricultural Research Council (ARC)		Mota-Engil,		Housing Development Agency (HDA)
Acquaintance or Saboteur	Eco-Atlantic Oil and Gas		Kleinzee Beach Cottage		Breede-Gouritz CMA		National Development Agency (NDA)		Northern Cape Arts and Culture Council
	Kleinzee Angling Club		Kleinzee Caravan Park		Department of Defence		National Youth Development Agency (NYDA)		SAIIA
Friend	Department of Higher Education and Training		Kleinzee Golf Club		Department of Forestry, Fisheries and Environment		Newlyn Group's Briardale Trading		South African Special Risk Insurance Association (SASRIA)
	Department of Public Enterprises		Lewensdroom Gastehuis	**Saboteur or Saviour**	Department of Health		Northern Cape Economic Development, Trade and Investment Promotion Agency (NCEDA) *		
	Department of Public Works		Mcdougallsbaai Akkomodasie		Department of Human Settlements		Pembani Remgro Infrastructure Managers		
	Department of Social Development		Namaqua Coastal Expeditions		Department of Water and Sanitation		Port of Rotterdam		
	Economic Development and Tourism		Peaceful Place		SAMSA		Ports Regulator of South Africa		
	Kalahari Kid Corporation		Port Nolloth Beach Shack		South African National Parks (SANParks)		Project Elephant Consortium		
	Mintek (Council for Mineral Technology)		Port Nolloth Primary School				Raubex Group		
	National Agricultural Marketing Council		Pulls Full Gospel Church				SAEON		
	Northern Cape Heritage Resources Authority (NCHRA)		Recreational Fishers				South African National Road Agency		
	Northern Cape Tourism Authority		Richtersveld Experience				South African Tourism		
	Small Enterprise Finance Agency (SEFA)		Richtersveld Tours				Thelo		

	South African Weather Service (SAWS)		Rooi Spinnekop				Trade and Investment South Africa (TISA)		
	Centre for environmental rights		Sea View Holiday House				Transnet		
	Centre for Rural Legal Studies (CRLS)		Seaside Villas				Traxtion Sheltam		
	Coastal Livelihoods Foundation		Seaway backpackers and Function Avenue				Vinci Construction		
Friend or Saboteur	SANCCOB		Spoelklippie Gastehuis				WSP Consulting Engineers		
	South African Heritage Resources Agency		Visbeen Lodge				Yapi Merkezi Insaat ve Sanayi Anonim Sirketi		
	The Economic Justice Network		Voetbaai Gastehuis						
	Wild Oceans		Vori Klip						
	Department of Basic Education		Yield House and Cottages						
	Department of Communications and Digital Technologies	**Observer or Saboteur**	Kazera Global Plc (Deep Blue Minerals Mining)						
Friend or Saviour	Department of Cooperative Governance								
	National House of Traditional Leaders and Khoi- San Leaders								
	South African Local Government Association (SALGA)								

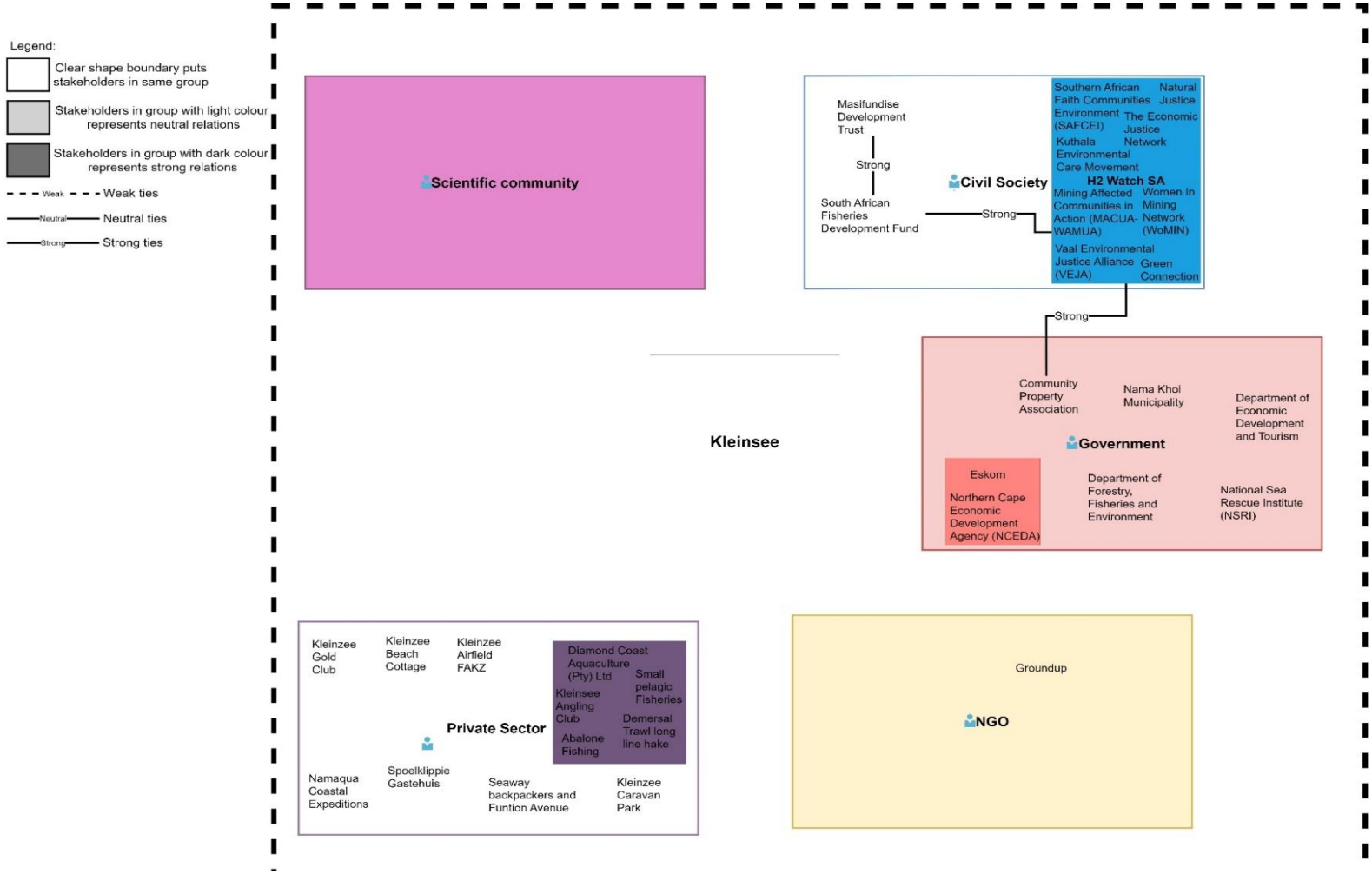
Appendix 2J. Stakeholder Relationships SNA for Alexander Bay



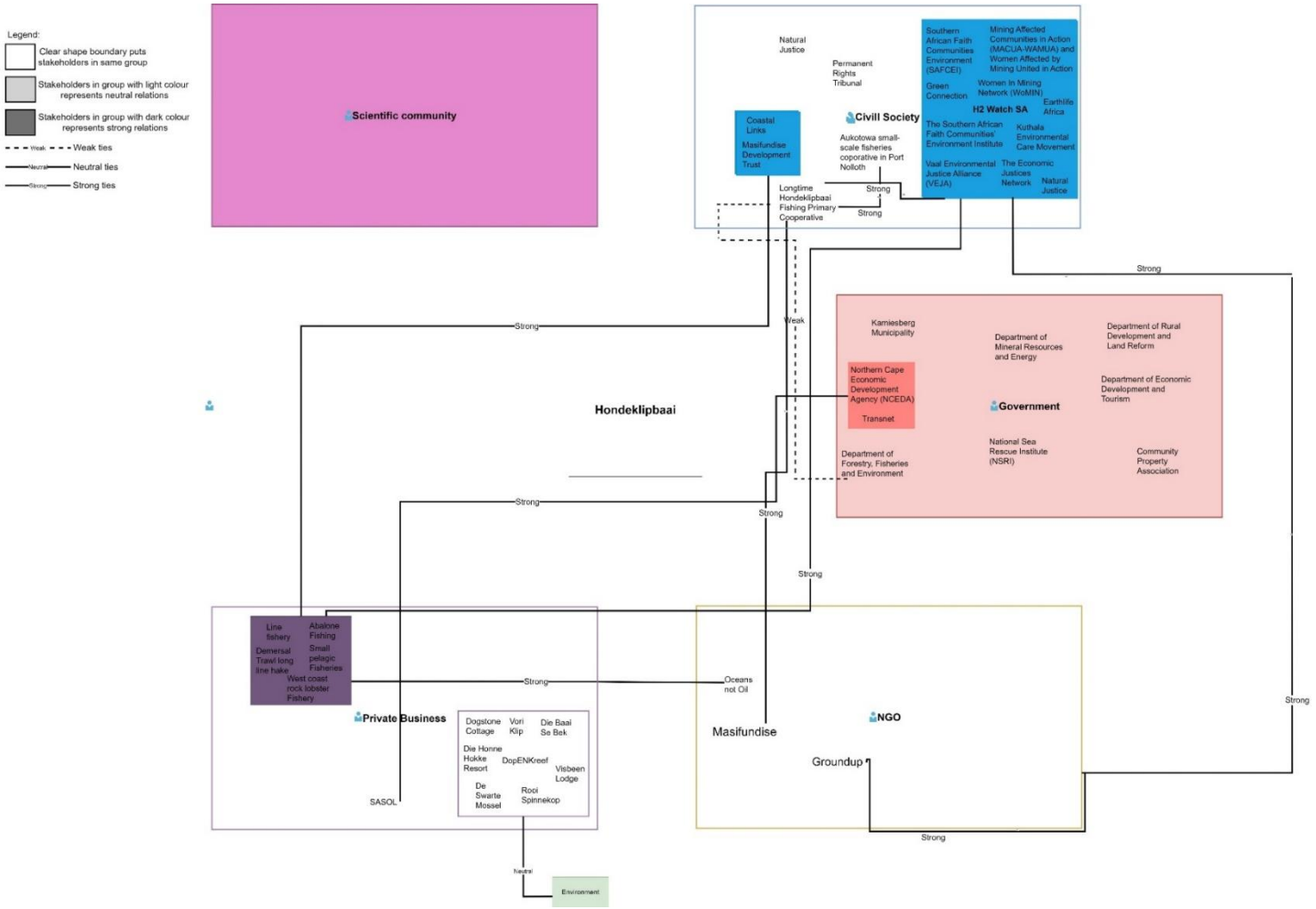
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Appendix 2L. Stakeholder Relationships SNA for Kleinzee



Appendix 2M. Stakeholder Relationships SNA for Hondeklipbaai



DIGITAL APPENDIX 6-2

Annex Report 2: Fisheries and Coastal Community Profiles

Fisheries and Coastal Livelihoods Expert Group

Work Package 1

Boegoebaai Port Development and Special Economic Zone (SEZ) Strategic Environmental Assessment (SEA)

November 2024

Authors: Zanne Zeeman

Contributors: Louise C. Gammage, Annastacia Mpala, Marieke Norton, Kelly Ortega-Cisneros and Catherine D. Ward



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Abbreviations and Acronyms

BCLME	Benguela current large marine ecosystem
CSIR	Council of Scientific and Industrial Research
DFFE	Department of Forestry, Fisheries and the Environment
EEZ	Exclusive economic zone
GDP	Gross Domestic Product
MLRA	Marine Living Resources Act of 1998 (South Africa)
MSY	Maximum sustainable yield
NCEDA	Northern Cape Economic Development Trade and Investment Promotion Agency
NSRI	National Sea Rescue Institute
RFMO	Regional Fisheries Management Organization
SANEDI	South African National Energy Development Institute
SEA	Strategic Environmental Assessment
SP	Sub place
StatsSA	Statistics South Africa
TAC	Total Allowable Catch
TAE	Total Applied Effort
TNPA	Transnet National Ports Authority
PUCL	Precautionary Upper Catch Limit
WCRL	West coast rock lobster

CHAPTER 1: INTRODUCTION

A substantial programme of greenfield infrastructure has been proposed in the Northern Cape as part of South Africa's ambition to become a player in the globally emerging green hydrogen market (CSIR, 2024). This proposed greenfield infrastructure consists of three components:

1. A new breakwater port at Boegoebaai, dry and liquid bulk berths, and multi-purpose terminals.
2. A mixed-use Special Economic Zone (SEZ) located in the region adjacent to the proposed Boegoebaai port.
3. An expansive regional renewable energy (wind and solar PV) generation and transmission infrastructure.

As green hydrogen production envisaged at this scale in the Northern Cape will entail a diverse and multifaced process, a Strategic Environmental Assessment (SEA) has been initiated through a collaboration between the South African National Energy Development Institute (SANEDI), Northern Cape Economic Development Trade and Investment Promotion Agency (NCEDA), and Transnet National Ports Authority (TNPA). This SEA is being undertaken by the Council for Scientific and Industrial Research (CSIR) (CSIR, 2024).

Under Work Package 1, the area of interest concentrates on a local spatial scale (33 500 ha) covering the extent of the proposed Boegoebaai Port and SEZ, focused on a land use perspective (see Figure 1). However, for the purpose of this report, the area of interest has been expanded to better capture descriptions of fisheries and coastal livelihoods in relation to the proposed development in Boegoebaai.

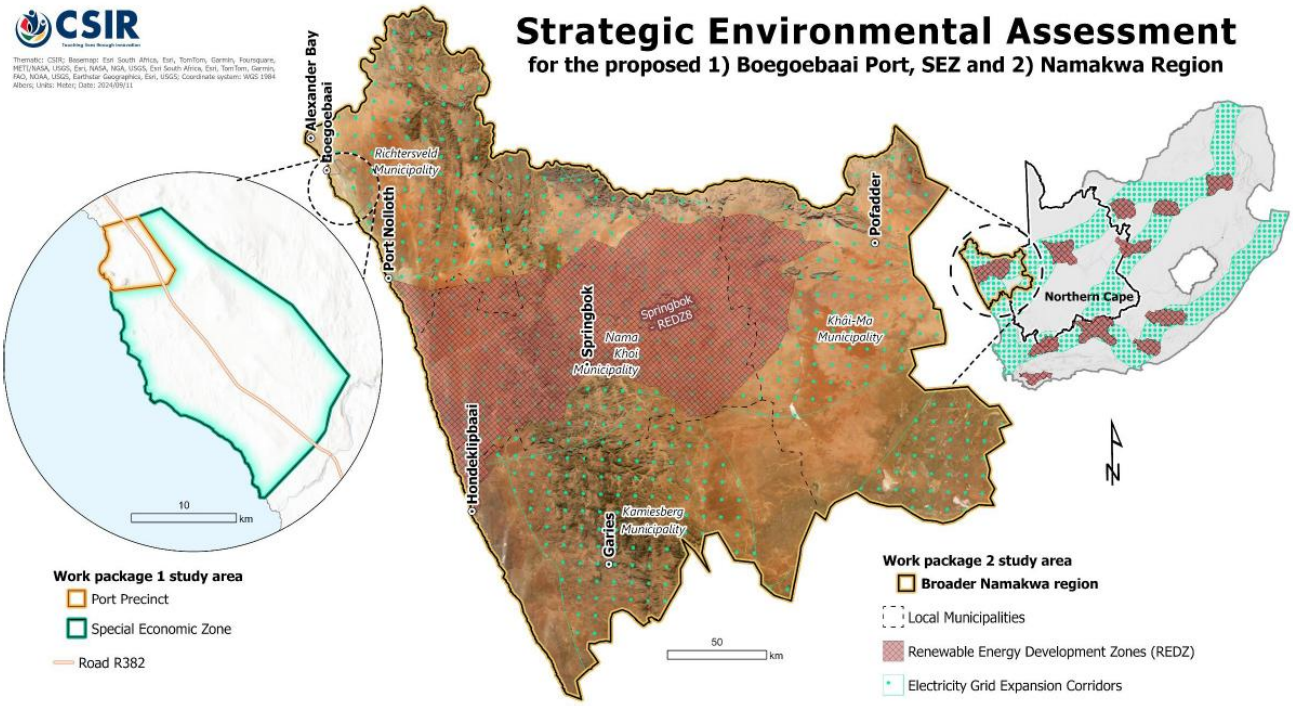


Figure 1. The spatial extent of the two SEA Work Packages for the proposed Boegoebaai Port and SEZ

This report provides a description of fisheries and coastal livelihoods through comprehensive community profiles developed for selected communities of interest, contributing to Work Package 1. The introduction (Chapter 1) introduces the area of interest and communities of interest, as well as the approach and methods undertaken for this report. Chapter 2 provides a description of fisheries through an overview of national fisheries in South Africa, west coast fisheries and fisheries in the Northern Cape Province. Chapter 3 details community profiles for the four communities of interest – Alexander Bay, Port Nolloth, Kleinzee and Hondeklipbaai. Chapter 4 concludes this report by outlining potential impacts of the proposed Boegoebaai Port and SEZ may have on the wider fishery system and communities of interest.

1.1 Overview of the receiving environment

The area of interest for this report falls within the coastline of the Northern Cape Province – including the adjacent marine environment. The Northern Cape is divided into five district municipalities and further subdivided into 26 local municipalities (Municipalities of South Africa, 2024). The Northern Cape is the largest province of South Africa with the smallest population size due to its largely arid climate (IKI, 2024). The majority of the population is located in the northern and north-eastern part of the Northern Cape – close to mining and agricultural activities that are the two primary economic activities in the province. The highest employment sectors within the Northern Cape include agriculture, forestry and fishing; community and social services; wholesale and retail trade; and mining and quarrying (IKI, 2024). The Northern Cape coastline spans 313 kilometres alongside the Atlantic Ocean and extends over three (out of six) local municipalities within the Namakwa District Municipality, namely the Richtersveld, Nama Khoi and Kamiesberg (Ramasar, 2004).

1.1.1 Seaward context

South Africa has roughly 3000 km of coastline and is dominated by two major ecosystems – the Agulhas Current Large Marine Ecosystem on east coast and the Benguela Current Large Marine Ecosystem (BCLME) on the west and southwestern Coast (Jarre *et al.*, 2015). The BCLME, an eastern boundary current system dominated by coastal upwelling, is a highly productive region that sustains significant fisheries for Angola, Namibia, and South Africa (e.g., BCC, 2013)). The BCLME is characterised by rich marine biodiversity that supports both small-scale and industrial fisheries in all three countries, making important contributions to food security, economic stability, and cultural identity in coastal communities (Sowman and Raemaekers, 2018). The BCLME, comprising four sub-(eco) systems (see Figure 2), has been shown to exhibit variability across several temporal scales and is experiencing warming at its peripheries (Hutchings *et al.*, 2009; Rouault *et al.*, 2010; Dufois and Rouault, 2012; Blamey *et al.*, 2015; Jarre *et al.*, 2015).

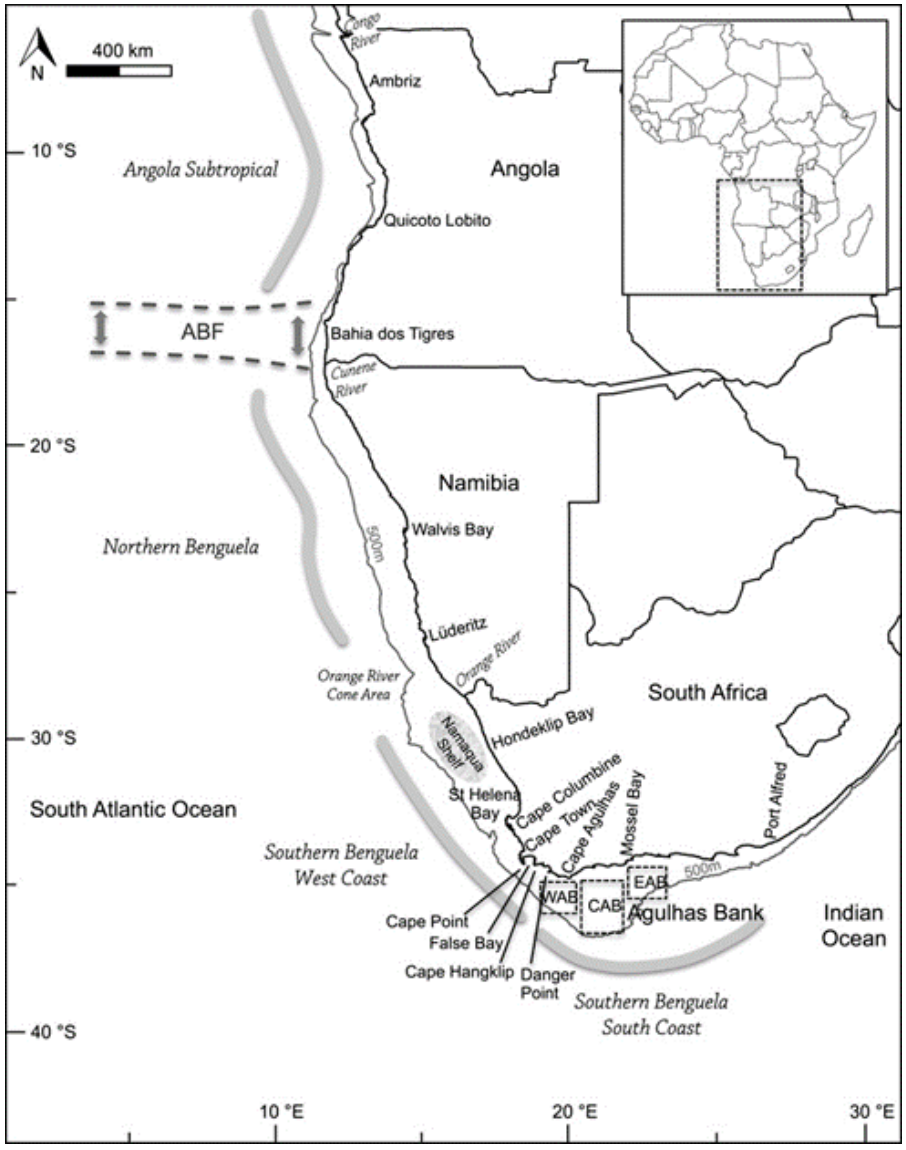


Figure 2. The four subsystems of the Benguela Current large marine ecosystem. The southern Benguela consists of two subsystems: the west coast, driven by the cold Benguela Current (including the western Agulhas Bank) and the south Benguela south coast/Agulhas Bank subsystem, under much stronger influence of the warm Agulhas Current. WAB, CAB, EAB: Western, central and eastern Agulhas Bank, ABF: Angola-Benguela front (Jarre et al., 2015)

Looking seaward and extending beyond the immediate boundary of Work Package 1, lies the southern Benguela – this larger, interconnected ocean space and its fishery resources play a critical role in maintaining the economic and cultural stability of local communities along the west coast. Therefore, this report considers fisheries operating at multiple scales, from national fisheries operating in South Africa's Exclusive Economic Zone (EEZ) along the west coast, to the two main regional fishing nodes in the Northern Cape Province, namely Port Nolloth and Hondeklipbaai (see Chapter 2).

Changing contexts in the marine system

The southern Benguela ecosystem is increasingly vulnerable to external pressures such as climate change, overfishing, and habitat degradation. These pressures present significant threats to fish stocks, with potentially severe consequences for the livelihoods that rely on them (Allison *et al.*, 2005; FAO, 2014; Ortega-Cisneros *et al.*, 2021). Climate change, in particular, affects both fish populations and their ecosystems, resulting in shifts in species distribution and abundance (Ortega-Cisneros *et al.*, 2021). Variations in climate, such as rising sea surface temperatures and changing oceanographic conditions, can disrupt traditional fishing practices and reduce the availability of key species to fishing (Gammage *et al.*, 2017, 2019; Jarre *et al.*, 2018; Martins *et al.*, 2019; Gammage and Jarre, 2020). Furthermore, overfishing

exacerbates these challenges by depleting fish populations, thereby threatening the sustainability of fisheries (Jarre *et al.*, 2018; Gammage and Jarre, 2020). Other anthropogenic pressures on the west coast marine SES include mining (expanded in section 1.1.2) and offshore oil and gas exploration (Masterson, 2021). Offshore gas and oil exploration and prospecting activities are currently undertaken in various licence blocks off the west coast (McGrath, 2024).

For example, commercial fisheries were a prominent industry from the 1920s to the 1990s in the northern part of the west coast. However, overfishing by commercial fisheries along the west coast in the 1960s resulted in the abrupt stock collapse of the sardine (*Sardinops sagax*) population, pushing the small pelagics industry to target alternative species (such as anchovy (*Engraulis encrasicolus*) and redeploy its workforce into canning factories. However, an ecosystem regime shift[1] occurring in the late 1990s/early 2000s resulted in distribution shift of small pelagics from the west coast to the south coast and the fishing industry subsequently shifted to follow the fish, closing many factories on the west coast that had significant consequences for dependent coastal communities (Jarre *et al.*, 2013). Both the Namaqua canning company in Hondeklipbaai and the John Ovenstone fish factory in Port Nolloth closed in the mid-90s and early-2000s respectively. These closures had significant impacts for local coastal livelihoods and women working in the fishing industry were severely impacted (Human, 2021; Soudens, 2022), where the cumulative stressors of competition in the ocean space with mining and oil and gas operations continue to hamper the livelihoods of these coastal fishing communities (Christianson, 2021) .

1.1.2 Landward context

The Namakwa District Municipality, running along the coastline of the Northern Cape, is the largest district in the province with the smallest population size (approximately 148 935) (StatsSA, 2022). While the Namakwa District Municipality has the lowest poverty rate (38.2% in 2022) in relation to the other district municipalities, poverty rates have increased over time across the district (Northern Cape Provincial Government, 2024). While agriculture and tourism are key economic sectors across the Namakwa District Municipality (Municipalities of South Africa, 2024), this differs across the three local municipalities running along the Northern Cape coastline. The local municipality of the Richtersveld is the smallest municipality in the district and the primary economic activities include mining, agriculture, fisheries and tourism (Municipalities of South Africa, 2024). While mining activities played a central role in economic activities in the past of the Nama Khoi Local Municipality, tourism is now viewed as the new frontier for economic development (Municipalities of South Africa, 2024). In the Kamisberg Local Municipality, agriculture employs the highest number of people in rural communities of this local municipality (Namakwa District Municipality, 2023).

The immediate landward area of Boegoebaai under consideration for the SEA is under restricted access linked to diamond mining activities under Alexkor (see https://alexkor.co.za/), where the area is currently uninhabited. Therefore, the communities of interest to examine local coastal livelihoods are selected based on their proximity to Boegoebaai, prioritising existing fishing communities and fishery related activities where relevant. These communities of interest fall under the Namakwa District Municipality. Four towns were selected, namely Alexander Bay, Port Nolloth, Kleinzee and Hondeklipbaai. Table 1 below details municipal jurisdiction for the selected towns, as well as the primary reason to include the select towns as communities of interest.

Table 1: Communities of interest for fisheries and coastal livelihoods

District Municipality	Local Municipality	Community (based on Main Place)	Reason to include as a community of interest
Namakwa	Richtersveld	Alexander Bay	Closest proximity to Boegoebaai
		Port Nolloth	Traditional fishing community
	Nama Khoi	Kleinzee	Aquaculture activities
	Kamiesberg	Hondeklipbaai	Traditional fishing community

[1] Ecological regime shifts are large and sudden changes in ecosystems that push systems into a different state which cannot necessarily be reversed, which can negatively impact people's livelihoods (Biggs *et al.*, 2009).

Changing contexts in the terrestrial system

The Northern Cape is a hot and dry region, where coastal areas are cooler than inland areas on average, resulting in temperature gradients and conditions favourable for strong winds and storms (Namakwa District Municipality, 2023). Changes in climate along the coastline of the Namakwa District Municipality are projected to negatively impact marine and terrestrial systems through variable rainfall patterns, drying trends and expected temperature increases. In particular, issues around water scarcity and quality are prevalent across this district municipality, where changes in climate are expected to exacerbate this problem through drought, reduced runoff, increased evaporation and an increase in flood events (Namakwa District Municipality, 2023). While agriculture plays a key role in local livelihoods, where small stock sheep and goat farming is the main economic activity and land user across the Namakwa District Municipality, projected changes in climate are set to negatively impact these rural communities dependent on small-scale agriculture (Namakwa District Municipality, 2023).

Mining activities are also prominent drivers of change along the coastline of the Northern Cape. The mining of minerals has played a central role in the historical development in the northern part of the west coast, where alluvial diamonds extracted from the beaches and the sea between Alexander Bay and Port Nolloth (Britz *et al.*, 2000; Municipalities of South Africa, 2024). Prospecting and mining activities for diamonds and heavy mineral sands in the ocean space off the Northern Cape take place on the coastal land, beaches, the nearshore environment and in the deep-sea (Masson, 2022). However, mining has become less significant for coastal livelihoods over the last 10 years – notably due to the mine closure in Kleinzee and the greatly reduced mining activities of Alexkor in Alexander Bay (Britz *et al.*, 2000). Some smaller companies have been given concessions to mine diamonds in the area, but systemic issues linked to illegal mining and marginalisation of small-scale miners remain widespread (Masson, 2022).

1.2 Approach

A description of the receiving environment was developed to contextualise fisheries and coastal communities in the area of interest (see section 1.1.). A description of fisheries was developed through a comprehensive literature review, drawing on relevant sources describing national, west coast and Northern Cape fisheries. This description of fisheries is detailed in Chapter 2 of this report. Importantly, this description must be read in conjunction with the specialist Marine Ecology report, developed for this SEA as this report places the emphasis on the intersection of fish and people.

A description of the communities of interest was created through developing community profiles for the four coastal communities, drawing on the stakeholder analysis (see Annex Report 1) that formed part of a wider approach to lay a foundation to better understand key stakeholders and relationships in the area of interest. The stakeholder analysis informed the type of livelihood activities that the selected communities of interest engaged in, which were then detailed using an approach to develop community profiles. In the case of coastal communities within the context of social-ecological systems, community profiles can provide a useful snapshot of communities engaged in coastal livelihood activities within their historic, demographic, economic and cultural contexts. Community profiles can provide information on the level of interest community members may have in being actively involved in a project and their preferred method of engagement (Clay and Olson, 2007; Colburn *et al.*, 2010). These community profiles are detailed in Chapter 3 of this report.

1.2.1 Methods and data collection

Description of fisheries

A desktop approach was used to gather data drawing on online research for the literature review of fisheries. The review included on peer-reviewed publications and relevant published grey literature – such as journal publications, government documents and research documents. This data collection process drew on secondary data (i.e., data that has already been collected through primary sources and made readily available for research) and no ethical clearance was required for this project phase. To gain a comprehensive understanding of this system, the review included an overview of national fisheries in South Africa, west coast fisheries and fisheries in the Northern Cape Province. This literature review was further

strengthened through the consultation of relevant subject matter experts – where verbal consent was obtained prior to these key expert interviews and are referenced in this report accordingly.

Developing community profiles

Drawing on the stakeholder analysis (see Annex Report 1), typologies of coastal livelihood activities for each community of interest were developed (see Appendix 1). These typologies informed which livelihood activities were pertinent to the relevant coastal communities and were expanded accordingly under the community profiles. Table 2 gives an overview of the key livelihood activity typologies identified and a general description per category based on research from the stakeholder analysis.

Table 2: Description of coastal livelihood activities

Coastal Livelihood Activity	Description
Agriculture	The cultivation of crops and the rearing of animals to provide food and other products
Conservation	Activities related to the conservation of natural resources that support livelihood activities
Fisheries	Marine and estuarine fisheries (and related marine industries), including small-scale fisheries and aquaculture
Mining	The extraction of valuable geological materials and minerals from the environment, including the seabed (and related mining industries)
Tourism	Activities related to receiving tourists to support the hospitality industry and tourist information centres

A community profile was created for each community of interest (see section 1.1) that included:

- **Location** – details on the geographic position and historical background
- **Demographic attributes** – population size, gender and age structure, racial profile, language and other relevant economic characteristics
- **Inventory of features** – land and sea use characteristics, existing businesses and services, community facilities and other relevant features
- **Involvement in coastal livelihood activities** – type of activity and characteristics

Initially, a desktop review was undertaken to build a profile for each community drawing on peer-reviewed publications and relevant published grey literature. Data sources included the 2011 South African Census[2] and other secondary sources. In alignment with Statistics South Africa (StatsSA), the main terms referenced in this report are expanded in Table 3 below. Other important sources included local tourism and municipal websites. As the data collection process for this desktop review only involved secondary data (i.e., data that has already been collected through primary sources and made readily available for research), no ethical clearance was required for this project phase.

Table 3: Main terms referenced in this report in line with StatsSA definitions

[2] At community level, the census data from 2011 was the most readily available resource. It should be noted that these data most likely are partly outdated as they are more than 10 years old, particularly as the socio-economic status of these communities have been impacted by political, economic, environmental and health stressors, including the Covid-19 global pandemic.

Term	Definition
Location	
Main Places	Named locations determined by StatsSA, which generally correspond to towns, small cities, regions of large cities, or traditional council areas. Areas that do not fall within any named settlement are incorporated in a main place named for the municipality.
Sub Places	Named locations determined by StatsSA, which generally correspond to suburbs, villages, or localities. When a main place contains only one sub place, that sub place is named for the main place with a suffix of "SP".
Small Areas	The smallest output unit for census data; on average each small area contains approximately 600 people.
Demographics	
Population Group	A group with common characteristics (in terms of descent and history), particularly in relation to how they were (or would have been) classified before South African gained independence in the 1994 elections. The following categories are provided in the census: Black African, coloured, Indian or Asian, white, other.
Black African	The majority population of South Africa are those that classify themselves Black Africans, which is a culturally and linguistically diverse group. The major ethnic parts of the group are the Zulu, Xhosa, Bapedi (North Sotho), Tswana, South Ndebele, Basotho (South Sotho), Venda, Tsonga and Swazi, who predominantly speak Southern Bantu languages.
Coloured	Stemming from the apartheid-era race classification, the term "coloured" refers to South Africans who have a mixed-race heritage, coming from a combination of ethnic backgrounds including Black Africans, Indigenous South Africans, Griqua, Asians and whites. The majority of this population group is concentrated in the Cape region of South Africa.
Indian or Asian	Stemming from the policies of apartheid, Indian (synonymous with Asian under this regime) is regarded as a race group in South Africa. The majority of this group descended from indentured labourers and migrants who arrived from British India during the late 1800s and early 1900s (and predominately reside in the Natal region of South Africa).
White	Predominantly descendants of Dutch, German, French Huguenots, English and other European settlers, where traditionally this group is divided culturally and linguistically divided into Afrikaners (who speak Afrikaans) and English-speaking groups.
Other	Captures self-classification that do not fall into the five main race categories provided by StatsSA. To note, the Khoisan of South Africa are the minority of indigenous South Africans that are conventionally classified under the Black South African population; however, some do not agree with this classification and identify as coloured, or a number of expatriate Khoisan identify as other (including linguistics as separating characteristic).
Linguistics	
Language	South Africa is a multilingual country with 11 official languages (Afrikaans, English, Ndebele, Sotho, Southern Sotho, Swati, Tsonga, Tswana, Venda, Xhosa and Zulu), each of which is guaranteed equal status. Most South Africans are multilingual and able to speak at least two or more of the official languages. For governance purposes, the Western Cape uses Afrikaans (the most widely used language in this region), isiXhosa and English.

This desktop review was supported by fieldwork conducted between 4 to 6 September 2024 in the four coastal communities of interest: Alexander Bay, Port Nolloth, Kleinzee and Hondeklipbaai. Observations of the four coastal communities during the fieldwork were used to ground truth and develop each community profile. In-person interviews were conducted with local stakeholders during the fieldwork, as well as remote interviews where select stakeholders were not available in person, to gain further insights and perspectives in relation to local coastal livelihoods and the proposed port development. These interviews aimed to gain high-level insights from a cross-section of local stakeholders, depending on their primary livelihood activity and which community of interest they resided in. These interviews supported the data collection for the profiles and did not serve as formal, intensive stakeholder engagement consultations.

Interviews focused on local stakeholders linked to agriculture, conservation, fisheries (including aquaculture), mining and tourism. Interview guides developed were semi-structured to capture insights on current livelihood activities, details on fishing activities (where applicable), and perceptions on the proposed development (see Appendix 2A). The interview guides were drawn up in both English and Afrikaans, where the researcher conducting the interviews was fluent in both languages. Participants were

required to sign a written consent form (in the preferred language of English or Afrikaans) that outlined the interview procedures around feedback, recording, permissions, and confidentiality (see Appendix 2B). A total of 12 local key stakeholders were interviewed between September to November 2024 (see Table 4), where all interview data was transcribed into English and captured via Microsoft Forms. Results from this interview process are referenced as "pers. comm." in this report to make the distinction between primary and secondary data sources, as well as to ensure local stakeholder interviewee anonymity. This was also supported by the consultation of relevant subject matter experts – where verbal consent was obtained prior to these key expert interviews and are referenced in this report accordingly.

Table 4: Local stakeholders interviewed to support the community profile development

Community of interest	Number of interviews	Area of expertise (i.e. coastal livelihood activity)
Alexander Bay	4	Agriculture; Conservation; Mining; Tourism
Port Nolloth	3	Fisheries; Other (local industry)
Kleinzee	3	Aquaculture; Mining; Tourism
Hondeklipbaai	2	Fisheries

CHAPTER 2: FISHERIES

The southern Benguela is one of the most productive marine ecosystems globally because of its nutrient-rich upwelling system. This upwelling supports a high plankton biomass, which forms the foundation of the marine food web, leading to abundant fish populations, particularly small pelagic species such as sardines and anchovies. These species are crucial for commercial fisheries and the overall health of marine ecosystems (Hutchings *et al.*, 2009; Ruzicka *et al.*, 2024). The southern Benguela fisheries are vital to coastal communities' livelihoods, providing direct employment in fishing, processing, and distribution and supporting thousands of households. The importance of these fisheries transcends economic value, being deeply interwoven with the cultural and social identities of these communities, contributing to both food security and the preservation of traditional practices (Griffiths *et al.*, 2010). This evolution highlights the critical role of these resources in maintaining the economic and cultural stability of local communities.

Beyond their local importance, the economic contributions of these fisheries extend nationally, with fisheries playing a key role in South Africa's gross domestic product (GDP), contributing although less than 1%, also generating foreign exchange earnings through exports (Brick and Hasson, 2016). The South African fishing industry comprises two main components: wild capture fisheries and aquaculture. The former includes the commercial, small-scale, subsistence, and recreational sub-sectors. The commercial sector provides direct employment to 28,000 individuals and supports indirect employment for between 100,000 and 130,000 people (Brick and Hasson, 2016). There are 22 commercial sub-sectors in South Africa, and estimates indicate approximately 30,000 subsistence fishers in the country (Clark *et al.*, 2002) . Small-scale and subsistence fishers heavily rely on fishing, representing a vital source of employment and food security in coastal communities with limited opportunities (Isaacs and Hara, 2015) – for example, in communities of Port Nolloth and Hondeklipbaai.

The fishing sector is critical for providing protein sources to local and Southern African populations, making a substantial contribution to food security (e.g. Griffiths *et al.*, 2010; Hara *et al.*, 2017). The interconnections between fisheries and broader economic systems underscore the necessity for sustainable management practices to ensure the long-term viability of these resources and the well-being of communities that depend on them. Moreover, the fisheries sector is not only an economic pillar but also an essential part of the social fabric of coastal communities, reinforcing cultural identities and traditional practices (Griffiths *et al*., 2010).

2.1 Overview of South African fisheries

South Africa's territorial waters are home to 22 commercial fisheries sectors (Sink *et al.*, 2019). The most important in terms of economic value and catch volume are the demersal trawl and long-line fisheries, which target Cape hakes (*Merluccius paradoxus and M. capensis*), and the purse-seine fishery, which focuses on small pelagics such as sardine (*Sardinops sagax*), anchovy (*Engraulis encrasicolus*), and red-eye round herring (*Etrumeus whitheadii*). The pelagic long-line and pole fisheries seasonally catch highly migratory tuna and swordfish within South African waters. These include albacore (*Thunnus alalunga*), bigeye tuna (*T. obesus*), yellowfin tuna (*T. albacares*), and swordfish (*Xiphias gladius*). Near the shore, the traditional line fishery targets a diverse range of species, including snoek (*Thyrsites atun*), Cape seabream (*Pachymetopon blochii*), geelbek (*Atractoscion aequidens*), kob (*Argyrosomus japonicus*), yellowtail (*Seriola lalandi*), and various reef fish. The crustacean fisheries comprise a trap and hoop net fishery for West coast rock lobster (*Jasus lalandii*), a line trap fishery for South Coast rock lobster (*Palinurus gilchristi*), and an East Coast-based trawl fishery targeting penaeid prawns, langoustines (*Metanephrops andamanicus* and *Nephropsis stewarti*), deep-water rock lobster (*Palinurus delagoae*), and red crab (*Chaceon macphersoni*) (Japp and Wilkinson, 2021; DFFE, 2023a). Other fisheries include a mid-water trawl fishery targeting horse mackerel (*Trachurus trachurus capensis*) predominantly on the Agulhas Bank, South Coast and a hand-jig fishery targeting chokka squid (*Loligo vulgaris reynaudii*) on the South Coast (Japp and Wilkinson, 2021; DFFE, 2023a). Table 5 provides an overview of the wholesale value of production of South African offshore commercial fishing sectors in 2017.

Table 5: South African offshore commercial fishing sectors: wholesale value of production in 2017 (adopted from Wilkinson and Coppin (2024))

Sector	No. of Rights Holders (Vessels)	Catch (tons)	Landed Catch/ Sales (tons)	Wholesale Value of Production in 2017 (R'000)	% of Total Value
Small pelagic purse-seine	111 (101)	313476	313476	2164224	**22.0**
Demersal trawl (offshore)	50 (45)	163743	98200	3891978	**39.5**
Demersal trawl (inshore)	18 (31)	4452	2736	90104	**0.9**
Mid-water trawl	34 (6)				
Demersal longline	146 (64)	8113	8113	319228	**3.2**
Large pelagic longline	30 (31)	2541	2541	154199	**1.6**
Tuna pole-line	170 (128)	2399	2399	97583	**1.0**
Linefish	422 (450)	4931	4931	122096	**1.2**
Longline shark demersal		72	72	1566	**0.0**
South coast rock lobster	13 (12)	699	451	*337912*	**3.4**
West coast rock lobster	240 (105)	1238	1238	*531659*	**5.4**
Crustacean trawl	6 (5)	310	310	32012	**0.3**
Squid jig	92 (138)	11578	11578	1099910	**11.2**
Miscellaneous nets	190 (N/a)	1502	1502	25589	**0.3**
Oysters	146 pickers	42	42	3300	**0.0**
Seaweeds	14 (N/a)	9877	6874	27095	**0.3**
Abalone	N/a (N/a)	86	86	*61920*	**0.6**
Aquaculture		3907	3907	881042	**9.0**
Total		**528966**	**458456**	**9841417**	**100**

Commercial fishing vessels use only designated fishing harbours, for instance, large industrial vessels targeting hake use only the major ports of Saldanha Bay, Cape Town, Mossel Bay and Gqeberha. On the West coast, the main landing sites for the small pelagic fleets are St. Helena Bay and Saldanha Bay where there is also the necessary infrastructure for processing anchovy and sardine into fishmeal and canning, respectively. Port Nolloth, Hondeklipbaai, Laaiplek, Hout Bay and Gansbaai harbours are the smaller fishing harbours on the West / South-West coast. On the East Coast, Durban and Richards Bay are the main ports for the crustacean trawl and large pelagic longline sectors (Japp and Wilkinson, 2021).

In 2016 the small-scale sector was legally created to acknowledge those fishers who depend on marine living resources for direct food security or those using traditional fishing methods. There are more than 169 small-scale fishing communities that support approximately 8 027 active small-scale fishers with an estimated 85% of them harvesting linefish (DFFE, 2023a). Small-scale fisheries commonly use small, open boats generally less than 10 m in length that mainly operate close to the shore and are only allowed access to nearshore target species. In addition to commercial and small-scale sectors, recreational fishing occurs along the coastline comprising shore angling and boat-based fishing. The commercial and recreational fisheries are reported to catch over 250 marine species, although fewer than 5% of these are actively

targeted by commercial fisheries, which comprise 90% of the landed catch (Wilkinson and Coppin, 2024) – refer to Table 6.

Table 6: South African fishing sectors, fishing areas, ports of operation and target species (adapted from Wilkinson and Coppin, 2024)

Sector	Areas of Operation	Main Ports in Priority	Target Species
Small pelagic purse-seine	West, South Coast	St Helena Bay, Saldanha, Hout Bay, Gansbaai, Mossel Bay	Anchovy (*Engraulis encrasicolus*), sardine (*Sardinops sagax*), Redeye round herring (*Etrumeus whiteheadi*)
Demersal trawl (offshore)	West, South Coast	Cape Town, Saldanha, Mossel Bay, Port Elizabeth	Deepwater hake (*Merluccius paradoxus*), shallow- water hake (*Merluccius capensis*)
Demersal trawl (inshore)	South Coast	Cape Town, Saldanha, Mossel Bay	East coast sole (*Austroglossus pectoralis*), shallow- water hake (*M. capensis*)
Mid-water trawl	West, South Coast	Cape Town, Port Elizabeth	Adult horse mackerel (*T. capensis*)
Demersal long- line	West, South Coast	Cape Town, Saldanha, Mossel Bay, Port Elizabeth, Gansbaai	Shallow-water hake (*M. capensis*)
Large pelagic long-line	West, South, East Coast	Cape Town, Durban, Richards Bay, Port Elizabeth	Yellowfin tuna (*T. albacares*), big eye tuna (*T. obesus*), Swordfish (*Xiphius gladius)*
Tuna pole-line	West, South Coast	Cape Town, Saldanha	Albacore tuna (*T. alalunga*)
Linefish	West, South, East Coast	All ports, harbours and beaches around the coast	Snoek (*Thyrsites atun*), Cape bream (*Pachymetopon blochii)*, geelbek (*Atractoscion aequidens)*, kob (*Argyrosomus japonicus)*, yellowtail (*Seriola lalandi),* Sparidae, Serranidae, Carangidae, Scombridae
South coast rock lobster	South Coast	Cape Town, Port Elizabeth	*Palinurus gilchristi*
West coast rock lobster	West Coast	Hout Bay, Kalk Bay, St Helena	*Jasus lalandii*
Crustacean trawl	East Coast	Durban, Richards Bay	Tiger prawn (*Panaeus monodon*), white prawn (*Fenneropenaeus indicus*), brown prawn (*Metapenaeus monoceros*), pink prawn (*Haliporoides triarthrus*)
Squid jig	South Coast	Port Elizabeth, Port St Francis	Squid/chokka (*Loligo reynaudii)*
Gillnet	West Coast	False Bay to Port Nolloth	Mullet / harders (*Liza richardsonii*)
Beach seine	West, South, East Coast	Coastal/Nearshore	Mullet / harders (*Liza richardsonii*)
Oysters	South, East Coast	Coastal/Nearshore	Cape rock oyster (*Striostrea margaritaceae*)
Seaweeds	West, South, East	Coastal/Nearshore	Beach-cast seaweeds (kelp, *Gelidium* spp. *Gracilaria)*
Abalone	West Coast	Coastal/Nearshore	*Haliotis midae*
Small-scale fisheries	**West, South, East**	**Coastal/Nearshore**	Various

In South Africa, all fishing-related activities, including the processing, sale and trade of marine resources, are regulated under the Marine Living Resources Act No 18 of 1998 and the Marine Living Resources Amendment Act no 5 of 2014. This legislation provides the foundational legal structure for managing and conserving South African marine resources, ensuring their sustainable use while safeguarding marine ecosystems against harmful human activities. The DFFE is tasked with overseeing and enforcing these regulations to prevent environmental damage and to promote the long-term sustainability of the country's fisheries industry. Its responsibilities include allocating fishing rights, establishing sustainable limits for Total Allowable Catch (TAC) and Total Allowable Effort (TAE), and developing and revising Operational Management Procedures (OMPs) designed to address changes in fish populations.

2.2 Fish and fisheries in the area of interest

Both the small pelagic fisheries and the hake fisheries operate south of Boegoebaai, with the demersal hake longline, large pelagic longline and demersal trawl fisheries operating further offshore. Figure 3 shows the fishing intensity in the EEZ of South Africa for selected fisheries (i.e., trawl, hake longline, small pelagics, pelagic longline, tuna pole, linefish, net fish, kelp harvesting, West Coast Rock Lobster) important to the area of interest, along the west and south western coasts.

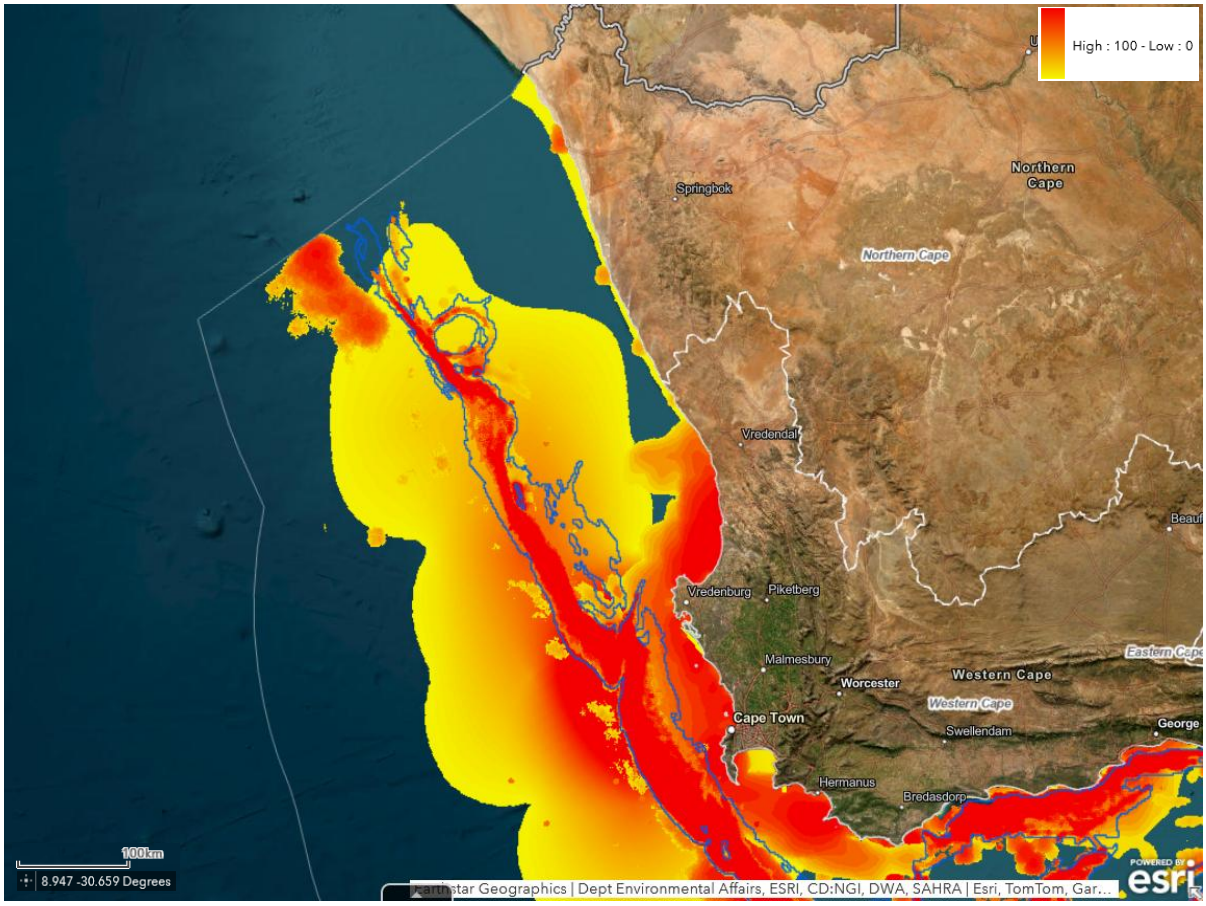


Figure 3. Fishing intensity of fisheries (trawl, hake longline, small pelagics, pelagic longline, tuna pole, linefish, net fish, kelp harvesting, West Coast Rock Lobster) with a focus on the west coast of South Africa (extracted from Coastal Viewer (DFFE, 2024))

Importantly, the area between St Helena Bay and the Orange River is an important nursery ground and the main area for recruitment of all small pelagic species on the Southern African coastal shelf (Hutchings *et al.*, 2002; Coetzee *et al.*, 2008). Therefore, the small pelagic fisheries of South Africa may be adversely affected by the development. Thus, the Boegoebaai development may have potential impacts on the pelagic fishing fleet further south. The same caution applies to the commercial hake fisheries as the coastal area around Boegoebaai serves as nursery grounds for these species (Hutchings *et al.*, 2002;

Grüss *et al.*, 2016). The area north of Port Nolloth is also known to have a high average density (kg nautical-mile-2) of shallow water hake (*Merluccius capensis*) (DFFE, 2023a).

2.2.1 Stock distribution, spawning and recruitment of fisheries of interest

Spawning, the process through which fish release and fertilize eggs, is essential for sustaining and replenishing fish populations. Environmental factors such as water temperature, light intensity, and ocean currents significantly influence when and where spawning occurs for many fish species. Recruitment refers to the stage when juvenile fish grow and eventually integrate into the adult population. This developmental phase is crucial in the fish life cycle, as the survival and maturation of juveniles directly affect the overall health and stability of fish populations. The South African coastline is dominated by seasonally variable and sometimes strong currents and most species have evolved highly selective reproductive patterns to ensure that eggs and larvae can enter suitable nursery grounds situated along the coastline. Coastal oceanographic dynamics in southern Africa, including eddies, filaments, retroflections, and offshore Ekman transport, often lead to the dispersal and loss of nutrient-rich shelf waters to the open ocean. These processes create challenges for the retention of planktonic eggs and larvae produced by broadcast spawners, thereby limiting successful spawning outcomes, despite the region's wide shelf edge and productive waters (Fowler and Boyd, 1998; Huggett *et al.*, 1998; Roy and Fréon, 2001, p 200; Hutchings *et al.*, 2002; Sink *et al.*, 2019). Consequently, many fish species in this area have evolved specific reproductive strategies to ensure that larvae remain in or return to coastal nursery grounds.

The inshore waters along South Africa's West coast serve as vital nursery areas for numerous pelagic and demersal fish species. While the central Namibian shelf also functions as a nursery ground, its importance is considered less critical. Additional nursery grounds in South Africa include the Natal Bight on the East Coast and the Agulhas Bank on the South Coast. Each of these nursery areas is closely associated with a corresponding spawning region, as well as mechanisms for transport, recirculation, and nutrient-rich upwelling along the coast or at the shelf edge (Hutchings *et al.*, 2002, 2009).

Figure 4 highlights the main reproductive habitats of southern African fisheries. Species such as hake, sardine, anchovy, and horse mackerel are broadcast spawners that release large quantities of eggs, which are then dispersed by ocean currents (Hutchings *et al.*, 2002). These species primarily spawn on the central and western Agulhas Bank. Coastal upwelling and the north-eastward flow of surface waters create a coastal jet current originating from the Agulhas Bank and extending along the West coast. This current is instrumental in transporting eggs and larvae to nursery areas along the West coast. At Cape Columbine, the jet diverges, forming offshore, alongshore, and inshore flow components (Hutchings *et al.*, 2002, 2009). Importantly, the coast immediately adjacent to the area of interest serve as important nursery grounds for commercially important west coast fisheries (Hutchings *et al.*, 2002, 2009). Any seaward disturbance in this area will likely have a large negative impact on these nursery grounds (L. Shannon, pers. comm.).

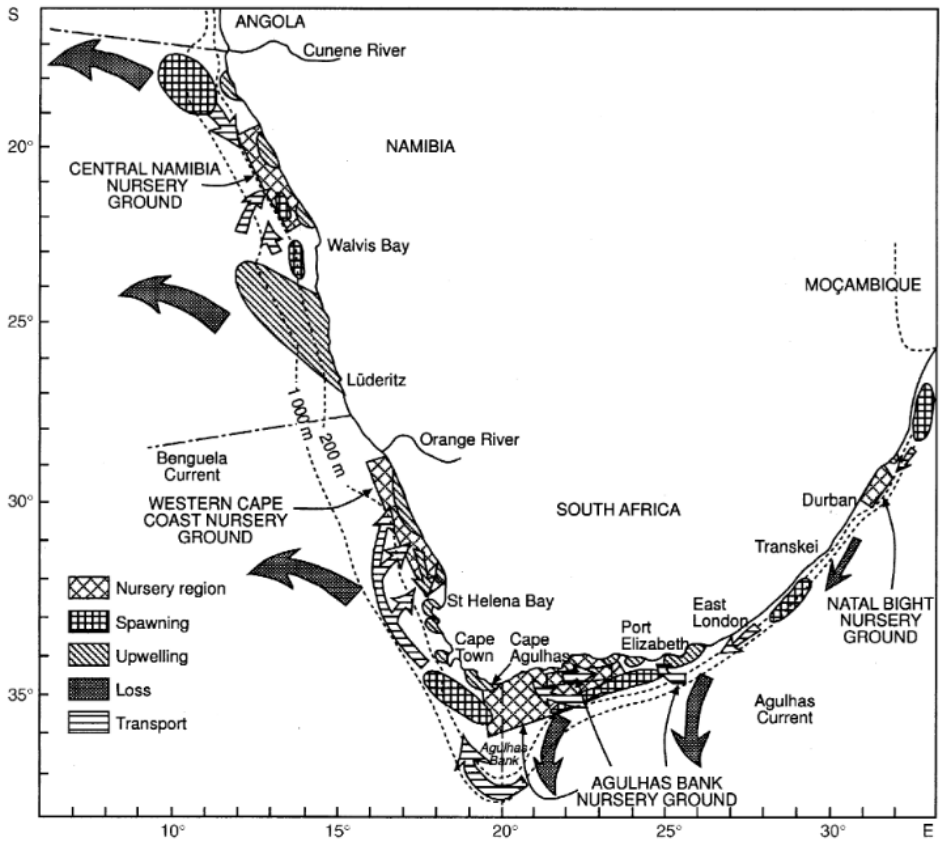


Figure 4. Spawning, transport and nursery grounds for pelagic fish in the southern African region. Pelagic fish use strong convergent flow on the western Agulhas Bank and the jet currents outside the upwelling cells to transport eggs and larvae from the Agulhas Bank spawning grounds to the west coast nursery grounds (Hutchings et al., 2002)

Sardine

Sardines *(Sardinops sagax*) inhabit coastal waters within the 200 m isobath along most of South Africa's coastline. They display a complex population structure, characterized by prolonged spawning periods, diverse reproductive strategies, and various recruitment mechanisms (Mhlongo *et al.*, 2015). Sardine populations in South Africa are thought to consist of multiple groups: those originating from the cool-temperate West coast, the warm-temperate South Coast, and a mixed-origin group (Teske *et al.*, 2021). Sardines from the West coast breed and recruit within that region throughout the year, with peak spawning activity occurring from August to March (McGrath *et al.*, 2020).

Some eggs spawned on the South Coast are carried by coastal currents to nursery grounds on the West coast, where they contribute to recruitment (McGrath *et al.*, 2020). Juvenile sardines originating from the South Coast migrate back to their region to spawn, while juveniles from the West coast move to the South-East Coast between June and November. This seasonal migration is popularly known as the "sardine run" (Sink *et al.*, 2019).

Anchovy

Anchovies (*Engraulis capensis*) share a distribution pattern similar to sardines, mainly occupying the continental shelf. In the southern Benguela system, anchovies migrate from nursery areas to more stable spawning grounds on the Agulhas Bank between July and September. Spawning occurs throughout the Agulhas Bank from October to March, with peak activity during the mid-summer upwelling season (November–December (van der Lingen and Huggett, 2003).

Occasionally, spawning extends to the West coast when warm waters from the Agulhas Bank flow past Cape Point. Since 1994, a noticeable shift in spawning distribution has been observed, with anchovy increasingly favouring the east-central Agulhas Bank (van der Lingen *et al.*, 2001; Roy *et al.*, 2007). Similar

to sardines, coastal jet currents transport anchovy eggs and larvae to West coast nursery areas, where juveniles eventually settle.

Cape Horse Mackerel

Cape horse mackerel (*Trachurus trachurus capensis*) are distributed along the West coast, across the Agulhas Bank, and as far east as Gqeberha, within the 500 m isobath. They spawn intermittently year-round, with two main periods of heightened activity occurring from May to August and October to January (Barange *et al.*, 1998). The South African stock spawns predominantly on the Agulhas Bank, with eggs either remaining inshore on the western Agulhas Bank or transported to nursery grounds on the West coast, where recruitment is most successful. Juveniles are typically found inshore, while adults migrate offshore as they mature, becoming more demersal.

During winter, adult horse mackerel in the West coast region move closer inshore and southward toward the Agulhas Bank for spawning. Horse mackerel form large shoals and exhibit diurnal vertical migration, remaining near the seabed during the day and ascending the water column at night to feed on zooplankton.

Hake

Shallow-water hake (*Merluccius capensis*) and deep-water hake (*Merluccius paradoxus*) are the dominant demersal species in the Benguela Current ecosystem and form the backbone of South African and Namibian fisheries. Both species migrate vertically, inhabiting demersal zones during the day and mid-water at night to feed. Spawning patterns differ between the two, influenced by depth, food availability, and environmental conditions. Hake are serial spawners, reproducing year-round, with peak activity occurring in October/November and March/April (Jansen *et al.*, 2015). Unlike pelagic species, hake eggs and larvae are found in deeper waters, reducing their susceptibility to offshore Ekman transport (Hutchings *et al.*, 2002).

Shallow-water hake are most abundant between depths of 100 m and 450 m, while deep-water hake inhabit depths of 300–1,000 m. Shallow-water hake primarily spawn on the continental shelf in South Africa and Namibia, with significant concentrations reported on the mid-shelf near Cape Columbine and the western Agulhas Bank (Jansen *et al.*, 2015). In Namibia, spawning occurs between 25°S and 20°S, peaking along the shelf break between July and September.

Deep-water hake primarily spawn between the western Agulhas Bank and Elands Bay, with their main nursery ground situated between Hondeklip Bay and the northern tip of the Orange Banks (Strømme *et al.*, 2016). As they mature, fish migrate northward into Namibia before returning south to spawn. Deep-water hake typically spawn at depths of 200–650 m, with eggs distributed between 340–1,500 m (Stenevik *et al.*, 2008). Unlike shallow-water hake, studies suggest that deep-water hake do not spawn in Namibian waters (Kainge *et al.*, 2007; Stenevik *et al.*, 2008; Strømme *et al.*, 2016)

Snoek

Snoek (*Thyrsites atun*) are distributed along South Africa's West and South Coasts, including the Agulhas Bank. They inhabit shallow waters, coastal shelves, and depths up to 500 m, as well as areas near seamounts. Snoek are predators of small pelagic species like anchovy and sardine, exerting a top-down influence on these prey populations and, consequently, on zooplankton dynamics. The species is targeted year-round by traditional linefish and small-scale fishers, with peak activity occurring during their seasonal inshore migration from April to July, colloquially referred to as the "snoek run." During this migration, snoek availability increases due to the recruitment of sardine and anchovy. Additionally, snoek is caught by demersal trawl fisheries in winter when they move further offshore for spawning, and by tuna-pole vessels during periods of low albacore tuna availability.

Spawning occurs along the shelf break at depths of 150–400 m, particularly on the western Agulhas Bank and the West coast, between June and October (Griffiths, 2002). Research indicates behavioural differences between females on the West coast and those on the western Agulhas Bank; West coast females are believed to move inshore to feed between spawning events, whereas females on the Agulhas Bank remain in offshore spawning grounds, likely due to greater prey abundance in that area (Griffiths, 2002).

Ocean currents transport snoek eggs and larvae to nursery areas, with the primary grounds located north of Cape Columbine on the West coast and a secondary area east of Danger Point on the South Coast. Juveniles remain in these nursery grounds until reaching maturity, after which their distribution is influenced by prey availability.

Large Pelagic Species

Large pelagic species, such as albacore tuna (*Thunnus alalunga*), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*), pelagic sharks, and swordfish (*Xiphias gladius*), are widely distributed along the offshore waters of South Africa. Albacore tuna are primarily targeted by the tuna-pole fishery, whereas bigeye and yellowfin tuna are key species for the longline fishery. The availability of these species varies seasonally, influencing catch volumes. For instance, the tuna-pole fishery experiences peak availability of albacore tuna from late summer to early autumn.

- **Albacore tuna** prefer subtropical waters with temperatures ranging between 16°C and 20°C, though their distribution varies based on life stage. Spawning occurs in equatorial regions where water temperatures exceed 24°C (Manning, 1998). Significant aggregations of albacore tuna are observed near the Tripp Seamount, located approximately 10 km south of the license block, which is a high-catch area for this species.

- **Bigeye tuna** spawn in the east-central Atlantic, north of 5°N, during the warm season when surface water temperatures exceed 24°C, as well as in the Gulf of Guinea (Manning, 1998).

- **Yellowfin tuna** are found between 10°S and 40°S in the South Atlantic. Spawning occurs in the central Atlantic near Brazil during the austral summer (Penney *et al.*, 1992). Juvenile and immature yellowfin tuna are present in the Benguela system year-round. Once mature, they migrate from southern African feeding grounds to spawning areas in the central Atlantic during summer (Crawford *et al.*, 1987).

- **Longfin tuna** availability increases during the summer upwelling season, coinciding with greater biological activity and the abundance of prey such as sardines and anchovies.

- **Swordfish** spawn in warm tropical and subtropical waters but migrate to cooler temperate zones during summer and autumn.

Weather plays a critical role in the operations of tuna fisheries, particularly the tuna-pole and longline sectors. Despite relatively low catch volumes along the West coast of South Africa, the high market value of tuna compensates for the limited availability in these regions (Manning, 1998).

2.2.2 Fishery sectors potentially impacted by the proposed development

Based on the 2018 fishing rights register (DEFF, 2018), Port Nolloth was allocated the following fishing rights: Hake longline, Hake handline, Hake deep-sea trawl, netfish, small pelagics, linefish, west coast rock lobster (WCRL) nearshore, WCRL commercial, and a fish processing facility. In Kleinzee, seaweed harvesting rights were allocated to rightsholders, and in Hondeklipbaai, linefish and WCRL nearshore rights were assigned to rightsholders. Additionally, there is an abalone aquaculture facility in Kleinzee.

Small Pelagic Purse Seine

South Africa's small pelagic purse seine fishery is the largest by volume and ranks as the second most valuable fishery after the demersal trawl sector. This fishery primarily targets sardines and anchovies, which together constitute about 80% of the annual catch. Some rights holders also focus on round herring (redeye) (*Etrumeus whiteheadi*). Additionally, there is incidental bycatch that includes chub mackerel (*Scomber japonicus*) and juvenile horse mackerel. Figure 5 shows the intensity of small pelagic catches in South Africa for 2000-2016.

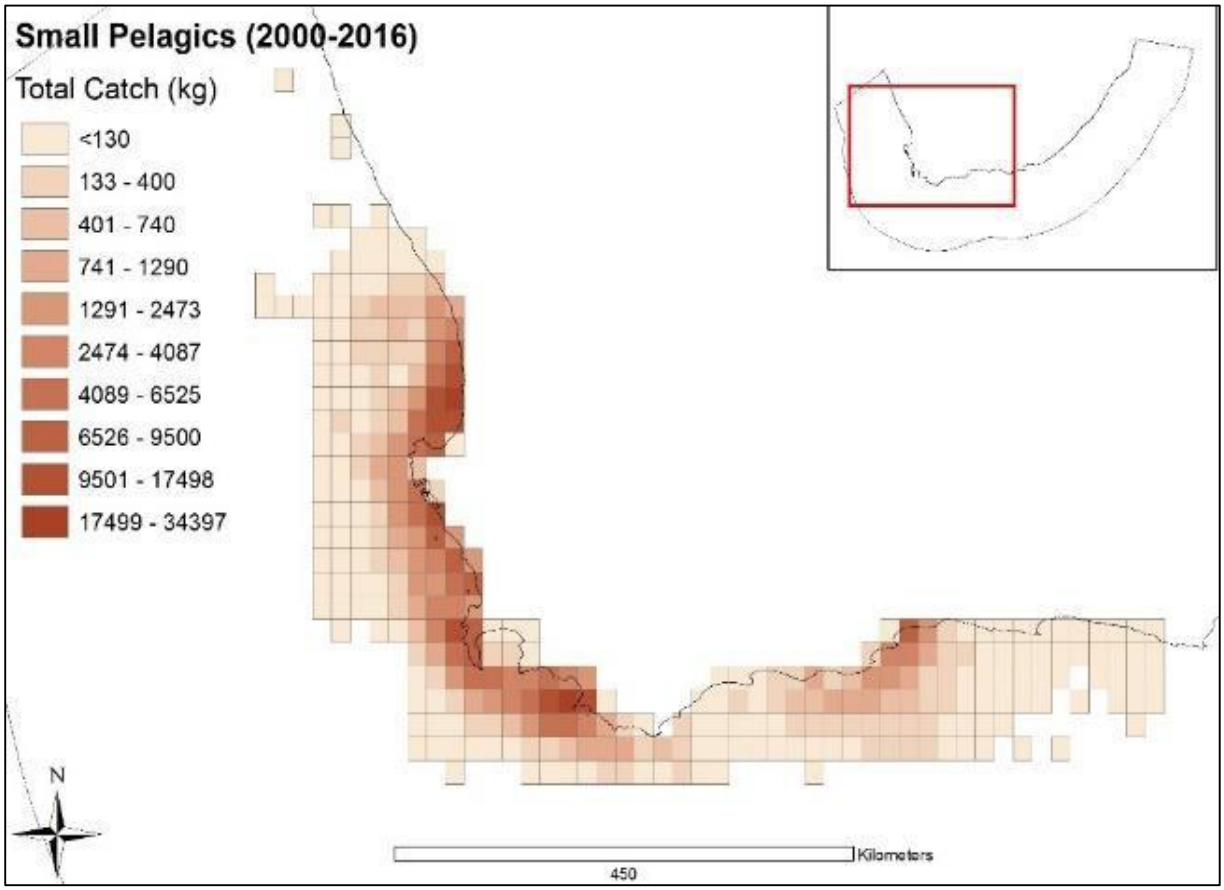


Figure 5. Map of intensity of small pelagic fishery reflecting total catch for period 2000-2016 (Sink et al., 2019)

These species naturally undergo significant fluctuations in abundance and distribution due to environmental variability associated with upwelling, even in the absence of fishing pressures. Long-term shifts in the relative abundance of anchovy and sardine have been observed both locally and globally over decadal and centennial timescales (van der Lingen, 2021; DFFE, 2023a). However, the abundance of sardine has mostly remained below the long-term average and Exceptional Circumstances were declared in December 2018 (Coetzee *et al.*, 2022). From 2016 to 2019, the total combined catch of anchovy, sardine, and round herring landed by the pelagic fishery declined by 45%, dropping from 396,000 tonnes to just 217,000 tonnes. This decrease was primarily due to a substantial reduction in anchovy catches. However, in 2020, anchovy catches rebounded to 285,000 tonnes, elevating the total combined catch of small pelagic fish above the long-term average. Despite setting high TACs for 2021 and 2022, anchovy catches remained low during these years. The average combined catch between 2017 and 2022 was 288,000 tonnes, approximately 45,000 tonnes less than the long-term annual average of 333,000 tonnes recorded from 1949 to 2022 (see Figure 6) (DFFE, 2023a).

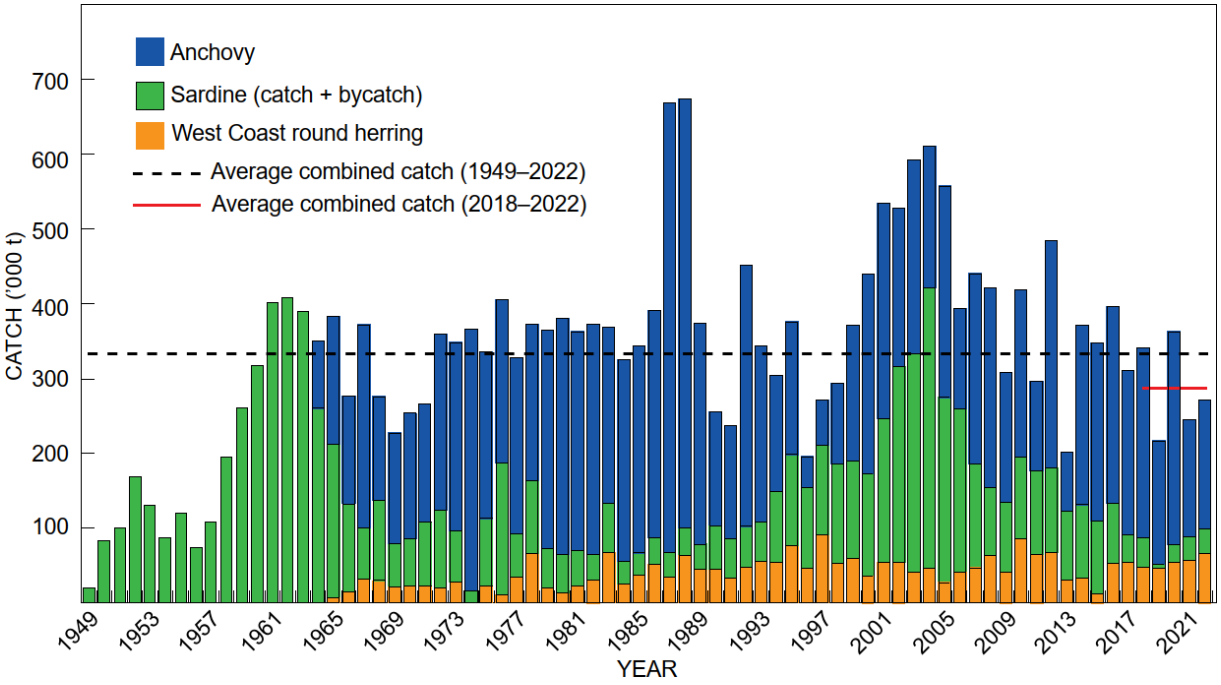


Figure 6. The annual combined catches of anchovy, sardine and round herring by the small pelagic fishery from 1949 to 2022. Also shown is the long-term average combined annual catch (black dashed line) and for the past five years (2018–2022; red solid line) (DFFE, 2023a)

At present, the South African sardine population is considered depleted, with recent pelagic surveys indicating very low biomass estimates. While the 2022 survey showed some signs of recovery, the population remains below the long-term average. In contrast, anchovy and round herring populations are abundant, although the anchovy biomass is significantly lower compared to the peak years of the early 2000s (van der Lingen *et al.*, 2001; DFFE, 2023a).

The fishing fleet comprises approximately 100 vessels ranging from 11 metres to 48 metres in length (McGrath, 2024). Most of these vessels operate along the West and South-West coasts, specifically from St Helena Bay, Laaiplek, Saldanha Bay, and Hout Bay, with a smaller number operating from South Coast harbours such as Gansbaai, Mossel Bay, and Gqeberha. The locations of these ports correspond with the sites of canning factories and fish reduction plants along the coastline.

The sardine-directed fleet concentrates its efforts in a broad area stretching from Lambert's Bay, moving south past Saldanha and Cape Town towards Cape Point, and then eastwards along the coast to Mossel Bay and Gqeberha. The anchovy-directed fishery mainly operates along the South-West coast, from Lambert's Bay to Kleinbaai (near Gansbaai). The intensity of this fishery depends on fish availability and is most active between March and September.

Round herring, a species regulated by a Precautionary Upper Catch Limit (PUCL), is being increasingly targeted in recent years, particularly from January to March, and is distributed from Lambert's Bay to areas south of Cape Point. This fishery can extend further offshore than those focused on sardines and anchovies. Operating throughout the year, the fishery sees increased effort during the winter months and observes a brief seasonal break from mid-December to mid-January. Fishing activities are concentrated inshore, up to a maximum distance of about 100 kilometres from the coast.

While this fishery does not operate within the immediate area of the proposed port development, there is a spatial overlap between the proposed site for the Boegoebaai harbour and support areas for the small pelagic fishery (Hutchings *et al.*, 2002; Grüss *et al.*, 2016). Therefore, the Boegoebaai harbour can potentially harm fisheries by reducing small pelagic stock thereby reducing catch and/or catch per unit effort, increasing costs and decreasing profit for fishing companies. This could have serious implications for coastal communities of South Africa reliant on fish resources, as this will impact businesses and communities involved in fisheries along the entire west coast, from Port Nolloth to Cape Town.

Demersal Trawl

South Africa's demersal trawl fishery is the country's most valuable, accounting for approximately half of the revenue from all commercial fisheries. This fishery is divided into an offshore sector targeting deep-water hake and an inshore sector focusing on shallow-water hake and Agulhas sole (*Austroglossus pectoralis*). By-catch species include various demersal fish, with monkfish (*Lophius vomerinus*), kingklip (*Genypterus capensis*), and snoek being the most commercially significant. Collectively, the inshore and offshore demersal trawl sectors generate catches exceeding R5.2 billion annually (DFFE, 2023a).

The Department of Forestry, Fisheries and the Environment (DFFE) sets a global TAC for both hake species, applied collectively to all hake-directed sectors (DFFE, 2021). Over 80% of this TAC is allocated to the offshore demersal trawl fishery, with the remainder distributed among the inshore trawl fishery, demersal longline, and hake handline sectors. A small portion is deducted to account for incidental hake by-catch in the midwater trawl fishery targeting horse mackerel (see Section 3.3.2). For 2024, the hake TAC has been set at 145,700 tonnes, with PUCL for monkfish and kingklip (significant by-catch species) of 7,875 and 3,733 tonnes, respectively.

The offshore demersal trawl fishery is confined to a designated area known as the "hake trawl ring fence." Established in 2005, this ring fence restricts vessels to regions already impacted by trawling, preventing the expansion of the seabed trawling footprint. Additionally, these vessels are prohibited from operating in waters shallower than 110 metres or within 5 nautical miles of the coast, whichever distance is greater. In contrast, vessels licensed for the inshore fishery on the South Coast typically trawl in waters shallower than 110 metres, though they are not restricted from operating in deeper waters. The ring fence was one of the measures implemented to support the fishery's Marine Stewardship Council (MSC) sustainability certification, first attained in 2004 and successfully renewed twice.

The offshore demersal trawl fleet comprises 61 trawlers (SADSTIA, pers. comm.), including fresh fish trawlers—commonly known as wetfish trawlers—that preserve hake on ice before returning to shore for processing, and freezer vessels that produce frozen headed and gutted hake or sea-frozen fillets. Wetfish vessels range from 24 to 56 metres in length, while freezer vessels are typically larger, ranging from 30 to 90 metres. Freezer vessels can operate in an area for up to a month, whereas wetfish vessels usually remain for about a week before returning to port. These vessels operate from major harbours such as Saldanha Bay, Cape Town, and Gqeberha.

The fishing grounds form an almost continuous band along the shelf edge of the West and South Coasts, between depths of 200 and 1,000 metres, with most effort off the West Coast concentrated between 300 and 800 metres (see Figure 7). Trawl nets are generally towed along depth contours, maintaining a relatively constant depth and running parallel to these contours in a north-westerly or south-easterly direction. Additionally, trawlers target fish aggregations around bathymetric features—particularly seamounts and canyons where there is an increase in seafloor slope—following the depth contours in these areas as well.

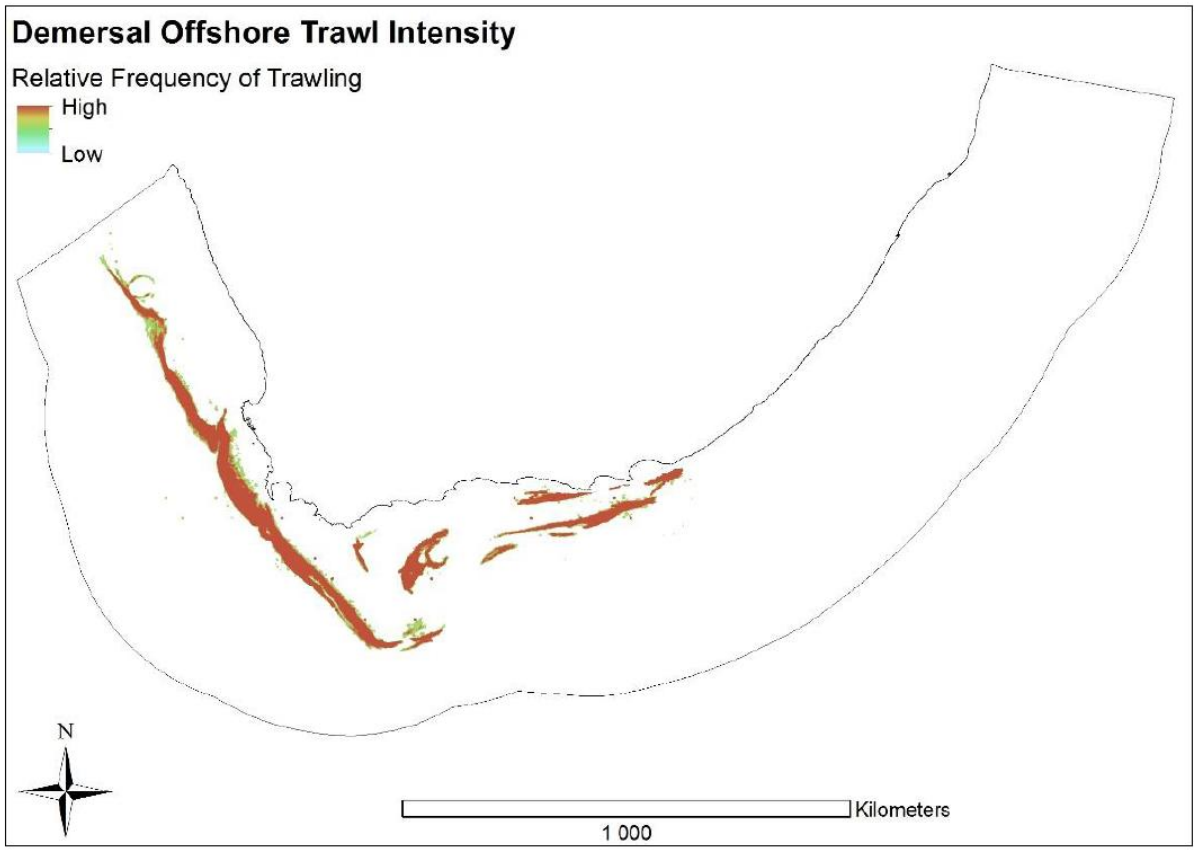


Figure 7. Map illustrating scaled pressure values to reflect fishing effort using frequency of trawling for the offshore demersal trawl sector in South Africa for period 2000-2016 (Sink et al., 2019)

The inshore fishery consists of 26 vessels operating mainly from the harbours of Mossel Bay and Gqeberha on the South Coast (McGrath, 2024). These vessels are smaller and less powerful than those in the offshore trawl fishery, ranging from 14 to 36 metres in length. The inshore fishing grounds are situated on the Agulhas Bank and extend towards the Great Kei River in the east. Vessels target sole close inshore between Struisbaai and Mossel Bay, at depths of 50 to 80 metres. Hake is targeted further offshore in traditional grounds between 100 and 200 metres depth, particularly in an area known as the Blues on the Agulhas Bank.

Hake Demersal Longline

The demersal longline fishery targets bottom-dwelling species, chiefly Cape hakes (both shallow-water and deep-water species), with kingklip frequently caught as bycatch. Fishing operations occur along the West and South-East Coasts, in areas similar to those used by the demersal trawl fishery. As with the offshore trawl sector, vessels are prohibited from operating in waters shallower than 110 metres or within 5 nautical miles of the coastline. An area offshore of Gqeberha, known as the "kingklip box," is closed to fishing from September to November to protect spawning aggregations of kingklip. The hake longline fishery typically accounts for between 5% and 6% of the annual total hake catch, with most catches over the past five years occurring on the West Coast (DFFE, 2021).

Currently, the fishery comprises 109 rights holders who collectively operate between 40 and 50 vessels. The majority of these are wetfish vessels, which remain at sea for approximately six days before returning to port, with their catch preserved on ice. Vessels operate from all major harbours, including Cape Town, Hout Bay, Mossel Bay, and Gqeberha. Secondary deployment points include St Helena Bay, Saldanha Bay, Hermanus, Gansbaai, Plettenberg Bay, and Cape St Francis. Vessels based in Cape Town and Hout Bay operate almost exclusively on the West Coast (west of 20° E).

i) Linefish

Linefishing, which involves capturing fish using hook and line, boasts a long history in South Africa dating back to the 1500s (DAFF, 2016). Key species targeted on the West coast include snoek, yellowtail (*Seriola lalandi*), Cape bream (*Pachymetopon blochii*), geelbek (*Atractoscion aequidens*), and dusky kob (*Argyrosomus japonicus*). These species possess varied life-histories which can make them vulnerable to overexploitation. Effort in linefishing along the Cape increased substantially during the 20th century, peaking during the 1980s and 1990s. This growth was driven by expanded fishing ranges, technological advancements, and the emergence of other fishing sectors. Overfishing of many stocks led to a linefish emergency being declared in 2000 which resulted in restrictions on both effort and target species (DFFE, 2023a). The traditional linefish fishery, also referred to as the commercial linefish fishery, ranks as the third most important fishery in South Africa in terms of both landed tonnage and economic contribution. The value of this fishery was estimated at R105.5 million in 2022 (McGrath, 2024)

The sector is regulated through a TAE allocating rights for boats. Since 2006, the TAE has been capped at 455 vessels across three management zones: Zone A (Port Nolloth to Cape Infanta), Zone B (Cape Infanta to Port St. Johns), and Zone C (KwaZulu-Natal) (DFFE, 2023b). Most of the national catch is attributed to Zone A's commercial fishery. Following the 2022 Fishing Rights Allocation Process (FRAP), 281 vessels in Zone A were allocated to the commercial linefishery, leaving 59 vessels allocated to the small-scale sector (DFFE, 2023b).

A significant proportion of small-scale fishers in South Africa target linefish. In line with the Small-scale fisheries policy, 172 small-scale fishing cooperatives were formed and granted 15-year fishing rights in the Western Cape, Northern Cape, Eastern Cape, and KwaZulu-Natal provinces. Many of the species included in the small-scale fishing basket overlap with those targeted by commercial and recreational linefish sectors, potentially increasing pressure on these stocks.

Linefishing occurs throughout the year, but catches are seasonal. The availability of species such as snoek and yellowtail inshore influence their annual catch, resulting in significant variability. Inter-fishery competition exists for these species, which are also harvested by the tuna pole fishery (snoek and yellowtail), the trawl fishery (snoek), and the beach seine-net fishery (yellowtail).

The linefishery is entirely boat-based, utilising vessels ranging from 4.5 m to 11 m in length. These boats are classified by operational categories, with offshore ranges restricted to a maximum of 40 nautical miles (75 km). However, most fishing activity takes place within 15 km of the coastline. Figure 8 shows the intensity of commercial linefishing in South Africa for 2000-2016.

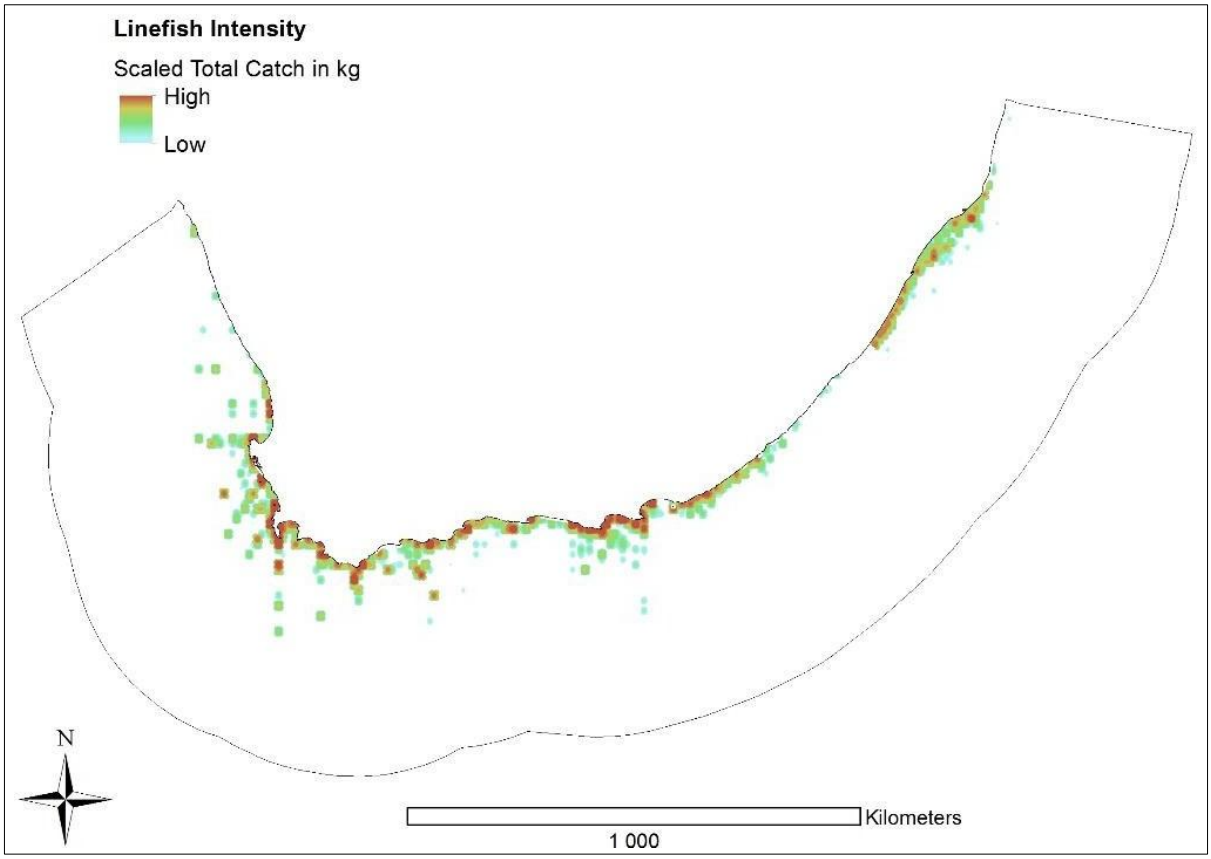


Figure 8. Map of intensity of commercial linefishing in South Africa for period 2000-2016, displayed as scaled total catch in kilograms (Sink et al., 2019)

The main linefish species targeted in the northern cape is snoek with possibly also Cape seabream, geelbek, kob and yellowtail (Japp and Wilkinson, 2021). Linefish fisheries operate inshore near small harbours. In the study area the fisheries operate from Port Nolloth to Hondeklipbaai (Capmarine, 2017). The snoek fishery is seasonal and during the off seasons fishers may target other species such as WCRL (Isaacs, 2013).

West coast rock lobster (WCRL)

The West coast rock lobster (*Jasus lalandii*) fishery is an essential component of South Africa's fishing industry, valued both for its significant market demand and for the livelihoods it supports in coastal communities. The WCRL fishery is commercially the third most valuable fishery in South Africa due to its high market value (more than R500 million per annum) and its importance in providing direct and indirect employment to ~4 300 sea- and land-based jobs. It is especially important for impoverished communities along the entire West coast (Eggers *et al.*, 2022; DFFE, 2023a).

Despite its importance, the resource is critically overexploited and heavily depleted, facing significant pressure from both legal and illegal (poaching) activities (DFFE, 2023a). For the 2023/24 fishing season, the TAC was reduced by 16.43% from the previous season, amounting to 460 tons. Management of the resource is geographically structured, with TACs determined annually for specific management zones. The TAC is further divided into five distinct subsectors: commercial offshore, commercial nearshore, recreational, small-scale nearshore (including subsistence), and small-scale offshore (see Figure 9). Both the commercial and small-scale sectors are permitted to fish for four months in each management zone, with closed seasons imposed on a zone-by-zone basis. Due to differences in stock abundances and fishing pressures, WCRL is managed in five (5) super areas that consist of 14 different fishing areas within six zones. The proposed development falls within management area zone A area 1.

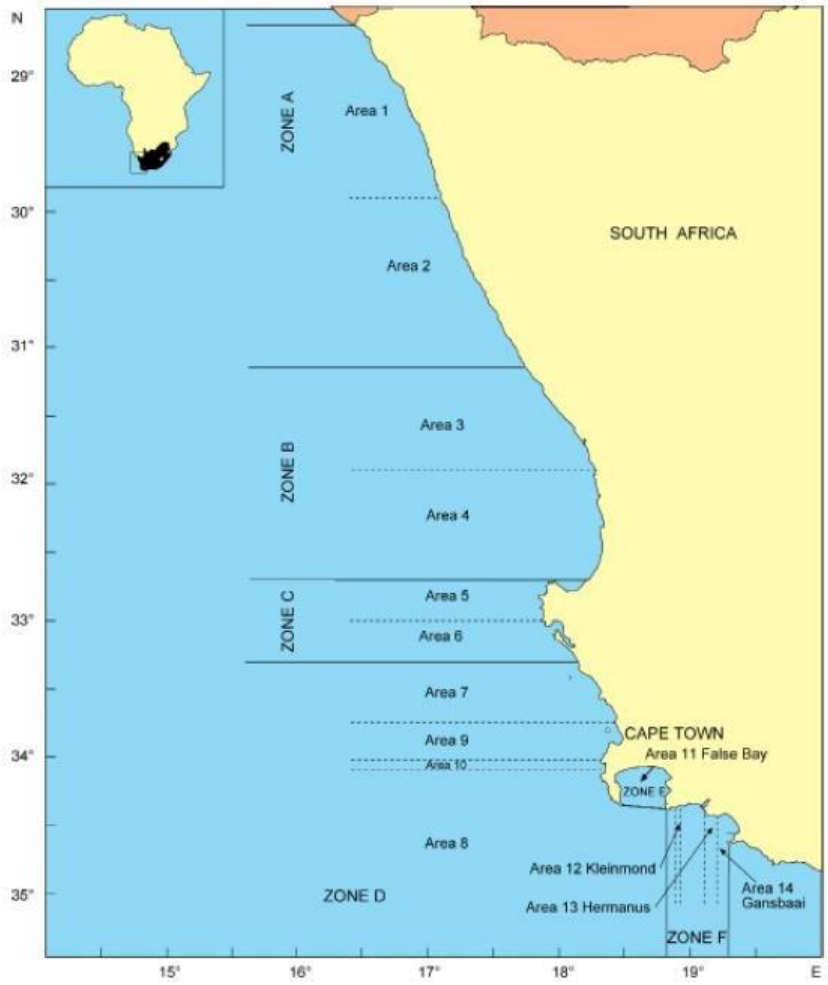


Figure 9. Map of fishing areas for West coast Rock Lobster (DAFF, 2016)

The commercial offshore sector operates at depths ranging from 30 m to 100 m, utilising traps made from rectangular metal frames covered with netting. These traps are typically deployed at dusk and retrieved early the next morning, with approximately 138 vessels participating in this sector. The commercial nearshore sector employs hoop nets to capture lobsters in specific reef areas located at depths of 15–30 m. Figure 10 shows the fishing effort using the total annual catch per square kilometre.

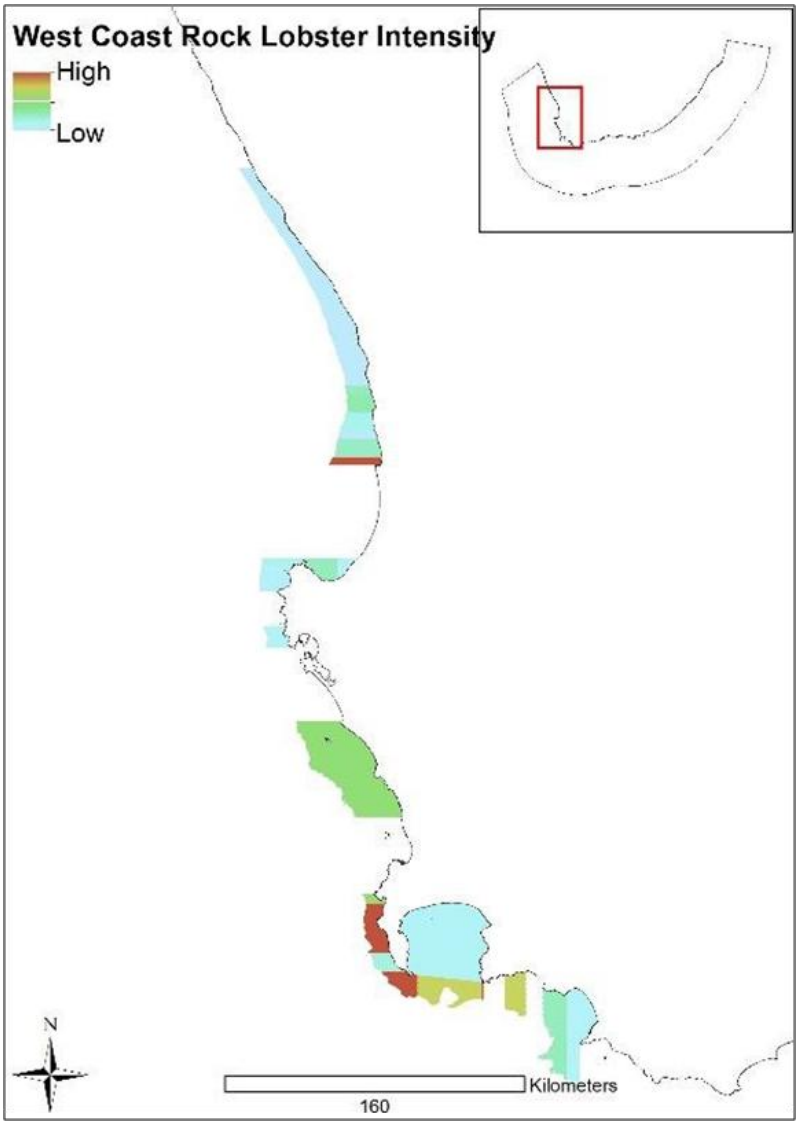


Figure 10. Map of West coast Rock Lobster fishing effort using the annual average total catch per square kilometre (Sink et al., 2019)

Most of these boats operate within a few nautical miles of the harbours, with only 30% of them being deployed from larger deck boats. As a result, WCRL fishing tends to be concentrated close to the shore, within a few nautical miles of Port Nolloth and Hondeklipbaai (Capmarine, 2017). WCRL fishing operates from just south of Alexander Bay to just north of Kleinzee and thus overlaps with almost the entire Northern Cape coastline (Capmarine, 2017).

Tuna pole fishery

The South African tuna pole fishery targets juvenile and sub-adult albacore tuna (*Thunnus alalunga*), also known as southern Atlantic longfin tuna. Other species caught include yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*), and skipjack tuna (*Katsuwonus pelamis*). The fishery largely operates off the west coast of South Africa from just south of Alexander Bay (particularly between 29° and 32°S), on the shelf break and beyond the 200m isobath. Most vessels are between 10 and 20 metres in length and lack freezing facilities, so fishing trips usually last up to a week. Larger vessels equipped with freezers can remain at sea for longer periods—over three weeks—and reach more distant fishing grounds. This fishery is seasonal, with vessels operating mainly from November to May, and peak catches occurring between November and January.

Due to the seasonal availability of tuna in South African waters, the tuna pole fishery opportunistically supplements its catches with snoek and yellowtail from inshore waters shallower than 100 metres. The yellowtail catch is regulated by a bag limit of 10 fish per person per trip, and all non-tuna species are designated as bycatch (DFFE, 2023a). Unlike the pelagic longline fishery, tuna pole vessels are prohibited from retaining any incidental catches of swordfish, billfish, or sharks.

Initially managed under the linefishery, this sector has been recognised as a separate fishery since 2003. The DFFE manages it through a TAE system. Following the most recent Fishing Rights Allocation Process (FRAP 2021/22), 150 vessels have been allocated fishing rights for 15 years (DFFE, 2023a). South Africa's membership in three tuna-focused Regional Fisheries Management Organisations (RFMOs) ensures that this fishery complies with their conservation and management measures.

The active fleet consists of approximately 90 vessels based in the ports of Cape Town, Hout Bay, and Saldanha Bay. No tuna pole rightsholders are registered in the Northern Cape, although some fishing does take place in the area of interest (see Figure 11). These vessels typically operate within a 100 nautical mile (185 km) radius of these locations, concentrating effort in the Cape Canyon area (south-west of Cape Point) and along the West coast up to the Namibian border.

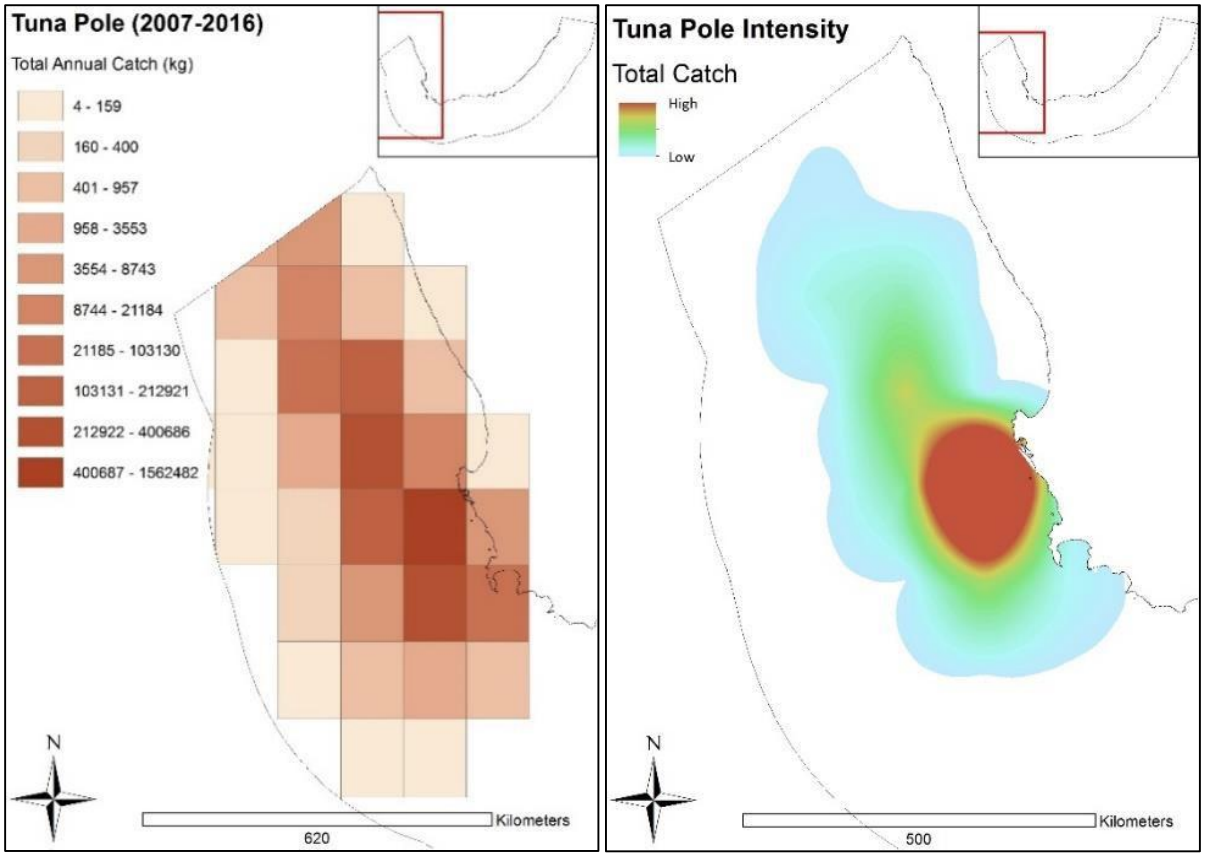


Figure 11. Maps of tuna pole intensity using annual average catch on a one-degree grid (left), and the scaled tuna pole intensity used in the assessment (right) (Sink et al., 2019)

Netfish

Netfishing in South Africa comprises two sectors: beach seining and gillnet fishing (see Figure 12). Beach seine fishing dates back to the mid-1600s and was initially primarily focused on large linefish species. While these activities employ very different fishing methods, they overlap in fishing areas and target species. Fishing rights were issued for 28 beach-seine and 162 gillnet right holders operating on the west coast from Port Nolloth to False Bay, with this area divided into 15 defined zones (DFFE, 2023a). This fishery is regulated through a TAE system, which allocates a fixed number of operators across 15 management zones.

Beach-seining is a labour-intensive fishing method where crews use woven nylon nets to encircle shoals of fish in the surf zone. These nets are then pulled to shore by teams of 6 to 30 individuals, depending on the size of the net and the length of the haul. Net sizes vary from 120 to 275 m in length and are limited to a maximum depth of 10 m.

The gillnet fishery operates along the West coast from Yzerfontein to Port Nolloth. Surface-set gillnets, used to catch mullet, are restricted to dimensions of 75 m in length and 5 m in depth. Bottom-set gillnets, targeting St Joseph sharks, are smaller, with dimensions of 75 m in length and 2.5 m in depth (da Silva *et al.*, 2015). Both types are deployed in shallow waters, at depths of less than 50 m. Figure 12. Map of gillnet (left) and beach seine (right) fishing effort illustrated using the average number of permits per square kilometre (Sink et al., 2019) shows the intensity of effort in both Beach Seine and Gillnet fisheries using the average number of permits per square kilometre.

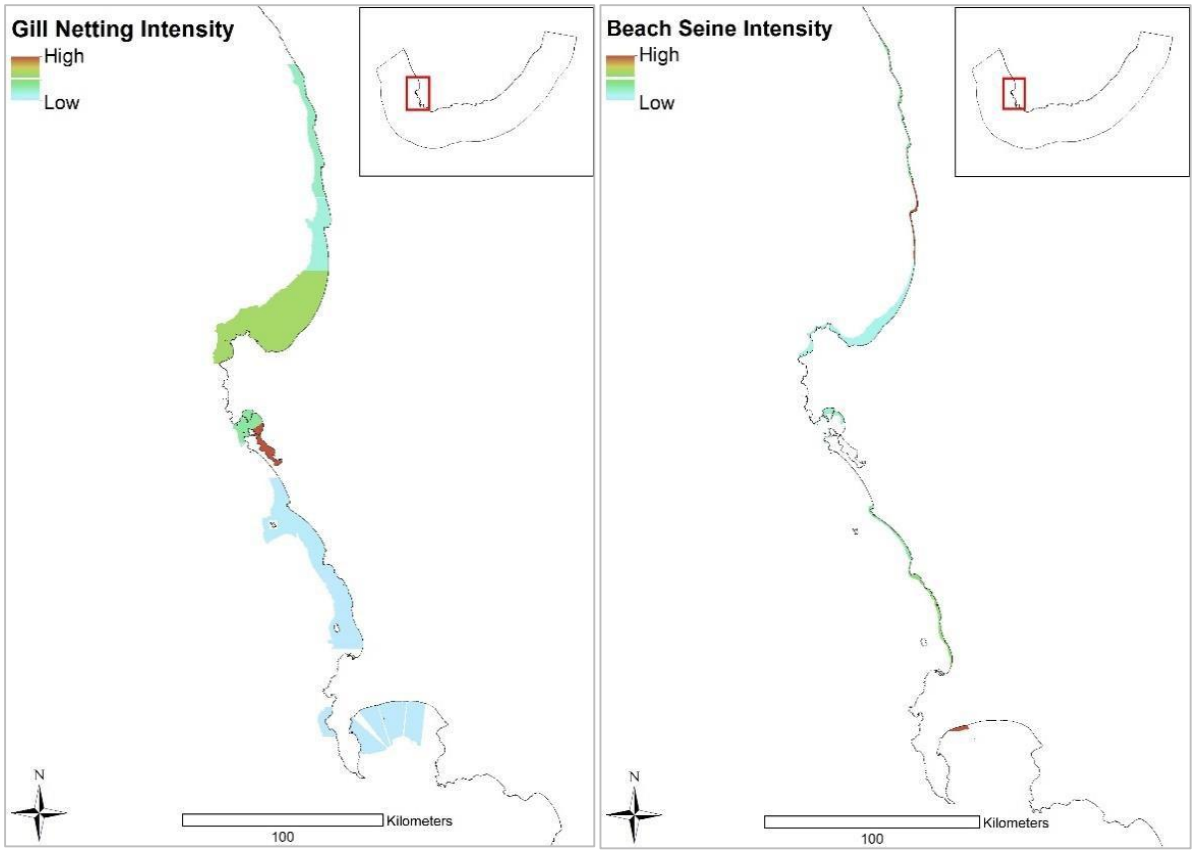


Figure 12. Map of gillnet (left) and beach seine (right) fishing effort illustrated using the average number of permits per square kilometre (Sink et al., 2019)

The main target species for the netfishery in the northern Cape are harders (*Chelon richardsonii*), St Joseph (*Callorhynchus capensis*) and species that appear on the 'bait list0F[3]'. Netfish falls within the small-scale fishery allocation, along with the hake handline, WCRL nearshore and linefish fisheries.

Small-scale fisheries

In South Africa, "small-scale fishing" refers to a variety of fishing activities that rely on low-technology, labour-intensive practices, often involving manually operated artisanal gear. The sector involves various methods targeting more than 30 species (Griffiths and Branch, 1997) across a range of habitats (Branch *et al.*, 2002; Clark *et al.*, 2002). In 2002, the sector was estimated at approximately 30 000 participants (Clark *et al.*, 2002). On the West coast, boat-based harvesting of near-shore subtidal species such as linefish and WCRL is the main activity (Clark *et al.*, 2002). There is significant overlap between small-scale

[3] The following species are classified as bait species according to the DFFE: *Lisa richardsonii*, *Callorhinchus capensis*, as well as *Trachurus trachurus capensis* and may be targeted by the netfishery.

fishing and other sectors, including recreational and commercial fisheries. On the West and South Coasts, communities typically use motorised vessels to gather nearshore resources, whereas intertidal subsistence activities dominate on the East Coast (Clark *et al.*, 2002).

Small Scale Fishers were not defined or provided for in the post-Apartheid fisheries policy framework (Marine Living Resources Act No 18 of 1998; MLRA), leading to more than a decade's legal wrangling to recognise and provide for the sector (Sowman and Sunde, 2021). Legal recognition was achieved through the gazetting of the Small-scale Fisheries Policy (Act No 474 of 2012) and the ensuing MLRA amendment (RSA, 2014).

Official recognition of the sector came with the establishment of fishing cooperatives across the four coastal provinces, a process completed in November 2023. The sector is governed through a community-based co-management system, involving these cooperatives. One of the primary goals of the small-scale fisheries framework is to provide redress for historically disadvantaged fishing communities affected by political, economic, or industrial developments in larger-scale fisheries. Applicants for small-scale fishing rights must demonstrate historical involvement in traditional fishing and a reliance on such activities for their primary livelihood. Key challenges in implementing the policy include overlaps with existing fisheries, stock assessments, catch monitoring, and ensuring compliance with regulations (DFFE, 2023a).

Two community cooperatives, comprising 103 fishers, were successfully established in the Northern Cape - the Aukotowa primary cooperative in Port Nolloth and the Longtime Hondeklipbaai fishing cooperative in Hondeklipbaai, and were awarded 15-year fishing rights. Similarly, 62 cooperatives in the Western Cape, encompassing 3,850 fishers, received 15-year rights.

The small-scale fisheries framework adopts a multi-species approach to allocating rights, granting access to a basket of species within designated areas. Cooperatives are restricted to species present in their local vicinity. Basket Area A stretching from the Namibian border to Cape of Good Hope, has 61 species (see Figure 13). When cooperatives target commercial species, their efforts and catches are regulated within the TAE and TAC limits for those species. For example, 77 linefish vessels were allocated to the small-scale sector from the total TAE of 455 vessels under the 2021/22 traditional commercial linefish allocation (DFFE, 2023a).

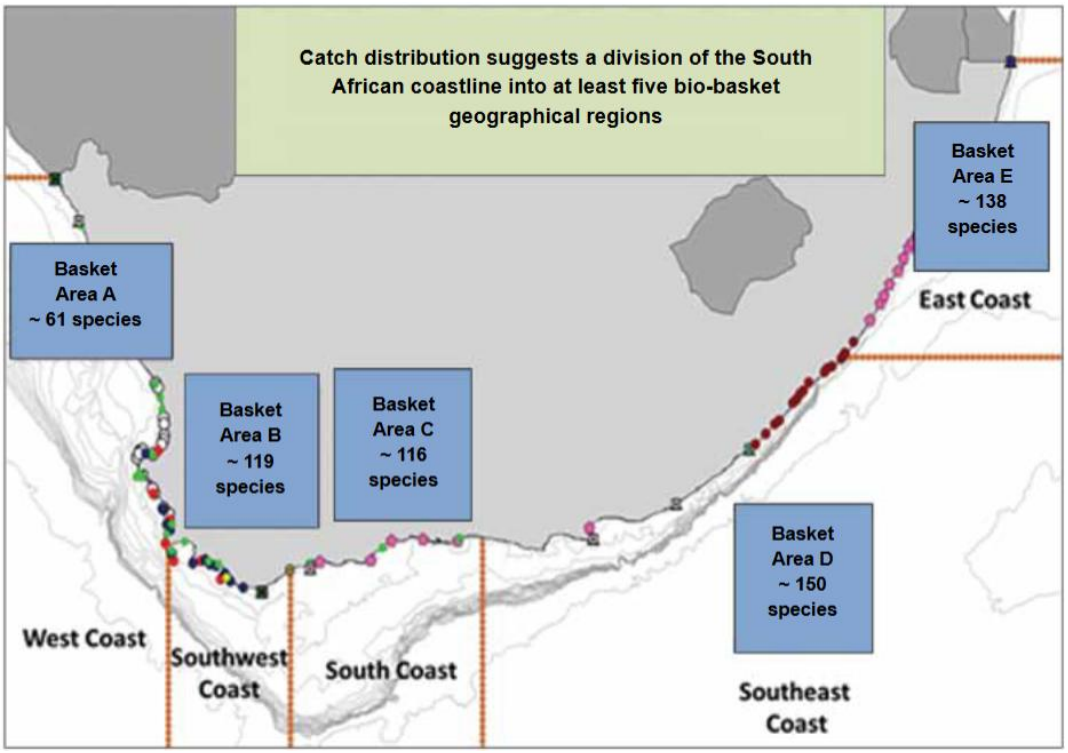


Figure 13. The number of species available to small-scale fishers in each of five Basket Areas on the South African coast. The coloured dots show the locations of identified small-scale fishing communities (DFFE, 2023a)

In the Northern Cape and Western Cape, small-scale fishers primarily engage in traditional linefishing, WCRL, and abalone fisheries. Nearshore species targeted by small-scale fishers on the West and South-West coasts include snoek, Cape bream, and yellowtail. Snoek, in particular, is a primary target during its seasonal migration from April to June, when it forms nearshore shoals and can be caught using handlines. Fishers also utilise hoop nets from small "bakkies[4]" to harvest WCRL on reefs at depths of less than 30 meters. Larger vessels in the commercial rock lobster fishery target depths of up to 100 meters. Wild abalone harvesting is typically conducted along the West coast at depths of up to 20 meters.

Recreational Fishing

Recreational fishing, defined as non-commercial and not-for-profit activity, is widespread along the coast and varies based on the size of the vessels used. This form of fishing encompasses elements of many commercial fisheries, including species such as linefish, West and East Coast lobsters, squid, abalone, crabs, spearfishing targets, and numerous others. Recreational anglers are required to obtain permits and must comply with restrictions on the quantity they can catch, which are regulated both seasonally and per individual fishing trip. Marine recreational fishers tend to use similar gear and target species as their commercial counterparts. Owing to the lack of catch and effort data for recreational boat-based fishing, the pressure data for the commercial linefishery is used as a proxy for recreational activities. The operation of small recreational or pleasure vessels offshore is constrained by their certification categories.

Aquaculture

There were approximately 44 operational marine aquaculture farms in South Africa in 2021, where the Western Cape Province has most of the marine aquaculture farms accounting for 77% of South African marine farms, followed by the Eastern Cape accounting for 12%, the Northern Cape accounting for 9%, and Kwa-Zulu Natal accounting for 2% (DFFE, 2022). The main marine aquaculture species cultured at commercial scale in South Africa include abalone (*Haliotis midae*), pacific oyster (*Crassostrea gigas*), mussels (*Mytilus galloprovincialis* and *Choromytilus meridionalis*), dusky kob (*Argyrosomus japonicas*), East Coast Rock Lobster (*Panulirus homarus*) and seaweed (*Ulva spp and Gracilaria spp*) (DFFE, 2022). The marine aquaculture industry has seen significant growth in South Africa in recent years – predominately in the Western Cape Province. In the Northern Cape, there were four abalone farms and one oyster facility in 2022. It is important to note that aquaculture has the potential to create more jobs compared to traditional fisheries (Britz *et al.*, 2000).

While abalone cultivation has traditionally been onshore, abalone ranching presents more cost-effective opportunities for production (Troell *et al.*, 2006). Abalone ranching involves stocking hatchery-produced seed into kelp beds outside the natural distribution area of abalone to harvest when grown (Troell *et al.*, 2006). Port Nolloth Sea Farms pioneered abalone ranching in 2000. The practice expanded in the area in 2013 when the then Department of Agriculture, Forestry and Fisheries (DAFF) issued rights for each of the four Concession Area Zones, starting just south of Alexander Bay to south of Kleinzee and overlapping with the Boegoebaai development area (Capmarine, 2017). Furthermore, the introduction of kelp as abalone feed has led to the creation of new job opportunities, with approximately 5000 tons of fresh kelp being harvested annually for abalone feed (Troell *et al.*, 2006; Capmarine, 2017).

Seaweed harvesting

The South African seaweed industry primarily targets kelps (*Ecklonia maxima* and *Laminaria pallida*) and red seaweed (*Gelidium spp.*), with most activities concentrated in the Northern and Western Cape regions. The seaweed industry directly employs around 400 people (Troell *et al.*, 2006; Capmarine, 2017). Harvesting involves collecting beach-cast material as well as cutting fresh kelps (Capmarine, 2017). The coastline stretching from Port Nolloth to Port St. Johns is divided into 23 designated harvesting areas, with 14 commercial seaweed harvesting rights allocated, allowing one right-holder per seaweed type within each area.

The harvesting zones between Doringbaai and Langebaan on the West coast are the most productive, contributing 98.5% of the national kelp harvest between 2000 and 2017. In 2021, the commercial seaweed sector recorded an annual yield of 5,233 tonnes (DFFE, 2023a).

[4] A traditional style of small fishing boat (i.e., two-people boats running on a motor or being rowed) with the colloquial name originating on the west coast of South Africa.

Although the only rights holder for seaweed harvesting in the Northern Cape is in Kleinzee, seaweed is harvested along the entire Northern Cape coast. The total prescribed maximum sustainable yield (MSY), as set out in annual permit conditions, for the Northern Cape (Rights holder zones 13-19) for the 2023/2024 season, is 7246 tons of whole kelp and 3624 tons of kelp fronds. Boegoebaai falls within rights holder zone 19, for which the prescribed MSY is 765 tons of whole kelp and 383 tons of kelp fronds (DFFE, 2023a).

2.3 Summary

Below provides a summary of the seasonality and relative intensity of fishing effort of each of the main commercial fishing sectors that operate off the west coast of South Africa (see Table 7).

Table 7: Seasonality of fishing intensity expended by fisheries operating on the West coast (adapted from McGrath (2024))

Fishery	Targeted Species	Fishing Intensity on the West coast											
Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Small pelagic purse-seine	Sardine, anchovy, round herring	M	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	M
Tuna pole	Albacore, snoek	**H**	**H**	**H**	**H**	**H**	M	M	M	M	M	**H**	**H**
Traditional Linefish	Snoek, Cape bream, geelbek, kob, yellowtail	**H**	M	M	M	M	M	M	M	M	M	M	**H**
West coast rock lobster	West coast rock lobster	M	M	M	M	M	M	M	M	N	M	M	M
Netfish	Mullet, St Joseph shark	M	M	M	**H**	**H**	**H**	M	M	M	M	M	M
Small-scale	Hake, monkfish, kingklip, snoek	M	M	M	M	M	M	M	M	M	M	M	M

Note: Ratings of high (H), low to moderate (M), and none (N) are relative within each row and are not comparable between fisheries.

CHAPTER 3: COMMUNITY PROFILES

3.1 Introduction

A community can be bounded by a shared history, location and/or social, economic and political interests, where most common core definitions of a community emphasize social interactions typically in a shared environment, frequently defined in spatial terms (Colburn *et al.*, 2010). When referring to a more specific group, such as a fishing community, definitions can include themes such as a visible or material connection to the industry and infrastructure elements (e.g., equipment and related businesses); connections between on-land and at-sea networks; the role kinship often plays in the labour process; multiple households and family-level ties to fishing; and a sense of cultural (even spiritual) connection to a specific livelihood occupation (Clay and Olson, 2007). In the South African context, community is a complex concept that occupies a space in the state's regulatory framework, such as in land restitution and land distribution matters (Averweg and Leaning, 2015). It is therefore important to note that there are many nuances in understanding what community means in terms of legal processes and popular understanding (e.g., refer to Box 1), where other interpretations of a community could be reduced and thus dimmish the social lives of those who live in unrecognised communities (Averweg and Leaning, 2015).

BOX 1: UNPACKING THE COMPLEXITIES OF SOUTH AFRICAN FISHING COMMUNITIES

The complexities of defining a fishing community in a South African context are highlighted through the evolution of policy for managing marine fisheries, largely due to historical policy under the apartheid regime favouring industrial fishing sectors, where small-scale and subsistence communities were excluded from policy definitions. This led to the Marine Living Resources Act of 1998 (MLRA), which worked to address the past inequalities. Given the multitude of different kinds of fishers operating within the South African context, related definitions were refined through the introduction of the Policy for the Small-Scale Fisheries Sector in South Africa (2012): where *community* is defined as "… any group of persons or a part of such a group who share common interests and regard themselves as a community." The Marine Resources Amendment (Act No 587) of 2014 further refined the definition of a small-scale fisher as "a member of a small-scale fishing community engaged in fishing to meet food and basic livelihood needs, or directly involved in processing or marketing of fish, who— (a) traditionally operate in near-shore fishing grounds; (b) predominantly employ traditional low technology or passive fishing gear; (c) undertake single day fishing trips; and (d) is engaged in consumption, barter or sale of fish or otherwise involved in commercial activity, all within the small-scale fisheries sector."

For example, the nature of fishing as a livelihood is, critically, so much more than just a means to make an income. While the income from fishing is vital to individuals and their dependents, the social and cultural aspects of fishing as an identity marker as a history is one of the ways in which communities maintain their sense of a collective identity (Van Zyl, 2009; Williams, 2021). The often-heard phrase is that the "sea is in our blood", denoting a physical, spiritual and cultural co-identification with the sea. Even though it is the men in the coastal communities in question who actively ***do*** the actual fishing, the communities self-identify as "fishing communities" due to these myriad and complex relationships, built up and maintained over generations, that the larger group has with the ocean and the act of fishing.

Key coastal livelihood activities were identified for each community of interest (see Appendix 1) and are detailed in Table 8 below. Key activities included agriculture, fisheries, mining and tourism. While conservation was also identified as a key activity, it did not play a central role in terms of contributing directly to livelihood activities in the communities of interest, but rather linked to and supported tourism activities. Thus, wider conservation activities are discussed in relation to tourism activities taking place in the communities of interest.

Table 8: Community profiles geographically distributed according to municipal demarcations

District Municipality	Local Municipality	Community of interest	Key coastal livelihood activities	
			Primary importance	Secondary importance
Namakwa	Richtersveld	Alexander Bay	Mining	Agriculture, tourism (including conservation)
		Port Nolloth	Fisheries, mining	Tourism (including conservation)
	Nama Khoi	Kleinzee	Fisheries (aquaculture)	Mining, tourism (including conservation)
	Kamiesberg	Hondeklipbaai	Fisheries	Tourism (including conservation)

The local spatial scale (33 500 ha) covering the extent of the proposed port and SEZ (see Figure 1) under Work Package 1 does not currently fall under these community profiles as the Boegoebaai area is currently under mining concessions owned by Alexkor, where the area south of Alexander Bay until just south of Boegoebaai is a restricted diamond mining area. There are thus no formal dwellings or permanent inhabitants in the Boegoebaai area, and the activities are restricted to diamond mining – where the natural harbour is accessed by sea and used as a shelter during winter storms by diamond boats from Port Nolloth (Local Stakeholder Interview, pers. comm.). However, according to local stakeholders, this area does hold historical and cultural significance to surrounding local communities, which predates mining activities.

In the Boegoebaai area, locally referred to as *Boegoeberg* (see Figure 14), local stakeholders account that there are 17 grave sites belonging to the Nama people (including that of Kaptein Swartbooi), as well as scarce *Buchu* plants that hold cultural and medicinal significance to the Nama people (Nortje and van Wyk, 2019). The Boegoebaai area also contains grave sites of early colonial settlers (1890s) that are linked to the original Rietfontein farmhouse that predated the mining activities and subsequent restrictions (Local Stakeholder Interview, pers. comm.). Furthermore, the Boegoebaai coastal area also historically formed part of traditional fishing grounds for small-scale fishers based in neighbouring Port Nolloth (M. Sowman, pers. comm.). Predating mining activities, Boegoebaai was an important traditional fishing area for WCRL (Local Stakeholder Interview, pers. comm.) – where small-scale fishers have lost access to these fishing grounds over time due to closures linked to mining restrictions (M. Sowman, pers. comm.).



Figure 14. Boegoeberg viewed from the main road between Alexander Bay and Port Nolloth (credit: Z. du Toit, 2024)

The profiles below provide a snapshot of community histories, social and economic characteristics, available infrastructure and service provision, and their respective involvement in the identified coastal livelihood activities for the four identified communities of interest: Alexander Bay, Port Nolloth, Kleinzee and Hondeklipbaai.

3.2 Alexander Bay

3.2.1 Location

Alexander Bay is the northwesternmost town in the Northern Cape (28°35'58"S 16°30'06"E). It is located on the Orange River, which forms the border with Namibia. The town is within the jurisdiction of the Richtersveld Local Municipality and Namakwa District Municipality.

Alexander Bay is primarily a mining town, where the town was proclaimed after the discovery of alluvial diamonds in 1925 (Marais, 2023). The original mining town was owned by the State-owned diamond-mining company Alexkor, and the town and surrounding areas were once closed off to the public. However, it is now accessible without permits. Mining operations continue to date (see Figure 15), although at a reduced scale (Showme South Africa, 2012). The result is that the town is sparsely populated, and very few industries survive there. The main industries are related to mining, such as diamond divers and those that service boats or mining equipment (Local Stakeholder Interview, pers. comm.).



Figure 15. Mining activities along the road towards Alexander Bay (credit: Z. du Toit, 2024)

3.2.2 Demographic attributes

In 2011, there were a total of 1,736 people residing in Alexander Bay, where 75.7% were of working age (15-64 years), 21.9% were young (1-14 years) and 2.3% were elderly (65+ years). Approximately 1.2% (aged 20+ years) had no schooling, 26.3% matriculated and 7% received higher education. Only 2.7% of residents had no income (StatsSA, 2011).

The town of Alexander Bay is divided into three small areas and the demographic features of the three areas are very similar (see Table 9). Afrikaans is the primary language in Alexander Bay and the home language for more than 90% of residents. The majority of residents across the three small areas are Coloured, followed by White and Black African.

Table 9: Select demographic characteristics of Alexander Bay (StatsSA, 2011)

		Small area 0014	Small area 0016	Small area 0018
General	Total Estimated Population (count)	557	572	607
	Population Density (count per km²)	291	390	712
	Number of Households (count)	163	158	190
	Males (%)	55%	60%	53%
	Females (%)	45%	40%	47%
Population Group	Black African (%)	14%	13%	3%
	Coloured (%)	83%	79%	62%
	Indian/Asian (%)	0	0.35%	0
	White (%)	3%	7%	35%
	Other (%)	0	1%	0
First Language	Afrikaans (%)	91%	90%	97%
	English (%)	0.19%	3%	1%
	IsiXhosa (%)	4%	3%	1%
	Other (%)	5%	4%	1%

3.2.3 Inventory of features

Most of Alexander Bay has formalised dwellings and services, where 96.7% of the town consists of formal dwellings. Approximately 98.6% contain a flush toilet connected to sewerage, 97.5% have piped water inside the dwelling, all (100%) have electricity for lighting, and 99.8% have access to weekly refuse removal services (StatsSA, 2011).

As a traditional mining town, the entire town of Alexander Bay belonged to the mine, which provided infrastructure and homes to all mine employees in the past. Food such as milk, eggs, fresh fruit and vegetables were subsidised, and water and electricity were provided by the mine. Upkeep of infrastructure and homes was also undertaken by the mine. Today, that is no longer the case, and infrastructure and service provision has subsequently eroded over time according to local stakeholders. Most residents still rent their homes from Alexkor at present (Local Stakeholder Interview, pers. comm.). The main tar road between Alexander Bay and Port Nolloth is in good condition; however, the roads in Alexander Bay have potholes and require substantial roadworks.

The Alexander Bay airport had one asphalt and two gravel runways but was closed in 2007. There is a working police station, a hospital and a community health clinic in town, and an Engen petrol station. There used to be a bus service between the town and the mine, but it is no longer operational. There is a small grocery store (Riverport Trading), one furniture store (Lewis), the Oppiestoep restaurant and one other at the angling club, a home industry shop that sells homemade cookies and a hairdresser. Many residents drive to Oranjemund in Namibia for groceries; however, that becomes expensive as border fees are applicable. The only automatic bank teller in town is often out of order. There is one primary and one high school in Alexander Bay and children from nearby Sendelingsdrif and Lekkersing also attend those schools. There are also two churches in the town (Local Stakeholder Interview, pers. comm.). Recreational facilities in the town consist of a Golf Club, Tennis & Squash courts, a rugby field and an angling club.

The Alexander Bay harbour is mainly used by the diamond boats. As part of Alexkor's diversification into aquaculture, an oyster farm that functioned as a hatchery for the Pacific oyster (*Crassostrea gigas*), was started. The hatchery cultivated seed oysters from imported oyster spat and provided tours of the facility; however, this facility is no longer operational (Robinson *et al.*, 2005).

3.2.4 Coastal livelihoods

As identified through the stakeholder analysis (see section 1.2.1), coastal livelihood activity typologies were identified for Alexander Bay and are detailed in Appendix 2. These typologies are expanded below, based on desktop review, fieldwork observations and local stakeholder interviews.

Involvement in agriculture

Alexander Bay has a long history in agriculture due to its geographical location to the Orange River. The original farm, where the town of Alexander Bay is today, was called Groenvlei and was established in 1847. Cattle farming has greatly increased since the successful land claims in 2003 (Local Stakeholder Interview, pers. comm.).

The Richtersveld Growers manage the Beauvallon Farm near Alexander Bay. It is a partnership between the Richtersveld community and private investors, focusing on promoting agricultural development and social upliftment in the Richtersveld region. They employ between 50-60 people directly and approximately 300 people during the harvest season when they use contractors to bring in the harvest. Produce cultivated include potatoes, onions and other vegetables and fruit that they sell at the Cape Town and, to a lesser extent, the Johannesburg market. They also cultivate grapes for raisins which is sold to South African Dried Fruit (SAD).[5] Not only does the association of the Richtersveld Growers directly employ community members of Alexander Bay but also support the local high school by contributing to the salary of the agriculture science teacher. Alexander Bay High School teaches agricultural science as a subject in the school and has access to a farm owned by the Richtersveld community where they plant maize and lucerne for teaching purposes (Local Stakeholder Interview, pers. comm.).

Involvement in fisheries

The history of fishing in Alexander Bay is only subsistence fishing, starting with migrant Nama people who fished in the area for food and hunted seals for their skins (Barnard, 1992). According to the 2018 Fishing Rights Register, no fishing rights were allocated to residents or businesses in Alexander Bay.

There is an angling club located in Alexander Bay, and the mouth of the Orange River is a popular fishing spot among recreational fishers. According to Alexkor, it is currently involved in talks with the Richtersveld community to revive the oyster farm (Alexkor, 2023).

Involvement in mining

For nearly a century Alexkor has mined diamonds in Alexander Bay, making the mine the main source of local employment. However, ownership of the land and the mining concessions are complex. The land where Alexkor had its mining operations was expropriated by the colonial state after the discovery of diamonds in the 1920s and all proceeds from diamond mining belonged to the state-owned mining company. In the late 1990s, the community lodged a claim for their land rights to be reinstated. After a protracted legal battle against the state and Alexkor, the Richtersveld community won its land back in 2003. The mining rights on the land were also ceded to the community and Alexkor was left with only its marine mining concessions (Reddy, 2021).

In 2011, the Pooling and Sharing Joint Venture (PSJV) was set up as a joint venture between Alexkor and the Richtersveld Mining Company as the community's mining conduit. It combined the community's land rights and Alexkor's marine rights and became the vehicle through which the diamonds were sold. In practice, the PSJV do not do any actual mining. Instead, mining is outsourced to private contractors who consist mainly of small boat-based marine divers who dredge the seabed using processing plants owned by the PSJV. The diamonds are then sold by them with the help of a diamond marketer and the proceeds

[5] See https://www.safaridriedfruit.co.za/

are shared with the contractors (Reddy, 2021). In 2023 Alexkor employed 1190 people, which included 1039 contractors (Alexkor, 2023).

Involvement in tourism and conservation

Alexander Bay's unique landscape and biodiversity, including the attraction of the area's diamond mining history, has created interest to promote employment for the local community through tourism. Alexkor diversified into the tourist market for a short while According to the Alexkor website (Alexkor, 2024), the company provides the following facilities as initiatives to support tourism development in the region:

- Funding of the local tourism website called "Diamondcoast"
- The running of guest houses in and around Alexander Bay
- The running of the local airport
- Local museum
- River mouth

However, very few of these initiatives are still operational. The airport is no longer active. Guesthouses are mostly used on a longer-term basis by contractors working on the mining operations. Alexkor also initially hosted mine tours that included a visit to the diamond mine museum (Diamondcoast, n.d.) – it is unclear whether this activity is still ongoing today. Alexander Bay is also mentioned on several tourism sites, however, the telephone number for the Alexander Bay Tourism Office no longer exists. There is a small information office at the entrance to the town. The Namakwa info website mentions walking and cycling trails that link points of interest in and around the town, as part of the "Living Museum" concept but that never became a reality (Local Stakeholder Interview, pers. comm.). There was limited evidence of tourist activities observed in the town during September 2024.

A conservation and tourist attraction in close proximity to Alexander Bay is the Orange River mouth – declared a Ramsar wetland in 1995 (Ramsar, 1995). The wetland is home to a variety of migratory birds and the endemic Barlow's Lark. However, it is a modified ecological system due to years of degradation due to diamond mining activities, river flow regulation, and poor mouth management. The mouth is still a popular recreational fishing site and several endemic and threatened fish species, including Namaqua barb (*Barbus hospes)* and rock catfish (*Austroglanis sclateri)*, are found there (Birdlife South Africa, 2015). Another a point of interest near Alexander Bay is the lichen fields (Jurgens and Niebel, 1991) - the world's most diverse lichen fields (Fleminger, 2024a).

The town is in close proximity to the /Ai-/Ais-Richtersveld Transfrontier Park – a cross-border conservation initiative between South Africa and Namibia and major regional tourism attraction. In addition, to the south of the Richtersveld National Park (on the South African side) is the Richtersveld Cultural and Botanical Landscape, a UNESCO World Heritage Site that constitutes a cultural landscape that is communally-owned and managed by the Nama people (Fleminger, 2024a). Sendelingsdrif, the main South African entrance to the park, is approximately 89km from Alexander Bay.

3.3 Port Nolloth

3.3.1 Location

Port Nolloth is located 86 km south of Alexander Bay and 144 km Northwest of Springbok on the Northern Cape coast (29°15'11"S 16°52'09"E). It is the seat of the Richtersveld Local Municipality and falls within the Namakwa District Municipality. The town was founded by Captain M.S. Nolloth in 1854, where the harbour was initially used for the transportation of copper and later diamonds and later became a fishing village from the 1950s (Southafrica.com, 2024). Traditional fishers based in Port Nolloth are deeply connected to the sea in terms of legacy (i.e., intergenerational fishing families) and culturally, where fishing is deeply personal and central to their coastal livelihoods – reflecting not only a profession but a way of life

for these fishing communities (Local Stakeholder Interview, pers. comm). At present, the principal livelihood activities are fishing (see Figure 16), mining and tourism.



Figure 16. Harbour use alongside the Port Nolloth jetty at the former fish factory (credit: Z. du Toit, 2024)

3.3.2 Demographic attributes

In 2011, there were a total of 6,092 people residing in Port Nolloth, where 69.4% were of working age (15-64 years), 24.1% were young (1-14 years) and 6.5% were elderly (65+ years). Approximately 2.1% (aged 20+ years) had no schooling, 22.1% matriculated and 8% received higher education. Approximately 12% of residents had no income (StatsSA, 2011).

Port Nolloth is divided into four sub-areas: McDougall's Bay; Nollothville; Owen Island and Port Nolloth SP (sub place) – refer to Table 10 below.

Table 10: Select demographic characteristics of Port Nolloth (StatsSA, 2011)

		McDougall's Bay	Nollothville	Owen Island	Port Nolloth SP
General	Total Estimated Population (count)	288	3,443	15	2,346
	Population Density (count per km²)	884.96	1,610.92	39.47	85.39
	Number of Households (count)	141	921	6	763
	Males (%)	43%	51%	60%	50%
	Females (%)	57%	49%	40%	50%
Population Group	Black African (%)	1%	1.8%	0%	39%
	Coloured (%)	10%	97%	0%	44%
	Indian/Asian (%)	0.35%	0.49%	27%	0.5%
	White (%)	86%	0.46%	60%	15%
	Other (%)	2%	0.52%	13%	1.5%
First Language	Afrikaans (%)	88%	97%	92%	66%
	English (%)	11%	1%	8%	6%
	IsiXhosa (%)	0%	0%	0%	19%
	Other (%)	1%	1%	0%	9%

McDougall's Bay was once a diamond area and thus access was controlled – it was opened to the public in 1986. Presently, McDougall's Bay is a popular holiday destination with a lot of holiday accommodation advertised as well as a caravan park and it's beach is certified as a blue flag beach (Fleminger, 2024b). Boating and recreational fishing are popular activities in McDougall's Bay. The population is predominantly white, Afrikaans-speaking people.

Nollothville was the traditional coloured area, and its population still consists mainly of Coloured people and most people speak Afrikaans. Owen Island is a very small area of only 0.38 km² and only 15 people live there. It consists mainly of the Port Nolloth Country Club Lodge. Port Nolloth SP is the largest sub-area in Port Nolloth and includes the old town, the harbour and the business centre. Most people speak Afrikaans, and its population consists mainly of Black African and Coloured people.

According to local stakeholders, rising unemployment and deteriorating infrastructure in recent years have increased social ills in the town.

3.3.3 Inventory of features

Most of Port Nolloth has formalised dwellings and services, where 97.9% of the town consists of formal dwellings. Approximately 87.2% contain a flush toilet connected to sewerage, 78.2% have piped water inside the dwelling, 98% have electricity for lighting, and 93.8% have access to weekly refuse removal services (StatsSA, 2011). The Richtersveld is a low rainfall area and thus water is a scarce commodity – the water which serves the town of Port Nolloth is pumped from the Orange River at Alexander Bay.

Port Nolloth has a busy business centre with many shops. There are five schools in the town as well as many churches in all denominations. The town is only 144 km from Springbok and is connected via the N7

and R382 which are tar roads. The offices for the Richtersveld Municipality are in Port Nolloth as well as a police station, community health clinic, hospital and magistrate's court. There is also a light industry (an associated activities) section in the town that includes local businesses involved in brick manufacturing, panel beaters, solar energy supplies and hardware supplies. This forms part of employment opportunities within Port Nolloth – for example, Richtersveld Bricks (*Steenwerke*) is one local industry that employs approximately 13 residents (Local Stakeholder Interview, pers. comm.).

Port Nolloth is one of six development nodes identified by the South African government to form part of the Operation Phakisa: Oceans Economy development program, to be developed as a sustainable coastal and marine tourism destination. The current small harbour mainly serves the diamond mines and local fishers. Although the Port Nolloth harbour consisted of two jetties, only one of them is operational at present. The De Beers jetty was upgraded in 2017 as part of Operation Phakisa. The De Beers Services Group held a five-year lease agreement to use the port as a supply base for its offshore diamond prospecting activity in Namibia. The Jetty belongs to Transnet and consists of an L-shaped concrete deck on a pile jetty with a 67-metre landing quay comprising a functional area of 1450 m^2 (Infrastructure News, 2017).

Port Nolloth lacks a deep harbour, which is a major limitation for commercial fishing. The harbour can only accommodate vessels up to 23m in size, allowing smaller trawlers and longline vessels to operate from there (Britz *et al.*, 2000). Currently, one of the primary challenges faced by the fishing industry is the deteriorating condition of the jetty (Masifundise, 2018). While the de Beers jetty was recently upgraded, the jetties next to the abandoned John Ovenstone fish factory were observed to be falling apart and not fit for use (see Figure 17). There is a lighthouse in Port Nolloth and a National Sea Rescue Institute (NSRI) station.[6]



Figure 17. Jetty next to the abandoned John Ovenstone fish factory (credit: Z. du Toit, 2024)

[6] See https://www.nsri.org.za/rescue/base-finder

3.3.4 Coastal livelihoods

As identified through the stakeholder analysis (see section 1.2.1), coastal livelihood activity typologies were identified for Port Nolloth and are detailed in Appendix 2. These typologies are expanded below, based on desktop review, fieldwork observations and local stakeholder interviews.

Involvement in agriculture

Port Nolloth has no history of farming and due to the scarcity of water in the area is not ideal for the cultivation of crops. Most farmers in the wider area are subsistence farmers and keep goats and sheep (Local Stakeholder Interview pers. comm.).

Involvement in fisheries

The Nama people were the first to fish for food and to hunt seals for their skins in the Port Nolloth area – locally referred to as *Aukotowa*, meaning "the place where the old man was taken away (by the sea)" (Carstens, 2011). While the port at Port Nolloth was first established in 1854 as a small-vessel harbour for the copper-mining industry, the town became a fishing village in 1953 (Southafrica.com, 2024). A fish processing factory was opened in 1960 and became the main source of employment in the town, along with the diamond mining industry. The majority of workers in the fish factory were women. The fish factory closed in 1993, leading to unemployment for many women factory workers and small-scale fishers in Port Nolloth (Masifundise, 2018).

According to the 2018 fishing rights register (DEFF, 2018) the following fishing rights were allocated to rightsholders in Port Nolloth: Three local companies were granted hake longline rights from 2006 to 2020, totalling 230.48 tons. One hake handline fishing right was initially allocated but later revoked. Two local companies were also awarded hake deep-sea trawl long-term rights from 2006 to 2020, comprising 1763.35 tons. Additionally, three netfish long-term rights are valid from 2016 to 2031. VM Young Visserye BK was allotted four small pelagic rights from 2006 to 2020, including 248.57 tons of anchovy, 331.28 tons of sardine, 24.9 tons of sardine bycatch, and 23.19 tons of sardine juvenile bycatch. There were also two traditional linefish rights, valid from 2014 to 2020, which were both subsequently revoked. Moreover, thirteen WCRL nearshore rights are valid from 2013 to 2033, with each rightsholder receiving 1250 kg of WCRL. Finally, six companies were granted WCRL commercial long-term rights from 2017 to 2033, totalling 14900kg.

Two fish processing facility licenses were granted in 2018, to Noordkaap Visserman Onderneming BK and Port Lobster (Pty)Ltd, respectively. The former is no longer in operation. The rights are valid from 2017 to 2032 (DEFF, 2018).

There are three fishing companies listed in Port Nolloth that were allocated commercial fishing rights according to the 2018 fishing rights register. J&J Visserye has offices in Port Nolloth; however, they are only the rightsholders. Seaharvest use their fishing rights and operate from Cape Town in the Western Cape Province. The company employs two people in their offices and has six directors, of which three live in Port Nolloth and three in Cape Town. Noordkaap Visserye employed three to five people in their offices in Port Nolloth, but these offices have subsequently closed. VM Young Visserye cc still has offices in Port Nolloth but, as with J&J Visserye, they do not operate any vessels from Port Nolloth – however, VM Young Visserye cc do hold fishing rights in the area and leases them to another company operating from Cape Town that undertakes the fishing activities (Local Stakeholder Interview, pers. comm.)

The Aukotowa Small-scale Fisheries Cooperative in Port Nolloth was established in 2018 as part of the implementation of the Small-scale Fisheries Policy (DAFF, 2012; Masifundise, 2022). It was one of the first small-scale fisheries cooperatives to be established in South Africa, along with the neighbouring Hondeklipbaai cooperative based in Hondeklipbaai. The cooperative includes 103 individuals, most of whom are Khoisan/Nama descendants and supports 75 households. The board of the cooperative is made up of seven members, five men and two women. Approximately one-quarter of the fishers are young people. These small-scale fishers traditionally use bakkies and operate close to shore. The cooperative operates eight fishing boats and 18 small lobster vessels, and their offices are located in the abandoned John Ovenstone fish factory in Port Nolloth. The Aukotowa fishing cooperative has small-scale fishing rights, as well as commercial rights for WCRL and offshore hake offshore – although the small-scale fishers do not have the capacity to utilise these rights (Local Stakeholder Interview, pers. comm.). The cooperative

subcontracted to Premier Fishing and Brands Limited (Pty) Ltd, operating out of Hout Bay harbour in the Western Cape Province, to harvest these species (Local Stakeholder Interview, pers. comm.).

Ocean squeeze has resulted in traditional fishing communities in Port Nolloth to increasingly lose access to their fishing grounds – where (for example) in the past, they could move their bakkies over land via trailer to fish north of Port Nolloth but can no longer do so as this access has been closed off due to mining restrictions (M. Sowman, pers. comm.). Port Nolloth is bordered by diamond mines on both sides and small-scale fishers currently only have access to less than 5% of their traditional fishing grounds, even though small-scale fishers are authorised to fish the entire 80 km of coastline between Port Nolloth and the Orange River (Masifundise, 2018; Christianson, 2021). Other concerns have been raised by local fishing communities due to mining activity – for example, the construction of Coffer Dams by mining companies along the Northern Cape coastline have negative impacts on marine life and thus livelihoods dependent on marine resources, such as snoek and WCRL (Masifundise, 2022). The Department of Forestry, Fisheries and the Environment (DFFE) has instituted legal action against Alexkor, for the use of rocks to build cofferdams, which is a very destructive method (Yeld, 2024).

Cumulative stressors on these traditional fishing communities include losing coastal access to their traditional fishing grounds; the rising cost of fuel that limits how far the fishers can travel at sea to their traditional fishing grounds; climate variability and change within the marine environment that limits days at sea; and decreases in fish stocks due to environmental and anthropogenic pressures (M. Sowman, pers. comm).

Involvement in mining

Port Nolloth has a long history in mining – where the town was first established as a harbour to ship copper from the copper mines in Okiep, and remained a transhipment point for copper and later diamonds until 1970 (Tracks4Africa, 2018). Until 1997, Alexkor and Marine West used the Port Nolloth harbour to offload gravel, mined by the diamond divers, for diamond extraction and sorting at Alexander Bay. However, in 1997, 452 people were retrenched by Alexkor due to the reduction in diamond mining activity in the area. Marine West, a private company, also withdrew from Port Nolloth. Currently, the harbour is mainly used by independent diamond divers, as well as offshore support vessels for diamond exploration by the De Beers Services Group in Namibia (Local Stakeholder Interview, pers. comm.). To this end, the De Beers Supply Chain Centre and De Beers Marine Business Manufacturing and supply depots were established in 1999 and by 2015 it employed 77 permanent and fixed-term contractors on site in Port Nolloth. 60 people were also employed to operate the supply vessels (De Beers Group, 2015). The depots are located at the Port Nolloth harbour.

Involvement in tourism

Key tourist attractions in the town include the Port Nolloth museum and Port Nolloth forms part of the Namaqualand Flower Route (Lazorko, 2024; Fleminger, 2024). Further afield, the Nama cultural settlement at Lekkersing[7] (which forms part of the UNESCO Richtersveld Cultural and Botanical Landscape) is 60 km north of Port Nolloth, and the Richtersveld National Park is 173 km from the town.

There are many holiday accommodation options in Port Nolloth, where the town received many tourists and holidaymakers during the spring wildflower season and in the December holidays in the past. However, tourism has decreased over time due to poor infrastructure leading to water shortages (compounded by changes to climate variability) and rising social ills linked to increased unemployment. Thus, the hospitality industry has declined in Port Nolloth, resulting in further unemployment (Local Stakeholder Interview, pers. comm.).

[7] See https://karoospace.co.za/lekkersing-richtersveld/

3.4 Kleinzee

3.4.1 Location

Kleinzee is located 62 km south of Port Nolloth and approximately 100 km from Springbok (29°40'35"S 17°04'12"E). The town was established by De Beers in 1942, after the first diamonds were found on the farm Kleyne Zee in 1927 (Gadd, 2024). The entire town was built and owned by the De Beers mining company and all residents were employed by the company, where access into Kleinzee was limited to permitholders and strict security measures were in place. De Beers closed their mining operations there in the early 2000s and by the end of 2011 infrastructure was deteriorating and the 370 houses in Kleinzee were mostly empty. The town's population decreased from approximately 7000 to 1000. Subsequently, Kleinzee was incorporated into the Nama Koi Local Municipality and declared a public town (Vanessa, 2011; Gadd, 2024). Today, aquaculture is the primary employer in Kleinzee (see Figure 18), where three aquaculture companies operate in the area (Local Stakeholder Interview, pers. comm).



Figure 18. Kelp harvesting as part of aquaculture activities in Kleinzee (credit: Z. du Toit, 2024)

3.4.2 Demographic attributes

In 2011, there were a total of 728 people residing in Kleinzee, where 86.3% were of working age (15-64 years), 12.1% were young (1-14 years) and 1.6% were elderly (65+ years). Approximately 25.5% matriculated and 23% received higher education. Only 1.7% of residents had no income (StatsSA, 2011).

The data and area for Kleinzee main place and Kleinzee SP (sub place) overlap, so for the purposes of this report, they were treated as one area (refer to Table 11). Afrikaans is the primary language in Kleinzee and

the home language for 90% of residents. The majority of residents in the town are Coloured (61%), followed by Black African and White (18%).

Table 11: Select demographic characteristics of Kleinzee (StatsSA, 2011)

	Demographic characteristics	Kleinzee (Main place and SP)
General	Total Estimated Population (count)	728
	Population Density (count per km²)	80
	Number of Households (count)	301
	Males (%)	58%
	Females (%)	42%
Population Group	Black African (%)	18%
	Coloured (%)	61%
	Indian/Asian (%)	1%
	White (%)	18%
	Other (%)	2%
First Language	Afrikaans (%)	90%
	English (%)	6%
	IsiXhosa (%)	2%
	Other (%)	2%

3.4.3 Inventory of features

All of the dwellings in Kleinzee are classified as formal and contain a flush toilet connected to sewerage. Approximately 99.3% have piped water inside the dwelling, 99.3% have electricity for lighting, and 99% have access to weekly refuse removal services (StatsSA, 2011).

When Kleinzee was proclaimed a public town, all the houses were sold to private owners and the Nama Koi Municipality took over the responsibility for infrastructure upkeep and service delivery in 2012 (Van Dyk, 2021). Kleinzee has several basic amenities, including two shops, a bottle store, and two bakeries that take orders. Town features also include a post office and a police station, as well as a local clinic that only operates on specific days of the week (Tracks4Africa, 2018). Additionally, there is a non-franchised fuel service station in the town. While there are no banks in Kleinzee, cash withdrawals can be made at the ATM located next to the grocery store (Van der Merwe, 2020). The school in Kleinzee offers a range of educational services, including pre-school, primary school, skills training, and support for children with special learning needs. Additionally, there is a home-schooling support centre that assists high school students (Van der Merwe, 2020). The roads leading to Kleinzee are primarily paved, with a short stretch of dirt road (ranging from 40 to 65 km) near the town.

Since its establishment in the Nama Khoi Local Municipality, Kleinzee has seen the opening of new businesses and an influx of residents. Many of these new enterprises focus on tourism, including restaurants and shops that sell baked goods. The tourist information centre is located within a small shop that specializes in cookies and souvenirs, which also houses the Kleinzee Diamond Mine Museum. This

shop was opened in May 2024 by one of the new residents who moved to Kleinzee (Local Stakeholder Interview, pers. comm).

Recreational facilities in Kleinzee include the Kleinzee Angling Club, a golf course, squash courts, and various sports grounds. The angling club hosts one angling competition per year for WCRL. While there is a slipway located next to the angling club in Kleinzee, this slipway is in disrepair and boats now launch from the adjacent beach.

3.4.4 Coastal livelihoods

As identified through the stakeholder analysis (see section 1.2.1), coastal livelihood activity typologies were identified for Kleinzee and are detailed in Appendix 2. These typologies are expanded below, based on desktop review, fieldwork observations and local stakeholder interviews.

Involvement in agriculture

The town of Kleinzee was established on the farm *Kleyne Zee*, which was sold to mining companies in 1927. In the area, there are only five or six active commercial farms, most of which raise Dorper sheep and goats. Many farms remain fallow due to droughts, the older generation retiring, and the younger generation showing little interest in taking over the farms. Given this difficult operating environment, many farmers have found it financially challenging to run farms and employ full-time staff – thus only seven people are currently employed as farmworkers. Near Komaggas, some subsistence farmers cultivate communal land and raise goats and sheep (Local Stakeholder Interview, pers. comm).

Involvement in fisheries

Recreational fishing has always been a way of life in Kleinzee; however, it has been severely impacted by siltation caused by mining operations (Local Stakeholder Interview, pers. comm).

For the past seven years, aquaculture has been the primary employer in Kleinzee, where three aquaculture companies operate in the area (Local Stakeholder Interview, pers. comm). Viking Aquaculture (Pty) Ltd established an abalone farm near Kleinzee in the diamond concession area, which produces 120 tons of abalone per year on 400 hectares. The farm employs a multi-trophic production system, wherein seaweed is grown using abalone effluent and then fed to the abalone. Viking Aquaculture employs 69 permanent staff for abalone production, along with five divers. The company has also been granted seaweed harvesting rights valid from 2017 to 2032 and employs an additional 60 to 70 people for harvesting live kelp, which serves as abalone feed. In 2018, the Sea Harvest Group, alongside a consortium of black-owned companies, acquired a majority stake in Viking Aquaculture (Crouth, 2023).

The Kleinzee Mariculture Oyster Farm, located on the outskirts of Kleinzee in a mined-out bedrock pit filled with seawater, cultivates seed oysters and employs approximately 10 people (Local Stakeholder Interview, pers. comm). Additionally, Port Nolloth Sea Farms operate an abalone ranch in Kleinzee, employing 10 residents who receive training in diving and related courses. The ranch has the potential to employ 20 to 30 people when fully operational; however, due to challenges in obtaining the necessary rights, it is currently unable to operate at its full capacity (Local Stakeholder Interview, pers. comm).

Involvement in mining

Kleinzee was established in 1942 by De Beers specifically to support the diamond mine and provide housing for its employees. Since the withdrawal of De Beers from the area, several smaller mining companies and independent miners have received mining concessions from the South African government. Notably, the Trans HEX Group has recently increased its mining activities in Kleinzee. Currently, three mining companies are establishing plants in Kleinzee, which primarily hire contractors for mining operations, security personnel, and the companies' health clinic. Permanent employees mainly consist of management. The mines also hire local residents for maintenance work (Local Stakeholder Interview, pers. comm.).

However, illegal mining is on the rise across all mining sectors in South Africa, including the Kleinzee area, where individuals operate in abandoned diamond mines under dangerous conditions. These illegal miners

in Kleinzee come from various Southern African countries, including Mozambique and Zimbabwe. (SABC, 2023).

Involvement in tourism

Although access to Kleinzee was restricted due to the diamond mine, the town has a history of tourism. The De Beers mine once offered diamond mine tours along with guided 4x4 excursions through restricted coastal diamond areas (Vanessa, 2011).

Kleinzee features several accommodation options and current tourist attractions include the 4x4 shipwreck trail, the natural phenomenon of wildflowers in spring, and birdwatching at the Buffels River estuary. Additionally, visitors can explore the Molyneux Nature Reserve, a small reserve (5.5 hectares) located just north of Kleinzee, which is home to over 100 indigenous plant species (Van der Merwe, 2020; Namakwa-info, 20924).

The farm Rooiklippies, south of Kleinzee, was bought by the Strandveld Conservation Club. It is managed as a permit area to control access and to preserve the area. Permits can be obtained from the tourist information office at the museum. The area consists of an unspoiled coastal zone with typical regional vegetation and rich bird life (Van der Merwe, 2020).

Tourism in Kleinzee is seasonal and most guesthouses typically employ only one or two permanent staff members. There are 6 to 8 guesthouses in the town. Die Houthoop, a guest farm and restaurant located approximately 17 km from Kleinzee, employs three permanent staff members. Additionally, there are two tour guides and one person working at the museum, which also includes a shop and information centre (Local Stakeholder Interview, pers. comm.).

Challenges faced by the tourism industry in Kleinzee include water scarcity and poor access due to the condition of roads (Local Stakeholder Interview, pers. comm.).

3.5 Hondeklipbaai

3.5.1 Location

Hondeklipbaai is a coastal village in the Kamiesberg Local Municipality. The town is named after a rock next to the police station that resembles a sitting dog (Tracks4Africa, 2024). Hondeklipbaai is located approximately 95 km southwest of Springbok (30°18'46"S 17°16'46"E). The town of Hondeklipbaai was initially established by Thomas Grace in 1846 due to a small natural harbour, where a trading station was established and to ship copper ore to the United Kingdom (SAHistory.org, 2020; Namakwa-Info, 2024). In 1925, a crayfish processing factory was built on the harbour and it became the main source of employment in Hondeklipbaai until its closure in 1996 (Britz *et al.*, 2000). Today, the town remains primarily a traditional fishing village (Local Stakeholder Interview, pers. comm.) – see Figure 19.



Figure 19. Bakkies (small boats) in front of the Longtime Hondeklipbaai Fishing Primary Cooperative offices in Hondeklipbaai (credit: Z. du Toit, 2024)

3.5.2 Demographic attributes

In 2011, there were a total of 543 people residing in Hondeklipbaai, where 67.4% were of working age (15-64 years), 24.7% were young (1-14 years) and 7.9% were elderly (65+ years). Approximately 1.3% (aged 20+ years) had no schooling, 20.5% matriculated and 4.9% received higher education. Approximately 26% of residents had no income (StatsSA, 2011).

While Hondeklipbaai is divided into two sub areas (Hondeklipbaai mine and Hondeklipbaai SP) for purposes of the 2011 Census, only Hondeklipbaai SP had any residents and is thus considered for this report (refer to Table 12). Afrikaans is the primary language in Hondeklipbaai and the home language for 97% of residents. The majority of residents in the town are Coloured (11%), followed by White (9%) and Black African (8%).

Table 12: Select demographic characteristics of Hondeklipbaai (StatsSA, 2011)

	Demographic characteristics	Hondeklipbaai SP/Small Area 0021
General	Total Estimated Population (count)	543
	Population Density (count per km²)	496
	Number of Households (count)	189
	Males (%)	48%
	Females (%)	52%
	Female Headed Households (%)	36.5%
Population Group	Black African (%)	8%
	Coloured (%)	81%
	Indian/Asian (%)	1.5%
	White (%)	9%
	Other (%)	1%
First Language	Afrikaans (%)	97%
	English (%)	1%
	IsiXhosa (%)	0.4%
	Other (%)	0.5%

3.5.3 Inventory of features

Most of Port Hondeklipbaai has formalised dwellings and services, where 97% of the town consists of formal dwellings. Only 29.5% contain a flush toilet connected to sewerage, 60.8% have piped water inside the dwelling, 98.9% have electricity for lighting, and 97.4% have access to weekly refuse removal services (StatsSA, 2011).

Hondeklipbaai can be accessed via a dirt road from Koingnaas, which is also the nearest petrol station. In Hondeklipbaai, there are no ATMs available, and only two very small shops that sell basic necessities, along with one bottle store. The town features a few restaurants as well (Tracks4Africa, 2024). Additionally, Hondeklipbaai has a police station and a community health care clinic. The Hondeklipbaai harbour consists of a decaying slipway, which local fishers do not use (see Figure 20) – rather fishers launch their bakkies from the beach. There is a lighthouse at the northern end of the harbour.



Figure 20. Slipway in the harbour of Hondeklipbaai (credit: Z. du Toit, 2024)

A major factor that has prevented development in Hondeklipbaai is the scarcity of water, where water was provided to residents by carting water by truck in the past. In 2001, the water pipeline from Koingnaas to Hondeklipbaai came into operation but it provides a limited amount of water (Hondeklip.co.za, 2024).

Hondeklipbaai is part of an initiative by the Namakwaland Municipality aimed at beautifying towns and boosting tourism (Local Stakeholder Interview, pers. comm.). This initiative is included in the municipality's Expanded Public Works Programme (EPWP) and consists of privately managed bakkie teams that work to combat illegal dumping. They support the municipal refuse trucks by cleaning public spaces and collecting waste when necessary (Kritzinger, 2024).

3.5.4 Coastal livelihoods

As identified through the stakeholder analysis (see section 1.2.1), coastal livelihood activity typologies were identified for Hondeklipbaai and are detailed in Appendix 2. These typologies are expanded below, based on desktop review, fieldwork observations and local stakeholder interviews.

Involvement in agriculture

The rural areas surrounding Hondeklipbaai have a long history of farming. In the early 1700s, the Nama people used the area around Hondeklipbaai for grazing for their livestock (cattle and sheep) (Local Stakeholder Interview, pers. comm.). In the mid-1800s, Dutch and English settlers established farms in the area (Travelleeto, 2023). Most rural communities in the wider area are subsistence farmers and keep goats and sheep (Local Stakeholder Interview, pers. comm.).

Involvement in mining

The town originally served as a port for the export of copper to the United Kingdom. However, it was too distant from the mines around Springbok, leading to the copper export operations relocating to Port Nolloth. For a period, the diamond mining industry employed members of the Hondeklipbaai community. De Beers initially provided jobs, but after they withdrew from the area, Trans HEX took over until they ceased operations in 2003 (Christianson, 2024; Hondeklip.co.za, 2024). There are still some private diamond concession holders in Hondeklipbaai who are engaged in small-scale prospecting activities in the surrounding area (SAHistory.org, 2020).

Involvement in fisheries

Hondeklipbaai is a small, traditional fishing village, where fishing activities are primarily undertaken by small-scale fishers (Local Stakeholder Interview, pers. comm.). The harvesting of WCRL has long been the main fishing activity in the Northern Cape, and Hondeklipbaai is no exception. The Hondeklipbaai WCRL processing factory, which opened in 1925, was the main source of employment in the area. However, due to declining numbers of lobster, the Namaqua Canning Company factory closed in 1996, resulting in significant job losses (Britz *et al.*, 2000; Soudens, 2022) – see Figure 21.



Figure 21. The remains of the Namaqua Canning Company factory in Hondeklipbaai (credit: Z. du Toit, 2024)

The Longtime Hondeklipbaai Fishing Primary Cooperative was established in 2018. It supports 14 active fishers and serves 70 households. The cooperative employs one administrative clerk and one person in the Small Vessel Safety Monitoring Center (VMS); however, due to a loss of funding, this individual is no longer being compensated for their work (Local Stakeholder Interview, pers. comm.; Christianson, 2024). The cooperative plays a significant role in community development by participating in initiatives like the Skipper's Training program, which aims to empower local fishers with essential skills. Additionally, it is involved in the wholesale trade of fish and seafood products (South African Fisheries Development Fund, 2021). The fishing cooperative currently owns 10 bakkies but only has engines for seven of these boats. The fishers primarily use handlines to catch linefish, focusing on species like snoek and Hottentot

seabream, and hoop nets for WCRL. During the snoek season, many fishers from Cape Town come to the area to catch snoek. These tourists rent accommodations from community members and hire part-time workers for various tasks, such as cleaning the fish (Christianson, 2024).

Additionally, the fishers have the rights to harvest beachcast kelp, which is exported to China through a middleman. The Longtime Hondeklipbaai Fishing Primary Cooperative also has the right to harvest live kelp, which they subcontracted to a company that uses rubber ducks to harvest kelp at Kleinzee. The live Kelp is used by Port Nolloth Sea Farms as feed for abalone (Local Stakeholder Interview, pers. comm.).

The following fishing rights were assigned to individual fishers in Hondeklipbaai: one Traditional linefish right – valid from 2014 to 2020, and 3 WCRL nearshore rights for 1250kg each – valid from 2017 to 2033.

Involvement in tourism

Hondeklipbaai has long been a popular holiday destination for local farmers, fishers, and divers. In recent years, tourism has become an increasingly important source of income for the area, leading to the construction of many new houses that are now available as holiday accommodations.

Activities in and around Hondeklipbaai include 4x4 routes along the unspoiled coastline, recreational fishing for WCRL where permits can be obtained in season from the urban centres of Springbok or Garies, scenic drives during the flower season, and the Shipwreck Route that features the wreck of the Aristea that ran aground in 1945 (located south of the town) (Namakwa-Info, 2024).

CHAPTER 4: KEY MESSAGES

A key theme highlighted throughout this report is the cumulative pressures playing out in the sea space that is significantly impacting local coastal communities and their respective livelihoods, particularly in relation to fisheries. This "slow" ocean squeeze on traditional fishers and the associated adverse environmental impacts on coastal and marine ecosystems should be taken into serious consideration when planning future activities that impact the Namaqualand coastline. The systemic erosion of socio-cultural values, traditions and access of local fishing communities linked to the sea, and associated environmental degradation of coastal and marine ecosystems due to historical and current mining and offshore oil and gas activities, should be a main concern when planning blue economy activities – which need to consider blue justice and just transitions to sustainable livelihoods for local communities. Furthermore, the interlinked nature of the ocean space in terms of impacts on sensitive marine habitats that have much wider regional and transboundary implications for both the ocean and socio-economic dependencies is very important to consider when planning ocean-based activities.

4.1 Fisheries

The Boegoebaai harbour has the potential to negatively impact the fisheries livelihoods by decreasing both overall catch and catch per unit effort of target species. This decline can lead to increased costs and reduced profits, resulting in further socio-economic consequences for communities and businesses involved in fishing. This will impact businesses and communities involved in fisheries along the entire west coast, from Port Nolloth to Cape Town.

Potential impacts on fisheries may include:

- Direct mortality of target fish species resulting from the proposed construction of the harbour and standard harbour operations can impact all life stages of fish species, including adults, juveniles, and recruits.

- Destruction of marine habitats or a decline in habitat quality that is critical for target fish species and their supporting ecosystems – such as feeding or spawning grounds, migration routes, and habitats vital for prey species, which can lead to a decrease in the abundance of fishery species. There is a spatial overlap between the proposed site for the Boegoebaai harbour and support areas for at least two of the most important fisheries in South Africa, the small pelagic and hake fisheries (Hutchings *et al.*, 2002; Grüss *et al.*, 2016).

- Disruption and alteration of fish behaviour, such as interference with annual spawning events or migration patterns, which may lead to reduced biological fitness – including a decline in lifetime reproductive output.

- Siltation caused by the construction of the harbour and regular harbour operations may lead to shading or smothering of seaweeds like kelp beds. This can negatively impact seaweed harvesting activities currently supporting local livelihoods and harm the populations of WCRL that rely on these kelp beds for recruitment.

- Establishing traffic exclusion zones around the harbour can lead to a reduction in productive fishing areas. However, these zones may also provide benefits by creating protected habitats for resident species. This protection could lead to an increase in the biomass of spawners, which could enhance catches in adjacent fishing areas through a spill-over effect.

- Direct mortality or sublethal damage to target fish and invertebrate species resulting from chemical pollution or oil spills from shipping activity. Oil spills impact all life stages of fish species, but eggs and larvae are particularly vulnerable to this pollution source (Langangen *et al.*, 2017).

- Negative impacts on the behaviour, physiology and survival of target fish and invertebrate species as a result of marine noise pollution from shipping traffic and harbour operations (Di Franco *et al.*, 2020).

4.2 Coastal Livelihoods

The primary coastal livelihoods in the communities of interest near the proposed Boegoebaai development include agriculture, fishing, mining, and tourism (linked to conservation). While the building of infrastructure around the proposed Special Economic Zone (SEZ) may lead to the growth of secondary economic activities and possibly increase job opportunities, it could also have negative impacts on existing livelihoods and communities.

Potential impacts to existing coastal livelihoods may include:

- The proposed harbour development may impact the ecologically sensitive marine ecosystem that could disrupt WCRL and fish migration patterns (for example snoek), which may have negative implications for small-scale fisheries operating downstream.

- Overlapping land use between the proposed SEZ and local farmers may reduce their earning potential by limiting available land for grazing and thus disrupt small-scale livestock practices.

- The proposed SEZ may have negative implications in terms of access by local communities to the Boegoebaai area, which may continue the mining legacy of land dispossession for the Richtersveld community.

- Improved access to potential markets for local produce (such as crops and meat) and raw materials (such as diamonds) through the establishment of infrastructure connected to the SEZ – including roads, railroads, and the harbour, may enhance the economic viability of these activities and lead to opportunities for greater job security and growth (including more available employment) within associated industries. However, this is dependent on what goods can be moved through the harbour and whether it will include other industries or be restricted to use related to energy considerations only.

- An influx of people due to employment opportunities in the proposed SEZ may benefit the local housing market, service providers and businesses in the adjacent communities. However, the proposed development could also have negative implications if local communities are marginalised and sustainable job opportunities are not locally sourced and sustained through skills and capacity development.

- Greater awareness and access to adjacent coastal communities could lead to increased tourism to the area that may benefit local businesses (including increasing employment opportunities) through the expansion of hospitality accommodation, shops and restaurants. However, the construction and normal operation of the proposed SEZ may harm ecologically sensitive areas containing endemic plant life, such as the lichen fields near Alexander Bay, potentially reducing tourism activities in the area.

REFERENCES

Alexkor. 2023. Annual Report. 2023 Integrated Report. Alexkor. https://nationalgovernment.co.za/entity_annual/3542/2023-alexkor-soc-ltd-annual-report.pdf (Accessed 30 October 2024).

Alexkor. 2024. Our community – Alexkor. https://alexkor.co.za/our-community/ (Accessed 29 October 2024).

Allison, E. H., Adger, W. N., Badjeck, M. C., Brown, K., Conway, D., Dulvy, N. K., Halls, A., *et al.* 2005. Effects of climate change on the sustainability of capture and enhancement fisheries important to the poor: analysis of the vulnerability and adaptability of fisherfolk living in poverty. Final Technical Report. Marine Resources Assessment Group, London, UK.

Averweg, U. R., and Leaning, M. 2015. The use of 'Community' in South Africa's 2011 Local Government Elections. Africa Spectrum, 50: 101–111. Institute of African Affairs at GIGA, Hamburg/Germany.

Barange, M., Pillar, S. C., and Hampton, I. 1998. Distribution patterns, stock size and life-history strategies of Cape horse mackerel *Trachurus trachurus capensis*, based on bottom trawl and acoustic surveys. South African Journal of Marine Science, 19: 433–447. Taylor & Francis.

Barnard, A. 1992. The Nama and others. *In* Hunters and Herders of Southern Africa: A Comparative Ethnography of the Khoisan Peoples, pp. 176–198. Cambridge University Press, Cambridge, UK.

BCC. 2013. Benguela Current Commission. http://www.benguelacc.org/index.php/en/about/the-bclme.

Biggs, R., Carpenter, S. R., and Brock, W. A. 2009. Turning back from the brink: detecting an impending regime shift in time to avert it. Proceedings of the National Academy of Sciences, 106: 826–831. Proceedings of the National Academy of Sciences.

Birdlife South Africa. 2015, February 12. Orange River mouth wetlands. https://www.birdlife.org.za/iba-directory/orange-river-mouth-wetlands/ (Accessed 9 October 2024).

Blamey, L. K., Shannon, L. J., Bolton, J. J., Crawford, R. J. M., Dufois, F., Evers-King, H., Griffiths, C. L., *et al.* 2015. Ecosystem change in the southern Benguela and the underlying processes. Journal of Marine Systems, 144: 9–29.

Branch, G. M., May, J., Roberts, B., Russell, E., and Clark, B. M. 2002. Case studies on the socio-economic characteristics and lifestyles of subsistence and informal fishers in South Africa. South African Journal of Marine Science, 24: 439–462.

Brick, K., and Hasson, R. 2016. Valuing the socio-economic contribution of fisheries and other marine uses in South Africa. Cape Town: University of Cape Town.

Britz, P., Sauer, W., Mather, D., and Philips, L. 2000. Towards equity, sustainability and stability: a sector planning approach to fishing and mariculture development in the Northern Cape Province, South Africa. Proceedings of the Tenth Biennial Conference of the International Institute of Fisheries Economics and Trade.

Capmarine. 2017. Spatial distribution of West Coast fisheries in relation to Alexkor's marine mining concession areas. Capricorn Marine Environmental (Pty) Ltd. https://sahris.sahra.org.za/sites/default/files/additionaldocs/Appendix2_4_Fisheries_Spatial_Distribution.pdf (Accessed 7 October 2024).

Carstens, P. R. 2011. Port Nolloth: The Making of a South African Seaport. Xlibris Corporation., Bloomington, IN, USA. 239 pp.

Christianson, B. 2024, August 25. In a village in South Africa, a lone sea shepherd guides small boats home. https://www.aljazeera.com/features/2024/8/25/shepherd-of-the-sea-guiding-small-boats-home-in-south-africa (Accessed 18 November 2024).

Clark, B. M., Hauck, M., Harris, J. M., Salo, K., and Russell, E. 2002. Identification of subsistence fishers, fishing areas, resource use and activities along the South African coast. African Journal of Marine Science, 24: 425–437.

Clay, P. M., and Olson, J. 2007. Defining fishing communities: issues in theory and practice. Annals for Anthropological Practice, 28: 27–42.

Coetzee, J., de Moor, C., van der Lingen, C., and Butterworth, D. 2022. A summary of the South African sardine (and anchovy) fishery. report. University of Cape Town. https://zivahub.uct.ac.za/articles/report/A_summary_of_the_South_African_sardine_and_anchovy_fishery/22146596/1 (Accessed 13 December 2024).

Coetzee, J. C., Van Der Lingen, C. D., Hutchings, L., and Fairweather, T. P. 2008. Has the fishery contributed to a major shift in the distribution of South African sardine? ICES Journal of Marine Science, 65: 1676–1688.

Colburn, L. L., Clay, P. M., Olson, J., Pinto da Silva, P., Smith, S. L., Westwood, A., and Ekstrom, J. 2010. Community Profiles for Northeast U.S. Marine Fisheries. NOAA Fisheries.

Crawford, R., Shannon, L., and Pollock, D. 1987. The Benguela ecosystem. Part IV: the major fish and invertebrate resources. Oceanogr. Mar. Biol. Ann. Rev.: 353–505.

Crouth, G. 2023, March 9. Sea Harvest takes another bite out of Viking Aquaculture. https://www.dailymaverick.co.za/article/2023-03-09-sea-harvest-takes-another-bite-out-of-viking-aquaculture/ (Accessed 7 November 2024).

CSIR. 2024. Strategic Environmental Assessment for the proposed Boegoebaai Port, SEZ and Namakwa Region Bid Document. Council of Scientific and Industrial Research (CSIR). https://www.csir.co.za/sites/default/files/Documents/BID_%20SEA%20for%20Boegoebaai%20Port%20and%20Namakwa%20Region_2024-07.pdf.

da Silva, C., Booth, A., Dudley, S., Kerwath, S., Lamberth, S., Leslie, R., McCord, M., *et al.* 2015. The current status and management of South Africa's chondrichthyan fisheries. African Journal of Marine Science, 37: 233–248. Taylor & Francis.

DAFF. 2012. Policy for the small scale fisheries sector in South Africa. 474.

DAFF. 2016. Status of the South African Marine Fishery Resources 2016. Pretoria, South Africa.

De Beers Group. 2015. Diamond mining supply vessel Aukwatowa is launched. http://www.debeersgroup.com/creating-stories/2015/diamond-mining-supply-vessel-aukwatowa-is-launched (Accessed 4 November 2024).

DEFF. 2018. Fishing Rights Register for all Commercial Fishing Sectors. https://www.dalrrd.gov.za/Branches/Fisheries-Management/-Fishing-Rights-Allocation-Process-FRAP 20 October 2021.

DFFE. 2021. Policy on the allocation and management of commercial fishing rights in the hake longline fishery. DFFE, Cape Town.

DFFE. 2022. Aquaculture Yearbook 2022 Status of the Sector (South Africa). https://www.dffe.gov.za/sites/default/files/reports/research/fisheries/aquacultureyearbook2022.pdf.

DFFE. 2023a. Status of the South African Marine Fishery Resources 2023. Department of Forestry, Fisheries and the Environment. https://api.odp.saeon.ac.za/catalog/SAEON/go/10.15493/DFFE.10000006 (Accessed 12 October 2024).

DFFE. 2023b. General published reasons for decisions on appeal: Traditional Linefish sector Fishing Right Allocation Process 2021/2022.

Di Franco, E., Pierson, P., Di Iorio, L., Calò, A., Cottalorda, J. M., Derijard, B., Di Franco, A., *et al.* 2020. Effects of marine noise pollution on Mediterranean fishes and invertebrates: a review. Marine Pollution Bulletin, 159: 111450.

Dufois, F., and Rouault, M. 2012. Sea surface temperature in False Bay (South Africa): Towards a better understanding of its seasonal and inter-annual variability. Continental Shelf Research, 43: 24–35.

Eggers, J., Cochrane, K., and Sauer, W. 2022. Estimating the economic income and social contributions derived from the South African west coast rock lobster fishery. African Journal of Marine Science, 44: 255–269.

FAO. 2014. Voluntary guidelines for securing sustainable small-scale fisheries in the context of food security and poverty eradication. Food and Agricultural Organisation, Rome. 18 pp.

Fleminger, D. 2024a. Richtersveld World Heritage Site - South Africa. https://southafrica.co.za/richtersveld-world-heritage-site.html (Accessed 3 December 2024).

Fleminger, D. 2024b. Port Nolloth Attractions, Northern Cape, South Africa. https://southafrica.co.za/port-nolloth-attractions.html (Accessed 5 November 2024).

Fowler, J. L., and Boyd, A. J. 1998. Transport of anchovy and sardine eggs and larvae from the western Agulhas bank to the west coast during the 1993/94 and 1994/95 spawning seasons. African Journal of Marine Science, 19. https://www.ajol.info/index.php/ajms/article/view/66332 (Accessed 12 December 2024).

Gadd, A. 2024. History of Kleinzee, Northern Cape, South Africa. https://southafrica.co.za/history-kleinzee.html (Accessed 5 November 2024).

Gammage, L.C., and Jarre, A. 2020. Using structured decision-making tools with marginalised fishers to promote system-based fisheries management approaches. Frontiers in Marine Science, 7.

Gammage, L. C., Jarre, A., and Mather, C. 2017. A case study from the southern Cape linefishery 1: The difficulty of fishing in a changing world. South African Journal of Science, 113: 1–8. Academy of Science of South Africa.

Gammage, L. C., Jarre, A., and Mather, C. 2019. A changing fishery system: perspectives from crew in the southern Cape's handline fishery. South African Geographical Journal, 101: 210–252. Routledge.

Griffiths, C. L., and Branch, G. M. 1997. The exploitation of coastal invertebrates and seaweeds in South Africa: historical trends, ecological impacts and implications for management. Transactions of the Royal Society of South Africa, 52: 121–148. Taylor & Francis.

Griffiths, C. L., Robinson, T. B., Lange, L., and Mead, A. 2010. Marine Biodiversity in South Africa: An Evaluation of Current States of Knowledge. PLoS ONE, 5: e12008.

Griffiths, M. H. 2002. Life history of South African snoek, Thyrsites atun (Pisces: Gempylidae): a pelagic predator of the Benguela ecosystem. Fishery Bulletin, 100: 690–711. National Marine Fisheries Service.

Grüss, A., Yemane, D., and Fairweather, T. 2016. Exploring the spatial distribution patterns of South African Cape hakes using generalised additive models. African Journal of Marine Science, 38: 395–409.

Hara, M., Greenberg, S., Thow, A. M., and Chimarito, S. 2017. Trade and investment in fish and fish products between South Africa and the rest of SADC: implications for food and nutrition security'. Working Paper 47. PLAAS, UWC, Cape Town. https://uwcscholar.uwc.ac.za:8443/server/api/core/bitstreams/1b603071-714c-41fb-b73f-49f95ff9970d/content.

Hondeklip.co.za. 2024. History of Hondeklipbaai. https://hondeklip.co.za/index-main.php/history-of-hondeklipbaai/ (Accessed 20 November 2024).

Huggett, J. A., Boyd, A. J., Hutchings, L., and Kemp, A. D. 1998. Weekly variability of clupeoid eggs and larvae in the Benguela jet current: implications for recruitment. African Journal of Marine Science, 19. https://www.ajol.info/index.php/ajms/article/view/66333 (Accessed 12 December 2024).

Human, L. 2021, December 15. Meet the woman at the centre of Port Nolloth's crayfish trade. https://groundup.org.za/article/meet-the-woman-at-the-centre-of-port-nolloths-crayfish-trade/ (Accessed 1 December 2024).

Hutchings, L., Beckley, L. E., Griffiths, M. H., Roberts, M. J., Sundby, S., and Van Der Lingen, C. 2002. Spawning on the edge: spawning grounds and nursery areas around the southern African coastline. Marine and Freshwater Research, 53: 307.

Hutchings, L., van der Lingen, C. D., Shannon, L. J., Crawford, R. J. M., Verheye, H. M. S., Bartholomae, C. H., van der Plas, A. K., *et al.* 2009. The Benguela Current: An ecosystem of four components. Progress in Oceanography, 83: 15–32. Pergamon.

IKI. 2024. Northern Cape. https://letsrespondtoolkit.org/municipalities/northern-cape/ (Accessed 9 December 2024).

Infrastructure News. 2017. Operation Phakisa project completed at Port Nolloth. https://infrastructurenews.co.za/2017/11/21/operation-phakisa-project-completed-at-port-nolloth/ (Accessed 4 November 2024).

Isaacs, M. 2013. Small-scale fisheries governance and understanding the Snoek (*Thyrsites atun*) supply chain in the Ocean View fishing community, Western Cape, South Africa. Ecology and Society, 18: 17.

Isaacs, M., and Hara, M. 2015. Backing small-scale fishers: opportunities and challenges in transforming the fish sector. Institute for Poverty Land and Agrarian Studies (PLAAS).

Jansen, T., Kainge, P., Singh, L., Wilhelm, M., Durholtz, D., Strømme, T., Kathena, J., *et al.* 2015. Spawning patterns of shallow-water hake (*Merluccius capensis*) and deep-water hake (*M. paradoxus*) in the Benguela Current Large Marine Ecosystem inferred from gonadosomatic indices. Fisheries Research, 172: 168–180.

Japp, D., and Wilkinson, S. 2021. Environmental impact assessment for marine prospecting activities in South African sea areas 14B, 15B and 17B West Coast, South Africa. Commercial fisheries assessment, Belton Park Trading: Concession 14b, 15b, 17b. SLR.

Jarre, A., Ragaller, S. M., and Hutchings, L. 2013. Long-term, ecosystem-scale changes in the southern Benguela marine pelagic social-ecological system: interaction of natural and human drivers. Ecology and Society, 18.

Jarre, A., Hutchings, L., Kirkman, S. P., Kreiner, A., Tchipalanga, P. C. M., Kainge, P., Uanivi, U., *et al.* 2015. Synthesis: climate effects on biodiversity, abundance and distribution of marine organisms in the Benguela. Fisheries Oceanography, 24: 122–149.

Jarre, A., Shannon, L. J., Cooper, R., Duggan, G. L., Gammage, L. C., Lockerbie, E. M., McGregor, E. S., *et al.* 2018. Untangling a Gordian knot that must not be cut: Social-ecological systems research for management of southern Benguela fisheries. Journal of Marine Systems, 188: 149–159. Elsevier.

Jurgens, N., and Niebel, A. 1991. The unknown Lichen Hill. Veld & Flora: 24–26.

Kainge, P., Kjesbu, O., Thorsen, A., and Salvanes, A. 2007. Merluccius capensis spawn in Namibian waters, but do M. paradoxus? African Journal of Marine Science, 29: 379–392. Taylor & Francis.

Kritzinger, R. 2024, September 20. Nama Khoi growing tourism potential beyond its flower season. https://nc.da.org.za/2024/09/nama-khoi-growing-tourism-potential-beyond-its-flower-season (Accessed 7 November 2024).

Langangen, Ø., Olsen, E., Stige, L. C., Ohlberger, J., Yaragina, N. A., Vikebø, F. B., Bogstad, B., *et al.* 2017. The effects of oil spills on marine fish: implications of spatial variation in natural mortality. Marine Pollution Bulletin, 119: 102–109.

Lazorko, T. 2024, June 3. Namaqualand Flowers. https://rove.me/to/south-africa/namaqualand-daisies (Accessed 5 November 2024).

Manning, P. R. 1998. Managing Namibia's marine fisheries: Optimal resource use and national development objectives. London School of Economics and Political Science (United Kingdom), England. 309 pp. https://www.proquest.com/docview/1615961904/abstract/ABAB5223A9A74BFEPQ/1 (Accessed 12 December 2024).

Marais, C. 2023. Alexander Bay: Memories of a diamond dorp on the West Coast. https://www.dailymaverick.co.za/article/2023-04-04-diamond-rush-the-precious-memories-of-a-diamond-dorp-on-the-west-coast/ (Accessed 11 December 2024).

Martins, I. M. M., Gammage, L. C. C., Jarre, A., and Gasalla, M. A. 2019. Different but similar? Exploring vulnerability to climate change in Brazilian and South African small-scale fishing communities. Human Ecology, 47: 515–526.

Masifundise. 2018, February 26. Coastal Mining Threats Small-scale Fishers' Livelihoods Along the Northern Cape Coastline. https://www.masifundise.org/coastal-mining-threats-small-scale-fishers-livelihoods-along-northern-cape-coastline/ (Accessed 26 August 2024).

Masifundise. 2022, October 27. Fishing Community Profile: Port Nolloth. https://www.masifundise.org/fishing-community-profile-port-nolloth/ (Accessed 21 August 2024).

Masson, E. 2022, July 3. War for diamonds: toil and triumph on the rich barren plains. https://mg.co.za/news/2022-07-03-war-on-diamonds-toil-and-triumph-on-the-rich-barren-plains/ (Accessed 20 September 2024).

Masterson. 2021, October 10. The West Coast's oil and gas frenzy. https://protectthewestcoast.org/post/the-west-coasts-oil-and-gas-frenzy/ (Accessed 6 December 2024).

McGrath, A. 2024. Fisheries Specialist Assessment. *In* ESIA for Exploration Drilling in Block Northern Cape Ultra Deep, South Africa, p. 130. SLR Consulting (South Africa) Proprietary Limited. https://cdn.sanity.io/files/b0ecix6u/production/ab6b9a01ca0078658a6f52081bcf8144357371a4.pdf (Accessed 4 December 2024).

McGrath, A. M., Hermes, J. C., Moloney, C. L., Roy, C., Cambon, G., Herbette, S., and van der Lingen, C. D. 2020. Investigating connectivity between two sardine stocks off South Africa using a high-resolution IBM: retention and transport success of sardine eggs. Fisheries Oceanography, 29: 137–151.

Mhlongo, N., Yemane, D., Hendricks, M., and van der Lingen, C. D. 2015. Have the spawning habitat preferences of anchovy (Engraulis encrasicolus) and sardine (Sardinops sagax) in the southern Benguela changed in recent years? Fisheries Oceanography, 24: 1–14.

Municipalities of South Africa. 2024. Municipalities of South Africa: Northern Cape Municipalities. https://municipalities.co.za/provinces/view/7/northern-cape (Accessed 19 September 2024).

Namakwa District Municipality. 2023. Municipality Vulnerability Assessment and Climate Change Response Plan. Local Government Climate Change Support Program. https://www.namakwa-dm.gov.za/wp-content/uploads/2023/04/Northern-Cape-Climate-Change-Response-Plan-Namakwa-2023.pdf.

Namakwa-Info. 2024. Hondeklip Bay Travel Information. https://www.namakwa-info.co.za/region/town/521 (Accessed 29 October 2024).

Namakwa-info. 20924. Kleinzee Travel Information. https://www.namakwa-info.co.za/region/town/523 (Accessed 8 November 2024).

Northern Cape Provincial Government. 2024. Northern Cape Socio-Economic Review 2024. https://www.treasury.gov.za/documents/provincial%20budget/2024/5.%20Guide%20to%20the%20Budget/NC/Northern%20Cape%20Socio-Economic%20Review%202024.pdf.

Nortje, J. M., and van Wyk, B.-E. 2019. Useful plants of Namaqualand, South Africa: a checklist and analysis. South African Journal of Botany, 122: 120–135.

Ortega-Cisneros, K., Cochrane, K. L., Rivers, N., and Sauer, W. H. H. 2021. Assessing South Africa's Potential to Address Climate Change Impacts and Adaptation in the Fisheries Sector. Frontiers in Marine Science, 8.

Penney, A. J., Krohn, R. G., and Wilke, C. G. 1992. A description of the South African tuna fishery in the. ICCAT Col. Vol. Sci. Pap 29, no. 1: 247–253.

Ramasar, V. 2004. Northern Cape State of the Environment Report 2004: Marine and Coast Specialist Report. Department of Tourism, Environment & Conservation.

Ramsar. 1995. Orange River Mouth | Ramsar Sites Information Service. https://rsis.ramsar.org/ris/744 (Accessed 1 December 2024).

Reddy, M. 2021, December 1. Gupta ghosts still haunt 'destroyed' Alexkor mine. https://www.news24.com/fin24/companies/all-that-glitters-how-state-capture-hobbled-alexkor-20211130 (Accessed 29 October 2024).

Robinson, T., Griffiths, C. L., Tonin, A., Bloomer, P., and Hare, M. 2005. Naturalized populations of oysters, Crassostrea gigas along the South African coast: distribution, abundance and population structure. Journal of Shellfish Research, 24: 443–450.

Rouault, M., Pohl, B., and Penven, P. 2010. Coastal oceanic climate change and variability from 1982 to 2009 around South Africa. African Journal of Marine Science, 32: 237–246.

Roy, C., and Fréon, P. 2001. An empirical model of anchovy recruitment variability in the southern Benguela. Small pelagic fishes and climate change programme, GLOBEC Report No.16. Cape Town, South Africa.

Roy, C., van der Lingen, C., Coetzee, J., and Lutjeharms, J. 2007. Abrupt environmental shift associated with changes in the distribution of Cape anchovy Engraulis encrasicolus spawners in the southern Benguela. African Journal of Marine Science, 29: 309–319. Taylor & Francis.

RSA. 2014. Marine Living Resources Amendment Act No 587 of 2014. Republic of South Africa Government Gazette: 1–4. Republic of South Africa.

Ruzicka, J., Chiaverano, L., Coll, M., Garrido, S., Tam, J., Murase, H., Robinson, K., *et al.* 2024. The role of small pelagic fish in diverse ecosystems: knowledge gleaned from food-web models. Marine Ecology Progress Series, 741: 7–27.

SABC. 2023, August 7. Illegal mining continues in SA mine despite deaths. http://web.sabc.co.za/sabc/home/channelafrica/news/details?id=264b7b97-6eea-49e3-8dd4-ad6d58551fa3&title=Illegal%20mining%20continues%20in%20SA%20mine%20despite%20deaths (Accessed 7 November 2024).

SAHistory.org. 2020, August 24. Hondeklipbaai, Namaqualand. https://www.sahistory.org.za/place/hondeklipbaai-namaqualand (Accessed 8 November 2024).

Showme South Africa. 2012. Alexander Bay, Northern Namaqualand, Diamond Coast - ShowMe South Africa. https://showmesa.co.za/alexander-bay-northern-namaqualand-diamond-coast/ (Accessed 7 October 2024).

Sink, K. J., Van Der Bank, M. G., Majiedt, P. A., Harris, L. R., Atkinson, L. J., Kirkman, S. P., and Karenyi, N. F. 2019. South African National Biodiversity Assessment 2018 Technical Report Volume 4: Marine Realm. South African National Biodiversity Institute, Pretoria, South Africa. http://hdl.handle.net/20.500.12143/6372.

Soudens, C. 2022. Dear Barbara Creecy, how can we celebrate Women's Day when our women's and environmental rights are violated? https://www.dailymaverick.co.za/article/2022-08-04-dear-barbara-creecy-our-womens-and-environmental-rights-are-violated/ (Accessed 1 December 2024).

South African Fisheries Development Fund. 2021. Skipper's Training – Northern Cape – South African Fisheries Development Fund. https://fisheriesfund.co.za/cases/skippers-training-northen-cape/ (Accessed 7 October 2024).

Southafrica.com. 2024. Port Nolloth, South Africa. https://www.southafrica.com/regions/northern-cape/port-nolloth/ (Accessed 4 November 2024).

South-North Tourism Route (SNTR) initiative. 2024. Alexander Bay - SNTR Diamond Coast Route. https://south-north.co.za/diamond_rt_alexbay.html (Accessed 29 October 2024).

Sowman, M., and Raemaekers, S. 2018. Socio-ecological vulnerability assessment in coastal communities in the BCLME region. Journal of Marine Systems, 188: 160–171. Elsevier.

Sowman, M., and Sunde, J. 2021. A just transition? Navigating the process of policy implementation in small-scale fisheries in South Africa. Marine Policy, 132: 104683.

StatsSA. 2011. Census 2011: statistics by place. https://www.statssa.gov.za/?page_id=964. https://www.statssa.gov.za/?page_id=4286 (Accessed 5 November 2024).

StatsSA. 2022. Statistics South Africa | Census Dissemination. https://census.statssa.gov.za/#/province/3/2 (Accessed 28 October 2024).

Stenevik, E. K., Verheye, H. M., Lipinski, M. R., Ostrowski, M., and Strømme, T. 2008. Drift routes of Cape hake eggs and larvae in the southern Benguela Current system. Journal of Plankton Research, 30: 1147–1156.

Strømme, T., Lipinski, M. R., and Kainge, P. 2016. Life cycle of hake and likely management implications. Reviews in Fish Biology and Fisheries, 26: 235–248.

Teske, P. R., Emami-Khoyi, A., Golla, T. R., Sandoval-Castillo, J., Lamont, T., Chiazzari, B., McQuaid, C. D., *et al.* 2021. The sardine run in southeastern Africa is a mass migration into an ecological trap. Science Advances, 7: eabf4514.

Tracks4Africa. 2018. Kleinzee. https://tracks4africa.co.za/listings/item/w136589/kleinzee/ (Accessed 7 November 2024).

Tracks4Africa. 2024. Tracks4Africa. https://tracks4africa.co.za/listings/item/w136618/hondeklip-bay/ (Accessed 7 November 2024).

Travelleeto. 2023. Hondeklipbaai - everything you need to know! https://travelleeto.com/hondeklipbaai/ (Accessed 20 November 2024).

Troell, M., Robertson-Andersson, D., Anderson, R. J., Bolton, J. J., Maneveldt, G., Halling, C., and Probyn, T. 2006. Abalone farming in South Africa: An overview with perspectives on kelp resources, abalone feed, potential for on-farm seaweed production and socio-economic importance. Aquaculture, 257: 266–281.

van der Lingen, C. D., Hutchings, L., Merkle, D., Van der Westhuizen, J. J., and Nelson, J. 2001. Comparative spawning habitats of anchovy (Engraulis capensis) and sardine (Sardinops sagax) in the southern Benguela upwelling ecosystem. Spatial processes and management of marine populations, 185, p.209. *In* Spatial Processes and Management of Marine Populations. University of Alaska Sea Grant., Anchorage, USA.

van der Lingen, C. D., and Huggett, J. A. 2003. The role of ichthyoplankton surveys in recruitment research and management of South African anchovy and sardine. *In* Proceedings of the 26th Annual Larval Fish Conference (Eds H.I. Browman & A. B. Skiftesvik), pp. 303–343. Institute of Marine Research, Bergen, Norway.

van der Lingen, C. D. 2021. Adapting to climate change in the South African small pelagic fishery. Adaptive management of fisheries in response to climate change: 177–194. FAO Fisheries and Aquaculture Rome, Italy.

Van der Merwe, J. 2020. Kleinzee … more than a diamond. http://www.westcoastjournal.co.za/2/post/2020/01/kleinzee.html (Accessed 20 November 2024).

Van Dyk, J. 2021. Diamonds are forever: (Re)building the archive of a prototypical mining town. University of Stellenbosch, Stellenbosch. 208 pp.

Van Zyl, M. 2009. Ocean, time and value: Speaking about the sea in Kassiesbaai. Anthropology Southern Africa, 32: 48–58. Taylor & Francis.

Vanessa. 2011, December 20. De Beers Diamond Coast 4x4 Tours, Northern Cape Coast. https://showmesa.co.za/de-beers-diamond-coast-4x4-tours-northern-cape-coast/ (Accessed 6 November 2024).

Wilkinson, S., and Coppin, R. 2024. Specialist Fisheries Assessment. *In* Impact assessment for a prospecting right application for sea areas 11A,12A, West Coast, South AFrica. SLR Consulting.

Williams, S. 2021. 'I fish because I am a fisher': Exploring livelihood and fishing practices to justify claims for access to small scale fisheries resources in South Africa. HTS Teologiese Studies/Theological Studies, 77.

Yeld, J. 2024, April 12. Alexkor vs Creecy in environment court battle. https://groundup.org.za/article/namaqualand-diamond-mining-coastal-dam-in-high-court-dispute/ (Accessed 7 October 2024).

Appendix 1

Key coastal livelihood activity typologies

Coastal Livelihood Activity	Stakeholder Category	Stakeholders Involved	Stakeholder Description
Provincial			
Conservation	Environmental NGOs	The Conservation Act Trust	The overriding goal of the Conservation Action Trust is to save and protect specifically identified species of fauna and flora from threats of destruction or extinction by promoting widespread and impartial investigation and reporting on important conservation and environmental issues. We hope to foster broader awareness and bring about greater public support of vital conservation and environmental issues. E.g. Seismic oil surveys on West Coast pose threat to marine food chain.
		Protect the West Coast (PTWC)	Protect the West Coast (PTWC) is a not-for-profit organisation (NPO) established in 2020 by a group of concerned citizens who wanted to put a stop to the illegal and destructive mining activities which are running rampant on South Africa's West Coast. The team comprises a collective of concerned South Africans (including scientists, journalists, activists, legal and media experts) who work for the organisation to ensure that mining on the West Coast of South Africa is conducted with the correct and proper oversight in accordance with fundamental principles of the law
		SANPARKS	System of sustaining national parks reconnecting and inspiring society.
		Endangered Wild Life Trust	The Endangered Wildlife Trust is dedicated to conserving threatened species and ecosystems in southern and East Africa to the benefit of all.
Alexander Bay			
Mining	State-owned enterprises	Alexkor Mining Company	The primary diamond mining company in Alexander Bay, historically managing both land and marine diamond mining concessions. Current operations are scaled down but employ contractors and community-based marine divers.

Coastal Livelihood Activity	Stakeholder Category	Stakeholders Involved	Stakeholder Description
	Private Sector/ Contractors	PSJV Contractors	Private marine diving contractors work under the Pooling and Sharing Joint Venture (PSJV), using hand-operated suction devices to collect diamond-bearing gravel.
		Eco- Atlantic Oil and Gas	Eco Atlantic has a strategic portfolio of offshore projects in Namibia and South Africa (Africa) in partnership with major energy companies and large independents.
		Kazera Global PLC	Kazera Global is a diamond mining operation in Alexander Bay.
	Community Based Organisations	Richtersveld Mining Company	Represents the Richtersveld community's interests in the PSJV; supports the Richtersveld community's economic inclusion in diamond mining after winning land rights.
Fisheries and aquaculture	Community Groups	Local Nama Fishers	Traditionally involved in subsistence fishing, mainly for personal consumption, and angling for recreation; limited rights for commercial fishing are evident.
		Richtersveld Local Council	Engaged in discussions with Alexkor to revive the oyster farm as part of a mariculture venture aimed at local economic development.
		Alexander Bay Angling Club	
Tourism	State-owned enterprises	Alexkor Tourism Initiatives	Initially funded the Diamond Coast tourism website, operated guesthouses, and provided mine tours; however, few initiatives remain active.
	Private Sector	Local Tourism Office	Manages limited tourism information at town entrance; organised through Namakwa Info but lacks consistent services due to operational closures.
	Private Sector	Hospitality	Local residents or property owners offering short-term rentals, catering mainly to visitors. Airbnb is not formally organised but represents informal economic activity that complements local tourism efforts. Small guesthouses or lodges, often family-owned, providing accommodation to tourists and contractors. These lodges are key for promoting local tourism and supporting the hospitality economy.
	Community based organisations	Richtersveld Transfrontier Conservation Park (TFCA)	Richtersveld TFCA, although primarily operated through Sendelingsdrif, promotes conservation and attracts nature-based tourism. Alexander Bay benefits indirectly as a nearby attraction.
	Recreational Activities	Alexander Bay Golf Club, Tennis & Squash Courts, Rugby Field,	Provide recreational sporting facilities for residents and visitors; also encourage local tourism and social cohesion.

Coastal Livelihood Activity	Stakeholder Category	Stakeholders Involved	Stakeholder Description
Agriculture	Private Sector	Richtersveld Growers	Private-public partnership operating the Beauvallon Farm; employs local residents and teaches Alexander Bay High School students agricultural techniques.
		John Livestock PTY	Livestock farming production in Alexander Bay
	Educational Institutions	Alexander Bay High School	Offers agricultural science courses and runs farming programs for students on community-owned land. The curriculum is aimed at promoting local agricultural skills development.
Port Nolloth			
Fisheries	Small-Scale Fisheries	Aukotowa Small-scale Fisheries Cooperative	Established in 2018 with 103 members, supporting 75 households, primarily Khoisan/Nama descendants. They operate 8 fishing boats and 18 lobster vessels, focusing on small-scale, nearshore fishing, and face challenges with restricted fishing grounds and infrastructure decay. Around 25% of the Aukotowa Cooperative's members are youth, playing an essential role in the fishery's future; however, they face limited access to traditional fishing grounds and declining economic opportunities.
		Small-scale Fishers	Traditional fishers using small boats (bakkies) close to shore, limited to less than 5% of traditional grounds due to mining access restrictions, leading to economic hardship.
	Commercial Fishers	Contracted Commercial Fishers	Cooperative contracted Premier Fishing and Brands Limited (Pty) Ltd. for offshore commercial species, including WCRL and hake, with additional local companies licensed for pelagic species and sardine bycatch.
	Fish Processing Facilities	Noordkaap Visserman Onderneming BK, Port Lobster (Pty) Ltd	Processing facilities granted licenses in 2018 to support local fishers and provide processing jobs; Noordkaap facility is no longer operational.
	Indigenous and Traditional Groups	Traditional Nama Groups	Indigenous Nama communities with deep cultural ties to the area, including traditional fishing and seal hunting. Face economic and social impacts from fishing and mining restrictions that limit cultural practices.
	Community Workforce	Women Former Fish Factory Workers	Previously employed in the fish processing factory until its closure in 1993, many have since experienced limited employment options due to the sector's instability, especially affecting women's economic security.

Coastal Livelihood Activity	Stakeholder Category	Stakeholders Involved	Stakeholder Description
Mining	Diamond Mining	Alexkor De Beers Group Giga Marine	Operates coastal diamond mining, affecting fishing grounds and marine ecosystems due to practices such as cofferdam construction, which locals believe harms target fish species.
	Diamond Miners	Local Miners	Provides local employment but limits Port Nolloth's economic diversification due to mining's restriction of coastal access for other activities.
Tourism	Hospitality	Accommodation	Locals providing accommodation for tourists and contractors as Airbnb Hosts. Airbnb helps diversify the economy by attracting visitors to the area, which has limited tourism infrastructure. Lodges offer accommodation for tourists and contractors, supporting the hospitality sector, often collaborating with local tour operators to showcase cultural heritage.
Kleinzee			
Fisheries and aquaculture	Aquaculture Companies	Diamond Coast Aquaculture (Pty) Ltd	Holds seaweed harvesting rights (2017–2032) and operates an abalone farm on a 400-hectare site within a diamond concession area, producing 120 tons of abalone per year and distributing through Viking Aquaculture.
		Port Nolloth Sea Farms	Operates an abalone ranch near Kleinsee, employing 10 local residents. The operation has the capacity to expand to 20-30 employees if licensing issues are resolved, allowing full production potential. Employed by Port Nolloth Sea Farms, with training opportunities provided for diving and aquaculture skills. This creates pathways for workforce development and potential income stability in Kleinzee.
		Viking Aquaculture	Partnered with Diamond Coast Aquaculture for distributing farmed abalone, enhancing Kleinzee's connectivity to national and international seafood markets.
	Aquaculture	Oyster Farming	Kleinzee's dam is being used to grow oysters for export and some of the locals are employed at the abalone aquaculture project, farming abalone in giant tanks. They already produce 100 tons a year.

Coastal Livelihood Activity	Stakeholder Category	Stakeholders Involved	Stakeholder Description
	Recreational Fishing	Kleinzee Angling Club	A community of fishing enthusiasts who come together for recreational or sport fishing. Members gain access to exclusive fishing spots, participate in competitions, and enjoy social events. These clubs also promote sustainable fishing practices, provide educational resources, and foster a supportive network for sharing fishing techniques and conservation efforts. They have a Facebook page. The angling club hosts one angling competition per year, for WCRL.
Mining	Mining Rights Holder	Kleinzee Holdings Proprietary Ltd (led by Melki Mining and HolGoun Investment Holdings)	Recently acquired Buffels Marine Mining Right (BMMR) from De Beers Group in August 2023. Plans to resume mining operations, bringing new employment and economic opportunities to Kleinzee and surrounding areas.
	Former Mining Operator	De Beers Group	Held and operated the BMMR until 2010, conducted rehabilitation of the site, and completed the sale to a qualified operator committed to responsible mining practices. De Beers is also investing in regional socio-economic development, focusing on education, skills development, and job creation.
	Informal (illegal) Small-scale Miners	Zamas-zamas	These are informal miners, including South African nationals and migrants who often enter abandoned mines. They face considerable risks but see mining as a last resort for survival due to a lack of job opportunities and high poverty rates in Namaqualand. Their activities have implications for both local economic resilience and regulatory enforcement. These stakeholders include those who lost jobs or livelihoods during the pandemic and now live in derelict housing left by mining companies. Their experiences reflect the broader economic decline in Namaqualand following the downturn of formal mining and limited local employment opportunities.

Coastal Livelihood Activity	Stakeholder Category	Stakeholders Involved	Stakeholder Description
Tourism	Heritage Eco Adventure Biodiversity	4X4 and Mine Tours Kleinzee Museum Kleinzee Nature Reserve Seal Colony Namaqua Coastal Expeditions Bird Life	Guided tour showcasing diverse natural and historical sites, including diamond mine workings. The Kleinzee Shipwreck Tour is a fantastic trek over the dune fields of the beach. Book the tour at the Kleinzee Tourism office right next door to the Kleinzee Museum, also worth a visit. The shipwreck tour has a 4x4 option of the 37km between Kleinzee and Koingnaas. Informative museum covering the history of diamond mining, natural environment, and early human history in the region. Nature reserve preserving the unique local flora. Home to a resident colony of more than 450,000 seals, protected by the adjacent mining area. The hugely abundant bird life at the Buffels River estuary at Kleinzee attracts birders, whilst the huge Seal colony just north of the beach, with around 350 000 animals right on the beach – the largest on-land colony in the country – is an added attraction.
	Hospitality	Accommodation	Options include Camping, B&Bs, Guest Farms, and Self-Catering cottages, catering to various budgets and providing unique local stays.
	Recreational Activities	Golf and Sports Club	The scenic nine-hole golf course in Kleinzee is on the banks of the Buffel's River. It is a well laid out course which is carefully maintained and offers a challenge to all golfers.
Hondeklipbaai			
Fisheries	Fishing Co-operative	Longtime Hondeklipbaai Fishing Primary Cooperative	Established in 2018, supporting 14 fishermen and 70 households. It plays a community development role by offering Skipper's Training and aims to empower fishermen with essential skills. It also engages in wholesale seafood trade.
	Small-scale Fishers	Individuals Fishers	Local fishermen in Hondeklipbaai hold rights for traditional line fish (2014–2020) and nearshore WCRL (2017–2033), with harvesting primarily focused on WCRL, despite reduced catch due to declining stocks.

Coastal Livelihood Activity	Stakeholder Category	Stakeholders Involved	Stakeholder Description
	Fishers Administration – Employment and Skills	Cooperative Staff	The cooperative employs one administrative clerk, supporting cooperative operations and contributing to local employment opportunities.
	Training Program/ Skills Development Initiatives	Skipper's Training Program	A program supported by the cooperative, aimed at equipping local fishermen with essential maritime skills to strengthen livelihoods and enhance safety in fishing practices.
Tourism	Natural Attractions Outdoor and Eco-Tourism Cultural and Heritage Hospitality and Culinary expenses	Silver Sands Trail Hondeklipbaai Beach Caracal eco-route Die Rooi spinnekop restaurant Hondeklipbaai light house	The Caracal Eco Route provides a 4x4 journey from mountains to coast through the scenic Namaqualand National Park, ideal for nature and adventure enthusiasts. Die Rooi Spinnekop restaurant, named after the local term for crayfish, offers freshly caught seafood on the Cape West Coast, showcasing regional flavours. The Hondeklipbaai Lighthouse, known for its rustic charm, serves as a remote historical landmark with stunning coastal views. The area also features activities like hiking and birdwatching in Namaqua National Park, known for its vibrant wildflowers and coastal scenery.
	Hospitality	Accommodation	Accommodation options in the area include a range of Airbnbs, guest farms, and self-catering cottages, catering to various budgets while offering unique local experiences. Notable choices include The HonneHokke Resort's chalets, Honne-Pondokkies, Fisherman's Cottage, Heuningness Guestfarm, Die Baai se Bek, and Die Baai se Bek Studio. The Hondeklipbaai caravan park is situated very close to the sea but is quite barren. Facilities include ablutions and braai stands.

Appendix 2

2A. Semi-structured questionnaire (English and Afrikaans)

August 2024

Semi-structured Interview Guide (English Version)

1. Name of interviewee (s)	
2. Name of interviewer (s)	
3. Date	
4. Organisation	
5. Role	
6. KII Number	

Interviewer to capture data here:
https://forms.office.com/Pages/ResponsePage.aspx?id=NUNFkk5Wz0ywsCREW4wD9-uEwwlkJ_BAi53Zl-mi2gZUNERFUFdBT0dZWlc0TUMM0hJNTE2TEFMUSQlQCN0PWcu

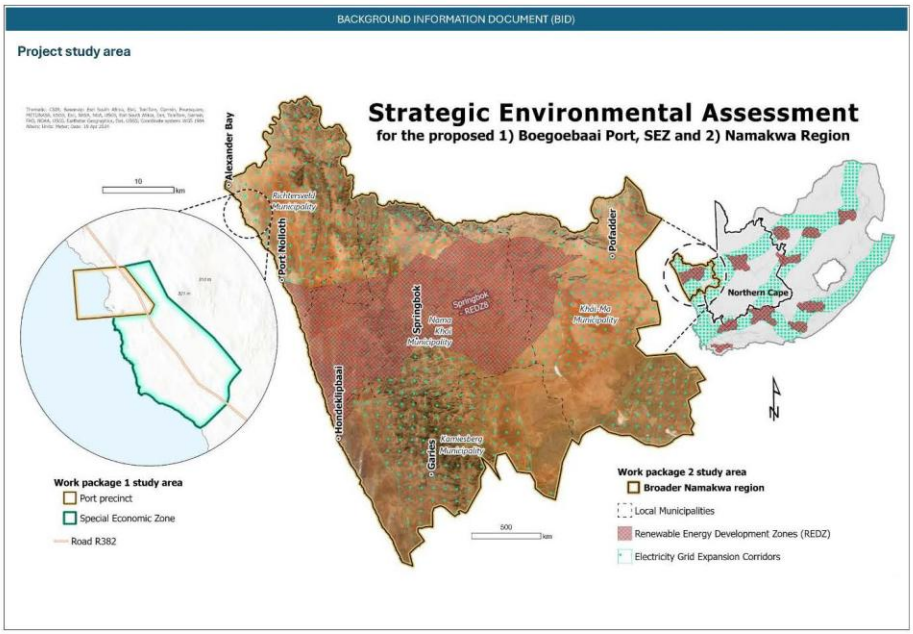
Introduction

Green hydrogen, and its derivative products (e.g., green ammonia and green methanol), provide an opportunity to decarbonise the South African energy economy, generate new revenues, create jobs and skills, and facilitate a Just Energy Transition. As part of South Africa's ambition to become a player in the globally emerging green hydrogen market, a substantial programme of greenfield infrastructure has been proposed in the Northern Cape consisting of three components:

1. A new breakwater port at Boegoebaai, dry and liquid bulk berths, and multi-purpose terminals.
2. A mixed-use Special Economic Zone (SEZ) located in the region adjacent to the proposed Boegoebaai port.
3. An expansive regional renewable energy (wind and solar PV) generation and transmission infrastructure (not the subject of this study).

The Council for Scientific and Industrial Research (CSIR) has been appointed to undertake the proposed development's strategic environmental assessment (SEA). The CSIR has contracted us to provide expert advice on the potential impact of the port and adjacent Special Economic Zone (SEZ) development on fisheries and coastal livelihoods.

1



A SEA is a knowledge-policy tool used to guide sustainability planning at different spatial scales. It encompasses several approaches, methods, and processes to assess the opportunities and risks of proposed development programmes and policies.

This expert group focuses on coastal livelihoods and fisheries to make sure that impacts on fisheries and coastal livelihoods are explicitly considered in the planning process.

Coastal livelihoods (for everyone)

7. Based on your experience, what are the most important livelihoods in this town or area.

8. Why do think these are the most important livelihoods?

9. Based on your experience, how have livelihoods (thinking about fishing, farming, mining, conservation, tourism) changed in the area (or specific town) over the last 10 years?

10. Is Boegoebaai important to you or other people in your community? For example, is Boegoebaai used for recreational activities such as fishing or any other activities

11. If you answered yes to the previous question, please elaborate.

2

12. Does this area hold any cultural or historical significance?

Fisheries

13. Type of fishing activity:

Recreational/Angling

14. Which species does the fishery target?

15. Which permits were allocated to rightsholders?

16. In which geographical area does the fishery operate?

17. What vessels are used in the fishery?

18. How many vessels are used in the fishery?

19. What type of gear is used?

20. How many households are supported by the fishery?

21. How many people are directly employed by the fishery?

22. How many people are indirectly employed by the fishery?

23. What does indirect employment entail?

24. Are the employees also employed elsewhere when not fishing?

25. If you answered yes in the previous question, where are employees employed?

Impacts of the proposed development

26. Based on your experience, would the construction of the Boegoebaai Port have a positive or negative impact on coastal livelihoods?

Positive/Negative/Neutral (select one)

27. List the impacts.

28. Based on your experience, would the construction of the SEZ have a positive or negative impact on coastal livelihoods?

Positive/Negative/Neutral (select one)

29. List the impacts.

30. Based on your experience, would the construction of the Boegoebaai Port have a positive or negative impact on fisheries?

Positive/Negative/Neutral (select one)

31. List the impacts

32. Based on your experience, what impacts would the construction of the SEZ have a positive or negative impact on coastal fisheries?

Positive/Negative/Neutral (select one)

33. List the impacts

Views on potential mitigation measures

32. How can positive impacts (benefits) be leveraged?

33. How can negative impacts be mitigated?

4

August 2024

Semi-gestruktureerde onderhoud gids

(Afrikaans weergawe)

1. Naam van deelnemer (s)	
2. Naam van onderhoudvoerder(s)	
3. Datum	
4. Organisasie	
5. Rol	
6. KII Nommer	

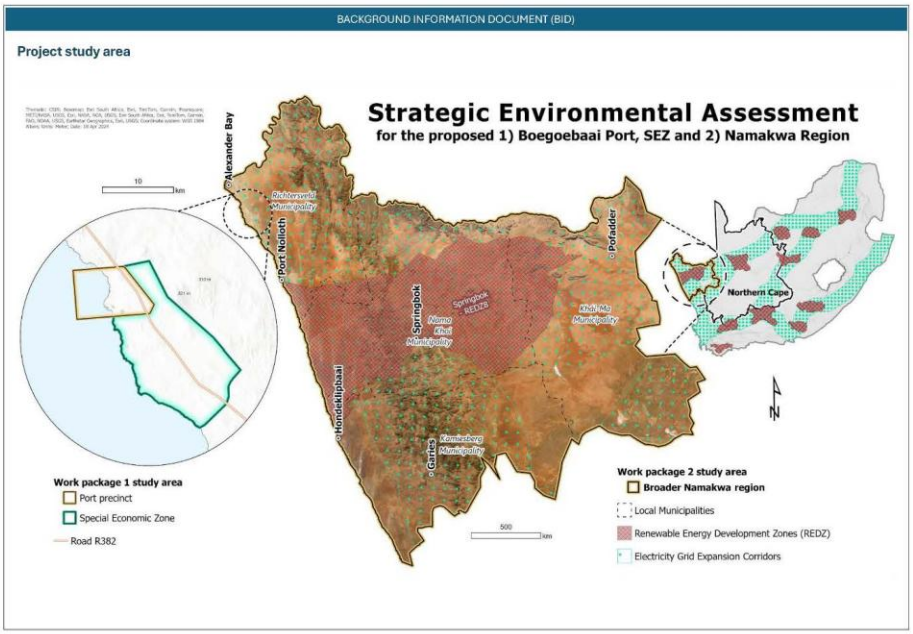
Onderhoudvoerder moet data hier vaslê: https://forms.office.com/Pages/ResponsePage.aspx?id=NUNFkk5Wz0ywsCREW4wD9-uEwwlkJ_BAi53Zl-mi2gZUNERFUFdBT0dZWlc0TUMM0hJNTE2TEFMUSQlQCN0PWcu

Inleiding

Groen waterstof, en sy afgeleide produkte (bv. groen ammoniak en groen metanol), bied 'n geleentheid om die Suid-Afrikaanse energie-ekonomie te de-karboniseer, nuwe inkomste te genereer, werk en vaardighede te skep, en 'n Regverdige Energie-oorgang te fasiliteer. As deel van Suid-Afrika se ambisie om 'n speler in die wêreldwye opkomende groen waterstof mark te word, is 'n infrastruktuur program in die Noord-Kaap voorgestel wat uit drie komponente bestaan:

1. 'n Nuwe breekwater hawe by Boegoebaai, droë en vloeibare grootmaat aanlê plekke, en veeldoelige terminale.
2. 'n Spesiale Ekonomiese Sone (SES) vir gemengde gebruik, geleë in die streek aangrensend aan die voorgestelde Boegoebaai-hawe.
3. Uitgebreide streeks hernubare energie (wind- en sonkrag-) opwekking en transmissie-infrastruktuur (nie die onderwerp van hierdie studie nie).

Die Wetenskaplike en Nywerheidsnavorsingsraad (WNNR) is aangestel om die Strategiese Omgewingsimpak Opname (SOA) te onderneem. Ons is deur die WNNR gekontrakteer om kundige advies te verskaf oor die potensiële impak van die ontwikkeling van die hawe en aangrensende Spesiale Ekonomiese Sone (SES) op bestaande visserye en kus (lewens) bestaan aktiwiteite.



'n SOA is 'n kennis-beleidsinstrument wat gebruik word om volhoubare beplanning op verskillende ruimtelike skale te rig. Dit sluit verskeie benaderings, metodes en prosesse in om die geleenthede en risiko's van voorgestelde ontwikkelingsprogramme en -beleide te assesseer. Hierdie kundige groep fokus op kus (lewens) bestaan aktiwiteite en visserye om seker te maak dat impakte op visserye en kus (lewens) bestaan uitdruklik in die beplanningsproses in ag geneem kan word.

Kus (lewens)bestaan aktiwiteite

7. Gebaseer op jou ervaring, wat is die belangrikste lewens bestaan aktiwiteite in hierdie dorp of gebied?

8. Hoekom dink jy is hierdie die belangrikste lewens bestaan aktiwiteite?

9. Gebaseer op jou ervaring, hoe het lewens bestaan aktiwiteite (dink aan visvang, boerdery, mynbou, bewaring, toerisme) in die gebied (of spesifieke dorp) oor die afgelope 10 jaar verander?

10. Is Boegoebaai vir jou of ander mense in jou gemeenskap belangrik? Byvoorbeeld, word Boegoebaai gebruik vir ontspanningsaktiwiteite soos visvang of enige ander aktiwiteite

11. Indien die antwoord vir die laaste vraag ja was, verduidelik asseblief u antwoord.

12. Hou hierdie gebied enige kulturele of historiese betekenis vir jou?

2

Vissery aktiwiteite

13. Tipe Visvangs aktiwiteit

Kommersieel/ontspanning/albei

14. Watter spesies teiken die vissery?

15. Watter permitte is aan Regshouers toegeken?

16. In watter geografiese gebied vang hierdie vissery vis?

17. Watter vaartuie word in die vissery gebruik?

18. Hoeveel vaartuie word in die vissery gebruik?

19. Watter tipe toerusting word gebruik?

20. Hoeveel huishoudings word deur die vissery ondersteun?

21. Hoeveel mense is direk in diens van die vissery?

22. Hoeveel mense is indirek in diens van die vissery?

23. Wat behels indirekte indiensneming?

24. Is die werknemers ook elders in diens wanneer hulle nie visvang nie?

25. Indien jy ja geantwoord het op die vorige vraag, waar is werknemers in diens?

Impakte van voorgestelde ontwikkeling

26. Gebaseer op jou ervaring, dink jy die bou van die Boegoebaai-hawe sal 'n positiewe of negatiewe impak op kus(lewens)bestaan aktiwiteite hê?

Positief/Negatief/Neutraal (kies een)

27. Lys die impakte.

28. Gebaseer op jou ervaring, sal die bou van die SES 'n positiewe of negatiewe impak op kus(lewens)bestaan hê?

Positief/Negatief/Neutraal (kies een)

29. Lys die impakte.

30. Gebaseer op jou ervaring, sal die bou van die Boegoebaai-hawe 'n positiewe of negatiewe impak op visserye hê?

3

Positief/Negatief/Neutraal (kies een)

31. Lys die impakte.

32. Gebaseer op jou ervaring, wat sal die impak wees van die bou van die SES op kus visserye? Sal dit 'n positiewe of negatiewe impak hê?

Positief/Negatief/Neutraal (kies een)

33. Lys die impakte.

Menings oor potensiële versagting maatreëls

34. Hoe kan positiewe impakte (voordele) benut word?

35. Hoe kan negatiewe impakte verminder word?

4

2B. Consent form (English and Afrikaans)

Proposed Boegoebaai Port and Special Economic Zone (SEZ) development

Fisheries and Coastal Livelihoods Study: Informed Consent Form

Invitation to participate and benefits: You are invited to participate in a study being conducted with key experts on fisheries and coastal livelihoods in the southern Benguela (Northern Cape area). The study aims to understand current fisheries and livelihood activities that may be impacted by the proposed Boegoebaai Port Development and adjacent Special Economic Zone (SEZ) and forms part of a Strategic Environmental Assessment (SEA) being conducted by The Council of Scientific and Industrial Research (CSIR).

Procedures: During this study, you will be asked to complete a semi-structured survey with the assistance of an interviewer.

Recording: We may record audio to capture your detailed responses. If you object to this, please indicate below. Objections to being recorded will not eject you from participating in the study. All personal information and data will be treated in line with the Protection of Information Act (POPIA).

Risks: There are no potentially harmful risks related to your participation in this study.

Feedback: The study's results will be part of the SEA report published by the CSIR. Once finalised, the final report will be available and shared on request. Any queries on the project can be directed to Lizande Kellerman (Lkellerman@csir.co.za).

Disclaimer/Withdrawal: Your participation is completely voluntary; you may refuse to participate and withdraw at any time without having to state a reason and without any prejudice or penalty against you. Should you withdraw, the interviewer commits not to use any of the information you provided without your consent. Note that the interviewer may also withdraw you from the study at any time.

Confidentiality: Your participation in the study will be kept anonymous and pseudonyms will be used if you wish to do so.

What signing this form means: You agree to participate in this research study by signing this consent form. The aim, procedures to be used, as well as the potential risks and benefits of your participation, have been explained verbally to you in detail using this form. Refusal to participate in or withdraw from this study at any time will have no effect on you in any way.

I agree to participate in this research (tick one box)	☐ Yes	☐ No	_____ (Initials)
I agree to be audio-recorded (tick one box)	☐ Yes	☐ No	_____ (Initials)
I which to preserve my anonymity (tick one box)	☐ Yes	☐ No	_____ (Initials)

_____	_____	_____
Name of Participant	Signature of Participant	Date
_____	_____	_____
Name of Interviewer	Signature of Interviewer	Date

Voorgestelde Boegoebaai Hawe en Spesiale Ekonomiese Sone (SES) Ontwikkeling

Vissery en kus- (lewens) bestaan studie: Ingeligte Toestemmingsvorm

Uitnodiging om deel te neem en voordele: U word uitgenooi om deel te neem aan 'n studie wat uitgevoer word met kenners oor visserye en kus lewensbestaan aktiwiteite in die suidelike Benguela (Noord-Kaap gebied). Die studie poog om huidige vissery- en kus lewensbestaan te verstaan wat moontlik deur die voorgestelde Boegoebaai Hawe-ontwikkeling en aangrensende Spesiale Ekonomiese Sone (SES) geraak kan word en vorm deel van 'n Strategiese Omgewings Analise (SOA) wat deur Die Raad vir Wetenskaplike en Nywerheidsnavorsing (WNNR) uitgevoer word.

Prosedures: Tydens hierdie studie sal u gevra word om 'n semi-gestruktureerde opname te voltooi met die hulp van 'n onderhoudvoerder.

Opname: Ons mag klank opneem om u antwoorde vas te lê. As u hierteen beswaar het, dui dit asseblief hieronder aan. Besware teen opname sal u nie van deelname aan die studie uitsluit nie. Alle persoonlike inligting en data sal volgens die Wet op Beskerming van Persoonlike Inligting (POPIA) hanteer word.

Risiko's: Daar is geen potensiële skadelike risiko's verbonde aan u deelname aan hierdie studie nie.

Terugvoer: Die resultate van die studie sal deel wees van die SOA-verslag wat deur die WNNR gepubliseer word. Sodra dit gefinaliseer is, sal die finale verslag beskikbaar wees en op versoek gedeel word. Enige navrae oor die projek kan gerig word aan Lizande Kellerman (Lkellerman@csir.co.za).

Vrywaring/Onthouding: U deelname is heeltemal vrywillig; u mag weier om deel te neem en kan enige tyd onttrek sonder om 'n rede daarvoor te verskaf en sonder enige vooroordeel of straf teen u. Indien u onttrek, verbind die onderhoudvoerder hom/haar daartoe om geen van die inligting wat u verskaf het, sonder u toestemming te gebruik nie. Neem kennis dat die onderhoudvoerder u ook enige tyd uit die studie kan onttrek.

Vertroulikheid: U deelname aan die studie sal anoniem gehou word en skuilname sal gebruik word indien u dit verkies.

Wat dit beteken om hierdie vorm te teken: U stem in om aan hierdie navorsingstudie deel te neem deur hierdie toestemmingsvorm te teken. Die doel, prosedures wat gebruik gaan word, asook die potensiële risiko's en voordele van u deelname, is mondelings aan u verduidelik in detail met behulp van hierdie vorm. Weiering om deel te neem of om te onttrek uit hierdie studie enige tyd sal geen effek op u hê nie.

Ek stem in om aan hierdie navorsing deel te neem (merk een blokkie) ☐ Ja ☐ Nee_____ (Voorletters)

Ek stem in om klankopgeneem te word (merk een blokkie) ☐ Ja ☐ Nee_____ (Voorletters

Ek wil my anonimiteit behou (merk een blokkie) ☐ Ja ☐ Nee_____ (Voorletters

_____	_____	_____
Naam van deelnemer	Handtekening van deelnemer	Datum
_____	_____	_____
Naam van onderhoudvoerder	Handtekening van onderhoudvoerder	Datum

CHAPTER 7

Sustainable port planning

CHAPTER 7:
Sustainable port planning

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Recommended citation: Taljaard, S. & Weerts, S. (2025) *Chapter 7: Sustainable port planning* in Schreiner, G., Mqokeli, B., Snyman-van der Walt, L. Lochner, L. and Tsedu, R. (eds.). (2025). *Work Package1: Strategic Environmental Assessment for the proposed Boegoebaai Port and Special Economic Zone*. CSIR/SPLS/Ems/EXP/2025/1107/A, CSIR: Pretoria: ISBN 978-0-7988-5675-1. Available at Boegoebaai Port | CSIR

Executive Summary

Purpose

Ports have experienced phenomenal growth over the past decades, not without negative environmental and societal impacts. With growing public awareness and regulatory pressures, ports around the world are obliged to account for these externalities and can no longer operate without acknowledging and incorporating societal and environmental considerations in their planning and management. Therefore, 'Sustainable Port Development' advocates a balance between economic growth, environmental protection, and social progress to secure their long-term 'license to operate'. Climate change impacts also require improved climate resilience in port planning and development.

In South Africa, Transnet is a State-Owned Company (SOC) signs an annual Shareholder's Compact with the Government. This Compact mandates Transnet to deliver on numerous strategic deliverables, including **sustainable economic, social and environmental outcomes**. As one of the five operating divisions of Transnet SOC Ltd, Transnet National Ports Authority (TNPA) is subject to these strategic deliverables, including sustainability performance at the country's commercial ports. The TNPA, therefore, recognises the importance of sustainability, also in the planning of a port, in this case the proposed Port of Boegoebaai.

The purpose here is to inform sustainability planning for the proposed Port of Boegoebaai. Acknowledging and addressing sustainability early on from the planning phase of a new port development will enable timeous identification of potential challenges and opportunities and inform appropriate interventions and solutions towards achieving sustainability. First a Framework for Sustainable Port Planning and Development (SPP&D) is posed, drawing on best practice (international, regionally and nationally), and aligned with TNPA's current sustainability initiatives. Thereafter, key sustainability criteria specific to the proposed Port of Boegoebaai are provided. Note that this document does not contain a detailed sustainability assessment of the proposed Boegoebaai development. Rather it provides high-level practical guidance on key criteria and best practice that should be considered and adhered to during future port planning, development and operations, should it go ahead, to claim sustainability.

Framework for Sustainable Port Planning and Development

To ensure continuity between port sustainability planning (e.g. for new port development or expansion in existing ports) and sustainability performance assessment and reporting (e.g. for operational ports) such initiative needs to be aligned. This has been achieved aligning the Framework for Sustainable Port Planning and

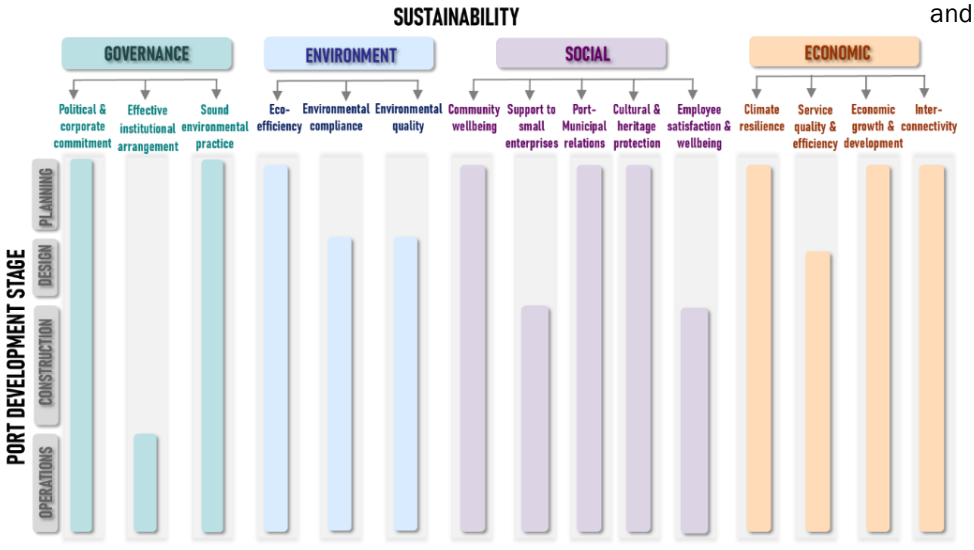


Figure S-1: Framework for SPP&D showing key sustainability domains (governance, environment, social and economic) and associated sustainability outcomes, as well as anticipated relevance across various stages in a port development cycle

Development (SPP&D) with exiting TNPA sustainability initiatives of the TNPA as illustrated in Figure S-1.

Key Sustainability Criteria for proposed Port of Boegoebaai

Key sustainability criteria for the proposed Port of Boegoebaai are presented in Tables S-1 to S-4 below, organised into the four pillars of sustainability and associated sustainability outcomes (see Figure S-1), also showing alignment with relevant SDGs.

Table S-1: Key criteria towards achieving sustainability outcomes within the governance dimension

GOVERNANCE		
Sustainability Outcome	**Related SDGs**	**Key Criteria**
Political & corporate commitment	16: Peace, Justice and Strong Institutions 17: Partnerships for the Goals	• Legislative framework in place to enable sustainable planning, development, and operations in ports • Organizational culture towards sustainable development • Dedicated budget allocation for sustainable development • Public communication mechanisms in place
Effective institutional arrangements	16: Peace, Justice and Strong Institutions 17: Partnerships for the Goals	• Formal in-house institutions overseeing sustainability matters • Dedicated institution to engage with port customers • Dedicated institution to engage with stakeholders outside port boundaries • Dedicated collaborative arrangements between port & adjacent local authorities
Sound management practice	6: Clean Water and Sanitation 7: Affordable and Clean Energy 9: Industry, Innovation and Infrastructure 12: Responsible Consumption and Production 13: Climate Action	• Environmental assessment and management through project lifecycle, including: - Strategic Environmental Assessment and Environmental Screening - Environmental Impact Assessment with associated Environmental Management Plans - Environmental Management Systems • EMPs and/or Standard Operational Procedures (SOPs) addressing sustainability (incl. monitoring) prepared and effectively • Contingency planning

Table S-2: Key criteria towards achieving sustainability outcomes within the environment dimension

ENVIRONMENT		
Sustainability Outcome	**Related SDGs**	**Key Criteria**
Eco-efficiency	6: Clean Water and Sanitation 7: Affordable and Clean Energy 9: Industry, Innovation and Infrastructure 12: Responsible Consumption and Production 13: Climate Action	• Water use efficiency • Energy efficiency • Selection and procuring of eco-friendly materials • Waste management (recycling of other waste) • Recycle/minimize construction and building waste (circular economy concept) • Efficient and responsible land/sea use (spatial planning) • Climate mitigation addressed
Environmental compliance	6: Clean Water and Sanitation 9: Industry, Innovation and Infrastructure 12: Responsible Consumption and Production	• Transparent reporting on potential impact sources monitored and control, including: - Atmospheric emissions - Noise - Wastewater discharges - Solid/hazardous waste • Environmental incidents • Port environmental assurance audits • Compliance to EMS
Environmental quality	14: Life below Water 15: Life on Land	• Environmental quality effectively monitored and evaluate, including: - Air quality - Noise - Marine water quality - Marine sediment quality - Soil & groundwater quality

ENVIRONMENT		
Sustainability Outcome	**Related SDGs**	**Key Criteria**
		• Status of habitat and biodiversity (terrestrial and marine) • Control marine invasive species

Table S-3: Key criteria towards achieving sustainability outcomes within the social dimension

SOCIAL		
Sustainability Outcome	**Related SDGs**	**Key Criteria**
Community wellbeing	1: No Poverty 2: Zero Hunger 6: Clean Water and Sanitation 7: Affordable and Clean Energy 3: Good Health and Well-being 4: Quality Education and Learning Opportunities 8: Decent Work and Economic Growth	• Corporate Social Initiatives planned and undertaken • Access rights for communities (e.g. to natural resources, clean water and energy), as and where appropriate • Community-based environmental education and awareness • Support to sustainability related community enterprises • Research, Development and Innovation (RD&I) investment
Support to small enterprises	1: No Poverty 8: Decent Work and Economic Growth	• Support to local/small businesses
Port-municipal relations	8: Decent Work and Economic Growth 11: Sustainable Cities and Communities	• Port-municipal collaboration • Sound port-municipal relationships
Cultural and heritage protection	11: Sustainable Cities and Communities	• Protection of cultural heritage assets
Employee satisfaction & wellbeing	4: Quality Education 5: Gender Equality 8: Decent Work and Economic Growth 10: Reduced Inequalities	• Training (incl. education on sustainability matters) • Employee engagement forums • Employee grievance/satisfaction addressed • Employees recognition • Wellness assistance • Occupational safety awareness • Employee safety • Employment equity • Employee job security

Table S-4: Key criteria towards achieving sustainability outcomes within the economic dimension

ECONOMICS		
Sustainability Outcome	**Related SDGs**	**Key Criteria**
Climate resilience	13: Climate Action	• Climate change (CC) preparedness • CC early warning systems • CC incident assessment
Service quality & efficiency	9: Industry, Innovation and Infrastructure 12: Responsible Consumption and Production	• Technical capacity and efficiency • Good quality potable water supplied • Customer satisfaction • Port security • Cyber security • Digitalisation of port systems • Improvement of port infrastructure maintained at acceptable quality
Economic growth & development	8: Decent Work and Economic Growth 9: Industry, Innovation and Infrastructure	• Port revenue generation through formal port activities • Revenue generation through complementary sectors operating in port • Business growth opportunities for others in port • Corporate tax and VAT generation • Employment opportunities • Economic contribution (gross value added) • New business production
Inter-connectivity	8: Decent Work and Economic Growth	• Effective hinterland connectivity • Effective international port connectivity

	9: Industry, Innovation and Infrastructure	

Framework for SPP&D (Figure 7-7), together with the key sustainability requirements (Table 7-10) provide a **science-based benchmark** for where to evaluate the extent to which port planning and development processes to be undertaken for the proposed Port of Boegoebaai port would support sustainability. This is relevant to the current SEA process, but also in potential future EIA processes, through construction and ultimately during operations.

All sustainability outcomes are important to consider in the planning of a proposed Port at Boegoebaai, but reflecting on the place-based circumstances at Boegoebaai, the following are likely to requite specially attention:

- Eco-efficiency (e.g. sustainable sources of water and energy)
- Community wellbeing (e.g. in the area local communities rely heavily on natural resources for their livelihood, as well as clean water and energy)
- Cultural & heritage protection (e.g. areas support an array of cultural and heritage assets)
- Climate resilience (e.g. west coast likely to be affected by climate change)
- Interconnectivity (e.g. area is very remote with connectivity challenges)

Further, foresight of likely future development plans around the port (for example, industrial, urban and suburban development) should be considered in the spatial planning for the port. This will be key in avoiding future port-city, and port-community conflict, also applying to infrastructure needed to ensure future interconnectivity.

Another key issue crucial to sustainability as it pertains to environmental issues and climate resilience, is access to long-term, inter-seasonal field data on, for example, climate, oceanic processes, environmental quality, and biodiversity. Given the remoteness of the study area, the collection of such data will be a challenge and should be considered and resolved soonest, should this project be approved.

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CHAPTER 7. SUSTAINABLE PORT PLANNING

7.1 INTRODUCTION

7.1.1 Background

With the development of a new port, such as is the case with the proposed Port of Boegoebaai, there is good opportunity to define sustainable trajectories, already in the planning stages, that explicitly strive for environmentally responsible, socially equitable and economically viable port development. This also echoes the aspiration of sustainable development captured in Agenda 2063: The Africa We Want, Africa's blueprint and master plan for transforming the continent into a future global powerhouse by 2063 (African Union 2015).

In South Africa, Transnet is a State-Owned Company (SOC) that signs an annual Shareholder's Compact with the Government, represented by the Minister of Public Enterprises (DPE). This Compact mandates Transnet to deliver on numerous strategic deliverables, including sustainable economic, social and environmental outcomes (Transnet 2024). As one of the five operating divisions of Transnet SOC Ltd, Transnet National Ports Authority (TNPA) is subject to these strategic deliverables, including sustainability performance at the country's commercial ports. In response to this commitment, TNPA has begun engaging in 'Green Port' initiatives. These initiatives include the installation of solar technologies to alleviate the country's power challenges and to support greener operations. This initiative has seen the greening of energy sources at lighthouses and other marine aids to assist with navigation of vessels within port limits and along the coast. TNPA has also acknowledged the importance of monitoring sustainability performance, for example through sustainability reporting, to guide decision making on interventions towards improving sustainability. To assist TNPA with the development of a standardised approach to sustainability performance assessment for the country's commercial ports, the CSIR shared its scientific research and invested in this space. This approach has since been pilot tested in the Port of Ngqura (TNPA 2024), as part of a regional capacity development programme by the Nairobi Convention Secretariat for the development and implementation of a *Toolkit for Sustainable Port Development in a Blue Economy*, in the Western Indian Ocean region (including South Africa) (UNEP et al. 2024).

7.1.2 Purpose

Considering the proposed port development at Boegoebaai, the TNPA recognizes the importance of the new port being sustainable (green). The purpose of this chapter is to inform sustainability planning for the proposed Port of Boegoebaai. Acknowledging and addressing sustainability early on from the planning phase of a new port development will enable timeous identification of potential challenges and opportunities and inform appropriate interventions and solutions towards achieving sustainability. First a Framework for Sustainable Port Planning and Development (SPP&D) is posed, drawing on best practice (international, regionally and nationally), and aligned with TNPA's current sustainability initiatives. Thereafter, key sustainability criteria specific to the proposed Port of Boegoebaai is provided, including useful information sources to support implementation. Note that this document does not contain a detailed sustainability assessment of the proposed Boegoebaai development. Rather it provides high-level practical guidance on key criteria and best practice that should be considered and adhered to during future port planning, development and operations, should it go ahead, to claim sustainability.

7.1.3 Layout of Document

To achieve the above, this introductory chapter (Chapter 1) is followed by a brief contextualisation of sustainable port development (Chapter 2). Thereafter a SPP&D Framework is provided (Chapter 3), followed by key sustainability requirements applicable to the proposed Port of Boegoebaai. Finally, useful documents from the literature are referenced providing guidance on specific activities that can be undertaken to meet key sustainability criteria for the proposed Port of Boegoebaai, as well as useful information sources to support implementation (Chapter 4).

7.2 Contextualising Sustainable Port Development

7.2.1 Need of Sustainability

Ports, by their very nature, are complex environmental systems given the magnitude of potential impacts associated with their activities, including atmospheric emissions, dredging, wastewater discharges, pollution of natural resources, and solid waste. Environmental impacts can occur due to normal port activities or by accident (Darbra et al. 2004; Darbra et al. 2005). According to the United Nations Conference on Trade and Development (UNTACD) the evolution of seaports comprised five main generations (Kaliszewski 2018), characterised as follows by Lee and Lam (2015):

- 1st generation: Simple loading/unloading operational ports
- 2nd generation: Logistic ports providing various services
- 3rd generation: Ports become part of supply chain, making use of electronic data exchange with customers
- 4th generation: Global e-ports transferring information on a global scale with global standards of cargo handling
- 5th generation: Ports focused on customers and local communities offering deep information technology integration with various stakeholders.

Therefore, in their simplest forms ports (1st generation) operated in areas of uncontested spaces, benefiting from seascapes in which they could be situated safely and cost-effectively without competition (Kaliszewski 2018; Lee et al. 2018). However, society has evolved, with rapid coastal urbanisation, growing global trade, stakeholder emancipation and depletion of natural resources (e.g., through physical alteration and destruction of habitat, pollution, and unsustainable levels of exploitation). As a result, port systems can no longer operate without acknowledging and incorporating societal and environmental considerations in their planning and management, having to strive to become 5th generation ports (Lam and Van der Voorde 2012; Roh et al. 2016). Singapore's Tuas Port, officially opened in 2022, is a good example of an emerging 5th generation port (Maritime Port Authority of Singapore 2024).

Driven by these challenges, concepts such as 'Green Ports' emerged with the primary objective of balancing environmental challenges and economic demand (Bergqvist and Monios 2019; Lam and Notteboom 2014) and striving for greater sustainability through increasing both economic and environmental competitiveness (Maritz et al. 2014). While some claim that sustainable port management must include the broader topic of ecosystem protection (Schipper et al. 2017), others argue that green ports implicitly will lead to positive outcomes on their economic performance (Lam and Van de Voorde 2012). The concept of 'Sustainable Ports' builds on 'Green Ports' by considering social sustainability, in essence advocating the need for port development to create a balance between economic growth, environmental protection and social progress to secure its long-term future (Hiranandani 2014; Taljaard et al. 2021). Therefore, with increasing public and regulatory pressures, ports worldwide are being compelled to pursue **sustainable port development** to safeguard their 'license to operate' and to grow their economic and environmental competitiveness (Lam and Van der Voorde 2012; Roh et al. 2016; Darbra et al. 2004). In addition, climate change - specifically sea-level rise and increased storminess (e.g., Azarkamand et al. 2020) – is becoming a major risk facing ports worldwide that must be addressed towards securing sustainability, both in terms of (i) Adaptation (e.g. upgrading infrastructure and designing new infrastructure to withstand projected climate change impacts) and (ii) Mitigation (e.g. reducing greenhouse gas emissions to contribute to reducing future climate change) (HR Wallingford and British Port Association 2021).

Therefore, sustainable ports can be defined as:

Ports which adhere to the concept of resource saving and environment-friendly development, actively fulfilling its social responsibilities, and comprehensively adopting technologies and management measures that are conducive to saving resources and energy, protecting environment and ecology, and coping with climate change – Guo and Liu (2018)

South Africa also is a signatory to the *International Convention for the Prevention of Pollution from Ships* (1973) of the International Maritime Organization (IMO). Annex VI of the Convention deals with air pollution from ships. As the main international Convention addressing prevention of pollution of the marine environment by ships, it sets the basic regulations for compliance regarding environmental sustainability. As per their 2023 Green House Gas (GHG) Strategy, the IMO aims to reduce CO_2 emissions from international shipping by at least 40% in 2030 (compared with 2008). Further it aims to secure uptake of zero or near-zero GHG emission technologies and fuels to be at least 5% (striving for 10%) of the energy used by international shipping by 2030 (IMO 2023). Ports have a key role to play in achieving this transformation in the energy-maritime value chain, by providing the necessary future infrastructure to support the supply of low and zero carbon fuels at scale for shipping to use and transport.

To this end, Transnet also has committed to climate targets in their Environmental Social & Governance (ESG) Strategy (Transnet 2023). A goal is to achieve net-zero emissions by 2040 with the following interim objectives:

- Reduce carbon footprint by 50% by 2030
- Secure 50% of the financing for decarbonization initiatives by 2026, reaching 100% by 2030
- Complete a climate change vulnerability and risk assessment across the value chain by 2025
- Secure 25% of the financing for climate change adaptation by 2026, increasing to 50% by 2030 and 100% by 2040.

To better understand the type of paradigm shifts required to move from traditional (business-as-usual) port practices to sustainable ports, key differences in typical practices are highlighted in Table 7-1 (Ares Moreno 2018).

Table 7-1: Comparing practices typical of Traditional vs Sustainable Ports (adapted from Ares Moreno 2018)

PRACTICE	TRADITIONAL	SUSTAINABLE
Stakeholders	No meaningful participation of stakeholders or community and normally only during ESIA	Co-creation with communities and stakeholders to generate an added value
Economic driver	Benefits/Economy	Green growth/ Economy, social and environment
Relation with nature	Replacing nature	With nature/develop nature along with port
Mentality	Short term (current benefits)	Long-term (future benefits)
Technology	No use of new and innovative technological developments	Involvement of technological and societal developments to enhance transition towards green growth
Port Authority role	Re-active landlord	Pro-active landlord in development of region and logistic chain
Energy	Energy obtained from fossil fuels	Energy efficiency from alternative (e.g. renewable) sources
Resources	'Take, make and dispose'	Reuse of resources
Air quality	No special measures for reducing air pollution during operation	Improving environmental performance through programmes to reduce emissions to a minimum during operation
Biodiversity	Reduction of negative impact on biodiversity	Enhancement of biodiversity and conservation areas
Cargo	Allowance of any type and origin of cargo	Attract diverse cargo, turnover from non-fossil cargo
Vision of sustainability	Sustainability as a legal obligation	Sustainability as an economic driver where a port is a net benefit, not just about avoiding negative impacts on environment and people, but about providing a net benefit to environment and people (i.e. how can a port be designed and operated to provide a net socio-ecological benefit for a region)
Site location selection	As per land ownership and/or without preliminary studies	As per optimization of material, in harmony with nature, minimum negative biodiversity impact &

PRACTICE	TRADITIONAL	SUSTAINABLE
		minimum negative community impacts (e.g., SEA process)
Growth approach	Focuses on Gross Domestic Product (GDP) growth	Elimination of sources of inefficiency, promotion of innovation, reboot of new economic opportunities from emergence of new green markets and activities
Environmental impacts	Compensation of impacts	Avoidance of impacts
Sustainable actions extent	Following actual regulations, ESIA	Long-term vision, irrespective of actual regulations
Use of material	No re-use/optimization of material	Use of material efficiently, including naturally present materials and land resources for functional requirements and for added value
Dealing with future uncertainty	Scenario-based planning for making quantitative forecasts	Adaptive planning, including flexibility in planning and design as a means towards sustainability
Design decisions	Based on the project boundaries	Based on understanding whole system
End of life cycle	Subject is left to future generations	Subject is treated from planning phase, reducing restrictions for future urban redevelopment

As illustrated in Table 7-2, these practices can be overarching across the port development cycles, but can also be associated with specific stages in this cycle across planning, design, construction and operations.

Table 7-2: Relevance of practices within the port development cycle (Adapted from Ares Moreno 2018)

PRACTICE	PORT DEVELOPMENT STAGE				
	Overarching	Planning	Design	Construction	Operations
Stakeholders		●	●	●	●
Economic driver	●				
Relation with nature			●		
Mentality	●				
Technology				●	●
Port Authority role	●		●		
Energy					●
Resources				●	●
Air quality					●
Biodiversity		●	●		
Cargo					●
Vision of sustainability	●				
Site location selection		●			
Growth approach	●				
Environmental impacts	●	●	●		
Sustainable actions extent	●				
Use of material		●	●	●	
Dealing with future uncertainty	●				
Design decisions			●		
End of life cycle		●	●		

The need for greater sustainability in ports, already has taken root in South Africa. As one of the five operating divisions of Transnet SOC Ltd, the TNPA is required to deliver on numerous strategic deliverables included in Transnet's Shareholder's Compact with the South African Government, including **sustainable economic, social and environmental outcomes** (Transnet 2024). Towards addressing this commitment, the TNPA has embarked on the installation of solar technologies to alleviate the country's power challenges and to support greener operations in its ports. This includes the greening of energy sources at lighthouses to assist with vessel navigation of vessels along the coast and within port limits. However, much still needs to be done to fully embrace sustainability in South African ports. To inform this process, this chapter proposes a Framework

for Sustainable (Green) Port Planning & Development (SPP&D), as well as key sustainability requirements for the proposed Port of Boegoebaai.

7.2.2 Policy and Legislative Obligations

Agenda 2030 Sustainable Development, as adopted by all United Nations Member States in 2015, provides a shared blueprint for **global sustainability** offering peace and prosperity for people and the planet, now and into the future. At the centre of Agenda 2030 are the 17 Sustainable Development Goals (SDGs) urgently calling for action by all countries - developed and developing - in a global partnership (Figure 7- 1). The SDGs recognise that efforts to end poverty and other deprivations must go together with strategies that improve health and education, reduce inequality, and spur economic growth, while tackling climate change and working to protect the natural environments (UN 2015). Figure 7-1 illustrates how the SDGs relate to (1) the natural resource base (2) sustainable production and consumption, and equitable distribution of goods and services, and (3) poverty and human well-being (Lucas and Wilting 2018).

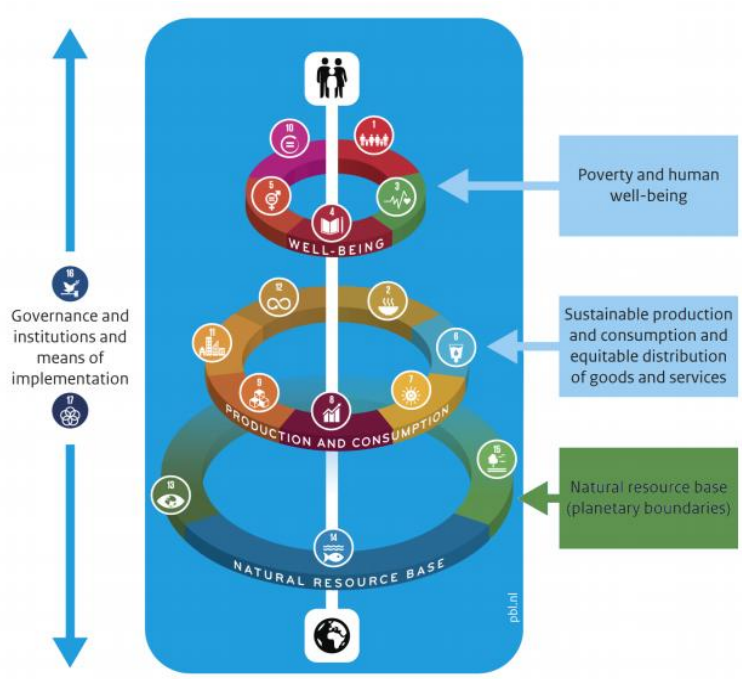


Figure 7-1: UN's SDGs as it relates to (1) the natural resource base (2) production and consumption, and (3) well-being (Source: Lucan and Wilting 2018)

Sustainable development also is a key aspiration of *Agenda 2063: The Africa We Want*, Africa's blueprint and master plan for transforming the continent into a future global powerhouse by 2063 (African Union 2015). Agenda 2063 provides *"the shared strategic framework for inclusive growth and* ***sustainable development*** *& a global strategy to optimize the use of Africa's resources for the benefit of all Africans",* including Africa's port environments. Seven Aspirations encapsulates Agenda 2063, with Aspiration 1 calling for a *'A prosperous Africa based on inclusive growth and sustainable development'*, defined by a set of goals and priorities as set out in Table 7-3.

Table 7-3: Goals and priorities for Agenda 2063's Aspiration 1: 'A prosperous Africa based on inclusive growth and sustainable development' (African Union 2015)

GOAL	PRIORITY
A high standard of living, quality of life and wellbeing for all citizens	• Incomes, jobs and decent work • Poverty, inequality and hunger • Social security and protection, including persons with disabilities • Modern, affordable and liveable habitats and quality basic services
Well educated citizens and skills revolution underpinned by science, technology and innovation	• Education and science, technology and innovation (STI) driven skills revolution
Healthy and well-nourished citizens	• Health and nutrition
Transformed economies	• Sustainable and inclusive economic growth • STI driven manufacturing, industrialization and value addition • Economic diversification and resilience • Tourism/Hospitality
Modern agriculture for increased productivity and production	• Agricultural productivity and production
Blue/ocean economy for accelerated economic growth	• Marine resources and energy • Port operations and marine transport • Marine energy and mining
Environmentally sustainable and climate resilient economies and communities	• Sustainable natural resource management • Biodiversity conservation, genetic resources and ecosystems • Sustainable consumption and production patterns • Water security • Climate resilience and natural disasters preparedness and prevention • Renewable energy

South Africa is a signatory to both the 2030 Agenda for Sustainable Development and the African Union Agenda 2063 and is therefore committed to a sustainable development future. At its core sustainable development strives for good governance, environmental responsibility, social equitability and economic viability. It can therefore be argued that legislation that underpins these aspirations, implicitly supports sustainability. Within the South African context, an array of legislation exists in support of responsible and sustainable use of the country's natural resources. Specifically focusing on the coastal and marine environment, the larger domain within which ports are situated, Taljaard et al. (2019) provided a detailed overview of relevant international obligations, as well as key national legislation and policies applying to sound coastal management spanning numerous sectors overlapping in the coastal spaces, including ports and shipping (Figure 7-2) (see Appendix A for details).

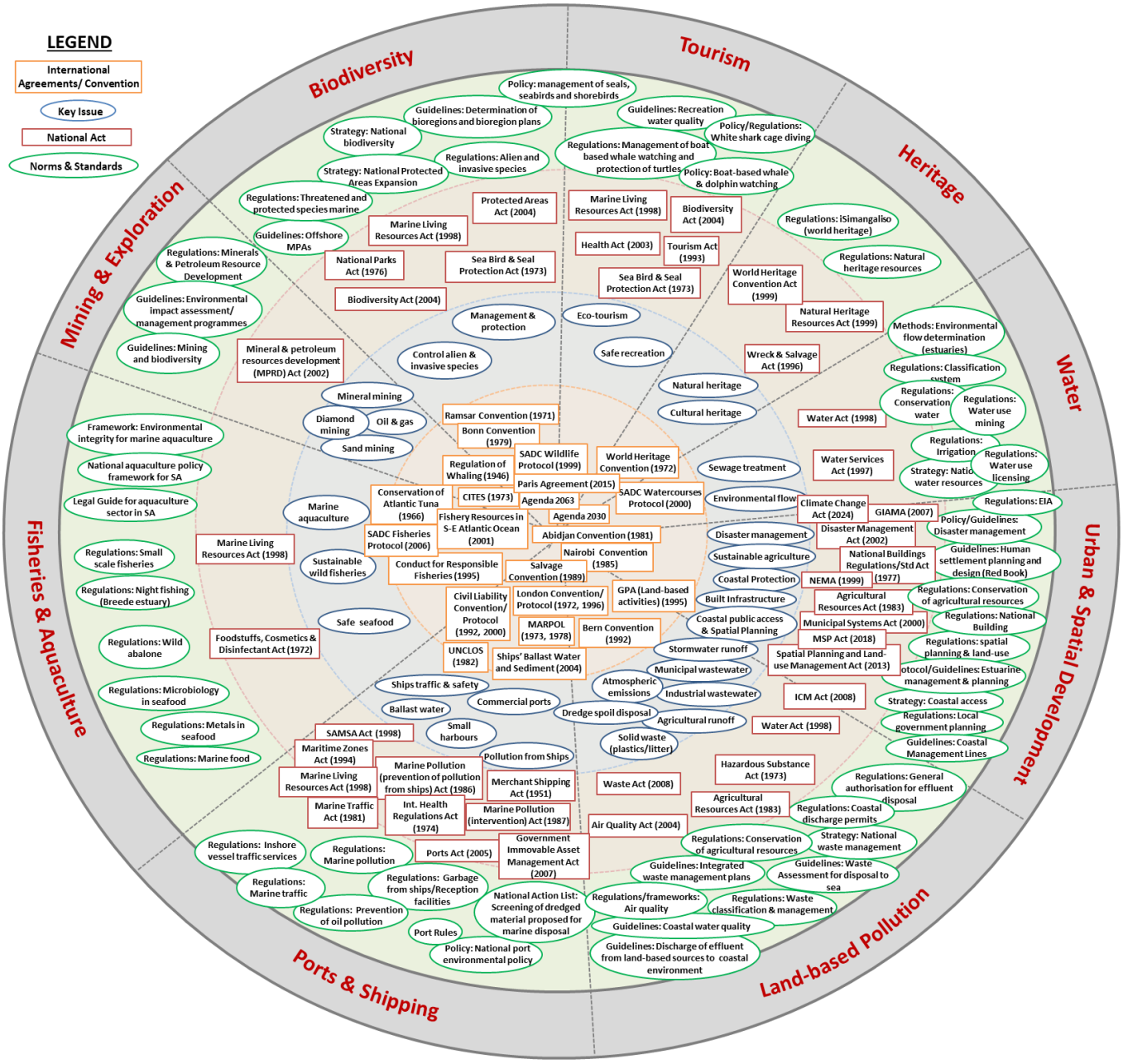


Figure 7-2: Overview of legal landscape governing protection and sustainable use of South Africa's coastal and marine environment (adapted from Taljaard et al. 2019)

As shown in Figure 7-2, legislative obligations pertaining to sustainable development can be vast, especially when including numerous other pieces of legislation, dealing with specific social and economic aspects, that also influence sustainability. Therefore, it is useful to identify the priority pieces of legislation in support of sustainable port development, considering key processes and activities to be governed within commercial ports as listed in Table 7- 4.

Table 7-4: Priority pieces of South African legislation in support of sustainable port development, considering key processes and activities to be governed within commercial ports (adapted from Taljaard et al. 2019)

SECTOR	ACT	LEAD AGENT	SHORT DESCRIPTION
General	Constitution of the Republic of South Africa, (Act 108 of 1996)	Parliament and Constitutional Court	The Constitution is the supreme law of the Republic of South Africa. The fundamental rights contained in Chapter 2 of the Constitution seek to protect the rights and freedom of individuals.
	Promotion of Access to Information (Act 2 of 2000)	South African Human Rights Commission The Information Regulator	Gives effect to the constitutional right of access to any information held by the State and any information that is held by another person that is required for the exercise or protection of any rights
Port & Shipping	National Ports Act (No. 12 of 2005)	Transport (through National Port Authority)	Provides for management of commercial ports, including environmental matters.
	South African Maritime Safety Authority Act (No. 5 of 1998)	Transport	Provides for establishment and functions of the South African Maritime Safety Authority (SAMSA)
Conservation	National Environmental Management: Biodiversity Act (Act 10 of 2004)	Environment	Provides for conservation of biological diversity and regulates the sustainable use of biological resources and to ensure a fair and equitable sharing of the benefits arising from the use of genetic resources.
	National Environmental Management: Protected Areas Act (No. 57 of 2003)	Environment	Provides for protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes.
Heritage	National Heritage Resources Act (No. 25 of 1999)	Environment (through South African Heritage Resources Agency)	Provides for an integrated and interactive system for management of national heritage resources (which include landscapes and natural features of cultural significance), providing opportunity for communities to participate in identification, conservation and management of cultural resources.
Water	National Water Act (No. 36 of 1998)	Water	Provides for protection of aquatic ecosystems of water resources, including estuaries.
	Water Services Act (No. 108 of 1997)	Water & Sanitation	Provides for right of access to basic water supply and basic sanitation necessary to secure sufficient water and an environment not harmful to human health or well-being.
Urban & spatial development	Climate Change Act (No. 22 of 2024)	Environment	Enables development of an effective climate change response and a long-term, just transition to a low-carbon and climate-resilient economy and society for South Africa in context of sustainable development
	Disaster Management Act (No. 57 of 2002)	Cabinet	Provides for integrated and co-ordinated disaster management policy that focusses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery.
	Local Government: Municipal Systems Act (No. 32 of 2000)	Provincial and Local Government	Provides for integrated development planning intended to encompass and harmonise planning over a range of sectors such as water, transport, land use and environmental management.
	Spatial Planning and Land Use Management Act (No. 16 of 2013)	Rural Development and Land Reform	Provides for a framework to govern planning permissions and approvals, sets parameters for new developments and provides for different lawful land uses.

SECTOR	ACT	LEAD AGENT	SHORT DESCRIPTION
	National Environmental Management Act (No. 107 of 1998)	Environment	Provides that sensitive, vulnerable, highly dynamic or stressed ecosystems require specific attention in management and planning procedures, especially where subjected to significant human resource usage and development, through mandating EIAs for specific listed activities.
	Marine Spatial Planning Act(No. 16 of 2018)	Environment	Provides national framework for marine spatial planning and for development of marine spatial plans and for institutional arrangements required for governance and implementation.
	National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008)	Environment	Provides for (amongst other matters) development and use of coastal resources that is socially and economically justifiable and ecologically sustainable.
Marine- and Land-based pollution	National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008)	Environment	It stablishes a system of integrated coastal and estuarine management in South Africa to promote the conservation of the coastal environment and maintain the natural attributes of coastal landscapes and seascapes, and to ensure that development and the use of natural resources within the coastal zone is socially and economically justifiable and ecologically sustainable. Specifically, it controls dumping at sea (including dredge disposal), land-based pollution, inappropriate development and other adverse effects on coastal environment.
	National Environmental Management: Waste Act (No. 59 of 2008)	Environment	Regulates (solid) waste management to protect health and environment by providing reasonable measures for prevention of pollution and ecological degradation and for securing ecologically sustainable development.
	National Environmental Management: Air Quality Act (No. 39 of 2004)	Environment	Regulates air quality to protect environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development while promoting justifiable economic and social development.
	National Water Act (No. 36 of 1998)	Water	Identifies certain land uses (e.g. activities resulting in stream-flow reduction such as afforestation and cultivation of crops), infrastructural developments (e.g. altering the bed, banks, course or characteristics of a watercourse), water supply/demand and waste disposal to estuaries (from land-based activities) as 'water uses' that require authorisation (licensing)
	Hazardous Substances Act (No. 15 of 1973)	Health	Provides for control of substances which may cause injury or ill health to, or death, of human beings by reason of their toxic, corrosive, irritant, strongly sensitising or flammable nature.
	Marine Pollution (Control and Civil Liability) Act (No. 6 of 1981)	Transport (prevention) and Environment (combating)	Provides for protection of marine environment from pollution by oil and other harmful substances
	International Health Regulations Act (No. 28 of 1974)	Ports Authority	Requires seaports to be provided with a system for removal and disposal of excrement, refuse, wastewater, condemned food and other matter dangerous to health.

7.2.3 Embedding Sustainability in Port Development Cycle

Traditionally, capital in ports mostly comprised physical infrastructure, operations & management, and services as described by Taneja et al (2012) in their port infrastructure system (referred to as the port 'inframodel'). Taljaard et al (2021) offered a conceptual change by including natural (environmental)

infrastructure as another integral capital to consider within the port system, as conceptualised in Figure 7-3.

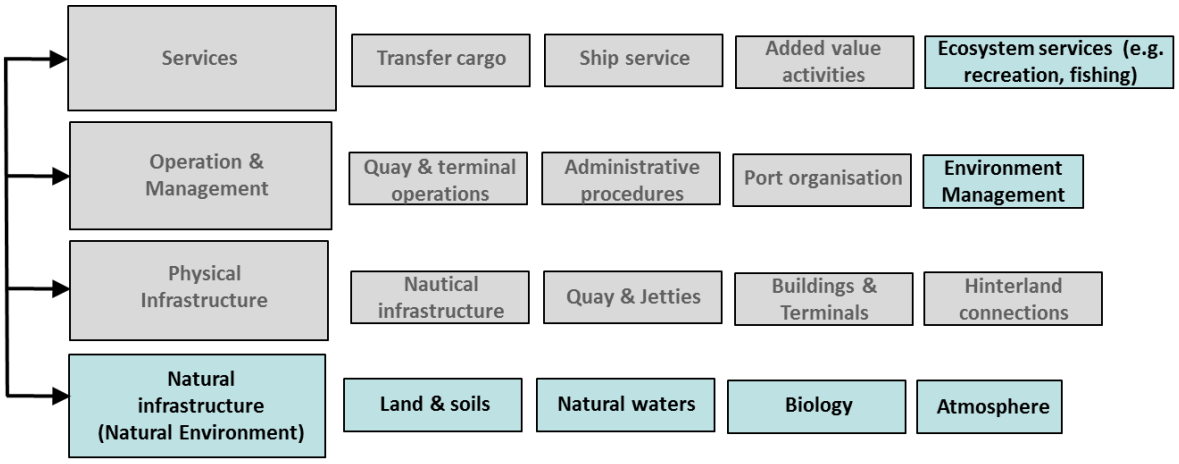


Figure 7-3: Positioning natural (environmental) infrastructure (blue shaded cells) in port inframodel (Source: Taljaard et al. 2021)

In this extended port inframodel, it is not only aspects within the natural infrastructure layer that is incorporated, but the operation and management, and services layers also expand. For example, *environmental management* becomes an integral component in port management and operations, with services no longer only relate to shipping and added value activities, but also recognise other ecosystem services within sheltered coastal environments occupied by ports, including benefits such as, recreation, fishing and serving as nursery areas to various marine biota (Taljaard et al. 2021). Therefore, instead of environmental (including social) issues being viewed as 'add-ons', often perceived as 'green handbrakes' to development and growth, the natural environment becomes an 'equal partner' in the port system (Audouin et al. 2011; Taljaard et al. 2021) allowing for sustainability (including environmental and social) considerations to be timeously addressed, acknowledged and incorporated in the port planning and management (de Boer et al. 2019).

Taljaard et al. (2021) proposed a framework for Integrated Port Management (IPM Framework) that conceptualises alignment of various environmental (including social) assessment processes with the port development phases (Figure 7-4). Specifically, these include **strategic environmental assessment** (SEA) (e.g., Dublin Port Company 2012a, 2012b), **environmental and social impact assessment** (ESIA), and **environmental management systems** (EMSs) (e.g., Gupta et al. 2005; Darbra et al., 2004; Darbra et al., 2005; Hossain 2018; Lawer et al. 2019) and **sustainability performance assessments** (e.g., Taljaard et al. 2024a), embracing inclusion of the SDGs of Agenda (2030) (e.g., Nitsenko et al. 2017).

The IMP Framework recognizes the different time frames in the port development cycle, where the larger cycle, involving site selection, planning, design and construction of new or expansive port infrastructure, represents stages typically occurring at 5-year (or longer) intervals (i.e. longer time scales). The smaller cycle (operations and maintenance and monitoring and auditing) nested within the larger cycle, represents the stages that occur continuously, on much shorter (i.e. day-to-day) time scales (Taljaard et al. 2021). Therefore, to achieve more sustainable ports, key environmental processes must become integrated into port development processes as early as during site selection (e.g. SEAs), through design and construction (e.g. EIAs), operations (EMS) and ultimately monitoring and auditing (Sustainability performance assessment). Also, flow of information and knowledge among various environmental assessment processes is critical for continual improvement to sustainable environmental practice through learning-by-doing. The solution, therefore, requires proper alignment and inclusion of environmental matters in port development, but also continuity and coordination across the different environmental assessment processes, as conceptualised in the IPM Framework (Figure 7-4).

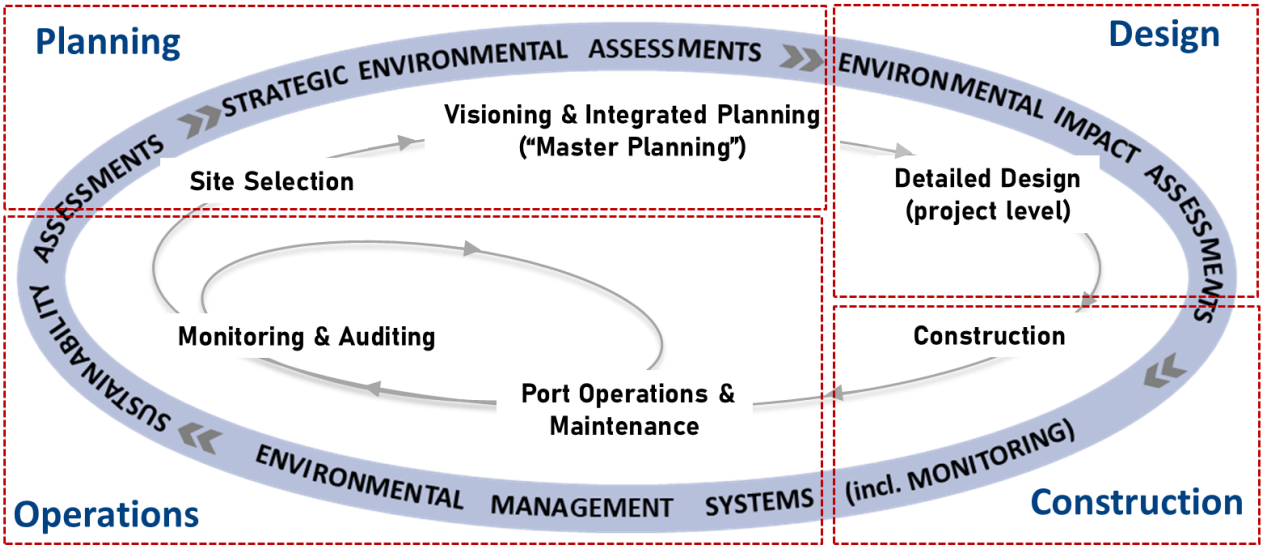


Figure 7-4: Key environmental (including social) assessment processes allowing for continuous consideration of sustainability matters across with various traditional port development stages, depicted as a IPM Framework (Source: Taljaard et al. 2021 & UNEP et al. 2024)

The acquisition of environmental data and information - underpinning all environmental and social assessment processes in ports - is expensive. Thus, institutional investment to develop coordinated long-term port monitoring strategies across the various assessment processes is critical. In doing so, the monitoring programme can be coordinated and conducted in a cost-effective manner geared for multi-purpose use. Finally, the value of investing in accessible institutional **environmental data and information management systems** to facilitate cross-sectoral flow of information and knowledge informing decision-making towards improving port sustainability should not be underestimated (Taljaard et al. 2021).

7.2.4 Implementation Mechanisms and Funding Opportunities

Implementation mechanisms that can be employed by relevant authorities to facilitate effective operationalisation of sustainable port measures and actions by operators, tenants, ships and land transport can be grouped broadly into (Table 7- 5):

- Regulations and standards *(ultimate backstop for sustainability and technological implementation)*
- Incentives and disincentives including grants
- Voluntary and compulsory agreements
- Training and information sharing.

Table 7-5: Implementation mechanisms for sustainable port development (Source: Alamoush et al. 2021)

MECHANISM	EXAMPLE
Regulations and standards	• International conventions and agreements • National regulations and standards • Port specific standards, procedures and guidelines
Incentives and disincentives	• Indices to incentivise ship and port operators who implement safety, security, and environmentally friendly measures (e.g., environmental shipping index - ESI) • Extra tariffs on polluters to incentivise cleaner performance (Warning: Without uniform application disincentive can compromise port competitiveness)
Voluntary and compulsory agreements	• Compulsory agreements with port operators, ships, and land transport, through concession contracts and licences to operate, that must include sustainability actions and measures • Voluntary agreements (e.g., speed reductions when approaching port, stakeholder involvement)
Training and information sharing	• Outreach of sustainability awareness to employees, port operators, ships and land transport • Develop training courses and seminars aim at changing behaviour toward better uptake of sustainability actions • Disseminate sustainability information and promote the sustainable port concept (e.g., seminars) within adjacent communities

In essence, sustainable port development aims to be environmentally responsible, socially equitable and economically viable, ultimately to safeguard a port's 'license to operate' and to grow its competitiveness (Lam and Van der Voorde 2012; Roh et al. 2016; Guo and Liu 2018). While it is argued that sustainable port development implicitly will lead to positive outcomes on economic performance (Lam and Van de Voorde 2012; Alamoush et al. 2021), 'sustainable' best practice typically comes with higher initial costs, often making motivation for feasibility an obstacle because project funding is traditionally based on short-term financial gain. This is especially relevant in developing regions of the world where public financial resources are often limited. Therefore, innovation in acquiring additional financial resources is critical for effective sustainable port development, including (Ares Moreno, 2018) for example:

- Blended finance - strategically using development finance to mobilise additional finances towards sustainable port development in developing countries
- Investment from stakeholders - operators, municipalities or industries investing especially where there is added value
- Green Bonds – such as offered by development banks (e.g. World Bank, South African Development Bank).

Further, international banks, insurers, and investors often source investment opportunities linked to sustainable development, including (UNEP-FI 2021):

- Green transport
- Green technology
- Responsible spatial management (considering sensitive natural ecosystems)
- Green supply chains
- Emissions incentives.

In order to access these funding opportunities early design plan must clearly indicate sustainability end points. The processes and tools discussed in this chapter provide guidance in this regard.

7.2.5 Sustainability Performance Assessment and Reporting

In 2015 the United Nations adopted the 2030 Agenda for Sustainable Development with 17 Sustainable Development Goals (SDGs) (UN 2015). With the adoption of these goals, it became necessary to embed these concepts in port planning and operations and to develop tools to measure progress, and so the concept of **sustainability performance assessment** emerged (Sala et al. 2015; Villeneuve et al. 2017). Various sustainability assessment tools have been developed, including the Sustainable Development Analytical Grid, which is recognised by the UN as part of their SDG Acceleration Toolkit (UNDG 2019). Not surprisingly, sustainability performance assessment has been finding its way into port systems globally, aligned with the SDGs of Agenda 2030 (e.g. Nitsenko et al. 2017). It has featured in numerous research studies ranging from the selection of port-specific indicators or criteria (e.g., Peris Mora et al. 2005; Shiau and Chuang 2015; Lu et al. 2016; Roh et al. 2016; Puig et al. 2017; Roos and Neto 2017; Stein and Acciaro 2020; Fobbe et al. 2020) to performance assessment methods (e.g., Lirn et al. 2013; Chiu et al. 2014; Asgari et al. 2015; Laxe et al. 2017; Schipper et al. 2017; Xiao and Lam 2017; Chen and Pak 2017; Oh et al. 2018; Brunila et al. 2023). However, formal top-down approaches often applied to sustainability performance assessment, come with challenges as their universal, techno-scientific approaches often become difficult to apply in local or smaller-scale contexts - sustainability may mean different things to different people (James 2015; Bell and Morse 2018), often discouraging place-based application.

To address this challenge, Taljaard et al. (2024a), in collaboration with the TNPA, developed a port sustainability performance (PSP) Index that combines global comparability and local relatability for use in sustainability performance assessment and reporting (Figure 7-5). In constructing the globally comparable framework for the PSP Index, they used the *four key pillars of sustainability* (governance, environment, social and economic) as main dimensions and recognisable (port related) *sustainability outcomes* as sub-categories, matched with globally representative sustainability indicators.

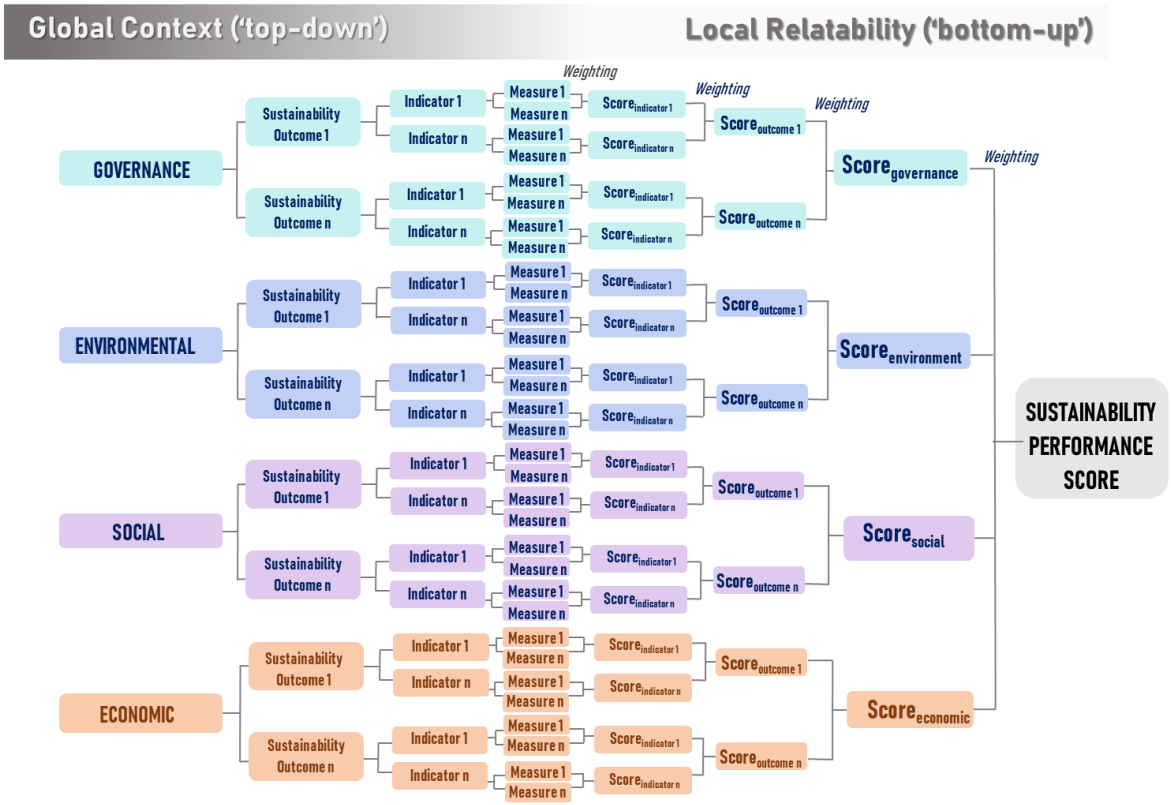


Figure 7-5: Conceptualisation of PSP Index, showing globally comparable dimensions, sustainability outcomes, and representative indicators, matched with locally relatable measures scored against agreed targets (Source: Taljaard et al. 2024a)

To achieve localisation of the PSP index, a set of locally relatable measures and agreed targets were identified, in this case by the TNPA through interaction with staff from the Economics, Planning and

Development, Project Delivery unit, Security, Utilities Development, Real Estate, New Business Development, Port Operations, Harbour Master, Human Resource, Customer Relation Management and Corporate Affairs. In many instances the TNPA could use data and information already being monitored in ports for legal and/or auditing purposes, it just required re-orientation into the four-pillar, sustainability outcome structure that has been globally adopted for science-based sustainability performance assessments (see Taljaard et al. 2024a for details).

A simple spreadsheet model is used to capture performance ratings for each of the measures using an incremental rating system to quantify performance against agreed targets. This incremental rating system ranges from full compliance [4] to targets to non-compliance [0]. For ease of interpretation, the rating allocated to a measure (i.e. potentially ranging from 0 to 4) is then normalised to 100 (4 = 100; 0 = 0). These are then aggregated to derive scores for selected sustainability outcomes, and finally for specific sustainability pillars, and finally into an overall sustainability performance score that can be used for temporal (within a port) or spatial (across ports) comparisons provided that the same measures, targets and ratings systems are applied. To visually display outputs a radar diagram is used showing performance per suitability outcomes within each of the four pillars of sustainability - so-called *Circles of Port Sustainability* (Figure 7-6).

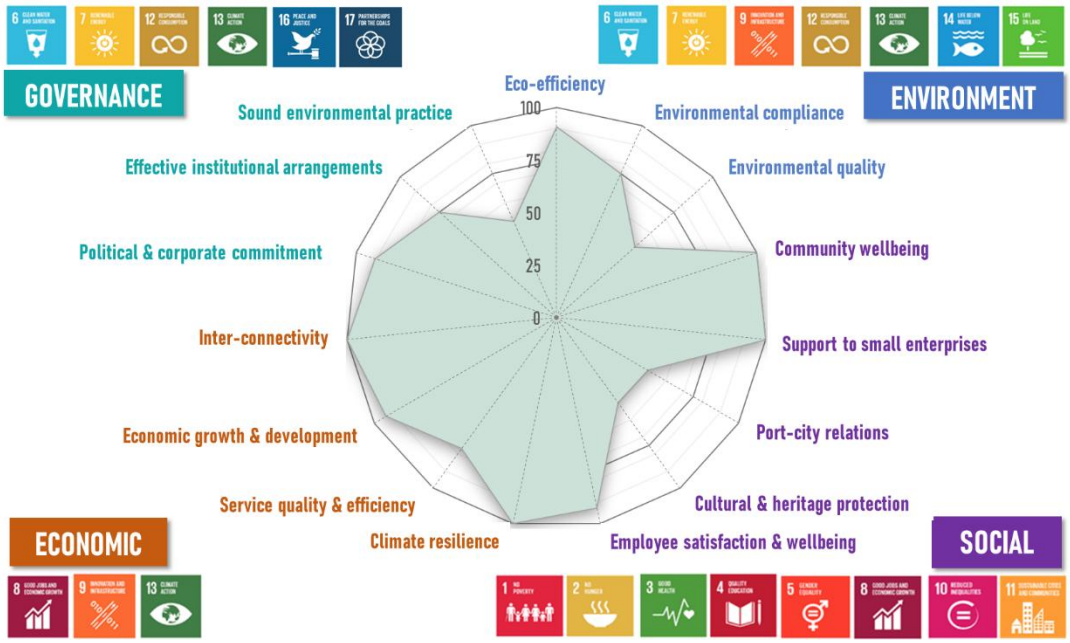


Figure 7-6: Demonstration of *Circles of Port Sustainability* visualizing a port's performance against various sustainability outcomes (expressed as a percentage, where 100% reflects full compliance) (Source: Taljaard et al. 2024a)

Further, it addresses alignment with SDGs. This method, therefore, provides an easy-to-use and structured approach for **reporting on port sustainability performance**, both over time in a specific port, or for comparing performance across ports, provided that the same indicators, measures, targets are applied. The application of the PSP Index in sustainability reporting and assessment has been pilot tested in the Port of Ngqura (TNPA 2024) as part of an initiative funded through UNEP Nairobi Convention Secretariat aimed at promoting sustainable port development in the Western Indian Ocean (UNEP et al. 2024). This PSP Index has been successfully pilot tested by the TNPA's Environment and Sustainability Unit in the Port of Ngqura.

7.3 Framework for Sustainable Port Planning & Development

Importantly, a SPP&D Framework needs to align with the thinking and sustainability approaches, both internationally and nationally. To best achieve this, two key aspects are important (i) Ensure alignment of port development stages with related environmental (including social) assessment processes, and (ii) Align SPP&D Framework (developed in this report and aimed at informing new port developments such as the proposed Port of Boegoebaai) with sustainability performance assessments currently undertaken by TNPA's Environment and Sustainability Unit in operational ports (e.g. Port of Ngqura). Therefore, it is best to coordinate and align initiatives to ensure a structured, standardised approach for sustainability across TNPA, from new port development through to operational ports. Failing to do so may result in various port initiatives having its own measures and targets towards achieving sustainability.

To ensure continuity between port sustainability planning (e.g. for new port development or expansion in existing ports) and sustainability performance assessment and reporting (e.g. for operational ports) such initiative needs to be aligned. For this reason, the SPP&D Framework developed in this report for new port developments such as the proposed Port of Boegoebaai, draws strongly on learning gained through the development of the PSP Index (Taljaard et al. 2024a), and its localization for the South African situation in collaboration with TNPA (coordinated through the Environment & Sustainability Department). To achieve such alignment, the SPP&D, therefore was framed similar to the PSP Index. First the four key pillars of sustainability (that is governance, environment, social and economic) are used as their main dimensions, reflecting the primary goals of sustainability, that is *good governance, environmental responsibility, socially equitability, and economic viability* (Stein and Acciaro 2020). Within each of these dimensions, logical *sustainability outcomes* are defined, also derived from international best practice and considered most identifiable and relevant to port systems (Taljaard et al. 2024a) (Figure 7-7). A description of sustainability outcomes, customized for the proposed Port of Boegoebaai, in provided in Table 7- 6.

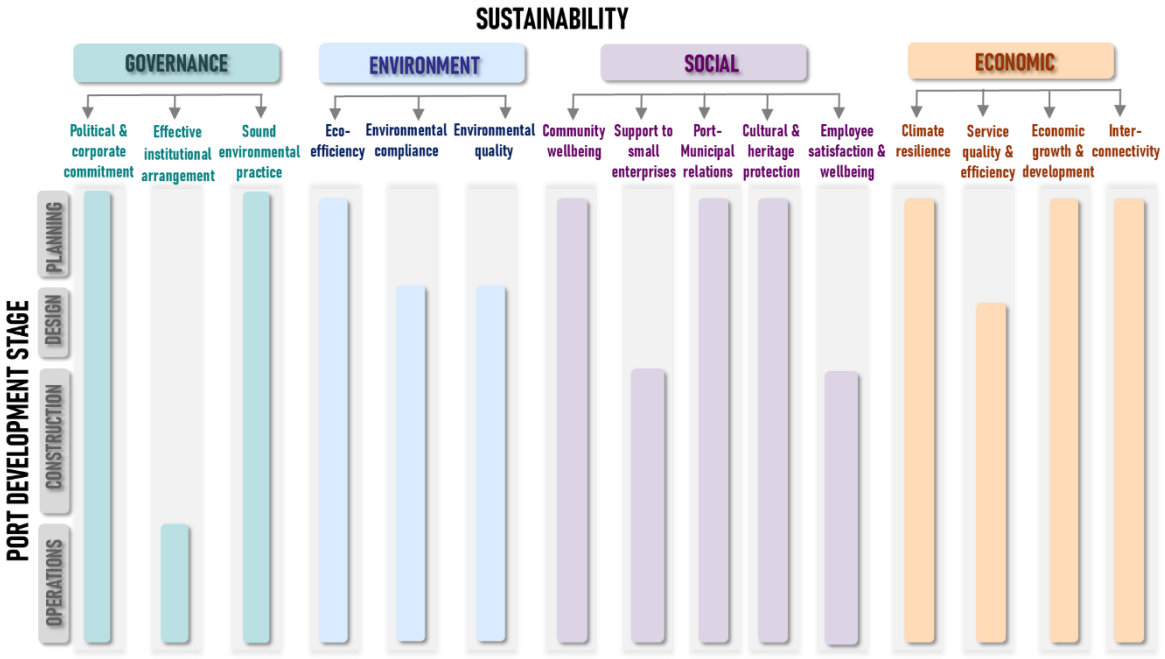


Figure 7-7: Framework for Sustainable Port Planning & Development, showing key sustainability domains (governance, environment, social and economic) and associated sustainability outcomes, as well as anticipated relevance across various stages in a port development cycle

Table 7-6: Description of key sustainability outcomes within each of the four key dimensions of sustainability presented in the SPP&D Framework, applicable to proposed Port of Boegoebaai - related SDGs listed in brackets (Source: Taljaard et al. 2024a)

DIMENSION	SUSTAINABILITY OUTCOME	DESCRIPTION
GOVERNANCE	Political & corporate commitment (SDG 16, 17)	Legislative framework and policies in place to enforce sustainability, with formal organizational commitment supported by dedicated resource allocations
	Effective institutional arrangement (SDG 16, 17)	Dedicated in-house institutions established to oversee sustainability matters, including engagement with port customers, related stakeholders outside port boundaries
	Sound environmental practice (SDG 6, 7, 9, 12, 13)	Formal environmental assessment processes are undertaken, with measures in place for effective implementation, such as management plans/ programmes, standard operating procedures, and contingency plans
ENVIRONMENT	Eco-efficiency (SDG 6, 7, 9, 12, 13)	Implementation of technologies supporting, for example efficient water use, mitigates climate change (e.g. emissions and fuel efficiency), using eco-friendly materials, minimizing/recycling waste, as well as greening and efficient land-use within ports
	Environmental compliance (SDG 6, 9, 12)	Effective compliance and enforcement to minimize potential environmental impact (e.g. through atmospheric emissions, waste and wastewater discharges, or spills) through sound environmental management systems and regular environmental audits
	Environmental quality (SDG 14, 15)	Good environmental health maintained, including air quality, water and groundwater quality, soil and sediment quality and habitat/biodiversity
SOCIAL	Community wellbeing (SDG 1, 2, 3, 6, 7, 8)	Wellbeing of affected communities are addressed (including access to support livelihoods, access to clean water and energy, as and where appropriate), with open communication channels and community-based environmental education and awareness
	Support to small enterprises (SDG 1, 8)	Support to sustainability-related community and small business enterprises
	Port-Municipal relations (SDG 11)	Effective collaboration and communication across port-municipal nexus
	Cultural & heritage protection (SDG 11)	Protection of cultural heritage assets, including areas used for traditional practices
	Employee satisfaction & wellbeing (SDG 4, 5, 8, 10)	Wellbeing of employees are addressed in terms of health, safety, job security, and equity including open communication channels with adequate training, and education and awareness programmes
ECONOMIC	Climate resilience (SGD 13)	Climate change (CC) preparedness in terms of infrastructure and operations, as well as effective early warning climate systems
	Service quality & efficiency (SDG 9, 12)	Satisfied customers, achieved through good port infrastructure, technological efficiency, as well as sound port and cyber security
	Economic growth & development (SDG 8, 9)	Economically viable port, reflected in good revenue generation, growth opportunities and tax generation
	Interconnectivity (SDG 8, 9)	Well-connected port, both in terms of hinterland connectivity and international port connectivity (block chain), as well as regional infrastructure integration

The achievement of these sustainability outcomes does not occur automatically, it needs to be planned for and implemented by port authorities and other related role players across various components within the port development as depicted in the IPM Framework (Figure 7-4). These components can broadly be grouped into four key stages, that is planning, design, construction, and operations (e.g. Ares Moreno 2018, UNEP et al. 2024). The SPP&D Framework, therefore, also reflects alignment between *port development stages* and various *sustainability outcomes* (Figure 7-7). As is evident, a significant number of sustainability outcomes spans all stages of port development. For example, within the *governance* dimension, *political and corporate commitment* must feature early on in planning stages, already addressing commitment to sustainability at site selection and master planning; Similarly *Eco-efficiency* (*Environment* dimension), *Community wellbeing, Port-city relations*, and *Cultural and heritage protection* (*Social* dimension), and *Climate resilience, Economic*

growth & development and *Inter-connectivity* (*Economic* dimension) must be addressed from the early planning stage. Within this SPP&D Framework, details on **key requirements for securing related sustainability outcomes in the proposed Port of Boegoebaai is provided in the next section.**

7.4 Sustainability Planning for Proposed Port of Boegoebaai

7.4.1 Key Sustainability Criteria

To ensure further alignment between port sustainability planning (e.g. for new port development or expansion in existing ports) and sustainability performance assessment and reporting (e.g. for operational ports), it is not only important to frame planning and performance in a similar manner. Also critical is the alignment of key sustainability requirements within planning (i.e. SPP&D Framework) with the indicators, measures and targets applied in performance assessment (i.e. PSP Index - Taljaard et al. 2024a). As a result, the *key sustainability requirements* for the proposed Port of Boegoebaai, were largely informed by the sustainability indicators and measures applied the PSP Index, as derived in consultation with the TNPA (see Taljaard et al. 2024a for details). The key sustainability criteria for the proposed Port of Boegoebaai are presented in Tables 7-7 to 7-10. These are organised into the four pillars of sustainability and associated sustainability outcomes (see Table 7- 6), also showing alignment with relevant SDGs.

Table 7-7: Key criteria towards achieving sustainability outcomes within the governance dimension (adapted from Taljaard et al. 2024a)

GOVERNANCE		
Sustainability Outcome	**Related SDGs**	**Key Criteria**
Political & corporate commitment	16: Peace, Justice and Strong Institutions 17: Partnerships for the Goals	• **Legislative framework in place to enable sustainable planning, development, and operations in ports** (see Appendix A on national legislation and policies potentially applying to port environments) • **Organizational culture towards sustainable development** (e.g. adopting a TNPA sustainability outcomes framework), e.g. establish supply chain partnerships for ensuring CSR values throughout chain • **Dedicated budget allocation for sustainable development**, through: - Funding allocated to environmental issues (e.g. monitoring and reporting) - Funding allocated to social issues (e.g. Corporate Social Investment) • **Public communication mechanisms in place** through transparent internal and external communications (e.g. media releases and public documents reporting on environmental and social matters (e.g. TNPA News Bulletin)
Effective institutional arrangements	16: Peace, Justice and Strong Institutions 17: Partnerships for the Goals	• **Formal in-house institutions overseeing sustainability matters** through: - Dedicated department addressing sustainability - TNPA Sustainability Forum at port level • **Dedicated institution to engage with port customers** (tenants/terminal operators) through: - TNPA customer engagement meetings implementation at port level • **Dedicated institution to engage with stakeholders** outside port boundaries through: - Port consultative forum or committee • **Dedicated collaborative arrangement between port & adjacent local authority** through MoU or other formal arrangement
Sound management practice	6: Clean Water and Sanitation 7: Affordable and Clean Energy 9: Industry, Innovation and Infrastructure 12: Responsible Consumption and Production 13: Climate Action	• **Environmental assessment and management through the project lifecycle**, through: - Strategic Environmental Assessment and Environmental Screening in the conceptual planning and pre-feasibility stage - Environmental Impact Assessment at a project level in the Feasibility Phase with associated Environmental Management Plans (EMP) for the construction and operations phases - Environmental Management System implemented for the operations phase, e.g. Transnet Integrated Management Systems (TIMS) • **EMPs and/or Standard Operational Procedures (SOPs) addressing sustainability** (incl. monitoring) prepared and effectively implemented for: - Air quality - Marine environmental quality - Soil/groundwater - Biodiversity management

GOVERNANCE		
Sustainability Outcome	**Related SDGs**	**Key Criteria**
		- Wastewater - Solid Waste, including marine litter and - Hazardous Waste - Hull cleaning - Ballast water - Dredging (Capital and Maintenance) - SMME (small, medium, and micro-enterprises) • **Contingency planning** through: - Oil/fuel spill management - Emergency preparedness plan to ensure business continuity

Table 7-8: Key criteria towards achieving sustainability outcomes within the environment dimension (adapted from Taljaard et al. 2024a)

ENVIRONMENT		
Sustainability Outcome	**Related SDGs**	**Key Criteria**
Eco-efficiency	6: Clean Water and Sanitation 7: Affordable and Clean Energy 9: Industry, Innovation and Infrastructure 12: Responsible Consumption and Production 13: Climate Action	• **Water use efficiency** through: - Integration of desalination planning into the port design - Generation of water from alternative resources (e.g., desalination) - Monitor and ensure water use efficiency by TNPA, tenants and Capital Projects • **Energy efficiency** through: - Produce and/or source renewable energy sources (solar, wind green hydrogen) - Monitoring and minimise of energy consumption by TNPA & tenants - Encourage third parties to avoid or reduce use of fossil fuels and use renewable energy • **Selection and procuring eco-friendly materials** through supply-chain that promotes such use • **Waste management** (recycling of other waste) through optimising port processes/ operations/services to avoid, recycle and/or minimise waste (e.g. grey water recycled) • **Recycle/minimize construction and building waste** (circular economy concept) • **Efficient and responsible land/sea use** (spatial planning through implementing efficient occupation planning and consider sensitive ecosystems & areas of cultural importance) • **Climate mitigation** through: - Control greenhouse gas emissions by TNPA, tenants, non TNPA trucks and visiting ships (CC mitigation) - Use of environmentally friendly fuels for tugs, vehicles dredger & (e.g. low S fuel <500 ppm)
Environmental compliance	6: Clean Water and Sanitation 9: Industry, Innovation and Infrastructure 12: Responsible Consumption and Production	• **Environmental compliance monitored, reporting and control**, including: - Atmospheric emissions (port operations & visiting ships) - Noise - Wastewater discharges - Solid/hazardous waste (e.g. NCR's and Audit findings and non-compliance reports issued to tenants by SHE Department as per related legislation) • **Environmental incidents** limited (e.g. spills) (Level 1 and 2 - NEMA Section 30 and Section 20; Level 3 and 4) • **Port environmental assurance audits** performed and evaluated and communicated to stakeholders • **Compliance to EMS,** specifically TNPA's internal TIMS
Environmental quality	14: Life below Water 15: Life on Land	• **Environmental quality** effectively monitored and evaluate, including: - Air quality - Noise (e.g. impact on marine mammals) - Marine water quality (e.g. using CSIR health index for ports) - Marine sediment quality (e.g. using CSIR health index for ports) - Shoreline erosion and accretion - Soil & groundwater quality, especially for fuel storage areas • **Status of habitat and biodiversity** such as: - Protect coastal and marine habitat and biodiversity effectively monitored and evaluated (e.g. using CSIR health index for ports) - Support protection and recovery of disturbed terrestrial habitats and biodiversity (e.g. areas effected by wind-blown sand). • **Control marine invasive species** (e.g. ballast water management)

Table 7-9: Key criteria towards achieving sustainability outcomes within the social dimension (adapted from Taljaard et al. 2024a)

SOCIAL		
Sustainability Outcome	**Related SDGs**	**Key Criteria**
Community wellbeing	1: No Poverty 2: Zero Hunger 3: Good Health and Well-being 4: Quality Education and Learning Opportunities 6: Clean Water and Sanitation 7: Affordable and Clean Energy 8: Decent Work and Economic Growth	• **Corporate Social Initiatives planned for and undertaken** through: - Support of cultural activities and NGOs - Proactive community engagement programmes and partnerships with local communities to strengthen port-region relations - Cooperate with schools, universities and research centres in educational programmes - Internships and port visits • **Access rights for communities (where appropriate)** through identifying and resolving community interests, e.g.: - Providing access for fishing, harvesting, cultural activities - Providing assess to clean water and energy • **Community-based environmental education and awareness** through related programmes and events pertaining to sustainability • **Support to sustainability related community enterprises** through: - Providing opportunities for skills development and training for members of the local communities to support their potential employment in the port and associated economic activities - Providing opportunities for communities to engage in and benefit from the port and associated development • **RD&I investment** (studentship/intern opportunities and collaboration) through: - Creating synergies with universities in port RD&I projects - Joint research and development projects involving port stakeholders, academia, industry and authorities
Support to small enterprises	1: No Poverty 8: Decent Work and Economic Growth	• **Support to local/small businesses** through: - Awarding contract to SMMEs (small, medium, and micro-enterprises) - Supporting local enterprise development (e.g. proportional allocation from net profits) - Supporting supplier development (e.g. proportional allocation from net profits)
Port-municipal relations	8: Decent Work and Economic Growth 11: Sustainable Cities and Communities	• **Port-municipal collaboration** through joint sustainability-related events and/or programmes undertaken with municipal and provincial authorities • **Port municipal relationship** managed through identifying and resolving Issues/conflicts with municipal/provincial authorities through established forums
Cultural and heritage protection	11: Sustainable Cities and Communities	• **Protection of cultural and heritage assets** through: - Identifying mapping protecting and monitoring of assets - Integrating port development into the cultural heritage and landscape planning for the region (e.g. tourist routes)
Employee satisfaction & wellbeing	4: Quality Education 5: Gender Equality 8: Decent Work and Economic Growth 10: Reduced Inequalities	• **Training (incl. education on sustainability matters)** through: - Cooperating with other ports for educational/training purposes (e.g., joint port training programs and centres) - Offering training to port professionals through regional and national institutions - Ensuring eligible employees are trained - Monitoring and evaluating time spend on training - Ensuring eligible employees receive promotion as per employment equity targets • **Employee engagement forms** through: - Establishing and running employee Imbizo-type forums - Employee grievances/ satisfaction Business forums with employees as prescribed by recognition agreement • **Employee grievance and satisfaction addressed** through: - Establishing grievance procedures and registration - Conducting employee satisfaction surveys - Logging legitimate employee complaints (e.g. HR Complaints App) • **Employees recognition** (e.g., long service rewards, performance awards) • **Wellness assistance** through usage of employee assistance programmes • **Occupational safety awareness** ensured through safety culture initiatives (e.g. International Labour Organisation Health and Safety Day) • **Employee safety** achieved as per TNPA targets • **Employment equity** promoted as per TNPA targets • **Employee job security** (e.g. not only contract work)

Table 7-10: Key criteria towards achieving sustainability outcomes within the economic dimension (adapted from Taljaard et al. 2024a)

ECONOMICS		
Sustainability Outcome	**Related SDGs**	**Key Criteria**
Climate resilience	13: Climate Action	• **Climate change (CC) preparedness** through: - Planning and design of infrastructure for enhanced climate resilience to be undertaken using the future climate change scenarios (e.g. in terms of changes in, temperatures, sea level rise and intense storms) as prepared by the Intergovernmental Panel on Climate Change (IPCC) scenarios. TNPA is currently undertaking a project on climate change adaptation including downscaling relevant IPCC climate scenarios for application at specific port planning and design scales along South Africa's coast. - Establishing CC cluster as per TNPA's systems - Establishing operational CC business continuity management (BCM) plan as per TNPA systems • **CC early warning systems** implemented (e.g., weather (waves, wind, flooding), seasonal forecasting, also addressing shorter term CC effects, plus local wind, waves in real time (e.g. IPOSS) to protect vessels and port infrastructure • CC incidents assessment through logging and addressing incidents, such as extreme sea-state, intense storms, and dry periods with strong winds and dust storms (Business Impact Analysis, Mission Critical Activities)
Service quality & efficiency	9: Industry, Innovation and Infrastructure 12: Responsible Consumption and Production	• **Technical capacity and efficiency** achieved as per TNPA targets for: - Ship turnaround times - Marine service delays - Anchorage - Cargo volumes handled • **Good quality potable water supplied** to tenants/ships • **Customer satisfaction** achieved through addressing issues arising through meetings of established institutional structures • **Port security** achieved by limiting criminal and security incidents • **Cyber security** achieved by preventing potential security incidents • **Digitalisation** of port systems • **Improvement of port infrastructure** through: - Maintaining at acceptable quality - Industrial innovation to ensure resilient and future-fit infrastructure
Economic growth & development	8: Decent Work and Economic Growth 9: Industry, Innovation and Infrastructure	• **Port revenue generation through formal port activities as** per targets set as per TNPA's financial system (e.g. Operation Ratios, Cash Interest Cover, Margin, Return on invested capital) • **Revenue generated through complementary sectors** (e.g. energy, transport services and tourist activities) • Business growth opportunities for others in port and wider region through: - Availability of a port to wider region: - Access to port facilities for private sector in the region (reduced travel distance to get export products to port) - Opportunities for Broad-Based Black Economic Empowerment • **Corporate Tax and VAT generation** through national and provincial revenue • **Employment opportunities** created through CAPEX employment opportunities as per TNPA target • **Economic contribution (gross value added)** created through CAPEX: Contribution to gross domestic product as per TNPA target • New business production through CAPEX creating new business opportunities as per TNPA target
Inter-connectivity	8: Decent Work and Economic Growth 9: Industry, Innovation and Infrastructure	• **Effective hinterland connectivity** addressed and resolved (e.g. railway lines, road transport routes, potential gas pipeline) • **Effective international port connectivity** through addressing and resolving international links, enhancing such as link with intended green hydrogen development in southern Namibia

Framework for SPP&D (Figure 7-7), together with the key sustainability requirements (Table 7-10) provide a **science-based benchmark** for where to evaluate the extent to which port planning and development processes to be undertaken for the proposed Port of Boegoebaai port would support sustainability. This is relevant to the current SEA process, but also in potential future EIA processes, through construction and ultimately during operations.

All sustainability outcomes are important to consider in the planning of a proposed Port at Boegoebaai, but reflecting on the place-based circumstances at Boegoebaai, the following are likely to requite specially attention:

- Eco-efficiency (e.g. sustainable sources of water and energy)
- Community wellbeing (e.g. in the area local communities rely heavily on natural resources for their livelihood, and will require access to clean water and reliable energy)
- Cultural & heritage protection (e.g. areas support an array of cultural and heritage assets)
- Climate resilience (e.g. west coast likely to be affected by climate change)
- Interconnectivity (e.g. area is very remote with connectivity challenges)
- Capacity building and training on sustainability planning and the implementation of key criteria for those involved should the project this project be approved (as highlighted under *Employee satisfaction & wellbeing*).

Further, foresight of likely future development plans around the port (for example, industrial, urban and suburban development) should be considered in the spatial planning for the port. This will be key in avoiding future port-city, and port-community conflict, also applying to infrastructure needed to ensure future interconnectivity.

Another key issue crucial to sustainability as it pertains to environmental issues and climate resilience, is access to long-term, inter-seasonal field data on, for example, climate, oceanic processes, environmental quality, and biodiversity. Given the remoteness of the study area, the collection of such data will be a challenge and should be considered and resolved soonest, should this project be approved.

In the next section, examples of specific activities or actions that could be undertaken to meet the key sustainability requirements, linked to sustainability outcomes and SDGs, as provided by the World Ports Sustainability Program and the regional Nairobi Convention.

7.4.2 Useful Information Sources to Support Implementation

7.4.2.1 World Ports Sustainability Program

The World Ports Sustainability Program (PSP) was established in May 2017, managed by the International Association of Ports and Harbors (IAPH). The Program aims to demonstrate global leadership of ports in contributing to the SDGs of Agenda 2030. Its web-based platform (https://sustainableworldports.org/) serves as a reference database of best practices of ports, focusing on environmental care and climate and energy (Environment), health safety and security and community building (Social), as well as digitalization and infrastructure (Economic). Their aim is for port authorities to engage with business, governmental and society in creating sustainable added value for the local communities and wider regions in which their ports are embedded, much aligned with the sustainability outcomes as proposed in the SPP&D Framework. Table 7-11 captures practical examples of types of activities that could be undertaken in support of specific SDGs across the four key pillar or dimensions of sustainability (WPSP 2020).

Table 7-11: Type of activities supporting SGDs within governance, environment, social and economic dimensions for consideration in the proposed Port of Boegoebaai (adapted from WPSP 2020)

SUNSTANABILITY DIMENSION & SDGS		TYPE OF ACTIVITY
GOVERNANCE	16: Peace, Justice and Strong Institutions	• Constructive dialogue between employer and employees • Good governance (a clear policy statement, stakeholder analysis, defined measurements, consistent reporting) • Peace initiatives (e.g., peace education on the work floor, prevention of illegal arms trafficking) • Addressing security: cyber security measures, commercial and operational data protection, improving the careful use and protection of personal data • Open dialogue and collaboration with all stakeholders (including emergency services, customs and armed forces) and availability of a hotline for complaints and questions • Transparent internal and external communication
	17: Partnerships for the Goals	• Partnerships with local communities for port-city relation initiatives • Partnering with other ports and parties in the logistics chain in joint projects of common interest • Public-private partnerships for funding and implementing sustainability projects • Establishing supply chain partnerships for ensuring CSR values throughout the chain • Cooperating with other ports for educational/training purposes (e.g., joint port training programs and centres) • Joint research and development projects involving port stakeholders, academia, industry and authorities
ENVIRONMENT	6: Clean Water and Sanitation	• Providing drinking water and clean sanitation facilities for port employees and visitors (e.g., vessels' crew, truck drivers) • Minimizing/optimizing water consumption in the port area • Harvesting rainwater for port use • Protecting water-related ecosystems (e.g., estuaries, wetlands, mangroves) in and around the port area • Projects protecting freshwater resources (e.g., wastewater and stormwater treatment)
	7: Affordable and Clean Energy	• Locally producing and/or sourcing renewable energy • Supporting research and development on clean energy technology • Producing and/or recovering energy from industrial waste streams • Investing in energy-efficient port equipment (stationary and mobile material handling equipment, lighting and technology) • Encouraging clean energy initiatives from third parties (vessels, tenants and operators) through appropriate instruments (incentives, clauses in lease/concession agreements) • Providing Onshore Power Supply from renewable sources • Providing cleaner (marine) fuels in a safe and efficient manner • Optimizing port operations and processes (logistics, port calls)
	9: Industry, Innovation and Infrastructure	• Devising sustainable port development policies supported by relevant key performance indicators • Digitally optimizing infrastructure and port operations/processes/services • Piloting, testing and implementing innovative IT and digital technologies in the port for public and private use • Foreseeing the adaptation of port infrastructure to withstand climate change • Adapting port infrastructure and processes to meet market demands (such as increasing ship size) • Sustainable port development projects • Investing in infrastructure for all transport modes to enable a balanced modal split • Minimizing environmental impact of the port activities
	12: Responsible Consumption and Production	• Sustainably managing natural resources, chemicals and waste • Implementing responsible procurement and sustainable investments in port area management and development as well as the end-to-end supply chain etc. • Encouraging circular economy and industrial reuse and mutually beneficial use of resources in the port community • Optimizing port operations/processes/services • Reducing food wastage and food loss in the production / supply chain (e.g., connecting the cruise industry with an NGO addressing poverty in your city or region)
	13: Climate Action	• Improving energy efficiency of port operations, processes and services • Enabling the reduction of carbon and greenhouse gas emissions within the port area • Providing services to reduce greenhouse gas emissions at sea and on the waterways, as well as the hinterland part of the supply chain • Producing and/or sourcing renewable energy • Encouraging third parties (vessels, tenants and operators) to take clean energy initiatives, by providing incentives and integrating clauses in lease and concession agreements
	14: Life below Water	• Taking measures to prevent waste from ending up in the oceans (e.g., port reception facilities, fishing for litter, cleanup actions) • Promoting sustainable fishing activities • Supporting research regarding sustainable use of maritime resources • Reducing the emission of CO_2, SO_2, NO_x, NH_3 from port- related activities to avoid acidification of the oceans • Minimizing water pollution through adequate wastewater treatment facilities • Protecting coastal and estuarine ecosystems • Minimizing disturbing factors such as underwater noise for marine mammals
	15: Life on Land	• Supporting local projects regarding nature development and biodiversity • Recovering and protecting nature and biodiversity in the port surroundings • Preventing deforestation through the usage/procurement of sustainably certified wood and paper • Offering nature and environmental education programs to employees • Port area development in balance with ecosystems • Minimising environmental externalities of port operations (e.g., air pollution, noise)
SOCIAL	1: No Poverty	• Setting a good minimum wage for the port employees and encouraging similar practices in the port community • Taking responsibility for the application of ethical standards throughout the supply chain (e.g., working conditions and human rights in developing countries) • Including sustainability requirements (e.g., Fairtrade label) in procurement

SUNSTANABILITY DIMENSION & SDGS		TYPE OF ACTIVITY
		• Supporting local communities in need through social projects targeting sustainable growth • Supporting local social institutions (e.g., schools, orphanages, NGOs)
	2: Zero Hunger	• Supporting local projects targeting the provision of food to families/communities in need • Encouraging the transfer of food surpluses out of the warehouses in the port to charities, food banks and community organizations • Supporting the trade/storage of Fairtrade and other ethically produced agricultural products in cooperation with NGOs and community organizations • Sourcing Fairtrade food products for own catering
	3: Good Health and Well-being	• Improving health and safety awareness of employees and local communities through training and transparent communication on health and safety risks • Minimizing environmental externalities (e.g., air pollution, water pollution, noise) of port operations and greening of the port and urban areas • Initiatives on sustainable / safe mobility and projects targeting congestion • Enhancing port safety and security and minimizing risks • Awareness raising and actions against the use of addictive substances (e.g., tobacco, alcohol, drugs) • Protecting habitats and biodiversity in and around the port area
	4: Quality Education and Learning Opportunities	• Competence and talent policy for port employees • Enhance life-long learning for the port employees • Cooperating with local schools, universities and research centres in educational programs, internships and port visits. • Offering training to port professionals through dedicated institutions • Creating synergies with universities in port research and development projects
	5: Gender Equality	• Gender-neutral hiring and remuneration policies • Promoting women to leadership roles; training and hiring more women for port operational positions (e.g., crane operators) • Leveling the male/female ratio of port employees for operational and managerial positions • Taking measures that make the port working environment more attractive to women (e.g., separate toilets, promotional campaigns, family-friendly HR-policy)
	6: Clean Water and Sanitation	• Providing drinking water and clean sanitation facilities for communities • Protecting water-related ecosystems (e.g., estuaries, wetlands, mangroves) in and around the port area • Projects protecting freshwater resources (e.g., wastewater and stormwater treatment)
	7: Affordable and Clean Energy	• Locally producing and/or sourcing renewable energy, also acknowledging needs of local communities • Encouraging clean energy initiatives through appropriate instruments
	8: Decent Work and Economic Growth	• Ensuring that economic growth positively impacts local communities economically and socially • Promoting employment, including opportunities for disadvantaged groups and young people • Striving for a healthy and safe working environment for all: specific actions related to safety and ergonomics, and creating a good work/life balance • Taking responsibility for applying ethical standards throughout the end-to-end supply chain (e.g., working conditions and human rights in developing countries) • Including trade unions in constructive dialogues between employer and employee towards a just transition away from fossil fuel industries to green energy
	10: Reduced Inequalities	• Promotion of gender equality • Achieving equality within the port independent of gender, origin, belief, conviction etc. • Port community initiatives being all inclusive irrespective of socio-economic background (e.g., supporting sensitive social groups) • Social background-neutral hiring and renumeration policies • Taking responsibility for the application of ethical standards throughout the supply chain (e.g., working conditions and human rights in third world countries) • Financial support to local communities in need and social projects targeting sustainable growth of neighbouring communities • Ethical investment and banking
	11: Sustainable Cities and Communities	• Improving sustainable mobility and reducing congestion for both employees and goods • Restoring ecosystems and making the port accessible and attractive for people in neighbouring urban areas • Minimizing environmental externalities of port operations (e.g., air pollution, water pollution, noise) • Disaster recovery planning • Community engagement programs and initiatives • Supporting local communities in need through social projects targeting decent living and working opportunities that generate sustainable growth of neighbouring communities • Supporting local social institutions (e.g., schools, orphanages, NGOs)
ECONOMIC	8: Decent Work and Economic Growth	• Achieving economic growth through diversification, innovation and technological modernization • Generating viable economic growth in an environmentally sustainable manner • Generating a sustainable model for cruise tourism • Taking responsibility for applying ethical standards throughout the end-to-end supply chain (e.g., working conditions and human rights in developing countries)
	9: Industry, Innovation and Infrastructure	• Devising sustainable port development policies supported by relevant key performance indicators • Digitally optimizing infrastructure and port operations/processes/services • Piloting, testing and implementing innovative IT and digital technologies in the port for public and private use • Foreseeing the adaptation of port infrastructure to withstand climate change • Adapting port infrastructure and processes to meet market demands (such as increasing ship size) • Sustainable port development projects • Investing in infrastructure for all transport modes to enable a balanced modal split • Minimizing environmental impact of the port activities
	13: Climate Action	• Improving energy efficiency of port operations, processes and services • Enabling the reduction of carbon and greenhouse gas emissions within the port area

SUNSTANABILITY DIMENSION & SDGS		TYPE OF ACTIVITY
		• Adapting port infrastructure and port related operations to Climate Change • Providing services to reduce greenhouse gas emissions at sea and on the waterways, as well as the hinterland part of the supply chain • Producing and/or sourcing renewable energy • Encouraging third parties (vessels, tenants and operators) to take clean energy initiatives, by providing incentives and integrating clauses in lease and concession agreements

7.4.2.2 Nairobi Convention's Toolkit for Sustainable Port Development

The need to accelerate regional efforts towards sustainable port development in the Western Indian Ocean (WIO) also became a recent concern of the Contracting Parties to the Nairobi Convention (Odhiambo 2018). Signatories to this convention are Comoros, Kenya, Mauritius, Mozambique, Madagascar, Seychelles, Somalia, **South Africa**, and Tanzania. The aim of this Convention being to address accelerating degradation of ocean and coastal areas in the WIO region through promoting and guidance of sustainable us and management practices.

Contracting parties called for the development of a toolkit for sustainable port development, and in response the Nairobi Convention Secretariat initiated the development of a ***'Toolkit for Sustainable Port Development in a Blue Economy'*** in partnership with the CSIR (UNEP 2024, in press). This toolkit was developed in consultation with port authorities in the region, including the TNPA. The output of this project was recently endorsed by contracting parties for uptake in the region at the 10th Conference of Parties held in Madagascar in August 2024 and is currently in press, shortly to be officially released by the Nairobi Convention Secretariat to be available for countries in the region to consider for implementation, also by the proposed Port of Boegoebaai.

The toolkit offers a range of 'tools', primarily consolidated from international practice, that port authorities can consider in the implementation of sustainable port planning and development (**UNEP et al. 2024, in press**; Taljaard et al. 2024b). Aligned with the core mandate of the Nairobi Convention, i.e. to advance sustainable management and use of the *coastal and marine resources*, the ***Toolkit*** primarily focuses on 'tools' to advance sustainability in the **environment dimension**, but with obvious ripple effects into aspects of governance, social and economic sustainability. Table 7-12 provides an overview of the tools captured in the ***Toolkit***, as well as a list of key information sources from which to learn more (full references to these sources are provided in Appendix B.

Table 7-12: Overview of 'tools' contained in the Nairobi Convention's *'Toolkit for Sustainable Port Development in a Blue Economy'* for consideration in the proposed Port of Boegoebaai (see Appendix B for detailed reference list) (Source: UNEP et al. 2024, in press; Taljaard et al. 2024b)

		TOOL	INFORMATION SOURCE
PORT DEVELOPMENT STAGE	Planning	Guidance on Strategic Environmental Assessment	Senécal et al. 1999; Dalal-Clayton and Sadler 1999, 2005; CEC 2001; IAIA 2002; Partidário 1999, 2003; ODPM 2005; OECD 2006; GHD 2013; UNEP 2018
		Site selection and Master Planning	PIANC 2014a, 2019a; ALG Transport & Infrastructure 2021
		Planning for Climate Change	Asariotis et al. 2019; Azarkamand et al. 2020a; PIANC 2020, 2022
		Concept of Nature-Based solution	WWF 2016; Cohen-Shacham et al. 2016, 2019
		Scenario Analysis Tools for Planning	Alcamo 2001; Walker 2019; Elsawah et al. 2020; UNEP et al. 2024
	Design	Guidance on Environmental and Social Impact Assessment	UN 1992; Morrison-Saunders et al. 2007; UNEP 2018; Bishoge &Mvile 2022; Tarr n.d.
		Design for Biodiversity Offsets	IUCN 2004; Ten Kate et al. 2004; BBOP 2009; World Bank Group 2016; Nairobi Convention. 2018; Jacob et al. 2020
		Building-with-Nature Design Approach	Waterman et al. 1998; Waterman 2010; de Vriend and Van Koningsveld 2012; Vikolainen et al. 2014; de Vriend et al. 2015; PIANC 2018; De Boer et al. 2019; Oerlemans et al. 2021; Ecoshape 2021, 2022

	TOOL	INFORMATION SOURCE
	Ecological Enhancement Options	Paalvast et al. 2012; Browne and Chapman 2014; Ido and Perkol-Finkel 2015; Coombes et al. 2015; Naylor et al. 2017; Morris et al. 2019; Hall et al. 2018; Perkol-Finkel et al. 2018; Chee et al. 2020; EcoShape 2020; MacArthur et al. 2020
Construction	Construction Environmental Management Plans	LPC 2019; EPA South Australia 2021; Nihon Kaetsu 2022; Notteboom et al. 2022
	Dredge Management (also in Operations)	IMO 2014; PIANC 2006, 2009a, 2009b, 2009c, 2010, 2014b; IADC 2019; EPA South Australia 2020
	Considerations for Port Decommissioning	IOGP 2017; Melbourne-Thomas et al. 2021; da Cunha Jácome Vidal et al. 2022
Operations	Guidance on Environmental Management Systems	Whitehead 2000; Darbra et al. 2004; Brouwer and van Koppen 2008; Iraldo et al. 2009; ESPO 2012b,2020; Rebelo et al. 2014; ISO 2020a, 2020b; Petrosillo et al. 2012; Testa et al. 2014; Arabi et al. 2022
	Circular Economy in Ports	De Langen and Sornn-Friese 2019; Obura et al. 2017; Schönborn & Junge 2021; Ellen MacArthur Foundation 2022; Ali 2023
	Examples: Sustainable Port Development Actions	WPSP 2020; Liu et al. 2023; Guo et al. 2024; Zhang et al. 2024
	Securing External Finance for Port Development Projects	UNEP-FI 2021
	Sustainable Use of Materials and Land	NSW Port Authority 2017
	Energy Efficiency Management	ESPO 2012a; Boile et al. 2016; AIEA Bioenergy 2017; NSW Port Authority 2017; Iris and Lam 2019; Bjerkan and Seter 2019; PIANC 2019b; Sdoukopoulos et al. 2019; IMO 2020; Macía et al. 2021
	Management of Carbon Footprint	WPCI 2010; PIANC 2019c; Azarkamand et al. 2020b; De los Reyes et al. 2020; Fadiga et al. 2024
	Management of Water Consumption	ESPO 2012a; NSW Port Authority 2017; Sensiba 2021
	Waste Management	UNEP 2013; NSW Port Authority 2017; ESPO 2012a
	Ballast Water Management	IMO 2022a, 2022b
	Guidance on Sustainable Hull Cleaning	IMO 2011, 2012; US-EPA 2011; Commonwealth of Australia 2015; BIMCO 2021a, 2021b
	Towards Improving Port Environmental Quality	ESPO 2012a; PEMA 2016; NSW Port Authority 2017; NIOSH 2022; Mont-Mégantic International Dark Sky Reserve 2022
	Ecosystem Restoration	Keenleyside et al. 2012; Fitzsimon et al. 2019; Gann et al. 2019, 2022; Léocadie et al. 2020; UNEP-Nairobi Convention/ WIOMSA 2020a, 2020b; González et al. 2020; UNEP 2021a, 2021b; Eger et al. 2022; Escovar-Fadul et al. 2022
	Marine Litter Clean up Technologies	Armitage and Rooseboom 2000; Barnardo and Ribbink 2020; Barcelo and Pico 2020; Schmaltz et al. 2020
	Oil Spill Contingency Planning	UNEP/OCHA 1996a, 1996b; Swanepoel 2020; UNEP et al. 2020a, 2020b; Marine Coast Maritime and Coastguard Agency, UK 2021; IMO 2022c; ITOPF n.d.
	Environmental Monitoring and Evaluation	ANZECC 2000; Kusek and Rist 2004; Barentine 2019; Capelli et al. 2019; Mocerino et al. 2020; WHO 2021; Ferrario et al. 2022; UNEP et al. 2022a, 2022b
	Environmental Information Systems	Günter 1998; El-Gayar and Fritz 2006; Pitt et al. 2011; Baholli et al. 2013; Coman and Cioruța 2013; Bourgeois 2019
	Effective Capacity Development	OECD 2008, African Union 2015, 2016; EU 2019; Thapa et al. 2019; Bob-Manuel 2020
	Introduction to Natural Capital Accounting	UN 2014a, 2014b, 2019; Eigenraam et al. 2016; Chenoweth et al. 2018; GOAP 2019; Chen et al. 2020; Taljaard et al. 2023

		TOOL	INFORMATION SOURCE
		Sustainability Performance Index for Ports	Peris Mora et al. 2005; Lirn et al. 2013; Chiu et al. 2014; Shiau and Chuang 2015; Asgari et al. 2015; Laxe et al. 2017; Lu et al. 2016; Roh et al. 2016; Roos and Neto 2017; Schipper et al. 2017; Xiao and Lam 2017; Puig et al. 2017; Chen and Pak 2017; Oh et al. 2018; Stein and Acciaro 2020; Alamoush et al. 2021; Brunila et al. 2023; Taljaard et al. 2024a

7.5 References

African Union. 2015. Agenda 2063 – the Africa we want. Framework Document. https://au.int/en/agenda2063/overview

Alamoush AS, Ballini F and Ölçer AI. 2021. Revisiting port sustainability as a foundation for the implementation of the United Nations Sustainable Development Goals (UN SDGs). Journal of Shipping and Trade 6: 19. https://doi.org/10.1186/s41072-021-00101-6.

Arabi S, Taljaard S and Weerts SP. 2022. Adapting environmental management systems for African ports. WMU Journal of Maritime Affairs. https://doi.org/10.1007/s13437-022-00262-6.

Ares Moreno A. 2018. A methodology for developing a green port. Case study: Amatique Port in Guatemala. Master Thesis. Faculty of Civil Engineering and Geosciences, Delft University of Technology, Netherlands. https://repository.tudelft.nl/record/uuid:2debc917-e389-4944-a794-342d35788769

Asgari N, Hassani A. Jones D and Nguye HH. 2015. Sustainability ranking of the UK major ports: Methodology and case study. Transportation Research Part E: Logistics and Transportation Review 78: 19-39. https://doi.org/10.1016/j.tre.2015.01.014.

Audouin M, Lochner P and Tarr P. 2011. SEA in Southern Africa. In: Sadler, B., Aschemann, R., Dusik, J., Fischer, T.B., Partidario, M.R., Verheem, R. (Eds.) Handbook of Strategic Environmental Assessment, Earthscan, London. pp. 151-164.

Azarkamand S, Balbaa A, Wooldridge C and Darbra RM. 2020. Climate change— challenges and response options for the port sector. Sustainability 12: 6941. https://doi.org/10.3390/su12176941

Bell S and Morse S. 2018. Sustainability Indicators Past and Present: What Next? Sustainability 10(5): 1688. https://doi.org/10.3390/su10051688.

Bergqvist R and Monios J. 2019. Green ports in theory and practice. In: Bergqvist, R., Monios, J. (Eds.), Green Ports; Inland and Seaside Sustainable Transportation Strategies. Elsevier, Cambridge, MA, pp. 1–17.

Bishoge OK and Mvile BN. 2022. A critique of EIA report selected from the East African region considering what is required in ideal EIA report. Journal of Applied and Advanced Research 7: 8-17. https://doi.org/10.21839/jaar.2022.v7.7478

Bob-Manuel KDH. 2020. Capacity-building for sustainable maritime industry in developing coastal countries. Journal of Emerging Trends in Engineering and Applied Sciences 11(1): 6-13. https://hdl.handle.net/10520/EJC-1ce0fc5cac

Bourgeois D. 2019. Information Systems for Business and Beyond (2019) https://opentextbook.site/informationsystems2019/

Brunila OP, Kunnaala-Hyrkki V and Inkinen T. 2023. Sustainable small ports: performance assessment tool for management, responsibility, impact, and self-monitoring. J. shipp. trd. 8: 14. https://doi.org/10.1186/s41072-023-00142-z.

Chen Z and Pak M. 2017. A Delphi analysis on green performance evaluation indices for ports in China. Maritime Policy & Management 44(5): 537-550. https://doi.org/10.1080/03088839.2017.1327726

Chiu R-H, Lin L-H and Ting S-C. 2014. Evaluation of Green Port Factors and Performance: A Fuzzy AHP Analysis. Hindawi Publishing Corporation Mathematical Problems in Engineering Volume, Article ID 802976, 12 pp http://dx.doi.org/10.1155/2014/802976

Darbra RM, Ronza A, Casal J, Stojanovic TA and Wooldridge C. 2004. The Self Diagnosis Method A new methodology to assess environmental management in seaports. Marine Pollution Bulletin 48: 420–428. https://doi.org/10.1016/j.marpolbul.2003.10.023

Darbra RM, Ronza A, Stojanovic TA, Wooldridge C and Casal J. 2005. A procedure for identifying significant environmental aspects in seaports. Marine Pollution Bulletin 50 (8): 866-874. https://doi.org/10.1016/j.marpolbul.2005.04.037

de Boer W, Slinger J, Kangeri A, Vreugdenhil H, Taneja P, Addo Appeaning K and Vellinga T. 2019. A framework to structure ecosystem-based alternative identification in seaport design applied to Tema Port, Ghana. Sustainability 11: 6633. https://doi.org/10.3390/su11236633.

de los Reyes RS.; Fernández-Sánchez G.; Esteban MD and Rodríguez RR. 2020. Carbon Footprint of a Port Infrastructure from a Life Cycle Approach. Int. J. Environ. Res. Public Health 17: 7414. https://doi.org/10.3390/ijerph17207414

Dublin Port Company. 2012a. Dublin Port Masterplan Strategic Environmental Assessment Environmental Report: Non-technical Summary. Dublin , Ireland https://www.dublinport.ie/wp-content/uploads/2017/01/Dublin_Port_Masterplan_SEA_ER_NTS.pdf

Dublin Port Company. 2012b. Dublin Port Masterplan Strategic Environmental Assessment Environmental Report: Post Adoption Statement. Dublin, Ireland. http://www.dublinport.ie/wp-content/uploads/2018/04/06.-DPC_MP_SEA_-POST-ADOPTION-STATEMENT-Feb-2012.pdf

Guo X and Liu L. 2018. Approach to the Construction of Green Port in Tianjin Port. MATEC Web Conf. 175 04012. https://doi.org/10.1051/matecconf/2018175

Gupta AK, Gupta SK and Patil RS. 2005. Environmental management plan for port and harbour projects. Clean Technol. Environ. Policy 7: 133–141. https://doi.org/10.1007/s10098-004-0266-7

Hiranandani V. 2014. Sustainable development in seaports: a multi-case study. WMU J. Maritime Affairs 13(1): 127–172. DOI:10.1007/s13437-013-0040-y

Hossain MT. 2018. Assessment of sustainability initiatives in port operations: an overview of global and Canadian ports. In: Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Environmental Studies. Dalhousie University, Halifax, Nova Scotia, Canada.

HR Wallingford and British Port Association. 2021. Climate change and ports Impacts and adaptation strategies. HR Wallingford, UK. https://www.hrwallingford.com/sites/default/files/2021-10/climate_change_for_ports_-_impacts_and_adaptation_strategies_by_hr_wallingford_bpa_r3-0.pdf

IMO. 2022a. Ballast Water Management Convention. https://www.imo.org/en/OurWork/Environment/Pages/BallastWaterManagement.aspx

IMO. 2022b. Implementing the Ballast Water Management Convention. https://www.imo.org/en/MediaCentre/HotTopics/Pages/Implementing-the-BWM-Convention.aspx

IMO. 2022c. Oil spill contingency planning. https://www.imo.org/en/OurWork/Environment/Pages/Oil%20Spill%20Contingency%20Planning.aspx

IMO. 2023. 2023 IMO Strategy on Reduction of GHG Emissions from Ships. https://www.imo.org/en/OurWork/Environment/Pages/2023-IMO-Strategy-on-Reduction-of-GHG-Emissions-from-Ships.aspx

Jacob C, van Bochove J-W, Livingstone S, White T, Pilgrim J and Bennun L. 2020. Marine biodiversity offsets: Pragmatic approaches toward better conservation outcomes. Conservation Letters 13: e12711. https://doi.org/10.1111/conl.12711

James P. 2015. Urban Sustainability in Theory and Practice: Circles of sustainability, 1st ed.; Routledge: London, UK. https://doi.org/10.4324/9781315765747.

Kaliszewski A. 2018. Fifth and sixth generation ports (5GP, 6GP) – evolution of economic and social roles of ports. https://www.researchgate.net/profile/Adam_Kaliszewski2.

Lam JSL and Van de Voorde E. 2012. Green port strategy for sustainable growth and development. In: Yip TL, Fu X and Ng AKY. (Eds.), Transport Logistics for Sustainable Growth at a New Level. Proceedings of the International Forum on Shipping, Ports and Airports (IFSPA), Hong Kong, May 28-30, 417-427. The Hong Kong Polytechnic University, Hong Kong.

Lam, JSL and Notteboom T. 2014. The greening of ports: a comparison of port management tools used by leading ports in Asia and Europe. Transport Rev. 34 (2): 169–189. https://doi.org/10.1080/01441647.2014.891162

Lawer ET, Herbeck J and Flitner M. 2019. Selective adoption: how port authorities in Europe and West Africa engage with the globalizing 'green port' idea. Sustainability 11: 5119. https://doi.org/10.3390/su11185119

Laxe FG, Bermúdez FM, Palmero FM and Novo-Corti I. 2017. Assessment of port sustainability through synthetic indexes. Application to the Spanish case. Marine Pollution Bulletin 119(1): 220-225. https://doi.org/10.1016/j.marpolbul.2017.03.064

Lee PTW and Lam JSL. 2015. Container Port Competition and Competitiveness Analysis: Asian Major Ports. In: Lee CY and Meng Q (eds.), Handbook of Ocean Container Transport Logistics – Making Global Supply Chain Effective,

International Series in Operations Research & Management Science, Vol. 220, New York: Springer, pp. 97-136.DOI: 10.1007/978-3-319-11891-8_4

Lee PT-W, Lam JSL, Lin C-W, Hu K-C and Cheong I. 2018. Developing the fifth-generation port concept model: an empirical test. The International Journal of Logistics Management 29(3): 1098-1120. doi:10.1108/ijlm-10-2016-0239

Lirn T-C, Wu Y and Chen Y. 2013. Green performance criteria for sustainable ports in Asia. International Journal of Physical Distribution & Logistics Management 43(5/6): 427-451. DOI:10.1108/IJPDLM-04-2012-0134.

Lu C-S, Shang K-C and, Lin C-C. 2016. Identifying crucial sustainability assessment criteria for container seaports. Marit. Bus. Rev. 1 (2): 90–106. DOI: 10.1108/MABR-05-2016-0009.

Lucas PL and Wilting HC. 2018. Using planetary boundaries to support national implementation of environment-related Sustainable Development Goals, PBL Netherlands Environmental Assessment Agency, The Hague. https://www.pbl.nl/sites/default/files/downloads/Using_planetary_boundaries_to_support_national_implementation_of_environment-related_Sustainable_Development_Goals_-_2748.pdf.

MacArthur M, Naylor LA, Hansom JD and Burrows MT. 2020. Ecological enhancement of coastal engineering structures: Passive enhancement techniques. Science of The Total Environment 740: 139981. https://doi.org/10.1016/j.scitotenv.2020.139981.

Maritime Port Authority of Singapore. 2024. Tuas Port – A Smarter and Greener Port. https://www.mpa.gov.sg/maritime-singapore/port-of-the-future#:~:text=in%20your%20browser.-,A%20New%20Chapter,and%20ready%20for%20the%20future.

Maritz A, Shieh CJ and Yeh SP. 2014. Ecology – green ports – risk assessment innovation and success factors in the construction of green ports. J. Environ. Protect. Ecol. 15 (3a): 1255–1263.

Nihon Kasetsu. 2022. Environmental monitoring for construction projects. https://nihonkasetsu.com/environmental-monitoring-for-construction-projects/

Nitsenko V, Nyenno I, Kryukova I, Kalyna T and Plotnikova M. 2017. Business model for a sea commercial port as a way to reach sustainable development goals. Journal of Security and Sustainability Issues 7(1): 155-166. http://doi.org/10.9770/jssi.2017.6.4(13)

Oerlemans C, Wegman C, Jinkman B and Aarninhof S. 2021. The impact and costs of Building with Nature projects. Terra et Aqua 165: 37-43. https://www.iadc-dredging.com/article/impact-costs-building-with-nature/

Oh H, Lee S-W and Seo Y-J. 2018. The evaluation of seaport sustainability: The case of South Korea. Ocean & Coastal Management 161: 50-56. https://doi.org/10.1016/j.ocecoaman.2018.04.028.

Peris-Mora E, Diez Orejas JM, Subirats A, Ibáñez S and Alvarez P. 2005. Development of a system of indicators for sustainable port management. Marine Pollution Bulletin 50: 1649–1660. https://doi.org/10.1016/j.marpolbul.2005.06.048.

Puig M, Pla A, Seguí X and Darbra RM. 2017. Tool for the identification and implementation of Environmental Indicators in Ports (TEIP). Ocean & Coastal Management 140: 34-45. https://doi.org/10.1016/j.ocecoaman.2017.02.017.

Roh S, Thai VV and Wong YD. 2016. Towards sustainable ASEAN port development: challenges and opportunities for Vietnamese ports. Asian J. Shipp. Logistics 32 (2): 107–118. https://doi.org/10.1016/j.ajsl.2016.05.004

Roos EC and Neto FJK. 2017. Tools for evaluating environmental performance at Brazilian public ports: Analysis and proposal. Marine Pollution Bulletin 115(1–2): 211-216. https://doi.org/10.1016/j.marpolbul.2016.12.015.

Sala S, Ciuffo B and Nijkamp P. 2015. A systemic framework for sustainability assessment. Ecological Economics 119: 314–325. https://doi.org/10.1016/j.ecolecon.2015.09.015

Schipper CA, Vreugdenhil H and De Jong MPC. 2017. A sustainability assessment of ports and port-city plans: Comparing ambitions with achievements. Transportation Research Part D: Transport and Environment 57: 84-111. https://doi.org/10.1016/j.trd.2017.08.017

Sdoukopoulos E, Boile M, Tromaras A and Anastasiadis N. 2019. Energy Efficiency in European ports: State-of-practice and insights on the way forward. Sustainability 11: 4952. https://doi.org/10.3390/su11184952

Shiau T-A and Chuang C-C. 2015. Social construction of port sustainability indicators: a case study of Keelung Port. Maritime Policy & Management 42(1): 26-42. https://doi.org/10.1080/03088839.2013.863436.

Stein M and Acciaro M. 2020. Value Creation through Corporate Sustainability in the Port Sector: A Structured Literature Analysis. Sustainability 12: 5504. https://doi.org/10.3390/su12145504

Taljaard S, Slinger JH, Arabi S Weerts SP and Vreugdenhil H. 2021 The natural environment in port development: A 'green handbrake' or an equal partner? Ocean Coast Manag. 199: 105390. https://doi.org/10.1016/j.ocecoaman.2020.105390

Taljaard S, Slinger JH, Weerts SP, Vreugdenhil HIS and Nzuza C. 2024a. Circles of port sustainability: A novel method combining global comparability and local relatability in performance assessment. Environmental Development 52: 101068. https://doi.org/10.1016/j.envdev.2024.101068

Taljaard S, Weerts SP and Audouin M. 2024b. Advancing sustainable port development in the Western Indian Ocean region. Current Opinion in Environmental Sustainability 71: 101489. https://doi.org/10.1016/j.cosust.2024.101489

Taljaard S, van Niekerk L and Weerts SP. 2019. The legal landscape governing South Africa's coastal marine environment – Helping with the 'horrendogram'. Ocean & Coastal Management 178: 104801. https://doi.org/10.1016/j.ocecoaman.2019.05.003.

Taneja P, Ligteringen H and Walker WE. 2012. Flexibility in Port Planning and Design. European Journal of Transport and Infrastructure Research 12(1): 66-87. https://doi.org/10.18757/ejtir.2012.12.1.2950.

Thapa RB, Matin MA and Bajracharya B. 2019. Capacity Building Approach and Application: Utilization of Earth Observation Data and Geospatial Information Technology in the Hindu Kush Himalaya. Front. Environ. Sci. 7: 165. https://doi.org/10.3389/fenvs.2019.00165

TNPA (Transnet National Ports Authority). 2024. Towards Sustainable Port Development in the Western Indian Ocean: Implementation of a Toolkit for Sustainable Port Development in a Blue Economy. Pilot Testing Workshop Report. Port of Ngqura. Report prepared by Maxama A, Magidela Z, Nzuza C and Sani Z. for Nairobi Convention Secretariat, Kenya, Nairobi.

Transnet. 2023. Environment, Social and Governance (ESG) Strategy. Report compiled by Corporate Sustainability. Approved by Transnet's Remuneration, Social & Ethics Committee (REMSEC) on the 15th of November 2023.

Transnet. 2024. Overview.

https://www.transnet.net/AboutUs/Pages/overview.aspx#:~:text=Transnet%20signs%20an%20annual%20Shareholder's,economic%2C%20social%20and%20environmental%20outcomes.

UN (United Nations) 2015. Transforming Our World: The 2030 Agenda for Sustainable Development. https://sdgs.un.org/

UNDG (United Nations Development Group) 2019. Sustainable Development Goals Acceleration Toolkit. https://undg.org/2030-agenda/sdg-acceleration-toolkit/

UNEP, Nairobi Convention Secretariat and Council for Scientific & Industrial Research. 2024. Towards Sustainable Port Development in the Western Indian Ocean. Toolkit for Sustainable Port Development in a Blue Economy. UNEP, Nairobi, Kenya.

UNEP, Nairobi Convention Secretariat and Council for Scientific and Industrial Research (CSIR). 2022a. Western Indian Ocean: Strategic Framework for Coastal & Marine Water Quality Management. UNEP, Nairobi, Kenya. XXIV + 89 pp + Appendices. Strategic Framework for Coastal & Marine Water Quality Management | Nairobi Convention Clearinghouse Mechanism

UNEP, Nairobi Convention Secretariat and CSIR. 2022b. Western Indian Ocean: Guidelines for Setting Water and Sediment Quality Targets for Coastal and Marine areas. UNEP, Nairobi, Kenya. XXIV + 109 pp +Appendices. Guidelines for Setting Water and Sediment Quality Targets for Coastal and Marine areas | Nairobi Convention Clearinghouse Mechanism

UNEP. 2021a. Principles for ecosystem restoration to guide the United Nations Decade 2021-2030. https://www.decadeonrestoration.org/

UNEP. 2021b. Ecosystem Restoration Playbook. A practical guide to healing the planet. https://www.decadeonrestoration.org/publications/ecosystem-restoration-playbook-practical-guide-healing-planet

UNEP-FI (United Nations Environment Programme Finance Initiative) 2021. Turning the Tide: How to finance a sustainable ocean recovery—A practical guide for financial institutions. Geneva. https://www.unepfi.org/publications/turning-the-tide/

Villeneuve C, Tremblay D, Riffon O, Lanmafankpotin GY and Bouchard S. 2017. A Systemic Tool and Process for Sustainability Assessment. Sustainability 9: 1909. https://doi.org/10.3390/su9101909

WPSP (World Ports Sustainability Program) 2020. World ports sustainability Report. 2020. https://sustainableworldports.org/wp-content/uploads/WORLD-PORTS-SUSTAINABILITY-REPORT-2020-FIN.pdf

Xiao Z and Lam, JSL. 2017. A systems framework for the sustainable development of a Port City: A case study of Singapore's policies. Research in Transportation Business & Management 22: 255-262. https://doi.org/10.1016/j.rtbm.2016.10.003.

Appendix A: Relevant International Obligations, National Legislation & Policies

Taljaard et al. (2019) provided details on each of the entries in the illustration above as extracted below. Entries directly related to port and shipping have been highlighted.

Important international obligations and agreements

INTERNATIONAL OBLIGATION/AGREEMENT	SHORT DESCRIPTION
Agenda 2030 (2015)	**This agenda is a plan of action for people, planet and prosperity. It also seeks to strengthen universal peace in larger freedom with goals and targets aimed at stimulating action in areas of critical importance for humanity and the planet (as expressed in the sustainable development goal – SDGs) (2015-2030).**
Agenda 2063: The Africa we want (2015)	**This agenda is Africa's blueprint and master plan for transforming the continent into a future global powerhouse by 2063. It provides for a shared strategic framework for inclusive growth and sustainable development with a global strategy to optimize the use of Africa's resources for the benefit of all Africans, including Africa's port environments.**
International Convention for the Regulation of Whaling (1946)	This Convention provides for the conservation of whale stocks and makes possible the orderly development of the whaling industry.
International Convention for the Conservation of Atlantic Tunas (ICCAT) (1966)	The Convention provides for the conservation of tunas and tuna-like species in the Atlantic Ocean.
Civil Liability Convention (1969) as replaced by its 1992 Protocol and amended in 2000	The Convention provides for adequate compensation to persons who suffer oil pollution damage resulting from maritime casualties involving oil-carrying ships, placing the liability for such damage on the owner of the ship from which the polluting oil escaped or was discharged.
Convention on Wetlands of International Importance especially as Waterfowl Habitat (1971) (Ramsar Convention)	The Ramsar Convention promotes wise use of all wetlands and to prevent loss (includes estuaries and coastal lakes in its definition of wetlands).
Convention Concerning the Protection of the World Cultural and Natural Heritage (1972) (World Heritage Convention)	This Convention holds state party to recognising the duty of ensuring the identification, protection, conservation, presentation and transmission to future generations of the cultural and natural heritage situated in its territory (which may include estuaries).

INTERNATIONAL OBLIGATION/AGREEMENT	SHORT DESCRIPTION
Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter (1972, as amended) (London Convention)	**The Convention (and its Protocol) is an international treaty that limits the discharge of waste that are generated on land and disposed of at sea. The 1996 Protocol is a separate agreement that modernised and updated the London Convention, following a detailed review that began in 1993. In 1996 Protocol replaced the London Convention.**
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1973)	CITES provides for the protection of endangered plants and animals, including marine organisms. It also governs the trade in critically endangered and endangered species such as seahorses, eels, hard corals, abalone and great white sharks.
International Convention for the Prevention of Pollution from Ships (MARPOL) (1973/1978)	**The Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and updated by amendments through the years. The Convention includes regulations aimed at preventing and minimising pollution from ships and includes various technical annexes.**
Convention of Migratory Species of Wild Animals (1979) (Bonn Convention)	The Convention provides for cooperation of nations in the conservation of animals that migrate across their borders. These include terrestrial mammals, reptiles, marine species and birds.
Abidjan Convention (1981)	These regional Conventions were developed as part of the United Nations Environment Programme's Regional Seas Programme to improve the control of marine pollution and management of marine and coastal resources (including estuaries) in countries of the West and Central African region (Abidjan Convention) and the Eastern African or West Indian Ocean region (Nairobi Convention).
Nairobi Convention (1985)	
United Nations Convention on the Law of the Sea (UNCLOS) (1982)	**The Convention provides for regulation by the international community of all aspects of the resources of the sea and its uses, such as navigational rights, territorial sea limits, economic jurisdiction, legal status of resources on the seabed beyond the limits of national jurisdiction, passage of ships through narrow straits, conservation and management of living marine resources, protection of the marine environment, a marine research regime and, a more unique feature, a binding procedure for settlement of disputes between States.**
International Convention on Salvage (1989)	The Convention provides for matter relating to marine salvage, that is the recovering a ship and its cargo after a shipwreck or other maritime casualty.
Southern African Developing Countries (SADC) Protocol on Fisheries (1992)	The Protocol promotes responsible and sustainable use of the living aquatic resources and ecosystems of interest to state parties in order to promote and enhance food security and human health, safeguard the livelihood of fishing communities, to generate economic opportunities for nationals in the region, to ensure that future generations benefit from these renewable resources and to alleviate poverty with the ultimate objective of its eradication.
Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1992) (Basel Convention)	The Convention provides for the reduction of the production of hazardous waste and the restriction of transboundary movement and disposal of such waste. It also aims to ensure that any transboundary movement and disposal of

INTERNATIONAL OBLIGATION/AGREEMENT	SHORT DESCRIPTION
	hazardous waste, when allowed, is strictly controlled and takes place in an environmentally sound and responsible way.
United Nations Framework Convention on Climate Change (1992)	**The Convention sets an '"ultimate objective' by stabilising greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, taking into account in such matters as agriculture, energy, natural resources, and activities involving sea coasts.**
United Nations Convention on Biological Diversity (1993)	The Convention provides for the conservation of biological diversity, the sustainable use of biological resources and the fair and equitable sharing of benefits arising from the use of genetic resources.
Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) (1995)	The international programme provides assistance to states in taking action, individually or jointly, within their respective policies, priorities and resources, that will lead to the prevention, reduction, control or elimination of the degradation of the marine environment, as well as to its recovery, from the impacts of land-based activities (including pollution and developments/activities leading to the destruction of marine habitat). The Regional Seas Programme of UNEP is used as framework for delivery of this programme at regional level.
Code of Conduct for Responsible Fisheries (1995)	The Code takes cognisance of the state of world fisheries and aquaculture and proposes actions towards implementing fundamental changes within the fisheries sector to encourage the rational and sustainable utilisation of fisheries and aquaculture. The Code is a voluntary instrument rather than a legally binding international agreement.
Convention on the Conservation and Management of Fishery Resources in the Southeast Atlantic Ocean (2001)	The Convention provides for long-term conservation and sustainable use of fish stocks other than highly migratory stocks found in areas of the South East Atlantic beyond the limits of national jurisdiction.
International Convention for the Control and Management of Ships' Ballast Water and Sediments (2004)	**The Convention provides for control and reduced transfer of harmful aquatic organisms and pathogens in ships' ballast water.**
Paris Agreement (2015)	This agreement is a legally binding international treaty on climate change that was adopted by 196 Contracting Parties at the 21st United Nations Climate Change Conference held in 2015, with the aim of limiting global warming to well below 2^{o}C compared with pre-industrial levels and to pursue efforts to limit this increase even further to 1.5^{o}C
Sothern African Development Community (SADC) Protocol on Wildlife Conservation and Law Enforcement (Wildlife Protocol) (1999)	The Protocol aims to establish a common framework for conservation and sustainable use of wildlife in the region.
Protocol on Shared Watercourses in the SADC (Watercourse Protocol) (2000)	The Protocol aims to foster closer cooperation for judicious, sustainable and coordinated management, protection and utilisation of shared watercourses and advance the SADC agenda of regional integration and poverty alleviation.

INTERNATIONAL OBLIGATION/AGREEMENT	SHORT DESCRIPTION
Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa (2005)	A legally binding human rights treaty for the African continent that guarantees women's rights
SADC Protocol on Fisheries (2006)	The Protocol aims to support national initiatives taken and international conventions for the sustainable use and protection of the living aquatic resources and aquatic environment of the region
United Nations Declaration on the Rights of Indigenous Peoples and International Labour Organisation Convention (2007)	Declaration: UN resolution outlining the rights of indigenous peoples Convention Legally binding international treaty adopted by the International Labour Organization that sets out basic rights at work, including freedom of association, discrimination, forced labour, and child labour.

Key National Legislation (Acts)

SECTOR	ACT	LEAD AGENT	SHORT DESCRIPTION
General	Constitution of the Republic of South Africa, (Act 108 of 1996)	Parliament and Constitutional Court	The Constitution is the supreme law of the Republic of South Africa. The fundamental rights contained in Chapter 2 of the Constitution seek to protect the rights and freedom of individuals.
	Promotion of Access to Information (Act 2 of 2000)	South African Human Rights Commission The Information Regulator	Gives effect to the constitutional right of access to any information held by the State and any information that is held by another person that is required for the exercise or protection of any rights
Conservation	National Environmental Management: Biodiversity Act (Act 10 of 2004)	Environment	The Act gives legal status to Convention on Biological Diversity, Convention on Wetlands of International Importance especially Waterfowl Habitat (Ramsar Convention) and Convention on Migratory Species (Bonn Convention). It provides for the conservation of biological diversity and regulates the sustainable use of biological resources and to ensure a fair and equitable sharing of the benefits arising from the use of genetic resources. According to the Act the state is the custodian of South Africa's biological diversity and is committed to respect, protect, promote and fulfil the constitutional rights of its citizens.
	National Environmental Management: Protected Areas Act (No. 57 of 2003)	Environment	The Act provides for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes, the establishment of a national register of all national, provincial and local protected areas and for management of those areas in accordance with national norms and standards.
	Marine Living Resources Act (Act 18 of 1998, as amended in 2000)	Fisheries (delegated to Environment)	The Act provides for the declaration of marine protected areas to facilitate fisheries management by protecting spawning stock, allowing stock recovery, enhancing stock abundance and providing pristine communities for research. These functions are currently delegated to Department responsible for Environment.
	National Parks Act (No. 57 of 1976)	Environment (through South African National Parks)	The Act provides for the establishment of National Parks. National Park status establishes the strongest claim to permanent protection that is possible. Areas above and below the intertidal zone may be included in a National Park.
	Sea Bird and Seal Protection Act (No. 46 of 1973)	Environment	The Act governs the protection and control of the capture, killing and products produced from seabirds and seals. Parts of this act have now been repealed under the Marine Living Resources Act (Act 18 of 1998).

SECTOR	ACT	LEAD AGENT	SHORT DESCRIPTION
Tourism	Marine Living Resources Act (Act 18 of 1998, as amended in 2000)	Fisheries (delegated to Environment)	The Act provides for control of tourism activities related to marine living resource (e.g. sharks, whales and dolphins). This includes the control of fishing activities and appointment of harbour masters in the small fishing harbours.
	Sea Bird and Seal Protection Act (No. 46 of 1973)	Environment	The Act governs the protection and control of the capture, killing and products produced from seabirds and seals. Parts of this act have now been repealed under the Marine Living Resources Act (Act 18 of 1998).
	National Health Act (No. 61 of 2003)	Health &t Municipalities	The Act delegates responsibility for environmental health to metropolitan and district municipalities, where these organs of state must ensure that appropriate municipal health services are effectively and equitably provided in their respective areas. These include (insofar as it influences human health, except in ports) water quality monitoring, waste management and environmental pollution control.
Heritage	World Heritage Convention Act (No. 49 of 1999)	Environment	The Act provides for the incorporation of the World Heritage Convention into South African Law, as well as for recognition and establishment of world heritage sites and related authorities The Act acknowledging the urgent national need for development and poverty alleviation. The Act requires government to find innovative and effective ways of combining the conservation of South Africa's extraordinary endowment of natural resources with wealth-creating sustainable economic development. iSimangaliso Wetland Park was entered on the World Heritage List in 1999.
	National Heritage Resources Act (No. 25 of 1999)	Environment (through South African Heritage Resources Agency)	The Act provides for an integrated and interactive system for the managements of national heritage resources (which include landscapes and natural features of cultural significance), providing opportunity for communities to participate in the identification, conservation and management of cultural resources. Anyone who intends to undertake a development must notify the heritage resources authority and if there is reason to believe that heritage resources will be affected, an impact assessment report must be compiled at the developer's cost.
Water	National Water Act (No. 36 of 1998)	Water	This Act ensures protection of the aquatic ecosystems of South Africa's water resources, including estuaries and groundwater. It requires establishment of resource quality objectives, i.e. specifying targets for freshwater inflow, water quality, habitat integrity, biotic composition and functioning requirements. The act does not recognise the coastal or marine environment as a receiving environment or water resource in need of an allocation.
	Water Services Act (No. 108 of 1997)	Water & Sanitation	This Act amongst other matters provides for right of access to basic water supply and basic sanitation necessary to secure sufficient water and an environment not harmful to human health or well-being. Management and control of water services, in general, including water supply and sanitation.
	Climate Change Act (No. 22 of 2024)	**Environment**	**The Act enables the development of an effective climate change response and a long-term, just transition to a low-carbon and climate-resilient economy and society for South Africa in the context of sustainable development**

SECTOR	ACT	LEAD AGENT	SHORT DESCRIPTION
Urban & spatial development	Disaster Management Act (No. 57 of 2002)	Cabinet	The Act provides for an integrated and co-ordinated disaster management policy that focusses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery; the establishment of national, provincial and municipal disaster management centres; disaster management volunteers; and matters incidental thereto. The act also governs artificial breaching of estuary mouths in urban settings once approval have been granted under the National Environmental Management Act (No. 107 of 1998).
	Local Government: Municipal Systems Act (Act 32 of 2000)	Provincial and Local Government	The Act provides for integrated development planning (which municipalities are obliged to prepare and to update regularly) intended to encompass and harmonise planning over a range of sectors such as water, transport, land use and environmental management.
	Spatial Planning and Land Use Management Act (No. 16 of 2013)	Rural Development and Land Reform	The Act provides for a framework to govern planning permissions and approvals, sets parameters for new developments and provides for different lawful land uses.
	National Environmental Management Act (No. 107 of 1998)	Environment	The Act amongst other matters provides that sensitive, vulnerable, highly dynamic or stressed ecosystems require specific attention in management and planning procedures, especially where subjected to significant human resource usage and development, through mandating EIAs for specific listed activities.
	Marine Spatial Planning Act (No. 16 of 2018)	Environment	The Act provides South Africa's framework for marine spatial planning (MSP) and for the development of marine spatial plans and for the institutional arrangements required for governance and implementation
	National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008)	Environment	The Act amongst other matters ensures that development and the use of natural resources within the coastal zone is socially and economically justifiable and ecologically sustainable.
	National Buildings Regulations and Building Standards Act (No. 103 of 1977, as amended)	Economic Affairs and Technology	The Act provides for promotion of uniformity in the law relating to the erection of buildings in municipal areas, including coastal areas.

SECTOR	ACT	LEAD AGENT	SHORT DESCRIPTION
	Conservation of Agricultural Resources Act (No. 43 of 1983)	Agriculture	The Act provides for conservation of the natural agricultural resources in South Africa through for example, combating and preventing erosion and weakening or destruction of water sources, and the protection of the vegetation and the combating of weeds and invader plants.
	Conservation of Agricultural Resources Act (No. 43 of 1983)	Agriculture	The Act provides for conservation of the natural agricultural resources in South Africa through for example, combating and preventing erosion and weakening or destruction of water sources, and the protection of the vegetation and the combating of weeds and invader plants.
Land-based pollution	National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008)	Environment	The Act gives legal status to South Africa's international obligations related to coastal matters. It stablishes a system of integrated coastal and estuarine management in South Africa in order to promote the conservation of the coastal environment, and maintain the natural attributes of coastal landscapes and seascapes, and to ensure that development and the use of natural resources within the coastal zone is socially and economically justifiable and ecologically sustainable. It defines rights and duties in relation to coastal areas and determines the responsibilities of organs of state in relation to coastal areas. It prohibits incineration at sea, and controls dumping at sea, land-based pollution in the coastal, inappropriate development in coastal environment and other adverse effects on the coastal environment.
	National Environmental Management: Waste Act (No. 59 of 2008)	Environment	The Act regulates (solid) waste management in order to protect health and the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development, as well as governance of thereof.
	National Environmental Management: Air Quality Act (No. 39 of 2004)	Environment	The Act regulates air quality in South Africa in order to protect the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development while promoting justifiable economic and social development and governance therefor.
	Conservation of Agricultural Resources Act (No. 43 of 1983)	Agriculture	The Act provides for conservation of the natural agricultural resources in South Africa through for example, combating and preventing erosion and weakening or destruction of water sources, and the protection of the vegetation and the combating of weeds and invader plants.
	National Water Act (No. 36 of 1998)	Water	The Act (section 21) identifies certain land uses (e.g. activities resulting in stream-flow reduction such as afforestation and cultivation of crops), infrastructural developments (e.g. altering the bed, banks, course or characteristics of a watercourse), water supply/demand and waste disposal (from land-based activities) as 'water uses' that require authorisation (licensing).
	Hazardous Substances Act (No. 15 of 1973)	Health	The Act provides for the control of substances which may cause injury or ill health to, or death, of human beings by reason of their toxic, corrosive, irritant, strongly sensitising or flammable nature. Also it provides for the prohibition and control of the importation, manufacture, sale, use, operation, application, modification, disposal or dumping of such substances and products.

SECTOR	ACT	LEAD AGENT	SHORT DESCRIPTION
Port & Shipping	National Ports Act (No. 12 of 2005)	Transport (through National Port Authority)	The Act provides for management of commercial ports, including environmental matters.
	Government Immovable Asset Management Act (No. 19 of 2007)	Public Works	The Act provides for the maintenance and repairs of infrastructure in proclaimed fishing (or small) harbours along the coast (also other coastal land and properties owned by the state). However, the control of fishing activities and appointment of harbour masters falls under the Marine Living Resources Act (Act 18 of 1998, as amended in 2000).
	Marine Living Resources Act (Act 18 of 1998, as amended in 2000)	Fisheries	The act regulates the control of fishing activities (e.g. selling of fish, compliance management) and appointment of harbour masters in the small fishing harbours.
	South African Maritime Safety Authority Act (Act 5 of 1998)	Transport	The Act provides for the establishment and functions of the South African Maritime Safety Authority (SAMSA)
	Maritime Zone Act (No. 15 of 1994)	Transport	The Act provides for the demarcation of maritime zones of the Republic (e.g. internal waters, territorial waters, contiguous zone, maritime cultural zone, exclusive economic zone, continental shelf) and to provide for matters relating to installations, maritime casualties and self-defence.
	International Convention for Prevention of Pollution from Ships Act (No. 2 of 1986)	Transport	The Act gives legal effect to MARPOL in South Africa, as well as Annex I (regulations on oil) and Annex II (regulations on noxious liquid substances in bulk) of the Convention.
	Marine Traffic Act (No. 2 of 1981)	Transport	The Act regulates marine traffic in South Africa and provides for matters such as regulating ship traffic and the stopping or anchoring of ships outside fishing harbours and the sinking and abandoning of ships.
	Marine Pollution (Control and Civil Liability) Act (No. 6 of 1981)	Transport (prevention) and Environment (combating)	The Act provides for the protection of the marine environment from pollution by oil and other harmful substances, the prevention and combating of such pollution; as well as the determination of liability in certain respects for loss or damage caused by the discharge of oil from ships, tankers and offshore installations. It prohibits the discharge of oil from ships, tankers and offshore installations, but provides exemptions in the case of, for example, the oil being released as a result of damage and steps being taken as soon as practicable to stop or reduce the escape of oil.
	International Health Regulations Act	Ports Authority	The Act requires seaports to be provided with a system for the removal and disposal of excrement, refuse, wastewater, condemned food and other matter dangerous to health.

SECTOR	ACT	LEAD AGENT	SHORT DESCRIPTION
	(No. 28 of 1974)		
	Wreck and Salvage Act (No. 94 of 1996)	**Transport**	**The Act provides for the salvage of certain vessels and for the application and incorporates requirements of International Convention on Salvage.**
Fisheries & Aquaculture	Marine Living Resources Act (Act 18 of 1998, as amended in 2000)	Fisheries	The Act governs the utilisation, conservation and management of marine living resources which includes any aquatic plant or animal, and any mollusc, crustacean, coral, sponge, holothurian or other echinoderm, reptile and marine mammals (all life stages), except sea birds and seals. Currently orderly control and development of marine aquaculture is also regulated under this Act (sections 18 and 27).
	Foodstuffs, Cosmetics and Disinfectant Act (No. 54 of 1972)	Health	The Act regulates the limits of chemical and microbiological constituents in the flesh of different marine organisms used for human consumption.
Mining & petroleum exploration	Mineral and Petroleum Resources Development Act (No. 28 of 2002)	Mineral Resources	The Act, in addition to regulating mining and petroleum resource exploitation, also regulates environmental protection and management of mining impacts, including sand, diamond, heavy minerals, phosphate, manganese, oil and gas in coastal and marine environments. It requires environmental management programmes (EMPs) that must identify environmental impacts, based on and EIA, and must provide a clear programme on how these will be managed. To ensure compliance with environmental issues, the act requires consultation with relevant departments charged with administration of any law that relates to any matter affecting the environment before approval of EMPs.

Important Policies, Regulations and Guidelines

SECTOR	ACT	IMPORTANT POLICIES, REGULATIONS AND GUIDELINES
Conservation	National Environmental Management: Biodiversity Act (2004)	Guidelines regarding the determination of bioregions and the preparation of and publication of bioregional plans (Government Gazette, 16 March 2009)
		South Africa's National Biodiversity Strategy and Action Plan (2015 – 2025) (July 2015)
		Alien and invasive species Regulations (Government Gazette, 1 August 2014)
		Threatened and protected species marine Regulations (Government Gazette, 30 May 2017)
		Guidelines for offshore marine protected areas in South Africa (2008)

SECTOR	ACT	IMPORTANT POLICIES, REGULATIONS AND GUIDELINES
	National Environmental Management: Protected Areas Act (2003)	National Protected Areas Expansion Strategy (NPAES), currently in the process of being revised with revised strategy in commenting phase (2008)
Tourism	Marine Living Resources Act (1998)	Regulations for the management of boat based whale watching and protection of turtles (Government Gazette, 4 July 2008)
		Regulations for the management of white shark cage diving (Government Gazette, 4 July 2008)
		Policy on white shark cage diving (Government Gazette, 31 May 2017)
	National Environmental Management: Biodiversity Act (2004)	Policy on boat-based whale and dolphin watching (Government Gazette, 31 May 2017)
	National Health Act (2003)	South African water quality guidelines for coastal marine waters. Volume 2: Recreational use (March 2012)
	Sea Bird and Seal Protection Act (1973)	Policy on the management of seals, seabirds and shorebirds (Government Gazette, 7 December 2007)
Heritage	World Heritage Convention Act (1999)	Regulations in connection with the Greater St Lucia Wetland Park (Government Gazette, 24 November 2000)
	National Heritage Resources Act (1999)	National Heritage Resources Act Regulations (Government Gazette, 2 June 2000)
Water	National Water Act (1998)	Water Resource Protection and Assessment Policy Implementation Process. Resource Directed Measures for protection of water resources: Methodology for the Determination of the Ecological Water Requirements for Estuaries. Version 2 (2008)
		National Water Resources Strategy. 2nd Edition (June 2013, as reviewed in Government Gazette, 16 August 2013)
		Regulations for establishment of the classification systems (Government Gazette, 17 September 2010)
		Regulations on use of water for mining and related activities aimed at protection of water resources (Government Gazette, 4 June 1999)
		Regulations requiring that the taking of water for irrigation purposes be measured, recorded and reported (Government Gazette, 17 February 2017)
		Water use licence and appeals Regulations (Government Gazette, 24 March 2017)

SECTOR	ACT	IMPORTANT POLICIES, REGULATIONS AND GUIDELINES
	Water Services Act (1997)	Regulations relating to compulsory national standards and measures to conserve water (Government Gazette, 8 June 2001)
Urban & spatial development	Disaster Management Act (2002)	Disaster management policy framework (Government Gazette, 29 April 2005)
		Guidelines on the development and structure of a disaster management plan (Government Gazette, 26 May 2017)
	National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008)	National Estuarine Management Protocol (Government Gazette, 10 May 2013)
		Guidelines for Development and Implementation of Estuarine Management Plans in terms of National Estuarine Management Protocol (March 2015)
		National Strategy for the facilitation of coastal access (March 2014)
		National guidelines National Guideline Towards the Establishment of coastal management lines (August 2017)
	Local Government: Municipal Systems Act (2000)	Local government: Municipal planning and performance management Regulations (Government Gazette, 24 August 2001)
	Spatial Planning and Land Use Management Act (2013)	Regulations in terms of the Spatial Planning and Land Use Management Act (Government Gazette, 23 March 2015)
	National Environmental Management Act (1998)	Environmental Impact Assessment Regulations (Government Gazette, 4 December 2014)
	National Buildings Regulations and Building Standards Act (1977)	Guidelines for human settlement planning and design (Red Book) (2000, under review)
		National Building Regulations and the application of the National Building Regulations (SANS10400)
Land-based pollution	National Environmental Management: Integrated Coastal Management Act (2008)	Guidelines for the assessment of wastes or other material that may be considered for dumping at sea (Schedule I of ICM Act)
		National Guideline for the Discharge of Effluent from Land-based Sources into the Coastal Environment (2014)
		National Action List: Screening of dredged material proposed for marine disposal (2012)
		South African water quality guidelines for coastal marine waters: Natural Environment & Mariculture (1995, under revision)
		Coastal Waters Discharge Permit Regulations (Government Gazette, 15 March 2019)

SECTOR	ACT	IMPORTANT POLICIES, REGULATIONS AND GUIDELINES
	National Environmental Management: Waste Act (2008)	Guideline for the development of Integrated Waste Management Plans (IWMP)
		National Waste Management Strategy (November 2011)
		Waste classification and management Regulations (Government Gazette, 23 August 2013)
	National Environmental Management: Air Quality Act (2004)	List of activities which result in atmospheric emissions which have or may have a significant detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions or cultural heritage (Government Gazette, 31 March 2010)
		National Dust Control Regulations (Government Gazette, 1 November 2013)
		National pollution prevention plans Regulations (Government Gazette, 21 July 2017)
		National framework for air quality assessment in the Republic of South Africa (Government Gazette, 26 October 2018)
	Conservation of Agricultural Resources Act (1983)	Regulations: Conservation of agricultural resources (Government Gazette, 25 May 1984, as amended)
	National Water Act (1998)	Revision of general authorisation in terms of section 39 of the National Water Act (Government Gazette, 6 September 2013) (estuaries)
	Hazardous Substances Act (1973)	Hazardous substances Regulations (Government Gazette, 25 March 1977)
Port & Shipping	**National Ports Act (2005)**	**National Safety, Health and Environmental Corporate Requirements for commercial Ports (http://www.transnetnationalportsauthority.net/DoingBusinesswithUs/SafetyHealthEnvironment/Pages/Introduction.aspx)**
		Port rules (Government Gazette, 6 March 2009)
	International Convention for Prevention of Pollution from Ships Act (1986)	**Prevention of pollution from garbage from ships Regulations (Government Gazette, 29 May 1992)**
	Marine Traffic Act (1981)	**Marine traffic (inshore vessel traffic services Regulations (Government Gazette, 5 May 2000)**
		Marine traffic Regulations (Government Gazette, 1 February 1985)
	Marine Pollution (Control and Civil Liability) Act (1981)	**Marine pollution Regulations (linked to Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk) Government Gazette, 23 January 1998)**

SECTOR	ACT	IMPORTANT POLICIES, REGULATIONS AND GUIDELINES
		Regulations under the prevention and combating of pollution at sea by oil Act (Government Gazette, 29 June 1984)
Fisheries & Aquaculture	Marine Living Resources Act (1998)	Regulations in terms of Marine Living Resources Act (Government Gazette, September 1998, as amended)
		Regulations for the protection of wild abalone (Government Gazette, February 2008)
		Regulations on the prohibition of fishing at night in estuary of Breede River (Government Gazette, 18 November 2013)
		Regulations relating to small-scale fishing (Government Gazette, 8 March 2016)
		Environmental integrity framework for marine aquaculture (2012)
		Aquaculture policy framework (Government Gazette, 11 October 2013)
		Legal guide for the aquaculture sector in South Africa. 1st Edition (2013)
	Foodstuffs, Cosmetics and Disinfectant Act (1972)	Regulations governing microbiological standards for foodstuffs and related matters (Government Gazette, 16 May 1997, and as amended)
		Regulations related to maximum levels of metals and foodstuffs (Government Gazette, 15 June 2018)
Mining	Mineral and Petroleum Resources Development Act (2002)	Mineral and Petroleum Resources Development Regulations (Government Gazette, 24 April 2004)
		Guidelines for the compilation of an environmental impact assessment and an environmental management programme (2013)
		Mining and biodiversity guidelines: Mainstreaming biodiversity into the mining sector (2013)

Appendix B: Information Source List for Nairobi Convention Toolkit

(Extracted from UNEP et al. 2024; Taljaard et al. 2024b)

African Union. 2015. Agenda 2063 – the Africa we want. Framework Document. https://au.int/sites/default/files/documents/33126-doc-framework_document_book.pdf

African Union. 2016. Agenda 2063. Capacity Development Plan Framework Buttressing Implementation of the First 10-Year Plan "The Africa We Want". https://www.africaportal.org/publications/african-union-agenda-2063-capacity-development-plan-framework-buttressing-implementation-of-the-first-10-year-plan-the-africa-we-want/

AIEA Bioenergy. 2017. Biofuels for the marine shipping sector An overview and analysis of sector infrastructure, fuel technologies and regulations. https://www.ieabioenergy.com/wp-content/uploads/2018/02/Marine-biofuel-report-final-Oct-2017.pdf

Alamoush AS, Ballini F and Ölçer AI. 2021. Revisiting port sustainability as a foundation for the implementation of the United Nations Sustainable Development Goals (UN SDGs). Journal of Shipping and Trade 6: 19. https://doi.org/10.1186/s41072-021-00101-6.

Alcamo J. 2001. Scenarios as tools for international environmental assessments. European Environment Agency. Environmental issue report No 24. https://op.europa.eu/en/publication-detail/-/publication/f806ee7c-3898-40ee-a5fe-ea7173d42a32

ALG Transport & Infrastructure. 2021. Port Master Planning; key aspects for a resilient port. AGL Newsletter #14. https://algnewsletter.com/maritime/port-master-planning-key-aspects-for-a-resilient-port/

Ali AH. 2023. Green AI for Sustainability: Leveraging Machine Learning to Drive a Circular Economy. Babylonian Journal of Artificial Intelligence 2023: 15-16. https://doi.org/10.58496/BJAI/2023/004

ANZECC (Australia and New Zealand Environment and Conservation Council). 2000. Australian guidelines for water quality monitoring and reporting. National Water Quality Management Strategy No 7. Canberra, Australia. ISBN 0 642 19562 5.

Arabi S, Taljaard S and Weerts SP. 2022. Adapting environmental management systems for African ports. WMU Journal of Maritime Affairs. https://doi.org/10.1007/s13437-022-00262-6.

Armitage N and Rooseboom A. 2000. The removal of urban litter from stormwater conduits and streams: Paper 3 - Selecting the most suitable trap. Water SA 26 (2): 195-204.

Asariotis R, Benemara H and Naray VH. 2019. Port industry survey on climate change impacts and adaptation. UNCTAD Research Report No. 18. UNCTAD/SER.RP/2017/18/Rev.1. https://unctad.org/en/PublicationsLibrary/ser-rp-2017d18_en.pdf

Asgari N, Hassani A, Jones D, Nguye HH. 2015. Sustainability ranking of the UK major ports: Methodology and case study. Transportation Research Part E: Logistics and Transportation Review 78: 19-39. https://doi.org/10.1016/j.tre.2015.01.014

Azarkamand S, Balbaa A, Wooldridge C and Darbra RM. 2020a. Climate change— challenges and response options for the port sector. Sustainability 12: 6941. https://doi.org/10.3390/su12176941

Azarkamand S, Ferré G and Darbra RM. 2020b. Calculating the Carbon Footprint in ports by using a standardized tool. Science of The Total Environment 734: 139407. https://doi.org/10.1016/j.scitotenv.2020.139407

Baholli I, Stana A, Meka E and Karafili M. 2013. Can Albanian Port Area be Part of The European Network of Eco-Ports Based on Environmental Information systems? Journal of Educational and Social Research, 3(2): 139. https://www.richtmann.org/journal/index.php/jesr/article/view/150

Barcelo D and Pico Y. 2020. Case Studies of macro- and micro-plastics pollution in coastal waters and rivers: Is there a solution with new removal technologies and policy actions? Case Studies in Chemical and Environmental Engineering 2: 100019. https://doi.org/10.1016/j.cscee.2020.100019

Barentine JC. 2019. Methods for assessment and monitoring of light pollution around ecologically sensitive sites. Journal of Imaging 5 (5): 54. https://doi.org/10.3390/jimaging5050054

Barnardo T and Ribbink AJ (Eds.) 2020. African Marine Litter Monitoring Manual. African Marine Waste Network, Sustainable Seas Trust. https://www.wiomsa.org/wp-content/uploads/2020/07/African-Marine-Litter-Monitoring-Manual_Final.pdf

BBOP (Business and Biodiversity Offsets Programme) 2009. Business, Biodiversity Offsets and BBOP: An Overview. BBOP, Washington, D.C. https://www.forest-trends.org/wp-content/uploads/imported/overview-phase-1-pdf.pdf

BIMCO (Baltic and International Maritime Council). 2021a. Approval procedure for in-water cleaning companies. https://www.bimco.org/about-us-and-our-members/publications/approval-procedure-for-in-water-cleaning-companies

BIMCO. 2021b. Industry standard on in-water cleaning with capture. Version 1.01. https://www.bimco.org/about-us-and-our-members/publications/industry-standard-on-in-water-cleaning-with-capture

Bishoge OK and Mvile BN. 2022. A critique of EIA report selected from the East African region considering what is required in ideal EIA report. Journal of Applied and Advanced Research 7: 8-17. https://doi.org/10.21839/jaar.2022.v7.7478

Bjerkan KY and Seter H. 2019. Reviewing tools and technologies for sustainable ports: Does research enable decision making in ports? Transportation Research Part D: Transport and Environment 72: 243-260. https://doi.org/10.1016/j.trd.2019.05.003

Bob-Manuel KDH. 2020. Capacity-building for sustainable maritime industry in developing coastal countries. Journal of Emerging Trends in Engineering and Applied Sciences 11(1): 6-13. https://hdl.handle.net/10520/EJC-1ce0fc5cac

Boile M, Theofanis S, Sdoukopoulos E and Plytas N. 2016. Developing a port energy management plan. Issues, challenges, and prospects. Transportation Research Record: Journal of the Transportation Research Board 2549: 19–28. https://doi.org/10.3141/2549-03

Bourgeois D. 2019. Information Systems for Business and Beyond (2019) https://opentextbook.site/informationsystems2019/

Brouwer MAC and van Koppen CSA. 2008. The soul of the machine: Continual improvement in ISO 14001. Journal of Cleaner Production 16:450-457. https://doi.org/10.1016/j.jclepro.2006.08.022

Browne MA and Chapman MG. 2014. Mitigating against the loss of species by adding artificial intertidal pools to existing seawalls. Mar Ecol Prog Ser 497: 119-129. https://doi.org/10.3354/meps10596

Brunila OP, Kunnaala-Hyrkki, V and Inkinen, T. 2023. Sustainable small ports: performance assessment tool for management, responsibility, impact, and self-monitoring. J. shipp. trd. 8, 14. https://doi.org/10.1186/s41072-023-00142-z

Capelli L, Bax C, Diaz C, Izquierdo C, Arias R and Seoane NS. 2019. Review on odour pollution, odour measurement, abatement techniques (D2.1). dnoses.eu/wp-content/uploads/2019/10/D2.1_Review-on-odour-pollution-measurement-abatement_v3.2.pdf.

CEC (Commission of the European Communities) 2001. Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment (SEA Directive). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32001L0042

Chee SY, Wee JLS, Wong C, Yee JC, Yusup Y and Mujahid A. 2020. Drill-Cored Artificial Rock Pools Can Promote Biodiversity and Enhance Community Structure on Coastal Rock Revetments at Reclaimed Coastlines of Penang, Malaysia. Tropical Conservation Science 13: 1-15. https://doi.org/10.1177/1940082920951912

Chen W, Van Assche KAM, Hynes S, Bekkby T, Christie HC and Gundersen H. 2020. Ecosystem accounting's potential to support coastal and marine governance. Marine Policy 122: 103758.

Chen Z and Pak M. 2017. A Delphi analysis on green performance evaluation indices for ports in China. Maritime Policy & Management 44(5): 537-550. https://doi.org/10.1080/03088839.2017.1327726

Chenoweth JJ, Anderson AR, Kumar P, Hunt WF, Chimbwandira SJ and Moore TLC. 2018. The interrelationship of green infrastructure and natural capital. Land Use Policy 75: 137–144.

Chiu R-H, Lin L-H and Ting S-C. 2014. Evaluation of Green Port Factors and Performance: A Fuzzy AHP Analysis. Hindawi Publishing Corporation Mathematical Problems in Engineering Volume, Article ID 802976, 12 pp http://dx.doi.org/10.1155/2014/802976

Cohen-Shacham E, Andrade A, Dalton J, Dudley N, Jones M, Kumar C, Maginnis S, Maynard S, Nelson CR, Renaud FG, Welling R and Walters G. 2019. Core principles for successfully implementing and upscaling Nature-based Solutions. Environmental Science & Policy 98: 20-29. https://doi.org/10.1016/j.envsci.2019.04.014

Cohen-Shacham E, Walters G, Janzen C and Maginnis S. 2016. Nature-Based Solutions to Address Societal Challenges. Gland, Switzerland: International Union for Conservation of Nature. https://doi.org/10.2305/IUCN.CH.2016.13.en.

Coman, M and Cioruța B-V. 2013. Environmental Information Systems as a possible solution for strategic development of local and regional communities. https://www.researchgate.net/publication/324809118_2013_15_-_Environmental_Information_Systems_as_a_possible_solution_for_strategic_development_of_local_and_regional_communities

Commonwealth of Australia. 2015. Anti-fouling and in-water cleaning guidelines. Department of Agriculture, Canberra. CC BY 3.0. https://www.agriculture.gov.au/biosecurity-trade/aircraft-vessels-military/vessels/marine-pest-biosecurity/biofouling/anti-fouling-and-inwater-cleaning-guidelines

Coombes MA, La Marca EC, Naylor LA and Thompson RC. 2015. Getting into the groove: Opportunities to enhance the ecological value of hard coastal infrastructure using fine-scale surface textures. Ecological Engineering 77: 314-323. https://doi.org/10.1016/j.ecoleng.2015.01.032

da Cunha Jácome Vidal, P, Aguirre González MO, Cassimiro de Melo D, de Oliveira Ferreira P, Vasconcelos Sampaio PG and Lima LO. 2022. Conceptual framework for the decommissioning process of offshore oil and gas platforms. Marine Structures 85: 103262. https://doi.org/10.1016/j.marstruc.2022.103262

Dalal-Clayton B and Sadler B. 1999. Strategic Environmental Assessment: A Rapidly Evolving Approach. Environmental Planning Issues No. 18, International Institute for Environment and Development (IIED), London. Issue 18.PDF (iied.org)

Dalal-Clayton B and Sadler B. 2005. Strategic Environmental Assessment: A Sourcebook and Reference Guide to International Experience. International Institute for Environment and Development (IIED). Earthscan, London, UK.

Darbra RM, Ronza A, Casal J, Stojanovic TA and Wooldridge C. 2004. The Self Diagnosis Method A new methodology to assess environmental management in sea ports. Marine Pollution Bulletin 48: 420–428. https://doi.org/10.1016/j.marpolbul.2003.10.023

De Boer WP, Slinger JH, wa Kangeri AK, Vreugdenhil HSI, Taneja P, Appeaning Addo K and Vellinga T. 2019. Identifying Ecosystem-Based Alternatives for the Design of a Seaport's Marine Infrastructure: The Case of Tema Port Expansion in Ghana. Sustainability 11(23): 6633. https://doi.org/10.3390/su11236633

De Langen P and Sornn-Friese H. 2019. Ports and the Circular Economy. In: Green Ports - Inland and Seaside Sustainable Transportation Strategies. Bergqvist R and Monios J (Eds.). Elsevier. pp 85-108. https://doi.org/10.1016/B978-0-12-814054-3.00005-0

de los Reyes RS.; Fernández-Sánchez G.; Esteban MD and Rodríguez RR. 2020. Carbon Footprint of a Port Infrastructure from a Life Cycle Approach. Int. J. Environ. Res. Public Health 17: 7414. https://doi.org/10.3390/ijerph17207414

De Vriend HJ and Van Koningsveld M. 2012. Building with Nature: Thinking, Acting and Interacting Differently. EcoShape, Building with Nature, Dordrecht, the Netherlands. https://www.ecoshape.org/app/uploads/sites/2/2016/07/ECOSHAPE_BwN_WEB.pdf

De Vriend HJ, Koningsveld M, Aarninkhof SGJ, De Vries MB and Baptist MJ. 2015. Sustainable hydraulic engineering through building with nature. J. Hydro Environ. Res. 9: 159–171. https://doi.org/10.1016/j.jher.2014.06.004

EcoShape. 2020. Pile and pontoon hulas. https://www.ecoshape.org/app/uploads/sites/2/2020/10/fact-sheet-pile-pontoon-hulas.pdf

EcoShape. 2021. Building with Nature: a future proof strategy for coping with a changing and uncertain world. Working with uncertainties. https://www.ecoshape.org/app/uploads/sites/2/2021/05/Whitepaper-a-future-proof-strategy-for-coping-with-a-changing-and-uncertain-world.pdf

EcoShape. 2022. Building with Nature. https://www.ecoshape.org/en/

Eger AM, Layton C, McHugh TA, Gleason M and Eddy N. 2022. Kelp Restoration Guidebook: Lessons Learned from Kelp Projects Around the World. The Nature Conservancy, Arlington, VA, USA. https://www.decadeonrestoration.org/publications/kelp-restoration-guidebook-lessons-learned-kelp-restoration-projects-around-world

Eigenraam M, McCormick F and Contreras Z. 2016. Marine and Coastal Ecosystem Accounting: Port Phillip Bay. Report to Commissioner for Environmental Sustainability, Department of Environment, Land, Water and Planning, State of Victoria, Australia.

El-Gayar, O and Fritz, BD. 2006. Environmental Management Information Systems (EMIS) for Sustainable Development: A Conceptual Overview," Communications of the Association for Information Systems 17: Article 34. https://aisel.aisnet.org/cais/vol17/iss1/34

Ellen MacArthur Foundation. 2022. Let's build a circular economy. https://ellenmacarthurfoundation.org/

Elsawah S, Hamilton SH, Jakeman AJ, Rothman D, Schweizer V et al. 2020. Scenario processes for socio-environmental systems analysis of futures: A review of recent efforts and a salient research agenda for supporting decision making. Science of The Total Environment 729: 138393. https://doi.org/10.1016/j.scitotenv.2020.138393

EPA South Australia (Environmental Protection Authority, South Australia) 2020. Dredge guideline. https://www.epa.sa.gov.au/files/14712_dredge_guideline_2020.pdf

EPA South Australia. 2021. Industry: Construction environmental management plan (CEMP). http://www.epa.sa.gov.au/files/12330_guide_cemp.pdf

Escovar-Fadul X, Hein MY, Garrison K, McLeod E, Eggers M and Comito F. 2022. A Guide to Coral Reef Restoration for the Tourism Sector. Partnering with Caribbean Tourism Leaders to Accelerate Coral Restoration. The Nature Conservancy. https://www.unep.org/resources/report/coral-reef-restoration-guidelines-tourism-sector

ESPO (European Sea Ports Organisation) 2012a. ESPO Green Guide. Towards excellence in port environmental management and sustainability. https://www.espo.be/media/espopublications/espo_green%20guide_october%202012_final.pdf.

ESPO. 2012b. Port Performance Indicators: Selection and Measurement (PPRISM). Project Executive Report. https://www.espo.be/media/pages/12-01-25_-_PPRISM_WP4_Deliverable_4.2_Website.pdf.

ESPO. 2020. ESPO Environmental Report 2020. https://www.espo.be/media/Environmental%20Report-WEB-FINAL.pdf.

EU (European Union). 2019. Guidelines on Human Capacity Building in Ports. Interreg, Danube Transnational Programme. https://www.interreg-danube.eu/uploads/media/approved_project_output/0001/27/ee31f6e3a7b7063fc5f3b6b2649c1c805b3c49f6.pdf

Fadiga A, Ferreira LMDF and Bigotte JF. 2024. Decarbonising maritime ports: A systematic review of the literature and insights for new research opportunities. Journal of Cleaner Production 452: 142209. https://doi.org/10.1016/j.jclepro.2024.142209

Ferrario F, et al. 2022. Holistic environmental monitoring in ports as an opportunity to advance sustainable development, marine science, and social inclusiveness. Elem Sci Anth 10: 1. https://doi.org/10.1525/elementa.2021.00061

Fitzsimons J, Branigan S, Brumbaugh RD, McDonald T and zu Ermgassen PSE (Eds.) 2019. Restoration Guidelines for Shellfish Reefs. The Nature Conservancy, Arlington VA, USA. https://www.decadeonrestoration.org/publications/restoration-guidelines-shellfish-reefs

Gann GD, McDonald T, Walder B, Aronson J, Nelson CR, Jonson J, Hallett JG, Eisenberg C, Guariguata MR, Liu J, Hua F, Echeverría C, Gonzales E, Shaw N, Decleer K and Dixon KW. 2019. International principles and standards for the practice of ecological restoration. Second edition. Restor Ecol, 27: S1-S46. https://doi.org/10.1111/rec.13035 or https://www.ser.org/page/SERStandards/International-Standards-for-the-Practice-of-Ecological-Restoration.htm

Gann GD, Walder B, Gladstone J, Manirajah SM, Roe S. 2022. Restoration Project Information Sharing Framework. Society for Ecological Restoration and Climate Focus. Washington, D.C. https://www.ser.org/resource/resmgr/publications/restoration-project-informat.pdf

GHD. 2013. Environmental best practice port development: An analysis of international approaches. Report prepared for the Department of Sustainability, Environment, Water, Population and Communities, Canberra, Australia. https://www.awe.gov.au/environment/epbc/publications/environmental-best-practice-port-development-analysis-international-approaches.

GOAP (Global Ocean Accounts Partnership) 2019. Technical Guidance on Ocean Accounting for Sustainable Development (United Nations, 1st edition, 2019). https://www.oceanaccounts.org/technical-guidance-on-ocean-accounting-2/.

González MJ, Ruiz C, Rivas MCG, Gereda C, Castañeda E, Segovia G and Paiz M (Eds.) 2020. Training guide for coral reef restoration. https://www.decadeonrestoration.org/publications/training-guide-coral-reef-restoration

Günter O. 1998. Chapter 1: Introduction. In: Environmental Information Systems. Publisher: Springer Berlin. pp 1-7. https://doi.org/10.1007/978-3-662-03602-0

Guo S, Wang H and Wang S. 2024. Managing port disruption through sailing speed optimization for sustainable maritime transportation. Cleaner Logistics and Supply Chain 11: 100153. https://doi.org/10.1016/j.clscn.2024.100153

Hall AE, Herbert RJH, Britton JR and Hull SL. 2018. Ecological enhancement techniques to improve habitat heterogeneity on coastal defence structures. Estuarine Coastal and Shelf Science 210: 68-78. https://doi.org/10.1016/j.ecss.2018.05.025

IADC (International Association of Dredging Companies) 2019. Dredged material as a resource. https://www.iadc-dredging.com/subject/what-is-dredging/dredged-material-resource/

IAIA (International Association of Impact Assessment) 2002. Strategic Environmental Assessment: Performance Criteria. IAIA, Special Publication Series No. 1, Fargo, USA.

Ido S and Perkol-Finkel S. 2015. Blue is the new green – Ecological enhancement of concrete based coastal and marine infrastructure. Ecological Engineering 84: 260-272. https://doi.org/10.1016/j.ecoleng.2015.09.016

IMO (International maritime organisation) 2011. Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species. Resolution MEPC.207(62). https://www.imo.org/en/OurWork/Environment/Pages/Biofouling.aspx

IMO. 2012. Guidance for minimizing the transfer of invasive aquatic species as biofouling (hull fouling) for recreational craft. Resolution MEPC.1/Circ.792. https://www.imo.org/en/OurWork/Environment/Pages/Biofouling.aspx

IMO. 2014. Waste Assessment Guidance. https://www.imo.org/en/OurWork/Environment/Pages/wag-default.aspx

IMO. 2020. IMO 2020 – cutting sulphur oxide emissions (https://www.imo.org/en/MediaCentre/HotTopics/Pages/Sulphur-2020.aspx)

IMO. 2022a. Ballast Water Management Convention. https://www.imo.org/en/OurWork/Environment/Pages/BallastWaterManagement.aspx

IMO. 2022b. Implementing the Ballast Water Management Convention. https://www.imo.org/en/MediaCentre/HotTopics/Pages/Implementing-the-BWM-Convention.aspx

IMO. 2022c. Oil spill contingency planning. https://www.imo.org/en/OurWork/Environment/Pages/Oil%20Spill%20Contingency%20Planning.aspx

IOGP (International Association of Oil & Gas Producers). 2017. Overview of International Offshore Decommissioning Regulations. Volume 1 – Facilities. Report 584. https://www.iogp.org/bookstore/product/overview-of-international-offshore-decommissioning-regulations-volume-1-facilities/

Iraldo F, Testa F and Frey M. 2009 Is an environmental management system able to influence environmental and competitive performance? The case of the eco-management and audit scheme (EMAS) in the European Union. Journal of Cleaner Production 17:1444–1452. https://doi.org/10.1016/j.jclepro.2009.05.013

Iris C and Lam JSL. 2019. A review of energy efficiency in ports: Operational strategies, technologies and energy management systems. Renewable and Sustainable Energy Reviews 112: 170–182. https://doi.org/10.1016/j.rser.2019.04.069

ISO (International Organisation for Standardisation) 2020a. ISO 14000 Family Environmental Management. https://www.iso.org/iso-14001-environmental-management.html.

ISO. 2020b. Moving from ISO 14001:2004 to ISO 14001:2015. The new international standard for environmental management systems. https://www.iso.org/standard/60857.html

ITOPF (International Tanker Owners Pollution Federation Limited). n.d. Contingency planning for marine oil spills. Technical Information paper 16. https://www.itopf.org/knowledge-resources/documents-guides/technical-information-papers/

IUCN (International Union for Conservation of Nature and Natural Resources).2004. Managing Marine Protected Areas: A Toolkit for the Western Indian Ocean. Environmental impact assessment: A6. Nairobi, Kenya. A6_Environmental_impact_assessment.pdf (wiomsa.org)

Jacob C, van Bochove J-W, Livingstone S, White T, Pilgrim J and Bennun L. 2020. Marine biodiversity offsets: Pragmatic approaches toward better conservation outcomes. Conservation Letters 13: e12711. https://doi.org/10.1111/conl.12711

Keenleyside KA, Dudley N, Cairns S, Hall CM and Stolton S. 2012. Ecological Restoration for Protected Areas: Principles, Guidelines and Best Practices. Gland, Switzerland: IUCN. https://www.iucn.org/resources/publication/ecological-restoration-protected-areas-principles-guidelines-and-best

Kusek JZ and Rist RC. 2004. A handbook for development practitioners. Ten steps to a results-based monitoring and evaluation system. World Bank, Washington, DC.

Laxe FG, Bermúdez FM, Palmero FM and Novo-Corti I. 2017. Assessment of port sustainability through synthetic indexes. Application to the Spanish case. Marine Pollution Bulletin 119(1): 220-225. https://doi.org/10.1016/j.marpolbul.2017.03.064

Léocadie, A., Pioch, S., Pinault, M. 2020. Guide to Ecological Engineering: The restoration of coral reefs and associated ecosystems. Published by IFRECOR. https://www.decadeonrestoration.org/publications/guide-ecological-engineering-restoration-coral-reefs-and-associated-ecosystems

Lirn T-C, Wu Y and Chen Y. 2013. Green performance criteria for sustainable ports in Asia International Journal of Physical Distribution & Logistics Management 43(5/6): 427-451. DOI:10.1108/IJPDLM-04-2012-0134

Liu D, Rong H and Soares CG. 2023. Shipping route modelling of AIS maritime traffic data at the approach to ports. Ocean Engineering 289 (Part 1): 115868. https://doi.org/10.1016/j.oceaneng.2023.115868

LPC (Lyttelton Port Company, New Zealand). 2019. Construction environmental management plan manual. Edition 2. https://www.lpc.co.nz/wp-content/uploads/2020/05/LPC-Construction-Enviornmental-Management-Plan-FULL-DOCUMENT.pdf

Lu, C-S., Shang, K-C., Lin, C-C., 2016. Identifying crucial sustainability assessment criteria for container seaports. Maritime Business Review 1(2), 90-106.

MacArthur M, Naylor LA, Hansom JD and Burrows MT. 2020. Ecological enhancement of coastal engineering structures: Passive enhancement techniques. Science of The Total Environment 740: 139981. https://doi.org/10.1016/j.scitotenv.2020.139981.

Macía YM, Rodríguez MP, Machuca P, Rodríguez SAA and Carmona CR. 2021. Green Hydrogen Value Chain in the Sustainability for Port Operations: Case Study in the Region of Valparaiso, Chile. Sustainability 13: 13681. https://doi.org/10.3390/su132413681

Maritime and Coastguard Agency, UK. 2021. Contingency Planning for Marine Pollution Preparedness and Response. Guidelines for Ports. https://www.gov.uk/government/publications/contingency-planning-for-marine-pollution-preparedness-and-response-guidelines-for-ports

Melbourne-Thomas J, Hayes KR, Hobday AJ, Little LR, Strzelecki J, Thomson DP, van Putten I and Hook SE. 2021. Decommissioning Research Needs for Offshore Oil and Gas Infrastructure in Australia. Front. Mar. Sci. 8: 711151. https://doi.org/10.3389/fmars.2021.711151

Mocerino L, Murena F, Quaranta F and Toscano D. 2020. A methodology for the design of an effective air quality monitoring network in port areas, https://doi.org/10.1038/s41598-019-57244-7

Mont-Mégantic International Dark Sky Reserve. 2022. New lighting guide. https://en.cieletoilemontmegantic.org/guide

Morris RL, Heery EC, Loke LHL, Lau E, Strain EMA, Airoldi L, et al. 2019. Design options, implementation issues and evaluating success of ecologically engineered shorelines. Oceanography and Marine Biology: An Annual Review 57: 169–228.

Morrison-Saunders A, Marshall R and Arts J. 2007. EIA Follow-Up International Best Practice Principles. International Association for Impact Assessment, Special Publication Series No. 6. Fargo, USA. SP6.indd (iaia.org)

Nairobi Convention. 2018. No Net Loss of Biodiversity and Ecosystem Services: Applying the Mitigation Hierarchy and Biodiversity Offsets as Tools to Achieve Sustainable Development in the Western Indian Ocean. Nairobi, Kenya. https://nairobiconvention.org/clearinghouse/taxonomy/term/5566)

Naylor LA, MacArthur M, Hampshire S, Bostock K, Coombes MA, Hansom JD, Byrne R and Folland T. 2017. Proceedings of the Institution of Civil Engineers - Maritime Engineering 170(2): 67-82. https://doi.org/10.1680/jmaen.2016.28

Nihon Kasetsu. 2022. Environmental monitoring for construction projects. https://nihonkasetsu.com/environmental-monitoring-for-construction-projects/

NIOSH (National Institute for Occupational Safety and Health) 2024. Hierarchy of Control. https://www.cdc.gov/niosh/topics/hierarchy/default.html

Notteboom T, Pallis A and Rodrigue J-P. 2022. Port Economics, Management and Policy. New York: Routledge. https://doi.org/10.4324/9780429318184; https://porteconomicsmanagement.org/

NSW (New South Wales) Port Authority. 2017. Green port guidelines. Sustainable strategies for port developments and operations. Port Authority of New South Wales, Australia. https://www.portauthoritynsw.com.au/media/2363/green-port-guidelines.pdf

Obura, D. et al. 2017. Reviving the Western Indian Ocean Economy: Actions for a Sustainable Future. WWF International, Gland, Switzerland. 64 pp. https://sustainabledevelopment.un.org/content/documents/13692WWF2.pdf

ODPM (Office of the Deputy Prime Minister, London) 2005. Crown copyright. ODPM Publications. A Practical Guide to the Strategic Environmental Assessment Directive: Practical guidance on applying European Directive 2001/42/EC “on the assessment of the effects of certain plans and programmes on the environment”. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/7657/practicalguidesea.pdf

OECD (Organisation for Economic Cooperation and Development). 2006. Applying Strategic Environmental Assessment: Good Practice Guidance for Development Co-operation. DAC Guidelines and Reference Series. OECD Publishing.

OECD. 2008. The Challenge of Capacity Development Working Towards Good Practice (Part 4). OECD Journal on Development 8(3): 233-276. https://doi.org/10.1787/journal_dev-v8-art40-en

Oerlemans C, Wegman C, Jinkman B and Aarninhof S. 2021. The impact and costs of Building with Nature projects. Terra et Aqua 165: 37-43. https://www.iadc-dredging.com/article/impact-costs-building-with-nature/

Oh H, Lee S-W and Seo Y-J. 2018. The evaluation of seaport sustainability: The case of South Korea. Ocean & Coastal Management 161: 50-56. https://doi.org/10.1016/j.ocecoaman.2018.04.028

Paalvast P, van Wesenbeeck BK, van der Velde G and de Vries MB. 2012. Pole and pontoon hulas: An effective way of ecological engineering to increase productivity and biodiversity in the hard-substrate environment of the port of Rotterdam. Ecological Engineering 44: 199-209. https://doi.org/10.1016/j.ecoleng.2012.04.002

Partidário M. 2003. Strategic Environmental Assessment (SEA): current practices, future demands and capacity-building needs. Course manual (IAIA Training Courses). Lisbon, Portugal. Microsoft Word - Course Manual 2003.doc (iaia.org).

Partidário MR. 1999. Strategic Environmental Assessment – Principles and Potential, In: Petts, J. (editor) Handbook of Environmental Impact Assessment: Volume 1, Environmental Impact Assessment: Process, Methods and Potential, Blackwell Science, Oxford, p 60-73.

PEMA (Port Equipment Manufacturers Association) 2016. Lighting Technologies in Ports and Terminals. http://www.pema.org/wp-content/uploads/downloads/2016/06/PEMA-IP10-Lighting-Technologies-in-Ports-and-Terminals.pdf.

Peris-Mora E, Diez Orejas JM, Subirats A, Ibáñez S and Alvarez P. 2005. Development of a system of indicators for sustainable port management. Marine Pollution Bulletin 50: 1649–1660. https://doi.org/10.1016/j.marpolbul.2005.06.048

Perkol-Finkel S, Hadary T, Rella A, Shirazi R and Ido S. 2018. Seascape architecture – incorporating ecological considerations in design of coastal and marine infrastructure. Ecological Engineering 120: 645-654. https://doi.org/10.1016/j.ecoleng.2017.06.051

Petrosillo I, De Marcoa A, Botta S and Comoglio C. 2012. EMAS in local authorities: Suitable indicators in adopting environmental management systems. Ecological Indicators 13: 263–274. https://doi.org/10.1016/j.ecolind.2011.06.011

PIANC (World Association for Waterborne Transport Infrastructure) 2006. EnviCom WG 10: Environmental risk assessment of dredging and disposal operations. https://www.pianc.org/publications/envicom/environmental-risk-assessment-of-dredging-and-disposal-operations

PIANC 2009a. EnviCom WG 100: Dredging management practices for the environment: A structured selection approach. https://www.pianc.org/publications/envicom/dredging-management-practices-for-the-environment-a-structured-selection-approach

PIANC 2009b. EnviCom WG 104: Dredged material as a resource. https://www.pianc.org/publications/envicom/dredged-material-as-a-resource

PIANC 2009c. EnviCom WG 109: Long-Term management of confined disposal facilities for dredged material. https://www.pianc.org/publications/envicom/long-term-management-of-confined-disposal-facilities-for-dredged-material

PIANC 2010. EnviCom WG 108: Dredging and port construction around coral reefs. https://www.pianc.org/publications/envicom/dredging-and-port-construction-around-coral-reefs

PIANC 2014b. EnviCom Guidance Document 124: Dredging and port construction: Interactions with features of archaeological or heritage interest. https://www.pianc.org/publications/envicom/envicom-guidance-document-124-dredging-and-port-construction-interactions-with-features-of-archaeological-or-heritage-interest

PIANC 2018. Guide for applying Working with Nature to navigation infrastructure projects. https://www.pianc.org/publications/envicom/wg176

PIANC 2020. EnviCom WG 178: Climate Change Adaptation Planning for Ports and Inland Waterways. https://www.pianc.org/publications/envicom/wg178

PIANC 2022. Managing climate change uncertainties in selecting, designing and evaluating options for resilient navigation infrastructure. \https://www.pianc.org/publications/envicom/ptgcc-1

PIANC. 2014a. WG-report 158. Master Plans for the Development of Existing Ports. https://bayplanningcoalition.org/2014/09/pianc-wg-report-158-masterplans-for-the-development-of-existing-ports/

PIANC. 2019a. MarCom WG 185. Ports on Greenfield Sites – Guidelines for Site Selection and Master Planning. https://www.pianc.org/publication/ports-on-greenfield-sites-guidelines-for-site-selection-and-masterplanning/

PIANC. 2019b. EnviCom 188: Carbon Management for Port and Navigation Infrastructure. https://www.pianc.org/publications/envicom/wg188

PIANC. 2019c. Report 159: Renewables and energy efficiency for maritime ports. https://www.pianc.org/publications/marcom/wg159

Pitt LF, Parent M, Junglas I, Chan A and Spyropoulou S. 2011. Integrating the smartphone into a sound environmental information systems strategy: Principles, practices and a research agenda. The Journal of Strategic Information Systems 20(1): 27-37. https://doi.org/10.1016/j.jsis.2010.09.005

Puig M, Pla A, Seguí X, Darbra RM. 2017. Tool for the identification and implementation of Environmental Indicators in Ports (TEIP). Ocean & Coastal Management 140: 34-45. https://doi.org/10.1016/j.ocecoaman.2017.02.017

Rebelo M, Santos G and Silva R. 2014. A Methodology to Develop the Integration of the Environmental Management System with Other Standardised Management Systems. Computational Water, Energy, and Environmental Engineering 3(4): 170-181. DOI: 10.4236/cweee.2014.34018

Roh S, Thai VV and Wong YD. 2016. Towards sustainable ASEAN port development: challenges and opportunities for Vietnamese ports. Asian J. Shipp. Logistics 32 (2): 107–118. https://doi.org/10.1016/j.ajsl.2016.05.004

Roos EC and Neto FJK. 2017. Tools for evaluating environmental performance at Brazilian public ports: Analysis and proposal. Marine Pollution Bulletin 115(1–2); 211-216. https://doi.org/10.1016/j.marpolbul.2016.12.015

Schipper CA, Vreugdenhil H and De Jong MPC. 2017. A sustainability assessment of ports and port-city plans: Comparing ambitions with achievements. Transportation Research Part D: Transport and Environment 57: 84-111. https://doi.org/10.1016/j.trd.2017.08.017

Schmaltz E, Melvin EC, Diana Z, Gunady EF, Rittschof D, Somarelli JA, Virdin J and Dunphy-Daly MM. 2020. Plastic pollution solutions: emerging technologies to prevent and collect marine plastic pollution. Environment International 144: 106067. https://doi.org/10.1016/j.envint.2020.106067

Schönborn A and Junge R. 2021. Redefining ecological engineering in the context of circular economy and sustainable development. Circular Economy and Sustainability 1: 375–394. https://doi.org/10.1007/s43615-021-00023-2.

Sdoukopoulos E, Boile M, Tromaras A and Anastasiadis N. 2019. Energy Efficiency in European ports: State-of-practice and insights on the way forward. Sustainability 11: 4952. https://doi.org/10.3390/su11184952

Senécal P, Sadler B and Goldsmith B et al. 1999. Principles of Environmental Impact Assessment Best Practice. International Association for Impact Assessment (IAIA) and Institute of Environmental Assessment (UK). Principles of IA (iaia.org)

Sensiba J. 2021. Audi to cut water consumption in half by 2035. https://cleantechnica.com/2021/03/26/audi-to-cut-water-consumption-in-half-by-2035/

Shiau T-A and Chuang C-C. 2015. Social construction of port sustainability indicators: a case study of Keelung Port. Maritime Policy & Management 42:1, 26-42. https://doi.org/10.1080/03088839.2013.863436

Stein M and Acciaro M. 2020. Value Creation through Corporate Sustainability in the Port Sector: A Structured Literature Analysis. Sustainability 12: 5504. https://doi.org/10.3390/su12145504

Swanepoel, E. 2020. Oil spills in the Western Indian Ocean. National contingency plans fall short. Institute for Security Studies Africa. https://issafrica.org/research/africa-report/oil-spills-in-the-western-indian-ocean-national-contingency-plans-fall-short

Taljaard S, Van Niekerk L, Adams JB, Riddin T. 2023. Advancing ecosystem accounting in estuaries: Swartkops Estuary case study. S Afr J Sci. 119(3/4), Art. #14303. https://doi.org/10.17159/sajs.2023/14303

Taljaard S, Slinger JH, Weerts SP, Vreugdenhil HIS and Nzuza C. 2024a. Circles of port sustainability: A novel method combining global comparability and local relatability in performance assessment. Environmental Development 52: 101068. https://doi.org/10.1016/j.envdev.2024.101068.

Taljaard S, Weerts SP, Audouin M. 2024b. Advancing sustainable port development in the Western Indian Ocean region. Current Opinion in Environmental Sustainability 71: 101489, https://doi.org/10.1016/j.cosust.2024.101489

Tarr P. n.d. Southern African Institute for Environmental Assessment (SAIEA). EIA: Guidelines for Impact Assessment in the Western Indian Ocean Region. United Nations Environment Programme (UNEP): Nairobi Convention. WIO-Lab EA Guidelines.pdf (nairobiconvention.org)

Ten Kate K, Bishop J and Bayon R. 2004. Biodiversity offsets: Views, experience, and the business case. IUCN, Gland, Switzerland and Cambridge, UK and Insight Investment, London, UK (https://www.iucn.org/content/biodiversity-offsets-views-experience-and-business-case).

Testa F, Rizzi F, Daddi T, Gusmerotti NM, Frey M and Iraldo F. 2014. EMAS and ISO 14001: the differences in effectively improving environmental performance. Journal of Cleaner Production 68: 165-173. https://doi.org/10.1016/j.jclepro.2013.12.061

Thapa RB, Matin MA and Bajracharya B. 2019. Capacity Building Approach and Application: Utilization of Earth Observation Data and Geospatial Information Technology in the Hindu Kush Himalaya. Front. Environ. Sci. 7: 165. https://doi.org/10.3389/fenvs.2019.00165

UN (United Nations). 1992. Assessment of the environmental impact of port development. A guidebook for EIA of port development. Economic and Social Commission of Asia and the Pacific https://www.unescap.org/sites/default/files/pub_1234_fulltext.pdf

UN 2014a. System of Environmental Economic Accounting 2012: Central Framework. New York City, USA (https://seea.un.org/content/seea-central-framework).

UN 2014b. System of Environmental-Economic Accounting 2012: Experimental Ecosystem Accounting. New York City, USA (https://seea.un.org/ecosystem-accounting).

UN 2019. Technical Recommendations in support of the System of Environmental-Economic Accounting 2012: Experimental Ecosystem Accounting. New York City, USA (https://seea.un.org/ecosystem-accounting).

UNEP, Nairobi Convention and IMO. 2020b. Regional oil spill preparedness in eastern African and the western Indian Ocean. Workshop Report – 3 to 5 March 2020. https://www.nairobiconvention.org/clearinghouse/sites/default/files/Report%20Oil%20Spills%20Workshop.pdf

UNEP, Nairobi Convention and International Maritime Organization (IMO) 2020a. Regional oil spill preparedness in eastern African and the western Indian Ocean. Background Document https://www.nairobiconvention.org/clearinghouse/sites/default/files/Regional%20Oil%20Spill%20Preparedness.pdf

UNEP, Nairobi Convention Secretariat and CSIR. 2023c (in prep). Towards Sustainable Port Development in the Western Indian Ocean. Scenario Analysis. UNEP, Nairobi, Kenya.

UNEP. 2013. Guidelines for National Waste Management Strategies: Moving from challenges to opportunities. https://www.unep.org/ietc/resources/toolkits-manuals-and-guides/guidelines-national-waste-management-strategies-moving

UNEP. 2018. Assessing Environmental Impacts – A Global Review of Legislation. https://wedocs.unep.org/handle/20.500.11822/22691

UNEP. 2021a. Principles for ecosystem restoration to guide the United Nations Decade 2021-2030. https://www.decadeonrestoration.org/

UNEP. 2021b. Ecosystem Restoration Playbook. A practical guide to healing the planet. https://www.decadeonrestoration.org/publications/ecosystem-restoration-playbook-practical-guide-healing-planet

UNEP/OCHA (United Nations Environmental Programme and United Nations Office for the Coordination of Humanitarian Affairs – Environment Unit). 1996a. Guidelines for the development of a national environmental contingency plan. https://www.unocha.org/sites/dms/Documents/Guidelines_Development_Nl_Env_Contingency_Plan.pdf

UNEP/OCHA. 1996b. Sample of national environmental contingency plan (https://www.eecentre.org/Modules/EECResources/UploadFile/Attachment/Sample_of_a_National_Environmental_Contingency_Plan.pdf)

UNEP-FI (United Nations Environment Programme Finance Initiative) 2021. Turning the Tide: How to finance a sustainable ocean recovery—A practical guide for financial institutions. Geneva. https://www.unepfi.org/publications/turning-the-tide/

UNEP-Nairobi Convention/WIOMSA. 2020a. Guidelines on Mangrove Ecosystem Restoration for the Western Indian Ocean Region. UNEP, Nairobi, 71 pp. https://www.nairobiconvention.org/CHM%20Documents/WIOSAP/guidelines/GuidelinesonMangroveRestorationForTheWIO.pdf

UNEP-Nairobi Convention/WIOMSA. 2020b. Guidelines for Seagrass Ecosystem Restoration in the Western Indian Ocean Region. UNEP, Nairobi, 63 pp.

https://www.nairobiconvention.org/clearinghouse/sites/default/files/Guidelines%20for%20Seagrass%20Ecosystem%20Restoration%20in%20the%20Western%20Indian%20Ocean%20Region.pdf

UNEP, Nairobi Convention Secretariat and Council for Scientific and Industrial Research (CSIR). 2022a. Western Indian Ocean: Strategic Framework for Coastal & Marine Water Quality Management. UNEP, Nairobi, Kenya. XXIV + 89 pp + Appendices. Strategic Framework for Coastal & Marine Water Quality Management | Nairobi Convention Clearinghouse Mechanism

UNEP, Nairobi Convention Secretariat and CSIR. 2022b. Western Indian Ocean: Guidelines for Setting Water and Sediment Quality Targets for Coastal and Marine areas. UNEP, Nairobi, Kenya. XXIV + 109 pp +Appendices. Guidelines for Setting Water and Sediment Quality Targets for Coastal and Marine areas | Nairobi Convention Clearinghouse Mechanism

UNEP, Nairobi Convention Secretariat and Council for Scientific & Industrial Research. 2024. Towards Sustainable Port Development in the Western Indian Ocean. Scenario Analysis. UNEP, Nairobi, Kenya.

US-EPA. 2011. Underwater Ship Husbandry Discharges. EPA 800-R-11-004. https://www3.epa.gov/npdes/pubs/vgp_hull_husbandry.pdf

Vikolainen V, Bressers H and Lulofs K. 2014. A shift toward building with nature in the dredging and port development industries: managerial implications for projects in or near natura 2000 areas. Environ. Manag. 54: 3–13. https://doi.org/10.1007/s00267-014-0285-z

Walker C. 2019. How to Use Scenario Analysis to Manage in Uncertain Times. https://www.asisonline.org/security-management-magazine/articles/2019/10/how-to-use-scenario-analysis-to-manage-in-uncertain-times/

Waterman RE, Misdorp R and Mol A. 1998. Interactions between water and land in The Netherlands. J. Coast Conservation 4: 115–126. https://doi.org/10.1007/BF02806503

Waterman RE. 2010. Integrated Coastal Policy via Building with Nature. Doctoral Thesis. Technical University of Delft, The Netherlands.

Whitehead P. 2000. Environmental management framework for ports and related industries. Terra et Aqua 80: 22-30.

WHO (World Health Organisation) 2021. WHO global air quality guidelines. Particulate matter (PM2,5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide https://apps.who.int/iris/handle/10665/345329

World Bank Group. 2016. Biodiversity Offsets. A User Guide. https://www.cbd.int/financial/doc/wb-offsetguide2016.pdf

WPCI (World Ports Climate) 2010. Carbon foot printing for ports. Guidance document. https://sustainableworldports.org/wp-content/uploads/Carbon_Footprinting_Guidance_Document.pdf

WPSP (World Ports Sustainability Program) 2020. World ports sustainability Report. 2020. https://sustainableworldports.org/wp-content/uploads/WORLD-PORTS-SUSTAINABILITY-REPORT-2020-FIN.pdf

WWF (World Wildlife Fund). 2016. Living Planet Report. Risk and Resilience in a New Era. WWF International, Gland Switzerland. https://wwf.panda.org/wwf_news/?282370/Living%2DPlanet%2DReport%2D2016

Xiao Z and Lam JSL. 2017. A systems framework for the sustainable development of a Port City: A case study of Singapore's policies. Research in Transportation Business & Management 22: 255-262. https://doi.org/10.1016/j.rtbm.2016.10.003

Zhang Z, Song C, Zhang J, Chen Z, Liu M, Aziz F, Kurniawan TA and Yap P-S. 2024. Digitalization and innovation in green ports: A review of current issues, contributions and the way forward in promoting sustainable ports and maritime logistics. Science of The Total Environment 912: 169075. https://doi.org/10.1016/j.scitotenv.2023.169075