CHAPTER 4

Biodiversity offset framework

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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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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.

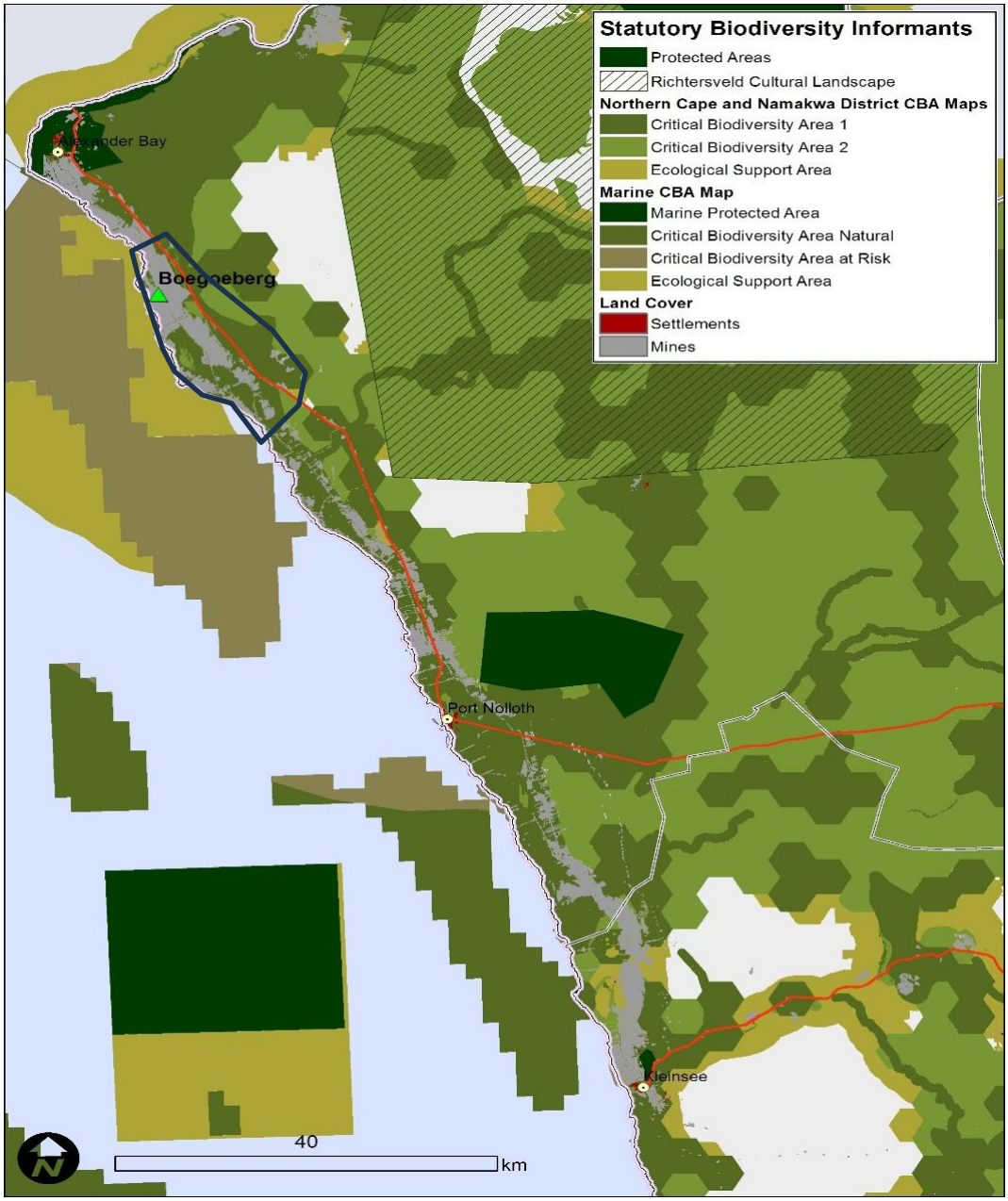

Figure S.1: Previously identified CBA (DENC 2016) potentially affected by development impacts at Boegoebaai and the SEZ (Blue outline). Offsets for impacts on these statutory planning features, if they are possible, would be substantial. Ecological compensation would be required if biodiversity targets cannot be met, or features are irreplaceable.

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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).

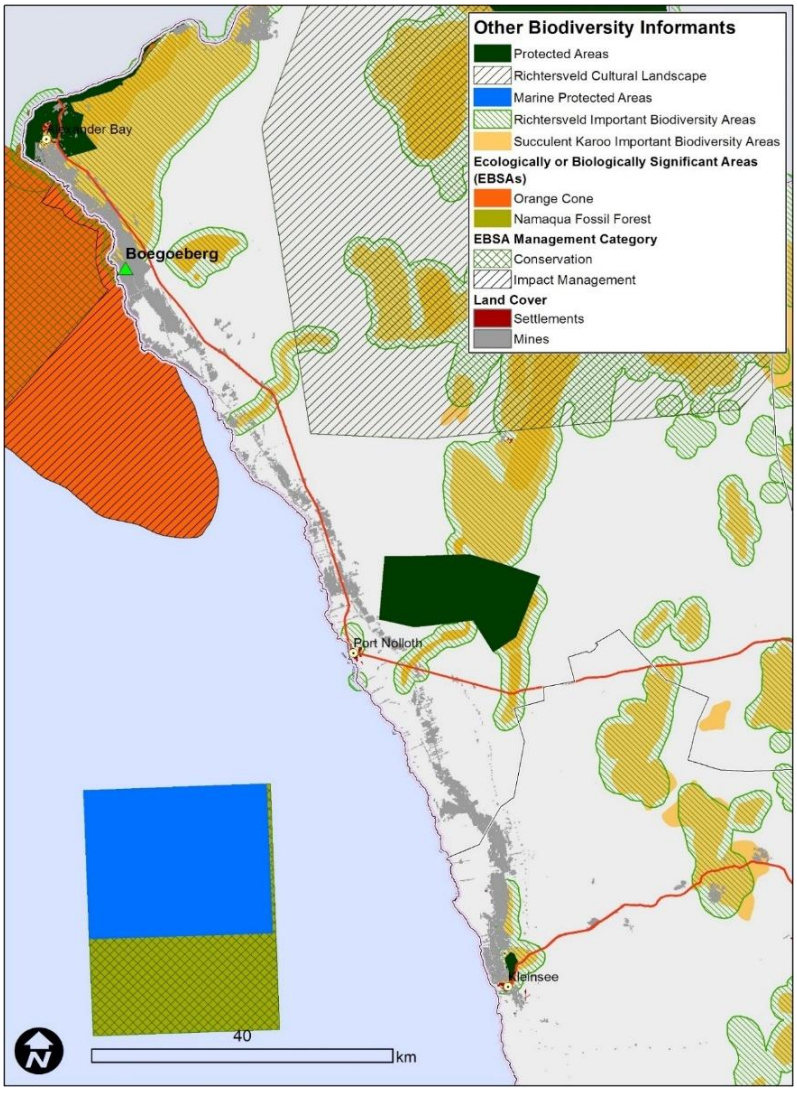

Figure 4-1: Previous guidance on avoidance and mitigation for potential impacts at Boegoebaai. From Botha & Desmet (2022). Note, the current study refines and augments the important biodiversity areas with site-specific data and community-mapped priorities, but their locations have not shifted much.

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.

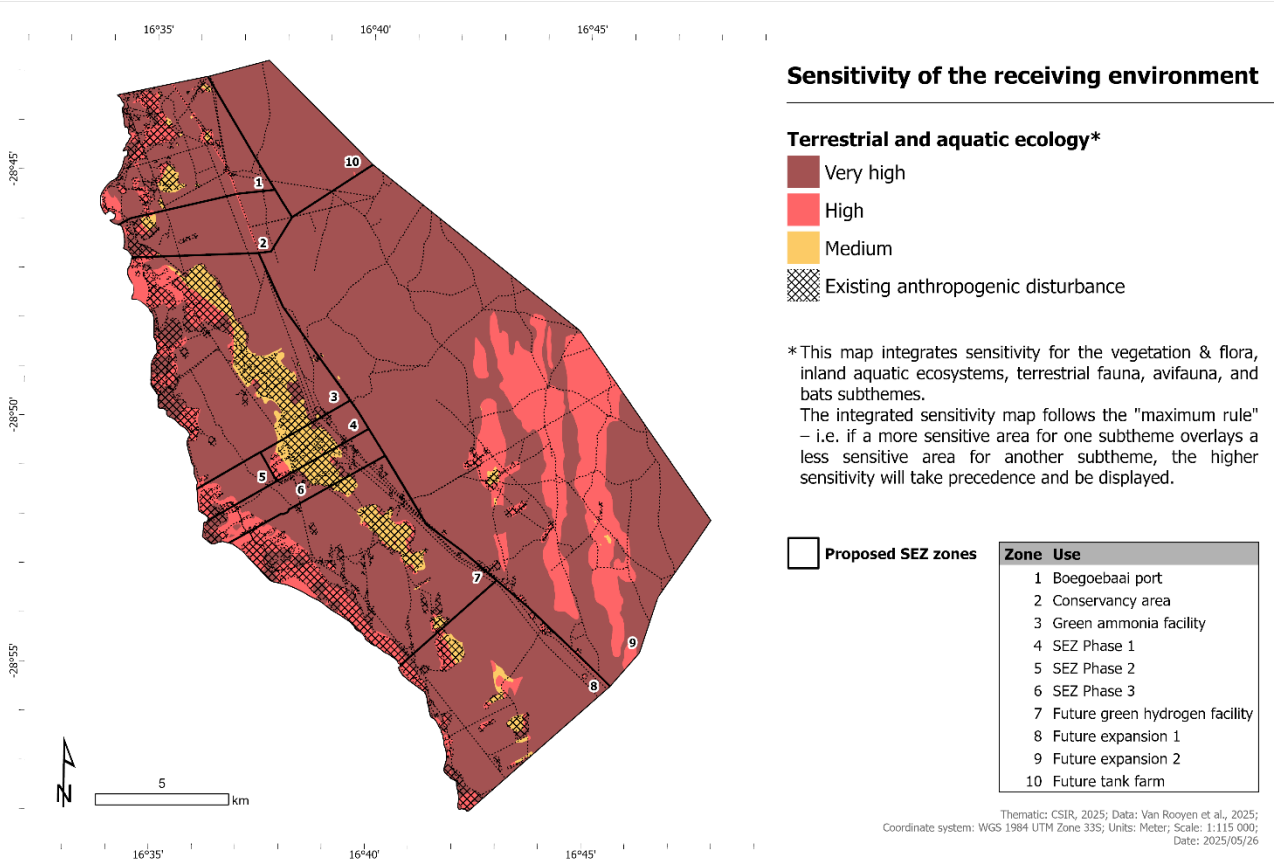

Figure 4-2: Major biodiversity informants for spatial planning, including vegetation types, wetlands, avian habitats, listed ecosystems, expert mapped important biodiversity areas. Some features not shown at this scale. (compilation by L Snyman-van der Walt May 2025).

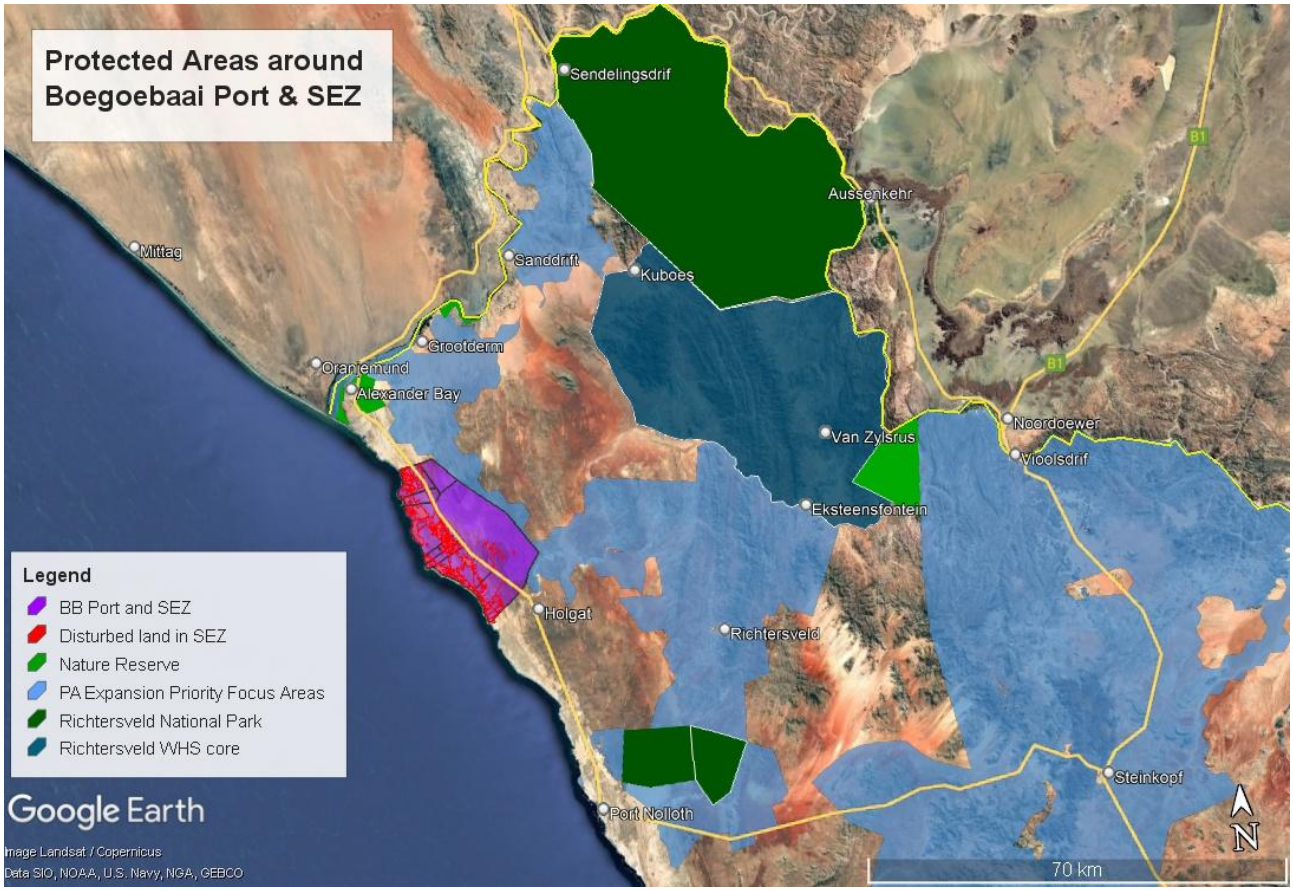

Figure 4-3: The protected areas and PA expansion priority focus areas around the SEZ. This does not show the Cultural and Botanical Landscape component of the Richtersveld WHS as its implications for the SEZ and offsetting are unclear. Note that the Western portion of the Oorgabies Wes Section of Richtersveld 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.

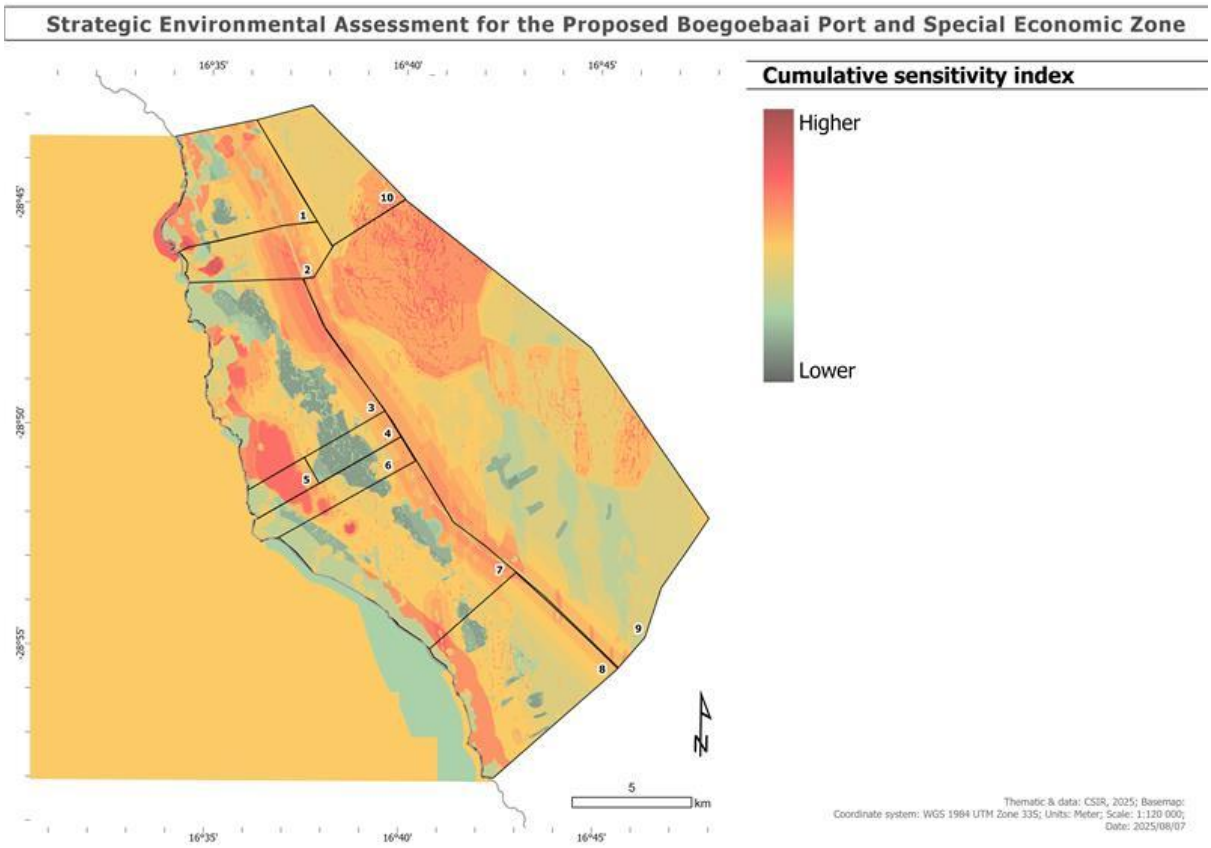

Figure 4-4: A cumulative sensitivity score map for all biodiversity themes (compilation by L Snyman-van der Walt May 2025).

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?

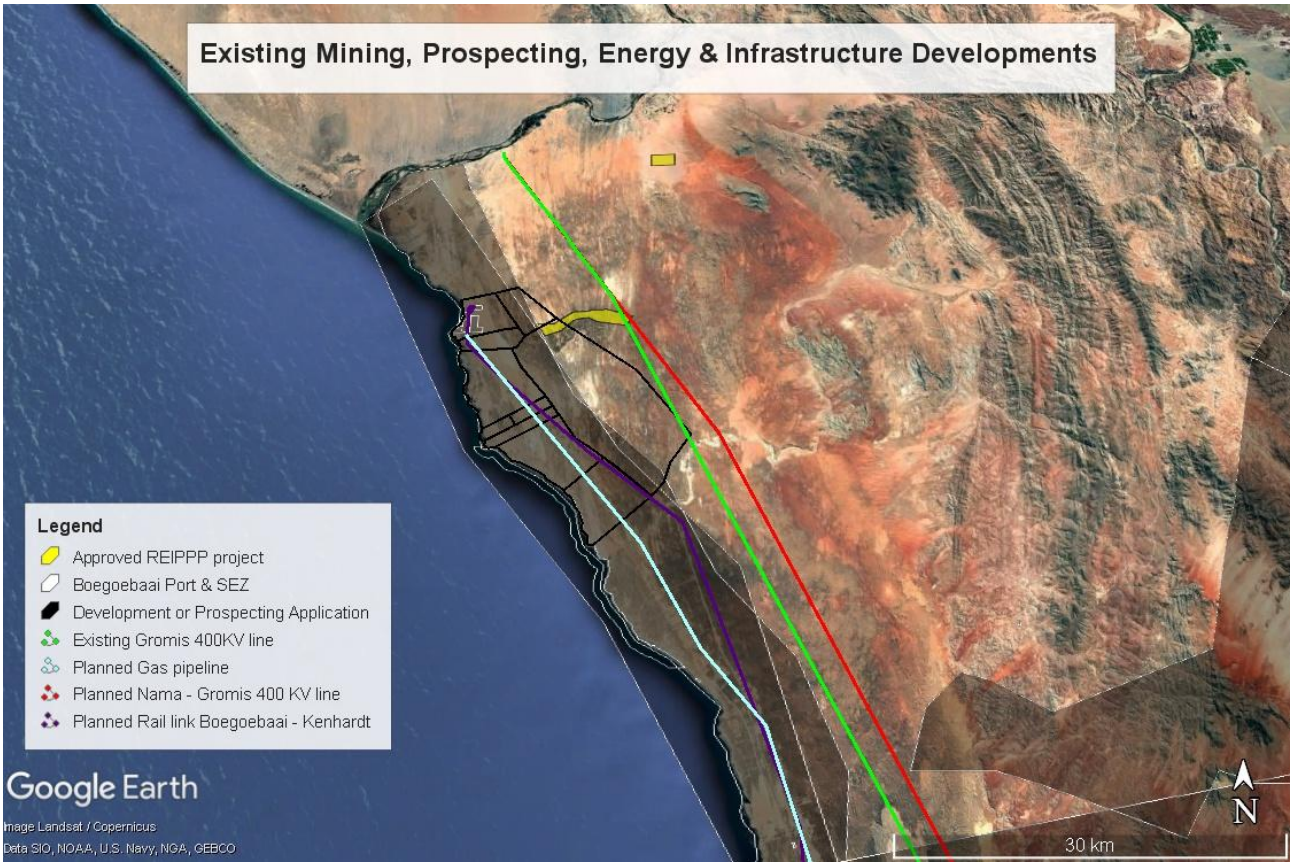

Figure 4-5: Current knowledge of existing mining right, petroleum exploration applications, energy and infrastructure developments in the region between Alexander Bay and Port Nolloth. Existing mining rights and other incompatible developments preclude effective offset establishment.

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.

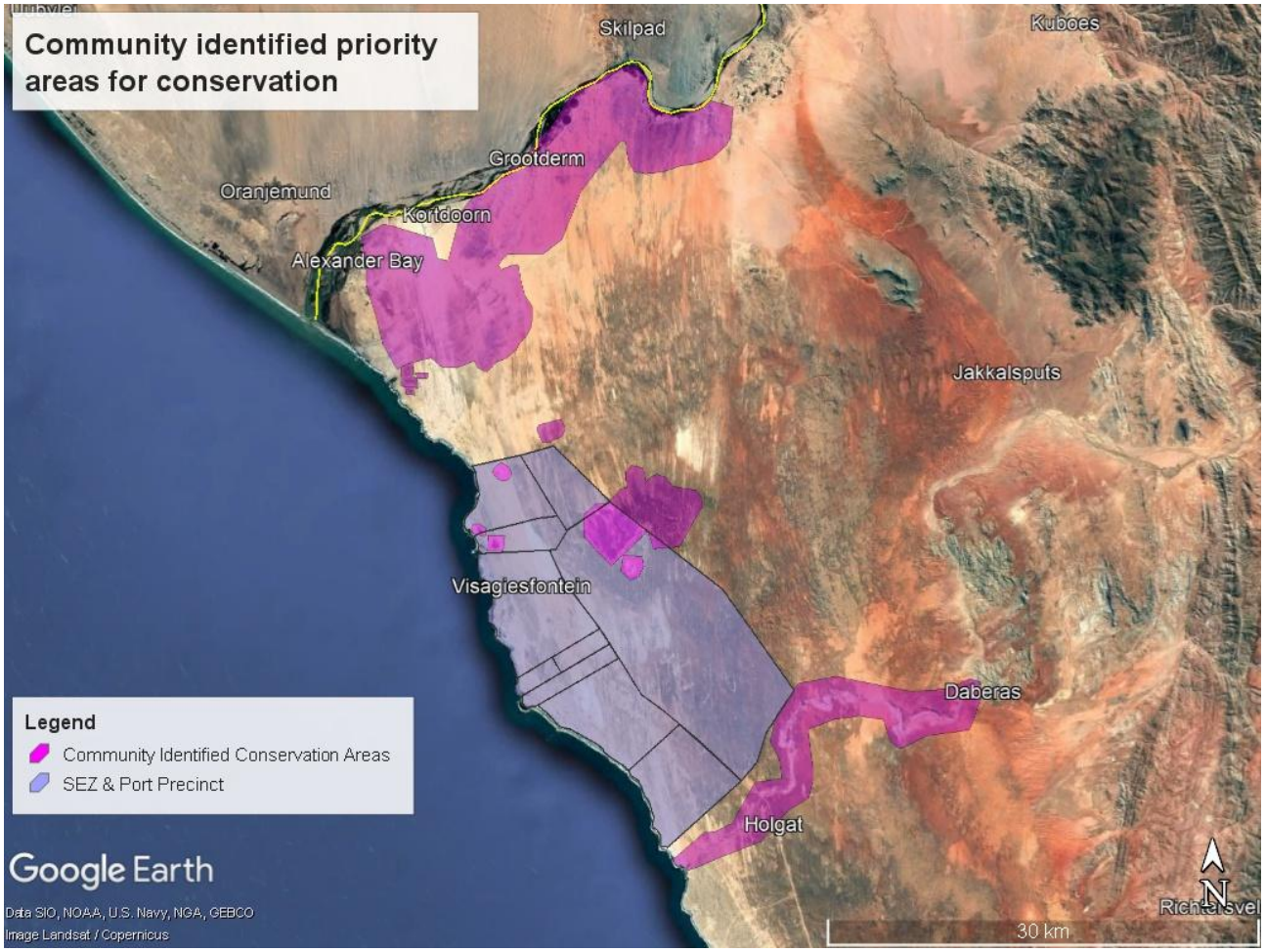

Figure 4-6: Areas identified by community consultation structures as deserving of conservation action and cultural and biodiversity heritage protection. These would be obvious candidates for offset receiving areas as the consent for their long-term protection, rehabilitation and management by the SEZ 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.

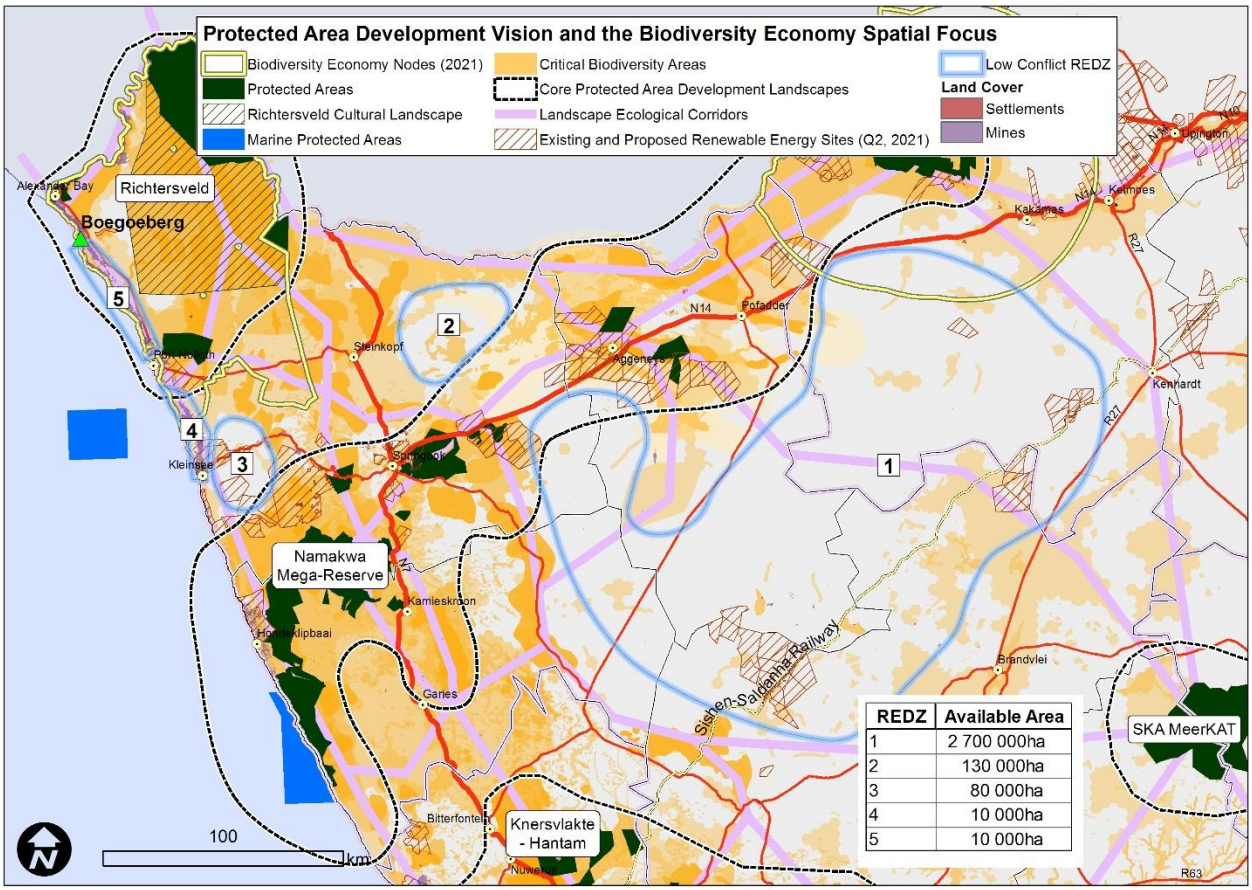

Figure 4-7: The three large areas able to accommodate especially PV production (1-3) to augment power from 2 large areas for WEF (4,5) on coastal mining scars. In a ratio of 60%PV:40%Wind for optimal operation. Note REDZ is used in a descriptive and not regulatory sense. (From Botha & Desmet 2022). An 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.

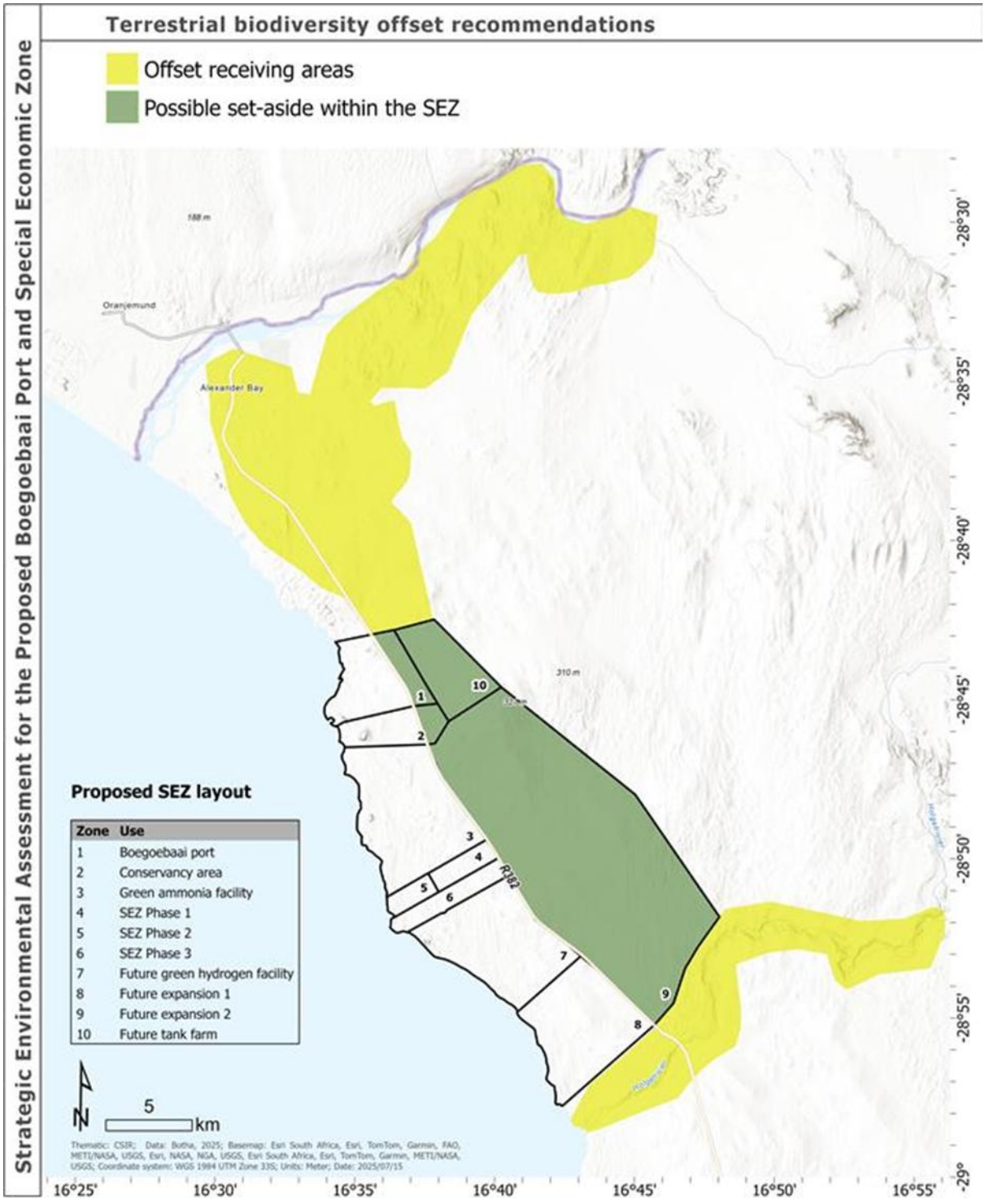

Figure 4-8: Prospective Offset receiving areas around the SEZ. Note the Possible set-asides within the SEZ, East and West of the R382, are also included in this figure, in line with recommended areas where development should be avoided. No attempt to redesign the "conservancy" zone as an Offset receiving 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.

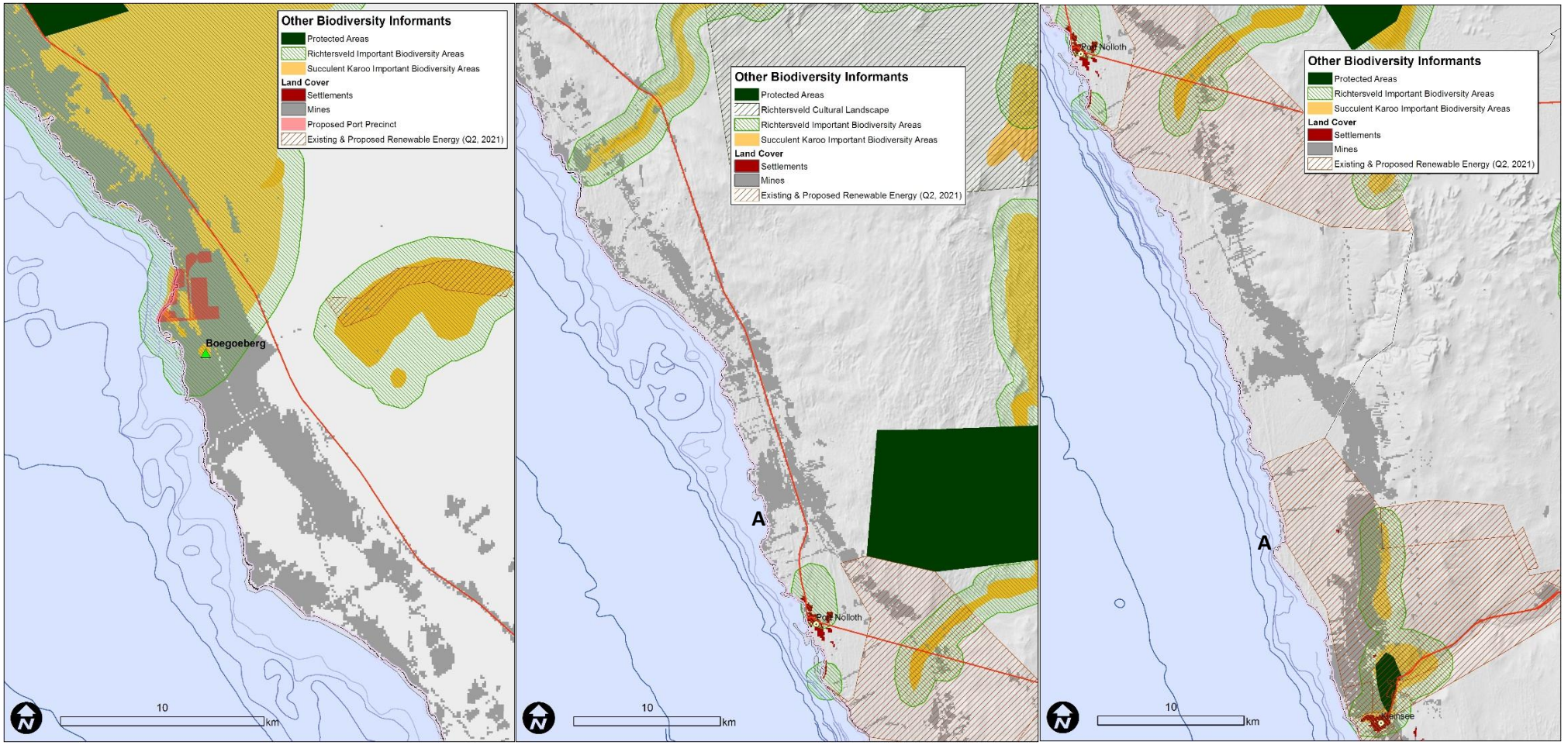

Figure 4-9: Coastal bathymetry, broad scale biodiversity informants and mining scars, indicating potential alternative sites ("A") for a port and Hydrogen loading facility, and location of desalination, electrolysers, liquid storage, and other industrial and renewable impacts from Alexander Bay down 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).

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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:

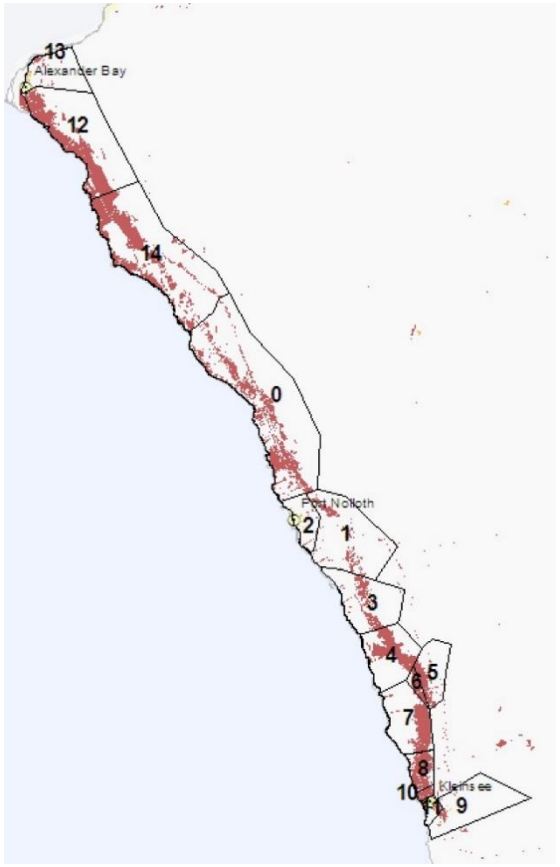
1. *Plan of Study*
    - *Outline the approach, data requirements, assumptions, limitations and timeframe of tasks.*
    - *Provide report / chapter framework.*
2. *Description of the receiving environment:*
    - *Describe the land use dynamics and change trends of the receiving environment and broader 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**