Social and Environmental Impact Assessment for Rössing Uranium's Proposed Desalination Plant near Swakopmund

SPECIALIST ASSESSMENT REPORT

Birds

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Prepared for:

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ACCRONYMS

AEWA	African-Eurasian Waterbird Agreement
BFD	Bird Flight Diverter
BID	Background Information Document
Bird movements	R = resident, N = nomadic, M = migrant, V = vagrant
Bird habitat categories	M = marine/coastal, W = wetland, T = predominantly terrestrial
CBD	Convention on Biological Diversity
CMS	Convention on Migratory Species
EIA	Environmental Impact Assessment
EIS	Environmental Information Service (www.the-eis.com)
Endemic status categories	E = endemic, NE = near-endemic, sA = southern Africa, Nam = Namibia
HLPCD (pole)	Horizontal line post compact delta (structure)
IBA	Important Bird Area
Impact categories	D = physical disturbance, HD = habitat destruction/ modification, C = collision with power line structures, E = electrocution on power line structures, N = potential to disrupt power supply through nesting activities
IUCN	International Union for Conservation of Nature
IUCN Red List categories	LC Least Concern V Vulnerable NT Near Threatened E Endangered CE Critically Endangered EW Extinct in the Wild E Extinct GT Globally Threatened
kV	kilovolt
MET	Ministry of Environment and Tourism
NNF	Namibia Nature Foundation
PA	Protected Area (proclaimed under the Nature Conservation Ordinance 1975)
QDS	Quarter Degree Square (Grid)
RO	reverse osmosis
RUL	Rössing Uranium Limited
SABAP1	South African Bird Atlas Project 1 (1987-1992)
SABAP2	South African Bird Atlas Project 2 (in Namibia from 2012 onwards)
SAIEA	Southern African Institute for Environmental Assessment
SEA	Strategic Environmental Assessment
SEIA	Social and Environmental Impact Assessment
SEMP	Social and Environmental Management Plan
TOR	Terms of Reference
U-SEA	Uranium Rush SEA

GLOSSARY

Endemic	Occurring within a restricted distribution range
IUCN Red List category	See abbreviations and acronyms (above)
Pentad	Bird atlassing unit for SABAP2 (approx.. 9 x 7 km; nine pentads per QDS

1 EXECUTIVE SUMMARY

1.1 BRIEF OUTLINE OF APPROACH

The approach to the assessment included the following general aspects:

- Identification of legal requirements and relevant national and or international standards relevant to the field of study;
- A description of the key (social and) environmental impacts associated with the field of study for the planning, construction, operations and decommissioning phase of the project;
- Assessment of the study area and surrounding land uses with the aim of identifying and describing the potential cumulative impacts associated with the project and surrounding land uses;
- Assessment of the identified impacts using the standard assessment methodology, for the "no-go" alternative, the base case site option and any other feasible alternative presented by the proponent in the impact phase project description;
- Identification and assessment of potential cumulative impacts associated with the project, taking into consideration surrounding landuses, activities and existing pressures on the socio-economic and biophysical environment, with reference to the description of cumulative considerations stemming from the Central Namib Uranium Rush Strategic Environmental Assessment (U-SEA);
- Identification and proposal of reasonable mitigation measures and management interventions (Including social and environmental monitoring) for inclusion into the SEMP and
- Assessment of the identified impacts, assuming that proposed mitigation measures are implemented to determine a "residual" impact significance rating.

The following additional aspects pertaining specifically to the avifauna were included, namely:

- An investigation of the potential impacts of noise and light pollution on birds (especially breeding species such as Damara Tern and Cape Cormorant), and incorporation of the findings of the noise specialist study;
- Further consultation with local birders, the owners of Swakopmund Salt Works and any other relevant reports for the area;
- Incorporation of the findings of the specialist studies in terms of the potential impacts of brine discharge on feeding marine birds;
- Addressing any further aspects arising from the public participation process; and
- Identification of spatial constraints and limitations.

1.2 LIMITATIONS TO STUDY AND GAPS IN KNOWLEDGE

- The description of bird diversity is based primarily on the first Southern African Bird Atlas Project (SABAP1), when data were gathered during 1987-1992 (Harrison *et al.* 1997). Although reliable, these data are relatively dated. In order to address this limitation, the above information was supplemented by available data, although still limited, from the second bird atlas project (SABAP2) that was launched in Namibia in 2012.
- Only limited information is available on the potential negative effects of noise on breeding birds, especially on African - and colonial - species such as cormorants. To address this, the growing literature on the effects of noise caused by wind turbines (which could have some similarities to noise caused by pumps used in the desalination process) was also consulted, although at present this literature pertains mainly to the effects of noise on humans.
- A major limitation to the assessment of potential impacts from power line structures is the difficulty in obtaining confirmed records of bird flight paths. On-site field observations and

available recent satellite tracking data for flamingos in Namibia were included to help address this limitation.

- Also limiting is the lack of long term data on power line incidents in Namibia. Available data from the NamPower/NNF Strategic Partnership (EIS 2014) were consulted in this respect.
- The impact significance ratings provided for the six project alternatives assessed assume that the recommended or equivalent mitigation measures have been applied in an effort to manage these impacts responsibly.

For all of the above limitations, the precautionary principle should apply until such time as further data can be obtained.

1.3 SUMMARY OF THE PREDICTED IMPACTS

In summary, the main predicted impacts are:

- Destruction/modification of bird habitat;
- Physical disturbance of (breeding) birds, including movement, noise and light disturbance; and
- Collisions and electrocutions of birds on power line structures.

A summary of the assessment of the predicted impacts on birds is provided in Table 1 below. The first assessment (column 1) relates to the unmitigated scenario for the base case site layout, whereas column 2 relates to the mitigated base case, and columns 3 and 4 present the assessment findings for the alternative locations in the mitigated scenario. Columns 5 and 6 relate to the potential impacts associated with the overhead/above-ground power line alternative (unmitigated and mitigated scenarios respectively).

Table 1: Summary of predicted impacts for the Rössing Desalination Plant project

Impact	Alternatives assessed					
	1	2	3	4	5	6
	Base case site layout, Desalination plant area no. 1	Mitigated base case, Desalination plant area no. 1	Alternative 1 – Desalination plant area no. 2	Alternative 2 – Desalination plant area no. 3	Alternative 3 – Overhead power line (unmitigated)	Alternative 3 – Overhead power line (mitigated)
Construction phase						
A: Destruction/ modification of Damara Tern breeding habitat	High	Low	Very low	Low	NA	NA
B: Destruction/ modification of habitat of other birds	Low	Low	Low	Low	NA	NA
C: Physical disturbance to breeding birds, especially Damara Terns	High	Low	Very low	Low	NA	NA
Operations phase						
D: Physical disturbance to breeding birds, especially Damara Terns	High	Low	Very low	Low	NA	NA
E: Physical disturbance to roosting/ breeding cormorants	Very low	Very low	Low	Very low	NA	NA
F: Collisions of birds with power line structures	NA	NA	NA	NA	High	Medium
G: Electrocutions of birds on power supply structures	NA	NA	NA	NA	Medium	Medium
Decommissioning phase						
H: Physical disturbance to breeding birds, especially Damara Terns	High	Low	Very low	Low	NA	NA

Legend	High (-)	Medium (-)	Low (-)	Very low (-)	Neutral	Very low (+)	Low (+)	Medium (+)	High (+)

1.4 IDENTIFICATION OF MAIN IMPACTS, INDICATING SIGNIFICANCE AND ACCEPTABILITY OF IMPACT AFTER MITIGATION

The main predicted impacts are identified as follows (see Table 1):

1.4.1 Risk to the environment (i.e. impact of development on environment)

- Construction phase impacts:
  - ~ A: Destruction/modification of breeding habitat of the Damara Tern: significance high and considered an environmental fatal flaw, acceptable with mitigation of moving site as far away from this breeding site as possible;
  - ~ B: Destruction/modification of the habitat of other birds: significance low, acceptable with mitigation; and
  - ~ C: Physical disturbance to birds, especially breeding Damara Terns: significance high, reduced to low with mitigation of moving site as far away from this breeding site as possible.
- Operations phase impacts:
  - ~ D: Physical disturbance to breeding Damara Terns: significance high, reduced to low with mitigation of moving site as far away from this breeding site as possible;
  - ~ E: Physical disturbance to roosting/breeding cormorants: significance very low;
  - ~ F: Collisions of birds with power line structures: significance high in the case of an over-head line, and medium with mitigation; and
  - ~ G: Electrocutions of birds on power line structures: significance medium in the case of an overhead line, and medium with mitigation.
- Decommissioning phase impacts:
  - ~ H: Physical disturbance to breeding birds, especially Damara Terns: significance high, reduced to low with mitigation of moving site as far away from this breeding site as possible.

The "no-go" alternative would have a neutral impact throughout, for all of the above impacts, and is therefore not included in the above assessment table.

1.5 BIRD SPECIES AT RISK

Bird species regarded as being at high or moderate risk in the study area fall within the aquatic category. Note that a number of other species are regarded as being at a low or very low risk to similar impacts.

1.5.1 High risk

- Damara Tern (Near Threatened, Globally Threatened): destruction of breeding habitat, disturbance in breeding habitat
- Lesser Flamingo (Vulnerable, Globally Threatened): collisions on power lines
- Greater Flamingo (Vulnerable): collisions on power lines

1.5.2 Moderate risk

- Cape Cormorant (Near Threatened, Globally Threatened): noise disturbance in breeding/ roosting habitat
- Great White Pelican (Vulnerable): collisions and electrocutions on power lines

- Black-necked Grebe (Near Threatened): collisions on power lines

1.6 MITIGATION AND MANAGEMENT MEASURES (EMP) TO BE IMPLEMENTED

1.6.1 Construction phase

- The base case site layout coincides with an established core breeding habitat for the Damara Terns, and should therefore be avoided and designated as a "no-go" area at all times, with zero further habitat destruction;
- The plant should be shifted to a position as far as possible from the known breeding Damara Tern areas: in the case of the mitigated base case site, the plant should be shifted to the furthest north-eastern extent of the area;
- To avoid disturbance of the Damara Tern breeding site it is also recommended that the alternative (northern) brine outfall be pursued, as this will reduce the disturbances to the core breeding area;
- Any construction activity located in or close to the Damara Tern breeding site should be scheduled to avoid taking place during the breeding months of October to April. This may apply to the upgrading of the intake channel, the construction of the intake/buffer pond and the intake pipeline from pond to plant; even then, excessive and unnecessary noise should be avoided;
- The plant and associated facilities (buffer pond; and pipelines, electrical cables and roads) should be designed and laid out to be compact and utilise the smallest possible footprint;
- Linear features (such as pipelines, electrical cables and roads) should share the same (existing) servitudes wherever possible and should be routed to avoid the core breeding areas;
- Construction activities should be restricted to the demarcated footprint;
- Approved access and service roads should be demarcated in collaboration with the owners to ensure that vehicles are kept on the designated routes, and no off-road driving should be permitted;
- All modified areas should be rehabilitated to an acceptable level after the disturbance;
- The construction of an earth berm/wall of 1.8-2.0 m high around the facility could be investigated, which would contribute to the reduction of physical disturbance associated with movement and construction activity, including noise and light;
- Further recommendations regarding noise guidelines/controls by the noise specialist study that pertain to avifauna should be applied;
- Construction activity should be restricted to daylight hours; however, should emergency night-time construction activity (i.e. a late concrete pour) be required, careful attention must be given to ensuring that lighting is task specific and does not result in the excessive light spill or flood lighting of vast areas;
- Outside lighting of the facility (including security lighting) must be kept to the minimum. Where required, all overhead lighting should be shaded and pointed downwards onto the area where illumination is needed, rather than directed upwards or outwards, in order to avoid light pollution. The guidelines laid down by the International Dark-Sky Association for the quality of outdoor lighting (including light design, wattage and light colour [preferably amber]) should be followed for preserving and protecting the night-time environment, including its wildlife (www.darksky.org);
- Construction plant and equipment should avoid using the bright headlight setting on their vehicles whilst driving through the Damara Tern breeding area. Similarly, construction vehicles should avoid the use of bright roof-mounted flashing lights (as is typical for construction sites); this becomes more critical during the breeding season, although construction activities should be scheduled outside this period if possible (see above);
- Ongoing awareness training should be promoted amongst staff about the negative impacts and undesirability of habitat destruction and disturbance, especially to breeding birds; and
- In particular, construction staff should be made aware of the breeding area during awareness training and this area must be treated as a "no-go" area during construction. Strict supervision

and control must be exercised to keep people and plant out of this area, especially during the tern breeding months.

1.6.2 Operations phase

- As far as possible, regular planned (annual) maintenance activities should be zoned in time outside the main Damara Tern breeding season, which is October to April. Even then, unnecessary noise disturbance should be avoided;
- Approved access and service roads should be demarcated in collaboration with the owners to ensure that vehicles are kept on the designated routes, and no off-road driving should be permitted;
- The construction of an earth berm/wall of 1.8-2.0 m high around the facility could be investigated, which would contribute to the reduction of physical disturbance associated with movement, as well as light and noise;
- Service doors, parking bays and windows in the facility should be designed to face away from the breeding and bird areas; doors should be kept closed at night to prevent the escape of noise and light into adjoining areas;
- Regular audits of operations noise levels should be conducted on an ongoing basis, according to the recommendations of the noise specialist study. If nest abandonment by the terns is observed that can be related to noise, measures should be taken to reduce that level of disturbance;
- Further recommendations regarding noise guidelines/controls by the noise specialist study that pertain to avifauna should be applied;
- Outside lighting of the facility must be kept to the minimum. Where required, all overhead lighting should be shaded and pointed downwards onto the area where illumination is needed, rather than directed upwards or outwards. The guidelines laid down by the International Dark-Sky Association for the quality of outdoor lighting (including light design, wattage and light colour [preferably amber]) should be followed for preserving and protecting the night-time environment, including its wildlife (www.darksky.org);
- Plant operations and equipment should avoid using the bright headlight setting on their vehicles whilst driving through the Damara Tern breeding area. Similarly, operations vehicles should avoid the use of bright roof mounted flashing lights at night; this becomes more critical during the breeding season;
- Regular audits of outside lighting fixtures should be undertaken in order to ensure that the guidelines laid down by the International Dark-Sky Association (see above) are maintained;
- Where the underground electricity cable is pursued there will be no impact and no need for mitigation; the following mitigations therefore relate only to an instance where the overhead power line is pursued. The subsection linking the plant to the C34 road will be a buried cable and then at least the first 3.5 km of above-ground power line south of this intersection should be marked with bird flight diverters (BFDs; see below). Note that it is difficult to predict exactly where collision incidents would take place; and a truly effective method of marking power lines to mitigate for collisions is still being sought. NamPower should be consulted in terms of expertise with regard to the final design and fitting of mitigation devices. The following marking methods are currently available and could be used in combination:
  - ~ Solar-powered LED bird flight diverter (BFD), an illuminated device incorporating a flashing light on the top and a moving flapper, that may assist in mitigating collisions of night-flying species such as flamingos; and
  - ~ Standard (double loop) bird flight diverters or a similar, smaller design have been shown to reduce collisions to some extent for diurnal species, and could be used in combination with the above device to reduce costs;

- Ongoing monitoring of all power line and substation structures (including transformers) is necessary (see below) to identify problem sites in terms of power line collisions; any incidents should be reported to the NamPower/NNF Strategic Partnership, which can offer advice and

support. Should collisions start to occur repeatedly in any one unmarked area on the line, the relevant section(s) should be fitted with appropriate mitigation measures (see above). Should collisions still take place after mitigation, the marking methods would need to be re-assessed;
- Roof structures (e.g. substation roofing) should be of a sloping design in order to deter the perching/ roosting of birds such as cormorants and pelicans;
- Ongoing awareness training should be promoted amongst staff about the negative impacts and undesirability of disturbance, especially to breeding birds; and
- In particular, operations staff should be made aware of the breeding area during awareness training and this area must be treated as a "no-go" area at all times. Strict supervision and control must be exercised to keep people and plant out of this area, especially during the tern breeding months.

1.6.3 Decommissioning phase

See above for mitigation measures for physical disturbance during the construction phase.

1.7 MONITORING

- Monitoring should be integrated with existing Rössing environmental protocols and guidelines;
- Regular/annual lighting audits need to be done, according to the guidelines of the International Dark-Sky Association (www.darksky.org);
- Regular noise audits need to be done during the operational phase of the project, according to the recommendations of the noise specialist report for this EIA;
- The monitoring of Damara Tern numbers and breeding success should continue during the annual breeding period;
- Cormorant occupation of the guano platforms should be monitored, if possible. This would require an innovative approach, and aerial photography could be investigated to detect possible signs of avoidance in relation to noise sources. Over the long term, annual guano productive rates could be used as an indicator of site occupancy, although the results should be interpreted with caution as other factors may be involved; and
- Stringent and regular monitoring is recommended for any power line as a matter of policy, especially after strong winds or other adverse environmental conditions. Ongoing monitoring would identify problem sites in terms of power line collisions and electrocutions. Dedicated monitoring surveys should be carried out, ideally once a month for the first year after completion; thereafter monitoring should be continued at least every quarter and at least up to five years after construction. All mortalities should be recorded and reported to the existing Rössing Environmental Section for follow up. All incidents should be reported to the NamPower/NNF Strategic Partnership.

1.8 MEASURES TO BE IMPLEMENTED TO ENHANCE SUSTAINABILITY OF PROJECT

The project offers an opportunity to increase the protection of the demarcated Damara Tern breeding area by the following means:

~ Increased awareness/publicity about the breeding site and its vulnerability (especially in view of Rössing's already demonstrated commitment to the conservation of Damara Terns);
~ Demarcation and protection of the site to exclude access by recreational and other vehicles and any other form of intrusive disturbance or habitat destruction; and
~ Ongoing monitoring of numbers and breeding success in the general area, and of threats.

The above measures would significantly contribute to the conservation of this threatened flagship coastal species, and also serve as an example of best practice for other developments.

2 INTRODUCTION

SLR Environmental Consulting (Namibia) (Pty) Ltd (SLR) in association with Aurecon Namibia (Pty) Ltd (Aurecon) (SLR/Aurecon) have been commissioned to undertake a Social and Environmental Impact Assessment (SEIA) study, to assess and address environmental and social impacts associated with a proposed new sea water desalination plant near the salt works north of Swakopmund, Namibia (Figure 1). The salt works are referred to both as the Swakopmund Salt Works and Mile 4 Salt Works.

Figure 1: Locality of the study area near Swakopmund, Namibia[1]

The environmental investigation requires specialist input to assist in the identification of potential social and environmental issues associated with the design, construction, operation and decommissioning of the project. Specialist input is required to identify potential impacts, assess the significance and recommend measures to mitigate negative impacts and optimise positive impacts, including follow-up studies and monitoring to verify impact assessment and allow for further social and environmental optimisations. Recommendations and mitigations will be carried through into a lifecycle Social and Environmental Management Plan (SEMP).

The documents will be submitted to the Ministry of Environmental Affairs and Tourism (MET) in support of the application for authorisation and used to inform a decision on the granting of an environmental clearance certificate, or not.

[1] Source: Modified from Google Earth®

3 BACKGROUND

3.1 PROJECT DESCRIPTION

The proposed location for the Rössing Uranium Desalination Plant is located 6 km north of Swakopmund and within the Swakopmund townlands. It lies within the Swakopmund Salt Works mining licence area and salt works complex (Figure 2). Please refer to the Social and Environmental Impact Assessment (SEIA) for a detailed description of the project and project alternatives.

Numerous project design and layout options were considered and these have been screened down through a series of trade-off studies, which considered the financial, technical, social and environmental merits of the options, to those that will be subjected to impact assessment. The social and environmental impact assessment will assess the impacts associated with each of the following alternatives:

- Base case site layout - The (pre-mitigation) base case for the desalination plant – centre of area No 1;
- Mitigated base case - The post-mitigation base case for the desalination plant – (north / north-eastern part of area No 1);
- Alternative 1 - Desalination plant area No 2 and associated changes;
- Alternative 2 - Desalination plant area No 3 and associated changes;
- Alternative 3 - Overhead power line, (as opposed to the preferred option of a buried power cable), unmitigated;
- Alternative 4 - Overhead power line (see above), mitigated; and
- Alternative 5 - The "no go" alternative.

Table 2 (below) provides an overview of the project description, namely the base case (mitigated) and the various alternatives, as introduced above, to be considered and assessed (where appropriate) in this impact assessment.

Note that the "no-go" alternative would have a neutral impact throughout, for all impacts, and is therefore not included in the above table of assessment alternatives.

Figure 2 provides the layout of the project alternatives, relevant to the present study, as described in the table below.

Table 2: Project overview, showing base case site and alternatives to be assessed

1	2	3	4	5	6
Base case site (pre-mitigation)	**Base case site (post-mitigation)**	**Alternative 1 – Site 2**	**Alternative 2 – Site 3**	**Alternative 3 – overhead power line (pre-mitigation)**	**Alternative 4 - overhead power line (post-mitigation)**
RO Plant ~ 10ml/d seawater reverse osmosis (RO) plant and associated facilities situated in the centre of site locality 1. The RO plant will house the pre-treatment systems and the various pumps for the clearwater system. The plant will also house various ancillary facilities (chemical stores, offices, ablutions, roads, parking bays, maintenance areas, spares stores, etc.). The RO plant and associated facilities will be mostly housed within a single warehouse type structure, to protect them from the corrosive coastal air.	Same as base case site except that the Plant would be situated in the north / north-eastern part of area1.	Same as base case site except that the Plant would be situated on site area 2.	Same as base case site except that the plant would be situated in site area 3.	NA	NA
Seawater intake system ~ A new seawater intake jetty and associated pumps and pipes will be erected just south of the existing salt works intake jetty. Seawater will enter the existing (possibly upgraded) salt works seawater intake channel and gravitate around the salt works and enter into a new seawater buffer pond located near the RO plant. A new electrical cable will be run from the RO plant around the eastern and northern shores of the salt pans, and provide power to the intake pumps on the new jetty.	Same as base case site except that the new seawater intake pond would be situated closer to the RO plant on Site locality 2.	Same as base case site except that the new seawater intake pond would be situated closer to the RO plant on Site locality 2.	Same as base case site.	NA	NA
Pre-treatment system ~ Sea water abstracted from the buffer pond will be filtered and conditioned ahead of the desalination process. This may involve the use of pre-treatment chemicals or biological processes in combination with physical screens and filters to ensure that the water is free of particulates that could foul the RO membranes, and that the pH is optimum to allow for efficient RO process.	Same as base case site.	Same as base case site.	Same as base case site.	NA	NA
Clearwater system ~ Clear water from the RO process will then be re-mineralised to meet potable water standards and pumped via an 850m long pipeline, running due east from the plant, into the existing NamWater pipeline running along the eastern side of the Henties Bay Road (C34).	Same as base case site.	Same as base case site.	Same as base case site.	NA	NA
Brine disposal system ~ Brine (together with filter backwash from the pre-treatment system and chemical cleaning processes) will be pumped from the plant via a new pipeline to ocean discharge (surf discharge) location situated south of the salt works bitterns outlet (southern discharge site).	Same as base case site except that due to RO plant location on site 2, the northern discharge (Outfall 1) site becomes preferred due to the	Same as base case site except that due to RO plant location on site 2, the northern discharge (Outfall 1) site becomes preferred due to the	Same as base case site.	NA	NA

1	2	3	4	5	6
Base case site (pre-mitigation)	**Base case site (post-mitigation)**	**Alternative 1 – Site 2**	**Alternative 2 – Site 3**	**Alternative 3 – overhead power line (pre-mitigation)**	**Alternative 4 - overhead power line (post-mitigation)**
	shorter pipe length.	shorter pipe length.			
Electrical supply system ~ A buried cable would run from the existing Tamarisk substation in the northern parts of Swakopmund, along the C34 toward Henties Bay and then turn due west on a vector to connect with the new mini-substation to be constructed adjacent the RO plant. The cable between the C34 and the plant should follow the same route as the clearwater pipeline connecting with the NamWater pipeline. Note also that a buried cable will run from the RO plant to the new seawater intake jetty.	Same as base case site. However the exact location where the buried cable would turn west from the Henties Bay Road is located further north.	Same as base case site. However the exact location where the buried cable would turn west from the Henties Bay Road is located further north.	Same as base case site. However the exact location where the buried cable would turn west from the Henties Bay Road is located further south.	Same as base case site except that the distribution line from the Tamarisk substation along the C34 to Henties Bay will be above ground as opposed to a buried cable, and unmitigated. From the C34 to the plant the cable will remain buried.	Same as base case site except that the distribution line from the Tamarisk substation along the C34 to Henties Bay will be above ground as opposed to a buried cable. This scenario is the mitigated line. From the C34 to the plant the cable will remain buried.

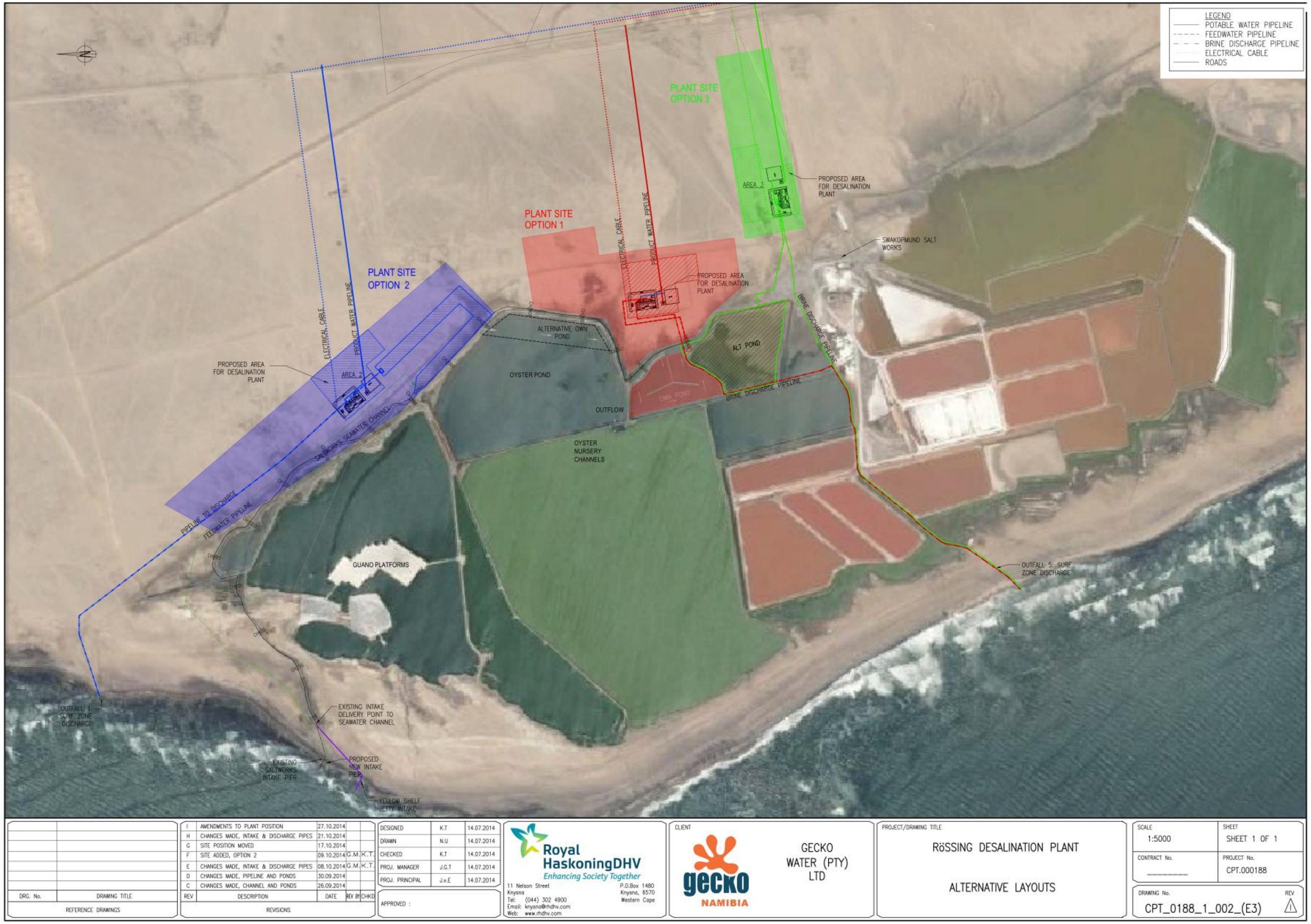

Figure 2: Layout of the base case site (pre-mitigation) and various other alternatives considered

3.2 DESCRIPTION OF PROJECT ALTERNATIVES

3.2.1 Base case site layout (area No 1)

The central portion of the base case site (area No 1, Figure 2) is regarded as highly sensitive by way of being a core, established breeding site for the Damara Tern (see Figure 3; M Boorman pers. comm.). The above layout has the desalination plant positioned centrally within this core breeding area. Any form of intrusive disturbance (including movement, noise [machinery], light pollution [light enhances opportunities for predators] during the breeding season, when the birds are present (from October to April), or habitat destruction could result in reduced breeding success or in the Damara Terns abandoning this breeding site, probably permanently. If they move to alternative breeding sites, their chances of breeding success would be reduced. Damara Tern breeding habitats are under threat elsewhere from development and human disturbance, and any further losses should be avoided.

Figure 3: Damara Tern breeding areas in relation to site options[2]

Note that all the alternatives (below) to the base case layout below are "mitigated scenarios" as it was identified early on in the process that the plant needs to be relocated out of the core Damara Tern breeding area.

3.2.2 Mitigated base case

Even if the plant were located to the immediate north-east of area No 1 (Figure 2; "1" in Figure 3) with the construction of a buffer pond in the depression to the west ("2" in Figure 3), its position is still relatively close to the core Damara Tern breeding area, especially in terms of the potential impacts of disturbance caused by increased movement and activity associated with noise, particularly at night. As yet these effects on breeding Damara Terns have not been studied, and consequently the precautionary principle should apply.

[2] Damara Tern core breeding area (purple, with two outliers [black markers]), secondary breeding area (blue) and proposed buffer zone (green); the base case site option is indicated by yellow marker 1, with a new buffer pond to the west (2); preferred localities from the avifaunal point of view are red markers 3, followed by 4 and 5; yellow lines indicate established road tracks

The mitigated base case site would, however, increase the length of the access route to the plant and may increase the associated traffic disturbances, compared with the other sites.

3.2.3 Alternative 1 (area No 2)

The first alternative, area No 2 (Figure 2) is nearer to the northern salt pans and associated guano platforms and breeding seabirds, chiefly cormorants. The Cape Cormorant is Near Threatened in Namibia and also Globally Threatened. The effects of ongoing noise resulting from the operation of the desalination plant on breeding cormorants are unknown, but could cause desertion of nests, resulting in increased predation and eventually a reduction in breeding success (see 7.1.4). Additionally, any reduction in the production of the existing guano industry would have negative economic implications (J Klein pers. comm.). Although the cormorants have probably become accustomed to the vehicle and construction-type noises already on site, they are also out feeding for much of the day. A new source of ongoing operational noise at night (when the cormorants come in to roost), possibly associated with inaudible (low- or high-frequency?) sound, that could easily propagate across an open water body, could become disruptive to breeding activity or have other indirect ecological effects.

3.2.4 Alternative 2 (area No 3)

The second alternative, area No 3 (Figure 2) is still fairly close to the core Damara Tern breeding site ("1") and some disturbance is possible through noise, movement and light during both the construction and operations phase, although the choice of this site would not physically displace breeding Damara Terns as with certain portions of the base case site.

3.2.5 Brine outfall location alternatives

Two brine outfall locations are being considered (Figure 2): a southern site, that forms part of the preferred alternative, is located just south of the existing salt works bitterns outlet; and the alternative northern outfall, that is associated with Alternative 2, is located at the now redundant salt works intake structure. If the northerly outfall site is selected, construction activities (i.e. trenching and placement of the pipeline) and related disturbance would increase in proximity to the guano platforms and the northern approach used to the site by the cormorants, potentially resulting in increased disturbances during the construction phase, although this outfall would also route the brine discharge pipeline away from the Damara Tern breeding areas.

3.2.6 Power line alternatives

Two alternatives for the plant power supply are being considered. The preferred alternative is to bury the cable for the full length from the Tamarisk substation at Swakopmund to the plant. The other alternative is to use an overhead power line, that will reuse existing distribution poles (where the power cable has been stolen) and an existing servitude and then an underground cable from the Henties Bay (C34) road to the plant.

A power line above ground may have significant impacts on birds in terms of collisions, and electrocutions, whereas running the power cable below ground would reduce the chances of collisions to zero, and also reduce the chances of electrocutions. Burying the power cable below the ground would, however, require increased construction activities in the form of trenching and related earthworks.

3.3 TERMS OF REFERENCE (TOR) FOR THE BIRD ASSESSMENT REPORT

The general Terms of Reference were to compile a specialist report including the following:

- Identification of legal requirements and national and or international standards relevant to the field of study;
- A description of the key (social and) environmental impacts associated with the field of study for the planning, construction, operations and decommissioning phase of the project;
- Assessment of the study area and surrounding land uses with the aim of identifying and describing the potential cumulative impacts associated with the project and surrounding land uses;
- Assessment of the identified impacts using the standard assessment methodology, for the "no-go" alternative, the base case site layout and any other feasible alternative (see section 2) presented by the proponent in the impact phase project description;
- Identification and assessment of potential cumulative impacts associated with the project, taking into consideration surrounding landuses, activities and existing pressures on the socio-economic and biophysical environment. Reference to be made to the following description of cumulative considerations stemming from the Central Namib Uranium Rush Strategic Environmental Assessment (U-SEA; Anon. 2010b):
  ~ The habitats in which plants and animals occur, the species which are most vulnerable due to endemicity or threatened status, the ecological processes which support life in the central Namib, and the areas of high biodiversity value, have been considered in terms of how these will be affected by the combined impacts expected from the Uranium Rush industries. Impacts on biodiversity will have a negative impact on tourism and recreation as well as a number of other significant secondary and tertiary impacts such as public health issues … **In developing, care should be taken that the ecological integrity and diversity of fauna and flora of the central Namib are not compromised by the Uranium Rush;**
- Identification and proposal of reasonable mitigation measures and management interventions (including [social and] environmental monitoring) for inclusion into the SEMP; and
- Assessment of the identified impacts, assuming that proposed mitigation measures are implemented, to determine a "residual" impact significance rating.

The specialist report also considered the following gaps or aspects pertaining to avifauna in greater detail:

- An investigation into the potential impacts of noise and light pollution on birds (especially breeding species such as Damara Tern and Cape Cormorant), and the incorporation of the findings of the noise specialist study;
- Further consultation with local birders, the owner of Swakopmund Salt Works and any other relevant reports for the area;
- Incorporation of the findings of the specialist studies in terms of the potential impacts of brine discharge on feeding marine birds;
- Addressing any further aspects arising from the public participation process; and
- Identification of spatial constraints and limitations.

4 APPROACH TO THE STUDY

4.1 SCOPE OF WORK

The following aspects were addressed in the study:

- The water intake system and associated infrastructure;
- The waste water discharge system and associated infrastructure;
- The pre-treatment plant and process;
- The reverse osmosis (RO) plant and process;
- The site of the pre-treatment plant, RO plant, electrical substation, and related services;
- The desalinated water supply line to the nearest NamWater bulk line (850m); and
- The power line from the Tamarisk substation to the RO plant substation.

4.2 METHODOLOGY AND INFORMATION REVIEWED

The methods used for the study are described below.

Figure 4: Quarter degree squares (QDS) for the study area (arrow), used for determining SABAP1 bird species distribution[3]

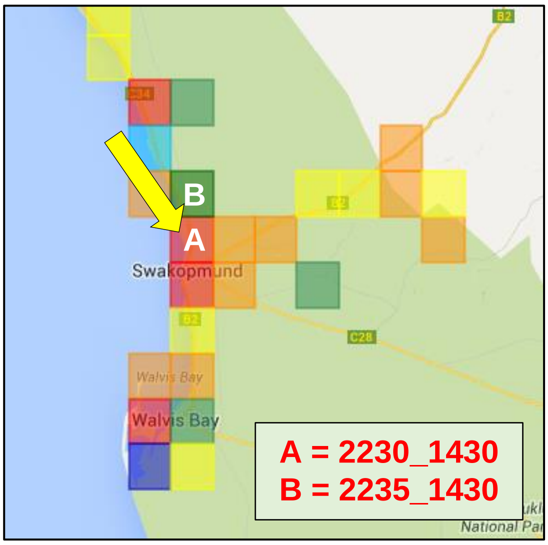

Figure 5: Pentads for the study area (A & B), used for determining SABAP2 bird species distribution on a finer scale[4]

The study area falls within one Quarter Degree Square (QDS), namely 2214Da (Figure 4). A comprehensive bird species list was compiled for this QDS from information from the first Southern African Bird Atlas Project (SABAP1), gathered during 1987-1992 (Harrison *et al.* 1997) and available on the Namibian Avifaunal Database (NAD; www.biodiversity.org.na). This database includes all available information on birds in Namibia including SABAP1 data, nest record cards, wetland bird counts, and Namibian Raptor Road Counts and museum specimens. More recent available records for the new SABAP2 (in Namibia from 2012 onwards) were also consulted for comparison with distribution data on a finer scale, based on Pentads 2235_1430 and 2230_1430 (Figure 5).

The above information was supplemented by the Environmental Information Service (EIS; EIS 2014), published sources (e.g. Hockey *et al.* 2005, Chittenden 2007, Sinclair *et al.* 2011), the draft Red Data Book for Birds in Namibia (Simmons & Brown in press), the global IUCN Red Data list for birds (IUCN 2014), available EIA reports for the area (e.g. Van Rooyen 2009); discussions with local bird experts

[3] Source: Google Earth map generated on EIS 2014
[4] Source: http://sabap2.adu.org.za/coverage.php#menu_top

(including Messrs Rod Braby and Mark Boorman and Ms Gisela Noci) and the owners of Swakopmund Salt Works, Messrs Jürgen and Detlef Klein; and both the authors' 30+ years of experience of working together on and observing birds in southern Africa, including Namibia. Existing GPS tracking data on flamingos in Namibia were also consulted (NamPower/NNF Strategic Partnership *in litt*.).

An initial scoping field visit was undertaken on 19 July 2014.

Due to the potential sensitivity of the Damara Tern breeding area as identified during the scoping study phase, regular monitoring visits were initiated three times per week from 15 September 2014 onwards. The purpose was to establish when the birds arrived and the activities they engaged in, and to verify whether and when they would take up sites in the identified breeding area. Any signs of disturbance in the area were also noted. Numbers of some other Red Data bird species were monitored opportunistically during these visits, including Chestnut-banded Plover and African Black Oystercatcher.

The following information for each bird species is provided in a table (Appendix 1):

- Taxonomic order according to Roberts VII Birds of Southern Africa (RVII; Hockey *et al.* 2005)
- Previous Roberts numbers (RVI)
- Species name: common
- Species names: scientific
- Red Data status (LC = Least Concern, V = Vulnerable, NT = near Threatened, E = Endangered, CE = Critically Endangered, EW = Extinct in the Wild, EX = Extinct): derived from the IUCN Red List of threatened species (IUCN 2014; www.iucn.redlist.org), a standard internationally accepted system for classifying species in terms of the risk of extinction on a global scale. BirdLife International is the official Red List Authority for birds for the IUCN Red List, supplying the categories and associated detailed documentation for all the world's birds to the IUCN Red List each year. The national categories are provided according to the (draft) Namibian Red Data Book (Simmons & Brown in press). These are supplemented by the above global Red Data categories. Other recent sources for birds in southern Africa were also consulted, e.g. Sinclair *et al*. (2011).
- Endemic status (E = endemic, NE = near-endemic, sA = southern Africa, Nam = Namibia; derived from the above sources)
- Movements (R = resident, N = nomadic, M = migrant, V = vagrant, Ra = Rare; derived from the above sources)
- Habitat (M = marine/coastal, W = wetland [coastal or inland], T = predominantly terrestrial; derived from the above sources)
- Reporting rates (%) for SABAP1 and SABAP2

A map depicting proportions of Red-listed power line sensitive bird species by QDS was compiled for the study area, using the Environmental Information System (EIS 2014).

A summary table of bird species regarded as being potentially at risk in the study area (Appendix 2) includes the following additional information:

- Type of potential impact possible (D = physical disturbance, HD = habitat destruction/ modification, C = collision with power line structures, E = electrocution on power line structures, N = potential to disrupt power supply through nesting and other activities)
- Potential for impact (very low, low, medium [med], high)

4.3 IMPACT ASSESSMENT METHODOLOGY

Potential sources of risk to avifauna as a result of the proposed project were identified, and *vice versa*.

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An assessment was made of all potential impacts that could result from the proposed project for the construction and operational phases.

The assessment of predicted significance of impacts for a proposed development is by its nature, inherently uncertain – environmental assessment is thus an imprecise science. To deal with such uncertainty in a comparable manner, standardised and internationally recognised methodology[5] has been developed. Such accepted methodology is applied in this study to assess the significance of the potential environmental impacts of the proposed development, outlined as follows:

For each impact, the EXTENT (spatial scale), MAGNITUDE (size or degree scale) and DURATION (time scale) are described. These criteria are used to ascertain the SIGNIFICANCE of the impact, firstly in the case of no mitigation and then with the most effective mitigation measure(s) in place. The tables on the following pages (Table 3-7) show the scale used to assess these variables, and define each of the rating categories.

Table 3: Assessment criteria for the evaluation of impacts

CRITERIA	CATEGORY	DESCRIPTION
Extent or spatial influence of impact	National	Within the country
	Regional	Within the province/recognised region
	Local	On site or within 1,000m (1 km) of the impact site
*Magnitude of impact (at the indicated spatial scale)	High	Social and/or natural functions and/ or processes are severely altered (i.e. function is severely hampered and processes are unlikely to function)
	Medium	Social and/or natural functions and/ or processes are notably altered (i.e. function is affected to a noticeable degree and processes struggle to function effectively)
	Low	Social and/or natural functions and/ or processes are slightly altered (i.e. while function is affected in a measurable way, processes are likely to function, albeit sub-optimally)
	Very Low	Social and/or natural functions and/ or processes are negligibly altered (i.e. function is slightly affected and processes are likely to function effectively)
	Zero	Social and/or natural functions and/ or processes remain unaltered
Duration of impact	Long Term	More than 10 years
	Medium Term	Up to 10 years (life of the project)
	Short term (construction period)	Up to 3 years

*NOTE: Where applicable, the magnitude of the impact has to be related to the relevant standard (threshold value specified and source referenced).

The magnitude of impact is based on specialist knowledge of that particular field.

The SIGNIFICANCE of an impact is derived by taking into account the temporal and spatial scales and magnitude. Such significance is also informed by the context of the impact, i.e. the character and identity of the receptor of the impact. The means of arriving at the different significance ratings is explained in the following table, developed by Ninham Shand in 1995 as a means of minimising subjectivity in such evaluations, i.e. to allow for replicability in the determination of significance.

[5] As described, inter alia, in the South African Department of Environmental Affairs and Tourism's Integrated Environmental Management Information Series (Gov. of SA, 2002).

Table 4: Definition of significance ratings

SIGNIFICANCE RATINGS	LEVEL OF CRITERIA REQUIRED
High	High magnitude with a regional extent and long term duration High magnitude with either a regional extent and medium term duration or a local extent and long term duration Medium magnitude with a regional extent and long term duration
Medium	High magnitude with a local extent and medium term duration High magnitude with a regional extent and construction period or a site specific extent and long term duration High magnitude with either a local extent and construction period duration or a site specific extent and medium term duration Medium magnitude with any combination of extent and duration except site specific and construction period or regional and long term Low magnitude with a regional extent and long term duration
Low	High magnitude with a site specific extent and construction period duration Medium magnitude with a site specific extent and construction period duration Low magnitude with any combination of extent and duration except site specific and construction period or regional and long term Very low magnitude with a regional extent and long term duration
Very low	Low magnitude with a site specific extent and construction period duration Very low magnitude with any combination of extent and duration except regional and long term
Neutral	Zero magnitude with any combination of extent and duration

Once the significance of an impact has been determined, the PROBABILITY of this impact occurring as well as the CONFIDENCE in the assessment of the impact has been determined using the rating systems outlined in the following two tables. It is important to note that the significance of an impact should always be considered in concert with the probability of that impact occurring.

Table 5: Definition of probability ratings

PROBABILITY RATINGS	CRITERIA
Definite	Estimated greater than 95% chance of the impact occurring.
Probable	Estimated 5% to 95% chance of the impact occurring.
Unlikely	Estimated less than 5% chance of the impact occurring.

Table 6: Definition of confidence ratings

CONFIDENCE RATINGS[6]	CRITERIA
Certain	Wealth of information on and sound understanding of the environmental factors potentially influencing the impact.
Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.
Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact.

Lastly, the REVERSIBILITY of the impact has been estimated using the rating system outlined in the following table.

Table 7: Definition of reversibility ratings

REVERSIBILITY RATINGS	CRITERIA
Irreversible	The activity will lead to an impact that is permanent.
Reversible	The impact is reversible, within a period of 10 years.

Despite attempts at providing a completely objective and impartial assessment of the environmental implications of development activities, environmental assessment processes can never escape the subjectivity inherent in attempting to define significance. The determination of the significance of an impact depends on both the context (spatial scale and temporal duration) and intensity of that impact. Since the rationalisation of context and intensity will ultimately be prejudiced by the observer, there can be no wholly objective measure by which to judge the components of significance, let alone how they are integrated into a single comparable measure.

[6] The level of confidence in the prediction is based on specialist knowledge of that particular field and the reliability of data used to make the prediction.

This notwithstanding, in order to facilitate informed decision-making, environmental assessments must endeavour to come to terms with the significance of the potential environmental impacts associated with particular development activities. Recognising this, SLR/Aurecon has attempted to address potential subjectivity in the current SEIA process as follows:

- Being explicit about the difficulty of being completely objective in the determination of significance, as outlined above;
- Developing an explicit methodology for assigning significance to impacts and outlining this methodology in detail. Having an explicit methodology not only forces the assessor to come to terms with the various facets contributing towards the determination of significance, thereby avoiding arbitrary assignment, but also provides the reader of the SEIA Report with a clear summary of how the assessor derived the assigned significance;
- Wherever possible, differentiating between the likely significance of potential environmental impacts as experienced by the various affected parties; and
- Utilising a team approach and internal review of the assessment to facilitate a more rigorous and defendable system.

Although these measures may not totally eliminate subjectivity, they provide an explicit context within which to review the assessment of impacts.

Environmental Assessment Policy in Namibia requires that, "as far as is practicable", cumulative environmental impacts should be taken into account in all environmental assessment processes. SEIAs have traditionally, however, failed to come to terms with such impacts, largely as a result of the following considerations:

- Cumulative effects may be local, regional or global in scale and dealing with such impacts requires coordinated institutional arrangements; and
- Environmental assessments are typically carried out on specific developments, whereas cumulative impacts result from broader biophysical, social and economic considerations, which typically cannot be addressed at the project level.

However, when assessing the significance of the project level impacts, cumulative effects must be considered as far as it is possible in striving for best practice. The sustainability of the project is closely linked to assessment of cumulative impacts. The Uranium Rush SEA (U-SEA, Anon. 2010b) provides a strategic context against which to measure elements of sustainability and cumulative impacts and impacts in this SEIA will be measured against the desired states identified in the SEA.

The mitigation hierarchy for all developments that cause negative environmental impacts involves four important principles (U-SEA, Anon. 201b):

- Wherever possible, avoid negative impacts;
- Where impacts are unavoidable, mitigate their severity;
- Where environmental damage is incurred, rehabilitate and restore; and
- Where possible, make a net positive impact through other beneficial actions, e.g. creating offset areas, supporting conservation activities.

4.4 CUMULATIVE IMPACT ASSESSMENT

According to the scoping report for this project, cumulative impacts are difficult to deal with on a project SEIA level, since they may occur outside of the geographical area of the particular project being assessed and thus require the collaboration of other institutions, and involve broader social, economic and biophysical considerations outside the scope of the specific project-level assessment. The fact that several other mining companies have been pursuing uranium interests in the Erongo Region emphasised the need for a holistic approach, by means of a strategic or sectorial level assessment. Such a Strategic Environmental Assessment (SEA) of the so-called "Central Namib Uranium Rush" (U-SEA, Anon. 2010b) was recently undertaken by the South African Institute for Environmental Assessment (SAIEA) in 2010, commissioned by the Ministry of Mines and Energy of the Government of Namibia.

The U-SEA (Anon. 2010b) provides a bird's eye view of cumulative environmental impacts in the Erongo region brought about as a result of the Uranium Rush (and other directly linked developments, and potential developments, such as desalination and chemical plants), and advises on how to avoid negative cumulative impacts and to enhance opportunities for positive impacts, within the uranium sector and between mining and other industries. Proceeding with information at hand, the U-SEA found that the cumulative impacts resulting from the Uranium Rush are not limited to the Erongo region, but are wide-ranging, affecting the southern African region as a whole, particularly the Namibian and South African economies.

According to the U-SEA (Anon. 2010b), the habitats in which plants and animals occur, the species that are most vulnerable due to endemicity or threatened status, the ecological processes that support life in the central Namib and the areas of high biodiversity value have been considered in terms of how these will be affected by the combined impacts expected from the Uranium Rush industries (see section 6.2 below). Impacts on biodiversity will also have a negative impact on tourism and recreation as well as a number of other significant secondary and tertiary impacts such as public health issues.

The cumulative impacts of the Uranium Rush on biodiversity may be categorised as follows (U-SEA, Anon. 2010b):

- Deterioration of water quantity and quality for biodiversity and ecosystem functioning;
- Habitat loss, degradation and fragmentation caused by mines and infrastructure; and
- Threats to specific (Endemic and Threatened) plants and animals.

5 ASSUMPTIONS AND LIMITATIONS

- The description of bird diversity is based primarily on the first Southern African Bird Atlas Project (SABAP1), when data were gathered during 1987-1992 (Harrison *et al.* 1997). Although reliable, these data are relatively dated. In order to address this limitation, the above information was supplemented by available data, although still limited, from the second bird atlas project (SABAP2), which was launched in Namibia in 2012;
- Only limited information is available on the potential negative effects of noise on breeding seabirds, especially on African - and colonial - species such as the Cape Cormorant (Near Threatened in Namibia, Globally Threatened [Endangered]) on the guano platforms in the study area. To address this, the growing literature on the effects of noise caused by wind turbines (which could have some similarities to noise caused by pumps used in the desalination process) was consulted, although this literature pertains mainly to the effects of noise on humans;
- A major limitation to the assessment of potential impacts from power line structures is the difficulty in obtaining confirmed records of bird flight paths. Available recent satellite tracking data for flamingos in Namibia were included to help address this limitation;
- Also limiting, is the lack of long term data on power line incidents in Namibia. Available data from the NamPower/NNF Strategic Partnership (EIS 2014) were consulted in this respect; and
- The impact significance ratings provided for the project alternatives assessed assume that the recommended or equivalent mitigation measures have been applied in an effort to manage these impacts responsibly.

For all of the above limitations, the precautionary principle should apply until such time as further data can be obtained.

6 LEGISLATIVE CONTEXT

6.1 APPLICABLE LAWS, POLICIES AND AGREEMENTS

Environmental conservation aspects in Namibia fall under the jurisdiction of the Ministry of Environment and Tourism (MET) of the Government of Namibia.

The Environmental Management Act (Act 7 of 2007) came into effect on 18 January 2012 (Anon. 2012 - Government Gazette of the Republic of Namibia No. 4878, Windhoek, 6 February 2012). This legislation requires the full consideration of biodiversity, habitat and landscape parameters, values and criteria as part of the environmental assessment processes. Under this Act and the Environmental Impact Assessment Regulations (2012), both the release of brine back into the ocean by desalination plants and the construction of facilities for the transmission and supply of electricity require an Environmental Clearance Certificate, amongst other lesser activities.

The Nature Conservation Ordinance of 1975 applies to the conservation of terrestrial birds in Namibia. According to this legislation, all species of birds are "Protected Game" except (a) huntable game birds (francolins and quails, button-quails, guineafowl, ducks, geese and Namaqua Sandgrouse); and (b) certain birds that are perceived as potential "problem birds" (weavers, sparrows, mousebirds, Red-billed Quelea, bulbuls and the Pied Crow).

It is envisaged that the (draft) Parks and Wildlife Bill will eventually replace the above Nature Conservation Ordinance. The list of Specially Protected Birds according to this Bill is based on the (draft) Namibian Red Data Book (Simmons & Brown in press), and the Red Data categories in the latter document are used in the present report.

The Swakopmund Salt Works ("Mile 4 Saltworks") is a proclaimed private nature reserve (Panther Bake) in terms of MET regulations. The area lies adjacent to, but not within the Dorob National Park. The salt works is also classed as an Important Bird Area (IBA; Simmons *et al*. 1998; see 7.3.1.3 below) and comprises one of a chain of five IBAS on the central part of the Namibian coast. IBAs are sites of international significance for the conservation of birds at the Global, Regional (Continental) or Sub-regional (southern African) level, selected according to stringent criteria (Barnes 1998). However, not all IBAs have official protection.

With regard to international agreements pertaining to the conservation of wetlands and their bird species, Namibia is a signatory to the international Convention on Biological Diversity (CBD; Rio de Janeiro, 1992), a legally binding instrument for the global conservation and sustainable use of biological diversity.

The study area lies 45 km north of a proclaimed Ramsar site, the Walvis Bay Wetlands, with regular movement of birds between these two localities. Ramsar sites receive special protection status in terms of the Convention on Wetlands of International Importance, 1971 (Ramsar).

The international African-Eurasian Waterbird Agreement (AEWA; 1995) 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. Although guided by its principles, Namibia is not yet a contracting party to this agreement. One way in which the agreement attempts to execute its mandate is by species action plans. In September 2014, AEWA held a workshop in Swakopmund to draft a multiple species action plan for coastal seabirds in the Benguela upwelling region (Anon. 2014a). The plan specifically concentrated on species identified as a conservation priority, these being African Penguin, Bank Cormorant, Crowned Cormorant, Cape Cormorant, Cape Gannet, Damara Tern, Caspian Tern, Swift Tern and African Black Oystercatcher.

The international Convention on Migratory Species (CMS 2011) provides an excellent overview of and guidelines on the management of threats to migratory birds, including conflict with electricity power grids in the African-Eurasian Region (CMS 2011).

6.2 RELEVANT STANDARDS TO COMPLY WITH

As mentioned above, the Uranium Rush SEA (U-SEA; Anon. 2010b) provides a strategic context against which to measure elements of sustainability, and cumulative impacts and impacts in this SEIA will be measured against the desired states identified in the SEA.

According to the U-SEA, plants and animals that are classified as conservation priorities in the Central Namib include the Endangered Damara Tern. The ecological integrity of the area relies on ecological processes being allowed to continue freely, and on plants and animals being allowed to fulfil their ecological roles.

Areas of relatively high biodiversity value (and that are sensitive to activities e.g. such as mining and prospecting) have been identified and mapped in the U-SEA (Figure 6). Areas that must be considered "Red Flag" areas (Biodiversity Category 1, where mineral licence applications should also preferably not be allowed) have been proposed on the basis of the following guiding principles:

- Areas with high levels of endemicity and diversity;
- Conservation status of species;
- The extent to which habitats are threatened or vulnerable to disturbance; and
- Habitats or migration routes which are critical for species' survival.

These "Biodiversity Red Flag Areas" (Anon. 2010b; Figure 6) include Area 57 (Mile 4 wetland - Important Bird Area at Saltworks) and Area 58 (Area north of Swakopmund, up to 5 km inland from coast - Important Damara Tern breeding and feeding area).

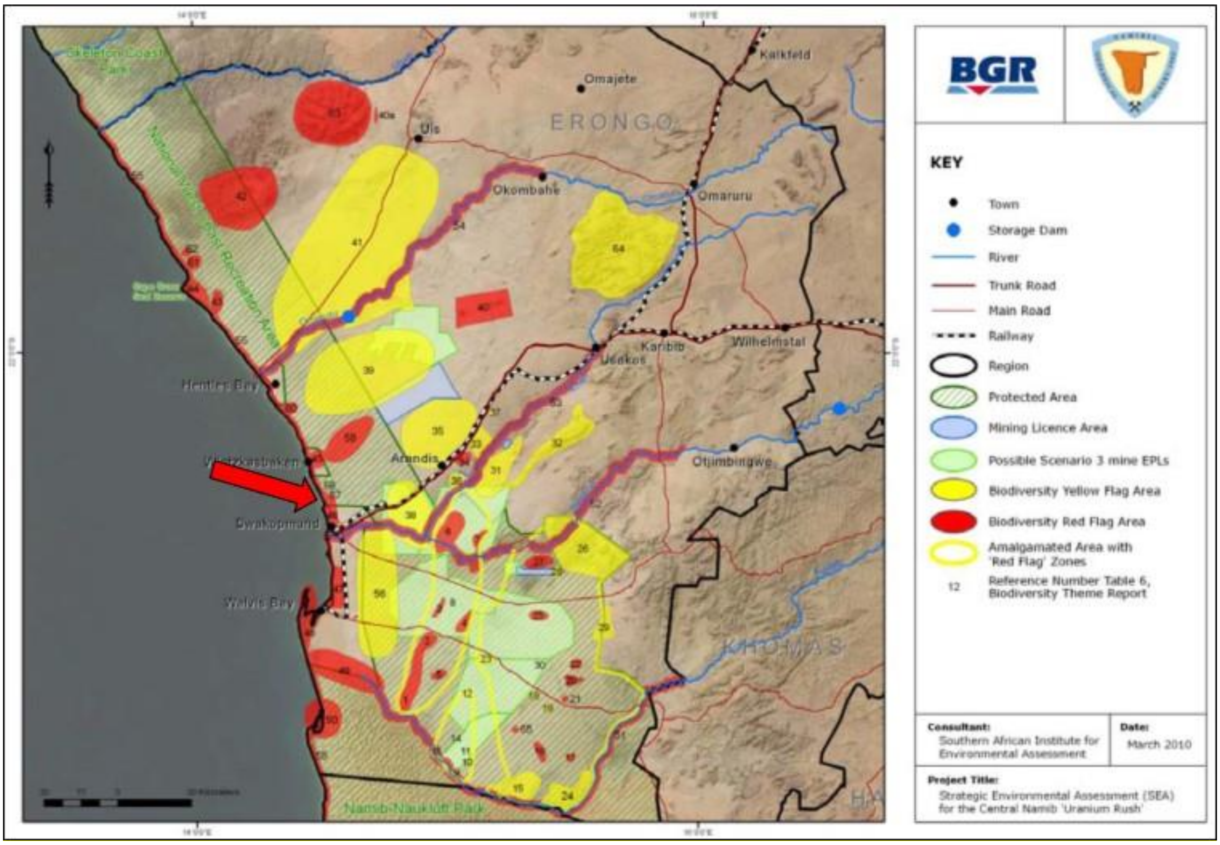

Figure 6: Protected land status of the study area [7]

[7] This map indicates areas of high biodiversity value in the central Namib in the context of the Uranium Rush. Within the greater study area, areas flagged "red" include Area 57 (Mile 4 wetland - Important Bird Area at Saltworks) and Area 58 (Area north of Swakopmund, up to 5 km inland from coast - Important Damara Tern breeding and feeding area) (Source: Anon. 2010b)

7 DESCRIPTION OF THE ENVIRONMENT AND UPDATE TO BASELINE REPORT

7.1 SECTOR CONTEXT

Namibia has a proud conservation record that is recognised internationally. The country's commitment to the conservation of biological diversity (biodiversity) is evidenced by the establishment and management of some 20 Protected Areas (PAs), proclaimed under the Nature Conservation Ordinance of 1975. Apart from these formally protected areas, this reputation also rests extensively on conservation outside parks and reserves on freehold and communal land (Anon. 2010a). In total, almost 20% of Namibia is protected, an area of some 130,000 km^2.

In 1995 Namibia acceded to the Ramsar Convention, an international treaty to protect waterbird habitat that covers all aspects of wetland conservation and wise use (Kolberg undated; see above). Four wetlands have been designated to the *List of Wetlands of International Importance*, namely Walvis Bay, Sandwich Harbour and the Orange River Mouth on the coast, and the Etosha Pan; other sites also qualify but have not been awarded this status as yet.

The Walvis Bay Ramsar Site lies about 45 km south of the study site. It is regarded as the most important coastal wetland in the southern Sub-region and is probably one of the most important coastal wetlands in Africa (Simmons *et al*. 1998). This area regularly supports over 100,000 birds (up to 150,000 birds) in summer; these comprise mostly non-breeding intra-African and Palearctic migrant species: between 80-90% of the Sub-region's flamingos over-winter here. The Swakopmund Salt Works is the only man-made wetland in Namibia qualifying for, but yet to be awarded, the above international Ramsar status (Kolberg undated). The central coastal wetlands (including Sandwich Harbour, Walvis Bay, Swakopmund Salt Works and Cape Cross) form an important inter-linked system of critical importance for large numbers of waterbirds.

Namibia also boasts 21 Important Bird Areas (IBAs), ten of which lie on the coast (Simmons *et al*. 1998). IBAs are places of international significance for the conservation of birds at the Global, Regional (Continental) or Sub-regional (southern African) level, selected according to stringent criteria (Barnes 1998; Simmons *et al*. 1998). One of the main criteria for which the Mile 4 Saltworks is accorded Global IBA status is the presence of three globally threatened species: the Damara Tern, Lesser Flamingo and African (Black) Oystercatcher (Simmons *et al*. 1998; also see below). Subsequent to the IBA publication, the globally threatened Cape Cormorant may now be added to this list. Further criteria for which the site qualifies as an IBA are the presence of 1% or more of the population of Cape Cormorants, Greater Flamingo and Kelp Gull; and 0.5% or more of the population of Chestnut-banded Plover (also see Table 9 below). The ecological sensitivities of these species are mentioned below.

7.1.1 Damara Tern

The Damara Tern is a breeding endemic seabird, globally Near Threatened and also Near Threatened in Namibia (IUCN; Simmons & Brown in press; Figure 7).

The Damara Tern was the subject of recent in-depth study (Braby 2011) that has provided updated information on ecology and numbers for a species that is little known and faces several conservation issues. These findings contribute to the first baseline demographic information for the Damara Tern, providing a more scientific basis for conservation management recommendations.

Figure 7: The Damara Tern[8]

The above study included a review of all accessible information of breeding populations in Angola, Namibia and South Africa and identified 70 breeding colonies globally for the species (Braby 2011). Most of the population (98%) breeds in Namibia, where overall breeding success (measured as the probability of fledging one chick per pair per season) is estimated at only 0.36.

In 2011 the total breeding population of Damara Terns was estimated at 1,001-2,685 breeding pairs or 5,370 breeding individuals (Braby 2011). This estimate is substantially lower than the 13,500 individuals initially estimated by Simmons *et al.* (1998; IUCN 2014), which is now considered a probable over-estimate (Braby 2011). A more recent (conservative) estimate places the entire breeding population at a minimum of only 900 pairs (R Braby pers. comm. July 2014).

Estimates for the species at Mile 4 Salt Works include 24 adults in 1977 (Underhill & Whitelaw 1977); and 10-20 pairs in 2008-2010 (Braby 2011) and 10-15 pairs in 2013-2014 (M Boorman pers. comm.). The terns arrived for the current breeding season (2014-2015) on 8-11 October 2014, and their numbers still await confirmation at the time of writing this report. However, long term monitoring data indicate the regular use of the area proposed for the desalination plant (Site alternative 1) by 10-20 breeding pairs. This amounts to 0.4-2.0% of the global population of 1,001-2,685 breeding pairs. At least some of the chicks are ringed on a regular basis, including eight in 2014 (M Boorman pers. comm.; Figure 8). There is regular disturbance in the breeding area by vehicles and people, including revellers at night (D Klein pers. comm. October 2014).

Figure 8: One of eight Damara Tern chicks ringed at Swakopmund Salt Works in January 2013

[8] The Damara Tern is an endemic breeding seabird and a flagship species for coastal conservation efforts in Namibia; however, it is highly threatened by coastal development and uncontrolled off-road driving (photo Ron Knight)

Damara Terns feed off the highly productive Benguela Upwelling System (Braby *et al*. 2012). They breed on the coastal desert mainland of Namibia where development and off-road driving are threatening breeding areas. The breeding season extends from October to March (see Table 8). Most nests are close to feeding sites, although breeding colonies may sometimes be found up to 11.5 km inland on gravel plains between the dunes. The highest densities of breeding pairs are found in the central coast between Sandwich Harbour and the Ugab River. The densest breeding colony known is at Caution Reef, south of Swakopmund. Nesting pairs and their single chicks are highly sensitive to human disturbance. Although it lies within the Dorob National Park, the Caution Reef site is currently under threat due to a proposed development. Further details of breeding ecology are provided in Table 8 below.

Table 8: Details of Damara Tern breeding ecology

Breeding season	October - March
Nesting habitat	Gravel plains between dunes, salt pans, sand and gravel plains, up to 11.5 km inland
Nesting colony	Defined as a distinctive area of breeding habitat of Damara Terns to which breeding pair(s) return each year to breed.
Nest type	Shallow scrape with shells, pebbles
Clutch size	Unlike other terns, normally only one egg
Incubation	Mean 23 days
Fledging	20-22 days
Fledging dependency	2-5 months. The earliest recorded age at which chicks fledge is 20 days and fledged chicks are still considerably smaller at this age than adults, averaging 6 g lighter (Clinning 1978; Braby 2011). Chicks are fed until at least two and a half months after fledging (Clinning 1978, Williams and Meyer 1986; Braby 2011).
Fecundity	Damara Terns have low fecundity as a result of a small clutch, and breeding success (measured as the probability of fledging one chick per pair per season) is low, estimated at only 0.36 (Braby 2011). In light of this low fecundity, special consideration should be given towards the protection and management of breeding areas in Namibia.
Causes of nest failure	Predation is the most common cause of nest failure in Namibia, and Black-backed Jackals are the most common predators of tern eggs and chicks at most colonies (Braby 2011).

Damara Terns migrate c. 8,000 km each year and breed in harsh desert environments with high rates of predation, but feed in highly productive waters where food is abundant (Braby *et al*. 2012). Low breeding success (probability of less than 0.4 of nests surviving predation per season per pair), high annual survival and fidelity to breeding sites may have evolved as a response to these conditions. Understanding the spatial dynamics of populations is essential for conservation of species at the landscape level. Species that have adapted to stable environments may not move from their breeding areas even if these have become sub-optimal due to anthropogenic disturbances. Instead, they may breed unsuccessfully or choose not to breed at all. If they do leave, e.g. due to increased predation or disturbance, they would move to another established breeding colony where they would be less successful due to their limited knowledge of and experience of the site and its predators.

Threats faced by Damara Terns throughout their breeding range include the following (Braby 2011):

- Coastal development causing colony extinctions; coastal development has been the major cause of declines in similar species;
- Off-road driving causing disturbance to breeding areas, resulting in low reproductive success;
- Predation is the most common cause of nest failure in Namibia, and Black-backed Jackals are the most common predators of tern eggs and chicks at most colonies (Braby 2011). Anthropogenic activities may result in increases in predator densities (e.g. offal from fishing that attracts larger numbers of black-backed jackals; artificial light may increase opportunities for predation). These jackals appear to follow human footprints in search of prey (R Braby pers. comm.; pers. obs.); and
- In Angola, Damara Terns are captured by humans for food; almost the entire global population passes through this area during annual migrations (Braby 2011).

In the light of the above findings, the most important management approach for the population viability for seabirds such as the Damara Tern, which display high rates of site fidelity, may be long-term maintenance and protection of current colony sites.

Conservation actions (Braby 2011, IUCN 2014) should thus focus on the protection of important breeding colony sites in Namibia, and also at the extremities of the range in South Africa and Angola; disturbance-free areas on nesting beaches should be designated, and population trends monitored. Although at least 95% of the breeding population can be found in protected areas, their conservation remains difficult. This is mainly because human activities that create disturbances are still allowed in these areas. Colonies that make up more than 1% of the breeding population should be protected from human disturbance (Braby 2011). Based on the above population estimates of 1,001-2,685 breeding pairs (Braby 2011), 10-20 pairs at Mile 4 would comprise 0.4-2.0% of this population.

7.1.2 Lesser Flamingo

The Lesser Flamingo is also classed as Globally Near Threatened (IUCN 2014), and Vulnerable in Namibia (Simmons & Brown in press). In 1997, the Mile 4 Salt Works area witnessed the first recorded event of Lesser Flamingo and Greater Flamingo breeding in coastal areas. Eggs were laid in just over 100 nests (including 36 Lesser Flamingo), but presumed disturbance by blackbacked jackals led to early failure.

The population is estimated at 15,000-25,000 individuals in West Africa; 1,500,000-2,500,000 in East Africa; 55,000-65,000 in South Africa and Madagascar; and 650,000 in South Asia (IUCN 2014). The population estimate for Namibia is 40,000-64,500 adults (resident; Simmons & Brown in press). This local population fluctuates, with recent increases in the 1990s.

The habitat is coastal lagoons, flooded salt pans and salt works. The Lesser Flamingo feeds by filtering cyano-bacteria from the surface, and small diatoms from the bottom layers. This species is more restricted in distribution in southern Africa than the Greater Flamingo, and it breeds in mass concentrations at only two flooded salt pans, namely Etosha (Namibia) and Sua Pan (Botswana; Berry 1972, McCulloch & Irvine 2004). In East Africa it also breeds regularly at Lake Natron in Tanzania (Brown *et al.* 1982).

Threats include low breeding frequency and success, and water abstraction from the breeding sites. Collisions are frequently reported with cattle fences that cross Sua Pan in Botswana, and with overhead power lines in both Botswana and Zimbabwe (G McCulloch pers. obs., PJ Mundy pers. obs.).

In Namibia, direct threats include low level organochlorine pesticide residues used extensively in the catchment area of the Ekuma River against malaria mosquitoes (Simmons & Brown in press). A growing number of records of collisions with power lines (hitherto underestimated) is also cause for concern (see below). Flamingos are prone to such impacts due to their flying habits in groups and at night, when overhead lines present an unexpected obstacle in their flight paths. The risk is exacerbated in the areas where they come in to land and take off.

7.1.3 African (Black) Oystercatcher

The African (Black) Oystercatcher is classed as Globally Near Threatened (IUCN 2014), and also Near Threatened in Namibia (Simmons & Brown in press).

The species has a coastal breeding range that stretches from Mazeppa Bay in South Africa to Lüderitz in Namibia (IUCN 2014). In the early 1980s the global breeding population was estimated at less than 2,000 pairs and 4,800 individuals (Hockey 1983), making it the third rarest, as well as one of the most range restricted oystercatcher species in the world (Stattersfield & Capper 2000). The total population is now estimated at 5,000-6,000 individuals, with about half occurring along the Western Cape (South Africa) coastline, and half of these on its near-shore islands (IUCN 2014).

In Namibia, recent research has increased the Namibian population estimates (originally 1,200 birds: Hockey 1983) to 1,840 birds, or 38% of the world population (Simmons *et al.* MS; Simmons & Brown in press). This is considered to represent a real increase (rather than enhanced census), given the increased chick production in South Africa (Hockey 2001), 40% of which are estimated to make their way to Namibian nurseries (Leseberg 2001, Hockey *et al.* 2003), as well as increases in bird densities in South Africa (Underhill 2000) and the increased food resource in the form of the alien invasive Mediterranean mussel *Mytilus galloprovincialis* throughout the region (Simmons & Brown in press).

The four largest nurseries for the oystercatchers (three situated north of Lüderitz around Hottentot's Point, Caravan Beach and Douglas Point, and the fourth at Walvis Bay) support 300-350 juvenile birds (Simmons & Roux 2001, Simmons *et al.* MS, Leseberg 2001, Wheeler 2001). Estimates at Mile 4 Salt Works, a roosting area, include a mean of 18 ± 11 and a maximum of 34 for seven counts (Braby *et al*., Namibian Avifaunal Database); in July 2014, 43 individuals were counted at this site (M Boorman pers. comm.).

The single largest cause of breeding failure in this species is human disturbance (Leseberg *et al*. 2000; Scott *et al*. 2011; Simmons & Brown in press). Off-road vehicles enable more people to reach otherwise remote stretches of coast, exacerbating disturbance effects and reducing productivity. Non-breeding birds, such as those at Mile 4 Salt Works, are relatively less sensitive to such disturbance. It is presumed that the high frequency of jackals on Namibia's coast (M Griffin pers. comm.) keeps the number of breeding birds on all but the islands at very low levels (Simmons *et al.* MS). Disturbance of Namibian nurseries is minimal at present, but predation by gull populations on the islands (Underhill 2000) can be detrimental to the few pairs that do breed. Some evidence of a reduction in roost size is apparent from Elizabeth Bay, where sediment deposition in the bay may have smothered foraging grounds and has increased beach accretion by 500 m since 1990 (Simmons 2005).

Oystercatchers feed in the intertidal zone, in both rocky and sandy habitats. They are confined to a limited feeding time, at low tide, when their prey (mussels, limpets and other marine invertebrates) is accessible; this restricted feeding time could be further decreased by human disturbance in the area. The impacts of the proposed development on these non-breeding African Oystercatchers are anticipated to be minimal, however.

Numbers of oystercatchers were monitored opportunistically during the field work for the present study, the highest count to date being 10 individuals. However, counts are normally done during periods when the oystercatchers are foraging on the coast.

7.1.4 Cape Cormorant

The Cape Cormorant is Globally Near Threatened (IUCN 2014), and also Near Threatened in Namibia (Simmons & Brown in press). It is near-endemic to southern Africa, and common to locally abundant. The information below is derived from Crawford (2005). More than 1% of the global population (average 45,000, maximum 700,000) is found at the Mile 4 Salt Works IBA, where it breeds on extensive guano platforms.

In the early 1970s, prior to the collapse of the Namibian sardine *Sardinops sagax* stocks, the global population numbered more than one million birds. By 1973 this had declined to an estimated 107,000 pairs, and in 1996 to 72,000 pairs or 220,000 to 330,000 birds. The largest Namibian colonies are on Ichaboe Island (45,805 birds), followed by the Swakopmund platforms (Mile 4 Salt Works; 43,542), compared to the largest in South Africa, Dyer Island (35,580) and Jutten Island (24,277).

The proportion of adults breeding each year depends on food availability. Age at first breeding is 2-3 years; annual juvenile survival is estimated at 44%, and longevity is at least 15 years. Occasional die-offs (involving thousands of birds) due to a number of causes can be exacerbated by hunger stress, often with the greatest effects on chicks and juveniles.

The species is mainly sedentary, with much post-breeding dispersal. It is restricted to inshore marine habitats, including estuaries and coastal lagoons, mainly in the cool waters of the Benguela upwelling system.

Cape Cormorants are gregarious, roosting in large flocks often of hundreds and thousands. Recently-fed chicks and adults regurgitate when disturbed; one bird panicking often starts a chain reaction, with roosting birds panicking first, sometimes knocking breeders from nest sites. At night, if disturbed, the birds may circle over the colony.

The species is monogamous and a colonial nester, with territory defence extending to the nest perimeter. Laying dates are from October to February in Namibia, with 1-4 eggs being laid. Incubation takes 20-23 days and the chick leaves the nest after five weeks, fledging after 7-9 weeks but remaining partially dependent on the adults for several more weeks. During food-rich years, 87% of the eggs hatch and 91% of the chicks fledge; during times of food scarcity up to 95% of breeders may desert their nests. Post-fledging mortality is high in some years.

The Red Data status for this cormorant is based on the recorded decline from 277,000 pairs in 1977-1981 to 72,000 pairs in 1996 (see above). This trend may be part of a natural cycle, as the breeding population is linked to the cycle of anchovy *Engraulis encrasicolus*, which experiences large natural fluctuations. Human disturbance leads to nest desertion, and loss of eggs and chicks to avian predators. The construction of guano platforms in Namibia in 1930-1971 provided alternative breeding space after islands in Cape Cross Lagoon and Sandwich Harbour were linked to the mainland. The species is occasionally affected by oil spills; rehabilitation success is low.

Breeding Cape Cormorants have the potential to be impacted by noise disturbance from the operation of the plant in the proposed development. Any reduction in breeding success or abandonment of nests would also have economic implications.

7.1.5 Greater Flamingo

The Greater Flamingo is classed as Vulnerable in Namibia (Simmons & Brown in press). More than 1% of the global population (average 1,305, maximum 2,688) is found at the Mile 4 Salt Works IBA. In 1997, the area witnessed the first recorded event of Lesser Flamingo and Greater Flamingo breeding in coastal areas. Eggs were laid in just over 100 nests (including 64 Greater Flamingo), but presumed disturbance by Blackbacked Jackals led to early failure.

The species has a very large range and population size. The Palearctic population (including West Africa, Iran and Kazakhstan) is estimated to number between 205,000 and 320,000, the South West and South Asian populations combined at 240,000, and the sub-Saharan African populations between 100,000 and 120,000 (Delany & Scott 2006; http://www.birdlife.org/datazone/species/factsheet/ 22697360). The population estimate for Namibia is 41,000-51,000 adults (resident; Simmons & Brown in press); this local population fluctuates due to the nomadic habits of the species.

The Greater Flamingo prefers less saline habitat than Lesser Flamingo, including recently flooded salt pans (s. Africa), as well as alkaline lakes, coastal bays and river mouths, sewage works and inland dams. It feeds mainly on marine benthic organisms such a molluscs, and diatoms, and saline lake crustaceans such as fairy shrimps (e.g. *Branchinella* spp.) and brine flies (*Ephydra* spp.; Berry

1972, G McCulloch unpubl. data). Breeding occurs in large, typically mixed colonies on raised islands on flooded salt pans at Etosha, with a maximum of 27 000 pairs recorded in 1971 (Berry 1972).

Direct threats in Namibia include low level organochlorine pesticides used extensively in the catchment area of the Ekuma River against malaria mosquitoes. Naturally low breeding frequency and success in Etosha may be exacerbated by possible reduction of water into Etosha Pan due to mining activities, as well as reduced rainfall for large parts of southern Africa. At one of few breeding sites in southern Africa, soda ash mining around the main breeding site in Sua Pan, Botswana, may reduce water levels on the pan. Night-time collisions with game fences and overhead powerlines in Botswana and Zimbabwe frequently occur (G McCulloch pers. obs., PJ Mundy pers. obs.). Mass die-offs take place including on the Namibian coast, associated in part with hydrogen-sulphide eruptions. Low-flying aircraft cause disturbance to feeding birds. A growing number of records of collisions with power lines in Namibia (hitherto underestimated) is also cause for concern (see above). Flamingos are prone to such impacts due to their nocturnal flying habits, when overhead lines present an unexpected obstacle in flight paths. The risk is exacerbated in the areas where they come in to land and take off.

7.1.6 Kelp Gull

More than 1% of the overall population of Kelp Gulls is found at Mile 4 Salt Works, comprising 372 (average) and 706 (maximum) individuals, and 120 breeding pairs (Simmons *et al*. 1998).

The Kelp Gull is not included on the Red Data list and is not regarded as being under threat from the present development.

7.1.7 Chestnut-banded Plover

This small wetland bird species feeds and breeds on highly saline pans, coastal flats and in artificial evaporation pans, including mainly the area south of the main salt works at Mile 4. The potential sensitivity of this species is related to the fact that it is highly specialised and adapted to these saline habitats.

Its core non-breeding quarters include the central Namibian coastal, namely the Ramsar sites of Walvis Bay and Sandwich Harbour (Simmons & Brown in press). Here up to 96% of the known population of 11,486 birds of the southern race (Simmons *et al.* 1998) often congregates. At the Mile 4 IBA 50-200 birds have been counted, including 20 breeding pairs (Simmons *et al*. 1998) and, more recently, 100 breeding pairs (M Boorman pers. comm.). Numbers of Chestnut-banded Plovers were monitored opportunistically during the field work for the present study in September-October 2014, the highest count to date being 123 individuals, all in the area south of the proposed development.

Breeding occurs mainly at the coast, Etosha and Lüderitz ((Simmons *et al*. 1998). Nests are typically scrapes in dry sand or on hard salt crust on the edge of salt pans or coastal flats well beyond the reach of water. Coastal salt works with their more dependable water levels are frequently used sites (M Boorman unpubl. data).

The dependence of over 90% of this species' population on just two coastal sites puts the Chestnut-banded Plover at risk. The southern African race (*pallidus*) is designated as Near-Threatened in Namibia because the population fluctuates around 10 000 individuals, and the majority are, at critical times of year, concentrated in only two locations on the Namibian coast.

This species uses mainly the saltpan area south of the Swakopmund Salt Works and is therefore not considered at risk by the proposed development.

7.2 NATIONAL CONTEXT

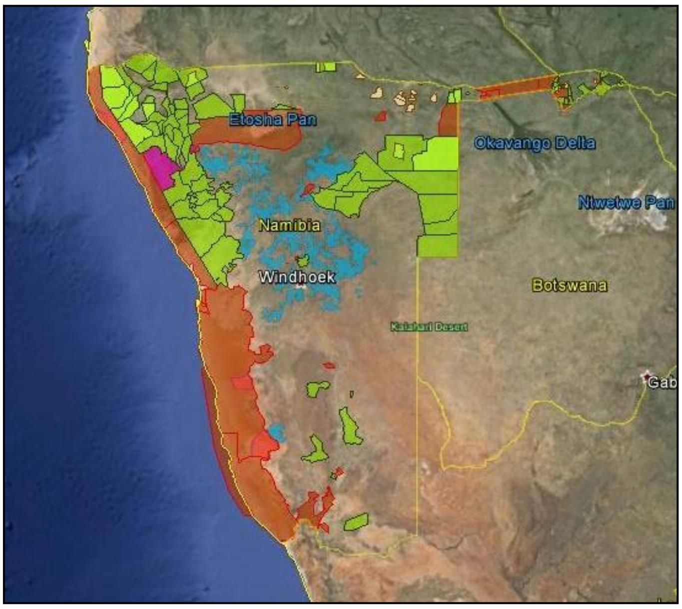

Figure 9: Protected/conservation areas in Namibia[9]

Protected/conservation areas in Namibia include those areas formally protected by the State (Parks and Reserves), communal conservancies, freehold conservancies, community forests, concessions and Marine Protected Areas (Figure 9).

With the declaration of the Dorob National Park (NP) in 2010, the coastline from the Kunene River on the Angolan border to the Orange River on the South African border became a solid continuum of parks (Figure 9). Namibia has become the first and only country to have its entire coastline protected through a national parks network.

[9] Notes: State/formally protected areas (orange), communal conservancies (green), freehold conservancies (blue), community forests (beige), concessions (pink) and Marine Protected Areas (red; EIS 2014)

7.3 REGIONAL CONTEXT

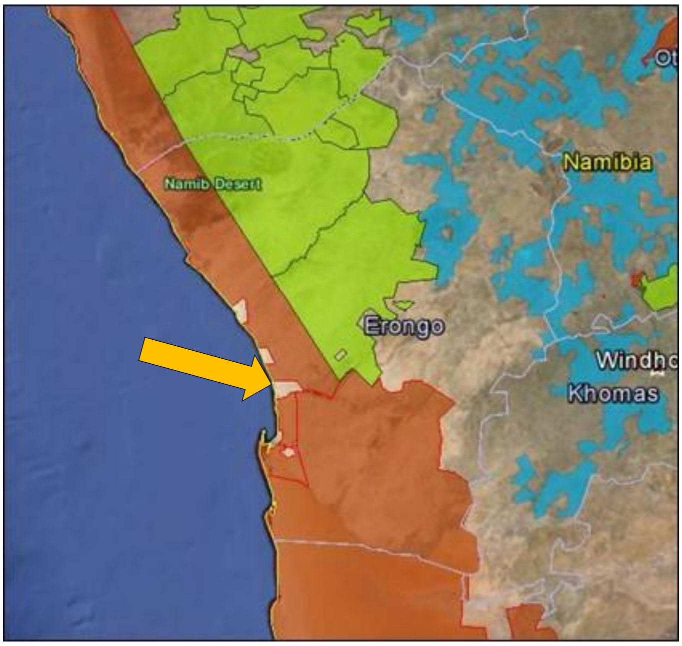

Figure 10: Protected areas within the Erongo Region[12]

7.3.1 Physical characteristics of the broad study area

The study area is situated in the Erongo region just north of Swakopmund, on Namibia's central west coast (Figure 10).

The central coast line is an area of hyper arid desert. The area has a very low rainfall, with an average (and median) of less than 50 mm per year (Mendelsohn *et al*. 2002). The average rainfall measured at Walvis Bay from 1960-2000 is 10 mm pa (Robertson *et al*. 2012). The average annual temperature lies in the zone of 16-18°C, with average maxima of 20-26°C during the hottest month and average minima of 10-12°C during the coldest month (Mendelsohn *et al*. 2002).

Fog occurs more frequently along the Central Namib Desert coast than elsewhere, probably due to the upwelling off that part of the coast; an average of 146 days of fog per year has been recorded at Walvis Bay (Mendelsohn *et al*. 2002). The fog belt varies but stretches as far inland as Arandis (50 km from the coast).

The geology is classified as the Swakop Group, falling within the Damara Supergroup and Gariep Complex, with Damara Granites and Kalahari and Namib Sands; the dominant soils are Petric Gypsisols and Petric Calcysols (Mendelsohn *et al.* 2002). The dominant landscape is mainly Central-western Plains. Broad geomorphological characteristics include a shore of mixed sand and rock, gravelly coastal flats in the study area, with the Arandis Mountain (just over 600 m high) further to the east and a narrow dune belt further to the south. (Natural) surface water is limited to drainage lines and coastal pans. To the south lies the Swakop River Valley, deeply incised by an ephemeral river. Man-made aquatic habitats in the vicinity of the study area include the Swakopmund Salt Works and Municipal sewage works.

The study area lies within the Central Namib Desert Biome. The dominant vegetation structure is sparse shrubs and grasses (Mendelsohn *et al*. 2002); the vegetation cover, however, is extremely limited.

[12] Notes: national parks (orange), communal conservancies (green) and freehold conservancies (blue; EIS 2014)

7.3.2 The Dorob National Park

Dorob National Park (NP), meaning "dry land", is a 1,600 km long strip of land, encompassing a spectacular coastal dune belt, vast gravel plains, rich botanical diversity (including extensive lichen fields), major ephemeral river systems and their river mouths and Namibia's richest coastal area for birds (Anon. 2010a). Mile 4 Saltworks lies within the Swakopmund local authority area adjacent to the Dorob NP.

Some 75 species of birds flock to this coast, with nearly 1.6 million birds recorded here at times[13]. Apart from several Ramsar listed wetlands, the Dorob NP has been included under the category of Important Bird Areas (IBAs) by BirdLife International (see below).

The Damara Tern, a breeding seabird that is endemic to Namibia (see above), is considered a flagship species of the coastal area. It is found in the park, although non-breeding individuals will migrate to the north in winter.

7.3.3 Important Bird Areas in the Erongo Region

Important Bird Areas (IBAs) are places of international significance for the conservation of birds at the Global, Regional (Continental) or Sub-regional (southern African) level, selected according to stringent criteria (Barnes 1998; Simmons *et al*. 1998; also see above).

Seven IBAs lie within the Erongo Region, namely the Brandberg Mountain (N009), Cape Cross Lagoon (N010), Mile 4 Saltworks (N012), 30 km Beach: Walvis-Swakopmund (N013), Walvis Bay (N014), Sandwich Harbour (N015) and the Namib-Naukluft Park (N011; Figure 11).

Figure 11: Seven Important Bird Areas (IBAs) lie within the Erongo Region[14]

[13] Source: http://travelnewsnamibia.com/news/2012-2013-rules-regulations-dorob-national-park/#.UYdhYb2- 6ZLM
[14] Notes: Seven Important Bird Areas (IBAs) lie within the Erongo Region namely the Brandberg Mountain (N009), Cape Cross Lagoon (N010), Mile 4 Saltworks (N012), 30 km Beach: Walvis-Swakopmund (N013), Walvis Bay (N014), Sandwich Harbour (N)15) and Namib-Naukluft Park (EIS 2014)

7.4 LOCAL AND SITE CONTEXT

7.4.1 Local habitats

The Swakopmund Salt Works is the only man-made wetland in Namibia qualifying for Ramsar status, although as yet undeclared (Kolberg undated; see above). The site consists of several shallow evaporation ponds, used for commercial salt production and oyster and clam farming. The owners of the salt works have built an extensive guano platform in one of the ponds and this is used by thousands of seabirds.

Mile 4 Saltworks is also an Important Bird Area (IBA N012) of 3,400 ha in total, and described as fully protected (Simmons *et al*. 1998; see above). This coastal IBA comprises a private nature reserve (the aquatic portion of 400 ha, known as "Panther Bake") and a salt works. It is accorded Global IBA status on account of the following criteria (see Table 9):

- A1: Globally threatened species;
- A4 i: Site known to hold or thought to hold, on a regular basis, ≥1% of a biogeographic population of a congregatory waterbird species; and
- A4 iii: Site known or thought to hold, on a regular basis, ≥20,000 waterbirds or ≥10,000 pairs of seabirds of one or more species.

Table 9: Criteria for the Mile 4 Saltworks Important Bird Area[17]

Criterion	Breeding (pairs) Confirmed: 1998	Total numbers
Globally near-threatened species		
Lesser Flamingo	40 (once: 1997)	883 (av) – 1,996 (max)
African (Black) Oystercatcher	-	21 (av) – 34-42 (max)
Damara Tern	9-12 / 10-20 / 10-15	12 (av) – 88 (max)
1% or more of population		
Cape Cormorant	Breeding	45,400 (av) – 700,000 (max)
Greater Flamingo	64 (once: 1997)	1,306 (av) – 2,688 (max)
Kelp Gull	120	372 (av) – 706 (max)
0.5% or more of a population		
Chestnut-banded Plover	20 / 100	50-200 (max)
KEY: *Av – average (1998); max – absolute maximum (1998)* *Red: recent updates*		

The IBA lies adjacent to the sea on the central Namib coast and has been extensively altered to create numerous evaporation ponds (Simmons *et al*. 1998). Immediately inland lie the gravel plains of the Namib Desert. The salt works is situated about 7 km (4 miles) north of Swakopmund. Production of the concentrated brine at the salt pan, known as "Panther Bake" (Beacon) began in 1933, but by 1952 the salt source was exhausted. Seawater has since been pumped into the open evaporation and concentration ponds, from which crystallised salt is removed by means of mechanical scrapers. The pans are shallow and of varying salinity. A large wooden commercial guano platform covering 31,000 m^2 has been built in one of the northern pans. Apart from a few halophytes, the salt works are devoid of vegetation.

Mile 4 occasionally supports massive numbers of waterbirds and the guano platform has supported up to 700,000 Cape Cormorants in the past, with an average of 45,000 in the years up to 1998 (Simmons *et al*. 1998). Apart from the cormorants the area may hold more than 50,000 other waterbirds, including relatively large numbers of Greater Flamingo, Lesser Flamingo and African (Black) Oystercatcher, and up to 100,000 Common Tern.

[17] Source: IBA; Simmons et al. 1998

Breeding species at the salt works include Damara Tern, Chestnut-banded Plover, Kelp Gull, Hartlaub's Gull and Caspian Tern (Simmons *et al*. 1998), and Black-winged Stilt, South African Shelduck, White-fronted Plover and Swift Tern (M Boorman pers. comm.).

White Pelicans have attempted to breed on the platforms (M Boorman pers. comm.), but due to their disruption of cormorant breeding and their poor quality guano, they are dissuaded by the owners (Simmons *et al*. 1998). In 1997, the area witnessed the first recorded attempt of Greater Flamingo and Lesser Flamingo breeding in coastal areas (Simmons *et al*. 1998). Just over 100 nests were built in the salt pan and eggs were laid, but presumed disturbance by black-backed jackal led to early failure. Recent breeding attempts (1998) on small islands in the salt pans by Bank Cormorants and the occurrence and possible breeding of the near-endemic Gray's Lark immediately inland add to the reserve's importance.

The Richwater Oyster Company has been cultivating oysters on the pan since 1985 (Simmons *et al*. 1998). Oyster production and guano scraping appear to be compatible with maintaining good populations of wetland birds, judging by the large numbers present, and the breeding of terns, cormorants and plovers in and around the salt works. The value of these commercial salt pans as habitat for waders and other birds is obvious from biannual wetland counts (up to 93,000 birds of 35 species at any one time, up to 1998).

Recent bird counts at the salt works are reflected in Table 10. Note that these counts exclude the thousands of Cape Cormorants on the guano platforms; the dominant groups in the counts are waders/shorebirds and flamingos. Note also that the cormorants are not present when the guano platforms are being scraped for harvesting (once a year; D Klein pers. comm.).

Table 10: Recent counts of birds (excluding cormorants) at the Swakopmund Salt Works[18]

Date	Total no. of birds	Total no. of species
January 2010	3,056	27
July 2012	5,247	24
July 2013	3,434	21
July 2014	5,845	21

The Mile 4 Salt Works IBA is a breeding area for one of Namibia's most endangered bird species, the rare and near-endemic Damara Tern that has become a flagship species for coastal conservation (Simmons *et al*. 1998, b; Robertson *et al*. 2012; see above). Its global population has been estimated at a minimum of 900-1001 pairs / 1,800 adult birds (Braby 2011; R Braby pers. comm.), of which 98% breed in Namibia between late October and mid-November. The terns disperse north after breeding and are recorded regularly from West African coastal waters.

[18] Source: African Waterbird Census: M Boorman in litt.

KEY:
1 = Chestnut-banded Plover (breeding early 2000s)
2 = Core Damara Tern breeding area
3 = Secondary Damara Tern breeding area; Red-capped Lark and (seldom) Gray's Lark;
4 = Oyster pond: Flamingos: feeding and roosting; Damara Tern feeding
5 = Flamingos, Damara Tern feeding; oystercatcher roost
6 = Flamingo breeding site (once, 1997)
7 = Guano platforms: Cape Cormorant breeding
8 = (Lesser) Flamingo, oystercatcher roost
9 = Cormorant roost on present intake pipe, oystercatcher (and flamingo) feeding area
10 = Tern roosts (varying localities)
11 = Shoreline birds
Red arrows: Cormorant flight paths

Figure 12: Some micro-habitats for birds in the study area[19]

Micro-habitats at Mile 4 Saltworks that appear to be important/attractive to birds are shown in Figures 12 and 13. These include:

- Established core Damara Tern breeding area (potentially a highly sensitive site) and secondary/ breeding areas in surrounds to the north and east; feeding areas over pans that contain small fish, especially the Oyster Pond;
- Chestnut-banded Plover roosting/feeding area (breeding early 2000s);
- Flamingos roosts and feeding areas, including a once-off breeding site (1997);
- Guano platforms: large numbers of Cape Cormorants roosting and breeding; main flight paths are between the platforms and the coast to the north/west. Breeding attempts by White-backed Pelican are dissuaded by the owners;
- African (Black) Oystercatcher roosts and feeding areas;
- Tern roosts and feeding areas (varying sites and species and numbers);
- Cormorant roost on present inlet pipe;
- Red-capped Lark and (seldom) Gray's Lark on gravel plains; and
- Other shoreline birds on the coast (roosting, feeding, breeding).

[19] Notes: based on a Google Earth map, also showing the main observed cormorant flight path

Chestnut-banded Plover (large breeding effort early 2000s)

Regular Damara Tern breeding area

Secondary Damara Tern breeding area; Red-capped Lark and (seldom) Gray's Lark on gravel plains

Flamingos: feeding and roosting; Damara Tern feeding

(Lesser) Flamingo: feeding and roosting; African (Black) Oystercatcher and tern roost; guano platforms in the left background

Cormorant roost on present inlet pipe

Figure 13: Some microhabitats for birds in the Swakopmund Salt Works area

7.4.2 Bird diversity

During the first bird atlassing period (SABAP1), 223 bird species were recorded for QDS 2214Da, broadly representing the study area (Appendix 1). Although still limited, the supplementary, more recent data from SABAP2 since 2012 (for the more precise study locality, referenced by pentads 2235_1430 and 2235_1430), show a corresponding diversity and add 10 species to the SABAP1 data (total 105 species). This brings the total for the study area to 233 species, representing 35% of the 676 Namibian species, and comprising an interesting assemblage that may be regarded as unexpectedly diverse for a hyper-arid desert habitat.

These bird species are more or less evenly distributed between aquatic and terrestrial habitats. It should be kept in mind that birds are highly mobile, especially in a desert habitat, and tend to move opportunistically according to the food source. Years with high rainfall and subsequent availability of food tend to draw large numbers of birds. In addition, strong winds and/or unseasonal weather may displace birds from their usual distribution.

7.4.3 Potential sensitivity of bird species

The potential sensitivity of the bird species for the study area QDS (2214Da) is assessed according to the following criteria: Red Data status, endemism/habitat specialisation and nomadic/migrant habits, together with other physiological, behavioural and/or ecological sensitivities, all of which act synergistically to increase the likelihood of impacts becoming cumulative. (Species recently confirmed in the SABAP2 pentad records for the specific study area are underlined below.)

7.4.3.1 *Red Data bird species*

The 233 bird species recorded for the broad study area (QDS 2214Da) include 26 (11%) that are classed as Threatened in Namibia; eight of these (3%) are also Globally Threatened (Appendix 1). Red data status is an indication of the potentially increased vulnerability of a species to negative impacts.

The following species are included in each Red Data category:

- Endangered (7)
  ~ Great Crested Grebe, Cape Gannet, African Penguin, Black-browed Albatross, Atlantic Yellow-nosed Albatross, Martial Eagle, Black Stork

- Near Threatened (11)
  ~ Damara Tern, African (Black) Oystercatcher, Chestnut-banded Plover, Black-necked Grebe, Maccoa Duck, Cape Cormorant, Crowned Cormorant, Bank Cormorant, Peregrine Falcon, Verreauxs' Eagle, Rüppell's Parrot

- Vulnerable (8)
  ~ Lesser Flamingo, Greater Flamingo, Great White Pelican, Caspian Tern, Hartlaub's Gull, White-chinned Petrel, Lappet-faced Vulture, African Fish-eagle

- Species above that are also Globally Threatened (9)
  ~ Damara Tern, Lesser Flamingo, African (Black) Oystercatcher, Cape Cormorant, Crowned Cormorant, Bank Cormorant, Cape Gannet, African Penguin, Lappet-faced Vulture

7.4.3.2 *Endemic bird species*

The broad study area is home to 42 endemic/near-endemic species (18% of the total; Appendix 1). These species have a restricted distribution range; such habitat specialisation increases the vulnerability of a species to impacts such as habitat destruction and disturbance.

Seven of the above species are endemic/near-endemic to Namibia. The Damara Tern is a breeding endemic with a very restricted habitat. The Dune Lark is endemic to the Namib Desert. Near-endemics are Gray's Lark, Rüppell's Korhaan, Rüppell's Parrot, Rosy-faced Lovebird and Bradfield's Swift.

Thirty-five species are endemic/near-endemic to southern Africa. These include Red-billed Spurfowl, South African Shelduck, Cape Shoveler, Monteiro's Hornbill, Southern Yellow-billed Hornbill, Namaqua Sandgrouse, Hartlaub's Gull, Cape Cormorant, Crowned Cormorant, Bank Cormorant, Southern Pale Chanting Goshawk and a diversity of other smaller species.

7.4.3.3 *Resident, migrant and nomadic bird species*

Of the total, 150 species (64%) are resident, 80 (34%) are nomadic at times and 72 (31%) are migrant at times (Appendix 1).

Migrant species undertake large-scale, regular seasonal movements, usually to the northern hemisphere and back. In contrast, nomadic species generally remain within the southern African sub region, moving around widely and in no fixed pattern to exploit patchy and unpredictable food, water and other environmental resources, mainly in opportunistic response to climatic conditions (Brown *et al.* 2011). Numbers of species and abundance may thus vary markedly over time. Both migrant and nomadic movements increase the vulnerability of species to impacts such as collisions with overhead structures.

Among the migrant aquatic birds are Damara Tern, Southern Pochard, Lesser Moorhen, Black-tailed and Bar-tailed Godwit, Common Whimbrel, Eurasian Curlew, Common Redshank, Marsh Sandpiper, Wood Sandpiper, Terek Sandpiper, Common Sandpiper, Common Greenshank, Ruddy Turnstone, Red Knot, Sanderling, Little Stint, Curlew Sandpiper, Ruff, two phalaropes, Greater Painted-snipe, African Jacana, Black-winged Stilt, Pied Avocet, nine plovers (including Grey Plover, Common Ringed Plover, Kittlitz's plover, Chestnut-banded Plover), two lapwings, Subantarctic Skua, nine terns (including Swift, Sandwich, Common), two jaegers, four cormorants (including Cape, Bank, Crowned), Little Egret, two flamingos and White Stork.

Species that are nomadic (at times) in the study area include aquatic species such as White-faced Duck, White-backed Duck, Maccoa Duck, Egyptian Goose, South African Shelduck, Cape Teal, Cape Shoveler, Red-billed Teal, Hottentot Teal, Rüppell's Parrot, Rosy-faced Lovebird, Common Moorhen, Red-knobbed Coot, Namaqua sandgrouse, African (Black) Oystercatcher, Black-winged Stilt, Pied Avocet, three plovers, African Wattled Lapwing, Grey-headed Gull, Hartlaub's Gull, Caspian Tern, Little Grebe, Black-necked Grebe, Cape Gannet, Reed Cormorant, White-breasted Cormorant, Cape Cormorant, Bank Cormorant, three egrets, two flamingos, African Spoonbill, Great White Pelican, Black Stork, two storm-petrels, three albatrosses, two petrels, Sooty Shearwater, Pied Crow and a number of other smaller species.

Recent satellite tracking data for three Greater Flamingos and one Lesser Flamingo (NamPower/NNF Strategic Partnership 2014) in Namibia illustrate the degree of nomadism in these aquatic species; large-scale migratory movements inland have not yet been recorded, most likely due to the present relatively unsuitable breeding conditions there in summer (Figure 14 and 15).

Flamingos usually fly at night or under conditions of poor light (Figure 16), which renders them vulnerable to collisions with man-made structures, including power lines, during day to day nomadic movements that are usually at low altitudes. On migratory flights inland and back to the coast, flights are at higher altitudes except when taking off and coming in to land.

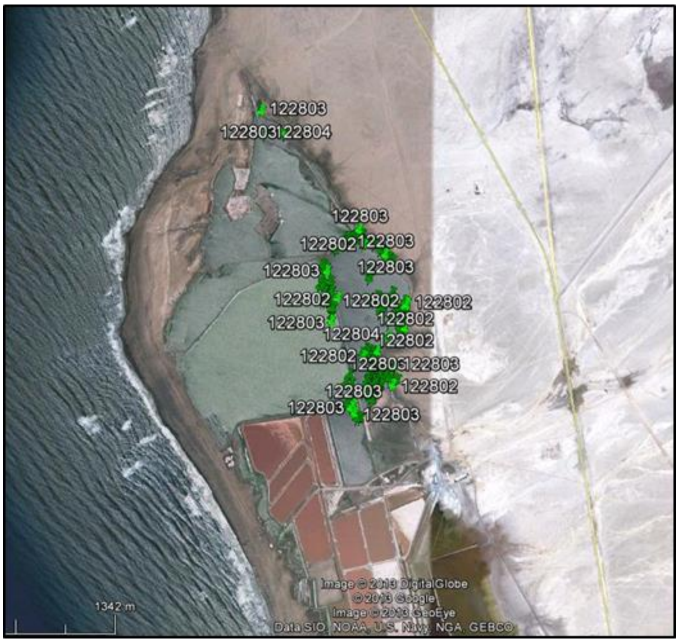

Figure 14: Recent satellite tracking data for three Greater Flamingos and one Lesser Flamingo at Mile 4 Salt Works (March 2013)[20]

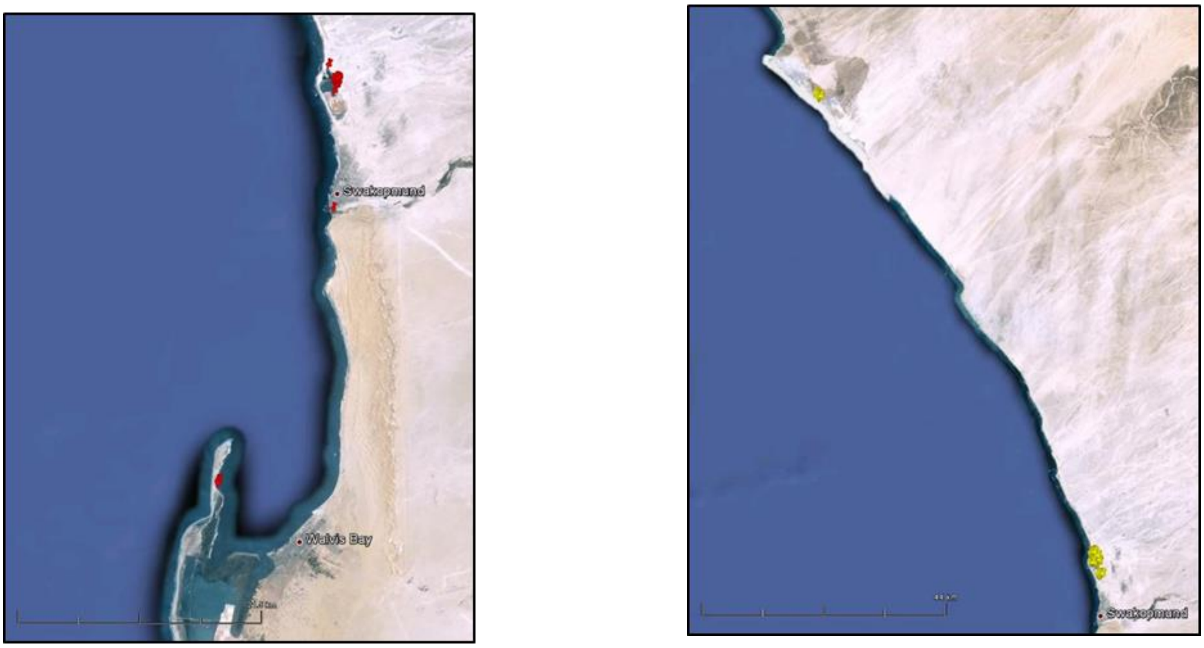

Figure 15: Recent satellite tracking data for (a) three Greater Flamingos and (b) one Lesser Flamingo[21]

[20] Notes: Illustrate the areas apparently preferred by these species at Swakopmund Salt Works / Mile 4 Salt Works (NamPower/NNF Strategic Partnership 2014)

[21] Notes: Shows nomadic movements on the Namibian coast, from Mile 4 Salt Works (where the tracking devices were fitted) to the Swakop River Mouth and Walvis Bay Lagoon in the south (a: red dots), and to Cape Cross Lagoon in the north (b: yellow dots); the exact flight paths are unfortunately not recorded (NamPower/NNF Strategic Partnership 2014)

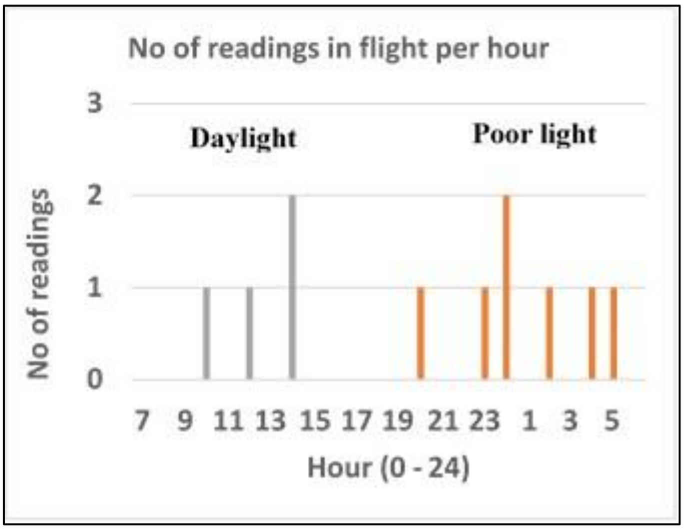

Figure 16: Number of readings per hour for a Lesser Flamingo fitted with a GPS PTT at Cape Cross Lagoon[22]

7.4.3.4 *Sensitivity to artificial light*

The presence of artificial lights has the potential to affect birds in various ways: (i) by providing more feeding time by allowing nocturnal feeding; (ii) by causing disorientation or direct mortality (Hockin *et al*. 1992); and (iii) by causing birds roosting on the ground to cast a shadow, making them it easier for terrestrial predators to see them and potentially increasing predation, although lighting also makes it easier for birds to see predators.

The effect of artificial lights on birds has been known for centuries (http://myfwc.com/ conservation/you-conserve/lighting/pollution/birds). In the past, people used flame and lights to attract birds at night to capture them for food. Since their inception, there have been reports of seabirds attracted to the light beam of lighthouses. Artificial lights can "trap" migratory birds by bleaching their visual pigments, causing them to lose sight of the horizon and circle within the cone of light endlessly. They then can die from exhaustion or collision with the light source. It can extend the day for diurnal species of songbirds, making them more susceptible to predators as they sing out their location, or causing them to breed too early since they associate breeding with longer days. It can attract seabirds away from their normal feeding grounds, possibly because these birds feed on bioluminescent sea animals and are cued in to low levels of light. Further information about the effects of light pollution on migratory birds can be found can be found at the Fatal Light Awareness Program (FLAP; www.flap.org).

Disorientation in night-flying birds, especially migrants, due to artificial light may result in erroneous navigation and enhancing the potential for (mass) collisions with overhead structures (see http://www.flap.org/new/nestegg.htm; http://myfwc.com/conservation/you-con serve/lighting/pollution/ birds/). Any relatively isolated pool of light created in low cloud and mist is a potential attractant and hazard for a bird (GR Martin pers. comm.). Given the regular overnight rolling in of fog from the ocean along the Namibian coast, then a diffuse pool of light (e.g. emanating from the plant) could become an attraction if birds (including flamingos) are moving at night, especially if there is no moon. Once birds are attracted down into the pool of light and fog then they would become prone to collision with any obstacle due to disorientation.

Night-flying among migrant birds is common: for example, of 147 migrant species (from 16 orders) surveyed in Britain, none fell into an exclusively nocturnal category, but 75% of all species had been recorded as a night migrant at some time (Martin 1990). Birds making nomadic movements at night, in particular Lesser Flamingo and Greater Flamingo at Mile 4 Salt Works, could be affected similarly

[22] Altitudes are for readings where speed data indicated short local movements May-June 2014; NamPower/NNF Strategic Partnership 2014

by artificial lighting. Flamingos with broken legs have been observed at the Walvis Bay Lagoon; it is speculated that this could be linked to disorientation at night, due to the reflected light on the water surface, and coming in to land too hard (J Paterson pers. comm.).

Particularly if unshielded, artificial light also has the potential to disturb breeding birds, and indirectly to increase opportunities for predation (e.g. by jackals), particularly on ground-nesting species such as Damara Terns and their eggs and chicks.

Lights that point outward or upward could result in the above-mentioned impacts by spreading their effect more widely than required. It appears that intermittent (flashing) lighting may be less attractive to birds than continuous lighting, and that possibly red/amber light is less attractive than white light (Strugnell *et al*. 2009).

7.4.3.5 ***Sensitivity to human-induced noise***

The impacts of noise on birds for the present development are dealt with in a separate specialist noise study by Airshed Planning Professionals. Some of the concerns regarding the impacts of human-induced noise on birds are mentioned below.

Calls are important in the isolation of species, pair bond formation, pre-copulatory display, territorial defence, danger, advertisement of food sources and flock cohesion (Anon. 2011). Calls are also important for adults and their offspring to identify one another, e.g. in colonially nesting species.

In a review of 50 studies on the effects of human disturbance on birds, Borgmann (2011) found that 86 percent of these studies reported that human-caused disturbances impacted on the study species of birds. Responses to anthropogenic noise differ significantly among species, types of disturbance, body condition, food availability and frequency of disturbance; however, 57% of the studies reviewed reported birds taking flight in response to a human-caused disturbance.

Most researchers agree that noise can affect an animal's physiology and behaviour and, if it becomes a chronic stress (such as ongoing noise from machinery/pumps), noise can be injurious to an animal's energy budget, reproductive success and long-term survival (Radle 2007, Ortega 2012, Francis *et al*. 2013) and lead to a cascade of secondary stressors such as increasing the ambiguity in received signals or causing animals to leave a resourceful area, all with potential negative if not disastrous consequences (Wright *et al*. 2007)

In a study of bird species around upland wind farms, seven of the the 12 species exhibited significantly lower frequencies of occurrence close to the turbines (that generate this type of noise), after accounting for habitat variation, with equivocal evidence of turbine avoidance in a further two species (Pearce-Higgins *et al*. 2009).

The potential impacts of noise on coastal birds are reviewed comprehensively by Van Rooyen (2009) for a similar desalination plant study north of the present study area. The results (for a non-African context) included the following findings:

- Different species react differently to noise disturbance;
- Many species are seemingly capable of tolerating high noise levels (>80dBA) on a regular basis without any significant negative behavioural or physiological consequences; and
- Visual cues associated with noise may be as important if not more important than the actual noise levels in causing disturbance.

Human-induced disturbances during the breeding season can have a significant negative effect on breeding success by causing nest abandonment or increased risk of nest predation due to exposure (Hockin *et a*l. 1992, Borgmann 2011). However, the more subtle effects such as masking, annoyance and changes in behaviour are often overlooked. Damara Terns are highly vocal (with high-pitched calls) during the breeding season; apart from for courtship and mate identification, these calls are important for adults to make contact with chicks once they leave the nest, when they are highly mobile within the breeding/nursery area before fledging. The masking of such calls, e.g. by machinery noises, could potentially disrupt these processes. Breeding colonial waterbirds (such as cormorants) are particularly susceptible to human disturbance because of their high-density nesting habits (Rodgers & Smith 1995). Identified detriments to reproductive success include egg and nestling mortality, nest evacuation, reduced nestling body mass and slower growth, premature fledging and modified adult behaviours.

Although the need for underwater blasting is not anticipated as being required for this project, it can cause the disturbance, injury or death of marine bird species (Van Rooyen 2009. Species likely to be affected by this impact are cormorants and the African Penguin, which forage by diving under water (Cooper 1995; Van Rooyen 2009).

The above literature indicates that noise disturbance can become an issue for some birds.

The term "habituation" may often be used incorrectly to refer to any form of moderation in wildlife response to human disturbance, rather than to describe a progressive reduction in response to stimuli that are perceived as neither aversive nor beneficial (Bejder *et al*. 2009). This misinterpretation, can lead to inappropriate decisions about the threats human interactions pose to wildlife (Wright *et al.* 2007). These findings indicate that caution is required when assuming that species such as Damara Terns that breed in noisy localities (e.g. next to the Mile 4 Salt Works where construction vehicles and people have been moving/operating for a long time; or at Caution Reef, south of Swakopmund, in close proximity to the main C34 tarred road [R Braby pers. comm.]) are "habituated", i.e. tolerant of or indifferent to the noise disturbance, whereas the stress effects of this form of disturbance may in fact be being masked.

Bird groups with the potential to be affected negatively by noise during the present study include breeding Damara Terns; and breeding cormorants, especially Cape Cormorant, on the guano platforms. It is possible that the cormorants would be more disturbed by ongoing noise during the operational phase than by construction-type of noises, to which they probably have become accustomed. Other (non-breeding) Red Data species such as Lesser Flamingo and Greater Flamingo and the African (Black) Oystercatcher are likely to experience similar disturbance, temporarily affecting the distribution, extent and frequency of habitation by these species.

7.4.3.6 ***Sensitivity in terms of power line interactions***

The incidence of power line sensitive bird species in the study area and surrounds is shown in Figure 17. Note that the Mile 4 Salt Works lies within a QDS with a relatively high concentration of such species.

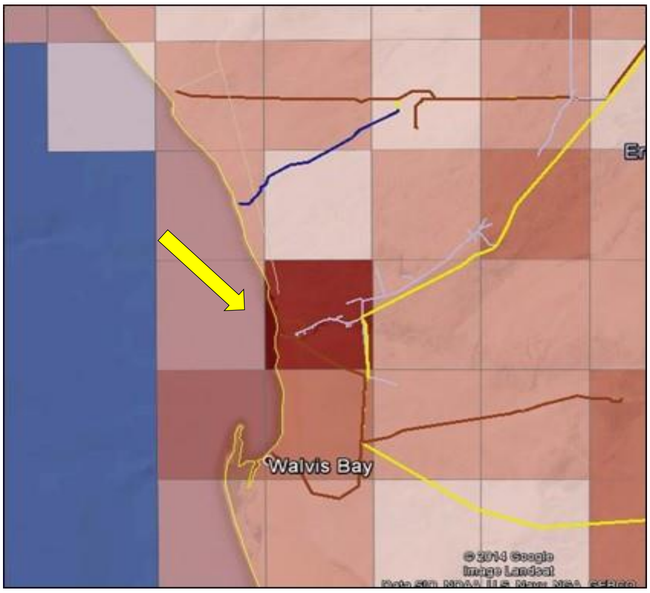

Figure 17: Incidence of power line sensitive bird species in the study area[23]

Since 2009 the NamPower/Namibia Nature Foundation Strategic Partnership (EIS 2014) has documented wildlife and power line incidents involving some 280 animals, mostly birds. Due to the difficulty of obtaining records in bushy areas (especially the northern and north-eastern parts of the country) and the high scavenging rates in general, it is likely that the number of incidents on record is an under-estimate.

The HLPCD (horizontal line post compact delta) structure is likely to be used for the proposed power distribution line, with the A-frame structure to supply strength at bends. At least 60 of the above incidents (21%) have been recorded in this group of structures to date (Figure 18). Most of the incidents recorded have involved bustards/korhaans (44%) and flamingos (25%; Figure 19). A further 46 (16%) have involved raptors, mainly vultures as well as eagles, snake-eagles and owls.

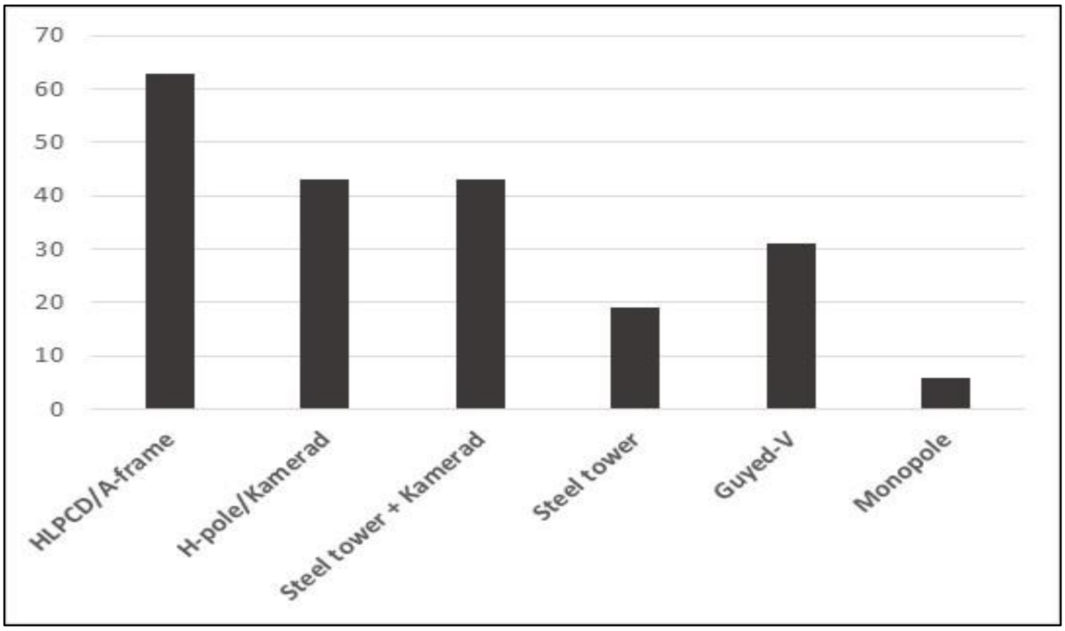

Figure 18: Recorded collision incidents in Namibia in 2009-2013[24]

[23] Shading ranges from dark (high percentage) to light (low percentage of species); source EIS 2014
[24] Source: NamPower/NNF Strategic Partnership 2013

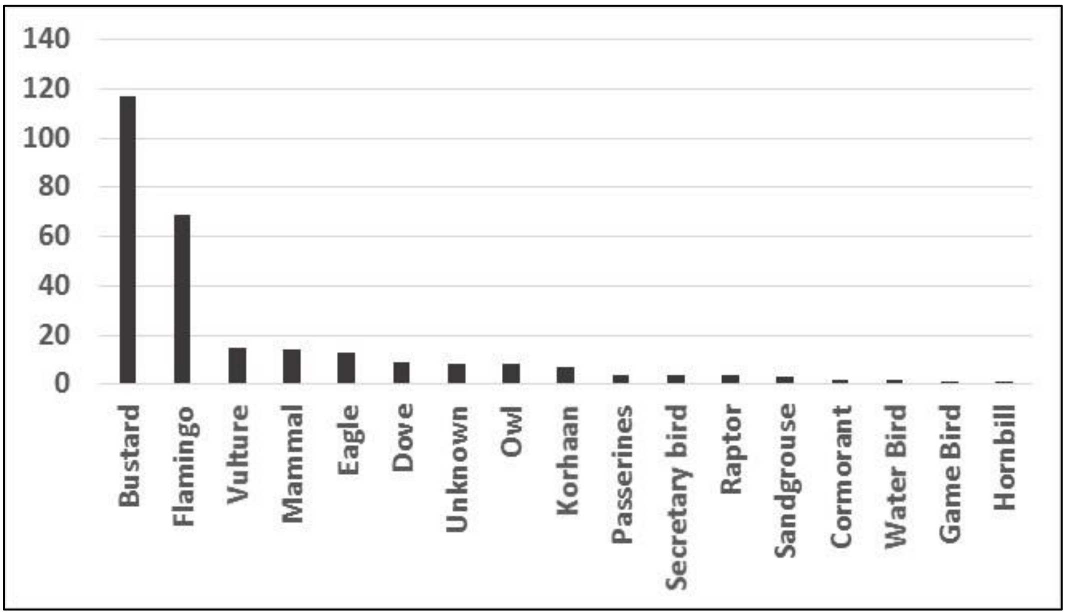

Figure 19: Relative number of animals involved in power line incidents in Namibia, 2009-2013[25]

Power line incidents on record for the Erongo Region in Namibia

Flamingos are prone to collisions with overhead structures (Figure 20-22). This is in part due to their habit of flying low at times, in groups, and usually at night. The collision problem appears to be exacerbated by adverse weather conditions, including strong winds and fog, and by confusion caused by artificial light. Flamingo flight paths in the area are indicated by both satellite tracking (see below) and by collisions of the species on power lines in the area (Figure 20-22). The risk of further power line collisions with the construction of a new above-ground power line that intersects some of these flight paths is therefore considered high.

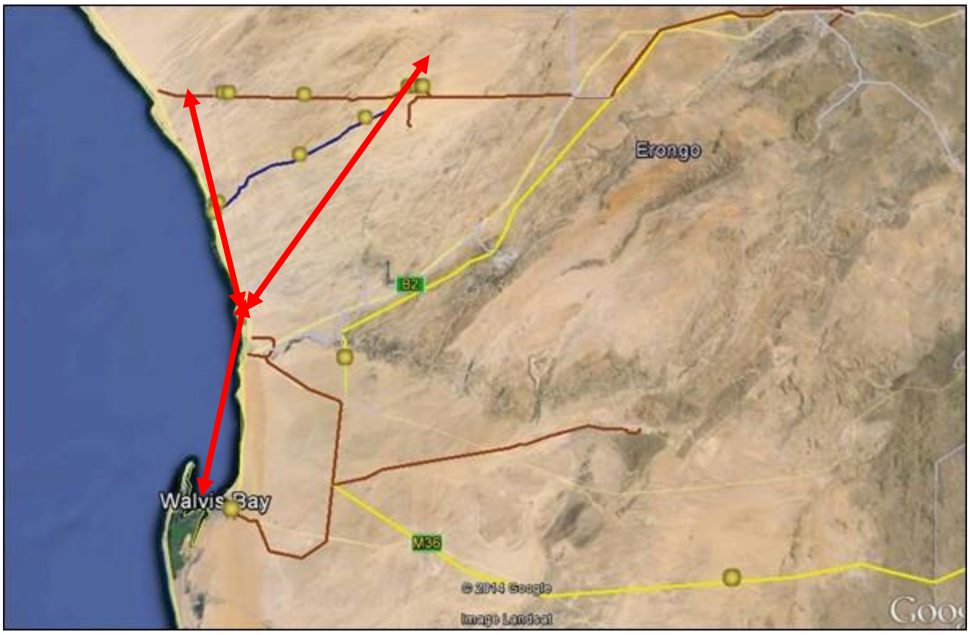

Figure 20: Recent flamingo collision incidents[26]

[25] n = 281 animals; NamPower/NNF Strategic Partnership 2013

[26] Notes: Recent flamingo collision incidents (gold dots) recorded in the Erongo Region (n= 45 birds; arrows indicate some suspected flight paths to and from Swakopmund Salt Works) (NamPower/NNF Strategic Partnership 2014; EIS 2014)

Figure 21: Recent collisions of flamingos and a Black-necked Grebe recorded on the Trekkopje-Wlotzka 132 kV power line[27]

Collision surveys have resulted in the following records for the power line up to 2.3 km east of the Wlotzka Desalination Plant, some 20 km north of Swakopmund Salt Works (photos AREVA):

- Six Greater Flamingos on 15 April 2013 (left)
- Two Greater Flamingos in November 2010
- One Lesser Flamingo in March 2013
- One flamingo in June 2014
- One Black-necked Grebe in February 2013 (right)

Figure 22: Recent collisions recorded on the Trekkopje-Wlotzka 132 kV power line

7.4.4 Conclusions on potential sensitivity of the site

Mile 4 Salt Works is registered as an Important Bird Area (IBA), lying adjacent to the Dorob National Park and forming part of an extensive coastal conservation system. It is also a private nature reserve, Panther Bake, and is situated on an important international flyway for migrant bird species.

The 233 bird species recorded for the broad study area (QDS 2214Da) include 26 (11%) that are classed as Threatened in Namibia; eight of these (3%) are also Globally Threatened. Forty-two

[27] Notes: Example of recent collisions recorded on the Trekkopje-Wlotzka 132 kV power line up to 2.3 km east of the Wlotzka Desalination Plant, some 20 km north of Swakopmund Salt Works (n= 11 birds; NamPower/NNF Strategic Partnership 2014; see also Figure 22 and 24)

(18%) species are endemic/near-endemic, with seven of these endemic/near-endemic to Namibia. One hundred and fifty species (64%) are resident, 80 (34%) are nomadic at times and 72 (31%) are migrant at times. The Mile 4 Salt Works also lies with a QDS with a relatively high relative concentration of power line sensitive species in terms of the greater area.

According to the above assessment of bird species and sites, the Mile 4 Salt Works can thus be categorised as area of high sensitivity of regional and global importance. Consequently, bird protection must form an important consideration for this project.

Although many of the bird species recorded in the study area could potentially be at risk from the proposed development, it is important to direct risk assessments and mitigation towards species that have high biological significance, in order to achieve the optimal results with the available resources at hand (Van Rooyen 2008). These species fall mainly into the aquatic category and include the identified Red Data species, as well as endemic/near-endemic species and those that are nomadic/migrant at times (Appendix 2). Note that, in addition, a number of other species are regarded as being at a low or very low risk to similar impacts.

Species identified as being at high risk from the proposed development include:

- Damara Tern (Near Threatened, Globally Threatened), threatened by disturbance in breeding habitat, destruction of breeding habitat;
- Lesser Flamingo (Vulnerable, Globally Threatened), threatened by power line collisions; and
- Greater Flamingo (Vulnerable), also threatened by power line collisions.

Species identified as being at moderate risk include:

- Cape Cormorant (Near Threatened, Globally Threatened), threatened by potential noise disturbance in breeding/ roosting habitat;
- Great White Pelican (Vulnerable), prone to power line collisions; and
- Black-necked Grebe (Near Threatened), prone to power line collisions.

7.5 SUMMARY OF ENVIRONMENTAL ISSUES WITH REGARD TO BIRDS

Potential environmental issues with regard to birds include destruction/modification of bird breeding habitat; physical disturbance (movement, noise, light) of (breeding) birds due to construction activity; disturbance (movement, noise, light) due to facility operation, potential exposure of birds and their food items to brine discharges in the surf zone; and collisions and electrocutions of birds on power line structures. A number of the above issues are associated with cumulative environmental impacts.

8 IMPACT ASSESSMENT

8.1 PREDICTED IMPACTS OF PROPOSED DEVELOPMENT IDENTIFIED IN TERMS OF:

- Construction phase:
  ~ A: Destruction/modification of Damara Tern breeding habitat;
  ~ B: Destruction/modification of habitat of other birds; and
  ~ C: Physical disturbance to breeding birds, especially Damara Terns.

- Operations phase:
  ~ D: Physical disturbance to breeding birds, especially Damara Terns;
  ~ E: Physical disturbance to roosting/breeding cormorants;
  ~ F: Collisions of birds with power line structures; and
  ~ G: Electrocutions of birds on power line structures.

- Decommissioning phase:
  ~ H: Physical disturbance to breeding birds, especially Damara Terns.

8.2 DESCRIPTION OF POTENTIAL IMPACTS

8.2.1 Construction phase impacts

8.2.1.1 *Impact A: Destruction/modification of Damara Tern breeding habitat*

Impact description

This impact assesses the potential significance of loss or modification of breeding habitat that may arise due to the activities associated with construction of the proposed desalination plant and associated infrastructure. This impact is driven primarily by location and the extent of the project footprint in relation to the known core Damara Tern breeding area, and of the base case site (post-mitigation) to other secondary Damara Tern breeding areas. This disturbance associated with the construction phase activities could impact on the Damara Tern breeding habitat, and the impact duration could extend beyond the construction term.

Impact assessment

Table 11 provides the impact significance assessment for each of the project alternatives under consideration. The impact significance ratings for Alternatives 1, 2 and 3 assume that the mitigation measures below (other than relocating the plant) will be implemented. The alternative of an overhead power line would have no effect, given that the section between the plant and the C34 would in any case be buried (see above). This impact is therefore not mentioned in the above table.

Table 11: Significance assessment for Impact A: Destruction/modification of Damara Tern breeding habitat (construction phase)

Criteria	Base case site layout - Pre-mitigation	Base case site layout - Post-mitigation	Alternative 1 - Plant site 2	Alternative 2 - Plant site 3
Type	Negative	Negative	Negative	Negative
Extent	Local	Local	Local	Local
Magnitude	High	Low	Very low	Low
Duration	Long term	Long term	Long term	Long term
SIGNIFICANCE	High (-)	Low (-)	Very low (-)	Low (-)
Probability	Definite	Probable	Probable	Probable
Confidence	Certain	Sure	Sure	Sure
Reversibility	Irreversible	Irreversible	Irreversible	Irreversible

Legend: High (-) | Medium (-) | Low (-) | Very low (-) | Neutral | Very low (+) | Low (+) | Medium (+) | High (+)

The significance of this impact is high for the base case site (pre-mitigation) as this site coincides with an established core breeding site of the Damara Tern. The levels of physical disturbance and habitat destruction resulting from the selection of the central areas of this site for the proposed development are regarded as being incompatible with the breeding requirements for this species. The impact includes the habitat destruction caused by site levelling, burying of pipelines and of power cables (at least between the plant and the C34 road) and construction of intake/buffer ponds. These negative impacts are likely to be irreversible. Some habitat destruction has already taken place during the exploratory stages of the project, with potential physical disturbance had the terns already been nesting in the area. Any further habitat destruction of the core Damara Tern breeding sites would be viewed as an unacceptably high impact, hence the importance of site selection.

The significance of this impact is low for the mitigated base case site and Alternative 2 (Plant site 3), as both still lie within or near secondary breeding areas for Damara Terns.

The significance is very low for site Alternative 1 (Plant site 2) as this is not known to be a Damara Tern breeding area.

The impacts of the choice of discharge site are of very low significance to birds throughout.

Impact mitigation

The impact significance ratings provided for the alternatives assume that the following or equivalent mitigation measures have been applied in an effort to manage these impacts responsibly. These mitigation measures have been developed primarily for the base case site (mitigated) and are as follows:

- The base case site (i.e. centre of area No. 1) coincides with an established core breeding habitat for the Damara Terns, and should therefore be avoided and designated as a "no-go" area at all times, with zero further habitat destruction;
- The plant should be shifted to a position as far as possible from the known breeding areas: in the case of the base case site (post-mitigation), the plant should be shifted to the furthest north / north-eastern extent of the area;
- To avoid disturbance of the Damara Tern breeding site it is also recommended that the alternative (northern) brine outfall be pursued, as this will reduce the disturbances to the core breeding area;
- Any construction activity located in or close to the Damara Tern breeding site should be scheduled to avoid taking place during the breeding months of October to April. This applies to the desalination plant and may apply to the upgrading of the intake channel, the construction of the intake/buffer pond and the intake pipeline from pond to plant;
- The plant and associated facilities (buffer pond; and pipelines, electrical cables and roads) should be designed and laid out to be compact and utilise the smallest possible footprint;
- Linear features (such as pipelines, electrical cables and roads) should share the same (existing) route wherever possible and should follow a route that avoids the known breeding areas as far as possible; and
- Construction staff should be made aware of the breeding area during awareness training and this area must be treated as a "no-go" area during construction. Strict supervision and control must be exercised to keep people and plant out of this area, especially during the tern breeding months.

8.2.1.2 ***Impact B: Destruction/modification of habitat of other birds***

Impact description

This impact assesses the potential significance of the destruction/modification of the habitat of other birds that may arise due to the construction of the plant and associated infrastructure (Table 12).

These species include Chestnut-banded Plover (Near Threatened) and White-fronted Plover, that use both the pre- and post-mitigation base case sites; and Gray's Lark (a Namibian near-endemic) and Red-capped Lark, that use the post-mitigation base case site and surrounding areas.

The levelling of the plant site will cause irreversible habitat damage to a limited area (maximum 100 x 100 m). Minor habitat disturbances will occur with the trenching and backfilling required for burying linear infrastructure, e.g. the power line cable in the section between the plant and the C34 road, but from then on the line will run along an existing, already disturbed servitude. The pipeline construction between the plant and the C34 road could likewise have a limited, temporary impact on the habitat of both aquatic and terrestrial bird species (see above) in the area. The construction of both the plant and the buffer pond may be designed to incorporate existing borrow pits, which would minimise the destruction of undisturbed habitat.

Changes to the existing surface water structures in the area (e.g. the use of buffer ponds next to the desalination plant) may also impact on local faunal residents and migrants. Birds may move away from these areas during construction/implementation, but if the habitat is suitable they could also move in afterwards. These impacts are considered of less importance, given that the salt pan habitat has already been modified and a variety of other habitats are nearby. Further impacts are associated with the construction of feed water intake and brine discharge structures into the marine environment, and desalination plant infrastructure extending into the sea.

Impact assessment

Table 12: Significance assessment for Impact B: Destruction/modification of habitat of other birds (construction phase)

Criteria	Base case site layout - Pre-mitigation	Base case site layout - Post-mitigation	Alternative 1 - Plant site 2	Alternative 2 - Plant site 3
Type	Negative	Negative	Negative	Negative
Extent	Local	Local	Local	Local
Magnitude	High	Low	Low	Low
Duration	Long term	Long term	Long term	Long term
SIGNIFICANCE	**Low (-)**	**Low (-)**	**Low (-)**	**Low (-)**
Probability	Definite	Probable	Probable	Probable
Confidence	Certain	Sure	Sure	Sure
Reversibility	Irreversible	Irreversible	Irreversible	Irreversible

Legend	High (-)	Medium (-)	Low (-)	Very low (-)	Neutral	Very low (+)	Low (+)	Medium (+)	High (+)

The significance of this impact is low for the base case layout (pre-mitigation) as the habitat is also used by other species, e.g. Chestnut-banded Plover, (breeding) White-fronted Plover.

The significance is low for the base case site (post-mitigation). Construction activities such as the preparation of the site for the plant and the burial of the electric cables and pipelines will cause limited local habitat destruction in an area that is relatively less important for birds. The buffer pond will be sited in an existing borrow pit. The plant may also be constructed in an existing borrow pit.

The significance is low for site Alternative 1 (area No 2); a new buffer pond will be constructed. The above construction activities will cause limited local habitat destruction in an area that is relatively less important for birds.

The significance is also low for site Alternative 2 (area No 3); the buffer pond will be sited in an existing pond that will be modified. The above construction activities will cause limited local habitat destruction whilst avoiding the core Damara Tern breeding site.

Impact mitigation

The following mitigation measures are proposed to keep general destruction/modification of bird habitat to a minimum:

- Construction activities should be restricted to the demarcated footprint;
- Roads, pipelines, cables should share servitudes as far as possible, and be routed to avoid the core bird breeding areas;
- Approved access and service roads should be demarcated in collaboration with the owners to ensure that vehicles are kept on the designated routes, and no off-road driving should be permitted;
- All modified areas should be rehabilitated to an acceptable level after the disturbance; and
- Ongoing awareness training should be promoted amongst staff about the negative impacts and undesirability of habitat destruction, especially to breeding birds.

8.2.1.3 *Impact C: Physical disturbance to breeding birds, especially Damara Terns*

Impact description

This impact assesses the potential significance of physical disturbance (including human-induced light and noise) on breeding birds, especially Damara Terns (Table 13).

Physical disturbance

Increased activities involving people and vehicles/machinery in the area during the construction of both the desalination plant and the associated infrastructure may result in disturbance of breeding, foraging and roosting birds.

In particular, the proposed site for the desalination plant (i.e. base case site – pre-mitigation) coincides with an established core breeding site for the Damara Tern. Some 10-15 pairs regularly breed in this area at present (M Boorman pers. comm.), and are likely to move away, possibly permanently, should disturbance increase. Damara Terns are increasingly under pressure in other parts of the coast, due to recreational disturbance and development (Braby 2011, R Braby pers. comm.), and any further loss of breeding effort should be avoided.

Other breeding birds in the area could also be affected by these construction disturbances, although to a lesser extent, e.g. cormorants, Chestnut-banded Plover, White-fronted Plover, Caspian Tern and Swift Tern.

Light

The presence of artificial lights has the potential to affect birds in various ways, particularly if unshielded: (i) by providing more feeding time by allowing nocturnal feeding; (ii) by causing disorientation or direct mortality (Hockin *et al*. 1992); and (iii) by causing birds roosting or nesting on the ground to cast a shadow, making it easier for terrestrial predators to see them and thereby potentially increasing predation, although lighting also makes it easier for birds to see predators (see 7.4.3.4 above).

The impacts of light will be minimal during the construction phase, as most of the activity will take place by day, although emergency night-time construction activity may be required (e.g. a late concrete pouring); and security lights are likely to be used on the construction site.

The impacts of light on birds are discussed further under the operations section, as this is when the main impacts are expected to occur.

Noise

The impacts of noise on birds for the present development are dealt with in a separate specialist noise study by Airshed Planning Professionals. Some of the concerns regarding the effects of noise associated with the construction of the desalination plant, from an avifaunal point of view, are mentioned above (see 7.4.3.5).

Many researchers agree that noise can affect an animal's physiology and behaviour and, if it becomes a chronic stress (such as ongoing noise from machinery/pumps), noise can be injurious to an animal's energy budget, reproductive success and long-term survival (Radle 2007, Ortega 2012, Francis *et al*. 2013) and lead to a cascade of secondary stressors such as increasing the ambiguity in received signals or causing animals to leave a resourceful area, all with potential negative if not disastrous consequences (Wright *et al*. 2007)

Human-induced disturbances during the breeding season can have a significant negative effect on breeding success by causing nest abandonment or increased risk of nest predation due to exposure (Hockin *et a*l. 1992, Borgmann 2011). However, the more subtle effects such as masking, annoyance and changes in behaviour are often overlooked.

The above literature (see 7.4.3.5) indicates that noise disturbance can become an issue for some birds. Bird groups with the potential to be affected negatively by noise during the present study include breeding Damara Terns; and breeding cormorants, especially Cape Cormorant, on the guano platforms. It is possible that the cormorants would be more disturbed by ongoing noise during the operational phase than by construction-type of noises, to which they probably have become accustomed. Other (non-breeding) Red Data species such as Lesser Flamingo and Greater Flamingo and the African (Black) Oystercatcher are likely to experience similar disturbance, temporarily affecting the distribution, extent and frequency of habitation by these species.

The specialist noise study by Airshed Planning Professionals for the present project found that, based on an interim guideline proposed by Dooling and Popper (2007), it is unlikely that a noise level below an overall level of about 50 to 60 dBA would have much of an effect on acoustic communication or the biology of a bird in a quiet suburban area.

"Worst-case" noise levels at the centre of the Damara Tern area during the construction phase were predicted at 52.9 LAeq (dBA) during the day and 52.5 at night.

During the construction phase, the impact of noise on birdlife is therefore considered "Very Low".

Impact assessment

Table 13: Significance assessment for Impact C: Physical disturbance to breeding birds, especially Damara Terns (construction phase)

Criteria	Base case site layout - Pre-mitigation	Base case site layout - Post-mitigation	Alternative 1 - Plant site 2	Alternative 2 - Plant site 3
Type	Negative	Negative	Negative	Negative
Extent	Local	Local	Local	Local
Magnitude	High	Low	Very low	Low
Duration	Long term	Short term	Short term	Short term
SIGNIFICANCE	**High (-)**	**Low (-)**	**Very low (-)**	**Low (-)**
Probability	Definite	Probable	Probable	Probable
Confidence	Certain	Sure	Sure	Sure
Reversibility	Irreversible	Irreversible	Irreversible	Irreversible

Legend	High (-)	Medium (-)	Low (-)	Very low (-)	Neutral	Very low (+)	Low (+)	Medium (+)	High (+)

The significance of this impact is high for the base case site (pre-mitigation) as it coincides with an established core breeding site of the Damara Tern, a threatened species. The levels of physical disturbance resulting from the selection of this site for the proposed development are regarded as being incompatible with the breeding requirements for this species. If the birds leave the site due to disturbance, it is unlikely that they will return; nor would they be as successful if they were to move to another (established) breeding site. The site has already been threatened by some potential physical disturbance during the exploratory stages of the project, had the terns been nesting in the area. Any further physical disturbance in the core Damara Tern breeding sites would be viewed as an unacceptably high impact, hence the importance of site selection.

The significance is low for the base case site (post-mitigation) as it lies further than the core breeding site, but still within or near secondary breeding areas for Damara Terns.

The significance is also low for site Alternative 2 (Plant site 3), as it lies near secondary breeding areas for Damara Terns.

The significance is very low for site Alternative 1 (Plant site 2) as this is not a Damara Tern breeding area.

Impact mitigation

Physical disturbance

- Construction activities such as earth-moving and the laying of pipelines and cable, and the construction of the buffer pond, should be zoned in time outside the main Damara Tern breeding season, which is October-April. Even outside these times, excessive and unnecessary noise disturbance should be avoided;
- The construction of an earth berm/wall of 1.8-2.0 m high around the facility could be investigated, which would contribute to the reduction of physical disturbance associated with movement and construction activity;
- Only designated and demarcated access and service roads should be used, and strict control and supervision is required to prevent off-road driving; and
- Ongoing awareness training should be promoted amongst staff about the negative impacts and undesirability of disturbance, especially to breeding birds.

Noise

- Laying of pipe, road construction and other activities on ancillary infrastructures located in or near the Damara Tern breeding area should be programmed to occur outside the breeding period from October to April;
- Further recommendations regarding noise controls by the noise specialist study should be applied.

Light

- Construction activity should be restricted to daylight hours and where emergency night-time construction activity (i.e. a late concrete pour) is required, careful attention shall be given to ensuring that lighting is task specific and does not result in the excessive light spill or flood lighting of vast areas.
- Outside lighting of the facility (including security lighting) must be kept to the minimum. Where required, all overhead lighting should be shaded and pointed downwards onto the area where illumination is needed, rather than directed upwards or outwards, in order to avoid light pollution. The guidelines laid down by the International Dark-Sky Association for the quality of outdoor lighting (including light design, wattage and light colour [preferably amber]) should be followed for preserving and protecting the night-time environment, including its wildlife (www.darksky.org);
- Construction plant and equipment should avoid using the bright headlight setting on their vehicles whilst driving through the Damara Tern breeding area. Similarly, construction vehicles should avoid the use of bright roof-mounted flashing lights (as is typical for construction sites); this becomes more critical during breeding season, although construction activities should be scheduled outside this period if possible.

8.2.2 Operations phase impacts

The key issues associated with the operations phase are physical disturbance, including movement and light, and traffic, to breeding/roosting birds such as Damara Terns, and cormorants on the guano platforms; and collisions and electrocutions of birds on above-ground power line structures.

8.2.2.1 *Impact D: Physical disturbance to breeding Damara Terns*

Impact description

This impact assesses the potential significance of physical disturbance (including human-induced light and noise) on breeding Damara Terns (Table 14).

Physical disturbance

Operations activities involving people and vehicles/machinery in the area may result in disturbance of breeding, foraging and roosting birds.

In particular, the proposed base case site for the desalination plant coincides with an established core breeding site for the Damara Tern. Some 10-15 pairs regularly breed in this area at present (M Boorman pers. comm.), and are likely to move away, possibly permanently, should disturbance increase. Damara Terns are increasingly under pressure in other parts of the coast, due to recreational disturbance and development (Braby 2011, R Braby pers. comm.), and any further loss of breeding effort should be avoided.

Physical disturbance (in association with light and/or noise, see below) also has the potential to result in nest abandonment by cormorants, and a consequent increase in the risk of predation (Borgmann 2011). Other breeding birds in the area could be affected, although to a lesser extent, e.g. Chestnut-banded Plover, White-fronted Plover, Caspian Tern and Swift Tern.

Light

Concerns about the impacts of artificial light on birds are mentioned above (7.4.3.4).

Sources of artificial light are likely to increase with the new development at Swakopmund Salt Works. During the operations phases the site will be illuminated at night, both for work and security reasons. The presence of artificial lights has the potential to affect birds in various ways: (i) by providing more feeding time by allowing nocturnal feeding; (ii) by causing disorientation or direct mortality (Hockin *et al*. 1992); and (iii) by causing birds roosting on the ground to cast a shadow, making them it easier for terrestrial predators to see them and potentially increasing predation, although lighting also makes it easier for birds to see predators.

Disorientation in night-flying birds, especially migrants, due to artificial light may result in erroneous navigation and enhancing the potential for (mass) collisions with overhead structures (see above).

Particularly if unshielded, artificial light also has the potential to disturb breeding birds, and indirectly to increase opportunities for predation (e.g. by jackals), particularly on ground-nesting species such as Damara Terns and their eggs and chicks.

Lights that point outward or upward could result in the above-mentioned impacts by spreading their effect more widely than required. It appears that intermittent (flashing) lighting may be less attractive to birds than continuous lighting, and that possibly red/amber light is less attractive than white light (Strugnell *et al*. 2009).

Noise

Concerns about the potential impacts of noise on birds are outlined in 7.4.3.5 above.

"Worst-case" noise levels at the centre of the Damara Tern area during the operations phase were predicted at 59.3 LAeq (dBA) during the day and 60.4 at night in the noise specialist study (Airshed Planning Professionals).

During the operations phase, with the installation of a boundary wall to act as an acoustic barrier, it is predicted that the significance of impacts on birdlife will reduce from "Low" to "Very Low".

While no major impact is thus anticipated from potential noise disturbance during the operation of the plant, this factor needs to be taken into account should the terns abandon the site in the future. Monitoring of tern numbers and breeding success is thus of critical importance.

Habitat modification

Other issues and potential impacts in terms of marine pollution and ecology include altered flows at the intake and discharge resulting in ecological impacts; and potential for habitat health impacts/losses resulting from elevated salinity in the vicinity of the brine discharge. Brine discharge could impact on marine habitats and their organisms, and indirectly on feeding marine birds, including oystercatchers and other coastal waders, flamingos, cormorants and penguins, as the salinity is higher than that of normal sea water. However, the effects of brine discharge on birds, or (indirectly) on their food items, are not considered a key issue as only a limited amount of the sea water area would be affected by the brine (Van Rooyen 2009). The above finding was arrived at in collaboration with a marine modelling specialist and marine ecologists in the EIA team for the Mile 6 Desalination Plant.

Should drying ponds be created to treat sludge and filter backwash, before it is taken to the landfill, the use of the ponds by bird species would need to be monitored for possible negative impacts, e.g. from pollution by chemicals.

Impact assessment

Table 14: Significance assessment for Impact D: Physical disturbance to breeding birds, especially Damara Terns (operations phase)

Criteria	Base case site layout - Pre-mitigation	Base case site layout - Post-mitigation	Alternative 1 - Plant site 2	Alternative 2 - Plant site 3
Type	Negative	Negative	Negative	Negative
Extent	Local	Local	Local	Local
Magnitude	High	Low	Very low	Low
Duration	Long term	Long term	Long term	Long term
SIGNIFICANCE	**High (-)**	**Low (-)**	**Very low (-)**	**Low (-)**
Probability	Definite	Probable	Probable	Probable
Confidence	Certain	Sure	Sure	Sure
Reversibility	Irreversible	Irreversible	Irreversible	Irreversible

Legend	High (-)	Medium (-)	Low (-)	Very low (-)	Neutral	Very low (+)	Low (+)	Medium (+)	High (+)

The significance of this impact is high for the base case site (pre-mitigation) as the site coincides with an established core breeding site of the Damara Tern, a threatened species. The levels of physical disturbance resulting from the selection of this site for the proposed development are regarded as being incompatible with the breeding requirements for this species. The impact includes the physical disturbance associated with the operations activities. Any physical disturbance of the core Damara Tern breeding sites would be viewed as an unacceptably high impact, hence the importance of site selection.

The significance is low for the base case site (post-mitigation) as it lies further than the core breeding site, although within or near secondary breeding areas for Damara Terns.

The significance is also low for site Alternative 2 (Plant site 3), as it lies near secondary breeding areas for Damara Terns.

The significance is very low for site Alternative 1 (Plant site 2) as this is not a Damara Tern breeding area.

Impact mitigation

Physical disturbance

- As far as possible, planned (annual) maintenance activities should be zoned in time outside the main Damara Tern breeding season, which is October to April. Even then, unnecessary noise disturbance should be avoided;
- Approved access and service roads should be demarcated in collaboration with the owners to ensure that vehicles are kept on the designated routes, and no off-road driving should be permitted;
- The construction of an earth berm/wall of 1.8-2.0 m high around the facility could be investigated, which would contribute to the reduction of physical disturbance associated with movement; and
- Ongoing awareness training should be promoted amongst staff about the negative impacts and undesirability of disturbance, especially to breeding birds.

Noise

- Service doors should be kept closed at night to prevent the escape of noise into adjoining areas;
- The construction of an earth berm/wall of 1.8-2.0 m high around the facility could be investigated, which would contribute to the reduction of noise pollution;
- Regular audits of operations noise levels should be conducted on an ongoing basis, according to the recommendations of the noise specialist study. If nest abandonment by the terns is observed that can be related to noise, measures should be taken to reduce that level of disturbance; and
- Further recommendations regarding noise controls by the noise specialist study should be applied.

Light

- Outside lighting of the facility must be kept to the minimum. Where required, all overhead lighting should be shaded and pointed downwards onto the area where illumination is needed, rather than directed upwards or outwards. The guidelines laid down by the International Dark-Sky Association for the quality of outdoor lighting (including light design, wattage and light colour [preferably amber]) should be followed for preserving and protecting the night-time environment, including its wildlife (www.darksky.org);
- Service doors, parking bays and windows in the facility should be designed to face away from the breeding and bird areas;
- The construction of an earth berm/wall of 1.8-2.0 m high around the facility could be investigated, which would contribute to the reduction of light pollution;
- Plant operations and equipment should avoid using the bright headlight setting on their vehicles whilst driving through the Damara Tern breeding area. Similarly, construction vehicles should avoid the use of bright roof mounted flashing lights (as is typical for construction sites) at night. This becomes more critical during breeding season; and
- Regular audits of outside lighting fixtures should be undertaken in order to ensure that the guidelines laid down by the International Dark-Sky Association (see above).

8.2.2.2 *Impact E: Physical disturbance to roosting/ breeding cormorants*

Impact description

This impact assesses the potential significance of physical disturbance (including human-induced light and noise) on breeding Cape Cormorants (Table 15).

See 8.2.1.1 (above) for full impact description.

Impact assessment

Table 15: Significance assessment for Impact E: Physical disturbance to roosting/ breeding cormorants (operations phase)

Criteria	Base case site layout - Pre-mitigation	Base case site layout - Post-mitigation	Alternative 1 - Plant site 2	Alternative 2 - Plant site 3
Type	Negative	Negative	Negative	Negative
Extent	Local	Local	Local	Local
Magnitude	Very low	Very low	Low	Very Low
Duration	Long term	Long term	Long term	Long term
SIGNIFICANCE	**Very low (-)**	**Very low (-)**	**Low (-)**	**Very Low (-)**
Probability	Probable	Probable	Probable	Definite
Confidence	Sure	Sure	Sure	Certain
Reversibility	Irreversible	Irreversible	Irreversible	Irreversible

Legend: High (-) | Medium (-) | Low (-) | Very low (-) | Neutral | Very low (+) | Low (+) | Medium (+) | High (+)

The significance of this impact is very low for the base case site (pre-mitigation) as it is some distance (minimum 1.3 km) from the guano platforms.

The significance is still very low for the base case site (post-mitigation) although it is slightly closer to the guano platforms.

The significance is low for site Alternative 1 (Plant site 2) as it is relatively closer to the guano platforms (0.5 km), and some disturbance is possible.

The significance is also very low for site Alternative 2 (Plant site 3), as it is the furthest (2 km) from the guano platforms.

Impact mitigation

See 8.2.2.1 for impact mitigation.

8.2.2.3 *Impact F: Collisions of birds with power line structures*

Impact description

This impact assesses the potential significance of collisions of birds with power line structures (Table 16).

A bird collision occurs when a bird in mid-flight does not see the overhead cables until it is too late to take evasive action. These impacts could take place on any parts of the power line, but are more likely in sections where the line crosses flight corridors such as drainage lines. Collisions may also take place on stay wires (e.g. on poles at bend points), for instance when a bird is flushed from its position on the ground.

Red Data bird species in the study area at risk from power line collisions include the Greater Flamingo, Lesser Flamingo, Black-necked Grebe and Great White Pelican. The incidence of power line sensitive bird species in the greater study area is indicated in Figure 22 (above).

The power line will cross flamingo flight paths (indicated in 8.1.3.6), which greatly increases the risk of placing a new power line above ground in the vicinity of the Mile 4 wetlands. The continued life of the power line after the project is also a concern, in view of recorded impacts in terms of bird collisions and cumulative effects.

Power line incidents on record for Namibia are mentioned in 7.2.1 (above), and for the Erongo Region in 7.3.1.4 (above).

Impact assessment

Table 16: Significance assessment for Impact F: Collisions of birds with power line structures (operations phase)

Criteria	Alternative 3 – Overhead power line (pre-mitigation)	Alternative 3 – Overhead power line (post-mitigation)
Type	Negative	Negative
Extent	Regional	Regional
Magnitude	High	Low
Duration	Long term	Long term
SIGNIFICANCE	High (-)	Medium (-)
Probability	Probable	Probable
Confidence	Certain	Sure
Reversibility	Reversible	Reversible

The significance of this impact will be high for the alternative of an overhead power line in view of the high collision threat it would present in close proximity to a wetland area and the its bird populations, although the section between the plant and the C34 road would be buried in both cases. Even though the magnitude of the impact would be reduced from high to medium with mitigation (marking of the line), there is no truly effective way of preventing collisions other than burying the cable.

The impact is reversible if the line is removed at the end of the project duration; however, the long-term lifespan of the line beyond this period is a potential concern.

Impact mitigation

- Where the underground cable is pursued there will be no impact and no need for mitigation; the following mitigations therefore relate only to an instance where the overhead power line is pursued;
- The subsection linking the plant to the C34 road will be a buried cable and then the first 3.5 km of above-ground power line south of this intersection should be marked with bird flight diverters (BFDs; see below). Note that it is difficult to predict exactly where collision incidents would take place; and a truly effective method of marking power lines to mitigate for collisions is still being sought. NamPower should be consulted in terms of expertise with regard to the final design and fitting of mitigation devices. The following marking methods are currently available and could be used in combination:
  - ~ Solar-powered LED bird flight diverter (BFD) (Figure 23), an illuminated device incorporating a flashing light on the top and a moving flapper, that may assist in mitigating collisions of night-flying species such as flamingos;
  - ~ Standard (double loop) bird flight diverters (Figure 24) or a similar, smaller design have been shown to reduce collisions to some extent for diurnal species, and could be used in combination with the above device to reduce costs; and
- Ongoing monitoring is necessary (see below) to identify problem sites in terms of power line collisions; any incidents should be reported to the NamPower/NNF Strategic Partnership, which can offer advice and support. Should collisions start to occur repeatedly in any one unmarked area on the line, the relevant section(s) should be fitted with appropriate mitigation measures (see above). Should collisions still take place after mitigation, the marking methods would need to be re-assessed.

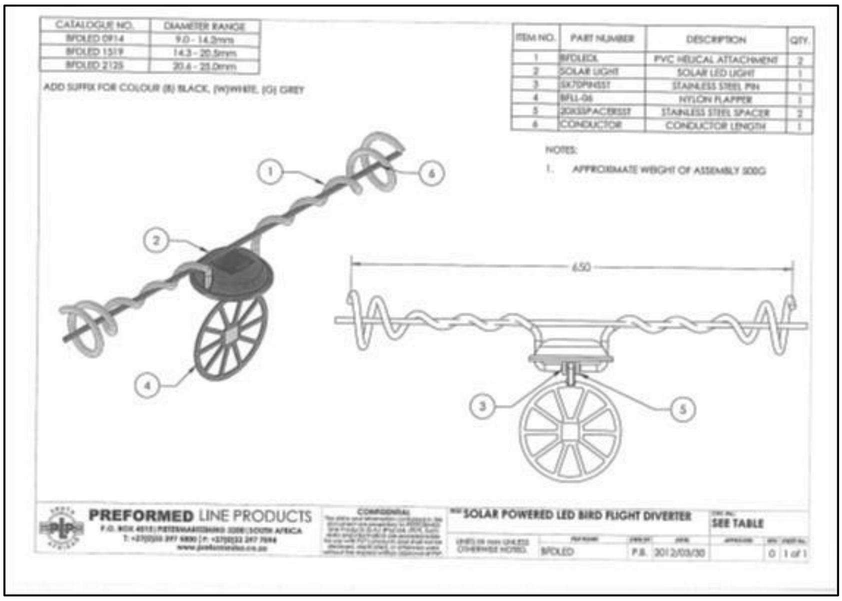

Figure 23: Solar-powered LED flight diverter[28]

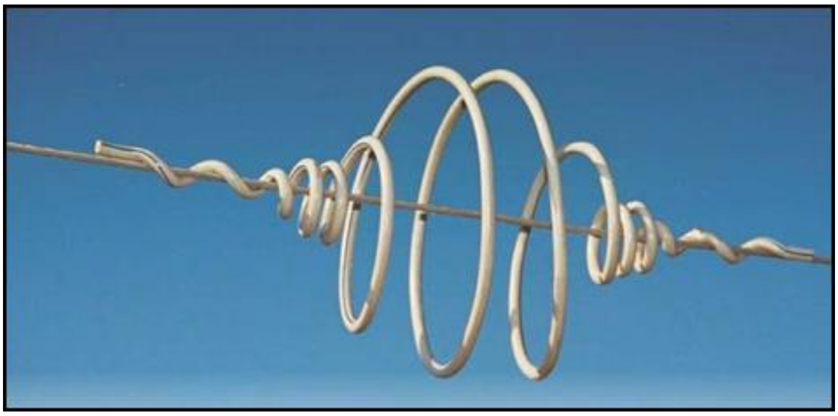

Figure 24: Standard double loop flight diverters[29]

8.2.2.4 *Impact G: Bird electrocutions on power supply structures*

Impact description

This impact assesses the potential significance of bird electrocutions on power supply structures (Table 17).

A bird electrocution occurs when a bird is perched or attempts to perch on an electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components.

Electrocutions may take place when birds attempt to perch or nest on power line poles, transformers and substation structures (e.g. transformers, switchgears), and the risk is increased if birds are attracted to an open source of water nearby for bathing or drinking.

Bird species in the study area at risk from power line electrocutions include raptors such as owls; and Peregrine Falcon, African Fish-eagle and Lappet-faced Vulture in the general area; however, the likelihood is considered to be very low. Species such as cormorants may also perch on power line structures and become electrocuted.

[28] Illuminated device incorporating a light on the top and a moving flapper, that may prove effective in terms of collisions of flamingos, which fly mainly at night

[29] These diverters or a similar, smaller design may be used as a mitigation measure to make the line more visible, in combination with other devices

Some birds, e.g. Pied Crow, have the potential to disrupt the power supply through their nesting activities. Crows may incorporate pieces of wire into their nesting material, which could result in short circuits. The potential of this impact is also considered very low in the study area.

Impact assessment

Table 17: Significance assessment for Impact G: Electrocutions of birds on power supply structures (operations phase)

Criteria	Alternative 3 – Overhead power line (unmitigated)	Alternative 3 – Overhead power line (mitigated)
Type	Negative	Negative
Extent	Regional	Regional
Magnitude	Low	Low
Duration	Long term	Long term
SIGNIFICANCE	Medium (-)	Medium (-)
Probability	Probable	Probable
Confidence	Sure	Sure
Reversibility	Irreversible	Irreversible

The presence of an overhead power line in the area would have a medium impact as it would increase the potential for electrocutions. There is little to be done in terms of mitigating this impact, until problem sites can be identified by means of monitoring. The long term lifespan of the power line is a potential concern.

Impact mitigation

- Roof structures (e.g. substation roofing) should be of a sloping design in order to deter the perching/ roosting of birds such as cormorants and pelicans; and
- Ongoing monitoring of all power line and substation structures (including transformers) is necessary to identify problem sites in terms of electrocution; any incidents should be reported to the NamPower/NNF Strategic Partnership, and additional mitigation measures then considered.

8.2.3 Decommissioning phase impacts:

8.2.3.1 *Impact H: Physical disturbance to breeding birds, especially breeding Damara Terns.*

Impact description

This impact assesses the potential significance of physical disturbance (including human-induced light and noise) on breeding birds, especially Damara Terns (Table 18).

Physical disturbance

Increased activities involving people and vehicles/machinery in the area during the decommissioning of both the desalination plant and the associated infrastructure may result in disturbance of breeding, foraging and roosting birds. The process could probably occur in less than six months, so the impact would be less than that during the construction phase.

In particular, the base case site for the desalination plant coincides with an established core breeding site for the Damara Tern (see above). Other breeding birds in the area could be affected by these disturbances, although to a lesser extent, e.g. cormorants, Chestnut-banded Plover, White-fronted Plover, Caspian Tern and Swift Tern.

Light

The impacts of light will be minimal during the decommissioning phase, as most of the activity will take place by day; security lights may still be used on site.

Noise

Concerns about the potential impacts of noise on birds are outlines in 8.2.1.3.above.

Impacts on the decommissioning phase were not included in the noise specialist study, but for the construction phase (roughly equivalent), "worst-case" noise levels at the centre of the Damara Tern area were predicted at 52.9 LAeq (dBA) during the day and 52.5 at night.

During the decommissioning phase, the impact of noise on human receptors and birdlife could therefore also be considered "Very Low".

Impact assessment

Table 18: Significance assessment for Impact H: Physical disturbance to breeding birds, especially Damara Terns (decommissioning phase)

Criteria	Base case site layout - Pre-mitigation	Base case site layout - Post-mitigation	Alternative 1 - Plant site 2	Alternative 2 - Plant site 3
Type	Negative	Negative	Negative	Negative
Extent	Local	Local	Local	Local
Magnitude	High	Low	Very low	Low
Duration	Long term	Short term	Short term	Short term
SIGNIFICANCE	High (-)	Low (-)	Very low (-)	Low (-)
Probability	Definite	Probable	Probable	Probable
Confidence	Certain	Sure	Sure	Sure
Reversibility	Irreversible	Irreversible	Irreversible	Irreversible

Legend	High (-)	Medium (-)	Low (-)	Very low (-)	Neutral	Very low (+)	Low (+)	Medium (+)	High (+)

The significance of this impact is high for the base case site (pre-mitigation) as it coincides with an established core breeding site of the Damara Tern. The levels of physical disturbance resulting from the selection of this site for the proposed development are regarded as being incompatible with the breeding requirements for this species. If the birds leave the site due to disturbance, it is unlikely that they will return; nor would they be as successful if they were to move to another (established) breeding site. Any further physical disturbance in the core Damara Tern breeding sites would be viewed as an unacceptably high impact, hence the importance of site selection.

The significance is low for the base case site (post-mitigation) as it lies further away from the core breeding site, but still within or near secondary breeding areas for Damara Terns.

The significance is also low for site Alternative 2 (Plant site 3), as it lies near secondary breeding areas for Damara Terns.

The significance is very low for site Alternative 1 (Plant site 2) as this is not a Damara Tern breeding area.

Impact mitigation

See 8.2.1.3 for mitigation measures for physical disturbance during the construction phase.

8.3 LIMITS OF ACCEPTABLE CHANGE

- Any human-induced loss of Damara Tern breeding habitat or disturbance of breeding pairs would not be acceptable; nor would the disturbance of breeding activities of any other threatened bird species;
- The Mile 4 guano platforms are home to the second largest breeding population of Cape Cormorants in Namibia. Apart from environmental impacts, human-induced reductions in numbers of these colonially breeding birds would also have severe economic implications;

- Habitat destruction/disturbance should be minimised;
- Light pollution should be minimised in accordance with International Dark-Sky Association guidelines (www.darksky.org);
- Guidelines/recommendations of the specialist study on noise that pertain to the disturbance of birds, especially breeding pairs, should be complied with;
- Chances of bird mortalities on power line structures should be minimised.

8.4 CUMULATIVE IMPACTS

The cumulative impacts of the Uranium Rush on biodiversity (U-SEA, Anon. 2010b) are discussed in 4.4 (above).

Some potentially cumulative effects have already been identified in the above assessment. These include:

- Activities relevant to the present study that are responsible for loss, degradation and fragmentation of habitats, e.g. construction activities and illegal off-road driving;
- Disturbance of birds at their nests, even if unintentional; this includes Damara Terns and large numbers of Cape Cormorants; and
- The cumulative impacts of the growing network of power lines both in the area and throughout Namibia, and the impact in terms of bird mortalities, especially from collisions.

Other cumulative impacts identified are the following:

- Mile 4 Salt Works is an Important Bird Area (IBA) and as such serves as a stopover for more than 70 migratory bird species (31% of those recorded at the site). A deterioration of this habitat could have far-reaching impacts on regional and international bird populations.The potential impacts of lighting, if unshielded, together with other [increasing] ambient artificial lighting on the navigation of flying birds are likely to increase, and this could impact on the large numbers of migrant bird species using the Swakopmund Salt Works and surrounding coastal areas, particularly in terms of night-flying species, e.g. terns. The ambient light in the Mile 4 area has increased markedly over the years (M Boorman pers. comm.), indicating a cumulative effect; and
- Some 71 Damara Tern breeding areas have been identified globally (Braby 2011), many of which are under pressure elsewhere on the Namibian and South African coastline as a result of human strip development along coastal areas and the tendency for humans to use river mouths and estuaries for their endeavours. The species is also under hunting pressure during its migrations northwards over Angola. Accelerated growth and development on the coast has secondary impacts on species such as Damara Terns that have lost breeding areas and suffer increased mortalities at nests as a result of the expansion of Walvis Bay and Swakopmund, and this species serves as a flagship for the negative impacts of unsustainable development on coastal species and their habitats.

The objective of the U-SEA with respect to biodiversity is that the ecological integrity and diversity of fauna and flora of the central Namib are not compromised by the Uranium Rush. Integrity in this case means that key habitats are protected; rare, endangered and endemic species are not threatened; ecological processes are maintained; and areas of high biodiversity value are conserved.

8.5 MONITORING

The following recommendations are made for monitoring:

- Monitoring should be integrated with existing Rössing environmental protocols and guidelines;
- Regular/annual lighting audits need to be done, according to the guidelines of the International Dark-Sky Association (www.darksky.org);

- Regular noise audits need to be done during the operational phase of the project, according to the recommendations of the noise specialist report for this EIA;
- The monitoring of Damara Tern numbers and breeding success should continue during the annual breeding period;
- Cormorant occupation of the guano platforms should be monitored, if possible. This would require an innovative approach, and aerial photography could be investigated to detect possible signs of avoidance in relation to noise sources. Over the long term, annual guano productive rates could be used as an indicator of site occupancy, although the results should be interpreted with caution as other factors may be involved; and
- Stringent and regular monitoring is recommended for any power line as a matter of policy, especially after strong winds or other adverse environmental conditions. Ongoing monitoring would identify problem sites in terms of power line collisions and electrocutions. Dedicated monitoring surveys should be carried out, ideally once a month for the first year after completion; thereafter monitoring should be continued at least every quarter and at least up to five years after construction. All mortalities should be recorded and reported to the existing Rössing Environmental Section for follow up. All incidents should be reported to the NamPower/NNF Strategic Partnership.

9 KEY RECOMMENDATIONS

The following key recommendations are made:

- The base case site is an established core breeding habitat for the Damara Terns and should be avoided and designated as a "no-go" area at all times, with zero further habitat destruction. These mitigation measures must be carried forward into the SEMP for implementation during the project lifecycle. If the desalination plant is moved to the north-eastern portions of this site, that are outside the core breeding area, the project could then proceed, subject to the implementation of all other recommended mitigation measures
- The development has the potential for increasing the conservation of the established core Damara Tern breeding site by means of:
  - ~ Increasing awareness/publicity about the breeding site and its vulnerability (especially in view of Rössing's already demonstrated commitment to the conservation of Damara Terns);
  - ~ Demarcation and protection of the site to exclude access by recreational and other vehicles and any other form of intrusive disturbance or habitat destruction; and
  - ~ Ongoing monitoring of numbers and breeding success in the general area, and of threats;
- Both construction and planned (annual) maintenance activities should preferably be zoned in time outside the main Damara Tern breeding season, which is October to April. Even then, unnecessary noise disturbance should be avoided;
- The power cable should preferably be buried, which would reduce the bird collision potential to zero. Should this not be possible in its entirety, at least the subsection linking the plant to the C34 road and then the first 3.5 km south of this intersection should be buried;
- Recommended mitigation measures for the impacts identified in this report and the reasons for them should be included in the induction of both construction and operational staff. Any offences should be dealt with promptly;
- Ongoing awareness should be promoted about:
  - ~ Negative impacts and undesirability of habitat destruction including off-road driving; and
  - ~ Negative impacts of disturbance, especially to breeding birds; and
- Ongoing monitoring (to be integrated with existing Rössing environmental protocols and guidelines):
  - ~ Regular/annual audits of outside lighting fixtures in order to ensure that the guidelines laid down by the International Dark-Sky Association for the quality of outdoor lighting are maintained (www.darksky.org);
  - ~ Regular audits of noise levels during the operational phase;
  - ~ All power line structures for collisions or electrocutions (incidents should be reported to the NamPower/NNF Strategic Partnership);
  - ~ Damara Tern numbers and breeding success, and threats, in the greater area during the breeding season; and
  - ~ Cormorant occupation of the guano platforms (if possible, e.g. by aerial photography; annual guano production).

10 CONCLUSIONS

The biodiversity value of the Swakopmund Salt Works area, proposed for the construction of the Swakopmund Salt Works, is high with a number of Red Data and/or endemic breeding bird species and migrants.

In terms of risk to the environment, the main predicted impacts are identified as follows during the construction phase: destruction/modification of Damara Tern breeding habitat; destruction/ modification of habitat of other birds; and physical disturbance, to breeding birds, especially Damara Terns. During the operations phase, the impacts are physical disturbance to breeding birds, especially Damara Terns; physical disturbance to roosting/breeding cormorants; collisions of birds with power line structures; and electrocutions of birds on power line structures. During the decommissioning phase, the impact is physical disturbance to breeding birds, especially Damara Terns.

Aquatic bird species identified as being at high risk include the Damara Tern (Near Threatened, Globally Threatened): disturbance in breeding habitat, destruction of breeding habitat; Lesser Flamingo (Vulnerable, Globally Threatened): collisions on power line; and Greater Flamingo (Vulnerable): collisions on power line. Species at moderate risk include the Cape Cormorant (Near Threatened, Globally Threatened): potential noise disturbance in breeding/ roosting habitat; Great White Pelican (Vulnerable): prone to collisions and electrocutions on power lines; and Black-necked Grebe (Near Threatened): prone to collisions on power line.

A number of mitigation measures have been recommended that, if implemented effectively, will help reduce the above impacts. Because resources and funds available for the conservation management of many threatened species are limited, it is important to determine the effectiveness of different conservation measures aimed at protecting threatened species by means of an integrated monitoring programme (Braby *et al*. 2009).

The base case site layout as presented at the commencement of this study, that places the desalination plant at the centre of area No. 1, coincides with an established core Damara Tern breeding area. Given the conservation importance of this species and the cumulative impacts currently affecting its breeding areas across the coastline, it is believed that the pursuit of this layout constitutes an environmental fatal flaw and should not be authorised. If the desalination plant is moved to the north-eastern portions of this site, that are outside the core breeding area, the project could then proceed, subject to the implementation of all other recommended mitigation measures.

Rössing Uranium Limited has a commendable track record in terms of environmental management, and it can be predicted confidently that the mitigation measures will be implemented.

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APPENDIX 1. CHECKLIST OF BIRD SPECIES RECORDED IN THE RÖSSING DESALINATION PLANT STUDY AREA (2214DA)

Key:
RVII = taxonomic order according to Roberts VII Birds of Southern Africa
RVI = Previous Roberts numbers
RDS = Red Data Status (LC = Least Concern, V = Vulnerable, NT = near Threatened, E = Endangered, CE = Critically Endangered; [1]Simmons & Brown in press; [2]BirdLife International 2014 (The IUCN Red List of Threatened Species. Version 2014.1. <www.iucnredlist.org>)
End S = Endemic status (E = endemic, NE = near-endemic, sA = southern Africa, Nam = Namibia)
Mov = movements (R = resident, N = nomadic, M = migrant, V = vagrant, Ra = rare)
Habitat (M = marine/coastal, W = wetland [coastal or freshwater], T = predominantly terrestrial)
Reporting rate (%): SABAP1 (1986-1997; QDS 2214Da) and Namibian Avifaunal Database (NAD); SABAP2 (2012 onwards; P1 = Pentad 2235_1430 [south], n = 43; P2 = Pentad 2230_1430 [north], n= 9)

RVII	RVI	Species (common name)	Species (scientific names)	RDS	End S	Mov	Habitat	Reporting rate (%)		
								SABAP1	SABAP2	
								2214Da	P1	P2
10	194	Red-billed Spurfowl	*Pternistis adspersus*	LC	NE (sA)	R	T	1		
20	203	Helmeted Guineafowl	*Numida meleagris*	LC		R	T			11
22	99	White-faced Duck	*Dendrocygna viduata*	LC		R,N	W		2	
23	101	White-backed Duck	*Thalassornis leuconotus*	LC		R, N	W	1		
24	117	Maccoa Duck	*Oxyura maccoa*	NT[1]		R, N	W	6	2	
25	102	Egyptian Goose	*Alopochen aegyptiaca*	LC		N	W	26	37	
26	103	South African Shelduck	*Tadorna cana*	LC	E (sA)	R, N	W	29	12	12
30	106	Cape Teal	*Anas capensis*	LC		N	W	63	77	44
34	112	Cape Shoveler	*Anas smithii*	LC	NE (sA)	N	W	44	21	
36	108	Red-billed Teal	*Anas erythrorhyncha*	LC		R, N	W	16	9	
39	107	Hottentot Teal	*Anas hottentota*	LC		R, N	W	2	12	
40	113	Southern Pochard	*Netta erythrophthalma*	LC		R, M	W	2		
53	483	Golden-tailed Woodpecker	*Campethera abingoni*	LC		R	T	NAD		
57	486	Cardinal Woodpecker	*Dendropicos fuscescens*	LC		R	T	NAD		
58	487	Bearded Woodpecker	*Dendropicos namaquus*	LC		R	T	0.3		
70	462	Monteiro's Hornbill	*Tockus monteiri*	LC	E (sA)	N	T	0.3		
73	459	Southern Yellow-billed Hornbill	*Tockus leucomelas*	LC	NE (sA)	R	T	0.3		
76	457	African Grey Hornbill	*Tockus nasutus*	LC		R	T	6		
81	452	Green Wood-Hoopoe	*Phoeniculus purpureus*	LC		R	T	0.3		
83	454	Common Scimitarbill	*Rhinopomastus cyanomelas*	LC		R	T	1	2	
99	428	Pied Kingfisher	*Ceryle rudis*	LC		R, N	M, W	0.3		
102	445	Swallow-tailed Bee-eater	*Merops hirundineus*	LC		R	T	9		
109	425	White-backed Mousebird	*Colius colius*	LC	E (sA)	R	T	17		
111	426	Red-faced Mousebird	*Urocolius indicus*	LC		R	T	4	14	
125	386	Diderick Cuckoo	*Chrysococcyx caprius*	LC		M	T	1		

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RVII	RVI	Species (common name)	Species (scientific names)	RDS	End S	Mov	Habitat	Reporting rate (%)		
								SABAP1	SABAP2	
								2214Da	P1	P2
136	365	Rüppell's Parrot	*Poicephalus rueppellii*	NT[1]	NE (Nam)	R, N	T	0.3		
137	367	Rosy-faced Lovebird	*Agapornis roseicollis*	LC	NE (Nam)	N	T	0.3		
144	421	African Palm-Swift	*Cypsiurus parvus*	LC		R	T	2	2	
145	418	Alpine Swift	*Tachymarptis melba*	LC		R	T	1	2	
150	413	Bradfield's Swift	*Apus bradfieldi*	LC	NE (Nam)	R	T	4	5	
151	417	Little Swift	*Apus affinis*	LC		R, M	T	1	4	
153	415	White-rumped Swift	*Apus caffer*	LC		M	T	1	2	
159	373	Grey Go-away-bird	*Corythaixoides concolor*	LC		R	T	6		
160	392	Barn Owl	*Tyto alba*	LC		R	T	0.3		
165	401	Spotted Eagle-Owl	*Bubo africanus*	LC		R	T	1		
166	402	Verreaux's Eagle-Owl	*Bubo lacteus*	LC		R	T	0.3		
169	398	Pearl-spotted Owlet	*Glaucidium perlatum*	LC		R	T	0.3		
179	348	Rock Dove	*Columba livia*	LC		R	T	29	40	
180	349	Speckled Pigeon	*Columba guinea*	LC		R	T	2	5	
185	355	Laughing Dove	*Streptopelia senegalensis*	LC		R	T	53	44	
187	354	Cape Turtle-Dove	*Streptopelia capicola*	LC		R, N	T	6		
192	356	Namaqua Dove	*Oena capensis*	LC		R, N	T	13		
200	236	Rüppell's Korhaan	*Eupodotis rueppellii*	LC	NE (Nam)	R	T	1		
217	213	Black Crake	*Amaurornis flavirostris*	LC		R	W	0.3		
221	223	African Purple Swamphen	*Porphyrio madagascariensis*	LC		R	W	11		
224	226	Common Moorhen	*Gallinula chloropus*	LC		R, N	W	48	33	
225	227	Lesser Moorhen	*Gallinula angulata*	LC		M	W	1		
226	228	Red-knobbed Coot	*Fulica cristata*	LC		R, N	W	57	21	
227	344	Namaqua Sandgrouse	*Pterocles namaqua*	LC	NE (sA)	N	T	1		
232	286	African Snipe	*Gallinago nigripennis*	LC		N	W	0.3		
233	287	Black-tailed Godwit	*Limosa limosa*	LC		M	W	0.3		
235	288	Bar-tailed Godwit	*Limosa lapponica*	LC		M	W	27	2	2
236	290	Common Whimbrel	*Numenius phaeopus*	LC		M	M, W	46	61	56
237	289	Eurasian Curlew	*Numenius arquata*	LC		M	M, W	9		
239	268	Common Redshank	*Tringa totanus*	LC		M	W	4	9	6
240	269	Marsh Sandpiper	*Tringa stagnatilis*	LC		M	W	14		
241	270	Common Greenshank	*Tringa nebularia*	LC		M	M, W	33	49	49
245	266	Wood Sandpiper	*Tringa glareola*	LC		N, M	W	13		10
246	263	Terek Sandpiper	*Xenus cinereus*	LC		M	W	2		
247	264	Common Sandpiper	*Actitis hypoleucos*	LC		M	W	30	14	
248	262	Ruddy Turnstone	*Arenaria interpres*	LC		M	M	65	84	78

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RVII	RVI	Species (common name)	Species (scientific names)	RDS	End S	Mov	Habitat	Reporting rate (%)		
								SABAP1	SABAP2	
								2214Da	P1	P2
249	271	Red Knot	*Calidris canutus*	LC		M	M, W	13	2	
251	281	Sanderling	*Calidris alba*	LC		M	M	26	37	22
252	274	Little Stint	*Calidris minuta*	LC		M	M, W	33	56	11
260	272	Curlew Sandpiper	*Calidris ferruginea*	LC		M	M, W	55	63	22
261	282	Buff-breasted Sandpiper	*Tryngites subruficollis*			V Ra	W			1
262	283	Broad-billed Sandpiper	*Limicola falcinellus*	LC		M	W	0.3		
263	284	Ruff	*Philomachus pugnax*	LC		M	M, W	30	12	11
265	292	Red-necked Phalarope	*Phalaropus lobatus*	LC		M	W	0.3	2	
266	291	Red Phalarope	*Phalaropus fulicaria*	LC		M	W	0.3		
267	242	Greater Painted-snipe	*Rostratula benghalensis*	LC		N, M	W	0.3		
268	240	African Jacana	*Actophilornis africanus*	LC		R	W	1	7	
272	297	Spotted Thick-knee	*Burhinus capensis*	LC		R	T	3		
273	243	Eurasian Oystercatcher	*Haematopus ostralegus*	LC		M, V	M	1		
274	244	African (Black) Oystercatcher	*Haematopus ostralegus*	NT[1], GT[2]		R, N	M	24	61	56
275	295	Black-winged Stilt	*Himantopus himantopus*	LC		R, N, M	W	38	84	22
276	294	Pied Avocet	*Recurvirostra avosetta*	LC		R, N, M	W	57	79	44
277	253	Pacific Golden Plover	*Pluvialis fulva*	LC		V	W, T	0.3		
278		American Golden Plover	*Pluvialis dominica*	LC		W			2	
279	254	Grey Plover	*Pluvialis squatarola*	LC		M	M, W	50	67	89
280	245	Common Ringed Plover	*Charadrius hiaticula*	LC		M	W	20	16	22
282	248	Kittlitz's Plover	*Charadrius pecuarius*	LC		R, N, M	W, T	23	5	11
283	249	Three-banded Plover	*Charadrius tricollaris*	LC		R, N	W	58	23	
284	247	Chestnut-banded Plover	*Charadrius pallidus*	NT[1]		R, N, M	M, W	23	70	11
286	246	White-fronted Plover	*Charadrius marginatus*	LC		R	M, W	61	95	89
287	250	Lesser Sand Plover	*Charadrius mongolus*	LC		M	M	0.3		
288	251	Greater Sand Plover	*Charadrius leschenaultii*	LC		M	M	0.7		
289	252	Caspian Plover	*Charadrius asiaticus*	LC		M	W, T	0.7		
291	258	Blacksmith Lapwing	*Vanellus armatus*	LC		R, N, M	W	55	30	
294	260	African Wattled Lapwing	*Vanellus senegallus*	LC		R, N, M	W		9	
297	255	Crowned Lapwing	*Vanellus coronatus*	LC		R, N	T	1		
299	301	Double-banded Courser	*Rhinoptilus africanus*	LC		R	T	0.3		
307	310	Subantarctic Skua	*Catharacta antarctica*	LC		M?	M	0.3		
309	309	Pomarine Jaeger	*Stercorarius pomarinus*	LC		M	M	0.3	2	
310	307	Parasitic Jaeger	*Stercorarius parasiticus*	LC		M	M	4	2	
313	312	Kelp Gull	*Larus dominicanus*	LC		R	M	80	100	89
316	315	Grey-headed Gull	*Larus cirrocephalus*	LC		R, N	M, W	46	28	1

APPENDIX 1. CHECKLIST OF BIRD SPECIES RECORDED IN THE RÖSSING DESALINATION PLANT STUDY AREA (2214DA)

RVII	RVI	Species (common name)	Species (scientific names)	RDS	End S	Mov	Habitat	Reporting rate (%)		
								SABAP1	SABAP2	
								2214Da	P1	P2
317	316	Hartlaub's Gull	*Larus hartlaubii*	V[1]	E (sA)	R, N	M, W	81	95	78
318	319	Common Black-headed Gull	*Larus ridibundus*	LC		V	M, W		2	
320	317	Franklin's Gull	*Larus pipixcan*	LC		V	M	0.7		
324	322	Caspian Tern	*Sterna caspia*	V[1]		R, N	M, W	13	14	
327	324	Swift Tern	*Sterna bergii*	LC		R, N	M	30	91	44
328	326	Sandwich Tern	*Sterna sandvicensis*	LC		M	M	32	65	33
331	327	Common Tern	*Sterna hirundo*	LC		M	M	26	40	11
332	328	Arctic Tern	*Sterna paradisaea*	LC		M	M	16		
334	335	Little Tern	*Sterna albifrons*	LC		M	M	0.7		
335	334	Damara Tern	*Sternula (Sterna) balaenarum*	NT[1], GT[2]	BE (Nam)	R, M	M	24	40	11
339	338	Whiskered Tern	*Chlidonias hybrida*	LC		R, N	W	1		
340	339	White-winged Tern	*Chlidonias leucopterus*	LC		M	W	3	1	
341	337	Black Tern	*Chlidonias niger*	LC		M	M	12	7	
		Elegant Tern	*Thalasseus elegan*			V			2	
348	127	Black-shouldered Kite	*Elanus caeruleus*	LC		R, N	T	3		
350	148	African Fish-Eagle	*Haliaeetus vocifer*	V[1]		R	W	0.3		
358	124	Lappet-faced Vulture	*Aegypius tracheliotus*	V[1], GT[2]		R, N	T	0.3		
360	143	Black-chested Snake-Eagle	*Circaetus pectoralis*	LC		R, N	T	0.7		
373	162	Southern Pale Chanting Goshawk	*Melierax gabar*	LC	NE (sA)	R, N	T	0.3		
374	161	Gabar Goshawk	*Melierax gabar*	LC		R	T	1		
384	153	Augur Buzzard	*Buteo augur*	LC		R	T	0.3		
389	131	Verreauxs' Eagle	*Aquila verreauxii*	NT[1]		R	T	0.3		
394	140	Martial Eagle	*Polemaetus bellicosus*	E[1]		R	T	1		
400	181	Rock Kestrel	*Falco rupicolus*	LC		R, N	T	14	19	33
401	182	Greater Kestrel	*Falco rupicoloides*	LC		R, N	T	0.3		
411	172	Lanner Falcon	*Falco biarmicus*	LC		R, M	T	0.3		
412	171	Peregrine Falcon	*Falco peregrinus*	NT[1]		R, M	T	0.3	5	
414	8	Little Grebe	*Tachybaptus ruficollis*	LC		R, N	W	51	17	
415	6	Great Crested Grebe	*Podiceps cristatus*	E[1]		R	W	5	2	
416	7	Black-necked Grebe	*Podiceps nigricollis*	NT[1]		R, N	M, W	21	79	
420	53	Cape Gannet	*Morus capensis*	E[1], GT[2]		N	M	13	2	11
424	60	African Darter	*Anhinga rufa*	LC		R	W	0.3		
425	58	Reed Cormorant	*Phalacrocorax africanus*	LC		R, N	W	8	2	
426	59	Crowned Cormorant	*Phalacrocorax coronatus*	NT[1], GT[2]	E (sA)	R	M	5	49	22
427	55	White-breasted Cormorant	*Phalacrocorax lucidus*	LC		R, N	M, W	74	98	89
427	56	Cape Cormorant	*Phalacrocorax capensis*	NT[1], GT[2]	NE (sA)	N	M	69	98	89

APPENDIX 1. CHECKLIST OF BIRD SPECIES RECORDED IN THE RÖSSING DESALINATION PLANT STUDY AREA (2214DA)

RVII	RVI	Species (common name)	Species (scientific names)	RDS	End S	Mov	Habitat	Reporting rate (%)		
								SABAP1	SABAP2	
								2214Da	P1	P2
428	57	Bank Cormorant	*Phalacrocorax neglectus*	NT[1], GT[2]	NE (sA)	R, N	M	11	7	10
431	69	Black Heron	*Egretta ardesiaca*	LC		R	W	0.3		
432	67	Little Egret	*Egretta garzetta*	LC		R, N	M, W	56	77	67
434	68	Yellow-billed Egret	*Egretta intermedia*	LC		R, N	W	0.7		
435	66	Great Egret	*Egretta alba*	LC		R, N	W	2		
438	62	Grey Heron	*Ardea cinerea*	LC		R	W	56	65	33
439	63	Black-headed Heron	*Ardea melanocephala*	LC		R	W, T	8		
441	65	Purple Heron	*Ardea purpurea*	LC		R	W	16		
442	71	Cattle Egret	*Bubulcus ibis*	LC		R	W, T	28		
443	72	Squacco Heron	*Ardeola ralloides*	LC		R, N	W	2		
446	74	Green-backed Heron	*Butorides striata*	LC		R	W	0.3		
447	76	Black-crowned Night-Heron	*Nycticorax nycticorax*	LC		R, N	W	0.3		
452	81	Hamerkop	*Scopus umbretta*	LC		R	W, T	1		
453	96	Greater Flamingo	*Phoenicopterus roseus*	V[1]		R, N, M	M, W	57	98	56
454	97	Lesser Flamingo	*Phoeniconaias minor*	V[1], GT[2]		R, N, M	M, W	57	88	44
459	95	African Spoonbill	*Platalea alba*	LC		R, N	W	3		
460	49	Great White Pelican	*Pelecanus onocrotalus*	V[1]		R, N	M, W	73	35	22
461	50	Pink-backed Pelican	*Pelecanus rufescens*	LC		R	W	0.7		
464	84	Black Stork	*Ciconia nigra*	E[1]		R, N	W, T	0.3		
467	83	White Stork	*Ciconia ciconia*	LC		M	W, T	0.3		
476	3	African Penguin	*Spheniscus demersus*	E[1], GT[2]		N	M	1		
478	44	Wilson's Storm-Petrel	*Oceanites oceanicus*	LC		N	M	0.3		
494	12	Black-browed Albatross	*Thalassarche melanophrys*	E[1]		N	M	0.3		
496	14	Atlantic Yellow-nosed Albatross	*Thalassarche chlororhynchos*	E[1]		N	M	0.3		
497		Indian Yellow-nosed Albatross	*Thalassarche carteri*	LC		R, N	M	0.3		
500	17	Southern Giant-Petrel	*Macronectes giganteus*	LC		N	M	0.7		
519	32	White-chinned Petrel	*Procellaria aequinoctialis*	V[1]		N	M	0.3		
520		Spectacled Petrel	*Procellaria conspicillata*	LC		R, N	M	0.3		
526	37	Sooty Shearwater	*Puffinus griseus*	LC		N	M	0.3		
534	543	Eurasian Golden Oriole	*Oriolus oriolus*	LC		M	T	0.3		
539	541	Fork-tailed Drongo	*Dicrurus adsimilis*	LC		R	T	2	7	
546	743	Brown-crowned Tchagra	*Tchagra australis*	LC		R	T	0.3		
551	739	Crimson-breasted Shrike	*Laniarius atrococcineus*	LC	NE (sA)	R	T	0.3		
552	746	Bokmakierie	*Telophorus zeylonus*	LC	NE (sA)	R	T	4	2	
567	703	Pririt Batis	*Batis pririt*	LC	NE (sA)	R	T	1		
570	547	Cape Crow	*Corvus capensis*	LC		R	T	2		

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RVII	RVI	Species (common name)	Species (scientific names)	RDS	End S	Mov	Habitat	Reporting rate (%)		
								SABAP1	SABAP2	
								2214Da	P1	P2
571	548	Pied Crow	*Corvus albus*	LC		N	T	20	14	
573	733	Red-backed Shrike	*Lanius collurio*	LC		M	T	0.7		
576	732	Common Fiscal	*Lanius collaris*	LC		R	T	11	7	
594	533	Brown-throated Martin	*Riparia paludicola*	LC		R, M	W, T	4	2	
598	518	Barn Swallow	*Hirundo rustica*	LC		M	T	24	12	
600	520	White-throated Swallow	*Hirundo albigularis*	LC		M	T	4		
603	523	Pearl-breasted Swallow	*Hirundo dimidiata*	LC		M	T	1		
604	526	Greater Striped Swallow	*Hirundo cucullata*	LC		M	T	2		
609	528	South African Cliff-Swallow	*Hirundo spilodera*	LC		M	T	1		
610	529	Rock Martin	*Hirundo fuligula*	LC		R, N, M	T	18	9	11
611	530	Common House-Martin	*Delichon urbicum*	LC		M	T	NAD		
616	567	African Red-eyed Bulbul	*Pycnonotus nigricans*	LC	NE (sA)	R, N	T	23	7	
634	651	Long-billed Crombec	*Sylvietta rufescens*	LC		R	T	0.7		
635	653	Yellow-bellied Eremomela	*Eremomela icteropygialis*	LC		R, N	T	3		
644	634	Sedge Warbler	*Acrocephalus schoenobaenus*	LC		M	W, T	0.3		
646	631	African Reed-Warbler	*Acrocephalus baeticatus*	LC		M	W, T	17	14	
651	635	Lesser Swamp-Warbler	*Acrocephalus gracilirostris*	LC		R	W, T	0.7		
653	625	Icterine Warbler	*Hippolais icterina*	LC		M	W, T	0.3		
656	643	Willow Warbler	*Phylloscopus trochilus*	LC		M	W, T	1	2	
666	621	Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*	LC		R	T	6		
668	619	Garden Warbler	*Sylvia borin*	LC		M	T	0.7		
671	796	Cape White-eye	*Zosterops virens*	LC	E (sA)	R	T	7		
678	669	Grey-backed Cisticola	*Cisticola subruficapilla*	LC	NE (sA)	R	T	0.3		
687	664	Zitting Cisticola	*Cisticola juncidis*	LC		R	T	1		
688	665	Desert Cisticola	*Cisticola aridulus*	LC		R	T	0.7	5	11
693	685	Black-chested Prinia	*Prinia flavicans*	LC	NE (sA)	R	T	13		
717	498	Sabota Lark	*Calendulauda sabota*	LC	NE (sA)	N	T	0.3		
722	503	Dune Lark	*Calendulauda erythrochlamys*	LC	E (Namib)	R	T	NAD		
724	514	Gray's Lark	*Ammomanopsis grayi*	LC	NE (Nam)	R, N	T	6	21	44
734	516	Grey-backed Sparrow-lark	*Eremopterix verticalis*	LC	NE (sA)	N, M	T	NAD	7	11
735	507	Red-capped Lark	*Calandrella cinerea*	LC		R, N, M	T	6	16	44
754	697	Chat Flycatcher	*Bradornis infuscatus*	LC	NE (sA)	R	T	0.3		
758	689	Spotted Flycatcher	*Muscicapa striata*	LC		M	T	0.3		
784	586	Mountain Wheatear	*Oenanthe monticola*	LC	E (sA)	R	T	2		
790	592	Karoo Chat	*Cercomela schlegelii*	LC	NE (sA)	R	T	1		
791	590	Tractrac Chat	*Cercomela tractrac*	LC	NE (sA)	N	T	20	33	33

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RVII	RVI	Species (common name)	Species (scientific names)	RDS	End S	Mov	Habitat	Reporting rate (%) SABAP1 2214Da	SABAP2 P1	SABAP2 P2
792	589	Familiar Chat	*Cercomela familiaris*	LC		R, N	T	12	14	
793	595	Ant-eating Chat	*Myrmecocichla formicivora*	LC	E (sA)	N	T	0.3		
797	770	Pale-winged Starling	*Onychognathus nabouroup*	LC	NE (sA)	N	T	8		
800	764	Cape Glossy Starling	*Lamprotornis nitens*	LC		R	T	0.3		
808	760	Wattled Starling	*Creatophora cinerea*	LC		R, N	T	7	2	
819	791	Scarlet-chested Sunbird	*Chalcomitra senegalensis*	LC		R, N	T	0.7		
830	788	Dusky Sunbird	*Cinnyris fuscus*	LC	NE (sA)	R, N	T	32	23	
836	798	Red-billed Buffalo-Weaver	*Bubalornis niger*	LC		R, N	T	0.7		
837	806	Scaly-feathered Finch	*Sporopipes squamifrons*	LC	NE (sA)	R, N	T	0.7		
838	799	White-browed Sparrow-Weaver	*Plocepasser mahali*	LC		R	T	0.3		
846	814	Southern Masked-Weaver	*Ploceus velatus*	LC	NE (sA)	R, M	T	29	26	
857	824	Southern Red Bishop	*Euplectes orix*	LC		R	T	2		
874	847	Black-faced Waxbill	*Estrilda erythronotos*	LC		R	T	0.3		
877	846	Common Waxbill	*Estrilda astrild*	LC		R	T	53	33	
901	801	House Sparrow	*Passer domesticus*	Alien		R	T	41	19	
902	802	Great Sparrow	*Passer motitensis*	LC	NE (sA)	R, N	T	1		
903	803	Cape Sparrow	*Passer melanurus*	LC	NE (sA)	R	T	34	65	22
904	804	Southern Grey-headed Sparrow	*Passer diffusus*	LC		R, N	T	0.3		
905		Northern Grey-headed Sparrow	*Passer griseus*	LC				0.3		
908	713	Cape Wagtail	*Motacilla capensis*	LC		R	M, W, T	55	86	44
909	714	Yellow Wagtail	*Motacilla flava*	LC		M	W	0.3	2	
920	716	African Pipit	*Anthus cinnamomeus*	LC					14	
925	717	Long-billed Pipit	*Anthus similis*	LC					19	
936	870	Black-throated Canary	*Crithagra atrogularis*	LC		R	T	0.3		
939	878	Yellow Canary	*Crithagra flaviventris*	LC	NE (sA)	R, N	T	1		
941	879	White-throated Canary	*Crithagra albogularis*	LC	NE (sA)	R, N	T	1	2	
947	887	Lark-like Bunting	*Emberiza impetuani*	LC	NE (sA)	N	T	0.3		
948	886	Cinnamon-breasted Bunting	*Emberiza tahapisi*	LC		R, M	T	0.3		
TOTALS		**233 species** **35% of 676 Namibian species**	**26 (11%) threatened in Namibia;** **9 (4%) globally threatened**	**35 E/NE sA; 7 NE Nam** **(including 1 E Namib, 1 BE)** **Tot E/NE 42 spp (18%)**			**150 (64%) resident** **80 (34%) nomadic at some stage** **72 (31%) migrant at some stage**			

APPENDIX 2. SUMMARY CHECKLIST OF BIRD SPECIES REGARDED AS BEING POTENTIALLY AT RISK IN THE RÖSSING DESALINATION PLANT STUDY AREA (2214DA)

Key:
RVII = taxonomic order according to Roberts VII Birds of Southern Africa; **RVI** = Previous Roberts numbers
RDS = Red Data Status (LC = Least Concern, V = Vulnerable, NT = near Threatened, E = Endangered, CE = Critically Endangered; [1]Simmons & Brown in press; [2]BirdLife International 2014 (The IUCN Red List of Threatened Species. Version 2014.1. <www.iucnredlist.org>)
End S = Endemic status (E = endemic, NE = near-endemic, sA = southern Africa, Nam = Namibia)
Mov = movements (R = resident, N = nomadic, M = migrant, V = vagrant, Ra = rare)
Habitat (M = marine/coastal, W = wetland [coastal or freshwater], T = predominantly terrestrial)
Reporting rate (%): SABAP1 (1986-1997; QDS 2214Da) and Namibian Biodiversity Database (NAD); SABAP2 (2012 onwards; P1 = Pentad 2235_1430 [south], n = 43; P2 = Pentad 2230_1430 [north], n= 9)
Impact D = physical disturbance (br = breeding), HD = habitat destruction/modification, C = collision with power line structures, E = electrocution, N = potential to disrupt power supply through nesting activities
Potential = potential for impact (very low, low, mod = moderate, high)

RVII	RVI	Species (common name)	Species (scientific names)	RDS	End S	Mov	Habitat	Reporting rate (%)			Impact	Potential
								SABAP1	SABAP2			
								2214Da	P1	P2		
24	117	Maccoa Duck	*Oxyura maccoa*	NT[1]		R, N	W	6	2		C, HD	Low
274	244	African (Black) Oystercatcher	*Haematopus ostralegus*	NT[1], GT[2]		R, N	M	24	61	56	D	Low
284	247	Chestnut-banded Plover	*Charadrius pallidus*	NT[1]		R, N, M	M, W	23	70	11	D, HD	Low
317	316	Hartlaub's Gull	*Larus hartlaubii*	V[1]	E (sA)	R, N	M, W	81	95	78	C?	Low
324	322	Caspian Tern	*Sterna caspia*	V[1]		R, N	M, W	13	14		C	Low
335	334	Damara Tern	*Sternula (Sterna) balaenarum*	NT[1], GT[2]	BE (Nam)	R, M	M	24	40	11	D (br), HD	High
350	148	African Fish-Eagle	*Haliaeetus vocifer*	V[1]		R	W	0.3			C, E, HD	Very low
358	124	Lappet-faced Vulture	*Aegypius tracheliotus*	V[1], GT[2]		R, N	T	0.3			C, E, D, HD	Very low
360	143	Black-chested Snake-Eagle	*Circaetus pectoralis*	LC		R, N	T	0.7			C	Very low
412	171	Peregrine Falcon	*Falco peregrinus*	NT[1]		R, M	T	0.3	5		C, E	Low
415	6	Great Crested Grebe	*Podiceps cristatus*	E[1]		R	W	5	2		C, HD	Very low
416	7	Black-necked Grebe	*Podiceps nigricollis*	NT[1]		R, N	M, W	21	79		C	Mod
426	59	Crowned Cormorant	*Phalacrocorax coronatus*	NT[1], GT[2]	E (sA)	R	M	5	49	22	D (br)	Low
427	56	Cape Cormorant	*Phalacrocorax capensis*	NT[1], GT[2]	NE (sA)	N	M	69	98	89	D (br)	Mod
428	57	Bank Cormorant	*Phalacrocorax neglectus*	NT[1], GT[2]	NE (sA)	R, N	M	11	7	10	D (br)	Low
453	96	Greater Flamingo	*Phoenicopterus roseus*	V[1]		R, N, M	M, W	57	98	56	C	High
454	97	Lesser Flamingo	*Phoeniconaias minor*	V[1], GT[2]		R, N, M	M, W	57	88	44	C	High
460	49	Great White Pelican	*Pelecanus onocrotalus*	V[1]		R, N	M, W	73	35	22	C	Mod
571	548	Pied Crow	*Corvus albus*	LC		N	T	20	14		N	Low
724	514	Gray's Lark	*Ammomanopsis grayi*	LC	NE (Nam)	R, N	T	6	21	44	D, HD	Low?