ENVIRONMENTAL IMPACT ASSESSMENT

OF THE PROPOSED 66Kv POWER-LINE ROUTE TO SERVICE TREKKOPJE URANIUM MINE AND THE ASSOCIATED DESALINATION PLANT AT WLOTZKASBAKEN

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Existing Khan – Henties power-line

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Introduction

1.1. Demand for the proposed power-line

The proposed uranium mine at Trekkopje, 40 km NE of Swakopmund in Erongo Region, being operated by Uramin Namibia, involves the establishment of a large-volume, low-grade mining operation and associated heap-leach uranium extraction process. The heap-leach process will require an estimated 15 Mm³ of water per year, which is to be provided to the mine from a desalination plant to be constructed at Wlotzkasbaken, 30 km N of Swakopmund. The mining, heap-leaching and desalination processes will require electricity. This is to be obtained from the national electricity grid that is maintained by NamPower.

As part of the existing electricity grid, there are power-lines and substations in the proximity of the proposed developments (refer Fig 1). A 220Kv line runs from Usakos to Swakopmund to the east and south of the site. It gives off a 66Kv line at Khan Substation situated on the farm Namibfontein, about 30km east of Trekkopje, and this line passes over the Trekkopje tenement on its way to Henties Bay. The proposed power-line to service Trekkopje and the desalination plant will be an additional 66Kv line running parallel to the existing line from Khan Substation. It will have two substations at the mine, close to the plant site and at the terminal reservoir where desalinated water will be stored before it is piped onto the mine property. There will also be a terminal substation close to Wlotzkasbaken at the desalination plant.

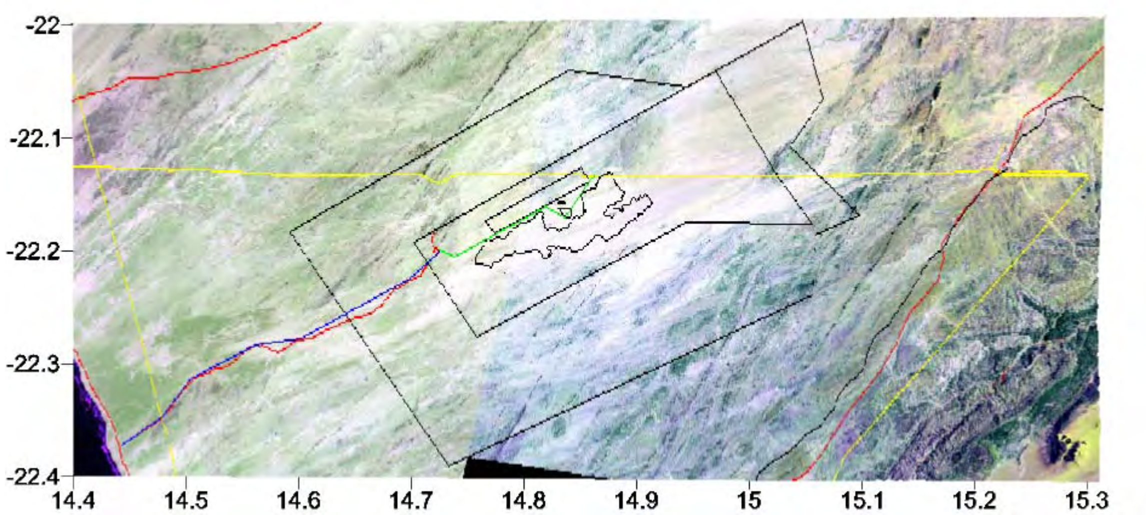

Figure 1. Overview of the project area and surroundings. Features of interest overlain on Landsat satellite image. Refer to smaller scale maps below for more details.

A meeting in Windhoek in June 2007, of concerned stakeholders around issues of water and power supply to the proposed Trekkopje Mine, discussed the alternative of siting the desalination plant at or close to the Swakopmund Salt Works. This alternative would remove the need for a power-line from the Trekkopje Mine plant to Wlotzkasbaken, as power could potentially be supplied from the much nearer Tamarisk Substation situated on the northern side of Swakopmund. Although the meeting decided that this alternative should be investigated, the implications for power-lines were not included in this assessment.

The same meeting also decided to request authorities to investigate the construction of a single, larger desalination plant at an unspecified central location in order to service the water needs not only of Trekkopje, but also of the several other emerging or planned uranium mines in the area. The power-line implications of such an alternative obviously could not be included in this assessment either.

1.2. Terms of reference

EEAN was requested to undertake an environmental impact assessment of the construction and operation of the proposed power-line. Biodata was requested to investigate both the power-line route and the mining area with specific reference to insects. The identified route of the power-line was provided in a map (similar to Figure 1) and as GPS coordinates.

The precise route of the proposed power-line was not confirmed at the time of the assessment, but our instructions were to investigate the following:

- From the Khan Substation on the farm Namibfontein, to the point at which the existing 66Kv line leaves the Trekkopje tenement (approximately 22°08'04"S 14°48'13"E).
- A suitable route from the Khan-Henties Bay line to the estimated location of the mine plant (22°10'11"S 14°50'11"E).
- A suitable route from the plant site to the proposed site of the terminal reservoir.
- From the terminal reservoir to the proposed desalination plant site north of Wlotzkasbaken.

1.3. Scope and schedule of work

The route was to be assessed with respect to expected impacts on the biophysical environment during construction and operation of the power-line. Recommendations would be given regarding mitigatory actions to reduce negative impacts, and suggestions could be made on alternative routes with justification for the proposed changes. Following a description of each impact, it would be assessed with regard to the following criteria:

- Intensity of the impact: whether low, medium or high.
- Phase of occurrence of the impact: during construction or operation and maintenance, or both.

- Duration: whether short-term (less than 2 years), medium-term (2-5 years) or long-term (greater than 5 years).
- Extent: an estimation of the area that would be impacted.
- Probability: whether unlikely (low probability), likely (medium probability) or certain (high probability).
- Significance: whether, in the light of the above factors, the impact is considered low, medium or highly significant.
- Mitigation possibility: whether there are reasonable and practical ways to reduce the severity of negative impacts. Mitigation activities would be suggested.

Turgis Consulting is undertaking a full social impact assessment (SIA) of the proposed mine developments. Mobilisation and integration of the landowners affected by the power-line was not included in this study, as it has and will continue to be taken up under the SIA.

Familiarisation of the details of the project has been achieved through involvement of John Pallett in other aspects of Trekkopje work. The route of the power-line was assessed from 25 – 29 June 2007.

2. Description of the affected environment

2.1. Climate

The power-line route traverses the width of the Namib Desert from about 100 km inland to the coast itself, an area that has a pronounced climatic gradient. Average annual rainfall at Namibfontein is about 50mm. At Wlotzkasbaken, average rainfall is about 12mm, and this is supplemented by very frequent fog (more than 125 days per annum) that contributes additional precipitation. Although the amount of fog water is small, it is very significant in relation to the amount of rain, and it is a much more consistent source of moisture. The east-to-west transect therefore witnesses a change from summer rainfall received in intense bouts, to a much lower amount of precipitation received mainly from fog over most of the year. There is a similar temperature gradient. Average annual temperature at Namibfontein is 20-22°C, but less than 16°C at Wlotzkasbaken. (Mendelsohn *et al.*, 2002).

2.2. Landscape and substrate

In the vicinity of the Khan Substation, the land is quite heavily dissected by tributaries leading towards the Khan River. However this lasts for less than the first three kilometers, after which the terrain is gently undulating with occasional hills and koppies in the section between Namibfontein and Trekkopje. In this section, there are parallel ridges of marble and dolerite that stand out as positive relief obliquely transverse to the power-line route. The substrate in this area is generally hard and gravely, with marble and granite bedrock appearing at the surface in many places. Shallow washes are quite frequent but the channels are often indistinct, with braiding and re-joining of shallow channels within wider swathes marked only by the presence of more abundant shrubs and small trees.

As one moves onto the Trekkopje tenement the land opens up into wide, flat or very gently undulating plains. The undulations are caused by numerous shallow washes that are generally oriented northeast to southwest. The plains are mostly bare with only a thin cover of grass and occasional shrubs and bushes. At the time of this assessment all grass tufts were dried out. After rains the plains are green with fresh grass, and at other times they may go for many years in succession with almost no vegetation cover at all. The soil on the plains has a thin surface layer of gravel with very fine (almost powdery) gypsum-rich soil beneath, so these areas are easily scarred by vehicle tracks.

Towards the western side of the tenement the plains are slightly more dissected by small washes, and they are interrupted by dolerite and marble dykes that trend to the southwest. The plains carry vegetation similar to that for the plains in the central part of the tenement, but on the western side they also carry a surface coating of lichens that grow on stones and the soil crust. Orange, black and grey-green lichens give these surfaces a darker appearance, and they are interspersed with paler patches where lichens are absent and the white colour of the quartz stones making up the pavement predominates. The black linear dolerite ridges stand out, with the crests of the ridges composed of large blocky boulders and the flanks scattered with angled and faceted fragments of smooth dolerite. The ridges tend to trap fog water and therefore host many plants and lichens.

2.3. Vegetation

The flora reflects the climate gradient very strongly. Towards the east large plants (such as small trees and large shrubs) are relatively common and there is quite abundant cover of short grasses. Further westwards, shrubs are mostly confined to ephemeral river washes and the plains have only a thin cover of grasses. Close to the coast the plains are almost entirely bare except for occasional shrubs, but they support an abundance of lichens on the soil surface.

Vegetation at Namibfontein is dominated by large shrubs (such as ‘melkbos’ *Euphorbia damarana*), smaller shrubs such as *Lycium*, *Petalidium* and *Monechma*, and small trees such as *Commiphora* spp and rather infrequent *Acacias*.

True Namib Desert plants are first encountered on the Trekkopje tenement. Examples are *Commiphora saxicola* on hard substrates with shallow or surface bedrock, and dollar-bush (*Zygophyllum stapfii*) in the riverbeds.

The open plains of the central Trekkopje area support almost only grasses, but are also scattered with low bushes such as *Zygophyllum stapfii* and *Arthraerua leubnitzae*, and, since the good rains in 2005-2006, many small spiny *Blepharis* plants. Only along drainage lines are small shrubs abundant, predominantly *Zygophyllum stapfii* and *Salsola* spp, and low stunted trees such as *Acacia reficiens* and *Boscia foetida* also grow in the washes. Mannheimer (2006) treats the vegetation of the central area in more detail.

Within about 30 km of the coast there is very little vegetation on the plains. *Arthraerua luebnitzae* is still dominant, but this is also the zone where lichens grow abundantly on the soil crust and surface pavement.

2.4. Fauna

Animals found living in the area have been described in other EIA reports dealing with proposed mining and water supply to Trekkopje (Cunningham 2006; Christian and Pallett 2007; Henschel, Pallett and Seely 2007; Irish 2007). Information from these sources echoes the same concern for koppies: because they harbour more vegetation and provide a greater diversity of resting, sheltering and feeding niches, they are expected to host a greater abundance and diversity of invertebrate and small vertebrate fauna.

3. Route assessment

3.1. Engineering assumptions

- A straight power-line is preferred over one that weaves. Straight lines limit the total length of the line and associated costs. However, exceptions are and have been made if topography so dictates, e.g., the existing Khan-Henties Bay line has a kink in it (centered on 14.725 E, 22.140 S) in order to avoid a dolerite ridge swarm (Fig. 2).
- A power-line that stays mainly on flat ground and that is routed through gaps in topography is preferred over one that attempts to cut straight through rugged terrain. Construction and maintenance is easier on flat ground.
- Power-lines should preferably not cross each other, but can and do when the situation so dictates.

3.2. Guiding environmental principles

- A new power-line parallel and adjacent to an existing power-line is preferred over one that cuts across country that previously had no power-lines. Power-lines detract aesthetically from both the current and the potential post-mining tourism appeal of the area.

- A parallel power-line should be sited the shortest distance away from an existing power-line that is compatible with the servitude requirements of both lines. This can limit the area disrupted during construction.
- Power-line routes should avoid the more prominent ridges and hills, since these are relatively biodiversity-rich and more vulnerable than adjacent flat ground.
- Power-lines may cross directly over low ridges (< 3 - 5m relative height), providing that pylons straddle the ridge and are not sited on the summit.

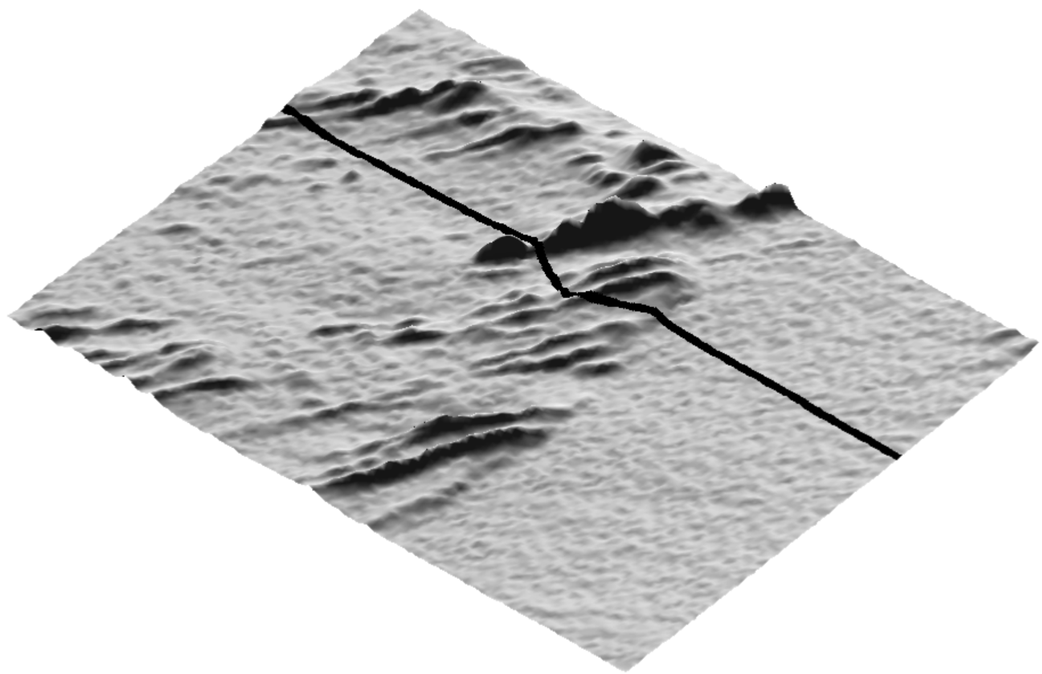

Figure 2. Kink in existing Khan-Henties Bay power-line, northwestern part of EPL 3573.

The proposed power-line route

3.3. Section 1: Khan Substation to main road and cell phone towers (Figs 3, 4)

In this section a minor power-line that services the two cell phone towers on the hills at ca. 22°07’S, 15°13’E runs parallel to the main Khan-Henties Bay line, branching north to the towers after crossing the Swakopmund-Usakos main road. Due to transverse fences and locked gates, we could not traverse this whole section. Our assessment is based on ground visits to the substation and the area immediately to the west of it, the lines around “Fort Hill”, and binocular examination of the rest of the area from the top of “Fort Hill”.

Besides the general and overall concerns, there are no additional concerns in this section. The new power-line should be parallel and proximate to the existing line. Within Section 1, there are no issues that favour siting of the new line on the one or other side of the existing line: both would have similar impacts. The route to be followed in Section 2 will likely determine whether the route in Section 1 runs north or south of the existing line.

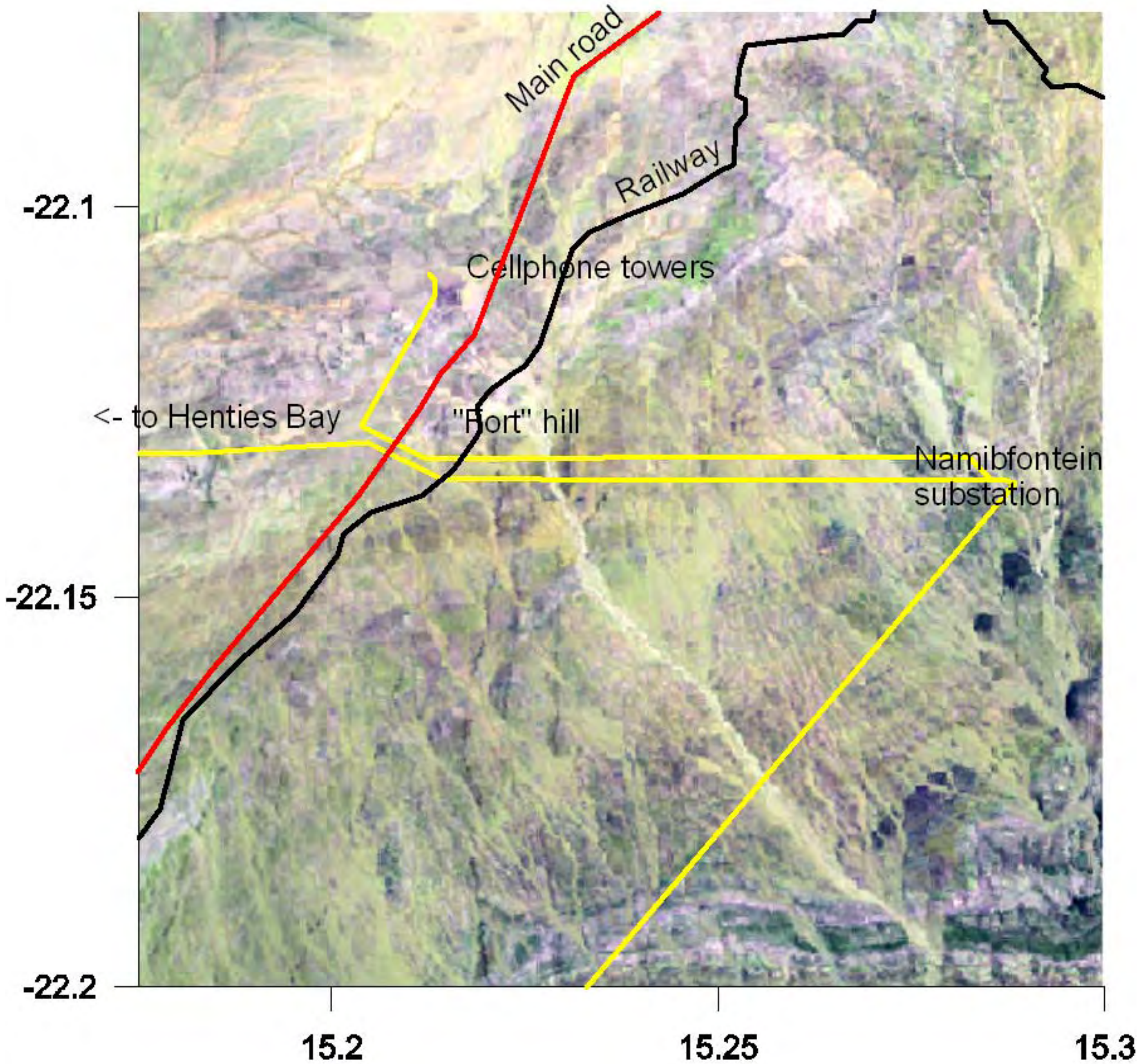

Figure 3. Power-line route Section 1, plan. Base satellite image, this and subsequent figures: Landsat series, courtesy of NASA.

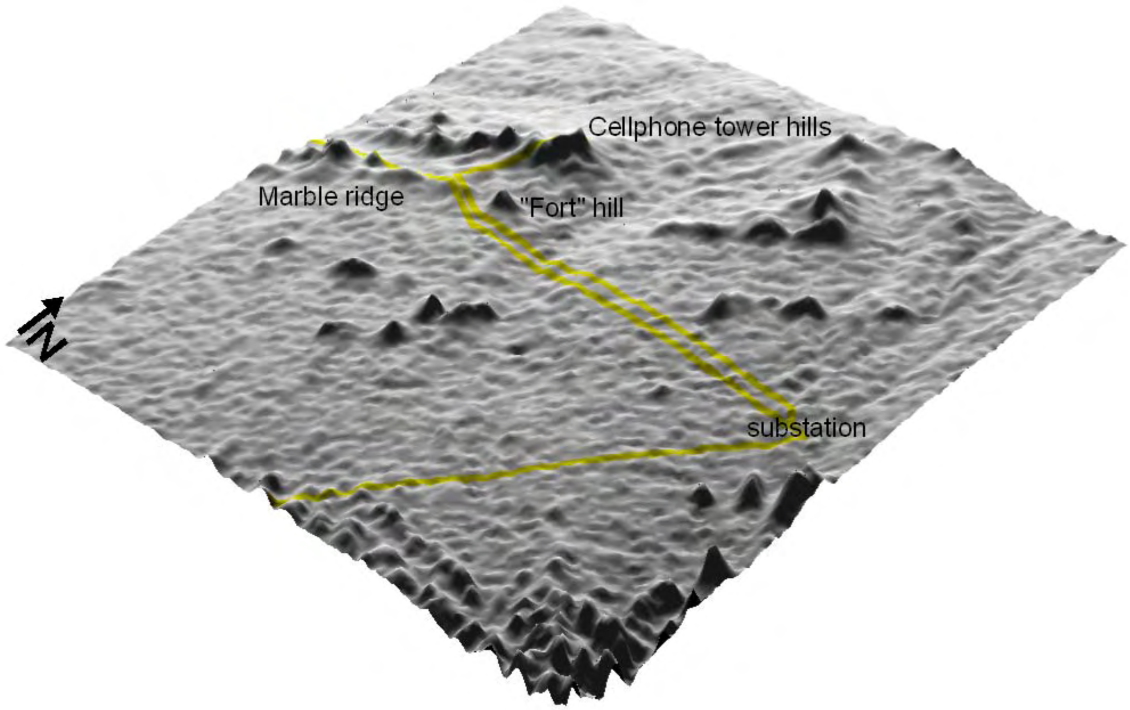

Figure 4. Power-line route Section 1, elevation model. Topography in this and subsequent figures based on SRTM dataset, courtesy of NASA. Vertical exaggeration: 500 times. Coverage as for Figure 3.

3.4. Cell phone towers to mining offices (Figs 5, 6)

At the eastern end of this section, the existing Khan-Henties Bay power-line passes through a natural gap in a series of marble ridges that extend north eastwards to the cell phone tower hills. The ridge is highest and most rugged at 22 07.922S 15 10.837E. At that point, routing a parallel proximate power-line to the south of the existing line is not feasible, but there is enough flat space to the north (Fig. 5).

Routing the Trekkopje Mine power-line to the north of the existing line would necessitate it crossing an existing line. If the new line is sited south of the existing line in Section 1, it will need to cross that, if north, it would need to cross the cell phone tower line. In both cases, the logical crossing point would be where the two existing lines diverge. A crossing of the minor cell phone line rather than the major 66Kv line might be more acceptable.

The alternative would be for the new line not to cross existing lines, which would necessitate a detour around the southern extent of the marble ridge and possibly adjacent dolerite ridges as well, or crossing the ridges. Both options would be environmentally less acceptable, and possibly more expensive and technically challenging as well.

Figure 5. View from marble ridge at ca. 22°08'S, 15°11'E, looking eastwards. Note lack of sufficient space for an additional power-line and servitude parallel to and south (right) of the existing line.

For the rest of the existing line in this section, there are two areas of concern. A swarm of transverse dolerite ridges cross the power-line route in the area marked 'Dolerite ridge area 1' on Figs 6 and 7. A parallel proximate line to the existing power-line would need to cross a number of these irrespective of which side of the existing line it runs. Since all are low and of limited width, the potential effect of power-line construction can be mitigated by having pylons straddling ridges, and access routes running around instead of over ridges.

For the smaller 'Dolerite ridge area 2', immediately to the east of the Uramin mining offices, the same concerns and suggestions apply as in area 1.

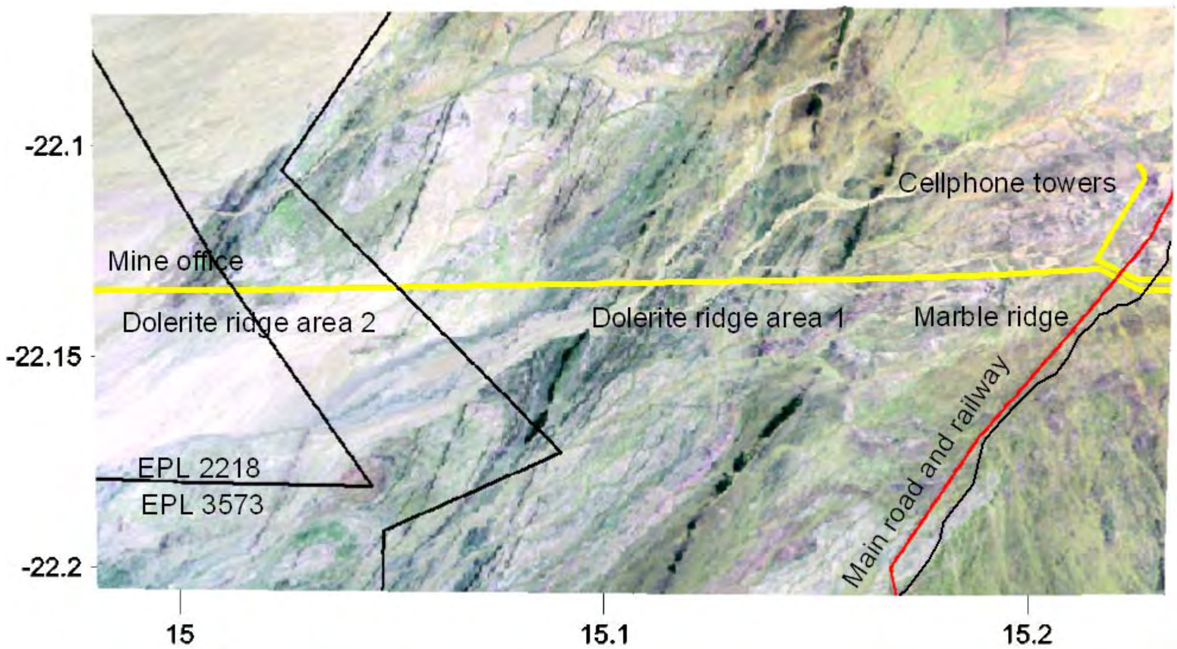

Figure 6. Power-line route, Section 2, plan.

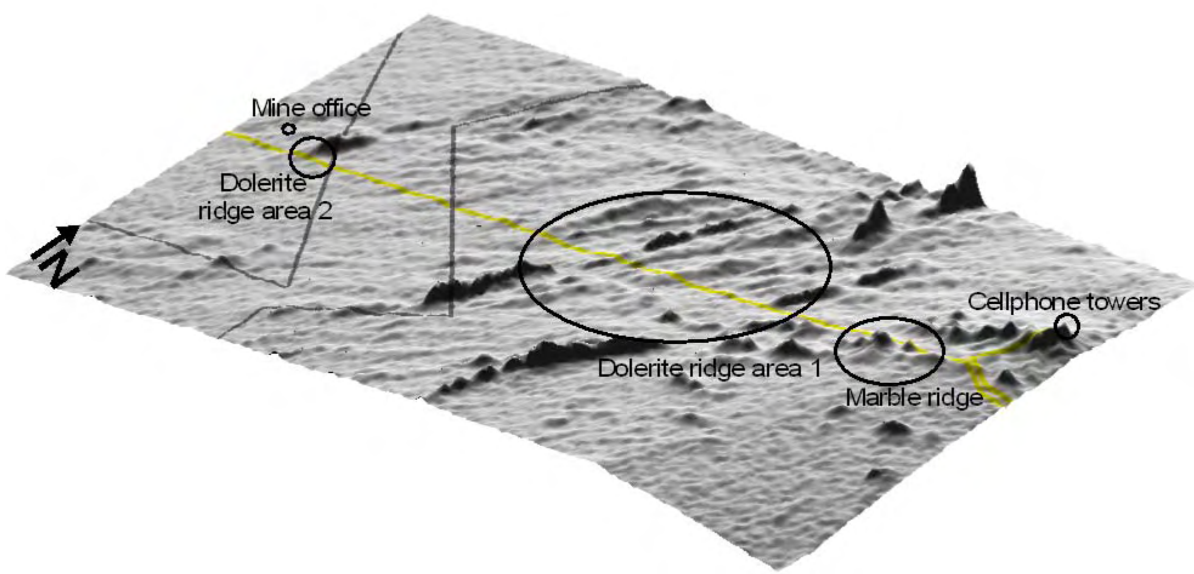

Figure 7. Power-line route, Section 2, elevation model.

3.5. Section 3: Mining offices to proposed plant site and reservoir (Figs 8, 9)

There are no particular issues on the section of the Khan-Henties Bay power-line from the Uramin offices to where it leaves EPL 2218. We have assumed that the line feeding the plant would need to avoid the planned positions of the pit and ponds, came up with the possible route indicated in Fig. 8, and assessed that.

There are no particular issues within the core mining area: given the general habitat destruction expected there, none would be relevant. The only area of concern is a marble ridge lying east of the more prominent dolerite ridge adjacent to the reservoir. The power-line and associated roads from the plant to the reservoir should preferably not cross any of these ridges. Under current configuration the pit and ponds prevent a straight power-line from plant to reservoir. Since there will have to be a knick in the line anyway, it is suggested that the knick be sited so as to avoid the marble ridge. Should the final position of the plant change significantly, this will need to be re-evaluated.

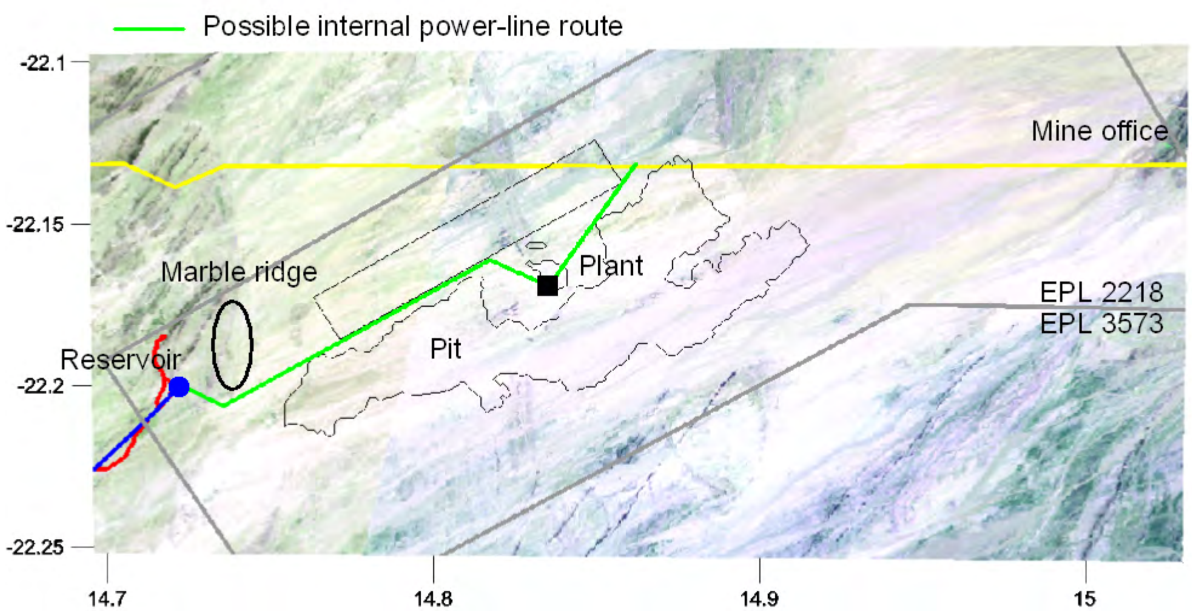

Figure 8. Power-line route, Section 3, plan.

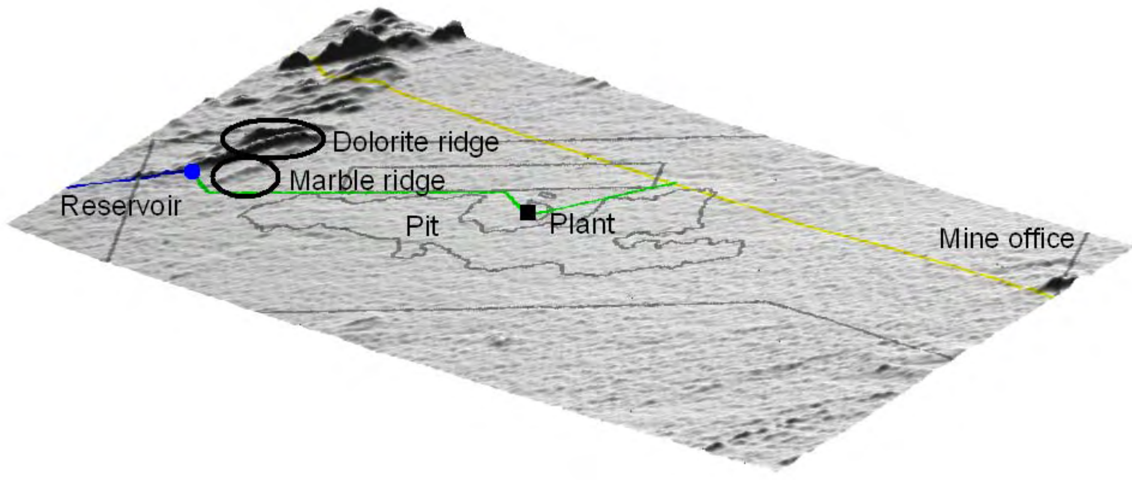

Figure 9. Power-line route, Section 3, elevation model.

3.6. Section 4: Reservoir to desalination plant (Figs 11, 12)

This is without doubt the ecologically most sensitive section of the entire route.

We worked on the assumption that the power-line and pipeline would run parallel and proximate to each other on this section, in order to restrict the area of disruption to the minimum. Since the areas of concern, other than the ubiquitous lichen fields, were all ridges, and since a power-line could cross ridges without touching them but a pipeline would need to go through them, we considered the routing of the pipeline key to determining the best power-line route. The proposed pipeline route was being pegged while we were in the area (Table 1).

Table 1. Pegged pipeline route, key coordinates. Source: Ms. Janine Vorster, Namwater.

Key point	Longitude	Latitude
Reservoir	14.72658	-22.19908
M5	14.70049	-22.22416
M4	14.60311	-22.27705
M3	14.56161	-22.28293
M2	14.50497	-22.31319
M1	14.478161	-22.34748
Desalination site	14.44331	-22.37142

The proposed route is as environmentally friendly as is possible under the circumstances, and with only 5 kinks (M1 to M5) it is probably what the engineers wanted as well. In all but two cases (Ridges 1 and 2 on Figs 11, 12) it misses significant ridges. Both ridges could be avoided by subtle changes to the positions of kink-points, without introducing any new bends in the line. Ridge 2

(Fig. 10) can be avoided by shifting the position of kink M4 a few tens of meters towards M3 along the line of leg M4-M3 to produce a new, still straight, leg M4-M5. This will cause the pipeline to pass through a gap immediately to the north of ridge 2.

Figure 10. Biodiversity rich dolerite ridge at 22°15.873'S, 14°37.571'E (= Ridge 2 on Figs 11, 12). Current pegged pipeline route passes directly through ridge, but minor re-alingnment could miss it.

Ridge 1 might similarly be avoided by shifting the position of M5 towards M4 along leg M5-M4, but the case is less clear-cut. Currently the eastern portion of leg M5-Reservoir runs parallel but proximate to a much more prominent dolerite ridge, and changing the position of M5 might cause it to encroach on the larger ridge instead. The latter would be even less desirable than the pipeline crossing Ridge 1. The effect of changing the orientation of this leg should be carefully considered.

With the pipeline route established, we subsequently assessed a power-line route parallel to the pipeline. We consider the most positive effect of the future existence of a pipeline here to be its potential to act as a barrier to random vehicular traffic. To function effectively like this, the parallel power-line, as well as any access roads, should be south of it. All ridges along the route can be crossed without siting pylons on summits, and this should be done.

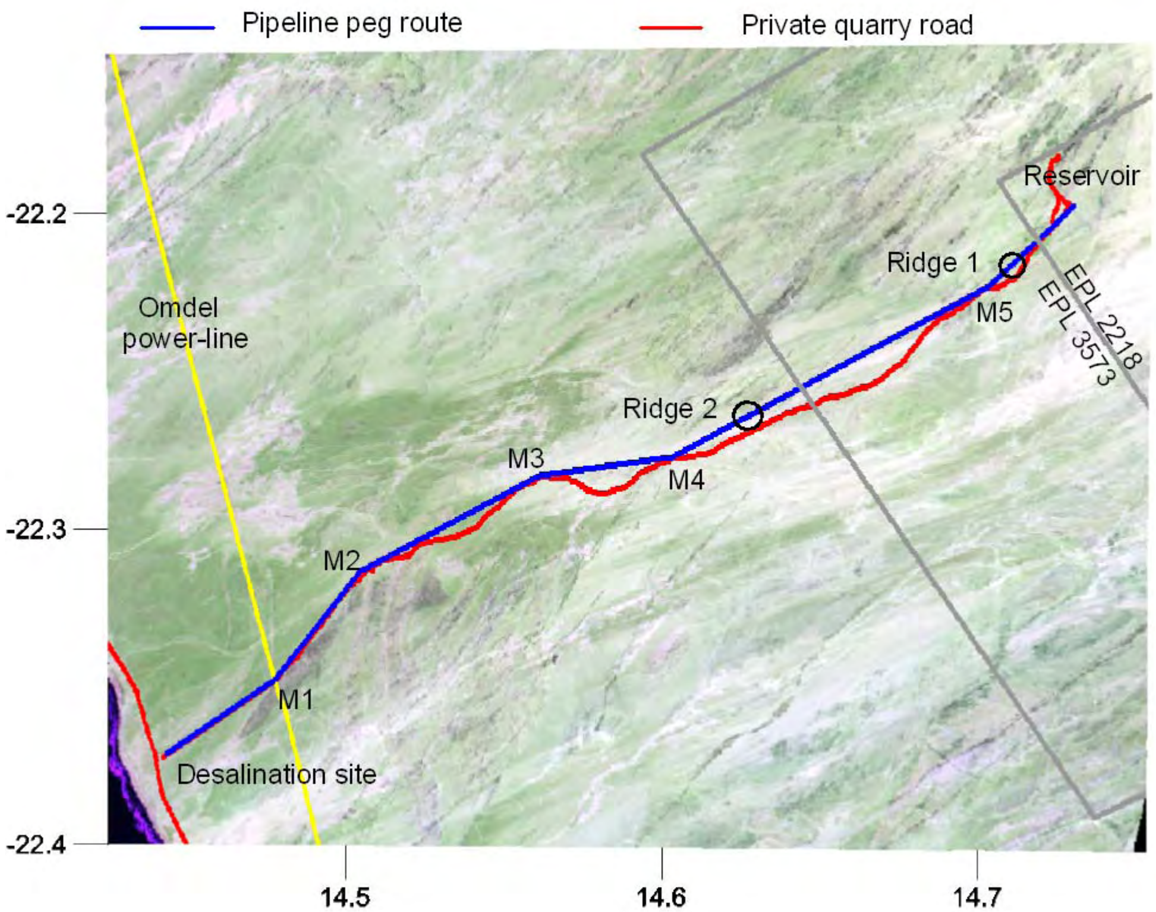

Figure 11. Power-line route, Section 4, plan.

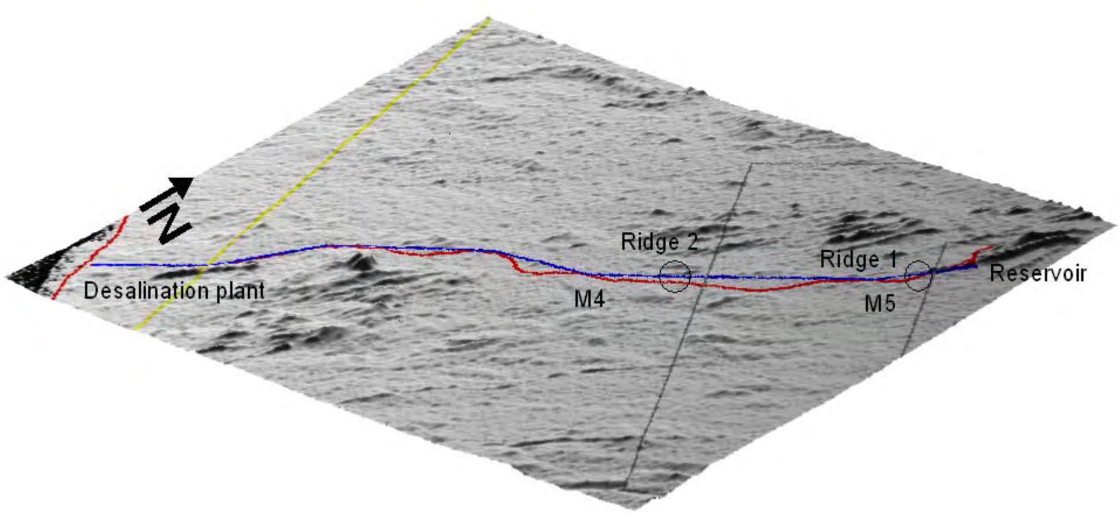

Figure 12. Power-line route, Section 4, elevation model.

4. Predicted impacts

Vehicle tracks on the substrate

Vehicle tracks made on the desert floor remain visible for many years, making scars on the landscape, and they also destroy the soil crust and lichens that grow on the surface. They are especially damaging and visible where gypsum-rich soils are compacted downwards from the weight of the vehicle, so that the tracks are visible from the grasses and lichens which they squash as well as from the depressions they cause. In the process, small grains and pebbles on the surface become pressed into the underlying layers, so that the protective surface pavement that they form is destroyed. The damage is both aesthetic as well as biological as the surface plants, soil crust organisms and lichens are largely responsible for cycling of nutrients from the surface into the soil, and the vegetation together with the pavement form an intact 'carpet' that prevents deeper layers of fine soil from being eroded by wind. Many tracks on the Trekkopje site are already forming deep ruts where the very fine, powdery gypsum-rich soil is churned up by each passing vehicle and carried away in the wind. In many of these cases, drivers avoid these dusty patches by driving around them, so that the zone of damage is widened.

Almost the entire western power-line route does pass through lichen fields (Fig. 13). Tracks and other forms of substrate disruption should be restricted to the absolute minimum here. Note that there are similar maps (e.g. Uramin 2007), based on the same data as Fig. 13, that appear to show the western part of the pipeline passing through gaps between lichen fields. On those maps the particularly vulnerable (crustose) lichens have unfortunately been plotted in colours that blend into the background and give the appearance that they are lichen-free. Figure 13 maps all lichens equally.

EPL 2218 of the Trekkopje tenement has been very badly damaged by irresponsible driving during the prospecting, drilling and trial mining phases, leaving the surface scarred with many unnecessary vehicle tracks. Although many of these tracks will be obliterated when the area is properly mined, there are large parts where mining will not occur. We have observed that track discipline has been very poorly enforced, and much avoidable damage has been done. This makes it difficult to introduce stronger track discipline since others see the poor example as licence for them to do the same.

Since all of the routes of the power-line will be on land that will not be mined, it is very important that all vehicles should be forbidden from making new tracks. The existing Khan-Henties line has a series of track meandering under and in parallel to it, up to several 100 m from the line itself. This is unnecessary: a single track should suffice for the construction of the new line. This should be backed up with the implementation of penalty clauses that will punish contractors who are found responsible for unnecessary tracks.

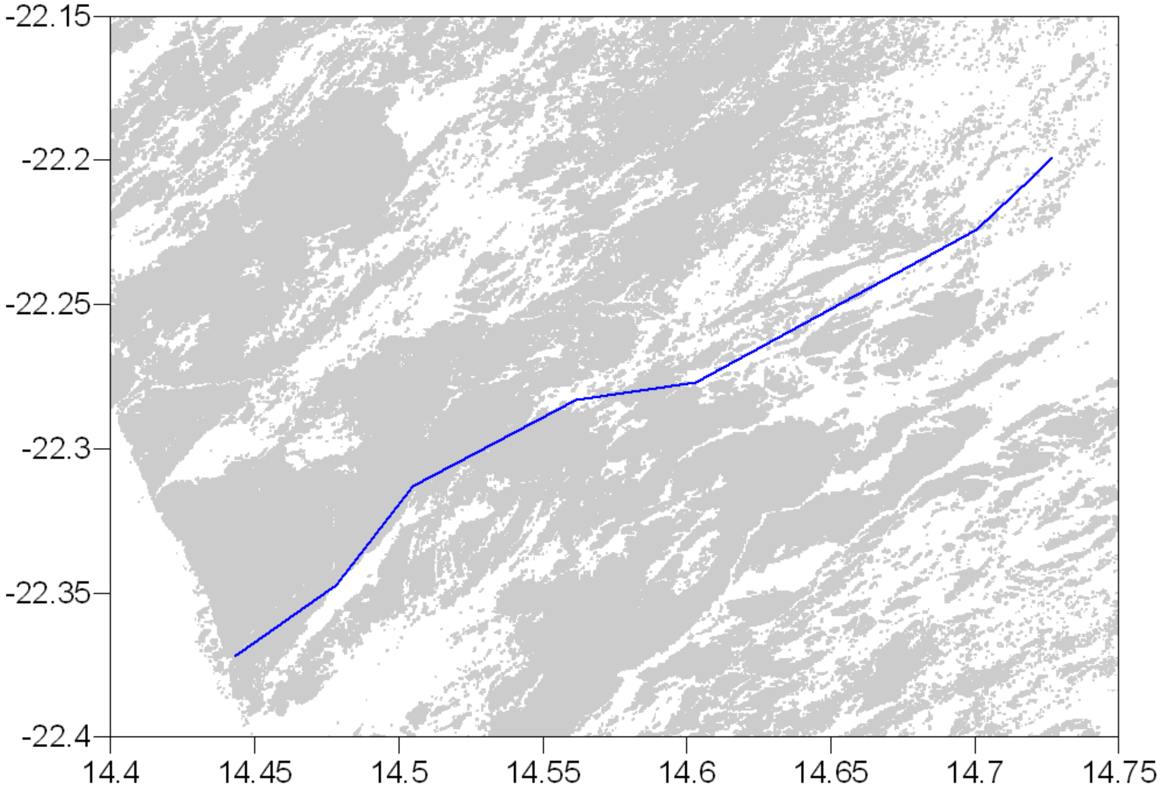

Figure 13. Pegged pipeline, and hence power-line, route (blue) in relation to lichen fields in the area (grey, based on Schultz, 2006).

Since the entire new line is adequately serviced by existing access roads there is no need to make new access routes to reach the line. Existing access roads are: Swakopmund-Usakos main road, Uramin road from latter to mining area, private quarry road from coast, Omdel power-line road, Swakopmund-Henties Bay main road. These roads may be used to reach the line, where after the single new track associated with the line could be used to reach any part of the line.

There is an opportunity to use the pipeline / power-line in the western part of the route to restrict future damage to lichen fields in the area. On the eastern side of the Wlotzkasbaken – Henties Bay coastal road there exists a barrier intended to keep vehicles out of a particular lichen field. It is not very effective, and at the time of our visit fresh tracks entering the lichen fields next to a signpost were apparent (Fig. 14). The barrier's south end is 400 m north of the proposed desalination plant site. Since the pipeline by itself should be an effective barrier to vehicular traffic, closing this 400 m wide gap by extending the lichen barrier southwards to join up with the perimeter fencing of the desalination plant would effectively render vehicular access to a large area of high lichen diversity less easy than it is now.

Figure 14. Current lichen barrier north of Wlotzkasbaken, showing fresh tracks entering lichen field next to barrier and signpost.

Table 2. Expected impact of vehicle tracks and off-track driving.

	Vehicle tracks
Intensity:	Environmental damage by vehicle tracks is a high-intensity impact.
Phase:	During construction, but can also be a problem during maintenance operations on power-lines.
Duration:	Biological and aesthetic damage can be long lasting.
Extent	Wherever construction vehicles move around along and close to the power-lines, as well as along routes leading to the work sites.
Probability	In view of the way that wanton tracks have been created over much the Trekkopje tenement, it will be difficult to convince other drivers that off-track driving is strongly forbidden. The probability of further damage being inflicted by work teams associated with the power-lines is considered high. A very dedicated and serious approach will be needed to prevent off-track driving.
Significance	High

Collecting of wood and plants for fuel

Labour teams involved in construction always need a source of energy for cooking, and often gather firewood from local trees and bushes for this purpose. Woody material, even dead wood on trees or lying on the ground, performs many functions in the Namib ecosystem.

- It is an important food resource for invertebrates such as termites, which, in terms of biomass, are probably the most important herbivores in the system.
- It provides shelter and protection for small animals.
- It may be used as nesting material.
- It contributes nutrients to the system when it is decomposed or eaten and cycled through the food chain.

Given the scarcity of wood in the area to begin with, removing wood for fuel seriously interrupts ecosystem processes and is not desirable.

Collecting of firewood should be forbidden and this should be backed up with penalty clauses so that offenders are fined or taken off the site if they are found gathering wood.

Table 3. Expected impact of wood and plant removal.

	Removal of wood or plants for fuel
Intensity	Environmental damage through wood removal is a low- to medium-intensity impact.
Phase	During construction.
Duration	Impacts of wood removal are short- to medium-term.
Extent	Within the areas where labour teams work and stay during off time.
Probability	Depends on the amount of control and inspection on the ground. If work teams are poorly supervised and not adequately informed about wood gathering being forbidden, then wood harvesting can be expected. If on-the-ground supervision is good, then it is likely to occur only minimally
Significance	Low

Increased access by the public along routes opened up for construction

As planners, engineers, contractors and other staff come into the area during development of the mine, access routes from the surrounding areas are created. This has already started, for example, in contractors and suppliers driving in to the Trekkopje site from the Stone Evolution road that comes from Wlotzkasbaken, instead of using the proper entrance to the site from the B2 main road. Similar ‘illegal’ routes in and close to Trekkopje can be expected to be made from Arandis as the temporary pipeline route is opened and used, and as power-line contractors and their service providers create and use other access routes to the work sites.

For whatever reasons, drivers on these roads often take ‘short cuts’ cross-country and drive unnecessarily off the tracks that are provided. This creates vehicle track damage, described above. Greater volumes of traffic disturb wildlife, such as springbok that presently live naturally in this area without the benefit of formal conservation protection. Poaching may occur, as well as illegal gathering of favoured plants (e.g. *Lithops* spp.) by rare plant collectors. People looking for a braai-spot may gather firewood. Recreational, off-road drivers may move in and use the area as an off-road playground, as has already happened at many places on the Stone Evolution road. In short, increased access to previously undisturbed areas increases the rate of environmental damage to those areas.

Unfortunately, gates and fences are ineffective barriers in remote areas. Unscrupulous off-roaders, or intentional poachers, will simply break them open, flatten or cut them, secure in the knowledge that it may be weeks before this is noticed. Barriers are only effective where regular policing is an option.

Table 4. Expected impact of increased public accessibility.

	Increased public access
Intensity	Before the current prospecting and mining activities began at Trekkopje, this area of the Namib was relatively undisturbed. Development of the mine itself and establishment of the water and power infrastructures is causing environmental damage in previously pristine areas. In terms of loss of wilderness character, this is a medium-intensity impact.
Phase	The impact lasts during construction and for as long as the tracks along the power-lines remain accessible to the public.
Duration	Once tracks are made, they cannot be obliterated and continued use (whether legal or informal) keeps them in use. Thus the impact is forever.
Extent	Along the newly created power-line routes.
Probability	Very likely, as it is almost impossible to prevent people from using tracks that have been made.
Significance	Medium to high.

Poaching

Poaching of wild animals is a common problem where labourers are brought into proximity with wild animals, ass will happen during the construction phase of the power-line. Quite large numbers of springbok live in the Trekkopje area (as part of the wildlife resources of the Gaingu Conservancy, although they are not fenced in), and there is evidence of occasional gemsbok and ostrich. Other animals which might be considered worthy of shooting (to kill), hunting (to eat) or catching (to keep) are black-backed jackal, bat-eared fox, steenbok, Ludwig’s bustard, Namaqua sandgrouse and leopard tortoise.

Any catching or killing of these wild animals is forbidden by law and this law should be supported and strictly applied. Any person found contravening this law should be fined with a penalty clause in the contract, reported to the police and permanently removed from the site.

In the long term, increased access into the area by way of the new routes being opened up will also increase opportunities for poaching beyond the construction phase.

Table 5. Expected impact of poaching.

	Poaching
Intensity	This is likely to be a low-intensity impact.
Phase	Immediate impact during the construction phase, thereafter a lingering impact due to increased accessibility along the power-lines.
Duration	Because of the long-term increased accessibility, this will be a continuous problem.
Extent	Construction: power-line routes mainly. Post-construction: entire area - by the time they are in there with intent to poach, they will probably not practice track discipline either.
Probability	Construction: medium if mitigated, high if not. Subsequent: medium.
Significance	Medium. If poaching reduces game levels in the larger region, it may negatively impact on the livelihoods of people in the neighbouring conservancy.

Direct impacts on biodiversity-rich ridges

Rocky ridges harbour concentrations of biodiversity in the study area, because of higher niche diversity. In contrast to the open plains, the broken ground offers a multitude of sheltering places and microhabitats. Bare rock surfaces, especially dolerite blocks, condense moisture from fog. Moisture drips downwards and sustains a relatively rich plant life (Mannheimer, 2006) in sheltered spots among the boulders. The generally northeast to southwest orientation of the ridges result in one or the other side being shadier for part of the day, resulting in a slightly less harsh habitat. Plants support herbivores, with their associated carnivores and the parasites, commensals and symbionts of both. In addition, windblown sand in the lees of ridges provides a habitat that is absent elsewhere in the area, and is inhabited by specialised psammophilous creatures. Cunningham (2006) identified rocky outcrops and ridges as important sites for vertebrates in the area.

Where existing power-lines cross ridges, tracks have been made straight over the ridges, destroying the habitat. On black dolerite ridges especially, the scars of roads and tracks are prominently visible from a distance. They are essentially irreparable, and detract from the potential post-mining tourism potential of the area. Tracks should rather wind around ridges wherever possible.

At the same time, the siting of pylons on the summits of ridges should not be done, since this automatically causes roads to have to be made there. The suggested route above avoids the one high ridge of relevance in the area. All remaining ridges are low enough to allow pylons to be sited between ridges, with cables passing over the summits. Individual ridges of special concern have been identified above, but all ridges should be treated with the same respect.

Table 6. Expected impact on biodiversity-rich ridges.

	Biodiversity-rich ridges
Intensity	High.
Phase	Primarily during construction, but may be relevant during subsequent maintenance as well, unless track discipline is enforced.
Duration	Road scarring and pylon siting are permanent impacts.
Extent	Places where power-lines cross ridges.
Probability	High if not mitigated.
Significance	High. Ridges function as reservoirs of biodiversity at times when prolonged drought may render the plains less inhabitable.

Impacts discussed above are summarized in Table 7.

Table 7. Summary of predicted impacts. Darker shades of grey denote greater significance of impact. Key: D = Duration, E = Extent, I = Intensity, Ph = Phase, Pr = Probability, S = Significance.

Impact	**I**	**Ph**	**D**	**E**	**Pr**	**S**
Vehicle tracks, off-track driving	High	Construction, maintenance	Long-term	Power-line + access routes	High	**High**
Wood collecting	Low to medium	Construction	Short-term	Power-line + camp sites	Medium to high	**Low**
Increased access	Medium	Post-construction	Medium to long-term	Power-lines	High	**Medium to High**
Poaching	Low	Construction + subsequent	Short to long-term	Power-lines and surroundings	Medium to high	**Medium**
Biodiversity loss on ridges	High	Construction, maybe maintenance	Long-term	Power-lines over ridges	High	**High**

5. . Recommended mitigatory measures

While some mitigatory measures recommended below are aimed at the strategic level (‘where does the power-line go?’), others are aimed at the implementation level (‘how do we do the job?’). The effectiveness of the latter measures will depend on a strong ‘field presence’ of an environmental officer and the amount of advice and supervision that this person renders to the work teams. Ideally, a person employed for this task would work closely with the NamPower and contractor teams, understand the issues that work teams face on the ground, be helpful and forthcoming with advice and information about environmental issues such as off-road driving and wood collecting, and be strict when corrective action or punishment is called for.

Suggested mitigatory measures are summarized in Table 8.

Table 8. Recommended mitigatory measures.

Vehicle tracks and off-track driving
Off-track driving can be prevented by instilling awareness of the problem in **all** drivers who work on site. While top managers might be aware of the severity of the problem, the message has to filter down to all staff and all contractors and sub-sub-sub-contractors, and especially their unskilled labourers who are involved in hot, tiresome and boring tasks on the ground. For many of them, the issue of track discipline probably seems trivial, and the attitudes to it include not caring or believing that they will not be found out nor punished (sadly, an accurate belief, in most cases). In the light of this, what can be done to prevent more track damage in and around Trekkopje? 1. Insert penalty clauses in the contracts of all workers on site, so that they can be fined or expelled from site if found making unnecessary tracks. 2. Employ a permanent environmental officer to monitor compliance on the ground. A team of junior officers moving amongst all work teams and ensuring compliance with this and other safety regulations should ideally support him/her. 3. Put up more warning signs forbidding off-track driving. Highlight places where off-road tracks have been made with signboards that say ‘Off-road driving such as this is forbidden’ and ‘Off-road driving can lead to a fine of N$xxxx or loss of your job’. Because of the ubiquitous presence of lichen fields, extreme care needs to be taken to avoid unnecessary tracks and damage to lichen fields along the entire length of Section 4 of the power-line route. Uramin should consider turning the presence of the western pipeline into a positive environmental feature, by extending the existing lichen barrier southwards up to the desalination plant, thereby creating a significant barrier to direct vehicular traffic in an important

lichen area. For what it is worth, prominent signposts at the western end of the Quarry road or its successor should discourage off-road driving. Enforcing that would not be feasible, and it will not deter the more obnoxious off-road driver, but it might play a small role in reminding law-abiding off-roaders to practice constraint. [Ignore this recommendation if the quarry road is to be closed by a barrier, see below]
Collecting of wood and plants for fuel
The temptation or need to gather firewood will be reduced if all work teams are provided with gas or paraffin stoves for cooking. Further mitigation of this problem can be achieved by thorough supervision of work teams.
Increased access
Mines usually have a security section that, among other duties, also controls public access to the mining area. It is suggested that their duties in this case should also be to police unauthorized movement on land under the care of Uramin (i.e. both EPL 2218 and EPL 3573). It is assumed that the current access road from the main Swakopmund-Usakos road will become the primary access route to the site. It is further assumed that there will be some form of access control point at the currently locked gate just north of the railway line. If only authorized vehicles are allowed on the road from there to the mine, there should be no off-road driving emanating from this access road, including any along the power-line track due east of the mining offices. There currently exist old tracks branching off from this road: they should not be allowed to be re-opened. Towards the northeast, the track leading from Klein Spitzkoppe largely crosses land outside Uramin's control. The open aspect of the country where the track crosses into the EPLs would make any gate or fence easily avoidable, but a simple sign prohibiting access might help. Any traffic ignoring it will end up on the mine site and can be dealt with accordingly. Probably the best thing Uramin could do to help prevent this track from becoming a more prominent access route into the area is to not use it themselves to access the mine site. Through disuse it may sink back into obscurity. Towards the northwest, the existing Khan-Henties Bay power-line does not seem to be currently used as an access route, possibly because it passes through rugged country (Fig. 2). It is not currently a concern, and since any future public access along this route would also end up right at the mine, mining security could take care of such cases. Towards the west the quarry road currently provides an easy access route into a

relatively unspoilt area. While the suggestion is to use the pipeline as a barrier to the north, this will not prevent off-roaders from driving to the south of it. The point where the quarry road branches off from the road along the Omdel power-line is also the place where the pipeline and power-line cross, and there is less than 100m between the planned infrastructure and a relatively high dolerite ridge to the south. Given the small distance involved, a sturdier than usual fence and gate here might be feasible. The fence may run from the pipeline up to the dolerite ridge, making use of damage already done to the ridge by the road cutting, and connect to the ridge in such a way that vehicular traffic cannot bypass the fence. Given the proximity to Wlotzkasbaken, and regular use of the road by quarry employees who fill a tanker at a take-off from the Omdel pipeline at this point, vandalisation of a gate/fence is less likely, and will be rapidly spotted when it does occur. Undoubtedly Uramin could come to some agreement with the quarry owners in this regard.

Towards the southwest, there is currently a road from Arandis to one of the quarries. There does not seem to be any control over traffic on it. Since it passes immediately by the proposed reservoir site, it falls within Uramin's sphere of concern. This road could provide access to the quarry road from the east, negating the effect of any gate/fence in the west. Since it will have to be re-routed around the Reservoir in the near future anyway, there is enough scope to do this in a creative way that will not allow easy access to the power-line track. Since the area is within Uramin's core EPL 2218, and well visible from the proposed plant site, policing it should not be a problem.

The temporary pipeline route from the south has similar issues, but fell outside the scope of this study.

Poaching

Thorough supervision of construction teams should minimize poaching incidents during the construction phase.

Access controls as discussed above should prevent power-line routes from becoming poaching routes in future.

Any employee or unauthorized trespasser found poaching should be handed over to the authorities for prosecution under Namibian anti-poaching laws. This policy should be made widely known.

Biodiversity impacts on ridges

The essence of ridge mitigation is not to damage or disturb ridges, by avoiding them from the outset.
So:

1. Do not site pylons on ridges.
2. Make access tracks through gaps in ridges even when the power-line crosses the ridge directly.

3. Do not make road scars on dolerite hills.
4. Route the power-line so as to avoid ridges of concern:
    - Section 2: Route the power-line to the north of the marble hills at 22°08’S, 15°11’E (Figs 5, 6, 7).
    - Section 2: Take special care with siting of pylons and routing of access tracks where the new power-line crosses through Dolerite ridge areas 1 and 2 (Figs 6, 7).
    - Section 3: Route the power-line so that it does not cross the marble ridge northeast of the Reservoir site (Figs 8,9).
    - Section 4: Route the power-line parallel to the pipeline, and south of it.
    - Section 4: Minimally re-align the pipeline so as to miss Ridge 2, and if possible, Ridge 1 as well (Figs 10, 11, 12).

6. References

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