KUDU GAS TO POWER PROJECT: INTEGRATED IMPACT AND MITIGATION REPORT

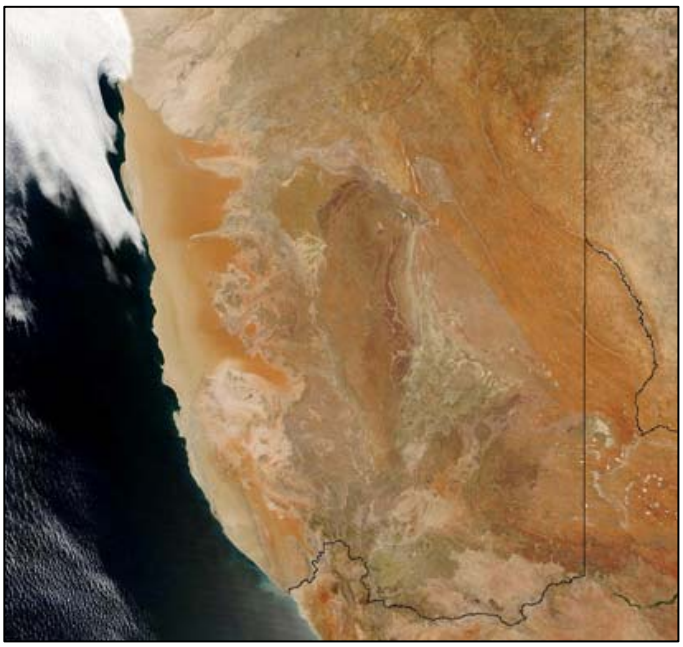
May 2006

NAMCOR

ENERGY AFRICA KUDU LIMITED
A TULLOW GROUP COMPANY

kudu power project

NamPower
Powering the Nation and beyond



SAIEA

Compiled by:

The Southern African Institute for Environmental Assessment

Contents

LIST OF ABREVIATIONS AND ACRONYMS

˚C	Degrees centigrade
a	Annum
ATC	Air traffic control
BOD	Biological oxygen demand
CAMALA	Cape Municipal Area Local Authority
CCGT	Combined cycle gas turbine
Cl	Chlorine
CO	Carbon monoxide
CO_2	Carbon dioxide
CSIR	Council for Scientific and Industrial Research
d	Day
DBMN	De Beers Marine Namibia
EA	Environmental assessment
EAP	Environmental Action Plan
ECO	Environmental Control Officer
EEZ	Exclusive Economic Zone
EIA	Environmental impact assessment
EIR	Environmental impact report
EMP	Environmental management plan
EPA	United States Environmental Protection Agency
ESDV	Emergency shut down valve
Eskom	Electricity Supply Commission (of South Africa)
FLNG	Floating liquefied natural gas (plant)
GCP	Gas Conditioning Plant
GDP	Gross domestic product
GIS	Geographic Information System
hr	Hour
HSRG	Heat recovery steam generator
I&AP	Interested and Affected Party
IFC	International Finance Corporation
IIMR	Integrated Impact and Mitigation Report
IRG	Inter-ministerial Review Group
IUCN	International Union for the Conservation of Nature
KDT	Kudu Development Team
KGPP	Kudu gas to Power Project
km	kilometres
KPP	Kudu Power Project
kV	Kilovolt
m	Metre
m^3	Cubic metres
MA1	Mining Area One
MARPOL	International Convention for the Prevention of Pollution from Ships
MEG	Monoethylene glycol

MET	Ministry of Environment and Tourism (Namibia)
MMscf/d	Million standard cubic feet per day
MOU	Memorandum of Understanding
MW	Megawatt
Namdeb	Namdeb Diamond Mining Corporation
NamPower	Namibian Power Corporation
NDP	National Development Plan (of Namibia)
NO_x	Oxides of nitrogen
OP	Operational Policy (of the IFC)
PEA	Preliminary environmental assessment
PM_{10}	Particulate matter 10 microns or less
ppm	Parts per million
RoD	Record of Decision
RSA	Republic of South Africa
SADC	Southern African Development Community
SAIEA	Southern African Institute for Environmental Assessment
SANS	South African National Standard
SAPP	Southern African Power Pool
SEPN	Shell Exploration and Production Namibia B.V.
Skorpion	Skorpion Zinc Project (near Rosh Pinah)
SO_2	Sulphur dioxide
TPM	Total particulate matter
WB	World Bank
WBM	Water based mud
WEC	Walmsley Environmental Consultants
WHO	World Health Organisation

Why this report?

This Integration Impact and Mitigation Report (IIMR) presents all the components of the Kudu Gas to Power Project (KGPP) in a single document. It provides readers with a succinct "big picture" overview and presents the information in a format that it is accessible to people from all walks of life. Although the project has three very different components, each of which has been subjected to specialist feasibility, technical and environmental studies, it is also necessary to assess the impacts of the "whole" project.

It is evident from all the studies completed thus far, that the Kudu Gas to Power Project is viable technically, socially and environmentally. Some of the areas that will be within the projects' "ecological footprint" are already highly disturbed – notably the Uubvlei site itself, parts of the seabed where the pipeline will be laid and some of the corridors along which the power lines will be constructed. The component- specific EIAs and this IIMR have identified the safeguards that must be put in place to avoid unnecessary negative impacts while enhancing project benefits. The next step in the implementation of this project is to formalise the safeguards as enforceable conditions.

1. INTRODUCTION

Between 1985 and 2002, Namibia's electricity demand grew at an average annual rate of 3.62%, to 390MW in 2004. Major demand increases took place from 2002 to 2004 and further major increases are expected if Namibia (rather than South Africa as is the case at present) begins supplying Skorpion Mine near Rosh Pinah in 2011 or 2012.

NamPower projects that the maximum demand growth will continue at a rate of approximately 4.5% per annum, resulting in a demand of approximately 550 MW by 2012. The assumed growth rate is in line with the country's development objectives, which project an average annual GDP growth of 6% from 2001 to 2030. This growth will be driven by expansion in the agricultural and manufacturing sectors, which are expected to become highly export oriented in the future.

Currently, Namibia has the Van Eck coal fired thermal power station in Windhoek with 120MW installed capacity, the 24 MW Paratus diesel powered station at Walvis Bay, and a 249MW hydro-electric power station at Ruacana. This gives the country a total installed generation capacity of 393MW, and a projected short-fall of 157MW by 2012. The hydro-electric power station at Ruacana is Namibia's main power generating source. The

excessive cost of fuel delivered at Windhoek makes the production of electricity at the Van Eck thermal power station uneconomic, and so it, and the Paratus diesel unit at Walvis Bay, are only used to provide backup services to the system.

The Kudu gas field, some 170 km off the south coast of Namibia, was discovered in 1974 by Chevron/SOEKOR. A further two wells drilled during 1987-1988 confirmed the potential of the discovery. Following Namibia's independence in March 1990 an extensive Licensing Round was initiated in which the entire Namibian continental shelf was divided into blocks of one-degree squares for licensing purposes.

Shell Exploration and Production Namibia BV (SEPN) and Energy Africa Kudu Ltd (then Engen (Kudu) Ltd) were awarded the licence for Area 2814A containing the Kudu gas discovery (Figure 1.1) on 6 May 1993 with SEPN as the operator. In 1996 Energy Africa divested two thirds of its holding to Texaco whereupon the equity share of the companies in the Kudu Joint Venture became SEPN 75%, Energy Africa 10% and Texaco 15%. Subsequently Chevron took over Texaco and became an equity holder as ChevronTexaco.

During late 1993, a 1600 km 2-D survey and a 300 km^2 3-D seismic survey were completed. This was followed in the second half of 1996 by the drilling of the Kudu-4 well, which confirmed that the Kudu gas discovery was commercially exploitable. A further 400 km of 2-D and 400 km^2 of 3-D seismic were shot in late-1996 and early-1997 to investigate the southern extension of the gas field.

Based on current knowledge and projections, there appears to be no viable alternative other than to use the proven gas volumes for fuelling an on-land power station.

Figure 1.1: The project area

1.1 Need for the Project

Since power generation at Ruacana is dependent on the highly variable water flow in the Kunene River, its annual power generation is also variable. This has a major impact on NamPower's ability to supply the demand from its own generation facilities and the bulk of the demand has to be imported from elsewhere in the SADC region. At the present time, Namibia imports more than 50% of its annual energy needs from South Africa; however, rising domestic demand in South Africa and Namibia is expected to lead to a shortfall in continued supply of electricity to Namibia beyond 2007 (Figure 1.2).

Furthermore, one of the aims stated in Namibia's White Paper on Energy is to reduce its dependence on South Africa for electricity supply, while meeting electricity demand in Namibia and exporting electricity to the regional market. NamPower, in its generation investment plan (NamPower, 2002), considered a range of alternatives for increasing electricity supply in Namibia.

Namibia's energy resource inventory includes hydropower, natural gas and renewable energy in the form of biomass, wind and solar energy. Of these, hydropower and natural gas are deemed to be the most feasible large-scale resources in a country in which over 90% of the rural population do not yet have access to grid electricity. The supply alternatives presented in Table 1.1 are those which utilize the natural capital of Namibia, and exclude alternatives based on imported coal and fossil fuels.

Figure 1.2: Namibian Demand Supply Graph with Caprivi Link 200 MW (2009), Kudu 800 MW (2010) and Baynes 500 MW (2020) Skorpion load added in 2010)

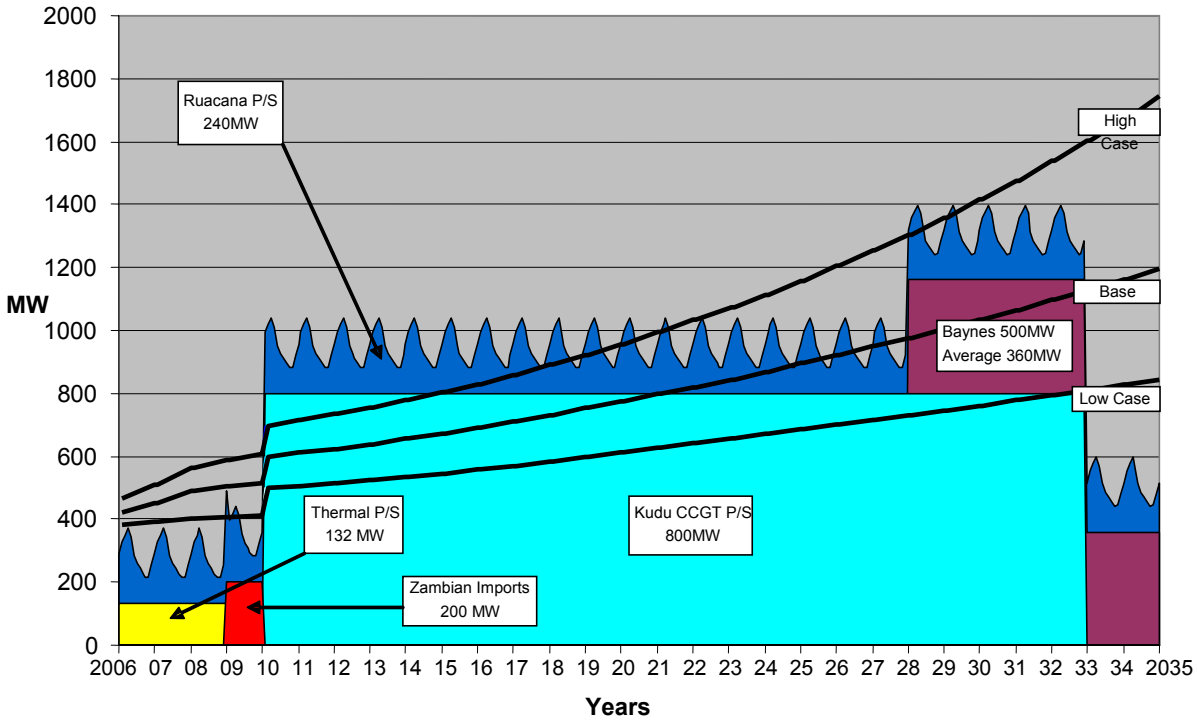


Table 1.1: Alternative Energy Sources in Namibia

Alternative Energy Source	Advantages in meeting base-load, long-term needs in a sustainable manner	Disadvantages in meeting base-load needs in a sustainable manner
Hydropower Epupa Falls, Kunene River	• Large and technically feasible.	• Undesirable environmental and social costs. • Unable to supply short-term power needs.
Baynes, Kunene River	• Large and technically feasible. • Environmentally more acceptable than Epupa Site.	• Depends on the upgrade and operation of Gove Dam in Angola, therefore high risks involved. • Unable to supply short-term power needs.
Popa Falls, Okavango River	• Will generate 20MW to supply local needs and stabilize the NE grid.	• Too small to address national demand and far from main demand areas. • Environmentally problematic with cross-border implications.
• Mepande Uncua, Mozambique • Kafue Gorge Lower, Zambia • Inga Falls, DRC	• Large-scale projects which could meet all regional long-term needs.	• High costs involved, geopolitical risks and unknown environmental and social costs. • Weak connections into southern African grid.
Biomass Power • Municipal waste • Industrial waste • Biofuel using invasive	• Small power stations (up to 30MW) could be viable to meet local demand if cost-effective.	• More studies required to determine cost effectiveness.

bush species		
Wind Power Grosse Bucht, Lűderitz	• Wind regimes were found to be suitable for a small (20MW) project and the project was deemed to be environmentally acceptable.	• High costs per unit energy, although there is potential to obtain carbon credits. Studies found that wind power cannot meet large-scale energy requirements in Namibia.
Solar Power	• High number of sunshine-hours per year. • High potential for householder-scale application, especially in off-grid areas.	• High unit costs for large–scale generation options. Studies found that solar power cannot meet large-scale energy requirements in Namibia.
Nuclear Power	• Uranium is mined in Namibia. • Suitable sites in remote areas	• Expensive compared to hydro- and gas-power. Would need to upgrade the uranium produced in-country before it could be used in a power plant, which would involve expensive and complex technology development. • Disposal of nuclear waste poses a problem.
Natural Gas Kudu Gas, Oranjemund	• Proven gas volumes located off the Namibian coast which could supply a 800MW power station (may be expanded to 1600MW if additional gas volumes are proven). • Relatively 'clean', cost-effective technology. Can be built and put into operation within 3 years. • Low environmental impacts associated with identified site.	• Far from main power demand areas, except for Skorpion Zinc and Namdeb.

It is clear from Table 1.1 that the Kudu Power Project is one of the preferred options to address the predicted shortfall in electricity maximum demand by 2007, base load capacity by approximately 2010, and growth in power demand in the region in the short-medium term. In addition to meeting NamPower's projected demand, electricity generated by the Kudu Combined Cycle Gas Turbine (CCGT) power plant will be exported to South Africa and other SADC countries to meet rising demand. The development of the Kudu gas field is therefore a major economic asset to Namibia.

1.2 Nature of the Project

This project consists of the following three distinct components:

- ***Gas Field Development*** - this is the component that delivers gas from under the ocean floor to the power station via an undersea pipeline – it is sometimes referred to as the "upstream component". The gas is located some 4.5 km underground in a complex network of porous rocks (known as the Kudu Gas Field). The gas can only be accessed through a number of boreholes which are joined to a sub-sea manifold by sub-sea pipelines. Highly sophisticated valves and pressure control mechanisms will be installed to enable engineers to monitor the flow of gas and to shut the flow down if there is a problem. From the manifold at a central point in the gas field, the gas will enter a single

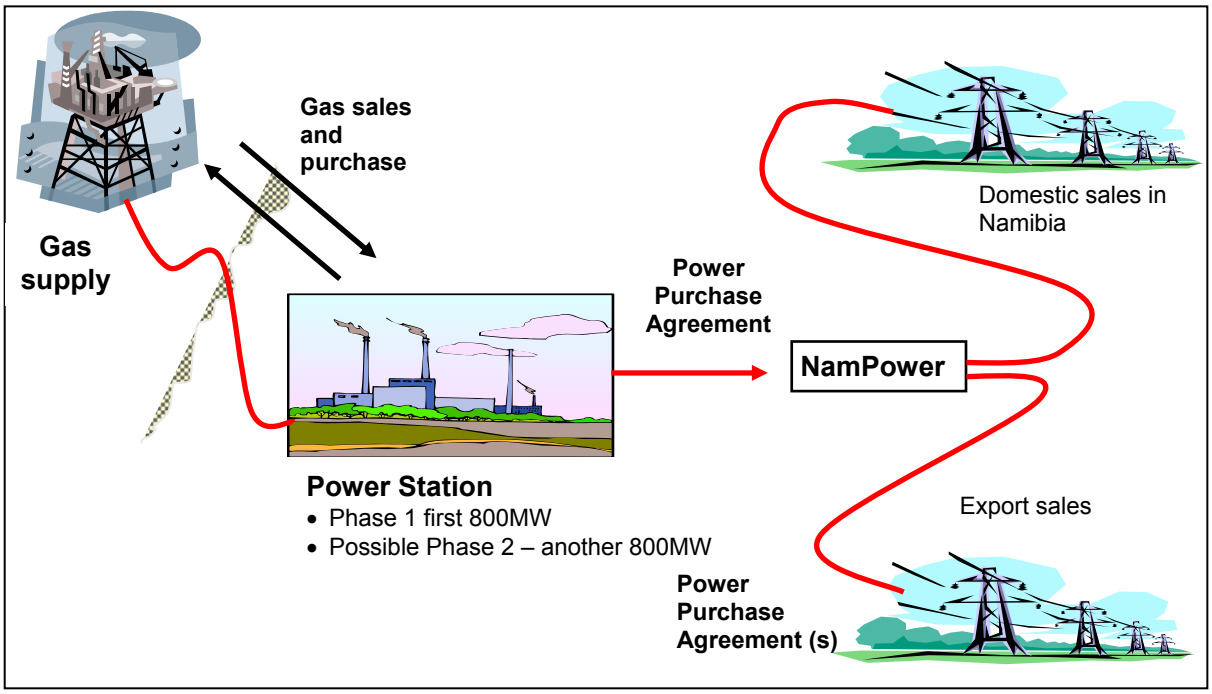
pipeline which will run for some 170 km until it reaches the coast near Uubvlei, some 25 km north of Oranjemund. Once on land, the gas will be treated at a gas conditioning plant, from which it is fed into the power station. The Gas Conditioning Plant will be built at the same site as the Power Station.

- ***Power Station*** - The gas will be used to generate power in a Combined Cycle Gas Turbine Power Station (CCGT) to be located at Uubvlei. Because the Uubvlei area has already been mined for diamonds by Namdeb, it is an already highly disturbed piece of land. The design of the power station is not yet finalised because a number of engineering options are still being considered, so as to achieve optimum performance and minimum environmental impacts. It is likely that seawater will be used to cool the exhaust steam from the steam turbines, which means that a seawater intake pipe will have to be constructed and cold seawater pumped to the station as required. The heated water from the cooling towers will be discharged directly back into the ocean. It is likely that the same corridor will be used at the beach landfall to accommodate all the pipes.

- ***Transmission lines*** – a new set of power lines will be erected to take the power from the power station to sub-stations that will enable power to be fed into the Namibian and South African grids.

The first phase of the Kudu Gas to Power Project (KGPP) will be the development of a nominal 800 MW power plant at Uubvlei, to be commissioned initially in 2009 but now probably delayed until 2010. The natural gas reserves within the Kudu Gas Field are sufficient for a nominal 800 MW power plant, operating for a minimum of 22 years, without the need for additional appraisal drilling in the gas field. It is anticipated that, if additional gas reserves are proven after 2-3 years of gas production, and the demand for electricity warrants it, the second phase of the project (an additional nominal 800 MW CCGT power plant) may be commissioned some 5 years later.

Figure 1.3: Diagrammatic illustration of the various components of the Kudu to Gas Project



1.3 Project History, Ownership and Status

One of the initial ideas for the development of the gas field was to export gas to a new power station at Saldanha Bay in South Africa, but after Eskom withdrew from this project, the Kudu Power Project was initiated in 1996 by Shell Exploration and Production Namibia (SEPN), NamPower and Eskom, with a view to generate electricity for the Namibian market and to export the surplus to South Africa.

During the initial stages of that project, NamPower commissioned a consulting company, Black and Veatch in 1997 to identify the best location for a gas power plant. Sites in Lűderitz, Oranjemund and Keetmanshoop were identified and evaluated according to several criteria relating to environmental impact, cost of gas pipelines and transmission lines, strategic position, availability of cooling water, founding conditions and operating efficiency. Oranjemund was found to be the best location for a power plant and three possible sites were identified close to the town.

In November 1997 a Memorandum of Understanding (MoU) was signed between SEPN and its partners, NamPower and Eskom, to promote the construction of a nominal 800MW CCGT power station at Oranjemund to be fuelled by Kudu gas. Later National Power, a UK based Independent Power Producer, also joined the consortium. This project, known as the

Kudu Power Project (KPP), included a first phase development of the gas field to be followed by a second phase for the export of gas to South Africa. A Techno-Economic feasibility study and Preliminary Environmental Assessment were commissioned to evaluate which of the three Oranjemund sites would best meet pre-determined criteria. During the study, a new site, Site D, was identified and it was found to be the best economic, technical and environmental alternative. The feasibility study demonstrated the commercial viability of the development to everyone's satisfaction except Eskom, the planned purchaser of the excess power generated over Namibia's needs, who felt the timing was premature and the cost too high. As a result the MoU was allowed to lapse at the end of 1998.

At that time a new commercialisation strategy was adopted comprising the development of a smaller power station in Oranjemund (400 MW – the OPP) in parallel with the development of a large power station in the Western Cape (1600 MW – the CPP) in conjunction with the Cape Municipal Area Local Authorities (CAMALA). This was termed the "integrated project" reflecting the fact that by combining the fuel demand of the two power stations, the offshore gas field infrastructure could be integrated into a single development rather than two separate developments.

In 2000 an independent feasibility study commissioned by SEPN and CAMALA clearly demonstrated the commercial viability of a 1200 – 2000MW gas fired power station in the Western Cape as the cheapest new generation option for South Africa within the targeted time window (2005 – 2008). But no decisions to develop this power station were taken.

In the meantime, SEPN continued work on a new phased development strategy for the Kudu gas field. This strategy comprised the construction of a 400MW CCGT power plant at Oranjemund and the investigation of installing a floating liquefied natural gas (FLNG) plant in the Kudu gas field. A 3-D seismic survey conducted in 2001 and an appraisal drilling campaign was expected to confirm the presence of sufficient gas to make the FLNG project viable. The first two wells, Kudu-6 and -7 were both "dry" and SEPN withdrew from the licence shortly thereafter as did ChevronTexaco a year later.

Energy Africa then took over as operator with the view to develop the Kudu gas field to supply gas to an 800MW CCGT power station to be built by NamPower in the vicinity of Oranjemund. Energy Africa Kudu Limited holds 90% of the equity in the venture and Namcor the balance (10%).

In 2004, NamPower, Energy Africa, Eskom and Namcor carried out a joint pre-feasibility study, which resulted in a Joint Development Agreement between NamPower, Energy Africa and Namcor for the development of the Kudu gas field to supply an 800MW CCGT power station near Oranjemund and a Memorandum of Understanding between NamPower and Eskom for the latter to purchase any surplus power.

A full Environmental Impact Assessment (EIA) was conducted on Site D near Oranjemund, and approved by the Ministry of Environment and Tourism (MET) in January 2005. However, it has since been found that the routing of the gas pipeline from the gas field to the site could interfere with Namdeb's diamond mining operations as it could "lock up" diamond reserves. Therefore another site was identified 25km north of Oranjemund, at Uubvlei. This would allow the incoming gas pipeline to be routed further north, around the main diamond reserves. Full EIAs for the new CCGT site and the outgoing transmission lines were then commissioned and completed in May 2005.

In the meantime, the "upstream" EIA was completed and approved and subsequently amended to reflect a change in development concept, the new CCGT site at Uubvlei and the new route for the gas pipeline. A production licence for the Kudu gas field was granted on 31 August 2005.

This Integrated Impact and Mitigation Report (IIMR) describes the entire Kudu Gas to Power Project based on the Uublvei site and the potential environmental impacts which may arise from the development at this site.

1.4 Environmental Studies

Each component of the Kudu Gas to Power Project, i.e.: the "upstream" gas field development; the "downstream" CCGT power plant; and transmission lines, has been addressed in separate environmental impact assessments at various times and by various independent consultants.

A summary of the studies done to date is presented in Table 1.2. It can be seen that the process has followed a traditional screening-scoping-EIA approach. It is also notable that a range of siting or routing and process alternatives has been evaluated at each stage. Indeed there are still some cases where the final preferred process options have not yet been determined. In spite of the long duration of the work, a degree of consistency has been maintained by the following means:

- Using the same consultants for many of the components;
- Using the Southern African Institute for Environmental Assessment (SAIEA) for external guidance and review of all the work on the CCGT power plant and transmission lines from the EIA stage. This included writing the Terms of Reference for the EIAs, guiding the process and reviewing the outputs;
- The public meetings at all stages of the project have been co-ordinated to present a 'single' project to the public and to address issues on an holistic basis;
- Many of the personnel in the proponents' teams have remained the same;
- Meetings have been held with relevant representatives of the Inter-ministerial Review Group (IRG).

Figure 1.4: During all three EIA studies, meetings were held with the public and interest groups. This photograph shows consultations between Nampower and Namdeb staff

Table 1.2: Summary of the Environmental Studies conducted to date

Project Stage	EIA stage	Date	KPP component	Consultant	Nature of Study	Decision
Planning	Screening	1997	CCGT	Black & Veatch	• Broad assessment of 3 possible locations for the CCGT: Lűderitz, Keetmanshoop, Oranjemund and the identification of 3 potential sites in the preferred general location of Oranjemund. • Environmental suitability was one of the key criteria used in the analysis	• The Kudu Development Team[1] decided to proceed with an investigation of the 3 sites in the Oranjemund vicinity.
Pre-feasibility and Site Selection	Scoping (Preliminary Environmental Assessment (PEA)) The upstream component was at the level of a full EIA.	1997-98	Gas Field	CSIR	• Desk study of proposed gas field development and pipelines up to the gas conditioning plant. • Included public participation in conjunction with the CCGT, analysis of alternatives, and identification of key issues for the EIA.	• Final report was not submitted to MME due to curtailment of the project in 1998.
		1997-98	CCGT	Walmsley Environmental Consultants (WEC) and CSIR	• Desk study of each of three identified sites around Oranjemund.[2] • Preliminary desk studies were undertaken on: flora, fauna, riverine ecology, birds, beach ecology, hydrogeology, archaeology, noise, air pollution and heated effluent dispersal at sea. • Public participation meetings were held to address both the CCGT and upstream gas field development components of the project. • Various process options were also evaluated, particularly relating to the cooling system. • *Site D using sea water from beach wells was found to be the preferred environmental, technological and economic option*.	• The EIA for Site D was approved by MET in 1998, but MET expressed a strong preference for a site inside the already disturbed mining area to be evaluated.
		1998-99	Power lines	WEC	• The transmission line study included an extensive evaluation of route alternatives from Site D at Oranjemund to Keetmanshoop. The routes were evaluated using GIS and a range of environmental, social and economic criteria. Public participation meetings were held at a number of towns and villages along the route. A preferred route was identified.	• NamPower accepted the findings of the study. • MET issued a positive Record of Decision in 1999.
Feasibility (Site D)	EIA	2002	Gas Field	ERM and CSIR	• ERM was commissioned by Shell to conduct an EIA of a revised development of the gas field to supply a Floating Liquefied Natural Gas (FLNG) plant. Oceanographic, seismic and benthic surveys	SEPN withdrew from the project and the study was not finished.

[1] The Kudu Development Team comprised Shell, NamPower and Eskom

[2] The Black & Veatch study identified 3 sites: A, located in the mining area north of Oranjemund, B near the Oppenheimer Bridge on the Orange River and C, located further upstream on the Orange River. The KDT discarded Site C as being uneconomic and Site A was moved out of the mining area to a coastal site near town for mining security reasons. The PEA team identified another site, D near Pink Pan south-west of Oranjemund.

Project Stage	EIA stage	Date	KPP component	Consultant	Nature of Study	Decision
					were conducted.	
		2004	Gas Field	CSIR	• CSIR were requested by Energy Africa to revise the gas field EIA in relation to Site D and to incorporate all the new findings since 2001.	EIA approved by MME in 2005
		2004	CCGT	CSIR and Enviro Dynamics	• Comprehensive ToR were set to investigate the key issues identified in the 1998 PEA. All aspects of construction, operation and decommissioning were considered. Because so much time had elapsed since the previous round of public meetings, an updated list of I&APs was compiled and additional meetings were held.	MET issued a positive Record of Decision in January 2005.
		2004	Transmission lines	Enviro Dynamics	• Although the EIA for the transmission line route from Keetmanshoop via Skorpion to Kudu (Site D) had received a positive RoD in 1999, NamPower issued a new ToR to look at additional routes from Site D to Obib. • The study undertook a short scoping exercise in conjunction with the CCGT EIA for Site D and specialist studies on fauna, flora and archaeology were commissioned.	MET issued a positive Record of Decision in April 2005.
Feasibility (Uubvlei site)	EIA	2005	Gas Field	CSIR	• The CSIR EIA for the gas field development providing gas to a plant at Site D was revised to reflect the changed position of the plant at Uubvlei and changes in the development concept.	Update of EIA (Addendum to EIA) approved by MME in March 2006.
			CCGT	CSIR and Enviro Dynamics	• The EIA for Site D was updated and amended to reflect the changed site for the power station at Uubvlei. An additional round of public and focus group meetings was held in Oranjemund and additional specialist studies on fauna, flora and archaeology were commissioned.	MET issued a positive Record of Decision in July 2005.
			Transmission lines	Enviro Dynamics	• A number of new routes had to be considered to link the CCGT power station at Uubvlei with Obib and Oranjemund substations. • A short scoping programme was conducted in conjunction with the CCGT EIA and additional specialist studies on fauna, flora and archaeology were commissioned.	MET issued a positive Record of Decision in June 2005.

1.5 Purpose and Structure of the Integrated Impact and Mitigation Report

At the request of some I&APs, some decision makers and the external reviewers, the project partners agreed to commission this IIMR so that it would be possible to integrate the EIAs of the three project components. A degree of integration has been achieved already since there has been some continuity in the personnel involved in the EIAs (see section 1.4 above). Also, it identifies synergistic effects arising from a combination of factors.

The purpose of the IIMR therefore is to:

- Provide a motivation for the project in the wider context of power supply and demand in Namibia and the southern African region (section 1.1);
- Present an overview of the environmental process to date (section 1.4);
- Provide a summary of the legal and policy framework as the context for the development (section 3);
- Present a succinct overview of the entire project (sections 1.3 and 4);
- Provide a summary of the environmental conditions of the project sites (section 5);
- Summarise the impacts (individual and cumulative) of each stage of project development (construction, operation and decommissioning);
- Summarise the potential mitigation measures that should be adopted to address the impacts identified and the implications that these measures will have for the project;
- Outline the 'way forward'.

2. METHODOLOGY

The methodology adopted to compile this IIMR was to review all the EIA reports for the Uubvlei site, capture all the impacts identified for each component by each project stage and to evaluate the cumulative impacts of these impacts. The mitigation measures required to address the identified individual and cumulative impacts were then identified.

There are a number of assumptions and limitations which must be noted:

- This IIMR is based on the development of the Kudu gas field, the new alignment of the gas pipeline to the CCGT power station at the Uubvlei site, the new route of the outgoing power lines and the resultant impacts at these sites;

- This document relies heavily on the information provided in the EIAs for the upstream gas development[3], the CCGT plant site at Uubvlei[4] and the EIA for the transmission lines to the Obib and Oranjemond sub-stations.[5] All information provided in these reports and used in this IIMR is therefore deemed to be correct;
- Some assumptions regarding mitigation measures will depend on the cooperation of Namdeb;
- It is assumed that the security issues regarding access to a) Oranjemund town and b) into Mining Area 1 (MA1) will be sorted out between the developer of the KGPP, Namdeb and MME.

3. POLICY AND LEGAL CONTEXT

3.1 Namibian Legal and Policy Framework

Namibia has a range of policies, acts and regulations which provide strategic direction and control over most activities that could have an impact on the environment as a whole. These policies and acts, both promulgated and in draft form, were identified in each of the EIAs and the project has been developed in compliance with these requirements. However, there are a number of actions which still need to be formalised in the Environmental Management Plan (EMP). Table 3.1 provides a summary of the Namibian policies and laws and indicates how the requirements have been applied, or are still to be applied (highlighted in bold).

3.2 International Obligations

Namibia is a signatory to a number of international conventions and treaties that are relevant to the KGPP. While these conventions place an obligation on the member states to fulfil certain requirements, rather than the project-level proponents, it is worth noting how the KGPP has complied with these international conventions (see Table 3.2).

[3] Prepared by P Morant of the CSIR. CSIR Report No ENV-S-C 2004-066 dated December 2004 and updated chapters 2 and 5 for the Uubvlei site/revision in development concept (dated December 2005).
[4] Prepared by H Fortuin of the CSIR. CSIR Report No ENV –S-C 2005-057 dated May 2005.
[5] Draft Report Prepared by Enviro Dynamics, dated May 2005.

Table 3.1: Namibia's Environmental Policy and Legal Context

Policy/Law	Relevant Requirement	Application by the Kudu Gas to Power Project
Constitution of the Republic of Namibia, 1990	Provisions relating to the environment are contained in Chapter 11, article 95, which states that the Republic of Namibia shall – *"actively promote and maintain the welfare of the people by adopting*, inter alia*, policies aimed at … maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilisation of living natural resources on a sustainable basis for all Namibians, both present and future;"*	Development of Namibia's natural resources (natural gas) to provide power to the people of Namibia and to stimulate economic growth, with the least impact on the environment is consistent with the Constitution. Although the utilization of natural gas is not sustainable *per se,* the re-use of mined out land and abandoned infrastructure reflects a degree of sustainable land use.
Namibia's Environmental Assessment Policy, 1995	The principles of this policy are: • To better inform decision-makers; • To consider a broad range of alternatives; • To strive for a high degree of public participation and involvement; • To take the environmental costs and benefits into account in decision-making; • To include internationally accepted norms and standards where appropriate; • To take into account secondary and cumulative effects; • To promote sustainable development and ensure that negative impacts are minimised and that project benefits are maximised.	• The aim of the EIAs and this IIMR is to integrate the separate EIA's for the 3 components of the Kudu Gas to Power Project . • A broad range of site, route and process alternatives has been investigated. • A high level of public participation has been achieved throughout this project. • Environmental costs and benefits have been described in qualitative terms in each EIA. • International standards, such as those set out by the World Bank, EPA, WHO and MARPOL have been used where appropriate in the EIAs. • All studies to date have proposed measures to minimise negative impacts and optimise the benefits through site and route selection processes and technology options.
The Second National Development Plan of Namibia 2001/2 – 2005/6, and Vision 2030	*"The nation shall develop its natural capital for the benefit of its social, economic and ecological well-being by adopting strategies that: promote the sustainable, equitable and efficient use of natural resources; maximise Namibia's comparative advantages; and reduce all inappropriate use of resources. However, natural resources alone cannot sustain Namibia's long-term development, and the nation must diversify its economy and livelihood strategies."*	Development of Namibia's natural resources (natural gas) to provide power to the people of Namibia and to stimulate economic growth, with the least impact on the environment is consistent with Vision 2030 and NDP2. Although the utilisation of natural gas is not sustainable *per se,* the re-use of mined out land and abandoned infrastructure reflects a degree of sustainable land use.
Draft Wetland Policy, 2003	The vision of the Wetland Policy of 2003 aims to integrate sustainable management into decision-making at all levels by stating that "*Namibia shall manage national and shared wetlands wisely by protecting their biodiversity, vital ecological functions and life support systems for the current and future benefit of people's welfare, livelihoods and socio-economic development."*	The decision to reject Site B during the PEA was largely based on the potential adverse effects that the abstraction of large volumes of cooling water and the discharge of heated effluent would have on the Ramsar site and on neighbouring South Africa. The shift to Uubvlei ensures that there will be no impacts on the Ramsar site *per se*
White Paper on National Water Policy	Water resource development must take into consideration issues such as: ownership, equity, ecosystem values and sustainability.	The KGPP will utilise sea water for cooling purposes. A small amount of freshwater will be required for the construction and operational phases, but this will be within

Policy/Law	Relevant Requirement	Application by the Kudu Gas to Power Project
for Namibia, 2000		the current water abstraction permit of Oranjemund.
White Paper on Energy	The policy objective is to achieve: security of supply, social upliftment, economic efficiency and sustainability.	The KGPP achieves the goals of the Energy Policy through the development of Namibia's natural resources (gas) to supply power to the country and to export the surplus into the SAPP grid via South Africa. The use of natural gas to produce electricity is recognised as being the most energy efficient of all the fossil fuels and has the lowest emissions to the environment.
The Petroleum (Exploration and Production) Act, No 2 of 1991,as amended by Act 11 of 1997	Chapter 11 requires: • Environmental damage to the licence area and adjoining lands to be minimised; • international standards are to be taken into account; • An EIA must be carried out for gas field development; • Mitigation measures for environmental control must be developed. • Spillage of water, drilling fluids or effluents in the licence area is prohibited except with a written exemption.	• Environmental studies were conducted to determine the impact of gas field development and production, gas pipeline routes to shore and onshore gas conditioning plant. Changes to minimise the impacts have been made in the preliminary design. • Reference has been made to MARPOL, IFC, World Bank, EPA etc standards. • The gas field EIA has been done. • Mitigation measures have been suggested. An EMP for the project is being compiled. • An exemption has been granted to the proponent to dispose of water-based drilling mud and drill cuttings offshore.
Territorial Sea and Exclusive Economic Zone of Namibia, Act 3 of 1990, as amended by Act 30 of 1991	In the 200 nautical mile Exclusive Economic Zone (EEZ) established under this Act, Namibia may exercise powers to control the use and conservation of living marine resources. With regards to non-living resources, the continental shelf is regarded as state land.	The Kudu gas field lies on the continental shelf, within Namibia's EEZ.
Prevention and Combating of Pollution of the SEA by Oil Act, 1981, as amended by Act 24 of 1991.	The aim of this act is to prevent oil pollution within 50 nautical miles of the coast from a ship, tanker or offshore installation.	• All ships supplying the drilling unit and the unit itself will have to comply with this act. • This issue is being addressed in the Gas Field EMP.
The Marine Traffic Act, Act 2 of 1981, as amended by Act 15 of 1991	No regulations have been made in terms of this act.	Not applicable.
Marine Resources Act, 2000	Article 52 imposes penalties on dredging or extraction of sand and gravel in Marine Reserves, discharges or deposits of waste or any other polluting matter and discharges in Namibian waters of anything which may be injurious to marine resources or which may disturb the ecological balance.	All matters pertaining to waste disposal from ships and the drilling unit will be addressed in the Gas Field EMP.

Policy/Law	Relevant Requirement	Application by the Kudu Gas to Power Project
Water Resources Management Act, Act 24 of 2004 (replaces the Water Act of 1956)	The objective of the Act is to ensure that Namibia's water resources are managed, developed, protected, conserved and used in ways which are consistent with or conducive to fundamental principles set out in section 3 of the Act.	Licences will have to be applied for in terms of this Act to: • Abstract and use water, including brackish or marine water for any purpose; • Discharge effluent to the sea, a waste water treatment plant or any other effluent disposal site (this could be a combined licence with the abstraction licence); • Drill new boreholes for any other purpose other than for groundwater exploration. The Minister may prescribe minimum standards for effluent quality.
Sea Fisheries Act, 29 of 1992	The Act deals mainly with: • Dumping at sea; • Discharge of wastes in marine reserves; • Disturbance of rock lobsters, marine invertebrates or aquatic plants; • Prohibited areas for catching/disturbing fish, aquatic plants or disturbing/damaging seabed.	All these issues will have to be addressed in the EMPs.
Nature Conservation Ordinance, 4 of 1975, as amended in 1996	Provides *inter alia* for the protection of scheduled species.	• The site of the CCGT will be on previously mined land which is already severely disturbed. • The routes of both the incoming gas pipeline and the outgoing transmission lines have been selected in order to minimise impacts on scheduled species. • Detailed management measures are to be stipulated in the EMPs.
Atmospheric Pollution Prevention Ordinance, 11 of 1976 (APPO)	In terms of Section *5* any person carrying on a "scheduled process" within a "controlled area" has to obtain a registration certificate from the administering authority, in this case the Department of Health. The Act lists 72 processes in Schedule 2; of relevance for the project are the sections on power stations (29), producer gas works (33) and gas and coke works (24).	• According to Sections *5* and 6 of the Ordinance, the premises in which such scheduled process will be conducted must be registered and a registration certificate (air pollution permit) obtained.
Diamond Act, 13 of 1999	Section 52 deals with Restricted Areas, where approved persons must enter with the required permit. Restricted Areas are declared as such by the Minister in the Government Gazette, and include areas where on- or offshore mining or related activities take place.	• The Diamond Regulations in terms of the Act make provision for security check procedures for persons wishing to enter Restricted Areas.
Environmental Assessment and Management Bill	Listed activities which would require an EIA include: • Construction and related activities that include roads, dams, factories, pipelines and other infrastructure;	EIAs have been conducted for all the relevant listed activities.

Policy/Law	Relevant Requirement	Application by the Kudu Gas to Power Project
	• Land-use planning and development activities that include rezoning and land-use changes; • Resource extraction, manipulation, conservation and related activities, such as mining and water abstraction; • The erection, construction or upgrading of facilities for the commercial transmission and supply of electricity with the exception of power supply line of less than 2km in length.	
Draft Pollution Control and Waste Management Bill of 1999 (to repeal the APPO, 11 of 1976; the Hazardous Substances Ordinance, 14 of 1974; and s.21 of the Water Act of 1956)	The Bill deals with the protection of particular species, resources and components of the environment. Aspects which would be relevant to the KGPP include: • Air pollution; • Water pollution; • Integrated pollution control; • Noise, dust and odour; • Waste management; • Hazardous substances; • Accident prevention.	All of these aspects will be addressed in the EMPs.
Parks and Wildlife Management Bill of 2001 (to replace the Nature Conservation Ordinance, 4 of 1975)	The Bill provides for the declaration of protected areas e.g. the Sperrgebiet National Park.	• All activities within the Sperrgebiet National Park (including the KGPP) will be subject to the provisions of this Act when it comes into force. • This factor will be a major consideration in the drafting of the EMPs.

Table 3.2: International Conventions and Treaties which are Applicable to the Kudu Gas to Power Project

Convention/Treaty	Requirements	Application by the KGPP
The United Nations Law of the Sea Convention, 1982 (UNCLOS)	Deals with the prevention of marine pollution and compensation for damage caused by this pollution. The Convention requires states to adopt legislation to reduce marine pollution from sea-bed activities in the EEZ and on the continental shelf.	• The KGPP has been designed to minimise the risks of marine pollution through the adoption of international standards. • Namibia has two legal instruments which govern marine pollution: The Petroleum Act, 2 of 1991 and the Prevention and Combating of Pollution of the Sea by Oil Act, 1981.
International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL 73/78)	This Convention covers a range of aspects relating to ship-generated pollution such as solid and liquid waste disposal and emissions to the atmosphere.	The specific requirements of this Convention have been identified in the Gas Field EIA and will be further developed in the EMP.
Convention on Biological Diversity, 1992 (CBD)	Article 14 requires each contracting party to carry out environmental impact assessments (EIAs) of projects that are likely to adversely affect biological diversity. It further requires that the EIA be aimed at avoiding or minimising such effects and, where appropriate, allow for public participation in the assessment.	EIAs have been done for each main component of the KGPP. The site of the power plant was selected partly on the basis that the area has already been disturbed by mining and the transmission line route has also been selected to minimise the impact on rare and endangered species. Extensive public participation has also taken place.
Stockholm Declaration on the Human Environment, 1972	Principle 21: States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction. Principle 22: States shall cooperate to develop further the international law regarding liability and compensation for the victims of pollution and other environmental damage caused by activities within the jurisdiction or control of such states to areas beyond their jurisdiction.	With the relocation of the CCGT plant to Uubvlei, some 30km north and downwind of Alexander Bay, the potential for the plant to have any impact on South Africa is remote.
Convention on Wetlands of International Importance, especially as Waterfowl Habitat,	The Orange River Mouth was designated a Wetland of International Importance 23 August 1995. In terms of Article 3.2, this makes Namibia responsible for ensuring that the convention secretariat is informed at the earliest possible time if the ecological character of the Orange River Mouth wetland is likely to change as the result of technological developments, pollution or other human interference.	• The relocation of the CCGT plant to Uubvlei means that there will be no impacts on the Ramsar site from this plant. The only potential impact on birds will result from the transmission lines crossing the Orange River to the Oranjemond Substation. However there is already an existing transmission line at this crossing point and the new lines will be clearly marked.

1971 (Ramsar Convention)	Namibia is responsible for communicating information on such changes, without delay, to the International Union for the Conservation of Nature and Natural Resources (IUCN).	
Protocol on Shared Watercourse Systems in the SADC Region, 1995	This Protocol is based on the conviction of *"the need for coordinated and environmentally sound development of the resources of shared watercourse systems in the SADC region in order to support sustainable socio-economic development".*	This Protocol is no longer relevant because cooling water for the CCGT plant will be abstracted from the ocean and not the Orange River.
United Nations Framework Convention on Climate Change, 1992 and the Kyoto Protocol	The objective of the Convention and subsequent related legal instruments (such as the Kyoto Protocol) is *"the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner".*	• The KGPP will utilise natural gas which has higher energy efficiency and produces lower quantities of greenhouse gases than coal, oil or diesel-fired thermal power plants. • The KGPP could be a candidate for carbon credits.
Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes ad their Disposal, 1989	The Convention aims to do the following: • Reduce trans-boundary movements of hazardous waste to a minimum; • Ensure that hazardous wastes should be treated and disposed of as close as possible to their source of generation; and, • Minimise hazardous waste generation at source.	• All hazardous waste from the KGPP must be removed to a licensed hazardous waste site in Namibia i.e. Kupferberg in Windhoek. • Permits would be required under this Convention to transport hazardous waste to RSA for example.

3.3 Land Ownership, Tenure and Rights

3.3.1 Gas Field and Gas Pipeline Route

The gas field falls within quadrant 2814 on the continental shelf of Namibia, which falls within Namibia's Exclusive Economic Zone (EEZ). An exploration licence for area 2814A was awarded in May 1993 with the signing of a Petroleum Agreement. This area was extended in 1996 to include two 15' sub-blocks to the south, however after further evaluation, these two blocks were relinquished in 1998. A production licence for the Kudu Production area, which includes part of the original area 2814A but extends slightly further west and south, was granted on 31 August 2005. The part of the Kudu Production Area west of longitude 14˚30'E overlaps the licence area in which BHP Billiton has exploration rights in the geological sequence above the Kudu reservoir sequence.

Of critical concern to the Kudu gas field development is the Atlantic 1 Diamond Mining Licence Area which lies in the path of the most economical pipeline route from the Kudu gas field to Oranjemund (Figure 1.1). The Atlantic 1 Licence area, held by Namdeb, is being mined under contract by De Beers Marine Namibia (Pty) Ltd (DBMN). A Right of Way agreement has been pursued with Namdeb since 1998, initiated by the former operator of the gas field development, Shell Exploration and Production Namibia B.V., and has recently been brought to a conclusion.

Atlantic 1 Mining Licence Area is approximately rectangular in shape and covers 6,098 km^2 of seabed in the south-eastern corner of the Namibian Exclusive Economic Zone (EEZ). The area extends 110 km to the north-west and is about 60 km wide. Most of the mining occurs in water depths exceeding 100 m beyond the 12 nautical mile territorial limit in the contiguous zone. A new development being considered for implementation in Atlantic 1 is extensive dredge mining using a cutter-suction dredger.

3.3.2 Land Operations

All the land-based operations including the gas pipeline landfall, gas conditioning plant, CCGT plant and transmission lines to the Obib and Oranjemond substations are situated on state land. The town of Oranjemund is also on state land, but all infrastructure and assets in the town are owned by Namdeb. There have been protracted negotiations between Namdeb and the state regarding the future proclamation of the town and a structure plan and site layout are being finalised. The intention is to set up an independent town management company to run the town on a commercial, municipal basis until proclamation. The status of the town of Oranjemund will have an important bearing on the ownership of

new housing for gas plant employees and the use by them of services currently being provided by Namdeb e.g. sewerage, water reticulation, power, roads schools, clinics and social services. The proposed CCGT site at Uubvlei is situated beyond the proposed municipal boundary, in Mining Area 1.

Figure 3.1: The town of Oranjemund looking from north east to south west. Note the Atlantic Ocean and Orange River Mouth in the distance, the Pink Pan in the middle of the photograph and the Oranjemund airfield to the left of Pink Pan.

The exclusive mining licence (for diamonds) for Mining Area 1 is held by Namdeb . It is a high security area stretching for 100km north along the coast from Oranjemund and approximately 10 – 20 km eastwards (Figure 1.1). The proposed pipeline corridors, gas conditioning plant (GCP), CCGT, construction works area and hostel are all located in this high security zone which will have implications under the Diamond Act, Act 13 of 1999 for access by all construction personnel, deliveries and waste disposal. These issues are being discussed and in principle agreement has been reached.

The proposed transport route for all equipment and supplies is along the coastal road from Lűderitz in the north. This gravel road, some 270km long, is currently a private road, owned and maintained by Namdeb. It passes through Mining Area 1 and other licence areas belonging to Namdeb (Figure 1.1). Currently access is strictly controlled in terms of the Diamond Act. Access from the south via Alexander Bay has been improved recently, but is

subject to immigration control at the international border with South Africa and Diamond Act restrictions once on Namibian territory. The road to Rosh Pinah is similarly restricted since it passes through the Orange River mining licence area.

The transmission line route traverses Mining Area 1 for about 12 km and then enters the proclaimed (but not yet gazetted) Sperrgebiet National Park. Construction along the section within the mining licence area will be subject to the strict access limitations imposed by the Diamond Act. The final section of the transmission line route to the Obib substation traverses several exploration and mining licence areas belonging to Anglo Base Metals, including the Skorpion Zinc Mining Licence area. The transmission line route to the Oranjemond substation traverses the MA1 and Orange River Mining Licences owned by Namdeb up to the north bank of the Orange River, which is still the proclaimed international boundary with South Africa.[6] From there, the line crosses the river to the Oranjemond substation on South African territory.

4. PROJECT DESCRIPTION AND ASSESSMENT OF ALTERNATIVES

4.1 Gas Field Development

4.1.1 Location and Scope of Development

The Kudu gas field lies approximately 170 km west of Oranjemund on the Namibian coast (Figure 1.1). The development of the gas field will comprise four sub-sea wells tied to a sub-sea manifold from which a pipeline will transport the gas to onshore production facilities for final conditioning prior to sale to the power station.

Figure 4.1: A drilling rig on site

[6] The international boundary with South Africa is currently on the north bank of the river, contrary to international practice of placing it along the 'thalweg' (deepest channel) of a navigable river or (in this case) along the centre of a non-navigable river. Negotiations between Namibia and South Africa have been ongoing since Namibian independence in 1990.

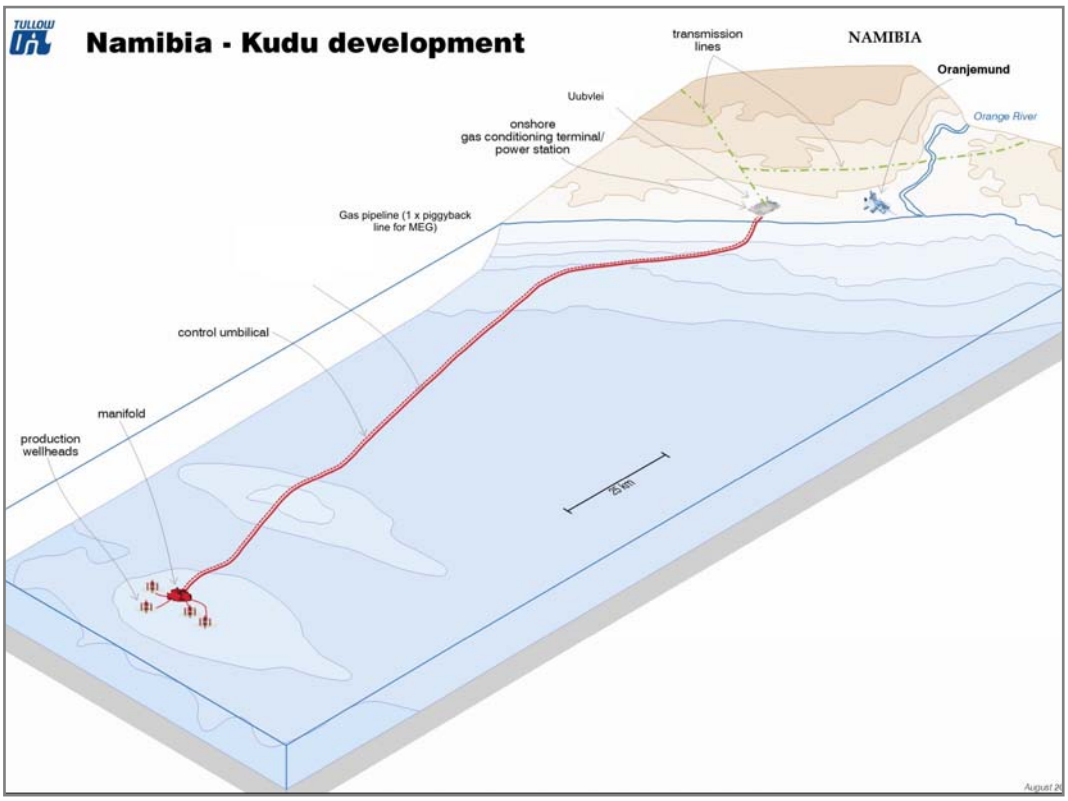
The entire production from the Kudu gas field will be used to generate electricity at Uubvlei in the vicinity of Oranjemund. Initially an 800MW CCGT power plant will be supplied with gas. This may be doubled to 1600MW at a later date if additional gas reserves are established (Phase 2).

4.1.2 Drilling

The current field development plan is to drill up to four sub-sea wells using a semi-submersible drilling unit (Figure 4.1). Three wells will be drilled at the start of field life, while a fourth one will have to be drilled some time in the future for maintaining the required gas production rate. The wells will provide up to 140 MMscf/d of gas during a contractual period of 22 years.

If additional gas volumes are proven through production history and/or exploratory appraisal drilling, further sub-sea wells will be drilled to provide for an increased gas production rate for either an expanded Kudu power station or for other uses. This would require a second sub-sea manifold to be connected to the first. The gas pipeline will have sufficient capacity to transport a higher field output of up to 280 MMscf/d as would be required by the presently envisaged Phase 2.

Figure 4.2: Diagrammatic illustration of the sub-sea wells, the pipeline and the power station.



The water depth above the Kudu gas field is approximately 170 m and the total depth of the wells will be between 4,500 and 5,000 m. The wells will be vertical. Drilling is initiated by lowering a drill bit to the sea floor on the drill string and rotating the drill string, causing the bit to crush the rock into small particles. The small rock particles generated at the bit are removed from the well bore by the drilling fluid or "mud", a specially formulated mixture of natural clays, polymers, weighting agents and/or other materials suspended in a fluid medium. The preferred drilling mud to be used at Kudu will be a water-based mud – WBM, which has an insignificant effect on the environment. Drill cuttings are separated from the mud at the surface by solids control equipment before the mud is re-circulated. The drilled rock cuttings are continuously removed from the mud and are discharged to the sea bed.

It is not foreseen that the Kudu production wells will be tested for any length of time. If flow testing is required, produced hydrocarbons will be burnt at the wellsite. Surface testing equipment will be installed and tested on the drilling vessel prior to flow testing. A high efficiency flare will be used to maximise combustion of the gas. Produced water, if any, will be treated and discharged overboard according to acceptable international standards.

4.1.3 Gas Production

The development of the gas field at a maximum gas flow rate to shore of about 140 MMscfd for an 800 MW CCGT power station at Uubvlei comprises ultimately of four sub-sea production wells connected by 10" flow lines to a sub-sea manifold. There will be no installations above the surface of the sea (Figure 4.2).

Phase 2 development will involve drilling an additional four sub-sea production wells, linked via flow lines to a second sub-sea manifold, which in turn will be connected to the Phase 1 manifold. The Phase 1 gas pipeline, monoethylene glycol (MEG) line and control umbilicals will all have sufficient capacity to allow for Phase 2.

4.1.4 Sub-marine Pipeline

A single 18" pipeline is to be installed from the Kudu gas field to transport the gas from the sub-sea manifold to the gas conditioning plant adjacent to the power station. The pipeline will be laid on the sea bottom and will be provided with an anti-corrosion coating and sacrificial anodes to resist external corrosion. In addition the pipe will be coated with concrete in order to stabilise it on the seabed. Near shore, the pipeline will also be trenched in places and/or covered with rock, to ensure that the pipeline is not dislodged by waves and

currents. As a minimum, all pipelines will be designed to meet international design standards.

The pipeline route has been selected on the basis of the preferred power station site at Uubvlei in consultation with Namdeb to avoid, within the technical pipe laying limitations, potentially high value parts of their diamond mining licence area.

Laying of the submarine flowlines and pipeline for the Kudu gas field development is expected to be performed using a conventional laybarge technique (Figure 4.3). This involves transporting lengths of pipe to a moored barge where they are welded to form the pipeline. The barge moves forward length by length, and in doing so, the pipe moves along a ramp on the barge through a series of welding stations, an X-ray testing station and weld-coating station where the weld is coated as protection against external corrosion and the gap in any concrete weight coating is filled. In addition to the laybarge vessel a typical installation spread will also include one or two pipe transportation vessels, one or two anchor handling vessels and a general support vessel.

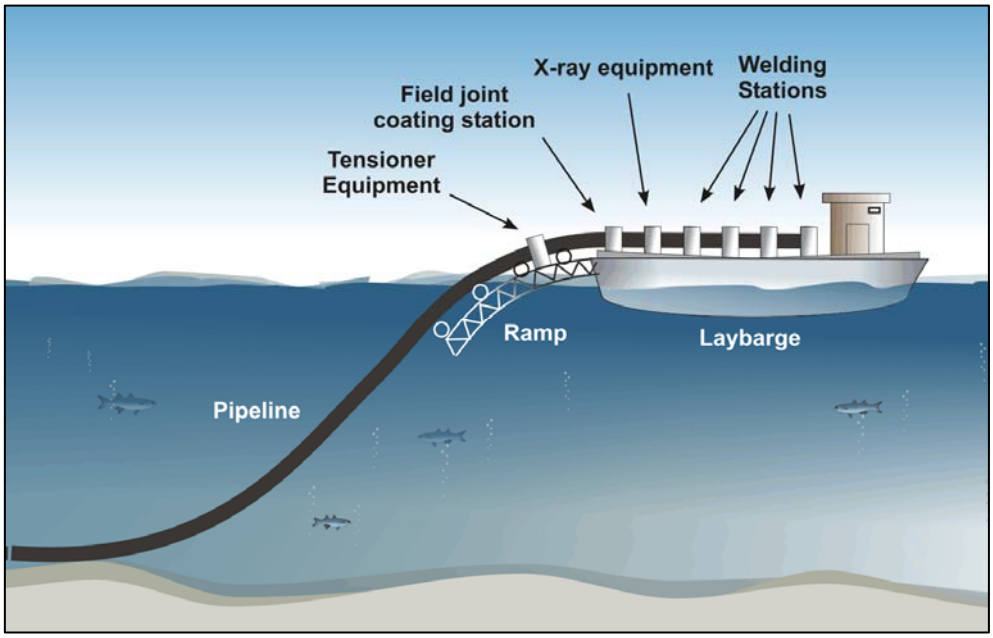


Figure 4.3: Schematic illustration of the pipe laying process

The pipeline will be laid at a time when sea conditions are generally calm, which is usually from November to March each year. The total installation time is estimated to be around 120 days excluding contingency time for rough sea or adverse weather conditions.

4.1.5 Monoethylene Glycol (MEG) Line

In order to prevent a build up of gas hydrates in the gas pipeline, a hydrate inhibitor is added to the gas flow line. This is usually in the form of monoethylene glycol (MEG), which also contains a corrosion inhibitor. A 4" line will be required to transport MEG from the onshore gas conditioning plant to the distribution manifold at the seabed. From there, the MEG will be transported to the sub-sea "trees" through the infield umbilicals. A technique termed "piggybacking" will be employed for its installation, whereby the small MEG line is strapped to the main gas pipeline as it is passed over the ramp at the stern of the laybarge.

4.1.6 Control Umbilicals

A power and control umbilical line will connect the shore installation to the sub-sea control distribution manifold (CDU) from which smaller umbilicals (termed infield umbilicals) connect to each well. The umbilical is a flexible armoured cable with cores to carry electrical power, instrument signals, tubing for hydraulic power and methanol for hydrate prevention at the well heads at start up. It enables engineers to monitor the subsea equipment and to fix certain problems should they arise.

The umbilicals will be laid separately from the pipelines by a suitable vessel. At the shoreline the umbilical will terminate at an instrument panel in a small building constructed for this purpose. From there a buried umbilical will connect to an instrument panel in the gas conditioning plant.

4.1.7 Gas Pipeline Landfall

The key factor involved in bringing a pipeline to shore is to perform the work in such a way that the pipeline is adequately protected throughout its lifetime. As a result of the high wave energy experienced along the south-west African coast the pipeline has to be buried to at least 2-3 m below the normal sea bottom level in the breaker zone and/or be positioned above the wave action.

The method selected for the Kudu pipeline is to concrete coat the pipeline, bury it in some areas and additionally to cover the affected areas with rock dumped from a barge.

Away from the breaking wave area, it may still be necessary to cover the pipeline to ensure that the line will not move when subjected to storm weather conditions. The need for this approach is highly dependent upon the orientation of the pipeline relative to the storm direction and how quickly the water depth increases along the route of the line. This will be analysed during detail design and appropriate measures taken to ensure pipeline on-seabed stability. Methods of stabilization could include trenching, rock dump, or stabilizing weighted

mattressing. This will be performed over the affected length, potentially the first 50 km of pipeline length from shore up to a water depth of approximately 60 m.

During the course of the detailed engineering design studies, the landfall method and any nearshore stabilization requirements will be confirmed.

4.1.8 Onshore Pipeline

From the pipeline landfall, the pipeline route will cross previously mined land for approximately 800m to the gas conditioning plant, located adjacent to the power station. It is proposed that all the pipelines to the sea (including the CCGT water intake and cooling water discharge lines etc) will be constructed in the same corridor, with a single access road and security fencing.

The onshore section of the gas pipeline will have a bonded polyethylene coating and be buried at a depth of at least 1m, with markers on surface every 100m and at changes in direction. In addition, the pipeline will be protected against corrosion by an impressed current cathodic protection system.

At the entrance of the gas conditioning plant, an emergency shutdown valve (ESDV) will isolate the pipeline from the plant in the event of an emergency. It is operated by dedicated process sensors and from a separate system than that used for the normal control of the plant. Manual valves upstream of the ESDV will allow it to be tested and maintained.

4.1.9 Gas Conditioning Plant

A gas conditioning plant (GCP) with its associated slug catchers will be constructed adjacent to the CCGT power station. The purpose of the gas conditioning plant is to supply dry gas to the power plant, and to recover the MEG for re-use. Gas and liquids from the pipeline are led into a slug catcher, which permits the separation of the gas from the condensate and water/MEG mixture. The slug catcher for Phase 1 will have a volume of 3000 bbls (approximately 450m^2). The gas is dried and heated before passing through a fiscal meter and on into the power station. The condensate and water/MEG mixture is passed through a separator. The condensate is cooled and stored for export by road tanker. The water/MEG mixture is further treated in a regeneration unit which separates the MEG from the water, and the MEG is recycled.

4.1.10 Supply Base

The supply base for the gas field development and production will be the Port of Lűderitz. It will serve as the base for the support vessels, and drilling supplies, pipeline sections and other construction materials will be stockpiled there. Concrete coating of the pipeline sections may also be undertaken in Lüderitz. If this option is selected the pipeline sections will be delivered to Lüderitz already corrosion coated. The facility will consist of bulk cement storage tanks, water tanks, mixing facilities and the concrete coating plant. The port of Walvis Bay is an alternative in case no dedicated wharf space and pipe yard can be secured at Lüderitz before the start of the gas field development.

4.1.11 Housing, offices, employment

The construction workers for the gas conditioning plant will be accommodated in the Uubvlei hostel and/or new temporary facilities and at appropriate accommodation in Lűderitz. Management staff will be housed in Oranjemund. The construction phase will require a labour force of up to 1500 at any one time, i.e. max 1200 for the power plant and max. 300 for the gas conditioning plant while the operational phase will be limited to some 60 permanent employees for the power station, and also some 30 for the gas conditioning plant and offshore field production control centre. The offices and control room for the gas field production facilities and the gas conditioning plant will be at the GCP.

All contractors will be requested to employ local Namibians through recruitment centres outside Oranjemund to try and reduce the influx of job seekers to the area.

4.2 Power Generation

4.2.1 Location

It is proposed that the Kudu CCGT Power Plant be located at Uubvlei 25km north of the town of Oranjemund. The site currently comprises mined-out land and lies within Namdeb's mining licence area (Mining Area 1).

It is proposed initially to construct a nominal 800 MW CCGT plant which will become operational in 2010 according to the latest estimate. The plant will comprise two gas turbines, with one or two steam turbines. A further nominal 800 MW may be constructed later to commence power generation some 5 years later if the gas volumes are proven to be sufficient, and power demand in Namibia and in surrounding countries can be confirmed. This extension to the plant will take place within the confines of the currently designated site.

The area of the site is about 49 ha (700 m x 700 m), which is the area required to provide for the CCGT as well as an adjacent contractors' work and laydown area.

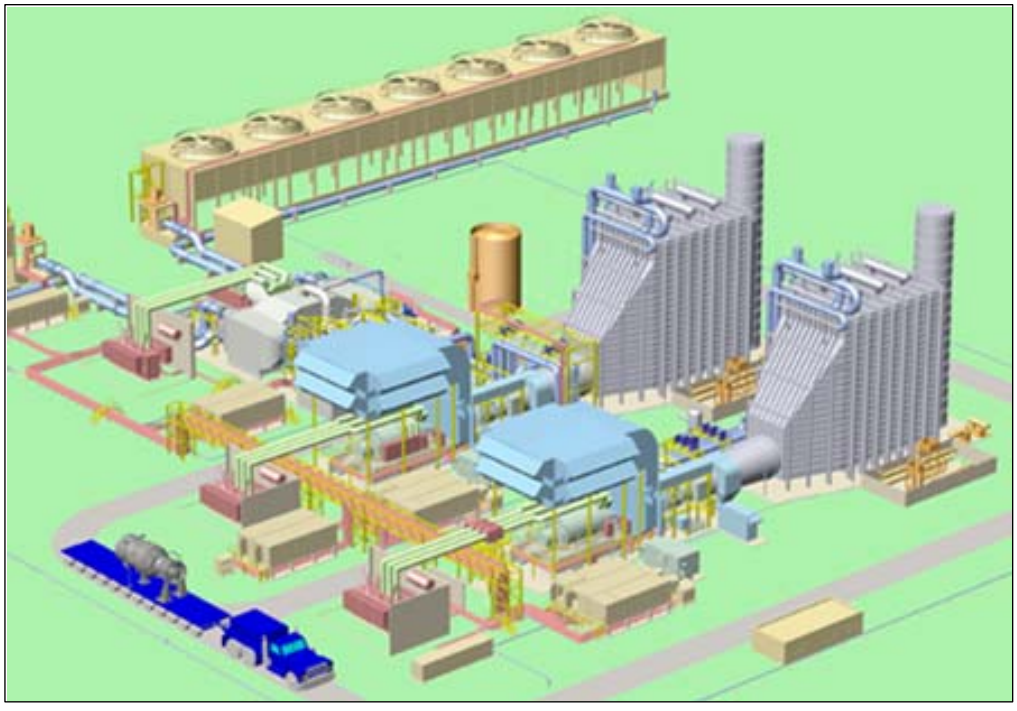
It is anticipated that major components of the CCGT plant will be delivered from the Port of Lüderitz by means of haulage vehicles suitable for extra-heavy loads.

4.2.2 Plant Design and Layout

The combined cycle gas turbine (CCGT) power plant utilises the following process: two gas turbines burning either gas or liquid fuel drive two generators for electricity production. Exhaust gases from each gas turbine pass through a heat recovery steam generator (HRSG) to generate steam. The steam generated in the two HRSGs drives a steam turbine which in turn drives a generator to produce further electrical energy.

The proposed plant will employ the most recently developed CCGT technology. A schematic of the process is shown in Figure 4.4.

Figure 4.4: Diagram of the probable layout of the power station that will be built at Uubvlei.



Two configurations, which may be referred to as single-shaft and multi-shaft, are possible for the Kudu CCGT power plant. A single-shaft arrangement consists of a gas turbine, steam turbine and generator arranged on a single shaft or power train. There would be two such units at Kudu CCGT.

The alternative multi-shaft option has two gas turbines and a steam turbine each with its own dedicated generator. For Kudu CCGT Power Plant the final choice between single-shaft and multi-shaft designs will be made on technical and economic grounds, following a competitive tender process.

Figure 4.5: A typical CCGT power station

4.2.3 Plant Components

The particular model of gas turbine to be installed will determine the overall size of the plant and its configuration and layout. The development will comprise the main structures as listed below. Exact dimensions of each element will become known only after contractor selection, but indicative heights are provided below. The main structures associated with the development will be the gas turbine, bypass stack (if provided), HRSG with associated stack, steam turbine building, cooling towers and ancillary buildings.

- Enclosures to house the gas turbines – height approximately 25m.
- Enclosure to house the steam turbine - height approximately 25m.
- HRSG - height approximately 40m.
- Cooling towers - height approximately 30m.
- Auxiliary boiler - height approximately 12m.
- Electrical Building to house switchgear enclosures - height approximately 12m.

- Enclosure for Water Treatment Plant with chemical storage tanks - height approximately 12m.
- Exhaust Stacks - height approximately 45 – 60m for HRSGs, 45m for by-pass stacks (if provided) and 45m for auxiliary boiler.
- Water storage tanks for raw water, semi-treated and treated water - height approximately 20m.
- Liquid fuel storage tanks (if provided) within a bunded area - height approximately 20m.

Other components at lower elevations include the following:

- Workshops and Stores Building
- Control and Administration Building
- Generator, Unit and House Transformers
- Gas compound
- 400 kV Switchyard
- Fenced enclosure to house gas compressors (if provided)
- Black-start facility (if provided).

Some of these buildings may be combined or be subdivided depending on the final choice of plant. The structural form of buildings will be determined at a later stage, but will conform to minimum SANS standards or better. External finishes to all structures and components will be appropriate to the highly corrosive and abrasive environment encountered at the site.

Depending on the choice of equipment, the following may also be provided:

- Gas compressor
- A by-pass stack for the gas turbines to allow them to operate in isolation from steam turbines
- Gas turbines or diesel generators for black start capability
- Liquid fuel storage facilities comprising bulk tanks

4.2.4 Power Generation

A gas turbine is one in which the working substance is a gas rather than a condensable vapour, as in a steam turbine, or a liquid, as in a water turbine. The gas turbine itself consists of an air compressor, a combustion chamber, a turbine and an electricity generator

coupled together. The air compressor, combustion turbine and electricity generator are all attached to one main shaft which rotates at high speed.

The air compressor takes in large quantities of air from the atmosphere and compresses it into the combustion chamber from where it flows through the turbine. Fuel is then injected into the combustion chamber and ignited. This addition of heat energy and combustion gases raises the temperature of the combined gases to over 1,300 °C and greatly increases the velocity of these gases through the turbine. The effect of this high velocity gas flow through the turbine drives both the air compressor to supply air and the electricity generator to produce the rated electrical power output. The expansion of the hot gases through the turbine and the extraction of mechanical work from them via the turbine reduces the temperature of the gases to approximately 600 °C.

Operation of a gas turbine as described above is referred to as open or simple cycle mode. However, it is possible to generate approximately 50% more electricity from the hot exhaust gases by diverting them through an HRSG (boiler) which extracts heat to make steam, which in turn drives a steam turbine. The temperature of the hot gases is reduced in this process to approximately 100 °C, but the heat recovery system does not in other respects alter the composition of the gases. They are discharged to the atmosphere via a stack on top of the HRSG.

The plant will have an efficiency over its working life of about 55% This means that 55% of the energy contained within the fuel is converted into electrical energy. The plant will employ technology recognised as being the most advanced for power production on the scale proposed. The high overall efficiency will lead to lower specific emissions to the environment compared to any other form of conventional thermal plant. Equivalent efficiencies in conventional thermal plants rarely reach 40%.

Water for the HRSG is drawn from a suitable supply, is treated in a water treatment plant to achieve high purity and is then stored prior to use. The steam produced is supplied through an inter-connecting pipe network to the steam turbine and is then exhausted to the condenser. The steam turbine drives the electricity generator to produce the additional power output. The electricity generated is fed to transformers where the voltage is stepped up for transmission to the power grid via a local substation.

During scheduled annual GCP maintenance periods, when gas will be unavailable, the power station will be fuelled by liquid fuel oil. It is anticipated that this would be for no more

than 10-15 days per annum. Fuel oil will be stored in tanks on site in preparation for such event.

4.2.5 Cooling Systems

Cooling water is used to condense the steam used in the steam turbine element of the combined cycle. The steam is condensed to hot water, which is then re-circulated to the HRSG. The heat transferred to the cooling water must be released to the environment. There are a number of possible arrangements, which include direct seawater cooling and evaporative cooling in a cooling tower. It is also possible to dissipate heat from steam condensation to the air using an air cooled condenser. For evaporative systems losses in the cooling system are made up from supplies drawn from a suitable source, in this case, the ocean.

The final cooling system has yet to be determined, but for the purposes of this IIMR, the evaporative cooling system is most likely to be used and is thus evaluated.

4.2.6 Housing, offices, employment

The construction workforce, a maximum of 1 300 workers, will be accommodated near to the CCGT site. Either the existing mine hostel facilities at Uubvlei will be suitably upgraded for this purpose, or new temporary facilities will be constructed at the designated location adjacent to the CCGT site, on land that is already disturbed by mining. It should consist of housing, ablutions, canteen and kitchen, bulk food stores, cold and freezing facilities and both indoor and outdoor recreation facilities. It would require full electrical, water and sewage reticulation, streets with area lighting and a high security perimeter fence. These temporary facilities will be in use for about two and a half years, after which they would have to be removed completely. In the event that the second phase of the power plant is foreseen, these accommodation facilities may be kept for a longer period.

4.3 Power Transmission

The rationale of the overall Kudu Gas Project is to meet the projected electricity demand of the country and to export excess power to neighbouring countries. High voltage lines are therefore needed to feed the generated power into the Namibian and South African grids. This will be achieved by constructing four parallel power lines from the CCGT Power Station. For the first phase of the project, two 400kV lines will be needed to feed into the Namibian and South African grids respectively as well as a 220kV line that needs to connect the power station to the South African 220kV network at Oranjemond Substation. The second phase of

the project (another 800MW) would require an additional 400kV line to feed into the South African power grid.

4.3.1 Route Alternatives

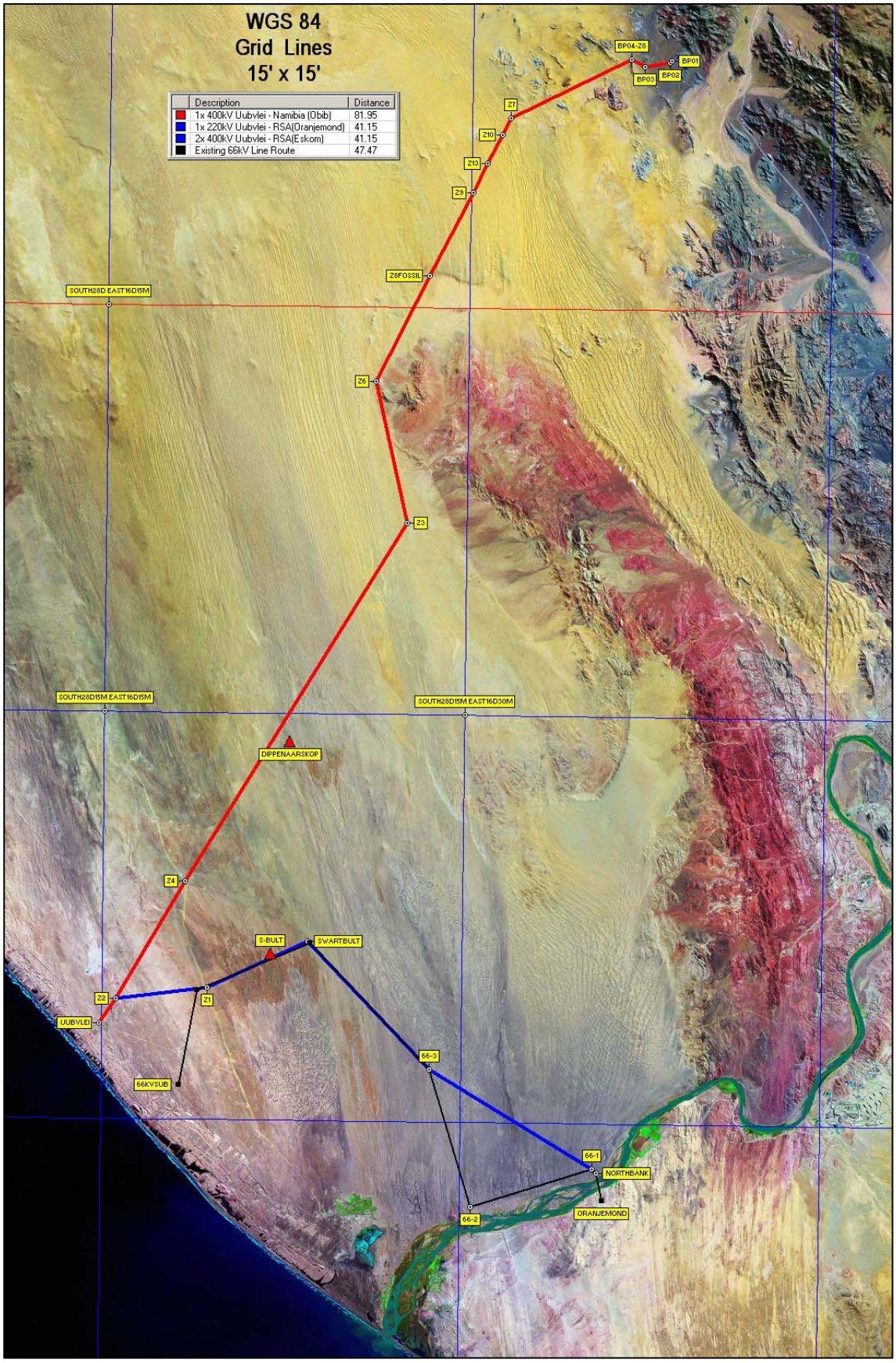
The proposed power lines will run from the proposed CCGT Power Plant at Uubvlei to the Obib substation near Rosh Pinah to connect with the Namibian power grid and to the Oranjemond substation in South Africa respectively.

During the EIA, a number of alternative routes were considered. The final choice was made after visual aspects had been assessed, public opinion had been obtained, consultations had been held and on-site inspections made with officials of the Ministry of Environment and Tourism, specialist studies had been completed on fauna, flora and archaeology of the area, consideration of aviation safety and Namdeb mining activities.

Also, the consultants took into account the length (and thus cost) of the various options, the suitability of the terrain from a substrate and access point of view and possible conflicts with future tourism plans for the area.

Fortunately, the Sperrgebiet Land Use Plan completed in 2001 has provided a strategic framework within which future development projects can be planned and assessed. The power lines envisaged for the Kudu to Gas Project were already envisaged when the plan was completed, and the current proposed alignment conforms with the plan.

Figure 4.6: The transmission line routes that were selected through the EIA process

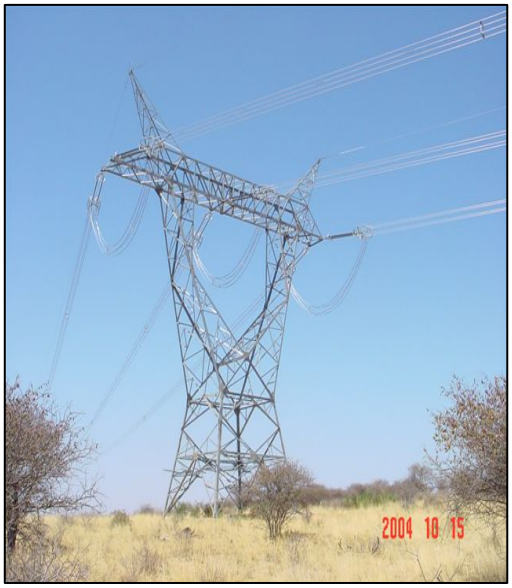


4.3.2 Transmission line Design and Corridor Width

The conductors will be supported on two different types of pylon: a Self-supporting Suspension and Strain Tower, which is 26.6m high, as shown in figure 4.7 and a Compact Cross Rope Suspension Tower, 37.3m high, as shown in figure 4.8. The former design will be used on bends, while the latter type will be used mostly on straight sections. The towers will be spaced 400m to 500m apart. The Compact Cross Rope suspension Tower is environmentally friendlier because the delta configuration reduces the chances of birds being electrocuted. The structures also contain far less steel and their footprint is minimal, comprising ground anchors which are drilled into bedrock or screwed into sandy terrain. The Self-supporting Suspension and Strain Tower has a larger footprint, requiring concrete foundations for each foot.

The corridor width needed to accommodate the individual power lines is 40 m for the 220kV line and 55m for the 400kV line. The route running from the Power Station eastwards will eventually have three 400kV and one 220kV power lines running parallel to each other, and will thus need a maximum corridor width of 205m. The route running northwards into the Namibian power grid will accommodate only one 400kV power line, and will thus have a corridor width of 55m. The route running to South Africa will have two 400kV and one 220kV power lines, thus requiring a corridor width of 150m.

Figures 4.7 and 4.8: Self-supporting Suspension and Strain Tower (left) and Compact Cross Rope suspension Tower (right)



4.3.3 Construction Activities

It will take an estimated 1.5 years to build the power lines from Uubvlei to Oranjemond and Obib substations respectively. If the Kudu Power Station is to be operational by 2010, then construction of the power lines needed for the first phase of the project, that is the 400kV to Namibia, and the 220kV and 400kV lines to South Africa, would have to commence by no later than 2008.

All the components for the power line construction (steel pylons, conductors, insulators, etc.) will be transported to site by road on low-bed trailers. According to NamPower (pers. comm., Langford), materials and equipment will be transported from Alexander Bay and Rosh Pinah.

It is proposed that the contractor be allowed to make two camps at accessible, yet environmentally less sensitive locations within the Sperrgebiet to facilitate construction in these remote areas.

The construction team will have to travel from Oranjemund and Rosh Pinah to the power line route and camps by way of existing tracks if they are sufficiently direct, or else new temporary access tracks will have to be constructed along the power line route. Once on the route, the construction team will travel only along the designated access track.

Bush clearing will not be necessary in this area where vegetation cover is very low, except where access tracks are needed.

Relatively little waste is generated during power line construction activities. A small amount of spoil will be generated from the foundation holes, and there is likely to be some waste cement, cement bags, gravel, sand, left over cable, and canteen waste etc, generated during construction. The Power station EIA has specified that all waste must be disposed in the designated construction waste site at Uubvlei, or at Oranjemund.

4.3.4 Maintenance Activities

Once a power line has been built it requires very little maintenance. Obvious accidents such as lightning strikes or towers blown over by exceptionally strong winds will be repaired by using the access roads under the line or by helicopter. Routine inspections of the lines are carried out from the air, thereby eliminating frequent use of the access track.

4.3.5 Accommodation, contractors' yards and employment

NamPower intends calling for tenders from electrical contractors with the relevant experience to construct the power line according to specifications. Since the construction of the line is of such a technical and skilled nature, there will be limited scope for the recruitment of unskilled labour from the area. Local labour can be used for digging the foundations, and for selective removal of vegetation in the pylon footprint areas and along the access tracks. This represents 1% or less of the total construction costs.

Workforce accommodation will be in the temporary hostels provided at Uubvlei and at temporary camps along the route. The transmission line contractors' yard and laydown area will be located in the general yard set aside for all contractors working on the various components of the project, next to the power station site at Uubvlei.

5. DESCRIPTION OF THE ENVIRONMENT

5.1 Marine Environment

5.1.1 Oceanographic overview

The coast of Namibia is one of the most hostile in the world. It is characterised by large swells and breakers, the strong, northward-flowing Benguela current, less strong counter currents and gale-force winds.

Natural processes that impact severely on the coastal ecosystem include high sediment loads from the Orange River and major floods causing mortality of intertidal organisms as a result of severely reduced salinity. The nearshore ecosystem also has been affected by the movement inshore of water having a low dissolved oxygen content.

Typically wave-driven flows dominate in the surfzone (characteristically 150m to 250 m wide). The influence of wave-driven flows extend beyond the surfzone in the form of rip currents. There is a seasonal variation in surface temperature, with the average summer and autumn temperatures being ~2°C higher than in winter and spring. In the short term this is modified by upwelling and in the longer term by El Niño events.

5.1.2 Marine fauna and flora

The Namibian continental shelf is subject to periods when the water is oxygen-deficient, leading to the evolution of a distinct community able to survive oxygen-deficient conditions. The main phyla contributing to the benthic (deep water) fauna are worms, molluscs, crustacea and mussles.

Fish

The fish fauna of the Namibian coast is characterised by a relatively low diversity of species compared with warmer oceans: 76 fish species are known from or likely to be found in the area under consideration – an equivalent area on the east coast of Africa would probably be inhabited by over 800 species.

This part of the Namibian marine environment has certain fish species which are of commercial importance, especially shallow-water and deepwater hake, Cape gurnard, monkfish, elephant fish, snoek, jacopever, maasbanker, buttersnoek and kingklip.

The vulnerability of a fish species to human disturbance (fishing, mining, pollution or other impacts) is subject to three main factors: fish abundance, fish distribution and the particular life-history characteristics of the fish species affected.

Characteristically upwelling zones are inhabited by fishes which are typically altricial producing large numbers of small eggs which hatch into small, incompletely developed young. These fishes play a 'low risk, high number' game in that the parental investment in each individual young is low, but the risk of mortality is spread among a large number of offspring. Altricial fishes are better able to adapt to random and even catastrophic mortalities; petroleum exploration and production and patchwork mining activities in a small part of their range are not likely to have a lasting detrimental impact. An exception is when the most vulnerable stages of the life cycle – the eggs, larvae and postlarvae are affected by unsuitable conditions, such as the deoxygenation of the water. The impact would therefore be on the breeding success of the adult fishes rather than on the adult fishes themselves.

Pelagic seabirds

A total of 50 species of seabirds has been recorded in the waters of southern Namibia. Only 22 of these 50 species have been definitely recorded in the Kudu gas field area, including the only southern African breeding species so far recorded in the area - the Cape Gannet.

Conservation concern has been expressed for nearly one third of the seabird species occurring in southern Namibian waters. Threatened species include both migrants (albatrosses and petrels) and southern African breeding species.

Twelve species of coastal seabirds have been recorded breeding in the study area. Significant proportions of the total breeding populations of the Kelp Gull (16%); Hartlaub's Gull (9%); Cape Cormorant (15%); Crowned Cormorant (26%); Bank Cormorant (11%) and Caspian Tern (8,5%) are present.

Figure 5.1: Because of the productive Benguela current, the Namib coast supports high numbers of seabirds. The Kudu to Gas project appears unlikely to have a significant impact on coastal and marine wildlife.

The breeding population of Penguins and Cape Gannet on the islands along the southern Namibian coast has declined drastically since the 1950s. The African Penguin, Caspian and Damara terns are listed in the Red Data Book. The African Penguin is considered to be "Vulnerable" and the population along the west coast of southern Africa is in a severe decline. The Caspian Tern is considered to be "Near-threatened" and the population decreasing. The Damara Tern is endemic to the west and south coasts of southern Africa i.e. Angola, Namibia and South Africa. The population size of the Damara Tern is estimated to be approximately 7 000 individuals.

The African Black Oystercatcher is a southern African endemic species occurring along the coasts of Namibia and South Africa. Its conservation status (“Near-threatened”) is of concern primarily as a result of the disturbance of nesting birds leading to severely reduced breeding success. The security status of Diamond Area 1 between Oranjemund and Lüderitz, provides de facto protection for this and other species that occur in southern Namibia.

Whales and dolphins

Between 22 and 25 species of cetacean (whales and dolphins) have been recorded or are expected to occur in southern Namibia.

Blue whales migrate northwards through southern Namibian waters between May and July to Angolan waters and return southwards after August. Although the offshore distribution of fin whales in southern Namibia is unknown, there is some suggestion that the species migrates along the continental shelf edge, while Sei whales are mainly found 60 to 100 miles offshore. Minkhe, Bryde’s and Humpback whales utilise coastal waters of southern hemisphere continents as migratory corridors during annual migrations between summer Antarctic feeding grounds and breeding grounds in coastal tropical and subtropical waters, while Southern Right whales in southern Namibia would be expected in extreme coastal

waters (within the 50 m isobath) between the months of July and November. The Pygmy right is a little known species whose incidence within southern Namibia is expected to be extremely low.

The majority of toothed whales and dolphins have more resident than migratory distribution patterns. Sperm whales are recorded throughout southern African pelagic waters. Their distribution would be expected to the west of the Kudu Gas area in deeper pelagic waters. Pygmy Sperm whales, Cuvier's beaked whales, Layard's beaked whales and Gray's beaked whales have been recorded on the Namibian coast, but probably originate from warm offshore waters. Killer whales have a cosmopolitan distribution in all major oceans of the world and are found throughout southern African waters regardless of season or water depth and may consequently be found within the Kudu gas field area.

Dusky dolphin are a year round resident species within coastal waters of the southern African west coast and may be found out to the 500 m isobath. Heaviside's dolphin are a resident species endemic to the nearshore waters of the west coast of southern Africa but do not generally occur out to the 200m isobath. The highest densities have been recorded inshore of the 100 m isobath. An apparent isolated distribution of southern right-wale dolphins occurs off the coast of southern Namibia, their distribution possibly associated with the Luderitz upwelling cell. Two forms of bottlenose dolphin occur in inshore waters around the southern African coast but this species is not expected to occur in the Kudu gas field area.

Seals

The Cape fur seal is abundant throughout the region. Numbers around the southern African coast have increased rapidly over the past seven decades, from an estimated 150 000 in 1920 to close to two million at present. Eight breeding colonies are located on islands and the shore between Lüderitz and Baker's Bay 120 km to the south. The major colonies at Wolf and Atlas bays some 30 km south of Lüderitz probably are the largest colonies of the Cape fur seal and arguably the largest mainland seal colony in the world. Cape fur seals generally forage in shallow waters, ranging to over 150 km from the coast and are known to dive to depths of 200 m. The Kudu gas field area falls within feeding range of South African fur seals.

5.2 Terrestrial Environment

5.2.1 Climate

The climate of the coastal zone area is mostly windy, and often cold and wet as a result of its proximity to the strong winds of the South Atlantic anticyclonic system and the associated cold upwelling of the Benguella current.

Fog occurs, on average, on more than 100 days per year at Oranjemund. It forms as moist cold air from the ocean and meets the hot dry air of the desert. The Orange River valley serves as a pathway for the fog to penetrate as far inland as Skilpad. The fog supplies fauna and flora with much of their water requirements.

Oranjemund and the lower reaches of the Orange River are situated in the winter rainfall area of southern Africa. The annual average rainfall at Alexander Bay is 51mm over the recorded period of 53 years, most of which falls between May and August. At Rosh Pinah, this figure is slightly higher at 68.7 mm per annum.

Southerly sea breezes occur during most of the year. They are usually strongest during the afternoons. The strong southerly winds are responsible for extensive sand movement and scouring of bedrock topography. Strong north-easterly winds prevail in winter, known as “east” or “berg” winds, which may blow for a few days at a time, and cause very dusty conditions. They are associated with very high temperatures.

Figure 5.2: Fog is a feature of the climate in south-western Namibia. Precipitation by fog in the Namib is considerably higher than by rainfall.

5.2.2 Geography

The topography between Oranjemund and the coast is low-lying and flat, but the sand dunes rise up gently towards the interior to the north and east of town. The main topographic features are the rocky outcrop of Swartkop, 73 metres above mean sea level, the mobile dunes east of town and the shallow Orange River valley. The eastern part of the area is more interesting visually, and inselbergs including Schakalberg and the Obib Mountains occur there. These have red dunes around their bases, and lighter coloured ones further towards the valley floors. These slopes, their associated valleys and contrasting dunes are the cause of the area's spectacular vistas.

The Orange River is the only perennial fresh water source along the coast for 370 km to the south and 1350 km to the north. This, together with the variety of habitats, makes it extremely important for wetland birds, especially migrants along a very inhospitable coast. Because of its international importance as a waterfowl habitat, it has been listed as a Ramsar Site by both Namibia and South Africa. In recent years the decreasing flows at the mouth have been a concern.

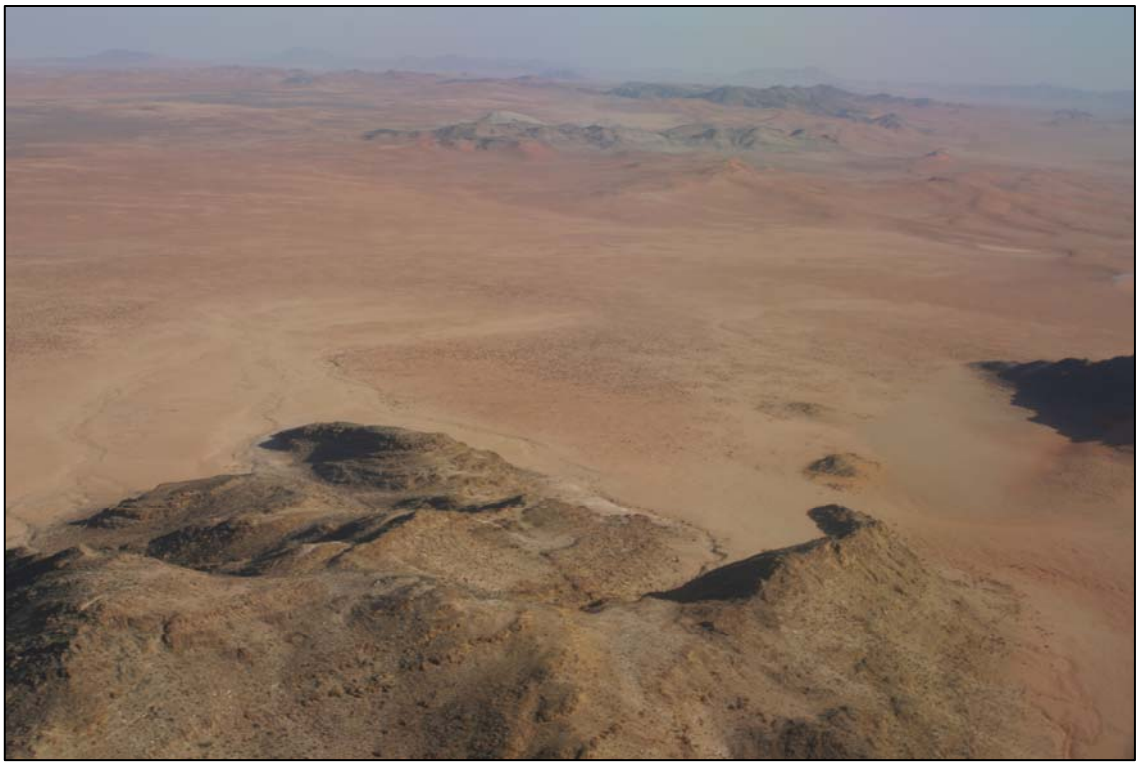
Figure 5.3: The Orange River upstream of Oranjemund. Note the contrast between the lush vegetation along the riverbank compared to the arid surroundings.

5.2.3 Geology

Highly deformed volcano sedimentary rocks of the Gariep group underlie the study area. They were formed during a period of ocean formation, destruction, and subsequent

mountain building. The resultant material is intensely deformed sedimentary and associated volcanic rocks.

Figure 5.4: The Namib Desert north-east of Oranjemund. Note predominance of dunes and sand, with occasional rocky outcrops.



The Rosh Pinah formation in the Obib substation surrounds is formed of basal conglomerates, thin volcanic rocks overlain by quarzites, carbonates, cherts, schists, and amphibolites. The rocky outcrops, inselbergs and mountains in the Rosh Pinah area comprise these rocks, and have been sheared, faulted and tilted over time. Both the Rosh Pinah Zinc Corporation and the Skorpion Zinc ore bodies are found in the rocks of the Rosh Pinah Formation.

In the Oranjemund area and along the banks of the Orange River, these rocks are unconformably overlain by sediments of the Cainozoic age. Most sand dunes are semi-stabilised. At a few locations, moving sand dunes occur. Dunes trend in a north-easterly direction with the prevailing dynamic wind patterns.

Changes in sea level over the past 3 million years have resulted in the formation of marine terraces north of the Orange River Mouth and river terraces along the lower reaches of the Orange River.

5.2.4 Soils

The soils of the study area are mainly poorly formed, immature desert soils as a result of the extremely arid climate, low rainfall, and high intensity winds. The soils are subject to high salinisation, aggravated by high evaporation levels. The soils in the region are generally not suitable for irrigated agriculture. The scarcity of water and arid climate further limit agricultural potential though a few small pockets of land along the Orange River are suitable for growing high value crops. They are approximately 40 km upstream from Oranjemund and are therefore not affected by this project.

5.2.5 Palaeontology and archeology

The Sperrgebiet has a particularly impressive fossil record, dating from the Cretaceous period, about 58 million years ago. Some extremely rich fossil sites have been found along the Orange River and in paeleo-channels (old meander channels).

Related archaeological and historical information suggest that materials from Early Stone Age, Middle Stone Age and Late Stone Age, covering the period from about one million years ago to the present, can readily be found in the entire Sperrgebiet.

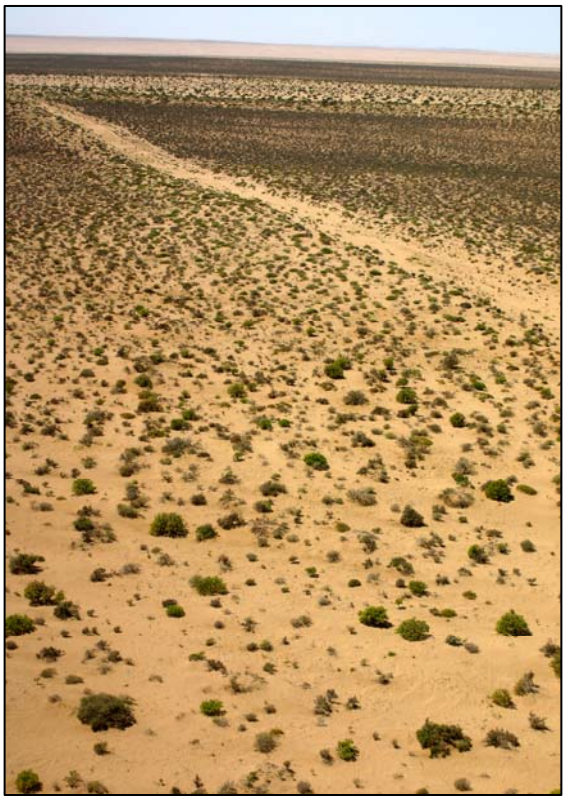
Some of the sites discovered during this study are particularly interesting. These include a highly unusual collection of three obviously man-made heaps of snail shell, indicating intense land snail exploitation at that point, a veritable midden of ostrich eggshell, mixed with other artefacts, showing that ostrich eggs were extensively utilised at this point, a site with a grindstone with three unique and completely inexplicable holes drilled in it, and lastly a site with high quality pottery and sea shells.

5.2.6 Vegetation

The greater area concerned falls into the northern section of the Succulent Karoo Biome, which is regarded as a global biodiversity hotspot. It is thus important in global, as well as national, terms, especially also due to its largely pristine nature as a result of protection for the diamond mining industry over several decades. It falls within the Desert and Succulent Steppe as defined by Giess (1971). Five broad zones were defined (A – E), based on overall habitat type and dominant species present. A summarised description of each of the zones follows.

Zone A: Coastal plains and stabilised hummocks:

This area, which stretches from the Uubvlei site within Mining Area 1 as far as Swartbult, is composed of a patchwork of coastal gravely-sandy plains and stabilised hummocky areas. Less diverse areas of sandy hummocks dominated by grass species intervene occasionally towards the western sections near the Uubvlei site. The vegetation is dominated by low-growing succulents. Species composition varies slightly from area to area. The vegetation in this zone, including the section east of the Uubvlei site in Mining Area 1, is largely undisturbed. Most of the plant species observed here are found in similar habitats along the coast of the southern Namib. Several more species of conservation concern have been recorded in this area previously, although they were not seen during the survey. These include some endemic red data species and protected species.



Figures 5.5: Overview of general habitat east of Uubvlei. Note clumps of succulent and other vegetation and the scar caused by vehicle movements. The dune area can be seen in the background.

Zone B: Unstabilised gravel and sand flats and hummocks

From Swartbult to the footslopes of the Schakalberge the prevailing habitat is one of gravely-sandy flats and slopes and dune hummocks. No species of high conservation concern were observed. Diversity drops closer to the Schakalberge. The area at the edge of the footslopes comprises mobile dunes where only grass species were observed. This zone is not sensitive from a vegetation aspect.

Zone C: Grassy plains and footslopes

The valley to the west of the Schakalberge is dominated by *Stipagrostis geminifolia*, a common southern African grass. The more gravely footslopes support large numbers of *Zygophyllum clavatum* shrublets, and *Augea capensis*, a common annual succulent. Diversity is far higher on the mountain slopes, where numerous endemic, protected and red data species are listed.

Zone D: Dune fields

The dune fields in this zone are interspersed by sandy dune valleys. Vegetation on the dunes is not very diverse, with about four species including the protected, near-endemic !nara, *Acanthosicyos horridus* occurring there.

Zone E: Grassy plains east of Obib

These plains are dominated by *Stipagrostis* spp. and other grasses. Remnants of annual daisies such as *Foveolina dichotoma* were also seen. One rare species, *Haemanthus pubescens* subsp. *arenicola* was collected on the plains beyond a dolomite koppie. More diverse areas surround these plains, mainly on footslopes of outcrops. The outcrops are well known and documented to harbour a high species diversity as well as many protected and endemic species. They should be avoided by the power lines.

5.2.7 Fauna

As in the rest of the Namib, the Sperrgebiet is home to a very diverse fauna that reflects the adaptations of various animals to the diverse habitats. For instance, there are fog-dependent frogs, an impressive 80 species of reptiles and 20 species of rodents.

Due to the poor coverage of animal collecting in the Sperrgebiet, the ranges of many species are estimations based on scattered and/or isolated records, very often at the edges of the Sperrgebiet such as along the eastern boundary and south of the Orange River. So knowledge is quite limited, making prediction of impacts on the fauna more difficult.

Coastal plains and hummocks

Uubvlei is situated in an area of low hummocks, and this habitat type is widespread in the Sperrgebiet within about 5 km of the coast. Large parts of this habitat within Mining Area 1 have been disturbed or severely degraded by diamond mining operations. Further inland, up to about 15 km from the coast, hummocks are less distinct and the substrate is gravely-sandy plains

Most of the ecological action in this area, like in much of the Namib, is carried out by small animals that can shelter from the harsh conditions of strong winds and meagre rainfall, and that can take advantage of the moisture provided by fog. Evidence of animal activity is seen in spider webs in most of the plants, tracks of snails, beetles, lizards, snakes, larks and hares on the ground, tracks of beetle larvae and legless lizards just beneath the surface, burrows of scorpions and small rodents, and various other signs of cryptic life. The habitat supports a well-developed, mainly sand-living invertebrate fauna with a large but unspecified number of endemic species.

Two frog species, desert rain frog and Namaqua rain frog, are found in this habitat. The former, *Breviceps macrops*, is noteworthy as it might even be a separate species from adjacent Namaqualand populations. If this is the case, Namibian responsibility for this species, would increase considerably. This unusual frog depends on fog moisture, confining it to a thin belt close to the coast, and lives in sandy hummock habitat in the Sperrgebiet only, much of which has been or will be destroyed in diamond mining operations.

Amongst reptiles, species of concern are the Namaqua dwarf adder (*Bitis schneideri*), and classified as Insufficiently Known [Griffin 1999]) and possibly some underground-living lizards which have still to be confirmed. These species are also confined to the coastal vegetated hummock habitat, and are thus threatened by mining activities. All of the mammals of conservation significance that occur in this habitat have distributions that extend well beyond the project area.

Unstabilised gravel and sand flats and low dunes

Areas to the east of the coastal plains comprise gravely and sandy flats, low dunes and hummocks, and dunes proper. The substrate is variable: in some places it is firm, even hard in the case of consolidated fossil dunes, in others very loose and fine-grained, such as on dunes. Invertebrate fauna comprises the wealth of insects, spiders and scorpions that are adapted to living in and on sand, for which the Namib is renowned. The same goes for species of reptiles and small mammals.

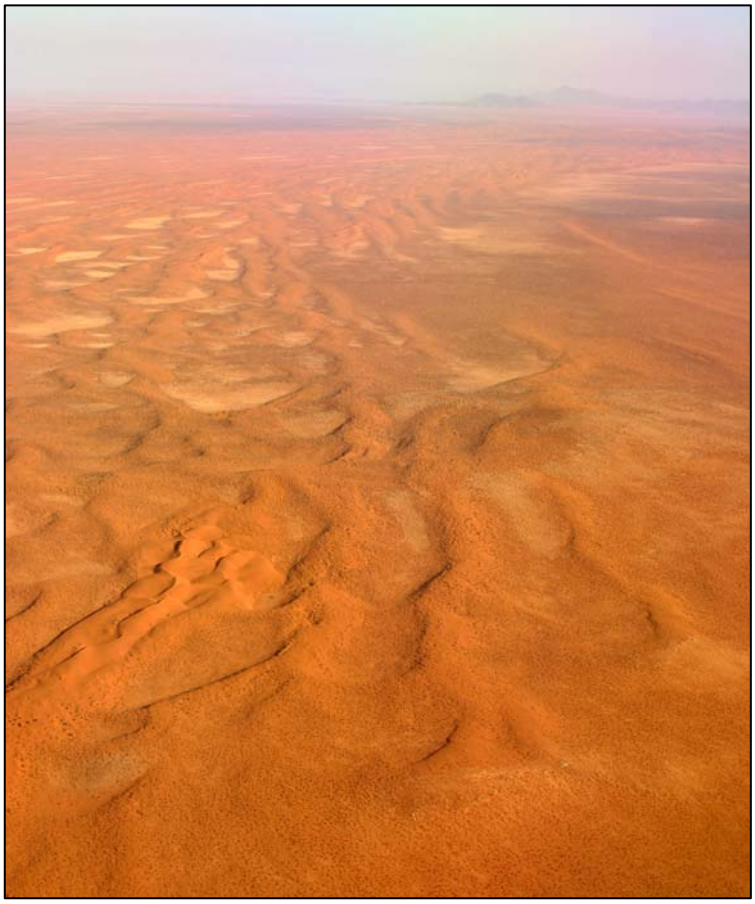


Figure 5.6: The eastern parts of the Sperrgebiet comprise mostly of low dunes with limited vegetation and wildlife. Because of the extreme conditions, most wildlife are endemic and highly specialised.

The species lists show that there are 49 reptile species and 41 mammal species known or expected to occur in this habitat. Some of these species (e.g. veld leguaan, yellow mongoose) are probably found here only when good rainfall allows expansion of their ranges westwards into the desert proper. Of the reptile species, three are of conservation concern: the leopard tortoise, tent tortoise and veld leguaan. Amongst the mammals, 8 species are of conservation concern: seven of these are carnivores that are persecuted by farmers, and the last, the small grey mongoose, is probably a vagrant in this area.

Rocky outcrops and inselbergs

Areas of rocky outcrop occur sporadically throughout the project area. These form small rises and low hills usually flanked by accumulated sand, and the large Schakalberg mountain is a very prominent feature of the area. Their geology and vegetation vary, but the significant feature is that they catch moisture from fog precipitation and retain it in crevices and cracks in the rocks, so support greater densities and varieties of plants than the surrounding sandy areas. These in turn support more fauna. The rocky outcrops, inselbergs and mountains are therefore the most sensitive habitats in the project area, and should be avoided as much as possible.

The red marble frog uses rock pools to breed and hides in crevices during the long dry season. Twenty-two species of reptiles in the project area depend on rocky substrates. Of these, eight are endemic to Namibia, and none are known to be threatened. However, caution is advised for two species, rough-scaled gecko and dwarf mountain adder, which are insufficiently known to be able to give reliable estimates of their conservation status.

Twenty-two species of mammals in the project area depend on rocky substrates and mountainous terrain: half of them require proper mountains providing caves, shelters and high relief such as is found on Schakalberg (e.g. bats, leopard, Hartmann's mountain zebra), while the others use rocky substrate for the firm substrate it provides to burrow into. Hartmann's mountain zebra is the only species in this group that is classified as Vulnerable.

Figure 5.7 and 5.8: Large mammals (e.g. Hartmann Zebra on the left) occur in low numbers in the Sperrgebiet, whilst smaller forms of wildlife (e.g. snakes and other reptiles- right) are more numerous.

5.3 Socio-economic environment

5.3.1 Economy and land use

Following the discovery of rich ore deposits on the north bank of the Orange River, south of Lüdertizbucht, the town of Oranjemund was founded in 1936. The land is owned by the State, but all the infrastructure and assets in Oranjemund are currently owned by Namdeb. In mid 2003, the Namibian Cabinet resolved to alienate unreserved state land in preparation for the future proclamation of Oranjemund as an independent town. Because it is a closed security town, no informal settlement has been allowed to develop around Oranjemund; according to the 2001 Housing and Population Census, Oranjemund has a population of 4451. These census figures are at variance with Namdeb estimates of 10 000. Population estimates of between 6000 and 9000, of whom 60% are males, can be assumed for planning purposes.

The nearest towns are the diamond mining settlement of Alexander Bay on the South African side of the Orange River and the mining town Rosh Pinah, some 75km to the north-east. Oranjemund falls within the Karas Region, with the regional government located in Keetmanshoop. The harsh climate limits agricultural potential, so that mining is the region's biggest employer.

Diamond Area 1 or "The Sperrgebiet" is off limits to all but Diamond Mining Companies that have held prospecting rights for this land for over 80 years. At present, the land falls under the jurisdiction of the Ministry of Mines and Energy. When the Sperrgebiet is proclaimed as a National Park, the Ministry of Environment and Tourism will control the land outside the diamond concession areas.

It is envisaged that the Sperrgebiet will act as a magnet for tourism in the south in much the same way that Etosha has done for the north. Not only do these parks create significant incomes in their own rights, but the surrounding areas have also benefited significantly from their presence.

The development of Oranjemund as a tourism node within this broader conservation area hinges on strategic decisions taken about its future (open up or keep closed with high security), and the implications of the Diamond Act on issues such as easy access to the town, land tenure, future mining areas, etc. According to the Sperrgebiet Land Use Plan, it is possible that Oranjemund would only become a tourist development node after the current mining areas are de-proclaimed, some time after 2020.

There are, however several development opportunities if the town is proclaimed and access controls to the town and immediate vicinity of the river are relaxed. These are mostly based on the river and the Ramsar site at the river mouth and include hotels, lodges, bird tours, sundowner cruises, golf, yachting, fish farm, mine museum, etc.

Away from the river, the landscape between Oranjemund, Uubvlei and towards Shakalberg are somewhat uneventful, and limited tourism opportunities including 4x4 trails on disturbed ground, camel safaris, etc. would be possible.

6. SUMMARY OF ENVIRONMENTAL IMPACTS AND PROPOSED MITIGATION

In order to truly reflect the cumulative impacts of the three main components of the KGPP, this section has been organized to address all the impacts which will result from the different project phases by affected area i.e. impacts on the marine environment, impacts at Uubvlei etc, irrespective of which component causes the impact. In this way the total impact of the project can be ascertained.

6.1 Construction Phase

Table 6.1 provides the reader with a list of construction activities which will occur in each affected area. Each sub-section presents a summary of the impacts identified and assessed per area, together with possible mitigation measures, and a summary is provided at the end of each sub-section. The information has been taken from the three EIA reports and SAIEA has relied on the assessments made in those reports. The full motivation and justification of

the assessments can be found in the relevant sections of the EIA reports. In some cases, impacts have not been identified in the EIA reports and these are shown in the tables below in italics and reflect SAIEAs own assessment.

Table 6.1: Project Construction Activities by Affected Area

Marine Environment	Uubvlei Area	Sperrgebiet	Oranjemund	Lűderitz
Mooring of semi-submersible drilling unit.	Construction of surf zone and beach installations (pipelines for gas, MEG, control umbilical, cooling water intake, heated water discharge, treated sewage; instrument control building, access road, security fencing).	Surveying and pegging out 3 transmission line routes and establishment of access tracks Adjustment of present security fencing to appropriate access to the construction site.	Helicopter operations to service drilling unit, finalise transmission line routes etc.	Establishment of contractors yard and supply depot for gas field development, including drilling.
Drilling of production wells, logging and testing.	Establishment of contractors on designated site (contractors' yard and laydown area, development of waste disposal site, erection of security fencing, construction of: temporary access road, temporary water supply infrastructure, temporary power supply, hostel refurbishment (or construction of worker accommodation units), construction of sewage plant)	Construction of pylons (steelwork, concrete foundations and anchors).	Meeting the service and commercial needs of up to 1300 construction workers, management staff, consultants etc.	Additional port traffic.
Attachment of sub-sea trees to well heads and laying flow lines to connect the wells to the sub-sea manifold.	Site clearance and bulk earthworks of the sites for the gas conditioning plant (GCP), CCGT power station, permanent access road.	Stringing and tensioning of conductor cables.	Increased heavy traffic through town.	Additional heavy road traffic.
Laying of the gas pipeline and piggyback MEG line.	Onshore pipeline corridor – trenching and laying of pipes as above, access road, culvert under mine haul road, security fencing. Construction of all components of the GCP and CCGT and related structures	Establishment of temporary construction sites.	Additional charter planes/air traffic. Construction of new suburb: houses, roads, wet services and power	Possible concrete coating of the gas pipeline. Meeting the service and commercial needs of consultants, engineers and

	(steelwork, concrete work, electrical work, wet services, piping etc).			contractors associated with the project.
Laying of the control umbilical line.	Commissioning of the GCP and CCGT.	Road transport of all equipment, materials and structural components along the Namdeb coast road from Lűderitz to Oranjemund; the Namdeb access road from Rosh Pinah to Oranjemund; and/or across the Oppenheimer Bridge from Alexander Bay to Oranjemund and Uubvlei.		

6.1.1 Construction Phase Impacts on the Marine Environment

All of the construction impacts on the marine environment will be caused by activities associated with the development of the gas field and the laying of pipelines to the coast, as described in section 4.1 and summarised above in Table 6.1. The marine environment includes all activities and impacts up to the low water mark on the beach.

Table 6.2 provides a summary of the planned activities, the related impacts, the assessment of the significance of the impact **before** mitigation is applied and a list of mitigation measures that need to be developed in the EMP.

It can be seen from Table 6.2 that the impacts on the marine environment during gas field development are generally low to negligible due to their localised nature. The gas field development site lies outside of the main shipping lanes and lies inshore of the trawling zone. It is also to the south of the main rock lobster fishing area. However, the development area does coincide with the main hake and tuna fishing grounds, which are fished by approximately 20-25 licensed vessels of each type.

Much of the assessment has been based on experiences gained elsewhere in the world and on ecological studies done for this project and therefore the confidence level in the assessment is high. Most of the proposed mitigation measures are required by various international (MARPOL) and Namibian legal requirements and are technically and economically achievable, however, training of crews and operators will be key to the success of these measures. A monitoring programme needs to be specified in the EMP to ensure that the predicted impacts are within stated limits of acceptable change.

Figure 6.1: Aerial view of the Uubvlei site (roughly centre of image). Note extensive habitat modification because of diamond mining activities.

Table 6.2: Construction Phase Impacts on the Marine Environment

Construction Phase Activity	Potential Impacts	Significance (before mitigation)	Possible Mitigation Measures
Mooring of semi-submersible drilling unit	Disturbance of the seabed by anchors	Very low	None
Interference with shipping and fisheries	1. Damage to fishing gear and vessels caused by collisions 2. Damage to the drilling operations caused by fishing activities and/or vessels	1. Low 2. Medium	The drilling unit will be certified for seaworthiness. Collision prevention equipment and procedures will include: • Multi-frequency radio • Foghorns • 24-hour standby vessel • 24-hour watches • Establishment of a 1000m-radius exclusion zone • Cautionary notices will be issued to mariners • Access to current weather service data • Full illumination of the unit • Provision of safety equipment and training to all crew members
Interference with nocturnal animals	1. Drilling unit illumination may disorientate pelagic seabirds and fish 2. Gas flare may attract birds	1. Very low 2. Very low	The number and orientation of the lights can be optimised to reduce impacts. The EMP must specify procedures with regard to: • Disorientated but unharmed seabirds • Injured birds • Ringed birds • Dead birds. None.
Disposal of drilling mud, cuttings and surplus cement	Discharge of drilling mud to the sea could cause smothering of benthic organisms and toxic effects on marine life	Very low	• Mud to be centrifuged before discharge to remove fine particles. • Mud to be recycled as far as possible. • Toxic effects will be mitigated by use of water based muds and by using low toxicity mud additives. • Drilling mud must conform with IFC toxicity standards
Waste discharges	• Release of SO_2, CO, CO_2, NOx and soot from diesel engine exhausts • Release of CO, CO_2 and possible dioxins from burning domestic waste on board • Release of CO_2, CO and NOx from well flow testing	Very low	The regular maintenance of all diesel motors and generators will be specified in the EMP.

Construction Phase Activity	Potential Impacts	Significance (before mitigation)	Possible Mitigation Measures
	flare		
	Drainage from decks could contain small amounts of oil, solvents, cleaners, additives, drilling mud etc. which are potentially toxic to marine organisms	Very low	• The drilling unit and supply vessels will be equipped with an oily water separator system which will treat waste water prior to discharge to the sea. • Biodegradable detergents will be used preferentially. • The crews will receive environmental training.
	Machinery space drainage and ballast water could contain small amounts of oil, diesel, lubricants, grease etc which could persist in the marine environment and be toxic to marine organisms	Very low	• The drilling unit and supply vessels will comply fully with MARPOL requirements. • All machinery space drains are to be routed to an oil water separator and the final discharge to the sea must comply with MARPOL standards for such discharge.
	Release of untreated sewage poses an organic and bacterial load on the natural degradation processes of the sea	Very low	All sewage will be properly treated as per MARPOL requirements prior to discharge at sea.
	Galley wastes comprising biodegradable food wastes can pose an organic and bacterial load on the sea's natural degradation processes. If not properly processed, galley wastes can attract large flocks of seabirds which can foul the drilling unit and could affect helicopter operations.	Low	All galley wastes will be processed and disposed of at sea as per the MARPOL requirements.
Laying of the submarine pipeline and umbilicals	1. Smothering of benthos along the route. 2. Interference with marine diamond mining operations	1. Very low 2. Low	1. None. 2. Has been routed to avoid active and high resource value mining areas.

6.1.2 Construction Phase Impacts In and Around Uubvlei

Uubvlei is the location of one of Namdeb's mining operations and includes a hostel, several scrap metal dumps and waste dumps, mined out areas, mine waste dumps, mine offices, haul roads and tracks. It is proposed that the CCGT power plant should be constructed in this area and therefore construction activities will include all developments from the low water mark on the beach to the GCP and CCGT and all associated structures in the Uubvlei area (as listed in Table 6.1 above).

Table 6.3 provides a summary of the planned activities, the related impacts, the assessment of the significance of the impact **before** mitigation is applied and a list of mitigation measures that need to be developed in the EMP. It can be seen that the most significant impacts are:

- The impact of vehicle-induced dust plumes on driver safety on all the gravel access roads. Experience from Skorpion Zinc showed that this was a significant problem and many accidents and several deaths occurred as a result;
- The impact of dust plumes from construction sites on downwind vegetation will be a significant (though localised) issue. While the natural environment has adapted to wind and blowing sand, manmade perturbations can result in thick dust plumes which smother the vegetation downwind of the dust source.
- Experience elsewhere shows that windblown litter is a serious problem, both as a result of negligence and as a result of extreme wind conditions. Litter ends up being widely dispersed in the environment. Given that the site is located in the Sperrgebiet National Park, this issue is significant though easy to mitigate.
- Since Uubvlei is a previously mined area, the impacts on the desert ecology will be low. However, if any activities occur on undisturbed land the impacts could be significant because the coastal dune hummocks support protected species of fauna and flora. Given that large tracts of this vegetation type have been lost due to mining, the further loss of such species is considered to be a potentially highly significant impact.

Table 6.3: Construction Phase Impacts on the Uubvlei Area

Construction Phase Activity	Potential Impacts	Significance (before mitigation)	Possible Mitigation Measures
Construction of surf zone and beach installations (pipelines for gas, MEG, control umbilical, cooling water intake, heated water discharge, plant effluent discharge, treated sewage; instrument control building, access road, security fencing)	1. Disturbance of fauna in the mine-altered beach and surf zones over an area of approx. 300m wide by up to 1400m from the shore out to sea. 2. *Interference with Namdeb's mining activities.* 3. *Impacts on water quality in the surf zone from waste cement, concrete, litter, oil, diesel, litter etc.*	1. Very low 2. *Medium* 3. *Low*	• Keep all construction activities within an area demarcated and fenced in consultation with Namdeb. • Rehabilitate the back beach area as per the EMP. • Daily remove all non-hazardous waste to the designated waste site at Uubvlei. • Daily removal all hazardous waste to a temporary holding area at the contractors' yard prior to transport to a licensed hazardous landfill as per the EMP. • All contractors are to set up their base and main laydown area in the designated contractors' yard. • All vehicles and equipment to be serviced in the main contractors' yard. • All oil/diesel-contaminated soil to be picked up and taken to the bioremediation site to be established near the main contractors' yard. • All personnel to be housed at the main construction camp. • Portable toilets are to be provided at the beach work area.
Onshore pipeline corridor – trenching and laying of pipes as above, access road, culvert under mine haul road, security fencing	*1. Disturbance of mined-out land along a corridor 800m long by 300m wide.* *2. Disturbance of localised fauna in the pipeline corridor.* *3. Interruption of coastal (longitudinal) movement of fauna e.g. jackals.* *4. Impact of blowing litter on Sperrgebiet environment.* *5. Impact of dust plume on downwind vegetation in the Sperrgebiet.* 6. *Noise.* 7. *Soil contamination by oil and diesel spills*	1. *Low (if mined out land) High (if undisturbed)* 2. *Low* 3. *Low* 4. *Medium* 5. *Medium* 6. *Very low* 7. *Low*	• All pipelines to be buried in trenches, which will be backfilled. Excess spoil to be spread and levelled. • All trenches to be marked every 100m and at changes in direction. • All pipelines to go under the main mine haulage road in culverts. • All construction activities to be confined to the demarcated and fenced corridor. • The entire area to be stabilised and rehabilitated as per the EMP • Chemical binders to be used on the access roads. • Speed control measures to be implemented. • Daily remove all non-hazardous waste to the designated waste site at Uubvlei or Oranjemund. • Daily removal all hazardous waste to a temporary holding area at the contractors' yard prior to transport to a licensed hazardous landfill as per the EMP. • All contractors are to set up their base and main laydown area in the

Construction Phase Activity	Potential Impacts	Significance (before mitigation)	Possible Mitigation Measures
			designated contractors' yard. • All vehicles and equipment to be serviced in the main contractors' yard. • All oil/diesel-contaminated soil to be picked up and taken to the bioremediation site to be established near the main contractors' yard. • All personnel to be housed at the main construction camp. • Portable toilets are to be provided in the work area
Establishment of contractors on designated site (contractors' yard and laydown area, development of waste disposal site, erection of security fencing, construction of: temporary access road, temporary water supply infrastructure, temporary power supply, hostel refurbishment (or construction of worker accommodation units), construction of sewage plant	1. *Disturbance of fauna and flora at contractors' yard, along fence lines, and along temporary pipeline, road and power line routes.* 2. *Impact of dust plumes (from sites and roads) on downwind vegetation.* 3. Proliferation of tracks prior to access roads being established. 4. *Noise.* 5. *Dust plume impact on driver visibility and road safety on all access roads to the site.* 6. *Road safety issues due to interactions between increased construction traffic and mine vehicles.* 7. *Waste disposal prior to set up of designated waste site*	1. *Low (if on disturbed land); High (on undisturbed land).* 2. *Medium-high* 3. Medium 4. *Low* 5. *High* 6. *High* 7. *Medium*	• Activities on previously disturbed land: stabilise/rehabilitate as per EMP. o Activities on undisturbed hummock vegetation: o initiate a plant and reptile rescue programme; o minimize the area of disturbance; • stabilise and revegetate as per EMP. • Demarcate access tracks to be used and close off non-essential tracks. • Provide driver education re off-road driving, track management, gravel road driving and mine vehicle interaction. • Implement speed controls on main access roads to site. • Use chemical binders on roads to minimise dust. • Remove all waste to a designated site in Oranjemund.
Site clearance and bulk earthworks of the sites for the gas conditioning plant (GCP), CCGT power station, permanent access road.	1. *Impact of the dust plume on downwind vegetation.* 2. *Noise.* 3. Disturbance of fauna and flora. 4. *Oil and diesel spills.* 5. *Impact of blown litter in the Sperrgebiet.*	1. *Medium-high* 2. *Low* 3. Low (in disturbed area; High in undisturbed area) 4. *Low* 5. *Medium*	• All earthworks activities to take place within a demarcated and fenced area. • Activities on undisturbed hummock vegetation: o initiate a plant and reptile rescue programme; o minimize the area of disturbance • Daily remove all non-hazardous waste to the designated waste site at Uubvlei. • Daily removal all hazardous waste to a temporary holding area at the contractors' yard prior to transport to a licensed hazardous landfill as per the EMP. • All contractors are to set up their base and main laydown area in the designated contractors' yard. • All vehicles and equipment to be serviced in the main contractors'

Construction Phase Activity	Potential Impacts	Significance (before mitigation)	Possible Mitigation Measures
			yard. • All oil/diesel-contaminated soil to be recovered and removed from site. • All personnel to be housed at the main construction camp. • Portable toilets are to be provided in the work area • Provide wind-proof litter bins.
Construction of all components of the GCP and CCGT and related structures (steelwork, concrete work, electrical work, wet services, piping etc)	*1 Impact of blowing litter on the Sperrgebiet.* *2 General waste.* *3 Hazardous waste.* *4 Noise.* *5 Dust.* *6 Oil and diesel spills.*	*1 Medium* *2 Low* *3 Medium* *4 Very low* *5 Low* *6 Low*	• Provide wind-proof litter bins. • Daily remove all non-hazardous waste to the designated waste site at Uubvlei. • Daily removal all hazardous waste to a temporary holding area at the contractors' yard prior to transport to a licensed hazardous landfill as per the EMP. • All contractors are to set up their base and main laydown area in the designated contractors' yard. • All vehicles and equipment to be serviced in the main contractors' yard. • All oil/diesel-contaminated soil to be picked up and taken to the bioremediation site to be established near the main contractors' yard. • All personnel to be housed at the main construction camp. • Portable toilets are to be provided in the work area • Use chemical binders on exposed areas to minimise dust in working area.
Commissioning of the GCP and CCGT	1 Noise associated with steam purging of the pipe work and gas flaring 2 Effluent from cleaning the HSRG tubes. 3 Emissions from flaring of excess gas from GCP	1 Low 2 Low 3 Low	• Purging and flaring should take place during daytime hours if possible. • Process effluent is to be removed by the cleaning contractors for disposal at a licensed hazardous waste site. • Fences to be erected at safe distances from flaring points

NB: Impacts highlighted in italics have been identified during the compilation of this IIMR

It is recommended that the Gas field EMP which is presently being compiled and includes the gas conditioning plant, and the Power station EMP will be closely aligned where relevant and cross-referenced where necessary to the existing Namdeb EMP. The environmental components of the tenderers' bids will be evaluated by a competent environmental manager of the respective parties. The environmental control officers (ECO) of the two proponents should work closely together to oversee the implementation of the EMPs and all monitoring work. Monthly and quarterly environmental compliance reports will be issued to management.

The extent of existing disturbance at Uubvlei is quite large, but there are a number of interventions which can reduce additional impacts at this location:

- Locate all components of the project as far as possible on previously mined/disturbed land;
- Erect security fencing at the beginning of the site establishment phase and keep all activity within the fenced areas;
- Set aside one general demarcated area for all the contractors to establish their yards and laydown areas
- Negotiate with Namdeb to use one of the existing waste disposal sites at Uublvei for a) all domestic, office and canteen waste and b) all industrial waste. Establish these sites at the outset of site establishment and issue instructions to all contractors to use them;
- Set up a recycling depot at the contractors' yard (or in Oranjemund if one already exists) for all bottles, cans, plastic, cardboard, paper and wood waste. This was very successful at the Skorpion Zinc construction site and significantly reduced the size of the waste dump and generated income at the same time;
- Set aside a temporary hazardous waste staging area in the contractors' yard for items such as batteries, tyres, fluorescent tubes, waste oil etc;
- Institute a policy whereby suppliers take back empty chemical containers, batteries etc;
- Treat and/or remove all hydrocarbon-contaminated soil;
- Insist that all contractors supply their workers with portable toilet facilities at each work site;
- Install a sewage treatment plant and sewerage pipes as a matter of urgency;
- Identify, with Namdeb, which tracks in the general construction area can be used for access and clearly mark these out;

- Impose penalties for off-road driving once the basic track network has been established i.e. to the landfall installations, pipeline corridor, sewage plant, transmission line route etc.;
- Use chemical binders on all access tracks and dusty work areas;
- All vehicles to be serviced and washed in properly designed wash and service bays equipped with oil separators in the contractors' yard;
- Refurbish the Namdeb hostel if possible;
- Negotiate with suppliers to provide a central concrete readymix plant and fuel station at the contractors' yard for use by all contractors;
- Retain a portion of each contractor's final payment until he has obtained a final environmental clearance certificate from the environmental control officer.

6.1.3 Construction Phase Impacts on the Sperrgebiet

The construction phase activities which will have the greatest impact on the Sperrgebiet are the transmission lines and the traffic along the main access routes from Lűderitz and Rosh Pinah to Oranjemund. These areas have been provisionally identified in the Sperrgebiet Land Use Plan (WEC, 2001) and form the basis for future zoning within the proclaimed (but not yet gazetted) Sperrgebiet National Park. Because so little research has been undertaken in the Sperrgebiet in the past, and given its importance as part of a global hotspot for biodiversity, the Precautionary Principle should be applied with respect to any possible impacts in this area.

Table 6.4 provides a summary of the planned activities, the related impacts, the assessment of the significance of the impact **before** mitigation is applied and a list of mitigation measures that need to be developed in the EMP. It can be seen that the most significant impacts are related to:

- Routing of the transmission lines;
- Waste management; and
- Dust.

It would appear that the preferred transmission line routes will largely overcome the negative impacts of visibility in a wilderness environment and undesirable impacts on protected species of fauna and flora. The transmission line contractors will have to abide by the requirements of the general EMP as well as special provisions relating to working in the Sperrgebiet with regards to issues such as waste management, off-road driving (banned), track management etc.

Road dust will be a major issue and negotiations will be required with all concerned (Namdeb, Roads dept, contractors, management etc) regarding this in order to prevent accidents and road deaths.

6.1.4 Construction Phase Impacts on Oranjemund

Even though the construction workforce and the bulk of construction activities will be at Uubvlei, 25 km north of Oranjemund, the town will experience a considerable amount of activity in the form of increased air traffic, increased road traffic, commerce, visitors and demand for services (see Table 6.1). Given that the town and its assets still belong to Namdeb and the land belongs to the state, it will be necessary to enter into negotiations with Namdeb and the state regarding the provision of services and the development of permanent housing. Discussions with Namdeb have already resulted in an in-principle agreement.

In the case of Skorpion Zinc the positive impacts on the economy of Rosh Pinah during construction, while not actually monitored, were significant, particularly with regards: shops, banking facilities, post office facilities and public phones, visitor accommodation and restaurants, sports and recreation facilities, waste disposal, traffic and immigration services. There were however, significant negative impacts on the land around the town as various contractors looked for borrow materials, building materials, waste sites, construction camp sites etc. This resulted in a proliferation of tracks, unplanned development, unauthorized dumping and so on. The value therefore in this IIMR is to ensure that construction infrastructure and needs are planned for in advance e.g. sources of borrow materials are identified, a waste site is designated, a recycling depot is established, access roads and tracks are marked out and so on. It is recommended that the KGPP proponents discuss the “lessons learnt” at Rosh Pinah with the organisations involved there: Kumba Resources, Skorpion Zinc, NamWater, NamPower, Roads Department and MET.

Table 6.4: Construction Phase Impacts in the Sperrgebiet National Park

Construction Phase Activity	Potential Impacts	Significance (before mitigation)	Possible Mitigation Measures
Finalisation of transmission line routes, surveying and pegging	1 "Lock up" of diamond reserves in the GP Pan area under routes 2A and/or 2B. 2 Visual impact along section 1E to Obib. 3 Visual and bird impacts at Orange River crossing. 4 Impact on archaeological sites. 5 Impact on protected flora and fauna.	1 High 2 High 3 High 4 High 5 High-Low	• Route transmission lines around the GP Pan area in consultation with Namdeb. • Keep transmission lines in one corridor to restrict visual impact at Orange River crossing • Place bird flappers on the lines at the Orange River crossing. • Conduct an archaeological and botanical survey at the same time as final surveying and pegging. • Fence off any archaeological sites close to the route. • Conduct a plant rescue or re-position the towers if plants of special scientific interest are found. • Discuss final route alignment around the Schakalberg with Sperrgebiet Park warden.
Establishment of temporary construction camp sites along transmission line route	*1 Impact of blowing litter in the Sperrgebiet.* *2 Attraction of waste disposal sites to scavenging hyenas and crows.* *3 Disturbance of fauna and flora.* *4 Visual impact of any industrial waste.* *5 Contamination of soils from oil and diesel spills.* *6 Off-road driving and the impacts this has on aesthetics, fauna and flora in the desert environment*	*1 Medium* *2 Medium* *3 Medium* *4 High* *5 Low* *6 High*	• Site camps in environmentally less sensitive areas. • Implement a waste disposal system that prevents wind blown litter and access by scavengers. • Remove all domestic waste to Uubvlei, Rosh Pinah or Oranjemund – do not dispose of this waste in the Sperrgebiet • Pick up all contaminated soil and dispose of it at the bioremediation site at Uubvlei.
Construction of towers	*1. Impact of blowing litter in the Sperrgebiet.* *2. Disturbance of fauna and flora.* *3. Visual impact of any industrial waste.* *4. Contamination of soils from oil and diesel spills.* *5. Off-road driving and the impacts this has on aesthetics, fauna and flora in the desert environment*	*1) Medium* *2) Medium* *3) High* *4) Low* *5) High*	• Implement a waste disposal system that prevents wind blown litter. • Conduct a plant recovery programme at each tower footing if necessary. • Remove all industrial waste and dispose it at a designated site at Uubvlei, Rosh Pinah or Oranjemund, whichever is nearest.
Stringing and tensioning of conductors	*1. Impact of blowing litter in the Sperrgebiet.* *2. Disturbance of fauna and flora.* *3. Visual impact of any industrial waste.* *4. Contamination of soils from oil and diesel spills.*	*1) Medium* *2) Medium* *3) High* *4) Low*	• Implement a waste disposal system that prevents wind blown litter. • Remove all industrial waste and dispose it at a designated site at Uubvlei, Rosh Pinah or Oranjemund, whichever is nearest.

	5. Off-road driving and the impacts this has on aesthetics, fauna and flora in the desert environment	*5) High*	• Pick up all contaminated soil and dispose of it at the bioremediation site at Uubvlei.
Importation of all plant, equipment, vehicles, men and materials etc along gravel access roads from Lűderitz and Rosh Pinah to the Uubvlei site and from there along the transmission line routes	*1) Vehicle dust entrainment will pose a safety hazard to all drivers.* *2) The wind-blown dust plume from these roads will smother downwind vegetation.* *3) There is potential for animal road kills.* *4) Off-road driving and the impacts this has on aesthetics, fauna and flora in the desert environment*	*1) High* *2) High* *3) Medium* *4) High*	• Since the gravel roads belong to Namdeb and are used frequently by mine vehicles, negotiations need to be held with Namdeb to implement driver training programmes, hazard warnings, speed control etc to reduce the amount of dust. • A range of dust suppression alternatives need to be considered including spray sealant, chemical binders or the use of sea water.

Even though all contractors at Skorpion had to employ labour through official Department of Manpower offices in urban centres e.g. Windhoek and Keetmanshoop, there was an increase in the number of people at the "Sand Hotel" informal settlement outside Rosh Pinah, as people came to the area looking for work on the construction site. The situation at Oranjemund is different in that strict access controls are still in place at the boundaries of the Sperrgebiet and itinerant workers will not get close to Oranjemund. However, it is expected that the informal settlements at both Rosh Pinah and Lűderitz will swell with outsiders looking for work.

The construction activities, impacts and possible mitigation measures at Oranjemund are summarised in Table 6.5.

6.1.5 Construction Phase Impacts on Lűderitz

The port of Lűderitz has been identified as the main supply base for the development of the offshore gas field. A contractors' yard will need to be established at the port and a pipe coating workshop may need to be set up. The project will also require berthing, wharfage and storage space at the port, which could place pressure on existing facilities and port services. It has also been indicated by NamPower that most of the construction materials, equipment, machinery and personnel for the construction of the KGPP at Uubvlei will come via Lűderitz. All these activities will result in an increase in port, air and road traffic and an increase in the number of visitors. In turn, this will place pressure on municipal services, hotel accommodation and health services. It is expected however that the impacts on Lűderitz, which is a fairly well-developed town, will be less significant than those experienced in Oranjemund. There will however be major benefits for commerce in the town.

It is recommended that the impacts of increased traffic should be mitigated by designating special routes through town for heavy vehicles and ensuring that all necessary environmental controls are installed at the contractor's yard in the port.

Table 6.5: Construction Phase Impacts on Oranjemund

Construction Phase Activity	Potential Impacts	Significance (before mitigation)	Possible Mitigation Measures
Increased air traffic (helicopters, scheduled and charter flights)	Low altitude flying can cause disturbance and mortality in seal and bird colonies	Medium	• All aircraft should, where possible, maintain an altitude of more than 500m within 2km of seabird colonies and more than 300m over seal colonies and the Ramsar wetland. • All pilots and air traffic control should be provided with maps showing approved flight paths (drawn up in consultation between ATC and ecologists).
Demand for social, recreational, health and commercial services in Oranjemund by the Uublvei workforce	1. Stress on existing health systems in Oranjemund. 2. Potential for increased crime and alcohol-related violence. 3. Impact on social and recreational facilities. 4. Impact on commerce. 5. Employment opportunities for retrenched Namdeb workers. 6. *Increased risk of illegal diamond dealing*.	1. Medium/Low 2. Medium/Low 3. Low 4. High positive 5. Low positive *6. ??*	• Establish a new temporary clinic at Uubvlei. • Provide HIV/AIDS awareness training. • Enter into negotiations with Namdeb re the use of the hospital, municipal services, social and recreation facilities, guest houses and housing. • Provide basic social and recreational facilities at Uubvlei construction workers camp. • Need to provide regular transport from Uubvlei to Oranjemund and back. • Co-ordinate with Namdeb regarding employment opportunities for retrenched workers.
Influx of temporary visitors on short- and long-term visits (consultants, administrative staff, management, general visitors, deliveries etc)	1. Stress on existing guest houses, social and recreational facilities. 2. Increased traffic in town could cause safety hazard and noise. 3. Impact on commerce. 4. Stress of increased population on municipal services (sewerage, water, power, waste etc) 5. Impact on Namdeb's housing stock until new houses can be built (if required)	1. High 2. Medium 3. Medium (*High*) positive 4. Low 5. Low	• Enter into negotiations with Namdeb re housing, services etc • May need to construct a new guest house for KGPP visitors. • Designate special routes for through traffic and heavy vehicles. • Provide traffic calming measures and speed limits along strategic routes.
Construction of new houses for KGPP permanent staff	*1. Impact on desert ecology at outskirts of town.* 2. Stress on municipal services. 3. Noise. 4. Nuisance dust. 5. Increased construction traffic. 6. *Borrow pits for building materials*.	*1. Medium* 2. Low 3. Low 4. Low 5. Medium 6. Low	• If new housing is required (i.e. if there is insufficient housing stock available), develop an area with low ecological sensitivity. • Use chemical binders on all exposed areas to minimise dust. • Designate routes for construction traffic. • Use existing borrow pits for building materials.
Influx of job seekers	*Impact on crime* *Impact on ecology* *Impact on services*	*Very Low in Oranjemund.* *Medium-High in Rosh Pinah*	• Ensure that all contractors employ labour through official channels and that this is broadcast widely within Namibia.

Table 6.6: Construction Phase Impacts at Lűderitz

Construction Phase Activity	Potential Impacts	Significance (before mitigation)	Possible Mitigation Measures
Increased air traffic (helicopters, scheduled and charter flights)	*Low altitude flying can cause disturbance and mortality in seal and bird colonies*	*Medium*	All aircraft should, where possible, maintain an altitude of more than 500m within 2km of seabird colonies and more than 300m over seal colonies. All pilots and ATC should be provided with maps showing approved flight paths (drawn up in consultation between ATC and ecologists)
Demand for social, recreational, health and commercial services in Lűderitz	1. *Stress on existing health systems in Lűderitz.* 2. *Potential for increased crime and alcohol-related violence.* 3. *Impact on social and recreational facilities.* 4. *Impact on commerce.* 5. *Increased risk of illegal diamond dealing.*	1. *Low* 2. *Low* 3. *Low* 4. *Medium positive* 5. *Low*	Provide HIV/AIDS awareness training.
Influx of temporary visitors on short- and long-term visits (consultants, administrative staff, management, general visitors, deliveries etc)	1. *Stress on existing guest houses, social and recreational facilities.* 2. *Increased traffic in town could cause safety hazard and noise.* 3. *Impact on commerce.* 4. *Stress of increased population on municipal services (sewerage, water, power, waste etc)*	1. *Medium positive* 2. *Medium* 3. *Medium positive* 4. *Low*	• Designate special routes for through traffic and heavy vehicles. • Provide traffic calming measures and speed limits along strategic routes.

6.1.6 Summary of Construction Phase Impacts

Essentially the KGPP is a "brownfields" project, using land that has been previously disturbed by mining and existing access routes and tracks. Use can also be made of existing towns and villages for accommodation, transport, social and commercial facilities. The exceptions are the gas field development and the transmission lines. The gas field development and pipeline route are both in areas of relatively low biodiversity where natural oceanographic processes will help to dissipate any localised adverse impacts. The biggest threat would be from oil spills from service vessels. The transmission lines traverse the Sperrgebiet National Park, which has outstanding visual qualities and many species of protected fauna and flora. The impacts on these qualities have been minimised as far as possible by careful routing of the lines. The impacts are therefore, generally low, but where

they have been assessed as being of high significance, most can be reduced to acceptable levels through the implementation of a number of basic mitigation measures.

The project will, however, have a major economic and social benefit for the people of the Karas region in particular as well as in the whole of Namibia. Noticeable benefits will be experienced in all the main Karas towns, as well as Windhoek, as a result of increased accommodation requirements, spending on goods and services and employment. To the extent possible, the KGPP proponent should liaise closely with Namdeb to minimise the impacts of the latter's down-scaling activities through take up by the KGPP project, especially with regard to employment, infrastructure (e.g. the hostel at Uubvlei), services etc.

6.2 Operational Phase

Table 6.7 provides the reader with a list of operational phase activities which will occur in each affected area. Each sub-section will present a summary of the impacts identified and assessed per area, together with possible mitigation measures, and a summary is provided at the end of each sub-section. The information has been taken from the three EIA reports and SAIEA has relied on the assessments made in those reports. The full motivation and justification of the assessments can be found in the relevant sections of the EIA reports. In some cases, impacts have not been identified in the EIA reports and these are shown in the tables below in italics and reflect SAIEAs own assessment.

Table 6.7: Activities by Area during Operations

Marine Environment	Uubvlei Environment	Sperrgebiet Environment	Oranjemund Environment	Lűderitz Environment
Operation of the sub-sea production facility	Gas Conditioning Plant operation	Traffic from Oranjemund and Lűderitz to Uubvlei	Accommodation, service and social facilities for permanent employees	Accommodation for visitors
Gas pipeline, MEG line and control umbilical – normal operations	Power generation – gas fired	Transportation of hazardous substances along access roads	Traffic (road, air)	Provision of goods and services for KGPP
Gas pipeline, MEG line and control umbilical – non-standard operations	Power generation – liquid fuel	Transmission line inspection and maintenance	Visitors, consultants, engineers to the KGPP	Traffic
Maintenance activities	Freshwater use			Influx of job seekers
Cooling water intake	Bulk chemical storage, use and disposal			
Cooling water discharge	Solid waste production and disposal			
Liquid effluent disposal	Transmission and distribution station transformer oils and detergents			

6.2.1 Operational Phase Impacts on the Marine Environment

The only notable impact on the marine environment during operation will be the discharge of cooling water purge from the power plant and other minor quantities of effluents. The design of the discharge point and its location have not been finalised and so the impacts broadly associated with an offshore discharge point (option 1) and a surf zone point (option 2) have been shown in Table 6.8 below. In reality, two alternatives are being considered for the offshore discharge point: either seaward of the cooling water intake, or shorewards of the intake. Although the confidence levels in the assessment are variable due to the presence or absence of data, it can be concluded that the environmental impacts of the effluent will be greater as one moves inshore.

Modelling of the effluent plume from an offshore outlet showed that the dispersal of the plume is highly sensitive to a number of factors such as discharge velocity, diffuser design, current strength, winds and tides, however under most hydrodynamic scenarios, the plume will be confined to the lower part of the water column and so the greatest impacts will be experienced by the benthic communities in the shallow soft sediments within an area of a few hundred metres downstream of the discharge point. The plume is not expected to come inshore and affect surf zone and beach communities, nor is it likely to reach deeper water. According to the specialist report and experience elsewhere, the impact of discharging warm water into a dynamic ocean system such as the Benguela, is low, especially if the discharge point is in reasonably deep water.

During normal operating conditions, there will be negligible impact from the sub-sea installations at the gas field and the pipeline to shore. The entire facility will be operated from the GCP. It is envisaged that maintenance of the sub-sea wells may be required twice per well over the life of the gas field. This would require a mobile drilling rig and therefore impacts similar to those which may occur during construction could happen, but on a shorter and much reduced basis (Table 6.2). Although few non-routine operations are envisaged, those that do arise will be due to unplanned shutdowns or maintenance of the wells or facilities. Unplanned shutdowns will require rapid response to restore the gas supply and the mobilisation of additional personnel. Some of the non-routine operations would require the mobilisation of a semi-submersible drilling unit, while others could be rectified remotely from the control centre onshore.

Table 6.8 presents a summary of the impacts identified on the marine environment during the operational phase of the KGPP.

Table 6.8: Operational Phase Impacts on the Marine Environment

Operational Phase Activity	Potential Impacts	Significance (before mitigation)	Possible Mitigation Measures
Operation of the sub-sea production facility (4 wells and associated sub-sea trees and manifolds)	1. Interference from fishing activities, especially hake and tuna vessels 2. Impact of the discharge of 21m^3/annum of hydraulic fluid on the marine environment	1. Low 2. Very low	• Design sub-sea facilities and the pipeline to withstand trawler damage and corrosion. • Set a 250m exclusion zone around the production area and provide notices to mariners. • Use low toxicity water-based hydraulic fluid.
Pipeline – normal operations	None	None	• Monitor pipeline for corrosion. • Set a 250m exclusion zone along either side of the pipeline and provide notices to mariners.
Pipeline – non-routine operations e.g. pipeline rupture	*Leak of gas and/or MEG into marine environment and impact on marine organisms*	*Low*	• Emergency shut-down valves will be installed. If a leak is detected, gas production will cease and the pipeline will be isolated from the wellhead and the GCP. • Regular testing and maintenance will be carried out.
Maintenance of sub-sea production facilities by mobile drilling rig	Similar impacts as those for construction but on a reduced scale (see Table 6.2)	Very low	See Table 6.2.
Cooling water intake from sea (other sources of saline water are from mine ponds and beach wells, which will have less environmental impact)	*1. Impact of intake structure on sediment transport* *2. Suction of larvae, small fish, plankton etc into pipe*	*1. Low* *2. Low*	• Design structure to withstand high energy wave environment. • Install fine mesh screens on intake pipes.
Discharge of cooling water purge at rate of 1300m^3/hr (up to 2600m^3/hr for 1600MW) with elevated temperature (10˚C more than seawater), elevated salinity (1.5x seawater) and residual biocide content (elevated Cl) **Option 1: offshore discharge**	1. Modification of physical characteristics of seawater in the immediate vicinity of the discharge point (temperature, salinity and chlorine) 2. Impact on marine biota 3. Impact on present recreational uses of sea 4. Impact on pelagic and demersal fisheries 5. Impact on rock lobster fisheries 6. Impact on future tourism in the Sperrgebiet	1. Low 2. Low 3. None 4. None 5. Low 6. Low	• Impacts can be mitigated by the design of the diffuser at the discharge point. • Implement a physical and biological monitoring programme from at least a year prior to any discharge taking place. • Plan discharge point in relation to intake pipe, route of gas pipeline and Namdeb's mining activities to maximise use of one corridor for all pipe work and minimise impact on Namdeb. • Issue notices to mariners regarding position of discharge point and likely plume area.
Discharge of cooling water purge **Option 2: Surf zone discharge**	1. Impact of thermal plume on marine biota 2. Impact of increased salinity on beach and surf zone animal communities. 3. Impact of biocide on beach and surf zone	1. Low-medium 2. Medium 3. Medium	• The confidence levels in this assessment are low because there is little baseline data and few corollaries elsewhere in the world. Therefore the best mitigation measure is to adopt the Precautionary Principle and adopt Option 1 for the cooling water discharge location.

Operational Phase Activity	Potential Impacts	Significance (before mitigation)	Possible Mitigation Measures
	communities.		
Discharge of other liquid wastes with cooling water purge **at either discharge option:** • Neutralised effluent from the water treatment plant (7l/s for 1hr/d) • Treated sewage effluent ($4m^3/d$) • HRSG blow down water ($150m^3/d$) (ultra pure) • Treated plant wash down water (infrequently)	1. Impact of trace quantities of aromatic hydrocarbons on marine biota, especially tainting of near shore spp such as lobsters. 2. Impact of trace amount of salts and ammonia from HRSG blow down water on marine biota. 3. Decline in dissolved oxygen from sewage effluent and HRSG blow down 4. Increase in BOD due to treated sewage effluent	1. Low 2. Low 3. Low 4. Low	• All oily discharges to pass through an oil separator prior to discharge. • All discharges will be diluted to well within acceptable concentration limits due to mixing with the cooling water purge.

6.2.2 Operational Phase Impacts on the Uubvlei Environment

The operation of a gas-fired power station is a relatively clean process due to the nature of the raw material, which is almost 100% methane. The use of sea water for cooling (as opposed to freshwater) also significantly reduces the overall impact of the operation on the environment. Furthermore, the fact that the Uubvlei site is on previously mined out land reduces the impact of the footprint even more. The main environmental concern relates to the presence of the power station within the proclaimed Sperrgebiet National Park and therefore all the impacts which might affect the Sperrgebiet must be minimised. These are discussed in section 6.2.3 below.

The potential impacts which may affect the environment in and around Uubvlei resulting from the operation of the GCP and CCGT plant are summarised in Table 6.9.

The main impacts associated with the normal operation of the power station are expected to be related to:

- Air quality on occupational health, but the risk of this impact should be minimised by the enforcement and use of the correct personal protective equipment by workers in and around the CCGT and GCP;
- Waste disposal. Without proper control, especially of windblown litter, the impacts of uncontrolled waste could be of medium-high significance given the position of the power station in the Sperrgebiet National Park. However, the potential risk of this impact occurring can be reduced considerably if a sound environmental management system is put in place at the GCP and CCGT power station which stipulates correct waste management procedures.

Other issues associated with the running of the power plant, which were identified as being important at Site D near Oranjemund, such as noise, visual impact and air emissions, are assessed as being of low and very low significance at Uubvlei. This is due to its distance from Oranjemund (25km) and Alexander Bay (30km), as well as its position downwind of these towns.

6.2.3 Operational Phase Impacts on the Sperrgebiet

The two main impacts on the Sperrgebiet relate to aesthetic impacts: the visual impact of the transmission lines in a wilderness environment, and the visual impact of night-time illumination of the power station and GCP on dark skies and star gazing within the wilderness area (Table 6.10). Both of these impacts are rated as being significant because

the whole beauty of the Sperrgebiet is its wilderness qualities. However, the reality is that Mining Area 1 is already highly disturbed with mine dumps, lit up diamond recovery plants, roads, transmission lines, waste dumps and a fully fledged town in evidence. Whilst the power plant and new power lines will add to the visual impacts, this portion of the Sperrgebiet will continue to be regarded as a "development zone" for the next 20 years or more. The impact of the transmission lines can be reduced through the combination of careful route planning of the lines themselves and judicious tourist route planning in the Sperrgebiet, so that visitors to the National Park seldom/never see the lines. The impact of night sky glow is more difficult to resolve, but it could be minimised by the choice of lighting used at the power plant, the placement of the lights, use of directional lights and so on, as well as the careful siting of tourist camps in the Sperrgebiet e.g. facing eastwards at the foot of a hill rather than high up on a west-facing slope.

The presence of the power station will mean that there will be an increase in traffic along the coastal road from Lűderitz to Oranjemund. Dust plumes along this road will have a localised negative impact on the surrounding vegetation.

The only other activities that will impact upon the Sperrgebiet will be periodic inspections of the transmission lines, and on rare occasions, maintenance and repair work. Both of these will be very short-lived and infrequent and will therefore have a minimal impact on the park and its visitors (Table 6.10).

Table 6.9: Operational Phase Impacts on the Uubvlei Environment

Operational Phase Activity	Potential Impacts	Significance (before mitigation)	Possible Mitigation Measures
Air emissions from GCP and gas-fired CCGT			
1. Discharge of 5 m^3/d condensed water waste as vapour via the heater exhaust stack in the GCP, which in the worst case could increase to a maximum of 140 m^3/d because of changed circumstances in the reservoir;	1. Impact of 0.3ppm hydrocarbons (methane) and 650ppm MEG on the environment.	1. Low	• Specify minimum emission standards in the design specifications in tenders. • Conduct regular maintenance checks of all equipment and vehicles. • Conduct in-stack continuous monitoring. • Establish fixed ambient air quality monitoring sites to monitor downwind impacts on vegetation and at public exposure locations. • Workers to be protected as per standard health and safety procedures.
2. Emissions of NOx from CCGT;	2. Potential nitrogen enrichment could cause water stress, nutrient imbalances and changes in plant community structures. Potential impact on public health.	2. Low	
3. Water vapour plume from cooling towers;	3. Visual impact of plume on future tourists to the Sperrgebiet National Park.	3. Low	
4. Steam from HRSG (occasional);	4. Possible occasional visual impact.	4. Very low	
5. Natural gas venting (infrequent);	5. No impact.	5. None	
6. Tank venting (minor);	6. No impact beyond power station.	6. None	
7. Lube oil vents (minor)	7. No impact beyond power station.	7. None	
Additional air emissions during liquid fuel operations	1. Impact of SO_2, NOx and TSP on public health 2. *Impact of fog-scavenged SO_2 on desert flora and fauna.*	1. Low 2. *Very low*	As above.
Liquid effluents from GCP and CCGT (not discharged at sea)	1. Impact of spillages of condensate, chemicals, diesel, fuel oil on the environment 2. Possible contamination of soils surrounding the plants by rainwater runoff. 3. Impact of gas turbine compressor wash water.	1. Very low 2. Very low 3. Very low	• Store all hazardous waste in bunded areas on concrete slabs. • Recycle or sell liquid wastes and by-products where possible. • Separate oily and non-oily areas and route all oily drainage via an oil separator. • Treated effluent to be discharged to sea with cooling water purge. Separated oil to be collected for recycling. • Non-oily runoff and wash water to be routed to the cooling water makeup basin for use in the cooling towers. • Use environmentally-benign surfactants in wash water. • Line all drains and sumps within the plant.

			• HRSG storage solutions and HRSG acid cleaning wash water to be removed by a specialist hazardous waste contractor.
Noise from GCP and CCGT operations: • Gas flaring from GCP in emergencies; • Gas turbine units, oil pumps, air intakes, compressors, cooling fans transformer fans, gas and steam releases and the steam turbine etc.	1. Impact on the population of Oranjemund (25km away) 2. Impact on future tourists to the Sperrgebiet National Park (nearest road 8km away; nearest possible camp site >40km away) 3. Impact on workers	1. Very low 2. None 3. High	• Prevailing wind direction and distance mitigates this impact for the residents of Oranjemund. • Workers to be equipped with hearing protection as per standard health and safety practices. • Fence off the gas flare area to ensure safe distance for noise and heat. • Include minimum specifications for noise in the tenders to ensure that noisy machinery and equipment is provided with appropriate silencers and noise reduction measures where necessary.
Solid waste: *1. Industrial non-hazardous waste e.g. air filters, scrap metal, packaging, tyres, drums etc* *2. Hazardous waste e.g. fluorescent tubes, batteries, asbestos cement, sludges from treatment plants and sumps, oily rags, soils contaminated with hydrocarbons, chemical containers, radioactive sources etc* *3. Domestic and office waste (paper, glass, cans, food waste etc)*	*1. Visual impact of wind-blown litter and general waste if not disposed of in a designated waste site.* *2. Potential impact on soil and soil fauna, human health, integrity of the Sperrgebiet environment.* *3. Visual impact of wind-blown litter and general waste if not disposed of in a designated waste site.*	*1. Medium* *2. High* *3. Medium*	*All impacts can be reduced to low if a proper waste management system is implemented. Key elements include:* • *Separate waste at source;* • *Sell all recyclable material such as scrap metal, glass, cardboard, paper etc;* • *Make sure sales contracts with suppliers include return of 'waste' e.g. batteries, chemical containers, packaging and so on;* • *Continue using the waste site developed during construction for all inert industrial and all domestic waste;* • *Compact and cover the waste daily or weekly depending on amounts;* • *Set aside a specially engineered and bunded area in the power station for temporary storage of all hazardous wastes prior to removal to the licensed hazardous landfill site in Windhoek;* • *Use wind-proof bins to prevent egress of windblown litter;* • *Fence in all waste collection and storage areas.*
Visual impact of all buildings, stacks, transmission lines, pipelines, access roads, fences etc associated with the KGPP installations at Uubvlei	1. Impact on residents of Oranjemund. 2. Visual impact of buildings and structures at Uubvlei on tourists travelling on Lűderitz-Oranjemund road	1. None 2. Low	• Distance, topography and salt spray haze will minimise the visual impact of the structures. • Paint all buildings a colour sympathetic to the desert environment.

Table 6.10: Operational Phase Impacts on the Sperrgebiet National Park

Operational Phase Activity	Potential Impacts	Significance (before mitigation)	Possible Mitigation Measures
Transmission line inspections by helicopter	1. *Disturbance of game and birds* 2. *Impact on tourists in the park*	1. *Low* 2. *High*	• Confine flights to transmission line corridor • Avoid flying at low level over herds of game. • Notify park officials when inspections are to take place.
Transmission line maintenance by ground crews	1. *Potential for off-road driving leaving indelible tracks* 2. *Litter and waste*	1. *High* 2. *Medium*	• All maintenance crews to be made aware of off-road driving rules and must stay on a single track. • All waste to be removed from the Sperrgebiet, including human waste. • Notify park officials when maintenance crews will be in the park.
Presence of transmission lines	1. Visual impact on wilderness qualities 2. Impact on bird flight paths (especially at the Orange River crossing)	1. High 2. High	• Route lines away from main tourist routes. • Align tourist routes and camps to avoid the transmission lines. • Put bird flappers on the lines at the Orange River crossing. • Use the same crossing as the existing 66kV line to Oranjemond.
Night-time illumination of the power station and GCP	*Visual impact of night time glow on star gazing, dark skies and wilderness qualities of the Sperrgebiet*	*Low*	• *Design lighting system at the power plant and GCP to reduce night-time glow.* • *Liaise with parks board to orientate affected camp sites to minimise impact of night-time glow.*
Traffic along coastal road between Lüderitz and Oranjemund	*Impact of dust plume on roadside vegetation and in downwind plumes*	*Low*	*A range of dust suppression measures needs to be evaluated including speed controls, spray sealant, chemical binders and seawater.*

6.2.4 Operational Phase Impacts on Oranjemund

It is possible that there will be up to 100 KGPP personnel and their families residing permanently in Oranjemund. These families will require the normal range of municipal services (health care, education, sewerage, waste disposal, roads, power, water etc), and commercial services such as banks, shops, post office, recreation clubs and so on. These are all currently provided in Oranjemund to Namdeb employees, and with the plans to downscale land mining operations in Mining Area 1, there will be some spare capacity in the town to accommodate these needs, without creating any stress on capacity (Table 6.11). However, the use of these facilities and services by KGPP personnel will have to be negotiated with Namdeb.

Indeed, it is foreseen that the presence of KGPP personnel in Oranjemund will help to reduce the negative impact on commerce which would have been experienced as part of Namdeb's downscaling operation and this then will have a positive impact.

Table 6.11: Operational Phase Impacts on Oranjemund

Operational Phase Activity	Potential Impacts	Significance (before mitigation)	Possible Mitigation Measures
Up to 100 KGPP personnel and their families, as well as visitors to the KGPP	Stress on health systems	Low	• Provide HIV/AIDS awareness • Should be spare capacity due to downscaling by Namdeb
	Impact on occupational health	None	• Power plant to be located at Uubvlei, 25km north of town
	Stress on educational, social and recreational facilities	Low	• Should be spare capacity due to downscaling by Namdeb
	Impact of increased crime and alcohol-related violence	Low	• Provide counselling services.
	Impact on urban infrastructure and services	Low	• Should be spare capacity due to downscaling by Namdeb
	Impact on commerce	Medium positive	•
	Impact on housing stock	Low	• Build new houses for KGPP personnel OR there may be sufficient stock available in town due to downscaling.
Increased traffic in town	Impact on safety and noise	Low	• Introduce traffic calming measures on strategic routes. • Encourage heavy traffic to avoid residential areas and the CBD
Employment opportunities for retrenched	Impact on employment prospects	Low positive	• Liaise with Namdeb to co-ordinate the retrenchment process with possible employment opportunities at the KGPP.

6.2.5 Operational Phase Impacts on Lűderitz

Once the KGPP is commissioned, the impacts on the Port of Lűderitz will diminish significantly: port, air and road traffic will be reduced, wharfage and berthing requirements will be minimal and the flow of visitors will be lower. Therefore the most significant negative impact of the project on Lűderitz is the possible influx of job seekers. The inflow of people into informal settlements could result in increased crime and social tension, an increase in the prevalence of HIV/AIDS and competition for space for informal housing. This will place stress on the local authorities and social services. On the other hand, the continued demand for goods and services by visitors en route to the KGPP will augment the local economy of the town.

6.3 Decommissioning Phase

6.3.1 Gas Field Production Facilities and Sub-sea Pipeline

All abandonment of facilities must be carried out in an environmentally responsible way and in accordance with Namibian, Tullow Oil and international environmental statutes. A full facility abandonment philosophy will be prepared through project specification and execution, and the initial draft will be submitted formally to the relevant ministries six months before project approval. The general approach will be:

- **Well abandonment:** the wells will have their trees removed, the casing stubs will be cut to below the sea bed and the well cemented. The removed wellheads and trees will be taken to shore for disposal.
- **Abandonment of submarine flow lines:** the flow lines will be cleared of hydrocarbons, cleaned, flooded and abandoned *in situ*.
- **Abandonment/removal of submarine manifold:** the manifold will be retrieved and taken to shore for disposal.
- **Abandonment of submarine pipeline:** the pipeline will be cleared of hydrocarbons cleaned, flooded and abandoned *in situ*.
- **Abandonment of sub-sea umbilicals:** the sub-sea umbilicals will be cleared of hydraulic fluids, cleaned, flooded and abandoned *in situ*.
- **Abandonment/removal of onshore pipeline:** The buried pipe will be cleared of hydrocarbons, cleaned and abandoned *in situ*. Any above ground portions will be removed and scrapped.
- **Abandonment/removal of onshore umbilical:** This umbilical will be cleared of hydrocarbons cleaned and abandoned *in situ*. Any above ground portions will be removed and scrapped.

6.3.2 Uubvlei Facilities

When the supply of gas is finished, the CCGT power station (NamPower's responsibility) and GCP (Tullow Oil's responsibility) and all pipe work and related structures will be decommissioned, the plant demolished and the site rehabilitated.

6.3.3 Transmission lines

Once power generation ceases at Uubvlei the transmission lines will be dismantled and the transmission line corridor rehabilitated as per the requirements of the Sperrgebiet National Park.

7. CONCLUSIONS AND RECOMMENDATIONS

It is evident from all the studies completed thus far, that the Kudu to Gas Project is viable technically, socially and environmentally. Some of the areas that will be within the projects' "ecological footprint" are already highly disturbed – notably the Uubvlei site itself, parts of the seabed where the pipeline will be laid and some of the corridors along which the power lines will be constructed. The component-specific EIAs and this IIMR have identified the safeguards that must be put in place to avoid unnecessary negative impacts while enhancing project benefits. The next step in the implementation of this project is to formalise the safeguards as enforceable conditions.

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