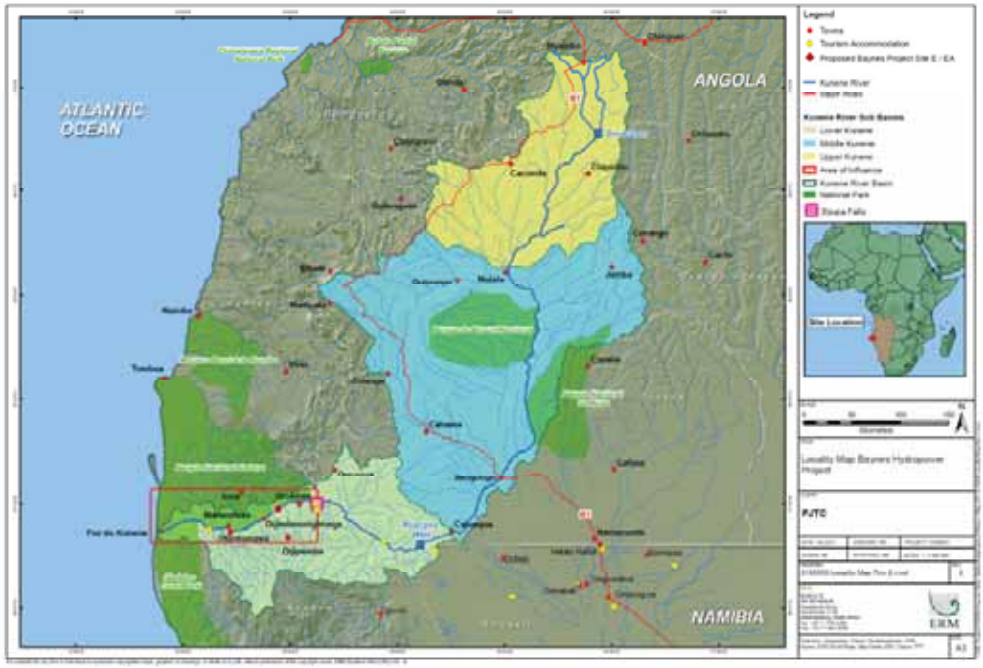
The Governments of Angola and Namibia have proposed the construction and operation of a hydropower development on the lower Kunene River, at a site located approximately 48km downstream from the Epupa Falls, where the river cuts through the Baynes Mountain range (hereafter referred to as the 'Baynes Hydropower Project (HPP)' or 'the Project'). The lower Kunene River, that stretches some 185km from the Epupa Falls to its mouth on the Atlantic Ocean at Foz do Cunene, forms the border between Angola and Namibia, and is considered to be the Project's Area of Influence. The location of the Baynes HPP is provided in the figure below and it is acknowledged that the Baynes Project's indirect influence may be felt more widely than the indicated Area of Influence.



Location of the Project Area, in Relation to the Kunene Catchment

In order to establish the feasibility of using the Kunene River Catchment as a source of hydropower to meet both Angolan and Namibian future energy demands, the Governments of the Republic of Angola and the Republic of Namibia appointed a Permanent Joint Technical Commission (PJTC) for the Kunene River Catchment. A committee of the PJTC, known as the Baynes Committee, has been established to act on behalf of the PJTC, and is responsible for the administration and management of both the technical and economic, as well as environmental feasibility of the Baynes Project.

The PJTC appointed the Cunene Consortium [1] to undertake a techno-economic study of the Baynes site for the generation of hydropower. In addition, the PJTC appointed Environmental Resources Management (ERM) to independently conduct the Environmental and Social Impact Assessment (ESIA), in parallel and in consultation with the techno-economic study.

This is the final ESIA report for the Baynes Hydropower Project. The main report (Volume I) sets out ERM's analysis of the environmental and social impacts of the Baynes HPP. Volume I is accompanied by Volume II - *Annexure A – F*, which provide supporting materials and additional information (see *Chapter 1*, *Table 1.2*). A Social and Environmental Management Plan (SEMP) will be forthcoming and is contingent on the outcomes of the ESIA study.

OBJECTIVES

The objective of the ESIA study is to assess the environmental and socio-economic impacts associated with the construction and operation of the Baynes HPP, resulting in an ESIA Report and SEMP. A copy of the Terms of Reference (ToR) for this study is provided in *Annex A*.

In line with the ToR, the ESIA conforms to the formal requirements of the Angolan EIA Regulations (*Decree 51/04 on Environmental Impact Assessment* established under Article 16 of the *Environmental Framework Law (Law 5/98)*) and the Namibian EIA Regulations (*Environmental Assessment Policy (1995)* established under the *Environmental Management Act (2007)*).

In addition, the ESIA has been guided by international guidelines and standards to ensure all issues are considered and managed in accordance with international good practice. The World Bank Safeguard Policies, the International Finance Corporation (IFC) Performance Standards, the World Commission on Dams' Strategic Principles, and the International Hydropower Association (IHA) Sustainability Guidelines and Protocols have all been considered in this ESIA.

A full legal review, to which the Project needs to comply, is contained in *Chapter 2.*

THE PROPOSED DEVELOPMENT

In 1969 the Governments of Portugal and South Africa entered into an agreement on the first phase of development of the water resources of the Kunene River. The agreement included a plan to develop a hydropower project at Ruacana, to be followed by a series of hydropower projects along the entire river system. This agreement resulted in the construction of three

(1) The Cunene Consortium is made up of a number of Brazilian companies including: Construtora Norberto Odebrecht S.A. (leader of the Consortium), Centrais Elétricas Brasileiras S.A - Eletrobrás, Furnas Centrais Elétricas S.A.- Furnas and Engevix Engenharia S.A.

schemes during the 1970s, namely the Gove Dam in Angola, the Ruacana Hydropower Scheme in Namibia and the Calueque Water Scheme in Angola, which facilitates water supply to the northern parts of Namibia, as well as to irrigation projects inside Angola.

In the late 1980s, SWAWEK (now NamPower) forecast the increasing need for power in Namibia and began to consider the construction of a hydropower scheme in the vicinity of Epupa. In 1991, the governments of Namibia and Angola agreed to go ahead with detailed technical and environmental investigations for a potential hydropower development at Epupa, with the studies commencing in 1992. During this study, all possible hydropower development sites along the lower Kunene River, downstream of Ruacana, were investigated. The Feasibility Study concluded that the Epupa site would be technically preferable, while the Baynes alternative would result in less ecological and social impacts. Opposition to the plans of a dam at the Epupa site by local and international NGOs, and the Himba(1), saw the project being shelved and caused the two governments to consider alternative power supply arrangements.

Such alternatives include:

- In Angola:
    - Liquefied Natural Gas (ALNG Project) power station in Soyo;
    - Rehabilitation of existing power plants; and
    - A variety of hydropower schemes.
- In Namibia:
    - A combined cycle gas-fired power station (Kudu Project);
    - a coal–fired power station at Arandis;
    - a diesel peaking station at Walvis Bay;
    - a series of small hydro stations on the Lower Orange River; and
    - A variety of renewable energy projects, including wind and solar power.

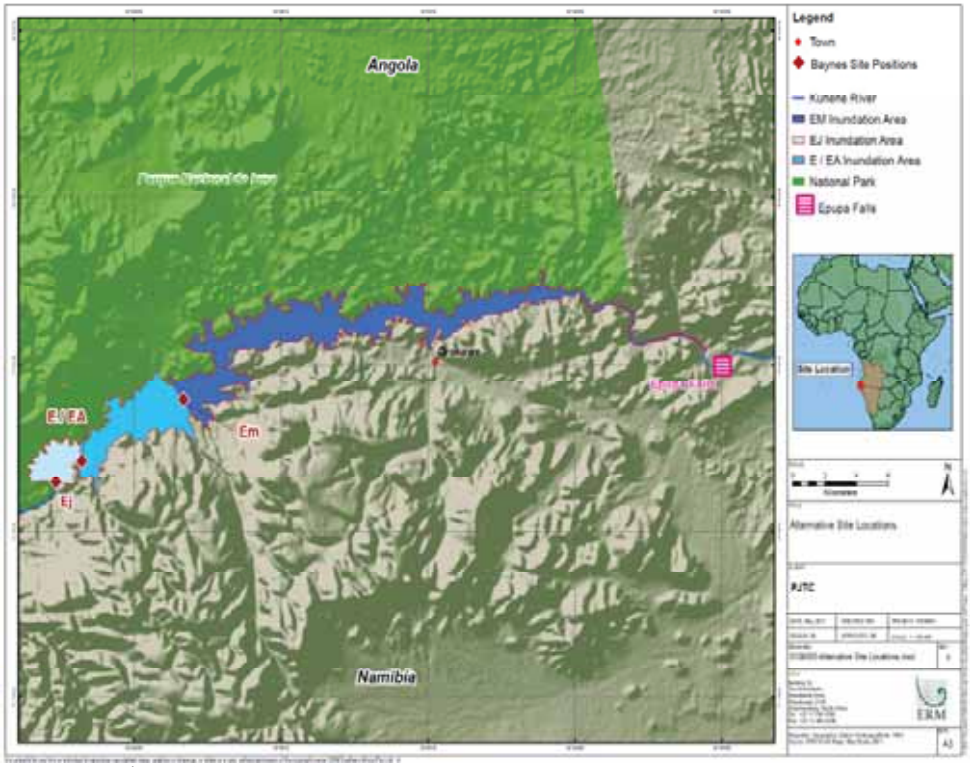
The Baynes alternative has remained an option for both countries, and due to a reduction in regional import capacity from neighbouring countries and the Southern African Power Pool (SAPP), increasing costs associated with electricity imports, increasing costs associated with electricity generation, and increasing demands for electricity in both countries, this power generation alternative is being revisited.

The energy demands in Angola and Namibia, strategic alternatives to electricity generation that have been assessed by both countries, and the

(1) The Himba (who share a common origin with the Herero tribe) are an indigenous pastoral and nomadic people found within the region. The Himba are also referred to as the Ova-Himba in Angola. For the purpose of this ESIA, this tribe will be referred to as the Himba.

rationale behind the need for the Baynes HPP, is discussed in detail in *Chapter 4*.

Four locations for the dam site were analysed by the Cunene Consortium based on field inspections and the review of available cartographic data. These four locations were annotated as site 'EM' (the most upstream site), Site 'E' (the reference site selected for the Baynes alternative in the previous Epupa studies of 1998), the alternative Reference Site 'EA' (a variant of the structure arrangement considered for site E), and the downstream site 'EJ' (approximately 3 km downstream of Site E).



Project Site Alternatives

In addition, ten layout alternatives were studied by the Cunene Consortium: three on site 'EM'; four on site 'E'; and three on site 'EJ'. For sites 'EM' and 'EJ', three water level (WL) options at elevations above mean sea level of 580m, 560m and 540m were considered. For Site 'E', two WL options were analysed at elevations of 580m and 560m, respectively.

On the basis of an alternatives evaluation carried out by the Cunene Consortium, it was concluded that the most competitive techno-economic option was alternative 'EA' at an elevation of 580m (EA580) with a preliminary installed capacity of 600 MW, due to it having the best cost-benefit ratio. (The dam wall was limited to an elevation of 580m, to avoid any flooding of the Epupa Falls, as the toe of these falls lies at this elevation). It should be noted that the choice of EA580 as the preferred site-specific alternative was based largely on technical and economic factors, with the only environmental informant being the high-level identification of the Baynes site as being preferable to the Epupa site from ecological and social perspectives.

Site EA would comprise a concrete face rockfill dam (CFRD), together with a separate free-flowing spillway controlled by a fixed weir. The generation scheme, located on the left (Namibian) bank of the river, is composed of a headrace channel, water intake, penstock, power station and tailrace. The reservoir is to be constructed to achieve a dam water level of a maximum of 580 metres with a reservoir area of 58.15km^2 at full supply level (FSL).

A detailed description of the proposed development is provided in *Chapter 4.*

A transmission line will be required to connect the Baynes power house to the Angolan and Namibian national electricity transmission grids. The design and exact routing of the transmission lines will be finalised during a pending Strategic Environmental Assessment (SEA) for the linear infrastructure requirements of the Project, and falls outside of the scope of this ESIA.

THE BIOPHYSICAL ENVIRONMENT

Chapter 6 provides a detailed description of the environmental baseline in the area of the proposed project, based on a thorough review of available secondary information, supplemented by additional surveys carried out by the specialists appointed for the task from 2009 to 2012. Principal points of the environmental baseline include:

- The majority of the mean annual rainfall (MAR) is generated in the Upper Kunene sub-catchment, which contributes from 75 percent to 90 percent of the total volume of flow of the River. Annual rainfall throughout the Upper Kunene catchment averages 1,300mm; however the Upper Kunene River section is temperate with dry winters, with a 4 to 5 month dry season from May to September. 90 percent of the annual rainfall falls in the five month rainy period from December to April, with the main season occurring between February and March.

- The Lower Kunene varies from tropical steppe to arid /desert at the coast, receiving rainfall of less than 50mm per annum at the river mouth, and 350mm per annum inland. Rainfall in this region is extremely variable from year to year with a variability of over 40 percent. As such, the river in this region is a linear oasis passing through an otherwise arid region.

Lower Kunene River near Orupembe

- Very little water in the Kunene River is contributed from the lower tributaries. The total contribution of the Lower Kunene to the total flow in the Kunene River is commonly less than 5 percent. These seasonal (ephemeral) tributaries in the lower Kunene River do, however function as ground water aquifers and are important elements in the landscape in spite of the limited surface run-off.

- Due to the topography of the area, only very skeletal soil has developed in the lower Kunene. This soil is of a poor quality (sandstone and lithosols) restricting the use of the land for agriculture, and also influencing the type of vegetation in the area.

Lower Kunene River Catchment

- The Lower Kunene River is considered of high wilderness and conservation value. In Namibia, the Kaokoveld is considered a high priority conservation area (IUCN).

- This steppe to desert environment supports the far western part of the Mopane savanna which is known for its high diversity of floral species, and is commonly referred to as the Kaokoveld Centre of Endemism. This centre of endemism extends into southern Angola, is floristically related to the Zambezian and Karoo-Namib floristic regions, and is considered a refuge for taxa capable of surviving arid conditions.

- A total of 168 floral species were observed within the four vegetation communities identified in the Project Area, of which 27 are near-endemics to Angola and Namibia and seven are protected under Namibian legislation. Based on National Herbarium of Namibia and Tree Atlas data, a total of 379 species could occur in the vicinity of the Baynes Site. Of these, six are listed in the Namibia Red Data List, 29 are protected under Forestry or Nature Conservation legislation in Namibia, whilst 69 species are considered endemic or near-endemic to Namibia. No information on protection status in Angola is available for these species.

- None of the birds observed or expected to occur in the Project Area are exclusively associated with the Baynes Site; however, several of the species have their distribution restricted to the Kunene River. The Epupa-Ruacana stretch of the river, approximately 80km to the east (upstream), has a Global Important Birding Area (IBA) status and the Kunene River Mouth in the Skeleton Coast Park, approximately 185km to the west (downstream), has a National IBA status in Namibia.

- Based on the 2010 field survey and historical records from the area, at least 86 mammal species (breeding residents) are known to, or are expected to, occur in the general Kunene River area, of which nine mammal species (10.5 percent) are endemics. The high proportion of endemics and species with protected status expected to occur in the general Kunene River area underscore the importance of this area for mammal populations.

- Several species known from the Project Area have particular conservation importance due to their rarity, population threats, and level of endemism. These include the *Black-faced Impala*, the *Brown Hyena*, the *Spotted-necked Otter* and the *Hartmann's Mountain Zebra*.

- Of the 75 reptile species known or expected to occur in the Project Area, five species are protected and/or have a Red List conservation status. None of the frog species known or expected to occur is on the IUCN Red List or protected in Angola or Namibia.

Aquatic Ecological Survey at Site EF 1 (Otjimborongbonga)

- A total of 379 invertebrate taxa (not species) are known or confidently expected to occur in the Project Area. Many taxa are undoubtedly restricted to the north-western Namibia plus south-western Angola Centre of Endemism, but current bio-geographical knowledge of the taxa concerned does not allow any to be identified.

- The Kunene River is the only perennial system in the Namib Ecoregion and provides habitat to the majority of the fish biodiversity of the ecoregion. Six endemic fish are known from the ecoregion, and two IUCN red listed fish species occur in the Kunene River. The system is not impacted by exotic fish.

- One unique aquatic habitat within the Project Area is found at the perennial springs along the edges of the Kunene valley, which are relatively abundant in the area but restricted in size. Given the relative dryness of the surrounding areas, they are range-restricted habitats of some importance. They function as important habitats for frogs and aquatic invertebrates and host different aquatic species compared to the actual Kunene River, including two regionally endemic fish species. Fifteen such springs were identified in the Baynes HPP inundation area.

- The Kunene River drains a generally undeveloped catchment and traverses an extremely arid stretch of country before reaching the sea. Nutrient loads from the catchment itself and from the limited fringing vegetation of this fast flowing river are therefore low. Water quality in the Kunene River is generally good, and the water is potable.

Lower Kunene River near Foz do Cunene

- The Lower Kunene River is unique in its starkness and remoteness. The harshness of the environment means that it is fairly low in terms of aquatic biodiversity, and has shown itself to be fairly resistant to the sorts of flow fluctuations that result from the operation of the Ruacana Hydropower Project (HPP). The Present Ecological State (PES) of the river downstream of the Ruacana HPP at each of three sites assessed is in a B-category, viz. slightly modified from the Reference Condition. Definitions of the PES, and a full description of the PES for each downstream site evaluated, are provided in *Chapter 6*.

- The relatively minor impact of the Ruacana HPP on the river ecology is probably related partly to the natural resilience of the river ecosystem, but it is also related to the fact that the wet season flows are largely unaffected by the Ruacana HPP. The Ruacana reservoir has a small storage capacity relative to the MAR of the Kunene River and, as such, does not attenuate the wet season floods in the Lower Kunene River, nor does it delay the onset of the wet season, through storage of early season flows.

- The Kunene River at its mouth operates as a river mouth as opposed to an estuary. The mouth is important as it is the bio-geographical limit of a number of marine and freshwater tropical species and plays a critical role as an oasis in the extremely harsh Namib Desert.

The Kunene River Mouth

Chapter 7 presents a detailed socio-economic baseline description, based on a systematic social survey in the Baynes area carried out in 2010 and 2011, and secondary data, from previous studies related to the proposed development, as well as national and regional data. Key points of the social baseline include:

- The area on both sides of the Kunene River is very sparsely populated and the nearest towns are a considerable distance away from the Baynes site. Okangwati is the closest settlement and Opuwo is the closest town, both of which are on the Namibian side to the Project Area.

- The area adjacent to the banks of the Lower Kunene River (within the area of influence) is utilised by the Himba for small scale subsistence agricultural activities and grazing. Although the Himba are a nomadic tribe, this area is utilised at various times of the year for grazing.

Himba Homestead

- The importance of livestock rearing activities of the local populations living next or close to the river must be highlighted. Informal interviews with local residents indicate that little fishing occurs in the Baynes HPP Area.

- Literacy rates in the Project Area are low. Only one person out of the entire community in the Project Area had attended school, and had only finished primary school. No other had any education. One of the reasons for this is the fact that most residents in the region are highly nomadic people who seasonally migrate with their livestock to other grazing areas during dry periods, seldom remaining in one place for the entire year.

- Few services are available in the project area. Health facilities in the area are extremely limited, and residents in the Project Area have to travel vast distances (40km to 70km) to access health facilities.

- The Orokawe area is closest to the proposed dam wall site. It accommodates a small number of households, all of which currently live inside the area that will eventually be inundated by the dam. The area is inaccessible and little traffic actually reaches the Orokawe area.

- Housing in the inundation area are exclusively traditional housing structures. There are no services such as formal water or sanitation at any of the homesteads. Within the inundation area of the proposed dam, the research team with the guidance of the local community, found 5 households on the Namibian side of the river and one on the Angolan side of the river. In addition, there are 12 cattle posts inside the inundation area; 8 on the Namibian side and 4 on the Angola side.

One of the Houses in the Inundation Area

- Livelihood in the area of influence of the dam is solely dependent on limited crop cultivation and livestock rearing. The Himba are skilled and successful cattle herders who have learned to subsist successfully in a very harsh environment. Although a cash economy is largely absent, these herders are among the most successful in Africa and their wealth is defined through their livestock.

Himba Homestead

- The Himba's success is closely linked to their unique culture and social organization. Their systems work well and entail highly participative processes that they use to deal with any problems in the community. They have developed a system of managing their grazing which has held up for centuries and assisted them to get through some of the worst droughts in history.

- Various degrees – from mild to very severe – of range degradation are reported in the broader impact zones. Perennial grasses have become sparse except on remote hilltops and have been replaced by annual grasses. As a result top-soil losses and soil capping are becoming serious problems and productivity of the rangelands has been reduced, especially in low rainfall years. Such rangeland degradation was, however not observed in the direct inundation zone. This can be attributed to low population density of both people and domestic stock and the operation of 'traditional' systems of descent-based authority.

- On the Angolan side of the Kunene, approximately two-thirds of the land adjacent to the river is designated as part of the Iona National Park while on the Namibian side, the Kunene River mouth area falls within the Skeleton Coast National Park. Two registered communal conservancies are located in Namibia, within close proximity to the Project site, namely the

Marienfluss and Orupembe conservancies. These conservancies are aimed at protecting biodiversity while at the same time diversifying livelihoods and generating income for the local population.

- Tourism in this region of Namibia is relatively common, although this is on a small scale, making use of the limited tourism infrastructure on offer within the conservancies and tourism concessions in Namibia.

- Uncontrolled development has taken place in the vicinity of Epupa. In spite of the presence of a police station, theft, public drunkenness and abuse of alcohol, fighting and other anti-social behaviour are now common.

- 43 sites were located during the Baynes Archaeological Survey and the Baynes project area should be considered as a highly sensitive archaeological landscape. A large proportion of the sites (~ 70 percent) are related to the traditional settlement arrangements of the Himba. These sites include graves, which are regarded as sacred places by the Himba.

Graves

KEY BIO-PHYSICAL IMPACTS

Chapter 8 details the biophysical impacts both within the catchment of the impoundment, within the impoundment itself, and downstream of the impoundment, all the way to the Kunene River mouth.

Terrestrial Habitats

Approximately 5,900 ha of land will be occupied as a consequence of the Baynes HPP, resulting in the direct loss of terrestrial habitats and vegetation and associated disruption in the ecological integrity of surrounding areas in the Kunene River valley. Vegetation most affected by inundation will include the *Combretum imberbe – Salvadora persica* riverine forests within the reservoir footprint, and the *Adenolobus garipensis – Euphorbia virosa* bushlands along the canyon slopes.

The operation of the dam will reduce or eliminate annual riparian flooding downstream of the dam, which could cause a loss of riparian vegetation in the river's floodplain. Annual flooding delivers critical nutrients, sediment, coarse debris, and other critical ecosystem components to riparian habitats so it is likely that downstream riparian habitat will undergo changes in species composition, vegetation density, etc.

Wildlife

Habitat loss and disturbance will be the primary impacts on terrestrial wildlife associated with the construction phase of the Baynes HPP. In addition to habitat loss, other impacts on wildlife associated with the Baynes HPP will include disturbance, displacement, and harassment.

Inundation of the reservoir will result in drowning of some mammals unable to escape from flooded areas. The reservoir will fill slowly which should avoid large scale direct loss, as most animals will be able to move to higher ground as the water level rises. Mortality due to drowning is likely to be most prevalent in ground dwelling and feeding mammals, especially rock/crevice dwelling species such as small rodents, tree dwelling species and burrow dwelling species. Most herptiles and invertebrates within the reservoir footprint will be lost as a result of inundation due to their limited ability to emigrate due to their short life spans and small size.

Aquatic Ecology and the Water Environment

The Baynes HPP will entail the construction of a dam and the inundation of an area of approximately 5,900 ha of land. The full supply level of the impoundment is 580m (so as not to impact on the Epupa Falls upstream), with a maximum reservoir volume of 2,570 million m^3. Flow in the Kunene River will be captured in the reservoir and released at a controlled rate for generation of hydropower. The Project will therefore create a new water environment within the impoundment, and controlled releases of water from the HPP will have an impact on the aquatic ecology downstream.

The dam will create an impoundment that will permanently alter the aquatic habitats of the 15 perennial spring ecosystems in the inundation area, by replacing them with an open water aquatic ecosystem that will be unsuitable habitat for most perennial spring taxa, causing them to disappear.

As the habitat changes within the growing reservoir, the riverine aquatic biota will tend to die off, migrate out of the old river channel as the water becomes deep enough to inhibit photosynthesis, and/or migrate upstream toward Epupa Falls in advance of the expanding lake. Rheophillic fishes with strong preferences for rocky substrate, fast flowing habitats can be expected to disappear from the reservoir in favour of those species with limnophillic floodplain habitat preferences. This will result in the development of a new fisheries resource in the reservoir.

The flow alterations resulting from the proposed Baynes HPP are expected to have a significant effect on both the abundances and diversity of fish and macroinvertebrates in the Namib Ecoregion downstream from the Baynes Project site. The Present Ecological State of the river downstream of the dam will change from a B (slightly modified from the Reference Condition) to a D (largely modified from the Reference Condition), as discussed in more detail *Chapter 8*.

The Baynes Reservoir will show stratification most of the year, with a temperature difference between the warmer upper layer (the *epilimnion*) and the cold lower layer (the *hypolimnion*). Seasonal vertical temperature stratification will range by ± 3°C in January, by ± 6°C in May and ± 4°C in September. The hypolimnion can become isolated from the effects of solar radiation and re-aeration at the water surface and may accumulate low temperature, low dissolved oxygen (DO) water. A deep hydropower release will in turn pass this water downstream, where biological communities acclimated to warmer temperatures and higher DO levels may be impacted.

Temperature impacts within the impoundment can be mitigated to some extent with some operational efforts. The availability of two multi-level offtakes (at elevations 530.5 and 547.0m) provides the ability to blend cooler water from the hypolimnion with warmer water within the epilimnion at elevations above 500m, thereby controlling the release water temperature. It is, however, likely that even with mixing, an anoxic and cooler body of water will remain within the deeper sections of the impoundment (below elevation 500m).

The effect of the reservoir will be to dampen the fluctuations in water temperature that occur in the Kunene River. The magnitude of this temperature difference is estimated from model results to range from 4°C above to 4°C below the ambient temperature. These results are, however, given for an offtake operating condition that is not optimised. Similar, but less severe, impacts can therefore be expected with a blended release schedule. Model results indicate that there could be a 1 to 2°C improvement (decreased

impact) when an optimised blending schedule is developed. Thermal changes within this range are regarded as insignificant to fish downstream from the proposed Baynes HPP, but may be more significant on the breeding and growth, and consequently, the populations of aquatic invertebrates, particularly the large freshwater prawn *M. vollenhovenii*, although should be confirmed through studies on the temperature tolerance of this species. Model results indicate that the temperature effects of release waters will be felt all the way to the Kunene mouth, albeit at lesser levels further downstream from the dam.

Based on water quality modelling results, and given that the productivity in the reservoir will be nitrogen-limited, it is anticipated that nutrient loading into the proposed reservoir will cause the reservoir to be *oligotrophic* (clear, low productivity). However, until the lake matures and reaches a more stable condition, it is likely to be *eutrophic* (nutrient rich and productive in terms of aquatic plant or animal life) due to the release of nutrients from the flooded riparian zone, which contains limited vegetation. After several years, the released nutrients from the remnant vegetation debris will have been flushed from the reservoir. It is currently not possible to estimate the extent of this period. However, once such flushing has occurred, phosphorus and nitrogen loading rates will stabilise and water quality will improve.

The Baynes HPP will have a considerably larger storage capacity than the Ruacana HPP upstream, which, when combined with a peaking power generation operation, could considerably affect both wet and dry season flows in the downstream river. In order to evaluate the implications of changes in the volume and distribution of flows downstream of the proposed Baynes HPP, an Environmental Flow Assessment (EFA) was undertaken. The EFA study used representative sites along the lower Kunene River downstream of the proposed Baynes HPP in order to determine the implications of changes in the volume and distribution of flows at each site. These sites were also to provide a range of flow release scenarios linking volume and timing of flows to river condition, and in assessing environmental flow releases.

The flow release scenarios that were evaluated as part of the EFA study were based on the proposed operation of the Baynes HPP in terms of downstream releases. Of the thirteen scenarios evaluated, only three (S2, M2 and NP6) limit the predicted drop in ecological category to one category (B to C). These three scenarios were, however discounted as they rendered the dam uneconomical, ie an Internal Rate of Return (IRR) of less than 10%. In this regard, Scenario NP5 (50 m^3s^{-1} compensation flows, plus spills) was selected as the best mitigation that could be achieved while still delivering a 10% IRR. This environmental flow release was therefore adopted as the preferred scenario for use in the Baynes HPP. As mentioned previously, the impact as a result of this scenario will result in a drop in the ecological state of the river from a B category (present state) to a D category. A D-category is widely considered to represent the lower limit of degradation allowable under sustainable development.

This impact is based on the assumption that during periods of low flow (< 50 m^3s^{-1}), environmental flow releases will take priority to electricity generation. The assumption made therefore was that during periods of low flow, no power would be generated.

There are three possible physical issues of concern with regards to river inflow reduction in the Kunene River Mouth, namely:

- Mouth closing as a result of decreased seasonal baseflows;
- Increase in salinity penetration resulting from a decrease in seasonal baseflows; and
- Infilling of the river channel as a result of a decrease in, or loss of, resetting flood events which cause increased sedimentation.

Closure of the Kunene River mouth is only likely to occur if river inflow below 10 m^3s^{-1} occurs for extended periods (weeks to months) at a time. An analysis of the Environmental Flow releases indicates that the probability of such flows occurring are less than 2 percent of the time, and then only for short periods. Mouth closure is therefore not considered to be an issue of concern during the operation of the proposed Baynes HPP, provided the environmental flow releases are realised.

The Kunene River mouth is considered a permanently open system under its present flow regime and as such, is a freshwater-dominated system, with salinity penetration limited to its lower reaches (200m to 500m from the mouth). There is the potential that flow pulses released from the HPP during low flows and drought conditions could create a situation where the system would fluctuate between fresh and brackish in its lower reaches (500m to 1,000m of the Kunene River mouth).

Overall, large floods are crucial in maintaining the long-term dynamic equilibrium with respect to the sediment regime in the Kunene River Mouth. It is surmised that the overall reduction in intermediate flows as a result of the HPP will cause the average extent of the marine sediment intrusion to be only slightly further upstream than at present.

The physical changes to the flow regime as a result of the proposed Baynes HPP as experienced at the Kunene River mouth will likely affect the volume of the river mouth basin and the extent of the freshwater wetland vegetation in this area, likely impacting on the flora and fauna of the river mouth region, in particular aquatic invertebrates.

Climate Change and Greenhouse Gasses

Changes in precipitation and evaporation as a result of climate change may affect stream flow, and an increasing demand for water in the Kunene River Basin will likely reduce water availability in the middle to lower reaches of this river.

The impact of climate change on stream flow in the region of the Baynes HPP is uncertain as the balance between increased precipitation (rainfall over central Africa and the upper reaches of the Kunene catchment, where the majority of the flow is generated, is projected to increase by 0 -20 percent with the largest increase occurring during the rainy season) and increased evaporation (evaporation rates will change due to variations in temperature, which is projected to increase in Angola, and precipitation) is not well understood.

Rather, the potential for water stress as a result of human demands in the middle Kunene Basin, particularly during periods of low flow (mainly in October and November), will likely pose a higher risk to the Baynes HPP in its ability to reliably supply power during water stress periods. The governments of Angola and Namibia are currently finalising an agreement to provide for the development, operation and maintenance of the Baynes HPP, with due regard to the environmental and social requirements of both Parties. Article 8 of this agreement (Water Use Arrangements) recognises the right of each Party to a share in the waters of the Kunene River for the purposes of consumptive and non-consumptive use, and stipulates the further need for an agreement between the Parties in terms of the maximum abstraction of water from the Kunene (taking into account upstream demand over the next 30 years) so as not to jeopardise the operations of the Project or compromise the environmental flow requirements of the River.

Other issues include the increased emission of greenhouse gases (GHG) from the reservoir due to decaying vegetation and carbon inflows from the catchment. Provided that vegetation is at least partially cleared prior to inundation, greenhouse gas emissions would be relatively low. The total potential emissions resulting from the Baynes HPP are not predicted to impact national GHG emissions materially in either country.

Climate change and GHG issues are discussed in *Chapter 8*.

KEY SOCIO-ECONOMIC IMPACTS

Chapter 9 details the predicted socio-economic impacts. The analysis of these impacts is based on available secondary information, combined with extensive surveys and social programmes. Key impacts in this regard are related to:

- Loss of Land and Natural Resources;
- Disruption to Social Networks and Rapid Cultural Change;
- Loss of Cultural Heritage;
- Pressure on Social Infrastructure;
- Disturbance due to Dust, Noise and Safety Hazards from Traffic;
- Impact on the Local Economy; and
- Impacts on Fishing.

The construction of the Baynes HPP and the resultant inundation of about 5,900 ha of land will result in the loss of valuable grazing for the local indigenous farmers. The grazing in the area of inundation and especially close to Orokawe forms part of the main grazing area of the permanent households, but is also regarded in both Angola and Namibia as an emergency grazing area. Reportedly, herders from quite far away utilise this area in times of adversity and the loss of this grazing area is likely to have an impact on the local indigenous population on both sides of the river.

The biggest fear of the local population relates to the 2,000 to 3,000 people who will move into the area during the construction period. The Himba people in the area have very tight knit social networks that are well organised through lineage heads and by the chieftaincy and traditional councilor system. The influx of large numbers of outsiders, who are likely to owe little allegiance to local leaders and the land-use patterns organised through such traditional authority structures (and who may have much more money than local people) may result in significant social tension and change, such as 1) the breakdown of local leadership structures; 2) a related rangeland crisis with potential to collapse the herding economy in the area; 3) increase in sexually transmitted disease, 4) loss of power and status of Himba woman; and 5) disintegration of social cohesion and lawfulness.

The Project Area suffers from inadequate education and health facilities for the local population, and a shortage of potable water and transport facilities, including road networks. The influx of large numbers of people could place a greater strain on these already limited facilities and infrastructure. The infrastructure in terms of road networks, services provision to the construction workforce, and health and education facilities are in any case inadequate to serve the needs of the project during construction and operation. New access roads will need to be built and self-contained facilities (health, education) and services (including electricity, water, sanitation and solid waste) will need to be provided for the construction workforce.

There is a clear conflict between reducing the negative impacts of a large uncontrolled workforce during the construction of the dam and enhancing positive local economic impacts likely to result from the project. It is therefore argued that the temporary and potentially small local economic benefit from the dam should be seen as secondary to the threat of the large construction workforce and the contact between this workforce and the local community.

From the experience of other dams around the world, it is probable that the existence of a permanent lake upstream of the dam wall would create a reservoir fishery that is more productive than the current riverine fishery. However, it is unlikely that the dam will be nutrient rich and it is uncertain if the fish resource would be significant enough to warrant any large scale commercial utilisation. The change in the flow regime of the river downstream could result in a decline in fish resources. The impact of declining fish stocks on food security in the area is however unlikely to be significant, given that

the directly affected communities downstream of the proposed dam do not commonly utilise fish as a main source of food.

Impacts on Archaeological and Cultural Heritage

Chapter 7 list the archaeological and cultural features in the area that will be lost to inundation or to the construction of the dam and its attendant facilities.

An archaeological assessment done for the Baynes area identified some 43 archaeological sites. Of these sites, 65 percent were attributable to recent Ovahimba settlement on the basis of culturally specific features. Of these, seven sites were either confirmed or suspected grave sites.

The Himba people place considerable importance on ancestral gravesites. These sites act as a focal point for defining identity, social relationships and relationships with the land, as well as being a focal point in religious ceremonies. The inundation of ancestral graves by the dam or the exhumation of such graves is unacceptable in their tradition.

PUBLIC CONSULTATION AND DISCLOSURE

The Baynes HPP has undertaken consultation at a number of stages during the evolution of the Project. Following the preparation of a Public Consultation and Disclosure Plan (PCDP), the plan was discussed with the project proponent and the affected communities. Following these discussions the plan was adopted as the guide for public consultation and disclosure for the entire project. An overview of the consultation programme that has been undertaken is described in *Chapter 5.* The PCDP is provided in *Annex D*.

In summary, consultation has been held in both Angola and Namibia on the central, regional and local levels. Meetings at the *local level* specifically, have included:

- Scoping meetings to provide background information about the proposed project, and to solicit input from the stakeholders about the rationale and potential impacts of the project;

Consultation at Local Level

- A report back on the Scoping Phase with the community and their leaders, to specifically elaborate the key issues that were identified during the Scoping Phase, and to explain the way forward in terms of the activities of the study team during Phase 2 (ESIA phase) of the assessment;

Consultation at Local Level

- This was followed by a field trip to the Orokawe area to show the extent of the inundation area to the traditional leaders, some regional councillors and regional council staff. (The extent of the inundation area was demarcated with whitewash stones to visually demonstrate the extent of the inundation area);

Demarcation of the Inundation Area

- Following the ESIA phase, the local leadership were taken on a visit to the von Bach and Hardap Dams in Namibia, to ensure the local leadership were familiar with the nature of large dams, prior to the discussion of any proposed mitigation measures;

- Finally, the team hosted the Mitigation Discussion Meeting at Opuwo. Approximately 200 people attended this meeting including Himba chiefs from both Angola and Namibia. Each impact and its associated mitigation measures and costs were discussed separately and time allowed for discussions after the presentation of each impact. Once completed, the community requested an opportunity to meet on their own to formulate a response to the proposals. Following this meeting, a spokesperson then presented the decision of the community, which is reported in *Chapter 5,* namely that consent by the local community is being withheld at this time.

Following disclosure, on-going consultation and engagement will take place throughout the life of the project (construction and operation) as part of the monitoring that will be a requirement of the SEMP.

DEVELOPMENT OF MITIGATION MEASURES IN THE SOCIAL AND ENVIRONMENTAL MANAGEMENT PLAN

As mentioned, an SEMP, currently in draft form, has been prepared as a separate, stand-alone volume as part of the ESIA process for the Baynes HPP.

The draft SEMP includes numerous proposed mitigation measures, and an analysis of the institutional requirements for their implementation. The mitigation measures concern:

- Design issues (pre-construction);
- A Site Preparation Plan;
- Construction Management Plan;
- Employment and Workforce policies;
- Community Health, Social and Security Plan;
- A Reservoir Management Plan; and
- A Resettlement Planning Framework.

Design measures include siting and route selection of project components/ancillary infrastructure (access roads, borrow pits, construction camp and laydown areas, etc), and the operating and release regimes.

Site preparation will include the clearance of larger vegetation in the inundation zone and will also encompass measures to record or "rescue" local archaeological heritage.

The implementation of a Construction Management Plan (CMP) will be a contractual obligation on the contractor. This will include: workforce and local residents' health and safety; "good housekeeping" site management practices; flow regimes during construction (particularly during diversion); emergency response to significant accidents/pollution incidents; site access; siting of temporary structures/work locations/materials sourcing; the precise timing of certain activities, and site clean-up and restoration of those areas temporarily affected by construction activities. It should be noted that there is currently a lack of technical information regarding construction activities and this is addressed as a limitation of the ESIA, as described in *Section 3.14.2* of *Chapter 3*.

Employment and workforce policies will be a contractual obligation on the contractor. Issues to be covered include: health screening, and health provision for workers; workforce health awareness; employment policies, favouring employment of local people where possible; codes of conduct for interactions between workers and local communities; and environmental and wildlife awareness programmes for workers.

Community support measures will concern a suite of actions to provide support to local communities in the project area, to lessen the socio-economic

impacts and maximise the economic opportunities arising from the presence of the project and the workforce in the area.

A Reservoir Management Plan will include operating schedules and blending rules for each month of the year and the maintenance of environmental flow requirements.

A Resettlement Planning Framework has been prepared to provide the detail on how the resettlement and compensation process should be finalised and implemented.

CONCLUSIONS

In presenting the conclusions to the Baynes HPP ESIA, it is necessary to recognise that certain constraints have limited the veracity of the study. These essentially comprise the absence of macro-scale planning of associated infrastructure (access roads and transmission lines), the lack of technical information related to construction activities, and the different assessment methodologies applied by the biophysical, socio-economic and archaeological specialists. The last-mentioned constraint does not affect the outcomes of the ESIA and, having been dealt with by judicious structuring of the report, may be discounted as a constraint. However, the need for macro-scale infrastructure planning and the lack of construction technical detail provide an important context against which the conclusions presented here should be seen.

It may be said that, with full and proper implementation of the mitigation measures identified in the ESIA process, and to be comprehensively specified in the final SEMP, the biophysical and socio-economic impacts of the construction and operation of the Baynes HPP may be ameliorated to a large extent. However, several post-mitigation impacts will remain as either significant or not currently well enough understood, to fully comprehend the implications of a hydropower development on the Kunene River.

With regard to the most significant socio-economic impacts that remain post mitigation, it can be concluded that consent by the local community is still withheld, despite fair mitigation measures and associated costs being accepted by the two governments. External reasons and conditions contribute to the position taken by the local indigenous population. However, the door has not been closed as is evident through the decision of the local community to be open for further negotiations.

While the socio-economic impacts are recognized as significant, and notwithstanding the context of the project and its national importance, it is now imperative that the Governments commence with negotiations with the local indigenous population, with the objective of reaching binding contractual agreements which would lead to free, informed and prior consent for the construction of the project. The project proponent must do everything

in its power to obtain such agreements before involuntary resettlement is considered. Due process has been followed throughout the preparation of the ESIA, and recognising that final negotiations between the two governments and the local indigenous population are outstanding, such a step may be considered, provided that all approved mitigation measures related to the socio-economic impacts on the local indigenous population, as reflected in the draft SEMP, are retained and implemented.

With regard to biophysical impacts, the change in the ecological health of the Kunene River downstream of the proposed dam must be recognised as the most significant. This would see the Present Ecological State of this section of the river alter from a B category (slightly modified from the Reference Condition) to a D category (largely modified from the Reference Condition). Even under these circumstances, periods of low flow would result in no power being generated at such times.

This changed ecological state would be reflected in the loss of riparian vegetation as a consequence of reduced or absent annual flooding of the riparian zone downstream. Changes in composition and density of biotic species would undoubtedly result. It goes without saying that the inundation of land required for the dam will see the direct loss of terrestrial habitats, although modified riparian zones would become established over time.

In summary of the conclusion to the present ESIA for the Baynes HPP, it must be acknowledged that it is lacking in completion of the construction activity technical description, the macro-scale assessment of associated infrastructure, and the formulation of acceptable socio-economic mitigation measures for the displacement of the affected indigenous population. Whether the deterioration of the ecological health of the downstream section of the Kunene River is within tolerable limits remains a decision that the Angolan and Namibian environmental authorities will have to make, although it is recognised that a D-category river is widely considered to represent the lower limit of degradation allowable under sustainable development.

The outcome of the assessment must therefore be that additional work is required to supplement the existing body of information, such that properly informed decisions can be made.