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Mammal Habitat Assessment

of

MOKOLO AND CROCODILE WATER AUGMENTATION PROJECT (MCWAP): PHASE 1

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- am committed to biodiversity conservation but concomitantly recognize the need for economic development. Whereas I appreciate the opportunity to also learn through the processes of constructive criticism and debate, I reserve the right to form and hold my own opinions and therefore will not willingly submit to the interests of other parties or change my statements to appease them
- abide by the Code of Ethics of the S.A. Council for Natural Scientific Professions
- act as an independent specialist consultant in the field of zoology
- am subcontracted as specialist consultant by Galago Environmental CC for the proposed project "Mammal Assessment – MCWAP Phase 1 Pipeline" described in this report
- have no financial interest in the proposed development other than remuneration for work performed
- have or will not have any vested or conflicting interests in the proposed development
- undertake to disclose to the Galago Environmental CC and its client as well as the competent authority any material information that have or may have the potential to influence the decision of the competent authority required in terms of the Environmental Impact Assessment Regulations 2006



I.L. Rautenbach

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1. INTRODUCTION

Galago Environmental CC. was commissioned to undertake a mammal survey for the intended route of Phase 1 of the Mokolo and Crocodile Water Augmentation Project, Limpopo Province. This assignment is in accordance with the EIA Regulations (No. R. 385, Department of Environmental Affairs and Tourism, 21 April 2006) emanating from Chapter 5 of the National Environmental Management Act 1998 (Act No. 107 of 1998).

The Phase 1 pipeline is scheduled for pumping water from the Mokolo Dam in the Mokolo River to Lephalele (Ellisras), Medupi (and later Matimbi) Power Station, Grootgeluk Coal Mine at Lephalele, and from there to a future development site north-west of the Village of Steenbokpan.

The primary objective of the investigation was to gauge which mammals might still reside on or near the pipeline route, whereas special attention was paid to the qualitative and quantitative habitat requirements of Red Data species deemed present on the site. This report thus focuses on the current status of threatened species likely to occur on or near the preferred and alternative routes, a description of the available and sensitive habitats on or near the routes, and the environmental impacts that constructional and operational phases may have.

2. SCOPE AND OBJECTIVES OF THE STUDY

- To qualitatively and quantitatively assess the significance of the mammal habitat components and current general conservation status of the route and adjoining properties;
- Comments on ecological sensitive areas;
- Comments on connectivity with natural vegetation and habitats on adjacent sites;
- To provide a list of mammals which occur or might occur, and to identify species of conservation importance;
- To highlight potential impacts of the proposed development on the mammals of the study site, and
- To provide management recommendations to mitigate negative and enhance positive impacts should the proposed development be approved.

4. STUDY AREA

The proposed phase 1 pipeline route of approximately 80km will mostly be laid alongside an existing underground water pipeline serviced by an access road fenced into a servitude, with the exception of a short deviation at the Medupi construction site and the initial uphill section from the pumping station below the wall of the Mokolo Dam on the farm Wolvenfontein. From the storage dams at the summit of the hill on the farm Wolvenfontein, water will flow by gravitation to its destinations.

Originally the entire Thabazimbi / Lephalele (Ellisras) / Vaalwater district was devoted mainly to cattle grazing. As such the bio-environment remained relatively undisturbed. However, in recent times there has been a notable shift to game

5.1 Field Surveys

During the site visits mammals were identified by visual sightings through random transect walks. No trapping or mist netting was conducted, as the terms of reference did not require such intensive work. In addition, mammals were also identified by means of spoor, droppings, burrows or roosting sites. Locals were interviewed to confirm occurrences or absences of species.

Three criteria were used to gauge the probability of occurrence of mammals on the study site. These include known distribution range, habitat preference and the qualitative and quantitative presence of suitable habitat.

5.2 Desktop Surveys

As the majority of mammals are secretive, nocturnal, hibernators and/or seasonal, distributional ranges and the presence of suitable habitats were used to deduce the presence or absence of these species based on authoritative tomes, scientific literature, field guides, atlases and databases. This can be done irrespective of season.

The probability of occurrences of mammal species was based on their respective geographical distributional ranges and the suitability of on-site habitat. In other words, *high* probability would be applicable to a species with a distributional range overlying the study site as well as the presence of prime habitat occurring on the study site. Another consideration for inclusion in this category is the inclination of a species to be common, i.e. normally occurring at high population densities.

Medium probability pertains to a mammal species with its distributional range peripherally overlapping the study site, or required habitat on the site being sub-optimal. The size of the site as it relates to its likelihood to sustain a viable breeding population, as well as its geographical isolation is also taken into consideration. Species categorised as *medium* normally do not occur at high population numbers, but cannot be deemed as rare.

A *low* probability of occurrence will mean that the species' distributional range is peripheral to the study site and habitat is sub-optimal. Furthermore, some mammals categorised as *low* are generally deemed rare.

5.3 Specific Requirements

During the visit the site was surveyed and assessed for the potential occurrence of Red Data and/or ridge and wetland-associated species such as: Juliana's golden mole (*Neamblosomus juliana*), highveld golden mole (*Amblysomus septentrionalis*), rough-haired golden mole (*Chrysospalax villosus*), African marsh rat (*Dasymys incomtus*), Angoni vlei rat (*Otomys angoniensis*), vlei rat (*Otomys irroratus*), white-tailed rat (*Mystromys albicaudatus*), rock dormouse (*Graphiurus murinus*), forest shrew (*Myosorex varius*), other shrew species, short-eared trident bat (*Cloeotis percivali*), other cave-dwelling bats, African clawless otter (*Aonyx capensis*), spotted-necked otter (*Lutra maculicollis*) and marsh mongoose (*Atilax paludinosus*).

6. RESULTS

Global mammal distributions correlate well with biomes as defined by Acocks (1953), Low and Rebelo (1998), Knobel and Bredenkamp (2005) as well as Mucina and Rutherford (2006). However, the local occurrences of mammals are more closely dependent on broadly defined habitat types, in particular terrestrial, arboreal (tree-living), rupicolous (rock-dwelling) and wetland-associated vegetation cover. It is thus possible to deduce the presence or absence of mammal species by evaluating the habitat types within the context of global distribution ranges. Sight records and information from residents or knowledgeable locals audit such deductions.

Mammal Habitat Assessment

From a mammal habitat perspective, it should thus be reported that all four major habitats are present along the pipeline route, i.e. terrestrial, arboreal, moisture-dependent and rupicolous. The latter is restricted to the servitude route passing through the Waterberg outlier between the Mokolo Dam and Lephalele.

The ecological repair of all four major mammal habitat types immediately adjacent to the proposed development site vary from good to pristine. It should be emphasized that the ecological repair of the existing Exxaro pipeline reserve is presently ecologically disturbed as a result of the past installation of the existing pipe line, consisting mostly of the disturbed grassland as well as main roads or access roads.

Connectivity: It would appear that the final route will be fenced. In fact, this report suggests a game fence. This implies that smaller species will be able to migrate freely, but understandably expensive game species will not be able to wander off the properties of owners.

The 200 meters zone of adjacent properties along the pipeline route consists of pristine private conservation areas.

Aquatic and wetland habitat is present along the route, although at low incidences. This habitat is represented for a short distance by the Mokolo River, the Rietspruit and a few seepage lines in the Waterberg section.

The likelihood of caves in the near vicinity of the lines is deemed low. However, cave-dwelling bats are quite likely to find suitable daytime roosts nearby in other structures such as rock overhangs, culverts, aardvark burrows and old mine adits.



Figure 2: Southerly view of the servitude for the existing pipe line, which is also the proposed route for the new pipe line. An outlier of the Waterberg complex is visible in the distance, whereas the Waterberg Mountain Bushveld vegetation type is visible in the foreground.

Expected and Observed Mammal Species Richness

A broader perspective was taken in deriving the mammal richness of the pipeline route considering the fact that it traverses over a distance of ≥ 80 km. In many instances the study site borders on game farms, and given the mobility of mammals the entire richness of that property was taken into consideration. In other words, even if a particular species occurs on only one adjoining game farm, it is listed as part of the mammal richness potentially affected by the proposed development.

The mammal richness of the area is inordinately high. This can be ascribed to three reasons, namely (1) the extensive area through which the pipeline will traverse, (2) the ecological complexity of the area, and (3) the aggressive conservation measures applied on game-fenced farms with proper management.

As a result of widespread game farming the present-day mammal richness is once again approaching that of historical times. Presently (immediately adjacent to the proposed pipeline route) elephants, and as far as is known lion are still absent, and quite possibly hippopotamus and buffalo. On the other hand, high profit-yielding species such as roan, sable, oryx, eland and red hartebeest are flourishing. Inevitably blesbok has been introduced outside its distributional range, obviously to extend the variety of a hunting basket on offer to clients. As an add-on to active game conservation it is submitted that naturally-occurring populations of medium and smaller mammals are concomitantly responding positively, viz. leopard, warthog, bush pigs and aardvark.

Mammals typical of the study area and narrowly adapted to especially terrestrial, arboreal and to a lesser extent to wetlands and rupicolous habitats, are all included in the list (Table 1).

Of the 76 mammal species expected to occur on the study site (Table 1), no less than 27 were confirmed during the site visit (Table 2). It should be noted that potential occurrences is interpreted as to be possible over a period of time as result of expansion and contractions of population densities and ranges which stimulate migration, and in this instance re-introductions.

Table 1 lists the mammals which were observed or deduced to occur at least on some farms along the development site, or to be occasional visitors. All feral mammal species expected to occur on the study site (e.g. house mice, house rats, dogs and cats) were omitted from the assessment since these species normally associate with human settlements.

Most of the species of the resident diversity (Table 1) are common and widespread, although several Rare and/or Endangered species are recorded (see below).

Threatened and Red Listed Mammal Species

Ten “Data Deficient” mammals are listed. This ranking is no more than a precautionary measure to express conservation concern in the face of insufficient field data to express a quantitative opinion. All ten are small mammals who to date failed to attract attention from researchers.

Eight “Near Threatened”, four “Vulnerable”, two “Rare” and one “Endangered” species are listed (Table 1). Considering the fact that habitat destruction and undue human pressure are the main causes for species to become threatened, it can be argued that thanks to progressive conservation in the region all Red Listed mammals enjoy an above average chance of maintaining healthy breeding populations.

No other Red Data or sensitive species are deemed present along the study site since it falls outside the distributional ranges of some species, or does not offer suitable habitat(s) (viz. golden moles).

Table 1: The mammal species observed or deduced to occupy the site.
(Systematics and taxonomy as proposed by Bronner et.al [2003] and Skinner and Chimimba [2005])

	SCIENTIFIC NAME	ENGLISH NAME
DD*	<i>Elephantulus brachyrhynchus</i>	Short-snouted elephant shrew
DD*	<i>Elephnatulus intufi</i>	Bushveld elephant shrew
*	<i>Elephantulus myurus</i>	Eastern rock elephant shrew
√	<i>Orycteropus afer</i>	Aardvark
*	<i>Procavia capensis</i>	Rock dassie
?	<i>Heterohyrax brucei</i>	Yellow-spotted dassie
*	<i>Lepus capensis</i>	Cape hare
√*	<i>Lepus saxatilis</i>	Scrub hare
*	<i>Pronolagus randensis</i>	Jameson’s red rock rabbit
√	<i>Cryptomys hottentotus</i>	African mole rat
√	<i>Hystrix africaeaeaustralis</i>	Cape porcupine
*	<i>Thryonomys swinderianus</i>	Greater cane rat
*	<i>Pedetes capensis</i>	Springhare
√	<i>Paraxerus cepapi</i>	Tree squirrel
DD*	<i>Graphiurus platyops</i>	Rock dormouse
*	<i>Graphiurus murinus</i>	Woodland dormouse
*	<i>Acomys spinosissimus</i>	Spiny mouse
DD*	<i>Lemniscomys rosalia</i>	Single-striped grass mouse
√	<i>Rhabdomys pumilio</i>	Four-striped grass mouse

	SCIENTIFIC NAME	ENGLISH NAME
√	<i>Mus indutus</i>	Desert pygmy mouse
√	<i>Mastomys natalensis</i>	Natal multimammate mouse
√	<i>Mastomys coucha</i>	Southern multimammate mouse
√	<i>Thallomys paedulus</i>	Acacia rat
√	<i>Thallomys nigricauda</i>	Black-tailed tree rat
*	<i>Aethomys ineptus</i>	Tete veld rat
*	<i>Aethomys chrysophilus</i>	Red veld rat
√	<i>Aethomys namaquensis</i>	Namaqua rock mouse
*	<i>Otomys angoniensis</i>	Angoni vlei rat
*	<i>Desmodillus auricularis</i>	Cape short-tailed gerbil
DD√	<i>Gerbilliscus leucogaster</i>	Bushveld gerbil
*	<i>Gerbillurus paeba</i>	Hairy-footed gerbil
*	<i>Saccostomus campestris</i>	Pouched mouse
*	<i>Dendromus melanotis</i>	Grey pygmy climbing mouse
*	<i>Steatomys pratensis</i>	Fat mouse
*	<i>Galago moholi</i>	South African galago
√	<i>Papio hamadryas</i>	Chacma baboon
√	<i>Cercopithecus pygerythrus</i>	Vervet monkey
DD?	<i>Crociodura fuscomurina</i>	Tiny musk shrew
DD?	<i>Cricidura maquassiensis</i>	Maquassie musk shrew
DD*	<i>Crociodura cyanea</i>	Reddish-grey musk shrew
DD*	<i>Crociodura hirta</i>	Lesser red musk shrew
NT*	<i>Atelerix frontalis</i>	Southern African hedgehog
*	<i>Epomophorus wahlbergi</i>	Wahlberg's epauletted fruit bat
?	<i>Rousettus aegyptiacus</i>	Egyptian rousette
*	<i>Taphozous mauritanus</i>	Mauritian tomb bat
?	<i>Sauromys petrophilus</i>	Flat-headed free-tailed bat
*	<i>Tadarida aegyptiaca</i>	Egyptian free-tailed bat
NT?	<i>Miniopterus schreibersii</i>	Schreibers' long-fingered bat
NT?	<i>Pipistrellus rusticus</i>	Rusty pipistrelle
√	<i>Neoromicia capensis</i>	Cape serotine bat
?	<i>Neoromicia zuluensis</i>	Aloe serotine bat
?	<i>Pipistrellus hesperidus</i>	African (Kuhl's) pipistrelle
√	<i>Scotophilus dinganii</i>	African yellow house bat
?	<i>Nycteris thebaica</i>	Egyptian slit-faced bat
?	<i>Rhinolophus hildebrandtii</i>	Hildebrandt's horseshoe bat
NT*	<i>Rhinolophus darlingi</i>	Darling's horseshoe bat
?	<i>Rhinolophus simulator</i>	Bushveld horseshoe bat
Vu*	<i>Manis temminckii</i>	Ground pangolin
R*	<i>Proteles cristatus</i>	Aardwolf
NT*	<i>Parahyaena brunnea</i>	Brown hyaena
NT√	<i>Crocuta crocuta</i>	Spotted hyaena
Vu?	<i>Acinonyx jubatus</i>	Cheetah
R*	<i>Panthera pardus</i>	Leopard
*	<i>Caracal caracal</i>	Caracal
NT?	<i>Leptailurus serval</i>	Serval
√	<i>Felis silvestris</i>	African wild cat
*	<i>Civettictis civetta</i>	African civet
*	<i>Genetta genetta</i>	Small-spotted genet
*	<i>Genetta tigrina</i>	SA large-spotted genet
*	<i>Cynictis penicillata</i>	Yellow mongoose
√	<i>Galerella sanguinea</i>	Slender mongoose

	SCIENTIFIC NAME	ENGLISH NAME
*	<i>Atilax paludinosus</i>	Marsh mongoose
√	<i>Mungos mungo</i>	Banded mongoose
√	<i>Helogale parvula</i>	Dwarf mongoose
*	<i>Otocyon megalotis</i>	Bat-eared fox
√	<i>Canis mesomelas</i>	Black-backed jackal
*	<i>Aonyx capensis</i>	African clawless otter
NT*	<i>Mellivora capensis</i>	Honey badger
DD?	<i>Poecilogale albinucha</i>	African weasel
*	<i>Ictonyx striatus</i>	Striped polecat
?	<i>Ceratotherium simum</i>	White rhinoceros
√	<i>Equus quagga</i>	Plains zebra
*	<i>Potamochoerus larvatus</i>	Bushpig
√	<i>Phacochoerus africanus</i>	Common warthog
?	<i>Hippopotamus amphibious</i>	Hippopotamus
√	<i>Giraffa camelopardalis</i>	Giraffe
?	<i>Syncerus caffer</i>	African buffalo
√	<i>Tragelaphus strepsiceros</i>	Kudu
*	<i>Tragelaphus scriptus</i>	Bushbuck
√	<i>Tragelaphus oryx</i>	Eland
√	<i>Connochaetes taurinus</i>	Blue wildebeest
√	<i>Alcelaphus buselaphus</i>	Red hartebeest
√	<i>Damaliscus pygargus phillipsi</i>	Blesbok
E*	<i>Damaliscus lunatus</i>	Tsessebe
Vu*	<i>Hippotragus equinus</i>	Roan
Vu*	<i>Hippotragus niger</i>	Sable
√	<i>Oryx gazella</i>	Gemsbok
√	<i>Sylvicapra grimmia</i>	Common duiker
?	<i>Redunca arundinum</i>	Southern reedbuck
?	<i>Redunca fulvorufula</i>	Mountain reedbuck
√	<i>Kobus ellipsiprymnus</i>	Waterbuck
?	<i>Pelea capreolus</i>	Grey rhebuck
√	<i>Raphicerus campestris</i>	Steenbok
√	<i>Aepyceros melampus</i>	Impala
?	<i>Oreotragus oreotragus</i>	Klipspringer

√ Definitely present or have a *high* probability to occur;

* *Medium* probability to occur based on ecological and distributional parameters;

? *Low* probability to occur based on ecological and distributional parameters.

Red Data species rankings as defined in Friedmann and Daly's S.A. Red Data Book / IUCN (World Conservation Union) (2004) are indicated in the first column: CR= Critically Endangered, En = Endangered, Vu = Vulnerable, LR/cd = Lower risk conservation dependent, LR/nt = Lower Risk near threatened, DD = Data Deficient. All other species are deemed of Least Concern.

Table 2: Mammal species positively confirmed from the study site, observed indicators and habitat.

SCIENTIFIC NAME	ENGLISH NAME	OBSERVATION INDICATOR	HABITAT
<i>O. afer</i>	Aardvark	Burrows	Sandy substrate
<i>L. saxatilis</i>	Scrub hare	Faecal pellets	Wide tolerance
<i>C. hottentotus</i>	African mole rat	Burrow system	Wide tolerance
<i>H. africae australis</i>	Cape porcupine	Quills	Wide tolerance
<i>P. cepapi</i>	Tree squirrel	Sight record	Woodland
<i>G. leucogaster</i>	Bushveld gerbil	Sandveld	Burrow system
<i>P.o hamadryas</i>	Chacma baboon	Sight record	Wide tolerance

SCIENTIFIC NAME	ENGLISH NAME	OBSERVATION INDICATOR	HABITAT
<i>C. pygerythrus</i>	Vervet monkey	Sight record	Woodland
<i>C. crocuta</i>	Spotted hyena	Tracks	Wide tolerance
<i>G. sanguinea</i>	Slender mongoose	Sight record	Wide tolerance
<i>M. mungo</i>	Banded mongoose	Sight record	Savannah
<i>H. parvula</i>	Dwarf mongoose	Sight record	Savannah
<i>C. mesomelas</i>	Black-backed jackal	Tracks	Wide tolerance
<i>E. quagga</i>	Plains zebra	Sight record	Grassy plains
<i>P. africanus</i>	Common warthog	Sight record	Wide tolerance
<i>G. camelopardalis</i>	Giraffe	Sight record	Savannah
<i>T. strepsiceros</i>	Kudu	Sight record	Wide tolerance
<i>T. oryx</i>	Eland	Sight record	Wide tolerance
<i>C. taurinus</i>	Blue wildebeest	Sight record	Savannah
<i>A. buselaphus</i>	Red hartebeest	Sight record	Savannah
<i>D. p. phillipsi</i>	Blesbok	Sight record	Grassveld
<i>O. gazella</i>	Gemsbok	Sight record	Open plains
<i>S. grimmia</i>	Common duiker	Sight record	Wide tolerance
<i>K. ellipsiprymnus</i>	Waterbuck	Sight record	Riparian woodland
<i>R. campestris</i>	Steenbok	Sight record	Wide tolerance
<i>A. melampus</i>	Impala	Sight record	Savannah

The inordinate number of confirmations is indicative of the intensity and success of conservation endeavours applied in the area. The presence of the spotted hyena is nevertheless a surprise. It is almost inevitable that blesbok was introduced outside its distributional range for commercial interests.

7. FINDINGS AND POTENTIAL IMPLICATIONS

With two exceptions the proposed pipeline will traverse along an existing pipeline and is not anticipated to directly result in a significant loss of ecological sensitive and important habitat units, ecosystem function (e.g. reduction in water quality, soil pollution), loss of faunal habitat, nor of loss/displacement of threatened or protected fauna. It is most likely that adjacent to the existing route an additional narrow strip of natural bushveld will be used for the new pipeline and converted into grassland eventually supporting pioneer vegetation; -but this is preferable to an independent route through pristine veld.

There should be no doubt that the Alternative C route through the Medupi construction site is preferable, since it will thus run through an already disturbed industrialized area. From a mammal perspective the environment at the Rietspruit and R510 is not exceptionally sensitive. The area consists of the Rietspruit, a drainage line and terrestrial, arboreal and rupicolous habitats. Given inordinate attention to ecological restoration after laying the pipeline, the area will continue to support a full plethora of mammals. Most of the Alternative B Environmental Corridor on the farm Wolvenfontein that start at the origin of the pipeline runs along the mountain summit on the Sable Hills Eco Park property. This will be preferable to the large quantities of rocks and debris which will roll down the slopes during excavation of the route with devastating ecological consequences should the route along the road to the Mokolo dam wall, the Alternative A – Mokolo dam route or the existing pipeline be followed. In fact, a strong case can be made in this instance to lay the pipeline on the surface to minimize ecological damage and disturbance to rare

mammal species, since this area falls within the core area of the Waterberg Biosphere. Blasting should be minimised (noise) but any pipe above ground must provide embankments at intervals or areas where the game can move underneath so as not to become a barrier.

The banks of the Mokolo River close to the pump station, the Rietspruit as well as seepage lines in the Waterberg are deemed sensitive and should be expeditiously repaired after the pipeline has been laid.

A large ecological concern is the potential deleterious effect that the volume of water to be extracted may have on the welfare of the Mokolo River system downstream of the Dam. The river system provides a unique habitat to a plethora of narrowly specialized species, and furthermore acts as a dispersal corridor. The reserve determination (in terms of the National Water Act, No. 36 of 1998) for the Mokolo River has however taken this into consideration and has determined that monitoring of the River will be an important measure to determine the impacts on the health of the river. Monitoring in the future must therefore take the following terrestrial features into account:

- Riverine and riverbank deterioration
- Water quality deterioration
- Decreasing biodiversity within the River that could cause a decrease in food that would have a negative impact on mammal species.

8. LIMITATIONS, ASSUMPTIONS AND GAPS IN KNOWLEDGE

This specialist is adequately qualified and experienced to derive reasonably accurate species assessments of a location such as the Phase 1 of the Crocodile / Mokolo Dam pipeline site. The specialist has access to ample databases and information resources, and has earlier conducted numerous intensive field surveys allowing the extrapolation of habitat diversity and quality into species richness. In this instance an intensive vertebrate survey would be enjoyable and lucrative, but is deemed an expensive and fruitless expense with little chance of radically altering our primary data and conclusions.

Even though every care is taken to ensure the accuracy of this report, environmental assessment studies are limited in scope, time and budget. Discussions and proposed mitigations are to some extent made on reasonable and informed assumptions built on *bone fide* information sources, as well as deductive reasoning. Deriving a 100% factual report based on field collecting and observations can only be done over several years and seasons to account for fluctuating environmental conditions and migrations. Since environmental impact studies deal with dynamic natural systems additional information may come to light at a later stage. Galago Environmental can thus not accept responsibility for conclusions and mitigation measures made in good faith based on own databases or on the information provided at the time of the directive. This report should therefore be viewed and acted upon with these limitations in mind.

9. RECOMMENDED MITIGATION MEASURES

The following recommended mitigation measures proposed by the specialist were developed in conjunction with the Gauteng Department of Agriculture and Rural Development (GDARD) but are also applicable to the Limpopo province:

- The topsoil must be kept separate during excavation, and correctly replaced when filling the ditch.
- Reasonable care must be taken to limit erosion, inter alia by sowing indigenous grass species and woody plants.
- Should the Alternative B on the farm Wolvenfontein be favored, it is suggested that the pipeline is laid in a meandering fashion to partially camouflage the aesthetic impact of its full extent. In fact, it should be pointed out that laying the line on the surface will minimize the ecological, noise and aesthetic impact thereof.
- If the pipeline is laid above ground in Alternative B, then care must be taken to provide embankments at intervals along the line where the game can cross over the pipeline or to raise the pipe enough so that game can move underneath in order to prevent the pipeline from becoming a barrier.
- Rehabilitation of natural vegetation should proceed in accordance with a rehabilitation plan compiled by a specialist registered in terms of the Natural Scientific Professions Act (No. 27 of 2003) in the field of Ecological Science.*
- Any post-development re-vegetation or landscaping exercise should use species indigenous to South Africa. Plant species locally indigenous to the area are preferred. As far as possible, indigenous plants naturally growing along the route, but would otherwise be destroyed during construction, should be used for re-vegetation / landscaping purposes.
- Where possible work should be restricted to one area at a time. This will give the smaller birds, mammals and reptiles a chance to weather the disturbance in an undisturbed zone close to their natural territories.
- The contractor must ensure that no fauna species are disturbed, trapped, hunted or killed during the construction phase. Conservation-orientated clauses should be built into contracts for construction personnel, complete with penalty clauses for non-compliance.
- The appropriate agency should implement an ongoing monitoring and eradication program for all invasive and weedy plant species growing within the servitude.
- Where the pipeline is to traverse a wetland (viz. crossing the Rietspruit and seepages in the Waterberg), measures are required to ensure that the pipeline has minimal effect on the flow of water through the wetland, e.g. by using a high level clear span bridge or box culverts rather than pipes.
- Prior to construction, fences (*game fences*) should be erected in such a manner to prevent access and damage to any sensitive areas identified.

10. CONCLUSIONS

From a mammalian view there is no compelling reason why the proposed pipeline routes should not be developed. Through most of its length it travels along an existing pipeline and service road and for a distance also along existing roads (being farm, tertiary or secondary roads). The Alternative C route south of the new road is preferred on the Medupi construction site, and the Alternative B route on the farm Wolvenfontein at the origin of the pipeline. The area at the Rietspruit and R510

should recover adequately given attention to ecological restoration of especially the wetland component.

The volume of water to be extracted raises a concern for the ecological welfare of the Mokolo River downstream and the reserve determination (in terms of the National Water Act, No. 36 of 1998) for the river must ensure that the potential impact on the River is monitored and steps taken in advance if biodiversity is threatened by the proposed development.

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